

AD-780 676

SUPPLEMENTAL GLOBAL CLIMATIC DATA:
JANUARY

C. Schutz, et al

RAND Corporation

Prepared for :

Defense Advanced Research Projects Agency

December 1973

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

R-915/2 ARPA

AD 780 676

DOCUMENT CONTROL DATA

1. ORIGINATING ACTIVITY The Rand Corporation		2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	
		2b. GROUP	
3. REPORT TITLE SUPPLEMENTAL GLOBAL CLIMATIC DATA: JANUARY			
4. AUTHOR(S) (Last name, first name, initial) Schutz, C. and W. L. Gates			
5. REPORT DATE December 1973		6a. TOTAL NO. OF PAGES 42	6b. NO. OF REFS. --
7. CONTRACT OR GRANT NO. DAHC15-73-C-0181		8. ORIGINATOR'S REPORT NO. R-915/2-ARPA	
9a. AVAILABILITY/LIMITATION NOTICES Approved for Public Release; Distribution Unlimited		9b. SPONSORING AGENCY Defense Advanced Research Projects Agency	
10. ABSTRACT The supplemental global distributions of sea-surface temperature, total cloud cover, planetary albedo, and outgoing long-wave radiation for January are presented as an update to all January data previously published (R-915, R-915/1). All data are presented on a global grid of 4 degree latitude and 5 degree longitude, both in the form of tabulated values and machine-analyzed maps. The corresponding zonal and global averages are also given. These data are being used at Rand as a guide for evaluating climate simulations based on the Rand version of the Mintz-Arakawa general circulation model.		11. KEY WORDS CLIMATE METEOROLOGY COMPUTER SIMULATION	

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

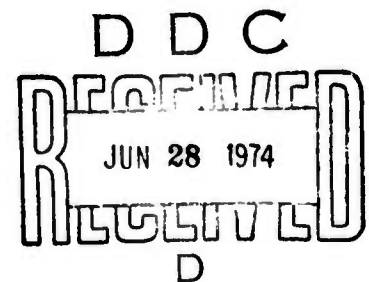
1.

42

R-915/2-ARPA
December 1973

Supplemental Global Climatic Data: JANUARY

C. Schutz and W. L. Gates



A Report prepared for
DEFENSE ADVANCED RESEARCH PROJECTS AGENCY



Preceding page blank

-111-

PREFACE

An important part of the Rand/ARPA research program on the dynamics of climate is the evaluation of the accuracy of simulations of the global climate given by numerical solutions of models of the general atmospheric circulation. To perform this evaluation systematically requires a knowledge of the global distributions of the primary climatic variables of pressure, temperature, humidity, wind, and precipitation, together with the associated distributions of global radiation elements and hydrologic balances. Such data are not readily available, and even those that are obtainable are usually in a variety of forms and not immediately comparable with other climatic data.

The data presented in this report follow the pattern of previous reports (Schutz and Gates, 1971, 1972, and 1973). In this January supplement, sea-surface temperature, total cloud cover, planetary albedo, and outgoing long-wave radiation data have been updated or added. Using the latest available data is in keeping with our objective of gathering in one place and in one format the most representative global climatologies of selected seasonal meteorological variables. A planned supplement for the quarterly data published for July will also include these new acquisitions. Except for the southern hemisphere cloud cover, which is only available for January and July, these supplementary data already appear in the publications for April and October.

Preceding page blank

-v-

SUMMARY

The supplemental global distributions of sea-surface temperature, total cloud cover, planetary albedo, and outgoing long-wave radiation for January are presented as an update to all January data previously published (Schutz and Gates, 1971 and 1972). All data are presented on a global grid of 4° latitude and 5° longitude, both in the form of tabulated values and machine-analyzed maps. The corresponding zonal and global averages are also given. These data are being used at Rand as a guide for evaluating climate simulations based on the Rand version of the Mintz-Arakawa general circulation model.

Preceding page blank

ACKNOWLEDGMENTS

Sincere appreciation is extended to several Rand colleagues for their valuable assistance: R. C. Alexander for his efforts in developing the data on sea-surface temperature and ice limits at high latitudes; L. D. Bregman for completing the arduous task of extracting the basic grid-point data from the varied global climatic charts; and R. L. Mobley and A. B. Nelson for reducing these data to the desired format and supervising the machine tabulations.

Preceding page blank

CONTENTS

PREFACE	iii
SUMMARY	v
ACKNOWLEDGMENTS	vii
Section	
1. INTRODUCTION	1
2. DATA SELECTION AND PROCESSING	2
Sea-Surface Temperature	2
Total Cloud Cover	4
Planetary Albedo	5
Outgoing Long-Wave Radiation	5
3. GLOBAL CLIMATIC ANALYSES	7
4. ZONALLY AVERAGED DATA	13
5. GLOBAL DATA TABULATIONS	19
REFERENCES	37

1. INTRODUCTION

The supplementary January data presented here for the sea-surface temperature, conventionally observed mean total cloud cover over the southern hemisphere, planetary albedo, and outgoing long-wave radiation represent refinements and additions to data presented in Schutz and Gates (1971 and 1972). They give the results of a continuing effort to use the best climatologies available in evaluating climate simulation experiments based on numerical general circulation models, the Mintz-Arakawa model in particular. The new January data appearing in this report are summarized in Table 1.1.

Section 2 discusses the data selection and processing. Section 3 presents a global analysis of each variable selected. The corresponding distribution of the zonal averages and the global average value are given in Sec. 4, and Sec. 5 gives tabulations of the associated grid-point data. The asterisk (*) in the grid-point data tabulations (Sec. 5) denotes missing data. These regions correspond to the blank or "no data" areas on the analyzed maps and zonal averages of Secs. 3 and 4. In the sea-surface temperature data in Secs. 3 and 5, the letter "I" is used to denote the locations of sea ice.

2. DATA SELECTION AND PROCESSING

This section briefly describes the processing of manipulation of each primary source of the mean data identified in Table 1.1. After a careful review of all known sources of pertinent data, we concluded that the sources used here represent the best collection of "global" data available at present, at least for the purpose of comparison with the model's global simulations. The observational content, special processing, and limitations of these data (including various record lengths) are discussed further in the data publications themselves. Although the present discussion refers primarily to the data of Figs. 3.1 through 3.4, it also applies to the corresponding zonally averaged data of Figs. 4.1 through 4.4, as well as to the supporting grid-point data presented in Tables 5.1 through 5.4.

SEA-SURFACE TEMPERATURE

Figure 3.1 shows the global distribution of average January sea-surface temperatures. The distribution is a composite of the January normals obtained from the National Center for Atmospheric Research (Washington and Thiel, 1970) and from the Fleet Numerical Weather Central in Monterey (northern hemisphere only). The grid elements containing more than 50 percent of sea ice are denoted by "I" in Fig. 3.1. This convention introduces a bias toward more severe ice conditions. (For example, if 60 percent of an area contains ice of 60-percent concentration, only 36 percent of the area is actually covered by ice.) This practice may partly compensate for the usual bias in the data toward calm, warm weather and ice-free conditions when ships can operate. These data on the 4°-latitude, 5°-longitude grid were taken from the appropriate points (without smoothing) of the global 1° tabulation being prepared by Alexander and Mobley (1973). These authors also give details on interpolation, merging of data sets, and treatment of ice limits.

Table 1.1

IDENTIFICATION OF SELECTED CLIMATIC VARIABLES FOR JANUARY

Data or Variable	Unit	Source	Maximum Record Period	Pages ^a
Temperature (sea surface)	deg C	Alexander and Mobley (1973)	Various	9, 15, 21
Cloudiness	Tenths	Environmental Technical Applications Center (1971) Van Loon et al. (1972)	1963-1968 Various	10, 16, 25
Albedo (planetary)	Fractions	Vonder Haar (1972)	1963-1966 and 1969-1970	11, 17, 29
Outgoing long-wave radiation	10^2 ly/day ⁻¹	Vonder Haar (1972)	1963-1966 and 1969-1970	12, 18, 33

^aThe numbers in this column are the page numbers in this report of the global map analyses, the zonally averaged data, and the global data tabulations, respectively.

TOTAL CLOUD COVER

The distribution of total cloud cover shown in Fig. 3.2 was developed separately for the northern and southern hemispheres. The northern hemisphere portion appeared in the original January report (Schutz and Gates, 1971), and was constructed from the digitized representation of both satellite and conventional observations compiled by the Global Weather Central (GWC) for the Environmental Technical Applications Center (1971). These data were collected at 0000Z and 1200Z and were compiled for this presentation in terms of the total cloud cover C from the formula

$$C = \sum_{N=0}^8 \frac{C_{00,N} + C_{12,N}}{2} \frac{N}{8},$$

where $C_{00,N}$ and $C_{12,N}$ are the percentages of the 00Z and 12Z observations that have N -eighths cloud cover. These digitized cloud data appear on the GWC grid. This is a square grid with octagonal boundaries superimposed on a polar stereographic projection, with a southern boundary at approximately 15°N . Equations from Murray (1962) were used to transform the latitude and longitude of each of the 46×72 points of the present grid to the coordinates in the GWC grid, followed by a bilinear interpolation using the four nearest GWC grid values.

Since the northern hemisphere data of Fig. 3.2 contain all modern cloud observations, during both day and night hours, they are considered the best available representation of northern hemisphere total cloud cover. In an effort to obtain global coverage, however, the climatological composite of total cloudiness for the southern hemisphere in January from van Loon et al. (1972) was added. It is a subjective fusion of the total cloudiness as discussed by Brooks (1927), Landsberg (1945), Vowinckel and van Loon (1957), Clapp (1964), and Sadler (1969), and shown in the marine climatological atlases of Germany, the Netherlands, the United Kingdom, and the United States. Since it shows many of the better-known features of the total cloud cover, such as the zones of high mean cloudiness over the eastern parts of the oceans in the tropics, it is probably a reasonably good picture of the total cloudiness.

PLANETARY ALBEDO

The December-January-February mean planetary (world) albedo values shown in Fig. 3.3 were summarized from satellite data during the periods including December-January-February 1963/1964, 1964/1965, December 1966, and January 20, 1969, through February 3, 1970. These data, the most up-to-date available, were reduced at Colorado State University into seasonal global maps as discussed by Vonder Haar (1972). They were transcribed directly onto the 4°-latitude, 5°-longitude grid for this report.

OUTGOING LONG-WAVE RADIATION

The December-January-February outgoing long-wave radiation data shown in Fig. 3.4 were also interpolated directly onto the 4°-latitude, 5°-longitude grid from the data of Vonder Haar (1972). These measurements cover the same periods as do the planetary albedo data.

Preceding page blank

-7-

3. GLOBAL CLIMATIC ANALYSES

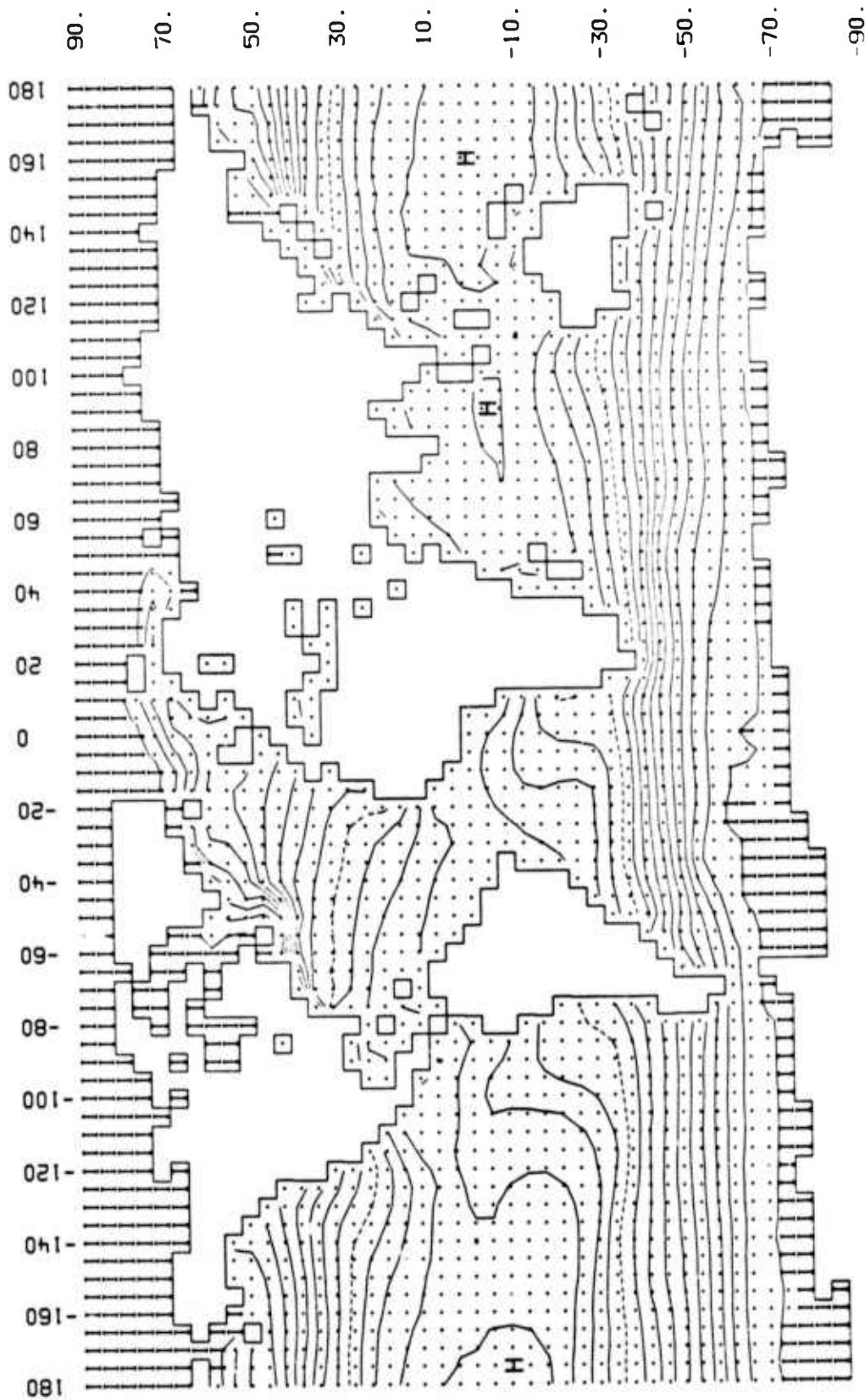


Fig. 3.1--January mean sea-surface temperature in deg C. The analysis interval is 2 deg, and the 20 deg C isotherm is dashed. "H" denotes grid elements with sea ice. Interpolated from a composite of normals formed in Alexander and Mobley (1973)

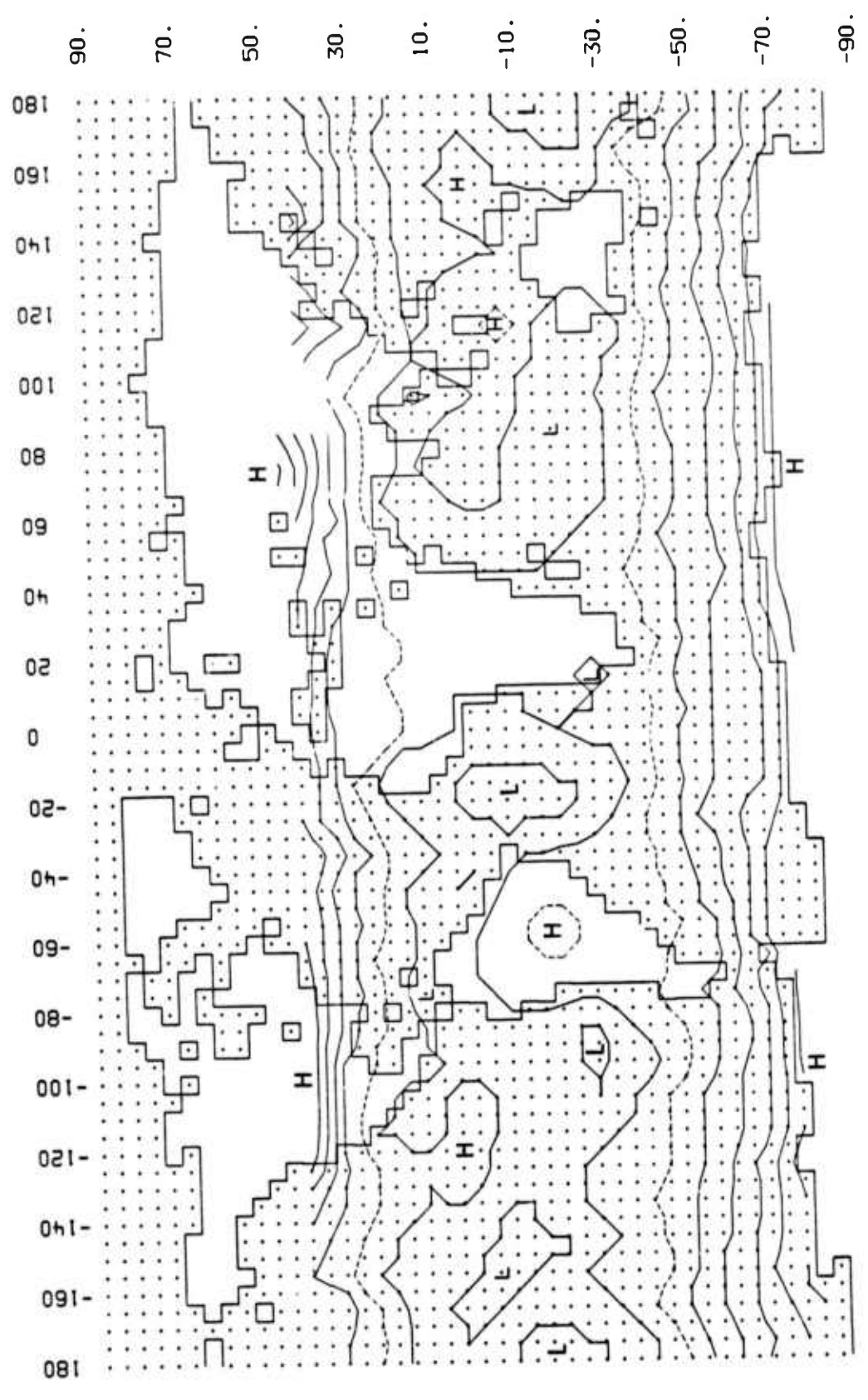


Fig. 3.3--December-January-February mean planetary (world) albedo (fractions). The analysis interval is 0.05, and the 0.3 isoline is dashed. Data are from Vonder Haar (1972)

4. ZONALLY AVERAGED DATA

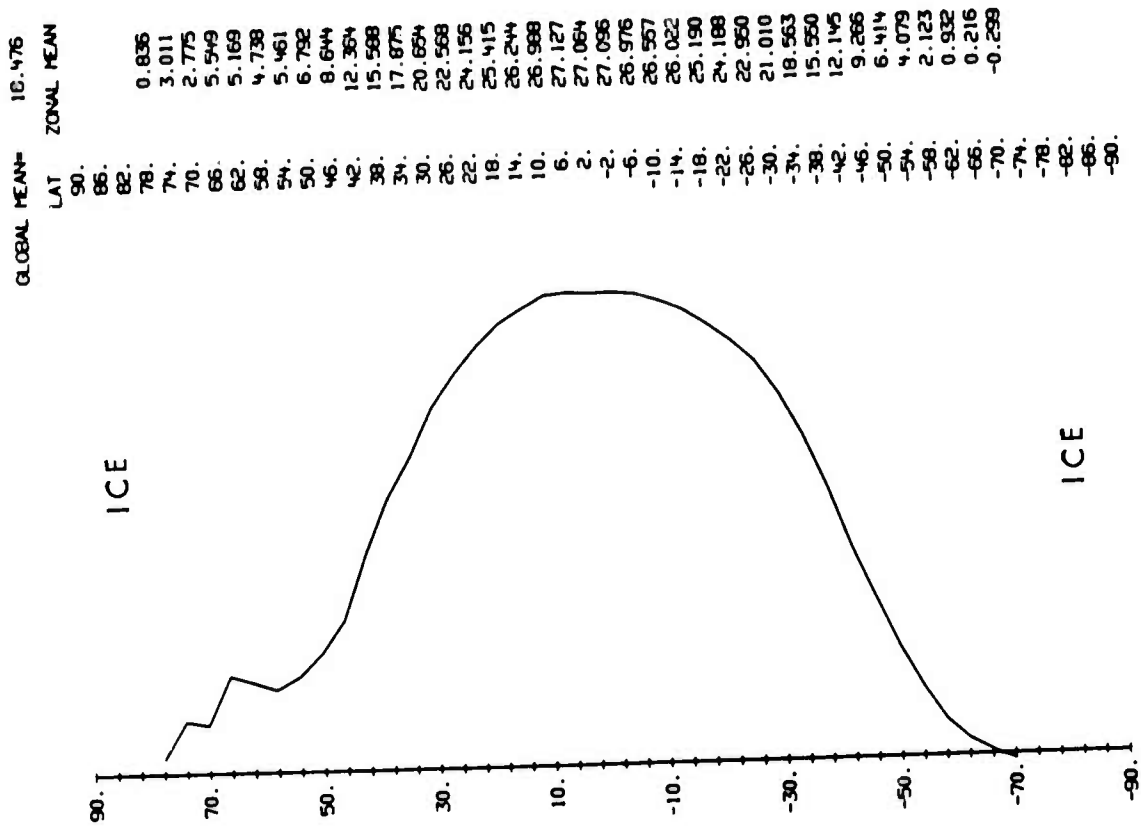


Fig. 4.1--January zonally averaged mean sea-surface temperature in deg C, as found from the data of Fig. 3.1

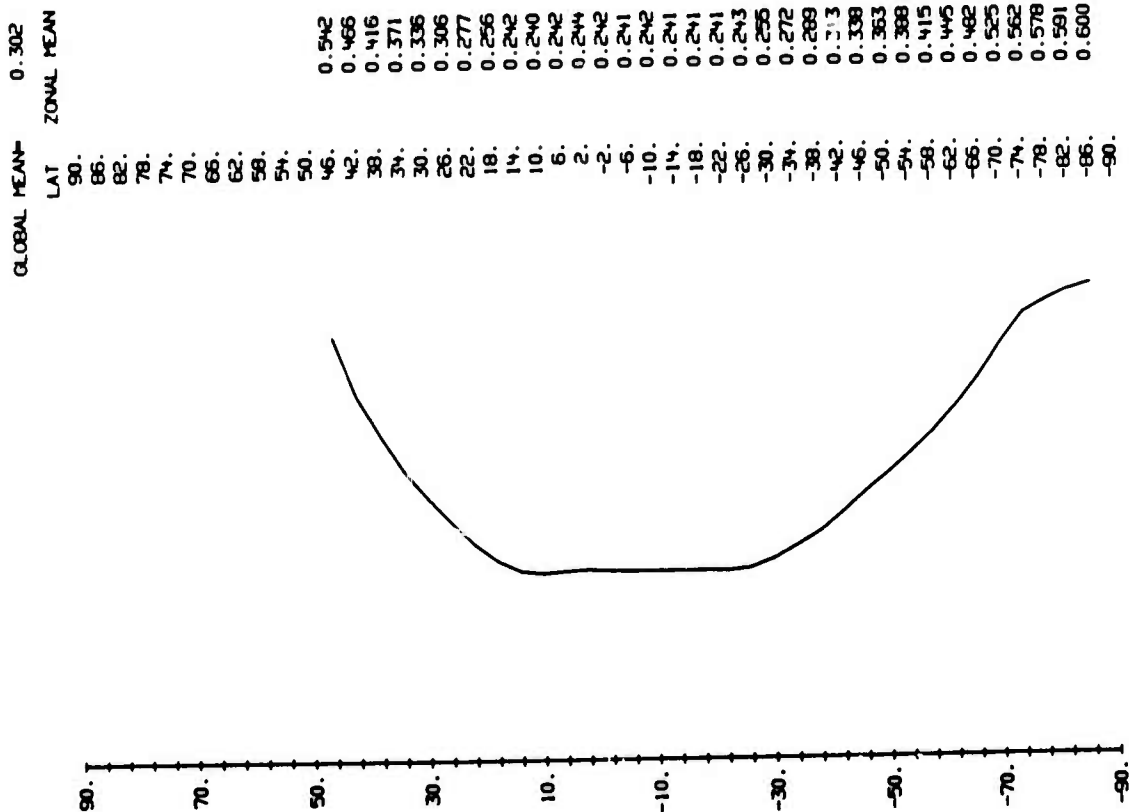


Fig. 4.3--December-January-February zonally averaged mean planetary albedo, in fractions, as found from the data of Fig. 3.3

5. GLOBAL DATA TABULATIONS

REFERENCES

- Alexander, R. C., and R. L. Mobley, *Updated Global Monthly Mean Ocean Surface Temperatures*, The Rand Corporation, R-1310-ARPA, 1973 (in preparation).
- Brooks, C. E. P., "The Mean Cloudiness over the Earth," *Memoirs of the Royal Meteorological Society*, Vol. 1, No. 10, 1927, pp. 127-139.
- Clapp, P. F., "Global Cloud Cover for Seasons Using TIROS Nephanalysis," *Monthly Weather Review*, Vol. 92, 1964, pp. 495-507.
- Environmental Technical Applications Center, *Northern Hemisphere Cloud Cover*, Project No. 6168, Department of the Air Force, Washington, D.C., 1971.
- Landsberg, H., "Climatology," *Handbook of Meteorology*, ed. F. A. Berry, E. Bollay, and N. R. Beers, McGraw-Hill Book Company, New York, 1945, pp. 927-997.
- Murray, F. W. (ed.), *Relation between Geographical Coordinates and GWC Grid Coordinates*, Scientific Service Technical Note No. 1, Headquarters 3rd Weather Wing, Offutt Air Force Base, Omaha, Nebraska, February 1962.
- Sadler, J. C., *Average Cloudiness in the Tropics from Satellite Observations*, East-West Center Press, Honolulu, 1969, 22 pp. and maps.
- Schutz, C., and W. L. Gates, *Global Climatic Data for Surface, 800 mb, 400 mb: January*, The Rand Corporation, R-915-ARPA, November 1971.
- Schutz, C., and W. L. Gates, *Supplemental Global Climatic Data: January*, The Rand Corporation, R-915/1-ARPA, May 1972.
- Schutz, C., and W. L. Gates, *Global Climatic Data for Surface, 800 mb, 400 mb: April*, The Rand Corporation, R-1317-ARPA, December 1973.
- Schutz, C., and W. L. Gates, *Global Climatic Data for Surface, 800 mb, 400 mb: July*, The Rand Corporation, R-1029-ARPA, November 1972.
- Schutz, C., and W. L. Gates, *Global Climatic Data for Surface, 800 mb, 400 mb: October*, The Rand Corporation, R-1425-ARPA (in preparation).
- Van Loon, H., J. J. Taljaard, T. Sasamori, J. London, D. V. Hoyt, K. Labitzke, and C. W. Newton, "Meteorology of the Southern Hemisphere," *Meteorological Monographs*, Vol. 13, No. 35, American Meteorological Society, November 1972.

Vonder Haar, T. H., "Natural Variation of the Radiation Budget of the Earth-Atmosphere System as Measured from Satellites," *Proceedings of the Conference on Atmospheric Radiation*, Fort Collins, Colorado, August 7-9, 1972. To appear in *Journal of Applied Meteorology*, 1973.

Vowinckel, E., and H. van Loon, "Das Klima des Antarktischen Ozeans: III Die Verteilung der Klimaelemente und ihr Zusammenhang mit der allgemeinen Zirkulation," *Archiv für Meteorologie, Geophysik und Bioklimatologie*, Vol. B8, 1957, pp. 75-102.

Washington, W. M., and L. G. Thiel, *Digitized Global Monthly Mean Ocean Surface Temperatures*, NCAR-TN-54, National Center for Atmospheric Research, Boulder, Colorado, 1970.