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TERMINAL FORECAST REFERENCE NOTEBOOK, OSAN AB, KOREA.(U)
JUN 81
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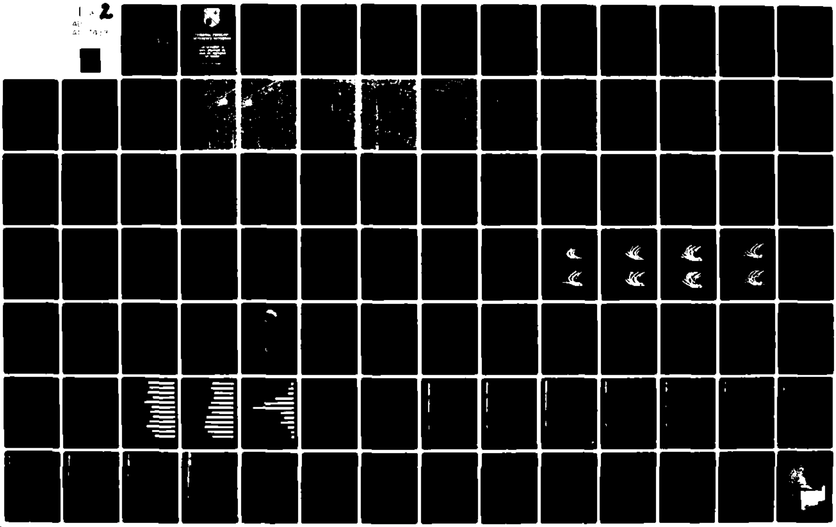

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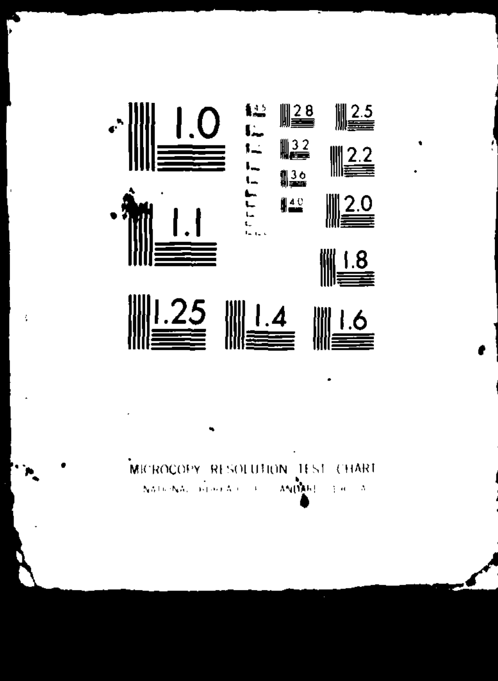

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This publication provides weather forecasting guidelines for Osan AB, Korea. The types of information contained within these guidelines is location, topography, local effects, customer requirements, and support provided, synoptic climatology, forecast studies, climatological data, synoptic case studies, and TAF work and preparation sheets.

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28 OCT 1981

TFRN

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TFRN

RECORD OF REVIEW

NAME AND GRADE	DATE	NAME AND GRADE	DATE

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Section E: Forecast Studies

Section F: Climatological Data

Section G: Synoptic Case Studies

Section H: TAF Work and Preparation Sheets

SECTION A:

LOCATION, TOPOGRAPHY, AND LOCAL EFFECTS

GENERAL GEOGRAPHY

A.1 The Korean Peninsula, now divided between north and south, extends to within 120 mi (190 km) of both Honshu, the main island of Japan, and the Shantung Peninsula of China. The distance between the Japanese islands of Tsushima and the South Korean island of Kuksom is no more than 21 mi (34 km), while the nearest islands to China lie some 100 mi (160 km) off the Shantung coast.

The Korean Peninsula extends 600 mi (965 km) from latitude 44 N to 33° 30' N and has a total area, including the offshore islands, of 85,269 sq mi (220,847 sq km). This is an area roughly the size of Minnesota or Nebraska, and somewhat less than Great Britain. There are 10,793 mi (17,300 km) of coastline near which lie some 3,300 offshore islands, about 300 of them inhabited.

The Peninsula is broadest at its northern border, and narrowest at its center (about 135 mi/215 km) where a military demarcation line divides North and South Korea. The Republic of Korea (ROK) has an area of 38,175 sq mi (98,477 sq km), which is about 45% of the total Peninsula, and is roughly the size of Indiana or Virginia. It has a north-south extent of about 300 mi (480 km), and a maximum east-west extent of about 185mi (295 km)

OSAN AIR BASE

A.2 Osan AB is located at 37° 06'N 127° 02'E in a section of South Korea known as the Western Lowlands. The field elevation of the east-west (09-27) runway is 38 ft above sea level. The lowland features of the surrounding terrain end rather abruptly north and northeast of the air base. Three (3) well defined ridges begin approximately eleven (11) miles north through northeast from Osan AB. They are oriented north-south, with heights varying from 1600' MSL to 2000' MSL. More gradual terrain changes occur east through south of the base for about 25 miles. However, even in this area of general gradual sloping conditions, some isolated hilltops do extend to 1000' MSL. An irregular chain of mountains with heights to 2200' MSL lies 25 miles east-southeast through south of the base. The western rim of the Southern Taebaek and Sobaek mountain ranges lie 40 miles northeast through southeast of the base.

Three seperate valleys merge in the vacinity of Osan AB to form a relatively large flat basin about 5 miles long and 2-4 miles wide. The undulating hills that border these valleys rise to heights of 600' MSL. The Chinwi River flows westward parallel to the runway, and joins the Hwanggai-Chon (river) one (1) mile west of the field. The Yellow Sea is approximately 12 miles due west, with one inlet to the southwest coming within 6 miles of the base. The base is also surrounded by rice paddies, which enhance the already abundant moisture sources effecting the area. As the amount of moisture available would indicate, fog is one of the major forecast problems for Osan AB. The hills from northwest through east through southwest shield Osan from most strong winds (30kts), but also tend to produce mechanical turbulence when low level winds (3000ft) are in excess of 15-20kts. Wind frow between 260 and 300 is practically unimpeded allowing strong moisture advection from the Yellow Sea. This often results in sea fog/stratus during the spring and fall, and snowshowers during the winter.

A-3 KOON-NI RANGE

1. Koon-Ni Range target area is within an 8000 foot circle centered at 37°01'54"N, 126°44'04"E. The range is located on the Korean west coast approximately 14.5 nautical miles west of Osan AB. Weather at Koon-Ni is affected to a large degree by its proximity to the Yellow Sea. A wind fetch off the water may cause localized strato-cumulus ceilings or restrictions to visibility by fog.

2. The observation site is located in the main tower and is well exposed to the weather. The observer has an unrestricted view in all directions. Ceiling heights are normally estimated but may be determined by balloon or, at night by using a ceiling light located 140° at 400 yards from the observation site. (See map, page 1-7, 314 ADR 55-22). TMQ-15 wind equipment is located southeast of the observation site on the roof of a barracks.

3. There is normally no significant dust or smoke at Koon-Ni Range. Observations are representative.

4. For a map of the area surrounding Koon-Ni Range, see page 1-4, 314 ADR 55-22.

A.4 NIGHTMARE/RODRIQUEZ RANGES

1. Nightmare and Rodriquez Ranges are located in (RK)/ P-518 and are used primarely as Army artillery impact areas. They are also used by US aircraft for tactical and close air support training. For exact coordinates see Chapter 2, 314 ADR 55-22. Both ranges are located in mountainous areas and the weather patterns are typical of such areas (i.e. valley fog and clouds caused by orographic lifting). Careful attention must be given to target altitude (see Chapter 2, 314 ADR 55-22) when forecasting for either range.

2. No surface observations are currently available from Nightmare and Rodriquez ranges. For forecasting purposes, observations from Camp Casey/Tongduchon (RKST), Camp Page/ Chunchon (RKNC), and Camp Laguardia/Uijongbu (RKSB) may be used in conjunction with reports from airborne and ground FACs.

3. Observations from RKST, RKNC, and RKSB are not sufficiently close in location or altitude to be representative for Nightmare or Rodriquez Range. Reports from FACs, while very helpful are not taken by trained observers, and are not normally available until after forecasts must be issued.

4. For maps of the area surrounding the Nightmare and Rodriquez Ranges, see Chapter 2, 314 ADR 55-22.

A-5 Observations are taken from the ground surrounding the base operations building. Visibility observations are severely restricted from the east-southeast through the west-southwest by various base structures. However, most of the sky is visible, and the observations are considered to be representative.

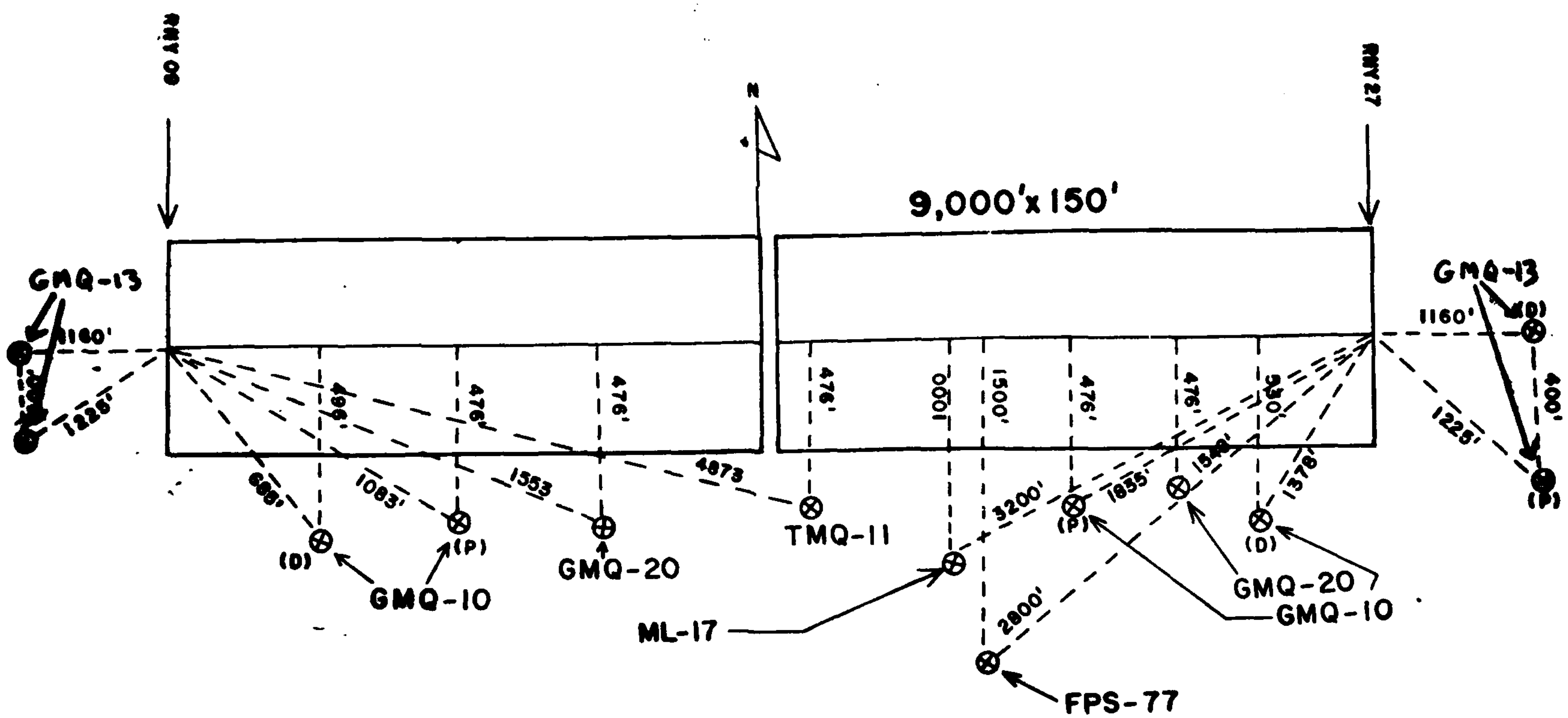
Osan AB has dual instrumintation (Rwy 09-27). The equipment available, and its location, are as follows: (Also see attached diagram)

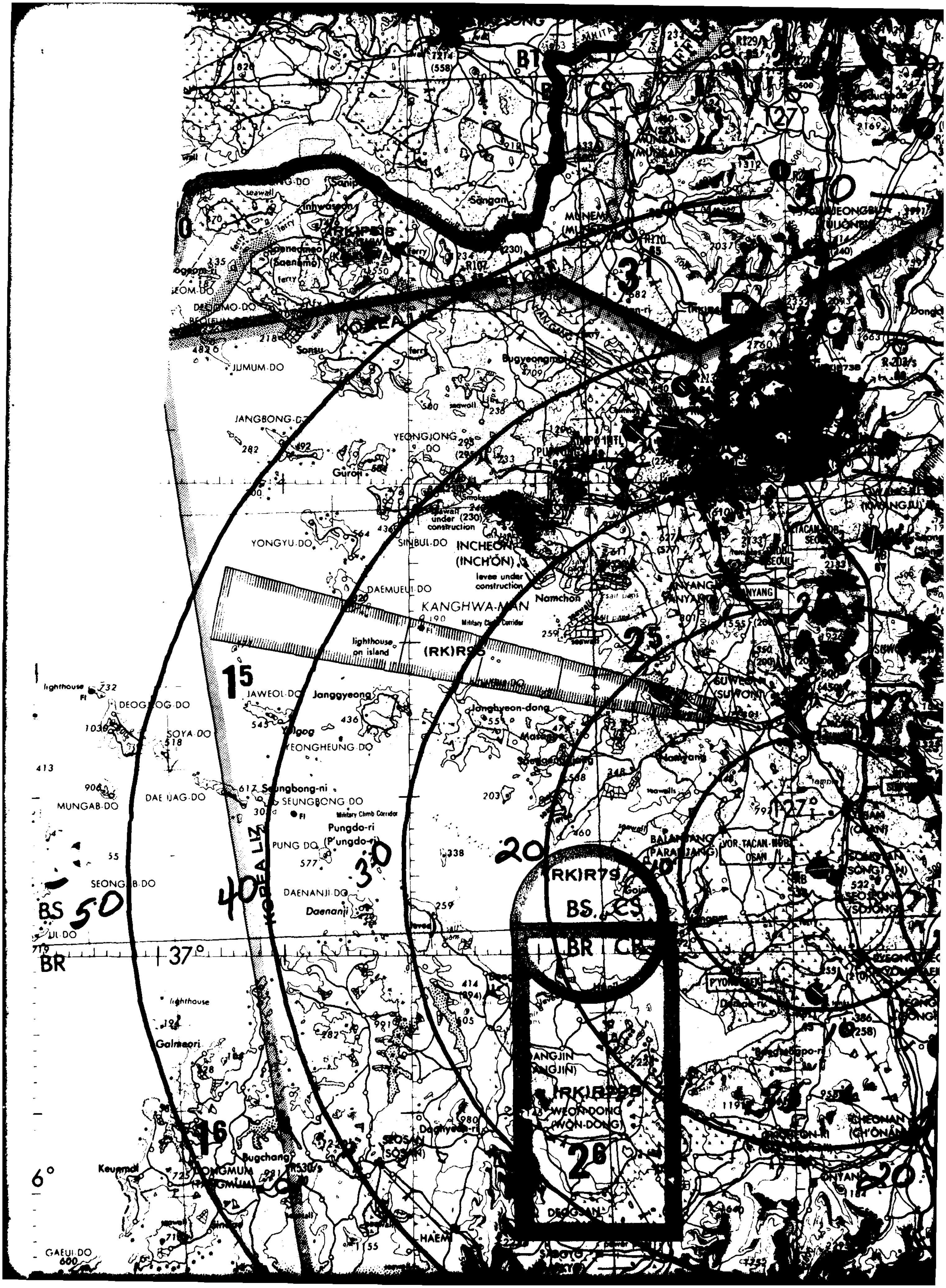
INSTRUMENT		LOCATION
AN/GMQ-20	Wind detector	1548' SW of the end of Rwy 27, and 476' S of the centerline. 1553' SE of the end of Rwy 09, and 476' S of the centerline
AN/GMQ-10/32	Transmissometer Projector	1835' SW of the end of Rwy 27, and 476' S of the centerline.
	Detector	1378' SW of the end of Rwy 27, and 530' S of the centerline.
	Projector	1083' SE of the end of Rwy 09, and 476' S of the centerline.
	Detector	685' SE of the end of Rwy 09, and 496' S of the centerline.
AN/GMQ-13	Rotating Beam Ceilometer Projector	1225' SE of the end of Rwy 27, and 400' S of the centerline.
	Detector	1160' due E of the end of Rwy 27.
	Projector	1225' SW of the end of Rwy 09, and 400' S of the centerline.
	Detector	1160' due W of the end of Rwy 09.
AN/TMQ-11	Temp/Dewpoint Set	4873' SE of the end of Rwy 09, and 476' S of the centerline.
AN/FPS-77	Radar Antenna	2800' SW of the end of Rwy 27, and 1500' S of the centerline.
	Set	Base Weather Station
Polarimeter		Base Weather Station
Barometer	ML-102G Aneroid	Base Weather Station elev 35.4'
	ML-512B Mercurial	Base Weather Station elev 35.26'

SURFACE OBSERVING EQUIPMENT PLAN

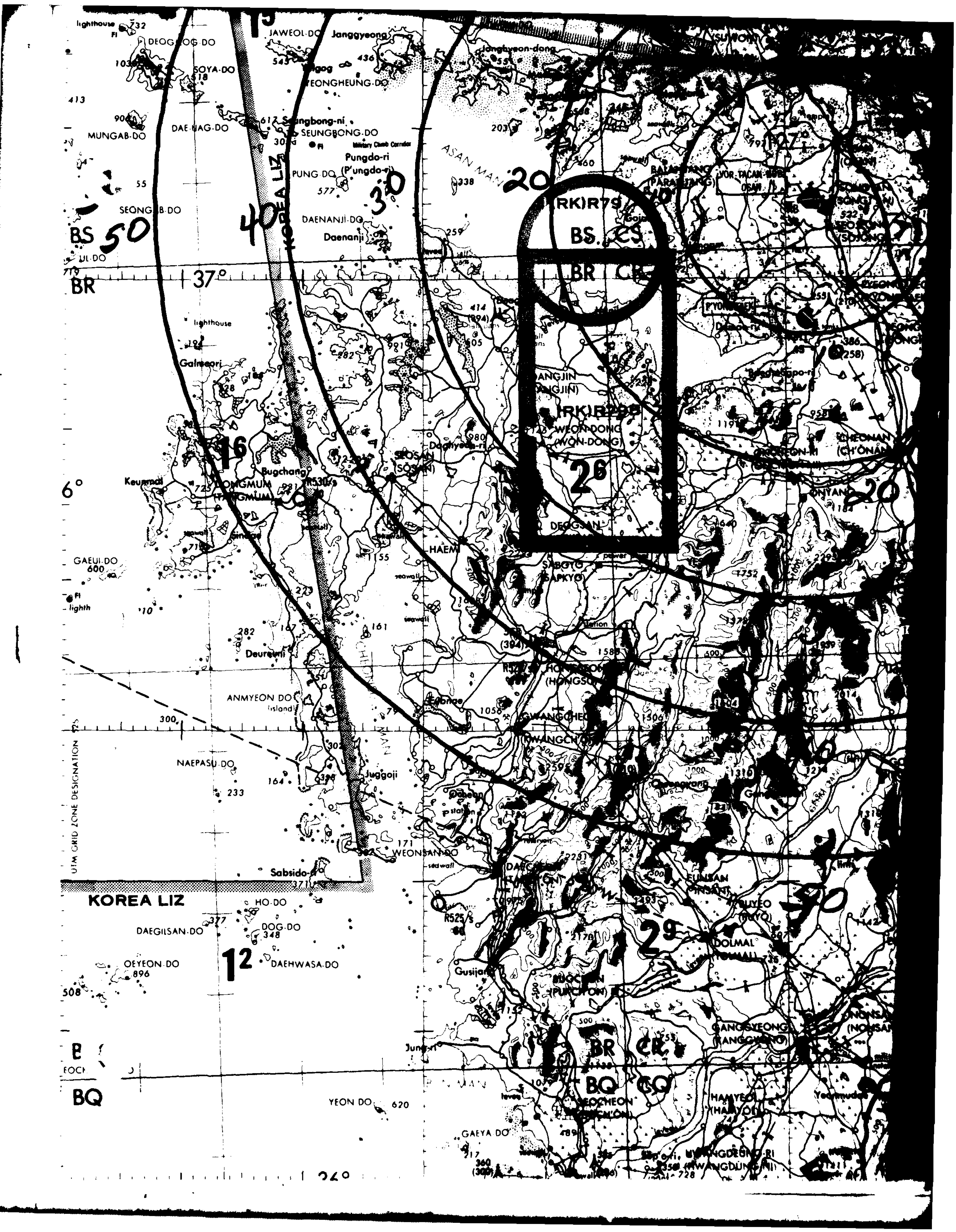
OSAN AB, KOREA

(NOT TO SCALE)



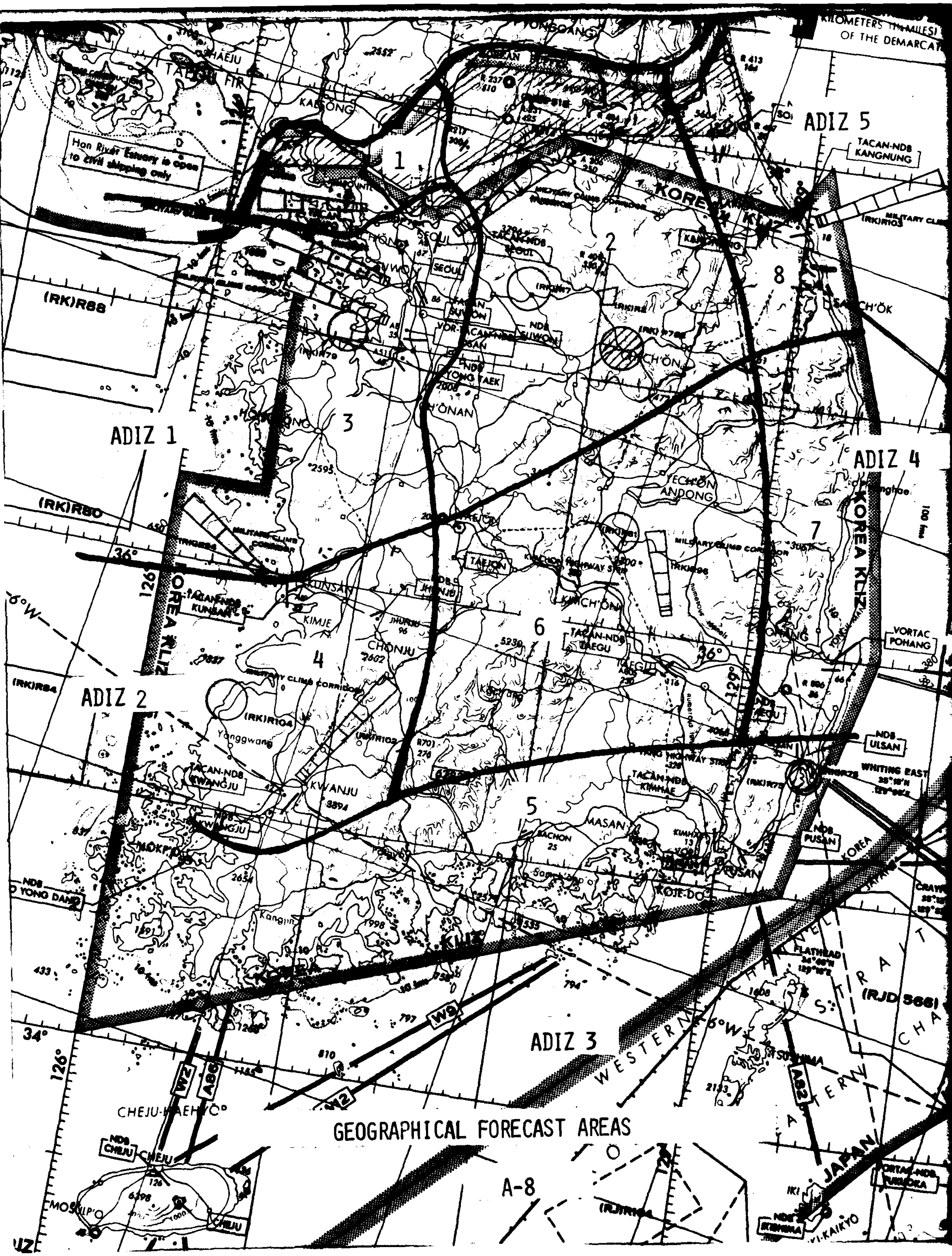

KOREA
JUMUM-DO
JANGBONG-DO
YEONGJONG-DO
Guron
YONGYU-DO
SINBUL-DO
INCHEON
(INCHŎN)
levee under construction
seawall under construction
DAEMUEUI-DO
KANGHWA-MAN
Military Climb Corridor
lighthouse on island
(RK)R95
Namchon
Bugyeongmo
15
JAWEOL-DO
Janggyeong
Jangbyeon-dong
DEOGJEOG-DO
SOYA-DO
YEONGHEUNG-DO
Seungbong-ni
SEUNGBONG-DO
MUNGAB-DO
DAEIJAG-DO
Pungdo-ri
(P'ungdo-ri)
PUNG DO
SEONGGAB-DO
DAENANJI-DO
Daenanji
BS
UL-DO
BR
37°
lighthouse
Galmaeori
16
Keunmal
Bugchang
DONGMUN
SEOSAN
(SOSAN)
HAEMI
DANGJIN
(RK)R58
WEON-DONG
(WŎN-DONG)
26
DEOGSAN
(RK)R79
BS CS
BR CR
BALANJANG
(PARANJANG)
VOR-TACAN-MOB
OSAN
SUWEON
(SUWŎN)
ANYANG
25
31
MUNEM
Sangan
seawall
ferry
CHEONAN
(CH'ŎNAN)
ONYANG
GAEUI-DO
6°
20
30
40
50
KOREA LIZ

SUWON
OSAN
(OSAN)
SONGTAN
SEOJEONG
(SOJONG)
PYONGTAEK
CHEONAN
(CH'ONAN)
ONYANG
JINCHEON
(CHINCHON)
UMSEONG
(UMSONG)
ICHEON
(ICH'ON)
Songhyeon
Wonjucheon
Dongchin
Golmi
Sugyeodong



KOREA LIZ
ASAN MAN
(RK)R79
BS CS
BR CR
BQ CQ
(RK)R230
DANGJIN
WEONDONG
(WON-DONG)
DEOGSAN
SEOSAN
(SOSAN)
HAEMI
HONGSEONG
(HONGSONG)
GWANGCHEON
ANMYEON DO
(island)
NAEPASU DO
WEONSAN DO
Sabsido-ri
HO DO
DOG DO
DAEGILSAN DO
OEYEON DO
DAEHWASA DO
YEON DO
GAEYA DO
GAEUI DO
MUNGAB DO
DAE NAG DO
SEUNGBONG DO
Seungbong-ni
PUNG DO
Pungdo-ri
(P'ungdo-ri)
DAENANJI DO
Daenanji
JAWEOL DO
Janggyeong
YEONGHEUNG DO
SOYA DO
DEOGJEOG DO
UL DO
SEONGGAB DO
Galmaeori
Keunmal
DONGMUN
Bugchang
Deureuni
Juggoji
Gusijang
Jung-ri
EUNSAN
BUYEO
(PUYO)
DOLMAL
GANGGYEONG
(KANGGYONG)
HAMYEOL
(HAMYOL)
SEOCHEON
CHEONAN
(CH'ONAN)
ONYANG
PYONGTAEK
OSAN
VOR TACAN
BALANGANG
PARANGANG
Military Climb Corridor
lighthouse
UTM GRID ZONE DESIGNATION
BS 50
40
30
20
20
30
37°
36°
BR
BQ
16
26
12
29

CHEONAN
(CH'ONAN)
JINCHEON
(CHINCH'ON)
(UMSONG)
GEUMSAN
(KUMSAN)
ONYANG
Songhyeon
HAJANG
DOLMAL
Yeonmudae
Bucheon
20
30



GEOGRAPHICAL FORECAST AREAS

P518
KOREA KLIZ
ACM YELLOW
ACM RED
MPSA 108A
108B
R88
(RK)R88
R80
(RK)R80
AREA 17
AREA 18
R84
(RK)R84
Han River Estuary is open to civil shipping only
SEOUL
KAESONG
HAEJU
KANGNUNG
SOKCHO
SUWON
OSAN
PYONG TAEK
CH'ONAN
TAEJON
KUNSAN
CHONJU
KWANGJU
MOKP'O
TAEGU
POHANG
ULSAN
PUSAN
MASAN
KOJE-DO
CHEJU
MOSULP'O
TSUSHIMA
IKI
FUKUOKA
WESTERN CHANNEL
EASTERN CHANNEL
KOREA STRAIT
RANGES
W9
W12
A86
A82
(RJD 566)
WHITING EAST
FLATHEAD
A-9

STATION LOCATIONS AND IDENTIFIERS

SECTION B:

WEATHER IMPACT ON SUPPORTED UNITS

CUSTOMER	AIRCRAFT	LOCATION	CRITERIA	IMPACT	OUR ACTIONS
Low LVL Wnd Shear					
36TFS	F-4E	Osan	Observed shear	Divert/abort take off	Met Watch
19TASS	OV-10	Osan	Observed shear	Divert/abort take off	Met Watch
Det 1, 18TFW	RF-4C	Osan	Observed shear	Divert/abort take off	Met Watch
Det 1, 18TFW/FOL	F-15	Osan	Observed shear	Divert/abort take off	Met Watch
38ARRS	HH-3	Osan	Observed shear	Divert/abort take off	Met Watch
Det 2, 9SRW		Osan	Observed shear	Divert/abort take off	Met Watch
TSTMS		Within 25NMI RKSO			
36TFS			In flying area	Divert/abort take off	Met Watch, TAF, Flimsy
19TASS			In flying area	Divert/abort take off	Met Watch, TAF, Flimsy
Det 1, 18TFW			In flying area	Divert/abort take off	Met Watch, TAF, Flimsy
Det 1, 18TFW/FOL			In flying area	Divert/abort take off	Met Watch, TAF, Flimsy
38ARRS			In flying area	Divert/abort take off	Met Watch, TAF, Flimsy
Det 2, 9SRW			In flying area	Divert/abort take off	Met Watch, TAF, Flimsy
Lightning 51CSG/ACB		Within 5NMI RKSO	Observed	Shut down computers	Met Watch
51COMPW/MA		Within 3NMI RKSO	Observed	Shut down fueling OPS	Met Watch

CUSTOMER	AIRCRAFT	LOCATION	CRITERIA	IMPACT	OUR ACTIONS
Precip					
38ARRS			Freezing	Ceases flying ops	LCL pt warning
51CSG/DE			Frozen (2 in. in 12 hrs)	Shovel snow/clear roadways	LCL pt warning
			Frozen (2" or >)	Puts snow crews on alert	Met Watch
Wind Chill 51CSG/MA			< -20^{o}	Crews cease work. Outside maintenance curtailed	LCL pt warning
Clouds & Vsby 36TFS	F-4E	Osan/Alt	300/1	Cat A pilot Landing/Take-off mins trng	Met Watch, TAF, Flimsy
			500/1½	Cat B pilot Landing/Take-off mins trng	Met Watch,TAF, Flimsy
			100/½	Alert Landing/Takeoff mins	Met Watch, TAF, Flimsy
		Range	3000/3	Conventional Weapons delivery	Range Forecast
			5000/5	Night Conventional Weapons Delivery	Range Forecast
			8000/5	30 Degree Dive	Range Forecast
			14000/5	High Angle Dive Toss	Range Forecast
		ACM	10000/5	Air Combat Training	Area Forecast
19TASS	OV-10	Osan/Alt	300/1 500/1½ 700/2 1500/3	Landing/take off mins trng	Met Watch
			100/½	Alert Landing/take off mins	Met Watch
		Range	1500/3	Conventional Weapons Delivery	Range Forecast

CUSTOMER	AIRCRAFT	LOCATION	CRITERIA	IMPACT	OUR ACTIONS
		P-518	5000/5	Live ordinance CAS missions	Forecast
Det 1, 18TFW	RF-4C	Osan/Alt Low/LVL Rte	1000/1	Landing mins Training runs	Met Watch Forecast
		Area A,B,C, and D	25000/10	Bench box mission	Tacel Forecast
Det 1, 18TFW/ FOL	F-15	Osan/Alt	? 300/1 600/2 100/½	 Cat B pilot landing/takeoff mins trng Cat C polot landing/takeoff mins trng Alert landing/t-keoff mins trng	 Met Watch Met Watch Met Watch
		Range	1500/3 ? ?		Range Forecast
38ARRS	HH-3	Osan/Alt	700/1 Acft CC decision	Training mins Alert mins	Met Watch Obs
			500/1	Site Support	Area Forecast
Det 2, 9SRW		Osan/Alt	200/½	Mission mins	Flimsy Package
Crosswinds 36TFS	F-4E	Osan/Alt	25kts/RSC Dry	Landing/Take off mins	-
19TASS			20KTS/RSC Dry		-
Det 1, 18TFW			15kts/RSC Dry		-
Det 1, 18TFW/FOL			30kts/RSC Dry		-
Det 2, 9SRW			15kts/RSC Dry		Met Watch

CUSTOMER	AIRCRAFT	LOCATION	CRITERIA	IMPACT	OUR ACTIONS
Winds					
51COMPW/LG	Maint	Osan	20-29kts	Tie down OV-10s	Met Watch
			30-40kts	Close canopies; head F-4s into wind	LCL pt warning
			40kts	Tie HH-3 down	LCL pt warning
			50kts		
			60kts	Tie wings down, retract flaps	LCL pt warning
			80kts	Bail out	LCL pt warning
Icing					
36TFS	F-4E		MOD	Divert acft/curtail flying	Met Watch, TAF, Flimsy
19TASS	OV-10		None	Divert/no fly	Met Watch, TAF, Flimsy
Det 1, 18TFW	RF-4C		MOD	Divert/no fly	Met Watch, TAF, Flimsy
Det 1, 18TFW/ FOL	F-15		None	Divert/no fly	Met Watch, TAF, Flimsy
38ARRS	HH-3		Trace	Divert/no fly	Met Watch, TAF, Flimsy
Det 2, 9SRW			MOD	Divert/no fly	Met Watch, TAF, Flimsy
Turbc					
36TFS	F-4E		SVR	Divert/no fly	Met Watch, TAF, Flimsy
19TASS	OV-10		SVR	Divert/no fly	Met Watch, TAF, Flimsy
Det 1, 18TFW	RF-4C		SVR	Divert/no fly	Met Watch, TAF, Flimsy
Det 1, 18TFW/ FOL	F-15		SVR	Divert/no fly	Met Watch, TAF, Flimsy
38ARRS	HH-3		MOD	Divert/no fly	Met Watch, TAF, Flimsy
Det 2, 9SRW			SVR	Divert/no fly	Met Watch, TAF, Flimsy

CUSTOMER	AIRCRAFT	LOCATION	CRITERIA	IMPACT	OUR ACTION
Tornado 51COMPW	N/A	Osan	Observed	Take cover, all activities curtailed base cleanup.	Lcl pt warning
Hail 51COMPW/MA	All	Osan	¼" or	Hangar or Evac Aircraft	Lcl pt warning

SECTION C:

SYNOPTIC CLIMATOLOGY

CLIMATE OF KOREA

C.1 The Korean Peninsula lies within the Asiatic monsoon circulation and experiences hot, short, humid summers and long, cold, dry winters. The spring and fall generally represent the transitional periods between the dominant monsoon regimes. Other important climatic controls that supplement the monsoon regime are the migratory systems that pass over or near the country, the varied terrain, and the adjacent seas and nearshore currents.

C.1.1 WINTER: November through March

Winter weather is dominated by a high pressure area caused by the intense cold over Siberia. In January, this Siberian high is more intense than at any other time of the year. Cold, dry air flows southward from the high along the east coast of the Asian mainland, pushing as far south as the northern Philippines. The outermost edge of this cold air, where it borders the warm moist air masses that have originated over the tropical oceans, is called the polar front. The clockwise circulation of air around the dominant high pressure area gives rise to northerly or northwesterly winds that are referred to as the northwest monsoon. The air transported by this system gives South Korea below freezing temperatures in late December and throughout January and February. The surface soil remains frozen until the end of January along the southern coast, and it generally begins to thaw at Osan AB about the end of February.

Although the northwest monsoon is the predominant feature of the winter weather, small low pressure areas occasionally form in the East China Sea near Taiwan (as a result of irregularities or waves on the polar front) and work their way northward to bring cloudiness and precipitation. Other small low pressure areas known as Shanghai lows form over the relatively warmer Yellow Sea and then pass eastward over the Korean Peninsula; with the passage of one of these, the winds along the east coast become more northeasterly, acquire moisture over the Sea of Japan, and bring heavy snowfalls to the Taebaek Mountains and the east coast north of Kangnung. On exceptionally cold nights, cold air stratocumulus may form over the Yellow Sea, and if the low level winds are from 270 to 310 degrees, will often move inland forming low cloud ceilings at Osan AB. These clouds usually cause light snow showers as they encounter the hillsides.

The weather of December, January and February, under the influence of the northwest monsoon, henerally remains clear and cold. The coldness of the polar outbreaks is accentuated gusty surface winds. Wind chill temperatures, therefore, are frquently 20 F below actual temperatures.

The month of March is generally the beginning of the end of the cold winter season. While continental dry air from the Siberian high pressure area continues to dominate the weather over the Peninsula and generally fair weather conditions prevail, the Siberian high is rapidly weakening.

Incursions of moist air from the oceans surrounding the Peninsula become fore frequent, increasing the level of cloudiness and precipitation by small amounts. In March, the polar front has moved northward from its true winter position and lies between Taiwan and the Philippines. About four to six times during this month, the Peninsula is affected by low pressure areas developing along the polar front somewhere between Taiwan and the area of Shanghai. The northeastward migration of these storms along the polar front brings short periods of warming southerly flow as far north as the Peninsula's southern coast. These storms produce increased cloudiness (even a thunderstorm or two) with short spasms of rain as far north as Taegu. After their passage, wintry weather returns.

C.1.2 SPRING: April and May

In April, the Siberian high weakens and the polar front begins to move northward toward the Korean Peninsula with an increasing intrusion of warm moist air from the south. By the latter part of the month, the northerly winds from the high pressure area over Siberia are no longer dominant. The warmer air raises the temperature into the 60's(F), and some southern cities such as Pusan and Chinhae have as much as six inches of rainfall.

Because the cpld, heavier air that originated in Siberia is being displaced more and more frequently by tropical maritime air, the country is said to be under the influence of a "migratory high." This high is sometimes displaced by low pressure areas from the south, but it is also displaced, though less frequently, by low pressure areas originating over northern China or Mongolia.

The types of weather these lows bring to South Korea depend on their place of origin and the latitude in which they pass over the Peninsula. Occasionally, a storm originating over the Mongolian desert can cause dry westerly winds over South Korea; these are known as "Yellow Winds" because they carry yellow dust picked up over the desert. An easterly wind of the foehn type (known on the Peninsula as "nopsae param," or "wind from the heights", which descends the leeward slopes of the mountains, can be seen whenever a strong, easterly, onshore, surface wind is blowing. It is particularly apparent over the western and central sectors of South Korea when a low pressure area originating in northern China makes a spring passage over the Korean Peninsula. With the passage of this low, however, the migratory high may reestablish itself and bring cool, clear nights and devastating late frosts as far south as Kwanju. The average date of the last frost for more than a third of the country, including Osan AB is April 20.

In May and early June, the weather pattern changes in preparation for the onset of the rain-bringing southwest monsoon in late June. In May, the summer low pressure area that is developing over the continent of Asia is to the north of the Peninsula, rather than to the west as is the case later in the summer. Because of this, the predominant wind direction in May is westerly, rather than southwesterly, with little change in cloudiness and rainfall.

The amount of rainfall in South Korea in May is usually about the same as in April. The actual amount of rainfall during both months depends to a large extent on a region's location relative to adjoining mountains.. Areas on the windward sides of mountains usually gave an average of 8-12 days of cloudiness and/or rain, while areas on the leeward side gave only 3-8 days. Investigations in the Naktong Basin indicate the annual rainfall in the mountains is 12% higher than in the valleys.

Since the pressure differences between the continent of Asia and the adjoining oceans are at a minimum in May and no large scale wind system predominates over the Korean Peninsula, purely local weather phenomena become more conspicuous. Radiation fog, advection fog and local winds are much more apparent at this time.

Sea and land breezes grow stronger with the warmer weather, and there are also local wind effects in the valleys. During the day, the enclosed heat process reverses and sends cold air flowing down to lower levels. In places where valleys open to the sea, the combination of sea and valley breezes creates an up-valley funnelling effect during the day, while at night the mountain breeze combines with the land breeze to produce a vigorous downdraft to the sea. At Chinhae, winds strengthened by this effect have been measured at 35 kts with gusts of more than 58 kts.

C.1.3 SUMMER: June to Mid-September

June marks the beginning of the summer, or southwest monsoon. June surface winds across the Peninsula are variable, but predominantly from the south toward a low pressure center over Manchuria. By late July, this onshore flow of air is well extablished and persists until the latter part of September. It should be noted here that a knowledge of both the air masses affecting the region and the movement of the polar front is basic to an understanding of summer's weather changes.

The polar front is the boundary zone between continental air masses from Asia and the warm moist air from the tropical oceans. This boundary gradually advances northward with the coming of summer. In February, it is as far south as the northern Philippines. By June, its average location runs from Shanghai east to southern Japan. The front is a buffer zone between the cooler northern air mass and the warm southern air. The light but persistent rains associated with the front, known as "Bai-U" or "plum rains" in Japan, affect southern Japan by the end of May.

The coming of sufficient rainfall to support South Korean agricultural needs is always a chance affair; in about one year out of five, the rains come too late. Such a lack of rainfall occurs when a high pressure cell to the north of Japan is unusually strong. This so-called Okhotsk high fends off the polar front and inhibits its progress toward the Peninsula. The Okhotsk high is quite distinct from the Bonin high pressure area which forms further south and dominates the western Pacific. In those years when the Okhotsk high is strongly developed, the arrival of the rains is delayed and the area suffers from drought.

Generally, however, the amount of rainfall in June, and particularly in the latter part of June, increases very substantially above that of the winter and spring months. Sunchon, near the southern coast, has an average June rainfall of 9.5 inches, Pusan 8 inches, and Sogwipo, on the southern shores of Cheju Island, 10.6 inches. Elsewhere the amounts are generally 4-6 inches. Temperatures also rise rapidly, with daily maximums of about 82 F. With the onset of the rains and the increase in temperature, the humidity also increases; relative humidity averages 70-80% for the month of June and is greatest in the west and southwest. The days are long, with sunrise shortly after 0500, sunset just before 2000, and twilight lasting an additional half hour.

In July, two main weather changes affect the region. The Bonin high pressure cell expands westward into the East China Sea, while a large continental low caused by landmass heating settles over northern China. This gives the Korean Peninsula high pressure to the south and low pressure to the north andcreates an airflow that brings warm moist tropical air from the south. The polar front runs from Peking to Cheju Island and then acress to central Japan, producing widespread cloudiness. The front is not stable and develops waves; these generate lows that intensify the cloudiness and rain.

Three or four of these lows push across the Peninsula during July, and often they stall in the Korea Strait against the mountains of western Honshu. These "hesitant" lows bring the wettest month of the year. In many years there may be a total of as much as 17 inches of rainfall, with rain to be expected on about half the days of the month. The maximum rainfall in 24 hours in July was 12 inches. The passage of one of the lows is frequently followed by a day or two of clear weather, with some thunderstorm activity developing in the afternoon.

June has the longest day and July is the month of the summer monsoon, but in many respects August is the most typical summer month. By August, the polar front has passed over South Korea and has a mean position over North Korea. South Korea then experiences extremely unstable tropical air south of the front; when there is no cloud cover, temperatures rise into the 90's (F) with equally high relative humidities.

In September, the average temperatures decrease to the high 70's (F), although the extreme maxima may still reach the mid-90's (F), and the average rainfall is less than during August. The polar front, which made relatively slow progress in its northward movement during June and July, moves very rapidly southward again in September. The front's southward movement can be traced by the accompanying wide band of rain. During this southward frontal movement, weather along the east coast of South Korea becomes very turbulent with exceptionally heave downpours. By the end of September, the polar front is south of Okinawa; the overall result is the replacement of the southerly flow of warm, moist, tropical air of the summer monsoon by a cooler, drier flow from the north.

C.1.4 FALL: Late September and October

As the Asian land mass cools, the Siberian high begins to form in September and becomes more noticeable in October. Most of the Western Pacific experiences the effect of this large scale change when cooler air masses break away from the Siberian high and are carried southward. In the Korean area this change in the weather often occurs about the time of "Chubun," the autumnal equinox.

By October, the southward surges of colder air become stronger and more frequent. The mean position of the polar front, so recently over the Korean Peninsula, now extends from near Hong Kong to the south of Taisan. October is a very pleasant month characterized by sunny days with maximum temperatures in the mik 60's (F) and cool nights with temperatures falling into the 40's (F).

By mid-Movember, the winter weather pattern is established. The polar front is now far to the south and freezing temperatures and some snow can be expected. The second week of November is considered the beginning of winter. The average date of the first snow for most of the country is 20 November, and temperatures fall below freezing 10 or more days in the month.

In the winter, mean daily maximum temperatures across the Peninsula are only moderately cold with readings in the range 30 to 45 F. These relatively warm maximym temperatures occur during those periods when the cold, winter monsoonal flow tracks over the Yellow Sea or Sea of Japan and fairly rapid warming in the lower levels occurs from contact with the relatively warm sea.

In summer, the monsoon circulation has a long trajectory over tropical waters and this is reflected in the season's high temperatures and humidities. The increase in temperature is especially evident in July and August when mean daily maximums are in the middle or upper 80's (F) with mean daily minimums in the low 70's (F) at most places.

Humidity is generally high throughout the year as a result of the surrounding water mass, and regional variations are generally small. Mean relative humidities are usually highest in the early morning, 60-95%. Highest values occur in summer or early fall with a minimum in winter. Daily minimums usually occur during early afternoon, 50-85%. At higher elevations, humidity can drop to 35%. Although diurnal changes vary from place to place, they are generally greatest in the interior.

C.2 UPPER AIR WINDS AND THE JETSTREAM:

The Korean Peninsula lies within a belt of prevailing westerly upper air winds. At around 30,000ft, strong westerly winds occur as part of the global high level wind system in a band of strong winds known as the jetstream. In January, the axis of the jetstream blows west to east across the southern part of South Korea at average speeds of 195kts, and elevations of 35-40,000ft. The location of the northern edge of this wind belt varies considerably, but it is usually south of Taejon during January. In February, the jetstream is located slightly further to the south over southern Japan, and is even stronger with winds close to 230kts. In March, although the mean position of the main axis of the stream remains the same, the jet band widens, bringing it closer to

South Korea. The center of the jet is above Cheju-do with winds of 170kts at around 40,000ft.

In April, the jetstream divides, with one axis located across North Korea and northern Honshu (the polar jet), and the other from Shanghai to Tokyo (the subtropical jet). The velocity associated with both branches decreases as spring changes to summer. By July, the southern branch has moved northward to lie over South Korea, its speed weakened to 90kts, or even lower on occasions. This branch remains over South Korea through August and September, extending from Seoul to Tokyo at a height of approximately 40,0000ft. As fall progresses, the southern branch moves away to central China, while the northern branch moves southward, first over North Korea, and then further south with speeds increasing to 150kts at 35,000ft. By December, both branches converge to form one main core over the Korea Strait.

The jetstream is at its lowest altitude and greatest velocity during the winter months. Its direction and flow in this region, as well as in other areas of the middle latitudes, governs the movement of low level pressure systems from west to east. Winter weather will generally originate on the west coast and move southeast. This steering effect of the jet, coupled with the funneling effect on surface winds as they pass between the Chiri Massif in the southwest, and Mt. Halla on Cheju-do, produces high winds on the north coast of Cheju Island, and surface wind velocities that average 17-19kts.

Good correlation between the mean jet axis and trajectories of prevailing ftorms exists over the Korean Peninsula in summer. Irregular, or anomalous jetstream behavior may be observed during any month, but it occurs most frequently during spring and fall.

C.3 VISIBILITY: Fog, Haze, and Smoke

Visibility over South Korea is generally good. Seasonal variations are large, with the lowest visibility usually occurring in summer, but regional variations are rather small. Diurnally, visibilities are lowest around sunrise, and best in the afternoons throughout the year. Fog is generally the chief restriction to visibility in summer, but fog, haze, and smoke are equally restrictive in winter, with haze and smoke most prevalent near the industrial centers. Dust occurs primarily in winter, although the frequency of this restriction is low. Precipitation may affect visibility throughout the year, but the effect is most noticeable in winter when any precipitation is likely to fall as snow.

Visibility of less than 2½ mi most often occurs during summer mornings throughout most of South Korea. During other hours in summer, especially in the afternoon, and during most hours in the other seasons, visibilities of less than 2½ mi are reported on fewer than 10% of all observations. The major exceptions are the central (Osan AB area) and southwestern parts of the northwest hills and plains, where low visibilities are fairly frequent in the mornings during most of the year.

Visibilities less than 6 mi are frequent, occurring at most locations as much as 40-70% of the time during the worst hours. During the afternoon period, visibilities greater than 6 mi are reported as much as 90% of the time. Regional variations are not significant, but seasonal variations differ appreciably by place and time. Many localities have visibilities below 6 mi most frequently in summer. Generally, visibility is less than 6 mi most often near sunrise and least often in the afternoon hours. Diurnal variations are usually smallest in winter, when daily ranges are mostly less than 30%, and largest in summer, when they can reach 60% at may locations.

Smoke and haze occur most frequently in winter, and are at their worst in a cold, stagnant air mass. Damp haze can persist in summer, but the frequency of occurrence is generally small. Smoke and haze occur most often near the larger industrial areas, where annual averages are about 100-180 days. Elsewhere, haze and smoke occur on fewer than 50 days per year. Dust is noted occasionally, but it is reported on fewer than 10 days per year at most locations. This dust is usually brought over the area from the deserts of Mongolia and North China by strong winds aloft, and visibilities may be restricted over wide areas for several days.

Precipitation also reduces visibility, particularly in winter when it falls mostly in the form of snow. This snowfall can cause very low visibility, especially in the mountains; blizzards and snow storms will occasionally reduce visibility to near zero.

Fog, the chief restriction to visibility, varies in frequency throughout South Korea, depending on location and time of year. However, the annual number of days with fog is generally large, averaging 100-180 days. There are two main types of fog that affect South Korea; seafog and radiation fog.

Sea fog forms over parts of the Sea of Japan and the Yellow Sea in late March through August, with maximymm occurrences in June and July. This fog forms when relatively warm air flows over the cooler sea waters, and the lower layers of the air are cooled until condensation occurs. If the surface air flow is onshore, the fog may move inland for a considerable distance, especially on the western side of the Peninsula.

Radiation fog occurs throughout the year, but it is most frequent during the cooler months in protected areas, especially in river and valleys. However, this type of fog usually dissipates by midmorning. The west coast (OSAN AB area) experiences fog 22% of the time, compared to 7% on the east coast and 10% on the south coast. Thus, over an average year, the west coast can expect three times as many foggy days. The Seoul-Inchon-Osan area has the highest frequency of fog in the whole of South Korea, reaching a maximum frequency of 38% in July.

Typical pressure distributions by season for cases where the entire west coastal area is covered by fog are described by season below. These distributions indicate that warm, moist air arriving at the west coast from the south or southwest will frequently create a fog situation.

C.3.1 WINTER: The strong Siberian high west of Lake Baikal exerts its influence southeastward, with sometimes a southward and eastward surge of air near the point 45N 112E as a result of cyclogenesis in Korea Bay. When this occurs, the air over the west coast of South Korea generally becomes warmer and thick fog forms. However, under the direct influence of the Siberian high, (without any modification from cyclogenesis) the air becomes cold, dry, and fogfree, with some haze and smoke near the cities.

C.3.2 SPRING: The low pressure cell that originates from the declining Siberian high is active during this period, and is followed by the high from the southern region of China. As this system arrives at the west coast, thick fog is formed along the west coastal area.

C.3.3 SUMMER: The Peninsula is under the influence of the Kokasahara high as it reaches into the southern part of the country. When this occurs, there is fog throughout the coastal area, and sometimes inland as well.

C.3.4 FALL: The Siberian high is reestablished with the decline of the low over China. The high begins its push eastward, and is divided into southward and eastward influences by the cold front out of the low in the Sea of Okhotsk. Under this pressure distribution, there is much cloudiness and mist.

C.4 CLOUD COVER:

Cloudiness is quite extensive in summer over the entire Korean Peninsula, but skies are frequently clear in winter. The amount of cloud cover, and its height above the ground are particularly important in planning air operations in such a mountainous country. Although there is no indication of large scale regional differences, the terrain configuration does cause local variations, especially in ceilings during the summer monsoon. Ceilings in the valleys are frequently higher than those over the mountains, which at times may be completely obscured by clouds; this situation obviously can be dangerous for low-flying or descending aircraft.

Regional variations in cloudiness are generally small, but seasonal changes are large. The moist air of the summer monsoon causes considerable cloudiness with mean amounts ranging mostly between 60 and 80%. In fall, cloud amounts generally begin to decrease as the dry winter monsoon replaces the moist summer monsoon. In the southwestern part of South Korea, minimum cloudiness is experience during late fall or early winter, when cloud cover averages about 30 to 50%. Elsewhere, minimum cloudiness is experienced in winter, with averages generally ranging from 30 to 55%. Cloudiness generally increases at all locations during spring and reaches the maximum in summer.

Diurnal variations of mean cloudiness are not great, generally less than 20%. Although the time of day when maximum and minimum cloudiness occurs varies both regionally and seasonally, there is a general trend toward maximum cloudiness during the daylight hours and minimum cloudiness at night.

Cloud types over the Peninsula depend to a larg extent on the synoptic situation. The dry winter monsoon produces cumulus and, occasionally, strato-cumulus clouds. In the southern part of the area, stratus and nimbostratus clouds, with cumulus imbedded, are associated with fronts and occasional low pressure centers. As the polar front moves northward, stratus and nimbostratus clouds predominate north of the front, and cumulus and cumulonimbus are the primary types. Altocumulus and altostratus occur most frequently during the "plum rains", generally in the vicinity of cyclonic activity.

Ceilings less than 1000ft occur most often during the warmer months. However, frequencies are not large, mostly less than 15%, except during the early morning hours, when they rang between 15 and 50% at many locations. In general, stratus clouds are the predominant cause of low ceilings throughout the year; because stratus clouds are most prevalent soon after sunrise, the low ceilings are most frequent during this time. During the day, the lower layers of the atmosphere are heated and most of the low clouds either rise or dissipate. Consequently, low ceilings are at a minimum during the afternoon hours.

Much of the low cloudiness that occurs over South Korea appears to be based at 1000-3000ft. As with mean cloudiness and ceilings less than 1000ft, the frequency of ceilings below 3000ft varies appreciably from summer to winter. Ceilings are below 3000ft most often during June through August or September, with frequencies about 30-70%. In winter, these ceilings are reported on less than 30% of the observations at most locations. The major exceptions are the islands of Paengnyong-do (P-Y-do) and Ullung-do, where high frequencies of 35-65% occur in most months, both summer and winter.

C.5 THUNDERSTORMS AND TURBULENCE:

Thunderstorms are infrequent over the Korean Peninsula except in the mountains. The mean annual number of days with thunderstorms range from fewer than five at many places throughout South Korea, to over 20 at several places in North Korea; frequencies are somewhat higher in the mountains. During late spring through early fall, the period of maximum thunderstorm activity, very few localities have more than five days per month with thunderstorms, and most gusts in the 25-40kts range. Thunderstorms seldom occur during the winter monsoon.

Thunderstorm activity may be frontal, air mass, or orographic. Frontal thunderstorms are most likely to occur during early summer and fall; air mass thunderstorms are a result of convective activity and occur most frequently during the hot afternoons of summer. Orographic thunderstorms can occur any time that warm, moist, unstable air moves up a mountain slope. Frontal and orographic thunderstorms occasionally may be more severe than air mass thunderstorms because of the additional lift supplied by the fronts and mountains. Data are not available concerning the vertical development and tops of thunderstorms; however, tops can be expected to reach 50,000ft on occasions.

Moderate to severe turbulence can always be expected in the vicinity of thunderstorms and may extend to great heights. Although thunderstorms occur most frequently in late spring through early fall, these storms can usually be avoided by aircraft; a more dangerous situation may be encountered in spring, when thunderstorms are often masked by or imbedded in other clouds.

Because South Korea is a mountainous country, mountain waves may produce occasional severe turbulence that can affect flight operations. A wave condition generally occurs when strong winds blow across a mountain range; the actual wind direction may vary somewhat, but the strength of the wave diminishes rapidly as the wind becomes more nearly parallel to the mountains. The mountain wave can sometimes be identified by lenticular and roll clouds on the leeside of the mountains, and by cap clouds over the peaks. However, if the air is very dry, there may be no visible evidence of the turbulent wave. The most dangerous features of the wave are the turbulence in and below the clouds, and the downdrafts immediately to the lee of the mountain peaks, which may occasionally be obscured. In addition, pressure changes under wave conditions may cause large errors in the altitudes shown by and aircrafts altimeter.

Light clear-air turbulence can be expected on hot days below approximately 5000ft over flat terrain; it may achieve moderate intensity over rough mountainous terrain. This trubulence is caused by surface heating of the low level air on hot summer days. During the hottest months of the year, thermal turbulence may extend several thousand feet above the surface. Clear air turbulence at high levels over much of South Korea is virtually inevitable. Because of the rapid change in wind speed both vertically and horizontally in the vicinity of the jetstream, severe turbulence should be expected, especially during the winter months.

C.6 DUST STORMS:

The dust storms that occasionally affect the Peninsula (actually dust clouds that often extend upward several thousand feet) are raised at some distant location and then drift over the country. They are most frequent during the winter months when the winds pick up larg quantities of dust from the deserts of Mongolia and norther China. This phenomenon largely affects areas in North Korea, paricularly the northwest part of the northwest hills and plains, but dust occasionally affects South Korea as well. During late winter and spring, dust from the Gobi Desert may be carried south by active cold fronts from the northwest and cause reduced visibility. In spring, when there is a strong northwest or westerly flow over Manchuria and China, yellow dust will sometimes by carried as high as 15,000ft, and reduce flight visibility to as little as 1-2 miles.

C.7 ICING AND FREEZING LEVELS:

Aircraft icing is generally not a frequent problem during the winter because of the relatively dry winter air mass affecting the Peninsula; however, infrequent severe icing conditions may be encountered in frontal zones and well developed cyclones. Icing is most hazardous during spring and fall when the polar front is migrating across the Peninsula; during this time, the 0 degree C level lies anywhere between the surface and 9000ft, and moist tropical maritime air prevails south of the front (in summer, the 0 C level is generally near 15,000ft). Rotary wing aircraft (Dust-off and Jolly Green at Osan AB) are particularly prone to icing in these conditions; in most cases the icing is of the light to moderate rime variety. Flight through clouds at levels between the 0 C and -20 C isotherm, particularly in convective cumulus clouds, will usually result in severe, clear icing conditions. Frost conditions or freezing fog may occur in winter after frontal passage during the evening hours.

During summer and under stagnant air mass conditions in other seasons, the daytime freezing level will rise 500-1000ft higher than at night with the highest diurnal peak occurring about 2000 hours local time.

During late fall and early spring, the freezing level will appear to jump from the furface to 4-5000ft MSL near noontime as the low level inversion is wiped out by daytime heating.

Another frequent phenominon during the spring and fall transition months is the advent of warming aloft and cloudiness preceding a major storm systemfrom the west or southwest after a night of extensive radiational cooling over the entire Peninsula. Under such conditions, most areas of South Korea will have temperatures below freezing on the surface with temperatures above 0 C from 1000 to between 4-8000ft, and steady precipitation falling. A narrow or thin layer of air below freezing will persist at, or just off, the surface for three to six hours after sunrise and/or the onset of rain and may not be apparent from the upper air soundings.

C.8 TYPHOONS:

The typhoons that affect the Korean Peninsula generally originate east of the Philippines between 140-155E and 5-20N. The primary tracks are to the west, with recurvature to the northeast, although some are first detected in the South China Sea. These typhoons start traveling toward the southeast coast of China; some move onshore and are dissipated there, while others turn from west to north and then northeast. Of the average of one to four typhoons that form in June, about half travel north of Manila and reach China south of Hong Kong. Of the other half, a few move to the north China coast and the balance move west or south of Tokyo. These have little influence on Korean Peninsula weather. In July, August and early September, however, one or two typhoons may cross the southern half of the Peninsula. Past data indicate that the two periods of greatest probability are 11-20 July and 1-10 September, although a threat exists throughout the whole three months. After the middle of September, the main typhoon track moves east over Japan and the threat to the Peninsula subsides. By the time typhoons reach South Korea, they have generally lost wind strength and most of the damage is caused by the intense rains, and resulting floods.

C.9 FRONTAL SYSTEMS:

The majority of cold fronts that approach the east Asian coast are the result of old occluded fronts originating in Europe. Waves frequently develop on these fronts during their southerly movement toward the Korean Peninsula. To assist in the prediction of intensity and movement of such wave developments over the Yellow, East China, and Japan Seas, it is necessary to have some understanding of their history and associated frontal systems.

These cold fronts move from the Asian continent, avoiding the Tibetan plateau, and follow a southeastward and easterly movement toward the Korean Peninsula and Japan. They frequently cause very severe invasions of cold air from the areas noted for the lowest winter temperatures on record throughout the world. They can be divided into three basic types.

TYPES OF COLD FRONTS:

The three types of cold fronts, defined on the basis of origin and movement, are:

(1) Type A (western)......originates on the shores of the Arctic Ocean in western Siberia.

(2) Type B (central)......originates in eastern Siberia between longitude 100 to 140E and about latitude 55 to 70N.

(3) Type C (eastern)......forms near longitude 150E/latitude 60N and travels toward the south-southwest along the east Asian coast and towards the Korean Peninsula.

C.9.1 Type A cold fronts occur most frequently throughout the year and often branch in northern Mongolia at about 47N, 105E. One portion travels toward the east-southeast into northern China, reaching the coast at about 40N. The other portion, which occurs less frequently, travels south-southeast as fas south as southeast Asia. Cold fronts of Type A are quite shallow and rarely cause severe falls in temperatures over the Korean area. Cyclogenesis along these fronts over the Shantung Peninsula creates widespread frontal weather. This type may cover the greater part of East Asia during January to February, at which time the high pressure center behind the fronts will often reach a central pressure of 1065mb.

C.9.2 Type B cold fronts also occur frequently and are especially severe in northern and central China, Manchuria, Mongolia, the Korean Peninsula and Japan. They are considerably deeper than those of Type A, and are associated with very dry air and very pronounced reductions in temperatures. Type B is most frequently observed in midwinter.

C.9.3 Type C frontal systems, although not occurring as frequently as Types A and B, produce consideralbey more weather because of their marine trajectory. Heavy rain, snow and low overcast occur, particularly along the eastern coast of the Korean Peninsula, with overcast to broken skies in the Yellow Sea. Low centers along this fron at any time of the year may develop very rapidly and cause extremely high winds. Type C is most frequent during spring and early summer, with a secondary maximum of frequency in November.

Relatively strong meridional flow at 500mb, with a long wave position over the Korean Peninsula, will produce Type A outbreaks. Very strong meridional flow, or a block north of Mongolia, and a long wave over Japan will generate Type B outbreaks. A well established, nearly stationary low at 500mb over Kamchatka, or just to the east, with a high centered northeast of Asia, will produce Type C outbreaks. The flow pattern at 500 to 200mb determines the direction the cold air will follow. The availability of moisture determines the weather in terms of precipitation and clouds.

The first series of significant cold fronts, usually Type A or B, occur with great regularity between the latter part of October and early November; the second, more severe seies about early December; and the third, a very severe cold wave outbreak, in the latter part of January or early February.

Because speeds of advance of these cold waves are influenced by topography, forecasting is very difficult. They generally average 25kts, with speed maxima of 45-60kts down mountain slopes in winter, to less than 9kts in summer, fall, and spring when approaching the mountain ranges.

Although the vertical thickness of cold waves has not been determined, it is believed that they do not extend to much more than 6500ft, and may possibly reach 10,000ft on rare occasions during the more severe cold outbreaks. These estimates have been made mostly from observed movements of cold waves over the mountain ranges. Increases in temperature have been noted occasionally at mountain tops with an appreciable drop at the lower levels. It can also be shown that many cold waves remain stagnant in front of a range, while others move freely over, thus indicating to some measure the variability in the depth of the surging cold air.

C.10 SLOW MOVING COLD FRONTS:

The mountains of North Korea, 5000-7000ft high, will affect the majority of cold fronts, espedially the slow moving ones. As a general rule, the slow fronts will appear in spring, summer, and fall with an average speed of 12-16kts. Ahead of the front, 850mb level winds will generally be west to southwest 10-15kts, veering to west or northwest 15-30kts after passage. Slow fronts may undergo cyclogenesis in this area on the windward side of the mountains in central Manchuria. Cold, stable air will generally continue along the path of least resistance, and the front will likely continue south and approach the Shantung Peninsula. As it does, it is affected by the Shantung Hills, 3000ft in height, and cyclogenesis is again set in motion. If, in this instance, the semipermanent high appears to be moving southeasterly with its elongated axis oriented northwest-southeast, the cold front is likely to continue into the Yangtze River valley where a tertiary wave may form.

With such a synoptic situation involving three lows, no rapid movement or development should be expected until the line of discontinuity becomes more unstable. This will not occur until energy is induced into the system, and no area is more apt to encourage this that the Sea of Japan/Yellow Sea or the East China Sea. At such a time, a low in the Sea of Japan (formerly over the Shantung Peninsula) and a low in the East China Sea (formerly in the Yangtze River valley) will deepen and move east-northeast. The low in Manchuria will continue on a northeast or easterly course with its intensity remaining the same or possibly degenerating. The Shantung low will be of major importance to the Korian area in such a case, so a brief description of its weather conditions is given.

Preceding the frontal outbreak, warm front type clouds will exist on the west coast (Osan AB) as much as 36 hours in advance, with medium-level overcast skies 12 to 24 hours ahead of the front. This time sequence usually holds true only for winter. The cold sequence may appear during summer and transitional months, but the time element is very unpredictable. Considerable fog will occur along the northern part of the coast, especially in spring, summer, and fall. Winds will be variable in intensity from the south 5-20kts, depending on the position and intensity of the high pressure area east of the Korean Peninsula, and the low system to the west. Surface winds will shift to northwest 20-30kts after passage of the front.

The east coast will also have warm front type clouds preceding a slow moving cold front and will always experience lighter southerly winds than the west coast (except for certain areas where foehn winds occur). The warm front clouds will prevail, but they will not be as dense as along the west coast until approximately eight hours prior to the arrival of the front; then the ceiling will rapidly lower and scattered rainshowers or show will appear. Behind the front, surface winds will veer to westerly instead of northwesterly, increasing with the same intensity as on the west coast. The time of cloud sequence is quite regular in winter, but very changeable during the warmer months.

If a low overcast continues three to none hours after a frontal passage on either coast, the forecaster can expect either an approaching secondary low to exist to the west over the Hwang Ho (Yellow) River area, or an approaching secondary front. However, if the skies become broken to scattered soon after a frontal passage, clear skies should be forecast for the next 24 hours.

With a secondary low over the Hwang Ho Valley, and the frontal system over central North Korea, surface winds will be generally light and variable along the east and west coasts, with weather conditions dependent on the severity of the low to the west. Flying weather will be marginal in the coastal areas and instrument weather will prevail in the mountains. If surface winds become light westerly behind a front, and no large increase in pressure is observed, a secondary cold front or wave can be expected in 12 to 24 hours.

C.11 FAST MOVING COLD FRONTS:

The majority of cold fronts in winter are fast moving with average speeds of 25 to 35kts. These fronts extend to higher levels than the fronts in spring, summer and fall and are temporarily held up in their southward movement by the North Korean mountains; the layer above 5000-7000ft will pass off as an upper cold front at Wonsan. Then, within 75-125 miles of the coast, these fronts may be picked up at the surface again and at times may be very severe. Surface winds preceding the front will be dependent on whether or not a depression develops on the leeward side of the Peninsula. Very often, surface winds are west to southwest 10-20kts preceding the front, veering to west or northwest 25-35kts about three to six hours after the upper front's passage.

Any precipitation will normally last from one to three hours with ceilings 500ft and at times 100ft and below in showers.

On the west coast, the cold fronts move along the surface and as a result, considerable low stratocumulus clouds develop with bases at 2000ft lowering to 1000ft in snow or rain showers. A very definite wind veer from southwest 20-30kts to northwest 30-40kts (rarely over 25-30kts at Osan AB) accompanies the cold front. Across the Peninsula, high and middle clouds appear ahead of the front.

Preceding such outbreaks, pressure will drop and a rise in temperature will be felt 250 miles ahead of the front. Rates of pressure fall and temperature increase are reliable clues to the intensity and movement of fronts.

The only stations reporting representative wind directions are those on the west coast. Pressures and weather phenomena are nearly always representative, throughout. For example, at Pohang and Kangnung on the east coast, winds will be from the southwest preceding a front, and after passage, will remain southwesterly, but with increased strength.

Fast moving fronts are particularly conservative in their weather, especially in winter; rain showers accompany the fronts until November, and snow showers come in Cecember, January, and February. They are also preceded by a light shield of cirrus, becoming altostratus overcast at 8000ft and then lowering during the period of frontal passage. The cirrus is observed about 36 hours prior to the frontal passages.

Frequently, if strong winds 30-40kts occur for 24 hours after a cold frontal passage and then the winds suddenly drop to about 10kts, the forecaster can look for a trough development over the central part of the Peninsula and a "bubble high" to form over the Sea of Japan. Wind flow will become cyclonic at the surface and upper levels, producing widespread weather and slow clearance.

During the summer months, the fronts are less significant and cause only slight distrubances. If the wind a Vladivostok during summer becomes south from the surface to the 700mb level, a cold front will generally move into North Korea from the northwest. If this wind is greater than 30kts, the front will move across the Yalu River within 18 to 24 hours.

These fronts normally do not move much farther south than 38N and, in contrast to winter frontal situations, little weather accompanies them.

C.12 CYCLOGENESIS:

The upper flow off the east coast of Asia is almost always favorable for cyclogenesis during the winter season; given a favorable surface flow, cyclogenesis will inevitably ensue.

The synoptic pattern that most often produces this cyclogenesis is marked by a "bubble high" breaking off from the continental anticyclone. As this small high moves rapidly eastward, bad weather and cyclogenesis in the coastal Asian waters often follow in its wake. The reliability of this sequence of events makes the appearance of the surface "bubble high" a good predictor for cyclogenesis and ensuing bad weather, although there have been cases when no cyclogenesis occurred. The critical area for this small migratory high includes all of the Yellow Sea, the Sea of Japan, and the East China Sea north of Shanghai. There is no significant geographical separation between cases of cyclogenesis and no cyclogenesis. Therefore, cyclogenesis should be anticipated for any case of break-off from the cold Asian anticyclone and subsequent movement into the critical area.

From the location of the critical area, it is possible to determine some of the criteria for cyclogenesis. The thermal contrast between the polar air moving off the cold Asian continent and the adjacent sea areas must be intensified by the southerly flow on the west side of the "bubble". This mechanism explains the rather restricted area to which this method applies

Once formed, these storms temd to deepen rapidly. In practice, almost any surface cyclonic circulation in this area in winter should be forecast to increase in intensity. Some measure of deepening follow so reliably that it can be predicted with a high degree of confidence.

C.13 FORECAST GUIDANCE:

There are certain empirical rules that can aid the operational forecaster at Osan AB. Many of these indicators and relevant discussions are given in the remainder of this section.

(1) A good average speed for relatively shallow troughs moving from west to east is 15kts ofer land and 20-25kts over water.

(2) When the 500mb chart shows a deep low aloft northwest of the Korean Peninsula with a deep trough extending south to southwest through the Yellow Sea, frequent trough passages can be expected about every six hours for about 24 hours.

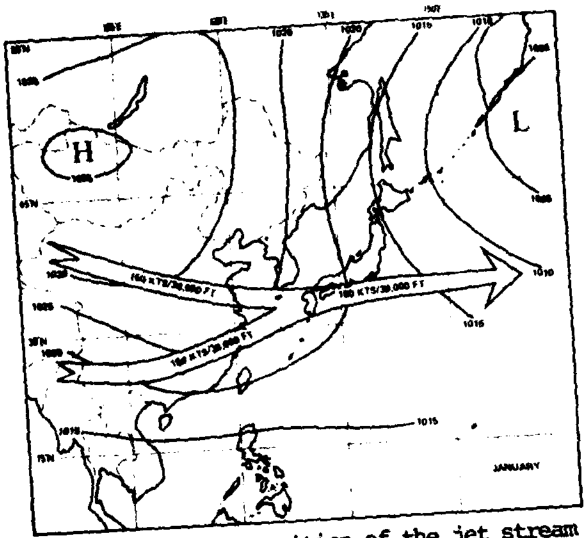
(3) Any kind of trough or front in the Yellow Sea will tend to set off isolated rain showers along the west coast from Osan to Kunsan between 0500 and 1100I with broken low and midlevel cloudiness extending along the entire west coast. Cumulonimbus clouds and/or thunderstorms are very likely to develop in the area after 1200I and move northeast.

(4) Low level air flow in winter from about 290 to 120 tends to give clear, cold weather to most of South Korea. Winds from any other direction tend to produce cumulus buildups and scattered snowshowers along the west coast, with ceilings and visibilities in the vicinity of showers lowering to about 2000ft and 1½ mi, respectively.

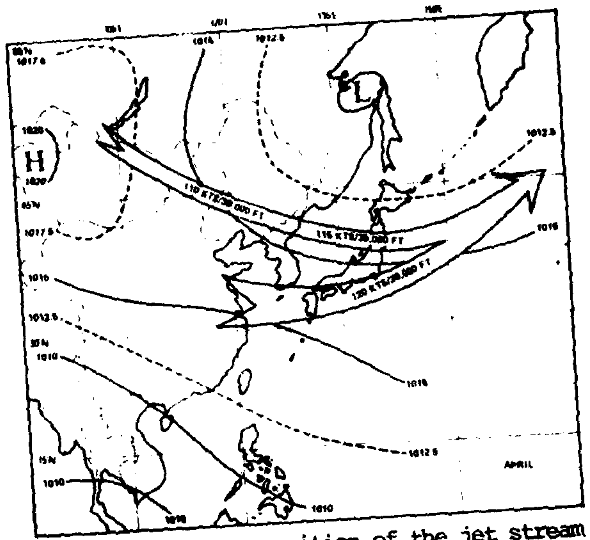
(5) In einter, strong northwesterly flow usually indicates the beginning of three to five days with fair skies, cold temperatures, and no precipitation. After the third day, morning fog/smoke will often develop between 0700 and 1100I.

(6) Approximately 36 hours after the initial outbreak of cold flow, a leeside trough usually forms along the east China coast. It should not be forecast to move until an upper air trough approaches it.

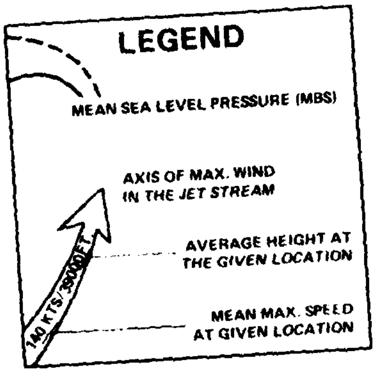
(7) A ridge will maintain itself or build if analysis of present and past 12hr upper air maps shows warm air entering the high center from south to west, assuming the high is warm-cored. (if the high is warm-cored, it will show up at 500mb level)

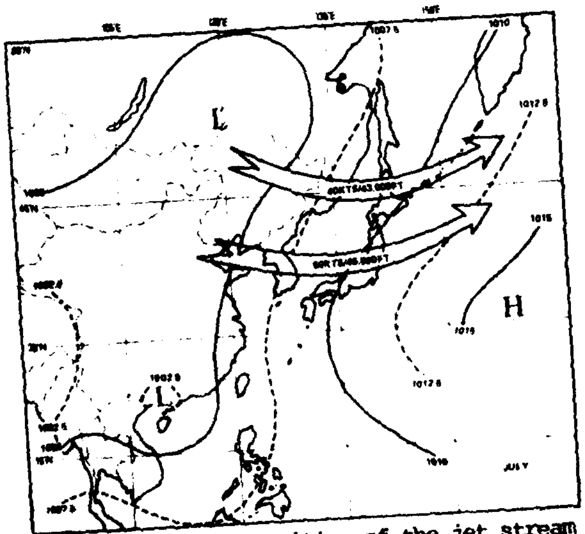


Mean position of the jet stream in January (from 1st Weather Wing, USAF).

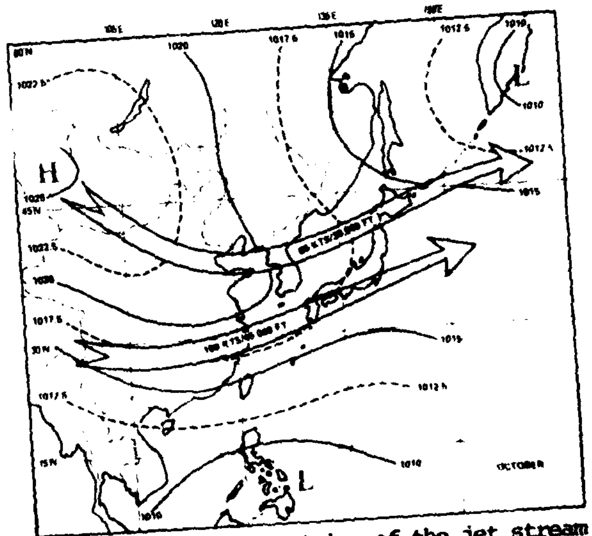


Mean position of the jet stream in April (from 1st Weath[illegible] Wing, USAF).

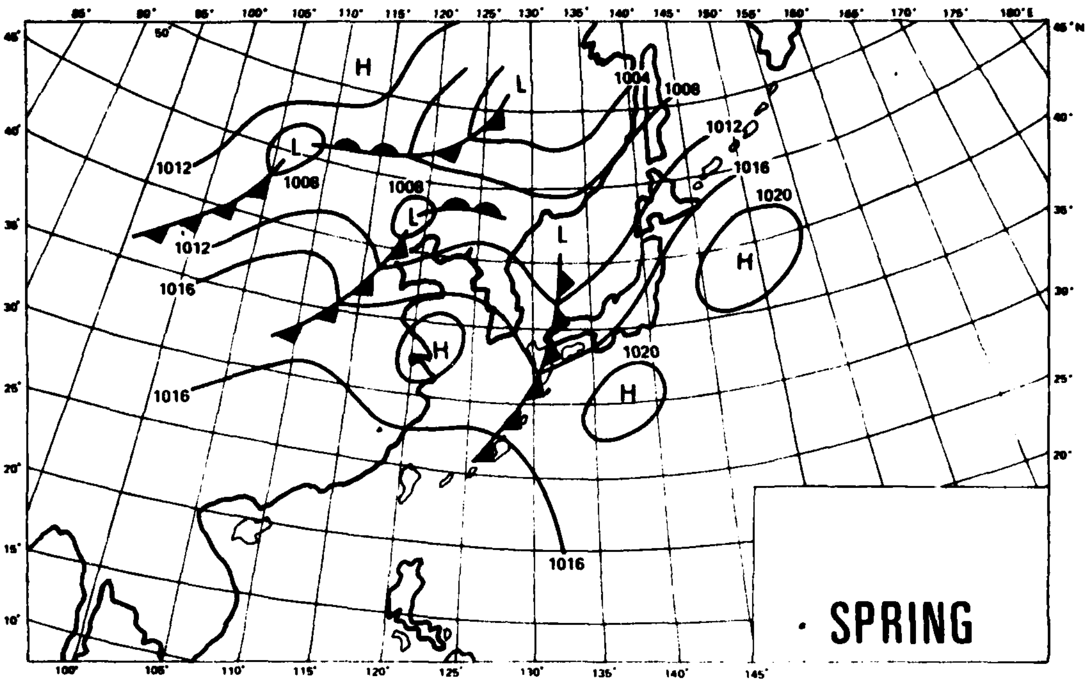




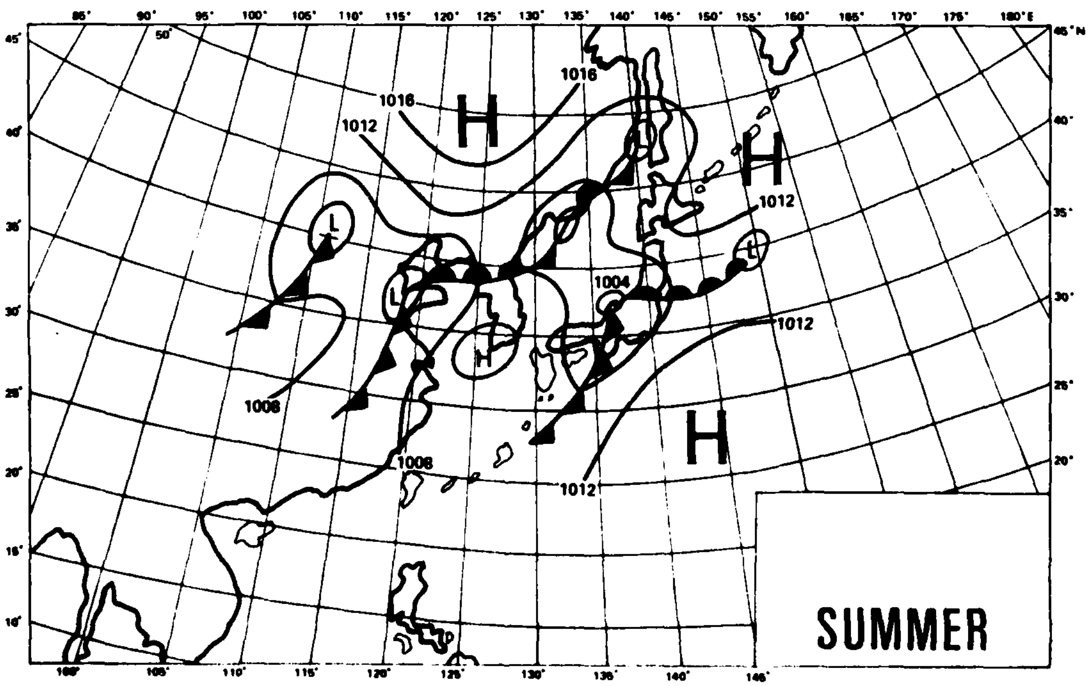
Mean position of the jet stream in July (from 1st Weather Wing, USAF).



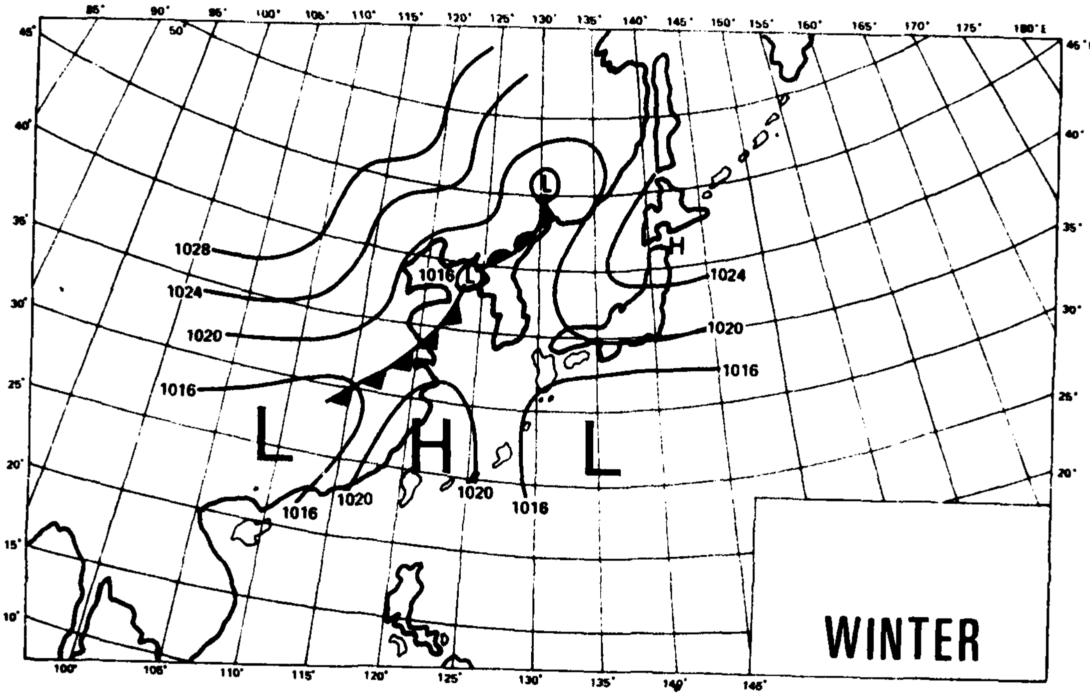
Mean position of the jet stream in October (from 1st Weather Wing, USAF).



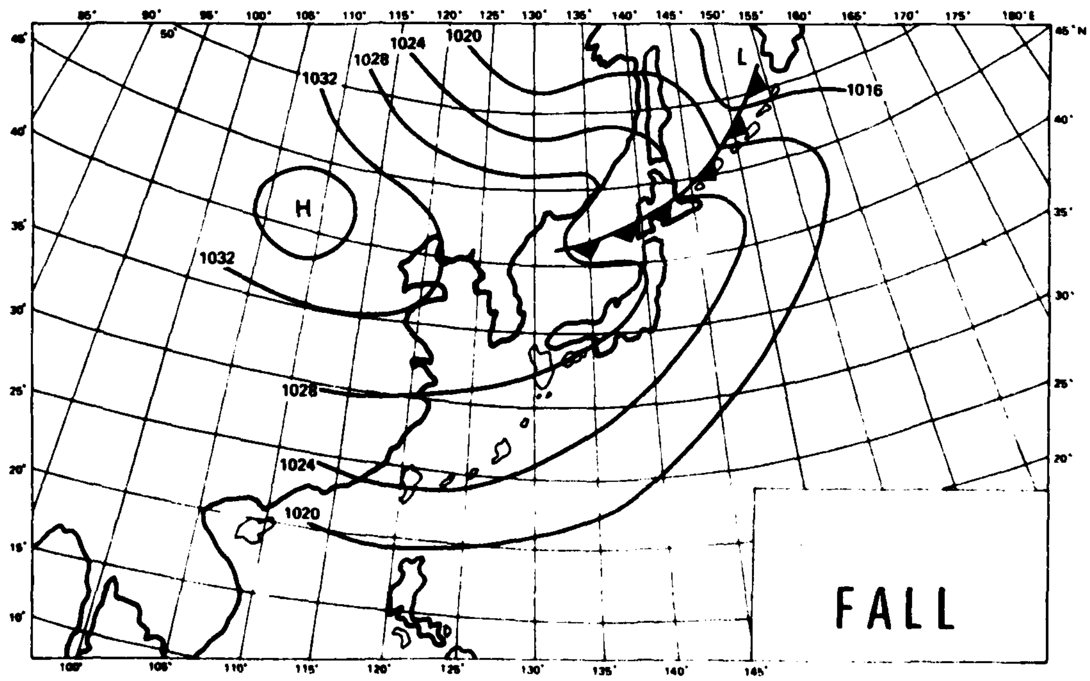
. Typical spring pressure distribution for west coast fog (from ROKAF).



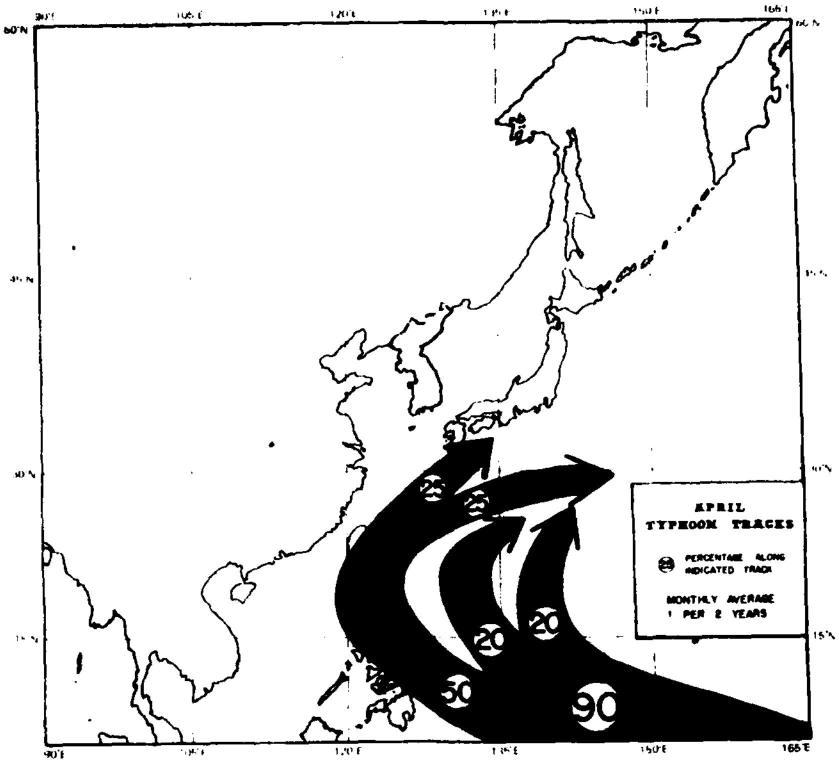
Typical summer pressure distribution for west coast fog (from ROKAF).

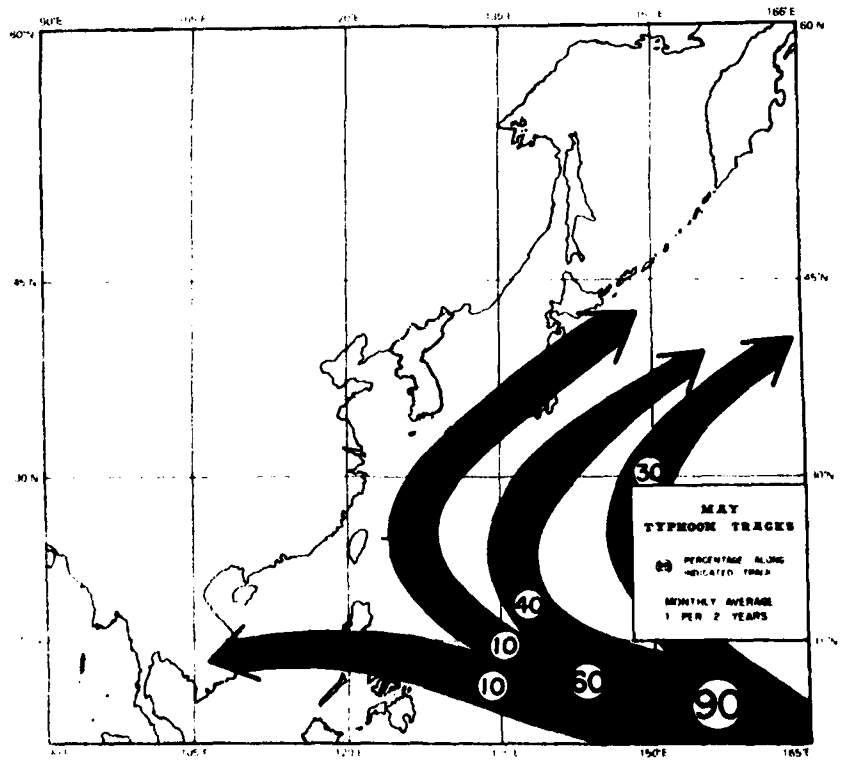


. Typical winter pressure distribution for west coast fog (from ROKAF).



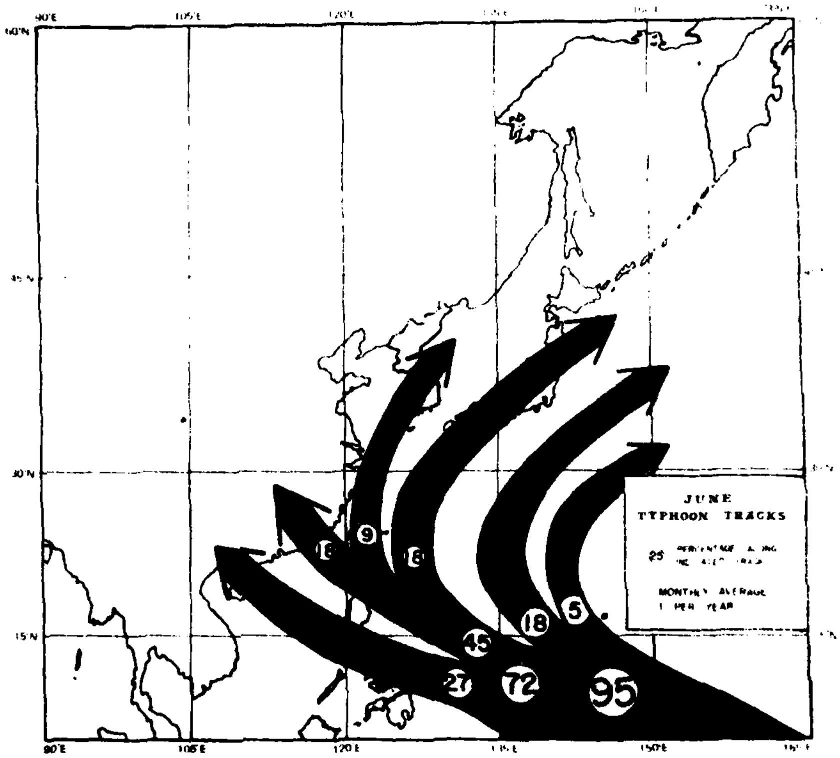
Typical fall pressure distribution for west coast fog (from ROKAF).

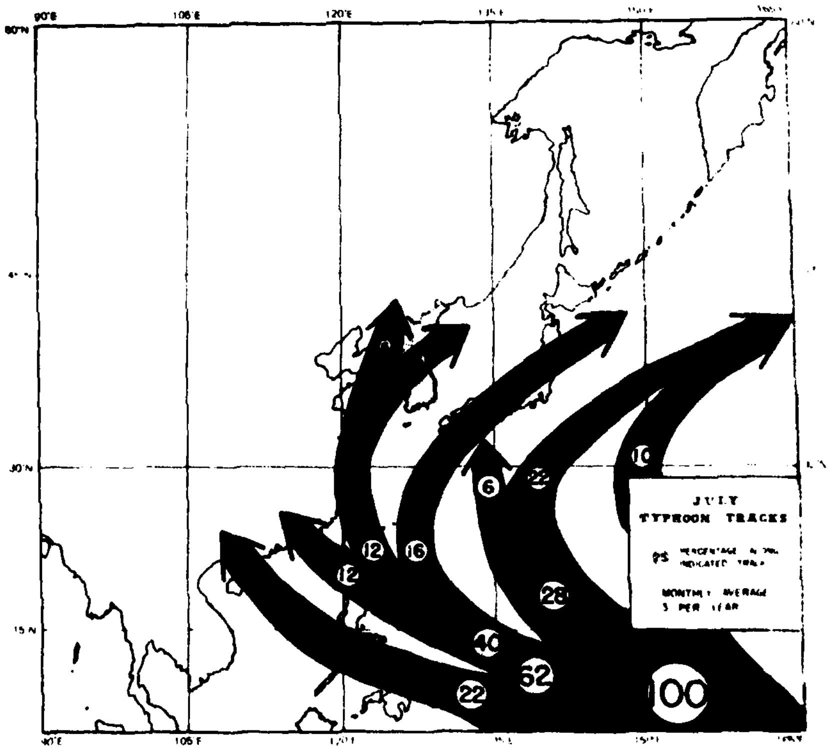




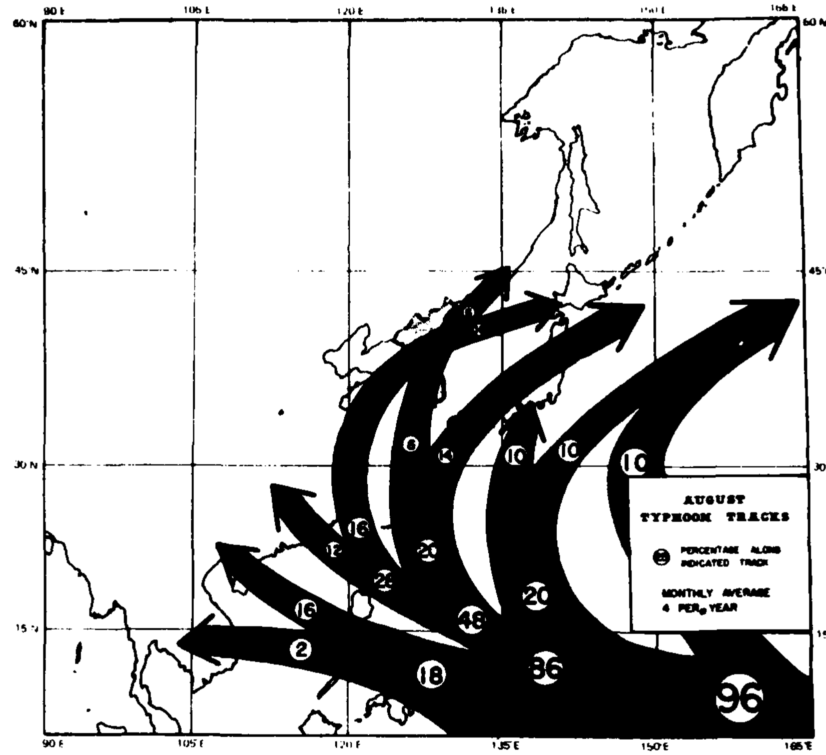
Typhoon tracks for the northwest Pacific, April-November.

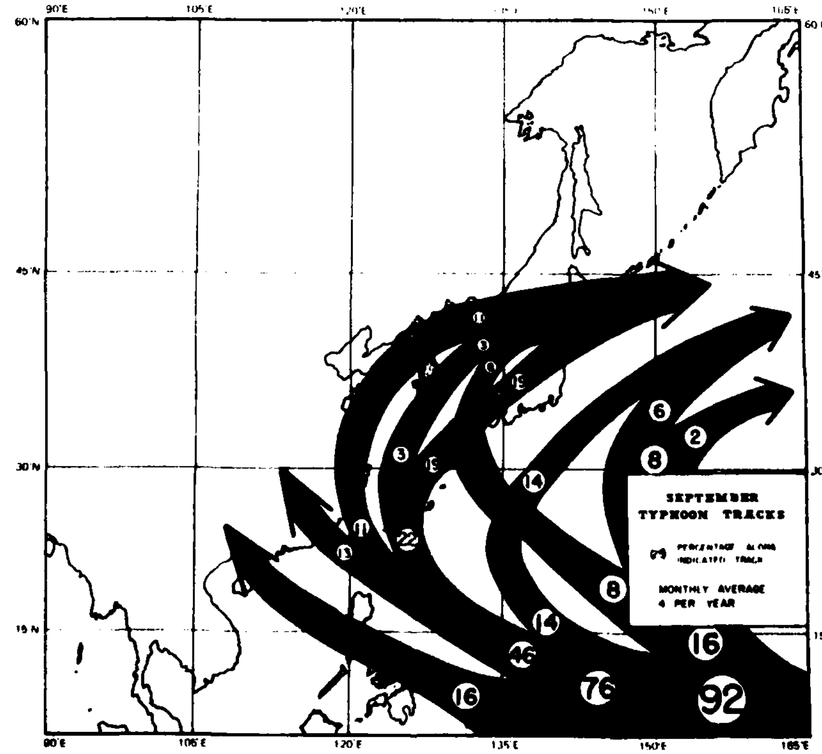
C-22


JUNE
TYPHOON TRACKS
MONTHLY AVERAGE

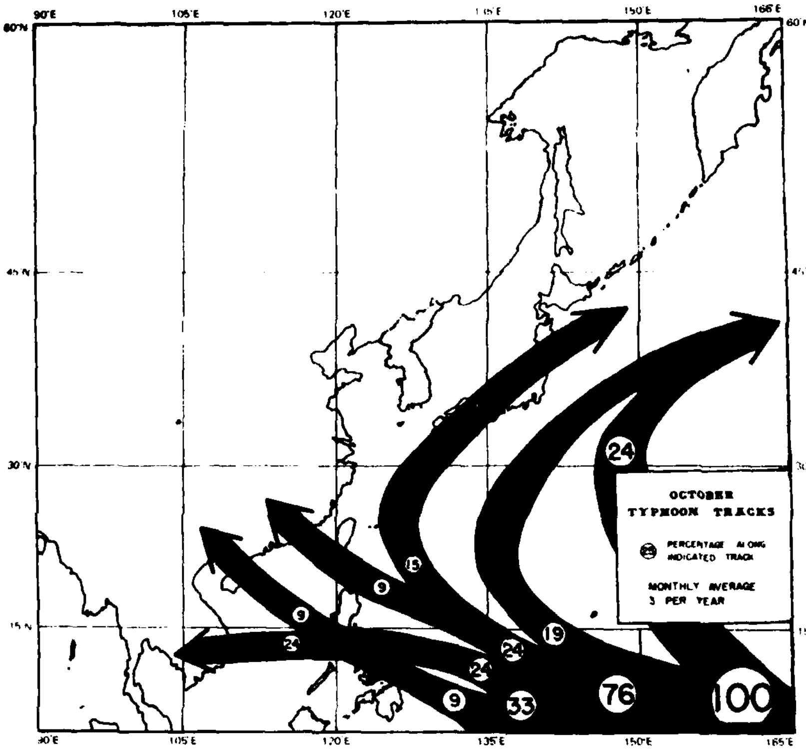

JULY
TYPHOON TRACKS
MONTHLY AVERAGE

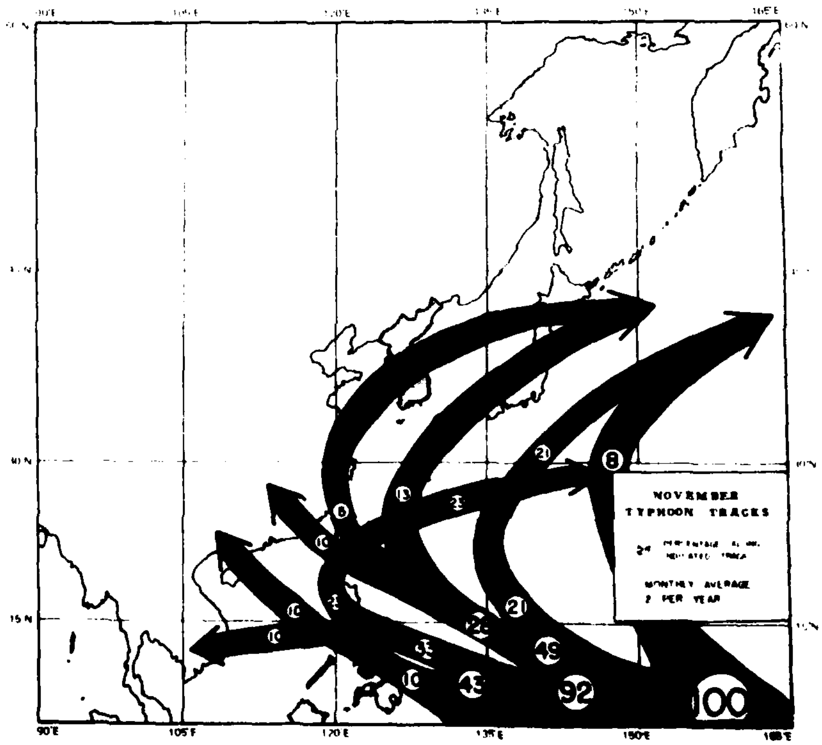
continued.


AUGUST
TYPHOON TRACKS
PERCENTAGE ALONG INDICATED TRACK
MONTHLY AVERAGE
4 PER YEAR
96
86
48
28
20
18
16
12
10
2

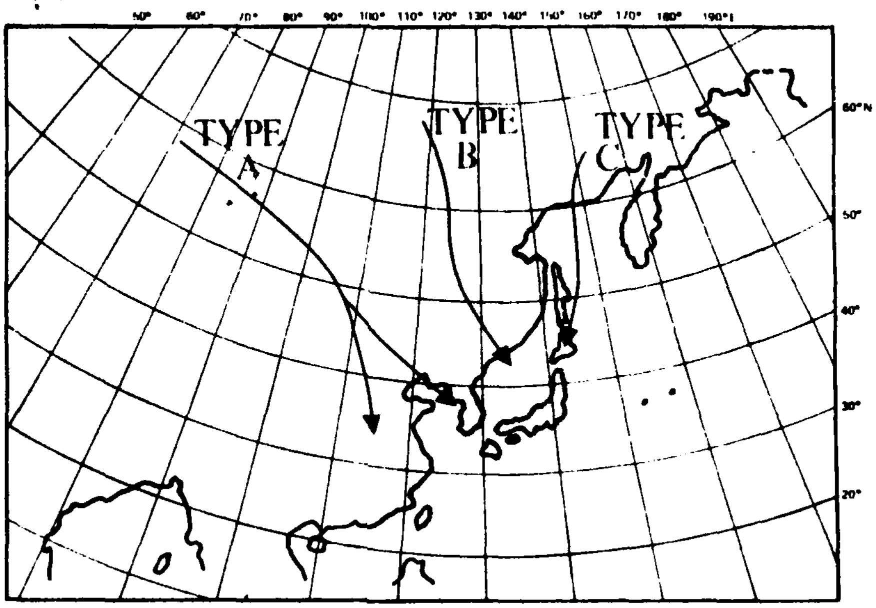

SEPTEMBER
TYPHOON TRACKS
PERCENTAGE ALONG INDICATED TRACK
MONTHLY AVERAGE
4 PER YEAR
92
76
46
22
16
14
11
8
6
2

continued.

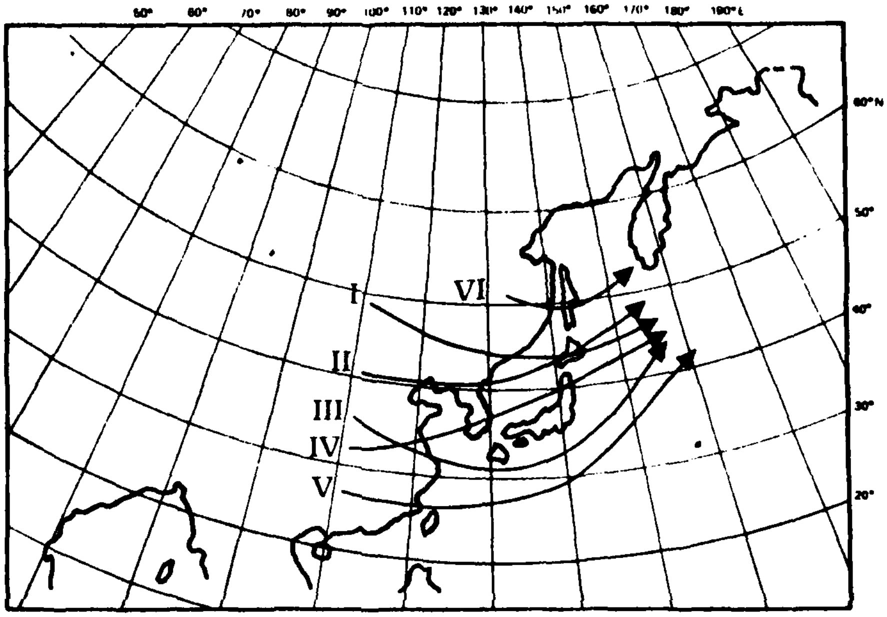

OCTOBER
TYPHOON TRACKS
PERCENTAGE ALONG INDICATED TRACK
MONTHLY AVERAGE
3 PER YEAR


NOVEMBER
TYPHOON TRACKS
MONTHLY AVERAGE
2 PER YEAR

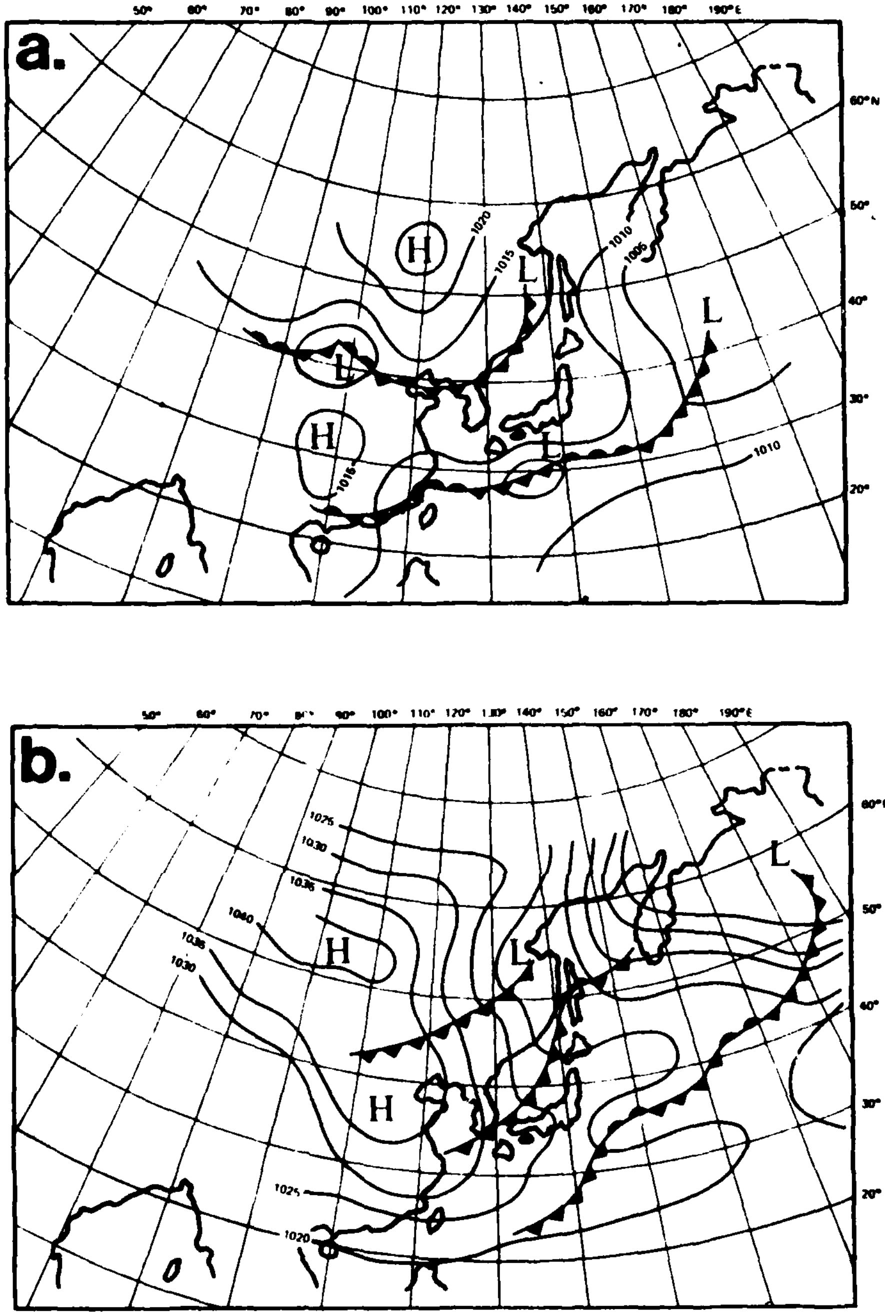
continued.



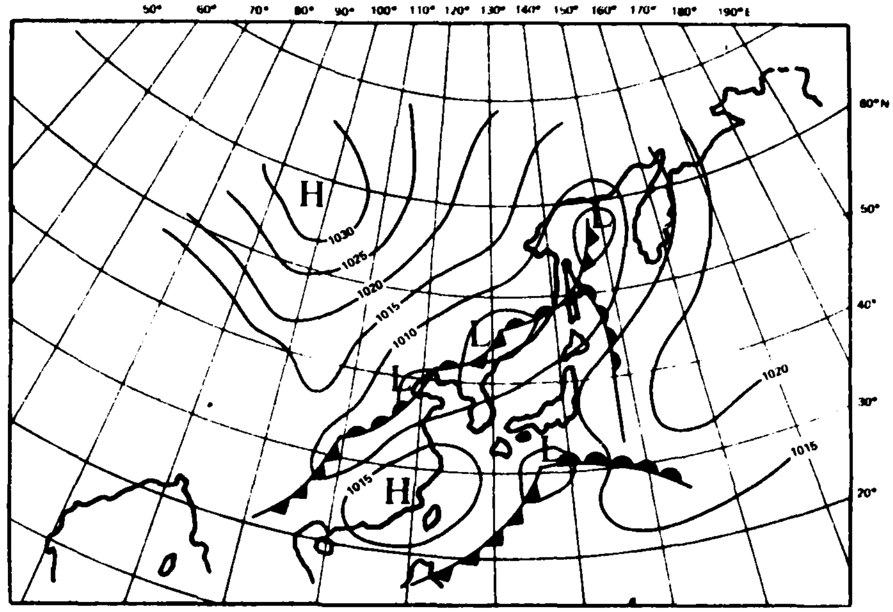
Tracks of cold frontal systems across Asia: Types A, B, C.



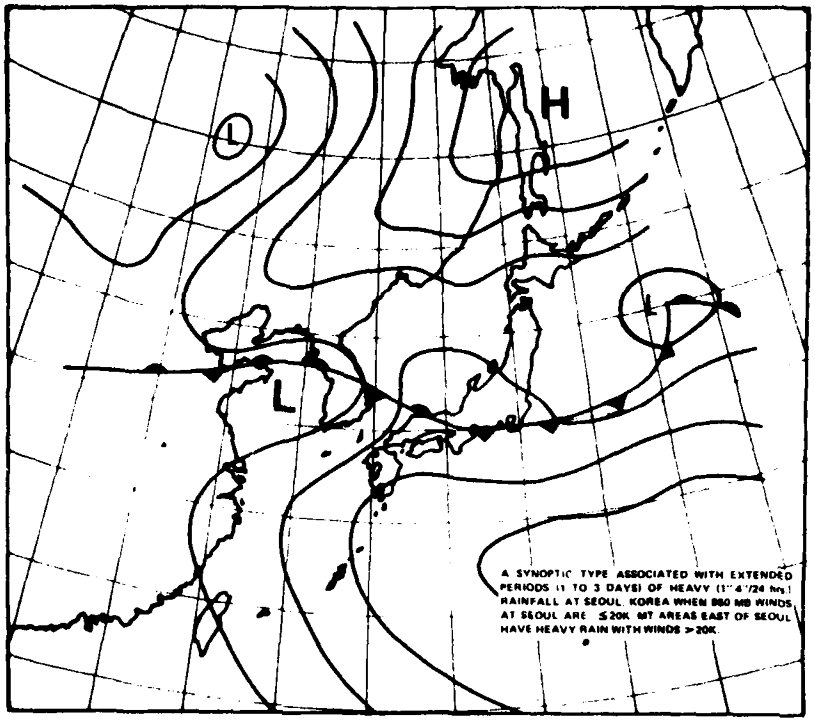
Tracks of primary lows,



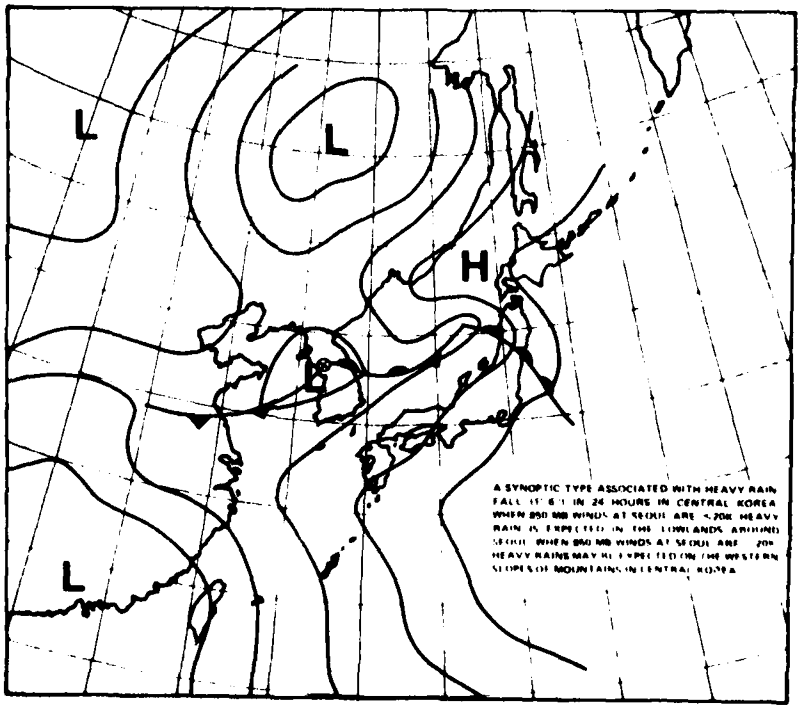
Approaching system/front: (a) approaching secondary or trailing low pressure system and (b) approaching secondary cold front.



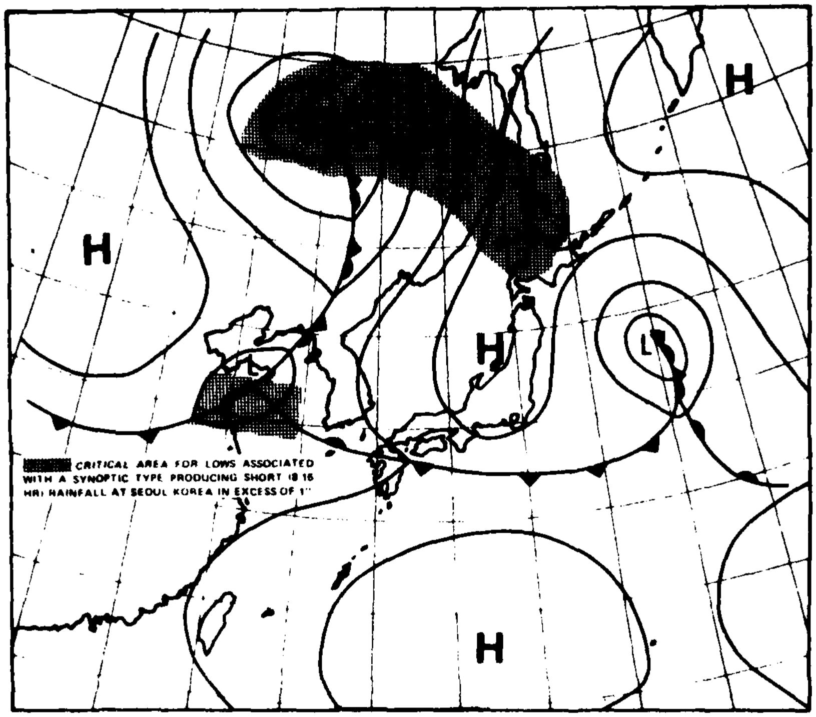
Series of waves associated with a slow moving front over the Korean Peninsula in a typical situation during the spring and fall seasons.



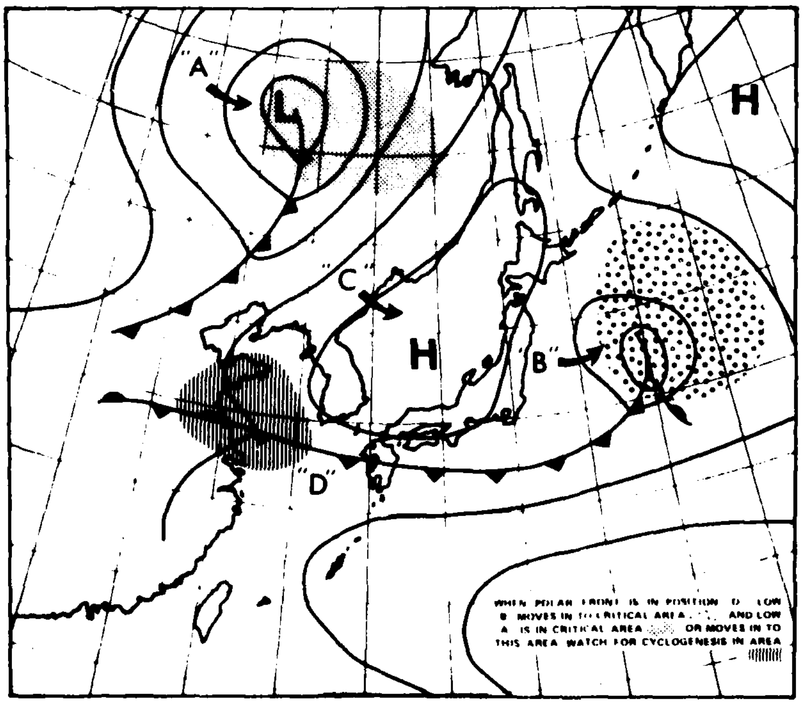
Flood forecasting for Korea May-Sep — frontal passage without wave development (from 1st Weather Wing, USAF).



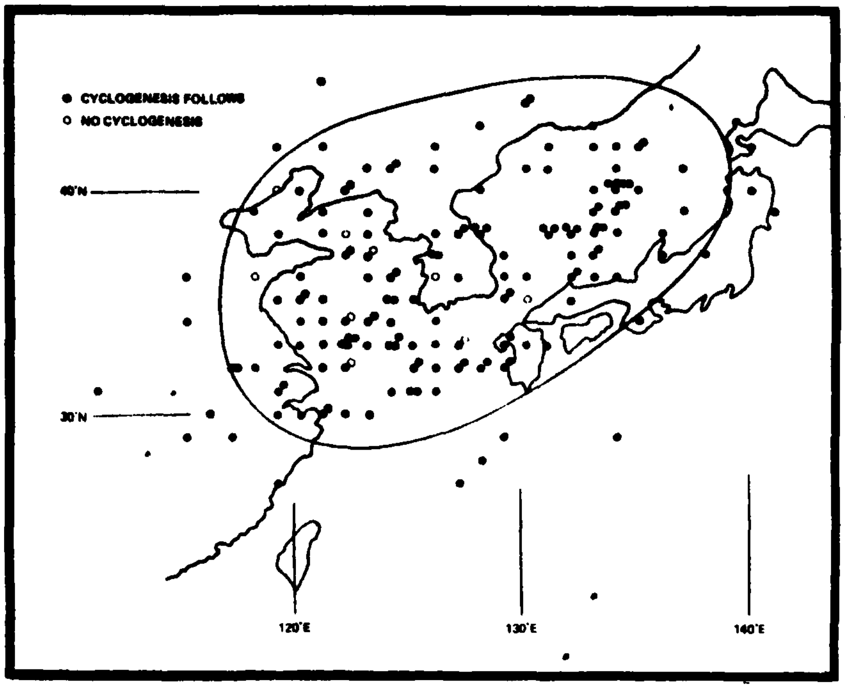
Flood forecasting for Korea May-Sep — frontal passage with wave development (from 1st Weather Wing, USAF).



Flood forecasting for Korea May-Sep — migration of low pressure system (from 1st Weather Wing, USAF).



Flood forecasting for Korea Sep-May -- migration of low pressure system following cyclogenesis in the Yellow Sea (from 1st Weather Wing, USAF).



Critical area for "bubble highs."

PREPARED BY USAFETAC SEPTEMBER 1979	STATION NAME OSAN AB KJ(OSAN-NI) LOCATION N37 05 E127 02	PERIOD JAN 53-NOV 77 8 ELEV 38	STN LTRS RKSO WBAN NO 43242 WMO NO 47122

AWS CLIMATIC BRIEF

MONTH	TEMPERATURE (°F) MEAN DAILY MAX	MEAN DAILY MIN	MEAN MONTHLY	EXTREME MAX	EXTREME MIN	PRECIPITATION (IN) MONTHLY MEAN	MONTHLY MAX	MONTHLY MIN	MAX 24 HRS	SNOWFALL (IN) MONTHLY MEAN	MONTHLY MAX	MAX 24 HRS
JAN	35	16	25	56	-15	1.1	4.2	.1	1.1	6	31	10
FEB	39	21	30	66	-17	1.2	4.4	.1	2.1	3	10	6
MAR	49	30	40	71	12	2.2	6.1	.1	2.4	1	9	4
APR	63	42	53	86	24	4.5	17.5	.8	5.4	#	#	#
MAY	73	52	63	89	39	3.4	9.7	.4	3.7	0	0	0
JUN	79	62	71	96	48	4.4	17.4	.2	5.5	0	0	0
JUL	86	71	78	97	57	13.6	24.0	4.7	10.2	0	0	0
AUG	86	71	79	98	53	9.6	31.8	1.5	10.[illegible]	0	0	0
SEP	78	59	69	91	38	6.2	19.1	.1	9.1	0	0	0
OCT	67	45	56	83	27	2.7	7.6	.1	4.[illegible]	#	#	#
NOV	53	33	43	72	9	1.9	3.9	.3	1.6	1	5	4
DEC	39	22	31	65	-8	1.0	4.8	.2	2.3	3	15	11
ANN	62	46	53	98	-17	51.2	31.8	.1	10.2	16	31	11
EYR	25	25	25	25	25	25	25	25	25	25	25	25

MONTH	MEAN RELATIVE HUMIDITY (%) LST 04	13	VAPOR PRESSURE (IN Hg)	DEW PT (°F)	PRESSURE ALTITUDE (FT) 99.95%	SURFACE WINDS PVLG DRCTN (16 PT)	SPEED MEAN (KT)	SPEED MAX (KT) **	MEAN CLOUD COVER (tenths)	PRECIP (IN) ≥ .01	≥ 0.5	SNOWFALL (IN) ≥ 0.1	≥ 1.5	THUNDERSTORMS	FOG VSBY < 7 MI	TEMP MAX ≥ 90	MAX ≥ 80	MIN ≤ 32	MIN ≤ 00
JAN	77	54	.10	17	250	ENE	4	35	5	7	#	5	2	0	14	0	0	30	2
FEB	76	53	.11	19	250	WNW	4	39	5	5	1	2	1	#	12	0	0	26	1
MAR	79	49	.15	27	350	W	5	48	5	6	1	1	#	#	15	0	0	21	0
APR	83	48	.25	40	500	W	5	43	6	8	3	#	0	1	16	0	#	3	0
MAY	84	52	.36	50	550	W	5	37	6	8	2	0	0	1	15	0	5	0	0
JUN	87	59	.52	60	600	W	4	42	6	9	2	0	0	1	19	1	15	0	0
JUL	88	69	.71	69	450	SSW	4	39	6	15	7	0	0	4	21	5	25	0	0
AUG	89	66	.74	70	600	ENE	4	51	6	12	5	0	0	3	19	7	28	0	0
SEP	88	60	.52	60	450	ENE	3	37	5	9	3	0	0	1	19	#	12	0	0
OCT	86	51	.31	46	300	ENE	3	45	6	6	1	0	0	1	19	0	1	1	0
NOV	80	54	.16	32	250	ENE	4	42	5	9	1	1	#	1	17	0	0	14	0
DEC	77	55	.11	20	200	NW	4	46	5	7	#	3	1	#	15	0	0	28	#
ANN	83	56	.28	43	650	W	4	51	6	101	26	12	4	13	201	14	86	123	3
EYR	10	10	10	10	10	10	10	15	4	25	25	25	25	25	25	25	25	25	25

REMARKS

RUNWAY POR:
HRLY OBS: DEC 67 - NOV 77
DAILY OBS: JAN 53 - NOV 77

TYPHOON DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	EYR
NO. OF TYPHOONS WITHIN 25 NM	0	0	0	0	1	0	1	2	1	0	0	0	5	17
WITHIN 50 NM	0	0	0	0	1	1	2	3	2	0	0	0	9	17
1953-67 100 NM	0	0	0	0	1	1	3	4	2	0	0	0	11	17

NOTE: * DATA NOT AVAILABLE # AMTS < UNITS SHOWN IN HEADING ** INSTANTANEOUS PEAK WINDS $ % CALM GRTR % PLVG DRCTN @ BASED ON < FULL MONTHS

CAV FREQ (%)	HRS LST	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	EYR
CEILING LESS THAN 3000 FT AND OR VISIBILITY LESS THAN 3 MI	00-02	16	16	10	14	14	21	29	23	17	12	16	11	17	
	03-05	17	18	13	16	18	33	44	35	27	22	20	12	23	
	06-08	21	24	25	26	27	39	49	42	38	31	27	21	31	
	09-11	31	26	20	16	15	20	33	27	17	13	21	24	22	
	12-14	11	12	11	10	12	10	22	16	8	4	8	9	11	
	15-17	8	11	8	10	9	7	17	12	6	3	7	9	9	
	18-20	10	11	8	9	10	9	14	11	5	2	7	9	9	
	21-23	13	12	8	10	11	15	18	15	7	3	10	8	11	
	ALL HRS	16	16	13	14	15	19	28	23	16	11	15	13	17	10
CEILING LESS THAN 1500 FT AND OR VISIBILITY LESS THAN 3 MI	00-02	12	9	6	10	8	13	15	12	12	10	13	9	11	
	03-05	13	11	9	14	12	24	28	24	22	20	18	10	17	
	06-08	18	15	19	24	22	32	33	31	32	29	24	18	25	
	09-11	27	20	15	10	9	11	15	12	10	11	16	21	15	
	12-14	8	5	4	6	5	4	7	6	2	2	5	5	5	
	15-17	6	5	4	6	5	4	6	5	2	1	3	4	4	
	18-20	7	6	5	6	5	4	7	6	2	1	3	5	5	
	21-23	9	6	6	6	6	6	9	7	3	2	6	7	6	
	ALL HRS	13	10	8	10	9	13	15	13	11	10	11	10	11	10
CEILING LESS THAN 1000 FT AND OR VISIBILITY LESS THAN 2 MI	00-02	8	5	4	6	6	7	9	7	8	7	10	7	7	
	03-05	9	6	6	11	8	17	18	15	16	16	15	7	12	
	06-08	11	10	12	17	14	21	24	23	26	23	19	15	18	
	09-11	17	12	8	6	6	4	7	7	6	8	12	13	9	
	12-14	4	3	3	3	2	2	4	3	1	1	3	3	3	
	15-17	4	2	2	4	2	2	3	2	1	#	2	2	2	
	18-20	4	4	2	3	2	2	4	4	1	1	2	3	3	
	21-23	6	3	3	4	3	5	6	3	2	#	4	5	4	
	ALL HRS	8	6	5	7	5	8	9	8	8	7	8	7	7	10
CEILING LESS THAN 200 FT AND OR VISIBILITY LESS THAN 1/2 MI	00-02	2	1	1	1	1	#	#	1	2	2	5	2	2	
	03-05	3	1	2	2	2	3	1	3	6	7	8	2	3	
	06-08	4	1	3	4	3	3	2	4	9	10	9	3	5	
	09-11	3	1	1	#	0	#	#	#	1	2	3	2	1	
	12-14	0	#	#	0	0	#	#	0	0	0	#	#	#	
	15-17	#	#	0	0	0	0	0	#	0	0	#	#	#	
	18-20	1	#	#	#	0	0	0	0	0	0	#	#	#	
	21-23	1	1	0	#	#	0	0	0	0	0	2	1	#	
	ALL HRS	2	1	1	1	1	1	#	1	2	3	3	1	1	10

AWS FORM NOV 76 82 PREVIOUS EDITION MAY BE USED

AWSP 105-4, VOL VII

SECTION D:

RULES OF THUMB (ROTs)

NO RULES OF THUMB CURRENTLY APPROVED

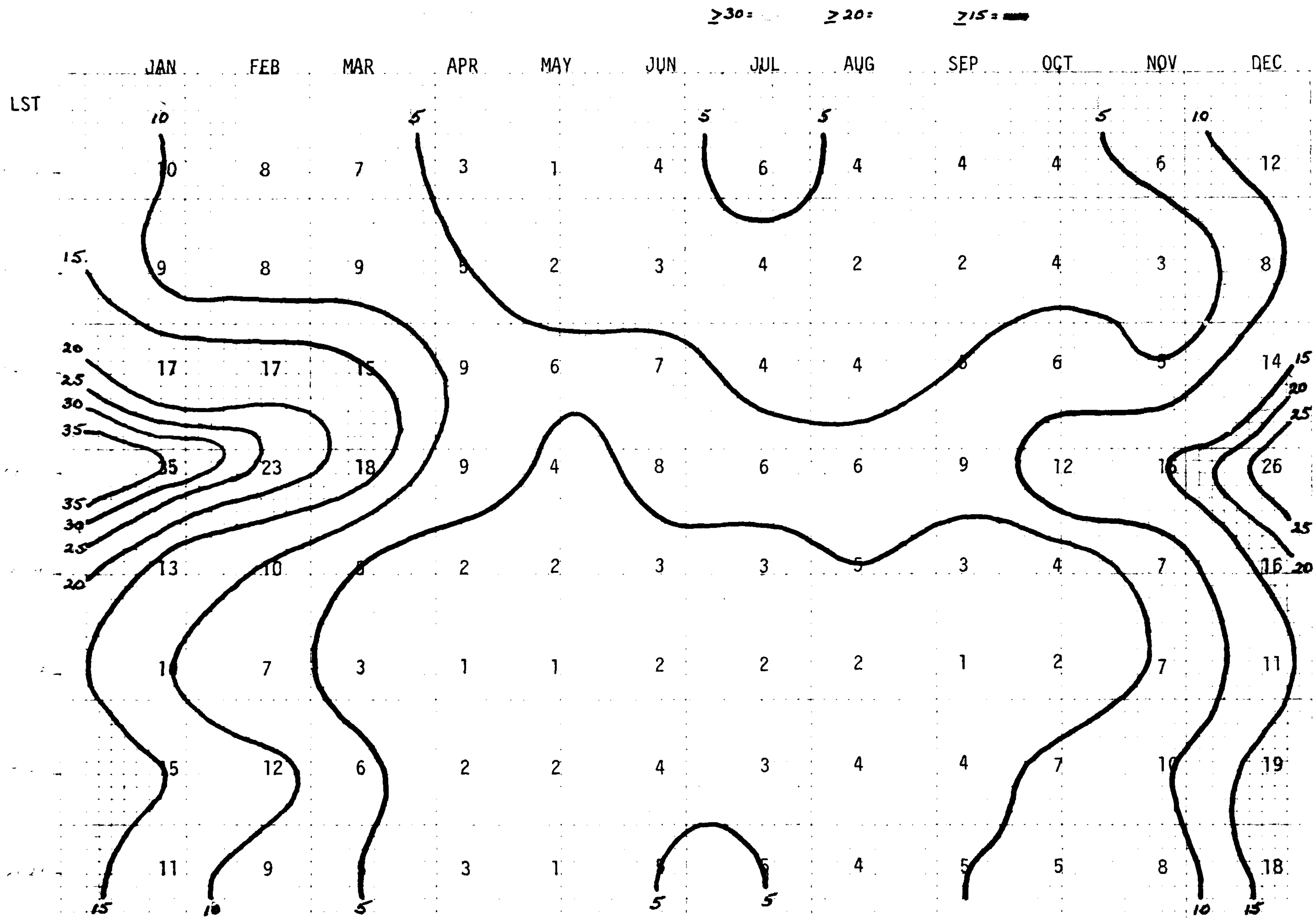
SECTION E:

FORECAST STUDIES

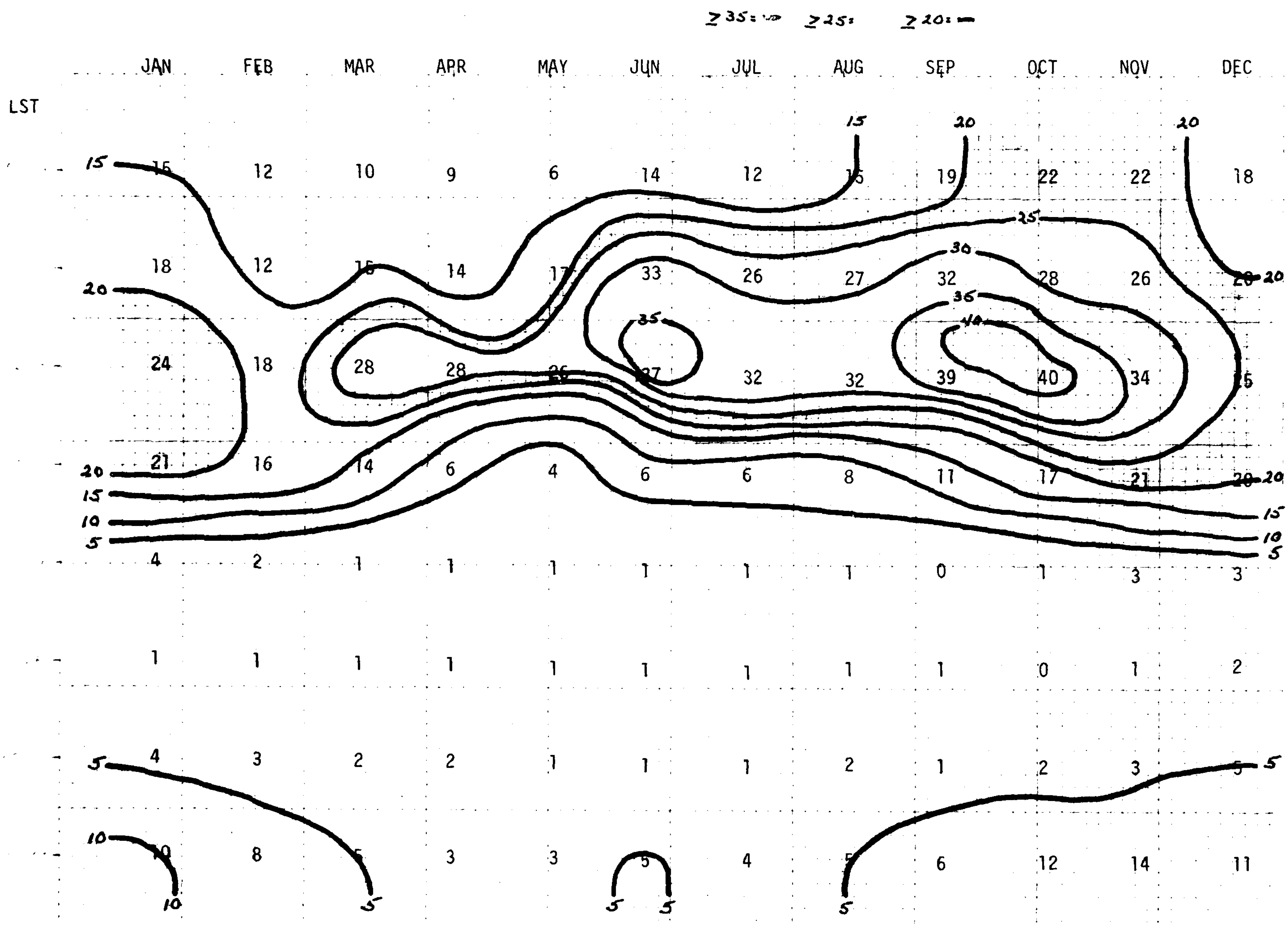
NO STUDIES CURRENTLY APPROVED

SECTION F:

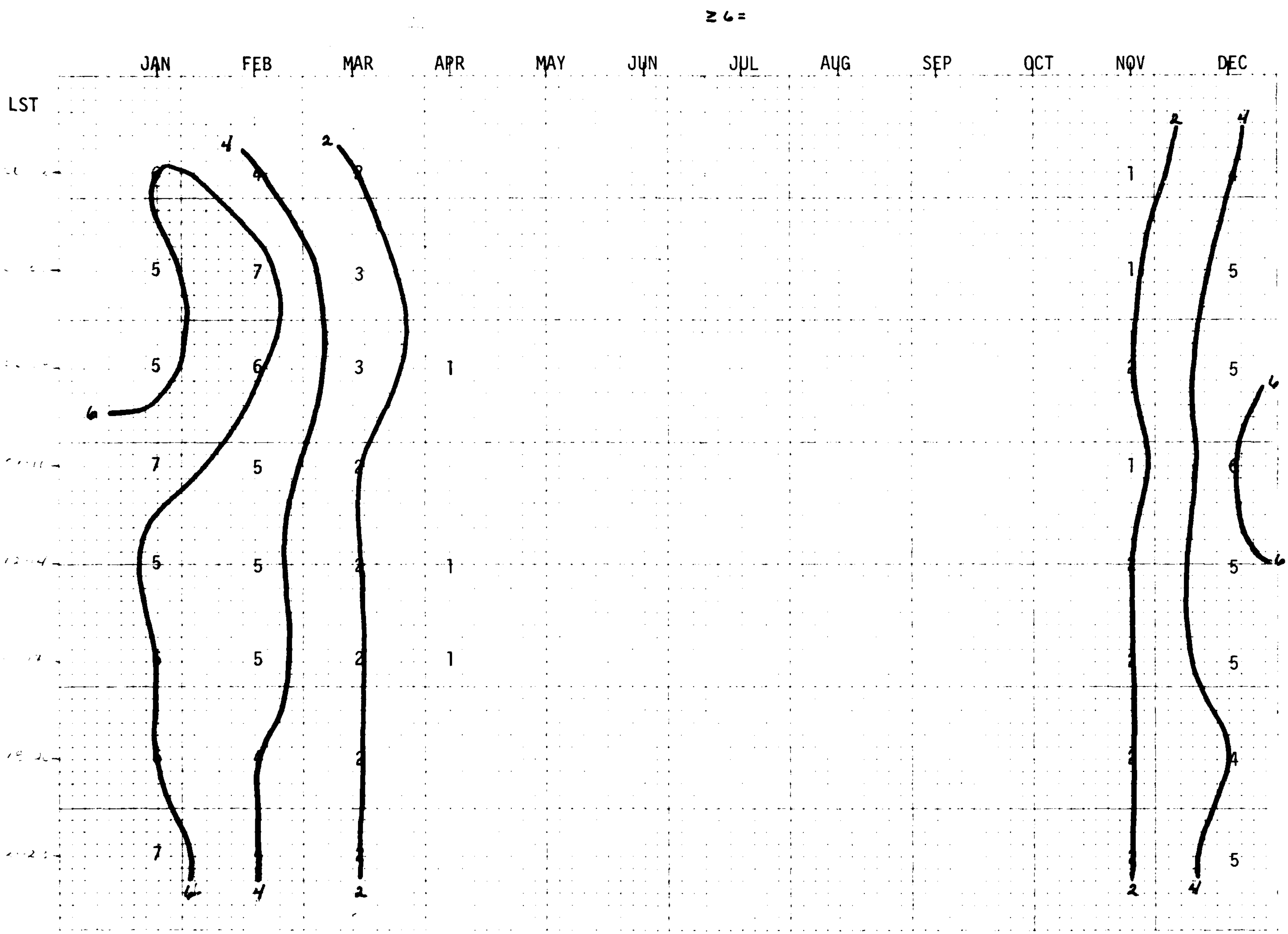
CLIMATOLOGICAL DATA



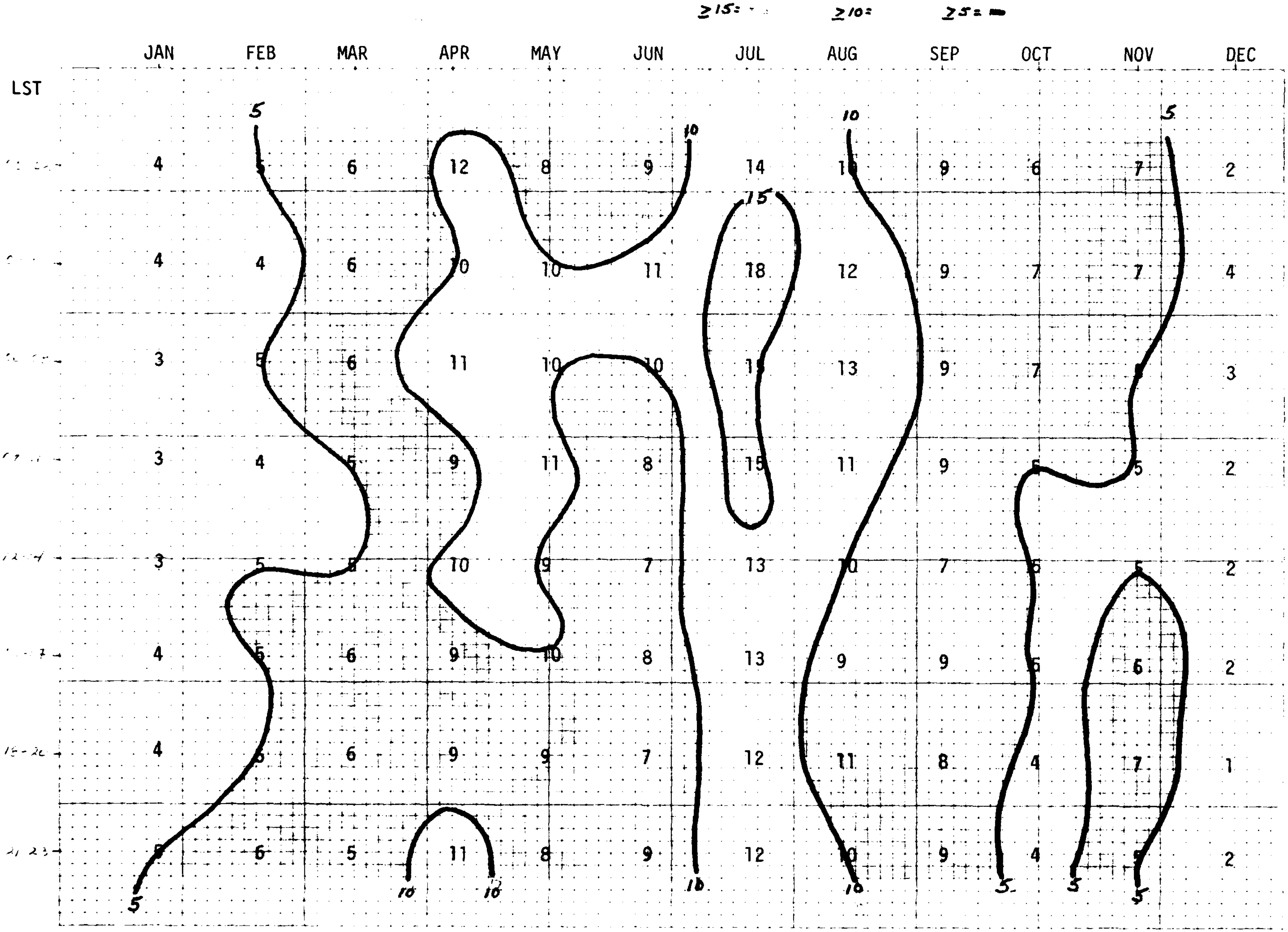
1. Percentage Frequency of Occurrence of Smoke and/or Haze



2. Percentage Frequency of Occurrence of Fog

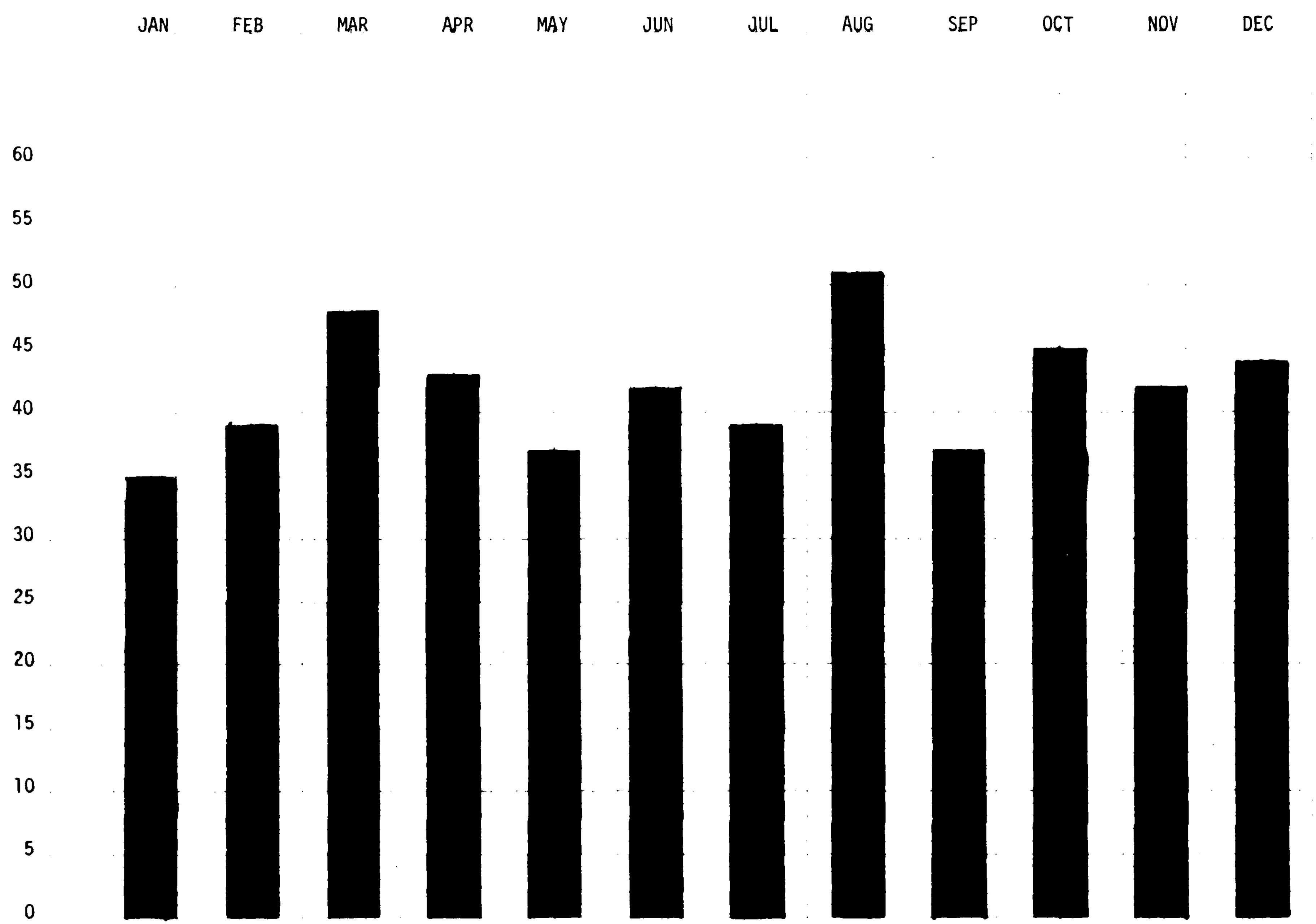


3. Percentage Frequency of Occurrence of Snow and/or Sleet

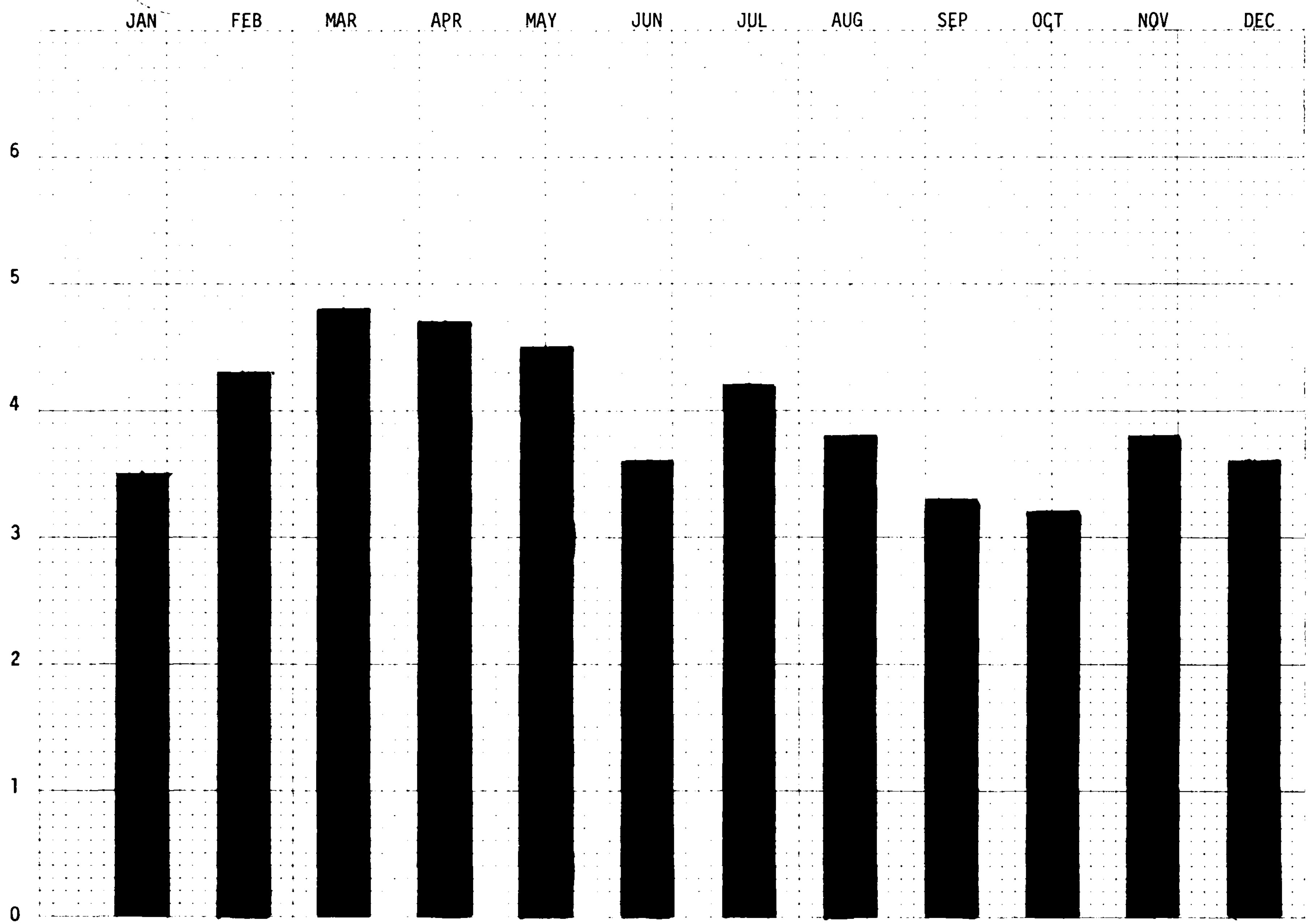


LST	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
[illegible]	4	5	6	12	8	9	14	10	9	6	7	2
[illegible]	4	4	6	10	10	11	18	12	9	7	7	4
[illegible]	3	5	6	11	10	10	15	13	9	7	5	3
[illegible]	3	4	5	9	11	8	15	11	9	5	5	2
12-14	3	5	5	10	9	7	13	10	7	5	5	2
[illegible]	4	5	6	9	10	8	13	9	9	5	6	2
18-20	4	5	6	9	9	7	12	11	8	4	7	1
21-23	5	6	5	11	8	9	12	10	9	4	5	2

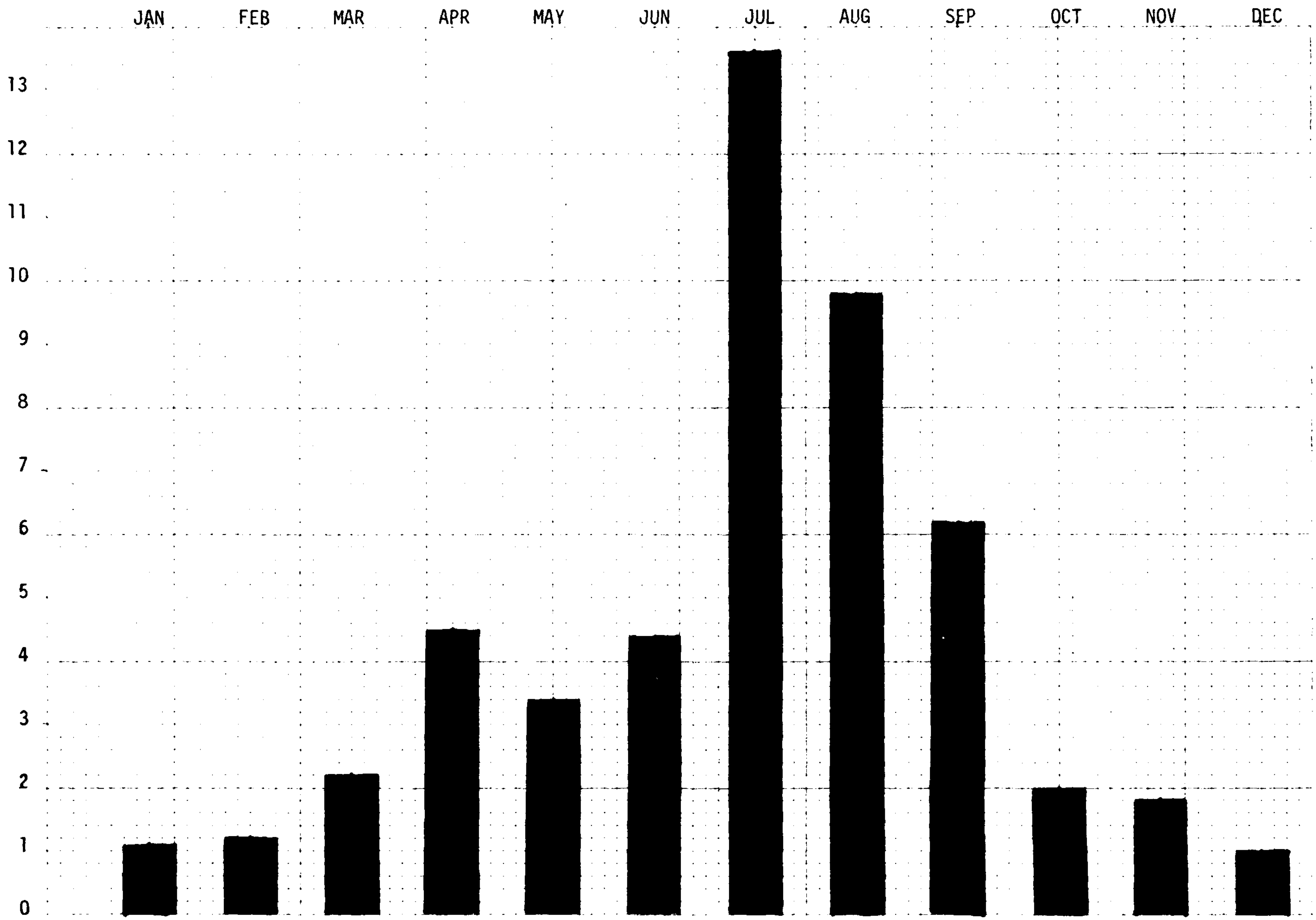
4. Percentage Frequency of Occurrence of Rain and/or Drizzle



MAXIMUM SURFACE WIND GUSTS



MEAN SURFACE WINDS (KNOTS)



MEAN LIQUID PRECIPITATION (INCHES)

SECTION G:

SYNOPTIC CASE STUDIES

THE RAINY SEASON

Mr. Chong Kwan Yi
Det 15, 20 Wea Sq

January 1969

I. BAI-U

1. Formation of the Bai-U Front.

During the latter part of April, most of the atmospheric activity transfers from continent to ocean. During May, the warm Pacific High begins to intensify and expand slightly to the north and west. South of the Polar Front, the low level circulation is from southwest to northeast as a southwesterly monsoon. At the same time, relatively cool, moist low level flow along the southern edge of the Okhotsk High tends to move south and meets the Pacific High in the vicinity of the Ogasawara (Bonin) Islands. During May the Bai-u front forms between the relatively persistent cool, moist northeasterly flow and the warm, moist southwesterly flow with the front over the ocean south of Japan. The mean position of the Polar Front is between Ogasawara and to south of Okinawa.

2. Movement of the Bai-U Front.

The mid-latitude high begins to weaken very slowly in June due to solar heating and lack of cold air. At the same time, the warm Pacific High expands to the north and west as the sun tracks to the north and the warm Pacific High pushes the Bai-U activity to the north and extends it further west. The frontal orientation is generally east-west rather than northeast-southwest in May. The Polar front moves over the south coast of Japan during mid-June and retains this position approximately two to three weeks because of mountain barriers over the Japanese Islands. This also aids in the intensification of the front and extends the Bai-U front further west to Southern China. The mean position of the Bai-U front is now from the south coast of Japan to near Shanghai. During July, the mid-latitude high continues to weaken and allows the Bai-U front to move further north to its final position from Southern Sakhalin to North Korea to Northern China.

Because of the more or less consistent northward movement of the Bai-U front, it is possible to determine the maximum precipitation potential through the following method:

Determine ten day precipitation amounts for stations to the south in the frontal zone and plot them on a chart. Locate a line equal to the maximum precipitation amounts. Use this method to establish continuity and determine maximum precipitation amounts.

Generally, the northward movement of the Bai-U front is approximately eighteen knots (Fig. 19).

An old proverb says "The rainy season ends with thunder." This is not always true. The rainy season starts in Korea at Chejudo around the 20th of June and lasts approximately one month. During the first part of July, the number of waves forming over the Yangtse River decrease as the cool, moist high over the Kurile Islands retreats northward due to the lack of regenerative cold air. The expanding Pacific high pushes the polar front northward and the Bai effect is over.

Decreasing cloudiness and afternoon thundershower activities follow the Bai-U. Unusual temperature increases also occur during the latter part of July due to the influx of maritime tropical air, less cloudiness consequently more insolation, and less precipitation. The annual maximum temperature occur during the period following the Bai-U.

II. THE AIR MASS MOVEMENT AND BAI-U RANGE

1. The Bai-U is an air mass phenomenon produced in the mixing zone between two maritime air masses one of which is warm and the other cool. As a rule, precipitation areas associated with maritime tropical air masses are not significant but with the addition of the lifting effect of the maritime polar air, deep layers of stratus clouds form to produce persistent light rain.

Precipitation associated with the polar front is normally warm frontal type or light persistent rain or drizzle. However, with the approach of a cyclonic storm moving along the front, more intense showery precipitation can be expected. Although the polar front undulates while slowly being displaced to the north and its position is a little diffrent each year, the mean position can be described as follows:

a. Initial Phase: May....Vicinity Ogasawara to Okinawa to Taiwan.

b. Mature Phase: June....Southern Japan to Chejudo to Shanghai and Yangtze River area.

c. Last Phase: July....Southern Sakhalin to Hokkaido to Northern Korea and Shantung area. (Southern Sakhalin, North Korea and Shantung experience a brief rainy season.)

III. DEVELOPMENT AND DISSIPATION OF THE BAI-U FRONT

1. Normal development and dissipation:

   a. Initial stage..............May

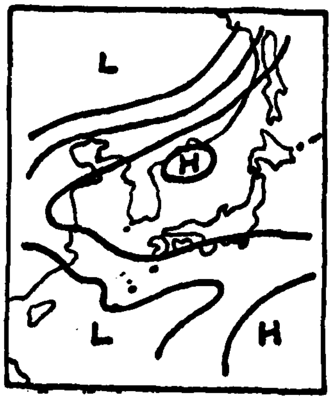


Fig 1. MAY
Mean low level flow

   b. Mature stage...............June

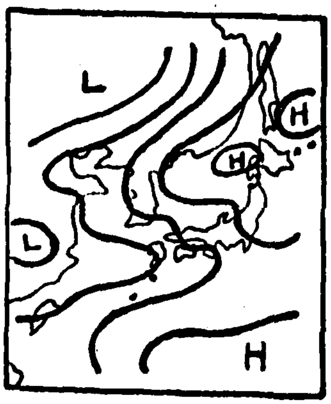


Fig 2. JUNE
Mean low level flow

   c. Dissipating stage.........July

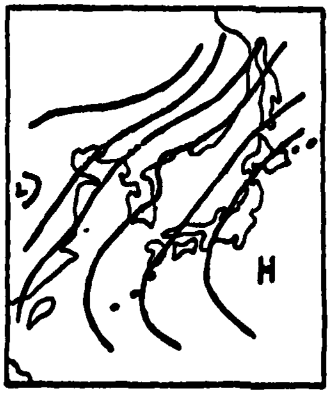


Fig 3. JULY
Mean low level flow

2. Irregular development and dissipation:

a. Terrain effect:

Terrain influences are of no concern during the initial stage when the polar front is for the most part over ocean areas. Generally, fluctuations in intensity of the polar front and terrain induced secondary low development becomes a problem during the mature stage when the polar front or Bai-U is located mostly over land. However, during the initial and mature stages, breaking up or weakening of sections of the polar front is rare although affected by terrain or cyclonic development. When it does occur, reassembly usually takes place quickly.

b. Wave effect:

Temporary relief from the monotony of the rainy season will occasionally be provided by the passage of a cyclonic storm. However a minor wave moving along the front will normally restrict this type of activity. Most of the waves form in the vicinity of Shanghai. During the mature stage of the Bai-U, waves move across the south coast of Japan regularly. These waves will normally either intensify the front or weaken it for short periods. During the approach of a deep low, winds increase on both sides of the front and heavy rain precedes the low.

IV. PICTORAL EXAMPLE OF LIFE CYCLE OF BAI-U FRONT

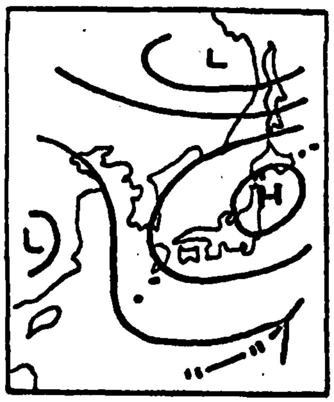


Fig 4. Formation of Bai-U front over the ocean and the Ogasawara area.

Fig. 5. Developing polar front moves slightly north, starting the rainy season in the Okinawa area.

Fig. 6. Mature stage (rainy season), over Hachijo-Jima, Okinawa and Taiwan.

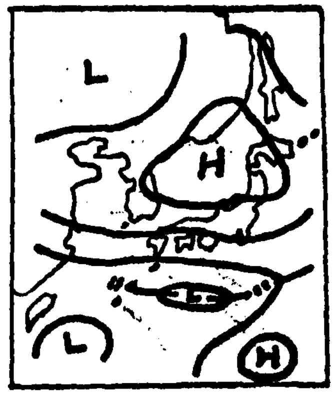


Fig. 7. Change in polar front orientation. Bai-U moving away from Ogasawara Islands. Honshu, Korea, Hokkaido and Sakhalin experience clear weather under the influence of Okhotsk High.

Fig. 8. Fair weather moves north. Rainy season begins in Japan west of Kanto and Yangtze River area. Tropical weather begins over Okinawa and Taiwan.

Fig. 9. Further intensification of polar front. Bai-U moves over Southern Korea.

Fig. 10. Polar front crosses Sea of Japan. Rainy season begins over Hokkaido, central and North Korea.

Fig. 11. Rainy season begins over Northern Hokkaido, Sakhalin, North Korea and Tatar Strait. Polar front disturbed by terrain and continental low.

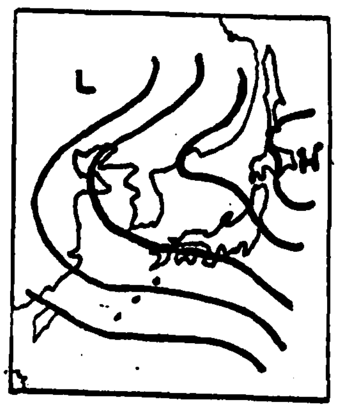


Fig. 12. Weakened polar front over Tatar Strait. Rainy season over Hokkaido and Sakhalin almost over.

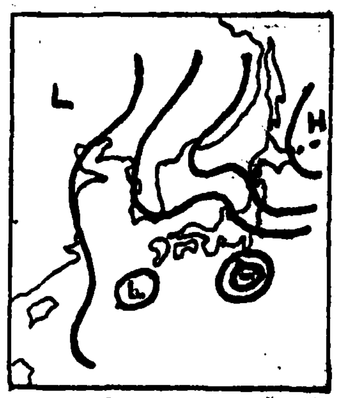


Fig. 13. Polar front over Northern Sakhalin southwest into Manchuria. Rapid temperature increases over Japan, Korea and China. Typhoon season starts.

V. PRECIPITATION OVER KOREA

1. Distribution of annual precipitation:

The total annual precipitation over Korea averages 500 mm to 1500 mm (19.7 to 59 inches), over various locations. This is twice the amount received over Manchuria and approximately half that received over Japan. Areas of more than 1200 mm of annual precipitation are shown in Fig. 14.

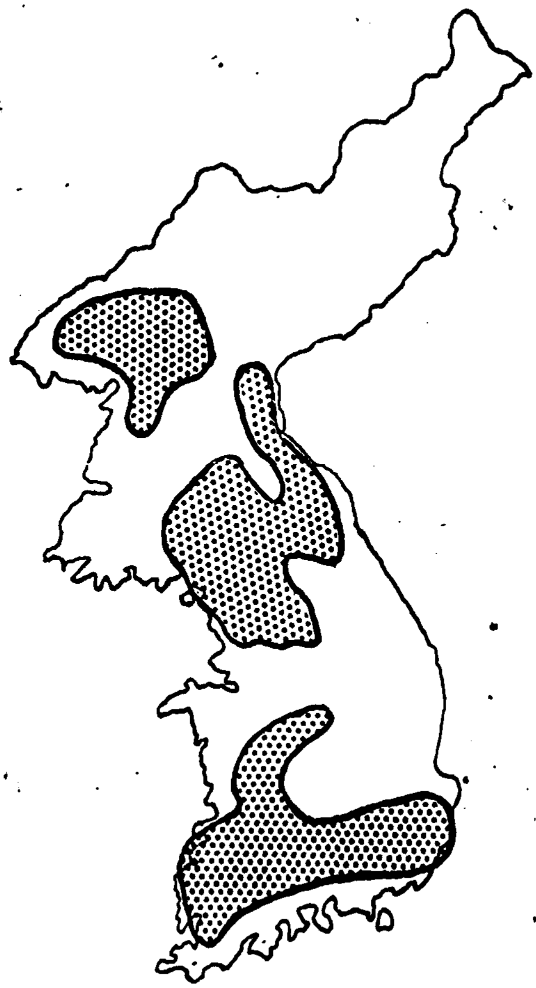


Fig 14. Area of more than 1200 mm of annual precipitation

2. Summer rainfall amounts:

The total rainfall during June, July and August (Korean summer months), accounts for 50 to 60% of the annual amount. The summer rainfall amounts as compared to annual amounts is shown in Fig. 15.

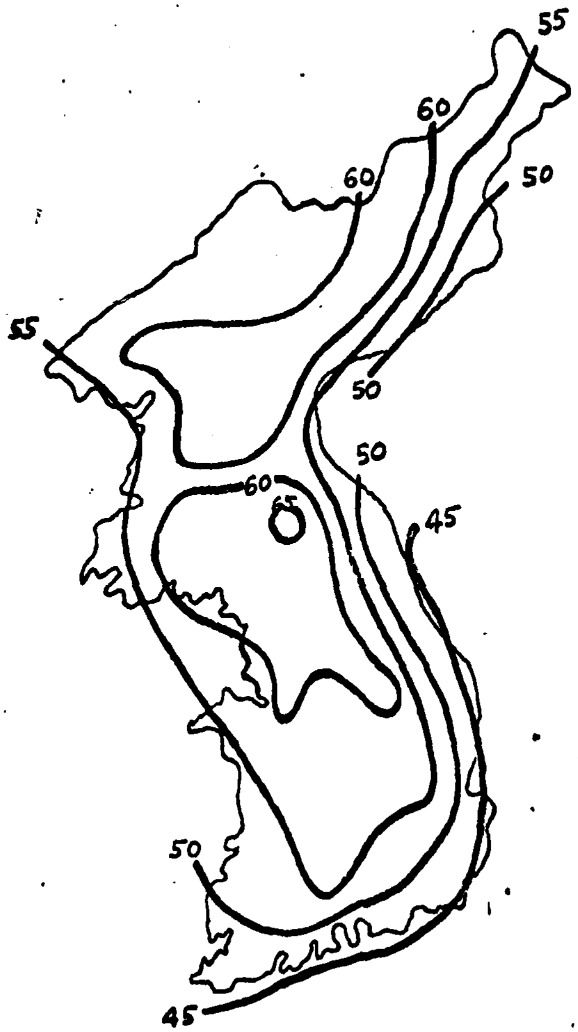


Fig. 15. The summer rainfall amounts as compared to annual amounts.

VI. WEATHER ASSOCIATED WITH THE BAI-U

1. North of and along the front:

a. Fair weather with prevailing easterly winds in Okhotsk High (Fig. 16).

b. West coast morning fog.

c. Persistent cloudiness with steady light rain or drizzle.

d. Fog and stratus especially during the morning hours with short-lived breaking up at night.

e. Warm frontal type weather.

f. Heavy rain with the approach of a cyclonic storm.

2. South of the front (Fig. 17 & 18):

a. Thunderstorms and rainshowers (morning stratus, afternoon cu & cb).

b. Season of maximum temperatures

c. Lowest daily temperature range with high relative humidity (greater than 80%).

d. Typhoon season (July, August, September).

(1) Temporary retrogression of Bai-U front.

(2) Intensification of Okhotsk High.

3. Severe weather:

a. Heavy rain, low ceilings and visibilities (04-10 AM).

b. Turbulence (light to extreme).

c. Thunderstorms.

Fig. 16. Intensification of Okhotsk High

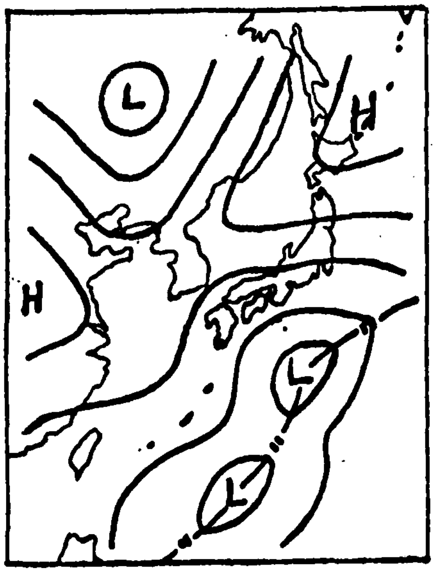


Fig. 17. Final position of Bai-U

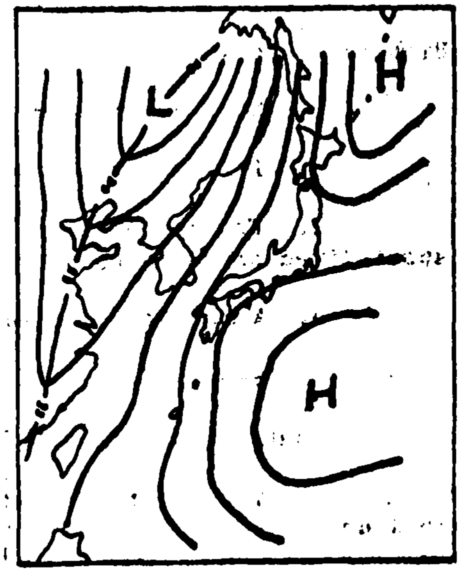


Fig. 18. Summer pressure systems

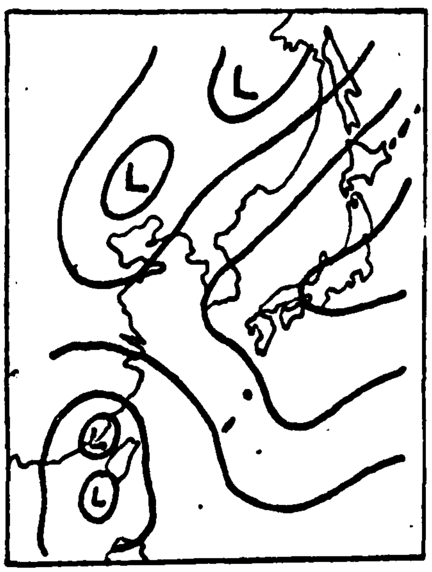
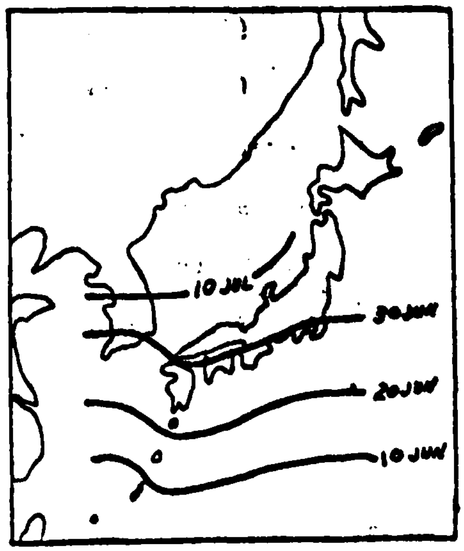
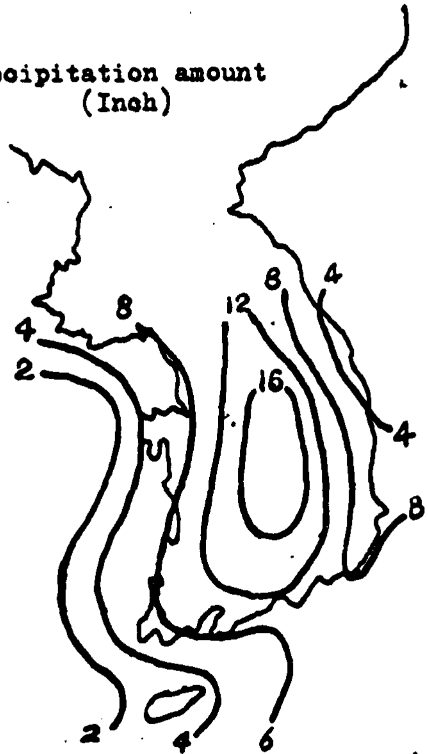


Fig. 19. The mean positions of Bai-U

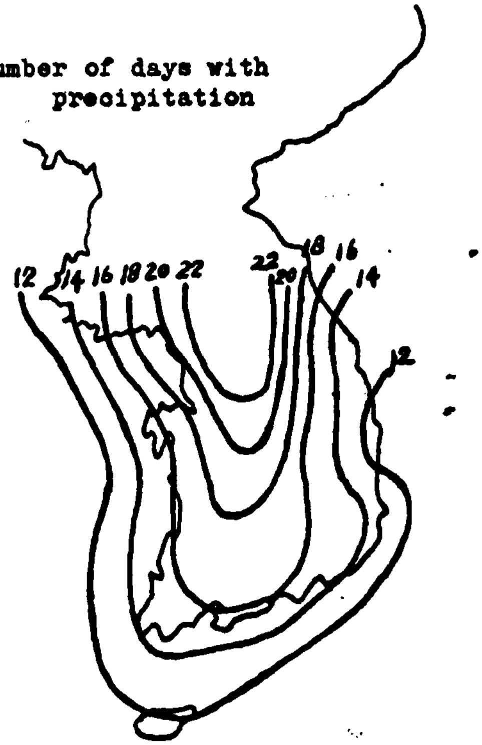


JULY 1961

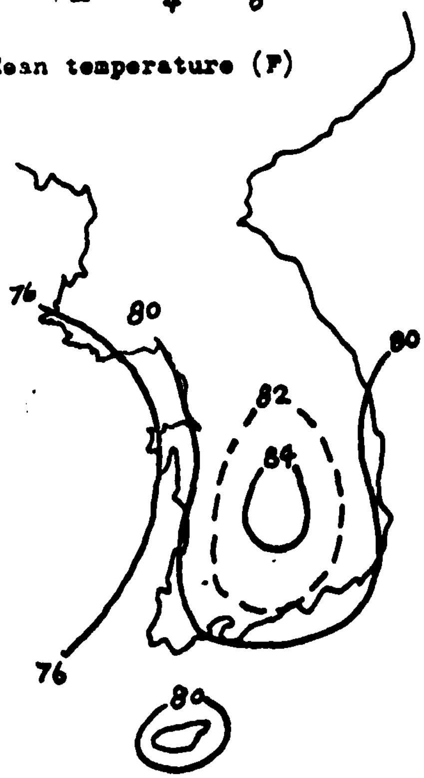
Precipitation amount
(Inch)



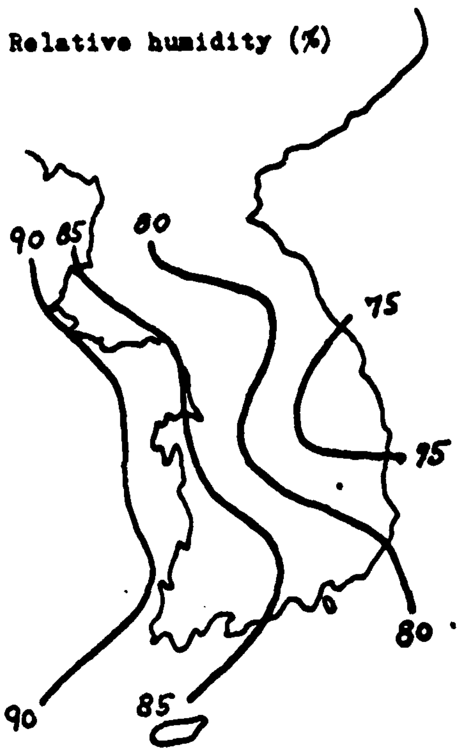
Number of days with
precipitation



Mean temperature (F)



Relative humidity (%)



CLIMATOLOGICAL SUMMARY - RAINY SEASON
OSAN

20th June - 31st July

ELE YEAR	BELOW 200'/1/2mi	TSTMS	GUST 20 KTS OR MORE	RAINFALL 2" OR MORE IN 12 HRS
1961	4	1	4	1
1962	1	5	7	0
1963	1	4	5	3
1964	3	6	6	4
1965	1	2	8	4
1966	3	5	10	4
	3 W/PRECIP	10 W/GUST	6 W/TSTMS	61 2.49" IN 6 HRS
REMARKS	10 W/FOG	13 WO/GUST	34 WO/TSTMS	1.8" IN 3 HRS 63 2.6" IN 6 HRS 64 2.22" IN 6 HRS 65 3.0" IN 6 HRS 66 3.96" IN 6 HRS

~~82-18~~
G1-12

THE SNOW PRODUCING CLOUD PATTERNS
REFLECTED ON
THE SATELLITE PICTURES

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Osan AB, Korea

INTRODUCTION

The months of December, January, and February constitute the Korean Winter. During these winter months the precipitation is mostly in the form of frozen precipitation with the maximum accumulation occurring during January. Osan's record snowfall occurred at the end of January this year. Snow, however, is not limited to these three months. Records from the Central Meteorological Observatory in Seoul indicate that the earliest occurrence was on 26 October in 1931 and the latest on 19 April in 1911.

Precipitation amounts in the winter are less than those of summer, and there are large variations throughout Korea due to topography and low level wind flow. For example, the north-south orientation of mountain ranges and a low level easterly wind with advection of moisture from the Sea of Japan results in highly significant snowfall amounts along the east coast.

Korea is a peninsula with its northern boundary facing Asia. The primary mountain range is oriented north-south along the east coast. A second range extends southwestward from the center of the primary range. These two ranges combined with the Yellow Sea on the west coast and the Sea of Japan on the east coast greatly affect snowfall amounts. Generally, the first snow occurs with a polar outbreak accompanied by a cold front which developed in association with a low pressure system in the area of Lake Baykal in Siberia. After the initial snow many different pressure systems contribute to future snowfall amounts. These systems are interesting to study in conjunction with satellite pictures. The satellite picture alone is not a very good forecasting tool, but when combined with synoptic and upper level charts it is quite useful.

The pressure systems causing snow or snowshowers are classified in 6 main categories. These are:

(1) A Cold Frontal System
(2) A Strong Thermal Trough (850MB) Behing The Cold Front
(3) A Low Level Easterly Flow
(4) A Weak Thermal Trough (850MB) With Different Pressure Systems at the Surface
(5) An Inverted Trough
(6) An Abnormal Polar Front

1. The Cold Frontal System

A cold front oriented northeast-southwest is depicted by the satellite picture in Fig 1. The surface chart and upper level charts show the system stacked up to 300MB's. From the 8th to the 9th of November the front moved to the southeast at 30 knots. The satellite pictures enable one to determine the length and width of the system. Generally, when the front is over land there is very little cloudiness behind the front. Over the water cloudiness behind the front is quite significant.

2. A Strong Thermal Trough (850MB) Behind The Cold Front

After the cold front has moved out over the water, cold air advection behind the front greatly affects the weather on the west coasts of Korea and Japan. This is a result of instability caused by the temperature difference between water and air. More cloudiness and precipitation can be expected with increases in the temperature differences. Although the surface front on 9 November is over northern Japan, the Yellow Sea was overcast with stratocumulus. The east coast of Korea was generally clear with offshore winds. This situation is supported by the 850MB thermal trough and the 300MB trough. The cold front passed Osan just prior to midnight on 8 November. Two to three hours after the front passed rainshowers started. A few hours later the rainshowers changed to snowshowers which lasted until midnight on 10 November. The low level flow generally was west to east, and quite a bit of cloudiness existed over the Yellow Sea. This synoptic situation is highly favorable for snow occurrence over the western half of Korea.

Although the first snow occurs usually on 21 November, Osan measured 2.2 inches on 9 November. The sounding for 9 November indicates low level instabilities and cloud tops at about 8,000 feet. On 10 November cloudiness over the Yellow Sea decreased due to the winds shifting to a northerly direction in the lower levels as the thermal trough moved inland. This wind flow still favorable for snowshower activity along the southwestern coast and less favorable at Osan.

This type of situation is difficult to forecast, especially for a new forecaster. General features, however, do exist for this situation. These are (1) an intense high pressure system at the surface building over Mongolia, (2) a strong thermal trough behind the 850MB trough, (3) a deepening 300MB trough with a closed low pressure center moving over southern Manchuria, and (4) a rapidly lowering of the tropopause height.

Figure 5 is a series depicting cold frontal passage from China to Eastern Japan. Frontal passage in Korea occurred on 10 January, but the colder air moved over the Yellow Sea on 12 January. Warm air advection at 850MB's will decrease the cumulus activity due to an increase in stability.

3. Low Level Easterly Flow

Low level easterly flow is indicated on the satellite picture for 19 February. Solid clouds prevail along the east coast while less cloudiness extends along the west coast. The 850MB contours are oriented northeast-southwest over Korea. The Manchurian Low was quite far north, and the 300MB flow was zonal. Upper level winds between the surface and 800MB's were light and easterly while those above were generally westerly. These conditions are highly favorable for moderate snowshowers along the east coast. The sounding for 19 February shows some moisture aloft but not enough to be significant. There are two inversions aloft, but the lapse rate is generally stable. Kangnung, on the east coast, recorded 5.8 inches of snow on this date while southeastern stations reported rain. Ceilings were 700 to 1200 feet, and visibilities ranged from 3/4 to 1 mile. The west coast reported 2500 to 3,000 foot ceilings and visibilities 5 to 10 miles with very light intermittent snowshowers.

4. A Weak Thermal Trough at 850MB With Different Surface Pressure Systems

(a) Type I (Figure 8)

This type is characterized by a high pressure area to the west and a low pressure system to the east. The surface chart indicates an induced trough oriented east-west from the Sea of Japan to central North Korea. The trough and thermal troughs at 850MB's and 300MB's are quite extensive. The clouds over the Yellow Sea are solid and similar to those of figure 2. The ceilings and visibilities were better than those of figure 2, but the weather lasted for a longer period of time with snowshowers predominating over all of western Korea. The sounding indicates low level instability similar to that of 9 November (figure 3). Tops are indicated at 9,000 feet, and the upper level winds are westerly.

(b) Type II (Figure 10)

The upper level pressure and thermal trough patterns are similar to those of figure 8 with a few differences in surface pressure patterns and upper level winds. Weather associated with this type of system usually lasts for a short period of time. However, ceilings and visibilities are lower than those occurring with figure 8. Without satellite pictures this type of weather is hard to predict. One feature to watch for is a wind shift from northwest to southwest in the lower 2 to 3 thousand feet. These winds will remain southerly until the trough passes. This trough usually develops quite rapidly in the Yellow Sea and becomes a fast moving system. The sounding of 17 January indicates cloud tops at about 8,000 feet.

5. An Inverted Trough

The inverted trough situation generally produces snowfall throughout all of Korea. The satellite picture in figure 11 depicts clouds associated with an inverted trough. These clouds are usually of a stratiform nature and fairly solid with tops at about 20,000 feet. The use of the satellite picture alone is not much use in forecasting what weather conditions will occur. However, when combined with the surface and upper level charts, it is extremely valuable. This system is likely to produce snow because the Shanghai Low is supported at 850MB's, and the surface trough extends northward into Mongolia. Good thermal packing is indicated on the 850MB chart. The 300MB Jet Stream is also favorable for the low to deepen and then move east-northeastward toward Kyushu (Japan). Many times this low will be blocked by a high pressure ridge thus allowing the low to become quite deep and resulting in a longer period of weather over Korea. The sounding of 15 February indicates that the clouds are solid with tops at 18,000 feet. Generally precipitation ends at Osan when the Shanghai Low moves east of our meridian.

6. An Abnormal Polar Front

The cloud pattern here is quite similar to that of the inverted trough situation. The frontal system on the surface chart is located just about in its June position. The sounding of 28 January (figure 14) indicates warm air advection and clouds solid to 25,000 feet. This particular system deposited little over 16 inches of snow at Osan during a 96 hours period.

CONCLUSION

Generally timing and forecasted conditions with various systems is obtained using the surface and upper level charts. Satellite pictures, however, have been extremely useful as auxiliary charts. At Osan the satellite picture often is the most important piece of data. With little or no data available over the Yellow Sea the satellite picture is our main forecasting tool at Osan. This is especially true for rapidly developing and fast moving systems west of Osan. The degree of success in forecast improvement using satellite pictures is not really known at this time. However, in many instances satellite pictures have proven to be invaluable. With more experience and study, correct interpretation of these pictures will no doubt result in much better forecasting techniques.


SNOW
IN
KOREA
MR. CHONG KWAN YI
DET 15 20TH WEA SQ
AN AB KOREA

AD-A107 433 WEATHER WING (1ST) HICKAM AFB HI F/G 4/2
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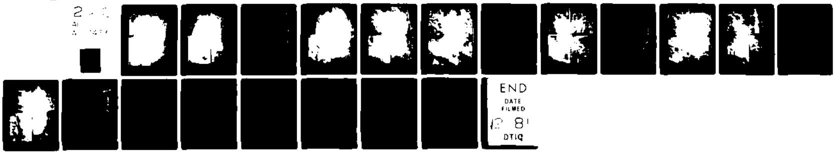
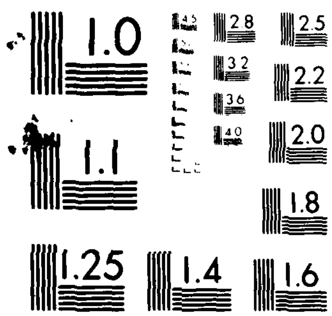
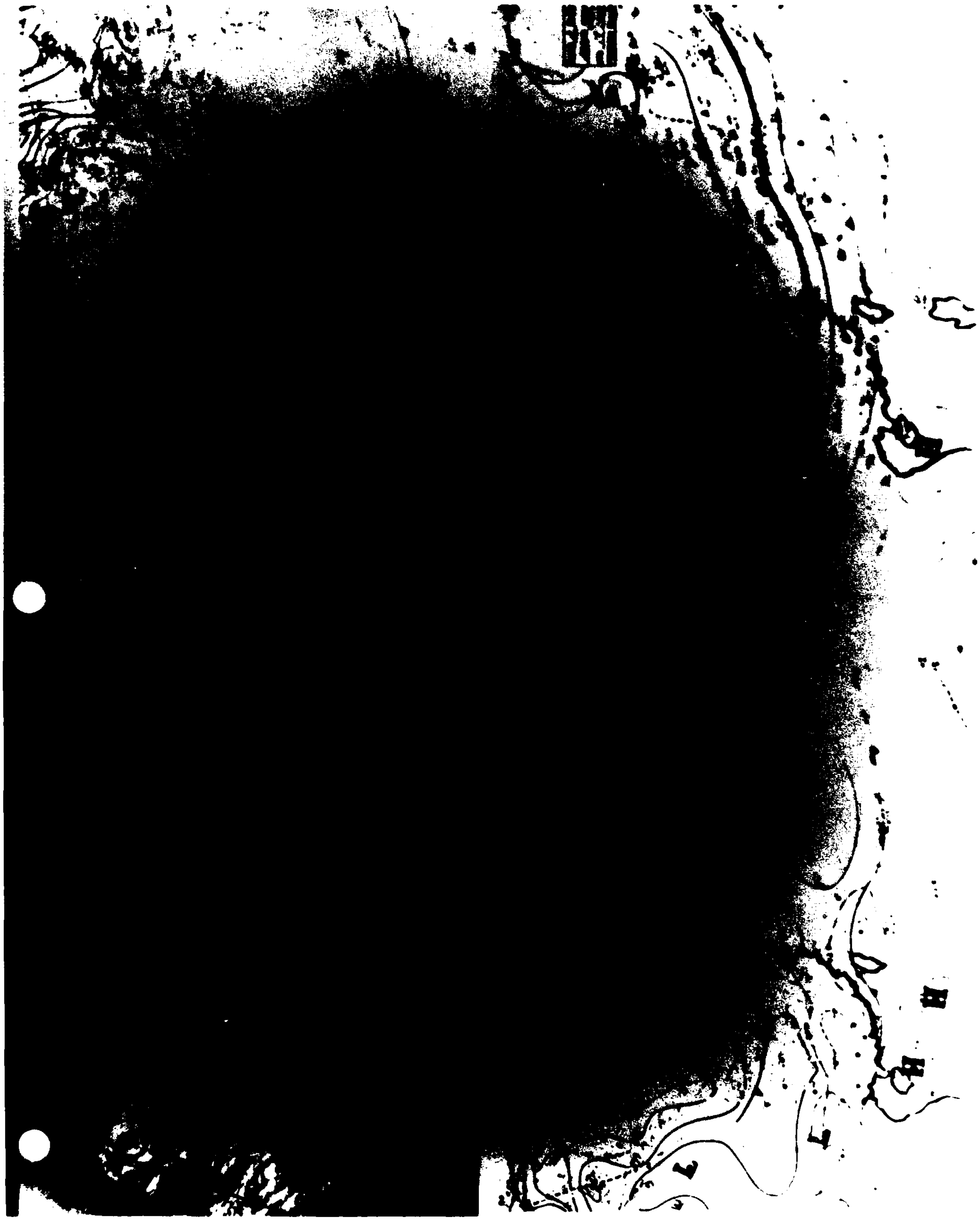
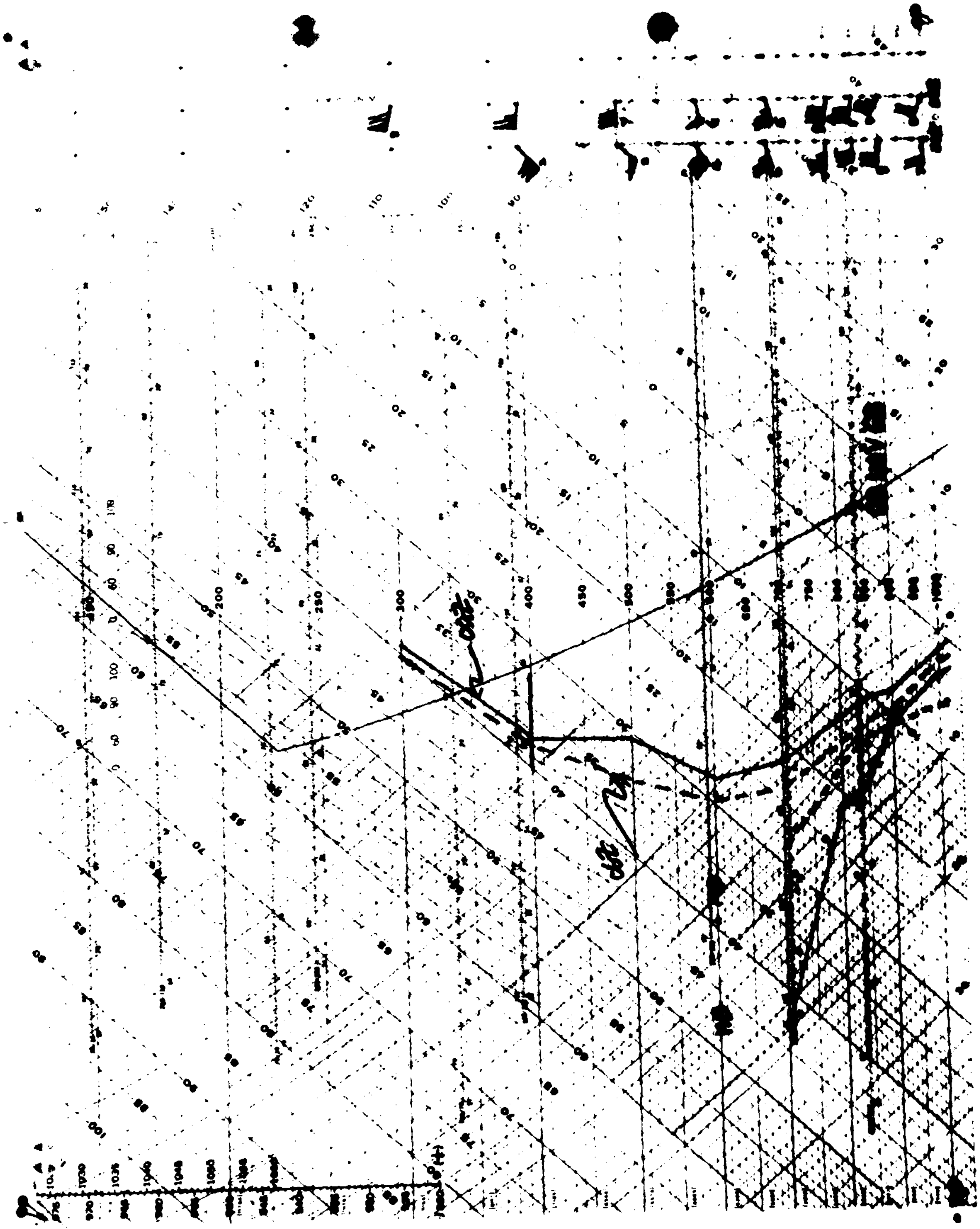
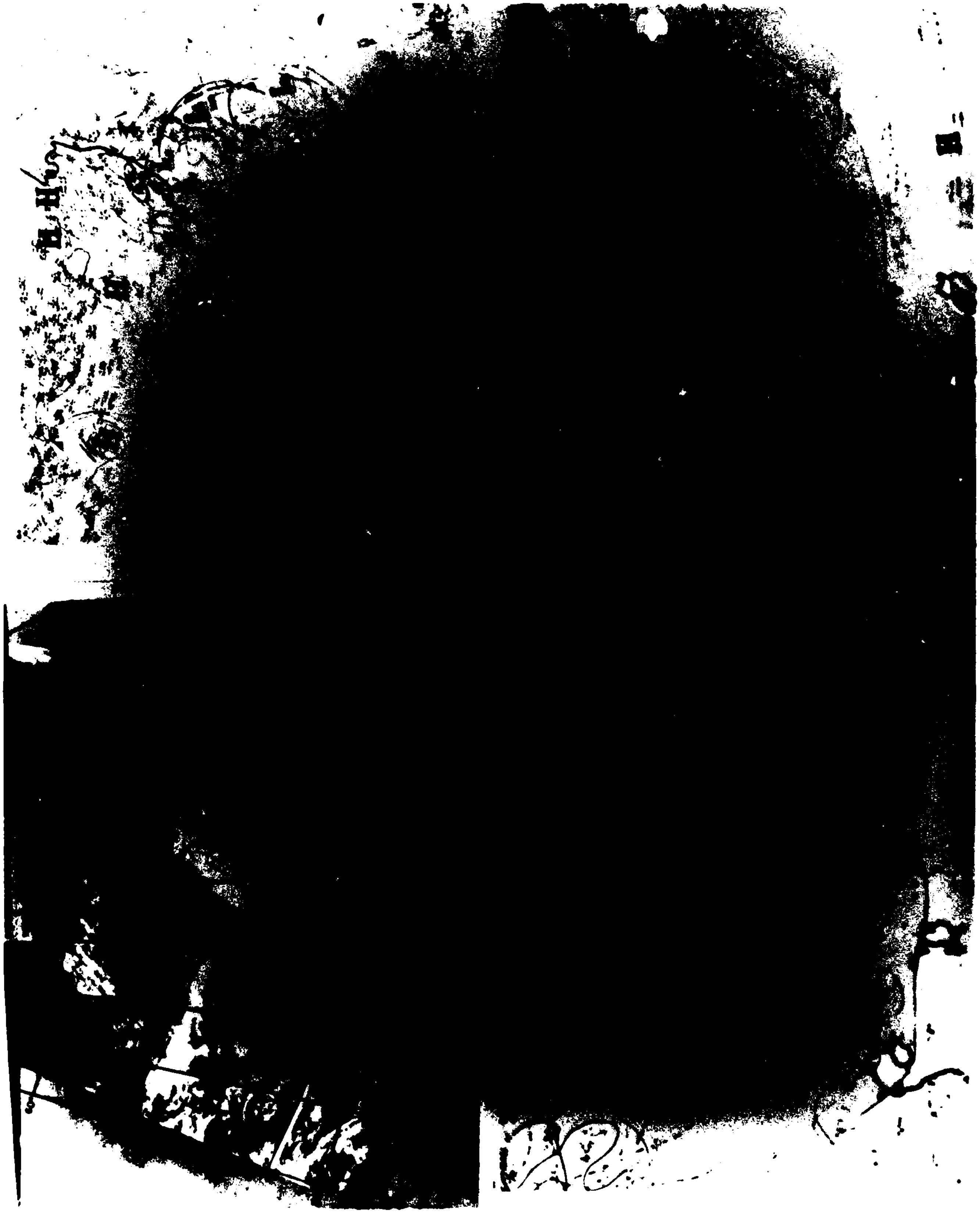


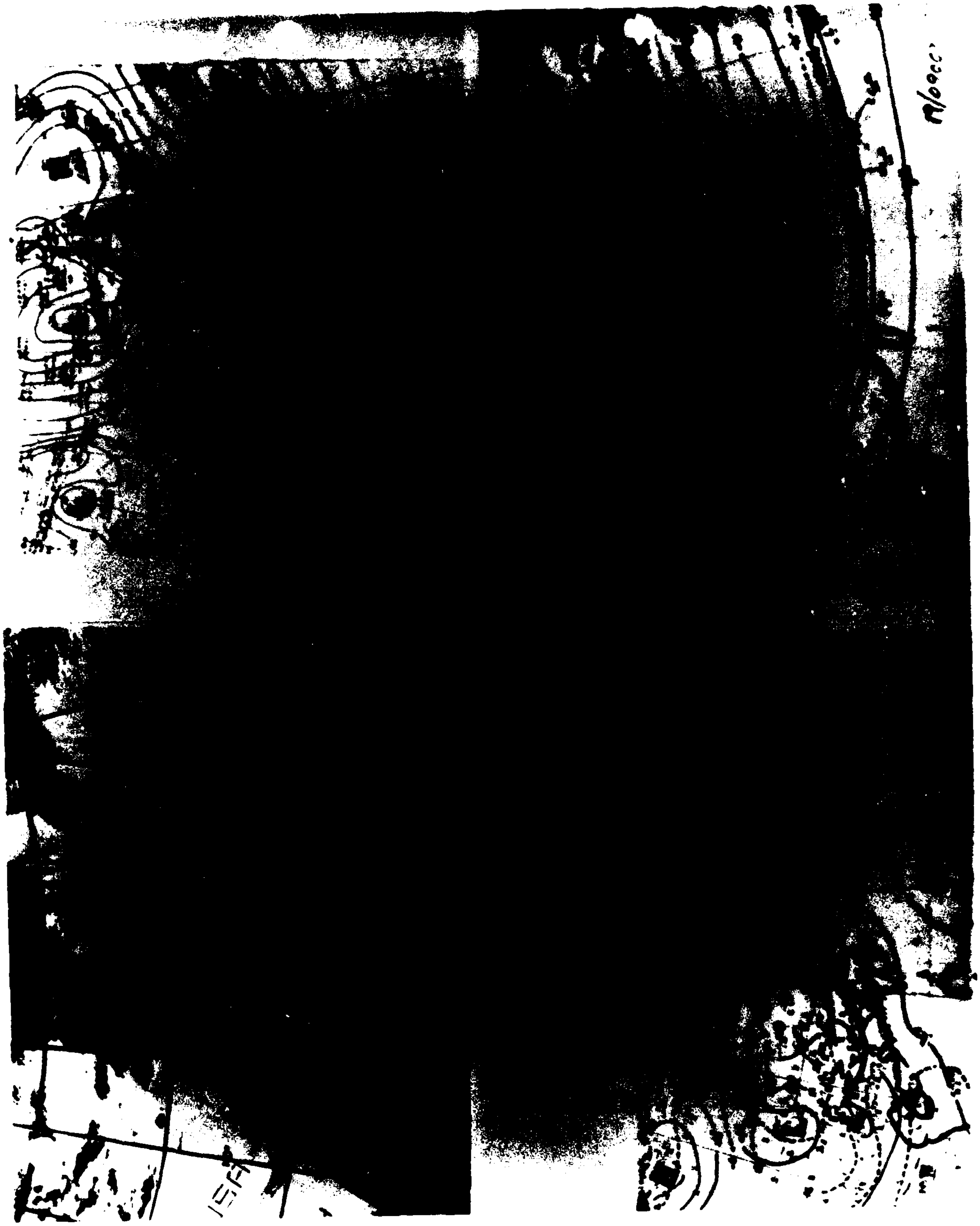


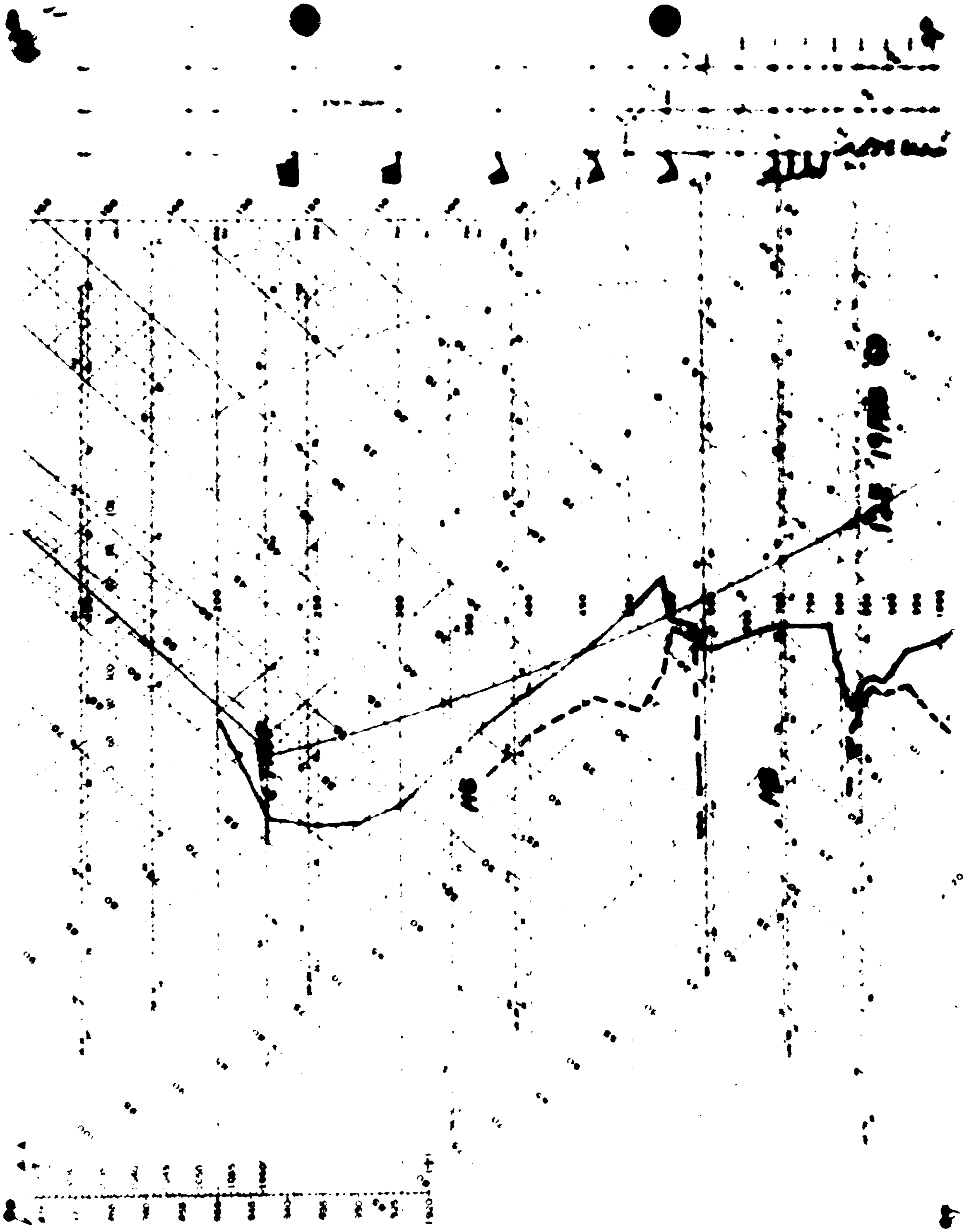
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

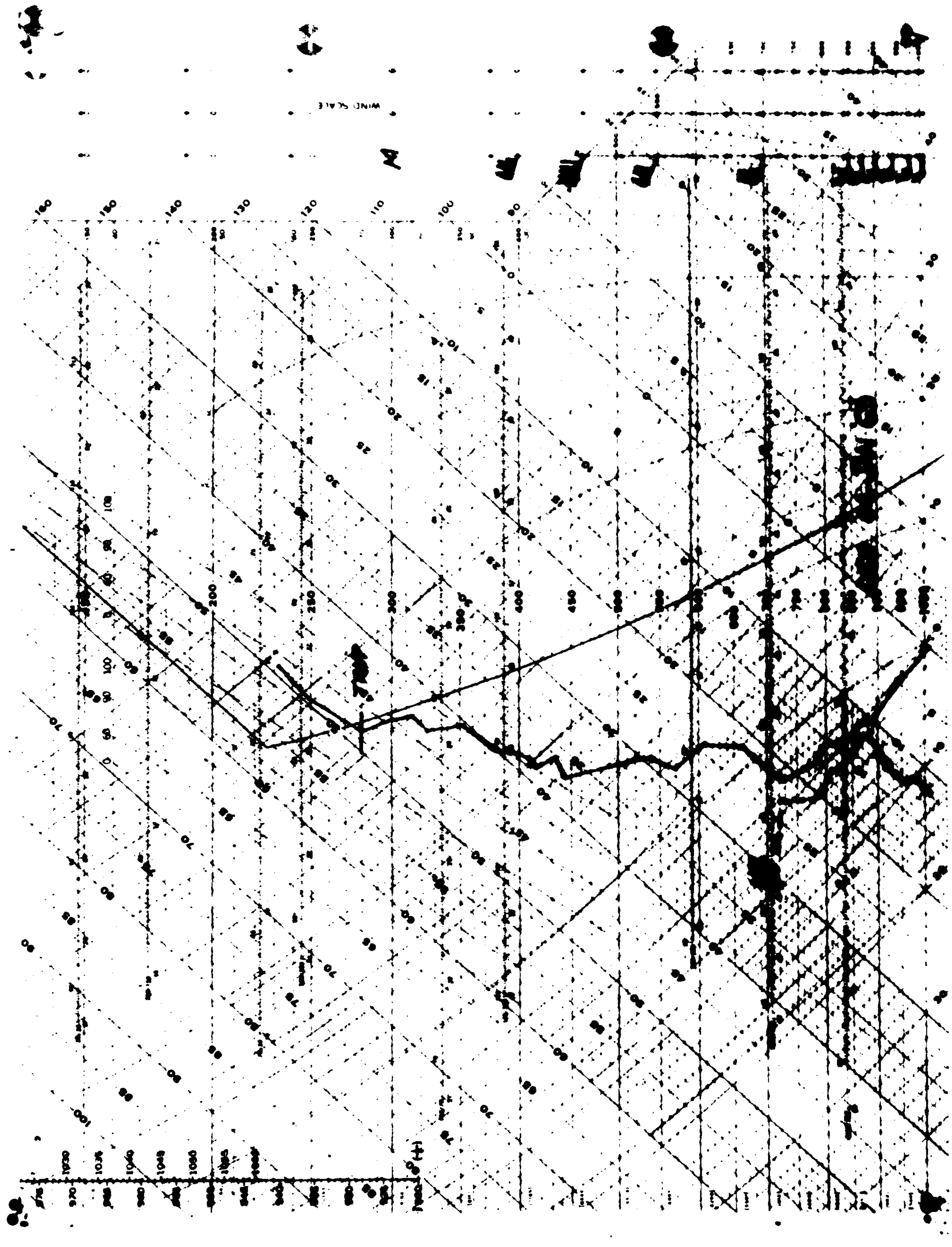


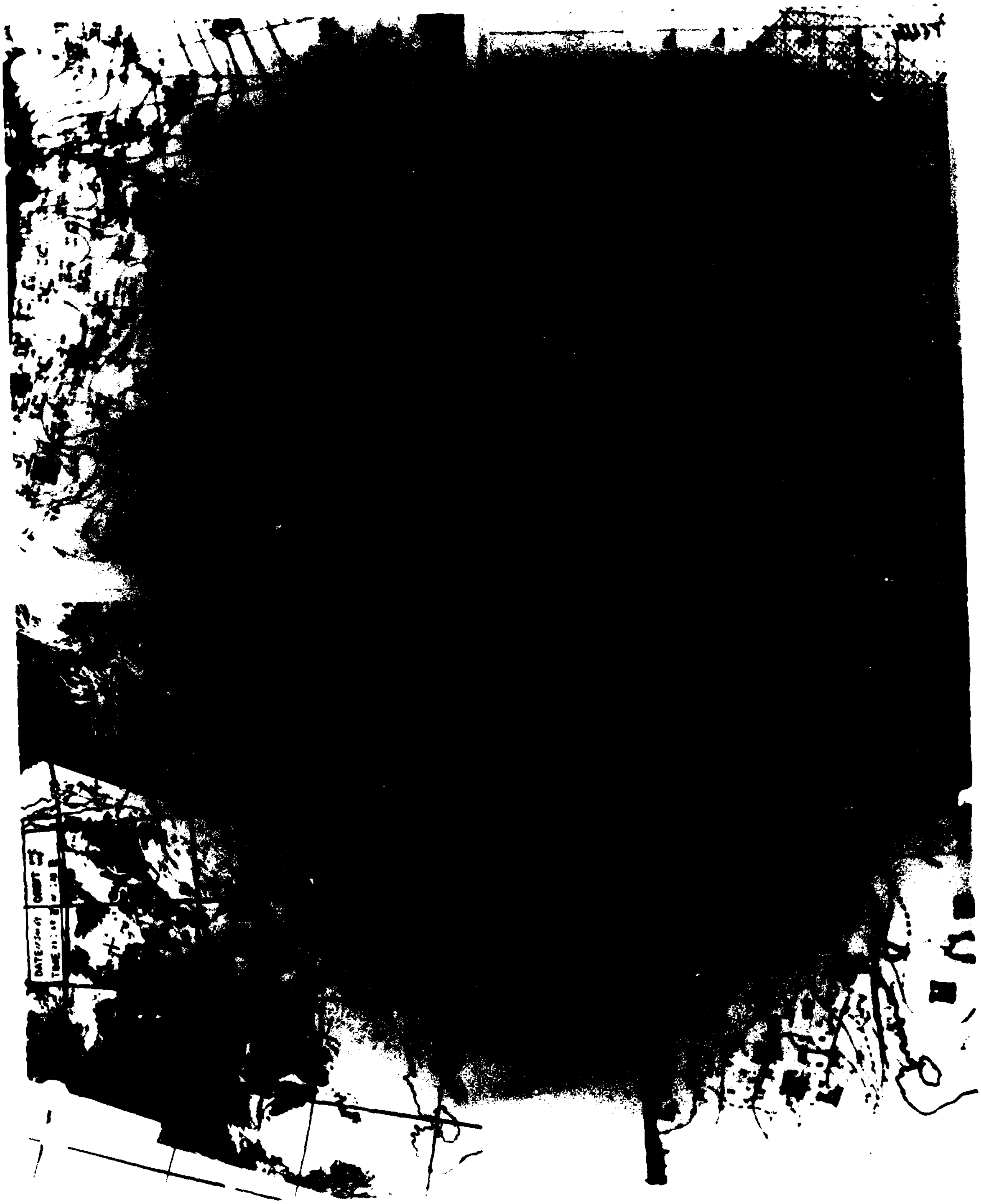


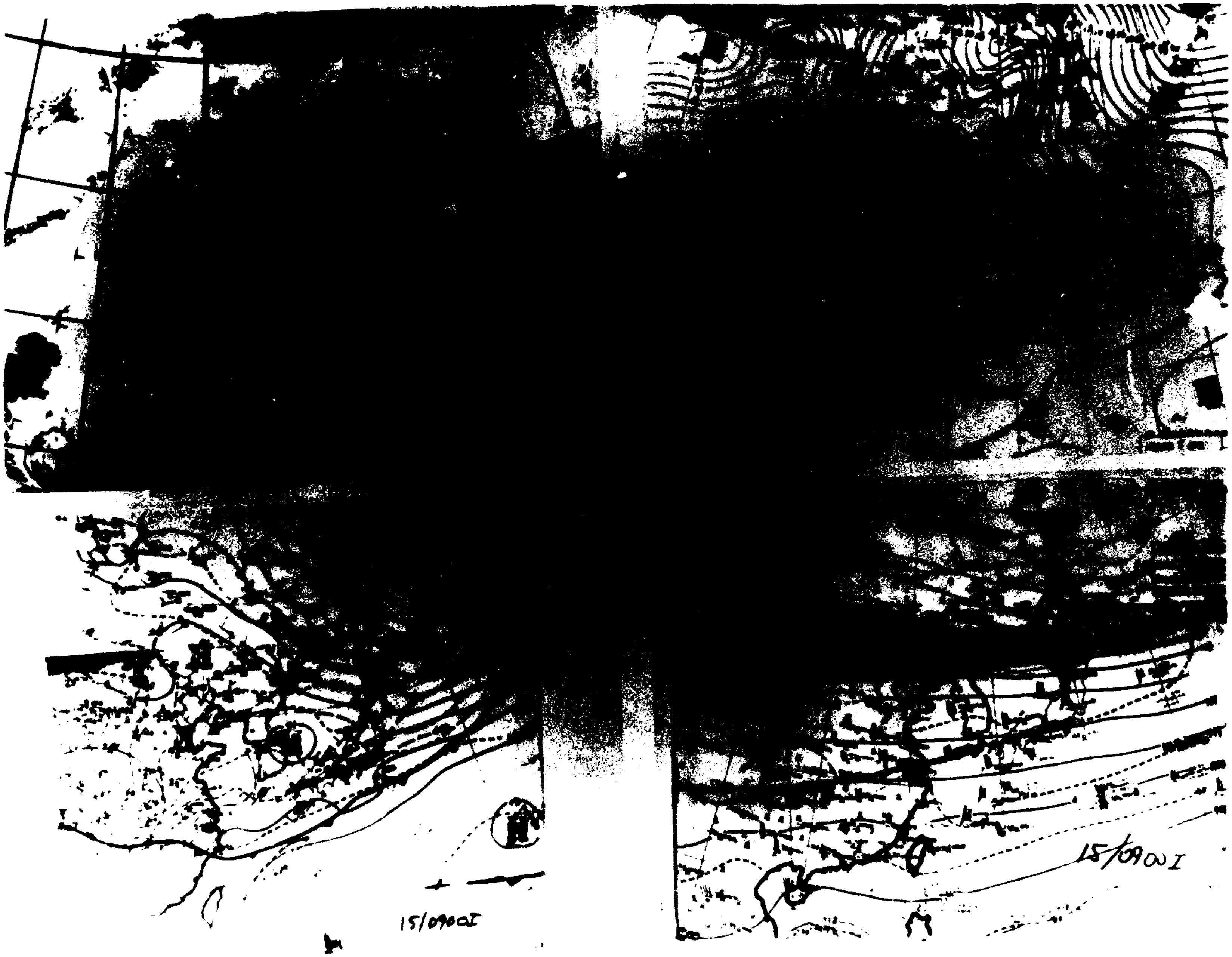








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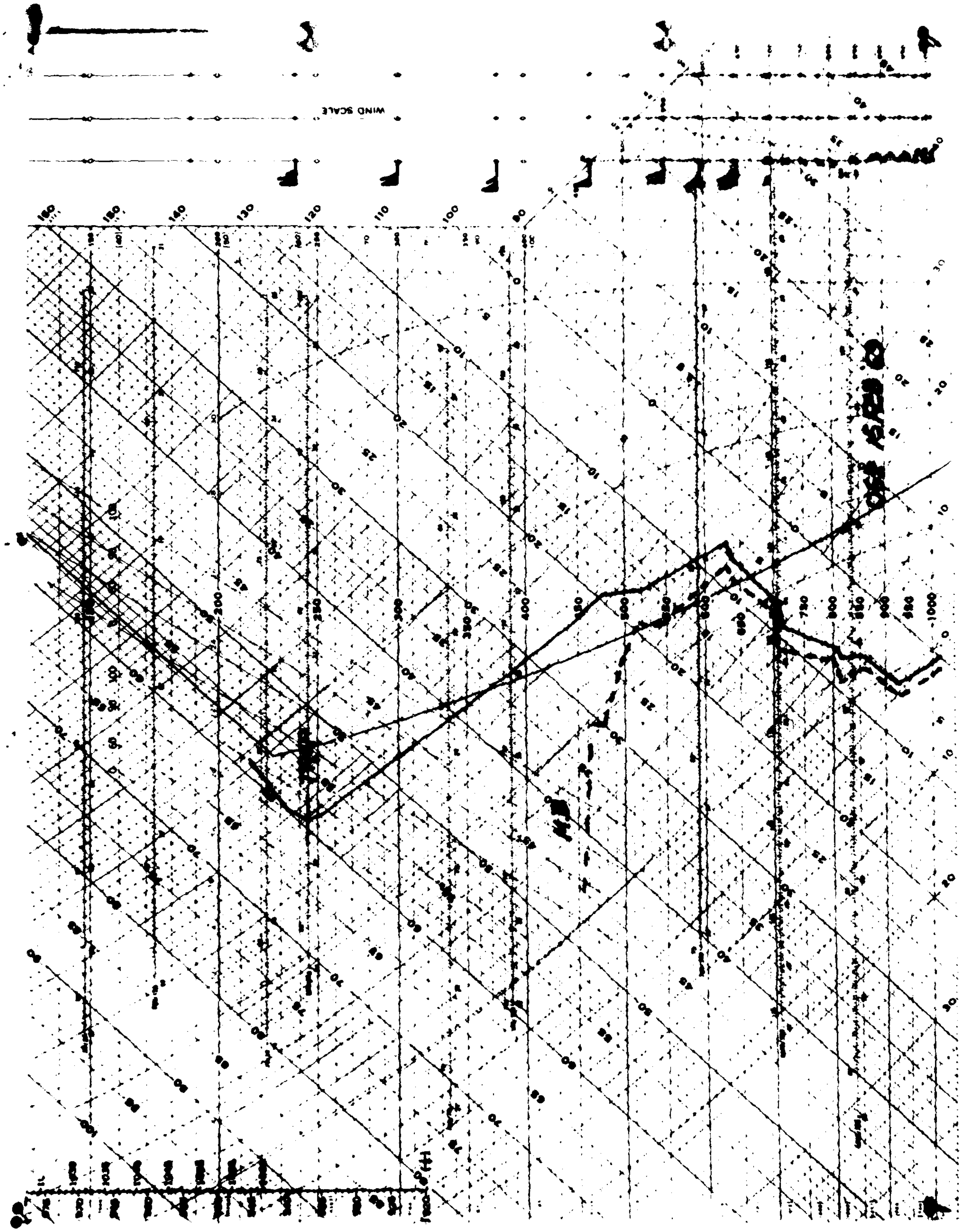

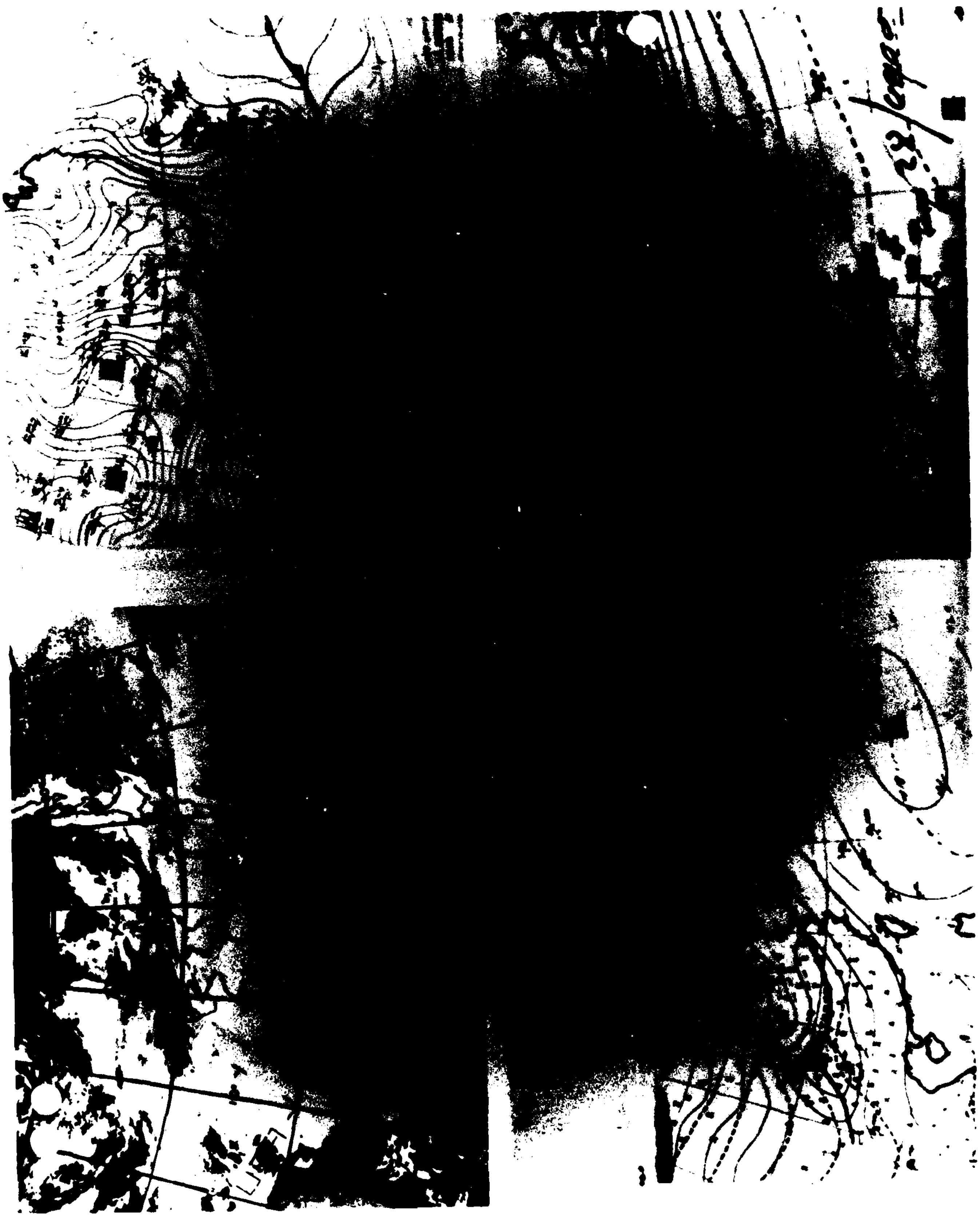

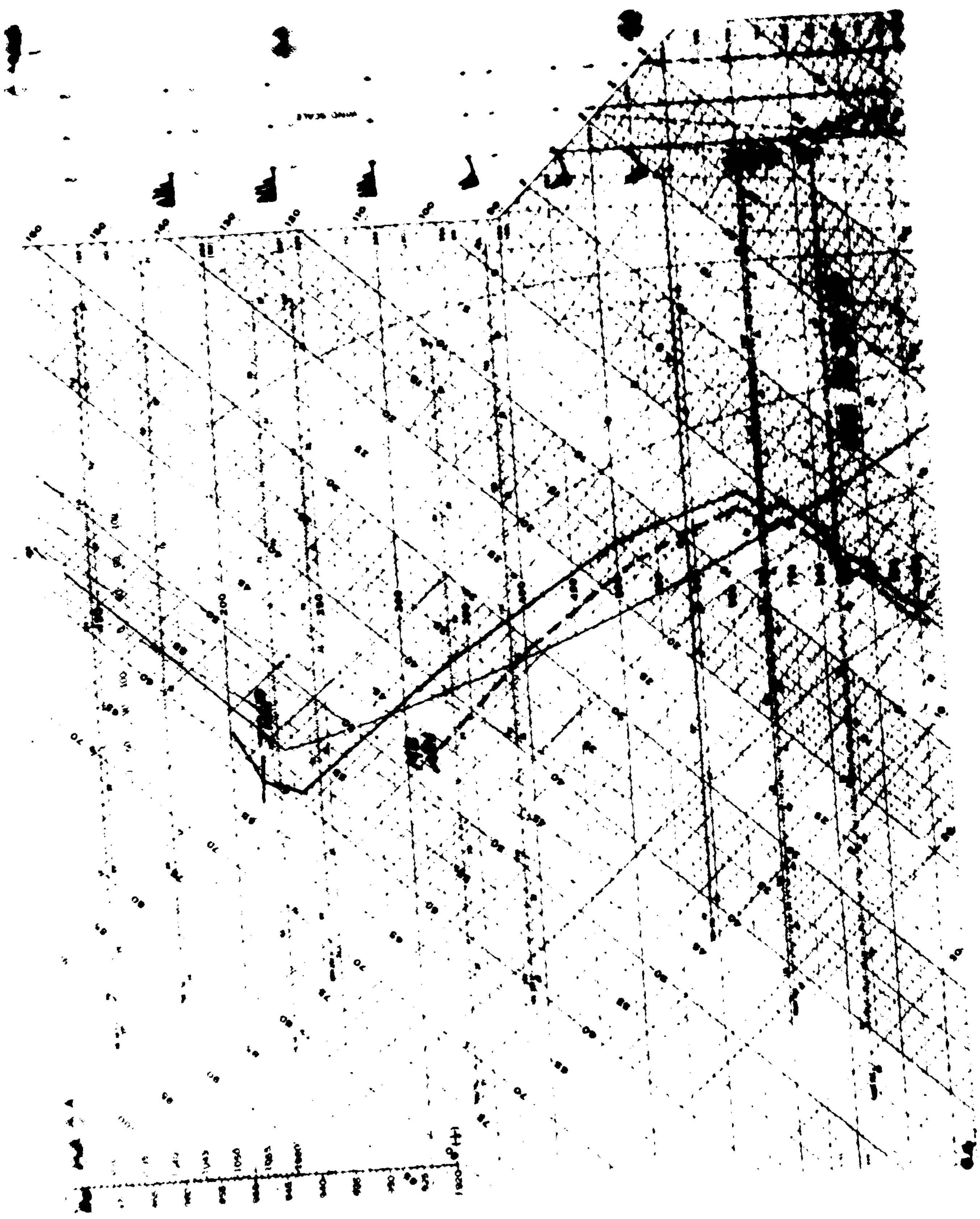

SECTION H:

TERMINAL FORECAST WORK AND PREPARATION SHEETS

(12 HR TAF FOR LCL DISS) (STAPLE 24HR HARDCOPY HERE)

FORECAST: VLD: Z+0 Z MONTH: YEAR: FCSTER:

RKSO TAF

FREEZING LEVEL(S) CONTRAILS LEVEL

AMD#1 BEFORE AFTER INTER HRS REP HRS NON-REP

RKSO TAF AMD

FREEZING LEVELS

AMD#2 BEFORE AFTER INTER HRS REP HRS NON-REP

RKSO TAF AMD

VERIFICATION BY HRS

PERS	H+0 Z	H+1 Z	H+2 Z	H+3 Z	H+4 Z	H+5 Z	H+6 Z	H+12 Z	H+24 Z		VERIFICATION 3	6	12	24
FCST										FCST				
OBS										PERS				
CC														

IS A BUST REVIEW REQUIRED? YES NO

FORECAST CATEGORIES: AWS CAT

AWS CAT
A= <500' ½ mile
B= ≥500' ½ mile <1000' 2 miles
C= ≥1000' 2 miles <3000' 3 miles
D= ≥3000' 3 miles

SUMMER

OSAN TERMINAL FORECAST WORKSHEET

DATE________________ FORECASTER________________

1. Current Conditions:
____a. Current wx influenced by______________________________

____b. Update continuity sfc and aloft.
____c. Review current satellite data.
____d. FPS 77 indicates______________________________
____e. Reviewed current pireps, FKUS Bulletins, rareps, observations.
____f. LAWC required?______________________________

2. Forecast Weather:
a. Upper Air:

	Temp advetn	Must advetn	SIG Feature	HGT Rises/Falls
850MB	______	______	______	______
700MB	______	______	______	______
500MB	______	______	______	______

b. FXPA 41:

	12 HR	18 HR	24 HR
Grad wnd	____	____	____
QP Fcst	____	____	____
THKNS(1000-500MB)	____	____	____
VV/SSI	__/__	__/__	__/__

c. FXAS:

	12 HR	24 HR
Vorticity	(+)(N)(-)	(+)(N)(-)
1000-500MB TKNS	______M	______M
700MB 2or5^{o} sprd	Yes/No	Yes/No

d. Jet Stream Located:______________________________.
e. Referred to FUXXX50________ FOKO________ FEAS________
FAXN________ FSXN________ PDPAs________
f. FJAS RKSO indicates cross/hatched areas at________Z. SSI at 12hrs________24hrs____
g. Changes expected in synoptic situation______________________________

Name development?________Z. FROPA?________Front Occluding?________

3. Sig Forecast Problems:
a. Fog and stratus: (1) CC Tables_____, (2) Wind 2000' & BLO 270-300^{o} & 5kts?_____ (Fog/Stratus), (3) Temp dew point spread 19L 6^{o}F?_____(Fog/stratus), (4) Dew point/sea SFC temp within 4^{o}C or less?_____(fog/stratus), (5) Yesterday's fog/stratus time________ to________. min vsby________., (6) Satellite data over yellow sea________.

b. Precipitation
(1) Thunderstorm - triggering mechanism and complete TSTM worksheet, (2) LAWC, (3) FXAS, (4) FJAS KGWC, (5) FXPA41, (6) FPS-77, (7) Skew T-Log P

4. Helpful Hints/R-O-T:
a. SFC temp 8^{o}F higher than previous day, no fog or stratus.
b. 24hr 1000MB temp increase? (increased thickness/duration of fog).
c. 24hr 1000MB temp decrease? (decreased thickness/duration of fog).
d. Recent precip during day which ended by evening and light wind circulation?

5. WSU coordination____________Initials____________
LPW required?____________MWA required?____________Low
LVL wnd shear?____________

Form 30WS 0-64
Apr 81

(12 HR TAF FOR LCL DISS) (STAPLE 24HR HARDCOPY HERE)

FORECAST: VLD: Z+0 Z MONTH: YEAR: FCSTER:

RKSO TAF

FREEZING LEVEL(S) CONTRAILS LEVEL

AMD#1 BEFORE AFTER INTER HRS REP HRS NON-REP

RKSO TAF AMD

FREEZING LEVELS

AMD#2 BEFORE AFTER INTER HRS REP HRS NON-REP

RKSO TAF AMD

VERIFICATION BY HRS

PERS	H+0 Z	H+1 Z	H+2 Z	H+3 Z	H+4 Z	H+5 Z	H+6 Z	H+12 Z	H+24 Z		VERIFICATION 3	6	12	24
FCST										FCST				
OBS										PERS				
CC														

IS A BUST REVIEW REQUIRED? YES NO

FORECAST CATEGORIES: AWS CAT

A= <500' ½ mile
B= ≥500' ½ mile <1000' 2 miles
C= ≥1000' 2 miles <3000' 3 miles
D= ≥3000' 3 miles

WINTER

OSAN TERMINAL FORECAST WORKSHEET

DATE________________ FORECASTER__________________

1. Current Conditions:

_____A current wx influenced by____________________.

_____B.Update continuity sfc and aloft.

_____C.Review current satellite data.

Indicates:__________________________________

_____D.FPS 77 indicates_____________________

_____E.Reviewed current pireps, FKUS Bulletins, rareps, observations.

_____F.LAWC required?_______________________

2. Forecast Weather:

a. Upper Air:

	Temp advetn	Must advetn	SIG Feature	HGT Rises/Falls
850MB	______	______	______	______
700MB	______	______	______	______
500MB	______	______	______	______

b. FXPA 41:

	12 HR	18 HR	24 HR
Grad wnd	____	____	____
QP Fcst	____	____	____
THKNS(1000-500MB)	____	____	____
VV/SSI	__/__	__/__	__/__

c. FXAS:

	12 HR	24HR
Vorticity	(+)(N)(-)	(+)(N)(-)
1000-500MB TKNS	______M	______M
700MB 2or5^{o} sprd	Yes/No	Yes/No

d. Jet Stream Located:______________________.

e. Refered to FUXX50__________ FOKO__________ FEAS__________

FAXN__________ FSXN__________ PDPAs__________

f. FJAS RKSO indicates cross/hatched areas at_______Z. SSI at 12hrs____24hrs____

g. Changes expected in synoptic situation____________________

Name development?__________Z. FROPA?__________Front Occluding?__________.

3. Sig Forecast Problems

a. Fog & stratus: (1) PP tables,(2) Low lvl wnds 270-330^{o} at 5-15kts, (3) Was there fog/stratus yesterday?________to________. min vsby?__________(4) Td depression less than 6^{o} after trof/front passage (past frontal), (5) Past snow T-Td less than 5^{o}F. (6) Recent frontal precip with light wind cir from SW-NW. (7) Satellite data and yellow sea.

b. Precipitation: (1) Snow-(see winter precip worksheet and LAFP rules), (2) LAWC, (3) FXAS, (4) FJAS KGWC, (5) FXPA 41, (6) FPS 77, (7) Skew T- Log P.

c. SFC Winds: (1) 5MB press Dif P-Y-DO-OSAN (20-30kts), (2) 5^{o} packing per 100mi at 850MB (20-30kts), (3) 10^{o} packing per 150mi at 850MB (30kts), (4) SFC inversion till____Z.

4. Helpful Hints/R-O-T

a. 3000' wnd 240-290^{o} - 85% chng CIGs $<$ 5000'

b. Onset of 2500-3500' CIGs-PSBL snow in 3 hrs

c. Backing winds - trof/front. Veering - stability

d. Do not fcst BLO zero temps unless ground is snow covered.

e. Most precip occurrs within 70% RH on LFM.

5. WSU coordination______________Initials______________

LPW required?______________MWA required?______________ Low LVL wnd shear?______________

30WS Form 0-63
Apr 81

THUNDERSTORM WORKSHEET

FCSTR __________ DATE __________

TOTALS INDEX

RKSO: 850MB Temp - 500MB Temp = __________(VT)
850MB Dew Pt - 500MB Temp=+ __________(CT)
__________(TT)

(VT 22-29) (CT 26-29) (TT 48-58)

SSI________ LI________ CCL________ TC________ LFC________ WBZ________

"K INDEX"

RKSO: a. 850MB Temp - 500MB Temp= __________
b. 850MB Dew Point = __________
c. 700MB Dew Point Spread= __________

(KI = A+B-C) KI= __________

K Value	Probability of TSTMS
< 15	0%
15-20	20%
21-25	20-40%
26-30	40-60%
31-35	60-80%
36-40	80-90%
> 40	Rear 100%

Probable Hail Size, if Applicable:____________________.

Probable SFC wind gusts, if applicable:________________.

850MB Winds______________________(230-290° -Optimum)

TSTMS FCST?__________Did TSTMS Occur?______________.

What, in your estimation, was the best predictor?

____

____

____

Form
30WS 0-59
Apr 81

DATE
FILMED

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