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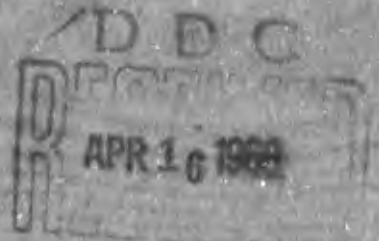
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L. G. HANSCOM FIELD, BEDFORD, MASSACHUSETTS

RESEARCH MONOGRAPH

**Acta Meteorologica Sinica
Translated Titles and Abstracts
From Volume 27 (1956)
Through Volume 35 (1965)**

N.H. NG



OFFICE OF AEROSPACE RESEARCH
United States Air Force



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ACTA METEOROLOGICA SINICA TRANSLATED TITLES
AND ABSTRACTS FROM VOLUME 27 (1956) THROUGH
VOLUME 35 (1965)

N. H. Ng

Emmanuel College
Boston, Massachusetts

December 1967

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ACTA METEOROLOGICA SINICA
TRANSLATED TITLES AND ABSTRACTS
FROM VOLUME 27 (1956) THROUGH VOLUME 35 (1965)

N. H. Ng

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ABSTRACT

This monograph contains some 360 translated abstracts of articles and titles of research notes appearing in Chinese in the journal Acta Meteorologica Sinica, Volumes 27 - 35, published by the Meteorological Society of China (mainland) during 1956 - 1965. The journal covers current research in all fields of meteorology. The translated abstracts and titles are grouped chronologically under appropriate subjects divided into 22 chapters: (1) atmospheric dynamics and thermodynamics; (2) boundary layer meteorology, turbulence, local winds; (3) climatology (particular places), climatic fluctuations; (4) cloud physics and dynamics; (5) convection, heat transfer, vertical motion; (6) drought and flood, rainfall distributions; (7) general circulation; (8) long-range forecasting; (9) meso and micrometeorology, agricultural meteorology, soil characteristics; (10) meteorological measurements and observations; (11) numerical forecasting (models and bases for); (12) orography and topographic effects; (13) radiation (solar, terrestrial; absorption, emission), solar-terrestrial effects; (14) radio and radar meteorology; (15) stratospheric and upper atmospheric circulation features; (16) synoptic analysis and forecasting, local forecasting; (17) synoptic climatology; (18) thunderstorms, hail, atmospheric electricity; (19) typhoons, tropical and subtropical meteorology, monsoons; (20) water vapor, evaporation, hydrologic cycle; (21) weather modification, cloud seeding; (22) miscellaneous. The monograph concludes with two author indexes, one in English appearing alphabetically and the other in Chinese arranged according to the number of strokes.

PREFACE

This monograph is a compilation of some 360 translated abstracts of articles and titles of research notes appearing in Chinese in the journal Acta Meteorologica Sinica, Volumes 27 - 35, published by the Meteorological Society of China (mainland) during 1956 - 1965. The journal contains current research in all fields of meteorology. It appears quarterly except for Volume 31, the first and second issue of which were published in 1960, the third in 1961 and the fourth in January 1962. The translations originated from the Oriental Science Library, Research Language Center, Emmanuel College, Boston, Massachusetts under the sponsorship of the Air Force Cambridge Research Laboratories.

The translated abstracts and titles are grouped chronologically under appropriate subjects divided into 22 chapters. The subjects are grouped somewhat arbitrarily to permit a reasonable number of entries in each of a limited number of chapters. Thus, while efforts were made to devise an effective content separation between chapters, no claims can be made as to the uniqueness of the classification or to the lack of overlapping. In addition, to avoid unnecessary repetition of entries, subjective decisions were necessary in many cases as to the most appropriate subject classification to use. The reader should thus be advised to check the abstracts in related chapters. Where no clear separation of subject was possible in a given abstract, it was arbitrarily placed in one of the pertinent chapters with a reference being added at the end of the other chapter.

The heading of each abstract contains the name(s) of the Chinese author(s) either taken from the English entry in the original journal or in the absence of such an entry given in the Pin Yin system used in mainland China. In both cases, the corresponding Wade-Giles equivalents follow in parentheses. The words, Volume, Number, and page or pages are omitted in each entry. Thus, an entry such as 27(1): 69-72, March 1956 indicates that the article appeared in Volume 27, No. 1, pages 69 to 72, March 1956. The number of figures, tables, references,

etc., contained in each article are shown in the heading. Here also is included the numerical designation of a full translation of the article if such a translation has been or is being made by the Library.

Two author indexes, one in English appearing alphabetically and the other in Chinese arranged according to the number of strokes, complete the monograph.

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CHAPTER 1

ATMOSPHERIC DYNAMICS AND THERMODYNAMICS

- 1.1 Koo Chen-chao (Ku Chen-ch'ao)
ON THE GRAPHICAL INTEGRATION OF THE
ATMOSPHERIC VORTICITY EQUATION
27(1): 69-72, March 1956
6 refs., eqs.

- 1.2 Chao Jih-ping (Ch'ao Chi-p'ing)
A PRELIMINARY INVESTIGATION ON THE EVALUATION
OF HEAT AND COLD SOURCES FROM THE STEADY
FLOW PATTERN OVER EAST ASIA
27(3): 167-179, September 1956
9 figs., 18 refs., eqs.

This paper presents an evaluation of the distribution and intensity of heat and cold sources from the steady flow pattern at 500 mb over East Asia in winter by means of a two-level model. The findings indicate that non-adiabatic heating and cooling exert a pronounced influence on the maintenance of the steady flow pattern.

It is also pointed out that in order to conduct further quantitative analyses a large amount of reliable data is urgently needed for the preparation of new mean contour and streamline charts.

- 1.3 Hsieh Yi-ping (Hsieh I-ping) and
Chen Chu-shih (Ch'en Ch'iu-shih)
THE EQUATIONS OF MOTION OF VORTICES IN A
BAROCLINIC ATMOSPHERE AND THEIR APPLICATION
TO WEATHER FORECASTING
27(4): 283-305, December 1956
7 figs., 10 tables, appendix, 23 refs., eqs.

In this paper, the equations of motion of vortices in a baroclinic atmosphere are derived in the light of classical hydrodynamics. The six basic factors governing the motion of vortices are examined. The physical interpretation of the well-known steering principle is presented together with some suggestions for modification and improvement. Preliminary examples are given to illustrate the application of these equations to the prediction of the movement of typhoons. The

possibility of extending this technique to forecast the movement of middle-latitude systems and the associated limitations are also investigated. Some possible misinterpretations on the effects of internal forces on these systems are summarized in the appendix. The amplitude and oscillatory period of the meandering movement of typhoons under the influence of a linear steering current are also examined.

- 1.4 Chu Pao-chen (Chu Pao-chen)
STEADY-STATE PERTURBATIONS IN THE WESTERLIES
IN RELATION TO LARGE-SCALE HEAT SOURCES,
HEAT SINKS AND TOPOGRAPHY (I) AND (II)
28(2): 122-140, May 1957
28(3): 198-224, August 1957
33 figs., appendix, 80 refs., eqs.

In the first part of this paper, the author attempts to evaluate the mean distribution of heat sources and sinks in the lower troposphere of the northern hemisphere for January and July by means of thermodynamic equations using surface wind data as well as upper-air temperature and pressure observations. The characteristics of the geographical distribution of these features are also discussed.

The effects of radiation, condensation and eddy conduction of sensible heat on the distribution of heat sources and sinks are described. The distribution pattern and the mean zonal heating derived in the present study are compared in detail with results obtained by other workers.

The second part of the paper deals with the steady-state perturbations caused by heat sources and topography and also their combined effects by means of a simple two-layer baroclinic model. It is found that mean troughs and ridges over East Asia are closely related to the presence of the Tibetan Plateau. Similarly, the formation of the North American trough and ridge may be explained in terms of the topographical effects of the Rocky Mountains and Greenland. In summer, when the westerly wind belt retreats to the north, variations in the intensity and position of mean troughs are largely determined by topography while the formation of these features is primarily governed by the perturbations

generated by heat sources. However, these perturbations are more directly associated with the development of the westerly jet stream in winter and minor troughs in summer. The computed flow field produced by the combined effects of heat sources and topography is found to closely resemble the observed pattern. Thus it is considered that the effects of heating and topography must be mutually related and that they are integrated through dynamic processes in the atmospheric circulation.

- 1.5 Yang Chien-chu (Yang Chien-ch'u) and
Lo Szu-wei (Lo Ssu-wei)
A STUDY OF PROBLEMS CONCERNING THE
CIRCULATION SYSTEMS AND HEATING EFFECTS
OF THE TIBETAN PLATEAU BASED ON SURFACE
OBSERVATIONS
28(4): 264-274, November 1957
5 figs., 3 tables, 11 refs.

In this paper, the activities of circulation systems over the Tibetan Plateau and its heating effects are discussed. The study is based on records of recent years from surface stations on the plateau as well as on upper-air soundings to the east of the highland. The main results may be summarized as follows:

(a) The Tibetan Plateau is influenced by upper-air circulation systems in the westerlies throughout the year with the exception of July and August. An investigation of the pressure variation at the various stations (2500 - 4500 m above sea level) on the plateau reveals that these systems are most active during spring and autumn.

(b) Variations in temperature and pressure are generally out of phase at the surface of the plateau. This is contrary to the conditions observed in the corresponding upper levels of the free atmosphere.

(c) The heating effect is not uniform over the plateau. The entire land mass is a more effective heat source in April (spring) than in July (summer). However, the southeastern part of the plateau may act as a heat source throughout all seasons of the year.

- 1.6 Chao Jih-ping (Ch'ao Chi-p'ing)
ON THE DYNAMICS OF OROGRAPHICALLY
PRODUCED FINITE PERTURBATIONS IN THE
BAROCLINIC WESTERLY WIND BELT
28(4): 303-314, November 1957
4 figs., 12 refs., eqs.

The present study shows that orographically produced perturbations in a frictionless, adiabatic and baroclinic atmosphere can be described by a three-dimensional Helmholtz equation. The solution to this equation is obtained by including the effect of topography in the boundary conditions.

A practical example is given by computing the perturbations caused by the Tibetan Plateau (including the mountain ranges in Asia) and the Rocky Mountains. The results indicate that the mean positions of troughs and ridges in the westerlies are related to topography. However, some discrepancy is noted between the computed and observed values with respect to the intensity of these systems. The damping effect produced by large-scale topographical features increases rapidly with altitude and it appears therefore that these features are of paramount importance in the study of westerly perturbations in the lower troposphere.

- 1.7 Hsu E. H. (Hsu^{''} Erh-hao)
DYNAMIC METEOROLOGY IN CHINA FROM 1949 TO 1959
30(3): 243-250, August 1959
5 figs., 28 refs., eqs.

- 1.8 Yeh Tu-cheng (Yeh Tu-cheng),
Chen Lung-shun (Ch'en Lung-hsün) and
Sun Shwu-ching (Sun Shu-ch'ing)
VARIATIONS OF THE TRANSFER OF PHYSICAL QUANTITIES
AND CONVERSION OF ENERGIES DURING THE BREAKDOWN
AND FORMATION OF ZONAL CIRCULATION (I) AND (II)
31(3): 246-267, November 1961
31(4): 289-303, January 1962
22 figs., 10 tables, 25 refs., eqs.

This paper presents a preliminary study of the variations of the transfer of atmospheric physical quantities and the conversion of energies during the period of intense variation of the general circulation. The fast breakdown of zonal circulation during 15 - 29 February 1956 and the rapid

formation of the same type of circulation during 2 - 14 January 1957 and 3 - 10 March 1956 are chosen as examples for computation and the physical mechanisms for these variations are examined. The results show the following:

(a) The northward transfer of angular momentum and sensible heat increases rapidly during the breakdown of zonal circulation. During the formation of zonal circulation (i. e., the damping of large-scale disturbances), the northward transfer of angular momentum decreases rapidly and sometimes even becomes a southward transfer. The northward transfer of sensible heat also decreases but not as pronounced as that of angular momentum. In many detailed aspects, however, the variations in the transfer do not follow the above trend. The physical mechanisms for the deviation from this trend are discussed.

(b) There is a marked increase in the amount of disturbed potential energy (P') and kinetic energy (K') during the breakdown of zonal circulation and a marked decrease during the formation of zonal circulation. The change in the basic kinetic energy \bar{K} with circulation is not quite noticeable.

(c) The basic potential energy \bar{P} is converted to P' , P' to K' and K' to \bar{K} during the breakdown of zonal circulation and \bar{P} to P' , K' to P' and \bar{K} to K' during the formation of zonal circulation. The rates of conversion from K' to \bar{K} and P' to K' during the former process are larger than those from \bar{K} to K' and K' to P' during the latter process. Thus, in the mean K' is converted to \bar{K} and P' to K' .

From the above results, it may be seen that the transfer of physical quantities and the conversion of energies depend largely on the change in circulation. There are two opposite trends in the processes. One is associated with the development of large-scale disturbances while the other, with the damping of large-scale disturbances. The climatic mean of the physical processes is composed of these two opposite trends.

- 1.9 Chao Jih-ping (Ch'ao Chi-p'ing)
SOME BASIC PROBLEMS ON THE DYNAMICS OF
SMALL-SCALE PROCESSES IN THE ATMOSPHERE
32(2): 104-118, June 1962
Table, 12 refs., 95 eqs.

This paper deals with some of the basic problems on the dynamics of small-scale processes in a stratified atmosphere.

The properties of the solution to the linearized equations of motion for small-scale processes are analyzed by the frequency method. The results show that the linearized equations contain two distinct types of waves, viz., sound waves, which are characterized by their high velocity of propagation, and gravitational waves, which are described by relatively low propagation velocity in comparison with the former.

In general, sound waves may be treated as a kind of "noise" in the spectrum of motions of meteorological significance; therefore, it is necessary to filter them from the equations of motion. Since static departure (non-static equilibrium) plays an important role in the development of small-scale processes, the conventional use of static approximation as a technique to filter the internal sound waves is thought to be unsuitable for the present study. In this paper, three different methods are introduced for the filtering of sound waves, viz., (a) assumption of incompressibility; (b) adoption of the solution in power series of the parameter $\epsilon' (= V^2/gL)$ and (c) application of the balance equation. Errors introduced by each of these methods are also analyzed.

The dispersion of sound waves excited through the interruption of static equilibrium by perturbations in a finite region of the atmosphere at a certain time is treated as an initial value problem. It is noted that the field undergoes an extremely rapid adaptive change from the moment of disruption of static equilibrium to the establishment of some other equilibrium state.

Finally, the above methods are used to establish a system of two-dimensional nonlinear equations of motion with sound waves filtered for the study of small-scale processes.

- 1.10 Chao Jih-ping (Ch'ao Chi-p'ing)
ON THE NONLINEAR INFLUENCE OF STRATIFICATION
AND THE WIND FIELD ON THE DEVELOPMENT OF
SMALL-SCALE DISTURBANCES
32(2): 164-176, June 1962
4 figs., 12 refs., 71 eqs.

The nonlinear interaction between the perturbed field and the mean field (environment) during the development of small-scale disturbances is discussed. The influence of atmospheric stratification and the prevailing wind on the growth of disturbances is analyzed. The results indicate that a neutral or unstable environment is favorable for the growth of disturbances but if certain critical conditions are fulfilled, disturbances may also grow to maturity in a stable environment. In general, the prevailing wind tends to suppress the development of disturbances; however, certain types of speed profile of the prevailing wind may promote the growth of disturbances.

- 1.11 Liao Tung-hsien (Liao Tung-hsien) and
Chow Tse-tung (Chou Tzu-tung)
ON THE METHOD FOR SOLVING THE BALANCE EQUATION
IN FINITE DIFFERENCE FORM
32(3): 224-231, September 1962
12 refs., 60 eqs.

The representation of the relationship between the wind field and the pressure field by the geostrophic approximation is generally unsuitable for application at low latitudes and would therefore give unsatisfactory forecast results over this region. However, the difficulties may be overcome by the use of the balance equation as a substitute. This paper presents a brief description of several finite difference methods for solving the balance equation which have been published during 1955 - 1958. Two new methods are also introduced. It can be shown that Bolin's method is only a special case of one of these two methods.

- 1.12 Wang Chung-hao (Wang Tsung-hao)
ON THE ITERATIVE METHOD FOR SOLVING THE
DIRICHLET BOUNDARY-VALUE PROBLEM OF THE
ELLIPTIC TYPE IN METEOROLOGICAL STUDIES
32(3): 240-254, September 1962
Fig., 2 tables, 20 refs., eqs.

With a view to meeting actual meteorological requirements, this paper makes use of the simple form of Green's function for the solution of the elliptic self-conjugate boundary-value problem to formulate an iterative method suitable for solving the Dirichlet boundary-value problem of the elliptic type in studies of dynamic meteorology. This method is suitable for general application. The approximate methods which have been widely used in meteorology, such as Belousov's, Mashkovitch's, Fjørtoft's methods and Liebmann's extrapolation techniques, may be considered as special cases of the present method. The general functional form of the present formulation may be used as the basic reference to assess the accuracy and the rate of convergence of the foregoing approximate methods. This scrutinization may lead to a clearer understanding of the clues of possible improvements on these methods. Formula II₁, Equation (2.7), was tested in the numerical solution of the balance equation and the results indicate that the present method which has a sound theoretical setting is a promising one for practical application.

- 1.13 Chin Tseng-hao (Ch'in Tseng-hao)
SOME COMMENTS ON "THE APPLICATION OF
LIAPOUNOFF'S THEORY OF KINEMATIC STABILITY
IN METEOROLOGY"*
32(3): 264-265, September 1962
3 refs., eqs.
- 1.14 Chao Jih-ping (Ch'ao Chi-p'ing)
REPLY TO THE COMMENTS BY CHIN TSENG-HAO ON
"THE APPLICATION OF LIAPOUNOFF'S THEORY OF
KINEMATIC STABILITY IN METEOROLOGY"**
32(3): 266, September 1962
3 refs.

* Chao Jih-ping. Collected papers on dynamic meteorology (Part I), The Science Press, Peking, China, 1961. pp. 32-37. For a translated abstract of this paper, see Emm-65-50(a).

** See 1.13.

- 1.15 Yeh Tu-cheng (Yeh Tu-cheng) and
Chen Yung-san (Ch'en Hsiung-shan)
THE VERTICAL STRUCTURE OF LONG WAVES AND
ITS RELATION TO THE SPEED OF MOTION AND
DEVELOPMENT
33(1): 25-36, February 1963
4 figs., 7 refs., 12 eqs.

This paper discusses the motion and development of long waves in the upper and lower part of the troposphere, using a linear two-layer model. The main results are:

(a) The general synoptic rule (disturbance develops when the pressure wave precedes the temperature wave) is valid only in the upper troposphere for ultra-long waves (with wavelengths $\geq 10^4$ km) and from the middle troposphere upward for long waves (with wavelengths $\approx 7 \times 10^3$ km). It is also valid throughout the troposphere for long waves of comparatively shorter wavelength.

(b) In the basic current with shear $\bar{u}_1 - \bar{u}_3 < \frac{\beta L^2}{4\pi^2}$, the upper part of the disturbance develops while the lower part damps when the axis of the trough or ridge line inclines westward with height, and the upper part damps while the lower part develops when the axis inclines eastward with height. When $\bar{u}_1 - \bar{u}_3 > \frac{\beta L^2}{4\pi^2}$, both the upper and lower parts develop and damp simultaneously.

(c) The temperature and pressure waves may move at different rates and their direction of motion may even reverse. In the upper as well as in the lower layer, disturbance develops (damps) when the ridge moves into the region of divergence (convergence) or the trough moves into the region of convergence (divergence).

(d) The amplitude and the speed of motion of the disturbance vary with time. They depend not only on the structure of the basic current and wavelength but also on the vertical structure of the disturbance.

(e) Periodically varied stable disturbances may increase or decrease in amplitude by more than 250% daily during the development stage. Thus, the large circulation variations usually observed in the westerly belt may not be the phenomenon of instability.

1. 16 Zeng Qing-zun (Tseng Ch'ing-ts'un)
THE INFLUENCE OF PERTURBATIONS ON THE
ADAPTIVE PROCESSES OF THE ATMOSPHERE
AND PROBLEMS ON THE APPLICATION OF
WIND OBSERVATIONS
33(1): 37-50, February 1963
3 tables, 9 refs., eqs.

In this paper, formulas for the final state of the adaptive processes in a baroclinic atmosphere are derived. Under certain limiting conditions, these expressions tend to lead to a barotropic state. The final state is shown to be significantly dependent on the horizontal scale and vertical structure of the initial disturbance. From an analysis, it is found that in a barotropic atmosphere, the vorticity field may be maintained and the pressure field will undergo adaptation with respect to the vorticity field when the horizontal scale of the initial perturbation, L , is less than a certain critical value L_0 . Similar conditions may be observed in a baroclinic atmosphere in which the intensity of the initial perturbation is uniformly distributed with respect to pressure or else the distribution follows approximately the logarithmic law (corresponding to a uniform temperature field along the vertical). When $L \gg L_0$, converse results will be obtained. In general, conditions in a baroclinic atmosphere are extremely complicated. When the initial perturbation exhibits a well-marked vertical discontinuity in the lower troposphere, the situation becomes favorable for the maintenance of the pressure field. Under such circumstances, the wind field will have to adapt itself to the pressure field.

The findings and conclusions of the above analysis are applied to a study of certain dynamical processes in the atmosphere. It is noted that under normal conditions, it is more reasonable to use the actual wind field than the contour field as initial data for forecasting the stream function by means of the quasi-geostrophic model.

- 1.17 Chen Chu-shih (Ch'en Ch'iu-shih)
FORMATION AND DESTRUCTION OF THERMAL WIND
IN A SIMPLE BAROCLINIC ATMOSPHERE
33(1): 51-63, February 1963
33(2): 153-162, May 1963
18 figs., 2 tables, 19 refs., eqs.
Full translation: Emm-65-22

This paper discusses the principle of vertical motion variations in the adaptation process of a thermal wind, using a simple two-layer baroclinic model. When the thermal wind vorticity in the wind field is larger than that in the temperature field, the ascending motion accelerates; otherwise, the descending motion accelerates.

For the baroclinic system in the upper troposphere between 250 and 750 mb, the temperature field is adapted toward the wind field when the scale of the system is smaller than the critical scale L_0 , and vice versa when the scale is larger than L_0 . This is demonstrated by examples computed according to two horizontal scales, 1000 and 300 km, respectively. In the former scale, the adaptation is mainly toward the temperature field, and in the latter, toward the wind field.

According to the contrast between the rates of formation and destruction of a thermal wind, the physical process of the formation of geostrophic and ageostrophic motions is described.

Finally, the proposed method is applied to examine the baroclinic instability of long waves and then to clarify the vorticity mechanism of the baroclinic instability.

- 1.18 Yeh Tu-cheng (Yeh Tu-cheng) and
Chen Yung-san (Ch'en Hsiung-shan)
THE NONLINEAR EFFECT IN THE FORMATION
OF A BLOCKING HIGH
33(2): 145-152, May 1963
4 figs., table, 5 refs., eqs.

The manner in which an unstable growing disturbance stops developing is investigated. The main mechanism for checking the development is the feedback effect of the unstable disturbances on the basic current.

It is shown that the time elapsed for an unstable disturbance to grow to its maximum intensity is roughly proportional to its initial amplitude. For an amplitude of 100 meters, the time is approximately 8 days; for 200 meters, approximately 5 days. Further, in the vorticity and thermodynamic equations, the nonlinear terms which are generally neglected are retained. This facilitates study of the mutual interaction of the disturbances. It is shown theoretically that this mutual interaction is important in the formation of Ω -shaped blocking highs.

- 1.19 Zeng Qing-zun (Tseng Ch'ing-ts'un)
ADAPTIVE PROCESSES AND DEVELOPMENT IN
THE ATMOSPHERE.
(I) PHYSICAL ANALYSIS AND THE LINEAR THEORY.
(II) NONLINEAR CASES
33(2): 163-174, May 1963
33(3): 281-289, August 1963
2 figs., 21 refs., eqs.

Adaptive processes and development are two fundamental courses of atmospheric motion. Under normal conditions, atmospheric motion is basically in a state of geostrophic balance. However, there also exists, at the same time, an evolutionary process of some form - the development process, which continually disturbs the geostrophic balance in order to maintain itself. (The atmosphere will be in a steady state if complete geostrophic balance is achieved.) Thus, adaptive processes are always present in the atmosphere, which is constantly subjected to an internal mechanism for destroying the geostrophic balance. In the past, adaptive processes have been studied by means of the linear theory, which adequately describes these processes but fails to account for the processes of development. (The resultant field has a tendency toward the steady state.) The development processes, however, depend on the nonlinear characteristics of the field, which are usually examined by means of a simplified model that does not allow for the processes of adaptation. It appears therefore that in order to pursue a detailed study of the internal mechanism of the atmosphere, a complete system of nonlinear dynamical and thermodynamical equations will be required. It is also necessary that these equations should reveal the quasi-geostrophic properties of the

atmospheric motion. Thus, the general solution should contain some terms to represent the geostrophic motion, which can be separated from the main functional form. This would enable an examination of the mutual interaction between the large-scale quasi-horizontal non-divergent (quasi-geostrophic) motion and the ageostrophic motion to be made. The applicability of the various simplified models may then be assessed.

The present article is an attempt to solve the above problems by means of a complete system of nonlinear equations.

- 1.20 Zeng Qing-zun (Tseng Ch'ing-ts'un)
CHARACTERISTIC PARAMETERS AND
DYNAMICAL EQUATIONS OF
ATMOSPHERIC MOTIONS
33(4): 472-483, November 1963
8 refs., eqs.

Dynamical equations of atmospheric motions are analyzed by similarity and dimensionality theories. The relationships between various models of the atmosphere and the limits of their applicability are shown. By analyzing the adiabatic motion of the inviscid flow assuming quasi-static equilibrium and the pressure gradient force and the coriolis force to have the same order of magnitude, three characteristic scales defined by external factors can be determined: the characteristic time scale ℓ_0^{-1} dependent on the coriolis parameter f_0 , the characteristic velocity scale C_0 dependent on the stratification and the average temperature of the atmosphere and the characteristic horizontal scale $L_0 = C_0 \ell_0^{-1}$. The ratios of these scales to the corresponding characteristic scales of the atmospheric motions, $\epsilon = 1/T f_0$, $\mu = L_0/L$ and $M_a^{-1} = C_0/U$ (or $\lambda = M_a \mu$), are the three basic parameters which determine the nature of the motions and the development process. When $o(\epsilon) \ll o(1)$, it is possible to preserve only terms of the order of $o(1)$ in the equations; the movement will then be quasi-stationary or quasi-geostrophic and the development process be described by a "quasi-geostrophic model". When $o(\epsilon^2) \ll o(1)$, we may retain the terms of the order of $o(1)$ and $o(\epsilon)$; the motion will then

be in a quasi-equilibrium state and the development process be described by a "quasi-equilibrium model". Although the horizontal divergence in this case is not of an order of magnitude less than the vorticity, the "equation of equilibrium" still holds. In the case of $\sigma(\epsilon^2) \geq 1$ when the simplification of the equations is inadmissible a complete system of equations or "a complete model" will be used.

On this basis, one universal system of equations finitely different in time suitable for analysis and comparison is presented. The various models correspond to the different values of the coefficients in the equations.

The asymptotic nature of the convergence in the method of expansion of small parameters is discussed. Equations for meso-scale systems ($L < L_0$) are especially studied. It is shown that an intermittent pressure change can occur at $M_a = U/C_0 \ll 1$.

- 1.21 Liao Tung-hsien (Liao Tung-hsien)
THE DISPLACEMENT OF PRESSURE AND
TEMPERATURE WAVES IN A
BAROCLINIC ATMOSPHERE
33(4): 501-511, November 1963
2 figs., 9 refs., 29 eqs.

The first part of this paper presents two formulas for evaluating the velocities of pressure and temperature waves in the case of a uniform basic current using a modified two-layer model. The main results are as follows:

(a) In the general case, the velocity of a temperature wave is greater than that of a pressure wave of the same wavelength, except for wave numbers 3 to 10.

(b) In the westerly belt, the velocity of a pressure trough is accelerated when it is moving from lowland to highland, and vice versa. The reverse is true for a pressure ridge.

The second part of the paper discusses a case where basic current changes with latitude. The main results are as follows:

(c) Both the velocities of pressure and temperature waves are closely related to and mainly determined by the distribution of the basic current. Roughly speaking, the magnitude of their speeds is proportional to the speed of the basic current averaged with respect to latitude.

(d) In the general case, the velocity of a pressure wave passing through the north of a certain highland is faster than that of a wave passing through the south of the same highland except in certain special cases.

Applying these results, some synoptic facts, such as the genesis of tilted troughs and the splitting of jet streams to the west of the Tibetan Plateau, may be reasonably explained.

- 1.22 Yeh T. C. (Yeh Tu-cheng)
SOME ASPECTS OF THE DYNAMICS OF DISTURBANCES
IN A WAVE-SHAPED BASIC WESTERLY CURRENT
34(1): 1-10, February 1964
3 figs., 9 refs., 17 eqs.

A pure zonal current is very rare in the atmosphere. In the mean charts, planetary waves are clear. These mean waves indicate that there are large-scale disturbances in the atmosphere whose geographic positions are fairly fixed. An analysis of the atmospheric wave spectra proves this inference. Thus, the basic state of atmospheric circulation should be a wave-shaped westerly current, and not a pure zonal one. This paper investigates the dynamics of disturbances in wave-shaped westerlies. The equation for the disturbed motion shows that in such a basic current, the disturbances of different wavelengths mutually interact. This does not happen in a pure zonal basic current.

Several rules governing the mutual interaction between the disturbances of different wavelengths are given. The evolution of an initial single-wave disturbance in the wave-shaped basic westerlies is also studied. The theoretical calculations give several phenomena which agree well with observation. It is especially worth mentioning that the

deepening process of a trough is very similar to that of Bjerknes' diffluent trough.

- 1.23 Wu Jung-sen (Wu Jung-sheng)
THE INFLUENCE OF LARGE-SCALE TOPOGRAPHY
ON THE INSTABILITY OF DISTURBANCES
34(1): 11-19, February 1964
5 refs., 69 eqs.

The first part of this paper studies the influence of large-scale topography on the instability of barotropic disturbances. The necessary condition for an unstable disturbance is $\frac{d^2 \bar{u}}{dy^2} - \beta - fA \frac{dh}{dy} = 0$, where \bar{u} is the basic current, and h, the topographic height. The rate of increase of the amplitude with time and the displacement velocity of the disturbances are also discussed. The second part of the paper presents a further study of the topic in the baroclinic case. It is shown that the influence in this case is more significant than that in the barotropic case.

- 1.24 Chen Yung-san (Ch'en Hsiung-shan)
THE INTERACTION BETWEEN BASIC CURRENT AND
DISTURBANCES IN A BAROCLINIC ATMOSPHERE
34(1): 20-30, February 1964
6 figs., 9 refs., 43 eqs.

The vorticity and adiabatic equations are converted into a set of non-linear ordinary differential equations, the integration of which is performed on a computer using the Runge-Kutta method. The results show that the basic current and the disturbances constrain each other, that the basic current alters quasi-periodically with periods of 10 to 13 days, and that the rate of change of basic current in each cycle is quite different. The disturbances of wave number six vary sinusoidally with a period of 11 to 13 days; the evolution of the disturbances of wave number four is complicated, and the disturbances of wave number two have a period of variation of about 3 days. The disturbances of wave number six develop or damp at the upper and lower levels simultaneously but the case is opposite for those of wave number four or two.

The results also show that for nonlinear equations, the solution using different initial values contains different mean periods of index cycles.

- 1.25 Chu Fu-kang (Chu Fu-k'ang)
POWER-SPECTRUM ANALYSIS OF
MEAN MONTHLY 500-MB CHARTS
AT 60° AND 30°N
34(1): 31-40, February 1964
5 figs., 2 tables, 16 refs., 10 eqs.

This paper presents a spectral analysis of the potential field and the zonally-averaged kinetic energy of meridional motions on mean monthly 500-mb charts of the northern hemisphere at 60° and 30°N. The seasonal variations of the amplitudes and phase angles of the first three waves and the differences between these entities at high and low latitudes are studied. The results are as follows:

(a) The major contributions of the normal potential field are mainly concentrated at the long quasi-stationary waves. They show significant seasonal variations.

(b) The waves of wave number one have marked differences in the latitudes north or south of 50° - 60°N. The long quasi-stationary waves displace gradually to the west as they approach the lower latitudes. For example, the quasi-stationary waves at 30°N deviate by 1/4 to 1/2 wavelength to the west from those at 60°N.

(c) The primary component of the zonally averaged meridional kinetic energy along 60°N is also concentrated in the quasi-stationary waves. The maximum value appears in the waves of wave number $n = 2$ to 4, the peak value having significant seasonal variations. The spectra of the zonally-averaged meridional kinetic energy along 30°N can be roughly classified into three types according to their seasonal variations:

(1) Winter type: The zonally-averaged meridional kinetic energy along 30°N has the highest maximum value at the quasi-stationary waves

near wave number three and the secondary maximum at the travelling planetary waves (near $n = 5$ to 8).

(2) Summer type: The zonally-averaged meridional kinetic energy along 30°N has only one maximum value at the wave of wave number 6 to 7.

(3) Transient type: The spectrum of the zonally-averaged meridional kinetic energy along 30°N is rather flat and has no stationary peak value.

- 1.26 Hsieh Yi-ping (Hsieh I-ping) and
Huang Yin-liang (Huang Yin-liang)
A PRELIMINARY STUDY OF THE INSTABILITY OF THE
WAVES ALONG THE INTERTROPICAL CONVERGENCE ZONE
34(2): 198-210, May 1964
4 figs., appendix, 3 refs., 67 eqs.

This paper presents a theoretical study of the shearing instability of the waves along the intertropical convergence zone using the simple method of fluid mechanics and three models, viz., barotropic, equivalent-barotropic and three-dimensional. It gives an analytical solution for the first model, a numerical solution for the second and a possible approach for a numerical solution for the third. The results show that the occurrence of instability depends on the magnitude of the shear of the basic currents, the latitude and the wavelength. The term $2\omega \cos \varphi$ usually neglected in analyses at middle and high latitudes is a stability factor. It is also shown from simple to complex model analyses that the actual condition is rather complicated. The factors neglected in simple models may lead to an increase in instability. From a theoretical viewpoint, the paper primarily proves that the transformation of the kinetic energy of the basic currents into that of perturbation due to instability may not be considered as an unimportant mechanism for the initiation of typhoons.

- 1.27 Yeh Tu-cheng (Yeh Tu-cheng) and
Li Mai-tsun (Li Mai-ts'un)
ADAPTATION BETWEEN THE PRESSURE AND THE
WIND FIELD IN MESO- AND SMALL-SCALE
MOTIONS
34(4): 409-423, November 1964
11 figs., 5 refs., 41 eqs.
Full translation: Emm-66-131

It is pointed out that in addition to the so-called geostrophic adaptation in a large-scale motion, there is an adaptation between the pressure and the wind field in meso- and small-scale motions.

Scale analysis shows that in the equations of motion (meso- or small-scale), the term for the time derivative is an order of magnitude smaller than the main terms. Hence, we may assume that motions of such scales evolve slowly in a quasi-balanced state. If, for any reason, this state of motion is disturbed, there will be a mechanism to restore it. A quasi-balanced state exists between the inertial force (velocity advection), the coriolis force and the pressure gradient force.

The progression from disturbance to restoration of a quasi-balanced state is known as an adaptive process and the evolution in a quasi-balanced state a quasi-steady process. The physical nature of these two processes is discussed. It is shown that for a meso-scale motion, $D \gg \zeta$ in an adaptive process and $D \leq \zeta$ in a quasi-steady process, D and ζ being the divergence and vorticity, respectively.

If in some limited region the balanced state of the motion is violently disturbed, further development of this motion may be calculated as an initial value problem. Calculated results show that within the initial short time interval, the meteorological elements undergo a rigorous change in which the quasi-balanced state is re-established and the motion enters a quasi-steady state.

- 1.28 Hsieh Yi-ping (Hsieh I-ping) and
Chen Shou-jun (Ch'en Shou-chün)
THE MEAN ZONAL WIND SPEED AND MERIDIONAL
CIRCULATION IN THE FREE ATMOSPHERE UNDER
THE INFLUENCE OF GIVEN HEAT SOURCES AND
LARGE-SCALE PROCESSES OF TURBULENT MIXING
34(4): 424-432, November 1964
2 figs., table, 9 refs., 52 eqs.

In this paper, Rossby's idea [1] about the influence of large-scale processes of horizontal turbulent mixing on the mean zonal wind speed is first clarified and then extended to a baroclinic atmosphere by means of a two-layer model. The resultant distribution of the mean zonal wind speed and meridional circulation is found to bear some resemblance to the actual observed pattern. The findings of the present study may serve as a starting point for further improvement on the basic assumptions and formulation of a more realistic model to investigate the laws of large-scale motions in the earth's atmosphere.

The present study is semi-theoretical and semi-empirical in nature and some of the parameters used are determined entirely by empiricism.

- 1.29 Chen Chu-shih (Ch'en Ch'iu-shih)
CONVECTIVE INSTABILITY OF INERTIA WAVES
AND PHYSICAL ANALYSIS OF THE FORMATION OF
TYPHOONS AT THE EARLY STAGE
34(4): 433-442, November 1964
5 figs., table, 14 refs., eqs.
Full translation: Emm-66-132

This paper discusses mainly the adjustment of the thermal wind in a moist atmosphere at low latitudes when the condition of convective instability ($\gamma > \gamma_m$) is satisfied. It is shown that the characteristics of this process are totally different from those discussed in reference [11]*. Initially, if the thermal vorticity of the wind field is larger than that of the temperature field and the horizontal scale of the disturbance

* See 1.17.

is smaller than the characteristic scale of the adjustment (L_0), convective instability of the inertia waves will occur. In this case, the instability of the inertia waves may, in a relatively short period of time (± 24 hours), result in a violent vortex, with an anticyclone on the 250-mb level, a cyclone on the 750-mb level and a warm center in the temperature field.

The paper also discusses the dynamical essence of the triggering mechanism for typhoon formation. It is pointed out that a typhoon is formed within the inherent unity of the destruction and formation of thermal wind equilibrium. If there exists a mechanism that may produce a non-thermal wind with the thermal vorticity in the wind field larger than that in the temperature field, then a rapid development of a large-scale vortex through the instability of the inertia waves will be induced. This is a mechanism for the initiation of typhoons.

- 1.30 Koo Chen-chao (Ku Chen-ch'ao)
SIMILARITY ANALYSIS OF SOME MESO- AND
SMALL-SCALE ATMOSPHERIC MOTIONS
34(4): 519-522, November 1964
10 refs., 14 eqs.

Employing similarity analysis, the author first points out that free convection in the atmosphere may be characterized by the parameter:

$$M \equiv \beta(\Delta\theta)^4 / \alpha^3 k^2,$$

where $\beta \equiv g/\theta$ with θ being the potential temperature, $\Delta\theta$ is the characteristic horizontal heating, $\alpha = \gamma - \gamma'$ with γ being the lapse rate and γ' the adiabatic lapse rate, and k is the diffusion coefficient. In this case, there are two characteristic times or characteristic lengths. The author then shows that the height variation of the pressure jump is represented by

$$\Delta h = hG(v^2/gh),$$

where v is the velocity of the flow, h the height and G an arbitrary function.

- 1.31 Chao Jih-ping (Ch'ao Chi-p'ing) and
Wu Qing-yu (Wu Ch'in-yueh)
SOME ASPECTS OF THE INTERNAL GRAVITATIONAL
INERTIA WAVES IN A GEOSTROPHIC CURRENT
34(4): 523-530, November 1964
5 figs., table, 5 refs., 32 eqs.

The instability, phase velocity and group velocity of the internal gravitational inertia waves in a geostrophic current are analyzed by use of a linear two-layer model. The results are as follows:

(a) When the geostrophic velocity exceeds the phase velocity, internal gravitational inertia waves of certain wavelengths will become unstable. This instability may be used to explain the development of some meso-scale systems.

(b) For waves of certain wavelengths, the group velocity can be greater than the phase velocity. Therefore, when a meso-scale system is developed over a certain region, its energy can travel faster downwind than the phase velocity and consequently can lead to the formation of a new system.

- 1.32 Yang Ta-ceng (Yang Ta-sheng)
DYNAMIC INSTABILITY OF EASTERLY DISTURBANCES
35(2): 189-199, May 1965
3 figs., 11 refs., 27 eqs.

In this paper, the dynamic instability of easterly disturbances is investigated in terms of the variation of the coriolis parameter with latitude and the characteristic features of the flow pattern in temperate and low latitudes by means of a two-layer model. The results show that this model gives rise to easterly disturbances of relatively short wavelength of about 2400 km.

See also: 5.10, 7.36 and 11.28

CHAPTER 2

BOUNDARY LAYER METEOROLOGY; TURBULENCE;
LOCAL WINDS

- 2.1 Chao Ber-lin (Chao Po-lin)
ON THE COEFFICIENT OF TURBULENT EXCHANGE
IN THE FRICTIONAL LAYER
27(3): 195-218, September 1956
21 figs., table, appendix, 11 refs., eqs.

The austausch coefficient in the frictional layer may be evaluated from a knowledge of the wind structure in this stratum. In 1902, Ekman established the spiral theory of the wind flow in the frictional layer and the austausch coefficient may then be calculated from the observed wind spiral. In 1953, Laikhtman obtained satisfactory results by considering the variation of pressure with height, i. e., by including the effect of thermal wind. However, Laikhtman's formula holds good only in a uniform current or under the conditions of a uniform temperature-pressure field which is invariant with respect to time. It is well known that these conditions are difficult to satisfy in physical systems. Problems concerning non-stationary fields in the frictional layer had been discussed by Jaw Jeou-jang and Dyubyuk in 1947. This paper is only a further attempt to determine the austausch coefficient for the non-stationary case. A general formula is also obtained in the present study. It is shown that the Laikhtman formula is a particular case of this general formula for a stationary temperature-pressure field with uniform pressure gradient and constant temperature. Similarly, the Ekman formula is another particular case of the general formula for a stable pressure field when temperature remains constant with respect to time and space. Thus, the general formula given by the present paper is more accurate for the evaluation of the austausch coefficient and can cope with a wide range of applications.

Finally, some computations from observational data are made and analyzed together with a discussion on the variation of the austausch coefficient in a natural environment.

- 2.2 Yang Ta-cheng (Yang Ta-sheng)
WIND PROFILE IN THE LOWEST LAYER
OF THE ATMOSPHERE OVER PEKING
28(3): 185-197, August 1957
7 figs., 16 refs.

Pibal observations over Peking during the two-year period 1954 - 1955 were analyzed and the wind data at the 500-meter level were divided into three groups, viz., strong winds, moderate winds and light winds. The frequency of moderate winds was found to be the highest of the three groups and its mean wind profile was therefore considered to be more representative in terms of sample size. Hence this profile was chosen for theoretical study in the present article.

Assuming that the eddy-transfer coefficient, K , is a function of altitude given by $K = (a - bz)^2$ for $z \leq 900$ m and $K = \text{constant}$ for $z > 900$ m, the computed results are found to agree closely with actual observations.

Finally, the new method proposed by D. L. Laikhtman for the determination of the eddy-transfer coefficient from wind data is discussed. Some important points on its application are also described.

- 2.3 Yang Ta-cheng (Yang Ta-sheng) and
Tseng Kwang (Cheng Kuang)
THE INFLUENCE OF THE ROUGHNESS OF THE SURFACE
ON THE WIND PROFILE IN THE UPPER PLANETARY
BOUNDARY LAYER OVER DAIREN
29(1): 1-6, February 1958
6 figs., 14 refs., eqs.

In this paper, wind data obtained from free-balloon observations over Dairen during 1955 are divided into four groups: winds from the sea at 1100 and 2300 hours and winds from the land at the same hours. Distributions of the wind speed with height in the upper planetary boundary layer are shown. Assuming that the austausch coefficient $K = (a - bz)^2$ with suitable values for a and b given and taking into consideration the appropriate thermal winds, the computed wind profile is found to agree with the observed wind distribution. Comparing

the different distributions of K with height for the four conditions, the influences of the stability and the roughness of the surface on the wind profile are discussed.

- 2.4 Su Tsung-shian (Su Ts'ung-hsien)
TURBULENCE IN THE SURFACE LAYER
OF A STRATIFIED ATMOSPHERE
29(2): 73-82, May 1958
7 figs., 2 tables, 17 refs., eqs.
Full translation: Emm-65-41

This paper discusses turbulent exchange in the surface layer of a stratified atmosphere. First, considering the effect of thermal stratification on turbulence, a new form of the function of the Richardson number is derived from the energy balance equation of a turbulent atmosphere. Secondly, a reasonable function is proposed describing the vertical distribution of elements in the stratified atmospheric surface layer. Several graphs are also given which make an accurate calculation of the turbulent characteristic values possible, such as turbulent exchange based on the observed data.

Some computations based on observed data are furnished for comparison with others. It is shown that the treatment in this paper is reasonable and the results are better than those of Monin and Obukhov.

- 2.5 Su Tsung-shian (Su Ts'ung-hsien)
ON THE BASIC REGULARITY OF THE TURBULENT
EXCHANGE IN THE SURFACE BOUNDARY LAYER
OF A STRATIFIED ATMOSPHERE
30(1): 114-118, February 1959
5 figs., 7 refs., eqs.

The results of the present discussion indicate that there exists a generic deterministic function to represent the turbulence characteristics in the surface boundary layer. This is none other than the expression $K = nV_*z [1 - \alpha Ri]^{1/4}$ given by Obukhov and Monin. It is found that the generic properties of the basic regularity are not adequately reflected by other expressions.

- 2.6 Liu Chen-hsing (Liu Chen-hsing)
PROBLEMS ON WIND-SAND STUDIES.
(I) THE TRANSPORTATION OF SAND IN A
TURBULENT ATMOSPHERE WITHIN THE
SURFACE LAYER
31(1): 75-83, February 1960
6 figs., 8 refs., 31 eqs.

This paper deals with the characteristics of the jumping movement and the impact of sand particles within the boundary layer above a sand-laden surface. Formulas for the evaluation of the rate of transportation and the concentration of sand particles within this layer are derived. The vertical distribution of the concentration of sand suspensoid is discussed with the aid of the theory of turbulent diffusion. An equation for the quantitative evaluation of the transportation of sand-suspensoid is then formulated.

- 2.7 Liu Chen-hsing (Liu Chen-hsing)
PROBLEMS ON WIND-SAND STUDIES.
(II) A PRELIMINARY INVESTIGATION ON THE
SYSTEMATIC MOVEMENT OF SAND-DUNES
UNDER THE INFLUENCE OF THE WIND
31(1): 84-91, February 1960
7 figs., 6 tables, 3 refs., 12 eqs.

This paper presents a discussion on the existing formulas for the determination of the speed of movement of sand-dunes under the simplifying assumption of a flat underlying surface. A nomogram for the evaluation of the rate of transportation of sand particles and the movement of sand-dunes under the influence of various wind speeds is also presented. The computed results are in general concordance with observed values.

- 2.8 Liu Chen-hsing (Liu Chen-hsing)
THE REGULARITY OF ATMOSPHERIC TURBULENT
MIXING IN THE SURFACE LAYER
31(2): 159-170, May 1960
10 figs., 18 refs., 45 eqs.

This paper discusses the characteristics of atmospheric turbulent exchange in the surface layer by using the energy-balance equation as a starting point. A new general form of correlation function for stable conditions is derived,

which incorporates the propositions of Monin-Obukhov and Budyko. A corresponding function for unstable conditions is also obtained from the energy-balance equation, which is similar in form to that derived from dimensional analysis. The distribution of important meteorological elements is discussed on a theoretical basis and the results are found to agree closely with actual observations under both stable and unstable conditions. Finally, graphs for the computation of the various parameters of turbulent exchange are presented from which values of dynamic velocity v_* , heat flux P and the dynamic height L may be evaluated from simple gradient measurements.

- 2.9 Chen Chia-i (Ch'en Chia-i)
SOME COMMENTS ON THE ARTICLE
"THE REGULARITY OF ATMOSPHERIC
TURBULENT MIXING IN THE SURFACE
LAYER"*
33(1): 129, February 1963
3 refs., eqs.
- 2.10 Liu Chen-hsing (Liu Chen-hsing)
REPLY TO CHEN CHIA-I IN RESPONSE TO HIS COMMENTS
ON THE ARTICLE "THE REGULARITY OF ATMOSPHERIC
TURBULENT MIXING IN THE SURFACE LAYER"**
33(1): 130, February 1963
1 ref., eqs.
- 2.11 Chen Chia-i (Ch'en Chia-i),
Tan Sin (T'an Hsin) and
Dong Su-zeng (Tung Su-chen)
THE MICROSTRUCTURE OF TURBULENCE IN THE
LOWER TROPOSPHERE
33(2): 271-280, May 1963
4 figs., 2 tables, 19 refs., eqs.
Full translation: E-T-Ch-64-16

This paper analyzes Deviatova's experimental data of the horizontal wind speed fluctuations at different heights from 100 to 1470 m. The main results are:

* See 2.8.

** See 2.8 and 2.9.

(a) The horizontal wind speed fluctuations at any height may be approximated by a Gaussian distribution.

(b) For heights up to a few hundred meters, the well-known "2/3" law holds within a scale of length comparable to or several times larger than the height.

(c) At higher levels, the scale range in which the "2/3" law holds is usually less than the height itself and no definite relationship between this scale range and the height has been found.

The validity of the data is also discussed.

- 2.12 Luo Xiu-qing (Lo Hsiu-ch'ing)
TURBULENT DIFFUSION FROM A CONTINUOUS POINT
SOURCE IN THE PRESENCE OF VERTICAL ADVECTION
33(3): 375-381, August 1963
4 figs., table, 8 refs., eqs.
Full translation: Emm-65-17

This paper discusses the problem of diffusion from an unsteady continuous point source in a turbulent atmosphere. The influence of vertical current, the deposition of the diffusing particles and the "net-catching effect" (absorption by ground surface) are considered. The theoretical formulas for the evaluation of the concentration field are derived. Several sample computations are presented and it is shown that there is good agreement between the computed results and observed data.

- 2.13 Chen Chia-i (Ch'en Chia-i)
THE CORRELATION OF WIND SPEED FLUCTUATION
IN A TURBULENT ATMOSPHERE
33(4): 426-434, November 1963
2 figs., 2 tables, appendix, 14 refs., eqs.

When the gustiness is small, the standard deviation and correlation function together with the structure function of wind speed fluctuations may be used to evaluate the horizontal eddy components to a moderate degree of approximation, and furthermore, the time correlation may be used instead of space correlation.

For gustiness normally encountered in the study of the micro-structure of atmospheric turbulence, the computed correlations of wind speed fluctuations by the expression given by the author are in good agreement with the observed values of correlations of eddy component along the mean direction.

The validity of the basic assumptions introduced by the author in deriving the various expressions for use in the atmosphere is also discussed.

- 2.14 Su Tsung-shian (Su Ts'ung-hsien)
THE EFFECTS OF THERMAL STRATIFICATION ON THE
TURBULENT EXCHANGE IN A DIABATIC SURFACE LAYER
33(4): 435-448, November 1963
12 figs., 19 refs., 42 eqs.
Full translation: Emm-65-42

This paper studies the effects of stratification on the turbulent exchange in the surface layer of the atmosphere using similarity theory and dimensional analysis. Using recently published data, the magnitudes of the empirical coefficient D in the general function of turbulent exchange are calculated. A scheme of transition from forced to free convection showing a rather smooth character is developed. Based on the characteristic length L_{Ri} , the author sets up a turbulent exchange model for a diabatic surface layer.

- 2.15 Pu Pei-min (P'u P'ei-min)
TURBULENCE IN THE SURFACE LAYER OF THE
ATMOSPHERE UNDER DIFFERENT THERMAL
STRATIFICATIONS
34(2): 211-224, May 1964
14 figs., table, 32 refs., eqs.

This paper discusses in general the characteristics of turbulence under different thermal stratifications based on physical analysis and using similarity theory. Assuming that the transition from forced to free convection is continuous, the characteristics of turbulence in extremely stable stratification are analyzed. A form of the universal function satisfying the requirements for physical analysis is introduced and the

values for the parameters involved are determined. Formulas and diagrams showing the austausch coefficient and eddy fluxes calculated according to data obtained from gradient observations are given and are compared with other data.

- 2.16 Chi Li-ren (Chi Li-jen)
NUMERICAL ANALYSIS OF THE PROCESS OF
LOW-LEVEL SHEAR LINE FORMATION OVER
CHINA
35(1): 18-33, February 1965
18 figs., 2 tables, 14 refs., eqs.

The process of low-level shear line formation over China during 17-18 June 1960 is investigated by calculating and analyzing some of its physical factors. The reasons for the variation of these entities are discussed, with particular emphasis on the dynamic influences of orography. Special attention is given to the effects of orographic friction on the evolution of local circulation.

Tentative numerical studies of shear line formation are made using one- and three-level quasi-nondivergent models, starting with ideal and actual initial flow distributions. The results are found to be quite consistent with the actual characteristics.

- 2.17 Ma Zhen-hua (Ma Chen-hua),
Li Hui-yun (Li Hui-yun) and
Liu Xian-wan (Liu Hsien-wan)
A HOT-WIRE TURBULENCE-SPECTRUM ANALYZER
FOR USE IN WIND TUNNELS
35(4): 434-439, November 1965
7 figs., 3 refs., eqs.

Based on the principle of spectral analysis for pulsational air currents, this paper describes the design principle, the construction specifications and the main instrumental parameters of a hot-wire turbulence-spectrum analyzer for direct measurement of the spectral density of the pulsational energy of air flow in wind tunnels. Some results of the measurements made by the prototype are also presented.

- 2.18 Yen Kai-wei (Yen K'ai-wei),
You Lai-kuang (Yu Lai-kuang),
Jen Yung-lin (Ching Jung-lin) and
Lee Kuo-jie (Li Kuo-chieh)
**THE USE OF CONSTANT-LEVEL BALLOONS IN
EVALUATING THE VERTICAL COMPONENT OF
CLEAR AIR TURBULENCE OVER PEKING**
35(4): 449-459, November 1965
10 figs., 4 tables, 9 refs., 15 eqs.

See also: 9.14, 11.6 and 16.31

CHAPTER 3

CLIMATOLOGY (PARTICULAR PLACES);
CLIMATIC FLUCTUATIONS

- 3.1 Su Tsung-shian (Su Ts'ung-hsien)
A METHOD FOR THE DETERMINATION OF
CONTINENTALITY IN CLIMATOLOGY
27(3): 263-278, September 1956
14 refs., eqs.

In this paper the meaning of continentality is first described. Past events are then related to the current ones. The basis of calculation and the principle of derivation may be classified into four categories, viz., (a) the temperature method, (b) the method of zonal average, (c) the air-mass method and (d) the composite method. The principle of derivation and the associated physical implication of the various methods are discussed together with some brief comments on their individual merits.

- 3.2 Chow Shiao-ping (Chou Hsiao-p'ing)
A STATISTICAL INVESTIGATION OF
BLOCKING SITUATIONS IN TEMPERATE
LATITUDES OVER ASIA
28(1): 75-85, February 1957
8 figs., 3 tables, 7 refs.

This paper presents a statistical analysis of 36 blocking situations in temperate latitudes over Asia during the period 1953 - 1955. The results reveal that both the frequency of occurrence of blocking situations and their geographical distribution follow definite characteristic patterns.

- 3.3 Chang Xuai (Chang Huai) and
Sh Giu-en (Shih Chiu-en)
THE ACTIVITIES OF ANTICYCLONES
OVER EAST ASIA
28(3): 167-174, August 1957
7 figs., 3 tables, 3 refs.

This paper presents a statistical survey of the activities of anticyclones over East Asia based on synoptic data for the period 1951 - 1955. The

frequency of occurrence, speed of movement, intensity and its variation with time of these systems are discussed. A classification of their tracks into various basic types is also made.

- 3.4 Yang Chien-chu (Yang Chien-ch'u)
A STUDY OF THE MAIN INTERDIURNAL PRESSURE
AND TEMPERATURE VARIABILITY AT THE SURFACE
AND OF THE MEAN INTERDIURNAL ALTITUDE AND
TEMPERATURE VARIABILITY AT THE 300, 500 AND
700-MB LEVELS OVER CHINA
29(3): 201-212, August 1958
4 figs., 8 tables, 12 refs.
Full translation: Emm-65-30

The mean monthly interdiurnal variability of pressure, altitude and temperature over China are computed using surface and radiosonde data obtained during 1951 - 1955. The seasonal characteristics of the weather and climate in China together with the influence of the Tibetan Plateau on the general circulation and upper-air climate are discussed. It is found that the great changes in weather in China in early spring (February and March) and late fall (November) are closely associated with the circulation pattern over the northern hemisphere.

- 3.5 Yao C. S. (Yao Ch'en-sheng)
THE VARIABILITY OF PRECIPITATION IN
EASTERN CHINA
29(4): 225-238, November 1958
14 figs., 2 tables, 10 refs., eqs.

This paper presents a calculation of the average absolute variability (the average absolute deviation) and the average relative variability (the ratio of the average absolute variability to the arithmetic mean in percentage) of precipitation in eastern China. The results show (1) that throughout the year there are low variability centers in the northeastern region and the Tai Hu basin, (2) that throughout the year there is a high variability center in the Taiwan Strait, (3) that there is a high variability center in summer but a low one for the rest of the year in the areas south of the Yangtze River and north of Nan Ling, (4) that in summer there are low variability centers in northern and

southwestern China, (5) that in early fall there is a low variability center in northwestern China, and (6) that during January - March there is a particularly high variability center in the Chengtu plain.

Furthermore, the latitudinal averages of the relative variability of precipitation are computed by interpolation.

Using the method of least squares, the empirical relations between the annual rainfall and the average annual absolute and relative variabilities of precipitation are determined. The latter relation is given in the form:

$$\bar{v}_r = 22.87 - \frac{17.26}{10^4} \bar{x} - \frac{63.40}{10^7} \bar{x}^2 + \frac{27.25}{10^{10}} \bar{x}^3$$

where \bar{v}_r is the average annual relative variability of precipitation, and \bar{x} , the annual precipitation. In addition, the anomaly of variability is calculated using

$$\Delta v_r = v_r - \bar{v}_r$$

where v_r is the observed variability. Before calculating, the empirical formula was tested for its goodness of fit with recorded data.

For the purpose of determining the mean square error of the average relative variability, the author derives a formula

$$\sigma_{v_r} = \frac{v_r \sqrt{0.572 + 1.571 \times 10^{-4} v_r^2}}{\sqrt{N}}$$

where N is the number of years of observation. Using data recorded in Shanghai, the author also studies the effect of the duration of records on the calculated values of variability, with the result that the calculated values are sufficiently accurate when records of 40 years are available.

- 3.6 Kao Yu-shie (Kao Yu-hsi) and
Kuo Chi-yün (Kuo Ch'i-yün)
AUTUMN RAIN AREAS IN CHINA
29(4): 264-273, November 1958
9 figs., 2 tables, 9 refs.

This paper shows that in September or October there are several areas in China in which both the amount of rainfall and the number of

rainy days are greater than those during the adjacent months. These areas are known as autumn rain areas located principally in western China and the Yangtze delta. It is found that the beginning and end of the autumn rain period are closely related to the advance of jet streams over southern Asia, with the end of the period also connected with the retreat of the Indian monsoon.

- 3.7 Chen Shou-jun (Ch'en Shou-chün)
THE MEAN WIND AND TEMPERATURE FIELD
ALONG THE 140°E MERIDIAN
30(1): 92-98, February 1959
7 figs., 2 tables, 10 refs.

In this paper, mean meridional cross sections along 140°E for January, April, July and October are constructed mainly by using data recorded from 1952 to 1955 as well as those obtained in 1956 and 1957. The westerly component of the mean geostrophic flow and the distribution of the mean temperature and mean tropopause are discussed. The results are compared with those of the cross sections along 80°W.

- 3.8 Dao Shih-yen (T'ao Shih-yen) and
Yang Chien-chu (Yang Chien-ch'u)
PROGRESS IN CLIMATOLOGY IN CHINA
FROM 1949 TO 1959
30(3): 251-257, August 1959
76 refs.

- 3.9 Koo Chen-chao (Ku Chen-ch'ao)
PROBLEMS ON THE FREQUENCY OF
OCCURRENCE OF ABNORMAL WEATHER
31(2): 181-184, May 1960
2 tables, 5 refs., eqs.

- 3.10 Chu Co-ching (Chu K'o-chen)
THE PULSATION OF WORLD CLIMATE
DURING HISTORIC TIMES
31(4): 275-288, January 1962
6 tables, 45 refs.

The question whether the climate of the world had changed during historic times has been a controversial one. The accumulation of

meteorological data and other relevant facts in the northern hemisphere during the past 60 years gives undeniable evidence of a general warming up during that period, especially in the high latitudes. China is no exception. Not only has the mean annual temperature of various regions increased during the first half of the 20th century, but recent explorations in Tien Shan and Nan Shan in northwestern China and Karakoran and the Himalayas in the southwest provide ample proof of retreats of existing glaciers. These glaciers, including the Mozard glacier on the eastern slope of Khan Tengri which retreated 750 meters during the period 1909 - 1959, are still retreating in recent years.

The pulsation of climate does not limit itself to recent eras but can be traced through historical periods to the Quaternary. Results of the works of A. V. Shnitnikoff of USSR, C. E. P. Brooks of Great Britain and H. W. Ahlman of Sweden, among others, are cited. In China phenological records were kept as early as 500 B. C.. Because of their significance to the agricultural calendar promulgated in 102 B. C. during the reign of Wu Ti of the Han dynasty and used by the Chinese farmers practically unaltered throughout the past 2000 years, these records are an invaluable source of tracing the ancient climate.

The phenological data contained in the diaries and poems of Chinese writers in the past are so rich that from the results of analysis of these materials, there is sufficient evidence to delineate a general outline of climatic variation in China for the past 1500 to 2000 years. The paper takes the second half of the 17th century as an example and shows from the dates of the freezing of the Grand Canal and the flowering of peaches and apricots in Hangchow and Soochow and the number of killing frosts in the citrus gardens in Kiangsi that this period must have been much colder than the present. The period is known as "The Little Ice Age" in western Europe.

Finally, the paper touches upon the cause of climatic variation and maintains that the fluctuation of solar radiation is the main factor. The number of times sunspots and aurorae boreales were observed in China

from the 2nd to the 17th century is tabulated along with the number of severe winters in each of these centuries and found that their correlation is rather close.

- 3.11 Wang Shao-wo (Wang Shao-wu)
SECULAR VARIATION OF THE CENTER OF
ATMOSPHERIC ACTIVITY
31(4): 304-318, January 1962
18 figs., table, 14 refs.

In this paper, the positions of the main centers of atmospheric activity in middle and low latitudes are determined by use of sea-level pressure charts for January and July 1873 - 1934. Using a 10-year sliding average, secular variations of these positions are analyzed. The correlations of the variations with the climatic oscillations in different parts of the world and the 22-year cycle of solar activity are discussed. The main results are as follows:

(a) There is a noticeable difference in the secular variations of the positions of the different centers of atmospheric activity between January and July.

(b) These variations have a distinct cyclicity; the main cycles are 22 and 35 years and possibly include the century cycle (80 - 90 years).

(c) The climatic oscillations in different parts of the world can be explained by the secular variations of the positions of the centers of atmospheric activity. Moreover, the effect of the longitudinal changes in the positions is no less than that of the latitudinal.

(d) There is a close relationship between the variation of position of the activity centers and the 22-year cycle of solar activity. This relationship is particularly evident in summer over the Pacific region. Thus, it can be assumed that the effect of solar activity on atmospheric circulation is essentially realized in that region.

- 3.12 Yang Chien-chu (Yang Chien-ch'u)
THE CHARACTERISTICS OF TEMPERATURE VARIATION
IN CHINA DURING THE PAST 50 YEARS
31(4): 360-370, January 1962
7 figs., 14 tables, 13 refs.

This paper analyzes the secular variations of temperature in China using the monthly charts of 1909 - 1958. The monthly temperature is divided into five categories: cold, warm, slightly cold, slightly warm and normal. It is shown that the secular variations of warm and cold months are essentially correlated with the cyclic variations of solar activity. After the appearance of a cold or a warm period (1 - 3 months), the probability of occurrence of the same trend of temperature within the following six months is greater than that of the opposite trend.

- 3.13 Wang Shao-wo (Wang Shao-wu)
CLIMATIC FLUCTUATIONS IN CHINA IN RELATION
TO THE SECULAR VARIATIONS OF ATMOSPHERIC
ACTION CENTERS IN THE FAR EAST
32(1): 19-36, March 1962
22 figs., 13 tables, 9 refs.

This paper deals with the study of the secular variations of the positions of atmospheric action centers on monthly mean surface isobaric charts for the months of January and July during the period 1873 - 1934. (In January, they are represented by the Siberian High, Aleutian Low and the Equatorial Trough, and in July, the Pacific High and the Indian Low.) The 10-year running means of the geographical positions of several January action centers and the latitudes and longitudes of the boundaries of all July centers are computed. The findings are discussed in terms of the climatic fluctuations in China. The main results are as follows:

(a) The secular variations of the positions of the action centers in the Far East appear to be rather complicated. The curves depicting the 10-year running means of these systems differ greatly from case to case, and there seems to be little correlation among them.

(b) A return period of 35 years appears to be most significant in the secular variations of the positions of the action centers in the Far East.

(c) The climatic fluctuations in China are closely related to the secular variations of the positions of the action centers in the Far East. Curves depicting the profile of the 10-year running means of the amount of precipitation and air temperature at many stations in China resemble those of the action centers. Some of them are in phase and others out of phase. The amount of precipitation and air temperature are related to the position of individual action centers by large correlation coefficients. It is also noted that the geographical distribution of these systems is very systematic.

- 3.14 Wang Shao-wo (Wang Shao-wu)
AN ANALYSIS OF THE CLIMATIC FLUCTUATIONS
IN SHANGHAI
32(4): 322-336, December 1962
9 figs., 10 tables, 10 refs., eqs.

This paper presents a comprehensive analysis of the climatic fluctuations in Shanghai for the 87-year period 1873 - 1959. The results are summarized as follows:

(a) An analysis of the curves of 10-year running means of each climatological element reveals that the monthly fluctuations of the same element are significant and that the variations of different elements are not necessarily the same for the same month. The profile of the fluctuations of air temperature is not highly similar to that of maximum temperatures, nor do the variations of the amount of rainfall closely resemble those for the number of rain-days. This shows that the long-term synoptic processes responsible for the climatic fluctuations are extremely complex.

(b) The observed climatic fluctuations of each element may be explained in terms of the secular change of the positions of action centers. The present investigation shows that the position of the action centers controls the prevailing circulation pattern and the

synoptic processes which in turn determine the characteristics of the climatic fluctuations of the various elements.

(c) Significant warming is noted after 1920 and the maximum is reached in the forties. However, the air temperature has begun falling during the past ten years.

(d) In general terms the climatic fluctuations for the past 87 years may be divided into five phases, and the typical differentiation by decades may be described by 1880 - 1889 (wet and cold), 1890 - 1899 (cold and dry), 1910 - 1919 (wet and cold), 1930 - 1939 (warm and dry) and 1945 - 1954 (wet and warm).

(e) Periodicity analysis shows that significant periodicity does exist in the climatic fluctuations. Return periods of about 35 years and 60 years are noted in the fluctuations of the amount of precipitation, while temperature oscillations are characterized by cycles of 20 - 25, 35 - 40 and 70 - 80 years.

(f) The precipitation and temperature anomalies for the next 20 years (1960 - 1979) are estimated according to the basic return periods from 10-year means. The results reveal that the prevalent climate is likely to be "cold and dry" for the first ten years and "cold and wet" for the next decade.

- 3.15 Chang Hsien-kung (Chang Hsien-kung),
Kong Yi (K'ung I) and
Hsu Chun (Hsu Ch'un)
A PRELIMINARY ANALYSIS OF ABNORMAL PRECIPITATION
IN CHINA DURING THE FIRST SIX DECADES OF THE
PRESENT CENTURY
33(i): 64-77, February 1963
6 figs., 8 tables, 15 refs.

Monthly precipitation charts are prepared from rainfall data of 86 stations in China for the period 1901 - 1960. The distribution and occurrence of years with abnormal precipitation are analyzed and their relationship with the Wolf index of solar activity is examined. The results indicate that China is at present being affected by a period

of negative anomaly. The rapid increase of the total frequency of abnormal precipitation in China in recent years is probably associated with the marked intensification of solar activities during the last cycle.

- 3.16 Zhang Ke-ying (Chang K'o-ying)
A PRELIMINARY ANALYSIS OF THE
CLIMATOLOGICAL FEATURES AND
CLIMATE-FORMING FACTORS IN
SOUTHERN YUNNAN PROVINCE
33(3): 218-230, May 1963
13 figs., 13 tables, 13 refs.

The climatological features of southern Yunnan are investigated. From various viewpoints, the author has divided the year into three to five periods. The local characteristics of the major climate-forming factors - solar radiation, atmospheric circulation and the natural geographical environment are analyzed.

- 3.17 Yao C. S. (Yao Ch'en-sheng)
APPLICATION OF THE FUNDAMENTAL
THEOREMS OF THE THEORY OF
PROBABILITY TO CLIMATOLOGICAL
STUDIES
33(2): 245-256, May 1963
5 tables, 38 eqs.

The first part of this paper deals with the methods for the evaluation of conditional, general and compound probabilities. The procedure adopted by Wurtle in obtaining the probabilities of the occurrence of fog with various specified wind directions is shown to be unnecessary. An example on the computation of rainfall probabilities for different wind directions is given. The general rainfall probability is also computed by means of the theorem of total probability. The conditional probability of the various wind directions associated with the occurrence of rain is obtained by Bayes' theorem.

In the second part, the author calculates the probabilities of simultaneous occurrences of rain-days at various stations and derived formulas for checking the results.

3. 18 Weng Du-ming (Weng Tu-ming),
Tan Guan-ri (T'an Kuan-jih),
Gui Xin-yong (Kuei Hsin-yung) and
Pang Jia-tang (P'ang Chia-t'ang)
ON THE ACCURACY OF THE
MEAN MONTHLY TEMPERATURE
33(3): 350-360, August 1963
4 figs., 7 tables, ref., eqs.

The monthly sliding average temperatures are computed for equivalent time periods for six stations (Shenyang, Peking, Tsingtao, Shanghai, Wuhan and Chungking), which are located in different climatological regions of China. By studying the accuracy of these temperatures, an empirical formula is derived, which shows the relationship between the error in the mean temperatures (V_N) and the number of years (N) during which these temperatures were computed. The formula is $V_N = \frac{N}{aN^2 + bN + c}$, where a, b and c are the empirical coefficients which change according to season and region. Certain climatological factors which affect the accuracy of the computed averages are also examined. The possibility of interpolating these values in time and space is discussed in terms of the temporal and spatial distributions of the errors.

3. 19 Chu Rai-chao (Chu Jui-shao)
THE CLIMATIC FRONTAL ZONES
OVER EAST ASIA
33(4): 527-536, November 1963
20 figs., 11 refs.

This paper analyzes the frequency distribution of frontal occurrences over East Asia using the daily surface weather charts of 1955 - 1959. The locations of the climatic frontal zones in January, April, July and October are determined.

- 3.20 Shi Yong-nian (Shih Yung-nien)
AN EXPERIMENT ON THE QUANTITATIVE DESCRIPTION
OF FIELDS OF CLIMATOLOGICAL ELEMENTS BY MEANS
OF ORTHOGONAL FUNCTIONS
35(3): 343-351, August 1965
3 figs., 18 refs., 20 eqs.
Full translation: Emm-66-89

This paper deals with the generalized problem of the quantitative description of fields of climatological elements by means of approximate analytical expressions. The present author is of the opinion that it is advantageous to use a linear combination of orthogonal functions as an approximate expression for the quantitative description of fields of climatological elements. A formula for the assessment of the accuracy of the computed results is also presented. Two numerical examples are given in which the "descriptive" equations are represented by a linear expression. The coefficients of the linear expression are determined. The initial input data are correlated with the coefficients of the descriptive equations. The standard error of estimate and the variance ratio are computed. The importance of each linear coefficient is assessed by a comparison of the individual contribution to the multiple correlation coefficient.

- 3.21 Hsu Chun (Hsü Ch'un)
MEI-YÜ OF THE MIDDLE AND LOWER
YANGTZE VALLEY IN THE PAST 80 YEARS
35(4): 507-518, November 1965
12 figs., 3 tables, 9 refs.

This paper presents an analysis of the mei-yü (plum rain) period in the middle and lower Yangtze valley for the years 1885 - 1963. The results show that the synoptic features during this period are characterized by the persistence of the subtropical ridge over the western Pacific between 20° - 25°N and of the polar front and the rain belt in the vicinity of the middle and lower Yangtze valley.

Mei-yü can be classified into two distinct types, viz., early mei-yü and typical mei-yü. The former is an unusual synoptic process associated with the abrupt poleward displacement of a rain belt and

occurs in the first and second decades of May while the latter is a well-known synoptic epoch which prevails from the second decade of June to the first decade of July. The inter-annual variation of the mei-yü period is large and ranges from short waves with return periods of 2 - 3 years through intermediate harmonics of 11 - 13 years to centurial oscillations. An analysis of the climatological conditions associated with mei-yü during the past 80 years is also presented.

See also: 2.2, 6.1, 7.29, 7.30, 7.32, 7.37, 9.2, 9.9,
16.9, 17.8 and 17.10

CHAPTER 4

CLOUD PHYSICS AND DYNAMICS

- 4.1 Koo Chen-chao (Ku Chen-ch'ao) and
Hu Kwang-shing (Hu Kuang-hsing)
A LINEAR THEORY OF THE INFLUENCE OF
CONDENSATION FEEDBACK ON THE
VERTICAL DEVELOPMENT OF A CLOUD MASS
32(1): 64-70, March 1962
Table, 5 refs., 37 eqs.

It is shown from a linear analysis of the microscale vertical motions that condensation feedback exerts a strong controlling influence on the vertical development of a cloud mass. This controlling influence appears to be more predominant in an environment with high temperature and humidity. The frequency equation with condensation feedback for the unsteady case and the formula for evaluating the propagation speed of waves for the steady case are derived. This leads to a possible theoretical explanation of the phenomenon of the rapid disintegration of the precipitating cloud mass into many layers after the cessation of rain. This phenomenon is often observed during the rainy season in the southern regions (South China).

- 4.2 Koo Chen-chao (Ku Chen-ch'ao)
A DISCUSSION ON THE THEORETICAL INVESTIGATIONS
IN RECENT YEARS ON THE FORMATION OF CLOUD-
AND FOG-DROPLET SPECTRA
32(4): 267-284, December 1962
6 figs., 28 refs., eqs.

This paper presents a critical discussion on the theoretical investigations in recent years on the formation of cloud- and fog-droplet spectra (condensation and coalescence spectra). Research activities in this field both at home (in China) and abroad were reviewed with special emphasis on notable achievements and inherent problems. The findings suggest that future research efforts should be focussed on investigations dealing with the effect of fluctuation characteristics on the formation of cloud and fog droplets and comprehensive studies of the relationship between macroscopic conditions and microscopic structures.

- 4.3 Chen Jui-yung (Ch'en Jui-jung)
THE INFLUENCE OF THE PROCESS OF
PRECIPITATION ON THE STRUCTURE OF
LOCAL CUMULUS
32(4): 285-300, December 1962
7 figs., table, 3 refs., 36 eqs.

This paper deals with the derivation of the equations of motion and the thermodynamical equations for a local cumulus system. Mathematical expressions for the liquid water content are also derived. The influence of frictional drag, cooling, fluctuations in the liquid water content and the feedback effect of the variations of the drag profile around raindrops on vertical motion are all included in the derivation. Variations in the vertical motion, temperature difference between the cloud mass and the environment and the liquid water content during the process of precipitation are examined. Five numerical examples are then computed from different sets of input parameters for an analytical comparison of the effects of different precipitation intensity, atmospheric stability, initial cloud and environmental conditions on the structure of the cumulus. The computed results indicate that under the influence of the precipitation process in a local cumulus, there is a significant decrease in the liquid water content and the intensity of vertical motion in the cloud mass as well as in the temperature difference between the cloud mass and the environment. Furthermore, the descending motion which first appears near the cloud base rapidly extends its regime upward. Thus, the dissipation of the cloud mass also starts from the cloud base and gradually spreads upward. It is noted that the computed results can well account for the observed processes of dissipation of a precipitating cloud.

- 4.4 Koo Chen-chao (Ku Chen-ch'ao) and
Tsan Li-san (Chan Li-shan)
ON THE GROWTH OF FOG AND CLOUD DROPLETS BY
GRAVITATIONAL COALESCENCE IN A FLUCTUATING
ENVIRONMENT
32(4): 301-307, December 1962
11 figs., 7 refs., eqs.

Since the properties of meteorological elements and physical entities are characterized by incessant fluctuations within the cloud mass and

the fog layer, studies of the profile of droplet growth by gravitational coalescence in a fluctuating environment and the formation of droplet spectra are of paramount importance. In this paper a theoretical type of droplet distribution is derived from the computed rate of droplet growth within the fog layer and the cloud mass, both of which are characterized by fluctuations in droplet concentration (liquid water content). The results indicate that the growth rate of cloud droplets is relatively high in a fluctuating environment. Consequently, in a relatively short period of time droplets in thin clouds may grow to a considerable size, i. e., 50 - 100 μ in radius. Thus, the so-called "growth barrier" which checks the rate of growth in the process of condensation and coalescence in a non-fluctuating environment when droplets reach about 20 - 30 μ in radius does not seem to exist in a fluctuating environment.

- 4.5 Zhou Xiu-ji (Chou Hsiu-chi)
A STATISTICAL THEORY OF THE MICROPHYSICAL
MECHANISM FOR PRECIPITATION FROM WARM CLOUDS
33(1): 97-107, February 1963
5 figs., 21 refs., eqs.

The main purpose of this article is to present a preliminary theoretical and experimental analysis of the microphysical mechanism for precipitation from warm clouds. The theory of the stochastic processes of droplet growth in clouds is discussed and a model of the micro-mechanism for warm cloud precipitation is proposed. The results indicate that the fluctuations produced by turbulence and the coalescence process in the eddy currents are of paramount importance in the production of precipitation.

- 4.6 Hsu Hua-ying (Hsu¹¹ Hua-ying) and
Koo Chen-chao (Ku Chen-ch'ao)
PRECIPITATION PRODUCED BY GRAVITATIONAL
COALESCENCE IN SHALLOW WARM CLOUDS UNDER
FLUCTUATING CONDITIONS
33(1): 108-114, February 1963
5 figs., 5 refs., eqs.

In this paper, an evaluation of the droplet growth by gravitational coalescence is made by taking into consideration the effect of the eddy fluctuations in the vertical currents. It is found that under the influence of the fluctuating

upcurrents, cloud droplets may grow to larger drops of different sizes ranging from minute precipitating elements to raindrops. A more reasonable explanation of the formation of rain in shallow warm clouds is then suggested.

- 4.7 Chen Jui-yung (Ch'en Jui-jung)
 EVOLUTION OF INDIVIDUAL CUMULUS
 33(2): 257-270, May 1963
 10 figs., 3 tables, 7 refs., eqs.
 Full translation: Emm-65-1

In this paper, the evolution of individual cumulus is studied with basic equations involving the drag effect of water droplets and the phase transformation of moisture (including evaporation caused by entrainment). Considering individual cumulus as a uniform cloud parcel, calculations are made for the thermal conditions and other properties in the evolution process. It is shown that the drag and phase transformation effects on cloud development are important. The results are discussed and compared with observations made in China, and fair agreement is found in many aspects.

- 4.8 He Zhen-zhen (Ho Chen-chen)
 THE MEASUREMENT OF SPECTRA OF
 SMALL RAINDROPS BY PHOTOGRAPHIC
 PAPER
 33(3): 399-401, August 1963
 2 tables, 2 refs.

- 4.9 Chao Jih-ping (Ch'ao Chi-p'ing) and
 Hu Kwang-shing (Hu Kuang-hsing)
 THE DRAG EFFECTS OF WATER DROPS
 ON THE AIR CURRENT IN CLOUDS
 33(4): 449-458, November 1963
 5 figs., table, 9 refs., 65 eqs.

This paper represents a further study of the drag effects of precipitating particles on air currents in convective clouds. By treating the precipitating particles and the environmental atmosphere as a combined medium and applying the theory of transportation of sand particles, a new fundamental

set of equations is derived, from which solutions for both the steady and non-steady states are obtained. Two interesting features are noted in the results:

(a) Subsiding motions produced by drag effects in clouds with realistic values of liquid water content are comparable in magnitude with those observed in practice.

(b) In regions of high concentration of precipitating elements (the precipitation bubble), water drops tend to accumulate along the front edge of the region and this may result in a showery-type precipitation at the ground. In other words, the intensity of precipitation may be very high at the onset.

4.10 Feng Da-xiong (Feng Ta-hsiung)
A CASE ANALYSIS OF THE SNOW CRYSTALS
COLLECTED FROM A WEAK PRECIPITATION
SYSTEM OVER NORTH CHINA
33(4): 554-561, November 1963
3 figs., photos, 5 refs.

4.11 Chao Ber-lin (Chao Po-lin)
ICE CRYSTAL FORMATION MECHANISM
AND DRY ICE EVAPORATION
34(1): 87-93, February 1964
6 figs., 6 tables, 8 refs., 14 eqs.
Full translation: Emm-65-2

This paper discusses the mechanism for ice crystal formation in the neighborhood of dry ice. It studies the evaporating process of dry ice in supercooled clouds. The results agree with experiment.

4.12 Chen Jui-yung (Ch'en Jui-jung)
THE ASYMMETRICAL EFFECT OF THE DISTRIBUTION
OF PRECIPITATION IN CLOUDS ON THE MOVEMENT
OF INDIVIDUAL CUMULUS
34(1): 122-125, February 1964
8 figs., ref., 8 eqs.

- 4.13 Li Shing-sheng (Li Hsing-sheng),
Chao Jih-ping (Ch'ao Chi-p'ing) and
Hwu Yiin-chyau (Hu Yin-ch'iao)
A DYNAMICAL ANALYSIS OF
THE DEVELOPMENT OF
CUMULONIMBUS INCUS
34(2): 225-232, May 1964
5 figs., 10 refs., eqs.
Full translation: Emm-65-36

This paper analyzes the development of the cumulonimbus incus using an approximate solution of the nonlinear differential equations of cumulus dynamics in which the latent heat of condensation is considered. It is shown that the incus structure is a necessary consequence of a strong cumulus development.

- 4.14 Wen Jing-song (Wen Ching-sung)
THE INFLUENCE OF CORRELATION TIME
OF FLUCTUATION FIELDS ON
THE STOCHASTIC GROWTH OF
WATER DROPLETS
34(3): 369-377, August 1964
8 figs., 2 tables, 8 refs., 20 eqs.
Full translation: Emm-65-25

This paper discusses the effect of correlation time on the growth of cloud droplets under the influence of fluctuation fields. The results reveal that the characteristic of the fluctuation field is an important parameter.

The findings of the present study show that the correlation time of the turbulent acceleration field is too short to contribute directly to the formation of raindrops.

A preliminary survey indicates that the fluctuation of liquid-water content contributes greatly to the growth of 30 - 50 μ droplets and accelerates the process by more than half an hour in comparison with the uniform growth of the conventional model.

- 4.15 Hsu Hua-ying (Hsu¹¹ Hua-ying)
AN ANALYSIS OF THE VARIOUS FACTORS
IN RAIN FORMATION WITH RESPECT
TO FLUCTUATIONS OF THE
VERTICAL CIRCULATION
34(3): 378-382, August 1964
5 figs., table, 2 refs., eqs.
Full translation: Emm-65-26

It was pointed out in reference [1]* that fluctuations of the ascending air current play an important role in the formation of precipitation elements in a shallow warm cloud. Based on this concept this paper further analyzes the effects of the various factors involved. It is shown that precipitation can develop only when there is an optimum combination of such parameters as the fluctuation of the vertical velocity, the average vertical velocity, the moisture content in the cloud and the cloud thickness. The paper discusses particularly the effect of the fluctuation on the raindrop spectrum. It appears that if the fluctuation is too great it will not benefit rain formation.

- 4.16 Chao Yen-tseug (Chao Yen-tseug),
Shih Wai-guang (Hsieh Wei-kuang) and
Chen Shi-ming (Ch'en Hsi-ming)
AN INSTRUMENT FOR DETERMINING THE
SPECTRA OF THE ELECTRIC CHARGE
OF CLOUD DROPLETS
34(4): 531-538, November 1964
9 figs., 5 refs., 3 tables, 7 eqs.
Full translation: Emm-66-129

This paper describes the design, construction and calibration of a simple instrument for determining the spectra of the electric charge of cloud droplets. The instrument was used to evaluate the spectra of the electric charge of droplets produced by sprays from the domestic water supply in a cloud chamber. A preliminary analysis of the results was made.

* See 4.6.

- 4.17 Xu Huan-bin (Hsu Huan-pin)
A PRELIMINARY STUDY OF THE FLUCTUATIONS
OF THE MICROPHYSICAL STRUCTURE OF CLOUD
AND FOG IN HENG SHAN
34(4): 539-547, November 1964
9 figs., 8 tables, 2 refs.
Full translation: Emm-66-130

This paper studies experimentally the fluctuations of the absolute total concentration of cloud and fog droplets in a natural environment and the spectral profile of cloud drops by means of the continuous sampling technique. It is shown that the cloud drop concentration in the middle and lower regions of stratocumulus exhibit fluctuations with a spatial scale of 1 - 6 meters and that the values of these fluctuations may reach 30 - 100%. Fluctuations in the profiles of the cloud drop spectra are related to variations in concentration. Within the scale of fluctuations, the cloud drop spectra are characterized by the abundance of small droplets in regions of low concentration and large drops in regions of high concentration. Even under the conditions of uniform concentration over a broad range, fluctuations in the droplet spectra could still occur in a small volume because of the stochastic nature of the distribution and dispersion of cloud drops. This type of fluctuation becomes very small in samples of more than 1000 - 2000 drops.

- 4.18 You Lai-guang (Yu Lai-kuang) and
Shi An-ying (Shih An-ying)
ANALYSIS OF THE CHARACTERISTICS OF VARIATION OF
ICE-NUCLEUS CONCENTRATION IN PEKING
DURING SPRING 1963
34(4): 548-554, November 1964
6 figs., 3 tables, 4 refs.

The concentration of ice nuclei active at temperatures -15°C , -20°C , -25°C and -30°C was measured in Peking during 18 March - 30 April 1963 using a mixed cloud chamber. It was found from the average concentration and daily variation that concentration of ice nuclei in the downwind area is higher when the visibility is low and when there is a dust storm. Thus, it appears that in the Peking region city pollution and the soil are important sources of ice nuclei.

- 4.19 Huang Mei-yuan (Huang Mei-yuan),
Hung Chung-hsiang (Hung Chung-hsiang) and
Hsiung Shang-ching (Hsiung Shang-ch'ing)
A CLOUD-DROPLET SAMPLER FOR
CONTINUOUS OPERATION AT
GROUND LEVEL
35(2): 257-262, May 1965
7 figs., 5 refs., eqs.
Full translation: Emm-67-154

This paper describes the design and construction of a cloud-droplet sampler for continuous operation at ground level. The equipment used previously can only work continuously for two seconds in a single probing, while in this one the duration of continuous sampling may be extended up to two minutes with an adjustable exposure control. Field experiments carried out in the spring of 1964 show that this instrument can be used to scan the fluctuations of parameters characterizing the microstructure of cloud and fog with periods of the order of 0.1 to 10 seconds. A simple assessment of the instrumental error has also been made.

- 4.20 Sun Ko-fuh (Sun K'o-fu) and
You Lai-guang (Yu Lai-kuang)
ICE AND SNOW CRYSTALS IN PRECIPITATING
COLD LAYER CLOUDS OVER KIRIN PROVINCE
DURING APRIL - JUNE 1963
35(3): 265-272, August 1965
5 figs., 9 tables, 6 refs.

This paper studies the general characteristics of ice and snow crystals in precipitating cold layer clouds using data on 432 specimens taken with aluminum foil sampling apparatuses in 15 aircraft observations over Kirin Province during April - June 1963. The results are as follows:

(a) The average concentration of ice crystals (diameter, 0.1 - 0.3 mm) in the cloud is 26.2 per liter and that of snow crystals (average diameter, 1 mm) is 0.18 per liter.

(b) Ice and snow crystals in layer clouds do not vary markedly; the observed values are close to the average values.

(c) The lower the temperature and the higher the altitude of the cloud top, the larger are the average concentrations of ice and snow crystals in the cloud.

(d) Ice and snow crystals at different temperatures within the cloud or at different levels of the cloud have different characteristics.

- 4.21 Wang Hsioh-ling (Wang Hsueh-ling),
Chang Wan-chun (Chang Wan-chun) and
Hsiung Shang-ching (Hsiung Shang-ch'ing)
ICE NUCLEI OVER THE PAICHENG AREA IN SPRING
35(3): 273-279, August 1965
5 figs., 5 tables, 4 refs.

Observations made over the Paicheng* area in Kirin Province from 30 April to 25 May 1964 indicated that the concentration of ice nuclei increased rapidly with decreasing temperature and that at times these particles were rather active in the atmosphere at -10°C . The air masses originating from the tilted troughs over the Yellow River bend in the arid region of northwestern China and from the cyclones over Inner Mongolia have the largest ice nucleus concentrations, followed by those from the cyclones over Lake Baikal in the semi-arid region of Soviet Asia. The ice nucleus concentrations in the air masses associated with the northern cold highs are the smallest. Furthermore, ice nucleus concentration is inversely proportional to visibility. This indicates that such a concentration depends heavily on the air-mass source region and the weather system. Soil particles in dust storms may possibly be the active nuclei which play an important role in the formation of cloud and precipitation.

- 4.22 Chao Ber-lin (Chao Po-lin) and
Feng Zhi-xian (Feng Chih-hsien)
THE TRANSFORMATION OF CLOUD DROPLETS TO
ICE PARTICLES IN NATURAL CLOUDS
35(4): 408-415, November 1965
7 figs., 6 refs., 15 eqs.

This paper discusses the transformation processes of water droplets into ice particles in supercooled natural clouds and the production of precipitation

* Also known as Taoan.

elements. The results of computations indicate that the conventional model which relies on a spectrum of uniformly distributed ice-formation nuclei in an isothermal environment under static conditions is unable to truly reveal the physical processes inside the cloud mass. The transformation is greatly influenced by upcurrents, non-isothermal effects and the spectral profile of the ice-formation nuclei.

- 4.23 Zhao Jian-ping (Chao Chien-p'ing),
Zhang Mi (Chang Mi),
Wang Yu-xi (Wang Yu-hsi),
Chen Zai-hua (Ch'en Tsai-hua) and
Lai De-jin (Lai Te-chin)
AN ANALYSIS OF SAMPLES OF ATMOSPHERIC NUCLEI
OVER CHINA
35(4): 416-422, November 1965
6 figs., 2 tables, 4 refs.

Atmospheric nuclei over Lanchow, Sian and Dairen were sampled under an average environmental temperature of -20°C at each station during the period from 15 March to 15 April 1964. The ice crystals were examined in sugar solutions of specific gravity ranging from 1.22 - 1.24. An analysis of the observed data reveals that the nucleus concentration amounts to 8×10^3 particles/ m^3 over North China in spring with a maximum value of 10^5 particles/ m^3 . The distribution is characterized by well-marked spatial variations, and the rapid changes in nucleus concentration are closely related to the evolution of the various synoptic processes.

- 4.24 You Lai-guang (Yu Lai-kuang),
Shun Guang-ying (Hsiung Kuang-ying),
Gao Ming-ren (Kao Ming-jen),
Loo Yi-jun (Lu Yü-chün),
Sun Ko-fuh (Sun K'o-fu) and
Ren De-fu (Jen Te-fu)
THE CHARACTERISTICS OF THE FORMATION OF
ICE CRYSTALS AND THE GROWTH OF SNOW CRYSTALS
IN STRATIFORM COLD CLOUDS OVER KIRIN IN SPRING
35(4): 423-433, November 1965
12 figs., 3 tables, 3 refs.

Samples of ice and snow crystals were taken on aluminum foils by reconnaissance aircraft from precipitating stratiform cold clouds over

Kirin during the spring of 1963. This paper summarizes the spatial distribution of the concentrations of ice and snow crystals, the variation of crystal configurations with concentration and ambient temperature and the change of the diameter of snow crystals with height. The characteristics of the variation of the crystal spectra in a single probing and the associated results are also presented. From the available observations, a preliminary analysis of the formation and growth of ice crystals in cold clouds, the water content in the solid phase and other related problems was made.

See also: 18.3 and 21.9

CHAPTER 5

CONVECTION; HEAT TRANSFER; VERTICAL MOTION

- 5.1 Lee Chi-chen (Li Ch'i-ch'en)
COMMENTS ON THE IMPROVEMENT OF THE
MEASUREMENT OF VERTICAL MOTIONS IN
THE FREE ATMOSPHERE BY MEANS OF
ZAICHIKOV'S "COMB-SAW" TYPE RADIOSONDE
27(1): 61-68, March 1956
3 figs., 3 tables, 3 refs., 8 eqs.

For the measurement of vertical motions in the free atmosphere by means of Zaichikov's "comb-saw" type radiosonde, it is necessary to estimate the relative velocity W_0 of the balloon with respect to the free atmosphere. In this paper the following expression is used for the evaluation of W_0 :

$$W_0 = a\rho\omega + b \quad (1)$$

to replace the functional relationship suggested by Zaichikov which is represented by

$$W_0 = A + B \frac{\rho_0}{\rho\omega} \quad (2)$$

where ρ denotes density of the air and ω the angular velocity of the miniature wind-mill of the radiosonde. Since the coefficients a and b in Equation (1) may be determined more easily and accurately, reliable estimates of W_0 can be obtained and thus errors in the evaluation of W due to inaccurate estimates of W_0 may be eliminated.

- 5.2 Kang Wen-tian (K'ang Wen-t'ien)
A FORMULA FOR THE EVALUATION OF THE
SLOPE OF AN ISENTROPIC SURFACE AND ITS
APPLICATION TO THE ESTIMATION OF
VERTICAL MOTIONS IN THE ATMOSPHERE
28(1): 86-90, February 1957
Fig., 4 refs., eqs.

- 5.3 Yen Kai-wei (Yen K'ai-wei)
COMMENTS ON THE ARTICLE "A FORMULA
FOR THE EVALUATION OF THE SLOPE
OF AN ISENTROPIC SURFACE AND ITS
APPLICATION TO THE ESTIMATION OF
VERTICAL MOTIONS IN THE ATMOSPHERE"*
28(4): 334-335, November 1957
- 5.4 Wu Yon-shen (Wu Jung-sheng) and
Acta Meteorologica Sinica. Editorial Committee
A NEW METHOD OF COMPUTING VERTICAL MOTION
DURING AN ISALLOBARIC WIND
30(1): 72-84, February 1959
30(4): 416, November 1959
9 figs., table, 8 refs., eqs.

This paper proposes a new method for computing vertical motion during an isallobaric wind. It gives certain qualitative rules for estimating the distribution of vertical velocity. These rules may be applied in routine forecasting.

- 5.5 Chao Jih-ping (Ch'ao Chi-p'ing)
THE DYNAMICS OF DEVELOPMENT OF
THERMAL CONVECTION IN A
STRATIFIED ATMOSPHERE
31(3): 191-204, November 1961
13 figs., 10 refs., 47 eqs.

This paper presents solutions for the simultaneous nonlinear partial differential equations representing the development of thermal convection, using the method proposed by Dorodnitsyn. It studies the dynamic process of the development under six types of unstable stratification. It is shown that in all cases examined, thermal convection grows very rapidly with time. For fully developed thermal convection, the air current is convergent in the lower level and divergent in the upper level, and in some cases, compensated downdrafts appear simultaneously in the upper level. The paper analyzes the mechanism for the appearance of the downdrafts and finally extends the theory to the study of the growth of cumulus.

* See 5.2.

- 5.6 Chao Jih-ping (Ch'ao Chi-p'ing)
AN APPROXIMATE ANALYSIS OF THE INTERACTION
BETWEEN THE DEVELOPMENT OF SMALL-SCALE
CONVECTION AND THE ENVIRONMENT
32(1): 11-18, March 1962
8 refs., 60 eqs.

This paper presents an analysis of the nonlinear relationship between the development of small-scale convection and the environmental conditions (mean motions) by means of an approximate model. The results show that in addition to the convective development under unstable and neutral conditions, convection may also develop when the stratification is stable. The perturbation amplitude finally tends to a finite value. The development of perturbations is also found to bring about changes in the mean state of the atmosphere. It is noted that neutral stability is eventually found to prevail irrespective of the initial atmospheric stratification and that the average wind speed decreases in all cases.

- 5.7 Chao Jih-ping (Ch'ao Chi-p'ing)
A PRELIMINARY THEORETICAL ANALYSIS OF SOME
METEOROLOGICAL CONDITIONS FAVORABLE FOR
CONVECTIVE DEVELOPMENT
32(1): 87-90, March 1962
8 refs., 20 eqs.

This paper deals with the analysis of the instability conditions introduced by the linearization of the differential equations governing the dynamics of microscale motions. Some meteorological conditions favorable for convective development are discussed. It is noted that the vertical derivative of wind shear of the basic current acts as a stabilizing factor and that the presence of cumulus streets on the macroscale is also related to the profile of the vertical derivative of wind shear.

- 5.8 Hu Kwang-shing (Hu Kuang-hsing)
A NONLINEAR THEORY OF THE DECAY OF
CONVECTIVE PROCESSES
32(2): 154-163, June 1962
4 figs., table, 13 refs., 30 eqs.

This paper presents a study of a particular type of cumulus development which is characterized by rapid growth and abrupt decay of convection.

The solution of a set of nonlinear simultaneous differential equations describing cumulus development is obtained by means of the method suggested by Dorodnitsyn. The computed results show that the process of decay begins at the cloud top and works its way downward. It is noted that the nonlinear terms and the instability of atmospheric stratification play a significant role during the decay of convective motion and that the downdraft is an extremely important factor in bringing about cumulus dissipation.

- 5.9 Zhou Ming-yu (Chou Ming-yü)
PRELIMINARY RESEARCH OF CONVECTIVE HEAT
TRANSFER IN THE LOWER ATMOSPHERIC LAYER
33(3): 290-296, August 1963
8 figs., 10 refs., eqs.
Full translation: E-T-Ch-64-26

Based on an analysis of the interaction between convective heat transfer and atmospheric stratification, this paper establishes a preliminary model of convective heat transfer, and numerical computations are given. The results of the computations show that the interaction between heat transfer and atmospheric stratification plays an important role in heat transfer. Heat flux is much greater during unstable stratification than during stable stratification. As a consequence of the vertical transfer of heat flux, atmospheric stratification clearly changes in the initial stage, while in the final stage, it approximates neutral stratification.

- 5.10 Chang Min-lie (Chang Ming-li)
A CASE STUDY OF THE HEAT BALANCE
OVER EAST CHINA DURING HIGH SUMMER
34(1): 74-86, February 1964
8 figs., 5 tables, 7 refs., 5 eqs.

In this paper, the values of each term in the energy equation were computed over East China together with the magnitudes of the energy transfer across the boundaries of the region. The data used were taken from the four-day period 23 - 26 July 1959, when the entire mainland of China was dominated by the subtropical anticyclone in the upper levels. The results indicate that the region was an energy source from which

heat and water vapor were transported outward. There were however significant differences in the mode of transfer across the various boundaries. The major difference was characterized by a net inflow across the southern boundary and a low-level outflow across the eastern one with a compensating inflow aloft. This transfer configuration was largely dependent on the circulation patterns of the low-level thermal depression and the upper-level subtropical anticyclone covering the region. In the case of heat transfer, the eddy flux was found to be more important than the mean transport. A study of the energy balance over the region reveals that energy loss was mainly caused by advection and radiative cooling while the vertical influx of sensible and latent heat from the underlying surfaces acted as important sources of supply. Changes in the internal heat energy and moisture content of the atmosphere exerted only very little effects on the balance. The eddy flux of sensible heat was found to be about 1.84 times that of latent heat from evaporation.

- 5.11 Chao Jih-ping (Ch'ao Chi-p'ing) and
Cheng Li-shoo (Ch'en Li-shu)
THE EFFECTS OF VERTICAL WIND SHEAR ON THE
DEVELOPMENT AND STRUCTURE OF CONVECTION
34(1): 94-102, February 1964
6 figs., 18 refs., 45 eqs.

This paper is divided into two parts. The first analyzes the effect of a prevailing wind with a vertical shear on the intensity of convective development. It is pointed out whether the vertical wind shear favorable to convective development depends on the structure of convective circulation. For a specific type of circulation, the relative importance of the vertical wind shear and unstable stratification to the development of perturbation is discussed quantitatively from calculations of the perturbation growth rate.

In the second part of the paper, solutions for the nonlinear convective equations of motion are carried out, taking into account the effect of the vertical wind shear. The computed results show that due to the effect of the vertical wind shear, the structure of convective

circulation is different from the case of a stationary atmosphere. It is not axially symmetrical, but is mainly formed by two clockwise vortex rings. This type of circulation structure is quite similar to those found in thunderstorms and shower clouds.

- 5.12 Wang Pai-lin (Wang P'ei-lin)
A MEAN INSTABILITY INDEX FOR THE PREDICTION
OF CONVECTIVE DEVELOPMENT
34(3): 299-303, August 1964
3 tables, ref., 13 eqs.

This paper deals with the derivation of a mean instability index, $\bar{S}(H)$, for routine application to prediction of convective development. In the derivation, the effect of buoyancy on the ascending air parcel is integrated throughout the entire convective column.

A verification test of this index is made by using independent data from Changsha for the months of July and August from 1959 to 1962 and the results indicate that $\bar{S}(H)$ is a useful predictor for forecasting processes of convective development.

- 5.13 Chou Shiao-ping (Chou Hsiao-p'ing),
Li Shing-shen (Li Hsing-sheng),
Chang Yao-ko (Chang Yao-k'o) and
Gung Chen-jing (Kung Tseng-chin)
A NUMERICAL EXPERIMENT OF
CUMULUS DEVELOPMENT
34(4): 475-485, November 1964
4 figs., 14 refs., 24 eqs.

This paper presents a three-dimensional axial-symmetric model of cumulus development with account taken of the effect of condensation feedback on the field of motion and the assumption that the environmental temperature lapse rate and the relative humidity decrease with height. Calculation performed on an electronic computer shows that when there is an initial temperature disturbance of $\sim 1^\circ\text{C}$, a 5 - 6 km thick cumulus cloud can develop within 20 minutes. In the lower part of the cloud, there is a moist adiabatic unstable region whose variation with time is slight; the field of motion and the temperature

field in this region also do not vary markedly. In the stable region in the upper part of the cloud, however, these fields fluctuate rather greatly with time, and the convective cells from the lower part of the cloud oscillate and gradually dissipate at the top. These features are in accord with the phenomena observed in the atmosphere.

See also: 2.14 and 4.7

CHAPTER 6

DROUGHT AND FLOOD; RAINFALL DISTRIBUTIONS

- 6.1 Hsü Shu-ying (Hsü Shu-ying)
A STATISTICAL ANALYSIS OF DROUGHTS AND
FLOODS IN DIFFERENT REGIONS OF THE
YELLOW RIVER VALLEY
27(4): 323-336, December 1956
4 figs., 4 tables, 4 refs.

This paper presents a statistical analysis of the relationship of droughts and floods in seven regions of the Yellow River valley. These regions are delineated on the same basis as in the previous investigation by the present author under the title of "A preliminary analysis of droughts and floods in the Yellow River valley"*. The main points of discussion of the present study are: (a) The chances of simultaneous occurrence of droughts or floods in any two or more regions; (b) the possibility of droughts and floods in all other regions when drought is occurring in a particular region; (c) a comparison of the intensity of drought in each region together with an estimate of the persistence of droughts. Finally, it is noted that drought conditions are most severe over the Hopei plain and in its vicinity with the exception of the northwest region of the upper Yellow River basin (Chiuchuan) and least serious over the Wei Ho basin.

- 6.2 Chen Chi-kung (Ch'en Ch'i-kung)
THE COMBINED DEDUCTIVE-EMPIRICAL METHOD
FOR THE FORECASTING OF LOCAL RAINFALL
AND THE RESULTS OF PRELIMINARY TESTING
IN CHINA
29(3): 143-161, August 1958
12 figs., 31 refs., eqs.

This paper introduces the combined deductive-empirical method of forecasting local rainfall. The application of this method to three areas in China is discussed.

* The Science Press, Peking, China. 1956.

- 6.3 Hsieh Yi-ping (Hsieh I-ping)
RESEARCH PROBLEMS OF PRECIPITATION
IN CHINA FROM 1949 TO 1959
30(3): 223-225, August 1959
36 refs.
- 6.4 Shangtung Provincial Meteorological Service
SEVERAL SYNOPTIC PATTERNS OF
HEAVY SUMMER RAINFALL IN
SHANGTUNG PROVINCE
35(3): 305-315, August 1965
16 figs., 8 tables

This paper analyzes 110 heavy rainfalls that occurred in Shangtung Province during June - September 1956 - 1962. It is shown that these downpours were attributed to five types of weather systems, viz., cyclone, typhoon, cold front, stationary front and warm front shear line. The occurrence and development process of each type of heavy rainfall are known to be associated with a corresponding circulation pattern. The paper also discusses the characteristics of the various types of heavy rain and the prediction problems.

See also: 3.17, 4.1, 7.9, 7.14, 9.12, 9.20, 16.6,
16.7, 17.9 and 19.8

CHAPTER 7

GENERAL CIRCULATION

- 7.1 Yeh Tu-cheng (Yeh Tu-cheng) and
Dunn Gun-yung (Teng Ken-yün)
MEAN MERIDIONAL CIRCULATION AND
ANGULAR MOMENTUM BALANCE
IN THE YEAR 1950
27(4): 307-321, December 1956
5 figs., 17 refs., eqs.

This paper studies the mean meridional circulation and the balance of angular momentum for the year 1950, using the average meridional component of upper winds ($[\bar{v}]$) computed by Buch [5] and Starr and White [6]. Charts depicting the annual, winter and summer configurations (Figures 1 to 3 respectively) reveal the existence of a three-cell structure characterized by two direct cells at low and high latitudes with an indirect cell in between.

The mean jet stream of 1950 is located within the indirect cell. The annual average position of the equatorial convergence zone is found near 5°N. All the three cells shift northward as the season advances from summer to winter, and the Hadley cell of the winter hemisphere extends to the summer hemisphere. These cells seem to be more intense in winter than in summer.

An analysis was made on the balance of angular momentum in the northern hemisphere from 10° - 70°N for the year 1950 (Figure 4). A streamline chart depicting the spatial transportation of angular momentum within this domain was prepared and is shown as Figure 5. It is found that the streamlines crossing the boundary separating the easterly and the westerly wind regimes are all vertical. This implies that the angular momentum of the easterly wind belt is transported vertically upward to the low-latitude upper westerly wind regime and thence horizontally to middle and high latitudes.

Finally, a discussion on the maintenance of the zonal circulation leads to the conclusion that this mechanism depends principally on large-

scale disturbances in middle and high latitudes, while in low latitudes, the mean meridional circulation is of paramount importance.

- 7.2 Wu Hung-shun (Wu Hung-hsun) and
Chin Long-shun (Ch'en Lung-hsun)
THE STRUCTURE OF THE GENERAL CIRCULATION
OVER ASIA FROM JANUARY TO THE FIRST DECADE
OF MARCH 1956
27(4): 361-381, December 1956
15 figs., 2 tables, 14 refs.

The structure of the general circulation over the Asiatic continent during the period from January to the first decade of March 1956 is examined by means of all available aerological data. The findings are summarized as follows:

(a) Average conditions during the above period indicate that two distinct jet streams co-existed over the Asiatic continent. They merged into one jet near 140°E .

(b) Both jets showed pronounced acceleration downstream. Acceleration started from 75°E along the southern jet and from 100°E along the northern one.

(c) The concentration of baroclinity of the atmosphere over the eastern Asiatic continent was most marked in the vicinity of the Tibetan Plateau.

After a preliminary study of the above phenomena the present authors are of the opinion that the existence of the Tibetan Plateau affects the general circulation in the following three ways:

(a) The plateau tends to induce an increase in the degree of baroclinity of the atmosphere and the formation of vertical circulation south of the plateau. As a result, the southern jet intensifies.

(b) The existence of the plateau brings about confluence of the two jets just beyond its eastern periphery. This gives rise to intensification of the jet downstream.

(c) The plateau maintains the intensity and the steadiness of the southern jet with little daily, seasonal and annual variations.

- 7.3 Dao Shih-yen (T'ao Shih-yen) and
Chen Lung-shun (Ch'en Lung-hsün)
THE STRUCTURE OF THE GENERAL CIRCULATION
OVER THE ASIATIC CONTINENT IN SUMMER
28(3): 234-247, August 1957
16 figs., table, 18 refs.

This paper presents an analysis of the structure of the mean wind field at 850 mb, 700 mb and 500 mb over the Asiatic continent in July for the period 1951 - 1955 and the mean contour pattern at 200 mb for July and August in 1956. Vertical cross-sections of the mean wind and temperature fields along 75°E, 90°E, 105°E and 120°E for July and August 1956 are also presented. It is found that the three-dimensional flow structure over the Asiatic continent in summer consists of three basic currents, viz., (a) the westerlies in middle latitudes, (b) the upper-level easterlies in the tropics and subtropics and (c) the southwest monsoon beneath the tropical and subtropical easterlies.

An investigation is also made of the general circulation over Asia during the transitional period from spring to summer 1956. It is noted that a marked change occurred during this period. The transition was characterized by the northward retreat of the subtropical westerly jet stream south of the Himalayas, development of the subtropical ridge over the Tibetan Plateau and establishment of a high-level easterly jet stream over South Asia (south of 12°N). Meanwhile, the southwest monsoon set in over India and the mei-yü¹¹ began to affect the Yangtze valley. It is further found that the northward displacement of the rain belt over the mainland of China in summer is closely related to the poleward retreat and the accompanying weakening of the westerlies.

- 7.4 Chu Pao-chen (Chu Pao-chen)
A HYDRODYNAMIC MODEL FOR THE SEASONAL VARIATION
OF THE GENERAL CIRCULATION AND LONG-RANGE
FORECASTING
29(1): 57-62, February 1958
8 refs., 28 eqs.
Full translation: Emm-65-61

A more realistic numerical model for long-range forecasting is set up from a system which includes relevant equations in hydrodynamics,

thermodynamics and radiation transfer. The model includes the effect of friction and turbulence and makes allowance for the mutual adjustment between atmospheric motions and radiation balance. Systems of differential equations suitable for numerical integration are presented for a two-level model and a three-dimensional model separately.

- 7.5 Yang Chien-chu (Yang Chien-ch'u),
Wang Kei-cheng (Wang Kuan-ch'eng) and
Lee Yu-lan (Li Yü-lan)
THE INFLUENCE OF THE TIBETAN PLATEAU ON THE
CIRCULATION SYSTEMS TO THE NORTH OF THE
PLATEAU
30(1): 99-113, February 1959
8 figs., 13 tables, 9 refs.

In this paper, changes in the speed of movement and intensity of migratory ridges and troughs passing to the north of the Tibetan Plateau are computed from daily 500-mb charts covering the Eurasian continent during the period June 1956 - May 1957. The results show that these changes are systematic and exhibit regional and seasonal characteristics.

- 7.6 Yeh Tu-cheng (Yeh Tu-cheng) and
Xie Guang-dao (Hsieh Kuang-tao)
WORK ON INVESTIGATION OF THE GENERAL CIRCULATION
IN CHINA FROM 1949 TO 1959
30(3): 263-276, August 1959
11 figs., 52 refs.

- 7.7 Yang Chien-chu (Yang Chien-ch'u) and
Lee Yu-lan (Li Yü-lan)
A STUDY OF THE CENTERS OF THE MEAN MONTHLY
PRESSURE DEVIATION FROM THE NORMAL OF THE
NORTHERN HEMISPHERE
30(4): 297-305, November 1959
2 figs., 8 tables, 14 refs.

This paper presents a statistical study of the movement of the centers of the mean monthly pressure deviation from the normal of the northern hemisphere between January 1930 and June 1939 (114 months). It was found that the centers of deviation of the same month concentrate in certain regions, such as, south of Alaska, northeastern Atlantic and the

Arctic coastal region of Eurasia; these regions can be considered as the key areas for the occurrence of anomalous circulation over the northern hemisphere. Most of these centers may be traced from month to month; during the transitional seasons, they shift from west to east. On the basis of the interaction of these monthly pressure deviation centers, the paper also discusses the climatic features in certain regions of the northern hemisphere.

- 7.8 Hwang S. S. (Huang Shih-sung) and
Yue T. H. (Yü Chih-hao)
THE STRUCTURE OF SUBTROPICAL HIGHS AND
SOME OF THE ASPECTS ASSOCIATED WITH THE
GENERAL CIRCULATION OF THE ATMOSPHERE
31(4): 339-359, January 1962
13 figs., 41 eqs.

This paper shows that the structure of subtropical highs is far more complicated than what is found in an ordinary model. Not only is there a difference between the individual cells but also the various parts of a cell. Subtropical highs are not purely dynamic; the thermal factor plays an important role in their development and maintenance, especially in those cells over the continent. The paper also shows that the appearance in winter of two westerly jet streams over the north and south of the Tibetan Plateau is not the result of a divergence forced by the plateau. Finally it proves the existence of indirect meridional circulation and discusses its association with subtropical highs.

- 7.9 Dao Shih-yen (T'ao Shih-yen) and
Hsu Shu-ying (Hsü Shu-ying)
THE CIRCULATION CHARACTERISTICS DURING
PERSISTENT DROUGHTS AND FLOODS IN THE
YANGTZE AND HWAI HO VALLEYS IN SUMMER
32(1): 1-10, March 1962
8 figs., 9 refs.

This paper presents an analysis of the characteristics of the general circulation in subtropical and middle latitudes during persistent droughts and floods in the Yangtze and Hwai Ho valleys for the months of July in 1954, 1957 and 1961.

The analysis reveals that a distinct flow configuration appears in the 500-mb field in middle latitudes during persistent droughts with a well-defined pattern of isohypse anomalies. The flow pattern in the subtropical region is also characterized by some well-defined features. Furthermore, the flow patterns in both temperate and subtropical latitudes exhibit a high degree of stability.

The seasonal variation of the general circulation for the year when flooding occurs in the Yangtze and Hwai Ho valleys is found to have advanced by one month. The flow pattern also exhibits pronounced stability during the period of persistent flooding.

Finally, the distribution of the heating field in the northern hemisphere for the months of July in 1954 and 1959 is evaluated by means of a two-level model. The computed results are found to differ greatly from the long-term average values. For example, the distribution of the heating field for July 1959 is opposite to the mean conditions for this month while that for July 1954 resembles the mean pattern of June. Such distributions of the heating field are, however, concordant with the types of stable long waves prevailing in these two months.

- 7.10 Zhu Yong-ti (Chu Yung-t'i)
A NUMERICAL EXPERIMENT ON THE PROCESSES
OF TOPOGRAPHIC PERTURBATIONS IN A
BAROCLINIC ATMOSPHERE
32(1): 37-43, March 1962
8 figs., 9 refs., eqs.

This paper presents a numerical calculation by means of a three-level model of the distribution of zonal circulation of an ideal field under the influence of the processes of topographic perturbations for a time interval of 60 hours. The results reveal that the influence of topographic perturbations is characterized by a distinct time lag (it takes some 48 hours for the processes of perturbation to attain a relatively stable state). On the other hand, the influence of the banded flow around the Tibetan Plateau ("detouring" phenomenon) is significantly reflected in the calculated results. In the northern hemisphere, the positions of troughs and ridges induced by

topography are basically concordant with those determined from the mean circulation pattern. This shows that realistic and appropriate boundary conditions have been included in the present study.

- 7.11 Dao Shih-yen (T'ao Shih-yen),
Hsü Shu-ying (Hsü Shu-ying) and
Kuo Chi-yunn (Kuo Ch'i-yün)
THE CHARACTERISTICS OF THE ZONAL AND
MERIDIONAL CIRCULATION OVER TROPICAL
AND SUBTROPICAL REGIONS IN EAST ASIA IN
SUMMER
32(2): 91-103, June 1962
10 figs., table, 7 refs.

This paper presents an analysis of two distinct types of circulation in the low-latitude regions of East Asia during the periods 21 - 30 July 1957 and 8 - 18 July 1958 for the purpose of studying their circulation characteristics. The results show that these two periods are characterized by marked differences in the geographical distribution of long-wave systems, the activities of subtropical anticyclones, the configuration of the inter-tropical convergence zone and the position of the zonal wind belt in the northern hemisphere. Furthermore, a significant difference in the activities and the frequency of occurrence of typhoons is also noted. However, the observed differences may be explained in terms of the features of the low-latitude flow pattern prevailing during these two periods. Over the mainland of China, the synoptic processes during these two periods are also different. The main rain belt over China assumes a southwest-northeast orientation during the period of meridional circulation, and an east-west orientation during the period of zonal circulation with the maximum centers near the Yangtze and Hwai Ho basin in the latter case.

In addition to the above, the interaction between the northern and the southern hemisphere during these two periods is also examined. An analysis of the available data suggests that the events in both hemispheres are closely related. When meridional circulation prevails over the low-latitude regions of East Asia, meridional circulation is also predominant in the southern hemisphere (particularly in Australia) and the mass transport from the southern

to the northern hemisphere attains its maximum in the vicinity of Australia. On the other hand, when zonal circulation prevails over East Asia at low latitudes, zonal flow is also predominant in the southern hemisphere. Thus, the activities of cold air are insignificant in the vicinity of Australia. It follows that the trans-equatorial mass transfer to the northern hemisphere is relatively small.

- 7.12 Liu Ruey-chih (Liu Jui-chih) and
Chao Ming-tze (Chao Ming-che)
A STUDY OF THE SPEED OF MOVEMENT
OF PRESSURE SYSTEMS IN A
BAROTROPIC ATMOSPHERE
32(2): 141-153, June 1962
6 figs., 3 tables, 4 refs., 12 eqs.

This paper deals with the numerical prediction of the flow pattern of a migratory system on a high speed electronic computer by means of the barotropic vorticity equation, which includes the influence of divergence in the whole atmospheric layer. The results show that the predicted movement of the pressure systems given by this model is slower than the observed speed. This phenomenon may be caused by factors which control the retrograde movement of ultra-long waves and is related to the initial choice of the average contour height for the barotropic model. Finally, a system involving the use of empirical coefficients is presented as an improved model.

- 7.13 Chen Shou-jun (Ch'en Shou-chün)
A SPECTRAL ANALYSIS OF THE FLOW PATTERN
DURING THE EVOLUTION OF A LARGE-SCALE
SYNOPTIC PROCESS IN THE NORTHERN HEMISPHERE
32(4): 308-321, December 1962
12 figs., 18 refs., eqs.

This paper presents a spectral analysis of 500-mb waves during the evolution of a large-scale synoptic process in the northern hemisphere. The results indicate that pentad waves play an important role in characterizing the change of circulation. The transfer of angular momentum is directly southward during the establishment of zonal circulation and

northward during the breakdown of zonal circulation. In both cases the transfer of angular momentum is accomplished mainly by pentad waves.

- 7.14 Hou Yi-ru (Hou I-ju) and
Chen Chian (Ch'en Ch'ien)
THE LONG WAVE OF THE
SUBTROPICAL JET OVER
ASIA IN SUMMER
33(3): 339-349, August 1963
7 figs., table, 2 refs.

This paper analyzes the subtropical flow pattern of the upper troposphere over Asia from June to September 1955 - 1961. It was found that there is a close relationship between the long wave of the subtropical jet and the weather distribution in China, that there is a good relationship between the stability of the subtropical long wave pattern and the period of persistent drought or flood in large territories, and that in summer, there are two mean subtropical long wave troughs at 65°E and 115°E, respectively.

- 7.15 Wang Shao-wo (Wang Shao-wu)
A PRELIMINARY STUDY OF THE
CHARACTERISTICS AND EVOLUTION
OF THE MEAN MONTHLY CIRCULATION
AT THE 500-MB LEVEL OVER THE
NORTHERN HEMISPHERE.
(I) ZONAL INDEX*
33(3): 361-374, August 1963
10 figs., 10 tables, 37 refs.

This paper covers the first part of a research project concerning the characteristics and evolution of the general circulation during the period 1951 - 1960. The results of an analysis of the monthly zonal index in the temperate latitude zone (35° - 55°N) from mean monthly 500-mb charts show that the zonal circulation is characterized by the following:

* See also 7.28.

(a) The mean zonal index during the period 1951 - 1960 is about 5 - 10% higher than that in 1941 - 1950, but slightly lower than that during 1900 - 1939. In the western hemisphere (180° - 10° W), the westerlies are strengthened mainly in the summer half of the year (May - October), whereas in the eastern hemisphere (0° - 170° E), this trend is more pronounced in the winter half of the year (November - April).

(b) The half-yearly mean zonal index shows a clear periodic fluctuation; the duration of the most prominent periods are 10 years, 5.5 years and 26 months. It is highly probable that the first two periods are related to the 11-year sunspot cycle.

(c) In the summer half of the year, there is a positive correlation between the half-yearly mean indexes of the eastern and western hemisphere, the correlation coefficient being approximately 0.77. In the winter half of the year, the correlation becomes negative and its value is approximately -0.54. Analysis suggests that this may be due to the asymmetry of the circumpolar current.

(d) The mean index in the summer half of the year has a negative (positive) correlation coefficient with that in the following winter half of the year in the eastern (western) hemisphere. But from winter to summer, there is a reverse trend in the change of the zonal index.

(e) This association of the zonal index from one half year to another actually induces a biennial oscillation. It not only concerns the eastern and western hemisphere separately, but also the northern hemisphere as a whole, since the oscillations of the zonal index in the eastern and western hemisphere are 90° out of phase.

(f) The monthly mean zonal index tends to maintain the same characteristic throughout the winter or summer half of the year. In the eastern hemisphere, the high zonal index pattern shows a greater persistence than the low zonal index pattern, while in the western hemisphere, the low zonal index pattern usually persists from month to month.

- 7.16 Zheng Cheng-jun (Cheng Ch'eng-chün)
THE STRUCTURE AND SEASONAL ACTIVITIES
OF SUBTROPICAL JET STREAMS OVER THE
TIBETAN PLATEAU
33(4): 459-471, November 1963
14 figs., table

This paper analyzes data from aerological resumes of 0800 hours of each day of each month for 1957 - 1959. Cross-section diagrams are given according to latitudes and time at 90°E, 105°E and 125°E which were constructed from the average wind and temperature values for the three given years. A study is made of the jet streams, wind and temperature fields during the winter, summer and transitional seasons, and two factors (subtropical high and large-scale trough of the westerlies) directly associated with the displacement of the subtropical jet streams are found. Since there are two major adjustments of the general circulation of the atmosphere in May - July and September - October respectively, a corresponding displacement of the jet streams is also noted, either from a low to a high latitude or from a high to a low latitude. The author is of the opinion that such a displacement is accomplished in several consecutive stages of changes of the general circulation. The main conclusions of this study are as follows:

(a) The subtropical jet streams can freely pass over the Tibetan Plateau; however, at height lower than 350 mb, the speed of the currents decreases considerably due to the frictional effect of the plateau.

(b) Because of the intermittent northward displacements of the center of the subtropical anticyclones, the jet streams also move northward to a summer position.

(c) The eastward displacement of the deepened trough and the intrusion of cold air cause the jet streams to move southward to the mean winter position.

- 7.17 Qi Xian-o (Ch'i Hsien-o),
Li Guang-qing (Li Kuang-ch'ing) and
Chow Tse-tung (Chou Tzu-tung)
A COMPARATIVE STUDY OF THE SOLUTIONS TO THE
HELMHOLTZ EQUATION BY AN ITERATIVE METHOD
AND BY GREEN'S FUNCTION
33(4): 494-500, November 1963
7 figs., 8 refs., 9 eqs.

In this paper, the accuracy of the solutions to the Helmholtz equation by Green's function in a localized domain and by the extrapolation of Liebmann's iterative method is discussed. The results of applying these two methods in practical examples of forecasting by means of a two-layer model are also compared.

- 7.18 Liao Tung-hsien (Liao Tung-hsien)
THE TRANSFORMATION OF CURVATURE AND
SHEARING VORTICITIES IN A BAROTROPIC
ATMOSPHERE AND ITS APPLICATION TO
WEATHER FORECASTING
33(4): 512-517, November 1963
5 refs., 24 eqs.

It was found from a great number of operational numerical forecasts using a barotropic model that the development of the pressure systems at the 500-mb surface can sometimes be predicted to some extent, even though the zonal current is predominant in the initial stream field. On the other hand, it is well known from synoptic experience that the development of a pressure pattern is closely related to the change in the curvature and shearing vorticities. Therefore, for the sake of studying the problem of development, two equations for predicting the two quantities are derived. It can be shown that both of these quantities are not conservative and can be transformed into each other in a confluent or diffluent stream region under certain circumstances, regardless of the effect of the variation of the coriolis parameter with latitude. From these results, the phenomena previously mentioned can be explained.

Finally, the paper proposes certain weather forecasting rules for practical applications.

- 7.19 Chen Shou-jun (Ch'en Shou-chün)
ANALYSIS OF THE EFFECTIVE
POTENTIAL ENERGY SPECTRA
IN THE PROCESSES OF
FORMATION AND BREAKDOWN
OF ZONAL CIRCULATION
33(4): 549-553, November 1963
4 figs., 5 refs., eqs.
- 7.20 Chen Wen-chi (Ch'en Wen-ch'i),
Wen Ke-gang (Wen K'o-kang),
Dong Xiao-min (Tung Hsiao-min) and
Di Ying (Ti Ying)
A SYNOPTIC ANALYSIS OF THE
EVOLUTION OF THE GENERAL
CIRCULATION IN THE UPPER
TROPOSPHERE OVER THE
NORTHERN HEMISPHERE
DURING EARLY SUMMER, 1958
34(1): 41-50, February 1964
10 figs., table, 5 refs.

This paper studies the structure of the atmosphere and the evolution of the subtropical jet and subtropical high during the period 22 May - 3 July 1958, using tropopause charts. The following results are obtained:

(a) The three-fold structure of the atmosphere is also rather clear in early summer; hence, tropopause charts can still be used for analyzing the general circulation in the upper troposphere.

(b) During this period, there are six or seven waves on the subtropical jet over the hemisphere. The amplitude and number of waves change periodically with a period of about 15 days.

(c) There is a sudden northward shift of the subtropical jet at the beginning and end of June when the amplitude of the subtropical jet waves increases.

(d) The northward shift of the axis of the subtropical high at 200 mb is consistent with the northward shift of the subtropical jet.

- 7.21 Lee Siao-chuan (Li Hsiao-ch'uan) and
Chu Tung-kan (Chú Tung-ken)
SPECTRAL ANALYSIS OF THE MONTHLY 500-MB
CIRCULATION INDEXES OVER ASIA
34(2): 127-134, May 1964
9 figs., 15 refs., eqs.

This paper presents an analysis of the power spectrum of the monthly 500-mb circulation indexes over Asia. It is shown that the difference in the spectrum between the meridional and zonal indexes is significant. In the spectrum of the meridional index there is a significant maximum harmonic component with a period of ± 5 months, while the total variance of the zonal index is contributed mainly by oscillations with periods longer than 5 months.

- 7.22 Zou Hao (Chou Hao),
Qian Zi-qiang (Ch'ien Tzu-ch'iang),
Zhu Cui-ying (Chu Ts'ui-ying) and
Qiang Pan-qing (Ch'iang P'an-ch'ing)
AN ANALYSIS OF THE 500-MB CIRCULATION
IN THE MIDDLE AND LOWER YANGTZE VALLEY
DURING THE MEI-YÜ PERIOD
34(2): 174-184, May 1964
8 figs., 3 tables, 12 refs.

This paper analyzes the 500-mb flow patterns during May - July 1954 - 1962, to determine the annual mei-yü period in the middle and lower Yangtze valley. It is shown that the changes in the subtropical high over the western Pacific and the westerlies over eastern Asia are important factors for determining the beginning and the end of the period. A more important factor is the variation of the ridge line of the subtropical high in the region $110^{\circ} - 125^{\circ}\text{E}$. Mei-yü begins when this ridge line moves across 20°N from a lower latitude and ends when it moves further northward and crosses 25°N . The variation of the westerlies on 500 mb is another factor. The disappearance of the subtropical jet and a sudden northward push of the easterlies signify a change of season. After this, mei-yü begins when the subtropical jet in the band $115^{\circ} - 125^{\circ}\text{E}$ retreats northward to north of 30°N and ends when it moves further northward and crosses 35°N .

- 7.23 Wu Jung-sen (Wu Jung-sheng)
THE INFLUENCE OF A MOUNTAIN ON THE
DISPLACEMENT OF BAROTROPIC DISTURBANCES
34(2): 192-197, May 1964
Fig., 4 refs., 41 eqs.
Full translation: Emm-66-67

This paper investigates the influence of a mountain with constant slope on the displacement of barotropic disturbances. The results obtained by Chow and Koo [1]* are discussed in detail.

- 7.24 Jü Chang (Chü Chang)
THE PROBLEM OF CRITICAL LATITUDE WITH
RESPECT TO THE MAINTENANCE OF
GEOSTROPHIC EQUILIBRIUM BY LARGE-SCALE
ATMOSPHERIC MOTIONS
34(2): 242-247, May 1964
4 figs., 3 tables, 8 refs.

- 7.25 Chen Chu-shih (Ch'en Ch'iu-shih) and
Lee Ming-de (Li Ming-te)
FORMATION OF THE THERMAL WIND IN A
FOUR-LAYER BAROCLINIC ATMOSPHERE
34(3): 253-270, August 1964
21 figs., table, 8 refs., eqs.

This paper analyzes the adjustment of a non-thermal wind to the state of a thermal wind using a four-layer model. The process of adjustment is carried out by four inertia waves whose front speeds are 306, 114, 36.2 and 19.2 m/sec, respectively. It is found that the higher the level the greater is the effect of the faster inertia wave. The external inertia wave is significant only below the 750-mb level. Calculations show that alternation of the divergence and convergence in the vertical is the result of the formation of a thermal wind under certain initial conditions. The adjustment process is calculated under different initial conditions to study large-scale weather developments. For example, a non-geostrophic vortex in the wind field on the 375-mb level can form a high with the warm center located in the troposphere

* See 12.4.

and the cold center in the stratosphere. A warm center not in geostrophic equilibrium in the lower layer of the troposphere will form a flow pattern different from that produced by a warm center in the middle layer through the adjustment process. The former can merely result in a shallow warm low in the lower troposphere but in the case of the latter, an intense anticyclone will develop in the upper troposphere with its effect extending to the lower stratosphere. The paper also discusses the adjustment of a non-thermal wind generated from the development of a frontal cyclone.

- 7.26 Chen Yung-san (Ch'en Hsiung-shan)
THE LONG-RANGE PROCESS OF THE
GENERAL CIRCULATION OF THE
ATMOSPHERE UNDER THE INFLUENCE
OF NON-ADIABATIC HEATING AND THE
DYNAMIC EFFECT OF OROGRAPHY
34(3): 271-284, August 1964
4 figs., table, 8 refs., 51 eqs.

An ideal model of the general circulation of the atmosphere for numerical experiments is constructed with simple assumptions made on radiation, turbulent exchange, condensation heating and orographic effects. The model consists of two continents and two oceans, the effects of which are manifested by the given temperatures of the earth's surface. The ordinary differential equations derived are numerically integrated on a computer using the Runge-Kutta method. Starting with an atmosphere at rest, the basic current is established in 40 days by the effect of non-adiabatic heating. The basic current varies annually under the influence of solar radiation, the temperature of the earth's surface and condensation heating, all having an annual period. The amplitude of disturbances decreases in summer and increases in winter. The seasonal variation of the temperature of the earth's surface controls the movement of those ultra-long waves with a wave number of 2. Cold troughs prevail over the east of the ocean in summer and over the east of the continent in winter. It is shown from numerical experiments that the initial values are effective only for approximately 100 days.

- 7.27 • Chu Pao-chen (Chu Pao-chen)
A PRELIMINARY STUDY OF THE ACTIVITIES
OF ULTRA-LONG WAVES IN RELATION TO
THE DYNAMIC CONTROL OF LARGE-SCALE
OROGRAPHY AND HEAT SOURCES
34(3): 285-298, August 1964
7 figs., 3 tables, 14 refs., eqs.

This paper discusses the dynamic process of ultra-long waves in the middle troposphere and lower stratosphere using a simple theoretical model and taking into account the inhomogeneity of the vertical stability. It studies linearly the effects of control of large-scale orography and heat sources over the activities of this type of waves. Due to the presence of the orographic and thermal factors, ultra-long waves fluctuate and intensify about a fixed geographic location. This may explain the maintenance of certain large-scale troughs and blocking highs in the middle troposphere. The amplitude of ultra-long waves varies periodically with a period of 10 - 30 days. The period depends upon the scale of motion, the structure of circulation and the earth rotation. When the parameters of the atmosphere remain invariant for an unlimited length of time, the field of motion tends to become steady. Calculations show that the average troughs and ridges observed in the middle troposphere are a system of steady ultra-long waves formed by the orography and heat sources.

- 7.28 Wang Shao-wo (Wang Shao-wu)
A PRELIMINARY STUDY OF THE CHARACTERISTICS
AND EVOLUTION OF THE MEAN MONTHLY CIRCULATION
AT THE 500-MB LEVEL OVER THE NORTHERN HEMISPHERE.
(II) ULTRA-LONG WAVES*
34(3): 316-328, August 1964
8 figs., 2 tables, 23 refs., eqs.
Full translation: Emm-65-18

This paper is the second report of a research project concerning the characteristics and evolution of the general circulation during 1951 - 1960. The amplitude and phase angle for the mean monthly 500-mb height along

* See also 7.15.

55°N and 35°N are calculated by means of the 4-term harmonic analysis. According to the spectral distribution and phase angle, the seasonal variation of the general circulation is discussed. The conclusions are as follows:

(a) There are pronounced seasonal patterns in the (relative) amplitudes of the first and third harmonic with a strong negative correlation between the two. The (relative) amplitudes of both the first and third harmonic at 55°N are negatively correlated to their counterparts at 35°N. No significant seasonal variation is indicated for the relative amplitude of the second harmonic.

(b) The change of the phase angle shows a regular seasonal course at 55°N except for the second harmonic.

(c) The variation of the spectrum shows that the seasonal variation is different from year to year but the general trend is the same for all years.

(d) The characteristics of the spectrum of transitional seasons are clearly distinct from those of summer and winter and therefore the natural synoptic seasons may be clearly defined. The beginning and ending as well as the length and character of the seasons vary from one year to another.

(e) The weather anomaly in China has a close relationship with the pattern of ultra-long waves in the northern hemisphere. This may be shown by the examples of July 1954 and 1959 and February 1957 and 1960.

- 7.29 Chen Yung-san (Ch'en Hsiung-shan)
A NUMERICAL STUDY OF THE GENERAL CIRCULATION
OF THE ATMOSPHERE
34(4): 443-461, November 1964
10 figs., 17 refs., eqs.
Full translation: Emm-66-133

A two-level quasi-geostrophic model which includes the distribution of land and sea in the northern hemisphere with the effects of topography and heating taken into account is set up for a numerical study of the

general circulation of the atmosphere. The influences of clouds on long and short-wave radiation in radiational heating are considered, with the assumption that the appearance of clouds depends only on the vertical current. The surface temperature is obtained by solving the heat conduction equation. The nonlinear ordinary differential equations derived are integrated numerically on an electronic computer using the Runge-Kutta method.

In the absence of disturbances, a zonally-averaged surface temperature field and basic currents are gradually set up under the influence of solar radiation which has an annual period. Both the surface temperature and basic currents undergo apparent seasonal fluctuations which lag behind those of solar heating by approximately a month. The computed surface temperatures in winter and summer are comparable with the observed climatic values. The basic currents decrease in intensity and the jet stream shifts northward in summer and the reverse is true in winter.

The cool air over Asia and the Pacific and the warm air over Europe and the Atlantic in winter can be attributed to the thermal properties of the distribution of land and sea in the northern hemisphere. Topography and non-adiabatic heating are jointly responsible for the formation of troughs over East Asia and North America as well as for the cold-air activity which usually originates in Novaya Zemlya in Soviet Russia and migrates southeastward.

- 7.30 Wang Shao-wo (Wang Shao-wu)
OSCILLATION OF THE GENERAL CIRCULATION
OF THE ATMOSPHERE DURING THE PAST
90 YEARS (I)*
34(4): 486-506, November 1964
13 figs., 2 tables, 33 refs.

This paper analyzes the oscillation of the general circulation of the atmosphere during 1871 - 1960 using surface charts (70°N - 50°S) for January. The main results are as follows:

* See also 7.37.

(a) It is shown from a comparison of the 10, 30 and 90-year mean charts that there is a distinct difference between the 30 and 90-year ones. The smallest difference between the 30-year chart for the period 1901 - 1930 and the 90-year one may be attributed to the fact that the period in the early twentieth century was in the middle of a centennial cycle.

(b) There is a uniform secular variation of the general circulation. This is demonstrated by a decrease in the zonal index, an equatorward shift of the subpolar low pressure belt and the subtropical high pressure belt in both hemispheres and a complete cyclic movement of the centers of activity in the oscillation region (East Asia, the Pacific and the Indian Oceans) during the 90 years.

(c) There is a pronounced 22-year oscillation of the general circulation, which is clearly manifested by the mean zonal index. The intensity of the circulation was strong in the years of a secondary sunspot maximum but weak in those of a maximum.

(d) There is a close relationship between the general circulation and the 11-year sunspot cycle, and this relationship varies with the centennial cycle. The 11-year cycle was prominent during 1879 - 1900 and 1934 - 1960, but during 1901 - 1933 there were obvious double oscillations.

(e) The climatic oscillations in China during the past 20 years may be explained in terms of the variation of the general circulation during the same period.

- 7.31 Chang Chia-cheng (Chang Chia-ch'eng),
Li Chi (Li Chi) and
Di Yang-bo (Ti Yang-po)
AN OBJECTIVE CRITERION FOR
CLASSIFYING MACROSYNOPTIC
PROCESSES
35(1): 1-5, February 1965
4 figs., 6 refs., eqs.

A convenient parameter - the variation index - for measuring the daily (or inter-periodic) evolution of a planetary frontal zone is presented.

The index not only describes the stability of variation within a natural synoptic period (or elementary period) but also shows clearly the date of periodic shifts. It is generally more effective than the empirical methods. Analysis shows that in Asia there are complex periods, each comprising 2 - 4 elementary periods. The length of an elementary period within a season is not quasi-constant; however, in most cases, the difference in length of two adjacent periods does not exceed one day.

- 7.32 Chu P. H. (Chu Ping-hai)
A PRELIMINARY STUDY OF THE
HISTORICAL OSCILLATION OF
THE GENERAL CIRCULATION
OVER EASTERN ASIA AND THE
WESTERN PACIFIC
35(1): 44-53, February 1965
Fig., 5 tables, 16 refs.

The residual zonal and meridional flow over eastern Asia and the western Pacific (105° - 180° E, 20° - 60° N) are computed for January and July using synoptic charts of 1873 - 1960 and assuming geostrophic equilibrium. Based on the results obtained, the regional circulation indexes I_w and I_s are proposed as a means of studying the historical oscillation of the circulation. Analysis shows that the circulation oscillation over this region is the same as that over Atlantic Europe, that since the beginning of this century circulation activity has been constantly on the increase and that the meridional component is more obvious than the zonal component; the increase of activity of the latter was in a state of confusion at the beginning of the century. Circulation activity was much more intense at the end of last century than at the beginning of this one. Circulation over the region under discussion has gradually weakened during the past 10 years.

The regional circulation indexes have been proven capable of revealing objective features of the general circulation and therefore they can be regarded as effective tools for studying oscillations of the circulation in middle and low latitudes with the aid of surface charts.

- 7.33 Yu Shai-hua (Yu Shih-hua)
A PRELIMINARY STUDY OF DYNAMIC STABLE LAYERS
OVER SOUTH CHINA IN THE WINTER HALF-YEAR
35(1): 63-74, February 1965
9 figs., 2 tables, 16 refs.

A new type of stable layer which often appears over South China in the winter half-year is discussed. The layer is characterized by an overlying warm and dry northwesterly and an underlying cool and moist southwesterly air current. It appears in the fall and ends in the beginning of summer, covering a large region.

The formation of this type of stable layer is attributed to the joint effect of adiabatic warming and cooling as a result of the descent and ascent of air above and below. Their growth and dissipation depend on the large-scale weather pattern over eastern Asia.

The circulation over South China in winter is characterized by a northeasterly air current in the surface boundary layer, a southwesterly current above it and a northwesterly current in the upper troposphere. In spring, it can be described by the southwesterly and northwesterly current in the lower and upper troposphere respectively. This type of circulation structure, which is primarily due to the large-scale weather pattern over eastern Asia, is instrumental in the formation of the type of stable layers under discussion.

- 7.34 Dao Shih-yen (T'ao Shih-yen),
Li Yo-fang (Li Yu-fang) and
Wen Yu-pu (Wen Yu-p'u)
A PRELIMINARY STUDY OF THE GENERAL CIRCULATION
IN THE UPPER TROPOSPHERE AND THE LOWER AND
MIDDLE STRATOSPHERE OVER EAST ASIA
35(2): 155-165, May 1965
7 figs., table, 8 refs.
Full translation: Emm-66-142

A preliminary analysis of the characteristics of the general circulation in the upper troposphere and the lower and middle stratosphere over East Asia based on aerological data from more than 90 stations for the years 1957 - 1961 is presented. The results are summarized as follows:

(a) The main features of the general circulation in the middle and upper troposphere in winter are basically in agreement with the findings of previous investigations, though differences in the circulation characteristics exist in summer over the plateau region. The present study reveals that the summer features are characterized by a weak cyclonic circulation in the middle troposphere (500 mb) with an anticyclone dominating the 300-mb level. The circulation of the upper anticyclone increases with height and reaches its maximum intensity at 100 mb over the plateau region. Such a vertical distribution of circulation is related to the heating effect of the plateau. Furthermore, there are considerable seasonal variations in both the pressure pattern and the wind field in the upper troposphere over East Asia. The configuration of the pressure field in middle and high latitudes during January is the reverse of that for July, while the axis of the subtropical ridge moves from 15°N to 28°N to accord with the seasonal transition from winter to summer.

(b) The annual variation of the monthly mean temperature in the middle stratosphere (30 mb) over several stations at middle latitudes along the East Asiatic coast is characterized by a "double-peak" configuration with one peak in January and another between June and July. The annual temperature profile at low latitudes also possesses "double-peak" features, but the peaks are out of phase with the mid-latitude configuration. The annual variation of temperature at low latitudes is related to radiation processes, while calculations show that the "January peak" at middle latitudes is greatly dependent on thermal advection.

(c) The seasonal reversal of the wind regimes in the upper troposphere and the lower and middle stratosphere is as pronounced as that in the middle and lower troposphere. The processes of the seasonal change of the circulation pattern in the upper and the lower regime are generally interrelated during the transition from summer to winter, but not so from winter to summer.

- 7.35 Chen Shou-jun (Ch'en Shou-chün) and
Hsieh Yi-ping (Hsieh I-ping)
A PRELIMINARY STUDY OF THE SEASONAL VARIATION
OF THE GENERAL CIRCULATION AT THE 100-MB LEVEL
IN LOW LATITUDES
35(2): 166-173, May 1965
9 figs., 14 refs.

The seasonal variation of the general circulation at the 100-mb level in low latitudes is much more pronounced in the eastern than the western hemisphere. In the eastern hemisphere, circumpolar westerlies prevail down to low latitudes in winter, while in summer an intense subtropical continental anticyclone dominates the upper troposphere over Asia and Africa, giving rise to strong easterlies in the low-latitude regime. The evolution of the flow pattern over East Asia is related to the advance of the season and this synoptic phenomenon may be called the "super monsoon". The change of amplitude and phase angle of the ultra-long wave with wave number 1 along 30°N may be used to characterize the transition of this "super monsoon".

- 7.36 Yeh Tu-cheng (Yeh Tu-cheng) and
Wang Hsiao-ling (Wang Hsiao-lin)
A PRELIMINARY STUDY OF THE INSTABILITY AND
DEVELOPMENT OF ULTRA-LONG WAVES
35(2): 174-188, May 1965
6 figs., 6 tables, 12 refs., eqs.

The instability and development of ultra-long waves under frictionless and adiabatic conditions are discussed. The vertical distribution of the static stability and the vertical wind shear of the basic current are found to be factors controlling the instability of ultra-long waves. The occurrence of instability requires that the environmental static stability increases with height and this condition is fulfilled in the atmosphere by virtue of the existence of the stratosphere. The greater the magnitude of the vertical wind shear the higher is the degree of instability of these waves.

Equations relating the vertical wind shear of the basic current to the variation of static stability are derived on the assumption that the disturbances exert a "feedback" effect on the basic current. This effect

is much more pronounced on vertical wind shear than static stability. The maximum amplitude and the time of growth for the disturbance to attain its maximum intensity are deduced under the condition that $\frac{d}{dt} (P' + K') = 0$, where P' and K' denote the potential and the kinetic energy of a particular wavelength. In broad general terms the theoretical deduction of the above entities agrees with observations. Furthermore, the maximum amplitude of a mature disturbance is quasi-conservative with respect to the amplitude of the initial disturbance.

In addition to the vertical wind shear of the basic current and the vertical distribution of static stability, the wavelength also affects the development of ultra-long waves though this parameter does not affect the maximum amplitude of the mature disturbance. However, the longer is the wavelength, the longer it takes for the disturbance to fully develop. The presence of the stratosphere tends to reduce the amplitudes of mature disturbances at low levels and enhance those at high levels.

- 7.37 Wang Shao-wo (Wang Shao-wu)
OSCILLATION OF THE GENERAL CIRCULATION
OF THE ATMOSPHERE DURING THE PAST
90 YEARS (II)*
35(2): 200-214, May 1965
11 figs., 3 tables, 3 appendices, 11 refs.

In this paper, the oscillation of the general circulation in both hemispheres (70°N - 50°S) in the month of July for the past 90 years from 1871 to 1960 is investigated. An analysis of the oscillations of the climates over China with respect to the variations of the general circulation over East Asia for the past 60 years is also presented. The main findings are summarized as follows:

(a) Since a long-term variation of the general circulation of the atmosphere is known to exist, mean charts for different periods of 30 years may vary significantly. Features on the mean charts for the past

* See also 7.30.

30 years (1931 - 1960) are characterized by a rise in barometric pressure in the subtropical anticyclones over the oceans and a fall over the Asiatic continent, North Africa and the polar region in the northern hemisphere. In the southern hemisphere, a pressure rise is observed over the South Atlantic, the Southwest Pacific and South America with significant fall elsewhere.

(b) The oscillation of the general circulation may be assessed by the positions of action centers and the zonal index (the pressure difference between 40° - 70° N and 30° - 50° S). Curves of the smoothed 10-year running means of these parameters reveal significant periodic oscillations. The major return periods comprise a centurial cycle, a Haire cycle and possibly a Bückner cycle as well.

(c) Oscillations in the climates of China for the past 60 years (1901 - 1960) may well be explained in terms of the variation of the position of action centers over East Asia and also by charts of pressure deviations. In the early thirties, the high over the northern Pacific was most intense with a deep low over India. Both action centers were located west of the secular positions. As a result, the climate over many parts of China during this period was relatively warm with subnormal rainfall.

- 7.38 Hsieh Yi-ping (Hsieh I-ping),
Chen Shou-jun (Ch'en Shou-chün) and
Kuo Xiao-lun (Kuo Hsiao-yung)
THE CHARACTERISTICS OF LOW-LATITUDE
FLOW PATTERNS OVER SOUTHEAST ASIA
AND THE WESTERN PACIFIC FROM
OCTOBER TO DECEMBER
35(3): 338-342, August 1965
5 figs., 2 refs.,
Full translation: Emm-66-88

Based on a study of 1958 - 1959 data, the large-scale flow patterns over the western Pacific at low latitudes in early winter may be classified into two types according to the vertical extent of the anticyclonic flow of the subtropical high, viz., the "shallow subtropical high" and the "deep subtropical high". The former is characterized by a low zonal index at

high latitudes and moderate development of easterly waves in the lower troposphere near the equator with the subtropical jet in phase with its mean position. The latter is characterized by a high zonal index at high latitudes and the presence of equatorial westerlies in the lower troposphere with the subtropical jet completely out of phase with its mean position. Typhoons may also form in the equatorial belt of convergence in the latter pattern. The sequential occurrence of these two types seems to follow a quasi-periodic oscillation with a period of about one month.

- 7.39 Chen Chiu-shih (Ch'en Ch'iu-shih) and
Lin Ben-da (Lin Pen-ta)
THE VORTICITY BUDGET IN THE
SUBTROPICAL HIGH PRESSURE BELT
OVER THE NORTHERN HEMISPHERE
IN WINTER
35(3): 364-370, August 1965
9 figs., 14 refs., 6 eqs.

This paper discusses the maintenance of winter subtropical highs over the northern hemisphere using the vorticity balance equation. Calculation shows that the divergence of vorticity transport due to large-scale eddies is the dominant factor for maintaining the anticyclonic vorticity in the region near 30°N. The anticyclonic vorticity due to this divergence process occurs mainly in the upper troposphere, while the transport of the geostrophic vorticity by the mean meridional circulation may steer it downward to the lower troposphere. The paper also discusses the maintenance of the westerly jet from the viewpoint of the vorticity transport. The northward vorticity transport by large-scale eddies reaches its maximum at 45°N. As a result, it plays an important role in the maintenance of both the mean zonal westerlies and their jet streams in the middle latitudes. At 30°N, however, the vorticity transport by large-scale eddies vanishes, and the fluxes of both the geostrophic and the relative vorticities take on larger values. It may thus be concluded that the subtropical jet is maintained by the mean meridional circulation.

- 7.40 Chyou Yung-yen (Ch'ou Yung-yen) and
Chen Kuo-fan (Ch'en Kuo-fan)
SOME EMPIRICAL PHASE RELATIONSHIP BETWEEN
THE FIELD OF OCEANIC HEATING AND
LARGE-SCALE ATMOSPHERIC DISTURBANCES
35(4): 465-475, November 1965
9 figs., 4 tables, 12 refs., eqs.

This paper examines the relationship between the development of 500-mb troughs and oceanic heating, which is essentially represented by the turbulent exchange of sensible heat and the transfer of latent heat (by evaporation and condensation) between the ocean and the atmosphere. The first part deals with the empirical phase relationship between heating and the development of troughs in 12 case studies of winter synoptic processes. In the latter part, the effect of heating on the 500 - 1000 mb thickness tendency and the change of the vorticity profile (at 500 mb) during the intensification and weakening of upper troughs is discussed.

The results of the analysis may be summarized as follows:

(a) An upper trough intensifies or weakens when a center of maximum heating is located ahead of or behind the trough axis. Most of the cases of intensification or weakening are associated with a center of maximum heating situated 5 - 10 degrees longitude ahead of or behind the trough line. The speed of movement of the troughs is in some way related to the heating configuration.

(b) Anticyclonic development is not simply or distinctly related to the position of the center of maximum heating.

(c) Heating definitely affects the thickness tendency. The center of maximum fall in thickness values tends to move away from the heat source with respect to the trough line.

(d) Vorticity over a heat source tends to increase ahead of the trough axis and decrease behind it.

See also: 8.8, 8.9, 16.33 and 19.7

CHAPTER 8

LONG-RANGE FORECASTING

- 8.1 Lu Wo (Lu Wu)
A SUMMARY OF THE SYMPOSIUM ON LONG- AND
MEDIUM-RANGE WEATHER PREDICTION AND
SYNOPTIC ANALYSES IN PLATEAU REGIONS
30(1): 45-52, February 1959

- 8.2 Yang Chien-chu (Yang Chien-ch'u),
Shih Chiu-en (Shih Chiu-en) and
Ai Tzu-hsing (Ai Tzu-hsing)
A SEASONAL LONG-RANGE WEATHER
FORECASTING METHOD
30(1): 53-63, February 1959
11 figs., 8 tables, 2 refs.

A method of seasonal long-range weather forecasting is presented. The method is based upon the classification of natural synoptic periods, the rhythm of different types of natural periods and the correlations between periods.

- 8.3 Yang Chien-chu (Yang Chien-ch'u)
LONG-RANGE WEATHER FORECASTING
IN CHINA FROM 1949 TO 1959
30(3): 231-235, August 1959
27 refs.

- 8.4 Hwang S. S. (Huang Shih-sung),
Tang M. M. (T'ang Ming-min) and
Dang J. C. (Tang Jen-ch'ing)
A METHOD OF LONG-RANGE WEATHER
PREDICTION BY AUTOCORRELOGRAMS
30(4): 306-315, November 1959
4 figs., 8 tables, 7 refs.

This paper presents a method of long-range weather prediction by means of autocorrelograms. Test results indicate that a high degree of accuracy is achieved by this method.

- 8.5 Hsieh Yi-ping (Hsieh I-ping),
Chen Shou-jun (Ch'en Shou-chün),
Wang Yao-sen (Wang Yao-sheng) and
Tai Wu-ja (Tai Wu-chieh)
A BRIEF DISCUSSION OF LONG-RANGE
WEATHER FORECASTING
30(4): 316-322, November 1959
8 figs., table

This paper discusses some features of the methods of long-range weather and the application of these methods to increase the accuracy of such forecasting.

- 8.6 Chen Chi-kung (Ch'en Ch'i-kung),
Zhou Jin-shang (Chou Chin-shang) and
Lu Ju-zhong (Lu Chü-chung)
LONG-RANGE WEATHER PREDICTION BY
SYNOPTIC CLIMATOLOGY
30(4): 323-335, November 1959
Fig., 5 tables, 3 refs.

This paper presents the results of empirical experiments on two-month long-range weather prediction by means of the synoptic climatology of the evolution of weather systems. A description of the criteria for the classification of synoptic patterns, the study on the characteristics of the activities of each type of synoptic situation and the techniques for the preparation of long-range weather forecasts are given. The results of two tests under operational conditions show that the predicted synoptic pattern and the associated weather condition are sufficiently comprehensive in detail and agree very well with actual observations.

- 8.7 Zhu He-zhou (Chu Ho-chou),
Chang Hsien-kung (Chang Hsien-kung) and
Li Zhen-hua (Li Chen-hua)
PREDICTION OF THE 500-MB ANNUAL CIRCULATION
PATTERN IN THE NORTHERN HEMISPHERE
30(4): 336-349, November 1959
7 figs., 4 tables, 9 refs., eqs.

This paper presents an analysis of the annual variation of the 500-mb monthly mean contours in the northern hemisphere. It is shown that the annual variation of the general circulation in the northern hemisphere

possesses traits of periodic oscillation. On this basis, a prediction equation for the 500-mb monthly mean contour heights is formulated, viz., $H_n = H - \frac{1}{2} (H_{n-1} - H_{n-2})$. Verification results obtained in four years give an average correlation coefficient of 0.65.

- 8.8 Zhang Ji-jia (Chang Chi-chia)
AN INTRODUCTORY NOTE ON THE RUSSIAN METHODS
OF LONG-RANGE SYNOPTIC PREDICTION OF
LARGE-SCALE CIRCULATION PATTERNS
30(4): 362-375, November 1959
5 figs., 2 tables, appendix, 19 refs.

This paper briefly describes the principles of the method of long-range synoptic prediction of large-scale circulation patterns formulated by the famous Russian climatologist, Prof. Vangengeim, and modified by Prof. Girs. This method has been used by the Russian Polar Research Institute for the preparation of monthly and seasonal weather forecasts and the long-range prediction of the basic synoptic processes associated with these two types of forecasts. Significant achievements are noted in practice. Monthly and annual circulation patterns over the northern hemisphere which may serve as useful reference information for the preparation of long-range weather forecasts over China are presented in the Appendix. (Materials presented in this article are mainly taken from notes of lectures given by Prof. Girs in the Leningrad Hydrometeorological Institute and also from other relevant literature.)

- 8.9 Zhang Ji-jia (Chang Chi-chia)
THE DEVELOPMENT OF SYNOPTIC METHODS OF
LONG-RANGE WEATHER PREDICTION BY THE
"MULTANOVSKII SCHOOL" IN RUSSIA
30(4): 376-389, November 1959
2 tables, 29 refs.

Multanovskii, the outstanding Russian meteorologist, formulated the first method for the long-range prediction of synoptic charts in the world. Since 1922, this method has been used by the Central Prognostic Institute of Russia for the preparation of monthly and seasonal prognostic

charts and also for the medium- and long-range prediction of natural synoptic cycles. It should deserve a mention that this method has gone through many important phases of development. Thus the author only attempts to give within the limitation of space a brief description of the main research achievements in each phase with due emphasis on the important developmental stages. However, more details are given on the research activities of this school in the past few years. It is hoped that workers in the field of long-range weather forecasting in China may acquire a systematic understanding and a clear picture of the development of this method through the present article.

(The author wishes to express his heartfelt thanks to his supervisor, Prof. Girs, for the scientific guidance, thoughtful encouragement and valuable help given him during the time when he was studying this method.)

8.10 Academia Sinica. Analysis Section, Institute of Mathematics
THE INITIAL VALUE PROBLEM OF A COMPOSITE
TYPE EQUATION FOR MEDIUM- AND LONG-RANGE
FORECASTING
30(4): 390-397, November 1959
2 appendices, 4 refs., eqs.

For practical use in weather forecasting, this paper considers the initial value problem for the vorticity equation

$$\left(\frac{\partial}{\partial t} + \alpha(\theta) \frac{\partial}{\partial \lambda} \right) \Delta z + \beta(\theta) \frac{\partial z}{\partial \lambda} = 0,$$

where $\Delta \equiv \frac{1}{\sin \theta} \frac{\partial}{\partial \theta} \left(\sin \theta \frac{\partial}{\partial \theta} \right) + \frac{1}{\sin^2 \theta} \frac{\partial^2}{\partial \lambda^2}$, with the initial condition

$$z(\theta, \lambda, 0) = z_0(\theta, \lambda).$$

The required solution $z(\theta, \lambda, t)$ is bounded in the region D,

$$0 < t, 0 < \theta < \pi, 0 < \lambda < 2\pi,$$

and is periodic in λ with the period 2π . Up to a constant term, the unique solution is found directly.

The method employed here may be used quite easily to solve the vorticity equation with more general coefficients.

- 8.11 Hwang Shih-sung (Huang Shih-sung) and
Tang Ming-min (T'ang Ming-min)
THE OCCURRENCE OF SIMILAR SEQUENCES IN
SYNOPTIC PROCESSES DURING A TWO-YEAR
PERIOD AND AN EXPERIMENTAL TEST ON ITS
APPLICATION TO LONG-RANGE FORECASTING
31(2): 138-149, May 1960
8 figs., table, 10 refs.

This paper describes a new phenomenon concerning the evolution processes of the general circulation. From the results of an experimental test, it is found that the occurrence of this new phenomenon may be used to predict the development of synoptic processes for a given month. These predictions can be prepared from single-station data a year ahead of the forecast period.

- 8.12 Shih Chiu-en (Shih Chiu-en) and
Hsu Chun (Hsu Ch'un)
A PRELIMINARY STUDY OF THE LONG-RANGE
PREDICTION OF PRECIPITATION IN THE
MIDDLE AND LOWER YANGTZE IN SUMMER
32(2): 129-140, June 1962
2 figs., 4 tables, 13 refs., eqs.

This paper applies the concept of time series to the long-range prediction of precipitation by techniques of mathematical statistics. The historical data on precipitation are treated by three stages of data processing for the assessment of (1) the secular trend, (2) periodicity and (3) aperiodicity. The technique of moving averages is used to smooth the basic data in order to determine the influence of the secular trend (ultra-long period oscillations in the 1st term), which is then represented by a theoretical curve. Waves of the order of several years per cycle (the 2nd term) are treated by the technique of "elimination

of contradiction" in solving the associated system of linear equations. Finally, aperiodicity (the 3rd term) is treated by the linear extrapolation of a stable stochastic process.

Precipitation data for the months of May to August over five stations in the middle and lower basin of the Yangtze valley were analyzed in this paper together with data from other regions. All calculations were performed on an electronic computer. It appears that the present method gives satisfactory results in trend forecasting.

Finally, some comments on the advantages and shortcomings of the proposed method are also presented with hints on the organization of further investigations.

See also: 3.14, 7.4, 13.4, 15.14, 16.5, 17.1, 17.7 and 19.6

CHAPTER 9

MESO- AND MICROMETEOROLOGY; AGRICULTURAL
METEOROLOGY; SOIL CHARACTERISTICS

- 9.1 Fu Pao-p'o (Fu Pao-p'o)
COMPUTATION OF THE POSSIBLE MAXIMUM
FREEZING DEPTH AND THE POSSIBLE
LOWEST SURFACE TEMPERATURE
29(2): 63-72, May 1958
Fig., 5 tables, 5 refs., 23 eqs.

This paper discusses in detail the method of determining the parameters in Shiehter's formulas when there is no direct observation. A method of computing the possible maximum freezing depth and the possible lowest surface temperature is given. By use of this method, the maximum freezing depth and the lowest surface temperature at Peking for the winter of 1954 are computed. The results are in good agreement with observed values.

- 9.2 Xi Yao-guo (Hsi Yao-kuo)
DISCUSSION OF THE FUTURE DEVELOPMENT OF
COTTON CULTIVATION IN WESTERN KANSU FROM
A CLIMATOLOGICAL VIEWPOINT
30(2): 137-149, May 1959
16 tables, 2 refs.

This paper describes the climatic features of western Kansu, and the possibilities of developing cotton cultivation are discussed. It is shown that during the growing season, the weather in this region is relatively stable, with sufficient amount of sunshine but little rainfall. These conditions are more favorable than those in the cotton-growing regions in the Yangtze and Yellow river valleys. However, this region also has climatic problems, viz., a short growing season, frequent weather variations during spring and autumn, a rapid temperature increase during spring and a rapid decrease in autumn. In certain localities, the temperature is too low for cotton growing. After analyzing the climate of various subdivisions of the region, suggestions are made to rectify these shortcomings.

- 9.3 Lü Jiong (Lü Chiung),
Duan Hua-ge (Tuan Hua-ko) and
Feng Xiu-zao (Feng Hsiu-tsao)
AGROMETEOROLOGY IN CHINA FROM 1949 TO 1959
30(3): 277-285, August 1959
65 refs.
- 9.4 Central Weather Bureau. Department of Agrometeorology
A DISCUSSION ON FORECASTING THE SUITABLE SOWING
PERIOD FOR COTTON PLANTATION
31(1): 1-9, February 1960
7 tables

This paper uses the principle and techniques of a "two-stage quadruple system"* to forecast a suitable sowing period for cotton plantation. Farm lore on the sowing period, data on the damage of cotton-shoot by cold weather and the wealth of experience of local farmers were collected from major cotton-farming regions in China. This information was combined with the analysis of meteorological data to yield a temperature index as a guide to monitor the sowing process. This index was represented by a climatological mean soil temperature of 12° - 13°C at 5 cm below ground surface. The index for the damage of cotton-shoot by cold weather was found to be an expected minimum air temperature of about 2°C at ground level. The sowing period (near the Chhing Ming** Festival) and the "head-selection" period (April-May) were then correlated with local temperature data for the various cotton-farming regions. Analyses of results indicate that the

* Translator's Note: "Quadruple" stands for a quadruple combination of the survey on the wealth of experience of the farming population, the analysis of meteorological data, the derivation of agrometeorological indices in relation to sowing period and the updating of long- and medium-range weather forecasts by supplementary actual observations to determine the suitable sowing period for cotton plantation. "Two-stage" includes the modification of the preliminary forecast by a "weather-watch" team of the "Peoples Communes" and the comprehensive use of the latest available observations to make the final decision prior to the commencement of the actual sowing process.

** See Needham, J. Science and Civilization in China, Volume 3. Cambridge University Press, 1959, p. 405.

climatological mean air temperature was 11° - 12°C during the sowing period. It was also found that the damage to cotton-shoot due to cold weather became appreciable when the minimum air temperature fell to 4° - 6°C. According to the above findings, a method to forecast the suitable sowing period for cotton plantation was formulated. The method emphasizes the combination of weather forecasts and supplementary actual observations with a view to protecting cotton-shoot from cold and frost and keeping the expected flowering period of the cotton plants away from "wet spells". Finally, actual examples of the comprehensive application of this method to predict the suitable sowing period for cotton plantation are given.

- 9.5 **Anonymous**
A PRELIMINARY INVESTIGATION OF THE FROST-INDEX
IN RELATION TO WINTER WHEAT PLANTATION OVER
NORTH CHINA AND SOME RELATED CLIMATOLOGICAL
ANALYSES
31(1): 10-35, February 1960
13 figs., 13 tables, 10 refs.

This paper deals with the frost damage on winter wheat (*Friticum vulgare*) plantation over North China in the months of March, April and May during 1951 - 1959. The basic data were collected from provinces in the northern region, viz., Hopei, Honan, Shansi, Shensi, Shangtung, Kiangsu and Anhwei. A preliminary examination of the curves depicting the profile of the damage conditions shows that the frost-indices for lag periods of 1 - 7 days, 7 - 14 days and 14 days or more after the date of transplantation are -4° to -5°C, -1° to -2°C and 0° to -1°C, respectively. The indices of severe frost for lag periods of 1 - 7 days, 7 - 14 days, 14 - 20 days and more than 20 days after the date of transplantation are -9° to -10°C, -6° to -7°C, -2° to -3°C and -1° to -2°C, respectively. The index for the "head-selection" period is -1° to -2°C. The influence of the major factors (such as the intensity of frost, species, topography, variations in agricultural techniques or soil properties) on the abovementioned "degrees" of frost is also discussed.

The climatological characteristics over North China in relation to these index values were analyzed. A preliminary chart of the distribution of the intensity of the various "degrees" of frost with respect to time and space was prepared. The frequency of occurrence of these phenomena and the deviation from the average "date of frost" over Peking, Chinan and Taiyuen were analyzed with due emphasis on the statistical characteristics. The probability of frost damage of different intensity during the transplantation period was discussed with reference to charts depicting the date of thaw for the various "degrees" of frost, average frequency diagrams and graphs of wheat growth. The tentative findings of the present study indicate that frost is likely to occur in the valley of Fen Ho, on hills in Shantung, the high ground of Chinling Mountains, the northern part of the Kiangsu-Anhwei region and a small region in northwestern Hopei and generally unlikely in Taiyuen, the region north of Yen-an and elsewhere. Finally, the possibility and necessity of taking precautions against the various "degrees" of frost in different regions are also presented.

- 9.6 Fu Yong-gang (Fu Yung-kang)
A DISCUSSION ON FORECASTING THE HARVEST TIME OF
WINTER WHEAT
31(1): 36-40, February 1960
4 figs., 5 refs.

This paper presents the principle and techniques of a "two-stage quadruple system" for forecasting the harvest time of winter wheat. The importance of a satisfactory forecast of the time of harvest on the effective yield of winter wheat was dealt with in the first place. The effect of meteorological factors on the speed of the maturing processes for wheat growth was then examined. The findings indicate that the appropriate time for the appearance of flowered spikelets and the rate of maturing for some species (particularly winter wheat from the southern regions) are closely related to the moisture factor. Finally, a method for forecasting the harvest time of winter wheat is formulated from the foregoing empiricism.

- 9.7 Anonymous
AN INVESTIGATION OF THE VARIATION OF TEMPERATURE,
HUMIDITY AND ISOLATION CONDITIONS OVER THE RICE-
FIELD AFTER THE INTRODUCTION OF "DENSE PLANTING"
31(1): 41-50, February 1960
4 figs., 10 tables

In recent years, the introduction of "dense planting" has significantly increased productivity in rice cultivation. A knowledge of the variation of meteorological conditions over the field after "dense planting" may lead to a better understanding of the factors governing the increase in productivity, possible development of techniques for improving the climatological conditions and an increase in efficiency in the utilization of solar energy. Thus, the effect of "dense planting" on the promotion of productivity may be appreciated in the correct perspective.

In 1959, microclimatological observations were made in Peking and Nanking. As a result of the variation of the absorption of solar radiation, differences in temperature, humidity and the intensity of effective insolation were observed over rice-fields of different plantation density. Consequently, the rate of rice-growth was also found to vary to some extent.

(a) Temperature: The amplitude of the diurnal variation of air temperature among the crops is small for a high density and large for a low density. The difference is most significant about noon on a fine day and relatively small at night. As regards spatial variations, the temperature difference is most significant at ground level before the appearance of auxiliary shoots. However, after this period, the level of maximum difference is found at $2/3$ of the crop-height while that of minimum difference 20 cm above the "base" of the crop. The profile of soil temperature lies between these extreme limits.

(b) Humidity: The amplitude of the diurnal variation of the humidity profile is also small for a high density and large for a low density. Differences due to unequal plantation density are significant about noon; whereas practically no difference is observed in the early morning.

(c) Intensity of Insolation: For the same range of plantation density, there is little difference in the insolation conditions before the appearance of auxiliary shoots. After this phase the intensity of insolation decreases appreciably during the period from prolific "branching" to the "budding of spikes" and the difference due to unequal density becomes significant. For dense plantation the intensity of insolation is weak and decreases after the appearance of flowered spikelets. The difference due to unequal plantation density is also relatively small.

(d) The Necessity of Increasing the Density of Planting: The plantation should be dense enough to make full use of the natural insolation but it must not be so dense as to cause a great decrease in the absorption of insolation with a detrimental effect on the normal growth of the crop. Under the conditions which would ensure a satisfactory crop yield, a reduction in the distance between crops coupled with an expansion of lane widths may be made to improve the insolation conditions over the field. "Lane blockage" would then be delayed advantageously.

(e) Transplantation Orientation: A preliminary survey shows that the east-west orientation is more efficient in improving the intensity of insolation on the crops than the north-south alignment. The east-west orientation gives a better crop yield especially when the declination of the sun is low.

- 9.8 Central Weather Bureau. Department of Agrometeorology, and
Hupei Provincial Weather Bureau
A PRELIMINARY INVESTIGATION OF THE CRITICAL
PRECIPITATION PERIOD FOR A SATISFACTORY YIELD
OF WINTER WHEAT
31(1): 51-59, February 1960
2 figs., 8 tables, 6 refs., 11 eqs.

This paper presents a preliminary report on the relationship between the yield of winter wheat and the amount of precipitation during March - April over eight districts in the neighborhood of T'ienmen and Yingch'eng in Hupei Province, using methods of mathematical statistics. The findings may be summarized as follows:

(a) The "critical precipitation period" for a satisfactory yield of winter wheat should occur 10 - 15 days before the appearance of flowered spikelets.

(b) The relationship between the yield of winter wheat and the amount of rainfall during the "critical precipitation period" is characterized by the functional form of a parabola.

(c) The appropriate amount of rainfall during the "critical precipitation period" for a satisfactory yield of winter wheat is found to be 30 - 90 mm.

9.9 Anonymous
 AGRICULTURAL PRODUCTION IN RELATION TO THE
 24 CHHI*
 31(1): 60-74, February 1960
 Fig., 8 tables, 20 refs.

The classification of the 24 "Chhi" is based on the wealth of agrometeorological experience of ancient Chinese farmers. The system still exerts a considerable influence on the program of agricultural production up to the present day. This paper first offers a concise explanation of the formation of the 24 "Chhi" with due emphasis on their subsequent impetus.

The major characteristics of the distribution of temperature and rainfall over China in general and over the middle and lower basin of the Yellow River in particular were analyzed with special reference to the configuration of the 24 "Chhi". The climatological implication of this system of classification was examined. The agricultural activities in relation to each "Chhi" were investigated on an agrometeorological basis. Studies on the development of the

* Translator's note: The word "Chhi" is taken from Needham's "Science and Civilization in China", Volume 3, Cambridge University Press, 1959, p. 405. This word is also written as "Chi" in various papers. "Phenophase" derived from "phenology" seems to be the word for "Chhi", at least in the context of this paper.

24 "Chhi" for the comprehensive application over the whole mainland of China and the practical adaptation of the system for present-day use were also carried out.

The formulation of the 24 "Chhi" represents the result of a successful combination of the effect of astronomy and climatology on agricultural production. This system permits the adequate utilization of land and natural resources together with an efficient deployment of human efforts on a national basis. It is a concise, accurate and flexible agrometeorological almanac to meet the requirements of agricultural production.

The effect of meteorological conditions on the growth of agricultural products is reflected by the farming activities in relation to the 24 "Chhi". Thus, the combination of climatological analysis and the configuration of the 24 "Chhi" could determine on an agrometeorological basis the suitable times of the year to initiate cultivation and plantation. Agrometeorological indices could also be derived to monitor the condition of crop growth. Furthermore, studies of the 24 "Chhi" might lead to a better understanding of the agricultural and agrometeorological experience of ancient China in relation to cultivation, plantation, farm management and precautions against natural calamities. Useful empiricism can then be derived from this fund of knowledge and experience for practical application on present-day agricultural production.

Finally, the present study points out that the value of the 24 "Chhi" would undoubtedly be enhanced if the phenophases (Chhi) suitable for the various agricultural activities are studied in terms of the meteorological and climatological conditions and the agricultural productivity and development for the locality concerned. Furthermore, the wealth of empiricism so derived may lead to the formulation of new farm lores and the appropriate modification of existing ones. Undoubtedly, these attempts would exert a tremendous impetus on the agricultural productivity in China.

- 9.10 Yen Kai-wei (Yen K'ai-wei) and
Jen Yung-lin (Ching Jung-lin)
A PRELIMINARY INVESTIGATION OF THE
MICROMETEOROLOGICAL EFFECT OF
ARTIFICIAL WIND BARRIERS
31(3): 205-215, November 1961
11 figs., 2 tables, 4 refs., eqs.

Parallel wind barriers are widely used on vegetable plantations in North China during the cold season. The structure and size of the barriers may vary in accordance with the experience of the local farmers. In general, the barriers are fences, 1.5 - 2 m high, 100 - 200 m long and are made of millet stems or reeds. To protect the crops from prevailing northwesterly winds, the fences are oriented in a west-east direction. The inclination and density of the fences vary with the season. In early spring the barriers are impermeable and incline toward the south at an angle of 60° - 70° to the horizon, and in early summer they become very open and erect. The distance between two successive impermeable fences is usually about 5 m and the crop growing area is confined within a narrow strip extending 2 - 3 m to the south from each fence. The distance between two successive open fences as well as the width of the protected area may exceed 15 m.

In this paper a preliminary investigation on the micrometeorological effect of the impermeable fences is made. Observations within the narrow crop-growing strips show the following:

(a) The effect of the barriers on the reduction of wind speed is eminent. In the case of gentle northwesterly breeze, the air at 25 cm above the ground immediately to the lee of the fence is nearly stagnant, and at a distance of about 2 m from the fence the air speed may increase to approximately 35 percent of the free wind speed in the open.

(b) The barriers shade the northern section of the sky and reflect the diffuse sky radiation coming from the south. The interaction between the shading and reflecting affects the total incoming radiation in such a manner that a larger amount of incoming radiation is associated with

higher fences, less clouds, a lower solar altitude, a shorter distance from the fence and a higher reflectivity of the fence, and among these factors clouds are the most important. It is found that at noon the total incoming radiation within the narrow strip may appreciably exceed that in the open when the sky is clear, and is much less than that in the open in a cloudy day.

(c) The fences obscure a large part of the solid angle of the sky so that the outgoing long-wave radiation is noticeably reduced.

(d) The eddy diffusivity close to the ground is smaller than that in the open.

In North China, the skies are generally clear in winter and early spring. After the passing of a cold front the weather is usually characterized by strong northwesterly winds with very low turbidity, at which time the impermeable wind barriers may be of the greatest usefulness.

- 9.11 Fuh Baw-puh (Fu Pao-p'io)
THE INFLUENCE OF THE ORIENTATION OF
SLOPING GROUND ON THE LOCAL
MICROCLIMATE
32(1): 71-86, March 1962
29 figs., table, 2 refs.

This paper presents a comprehensive discussion of the influence of the orientation of sloping ground on local air and soil temperatures, humidity and other important meteorological elements. Typical characteristics are found in the results of the present analysis.

- 9.12 Tao Zu-wen (T'ao Tsu-wen) and
Ju Ke-de (Chü K'o-te)
AN INVESTIGATION OF METEOROLOGICAL INDICES
FOR FROST DAMAGE ON WINTER WHEAT
32 (3): 215-223, September 1962
4 figs., 4 tables, 7 refs.

This paper presents an account of the survey of the actual frost damage on winter wheat in the spring of 1960 and a systematic analysis of meteorological indices in relation to frost damage.

The minimum air temperature and the lowest temperature at the surface of the leaves of the winter wheat are used to formulate a set of new criteria to determine the meteorological indices for the phase before "branching" occurs, during the "branching" period and the budding of spikes. Differences in the meteorological indices for the principle species of winter wheat are discussed.

The paper also discusses the practical aspects of using meteorological indices to guard against frost damage.

- 9.13 Lu Chi-yao (Lu Ch'i-yao)
THE INFLUENCE OF RAINFALL ON THE YIELD
OF WINTER WHEAT IN NORTHERN CHINA
33(3): 392-398, August 1963
Fig., 4 tables, 7 refs., 9 eqs.

This paper evaluates the influence of rainfall on the yield of winter wheat in northern China using R. A. Fisher's method of orthogonal polynomials and data on winter wheat yield in 11 different localities during 1955 - 1957. The results show that the yield depends greatly on the total rainfall during the growing season, that there is an increase in the yield caused by additional rainfall at any time during the growing season, and that the greatest effect of additional rainfall on the yield occurs during early wintering and around blooming stages. During these two stages, every additional millimeter of rainfall may increase the yield by 0.4 - 0.45 catty per mow*.

- 9.14 Fuh Baw-puh (Fu Pao-p'o)
WIND SPEED IN RIVER VALLEYS
33(4): 518-526, November 1963
9 figs., table, eqs.

In this paper, the characteristics and behavior of river valley winds are analyzed by using microclimatological field observations made by the Department of Meteorology of the Nanking University in the Upper Yangtze and in southern Yunnan.

* 1 catty = 1.33 lbs; 1 mow = 0.1518 acre.

- 9.15 Lan Hong-di (Lan Hung-ti),
Zhang Yang-cai (Chang Yang-ts'ai) and
Wang Jing-wen (Wang Ching-wen)
PRELIMINARY STUDY OF THE AGROCLIMATIC INDEX
OF PADDY RICE GROWN IN THE MIDDLE AND LOWER
YANGTZE BASIN IN TERMS OF SUNSHINE AND
TEMPERATURE
33(4): 537-548, November 1963
7 figs., 8 tables, 8 refs., eqs.

This paper presents a preliminary study of the agroclimatic index of paddy rice based on materials of the repeated phenological observations of 26 varieties for 1956 - 1957 (in Nanking) and for 1958 - 1959 (in Hankow). Using data on the average length of day and the average air temperature for the interphase periods, the authors establish a relationship between the rate of growth of the crops and the time of sunshine and air temperature. With the method of least squares, the authors then determine the temperature biological limits of the common rice and divide the 26 varieties into 5 groups according to their light sensitivity. The agroclimatic index for the entire vegetation period of these 5 groups is as follows:

Group 1: the sum of the effective temperature (greater than the biological limits) is calculated for the period from planting to waxen maturity.

Groups 2-5: the sum of the effective temperature (greater than the biological limits) is calculated for the periods from planting to blooming and from ripening to waxen maturity. If the length of day (x) is substituted for the day of blooming in the empirical formula, the duration (y) of the period from blooming to ripening will be found. This will also be the agroclimatic index which considers the time of sunshine and air temperature for the entire vegetation period. For groups 2-3 and 4-5, the empirical formula has the following forms: $y = ae^{bx}$ and $(y - a)^2 = -c(x - b)$.

- 9.16 Jiang Guang-heng (Chiang Kuang-heng) and
Ma Rong-tang (Ma Jung-t'ang)
INVESTIGATION OF THE MICROMETEOROLOGICAL EFFECT
OF WINTER SMOOTHING OF WHEAT FIELDS ALONG THE
YANGTZE RIVER IN NANKING
34(1): 111-121, February 1964
5 figs., 11 tables, 4 refs., 5 eqs.

Winter smoothing of wheat fields has been widely practiced in China. Its effect on production increase has been proven by practical application. At present, most experiments are concentrated on the study of its biological significance, with little done on the micrometeorological effect. Studies on the characteristics of this effect in the smoothing of different types of soil during the prevalence of cold waves and return to warm weather thereafter in winter from the heat exchange in the soil and the radiation balance are especially scarce.

This paper studies the micrometeorological effect in the smoothing of wheat fields during the prevalence of cold waves and return to warm weather thereafter in winter, using data recorded during 1961 - 1963. Preliminary results obtained are as follows:

(a) The smoothing of the fields can increase the weight by volume, porosity and moisture of individual soil layers. Such characteristic parameters as volume heat capacity, heat and temperature conductivities and heat absorption rate are also increased.

(b) The effect of smoothing on the heat exchange in soil is extremely significant. For different types of soil, the thermal effect of the smoothing during the prevalence of cold waves and return of warm weather thereafter is different. Thus, the temperature effect and freezing of the soil also vary. Furthermore, the freezing and thawing of the soil have an important influence on its thermal effect.

(c) The increase in temperature of different types of soil depends on the weather conditions. The magnitude of the temperature effect is independent of the influx of radiation heat, but depends on the difference in the heat exchange in soil and heat dissipation from thawing.

(d) There is a general increase in the reflecting power and effective radiation on the smoothed ground. Its radiation balance may decrease, but this decrease is less by far when compared with the heat exchange in soil and heat dissipation from thawing.

- 9.17 Wang Fu-tang (Wang Fu-t'ang) and
Li Yu-zhu (Li Yu-chu)
A PRELIMINARY ANALYSIS OF THE AGROCLIMATOLOGICAL
THERMAL RESOURCES IN THE PEKING REGION
34(3): 355-368, August 1964
15 figs., 9 tables, 20 refs.

This paper analyzes the distribution of thermal resources in space and their variation in time in the Peking region. Some of the characteristics of the resources are discussed. Taking into account the agroclimatic factors and effects on the principal crops, a preliminary study is made of the problem of a more efficient use of the resources and of the possibility of obtaining two harvests per year (including the rice-wheat system) on lowlands and three harvests per two years on highlands. The authors hope that the results of this study will be helpful to the agricultural reform in the Peking region as well as to the development of a method of evaluating the thermal resources in a local area.

- 9.18 Zhang Ying-fu (Chang Ying-fu)
COMMENTS ON THE ARTICLE "PRELIMINARY STUDY OF
THE AGROCLIMATIC INDEX OF PADDY RICE GROWN IN
THE MIDDLE AND LOWER YANGTZE BASIN IN TERMS OF
SUNSHINE AND TEMPERATURE"*
35(1): 111-113, February 1965
Table

- 9.19 Lan Hong-di (Lan Hung-ti),
Zhang Yang-cai (Chang Yang-ts'ai) and
Wang Jing-wen (Wang Ching-wen)
CONCERNING THE COMMENTS ON THE ARTICLE "PRELIMINARY
STUDY OF THE AGROCLIMATIC INDEX OF PADDY RICE GROWN
IN THE MIDDLE AND LOWER YANGTZE BASIN IN TERMS OF
SUNSHINE AND TEMPERATURE"**
35(1): 114-116, February 1965
2 tables, 10 refs.

* See 1.15.

** See 1.15 and 1.18.

- 9.20 Yu Gin-yeun (Yu Ching-yen)
MESOSCALE SYSTEMS WITHIN A HEAVY RAIN AREA
35(3): 293-304, August 1965
14 figs.

This paper presents a preliminary analysis of the mesoscale weather systems during a rain storm which lasted nine days in early August 1963 over the southwestern plain of North China. The maximum amount of rainfall at the center of the storm which was located at Changmo in Ch'iu Hsien, Hsingt'ai Special District, Hopei Province, was 2052 mm, with a large part of the plain covered with more than 1000 mm.

- 9.21 Lu Zuo-bo (Lu Tso-po)
EFFECTS OF SURFACE CONDITIONS ON THE WEATHER
AND CLIMATE IN THE ANKING REGION
35(3): 352-356, August 1965
5 figs.

This paper analyzes the surface wind field, temperature field and precipitation field in the Anking region using climatic data recorded at the various county weather stations in conjunction with the orographic conditions. It is shown that the effects of the surface on the weather and climate in that region are mainly sheltering, channelling, lifting and radiational. Consideration of these effects will facilitate weather prediction in the region.

See also: 13.8

CHAPTER 10

METEOROLOGICAL MEASUREMENTS AND OBSERVATIONS

- 10.1 Yen Kai-wei (Yan K'ai-wei) and
Chang Chun (Chang Chun)
A STUDY OF THE CHARACTERISTICS OF
GOLD-BEATER'S SKIN IN RELATION TO
RADIOSONDE MEASUREMENTS
28(2): 91-100, May 1957
11 figs., 11 refs., eqs.

This paper describes the characteristics of the gold-beater's skin hygrometer. Laboratory experiments and upper-air soundings with 1.0 to 1.5-mm strips indicate that:

- (a) the shape of the calibration curve changes when the applied force on the strip exceeds 5 gm,
- (b) the calibration of the strip is affected by a variation in tension,
- (c) the normal "Gay-Lussac" scale of elongation with humidity may be altered by a special treatment on the element in order to obtain a linear relationship between length and humidity,
- (d) the strip exhibits a large hysteresis effect but this phenomenon is not noticeable when the relative humidity rises to above 70 - 75%, and
- (e) when the strip is coated with a film of water, the calibration characteristics become unstable.

Some of the above properties are also common in other types of hygrometers. However, the gold-beater's skin strips treated by the authors are found to possess the following additional characteristic quality:

- (f) a high degree of sensitivity is maintained at low temperatures with a small lag coefficient comparable to that of the Frankenberg hair used in Germany (Figure 5).

These specially treated elements prove to be a most effective tool in upper-air measurements. Radiosonde ascents with ordinary hair,

Frankenberg hair and the specially treated gold-beater's skin were simultaneously carried out by the authors in Peking under various synoptic conditions and the results of these experiments are described in the present study.

- 10.2 Zhang Ai-chen (Chang Ai-ch'en)
SOME EXPERIMENTAL RESULTS ON THE
USE OF GOLD-BEATER'S SKIN HYGROMETER
IN SURFACE OBSERVATIONS
28(3): 175-184, August 1957
10 figs., 3 tables, 8 refs.

This paper presents the results of experiments made by the meteorological team of the Peking University on the use of gold-beater's skin hygrometer in surface observations. The important characteristics of gold-beater's skin are as follows:

(a) The variation of length with humidity is approximately given by the Gay-Lussac scale (Table 1).

(b) When the gold-beater's skin element is moistened by fog or melting snow-flakes, a fall of relative humidity to below 90% will cause a reduction in length corresponding to an underestimation of humidity by 7% (Figure 6).

(c) The lag coefficient is small. With a ventilation of $0.1 - 0.2 \text{ m sec}^{-1}$, the lag of the hygrometer in a saturated atmosphere is only 27 seconds at a temperature of 0°C and 34 seconds at -15°C (Tables 2 and 3).

(d) The average error of the gold-beater's skin hygrometer is $\pm 2\%$ (Figures 8 and 9) when compared with standard measurements by ventilated psychrometers.

(e) The calibration characteristics of the element are generally stable. The calibration curve varies within 2% during the two and half months in summer (Figure 8), while during the transitional period from winter to spring, practically no change in calibration is observed (Figure 10).

(f) The reduction in length of the gold-beater's skin by moistening does not impair the efficiency and sensitivity of the element (Figures 5 and 6)

and this error may readily be corrected so that adjusted readings are comparable in accuracy to those of a dry gold-beater's skin hygrometer (Figure 10).

- 10.3 Cheng Chwen-shu (Ch'eng Shun-shu) and
Yen Kai-wei (Yen K'ai-wei)
PROGRESS IN METEOROLOGICAL OBSERVATION
TECHNIQUES AND INSTRUMENT RESEARCH IN
CHINA DURING 1949 - 1959
30(3): 212-217, August 1959
6 figs., eqs.

- 10.4 Zhou Ming-yu (Chou Ming-yü)
A RADIOMETER EQUIPPED WITH A
PLASTIC WIND SHIELD
31(3): 268-273, November 1961
7 figs., 3 refs.

This paper proposes a radiometer equipped with a plastic wind shield. A test of the plastic film shows that the coefficient of transparency is 82 - 83% and can thus be assumed to be independent of the wavelength. Experiments conducted in a wind tunnel reveal that when the wind velocity is below 5 m/sec, the effect of the wind on the reading is not great; however, when it is above 5 m/sec, this effect will increase gradually with the wind velocity.

- 10.5 Yen Kai-wei (Yen K'ai-wei)
A CALIBRATION CHAMBER FOR
METEOROLOGICAL THERMOMETERS
32(3): 261-263, September 1962
4 figs., 3 refs., eqs.
- 10.6 Chen Chang-chao (Ch'en Chang-chao) and
Hu Teng-chang (Hu T'eng-chang)
AN EXPERIMENTAL STUDY OF THE PROPERTIES
OF THE VENTURI-PITOT TUBE
35(3): 371-379, August 1965
18 figs., 2 refs.

This paper deals with a series of experiments designed to study the factors controlling the gain and azimuthal effect of the Venturi-Pitot tube.

See also: 2.17, 4.19, 13.11 and 18.6

CHAPTER 11

NUMERICAL FORECASTING (MODELS AND BASES FOR)

- 11.1 Liao Tung-hsien (Liao Tung-hsien)
A SIMPLIFIED GRAPHICAL METHOD FOR
NUMERICAL PREDICTION WITH A
TWO-PARAMETER MODEL
27(2): 153-166, June 1956
12 figs., table, 3 refs., eqs.

This paper presents a simplified graphical method for the 24-hour prediction of 500-mb topography together with a description of the practical procedure for operational use. A total of three prognostic charts for 500 mb was prepared. Verification results indicate that these forecasts are in general concordance with observed data.

- 11.2 Koo Chen-chao (Ku Chen-ch'ao),
Chao Jih-ping (Ch'ao Chi-p'ing) and
Jü Chang (Chü Chang)
VERIFICATION OF NUMERICAL FORECASTS
PREPARED FROM A TWO-LEVEL
QUASI-GEOSTROPHIC MODEL
28(1): 41-62, February 1957
8 figs., 17 refs., eqs.

A number of 24 and 48-hour numerical forecasts of the 500-mb topography over a certain part of Asia were prepared by a graphical method with a two-level quasi-geostrophic model. The results of several examples indicate that in general the quality of these forecasts is satisfactory. However, it is noted that the system was incapable of predicting the negative height change which occurred south of the anticyclone center in the case of a blocking situation. Thus a blocking high did not appear in the prognostic charts. This inadequacy may be attributed to the fact that the divergence field at 500 mb has not been properly taken into account in the two-level quasi-geostrophic model. It is pointed out that the divergence field at 500 mb becomes relatively important in the case of intense development of synoptic systems. For the inclusion of the effect of this field, it is necessary to resort to a three-level model or a more sophisticated

approximation than the quasi-geostrophic assumption. On the other hand, some of the errors may be attributed to the use of Fjørtoft's graphical method (in the integration of the Poisson equation).

- 11.3 Koo Chen-chao (Ku Chen-ch'ao),
Jú Chang (Chú Chang) and
Chao Jih-ping (Ch'ao Chi-p'ing)
AN EXPERIMENTAL STUDY ON THE USE OF
A THREE-LAYER QUASI-GEOSTROPHIC MODEL
IN NUMERICAL PREDICTION
28(2): 141-156, May 1957
18 figs., 19 refs., eqs.

From an analysis of local temperature change, the authors first emphasize the frequent necessity of resorting to three-layer models in numerical prediction. A case study of computing the tendency of upper-air temperature and pressure fields is then presented. The purpose of the computation is to determine the critical moment for the development of a blocking high over the Urals and the results indicate that this objective can only be achieved by means of a three-layer model which adequately allows for negative height anomalies caused by cut-off highs and lows.

Based on the equations of the three-layer model used, the authors have formulated a forecasting rule which can simply be stated as "the height of an isobaric surface rises (weakening of a trough or intensification of a ridge) when cold (warm) advection increases (decreases) with altitude and falls (deepening of a trough or weakening of a ridge) when cold (warm) advection decreases (increases) with altitude". Thus the generally accepted rule that "warm advection gives rise to intensification of a ridge and cold advection produces deepening of a trough" is only truly applicable under certain restricting conditions.

The necessity and difficulty of obtaining closer approximations to the true winds in this type of study are discussed. It is shown that the existing form of coded upper-air wind reports is not adequate for the computation of divergence.

A method of group relaxation suitable for use with the Poisson equation is also suggested for computational purposes.

- 11.4 Chang Shih-lich (Chang Shih-lich)
FORMULATION OF QUALITATIVE FORECASTING
RULES FROM A TWO-PARAMETER BAROCLINIC
MODEL
28(4): 249-255, November 1957
13 figs., 4 refs., eqs.

In the present study, the two-parameter model developed by Thomson and Gates [1] is used to evaluate the factors governing the development of absolute vorticity and the variation of the thermal wind vorticity. Some qualitative rules for the prediction of large-scale disturbances are also formulated and given in the text.

- 11.5 Chen Yung-san (Ch'en Hsiung-shan)
Liu Ruey-chih (Liu Jui-chih),
Shu Yu-fung (Hsü Yu-feng),
Chih Li-jen (Chi Li-jen) and
Koo Chen-chao (Ku Chen-ch'ao)
AN EXPERIMENT ON THE PREDICTION OF SYNOPTIC
DEVELOPMENT IN THE PRESENCE OF ACTIVE FRONTS
BY MEANS OF A TWO-LAYER MODEL
28(4): 275-281, November 1957
7 figs., 5 refs., eqs.

- 11.6 Koo Chen-chao (Ku Chen-ch'ao)
SMOOTHING PROCEDURES IN OBJECTIVE ANALYSIS
AND NUMERICAL PREDICTION FOR THE FILTRATION
OF METEOROLOGICAL NOISE BY MEANS OF
TECHNIQUES USED IN TURBULENCE PROBLEMS
28(4): 319-323, November 1957
9 refs., eqs.

- 11.7 Chang Yen (Chang Yen)
A TEST OF A GRAPHICAL METHOD FOR QUANTITATIVE
PRECIPITATION FORECASTING IN CHINA
29(1): 7-15, February 1958
7 figs., 2 tables, 7 refs., eqs.

In this paper, a 24-hour precipitation forecast is made from a 500/1000-mb chart using a two-layer model and a graphical method for numerical prediction.

The method used is essentially a combination, with modification, of three methods by Estoque, Fjørtoft and Tokyo University, respectively. The horizontal transport of water vapor below 500 mb is computed to produce a 24-hour prediction of precipitation distribution. An example is given for the case at 0800 hours, 15 - 16 May 1957.

- 11.8 Koo Chen-chao (Ku Chen-ch'ao) and
Fan Yung-shang (Fan Yung-hsiang)
A STATISTICAL STUDY OF THE
EDDY TRANSPORT OF VORTICITY
IN A LARGE-SCALE TIME-AVERAGED
MOTION
29(1): 16-23, February 1958
7 figs., 8 refs., eqs.

This paper studies the statistical behavior of the various eddy transport terms in a set of time-averaged vorticity equations for a two-layer model using upper air data recorded in February 1956. From analysis made on the magnitude and change in the eddy transport of vorticity for different time intervals at Peking, Irkutsk, Moscow, Paris and Oslo, it was primarily determined that in general, the eddy transport term is not necessarily smaller than the mean transport term and is therefore not negligible. Furthermore, there is no simple relation between these two terms. In view of this, the use of the equation of averaged motion for medium and long-range forecasts appears inadequate.

- 11.9 Chou Ge-fen (Ch'ou Chi-fan) and
Liao Hsiang-yün (Liao Hsiang-yün)
A STATISTICAL STUDY OF FJØRTOFT'S
GRAPHICAL METHOD
29(1): 24-32, February 1958
7 figs., 3 tables, 1 ref., eqs.

This paper studies the accuracy of the approximate integration formula $\Delta H = -(\Delta \xi + 2\overline{\Delta \xi})$ and the steadiness of the space mean velocity field (or the space mean height field, i. e., the \overline{H} -field). By analyzing the change in the actual field, the errors introduced by them are discussed.

- 11.10 Koo Chen-chao (Ku Chen-ch'ao)
ON THE EQUIVALENCY IN THE TREATMENT
OF WEATHER FORECASTING AS AN
INITIAL-VALUE PROBLEM IN THE
NUMERICAL PREDICTION OF TOPOGRAPHY
AND AS AN EVOLUTION PROBLEM IN
SURFACE SYNOPTIC PROGNOSIS
29(2): 93-98, May 1958
4 figs., 11 refs., 7 eqs.

Weather forecasting is generally treated as an initial-value problem in numerical prediction studies but is regarded as an "evolution" problem of synoptic processes in operational practice. Although these two disciplines are basically different in approach, the present study shows that they may be considered as equivalent under certain simplifying assumptions. In this way, it is demonstrated that the three-dimensional structure of a baroclinic atmosphere is reflected by and related to the evolution of the surface pressure and temperature fields, which also determine the developments at other levels of this atmosphere.

- 11.11 Liao Tung-hsien (Liao Tung-hsien)
A SIMPLE TWO-LAYER MODEL
AND ITS EXTENSION
29(3): 162-175, August 1958
3 figs., table, 15 refs., 54 eqs.
Full translation: Emm-66-62

In this paper, a two-layer model applicable both to graphical integration and numerical computation is proposed. Using this model, the height of the 500-mb surface and the thickness between this and some chosen isobaric surface in the vicinity of the top of the friction layer can be derived. An extended model involving three layers is also designed. Unlike Sawyer and others, in designing these models, the distribution of the vertical velocity with height is not prescribed.

Finally, the steadiness of the space mean velocity field and the selection of lateral boundary conditions are discussed.

- 11.12 Koo Chen-chao (Ku Chen-ch'ao)
UTILIZATION OF PAST DATA IN
NUMERICAL FORECASTING
29(3): 176-184, August 1958
7 refs., eqs.
Full translation: Emm-66-63

Up to now, past data have not been utilized in numerical weather forecasting due to the particular formulations of the problem. This paper indicates that the condition for solution, formed by a whole set of available meteorological data, is not compatible with the general system of weather equations. Thus, it is necessary to study the best way of formulating the problem using greatest possible available data in the condition for solution in order to obtain the optimum way of forecasting. Two possibilities are given. First, it is shown that under certain conditions, weather forecasting may be formulated as an evolution problem, in which past data are utilized. Secondly, past data could be partly utilized in an initial value problem in which the system of weather equations, with certain meteorological variables eliminated, contains higher order time derivatives. The significance of these formulations is discussed.

- 11.13 Dobryshman E. M.
A NEW METHOD FOR THE INTEGRATION
OF THE NONLINEAR VORTICITY EQUATION
30(2): 121-136, May 1959
Fig., 2 tables, 9 refs., 56 eqs.

Under most circumstances, practically all the existing numerical methods for the short-range prediction of the pressure field rely on the partial derivative of the potential field (or the stream function), $\partial z/\partial t$ (or $\partial \psi/\partial t$). The generic functional form of this type of equation may be represented by $L \left(\frac{\partial z}{\partial t} \right) = F [x, y, \zeta, z(x, y, \xi, t)]$ [Equation (1)], where L denotes the linear differential operator, and operates on the spatial coordinates only. It follows naturally that its solution in the form of an inverse operator L^{-1} also operates on the spatial coordinates alone.

This paper presents another method for solving Equation (1). A maximum operator (Naibol'shii operator) is first established for the left-hand side of the potential or stream function, and the explicit form of the inverse operator is next found. Initial input data are then fed into the equation for solution. As an extension of the general operator, a term representing the variation of coriolis force with latitude is added. It is noted that this term is very important in investigations of large-scale synoptic processes.

The paper first deals with a barotropic model in Cartesian coordinates and then a baroclinic model in spherical coordinates. An investigation of the exact solution of the nonlinear vorticity equation is finally presented as an illustrative example.

- 11.14 Wu Yon-shen (Wu Jung-sheng)
A SCHEME FOR THE NUMERICAL PREDICTION
OF THE 500-MB TOPOGRAPHY
30(2): 165-172, May 1959
6 figs., 8 refs., eqs.

In order to avoid the usual assumption of a non-divergence level at 500 mb, this paper works on a model which assumes that the potential surface at $P = 0$ approximates a horizontal plane at height H with little variation with time. The prediction equation for the 500-mb topography derived from this simplifying assumption is very similar to the barotropic vorticity equation, particularly when the working grid is small (e. g. , 600 km). However, despite their similarity in form, there are basic differences in the two cases. In this article, it is pointed out that better results may be obtained from a barotropic model by using a fine grid. Practical examples indicate that the present method is fairly satisfactory.

- 11.15 Koo Chen-chao (Ku Chen-ch'ao)
A CASE STUDY OF THE CONTRIBUTION OF THE
LARGE-SCALE EDDY TERM TO HEIGHT TENDENCY
30(2): 191-194, May 1959
7 figs., 7 refs., eqs.

The contribution of the large-scale eddy term to height tendency in a barotropic model for the ten-day period 13 - 22 February 1956 was

computed. The results show that the contribution of the eddy transport term ($\overline{v' \cdot r' \zeta'}$) is of the same order of magnitude as that of the mean transport term ($\bar{v} \cdot r \bar{\zeta}$). However, these two terms exert unequal influence on the distribution of height tendency and are not simply related by proportional factors.

11.16 Koo Chen-chao (Ku Chen-ch'ao)
CHINESE PROGRESS IN NUMERICAL
WEATHER FORECASTING
30(3): 236-242, August 1959
32 refs., eqs.

11.17 Hsu E. H. (Hsu^{II} Erh-hao)
A DISCUSSION ON THE APPROXIMATE SOLUTION
TO THE HELMHOLTZ EQUATION
31(2): 101-109, May 1960
3 figs., 3 tables, 6 refs., 22 eqs.

An approximate solution to the Helmholtz equation is derived by the author, which is considered more accurate than the form of solution suggested by Fjørtoft and is also more convenient for practical application (particularly in graphical integrations connected with problems in numerical prediction). Fjørtoft's solutions to the Helmholtz and Poisson equations can also be obtained as particular cases from the author's present solution. Formulas for various values of M in the Helmholtz equation are presented which will be suitable for use in numerical forecasting by graphical methods. The accuracy of these formulas is discussed. A brief survey is also made of the applicability of the author's solution in problems involving the use of electronic computers.

11.18 Chyou Yung-yen (Ch'ou Yung-yen)
QUANTITATIVE PREDICTION OF
FRONTAL PRECIPITATION
31(2): 119-125, May 1960
11 figs., 3 refs., eqs.

In this paper, a method of forecasting frontal precipitation is proposed, which is based on the evaluation of the vertical velocity in the warm air

above the frontal surface on a frontal contour chart by the application of kinematic boundary conditions. The vertical velocity at various levels is also determined by assuming that this entity decreases linearly with height to a fixed level in the warm air. The computed values are then substituted in a conventional precipitation-rate formula to determine the amount of precipitation.

Two illustrations are presented and it is found that there is a fair agreement between the computed precipitation amounts and the actual observations.

- 11.19 Zhu Yong-ti (Chu Yung-t'i)
A THREE-LEVEL NONLINEAR PREDICTION MODEL
IN SPHERICAL COORDINATES
31(3): 216-233, November 1961
13 figs., 2 tables, 6 refs., eqs.
Full translation: Emm-66-64

This paper applies the theoretical results of References [1] and [2] to formulate a three-level nonlinear prediction model in spherical coordinates to assess the effect of topography on the prediction of the isobaric field, the working levels being 1000, 500 and 300 mb. The auxiliary function \mathcal{L} of the perturbation source function is computed from the contour fields at 1000, 700, 500, 300 and 100 mb by means of a system of localized rectangular coordinates. When $t > 0$, the \mathcal{L} -field and the contour field are predicted "in parallel" by a Eulerian method. An interpolation formula for the evaluation of the influence function* and an approximation of the function in the neighborhood of a singular point are suggested. The proposed model has been programmed for computation on the large high-speed electronic computer (BESM-1) of the USSR Academy of Sciences and the numerical output analyzed. The results show that the proposed model is suitable for the hemispherical prognoses of the flow pattern as well as the surface pressure field for more than 24 hours.

* Translator's Note: In western literature "Green's function" is a more familiar term than "influence function".

- 11.20 Liao Tung-hsien (Liao Tung-hsien),
Liu Hung-teh (Liu Hung-te) and
Li Yo-fang (Li Yü-fang)
A BAROTROPIC MODEL WITH ACCOUNT OF
LARGE-SCALE OROGRAPHIC INFLUENCES
31(3): 234-240, November 1961
7 refs., 34 eqs.
Full translation: Emm-66-65

This paper presents a linearized barotropic prognostic equation and its approximate solution with the effect of orography taken into consideration. It is found that when the characteristic frequency of a forced disturbance induced by orography is equal to that of a free disturbance, a resonance phenomenon occurs. In this case, the solution obtained may not be used for mid- or long-range prediction. However, this difficulty can be overcome if the frictional effect is introduced.

- 11.21 Chin Tseng-hao (Ch'in Tseng-hao)
A DYNAMIC MODEL FOR THE NUMERICAL
PREDICTION OF BAROCLINIC FLOWS
33(2): 131-144, May 1963
11 figs., table, 17 refs., eqs.
Full translation: Emm-65-23

Some authors [1] have shown that in China, the contribution to the height tendency of an isobaric surface due to surface friction is of the same order of magnitude as that of large-scale topographic influences, and that under certain special weather conditions, non-adiabatic heating must be taken into account, even in short-range forecasting. Considering these effects, this paper first derives a two-parameter baroclinic model suitable for numerical weather prediction by combining the hydrodynamic and thermodynamic equations and then solves the system of prognostic equations. The truncation errors in numerical weather prediction when a triangular grid-point system is used are discussed, and an optimum formula for the field is derived. Finally, the paper discusses briefly the problem concerning the development of large-scale baroclinic disturbances.

- 11.22 Chang Chia-cheng (Chang Chia-ch'eng),
Zhou Jia-bin (Chou Chia-pin),
Huang Wen-jie (Huang Wen-chieh) and
Ma Wei-hua (Ma Wei-hua)
A PRELIMINARY REPORT ON THE APPLICATION
OF THE CHEBYSHEV POLYNOMIAL TO THE
STUDY OF THE 500-MB CONTOUR FIELD
33(2): 231-244, May 1963
8 figs., 4 tables, 30 refs., eqs.

In this paper, the mean isohyse field is evaluated from the monthly 500-mb charts during the period 1957 - 1961 by means of the Chebyshev polynomial. The seasonal characteristics of the mean temperature and rainfall fields over the middle and lower Yangtze are also examined. The errors involved and the corrections required are described. The usefulness of the Chebyshev coefficient in the classification of circulation patterns is also discussed.

By assuming that the Chebyshev coefficient and the time series representing the evolution of circulation patterns form time-dependent ergodic Markov chains with a finite number of states, the transition probability and the absolute probability of this coefficient and of the circulation patterns are computed. The errors of the computation are assessed. The properties of the Markov chains and the use of the transition probability in the prediction of the contour field are then discussed.

- 11.23 Chou Ge-fen (Ch'ou Chi-fan),
Chow Tse-tung (Chou Tzu-tung) and
Du Xing-yuan (Tu Hsing-yüan)
A NEW COMPUTATIONAL SCHEME FOR A
BAROTROPIC MODEL
33(4): 484-493, November 1963
18 refs., 26 eqs.

The barotropic prognostic equation and the balance equation in spherical coordinates are solved by use of the method of integral relationship and Galerkin's technique. Assuming symmetry between the northern and southern hemisphere and excluding artificial boundary conditions, the authors expanded the actual forecasting region without effecting a change in the mean height of the isobaric surface.

The prognostic equation includes the difference in wind direction near the ground and at the 500-mb surface.

- 11.24 Huang Lan-chieh (Huang Lan-chi),
Wang Ping-xia (Wang P'ing-hsia),
Zeng Ji-rong (Tseng Chi-jung),
Yang Zhen-xiong (Yang Chen-hsiung) and
Chang Yao-ko (Chang Yao-k'o)
A PROGRAM LIBRARY FOR NUMERICAL
WEATHER PREDICTION
34(2): 185-191, May 1964
7 figs., 7 eqs.

Due to the complexity of the problems and procedures involved in numerical weather prediction, this paper proposes the establishment of a program library using the combination of available data and information analysis to facilitate the mapping out of procedures and examination of existing conditions for different models.

- 11.25 Du Xing-yuan (Tu Hsing-yüan)
Chow Tse-tung (Chou Tzu-tung) and
Chou Ge-fen (Ch'ou Chi-fan)
PROBLEMS OF THE SOLUTION OF CERTAIN
EQUATIONS USED IN WEATHER FORECASTING
34(4): 462-467, November 1964
10 refs., 26 eqs.

Problems concerning the existence and uniqueness of the solution of certain equations used in weather forecasting are discussed by considering the positive and definite properties of the differential operators. In a number of special cases, the advantages of some forecasting models over others are explained. The irrationality of certain boundary conditions used in numerical prediction is analyzed. It is shown that for solution of the problem of variation of the geopotential height in three-dimensional space, the use of the expression,

$$\int_{\zeta=0}^{\infty} \int \zeta^2 \frac{\partial q}{\partial \zeta} \sin \vartheta \, d\vartheta \, d\lambda = 0,$$

as the upper atmospheric boundary condition is sufficient.

- 11.26 Liao Tung-hsien (Liao Tung-hsien)
ON THE STABILITY AND CONVERGENCE OF
THE SO-CALLED "FORWARD AND CENTERED
FINITE-DIFFERENCE" SCHEMES FOR
EQUATIONS OF THE FORM $\frac{\partial \zeta}{\partial t} + u \frac{\partial \zeta}{\partial x} = 0$
34(4): 468-474, November 1964
7 refs., 25 eqs.
Full translation: Emm-66-134

With a view to solving equations of the form $\frac{\partial \zeta}{\partial t} + u \frac{\partial \zeta}{\partial x} = 0$, this paper first presents a discussion on the stability of the so-called "forward and centered finite-difference" schemes under general circumstances and specifies the conditions for stability. The results are found to be different from those given by conventional techniques using centered differences. Three types of finite-difference schemes are compared, and the analysis indicates that the widely used conventional system which employs forward finite-difference for the first time step and centered finite-difference for the rest of the computations gives the worst results, and is computationally unstable when $\lambda (= u\Delta t/\Delta s) \rightarrow 1 - 0$. This difficulty may be overcome by replacing the forward finite-difference operations by the procedure of any one of the other two schemes. Furthermore, better results may be achieved by the introduction of an "upwind analogue" in the second and the third scheme.

- 11.27 Sze Kiu-ung (Shih Chiu-en),
Chu Tung-ken (Chü Tung-ken),
Sun Shan-tse (Sun Shan-tse) and
Tsui Yu-hsi (Ts'ui Yü-hsi)
STUDY OF LONG-RANGE FORECASTING
BY STATISTICS.
(I) APPLICATION OF THE STEPWISE
MULTIPLE REGRESSION TECHNIQUE
34(4): 507-518, November 1964
Fig., 6 tables, 8 refs., 22 eqs.

The stepwise multiple regression technique is designed to single out from a large number of predictors the statistically significant ones to form a regression equation (prediction equation) for a specified predictand.

In this paper, the technique is used to analyze data on the monthly mean precipitation in July and August 1932 - 1962 recorded at five stations (Peking, Tientsin, Paoting, Shihchiachuang and Yingkow) in North China, with the mean precipitation considered as the predictand and the factors influenced either by solar radiation or pre-precipitation circulation together with several other meteorological elements as plausible predictors. Linear regression analysis shows that the predictors for forecasting monthly and seasonal precipitation over different regions in China are not necessarily the same. The results of 42 predictions made for summer and the individual months of June - October 1963 using this technique indicate a 10% higher test score than those generated by chance.

The paper gives a brief discussion of improvements in regression analysis. It is suggested that in addition to long-range forecasting, the technique can also be a useful tool for medium and short-range predictions as well as for climatic studies.

- 11.28 Chang Wou-koe (Chang Yao-k'ao)
CONSIDERATION OF THE FRICTION TERM
AND SMOOTHING PROCESS IN THE
BAROTROPIC VORTICITY EQUATION
35(1): 34-43, February 1965
4 figs., 3 tables, 3 refs., 31 eqs.

This paper first discusses the choice of a smoothing coefficient in accordance with the grid size. It then studies the influence on the solution of the differential equation by the addition of the friction term to the vorticity equation, and discusses the selection of a suitable friction coefficient. The influence on the computational stability of the finite difference scheme by the addition of the friction term is also discussed. It is shown that in the normal time centered difference scheme, computation is stable only if the friction term is taken in the $(n - 1)^{th}$ time layer. On the other hand, computation will be unstable if the term is taken in the n^{th} time layer. The time forward difference scheme may be stable after the addition of the friction term, but the friction coefficient required will be much larger. The paper also

discusses the relationship between the smoothing process and the friction term in numerical prediction using the vorticity equation. It was found that the two are not equivalent computationally. However, a suitable smoothing coefficient may be obtained by comparing the smoothing process with the diffusion equation.

- 11.29 Lio Ruey-chih (Liu Jui-chih) and
Chang Chi-peng (Chang Chi-p'eng)
A NUMERICAL EXPERIMENT
USING PRIMITIVE BAROTROPIC
EQUATIONS
35(1): 75-81, February 1965
3 figs., 4 refs., eqs.

A numerical experiment using primitive barotropic equations is presented. The finite difference scheme for centered differences in time and space is employed in the solution. Simple initial and boundary conditions are determined from the results of the experiment.

A 24-hour prediction is made for four actual cases. The results give a general picture of the barotropic processes.

- 11.30 Hwang S. S. (Huang Shih-sung)
ON THE EVALUATION OF THE
MOVEMENT AND DEVELOPMENT
OF TROUGHS AND RIDGES IN THE
WESTERLIES
35(1): 82-95, February 1965
9 figs., 13 refs., eqs.

A theoretical study is made of the movement and development of troughs and ridges in the westerlies by taking into account factors such as the latitudinal width of the westerly current, the intensity of the westerly jet, the latitudinal width of the wave, the difference in position between the jet axis and the wave, and the thermal structure of the troughs and ridges. The results agree with experiments.

- 11.31 Shen Ju-kuei (Shen Ju-kuei) and
Mou Wei-feng (Mou Wei-feng)
A PRELIMINARY VERIFICATION OF
48-HOUR 500-MB NUMERICAL
PREDICTION CHARTS ISSUED BY
THE CENTRAL WEATHER BUREAU
OF CHINA
35(4): 383-398, November 1965
15 figs., table, 4 refs.

This paper presents a preliminary verification of 48-hour 500-mb numerical prediction charts issued by the Central Weather Bureau of China during 1964 - 1965. The experience acquired in the application of numerical predictions during the past three years has also been summarized with particular emphasis on the discussion of the characteristics of forecast errors under various synoptic situations. This discussion provides materials for the understanding of the potential and efficiency of numerical predictions, and will be useful in the effective application of numerical forecasting on an operational basis.

- 11.32 Wang Chung-hao (Wang Tsung-hao)
A METHOD OF SETTING UP FINITE-DIFFERENCE
SCHEMES FOR PREDICTION EQUATIONS
35(4): 399-407, November 1965
6 figs., 2 tables, 3 refs., eqs.

This paper presents two types of finite-difference schemes to represent the barotropic vorticity equations as an analogy to the principle of conservation of vorticity. The first type is conservative with respect to integration and can be separated into an explicit component which is conditionally stable and an implicit component which is unconditionally stable. The other type is equivalent to a quasi-Lagrangian model and is an explicit scheme which is entirely unconditionally stable. However, when necessary, the time-step in an unconditionally stable scheme may be extended to meet operational requirements.

The evaluation of the wind field and the related problems on smoothing are discussed in relation to the computational requirements of each scheme.

The discussion includes specifications of boundary and initial conditions. The numerical results given by the explicit forms are assessed by means of actual predictions and the evaluation of idealized fields.

- 11.33 Yang Jen-shi (Yang Chin-hsi)
STABLE DISTURBANCES IN THE WESTERLIES
UNDER THE MUTUAL ADJUSTMENT OF
ATMOSPHERIC MOTION AND HEATING
35(4): 498-506, November 1965
5 figs., 8 refs., 42 eqs.

This paper describes a two-level model characterized by the mutual adjustment of atmospheric motion and heating due to the release of latent heat of condensation as well as radiative and turbulent transfer of sensible heat. Some of the characteristics and properties of the thermally driven disturbances produced by this model are discussed. The findings show that disturbances in the westerlies are more pronouncedly influenced by regular heat sources than the heating produced by "mutual adjustment" of the atmospheric motion. As a factor governing the development of stable, thermally driven disturbances, turbulent transfer of sensible heat ranks highest, the release of latent heat of condensation second and radiation last. The last two entities are respectively about half and a quarter as effective as turbulent transfer. The influence of "condensational heating" is more pronounced on troughs over Asia while the effect of "turbulence heating" is more important on troughs over America.

- 11.34 Wang Chung-hao (Wang Tsung-hao)
A NOTE ON THE APPLICATION OF
SUCCESSIVE APPROXIMATION IN
NUMERICAL WEATHER PREDICTION
35(4): 528-530, November 1965
7 refs., eqs.

See also: 7.17, 7.27, 16.15 and 16.17

CHAPTER 12

OROGRAPHY AND TOPOGRAPHIC EFFECTS

- 12.1 Yeh Tu-cheng (Yeh Tu-cheng)
THE INFLUENCE OF SMALL TOPOGRAPHICAL
FEATURES ON AIRFLOW
27(3): 243-262, September 1956
5 figs., 46 refs., eqs.

This paper presents a review on the influence of small topographical features on airflow with due emphasis on the controversies among existing theories on lee waves. The present author is of the opinion that these controversies are mainly brought about by the choice of upper boundary conditions and the pertinent differences in the scale of the underlying mountain. Lee waves occur when the half-width of the mountain $l \approx L_s / 2\pi$ [$L_s = u / \sqrt{(g/\theta)(\partial\theta/\partial z)}$], and when a persistent lid or surface of discontinuity exists at an appropriate level in the atmosphere.

In the first case, lee waves are characterized by the resonance of forced oscillations induced by the underlying mountain with the natural vibrations of the atmosphere. In the second case, the existence of lee waves is restricted to certain wave bands only. Thus this discussion leads to a clear understanding of the physics of lee waves.

- 12.2 Chu Pao-chen (Chu Pao-chen)
A DISCUSSION OF THE INFLUENCE OF
TOPOGRAPHY ON THE DEVELOPMENT
OF THE MEAN TEMPERATURE FIELD
28(4): 315-318, November 1957
Fig., table, 3 refs., eqs.

Steady perturbations in the 1000-500 mb mean temperature field caused by large-scale topographical features are evaluated by means of a two-layer model. The results show that topography exerts a significant influence on the development of thermal ridges and troughs. It is also found that orographic troughs do not exhibit any tilting with altitude.

- 12.3 Lo Szu-wei (Lo Ssu-wei)
ON THE STABILITY OF THE
FLOW PATTERN OVER THE
TIBETAN PLATEAU AND IN
ITS NEIGHBORHOOD
28(4): 326-330, November 1957
6 figs., 2 refs.
- 12.4 Chow Shiao-ping (Chou Hsiao-p'ing) and
Koo Chen-chao (Ku Chen-ch'ao)
THE INFLUENCE OF LARGE-SCALE
TOPOGRAPHY ON THE PROPAGATION
OF UPPER-LEVEL PLANETARY WAVES
29(2): 99-103, May 1958
3 figs., 4 refs., 6 eqs.

It is known from synoptic experience that wave disturbances travel faster along the northern edge of the Tibetan Plateau than along its southern periphery. This can be explained in terms of the theory of propagation of planetary waves as the result of forced convergence or divergence in the upstream and downstream currents of a progressing wave along a slope under certain kinematic boundary conditions. The difference in the propagation velocity of waves on both the northern and southern sides as given by theoretical computations is found to agree closely with actual observations.

- 12.5 Central Weather Bureau, Numerical Prediction Section,
Institute of Meteorological Research
THE OROGRAPHY OF THE NORTHERN HEMISPHERE
EXPRESSED BY SPHERICAL FUNCTIONS
30(4): 405-413, November 1959
3 figs., 3 tables, 1 ref., eqs.
Full translation: E-T-Ch-63-8

This paper presents an orographic chart for the northern hemisphere according to the data of the orographic height above mean sea level as given by Berkofsky. It was found that the chart expressed by spherical functions is in fair agreement with that prepared by Berkofsky except in the region near the North Pole.

- 12.6 Du Xing-yuan (Tu Hsing-yüan)
THE TOPOGRAPHICAL EFFECTS OF
PLATEAUS ON PRESSURE VARIATION
31(2): 93-100, May 1960
11 refs., eqs.

This paper describes two proposed methods for studying the effects of topography. The first is the parametric method using small intervals. The boundary conditions with respect to the height of the ground are expanded in terms of a Taylor series in the neighborhood of the sea level. The solution obtained is then a power series of the parameter involved.

In the second method, the principle of similarity is used to transform a forecast model obtained under sea-level conditions to one which may be suitable for application to any arbitrary plateau. A total of 40 forecast samples is analyzed by means of the "double-layer" graphical method and the average accuracy of forecast is found to be improved by 10%.

- 12.7 Lo Szu-wei (Lo Ssu-wei)
THE INFLUENCE OF THE "LIFTING EFFECT"
OF THE TIBETAN PLATEAU ON
SYNOPTIC SYSTEMS
31(2): 185-188, May 1960
3 figs., 2 refs.

- 12.8 Du Xing-yuan (Tu Hsing-yüan)
THE EFFECT OF OROGRAPHY ON THE
WIND FIELD AND PRESSURE IN A
TURBULENT ATMOSPHERE
33(3): 297-304, August 1963
Table, 21 refs., eqs.

This work investigates the different roles of orography in the change of the wind and pressure fields taking atmospheric turbulence into account. Under geostrophic conditions, it was found that when the pressure gradient coincides with the gradient of isohypses of the orography, there is an increase in pressure. If both gradients coincide but in different directions, the pressure decreases.

A pressure model is introduced which takes orography and turbulence into account.

It is also shown that the difference in the multi-annual, mean monthly pressure values averaged according to latitudes in both hemispheres can be explained by the difference in the orographic distribution.

- 12.9 Chao Jih-ping (Ch'ao Chi-p'ing)
Chang Kung-kuan (Chang Kuang-k'un) and
Yan Shiao-ming (Yüan Hsiao-ming)
A PRELIMINARY STUDY OF THE
FORMATION OF PRESSURE JUMPS
BY A SMALL MOUNTAIN IN A
TWO-LAYER MODEL
34(2): 233-241, May 1964
7 figs., 6 refs., 38 eqs.
Full translation: Emm-65-37

In this paper the influence of a small mountain on the airflow above is examined by means of a two-layer model. The one-dimensional solution for the steady state reveals that the degree of perturbation in the airflow in a mountainous region is determined by the upstream conditions as well as the height of the mountain. Provided that the height of the mountain reaches a critical value, a stationary pressure jump will occur on the lee side when the Froude number of the upwind side is less than 1. The occurrence of the pressure jump is then examined by means of a one-dimensional solution for the unsteady state.

- 12.10 Chen Shou-jun (Ch'en Shou-chün)
A STUDY OF THE STATIONARY
PERTURBATIONS IN THE WESTERLIES
DUE TO OROGRAPHY USING A
FOUR-LAYER MODEL
35(3): 357-363, August 1965
3 figs., 3 tables, 9 refs., 18 eqs.

It is shown in a four-layer model that in winter the orographically induced stationary perturbations in the westerlies with a wave number

of 1 - 2 can affect the circulation in the stratosphere. This effect, however, is small in summer.

See also: 1.4, 1.5, 1.6, 1.23, 1.30, 2.16, 7.2, 7.10, 7.23,
7.26, 8.1, 15.3, 15.4 and 16.31

CHAPTER 13

RADIATION (SOLAR, TERRESTRIAL; ABSORPTION,
EMISSION); SOLAR-TERRESTRIAL EFFECTS

- 13.1 Cheng Chwen-shu (Ch'eng Shun-shu)
AN ANALYSIS OF SOLAR RADIATION
OBSERVATIONS AT TAI SHAN
27(3): 181-194, September 1956
2 figs., 7 tables, 8 refs.

Solar radiation observations made at the Tai Shan Observatory (36°16'N, 117°12'E; 1545 m above sea level) in 1937 are summarized and discussed. The observations included intensity of insolation, total radiation on a horizontal surface and noon-hour ultraviolet radiation intensity (in Davos unit). The turbidity factor with respect to main air-mass situations and its variations are also discussed.

- 13.2 Yin Hung (Yin Hung)
THE DISTRIBUTION OF TOTAL INSOLATION
OVER EAST CHINA BASED ON COMPUTATIONS
FROM AN EMPIRICAL FORMULA
28(2): 101-107, May 1957
8 figs., 4 tables, 9 refs., eqs.

This paper first discusses the accuracy of the various empirical formulas for computing the total insolation by a comparative study of the insolation and total radiation records from Nanking and Peking. The distribution of the total insolation over East China is then evaluated by means of a semi-graphical method proposed by Hamon and others [1].

- 13.3 Xiao Wen-jun (Hsiao Wen-chün)
THE SEASONAL AND ANNUAL DISTRIBUTION
OF TOTAL RADIATION OVER CHINA
30(2): 186-190, May 1959
7 figs., table, 8 refs., eqs.

This paper presents an analysis of insolation records over 26 stations in China during the period December 1957 - November 1958 in the form of charts depicting the seasonal and annual distribution of total radiation

over China. The results are compared with the distribution over America and other places in the world. The accuracy of the various existing empirical methods of computation under different climatological conditions is discussed. The findings indicate that the choice of a particular empirical method for application in any region is to a great extent governed by the existing climatological conditions.

- 13.4 Yang Chien-chu (Yang Chien-ch'u)
A SURVEY OF THE RECENT INVESTIGATIONS
IN FOREIGN COUNTRIES ON THE INFLUENCE
OF SOLAR ACTIVITY ON THE GENERAL
CIRCULATION AND THE WEATHER
32(2): 177-194, June 1962
21 figs., 3 tables, 87 refs.

This paper presents a comprehensive survey of the investigations made in foreign countries in the past fifteen years or so on the influence of solar activity on the general circulation and the weather in the troposphere. The structure of the solar surface and the solar atmosphere, the definition of solar activity and a series of physical processes inducive to the spectral variation of solar radiation are dealt with in the first place. The important research achievements on the influence of solar activity on the general circulation and the weather are then summarized. Several possible mechanisms which have been proposed to explain the effects of solar activity on weather are also brought out for discussion. Finally, it is thought that a deeper understanding of this problem would throw light on some aspects of weather forecasting.

- 13.5 Pan Shou-wen (P'an Shou-wen)
THE CHARACTERISTICS OF RADIATION
CLIMATOLOGY IN THE UPPER AND
MIDDLE YANGTZE
32(3): 199-214, September 1962
7 figs., 15 tables, 33 refs., eqs.

In this paper, radiation data from the upper and middle Yangtze during the period 1958 - 1960 were analyzed. The characteristics of the diurnal

and annual variations of direct solar radiation, scattered radiation, total radiation, reflected radiation, effective radiation and the radiative balance in this region were discussed. They were related to topographical conditions and the characteristics of the general circulation over this region. It is noted that these radiative characteristics form a distinct controlling factor on the climatic patterns of the upper and middle Yangtze.

- 13.6 Tso Ta-kang (Tso Ta-k'ang)
Wang Yi-xian (Wang I-hsien) and
Chen Chian-xei (Ch'en Chien-sui)
CHARACTERISTICS OF THE DISTRIBUTION
OF TOTAL RADIATION IN CHINA
33(1): 78-96, February 1963
18 figs., 6 tables, 29 refs., eqs.

This paper presents a survey of all known empirical equations used for the computation of total radiation. Based on the observational data from 26 insolation stations in China for the period July 1957 to December 1960, the mean monthly total radiation on fine days for each $2\frac{1}{2}^{\circ}$ latitudinal zone in the region bounded by 20°N and 50°N is evaluated by means of the Ukraintsev method. An appropriate expression for the computation of monthly total radiation is then formulated which is used to determine the annual and monthly values of the total radiation for 136 stations. The results are utilized for preparing annual and monthly total radiation distribution charts for China. The significant features of the spatial distribution of annual and monthly total radiation are discussed.

- 13.7 Yin Zong-zhao (Yin Tsung-chao),
Wang You-lun (Wang Yu-lun) and
Tang Zhi-mei (T'ang Chih-mei)
REVISION OF THE VALUE OF THE COEFFICIENT
k IN THE SHAVANOV-ANGSTROM EMPIRICAL
FORMULA FOR COMPUTING THE TOTAL
RADIATION DISTRIBUTION IN CHINA
33(1): 126-128, February 1963
Fig., 2 tables, 9 refs.

- 13.8 Fu Baw-puh (Fu Pao-p'ò)
DETERMINATION OF THE COMPONENTS OF THE
RADIATION BALANCE IN AN UNDULATING REGION
34(1): 62-73, February 1964
5 figs., table, 4 refs., eqs.

This paper gives a theoretical calculation of the components of the radiation balance in an undulating region. The relative variations of the components of the radiation balance between two parallel wind-break hedges of different heights and interspaces are computed as an example.

- 13.9 Chou Yun-hua (Chou Yün-hua),
Li Yu-hai (Li Yü-hai) and
Tso Ta-kang (Tso Ta-k'ang)
COMPARISON OF SEVERAL RADIATION CHARTS*
34(2): 135-145, May 1964
3 figs., 6 tables, 16 refs., 15 eqs.
Full translation: Emm-65-35

The fundamental equations of eight radiation charts and their computed results are discussed in this paper. The effect of pressure and temperature on the transmission functions of the different charts, the absorption and emission of radiation by carbon dioxide and water vapor in the spectral overlapping bands are investigated and a comparison of the various charts for atmospheric emissivity is made. Since these charts give discordant results for the same input, factors causing the discrepancies are analyzed. A preliminary survey on the advantages and disadvantages of each radiation chart is then contemplated in the light of the foregoing discussion.

- 13.10 Chen Lung-shun (Ch'en Lung-hsün),
Kung Chih-pen (Kung Chih-pen),
Wen Yu-pu (Wen Yü-p'u) and
Sun Sau-chung (Sun Shou-chuang)
THE BUDGET OF THE ATMOSPHERIC RADIATION ENERGY
OVER EASTERN ASIA.
(I) THE BUDGET OF SOLAR RADIATION ENERGY OF THE
EARTH AND THE ATMOSPHERE**
34(2): 146-161, May 1964
12 figs., 2 tables, 18 refs., eqs.
Full translation: Emm-65-34

* See 13.17.

** See also 13.13 and 13.14.

This paper which is the first part of a study on the budget of the atmospheric radiation energy over eastern Asia discusses the following three problems:

(a) From the experimental data of the absorption spectra of water vapor presented by Howard, Burch and Williams [1], a formula suitable for the manual computation of the absorption of solar radiation is obtained [see Equation (6)] and compared with the M \ddot{u} gge-M \ddot{o} ller formula.

(b) The absorption energy of solar radiation and the heating rate for January and July from the surface to 100 mb for 39 stations over eastern Asia are computed from Equation (6). By incorporating a correction for cloud cover, a further attempt is made to evaluate the atmospheric absorption of radiation reflected by the earth's surface and the distribution of absorption energy in the entire troposphere.

(c) The distribution of planetary albedo over China and the budget of solar radiation energy of the earth-atmosphere system are discussed in terms of surface total radiation and albedo data for China during the years 1958 - 1960 and the computed atmospheric absorption energy.

13.11 Tao Zu-wen (T'ao Tsu-wen)
DETERMINATION OF THE SENSITIVITY
OF SUNSHINE RECORDERS AND THE
PERCENTAGE OF ACTUAL SUNSHINE
34(2): 248-252, May 1964
3 figs., 3 tables, 4 refs., eqs.

13.12 Weng Du-ming (Weng Tu-ming)
ON THE EVALUATION OF TOTAL RADIATION
BY CLIMATOLOGICAL METHODS
34(3): 304-315, August 1964
14 figs., 4 tables, 16 refs., eqs.
Full translation: Emm-66-82

Through a comparative discussion on the various proposed formulas for the evaluation of total radiation, the present study confirms the general validity of the expressions $Q = Q_0 f(S_1, \bar{n})$ and $Q = S_0 \varphi(S_1, \bar{n})$. The physical significance of the coefficient K in the Savinov-Ångström formula

and the related factors are discussed. A reason is offered to explain the fact that the sum of the percentage duration of sunshine and the average total cloud amount is not equal to 1 under conditions experienced in China. The annual variation of this entity is analyzed. The monthly and daily mean values of total radiation are computed from sunshine records at the various stations in China for the years 1958 - 1960. Empirical expressions for the direct radiation S' and scattered radiation D are determined with a view to satisfying the requisite condition that $Q = S' + D$. The accuracy in the determination of each entity in this expression is examined in the light of their functional dependence.

- 13.13 Chen Lung-shun (Ch'en Lung-hsün),
Kung Chih-pen (Kung Chih-pen),
Chen Chia-pin (Ch'en Chia-pin) and
Jen Tse-chün (Jen Tse-chün)
THE BUDGET OF THE ATMOSPHERIC RADIATION
ENERGY OVER EASTERN ASIA.
(II) LONG-WAVE RADIATION AND RADIATION
BALANCE IN A CLEAR ATMOSPHERE*
34(3): 329-344, August 1964
9 figs., 5 tables, 16 refs., 11 eqs.

This paper is the second part of a study of the budget of the atmospheric radiation energy over eastern Asia. It discusses the following problems:

- (a) The application of Elsasser's radiation data to the construction of radiation charts and the reliability of the data.
- (b) The computation of the budget of atmospheric long-wave radiation and the distribution of the cooling rate for various layers for 36 stations over eastern Asia.
- (c) The atmospheric radiation balance and the net radiation cooling rate in the tropospheric layers.

- 13.14 Chen Lung-shun (Ch'en Lung-hsün),
Kung Chih-pen (Kung Chih-pen),
Chen Chia-pin (Ch'en Chia-pin) and
Wang Chung-hsing (Wang Chung-hsing)
THE BUDGET OF THE ATMOSPHERIC RADIATION
ENERGY OVER EASTERN ASIA.

* See also 13.10 and 13.14.

**(III) THE HEAT BUDGET OF THE EARTH-ATMOSPHERE
SYSTEM IN A CLOUDY ATMOSPHERE***

35(1): 6-17, February 1965

5 figs., table, 15 refs.

Full translation: Emm-66-136

This paper, the third part of a study on the budget of the atmospheric radiation energy over eastern Asia, discusses three problems.

(a) Distribution of long-wave radiation and radiative balance in a cloudy atmosphere: Computed results show that except for the region over the Tibetan Plateau for July, the characteristics of distribution of long-wave radiation in a cloudy and a clear atmosphere are essentially the same, and that the distribution of radiative balance agrees with that of long-wave radiation of the corresponding months.

(b) Distribution of tropospheric heat sources and sinks over eastern Asia: In August the whole of eastern Asia is a heat sink, with two minima appearing respectively over Sinkiang and East China (32° - 25° N). In July, however, the entire region is a heat source with a strong center prevailing northeast of the Tibetan Plateau and a weak one over northern Sinkiang.

(c) The various types of heat budget of the earth-atmosphere system over eastern Asia: In terms of the earth-atmosphere system over the region, the heat loss in January is approximately compensated by the gain in July. However, if only the atmosphere is considered, the heat loss in January is greater than the gain in July. The characteristics of the heat budget are different in different localities.

- 13.15 Chen Chia-i (Ch'ien Chia-i) and
Lü Nai-ping (Lü Nai-p'ing)
AN OBSERVATIONAL ANALYSIS OF RADIATION
BALANCE IN RELATION TO THE REFLECTIVITY
OF CONTAMINATED WATER
35(2): 228-235, May 1965
7 figs., 2 tables, 8 refs.

This paper presents an analysis of observations of reflectivity and radiation balance made on a 100 m^2 evaporation pan at the Chungking

* See also 13.10 and 13.13.

Experimental Station and those at the water surface of the Yangtze from March to August 1959.

The reflectivity of a body of contaminated water increases with an increase in the quantity of sand-suspensoid. The rate of increase in reflectivity becomes moderate when the amount of sand-suspensoid is very large.

In the absence of surface waves, the reflectivity of the 100 m² pan is approximately equal to that of the Kuanting Reservoir in China and that at the surface of Lake Hefner in America.

The radiation balance in spring over river waters is evaluated for different suspensoid contents under various meteorological conditions. The estimated values of radiation balance over the 100 m² pan are also compared with results over a grassy lawn.

- 13.16 Kung Chih-pen (Kung Chih-pen) and
Liao Huai-che (Liao Huai-che)
THE ATMOSPHERIC ABSORPTION OF SOLAR
RADIATION IN THE STRATOSPHERE
35(2): 236-250, May 1965
14 figs., 3 tables, 17 refs., 26 eqs.

This paper deals with the following problems:

(a) The derivation of a set of formulas for the evaluation of the absorption of solar radiation by the stratosphere.

(b) A discussion on the errors of approximation introduced by the horizontal stratification of atmospheric layers which makes no allowance for the curvature of the earth.

(c) The evaluation of stratospheric heating due to absorption of solar energy for January and July.

- 13.17 Chen Lung-shun (Ch'en Lung-hsün) and
Kung Chih-pen (Kung Chih-pen)
COMMENTS ON "THE RADIATION CHARTS OF ELSASSER (1960)
AND YAMAMOTO" AND SOME REMARKS ABOUT "COMPARISON
OF SEVERAL RADIATION CHARTS"*
35(2): 263-264, May 1965
6 refs., 11 eqs.

* See 13.9.

- 13.18 Yin Hong (Yin Hung) and
Zhen Chang-zhong (Chen Ch'ang-chung)
THE EVALUATION OF RADIATIVE TRANSFER
IN THE ATMOSPHERIC 9.6 μ BAND OF OZONE
35(4): 519-527, November 1965
8 figs., 3 tables, appendix, 16 refs., 17 eqs.

In the evaluation of long-wave radiation in the atmosphere, it is customary to apply a pressure correction of the form $u' = u(p/p_0)^K$ to the optical path of the gaseous absorbent. In considering the effect of ozone in the 9.6 μ band, both theoretical and experimental studies indicate that K is a function of u and p . Thus the expression for pressure-correction may be written as

$$u' = u \left(\frac{p}{p_0} \right)^{K(u, p)} = uf(u, p).$$

The graphical functional form of $f(u, p)$ was derived from the experimental results of Walshaw. Tables were compiled to facilitate the evaluation of radiative flux and its divergence.

The weak-line approximation is valid when u is very small. The mean slab absorptivity is represented by $A_f = 1 - \exp\left(-\frac{2su}{d}\right)$ when $K \rightarrow 0$. When $u \rightarrow 0$, $\frac{dA_f}{du} = \frac{2s}{d}$, where $\frac{2s}{d}$ assumes a constant value.

See also: 3.11, 3.12, 3.15 and 7.30

CHAPTER 14

RADIO AND RADAR METEOROLOGY

- 14.1 Lee Chi-chen (Li Ch'i-ch'en)
THE METEOROLOGICAL RADAR EQUATION
FOR THE COHERENT SCATTERING OF
RADAR WAVES BY CLOUD DROPLETS
AND RAINDROPS
32(2): 119-128, June 1962
4 figs., 9 refs., 25 eqs.

A general meteorological radar equation is derived from studies on the coherent scattering of radar waves by cloud droplets and raindrops. The conventional meteorological radar equation is a special form of this new derivation by neglecting the effect of coherent scattering. From a discussion of several aspects of the new equation, it is noted that the commonly observed discrepancy between computed results from the conventional equation and experimental evidence may be due to the negligence of the effect of coherent scattering.

- 14.2 Lee Chi-chen (Li Ch'i-ch'en) and
Lü Da-ren (Lü Ta-jen)
SCATTERING OF RADAR WAVES BY
FLUCTUATIONS OF ATMOSPHERIC
REFRACTIVITY
33(1): 115-125, February 1963
6 figs., table, 13 refs., eqs.

This paper presents a study of the scattering of radar waves by fluctuations of atmospheric refractivity. The main results are:

(a) In the case of intensive atmospheric refractivity fluctuations, the power of back-scattered radiation due to the fluctuations may exceed the minimum detection power of the radar, and is of the same order of magnitude as meteorological "angels". With other evidences, it is hence suggested that the scattering by refractivity fluctuations may be an important mechanism in the formation of meteorological "angels".

(b) An equation is derived to express the wave magnitude as a function of the distance propagated in the medium with refractivity

fluctuations. It is found that generally the scattering does not affect the wave magnitude significantly, but may cause the wave-width to spread when the scale length of refractivity as well as the wave-width of the radar are quite small.

- 14.3 Chao Ber-lin (Chao Po-lin) and
Ma Zhen-hua (Ma Chen-hua)
ON THE OPTIMUM WAVELENGTH FOR
RAIN DETECTION BY RADAR
33(4): 421-425, November 1963
4 figs., 2 tables, 6 refs., 17 eqs.

The present article deals with the selection of the optimum wavelength for detection of rain by radar. The results show that the choice for maximum echo strength from the same intensity of rain is little different from that for maximum discrimination in echo strength from the same differences in rainfall intensity. 4 - 6 cm radars are generally suitable for rain detection. The accuracy of the use of the brightness pattern for estimating the distribution of rainfall intensity is also discussed. This method is found to be crude as variation in brightness on the display tube is not normally detectable until the rainfall intensity changes by more than 30 - 40%.

See also: 18.2

CHAPTER 15
STRATOSPHERIC AND UPPER ATMOSPHERIC
CIRCULATION FEATURES

- 15.1 Yang Chien-chu (Yang Chien-ch'u)
THE MEAN MONTHLY VARIATIONS OF
THE MASS OF AIR IN THE NORTHERN
HEMISPHERE
27(1): 37-59, March 1956
11 figs., 2 tables, 14 refs.

The monthly transportation of the mass of air in the atmosphere between continents and oceans in the northern hemisphere and also across the equator is calculated from monthly mean charts of surface pressure over the northern hemisphere for the period 1930 - 1939. The main results are summarized as follows:

- (a) The mass of air in the northern hemisphere decreases from January to July and increases from July to January. The rate of increase and decrease during these half-year periods are, however, different and the half-yearly fluctuation of mass is approximately 10.3×10^{18} gm.
- (b) Transportation of mass in the atmosphere between both hemispheres is most vigorous during the period from May to June and from October to November.
- (c) Transportation of mass across the equator is generally greater than that between continents and oceans in the northern hemisphere.
- (d) Transportation of mass between both hemispheres is mainly determined by the monthly variation of mass in the atmosphere over Europe and Asia.
- (e) Abnormal monthly variations of atmospheric mass over Asia and the Pacific exert a pronounced influence on the distribution of month'y mean temperature anomalies and also on the distribution of flooding and drought regions over China.

- 15.2 Dao Shih-yen (T'ao Shih-yen)
WAVES IN THE UPPER WESTERLIES
OVER CHINA DURING HIGH INDEX
CIRCULATION IN WINTER
27(4): 345-360, December 1956
17 figs., 12 refs.

During high index circulation over Central and South Asia, a wave-train of cold troughs in the upper westerlies usually moves from West Asia across the Tibetan Plateau into East China. These upper troughs appear as diffused features in the lower troposphere but are organized systems in the upper troposphere. In the present study the structure and the properties of these upper troughs are described. The upper trough of 10 - 12 February 1956 is cited as a synoptic example.

- 15.3 Yeh Tu-cheng (Yeh Tu-cheng),
Lo Szu-wei (Lo Ssu-wei) and
Chu Pao-chen (Chu Pao-chen)
THE WIND STRUCTURE AND HEAT BALANCE
IN THE TROPOSPHERE OVER THE
TIBETAN PLATEAU AND IN ITS
NEIGHBORHOOD
28(2): 108-121, May 1957
11 figs., 13 refs.

Surface and upper-air data for the period 1954 - 1956 were used in the present study to construct the mean wind field over the Tibetan Plateau and in its neighborhood. Values of vertical motion, temperature advection and radiation were also computed and the results may be summarized/as follows:

(a) In winter, diffluence in the westerlies is observed at the 1.5 km and 3.0 km levels over the western part of the plateau while confluence is apparent in the east. A "stagnant region" (characterized by light winds) is found on each side of the plateau. A ridge-type flow also exists to the north of the plateau with a trough-type flow to the south. With the exception of the "stagnant regions", all these main features persist up to the 6 km level.

(b) In summer, the steamlines at the 1.5 km and 3.0 km levels exhibit a cyclonic flow around the plateau. However, the flow becomes

anticyclonic at 6 km with the action center located at the southwestern part of the plateau. This center is displaced westward with height.

(c) Ascending motions are generally observed over the plateau during summer and this regime may extend upward to 9.0 km. In winter, subsidence is thought to be prevalent although upward currents may still occur in the southwest corner of the region.

(d) The plateau is undoubtedly a heat source in summer. In winter, the southwest corner continues to act as a heat source but the remainder of the region probably plays the role of a cold source.

- 15.4 Lo Szu-wei (Lo Ssu-wei)
AN ANALYSIS OF UPPER TROUGHS
OVER THE TIBETAN PLATEAU
28(2): 157-165, May 1957
12 figs., table, 6 refs.

It is shown that upper troughs south of 40°N are generally orientated northwest-southeast when they have passed from western Asia to northern India. Thereafter, these systems gradually assume a northeast-southwest orientation as they move eastward. Low-level troughs are usually blocked at the northwestern part of India and they rapidly die out in situ. A marked weakening of troughs is also observed when they have passed over the plateau and dissipation is commonly noted after they have reached Hankow. These trough systems, however, exert a pronounced influence on the weather over East and South China. The average speed of upper troughs over the Tibetan Plateau is about 11 - 12 degrees longitude per day.

- 15.5 Central Weather Bureau. Numerical Prediction Section,
Institute of Meteorological Research
SOME FEATURES OF THE CIRCULATION INDEX
IN THE NORTHERN HEMISPHERE
30(4): 398-404, November 1959
7 figs., 2 refs., eqs.

This paper presents an objective analysis of the monthly mean 500-mb contour heights in the northern hemisphere from the equator to 70°N .

The mean contour heights are averaged along the latitude circle. It is noted that a four-parameter expression can accurately represent this field with errors of less than 10 geopotential meters in both winter and summer. Two- and three-parameter representations are also made and the results compared. Finally, a three-parameter representation is used to calculate the average climatological conditions for each month, and also the daily situations of individual months. Some of the synoptic characteristics revealed by this analysis are summarized.

- 15.6 Lo Szu-wei (Lo Ssu-wei)
THE MEAN UPPER-AIR CIRCULATION OVER
TIBET IN WINTER AND SUMMER DURING
THE THREE-YEAR PERIOD 1957 - 1959 AND
SOME FEATURES OF THE FLOW PATTERNS
DURING THE PERIOD OF SEASONAL TRANSITION
31(2): 150-158, May 1960
8 figs., 5 refs.

This paper describes a study of the features of the upper-air circulation over Tibet in winter and summer using data for the period 1957 - 1959. The results may be summarized as follows:

(a) The effect of the Tibetan Plateau on the "branching" of the westerlies during winter is well-marked even up to the height of the tropopause. A vertical cross-section constructed along the 90°E meridian reveals that in addition to the normal polar-frontal jet stream and the subtropical jet stream, a third belt of strong westerly winds is also present along the northern edge of the plateau at 40°N. This belt is considered to be caused by the dynamic effects of the plateau.

(b) Although the Tibetan Plateau is located near the axis of the subtropical ridge, this axis is however broken up by the plateau at the 500-mb level. As a result of the rapid change in the profile of the isobaric surfaces with height, the plateau becomes the center of an intense warm high at 200 mb. The heating effect of the plateau becomes noticeable in May. During May and June, the plateau is dominated by a trough at 500 mb but this feature does not extend to the higher levels.

(c) During the transition period from winter to summer or vice versa, the subtropical jet stream may persist over the plateau for an average period of 40 days.

- 15.7 Tschen Hsiung-schan (Ch'en Hsiung-shan)
THE VERTICAL INFLUENCE OF DYNAMIC
DISTURBANCES BETWEEN THE
STRATOSPHERE AND THE TROPOSPHERE
31(4): 319-327, January 1962
4 figs., 26 eqs.
Full translation: Emm-66-66

The solution of the vertical velocity equation derived from the vorticity and thermodynamic equations with the stratospheric effect taken into consideration shows that the disturbances in the stratosphere with a longer wavelength can produce a slight effect on the troposphere but the effect of those with a shorter wavelength can hardly reach that part of the atmosphere. The effect of the disturbances in the troposphere with a longer wavelength on the stratosphere is greater than that in the stratosphere on itself. These effects are equal in the case of a shorter wavelength.

- 15.8 Zhou Jin-shang (Chou Chin-shang),
Zhang You-lian (Chang Yu-lien) and
Yang Zhong-qiu (Yang Chung-ch'iu)
CLIMATIC FEATURES IN THE FREE
ATMOSPHERE OVER NANKING
31(4): 328-338, January 1962
7 figs., 5 tables, 11 refs., eqs.

This paper studies the distribution of meteorological elements in the free atmosphere over Nanking using aerological data obtained during 1954 - 1959. Seasonal climatic features are described. The results of a harmonic analysis of the mean temperature and specific humidity at 600 mb and different levels below show that the phase shift of the annual variation of temperature with height is not appreciable while that of the annual variation of specific humidity is rather clearly expressed. The paper points out that the vertical temperature gradient is greater in summer than in winter. This is especially so in the 1 to 4-km

layer from June to August where $\bar{\gamma} > \gamma_w$; i. e., during this period stratification is extremely unstable and convective clouds are easy to develop.

The annual temperature range generally decreases with height; however, it increases somewhat in the middle part of the troposphere. The average specific humidity can be assumed basically to be decreasing with height according to the logarithmic rule; this decrease is more rapid in summer than in winter. The annual specific humidity range decreases rapidly with height; the ranges at 500 and 300 mb are merely 1/6 and 1/27 of that at 1000 mb, respectively.

The paper also studies the non-periodic interdiurnal variation of temperature at different altitudes and the distributed frequency of upper air temperature in different seasons. It analyzes in detail the distribution of relative humidity, clouds, precipitation and wind for individual years and their seasonal changes.

- 15.9 Chen Lung-shun (Ch'en Lung-hsün)
THE VARIATION OF THE GENERAL CIRCULATION
AND THE PULSATONAL WARMING IN THE
MIDDLE STRATOSPHERE DURING THE
WINTER HALF-YEAR
32(1): 44-63, March 1962
19 figs., 4 tables, 15 refs.

This paper presents a comprehensive study of the winter-time general circulation in the middle and lower stratosphere using aerological data of the winter half-year during 1958 - 1961. Problems discussed include the classification of stratospheric circulation patterns, analysis of periodic and interannual variations of the stratospheric flow configurations and a study of the relationship between the pulsational warming of the stratosphere and the subsequent evolution of the stratospheric general circulation. The main results may be summarized as follows:

- (a) The winter-time stratospheric circulation patterns are relatively simple and stable. They may be classified into types A, B, C, D, E, and

E_2 . Types A and B are characterized by average periods of about 20 - 22 days and their frequency of occurrence represents some three-quarters of the total number of occurrences. E_1 and E_2 are transitional types with periods of about 8 - 10 days.

(b) There are large interannual variations in the winter-time stratospheric circulation, but these variations are concordant with those in the troposphere.

(c) Variations of the winter-time flow pattern and air temperature in the stratosphere possess a periodicity of about 11 days. This type of variation may be related to the periodic intensification and weakening as well as the advance and retreat of the stratospheric Aleutian Low. Periodic variations of about 11 days are also found in the troposphere, and are probably related to their counterparts in the stratosphere. Thus, it appears that this type of periodic variation may be a manifestation of the inherent oscillations of the entire atmosphere.

(d) Geographically, centers of temperature variation during the pulsational warming in the northern hemisphere often originate near Alaska, Kamchatka, Europe and the Central Atlantic, while pulsational warming usually occurs over eastern Siberia, Europe, the northeastern part of North America and Greenland. Synoptically, centers of temperature variation during pulsational warming often form near the northern quadrant of a high pressure system and develop on the anticyclonic side of the stratospheric jet to give rise to pulsational warming in the initially cold regions and trough areas. The degree of pulsational warming is definitely related to the evolution of the general circulation and is dependent on the different trajectories of the migratory centers of temperature variation.

15.10 Lee Siao-chuan (Li Hsiao-ch'üan)
SOME CHARACTERISTICS OF THE 500-MB
CIRCULATION INDICES OVER ASIA
33(1): 1-14, February 1963
13 figs., 9 tables, 16 refs., eqs.

In this paper, the zonal and meridional circulation indices over Asia ($60^\circ - 150^\circ E$) are computed from the 500-mb monthly mean charts

covering a period of many years by using the method of Katz. The variations of these indices with latitude and season are examined and a comparison is made with the corresponding indices over the whole northern hemisphere. The characteristics of the monthly mean indices and the distribution and seasonal variation are then discussed in terms of the detailed results obtained for each pentad (or natural period) over the high- and middle-latitude regions (45° - 60° N, 60° - 150° E) in Asia. Certain climatic properties of these parameters are also examined by statistical analysis. Finally, the relationship between the secular variation of the circulation indices and the weather in China is investigated. It is shown that this variation falls in the domain of a long-period oscillation and is closely related to solar activities.

- 15.11 Chen Shou-jun (Ch'en Shou-chün)
THE SPECTRA OF LARGE SCALE ATMOSPHERIC
FLOW AT 100 MB (1 JANUARY - 10 FEBRUARY 1962)
33(3): 333-338, August 1963
7 figs., 9 refs.

In this paper, the spectra of meridional and zonal kinetic energy at 100 mb are computed, and the diurnal variations of ultra-long waves are studied and discussed. It was found that the changes in the circulation pattern at 100 mb are mainly due to the variation of waves with the wave number lower than three.

- 15.12 Dao Shih-yen (T'ao Shih-yen) and
Chu Fu-kang (Chu Fu-k'ang)
VARIATIONS OF THE 100-MB FLOW PATTERN OVER
SOUTHERN ASIA IN SUMMER AND ITS RELATION
TO THE ADVANCE AND RETREAT OF THE WEST
PACIFIC SUBTROPICAL ANTICYCLONE
34(4): 385-396, November 1964
6 figs., 10 refs.

From the results of a study of the variations of the 100-mb flow pattern over southern Asia in summer, it was found that the anticyclone over the Tibetan Plateau is the strongest and steadiest circulation center in

the subtropical region of the northern hemisphere and that it oscillates about its mean position. During the oscillation, two basic types of 100-mb flow patterns can be identified over southern Asia. The first type shows a replacement of the anticyclone over Tibet by a low pressure center and the establishment of a high on the east and west sides (50°E and 110°E) of the plateau; the second type occurs when the anticyclone is re-established over Tibet. During the change of one type of flow pattern to the other, there is an advance and retreat of the West Pacific subtropical high over the Chinese mainland. Moreover, the end of the annual mei-yü period over the Yangtze basin is related to the formation of the first type of flow pattern. The paper shows that there is a close relationship between the advance and retreat of the West Pacific subtropical high and the variation of the 100-mb flow pattern. The first type of flow pattern is accompanied by a northwest advance of the West Pacific subtropical high and the second type by a southeast retreat. Based on these criteria coupled with the forecasting experience acquired, the authors propose a standard for predicting the movement of the West Pacific subtropical anticyclone in summer.

- 15.13 Sun Shwu-ching (Sun Shu-ch'ing)
A METHOD FOR CALCULATING THE VERTICAL
MOTIONS AND THE DISTRIBUTION OF THE
HEAT SOURCES AND SINKS IN THE STRATOSPHERE
OVER THE NORTHERN HEMISPHERE IN
JANUARY 1958
34(4): 397-408, November 1964
11 figs., 12 refs., 4 eqs.
Full translation: Emm-65-19

In this paper, a new method has been proposed for the computation of the vertical motions in the stratosphere by integrating the vorticity equation with respect to pressure downward from the upper boundary of the stratosphere. This method is shown to be superior to the one based on the integration of the same equation upward from the surface of the ground.

Using the more reliable values of vertical motions obtained by the former method, the mean non-adiabatic heating in the stratosphere (10 - 100 mb) is then computed by means of the first law of thermodynamics. The basic data used are taken from the monthly mean pressure and air temperature charts for the stratosphere of the northern hemisphere for January 1958.

It is found that for the middle levels of the stratosphere, the distribution of heat sources and sinks is characterized by large-scale features, similar to those of the pressure field at these levels. The ultra-long waves (with wave number of one or two) are far more predominant than waves of other scales. The geographical distribution of heating and cooling in relation to the pressure systems is also discussed.

- 15.14 Shu Kuo-chung (Hsü Kuo-ch'ang)
THE DISTRIBUTION OF THE STANDARD DEVIATIONS
OF 500-MB MONTHLY MEAN CONTOUR HEIGHTS
AND ITS APPLICATION TO LONG-RANGE FORECASTING
OVER EURASIA
35(3): 333-337, August 1965
4 figs., 2 tables, 4 refs., 2 eqs.
Full translation: Emm-66-87

The geographical distribution of the standard deviations of 500-mb monthly mean contour heights over Eurasia is determined from data of 1951 - 1962. The characteristics of dispersion centers computed from 500-mb monthly mean contour heights over the Eurasian continent are analyzed.

Some related problems of the "method of index screening" are discussed with reference to the theory of binomial distribution. Dispersion centers determined by the deviation of contour heights are used to test the "method of index screening", and the results obtained from this analysis are encouraging.

See also: 7.7, 7.15, 7.21, 8.7, 11.22, 13.16 and 17.3

CHAPTER 16

SYNOPTIC ANALYSIS AND FORECASTING;

LOCAL FORECASTING

- 16.1 Hsieh Yi-ping (Hsieh I-ping) et al.
AN ANALYTICAL STUDY OF SEVERAL
RAIN-BEARING SYSTEMS OVER CHINA
IN THE SUMMER HALF-YEAR
27(1): 1-23, March 1956
25 figs., 25 refs.

This paper presents a summary of the results of a preliminary survey on several rain-bearing systems over China in summer. A general description of the methods of analysis used and their deviation from conventional practice adopted in China are given in the first section. Contours are drawn at 20 meters instead of 40 meters in all isobaric analyses, while isotherms are drawn at 2°C intervals instead of 5°C. It is thought that refined analyses at smaller intervals are more suitable for depicting the relatively weak temperature and contour fields prevalent in summer. Potential temperature is replaced by equivalent pseudo-potential temperature in cross-section analysis, which with the aid of isothermal analysis can more adequately describe the condensation and precipitation processes.

Five types of basic rain-bearing systems prevalent in the summer half-year are dealt with in the second section, viz., cold front, blocking high with cold vortex, monsoon heat low, warm front and typhoon. A brief description of the evolutionary processes of these systems is also presented.

The third section is a discriminative discussion on certain synoptic concepts. According to the additional observational evidence now available, it is shown that the multifarious properties of the monsoon and the mei-yü¹¹ are related to the large-scale features of the temperature and the flow fields. The use of upper-air humidity to differentiate the equatorial air mass from the tropical maritime air mass is found to be unsuitable, because the air in the middle atmospheric layer still remains relatively dry

over China in regions south of the precipitation area along the equatorial front. The high moisture content in the mid-troposphere over the precipitation region is brought about by convergence or uplift from the lower to the upper levels accompanied by the realization of latent convective instability. It is also found that the so-called forward tilting of the axis of the "northwest trough" seems to be an illusion caused by the erroneous combination of two systems into one entity. Finally, the usefulness and the limitations of the shear-line concept and other common synoptic models in weather analysis and forecasting are also discussed.

- 16.2 Kuei Pei-lan (Kuei P'ei-lan)
LARGE-SCALE CIRCULATION PATTERNS
OVER EAST ASIA DURING THE APPEARANCE
OF THE URALS ANTICYCLONE (AUTUMN,
WINTER AND SPRING)
27(1): 25-35, March 1956
5 figs.

The synoptic processes over East Asia are found to be greatly influenced by the existence of a high pressure system near the Urals. This paper investigates the various synoptic features of the large-scale circulations over East Asia during periods when a warm high was prevailing in the vicinity of the Urals. Observational data for the past three and a half years were used and a total of 34 cases was available for study. A careful analysis of these cases shows that the synoptic processes of the large-scale circulations over East Asia may be classified into three main types. Type I is characterized by the predominance of steady zonal flow in large-scale frontal zones within the circulation domain over East Asia. This feature is also prevalent in the broad frontal region of Type II, but a meridional circulation exists over the northern part of China and Mongolia with two troughs and one ridge. In Type III, frontal zones within the circulation domain over East Asia are orientated northwest-southeast. Types I and III may be subdivided into Ia, Ib, IIIa, IIIb, and IIIc according to the configurations of small-scale systems and differences in synoptic features. The above types of circulation result from different synoptic

processes over East China and consequently these systems give rise to different sequences of weather over the region. (In Type Ia short waves form along the southern periphery of the westerly wind belt over the meandering region of the Yellow River. Types II, IIIa and IIIb are favorable for the formation of small high cells and ridges of high pressure. Thus shear lines may easily evolve in the field of deformation between these systems and the western periphery of the Pacific anticyclone and also in the boundary zones separating these systems from the south-westerlies in the southern branch of the jet stream. In Types Ib and IIIc, high cells and their associated ridges of high pressure dominate the regions south of the Yangtze; hence the existence of subsidence tends to produce fine weather over East China.) The present analysis shows that the weather elements associated with each type of these patterns are not only dependent on the large-scale atmospheric circulations, but are also significantly affected by local topography, small-scale subtropical systems and the westerly wind belt during the synoptic cycle. These three aspects should all be considered in routine weather forecasting.

- 16.3 Jü Chang (Chü Chang)
EXTREME TEMPERATURE FALL OVER CHINA
IN RELATION TO THE PHASE OF SEVERE
POLAR OUTBREAKS
27(2): 101-112, June 1956
6 figs., 6 refs.

The concept of the Multanovsky school of U. S. S. R. is used to evaluate the large-scale synoptic processes of each phase of the polar outbreaks over East Asia (the Kara Sea track and the Taimir track of polar outbreaks). The basic data for the present study include 17 severe polar outbreaks which caused extreme temperature fall over China in ten winters (October through March). It is found that extreme temperature fall over East China is related to the synoptic processes of severe polar outbreaks from the Kara Sea.

- 16.4 Chao Jih-ping (Ch'ao Chi-p'ing)
A PRELIMINARY INVESTIGATION OF
THE EFFECTS OF RHYTHMIC OSCILLATIONS
OF SEVERE POLAR OUTBREAKS OVER
THE NATURAL SYNOPTIC REGIONS IN
EAST ASIA
27(2): 113-126, June 1956
6 figs., table, 2 refs.

This paper presents a preliminary investigation of the effects of rhythmic oscillations of severe polar outbreaks over the natural synoptic regions in East Asia by means of the analysis of surface synoptic charts during the period 1933 - 1937. The results show that harmonics with wavelengths of about three months are more prominent than other waves. Three empirical rules signifying extreme polar outbreaks over East Asia are also presented.

- 16.5 Koo Chen-chao (Ku Chen-ch'ao)
A PRELIMINARY INVESTIGATION OF
MEDIUM-RANGE PREDICTION OF
COLD WAVES OVER CHINA IN
AUTUMN AND WINTER
27(2): 127-134, June 1956
Fig., 7 refs.

This paper summarizes some of the results of the prediction of cold waves over East Asia in autumn and winter by the Multanovsky-Pagava method of medium-range forecasting. Winter cold waves over East Asia are classified into three types according to the trajectories of the high pressure centers associated with these waves. The development of each type of cold waves and the characteristic features of mean charts depicting the tendency of periodicity and charts of height change are also explained.

- 16.6 Yeh Tu-cheng (Yeh Tu-cheng) and
Hsu Shu-ying (Hsü Shu-ying)
ESTIMATING THE POSSIBLE MAXIMUM
LOCAL RAINFALL INTENSITY
27(4): 383-385, December 1956
Fig., 2 tables, 4 refs.

- 16.7 Chen Han-yao (Ch'en Han-yao)
THE CIRCULATION CHARACTERISTICS DURING
THE 1954 FLOODING PERIODS IN THE
YANGTZE AND HWAI HO BASINS
28(1): 1-12, February 1957
11 figs., 8 refs.

This paper presents a comparison of the summertime circulations in 1954 with those in 1952, 1953 and 1955 in order to reveal the circulation characteristics during the flooding periods of 1954. The following features are noted in particular:

(a) The formation and persistence of a ridge of high pressure over the Sea of Okhotsk induced a diffluent branching in the jet stream complex over East Asia. This, in turn, caused a southward displacement of the upper frontal zone by about 10° latitude from its normal position. Thus the axis of the subtropical ridge over the Pacific was also found to be south of its mean position. As a result, precipitation (over the Yangtze and Hwai Ho basins) was more persistent.

(b) In summer, precipitation over East China was found to be closely related to the passage of cold troughs over the Tibetan Plateau.

- 16.8 Chyou Yung-yen (Ch'ou Yung-yen)
THE STRUCTURE OF A COLD FRONT
AND THE HORIZONTAL TEMPERATURE
FIELD ASSOCIATED WITH A TYPE OF
COLD WAVE*
28(1): 13-26, February 1957
14 figs., appendix, 10 refs., eqs.

This paper discusses the temperature field and the structure of a cold front associated with a cold wave which is characterized by relatively simple physical processes in the atmosphere. The available observational evidence indicates that the structure of the cold front ahead of the cold wave changed with time as it moved from the Yellow River basin to South China. A preliminary discussion on modifications

* See also 16.13 and 16.14.

in frontal structure is also presented. In addition, it was found that there were very large changes in the upper-air temperature field toward the end of the cold wave period. The results of computations by the frontogenetic formula show that these changes were mainly due to differential temperature advection.

- 16.9 Dao Shih-yen (T'ao Shih-yen)
A COLD WAVE OVER EAST ASIA DURING
THE PERIOD OF THE BREAKDOWN OF A
BLOCKING SITUATION
28(1): 63-74, February 1957
6 figs., 9 refs.

This paper presents a synoptic analysis of a cold wave over East Asia which occurred during the last decade of February 1956. The analysis shows that the breakdown of a persistent blocking situation over the Atlantic and the Urals occurred during the outbreak of the cold wave. This was accompanied by marked changes in the circulation pattern over the northern hemisphere; and the transition was characterized by a change from low index to high index circulations. The source of cold air for this cold wave could be traced upstream to the Arctic Ocean east of Greenland. An analysis of the vertical structure of the jet complex along 125°E shows that the polar front jet and the subtropical jet co-existed as two distinct jet streams during the period of this cold wave.

- 16.10 Zhuang Yin-mo (Chuang Yin-mo)
THE CONTRIBUTION TO SURFACE PRESSURE
TENDENCY BY DENSITY ADVECTION IN
FRONTAL REGIONS
28(3): 225-233, August 1957
6 figs., 7 refs., eqs.

In the present study, the contribution to three-hourly surface pressure tendency by density advection in the lowest 10 to 13 km was evaluated. The results indicate that this factor satisfactorily accounts for the surface pressure variation on most of the occasions.

An analysis of surface pressure variation computed from density advection in anticyclones and cyclones reveals that the movement and

development of these systems are largely dependent on the configuration of density advection.

However, experiments using density advection and three-hourly pressure tendency to prepare 12 or 24-hour forecasts prove to be unsuccessful.

- 16.11 Koo Chen-chao (Ku Chen-ch'ao)
A DISCUSSION ON THE VERIFICATION AND
UTILIZATION OF WEATHER FORECASTS
IN THE LIGHT OF COMMUNICATION THEORY
28(4): 256-263, November 1957
10 tables, 8 refs., eqs.

By using the concepts and methods of communication theory, the author explains the disadvantages of the current systems of evaluating weather forecasts and presents a method for improvement. The "information parameter" or the "information index" may, for example, be used as an index of evaluation (prescriptor). Furthermore, the author points out that any modification of weather forecast done arbitrarily must necessarily decrease its informative value and that such attempts should not be made by users.

- 16.12 Tang Mou-tsang (T'ang Mou-ts'ang)
BLOCKING SITUATIONS OVER EAST ASIA
AND THEIR INFLUENCE ON CLIMATE
AND WEATHER
28(4): 282-293, November 1957
10 figs., table, 14 refs.

This paper presents an analysis of the blocking situations which occurred over East Asia (east of 100°E) during the period 1951 - 1956. The results indicate that blocking occurs most frequently over the coastal regions during the months of June and July and usually lasts for about 7 days. In general, a blocking situation gives rise to three distinct precipitation areas, one to the west of the blocking high, another to its south and a third along the northern edge of the subtropical anticyclone. It is found that temperature anomalies are basically opposite in sign to precipitation anomalies.

- 16.13 Yen Kai-wei (Yen K'ai-wei)
COMMENTS ON THE ARTICLE
"THE STRUCTURE OF A COLD FRONT
AND THE HORIZONTAL TEMPERATURE
FIELD ASSOCIATED WITH A TYPE OF
COLD WAVE*
28(4): 331-332, November 1957
- 16.14 Chyou Yung-yen (Ch'ou Yung-yen)
REPLY TO YEN KAI-WEI'S COMMENTS
ON THE ARTICLE "THE STRUCTURE
OF A COLD FRONT AND THE
HORIZONTAL TEMPERATURE FIELD
ASSOCIATED WITH A TYPE OF
COLD WAVE**
28(4): 333, November 1957
- 16.15 Koo Chen-chao (Ku Chen-ch'ao),
Chen Yung-san (Ch'en Hsiung-shan) and
Shu Yu-feng (Hsu Yu-feng)
A FRONTAL θ_{se} CHART AND ITS
APPLICATION TO THE ANALYSIS
OF THE UPPER BOUNDARY OF
COLD-WAVE FRONTS IN CHINA
29(1): 44-56, February 1958
17 figs., 16 refs.

In this paper, a frontal θ_{se} chart is presented as a tool for frontal analysis. It is shown from analysis of cold-wave fronts in China that the θ_{se} over the upper frontal boundary is far from uniform and that its maximum value varies rather considerably with time. These results indicate that the frontal surface is not a simple material surface always consisting of the same set of air particles, but rather a structure with its own mechanism of metabolism subjected continuously to frontogenesis and frontolysis. Finally, the significance of these findings with regard to frontal analysis and numerical prediction is discussed.

* See 16.8 and 16.14.

** See 16.8 and 16.13.

- 16.16 Hsu E. H. (Hsü Erh-hao)
A NEW METHOD OF PREPARING 1000 AND
500-MB PROGNOSTIC CHARTS BY
GRAPHICAL INTEGRATION
29(3): 185-200, August 1958
12 figs., table, 16 refs., 40 eqs.

In this paper, a new method of preparing 1000 and 500-mb prognostic charts by graphical integration is proposed. The main features are:

(a) The vertical structure of the entire troposphere is taken into consideration; Sawyer-Bushby's model is used in actual computation but the method can be extended to other models, e. g., Eliassen's model.

(b) The 500-mb surface is not taken as the level of non-divergence, which may be placed at other appropriate isobaric surfaces.

The proposed method deals essentially with calculation of the height changes of the 1000 and 500-mb surfaces by means of certain advections on equivalent baroclinic levels defined by Bolin. Some results of the experiment are discussed.

- 16.17 Chih Li-jen (Chi Li-jen),
Chao Ming-tze (Chao Ming-che) and
Koo Chen-chao (Ku Chen-ch'ao)
TENDENCY COMPUTATIONS FOR BAROCLINIC
DEVELOPMENT CONSIDERING THE KINEMATIC
BOUNDARY CONDITION OF THE EARTH'S
TOPOGRAPHY
29(3): 213-220, August 1958
14 figs., 10 refs., eqs.

This paper discusses a method of computing large-scale baroclinic developments by considering the kinematic boundary condition of the earth's topography. Using the relaxation technique, two cases of the development over the Tien Shan-Altai region are computed. The results show that over this region orographic disturbances may reach as large as 70-80 m/24 hrs and 100 m/24 hrs on the 700 and 900-mb levels, respectively. However, due to the difficulty involved in determining the surface wind, it is suggested that the boundary condition be reformulated.

- 16.18 Hsu E. H. (Hsu Erh-hao)
A THREE-DIMENSIONAL STUDY OF THE
VORTICITY FIELD OVER EAST ASIA DURING
THE OUTBREAK OF A COLD WAVE
29(4): 239-248, November 1958
10 figs., 8 refs., eqs.

As a typical case, this paper examines in detail the vorticity field over East Asia during the outbreak of a severe cold wave in mid-February 1955. The vorticity is computed by the Graham method using wind data recorded from pibal observations at nine levels from the ground up to 5500 m. It is found that the region over the surface high center is not completely of negative vorticity. Below 1000 m, there is a weak vorticity center either of positive or negative sign. From 1000 to 5500 m, the vorticity is positive in front of the surface high center and negative behind the center. The intensification of the surface high center is manifested by the gradual expansion of the region of negative vorticity. It is shown from the evaluation of the magnitude of the various terms in the vorticity equation that both the advection and divergence terms are of the order of $10^1 \times 10^{-10} \text{ sec}^{-2}$ but the latter is greater than the former in absolute magnitude. The movement as well as the development of the upper trough and ridge may be accounted for by the pattern of isopleths of the divergence term but not by that of the advection term. Neither the 5500-m nor the 3000-m surface may be considered approximately as one of non-divergence. The order of magnitude of the terms for vertical transfer and differential vertical velocity is $10^0 \times 10^{-10} \text{ sec}^{-2}$; these terms are therefore of minor importance. This proves that Sherman was incorrect by laying too much emphasis on the differential vertical velocity term.

- 16.19 Zhang Tan (Chang T'an)
ANALYSIS OF THE STRUCTURE OF A
COLD WAVE OVER EAST ASIA
29(4): 274-286, November 1958
7 figs., 22 refs.

This paper presents a three-dimensional analysis of the wind and temperature fields during a severe cold wave and a computation of the

vertical motion during the invasion of the cold wave over the east Asian continent and the western Pacific. On the basis of the analyzed data, it discusses the upper-air frontal zones and jet streams as well as the distribution and change in the vertical motion and circulation before and after the invasion of the cold wave. The results show that in the different sections of the cold trough, as the element of disturbance of the westerlies, the polar front, subtropical front, and the jet streams connected with them have a different structure. The distribution of the general vertical motion is comparatively regular. The meridionally orientated vertical circulation has opposite signs in the front and rear areas of the trough. The zonally orientated vertical circulation within the trough is expressed rather clearly and has well defined characteristic features.

- 16.20 Haoching County People's Council.
Department of Agriculture and Irrigation
A SUMMARY OF THE EXPERIENCE GAINED
IN THE PREDICTION AND DISPERSION OF
HAILSTONES IN HAOCHING COUNTY OF
YUNNAN PROVINCE
30(1): 1-4, February 1959

Much useful experience has been gained in the short-range prediction of hailstorms over Haoching. It has been found that satisfactory hail dispersion may be achieved by feeding smoke into clouds and by firing a cannon toward the cloud mass.

- 16.21 Anonymous
SUPPLEMENTARY TECHNIQUES IN SINGLE-STATION
WEATHER PREDICTION - A NEW TYPE OF
WEATHER FORECASTS
30(1): 64-71, February 1959

General synoptic forecasts for a vast region (issued by the Central Weather Bureau in China) are combined with the local synoptic features of the evolutionary pattern at a district meteorological (or climatological) station to produce detailed supplementary forecasts for local use. The results are found to be satisfactory.

- 16.22 Chen Lung-shun (Ch'en Lung-hsün)
THE INSTABILITY OF LARGE-SCALE
DISTURBANCES IN THE ATMOSPHERE
30(1): 85-91, February 1959
6 refs., eqs.

This paper discusses the degree of instability of large-scale disturbances in relation to the horizontal and vertical configuration of the basic current. The necessary criteria for the occurrence of unstable disturbances are dealt with. The effect of development and damping dissipation of disturbances on the general circulation is also discussed.

- 16.23 Kuei Pei-lan (Kuei P'ei-lan) and
Wang Zuo-shu (Wang Tso-shu)
ANALYSIS OF THE MECHANISM OF
CYCLONE DEVELOPMENT IN
NORTHEASTERN CHINA
30(2): 150-164, May 1959
14 figs., 7 refs.

This paper presents a three-dimensional analysis of an intense cyclone which developed in northeastern China over 16 - 20 December 1957.

It was found that at all levels in the center and within the cold dome of this cyclone, there was an ascending motion during the development. Accompanying this development, the ascending motion as well as the divergence and convergence over the center intensified, while the non-divergent level gradually lowered and tended toward symmetry.

A schematic distribution is given of the vertical motion associated with the formation of an isolated cold vortex. It shows that the ascending motion was concentrated approximately over the cold center and rapidly decreased northward to the cut-off area. A cut-off vortex formed due to this type of ascending motion distribution.

Precipitation was concentrated in the area of the cold dome, in agreement with the result of the computed vertical motion.

- 16.24 Xia Ping (Hsia P'ing)
FRONTAL ANALYSIS RESEARCH IN
CHINA DURING 1949 - 1959
30(3): 218-222, August 1959
4 figs., 32 refs.
- 16.25 Dao Shih-yen (T'ao Shih-yen)
RESEARCH ON COLD WAVES IN
EASTERN ASIA FROM 1949 TO 1959
30(3): 226-230, August 1959
15 refs.
- 16.26 Lu Wo (Lu Wu)
SUPPLEMENTARY WEATHER FORECASTS
FOR SINGLE STATIONS IN CHINA
30(3): 291-295, August 1959
- 16.27 Chang S. C. (Chang Shao-ch'ing) and
Ting S. C. (Ting Shih-ch'eng)
A PRELIMINARY INVESTIGATION OF THE
PREPARATION OF FORECASTS BY THE
SYNTHETIC METHOD
31(2): 110-118, May 1960
3 figs., 6 tables, 2 refs., 11 eqs.

A simple statistical method for weather forecasting at a single station is described and tested. Verification data from the tests are examined with the aid of the following expressions to determine if rational synthesis can be achieved.

$$S_m = \sum_{n=\frac{1}{2}(m+1)}^m P_n(m) \text{ and } S_{n,m} = \frac{1}{1 + \binom{q}{p}^{n-(m-n)}}$$

A simple synthetic forecasting technique is then developed for general application and the accuracy of forecasts so obtained is found to increase considerably. Results of verification tests indicate that the observed increase in the accuracy of forecasts is in close agreement with theoretical expectations.

- 16.28 Du Xing-yuan (Tu Hsing-yüan) and
Li Yo-fang (Li Yü-fang)
THE ROLE OF TEMPERATURE ADVECTION
IN FRONTOGENESIS AND CYCLOGENESIS
31(3): 241-245, November 1961
6 figs., 4 refs., eqs.

This paper presents simple formulas for predicting frontogenesis and cyclogenesis according to the distribution of temperature advection. The formulas are constructed on the basis of the fact that local temperature changes are essentially determined by advection.

By use of the formulas obtained more than 30 calculations are made. Some results of these calculations are given.

- 16.29 Liao Hsiang-yün (Liao Hsiang-yün) and
Chow Tse-tung (Chou Tzu-tung)
AN ANALYSIS OF THE EVOLUTION OF A
LARGE-SCALE SYNOPTIC PROCESS
32(3): 255-260, September 1962
2 figs., 2 tables, 2 refs., eqs.

This paper presents a synoptic and numerical analysis of the southward invasion of a zonally-orientated upper trough over Asia during the period 9 - 14 January 1958. The analysis reveals that the mechanism governing the behavior of this system is related to an area of low-level convergence beneath the zone of velocity divergence which exists behind a ridge of high pressure at 500 mb near the Urals and the establishment and breakdown of the wind regime which transports warm air from the southwest to the northeast in the lower troposphere. The establishment and breakdown of these two synoptic features are found to control the development and dissipation of the Ural blocking high. Following the breakdown of the blocking high, the zonally-orientated trough moves southward, giving rise to an outbreak of cold waves. The effect of the variation of vorticity due to each term of the vorticity equation on the synoptic processes during the southward invasion of this upper trough is then analyzed. The results indicate that the advection term is of paramount importance. However,

the computed divergence is an overestimation of the actual value, and the computed change of vorticity due to the divergence term is also not concordant with the observed tendency. Finally, the numerical values of each term of the vorticity equation are integrated for an extended period up to five days and the contribution of each term is examined.

- 16.30 Wang Zuo-shu (Wang Tso-shu)
A CASE STUDY OF THE SYNOPTIC PROCESSES
OF A SHEAR LINE OVER THE YANGTZE AND
HWAI HO VALLEYS
33(2): 189-205, May 1963
19 figs., table, 17 refs.

This paper presents a case study of the structure of a shear line over the Yangtze and Hwai Ho valleys during its formation and at its various stages of development.

The author emphasizes the importance of the thermodynamical and dynamical influences of a plateau on the development of a shear line. It is pointed out that the type of vertical circulation, the distribution of meteorological elements in the vicinity of the shear line and the intensification of the low-level frontal zone are all interrelated. Variations in the configuration of the vertical circulation with respect to the position of the frontal surface may give rise to a change in the properties of the front. It is found that subsidence may take place in the upper troposphere above the region of ascending currents over the shear line, so that the flow configuration associated with the shear line may affect the entire troposphere.

The author finally discusses problems of the effects of the vertical circulation on the properties of the frontal surface, the transformation of a polar front into an equatorial front and the nature and some characteristic properties of certain subtropical weather systems in China during summer.

- 16.31 Lo Szu-wei (Lo Ssu-wei)
AN ANALYSIS OF THE FORMATION OF A
SHEAR LINE OVER THE EASTERN SIDE
OF THE PLATEAU REGION IN CHINA
33(3): 305-319, August 1963
9 figs., table, 11 refs.

During the winter season, a shear line usually appears to the south of the Yellow River on 700-mb charts. This feature is characterized by a well-marked wind discontinuity although the system is generally indistinct in the contour field.

The formation of the shear line is explained in terms of frictional effects produced in the topographical boundary layer. Anticyclonic vortices are generated in the northwesterly air flow near the edge of the plateau and the migration of these systems downstream often results in the formation of a shear-line type discontinuity.

The structure and development of the shear line are examined by means of case studies and it is found that this system is different in properties from the trough line along the northern edge of the plateau and is also unrelated to any frontal zones. The general features revealed by these studies were confirmed by an operational investigation carried out in January 1959.

An analysis of 52 cases indicates that anticyclonic circulations are often found near the edge of the plateau (particularly in the vicinity of Chengchow), which move along an east by south direction. The eastward movement of these small high pressure systems then leads to the formation of a shear line.

Finally, a comparison is made between the actual synoptic processes in the atmosphere and those from an experimental model. The results show that the formation of a shear line closely resembles the development process in the wake of a water flow around a cylinder in the boundary layer.

Although the shear line may be related to certain frontal zones or large-scale synoptic systems on some occasions, it is clearly shown

from its structure that dynamical effects must also exert a considerable influence in the boundary layer.

- 16.32 Hwang S. S. (Huang Shih-sung)
A STUDY OF THE LONGITUDINAL MOVEMENT
OF SUBTROPICAL ANTICYCLONES AND ITS
FORECASTING
33(3): 320-332, August 1963
5 figs., 2 refs., eqs.

This paper studies the longitudinal movement of a subtropical anti-cyclone cell in relation to the nature and structure of the anticyclone itself, and a method for computing the movement of subtropical anticyclones is developed. The obtained velocity formula shows that the velocity of longitudinal movement is determined by the characteristics of the latitudinal distribution of the zonal currents and the nature and position of the anticyclone itself, and that this velocity varies from point to point within the anticyclone. The movement of the anticyclone center is investigated, and application of the velocity formula in daily forecasting is illustrated synoptically. The physical effect of the activities of westerly troughs and ridges in high latitudes and tropical depressions in low latitudes, and the effect of variations in the nature and intensity of the anticyclone itself on the movement of subtropical anticyclones are also discussed.

- 16.33 Yuan En-kuo (Yüan En-kuo)
Tan Tung-liang (T'an T'ung-liang) and
Lee Yü-ling (Li Yün-lin)
A STUDY OF THE RETREAT OF THE WEST
PACIFIC SUBTROPICAL HIGH DURING
4 - 12 AUGUST 1958
34(2): 162-173, May 1964
14 figs., 4 refs., eqs.

This paper analyzes the retreat of the West Pacific subtropical high from the mainland of China during 4 - 12 August 1958. It is shown that the retreat begins in the 200 - 400 mb layer and then propagates upward and downward, with the maximum changes occurring at the 200-mb level; the changes in the contour fields below 500 mb, however,

are small. This situation is attributed to the dynamic factors near the tropopause. It is also pointed out that the retreat of the subtropical high may be caused largely by the marked changes of the meridional circulation and easterly jet stream produced by the development of the large-scale circulation pattern. The paper further analyzes the physical mechanism of the retreat of the easterly jet-stream, the characteristics of the evolution in the structure of the high and the effect of the evolution on the retreat of the high.

16.34 Yu Gin-yeun (Yu Ching-yen)
SOME FEATURES OF THE STRUCTURE OF
THE WARM SHEARLINE OVER NORTH CHINA
35(1): 107-110, February 1965
3 figs., 2 refs.

16.35 Li Guo-wen (Li Kuo-wen)
A STUDY OF THE THERMAL LOW OVER
SOUTHWEST CHINA AND RELATED
FORECASTING PROBLEMS
35(2): 126-131, May 1965
5 figs., 2 tables
Full translation: Emm-66-141

The thermal low which develops near the Szechwan basin is an important synoptic system exerting a pronounced influence on the weather over Southwest China in spring. The affected region is characterized by high temperatures, low humidity, fine weather with good visibility and a marked intensification of southerly winds. In addition, strong southerlies often prevail over western Kweichow and northern Yunnan. The dissipation of this type of thermal low usually brings precipitation and a fall of air temperature in the Szechwan-Kweichow region. The present study reveals the relationship between the thermal low and the upper vortex which appears at the 700-mb level over Southwest China above the thermal low prior to its maximum development. However, about 24-36 hours after its birth the 700-mb vortex usually moves eastward under the influence of a 500-mb trough in the upper westerlies, and the surface thermal low then begins to fill up.

This paper summarizes the empirical rules governing the formation and development of the thermal low. Empirical predictors to forecast the growth and dissipation of the thermal low are derived from changes of meteorological elements at Kweiyang as plotted on synoptic charts.

- 16.36 Zhu Zhong-ji (Chu Chung-chi),
Hu Xue-mei (Hu Hsüeh-mei),
Chen Zeng-fu (Ch'en Tseng-fu),
Ji Nai-fu (Chi Nai-fu) and
Xu Hong-wen (Hsü Hung-wen)
AN INVESTIGATION ON THE PREDICTION
OF STRONG WINDS ASSOCIATED WITH
COLD FRONTS IN THE NORTHERN HONAN
REGION IN SPRING
35(2): 138-147, May 1965
15 figs., table
Full translation: Emm-66-140

This paper presents an analysis of the occurrence of strong winds over the region of Kaifeng, Chengchow and Hsinhsiang in Honan Province with respect to orographic conditions. The effect of pressure gradient, the characteristics of the low-level frontal zone and turbulent exchange on wind speed and the relationship between the flow pattern ahead of the front and the wind speed behind it were also discussed. The synoptic situations associated with the occurrence of strong winds accompanying a cold front over the northern Honan region in spring were classified into three main types, W, N, and E, and other subsidiary categories on the basis of synoptic climatology and the trajectories of the cold air. The characteristics of each type of strong winds and the evolution of the associated synoptic process were studied in detail for the formulation of an empirical method to forecast the occurrence of strong winds. The method evolved was then tested for the region under operational conditions during March - May 1964, and the accuracies were found to be 87.5% for Type W, 91.7% for Type N and 40% for Type E.

- 16.37 Wang Tsai-yun (Wang Ts'ai-yün) and
Deng Tsuan-ji (Teng Ch'uan-chih)
USE OF WINTER TEMPERATURE TO FORECAST THE
ONSET OF THE RAINY SEASON AND THE AMOUNT OF
RAINFALL IN MAY IN YUNNAN PROVINCE
35(3): 328-332, August 1965
8 figs., 2 tables

From a popular folklore, "The colder it is in December than in the following January, the more abundant the rainfall will be in May", which originated from the Hsi-hsuang-pan-na T'ai Race Autonomous Region in southwestern Yunnan Province, a rule for predicting the amount of rainfall in May in the autonomous region and Kunming is established. Based on this folklore, certain relationships between the circulation before and after the period are determined. These relationships not only can verify the reliability of the folklore but also can be used to predict the onset of the rainy season and the amount of rainfall in May in Yunnan Province. These predictions will be helpful in determining the area of rice paddies to be seeded and in formulating agricultural production plans.

- 16.38 Kweiyang Meteorological Observatory
THE APPLICATION OF "NODAL POINTS" IN
INDICATIVE PROCESSES FOR THE PREPARATION
OF MEDIUM-RANGE SIGNIFICANT
PRECIPITATION FORECASTS
35(4): 460-464, November 1965
2 figs., 2 tables

In this paper, empirical predictors from common weather lores are developed and extended to formulate a single-station technique for the preparation of medium-range (10-day) precipitation forecasts. The test results on Kweiyang data for the months of April to July during the period 1955 - 1963 are described. Finally, the time-sections of the variations of temperature over Wuhsiao Ling and the 24-hour pressure tendency over Kweiyang are used to derive adjustments for short-period forecasts from the medium-range predictions.

See also: 7.13, 7.20, 7.25, 8.1, 8.11, 11.10, 12.6, 15.12,
17.11 and 22.6

CHAPTER 17
SYNOPTIC CLIMATOLOGY

- 17.1 Yang Chien-chu (Yang Chien-ch'u)
AN INVESTIGATION OF THE CONFIGURATIONS
OF POSITIVE AND NEGATIVE ANOMALIES OF
MONTHLY MEAN TEMPERATURES OVER CHINA
27(2): 135-152, June 1956
13 tables, 11 refs.

This paper presents a statistical analysis of the large-scale features of positive and negative anomalies of monthly mean temperatures from monthly mean temperature charts over China for a 20-year period. The results indicate that anterior and posterior features are interrelated. This phenomenon is thought to be useful in long-range weather forecasting. The large-scale features of positive and negative anomalies of monthly mean temperatures are related to the effects of rhythmic oscillations of large-scale synoptic processes. This reveals a new physical significance of the mean temperature charts in portraying the properties of the general circulation.

- 17.2 Liu Kwang-nan (Liu K'uang-nan) and
Wu Hung-shun (Wu Hung-hsün)
A PRELIMINARY STUDY OF THE SYNOPTIC
CHARACTERISTICS AND THE DELINEATION
OF THE NATURAL SEASON OVER EAST ASIA
IN SUMMER FOR THE PAST FIVE YEARS
27(3): 219-242, September 1956
18 figs., 2 tables, 12 refs.

This paper analyzes the synoptic processes in summer using surface and aerological data for the period 1951 - 1955. The main results are as follows:

- (a) The variation of the position and intensity of the maximum westerly wind belt at 500 mb along 65°E , 105°E , 120°E and 140°E may jointly serve as a good index for determining the march of the natural synoptic seasons over East Asia. The disappearance of strong westerlies at low latitudes along 65°E signifies the advent of the mei-yü period, while the

dissolution of strong westerlies south of 40°N indicates the onset of summer. The accompanying change of synoptic processes is characterized by the disappearance of the major Asiatic trough over Japan and the poleward displacement of the subtropical high pressure belt over the Pacific from low latitudes to $30^{\circ} - 40^{\circ}\text{N}$. This usually occurs on about July 13 in each year and thus marks the end of the mei-yü period in regions south of the Yangtze. In other words, the mei-yü is a prevalent synoptic process before the summer season, and is closely related to the regime of strong westerly wind or frontal zonal at 500 mb.

(b) The re-appearance of a regime of strong westerlies at 500 mb between 30°N and 40°N along 140°E marks the end of summer and the advent of autumn. The accompanying change of synoptic processes is characterized by the re-establishment of the major upper trough over East Asia and the invasion of the surface continental cold high into North China from the source region just east of the Novaya Zemlya Island along a southeasterly track. This occurs on about September 5 in each year. Hence the average duration of summer in East Asia comes to 55 days only.

(c) The time-variation of the strong westerly wind belt at 500 mb within the latitude range of $30^{\circ} - 40^{\circ}\text{N}$ in each of the four meridional sections shows that in summer the disappearance of strong westerlies usually sets in earlier in the west than in the east and that their re-establishment begins from east to west. The phenomenon is well contrasted with the winter situation which is characterized by the earlier establishment of strong westerlies upstream. It appears that these opposite evolutionary characteristics during the transition from spring to autumn could not be satisfactorily explained by the assumption of mechanical splitting of the jet stream as a result of the presence of large-scale topography.

(d) The main features of the prevailing synoptic processes in the natural synoptic summer season are largely dependent on the intensity

of the subtropical high over the Pacific with respect to the pressure field further upstream and its latitudinal position with respect to the Tibetan Plateau. Hence the variation gives rise to at least four different types of synoptic patterns.

- 17.3 Chen Lung-shun (Ch'en Lung-hsün)
THE VARIATION OF THE WIND FIELD ALONG
THE 140°E MERIDIAN DURING THE LAST STAGE
OF THE MEI-YÜ
28(4): 294-302, November 1957
5 figs., 6 refs.

The peculiar characteristics of the upper winds at Tateno in Japan during the last stage of the mei-yü are presented in the form of an analysis of the daily 200-mb wind observations at the station for the months of June to August in the period 1950 - 1956. It is noted that the dissipation of the westerly jet stream and the appearance of a regime of easterlies in the upper levels may serve as a good indicator to mark the end of the mei-yü period and the onset of the summer season. Profile charts of 5-day mean zonal winds along the 140°E meridian for the months of June and July were prepared for each year of the period 1954 - 1956. It is found that the termination of the mei-yü is associated with a northward retreat at the upper westerlies over Japan and a well-marked poleward shift of the subtropical ridge. During this time, typhoons from the western Pacific invade the East China Sea and the Yellow Sea one after another. The above phenomena are observed to recur each year and may therefore be of value in weather forecasting.

- 17.4 Kao Yu-hsie (Kao Yu-hsi)
ON THE CLEAR WEATHER OVER
EASTERN ASIA DURING HIGH AUTUMN
29(2): 83-92, May 1958
10 figs., table, 12 refs.

This paper presents a preliminary analysis of the well-known phenomenon of "high autumn clear weather" in China, based on available climatological data. The regions of occurrence of this type of weather together with the dates of onset and termination are examined. A

comparative study is also made of the various other types of weather observed in the northern hemisphere, such as the "Indian summer" in North America and the "Old Wives' summer" in Europe. It is found that the clear weather in China sets in simultaneously with the arrival of the winter monsoon near the surface toward the end of August or at the beginning of September while its termination coincides with the establishment of the upper westerly jet stream, which marks the end of the summer monsoon over southern Asia.

- 17.5 Dao Shih-yen (T'ao Shih-yen),
Zhao Yu-jia (Chao Yü-chia) and
Chen Xiao-min (Ch'en Hsiao-min)
THE RELATIONSHIP BETWEEN THE MEI-YÜ
PERIOD IN THE FAR EAST AND THE
SEASONAL VARIATION OF THE UPPER-AIR
CIRCULATION OVER ASIA
29(2): 119-134, May 1958
8 figs., table, 22 refs.

This paper presents an analysis of the climatological features of the mei-yü in the Far East and the relationship of its period of occurrence with the seasonal variation of the upper-air circulation over Asia. The study is based on available climatological data and also on upper-air records for the period 1951 - 1957. It is found that the onset and termination of the mei-yü exhibits a high degree of regularity and are closely related to the seasonal change of the upper-air circulation. The mei-yü period coincides with the abrupt northward displacement of the planetary wind belt over Asia and the date of onset is concurrent with the outburst of the Indian monsoon at Calcutta. The termination of the mei-yü occurs at about the same time when the upper westerly jet stream disappears and is replaced by an easterly current over Tateno in Japan. This seasonal change in the circulation pattern is a typical annual phenomenon although the time of transition may vary slightly from year to year. It is considered that the revelation of such a phenomenon may lead to a better understanding of the mei-yü in the Far East and provide useful clues in problems of weather forecasting.

- 17.6 Yeh Tu-cheng (Yeh Tu-cheng),
Dao Shih-yen (T'ao Shih-yen) and
Li Mei-tsiun (Li Mai-ts'un)
THE ABRUPT CHANGE OF CIRCULATION
OVER THE NORTHERN HEMISPHERE
DURING JUNE AND OCTOBER
29(4): 249-263, November 1958
18 figs., 18 refs.

This paper shows that in June and October, there is an abrupt change of upper-air circulation over the northern hemisphere. The change in June is characterized by a sudden northward shift of the west and easterlies, with which there is also a great change in the upper flow pattern. Following this change, the typical summer circulation is established. In October there is a sudden southward shift of the west and easterlies, accompanied by a marked change in the upper flow pattern. After this change the pattern of upper flow becomes one typical of winter circulation.

With the onset of summer circulation is the outburst of the southwest monsoon in India and of plum rains in China and Japan and a rapid northward rush of the intertropical convergence zone. The onset of winter is accompanied by a southward retreat of the southwest monsoon and the intertropical convergence zone. The synoptic sequence of these developments is described.

- 17.7 Chen Lie-ting (Ch'en Lieh-t'ing) and
Lee Yu-lan (Li Yü-lan)
A STUDY OF THE SYNOPTIC PROCESSES
WHICH CAUSE EXCEPTIONALLY WARM
AND COLD WEATHER IN PEKING DURING
THE WINTER HALF-YEAR
31(2): 126-137, May 1960
11 figs., 5 tables, appendix, 10 refs.

This paper presents a synoptic and statistical analysis of the physical processes which give rise to exceptionally warm and cold weather in Peking. The findings are based on a study of daily departures of air temperature and an examination of surface and upper-air charts. The processes of "cooling" are classified into five types while those for

"warming" are grouped into four categories. Certain indices which are useful in long- and medium-range forecasting are also described.

- 17.8 Wang Rong-hua (Wang Jung-hua)
TRACKS OF EXTRATROPICAL CYCLONES
IN EAST ASIA
33(1): 15-24, February 1963
5 figs., table, 7 refs.

In this paper, the frequency of occurrence of extratropical cyclones over each $2\frac{1}{2}^{\circ}$ square in East Asia (east of 70°E and south of 55°N) is analyzed for each month using surface synoptic charts for the period 1951 - 1960. Maps depicting the frequency distribution of these low pressure centers are then prepared from which the main tracks are determined. Charts showing the distribution of cyclones at their formative stage (first appearance on the charts) during the winter and summer half-years together with composite diagrams depicting the percentage distribution with latitude and the frequency of depressions which crossed the 110° and 120°E meridians are also constructed. The results indicate that:

(a) Cyclones in the westerly wind belt of middle latitudes occur most frequently in Central Mongolia and Northeast China. Extratropical cyclones are not found south of 20°N .

(b) Cyclones which formed over the mainland of China south of 45°N are generally weak and the majority are without closed isobars. Intensification is also unlikely until these systems have moved to East China or entered the sea.

(c) The maximum frequency of occurrence of low pressure centers is found over the sea area to the southeast of Japan.

(d) The maximum frequency of cyclones occurs in spring and next in autumn. However, in summer, an increase of cyclonic activities over the Yangtze and Hwai Ho valleys is noted.

Finally, the tracks of the extratropical cyclones are classified into five main groups and eleven sub-groups. A short description of each group is also given.

- 17.9 Tang Mou-tsang (T'ang Mou-ts'ang)
PRESSURE SYSTEMS IN THE
CHILIEN SHAN DISTRICT
33(2): 175-188, May 1963
16 figs., table, 5 refs.

This paper presents an analysis of the pressure records from more than 30 surface stations and over 10 upper-air stations, which are situated at an altitude of approximately 3000 meters in Chilien Shan and its vicinity. Five meso-scale pressure systems are noted on the mean isobaric charts over this mountainous region, viz., the "Shule River High", the "Hei River Low", the "Tsaidam Low", a High over the eastern side of the mountains and a Low near the meandering region of the Yellow River. The annual variation of the intensity and location of these systems are discussed. It is found that the mean vertical circulation over this mountainous region as inferred from the distribution of the various meteorological elements during the winter season corresponds closely to the presence of these systems. A synoptic study of the influence of two meso-scale systems on rainfall distribution is presented and the relationship between these disturbances and the temperature field is discussed.

- 17.10 Wang Yao-sheng (Wang Yao-sheng) and
Ko Liang-fu (K'o Liang-fu)
THE RELATION BETWEEN THE ACTIVITY
OF MISGURNUS AND THE WEATHER -
A STATISTICAL STUDY
35(1): 54-62, February 1965
6 figs., 6 tables, 7 refs.

The relation between the activity of misgurnus and the weather is studied statistically using data of 1959 - 1963. It was found, within the existing limits of observational accuracy, that the misgurnus often reacts abnormally before the passing of a front. This reaction, however, is not clearly related to such elements as barometric pressure, temperature and humidity.

- 17.11 Hsu Tsih-hsiu (Hsu¹¹ Tzu-hsiu) and
Wang Mu-wei (Wang Mu-wei)
AN ANALYSIS OF THE SYNOPTIC PROCESSES
DURING THE EASTWARD MOVEMENT OF
TROUGHs IN THE SOUTHERN BRANCH OF
THE UPPER WESTERLIES ABOVE A CUSHION
OF COLD AIR OVER SOUTH CHINA IN SPRING
35(2): 117-125, May 1965
15 figs., 3 refs.
Full translation: Emm-66-139

After the intrusion of cold air into South China in spring a thin layer of cold air often prevails over the east of the Tibetan Plateau, forming a "cushion of cold air". When zonal circulation dominates the upper troposphere, troughs over the "cold cushion" tend to move eastward along the southern branch of the upper westerly jet. Under such circumstances, the high pressure area at the surface tends to break up to make way for frontogenesis and the development of surface troughs. The present study deals with such synoptic processes over South China for the months of March to May during 1958 - 1962. Problems on short-range prediction of precipitation and thunderstorm activities associated with these processes are also discussed.

See also: 1.32, 3.3, 3.4, 3.13, 3.16, 3.21, 4.21, 7.11, 7.22,
11.33, 15.2, 16.12 and 16.36

CHAPTER 18

THUNDERSTORMS; HAIL; ATMOSPHERIC ELECTRICITY

- 18.1 Chao Ber-lin (Chao Po-lin) and
Xue Fan-bing (Hsueh Fan-ping)
MECHANISM FOR HAIL GROWTH
33(4): 411-420, November 1963
10 figs., 7 refs., 24 eqs.

In this paper, the growth of hail in cumulus clouds with a non-uniform distribution in the ascending current and liquid water content is discussed. The necessity of considering this type of distribution is emphasized. Simple rules for the prediction of hail from given distributions of the ascending current and liquid water content are also formulated.

- 18.2 Zhou Xiu-ji (Chou Hsiu-chi) and
Qin Ren-zhong (Ch'in Jen-chung)
THEORETICAL ANALYSIS OF A
CRITICAL ELECTRIC FIELD TO
SPATTER CHARGED DROPLETS
34(1): 103-110, February 1964
6 figs., table, 7 refs., 22 eqs.

The criterion for the instability of the shape of a charged droplet in an electric field is given theoretically. The results agree well with Macky's experimental data. It is shown that in thunderclouds, in an electric field with a charge of 5000 v/cm, a spark discharge occurs even on the surface of the rain droplets. This possibility plays an important role in the formation of lightning within the cloud. In this case, the ion concentration in the clouds increases to $10^{10}/\text{cm}^3$, which creates a great conduction medium. Finally, as a result of the unstable deformation of rain droplets in a critical electric field, the intensity of a radar echo with a 3.2 cm wavelength suddenly intensifies 20 times.

- 18.3 Xu Jia-liu (Hsü Chia-liu),
Huang Meng-yong (Huang Meng-yung),
Liu Zhong-ling (Liu Chung-ling) and
Duan Shao-ji (Tuan Shao-chi)
AN ANALYSIS OF THE HAIL SPECTRA
AND THE STRUCTURE OF HAIL SECTIONS
DURING TWO HAIL STORMS OVER THE
MIN HSIEN REGION OF KANSU IN
JUNE - JULY 1964
35(2): 251-256, May 1965
8 figs., table, 8 refs.

An analysis of hail sections and hail spectra obtained by simple instruments during two hail storms indicates that the hail spectra follow an exponential distribution. The observed characteristics are discussed in terms of the statistical theory of microstructure of fog and cloud. The distribution of the type and size of "growth centers" and clear ice layers of hailstones is analyzed and the observed hail spectra are found to be related to these parameters, which adequately account for the characteristic intensity of the two hail storms.

- 18.4 Wang De-tsam (Wang Te-cheng)
THE RELATIONSHIP BETWEEN THE
CONVERGENCE BELT AND
THUNDERSTORM ACTIVITIES DURING
SPRING IN THE WARM REGION OF
FUKIEN
35(3): 316-327, August 1965
17 figs., 3 tables, 2 refs., eqs.
Full translation: Emm-66-86

The findings of this paper reveal that the thunderstorm activities during spring in the warm region of Fukien are closely related to the existence of convergence belts associated with the southerly currents at 850 mb along the southeast coast of China. These activities are often oriented NE - SW or E - W. The convergence belts are an important dynamical feature responsible for the development and realization of thunderstorms within the region under consideration. In the present study, a classification of these convergence belts at 850 mb have been made and their displacements analyzed statistically.

- 18.5 Liu Yuan-xun (Liu Yüan-hsün),
Liu Chang-yuan (Liu Ch'ang-yüan),
Zheng Ying-wu (Cheng Ying-wu) and
Di Fu-rong (Ti Fu-jung)
THUNDERSTORM PREDICTION IN THE
SHIHCHUANG AREA IN SUMMER
IN THE PRESENCE OF AN UPPER-LEVEL
TROUGH
35(3): 380-382, August 1965
4 figs.
- 18.6 Yuan Djen (Yüan Chen),
Chiang Pen-tang (Chiang Pen-t'ang),
Jen Li-hsin (Jen Li-hsin),
Chou Shih-chien (Chou Shih-chien) and
Cheng Ta-chou (Cheng Ta-chou)
A SPECIAL RADIOSONDE FOR PROBING
STRONG ELECTRIC FIELDS AND AN
ANALYSIS OF ELECTRIC-FIELD SOUNDINGS
IN THUNDERCLOUDS
35(4): 440-448, November 1965
10 figs., 2 tables, 4 refs., eqs.

The construction of a special radiosonde for probing the electric field in thunderclouds is described. The sonde consists of an inductance element in the form of pointed wires and a FM-AM telemetering system. A $2\Pi 1\Pi$ -electron tube is used in the frequency modulation circuit and another one in the transmitter section giving a broadcast frequency of 85 Mc/sec. An anti-interference circuit is incorporated in the ground receiver, thus efficiently filtering the interference by distant lightning. Five soundings were carried out in thunderclouds and a preliminary analysis of the results was made.

See also: 4.16 and 16.20

CHAPTER 19

TYPHOONS; TROPICAL AND SUBTROPICAL METEOROLOGY;
MONSOONS

- 19.1 Li Xian-zhi (Li Hsien-chih)
A COMPOSITE THEORY
FOR THE FORMATION
OF TYPHOONS
27(2): 87-100, June 1956
5 figs., 30 refs.

The formation of tropical cyclones which are called typhoons in East Asia has attracted much attention from meteorologists for more than a century. The number of theories published in the literature continues to grow with time, but up to the present a unifying theory is still lacking. Furthermore, the present state of our knowledge on the subject is not sufficient to give accurate and satisfactory answers to certain pertinent problems such as: (a) Why is the formation of tropical cyclones restricted to some regions? (b) Why is the frequency of occurrence of typhoons so small? This paper presents a theoretical supplement to part of the previous investigations on typhoons carried out by the author. Several favorable conditions for the formation of typhoons are listed together with the following three necessary and sufficient conditions: (1) Large-scale instability with respect to height and moisture contents, (2) very intense vorticity and (3) sufficiently strong external force - influx of cold air. (The first two conditions are well recognized.) In addition, some of the recent findings are summarized. After a discriminative analysis of available information and reference to important contributions in the literature, a composite theory on typhoon formation is then derived, which can be used to explain some of the above problems concisely and satisfactorily.

- 19.2 Liu Kwang-nan (Liu K'uang-nan) and
Tung Ke-chin (Tung K'o-ch'in)
THE SURFACE STRUCTURE AND RAINFALL
DISTRIBUTION OF THE TYPHOONS INVADING
SOUTHEASTERN CHINA
29(2): 104-118, May 1958
18 figs., 2 tables, 6 refs.

Using relatively complete surface data this paper analyzes the distribution of pressure, wind and rainfall as well as their interrelationship of four intense typhoons which invaded the mainland of China in 1953 - 1956. The main results are as follows:

(a) The pressure distribution within a typhoon varies considerably with its direction of motion. The filling of a typhoon is a function of its radius, and the 6-hour filling rate is consistent with the diurnal variation of the local pressure distribution.

(b) The wind distribution within a typhoon is considerably influenced by the earth's topography. The distribution of convergence agrees well with the rainfall distribution.

(c) After invading the continent, the rainfall distribution may be classified into three types, viz., symmetrical, asymmetrical and according to the stage of its development.

(d) Immediately after invading the continent, a typhoon shows two entirely different types of weather near its center, viz., clear and calm weather and violent rainfall.

In general, the structure of the typhoon changes considerably when it enters the westerlies from the easterlies. On the other hand, its structure is influenced appreciably by the land and sea as well as by the earth's topography.

- 19.3 Zhang Ji-jia (Chang Chi-chia)
THE SECULAR VARIATION OF TYPHOON FREQUENCY
OVER THE WESTERN PACIFIC AND ITS RELATION TO
THE VARIATION OF THE CIRCULATION PATTERN
29(2): 135-138, May 1958
3 figs., 2 tables, 6 refs.

- 19.4 Kao Yu-hsie (Kao Yu-hsi) and
Hsu Shu-ying (Hsu Shu-ying)
CLIMATIC RESEARCH IN THE
MONSOON REGION OF EASTERN ASIA
30(3): 258-262, August 1959
24 refs.
- 19.5 Chang Chia-cheng (Chang Chia-ch'eng)
SOME PROBLEMS CONCERNING THE
PROPERTIES OF THE MONSOONS
OVER CHINA
30(4): 350-361, November 1959
14 figs., 4 tables, 16 refs.

This paper discusses the following problems:

(a) The Distribution of Monsoon Winds: The use of monsoon indices indicates that the distribution of monsoon winds is very complicated. This is characterized by a region of maximum monsoon intensity over Southeast China, a zone of relatively weak monsoon winds over North China and a narrow belt of weaker monsoon activities along the southeast coast.

(b) The Monsoon Wind Field: There is a significant boundary of monsoon wind near the Chinese-Indian border. The formation of this monsoon boundary is closely related to the influence of the Tibetan Plateau. The differences in physical properties of the monsoons over China and India are analyzed, and the climatological regions over China are divided into three distinct regimes of monsoon winds.

(c) The Evolution of the Monsoons: The evolution of the monsoons which are closely related to the formation and dissipation of the southern branch of the westerly jet is found to be more or less independent of the dynamic influence of the Tibetan Plateau but is determined by the heat balance over the Asiatic continent. It is noted that the seasonal variation of the general circulation over the entire Pacific and the Far East is governed by the last factor.

(d) Oscillation of the Monsoons: The intensity of the monsoons is usually found to vary with time and space. The application of analogue

analysis of circulation patterns by the method of Vangengeim reveals that the secular variations of the monsoons over the Far East are basically concordant with those of the general circulation.

- 19.6 Hsieh Yi-ping (Hsieh I-ping),
Chen Shou-jun (Ch'en Shou-chün),
Chang I-liang (Chang I-liang) and
Huang Yin-liang (Huang Yin-liang)
A PRELIMINARY STATISTICAL AND
SYNOPTIC STUDY OF THE BASIC CURRENTS
OVER SOUTHEASTERN ASIA IN RELATION
TO THE FORMATION OF TYPHOONS
33(2): 206-217, May 1963
7 figs., 10 refs.

This paper presents a statistical and synoptic study of the relation between the basic currents in the low latitudes over southeastern Asia and the formation of typhoons, using recent aerological data. It is shown that approximately 80% of the typhoons developed in the eastern part of the equatorial convergence zone between the equatorial westerlies and trade winds of the western Pacific. The large-scale equatorial westerlies are relatively steady, and therefore can reasonably be called "basic currents"; the typhoons, being of a smaller scale, can be considered as vortices in the convergence zone between this and another type of basic current, i. e., the trade winds. There is a close relationship between the time, position and frequency of the formation of typhoons and the position and intensity of the basic currents in the low latitudes. The fact that the position and intensity of the basic currents vary quasi-periodically longer than a month may be helpful for the medium-range prediction of the formation and development of typhoons.

- 19.7 Chen Chiu-shih (Ch'en Ch'iu-shih),
Miao Jin-hai (Miao Chin-hai) and
Li Wei-liang (Li Wei-liang)
THE MEAN WIND FIELD AND MEAN MERIDIONAL
CIRCULATION OVER THE SOUTHWEST MONSOON
REGION IN SOUTHEAST ASIA AND OVER THE
TRADE-WIND BELT IN THE PACIFIC DURING
JULY 1958
34(1): 51-61, February 1964
11 figs., 15 refs.

The circulation features of the southwest monsoon in Southeast Asia are distinctly different from those of the trade winds in the Pacific. The monsoon region is characterized by ascending currents over the plateau regions in the north and subsidence in the south, thus resulting in a vertical monsoonal circulation. A deep southwesterly current is also present in the lower levels up to 400 mb with an easterly jet stream above. In the tradewind belt, a typical Hadley cell exists in low latitudes while the mid-Pacific subtropical westerly jet prevails in the upper levels. The northeast trades cover the lower troposphere with the easterly wind component decreasing with height.

The existence of vertical circulation in the monsoon provides a further basis for explaining the causes of the monsoon phenomenon.

- 19.8 Chao Shu (Chao Shu)
MONSOONS AND RAINY SEASON IN KWEICHOW
35(1): 96-106, February 1965
Fig., 8 tables, 1 ref.
Full translation: Emm-67-153

This paper presents a preliminary analysis of the characteristics of monsoons in relation to the rainy season in Kweichow using data for the period 1944 - 1962. Views on the definition of rainy season and a classification of monsoons are presented. Dates for the advance and retreat of monsoons and for the commencement and ending of the rainy season are given. The relationship between monsoons and droughts in Kweichow and the natural climatic seasons are also dealt with for the purpose of providing some guidance for the preparation of routine long-range forecasts.

- 19.9 Tung Ke-chin (Tung K'o-ch'in) and
Liu Zhi-jun (Liu Chih-chün)
ON THE RELATIONSHIP BETWEEN THE MOVEMENT
OF TYPHOONS AND THE BASIC CURRENT AT EACH
STANDARD ISOBARIC LEVEL
35(2): 132-137, May 1965
4 figs., 5 refs.

This paper presents an analysis of the relationship between the movement of typhoons and the basic current at each of the standard isobaric

levels from the surface to 200 mb using data from 71 case studies. The results indicate that the departure of the movement of typhoons from the low-level steering current below 700 mb is different from or opposite to that obtained from levels at and above 700 mb. The present authors are of the opinion that a two-level steering model may prove to be superior to the widely used single-level technique and that it is not necessary to resort to multi-level steering.

- 19.10 Wei You-xian (Wei Yu-hsien),
Wang Yin-tong (Wang Yin-t'ung),
Guo Xiu-ying (Kuo Hsiu-ying),
Qu Cui-hong (Ch'ü Ts'ui-hung) and
Han Guang-hua (Han Kuang-hua)
A PRELIMINARY INVESTIGATION OF THE
FORMATION AND DEVELOPMENT OF
TYPHOONS IN THE SOUTH CHINA SEA
35(2): 148-154, May 1965
7 figs., 3 tables, 6 refs.

In this paper, the 500-mb synoptic situations associated with the formation and development of 35 typhoons in the South China Sea for the years 1954 - 1961 were classified into seven types, which were found to be favorable for tropical depressions to deepen into weak typhoons.

In addition, a preliminary analysis of the environmental instability with respect to moisture and the pulsational influx of cold air as two factors affecting the formation of typhoons is presented. Empirical discriminants were derived from data of 14 storms during 1958 - 1961 for predicting the intensification of tropical depressions into typhoons in the South China Sea.

Tests were carried out on five storms which occurred in the South China Sea during 1962, and the results were satisfactory for four storms.

- 19.11 Chen Lieng-shou (Ch'en Lien-shou)
THE MOVEMENT OF TYPHOONS IN THE
WESTERN PACIFIC IN RELATION TO THE
MIDDLE- AND HIGH-LATITUDE FLOW
PATTERNS OVER ASIA IN MID-SUMMER
35(4): 476-485, November 1965
13 figs., 2 tables, 9 refs., eqs.

The movement of typhoons is closely related to changes in the subtropical flow patterns, which are in turn influenced by the variation of the flow

pattern in the westerlies. Weather charts covering a period of four years were studied to investigate the relationship between the movement of typhoons in the western Pacific and the flow patterns at middle and high latitudes over Asia in mid-summer. The results indicate that typhoon movements and changes in the subtropical flow patterns are closely affected by blocking situations over the Far East at middle and high latitudes, action centers and the three long-wave systems over western Asia, the East Asiatic coast and eastern Japan. These findings provide useful clues for the prediction of the advance and recession of the subtropical high and hence the movement of typhoons (i. e., steady westward course or recurving).

- 19.12 Chen Chu-shih (Ch'en Ch'iu-shih) and
Shuang Jian-kuo (Sang Chien-kuo)
A SYNOPTIC ANALYSIS OF THE INFLUENCE
OF LARGE-SCALE MOTIONS ON THE
FORMATION OF TYPHOONS
35(4): 486-497, November 1965
9 figs., 6 refs., eqs.

This paper describes the results of an analysis of 15 case studies in connection with the formation of typhoons. The basic flow configuration at 200 mb before the formation of a typhoon can be classified into three types. Significant advection of positive vorticity is observed at high levels one to three days before the formation. Such advection is often greater at high than low levels, resulting in the formation of an area of relative divergence which exists above the low-level disturbance. This disturbance subsequently develops into a typhoon. This is in good agreement with the findings of Reference [1]* on the triggering mechanism of the formation of typhoons and is related to the degeneration of thermal winds as well as the unification of the processes of "mutual adjustment". If the factors governing the degeneration of thermal winds assume sufficiently large values to maintain a configuration such that the vorticity of the "shear vector"

* See 1. 29.

field is greater than that of the thermal wind field, they act as the triggering mechanism for the formation of a typhoon. In the case studies under review, a wide variety of synoptic situations may exist at high and low levels. However, they have a common dynamical feature; i. e., the vorticity of the "shear vector" field is greater than that of the thermal wind field.

See also: 1.26, 1.29, 7.16 and 7.38

CHAPTER 20

WATER VAPOR; EVAPORATION; HYDROLOGIC CYCLE

- 20.1 Fu Pao-p'0 (Fu Pao-p'0)
ON THE BEHAVIOR OF THE WATER CYCLE
IN THE ATMOSPHERE
27(2): 77-85, June 1956
Fig., table, 1 ref., eqs.

The present paper deals with the derivation of formulas for the various parameters involved in the water cycle in the atmosphere under certain basic assumptions. These expressions throw some light on the behavior of the water cycle in the atmosphere. The annual and monthly values of the various terms for the circulation of water vapor over Europe and U. S. S. R. are also calculated from the basic observational data. The results show that the computed values of water cycle coefficient and the contribution of water vapor content of the local atmosphere to precipitation are slightly smaller than those obtained by Budyko and Drozdov; whereas the computed influx of precipitable water is slightly greater than their estimates. It is pointed out that the increase of total precipitation due to evaporation is much greater than that produced by the water vapor in the atmosphere.

- 20.2 Liu Chen-hsing (Liu Chen-hsing)
ON THE ESTIMATION OF EVAPORATION
FROM A LAND SURFACE
27(4): 337-344, December 1956
Fig., table, 6 refs., eqs.

In the published work of N. A. Vagrov, the evaporation from a land surface is estimated by means of the form $x = \int_0^z \frac{dz}{1 - (\frac{z}{z_0})^n}$ derived from certain basic assumptions. However, this expression can only be integrated under very restricted conditions. Even in these cases, the solutions are very complicated. Furthermore, z is an explicit function of x and z_0 when and only when $n = 1$ and 2 .

In this paper, the integral form of Vagrov is changed to $x = \int_0^z \frac{dz}{(1-\frac{z}{z_0})^n}$

which is integrable for all values of n . This modified integral is also very simple. Values of x are calculated for different values of z with $z_0 = 1$ and the computed values are then used for the preparation of Figure 1. Isopleths obtained in the present study are shown by full lines while those of Vagrov are indicated by broken lines. A comparison of these two sets of isopleths reveals that all the full lines lie below the broken lines when $x/z_0 < 1.10$. However, the full lines gradually become higher than Vagrov's isopleths when $x/z_0 > 1.10$ and the two sets become farther apart as x/z_0 increases.

- 20.3 Zhu Gang-kun (Chu Kang-k'un)
 A PRELIMINARY INVESTIGATION OF THE
 WATER BALANCE OVER DIFFERENT
 RIVER BASINS IN CHINA
 28(1): 27-40, February 1957
 8 figs., 3 tables, 9 refs., eqs.

In this paper, charts depicting the distribution of the three elements in water balance studies over East China are presented. Analyses and discussions of some important aspects of the problem are also given. Values of long-period average rainfall (r) over different stations are computed from the basic observations and those of evaporation (z) calculated from the Budyko formula (see Reference [6]):

$$z = \sqrt{\frac{R_0 r}{L} \operatorname{th} \frac{rL}{R_0} \left(1 - \operatorname{ch} \frac{R_0}{rL} + \operatorname{sh} \frac{R_0}{Lr} \right)}$$

where th , ch and sh denote hyperbolic tangent, hyperbolic cosine and hyperbolic sine respectively. $R_0/L = z_0$ represents the maximum possible amount of evaporation from a moist ground surface which is maintained by a continuous source. Values of this parameter are taken from the computed results of Reference [1]. Values of the long-period average flow-off are obtained indirectly from the water balance equation $f = r - z$. In addition to the determination of the distribution of annual evaporation, values of the seasonal evaporation are also computed in the paper. However, the former

has been determined to a higher degree of accuracy than the latter. Water balance studies over 17 basins are carried out and discussed at some length. A chart depicting the distribution of long-period average values of the flow-off coefficient is prepared, and the results compare favorably with those in Reference [9].

- 20.4 Hsü Shu-ying (Hsü Shu-ying)
WATER-VAPOR TRANSFER AND
WATER BALANCE OVER
EASTERN CHINA
29(1): 33-43, February 1958
29(3): 224, August 1958
15 figs., 13 refs., eqs.
Full translation: Emm-65-29
Emm-65-29-Supp.

Water-vapor transfer and water balance over eastern China are calculated using aerological sounding data of January and July 1956.

It is shown that along with the seasonal variations of monsoon circulation, there is a marked difference in the transfer of water vapor between summer and winter. However, in both of these seasons the inflow of water vapor from the south is most significant. In comparison with the total transfer, eddy transfer is generally less important. Maximum eddy transfer occurs in Central China, consistent with the translating path of the high in winter and the mean position of the polar front in summer.

During July 1956, mainland China is shown to be a source of water vapor where the amount of evapotranspiration is larger than that of precipitation.

- 20.5 Hsieh Yi-ping (Hsieh I-ping) and
Tai Wu-ja (Tai Wu-chieh)
A NUMERICAL STUDY OF THE TRANSPORTATION OF
WATER VAPOR OVER EASTERN CHINA DURING A
SYNOPTIC PROCESS
30(2): 173-185, May 1959
19 figs., 9 refs., eqs.

In this paper, the transportation of water vapor over eastern China during the period of heavy precipitation in the middle and lower basins of the

Yellow River from 11 to 20 July 1957 was calculated from the relevant wind observations and temperature records. Problems on the moisture cycle are also briefly discussed.

- 20.6 Liao Rong-sun (Liao Jung-sun)
ON THE COMPUTATION OF THE COEFFICIENT
OF MOISTURE CIRCULATION FOR AN INLAND REGION
31(2): 171-180, May 1960
5 figs., 3 refs., 30 eqs.

In the present study, the coefficient of moisture circulation $\mu(L)$ over a region OL is shown, under certain assumptions, to be

$$\mu(L) = 1 + \frac{E(\eta)}{uw_0},$$

where $E(\eta)$ is the evaporation over the region $O\eta$ and uw_0 is the inflow moisture advection flux. Assuming that $E(x) = Ex$, then $E(\eta) = \frac{m}{2} EL$ and m satisfies the condition $2 > m > 1$. Hence

$$\mu_2(L) = 1 + \frac{mEL}{2uw_0}.$$

If the average gradient of evaporation, a , is considered, the equation for the coefficient of moisture circulation may be written as

$$\mu_1(L) = 1 + \frac{n(E_0 L - \frac{1}{3} aL^2)}{2uw_0},$$

where n satisfies the condition $m > n > 1$. Let $\frac{E_0}{L} > a > 0$; then the ratio of the decimal fractions of $\mu_1(L)$ and $\mu_2(L)$ also satisfies

$$\frac{4}{3} > \frac{\mu_1(L) - 1}{\mu_2(L) - 1} > 1.$$

The value of this ratio is found to be $3/2$ by Pogosyan, which is slightly larger than that obtained from the present study.

- 20.7 Wang Zao-shu (Wang Tso-shu) and
Xu Xi (Hsü Hsi)
THE WATER CYCLE IN THE UPPER
YANGTZE BASIN IN SUMMER
34(3): 345-354, August 1964
4 figs., 4 tables, 9 refs., eqs.

This paper studies the yearly water cycle in the upper Yangtze basin in summer using aerological data for 1955 - 1961. The annual amount of water-vapor transfer in each layer from the ground to 400 mb over the four boundaries of the region and the values for the various elements of the water cycle are given; the latter are compared with those in several other regions (Mississippi valley, Euro-Russia, etc.). The paper also discusses briefly the relationship between the water-vapor transfer and the circulation pattern over this region in summer.

The coefficient K ($K = 1.094$) and the intensity of the water cycle in this region are larger than those in other regions. The ratio of evapotranspiration to precipitation is relatively small. A maximum water-vapor transfer occurs at the 850 - 700 mb level. These results are attributed mainly to the orographic condition; viz., the basin is situated at a rather high altitude above sea level and is surrounded by mountains.

It is concluded that the possibility of an increase of precipitation in this region by increasing the internal evapotranspiration is greater than in plain areas.

See also: 13.15

CHAPTER 21

WEATHER MODIFICATION; CLOUD SEEDING

- 21.1 **Anonymous**
**A REPORT OF THE EXPERIMENTS ON THE
ARTIFICIAL STIMULATION OF RAINFALL
IN KIRIN PROVINCE**
30(1): 5-10, February 1959

During the period from 8 August to 13 September 1958 a total of 20 cloud-seedings was carried out with dry ice as the seeding agent in the experiments on the artificial stimulation of rainfall. The results are found to be satisfactory, and the total yield is estimated to be 66 million cubic meters. Thus, irrigation problems are solved.

- 21.2 **Kansu Province. Cloud Seeding Group**
**A BRIEF REPORT OF THE EXPERIMENTS ON
THE ARTIFICIAL STIMULATION OF RAIN
IN KANSU PROVINCE DURING AUGUST -
OCTOBER 1958**
30(1): 11-27, February 1959
25 figs., 6 tables, 1 ref.

This paper describes the experimental work on the artificial stimulation of rain and the dispersion of cloud in Kansu together with the experimental results. It is noted that the efficiency of the process varies with the method of seeding and the type of seeding agents used. The experiments show that the probability of success in the artificial stimulation of rain in the Chilien Shan region of Kansu is generally high.

- 21.3 **Anhui Province. Cloud Seeding Group**
**A REPORT OF THE EXPERIMENTS ON THE
ARTIFICIAL INDUCEMENT OF CLOUD GROWTH
OVER NANKING ON 27 NOVEMBER 1958**
30(1): 28, February 1959

On 27 November 1958 dry ice was sown at 5600 m above mean sea level over Nanking at the rate of 18.3 kg per km along the track of the seeding aircraft. As a result of the seeding, an artificial cumulus congestus covering an area of 1300 m by 7000 m came into existence for 45 minutes.

- 21.4 **Anonymous**
**A REPORT OF SIX EXPERIMENTS ON
THE ARTIFICIAL STIMULATION OF
PRECIPITATION IN WUHAN**
30(1): 29-34, February 1959
Table

Dry ice and a solution of common salt were used as agents in the experimental seeding of warm clouds. The latter is found to be more efficient in producing artificial rainfall. A mixture of common salt and natural ice particles was also used in the experiments.

- 21.5 **Anonymous**
**A REPORT OF THE ARTIFICIAL DISPERSION
OF CLOUD AND FOG IN HOPEI PROVINCE**
30(1): 35-38, February 1959
Table

Five experiments on the artificial dispersion of cloud were carried out over Peking and in its vicinity. Dry ice and a solution of common salt were used as seeding agents. The results are found to be satisfactory.

- 21.6 **Hopei Provincial Weather Bureau. Cloud Seeding Group**
**A REPORT OF THE ARTIFICIAL STIMULATION OF
RAIN BY SILVER IODIDE IN THE REGION OF
HSIAOWUTAI SHAN**
30(1): 39-44, February 1959
5 figs., table, 1 ref.

Preliminary experiments on fog dispersion by means of silver iodide are found to be successful. In these experiments, powders of silver iodide are vaporized by a direct heat source instead of using a solution in acetone.

- 21.7 **Cheng Chwen-shu (Ch'eng Shun-shu)**
CLOUD MODIFICATION IN CHINA
30(3): 286-290, August 1959
4 tables, 6 refs.

- 21.8 Ye Jia-dong (Yeh Chia-tung)
AN EXPERIMENTAL STUDY OF
ARTIFICIAL CONDENSATION NUCLEI.
32(3): 232-239, September 1962
8 figs., 4 tables, 2 refs., eqs.

This paper deals with the experimental determination of the rate of condensation around different types of soluble microscopic nuclei [NaCl, MgCl₂, NH₄Cl, CaCl₂, P₂O₅, NH₄NO₃, (NH₄)₂SO₄, etc.] and suspensoids such as camphor, silicon aerosols, kaolin, lamp black and calcium lime (CaO). The findings reveal that the abovementioned soluble nuclei and camphor powder are active artificial hygroscopic condensation nuclei and that lamp black, silicon aerosols and kaolin are inactive nuclei around which no significant growth by condensation takes place in an unsaturated moist atmosphere.

- 21.9 Chao Ber-lin (Chao Po-lin) and
Ding Rong-liang (Ting Jung-liang)
THE POSSIBILITY OF INCREASING RAINFALL
FROM NIMBOSTRATUS CLOUDS BY
ARTIFICIAL METHODS.
(I) THE PROBLEM ON ICE-WATER
TRANSFORMATION IN OPEN SYSTEMS
33(3): 382-391, August 1963
2 tables, 10 refs., 42 eqs.

In this article, the influence of turbulent diffusion on ice-water transformation in clouds is discussed. It is found that the treatment of clouds as closed systems is not appropriate. Since the precipitation efficiency is less than 1 in actual conditions, numerical forecasts based on closed systems will inevitably lead to a gross error. In clouds which have a maximum efficiency in maintaining continuous precipitation, the concentration of ice crystals must be at an optimum value, which is considerably greater than the concentration of natural ice nuclei. It is therefore reasonable to expect that the introduction of a fixed quantity of ice crystals in a cloud will result in an increase of its precipitation efficiency. For replenishment purposes, a continuous seeding of ice-forming nuclei is required and the optimum quantity for open systems is

found to be at least three times the amount computed from closed systems. Thus the characteristics of open systems should deserve some particular consideration in this kind of studies.

- 21.10 Ma Pei-min (Ma P'ei-min),
Sun Yi-min (Sun I-min),
Zhao Rui-hua (Chao Jui-hua),
Lou Fu-cheng (Lou Fu-ch'eng) and
Xue Fan-bing (Hsüeh Fan-ping)
ANALYSIS OF THE RESULTS OF CUMULUS
CLOUD SEEDING WITH POWDERED SALT
OVER HUNAN PROVINCE IN THE
SUMMER OF 1963
35(3): 280-292, August 1965
12 figs., 9 tables, 2 refs.

This paper analyzes the macroscopic and microscopic cloud seeding data recorded in Hunan Province in 1963. A statistical survey of some of the macroscopic data taken during 1959 - 1962 is also made. It is shown that following dispersion of powdered salt into a cumulus congestus, the concentration of large water drops ($D \geq 100 \mu$) generally increases and the size spectrum widens. These consequences are proportional to the concentration of the dispersed salt particles. Furthermore, the vertical updraft is intensified, the water content is increased and the cloud top is distinctly raised. The precipitation period and intensity at the surface are also roughly proportional to the salt concentration. The paper uses certain classical cases to demonstrate the effects of powdered salt dispersion into a cumulus cloud and discusses the subsequent formation of precipitation and the effects on the circulation within the cloud. It is concluded that under favorable conditions, the use of appropriate seeding techniques may increase precipitation from a warm cumulus cloud.

See also: 16.20

CHAPTER 22

MISCELLANEOUS

- 22.1 Koo Chen-chao (Ku Chen-ch'ao)
SIMPLE APPROXIMATE SOLUTIONS FOR THE
FINITE-DIFFERENCE POISSON EQUATION
29(4): 287-295, November 1958
6 figs., table, 7 refs., eqs.

In this paper, the best approximate solutions for the finite-difference Poisson equation

$$\phi - \bar{\phi} = h \quad (1)$$

are determined using the method of double-harmonic series solution. The first approximate solutions with absolute and relative least square errors are, respectively,

$$\phi^* = -1.0h + 13.2\bar{h}, \quad 4 \leq \lambda/d \leq 12 \quad (2)$$

$$\phi^* = 0.9h + 3.1\bar{h}, \quad 4 \leq \lambda/d \leq 12. \quad (3)$$

An intermediate solution is found to be

$$\phi^* = 0.4h + 4.4\bar{h}, \quad 4 \leq \lambda/d \leq 12 \quad (4)$$

or simply

$$\phi^* = 4.8\bar{h}. \quad (5)$$

The paper proves that Belousov's nine-point formula

$$\phi^* = 4 \left(\frac{3}{8} h_0 + \frac{1}{8} \sum_1 h + \frac{1}{16} \sum_2 h \right) \quad (6)$$

is equivalent to

$$\phi^* = \left(\frac{3}{2} + 2A + A^2\right)h, \quad (7)$$

and can be replaced, with equal accuracy, by

$$\phi^* = 1.2h + 3.1\bar{h}. \quad (8)$$

The accuracy of the empirical formula

$$\phi^* = mh \quad (9)$$

is discussed and found to be unsatisfactory.

The paper concludes that formula (4) gives the best solution with the amount of computational work cut down by one half as compared to using formula (6).

- 22.2 Lu Wo (Lu Wu) and
Wang Peng-fei (Wang P'eng-fei)
PROGRESS AND DEVELOPMENT IN THE
METEOROLOGICAL SERVICES IN CHINA
DURING 1949 - 1959
30(3): 197-201, August 1959

This article describes the progress and development in the meteorological services in mainland China through the joint efforts of the people and the Communist Party during 1949 - 1959 in terms of provision of new services, expansion from small-scale to large-scale and elaboration from simplicity to comprehensiveness. The achievement plays an important role in national defence and is the key to the economic development of the state.

- 22.3 Xie Guang-dao (Hsieh Kuang-tao),
Hsieh Yi-ping (Hsieh I-ping) and
Ye Gui-xing (Yeh Kuei-hsing)
PROGRESS IN METEOROLOGICAL EDUCATION
IN CHINA DURING 1949 - 1959
30(3): 202-205, August 1959

- 22.4 Jaw Jeou-jang (Chao Chiu-chang)
PROGRESS IN METEOROLOGICAL RESEARCH
IN CHINA DURING 1949 - 1959
30(3): 206-211, August 1959
- 22.5 Tao Zu-wen (T'ao Tsu-wen)
ON THE COMPUTATION OF THE ANGLE
OF ELEVATION OF THE SUN
33(3): 402-407, August 1963
2 figs., 3 refs., 8 eqs.
- 22.6 Yang Chien-chu (Yang Chien-ch'u)
THE TEMPERATURE VARIATIONS OVER
CHINA AFTER THE ONSET AND CESSATION
OF MAGNETIC DISTURBANCES IN THE
WINTER HALF-YEAR
35(2): 215-227, May 1965
8 figs., 6 refs.

For the present study, the dates marking the onset and cessation of magnetic disturbances are objectively determined from the daily magnetic Ci-indices in the winter half-year during the periods of 1953 - 1955 and 1956 - 1959. The temperature variations over 28 stations in China with respect to each epoch are analyzed by the superposition of time series. The results give a comprehensive portrait of the evolution of the temperature profile over China within ten days from each epoch. The findings may provide some useful reference material for the medium-range prediction of temperature over China in the winter half-year.

- 22.7 She Shao-ming (She Shao-ming)
THE PREDICTION OF FOG UNDER
CLEAR SKY CONDITIONS IN
MUTANCHIANG DURING AUGUST
AND SEPTEMBER
35(4): 531-532, November 1965
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