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TIME-VARIABLE EARTH'S ALBEDO MODEL CHARACTERISTICS AND APPLICATIONS TO SATELLITE SAMPLING ERRORS

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ABS: Characteristics of the time variable Earth albedo model are described. With the cloud cover mulitplying factor adjusted to produce a global annual average albedo of 30.3, the global annual average cloud cover is 45.5 percent. Global annual average sunlit cloud cover is 48.5 percent; nighttime cloud cover is 42.7 percent. Month-to-month global average albedo is almost sinusoidal with maxima in June and December and minima in April and October. Month-to-month variation of sunlit cloud cover is similar, but not in all details. The diurnal variation of global albedo is greatest from November to March; the corresponding variation of sunlit cloud cover is greatest from May to October. Annual average zonal albedos

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Abstract

Characteristics of the "time variable earth albedo" model are described. With the cloud cover multiplying factor adjusted to produce a global annual average albedo of 30.3, the global annual average cloud cover is 45.5%. Global annual average sunlit cloud cover is 48.5%, nighttime cloud cover is 42.7%. Month to month global average albedo is almost sinusoidal with maxima in June and December (highest) and minima in April (lowest) and October. Month to month variation of sunlit cloud cover is similar, but not in all detail. The diurnalvariation of global albedo is greatest from November to March, the corresponding variation of sunlit cloud cover is greatest from May to October. Annual average zonal albedos and monthly average zonal albedos are in good agreement with satellite measured values of Ellis and Vonder Haar (1976), with notable differences in the polar regions in some months and at 15°S. The albedo of some 10° - 10° areas of the earth vs zenith angle are described.

Satellite albedo measurement sampling effects are described in local time and in Greenwich mean time. Regions on the earth are shown where satellite samples are obtained at 00:00 and 12:00 GMT (synoptic sampling times). Errors in satellite measured monthly average albedos of local areas are determined to be under 3.5% for 66% of the measurements obtained for the one satellite system, 92% for a two satellite system and 97% for a three satellite system.

1. Introduction

The work described in this report is a continuation of earlier efforts on "A Time Variable Model of Earth's Albedo" which is described in a report having that title (Bartman, 1980). During that initial phase of the work a time variable model of Earth's albedo was developed in the form of the FORTRAN computer program AVALB which uses three data files:

(a) SALB4: surface albedo data

(b) CNREG: cloud climatological type regions

(c) PRCLC: percent cloud cover data

Diurnal and monthly albedo variations were described briefly in the report and the results were compared with the zonal averages of Ellis and Vonder Haar (1976) which are based on satellite measurements.

Another FORTRAN computer program (ORBITS) was also written for use in studying the sampling effects in satellite radiation budget measurements; some results of calculations with this program were compared with a previous study of the sampling effects (Woerner and Cooper, 1977).

In the continuation of the work, which is described herein, the programs were improved. The original programs were modified to run under the NASA Langley Research Center computer system. Additional programs were also written. The results of this work, which are described in more detail in the following sections of this report are:

(a) A summary of some of the characteristics of the cloud cover model used, including diurnal and monthly variations

(b) The diurnal and monthly changes in global, zonal and local area albedos

(c) Satellite albedo measurement sampling effects shown in several different ways:

(i) Sampling in latitude and longitude as a function of local Sun time and as a function of GMT

(ii) Sampling in Sun's zenith angle as a function of GMT

(iii) Sampling in zonal regions versus Sun's zenith angle

(d) Results of a new program FORBALB, which combines ORBITS and AVALB, showing errors in satellite measured albedos under idealized conditions.

2. Some Definitions

Global Albedo: Planetary albedo. Generally values are averaged over some time period. In this report annual and monthly averages are referred to. However, instantaneous values are also referred to when the variation of global albedo during a 24-hour period is discussed. The variation during the 24-hour period is due to time variations and also due to the fact that as the Earth turns, different portions of the Earth are illuminated by the Sun.

Zonal Albedo: The albedo of a 10° latitude zone averaged over all 360° of longitude around the Earth. Annual and monthly time averages are considered in this report. The variation of zonal albedos during a 24-hour period as the Earth turns is not considered in this report, but will be in future work.

Local Area Albedo: The albedo of a $10^{\circ} \times 10^{\circ}$ latitude-longitude area. Annual and monthly time averages are discussed. Diurnal variations of an individual area on the Earth's surface are also considered briefly when the satellite sampling effect for a local area is discussed in terms of solar zenith angle.

Albedo of Cloud Climatology Region (Cloud type region): The area of a cloud type region varies from one to many contiguous $10^{\circ} \times 10^{\circ}$ latitude-longitude areas. In some cases a cloud type region will consist of several non-contiguous areas. In some cases a cloud type region will include several zonal regions plus portions of others.

3. Characteristics of Cloud Cover Used in the Albedo Model:

A modified version of the world-wide cloud cover distributions of Sherr, Glasen and Willand (1968) is used in the time variable albedo model. Detailed characteristics of this cloud cover data are summarized in tables in the previous report (Bartman, 1980). Five fractional cloud categories: 0, 1-3, 4-5, 6-9, and 10 tenths are specified for 29 cloud climatological regions, for eight times of the day, and for each month of the year.

Since the cloud climatic areas of Sherr et al. did not begin and end on the $10^{\circ} \times 10^{\circ}$ latitude-longitude regions of our model, his map areas were modified to fit our model. Table 1 shows the cloud climate regions used for each $10^{\circ} \times 10^{\circ}$ area in our model.

Sherr's general description of the nature of the clouds in each cloud climatic region is given in table 2. The detailed cloud cover data used is given in tables B-1 to B-96 in the previous report (Bartman, 1980). Monthly and yearly averages of percent cloud cover for each of the 29 cloud climatic regions are shown in table 3. The global annual cloud cover for these data is 60.6 percent.

The value of 60.6 percent is quite high compared to previous estimates of global annual cloud cover. Hoyt (1976), in his study of the radiation and energy budgets of the Earth, has summarized ground based and satellite derived values of total cloud cover. He gives values of global annual cloud cover of 53.2 percent (ground-based data) and 39.6 percent (satellite-derived values).

A multiplying factor GLCLC/60 was incorporated into the cloud cover data used in this model. By means of this factor the global annual cloud cover can be varied to study the effect of changing cloud cover on albedo. The value of GLCLC = 45 gave a result for global annual average albedo of 30.3 percent which agreed reasonably well with satellite measurements and gave a value of 45.5 percent global annual average cloud cover.

The month to month variation of global average cloud cover is shown in figure 1 (curve b). There is an absolute minimum of 43.9 percent in February and a minor minimum of 44.6 percent in October. The absolute maximum of 47.5 percent occurs in December with a minor maximum of 46.5 percent in June.

3.1 Sunlit Cloud Cover

Since it is the cloud cover under sunlit conditions which affects Earth's albedo, monthly average sunlit cloud cover values are also shown in figure 1 (curve a). Average sunlit cloud cover is always greater than 24-hour average cloud cover. The global annual average sunlit cloud cover is 48.3 percent with an absolute maximum in December of 52.2 percent and an absolute minimum of 46.3 percent in April.

Since the 24-hour global annual average cloud cover is 45.5 percent, this value of 48.3 percent global annual average sunlit cloud cover implies that the global annual average nighttime cloud cover is only 42.7 percent.

The average cloud cover in the sunlit hemisphere varies as the Earth rotates, i.e., varies as a function of the longitude of the sub-solar point. That variation is shown in figure 2 for each of the 12 months of the year. The largest variation occurs in July, however, the variation is quite large for the time period of May-October, late spring-summer-early autumn in the Northern Hemisphere. The minimum variation is in March, with a rather small variation in the period November-April, late spring-summer-early autumn in the Southern Hemisphere.

In July the sub-solar point longitude of maximum sunlit cloud cover is 135^{o}W, the minimum occurs at about 0-30^{o}W. Since the solar declination in July is 21.5^{o}N, the sub-solar point for maximum sunlit cloud cover would be located at 135^{o}W, 21.5^{o}N in the Pacific Ocean, about halfway between Hawaii and Mexico. The sub-solar point for minimum sunlit cloud cover in July would be located at about 15^{o}W, 21.5^{o}N, in the Atlantic Ocean just south of Liberia.

4. The Variability of Global, Zonal and Local Area Albedos

4.1 Global Albedo

Monthly average values of global albedo are shown in figure 3. These results were obtained with the cloud cover multiplying factor GLCLC set equal to 45. This produced a global annual average cloud cover of 45.5 percent and a global annual average albedo of 30.3 percent, which is in reasonably good agreement with satellite measured values, i.e., 30 percent (Vonder Haar and Suomi, 1971).

Figure 3 shows minima of albedo in March and August when the sub-solar point is close to the equator and maxima in June and December when the north pole and south pole, respectively, are illuminated by the Sun. The albedo maxima correspond to monthly average sunlit cloud cover maxima in June and December (see fig. 1); however, the albedo minima in March and August do not correspond exactly to the sunlit cloud cover minima which occur in April and October, respectively.

The variation of global albedo as the Earth rotates is shown in figure 4 for each month of the year. This figure shows curves of global albedo as a function of the longitude of the sub-solar point. The variation is greatest from November through March, when the sub-solar point is in the Southern Hemisphere. During this 5-month period the global albedo is a minimum when the longitude of the sub-solar point is about 135^{o}W, when the illuminated hemisphere of the Earth includes a large amount of ocean area. Maxima of albedo occur for sub-solar point longitudes of 15^{o}W and 270^{o}W, when the illuminated hemisphere of the Earth includes a large amount of continental area. Note that for this period of November through March the diurnal variation of percent cloud cover is not very large.

The variation of global albedo with longitude of sub-solar point is relatively small from May through September. This is the time period of the year when the corresponding variation of sunlit cloud cover is the largest. However, during these months the sub-solar point is north of the equator and the hemisphere of the sunlit Earth always includes a very large portion of continental area. Although the longitudinal variation of global albedo is not very large during these months it is a minimum for a sub-solar longitude of 315^{o}-330^{o}W, over Saudia Arabia or Somalia, and where the average sunlit cloud cover is nearly a minimum. Maxima of global albedo during this May-September period occur when the sub-solar longitude is about 75^{o}W and 210^{o}W, i.e., north of Venezuela and Australia, respectively.

4.2 Zonal Albedos

The annual average values of zonal albedo produced by the model are shown in figure 5 and in table 4. The zonal average values of Ellis and Vonder Haar (1976), which were obtained from 29 months of satellite measurements, are shown for comparison. The agreement between the model and satellite data is generally within about 5%. The most striking disagreement is at latitude 15°S, where the minor maximum of the model data does not appear in the satellite data. This feature in the model is mainly due to cloud cover. The resolution of the satellite is said to be such that "The numbers and graphs should be considered as representing fluxes of 10° to 20° latitude zones." Thus this kind of feature would be considerably smoothed in the satellite data.

Monthly average values of zonal albedo are given in tables and are shown in figures 6a to 6d, along with the satellite data of Ellis and Vonder Haar (1976). The agreement between the model data and the satellite data is not as good as in the annual average case. Noticeable disagreements exist at 85°S, 15°S and in the northern latitudes, especially towards the north pole, in each case for about 6 of the 12 months of the year. The model assumptions and detailed formulation need to be carefully examined to see whether the cause of this lack of agreement can be determined.

4.3 10° - 10° Area Albedos

Selected monthly average 10° - 10° area albedos are shown in figures 7a to 7i. The areas selected are all at about the same longitude, but vary in latitude from the north polar region to the south polar region.

Each figure shows the monthly average albedo vs zenith angle. The results include the effect of percent cloud cover change as a function of time, which accounts for some of the inequalities in the curves. Monthly and annual average values of albedo for each of these 10^0 - 10^0 areas are given in table 5.

5. Satellite Albedo Measurement Sampling Effects

5.1 Sampling in Local Time

The computer program "Orbits" has been used to study the sampling characteristics of the orbits of satellites used to measure earth's albedo. A three satellite system with orbital characteristics listed below was considered.

No.	Altitude	Declination	Northbound Equator Crossing Time	Note
1.	833 Km	98.74°	08:00	Sun-synchronous
2.	833 Km	98.74°	15:00	Sun-synchronous
3.	600 Km	50.00°	12:00 (noon) *	Period = 96.654 min.

The results of these calculations for 31 days of sampling, January 1 to January 31, at the rate of one sample per minute are shown in tables 6 to 20. Tables 6 to 8 show the zonal sampling for the satellite system. Table 6 shows the sampling by satellite number 1 which is in an 8:00 sun-synchronous orbit. Table 7 shows the sampling by satellites 1 and 2, in 8:00 and 15:00 sun-synchronous orbits respectively. Table 8 shows the sampling by the three satellite system indicated above. Each table shows the number of samples in each 10° latitude zone as a function of local time, one column for each of 24 hour periods during the day. In each case the sample position is taken to be that of the sub-satellite point. The one hour period corresponding to each time shown is the interval between the time shown minus 0.5 hour and the time shown plus 0.5 hour.

Similar results for a 30 day sampling period are shown in Bartman (1980) and are compared with results of Woerner and Cooper (1977) in that report.

*time of first northbound equator crossing on first day of each month.

The tables show that the gaps in local time sampling by the sun-synchronous satellites are partially filled in by the 50° orbit satellite. There are three noticeable major gaps remaining in each hemisphere, of maximum latitude-time extent as follows.

Maximum Latitude Spread	Maximum Time Spread
N.H. 80° to 20°	21:30 - 02:30
N.H. 80° to 50°	07:30 - 12:30
N.H. 90° to 60°	11:30 - 23:30
S.H. 90° to 50°	23:30 - 11:30
S.H. 80° to 50°	19:30 - 00:30
S.H. 80° to 20°	9:30 - 14:30

Sampling in longitude at a given local time for the same period of 31 days, January 1 to January 31 is shown by tables 9 to 11. In these tables, the samples taken in each 10° - 10° region in the 08:00 time period for the 31 days of January are shown. Again the results for one, two and three satellites are shown, table 9 for satellite 1, table 10 for satellites 1 and 2 and table 11 for satellites 1, 2 and 3. The sampling in latitude corresponds to the latitude sampling shown in tables 6, 7 and 8 respectively and is quite uniformly spread in longitude. Whereas there are longitude gaps for the 1 and 2 satellite systems, there are none for the 3 satellite system.

Latitude - Longitude sampling similar to the 08:00 time period of tables 8 to 11 are given for the 3 satellite system for each of the 24 hour periods in the day in Bartman (1980).

5.2 Sampling in Greenwich Mean Time

Zonal sampling as a function of GMT is shown in tables 12 to 14. These tables show that for each of the three satellite systems, for the 31 days in January, there is sampling in each latitude zone at each of the 24 hours of GMT. In particular, there is sampling in each latitude zone for the synoptic time periods 00:00 GMT and 12:00 GMT.

The latitude-longitude distribution of sampling for the three satellite systems, for the 31 days of January, for each of the synoptic time periods 00:00 GMT (24:00 GMT) and 12:00 GMT are shown in tables 15 to 20. Synoptic sampling is possible only for a small portion of the globe for the 1 and 2 satellite systems, however, for the 3 satellite system, synoptic sampling (on the average, for the month) is possible for 287 of the 648 10° - 10° latitude-longitude zones. Between latitudes +50° to -50°, 267 out of 360° 10 - 10° areas are sampled synoptically on the average for the month.

5.3 Sampling in Sun's Zenith Angle

The computer programs AVALB and FORBALB yield information on sampling as a function of sun's zenith angle. AVALB yields information on the range of sun's zenith angle at a given location as a function of the time of the year. FORBALB shows the sun's zenith angle for the satellite sampling. Some of these results are shown in figures 8a to 8f.

Each figure shows zenith angle sampling for several cloud type regions for each of the 12 months of the year. The envelope of each figure defines the range of zenith angles experienced by each cloud type region, the vertical lines indicate the range of zenith angles sampled by satellite 1 (left vertical line), satellite 2 (right vertical line) and satellite 3 (center vertical line). For example, consider the diagram for cloud type region 1 (NT = 1) for September. The range of zenith angles experienced by region one is 90^{0} to 20^{0}. The range of zenith angles experienced by region one is 90^{0} to 20^{0}. The range of zenith angles sampled by satellite 1 is 60^{0} to 40^{0}, by satellite 2, 66^{0} to 40^{0} and by satellite 3, 90^{0} to 20^{0}.

In some cases, the line representing the sampling by a given satellite is a broken line with two or more sections. This is because that particular cloud type region is located at several locations on the earth separated one from the other. In many cases, the apparent sampling by satellite 3 is greater than the range indicated by the envelope. This is because in the one program (AVALB) calculations are made for the month with a fixed solar declination angle corresponding to the 15th of that month, whereas, in the other program (FORBALB), the solar declination is allowed to change from day to day during the month.

In general, the zenith angle sampling by satellite 3 is very complete, with the following exceptions; NT = 8, in February; NT = 9, in February, March, April, June, October, November; NT = 14, in February, April, June, July, September, October; NT = 15, throughout the entire year; NT = 23, January, March; NT = 24, throughout the entire year.

On the other hand, the zenith angle sampling by satellites 1 and 2 is mostly quite incomplete, except that they supply most of the zenith angles missed by satellite 3 for NT = 8, 9, 14, 15, 23 and 24, as indicated above.

6. Errors in Satellite Measured Albedos Due to Selective Sampling

The errors in satellite measured albedos are difficult to establish. Instrument calibration errors, biases introduced by the methodology used to correct instrument readings to fluxes at the top of the atmosphere and the selection sampling due to the satellite orbit characteristics all contribute to the final errors in the measured albedos.

The computer program FORBALB which combines the program "ORBITS" with the time variable earth's albedo model "AVALB" was used to determine measured values of earth's albedo. These "measured" values are then compared with the "actual" albedo values of AVALB to determine errors due to the satellite selective sampling.

In the program FORBALB it is assumed that satellite measurements are converted to fluxes at the top of the atmosphere without error. The monthly average albedo of a 10 - 10° area in the model is assumed to be equal to the radiant energy weighted average of the measured albedos. The difference between "satellite measured" values obtained in this fashion and the "true" values obtained from AVALB are a measure of the errors produced by satellite selective sampling.

Table 21 is an example of the results obtained for the 10° - 10° area located between latitudes 0 - 10° north and longitudes 235 to 245° W. The cloud type region for this area is type 3. The table shows average values for this area for each month of the year. Satellite measured values are shown for each of the three satellites separately and also for the average of the "measurements" of satellites 1 and 2 and for the average of the "measurements" of satellites 1, 2 and 3, respectively. The percent difference between the true and "measured" values are shown below. The first column shows the percent error of satellite 1 "measurements," the second column shows the error of the average of the "measurements" of satellites 1 and 2, and the last column, the error of the average of the "measurements" of all three satellites.

	1	$\overline{12}$	$\overline{123}$
J	-6.7	-5.4	-3.4
F	-5.5	-2.9	-3.3
M	-2.0	-1.9	-1.3
A	-1.9	-1.9	-2.2
M	0.3	1.0	0.6
J	-0.7	0.8	0.1
J	1.2	1.1	0.8
A	1.6	1.8	1.0
S	0.0	0.8	0.2
O	-0.5	0.8	-0.4
N	-0.6	0.0	-0.5
D	-3.1	-1.7	-2.8

Results from eight other 10 - 10^{o} areas have been obtained so far. All areas were located in the 240^{o} longitude region, but at different latitudes from 75^{o}N to 85^{o}S. Each area had a different cloud type region. The results are shown in figure 9a, for 4 regions in the northern hemisphere, and in figure 9b, for 5 regions in the southern hemisphere. In each graph, the error of the average "measurement" of satellites 1 and 2 is almost always less than or equal to the error of the measurement of satellite 1. In those latitudes where satellite 3 makes measurements, 50^{o}N to 50^{o}S latitude, the error of the average of the "measurements" of all three satellites is generally less than the error of the average of satellites one and two, with one striking exception, that of K=10, J=24 and NT=4 at the top of figure 9b. In that case the error for the three satellite case is greater than the error for the two satellite case for 9 of the 12 months of the year (April through December). The explanation of this result is not known at this time.

A brief summary of these sample results is that for satellite 1, 66% of the results had errors less than 3.5%, 27% had errors in the range 3.5% to 7% and 7% had errors greater than 7%. For the averages of the measurements of satellites 1 and 2 the results were 93%, 7% and 1% respectively and for the average of all three satellites 97%, 3% and 0%, respectively. The improvement in going from the single satellite system to the three satellite system is apparent.

7. Summary

The characteristics of the time variable earth's albedo model and the characteristics of cloud cover used in the model can be summarized as follows:

a. Global annual average values

Cloud cover in sunlight	48.5%
Cloud cover in darkness	42.7%
Total cloud cover (24 hour)	45.5%
Albedo 30.3	

b. Global Month to Month Variations

sunlit cloud cover: maxima in June and December (highest), minima in April (lowest) and October.

total cloud cover: maxima in June and December (highest), minima in February (lowest) and October

Albedo: maxima in June and December (highest), minima in March and August (lowest).

c. Variations as Earth Rotates (Diurnal Global Variations)

sunlit cloud cover: large variations from May to October, maximum variation in July centered at 135°W, 21.5°N. Small variations from November to April, minimum in March, centered at 15°W, 21.5°N.

Albedo: large variations from November to March with minimum of 135°W, maximum at 90°E - 15°W. Small variations from May to December, with minimum at 315° - 330°W, maximum at 75° to 210°W.

d. Annual average zonal albedo: Agrees with satellite measured results of Ellis and Vonder Haar (1976) except at 15°S, where the model has a peak which does not appear in the experimental data.

e. Monthly Average Zonal Albedos: Agrees with satellite measured values except at 85°S, 15°S and at northern latitudes, especially near the north pole, in each case the disagreement is for about 6 months out of the year.

f. Albedo of 10° - 10° areas vs zenith angle: Data of monthly average albedo vs zenith angle are shown for 9 areas located at about 240°W. longitude and ranging in latitude from 80 - 70°N to 80 - 90°S. These figures show the changing zenith angle range at a given location as a function of the time of the year. The curves also indicate the effect of changing cloud cover as a function of time during the day, particularly the differences, at the same zenith angle, between morning and afternoon.

g. Satellite Albedo Measurement Sampling Effects (Monthly Averages)

   i. Sampling in Local Time: The three satellite system gives reasonably complete sampling at all latitudes at all local times, there are some gaps in the coverage. Longitude coverage is complete for those latitude-local time combinations that are covered.

   ii. Sampling in GMT: Latitude sampling is complete for all 24 hours of GMT. However, all longitudes are not covered at each latitude. At meteorological synoptic times of 00:00 GMT and 24:00 GMT only 285 out of the 648 10° - 10° lat.-longitude regions on the earth are sampled at both synoptic times by the 3 satellite system, 267 of these are in the 50°N to 50°S region of the earth (out of 360).

iii. Sampling in Sun's Zenith Angle: Sampling in sun's zenith angle for each of the 29 cloud climatological zones is quite complete, except for the following:

NT = 15 all year

NT = 9 in February, March, April, June, October, November

NT = 14 in February, April, June, July, September, October

NT = 23 in January, March

NT = 24 all year

h. Errors in Satellite Measured Albedos of 10° - 10° Areas Due to Sampling Effects: The decrease of errors due to sampling effects as we go from a single satellite to the three satellite system is apparent. For nine 10° - 10° latitude-longitude areas, ranging from 80 - 70°N to 80 - 90° south, having 9 different cloud type regions, the errors of monthly averages are as follows:

Satellites	% Error		
	3.5%	3.5 - 7%	7%
1	66%	27%	7%
1 and 2	92%	7%	1%
1, 2 and 3	97%	3%	---

8. Suggestions for Further Work:

Further study of the time variable earth's albedo model should include consideration of the following topics:

a. Annual and monthly zonal averages of sunlit and total cloud cover.

b. The albedo vs zenith angle of all 648 10° - 10° latitude-longitude regions of the earth.

c. Zenith angle sampling of the eighteen 10° latitude regions of the earth.

d. Errors in local average albedos due to satellite sampling for an additional nine 10° - 10° latitude-longitude regions of the earth.

e. The characteristics of this model should be compared more completely with experimentally measured characteristics of earth's albedo and cloud cover.

f. After the above have been completed, the revision and improvement of the model should be considered.

9. References:

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Sherr, P. E., A. H. Glasen, J. C. Barnes, and J. H. Willand, 1968: "World Wide Cloud Cover Distribution for use in Computer Simulations," NASA Contractor Report CR 61226, Allied Research Associated.

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Table 1 Positions of the 29 cloud cover type regions for the 10° latitude - 10° longitude model.

J	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	K
	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	1
	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	2
	14	14	11	11	9	9	9	9	9	9	9	9	10	10	10	10	10	9	9	9	9	9	9	9	9	10	10	10	9	9	14	15	15	14	14	14	3
	11	11	11	11	11	11	9	9	9	9	9	10	10	10	10	14	14	14	14	14	14	14	14	9	9	9	9	9	9	9	14	14	14	14	14	11	4
	11	11	11	18	18	18	19	2	2	2	10	10	10	10	13	13	13	13	13	13	13	13	13	13	8	11	11	11	11	11	13	13	13	13	13	11	5
	18	18	18	18	18	2	2	2	2	2	10	10	10	13	13	13	20	20	20	20	20	20	20	25	2	2	19	19	20	20	20	20	20	20	20	18	6
	1	1	1	1	1	1	2	16	16	16	19	19	20	20	20	20	20	20	4	4	4	4	12	12	7	2	4	4	4	4	4	4	4	20	2	2	7
	2	2	2	2	2	2	17	17	16	16	12	4	3	3	4	4	4	4	4	4	4	4	12	12	4	17	17	16	17	17	12	12	12	12	2	2	8
	16	16	16	4	2	2	4	4	4	12	4	4	3	3	3	3	3	3	3	3	3	3	3	3	4	16	16	4	3	3	3	3	3	3	3	16	9
	21	21	25	4	2	4	4	4	4	25	25	25	4	3	3	3	3	3	4	2	2	2	2	2	2	4	4	3	3	3	25	25	4	2	4	4	10
	5	26	25	4	26	21	21	21	21	4	4	26	25	25	4	4	3	3	4	4	4	4	4	4	4	4	4	3	6	25	25	21	4	4	4	3	11
	3	2	26	26	4	4	4	4	4	4	4	2	1	2	26	4	4	4	4	4	29	4	4	29	4	4	3	3	5	4	4	3	4	4	4	3	12
	29	29	29	29	29	29	29	29	29	29	29	29	27	27	28	29	29	29	29	29	29	29	29	29	29	29	29	29	5	28	28	29	29	29	29	29	13
	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	2	22	22	22	22	22	22	14
	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	15
	23	24	24	23	24	24	23	24	24	23	24	24	23	24	24	23	24	24	23	23	24	23	23	24	23	23	24	23	23	24	23	24	24	23	24	24	16
	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	17
	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	18

Table 2 General Description of Climatological Regions after <u>Sherr</u>, <u>et</u> <u>al</u>., 1968).

1	2	3	4	5	6	7	8	9
Region Number	General Description	Location	Seasonal Change in Cloud Amount	Mean Monthly Cloud Amount Jun-Aug (In Percent)	Mean Monthly Cloud Amount Dec-Mar (In Percent)	Predominant Cloud Type	Diurnal Variation in Cloud Amount	Hour of Maximum Cloud Amount (Local Time)
01	Essentially Clear	Major Desert Area	Small	< 20	< 20	--	Small	----
02	Little Cloudiness	Sub-Desert Areas	Small	<40	< 40	--	Small	----
03	Tropical Cloudy	Near Equator	Small	>60	>60	Convective	Large	1600
04	Tropical Moderate Cloudiness	North or South of Region 03	Small	~50	~50	Convective	Large	1600
05	Desert Marine	Over Ocean - off West Coasts	Small	~50	~50	Stratiform	Large	0800
06	Desert Marine Cloudy Winter	Over Ocean - West of Peru	Extreme	>70	< 30	Stratiform	Large	0800
07	Desert Marine Cloudy Summer	Over Ocean - West of Baja California	Extreme	>70	< 30	Stratiform	Large	0800
08	Mid Latitude - Clear Summer	North America	Extreme	~40	~70	Synoptic Scale	Small	----
09	High Latitude - Cloudy Summer	North America, Asia	Moderate	~70	~50	Synoptic Scale	Small	----
10	High Latitude - Clear Winter	Asia, North America	Extreme	~70	<30	Synoptic Scale	Small	----
11	Mid Latitude - Land	Northern Hemisphere	Moderate	~50	~70	Synoptic Scale	Small	----
12	Tropical - Cloudy Summer	North of Region 03	Moderate	>60	~50	Convective	Large	1600
13	Mid Latitude - Ocean	Northern Hemisphere	Moderate	~60	>70	Synoptic Scale	Small	----

Table 2 Continued.

1	2	3	4	5	6	7	8	9
14	High Latitude - Ocean	Northern Hemisphere	Moderate	>80	~70	Synoptic Scale	Small	----
15	Polar	Northern Hemisphere	Small	~60	~60	Synoptic Scale	Small	----
16	Tropical - Seasonal Change	North of Region 03	Extreme	>70	<40	Convective	Large	1600
17	Tropical - Clear Winter	Northern Hemisphere Near Region 16	Moderate	~50	<30	Convective	Large	1600
18	Mediterranean	Northern Hemisphere, Europe, Western North America	Extreme	~30 --	-- ~60	Convective Synoptic Scale	Small Small	---- ----
19	Sub Tropical	Northern Hemisphere ~30N	Moderate	<50 --	-- ~60	Convective Synoptic Scale	Large Small	1600 ----
20	Sub Tropical - Ocean	Northern Hemisphere ~30N	Moderate	~50 --	-- >60	Convective Synoptic Scale	Small Small	---- ----
21	Tropical - Cloudy Summer	South of Region 03	Moderate	~60	>60	Convective	Large	1600
22	Mid Latitude Ocean	Southern Hemisphere	Moderate	>70	~60	Synoptic Scale	Small	----
23	High Latitude - Ocean	Southern Hemisphere	Moderate	~70	>80	Synoptic Scale	Small	----
24	Polar	Southern Hemisphere	Small	~60	~60	Synoptic Scale	Small	----
25	Tropical - Seasonal Change	South of Region 03	Extreme	<40	>70	Convective	Large	1600
26	Tropical - Clear Winter	South of Region 25; Africa, Australia	Moderate	<30	~50	Convective	Large	1600
27	Mediterranean	Southern Hemisphere Australia, Chile	Extreme	-- ~60	~30 --	Convective Synoptic Scale	Small Small	---- ----
28	Sub Tropical Land	Southern Hemisphere ~30S	Moderate	-- ~60	<50 --	Convective Synoptic Scale	Large Small	1600 ----
29	Sub Tropical - Ocean	Southern ~30S	Moderate	-- >60	~50 --	Convective Synoptic Scale	Small Small	---- ----

Table 3. Monthly and Yearly Averages of Percent Cloud Cover in Each of the 29 Cloud Climatic Regions.

REGION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVG
1	.28	.35	.43	.34	.22	.10	.15	.11	.05	.05	.21	.34	.22
2	.46	.41	.42	.41	.35	.25	.11	.09	.22	.37	.43	.47	.33
3	.61	.57	.53	.55	.68	.81	.86	.90	.88	.76	.71	.69	.71
4	.47	.47	.49	.45	.42	.52	.60	.57	.56	.41	.42	.47	.49
5	.46	.48	.47	.52	.55	.56	.54	.55	.51	.51	.40	.44	.50
6	.49	.78	.59	.57	.51	.42	.41	.40	.51	.48	.44	.48	.51
7	.49	.49	.49	.49	.59	.71	.71	.71	.71	.59	.49	.49	.58
8	.71	.63	.60	.58	.56	.43	.24	.29	.28	.39	.55	.67	.49
9	.44	.46	.46	.52	.56	.59	.60	.68	.71	.69	.62	.52	.57
10	.28	.33	.43	.55	.63	.61	.66	.61	.54	.40	.36	.35	.48
11	.64	.61	.62	.60	.57	.53	.50	.43	.39	.41	.52	.61	.54
12	.65	.45	.47	.58	.75	.73	.80	.79	.75	.69	.72	.73	.68
13	.81	.79	.78	.79	.80	.77	.72	.69	.71	.75	.78	.80	.77
14	.82	.83	.86	.87	.90	.93	.89	.91	.87	.82	.80	.82	.86
15	.33	.42	.43	.46	.74	.79	.77	.78	.80	.73	.55	.37	.60
16	.32	.35	.42	.56	.75	.82	.80	.80	.83	.82	.77	.51	.65
17	.39	.35	.30	.51	.70	.78	.86	.86	.80	.77	.57	.50	.62
18	.57	.52	.51	.48	.45	.38	.31	.62	.31	.38	.46	.55	.46
19	.64	.59	.58	.58	.55	.47	.47	.41	.40	.38	.48	.57	.51
20	.70	.73	.76	.76	.80	.83	.72	.61	.55	.64	.73	.74	.71
21	.80	.79	.75	.69	.71	.71	.65	.45	.47	.58	.75	.73	.67
22	.72	.69	.71	.75	.79	.78	.81	.79	.78	.79	.80	.76	.77
23	.92	.91	.87	.83	.80	.82	.82	.83	.85	.87	.90	.93	.86
24	.77	.78	.81	.73	.54	.37	.32	.42	.43	.46	.74	.80	.60
25	.81	.80	.83	.82	.61	.38	.25	.27	.36	.56	.75	.81	.61
26	.85	.84	.80	.77	.57	.50	.39	.36	.30	.51	.69	.78	.62
27	.31	.36	.31	.38	.46	.55	.58	.52	.51	.48	.45	.37	.44
28	.47	.41	.40	.38	.48	.56	.64	.59	.58	.58	.55	.47	.51
29	.72	.61	.55	.64	.73	.74	.70	.73	.76	.76	.80	.83	.71

Table 4. Monthly Average Values of Zonal Albedo.

K	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	53.9	57.2	61.2	59.4	56.6	55.3	55.8	-	-	-
2	-	52.2	54.9	54.7	57.5	54.5	51.7	49.7	52.4	52.2	-	-
3	50.8	52.5	53.7	53.2	49.9	42.9	40.3	40.2	43.6	46.8	49.8	50.2
4	50.0	46.6	45.9	43.6	42.2	40.3	39.7	39.6	40.6	41.9	45.1	48.1
5	43.5	40.2	38.3	36.7	35.9	34.2	32.5	32.9	32.7	34.9	39.5	42.1
6	34.3	33.5	33.3	32.7	32.1	31.0	27.2	26.0	25.2	29.4	33.3	34.7
7	25.3	25.1	25.4	25.1	25.1	25.8	25.4	24.1	23.9	24.2	26.0	26.7
8	22.1	20.9	20.5	21.8	24.3	26.2	26.6	26.2	26.9	26.2	25.0	24.3
9	22.2	21.8	21.7	22.4	24.2	27.3	28.1	28.0	27.8	25.7	25.5	24.6
10	24.2	23.7	23.5	23.4	20.1	20.6	20.3	19.7	20.8	22.1	23.8	24.9
11	27.7	27.9	28.0	27.9	24.4	25.2	25.1	23.7	23.6	24.0	26.2	27.8
12	22.0	22.0	22.1	22.5	22.2	24.3	24.7	23.8	23.2	20.9	21.5	22.5
13	28.0	24.7	23.5	28.2	32.3	33.2	31.6	31.7	31.8	31.1	31.5	32.1
14	32.3	32.2	34.5	38.1	41.2	41.3	40.9	38.9	37.2	36.4	35.1	34.0
15	42.2	42.7	43.9	46.0	48.7	50.5	49.9	48.1	45.8	43.9	42.6	42.6
16	47.9	49.8	52.0	52.1	50.9	47.1	48.1	51.3	52.7	51.2	52.3	50.5
17	60.6	61.9	62.7	60.4	-	-	-	53.5	60.1	62.3	61.7	61.9
18	64.1	64.6	63.0	-	-	-	-	-	56.9	61.7	64.5	55.1

K J NT	2 24 15	4 24 10	6 23 13	8 24 3	10 24 4	12 24 1	14 24 22	16 24 23	18 24 24
JAN	—	44.3	49.5	25.0	19.0	23.4	33.6	50.4	63.6
FEB	53.5	42.9	47.3	24.0	19.0	25.1	33.8	52.2	63.7
MAR	55.3	44.2	45.7	22.5	19.3	26.4	35.0	51.4	63.1
APR	55.5	44.8	45.4	21.8	19.2	24.5	39.2	52.3	—
MAY	59.4	42.5	44.5	24.6	19.1	20.6	42.8	52.9	—
JUN	54.8	40.2	43.0	29.0	22.5	17.8	43.6	53.7	—
JUL	50.1	39.8	40.7	30.0	25.3	19.2	43.3	54.8	—
AUG	46.4	35.7	40.5	30.4	26.9	18.4	41.0	54.8	—
SEP	50.8	35.5	32.6	30.5	23.5	17.1	38.8	55.8	56.1
OCT	52.4	33.0	45.1	27.6	22.4	17.6	38.2	55.5	59.0
NOV	—	36.2	48.4	27.3	17.9	21.9	36.8	53.6	64.2
DEC	—	40.1	49.3	27.6	18.0	24.5	35.5	51.9	65.4
ANNUAL	53.3	40.0	44.6	26.7	21.2	21.8	36.7	52.7	63.6

Table 5. Monthly and Annual Average Albedo Values for Selected 10 - 10° Areas.

LATITUDE	N					6						12						18						24 ← HOURS L.T.
85	305	284	306	158	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	158
75	0	0	0	219	565	851	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	851	565	220
65	0	0	0	0	0	260	1076	0	0	0	0	0	0	0	0	0	0	0	0	0	1076	256	0	0
55	0	0	0	0	0	0	1297	0	0	0	0	0	0	0	0	0	0	0	0	0	1288	0	0	0
45	0	0	0	0	0	0	1232	39	0	0	0	0	0	0	0	0	0	0	0	44	1227	0	0	0
35	0	0	0	0	0	0	0	1263	0	0	0	0	0	0	0	0	0	0	0	1265	0	0	0	0
25	0	0	0	0	0	0	0	1260	0	0	0	0	0	0	0	0	0	0	0	1257	0	0	0	0
15	0	0	0	0	0	0	0	1255	0	0	0	0	0	0	0	0	0	0	0	1258	0	0	0	0
5	0	0	0	0	0	0	0	1257	0	0	0	0	0	0	0	0	0	0	0	1255	0	0	0	0
5	0	0	0	0	0	0	0	1253	0	0	0	0	0	0	0	0	0	0	0	1257	0	0	0	0
15	0	0	0	0	0	0	0	1253	0	0	0	0	0	0	0	0	0	0	0	1255	0	0	0	0
25	0	0	0	0	0	0	0	1256	0	0	0	0	0	0	0	0	0	0	0	1260	0	0	0	0
35	0	0	0	0	0	0	0	1262	0	0	0	0	0	0	0	0	0	0	0	1264	0	0	0	0
45	0	0	0	0	0	0	0	43	1224	0	0	0	0	0	0	0	0	0	1230	39	0	0	0	0
55	0	0	0	0	0	0	0	0	1285	0	0	0	0	0	0	0	0	0	1284	0	0	0	0	0
65	0	0	0	0	0	0	0	0	1074	257	0	0	0	0	0	0	0	258	1074	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	849	564	220	0	0	0	218	564	849	0	0	0	0	0	0
85	0	0	0	0	0	0	0	0	0	0	0	158	304	283	305	159	0	0	0	0	0	0	0	0
	S																							

Table 6. Latitude Sampling in Local Time by Satellite 1 for 31 Days.

LATITUDE						6						12						18						24 HOURS L.T.
N 85	305	284	306	158	0	0	158	305	284	306	158	0	0	0	0	0	0	0	0	0	0	0	0	158
75	0	0	0	219	1416	1416	220	0	0	0	219	565	851	0	0	0	0	0	0	0	0	851	565	220
65	0	0	0	1076	255	260	1076	0	0	0	0	0	260	1076	0	0	0	0	0	0	1076	258	0	0
55	0	0	0	1288	0	0	1287	0	0	0	0	0	0	1287	0	0	0	0	0	0	1288	0	0	0
45	0	0	44	1227	0	0	1232	39	0	0	0	0	0	1232	39	0	0	0	0	44	1227	0	0	0
35	0	0	1265	0	0	0	0	1263	0	0	0	0	0	0	1263	0	0	0	0	1265	0	0	0	0
25	0	0	1257	0	0	0	0	1260	0	0	0	0	0	0	1260	0	0	0	0	1257	0	0	0	0
15	0	0	1258	0	0	0	0	1255	0	0	0	0	0	0	1255	0	0	0	0	1258	0	0	0	0
5	0	0	1255	0	0	0	0	1257	0	0	0	0	0	0	1257	0	0	0	0	1255	0	0	0	0
5	0	0	1257	0	0	0	0	1253	0	0	0	0	0	0	1253	0	0	0	0	1257	0	0	0	0
15	0	0	1255	0	0	0	0	1253	0	0	0	0	0	0	1253	0	0	0	0	1255	0	0	0	0
25	0	0	1260	0	0	0	0	1256	0	0	0	0	0	0	1256	0	0	0	0	1260	0	0	0	0
35	0	0	1264	0	0	0	0	1262	0	0	0	0	0	0	1262	0	0	0	0	1264	0	0	0	0
45	0	1230	39	0	0	0	0	43	1224	0	0	0	0	0	43	1224	0	0	1230	39	0	0	0	0
55	0	1284	0	0	0	0	0	0	1285	0	0	0	0	0	0	1285	0	0	1284	0	0	0	0	0
65	258	1074	0	0	0	0	0	0	1074	257	0	0	0	0	0	1074	257	258	1074	0	0	0	0	0
75	849	0	0	0	0	0	0	0	0	849	564	220	0	0	0	218	1413	1413	220	0	0	0	218	564
S 85	0	0	0	0	0	0	0	0	0	0	0	158	304	283	305	159	0	0	158	304	283	305	159	0

Table 7. Latitude Sampling in Local Time by Satellites 1 and 2 for 31 Days.

N 6 12 18 24 HOURS L.T.

LATITUDE																								
85	305	234	306	158	0	0	158	305	284	306	158	0	0	0	0	0	0	0	0	0	0	0	0	158
75	0	0	0	219	1416	1416	220	0	0	0	219	565	851	0	0	0	0	0	0	0	0	851	565	220
65	0	0	0	1076	258	260	1076	0	0	0	0	0	260	1076	0	0	0	0	0	0	1076	258	0	0
55	0	0	0	1288	0	0	1287	0	0	0	0	2	1	1289	1	2	1	1	0	0	1288	0	0	0
45	0	0	46	1323	212	320	1653	569	653	699	699	696	698	1925	721	562	453	352	245	177	1246	0	0	0
35	0	5	1390	173	176	171	175	1432	178	280	343	345	344	323	1452	174	171	174	173	1435	155	30	0	0
25	0	100	1406	151	149	152	149	1411	151	155	262	301	291	168	1412	149	152	150	153	1408	152	133	11	0
15	46	143	1402	142	141	142	143	1396	143	141	157	276	200	144	1398	144	139	141	142	1400	142	141	89	0
5	123	136	1395	137	139	137	140	1397	140	139	139	179	138	139	1394	140	136	142	138	1395	139	142	137	34
5	138	141	1396	141	137	140	136	1393	136	140	136	34	125	138	1394	138	141	139	138	1395	137	139	138	176
15	196	143	1396	143	139	143	143	1396	144	143	87	0	47	141	1395	141	139	143	144	1398	144	143	157	274
25	293	168	1412	150	152	149	150	1406	151	131	11	0	0	102	1406	153	150	152	149	1412	149	152	263	300
35	345	314	1453	177	171	173	173	1434	157	27	0	0	0	6	1390	170	172	170	178	1435	177	279	346	346
45	699	1928	721	564	452	348	245	174	1241	0	0	0	0	0	46	1323	212	319	1653	573	651	698	697	702
55	0	1284	0	0	0	0	0	0	1285	0	0	0	0	0	0	1285	0	0	1284	0	0	0	0	0
65	258	1074	0	0	0	0	0	0	1074	257	0	0	0	0	0	1074	257	258	1074	0	0	0	0	0
75	849	0	0	0	0	0	0	0	0	849	564	220	0	0	0	218	1413	1413	220	0	0	0	218	564
85	0	0	0	0	0	0	0	0	0	0	0	158	304	283	305	159	0	0	158	304	283	305	159	0

S

Table 8. Latitude Sampling in Local Time by Satellite 1, 2 and 3 for 31 Days.

W. LONGITUDE

LATITUDE

N								90									180									270									360
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	0	2	1	0	2	1	1	1	1	1	1	0	2	0	1	1	2	0	2	1	1	2	1	2	1	1	1	2	0	2	0	2	0	1	1	2
35	38	35	33	39	33	35	38	33	36	35	35	37	31	39	34	33	38	33	35	37	33	37	33	35	37	32	37	34	36	35	32	39	33	34	39	30
25	40	32	35	38	30	37	39	30	36	36	34	36	32	38	33	35	38	30	37	36	33	36	31	37	35	34	38	31	37	36	34	36	33	38	36	31
15	36	32	37	34	35	36	35	34	37	31	37	35	34	37	32	37	34	34	38	32	36	36	31	39	33	34	37	31	38	34	34	38	31	37	35	34
5	35	33	37	33	37	36	33	36	36	32	39	32	35	38	31	37	33	35	38	30	37	36	33	37	32	36	35	36	35	32	36	36	34	36	33	37
5	33	34	38	30	38	34	31	38	35	33	38	31	37	36	31	39	33	34	38	31	37	34	34	38	31	37	35	34	36	33	37	34	35	35	32	39
15	34	34	38	33	35	35	31	37	35	33	38	31	37	35	34	36	33	37	33	35	37	31	38	34	34	37	32	37	35	33	38	32	35	38	31	37
25	32	39	32	35	38	30	35	38	31	38	34	35	38	30	39	36	31	38	33	35	39	30	37	34	35	37	30	39	34	33	37	33	36	34	35	36
35	33	37	34	36	37	31	34	37	32	38	34	35	37	30	39	34	33	39	32	36	36	34	38	32	37	35	34	37	32	37	36	32	39	33	35	37
45	1	0	2	1	1	2	1	0	2	0	1	1	1	2	1	1	2	1	1	2	0	2	1	1	1	2	0	2	1	2	1	1	1	2	1	2
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S																																				

Table 9. Longitude Sampling in the 08:00 Time Period by Satellite 1 for 31 Days.

N

LATITUDE									90									180									270									360 W. LONGITUDE
85	10	7	9	8	8	11	8	7	10	8	8	8	7	11	8	8	9	8	8	8	8	11	6	10	8	9	8	7	9	8	9	8	9	10	8	8
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	0	2	1	0	2	1	1	1	1	1	1	0	2	0	1	1	2	0	2	1	1	2	1	2	1	1	1	2	0	2	0	2	0	1	1	2
35	38	35	33	39	33	35	38	33	36	35	35	37	31	39	34	33	38	33	35	37	33	37	33	35	37	32	37	34	36	35	32	39	33	34	39	30
25	40	32	35	38	30	37	39	30	36	36	34	36	32	38	33	35	38	30	37	36	33	38	31	37	35	34	38	31	37	36	34	36	33	38	36	31
15	36	32	37	34	35	36	35	34	37	31	37	35	34	37	32	37	34	34	38	32	36	36	31	39	33	34	37	31	38	34	34	38	31	37	35	34
5	35	33	37	33	37	36	33	36	36	32	39	32	35	38	31	37	33	35	38	30	37	36	33	37	32	36	35	36	35	32	36	36	34	36	33	37
5	33	34	36	30	38	34	31	38	35	33	38	31	37	36	31	39	33	34	38	31	37	34	34	38	31	37	35	34	36	33	37	34	35	35	32	39
15	34	34	38	33	35	35	31	37	35	33	38	31	37	35	34	36	33	37	33	35	37	31	38	34	34	37	32	37	35	33	38	32	35	38	31	37
25	32	39	32	35	38	30	35	38	31	38	34	35	38	30	39	36	31	38	33	35	39	30	37	34	35	37	30	39	34	33	37	33	36	34	35	36
35	33	37	34	36	37	31	34	37	32	38	34	35	37	30	39	34	33	39	32	36	36	34	38	32	37	35	34	37	32	37	36	32	39	33	35	37
45	1	0	2	1	1	2	1	0	2	0	1	1	1	2	1	1	2	1	1	2	0	2	1	1	1	2	0	2	1	2	1	1	1	2	1	2
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table 10. Longitude Sampling in the 08:00 Time Period by Satellites 1 and 2 for 31 Days.

N 90 180 270 360 W. LONGITUDE

LATITUDE

85	10	7	9	8	8	11	5	7	10	8	8	8	7	11	8	8	9	8	8	8	8	11	6	10	8	9	8	7	9	8	9	8	9	10	8	8
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	13	18	16	14	17	15	18	13	17	15	16	14	13	16	15	16	17	15	20	12	16	18	12	19	15	18	15	17	15	13	16	17	17	16	16	19
35	43	40	35	45	36	41	43	37	41	38	41	42	36	44	38	39	41	38	39	42	39	41	39	37	43	38	40	40	39	41	36	44	39	37	45	34
25	45	35	40	42	34	42	42	35	40	41	37	39	36	43	38	39	43	34	41	40	36	43	35	41	39	37	43	34	42	41	40	40	35	42	40	37
15	38	35	41	38	41	39	39	38	41	35	39	40	37	41	36	41	38	38	43	37	41	40	33	43	36	39	42	35	42	38	38	42	35	42	37	38
5	39	38	42	38	40	40	37	39	40	36	43	36	38	41	35	41	38	39	42	32	41	39	36	43	35	40	39	40	39	35	41	41	38	39	37	40
5	37	38	41	34	40	37	36	41	40	37	42	34	41	41	36	44	35	38	42	34	41	39	38	42	35	41	38	39	39	38	40	36	39	39	36	45
15	38	37	42	36	39	40	35	41	38	37	43	35	42	38	37	40	35	42	37	40	42	35	42	37	38	41	37	41	37	37	42	36	40	43	35	41
25	36	43	37	38	42	34	38	43	34	44	38	40	42	33	44	40	36	42	36	39	42	34	42	40	39	40	34	42	39	37	41	39	40	38	38	40
35	37	42	39	41	41	37	39	41	38	42	40	40	41	35	43	40	38	43	37	41	42	38	42	37	41	41	38	41	38	40	42	36	43	38	39	43
45	3	4	3	5	3	5	6	3	7	2	7	3	5	8	4	6	5	5	6	5	5	4	6	6	4	7	2	8	2	7	3	3	6	5	5	6
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table 11. Longitude Sampling in the 08:00 Time Period by Satellites 1, 2 and 3.

LATITUDE	N					6						12						18						24 HOURS GMT
85	43	56	46	53	49	53	47	54	45	57	45	56	46	53	48	51	51	51	49	53	47	55	45	66
75	136	131	144	124	151	124	144	132	135	141	134	142	134	136	140	127	148	124	147	129	139	135	134	130
65	111	108	117	103	122	103	114	111	108	116	107	118	106	114	110	109	116	105	118	106	112	114	108	114
55	98	113	104	109	107	109	104	113	98	120	95	121	95	119	98	113	104	111	102	113	97	119	94	119
45	106	101	112	99	110	101	111	101	109	103	107	107	107	105	108	100	114	96	116	101	108	106	107	105
35	107	104	109	101	109	100	109	105	105	106	104	108	106	103	111	97	115	95	114	98	108	105	104	105
25	94	113	99	110	100	111	99	113	97	111	97	115	95	114	97	111	100	108	102	109	99	114	95	114
15	105	103	108	101	108	100	108	103	104	105	104	109	103	105	107	102	107	103	105	104	107	103	105	104
5	110	100	112	95	112	97	112	100	110	99	109	101	110	98	113	99	109	100	109	100	110	99	109	99
5	99	111	99	111	99	109	99	112	97	111	99	110	99	111	98	113	96	111	97	111	101	108	100	109
15	105	107	102	106	103	105	104	106	104	104	105	105	103	105	104	107	101	108	100	108	103	105	104	104
25	114	98	111	100	108	101	110	99	115	94	114	95	114	95	113	100	109	99	111	99	112	97	112	96
35	103	110	97	116	95	115	99	108	104	106	105	104	106	105	105	108	101	109	101	108	105	106	105	105
45	104	109	100	113	97	115	99	108	105	106	104	103	106	108	101	112	101	111	99	113	101	109	104	108
55	119	97	114	104	110	104	112	98	120	94	119	93	118	99	112	105	108	107	110	103	114	96	120	93
65	115	111	107	117	105	116	108	111	113	108	115	103	115	110	108	115	103	122	103	115	110	110	115	108
75	135	140	128	147	125	147	128	139	137	134	140	128	139	136	132	145	124	151	125	143	132	135	141	133
85	54	48	51	51	50	50	53	47	54	45	57	42	58	44	55	46	53	49	52	47	55	44	58	46
S																								

Table 12. Latitude Sampling in Greenwich Mean Time by Satellite 1 for 31 Days

N 6 12 18 24 HOURS GMT.

LATITUDE																								
85	86	112	92	106	98	106	94	108	90	114	90	112	92	106	96	102	102	102	98	106	94	110	90	124
75	272	262	288	248	302	248	288	264	270	282	268	284	268	272	280	254	296	248	294	258	278	270	268	270
65	222	216	234	206	244	206	228	222	216	232	214	236	212	228	220	218	232	210	236	212	224	228	216	228
55	196	226	208	218	214	218	208	226	196	240	190	242	190	238	196	226	208	222	204	226	194	238	188	238
45	216	202	224	198	220	202	222	202	218	206	214	214	214	210	216	200	228	192	232	202	216	212	214	210
35	214	208	218	202	218	200	218	210	210	212	208	216	212	206	222	194	230	190	228	196	216	210	208	210
25	188	226	198	220	200	222	198	226	194	222	194	230	190	228	194	222	200	216	204	218	198	228	190	228
15	210	206	216	202	216	200	216	206	208	210	208	218	206	210	214	204	214	206	210	208	214	206	210	208
5	220	200	224	190	224	194	224	200	220	198	218	202	220	196	226	198	218	200	218	200	220	198	218	198
5	198	222	198	222	198	218	198	224	194	222	198	220	198	222	196	226	192	222	194	222	202	216	200	218
15	210	214	204	212	206	210	208	212	208	208	210	210	206	210	208	214	202	216	200	216	206	210	208	208
25	228	196	222	200	216	202	220	198	230	188	228	190	228	190	226	200	218	198	222	198	224	194	224	192
35	206	220	194	232	190	230	198	216	208	212	210	208	212	210	210	216	202	216	202	216	210	212	210	210
45	208	218	200	226	194	230	198	216	210	212	208	206	212	216	202	224	202	222	198	226	202	218	208	216
55	238	194	228	208	220	208	224	196	240	188	238	186	236	198	224	210	216	214	220	206	228	192	240	186
65	230	222	214	234	210	232	216	222	226	216	230	206	230	220	216	230	206	244	206	230	220	220	230	229
75	270	280	256	294	250	294	256	278	274	268	280	256	278	272	264	290	248	302	250	286	264	270	282	253
85	108	96	102	102	100	100	106	94	108	90	114	84	116	88	110	92	106	98	104	94	110	88	116	92

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Table 13. Latitude Sampling in Greenwich Mean Time by Satellites 1 and 2 for 31 Days.

LATITUDE						6						12						18						24 HOURS GMT
N																								
85	86	112	92	106	98	106	94	108	90	114	90	112	92	106	96	102	102	102	98	106	94	110	90	124
75	272	262	283	248	302	249	288	264	270	262	268	284	268	272	280	254	296	248	294	258	278	270	268	270
65	222	216	234	206	244	206	228	222	216	232	214	236	212	228	220	218	232	210	236	212	224	228	216	228
55	198	227	208	218	214	218	210	227	196	240	190	242	192	238	196	226	208	222	205	227	194	238	188	238
45	563	528	574	530	561	552	546	554	564	533	560	558	546	563	540	545	577	518	585	538	551	561	538	562
35	388	372	389	368	385	376	380	378	375	380	387	381	377	374	389	369	401	350	399	364	387	383	369	378
25	330	370	351	369	345	368	341	380	343	366	339	376	339	384	336	362	349	364	357	362	339	380	337	379
15	350	347	356	335	354	346	354	341	342	348	356	356	340	349	354	346	351	339	351	348	354	347	343	347
5	350	330	369	328	360	326	356	334	360	334	357	334	351	334	362	335	353	337	351	331	357	338	360	331
5	332	360	332	354	332	352	340	362	327	352	333	353	337	363	328	353	326	364	334	357	330	350	337	355
15	352	358	340	346	342	351	354	346	341	350	352	346	340	346	354	355	338	354	335	358	349	344	344	348
25	370	344	368	353	362	344	367	347	381	337	367	335	380	335	375	344	363	355	366	341	368	340	383	342
35	375	397	352	401	359	397	375	381	371	386	372	381	382	369	385	383	371	387	367	389	380	376	378	386
45	546	565	527	580	542	556	545	546	556	564	533	554	562	541	551	566	537	572	522	573	553	545	561	530
55	238	194	228	208	220	208	224	196	240	188	238	186	236	198	224	210	216	214	220	206	228	192	240	186
65	230	222	214	234	210	232	216	222	226	216	230	206	230	220	216	230	206	244	206	230	220	220	230	229
75	270	280	256	294	250	294	256	278	274	268	280	256	278	272	264	290	248	302	250	286	264	270	282	253
85	108	96	102	102	100	100	106	94	108	90	114	84	116	88	110	92	106	98	104	94	110	88	116	92
S																								

Table 14. Latitude Sampling in Greenwich Mean Time By Satellites 1, 2 and 3 for 31 Days.

W. LONGITUDE

LATITUDE	N								90									180									270									360
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	12	8	9	9	9	10
75	20	23	15	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	22	14	12	3	0	0	0	0	3	0
65	0	0	25	29	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	31	26	0	0	0	0	0	0	0	0	0	0
55	0	0	3	41	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	38	3	0	0	0	0	0	0	0	0	0	0
45	0	0	0	22	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	18	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	12	37	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	37	11	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	5	39	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	36	7	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	1	32	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	34	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	27	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	25	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	21	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	22	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	18	37	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	17	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	11	35	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	34	8	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	2	36	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	32	6	0	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	30	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	31	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	14	31	2	0	0	0	0	0	0	0	0	0	0	0	0	2	32	12	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	24	27	1	0	0	0	0	0	0	0	0	0	0	2	26	27	1	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	1	17	23	14	13	1	0	0	0	0	2	8	14	23	16	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85	0	0	0	0	0	0	0	0	0	0	2	7	9	5	8	6	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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Table 15. Latitude-Longitude Sampling at the synoptic Time Period 00:00 GMT for Satellite 1. The Circled Values are Areas Also Sampled Synoptically at 12:00 GMT.

N 90 180 270 360 W.LONGITUDE

85	0	0	0	0	0	0	0	0	0	0	0	2	8	9	8	10	9	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	16	23	15	11	3	0	0	0	0	4	10	20	25	14	1	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	1	33	26	1	0	0	0	0	0	0	0	0	0	0	0	27	29	1	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	20	37	3	0	0	0	0	0	0	0	0	0	0	0	0	4	38	19	0	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	31	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	30	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	5	38	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	38	3	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	14	39	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	36	14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	17	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	20	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	24	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	22	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	31	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	32	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	34	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	38	1	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	6	30	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	36	4	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	16	31	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	34	13	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	22	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	25	0	0	0	0	0	0	0	0	0	0
55	0	0	0	3	30	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	31	2	0	0	0	0	0	0	0	0	0
65	0	0	2	23	27	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	23	1	0	0	0	0	0	0	0	0
75	7	16	22	15	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	15	24	12	11	3	0	0	0	0	1
85	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	8	6	6	7	7

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Table 16. Latitude-Longitude Sampling at the Synoptic Time Period 12;00 GMT for Satellite 1. The Circled Values are Areas Also Sampled Synoptically at 00:00 GMT.

LATITUDE	N								90									180									270									360	W. LONGITUDE
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	9	11	9	10	8	6	0	0	0	0	9	12	8	9	9	9	10	
75	20	23	15	1	0	0	0	0	0	0	0	0	0	0	7	22	18	14	6	1	0	0	0	1	6	33	42	38	17	3	0	0	0	0	3	0	
65	0	0	25	29	1	0	0	0	0	0	0	0	0	14	37	3	0	0	0	0	0	0	0	2	31	26	0	8	35	12	0	0	0	0	0	0	
55	0	0	3	41	18	0	0	0	0	0	0	0	0	38	19	0	0	0	0	0	0	0	0	16	38	3	0	0	21	39	2	0	0	0	0	0	
45	0	0	0	22	34	0	0	0	0	0	0	0	12	35	2	0	0	0	0	0	0	0	0	31	18	0	0	0	5	37	14	0	0	0	0	0	
35	0	0	0	12	37	3	0	0	0	0	0	0	23	30	0	0	0	0	0	0	0	0	5	37	11	0	0	0	0	30	22	0	0	0	0	0	
25	0	0	0	5	39	13	0	0	0	0	0	0	32	25	0	0	0	0	0	0	0	0	14	36	7	0	0	0	0	23	34	0	0	0	0	0	
15	0	0	0	1	32	20	0	0	0	0	0	0	36	15	0	0	0	0	0	0	0	0	17	34	0	0	0	0	0	16	36	1	0	0	0	0	
5	0	0	0	0	27	22	0	0	0	0	0	6	35	9	0	0	0	0	0	0	0	0	25	25	0	0	0	0	0	8	38	3	0	0	0	0	
5	0	0	0	0	21	34	0	0	0	0	0	13	35	6	0	0	0	0	0	0	0	0	32	22	0	0	0	0	0	4	39	12	0	0	0	0	
15	0	0	0	0	18	37	1	0	0	0	0	16	32	0	0	0	0	0	0	0	0	0	31	17	0	0	0	0	0	2	35	19	0	0	0	0	
25	0	0	0	0	11	35	3	0	0	0	0	24	23	0	0	0	0	0	0	0	0	5	34	8	0	0	0	0	0	0	27	22	0	0	0	0	
35	0	0	0	0	2	36	13	0	0	0	0	31	23	0	0	0	0	0	0	0	0	16	32	6	0	0	0	0	0	0	18	33	0	0	0	0	
45	0	0	0	0	0	30	26	0	0	0	4	37	11	0	0	0	0	0	0	0	0	21	31	0	0	0	0	0	0	0	13	36	7	0	0	0	
55	0	0	0	0	0	14	31	2	0	0	17	28	1	0	0	0	0	0	0	0	2	32	12	0	0	0	0	0	0	0	1	29	17	0	0	0	
65	0	0	0	0	0	0	24	27	1	10	34	12	0	0	0	0	0	0	0	2	26	27	1	0	0	0	0	0	0	0	0	8	35	9	0	13	
75	6	0	0	0	0	0	7	26	42	37	20	1	0	0	0	0	2	8	14	23	16	1	0	0	0	0	0	0	0	0	0	0	6	23	21	0	
85	4	9	7	7	8	7	4	0	0	0	2	7	9	3	8	6	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

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Table 17. Latitude-Longitude Sampling at the Synoptic Time Period 00:00 GMT for Satellites 1 and 2. The Circled Values are Areas Also Sampled Synoptically at 12:00 GMT.

N 90 180 270 360 W. LONGITUDE

LATITUDE

85	0	5	9	9	10	10	9	4	0	0	0	2	8	9	8	10	9	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	14	6	1	0	0	0	0	8	32	43	40	16	3	0	0	0	0	4	10	20	25	14	1	0	0	0	0	0	0	0	0	0	0	6	22	19
65	0	0	0	0	0	0	1	33	26	1	9	36	12	0	0	0	0	0	0	0	0	27	29	1	0	0	0	0	0	0	0	0	13	39	9	0
55	0	0	0	0	0	0	20	37	3	0	0	23	35	3	0	0	0	0	0	0	0	4	38	19	0	0	0	0	0	0	0	3	37	20	0	0
45	0	0	0	0	0	0	31	21	0	0	0	6	37	12	0	0	0	0	0	0	0	0	25	30	0	0	0	0	0	0	0	13	36	3	0	0
35	0	0	0	0	0	5	38	12	0	0	0	0	32	21	0	0	0	0	0	0	0	0	12	38	3	0	0	0	0	0	0	24	31	0	0	0
25	0	0	0	0	0	14	39	4	0	0	0	0	26	32	0	0	0	0	0	0	0	0	8	36	14	0	0	0	0	0	0	34	23	0	0	0
15	0	0	0	0	0	17	33	0	0	0	0	0	19	39	1	0	0	0	0	0	0	0	0	39	20	0	0	0	0	0	0	35	15	0	0	0
5	0	0	0	0	0	24	26	0	0	0	0	0	16	36	5	0	0	0	0	0	0	0	0	29	22	0	0	0	0	0	7	35	8	0	0	0
5	0	0	0	0	0	31	23	0	0	0	0	0	7	37	12	0	0	0	0	0	0	0	0	24	32	0	0	0	0	0	16	30	8	0	0	0
15	0	0	0	0	0	34	16	0	0	0	0	0	2	33	20	0	0	0	0	0	0	0	0	16	38	1	0	0	0	0	18	32	0	0	0	0
25	0	0	0	0	6	30	10	0	0	0	0	0	0	27	22	0	0	0	0	0	0	0	0	9	36	4	0	0	0	0	20	26	0	0	0	0
35	0	0	0	0	16	31	4	0	0	0	0	0	0	21	32	0	0	0	0	0	0	0	0	6	34	13	0	0	0	0	31	20	0	0	0	0
45	0	0	0	0	22	26	0	0	0	0	0	0	0	13	35	7	0	0	0	0	0	0	0	0	30	25	0	0	0	6	32	10	0	0	0	0
55	0	0	0	3	30	11	0	0	0	0	0	0	0	2	31	16	0	0	0	0	0	0	0	0	16	31	2	0	0	16	28	0	0	0	0	0
65	0	0	2	23	27	1	0	0	0	0	0	0	0	0	9	32	9	0	0	0	0	0	0	0	0	26	23	1	9	32	12	0	0	0	0	0
75	7	16	22	15	1	0	0	0	0	0	0	0	0	0	0	7	21	20	11	6	1	0	0	0	0	6	25	44	32	18	3	0	0	0	0	1
85	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	7	6	8	5	5	0	0	0	1	6	8	6	6	7	7

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Table 18. Latitude-Longitude Sampling at the Synoptic Time Period 12:00 GMT for Satellites 1 and 2. The Circled Values are Areas Also Sampled Synoptically at 00:00 GMT.

LATITUDE

W. LONGITUDE

N									90									180									270									360
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	9	11	9	10	8	6	0	0	0	0	9	12	8	9	9	9	10
75	20	23	15	1	0	0	0	0	0	0	0	0	0	0	7	22	18	14	6	1	0	0	0	1	6	33	42	38	17	3	0	0	0	0	3	0
65	0	0	25	29	1	0	0	0	0	0	0	0	0	14	37	8	0	0	0	0	0	0	0	2	31	26	0	8	35	12	0	0	0	0	0	0
55	0	0	3	41	18	0	0	0	0	0	0	0	0	38	19	0	0	0	0	0	0	0	0	16	38	3	0	0	21	39	2	0	0	0	0	0
45	0	0	0	23	38	7	9	12	11	13	16	21	33	56	20	19	19	18	20	22	19	17	15	44	30	10	6	6	7	37	14	0	0	0	0	0
35	0	0	3	17	43	5	4	5	6	6	4	3	28	41	9	12	9	8	8	11	7	6	8	41	17	6	4	6	4	33	24	0	0	0	0	0
25	0	6	6	6	41	17	5	5	4	5	2	5	37	30	7	6	7	11	10	2	3	6	19	40	11	2	5	4	5	29	38	0	1	0	0	0
15	4	4	3	6	36	24	4	4	2	4	5	5	41	19	1	8	8	9	4	4	2	4	21	39	5	4	1	5	4	20	41	4	0	0	0	2
5	4	4	1	4	31	28	4	2	3	5	4	10	39	10	4	4	5	5	5	5	4	3	28	30	4	3	4	4	4	13	42	7	2	1	0	5
5	5	1	6	5	25	37	5	3	5	4	5	16	39	11	5	4	2	1	4	4	4	5	35	24	4	6	4	4	1	8	43	16	5	5	2	2
15	5	4	4	4	23	38	5	5	5	4	3	18	36	4	5	3	0	0	2	3	6	4	35	19	6	3	4	5	5	3	40	24	4	5	8	6
25	7	5	5	5	12	40	8	4	4	6	1	29	28	6	3	0	0	0	0	0	3	9	40	12	4	2	5	4	4	5	32	24	6	9	8	12
35	11	8	4	5	8	42	17	5	4	6	5	37	29	2	0	0	0	0	0	0	0	19	37	11	6	6	2	4	6	6	22	40	7	10	9	19
45	21	16	21	17	18	46	36	11	9	6	10	41	12	0	0	0	0	0	0	0	0	21	31	2	4	6	9	14	14	15	28	56	26	19	21	0
55	0	0	0	0	0	14	31	2	0	0	17	28	1	0	0	0	0	0	0	0	2	32	12	0	0	0	0	0	0	0	1	29	17	0	0	0
65	0	0	0	0	0	0	24	27	1	10	34	12	0	0	0	0	0	0	0	2	26	27	1	0	0	0	0	0	0	0	0	8	35	9	0	13
75	6	0	0	0	0	0	7	26	42	37	20	1	0	0	0	0	2	8	14	23	16	1	0	0	0	0	0	0	0	0	0	0	6	23	21	0
85	4	9	7	7	8	7	4	0	0	0	2	7	9	5	8	6	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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Table 19. Latitude-Longitude Sampling at the Synoptic Time Period 00:00 GMT for Satellites 1, 2 and 3. The Circled Values are Areas Also Sampled Synoptically at 12:00 GMT.

LATITUDE

	N								90									180									270									360 W.LONGITUDE
85	0	5	9	9	10	10	9	4	0	0	0	2	8	9	8	10	9	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	13	6	1	0	0	0	0	8	32	43	40	16	3	0	0	0	0	4	10	20	25	14	1	0	0	0	0	0	0	0	0	0	0	6	22	19
65	0	0	0	0	0	0	1	33	26	1	9	36	12	0	0	0	0	0	0	0	0	27	29	1	0	0	0	0	0	0	0	0	13	39	9	0
55	0	0	0	0	0	0	20	37	3	0	0	23	35	3	0	0	0	0	0	0	0	4	38	19	0	0	0	0	0	0	0	3	37	20	0	0
45	18	22	20	22	19	15	45	31	13	9	8	12	40	12	0	0	0	0	0	0	0	0	25	30	2	8	10	9	12	11	15	34	57	23	19	17
35	11	12	8	4	2	11	44	17	5	4	5	5	37	26	1	0	0	0	0	0	0	1	13	42	8	6	4	5	4	6	5	29	40	9	7	10
25	7	5	5	6	3	17	44	8	5	4	3	2	30	38	5	2	0	0	0	0	0	6	13	41	20	3	3	5	4	5	5	36	26	8	9	10
15	5	2	4	4	5	21	37	3	5	4	4	4	24	42	5	5	2	0	0	0	5	5	4	43	23	1	4	4	6	5	3	38	20	4	7	8
5	5	3	2	5	5	28	30	1	3	4	4	5	14	37	10	4	4	0	2	4	3	5	5	33	25	5	5	5	3	2	11	39	12	5	3	3
5	1	4	4	3	3	39	29	5	2	5	5	4	11	41	14	4	4	6	4	4	6	4	2	27	37	4	4	5	1	4	21	35	12	3	0	0
15	0	2	5	4	1	39	20	4	5	3	2	4	8	37	24	3	5	8	8	4	4	4	2	20	42	6	4	4	4	4	22	36	4	4	0	0
25	0	0	2	5	11	32	15	5	5	4	3	3	4	32	27	9	6	9	9	7	3	4	5	15	40	6	4	4	4	5	25	28	3	1	0	0
35	0	0	0	1	21	37	9	2	5	6	5	5	6	26	42	10	11	10	9	8	9	9	6	10	37	17	6	5	5	6	35	23	0	0	0	0
45	0	0	0	0	22	30	6	7	7	12	15	16	18	32	55	24	20	23	18	20	17	18	19	17	47	36	10	6	6	10	33	10	0	0	0	0
55	0	0	0	3	30	11	0	0	0	0	0	0	0	2	31	16	0	0	0	0	0	0	0	0	16	31	2	0	0	16	28	0	0	0	0	0
65	0	0	2	23	27	1	0	0	0	0	0	0	0	0	9	32	9	0	0	0	0	0	0	0	0	26	23	1	9	32	12	0	0	0	0	0
75	7	16	22	15	1	0	0	0	0	0	0	0	0	0	0	7	21	20	11	6	1	0	0	0	0	6	25	44	32	18	3	0	0	0	0	1
85	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	7	6	8	5	5	0	0	0	1	6	8	6	6	7	7

S

Table 20. Latitude-Longitude Sampling of the Synoptic Time Period 12:00 GMT for Satellites 1, 2 and 3. The Circled Values are Areas Also Sampled Synoptically at 00:00 GMT.

MONTH	"TRUE" ALBEDO	"MEASURED" ALBEDO				
		1	2	3	12	123
JAN	24.67	23.12	24.75	23.75	23.94	23.87
FEB	23.90	22.66	23.78	22.98	23.21	23.14
MAR	22.42	21.99	22.01	22.40	22.00	22.13
APR	21.65	21.24	21.26	21.06	21.25	21.19
MAY	23.91	23.98	24.29	23.89	24.14	24.06
JUNE	28.09	27.89	28.72	27.73	28.31	28.12
JULY	28.65	29.00	28.96	28.70	28.98	28.89
AUG	29.51	29.99	30.10	29.35	30.05	29.82
SEP	29.71	29.73	30.19	29.39	29.96	29.77
OCT	26.94	26.81	27.51	26.12	27.17	26.82
NOV	26.78	26.64	26.97	26.39	26.79	26.65
DEC	26.96	26.17	26.86	25.64	26.51	26.62
ANNUAL AV	26.10	25.83	26.31	25.67	26.07	25.93

Table 21. True Albedos and Satellite Measured Albedos for the 10° - 10° Area Having K = 8, J = 24 and NT = 3 for Each Month of the Year.

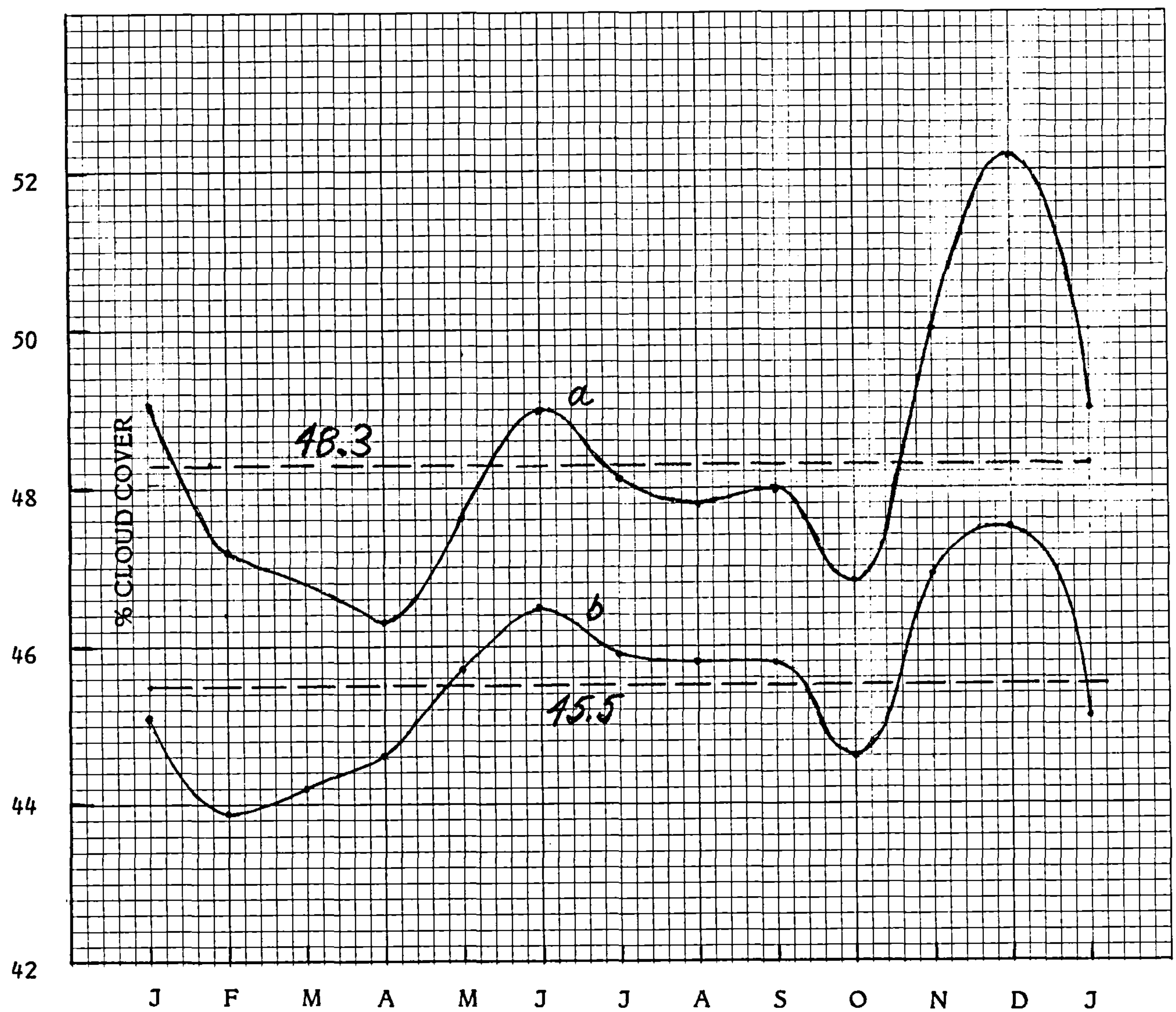


Fig. 1. Monthly average values of sunlit cloud cover (a) compared with monthly 24 hour average values of cloud cover (b).

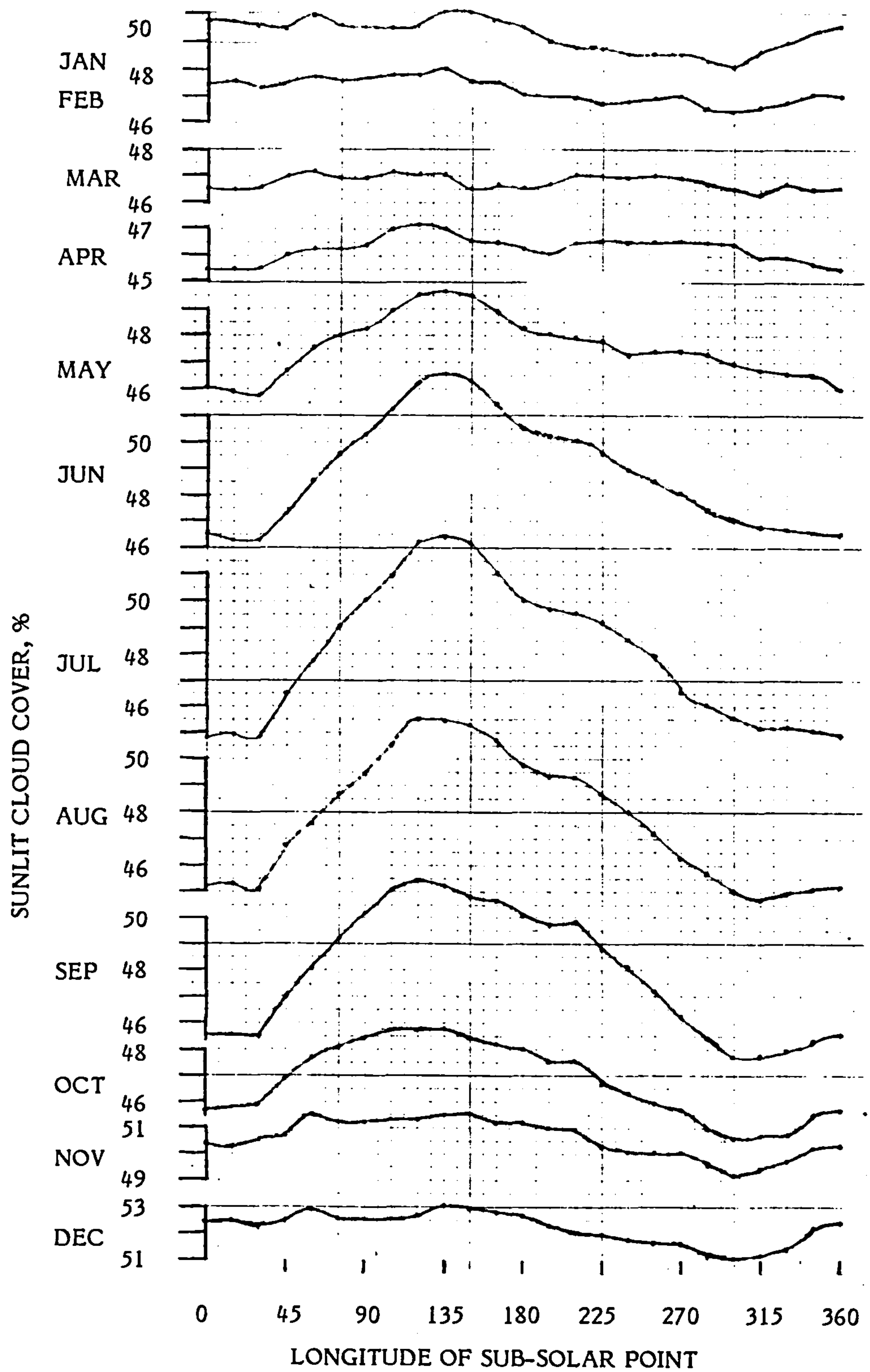


Fig. 2. Diurnal variation of average cloud cover on sunlit hemisphere of the earth. The curves show sunlit cloud cover as a function of the longitude of the sub-solar point.

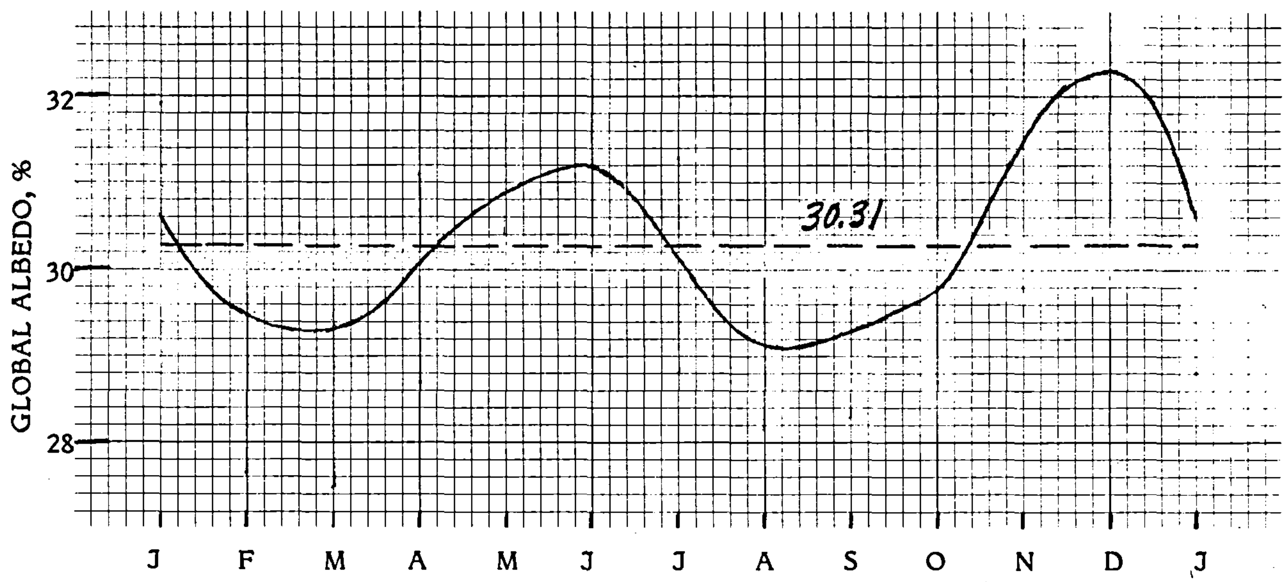


Fig. 3. Monthly average values of global albedo.

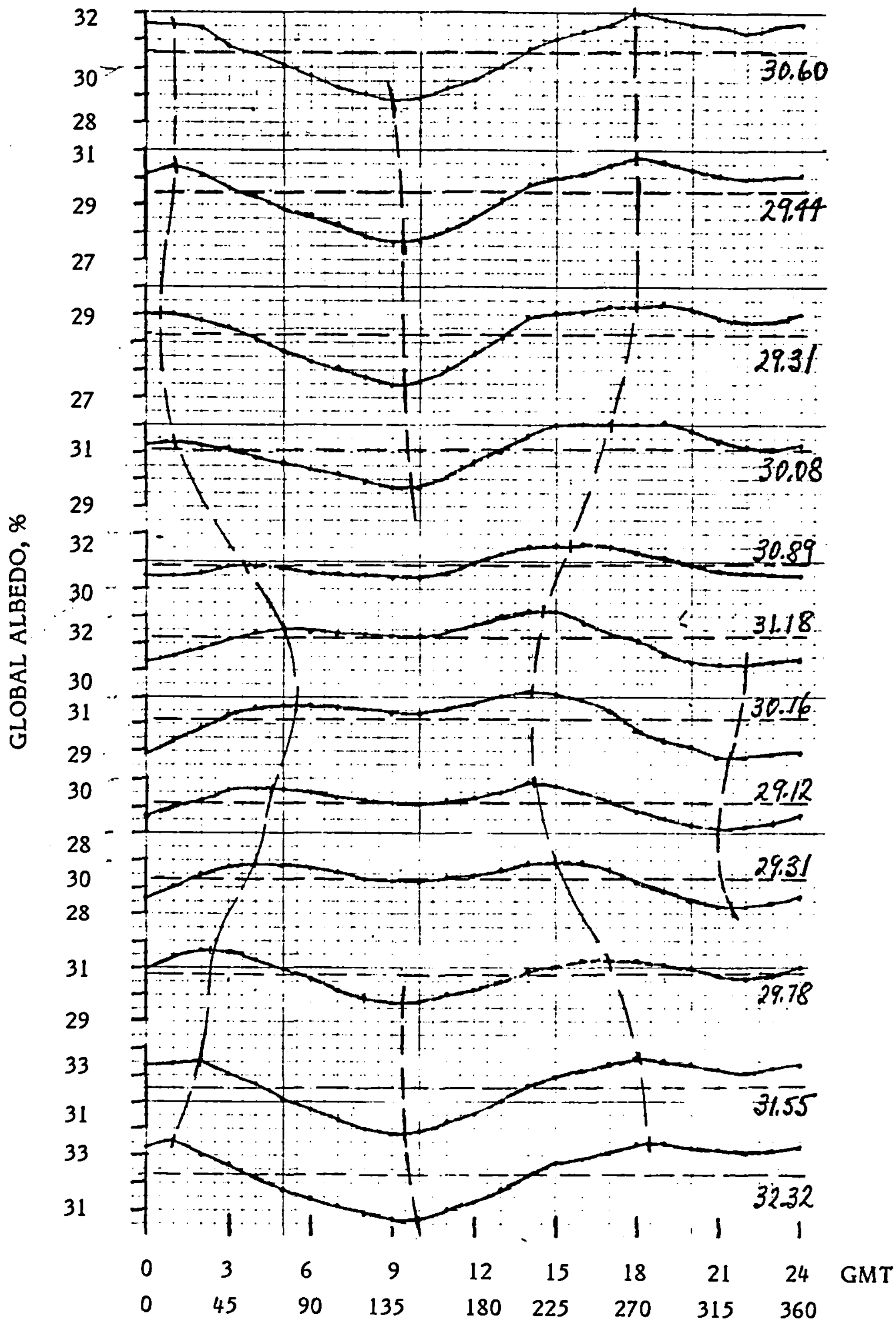


Fig. 4. Diurnal variation of global average albedo for each month of the year. Each curve is slotted as a function of the longitude of the sub-solar point (λ_{ss}). GMT is also shown.

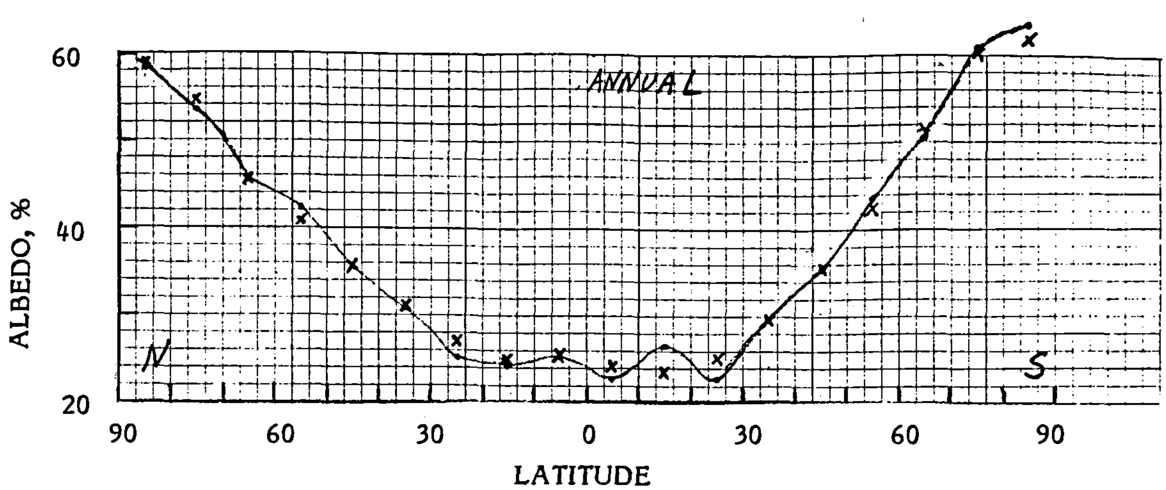


Fig. 5. Model annual average zonal albedo vs. latitude (line) compared with satellite data of Ellis and Vonder Haar (1976) (X).

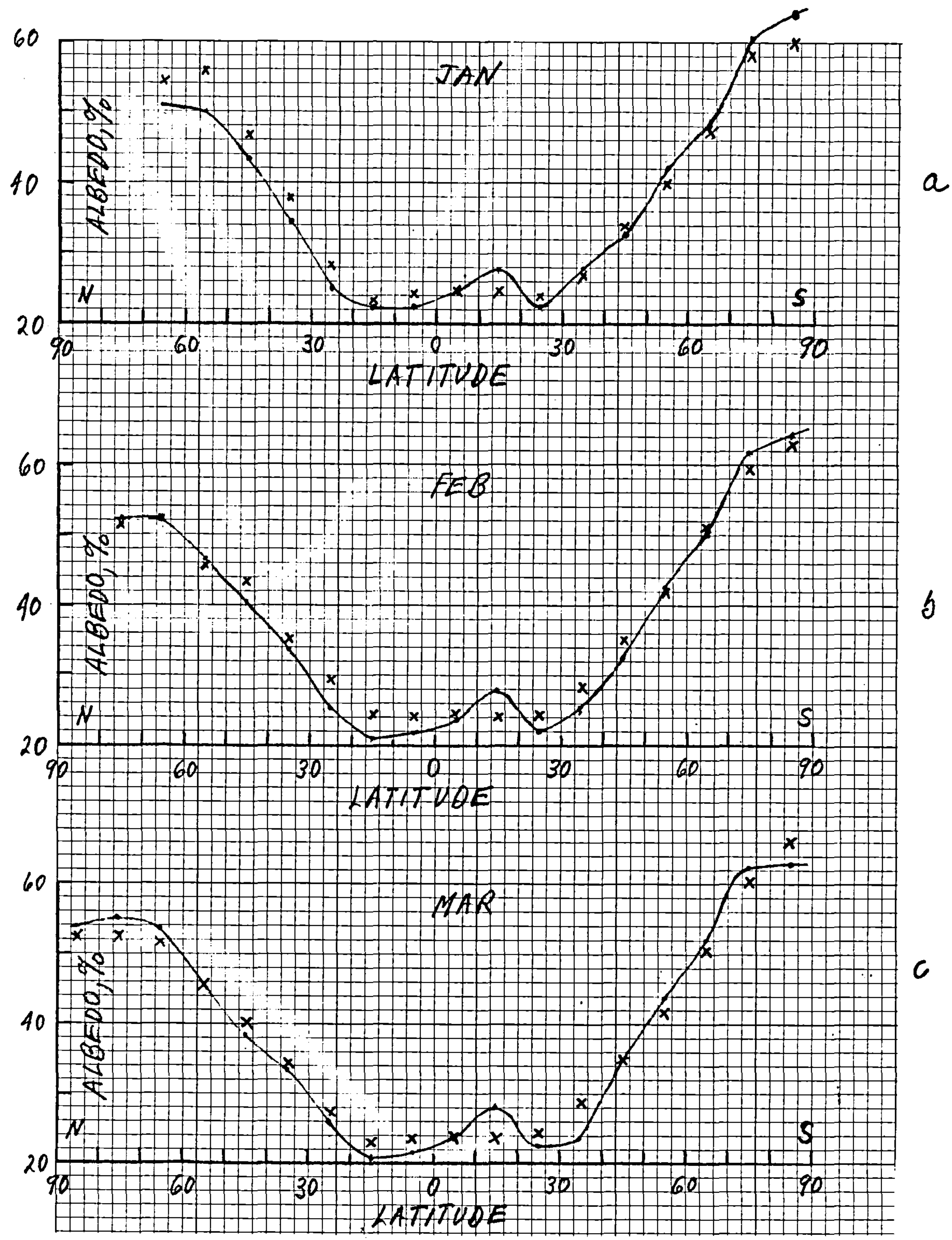


Fig. 6a. Model monthly average zonal albedo (line) compared with data of Ellis and Vonder Haar (1976) X, Jan., Feb. and March.

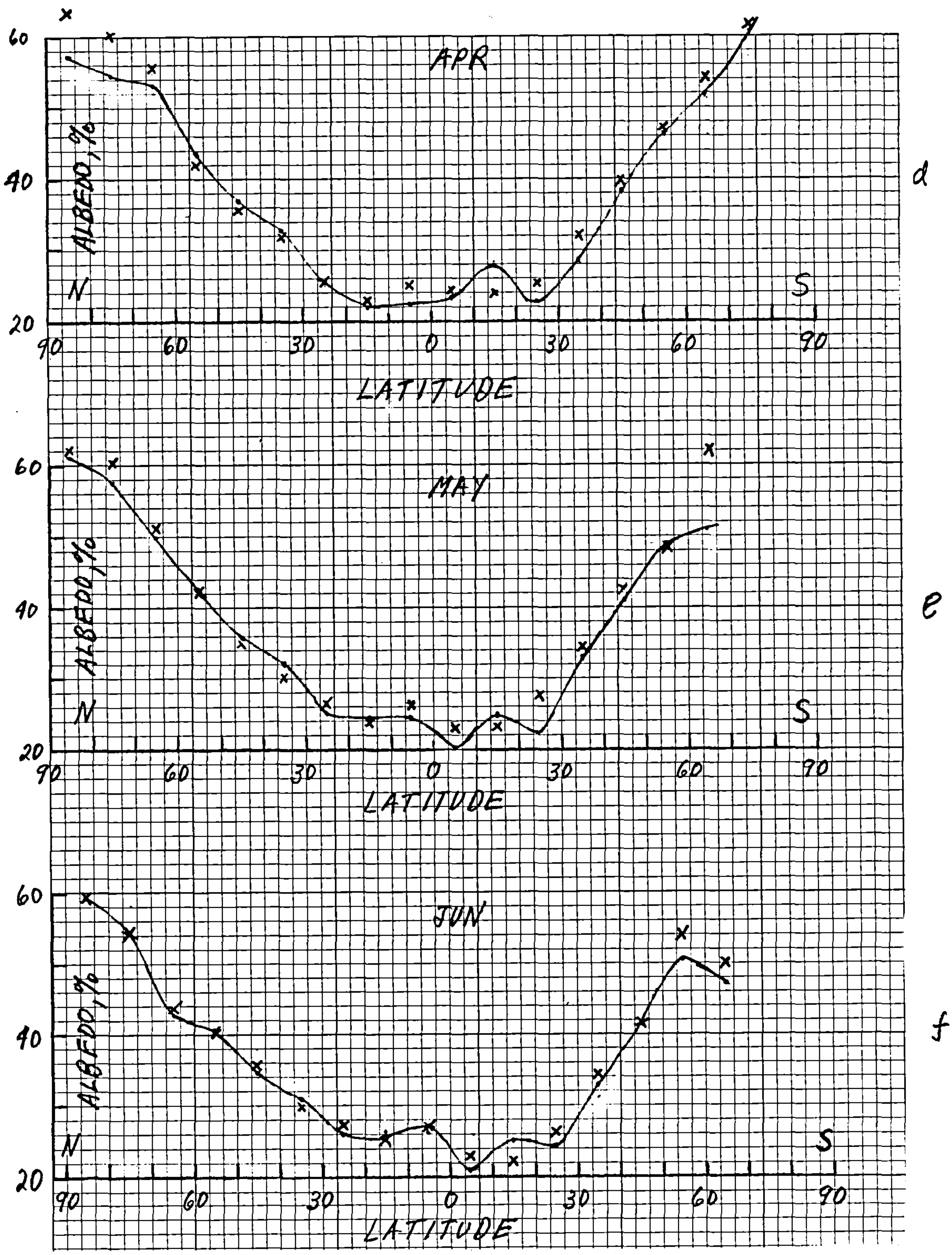


Fig. 6b. Model monthly average zonal albedo (line) compared with data of Ellis and Vonder Haar (1976) (X), April, May and June.

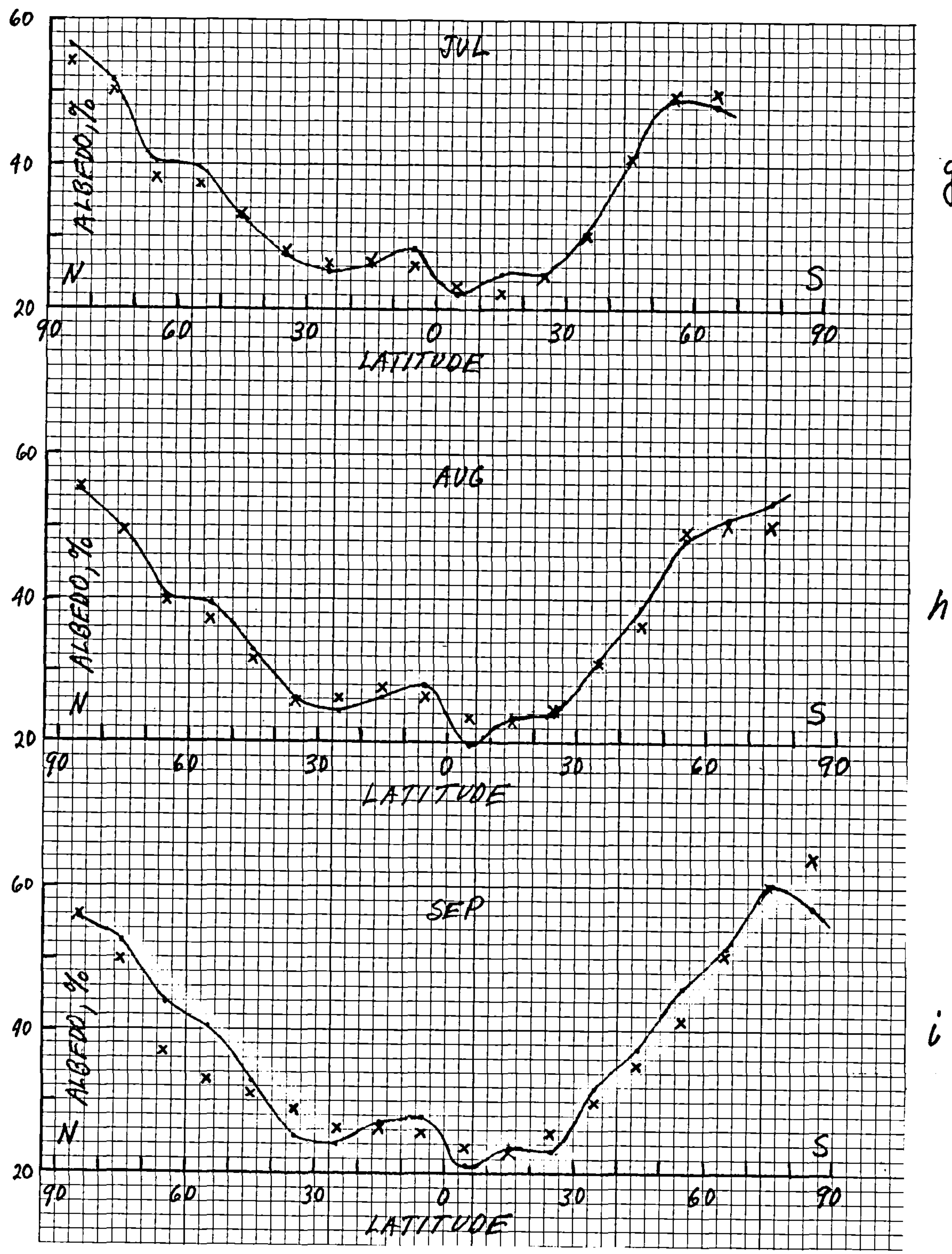


Fig. 6c. Model monthly average zonal albedo (line) compared with data of Ellis and Vonder Haar (1976) (X), July, August and September.

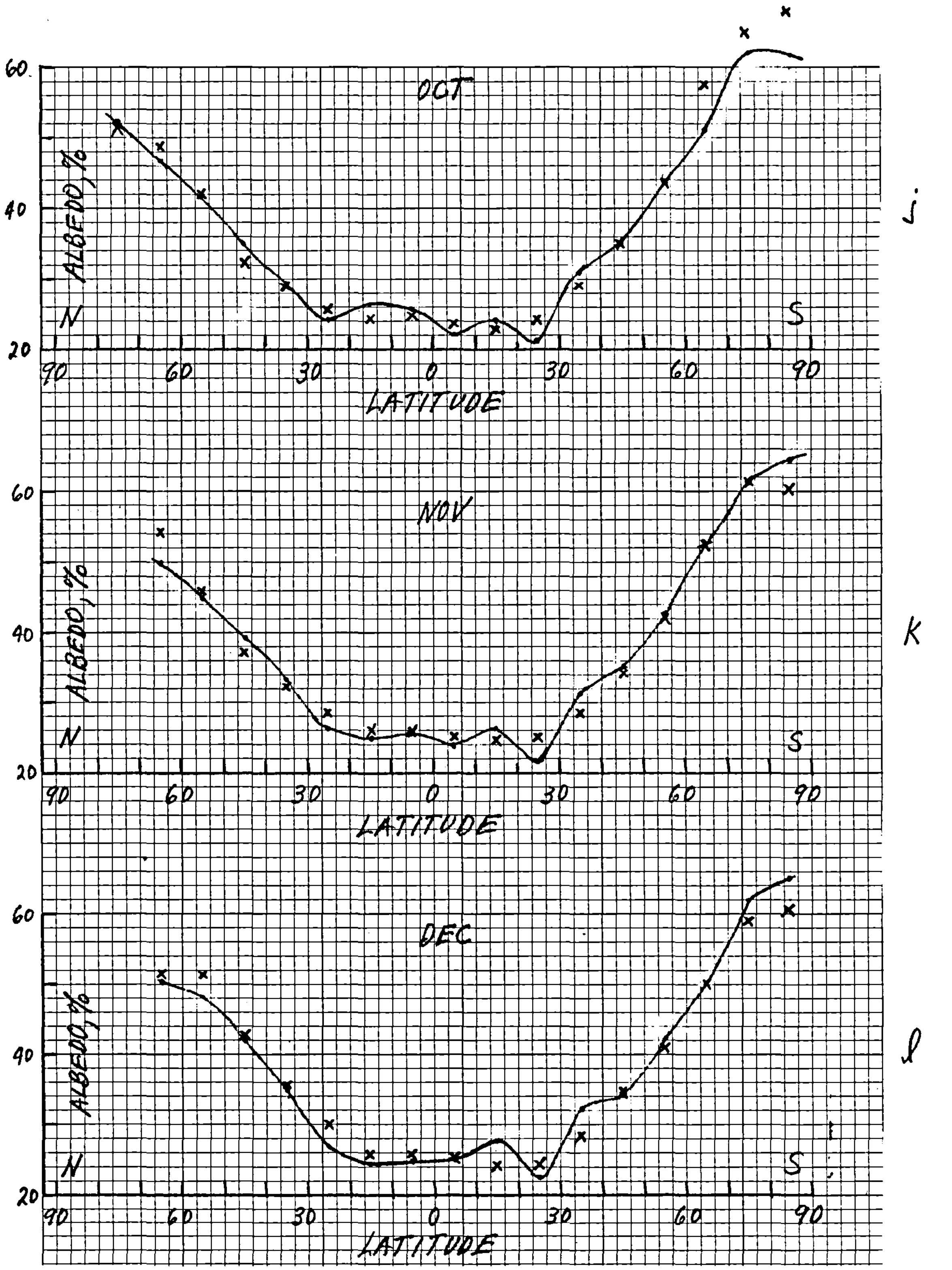


Fig. 6d. Model monthly average zonal albedo (line) compared with data of Ellis and Vonder Haar (1976) (X), October, November and December.

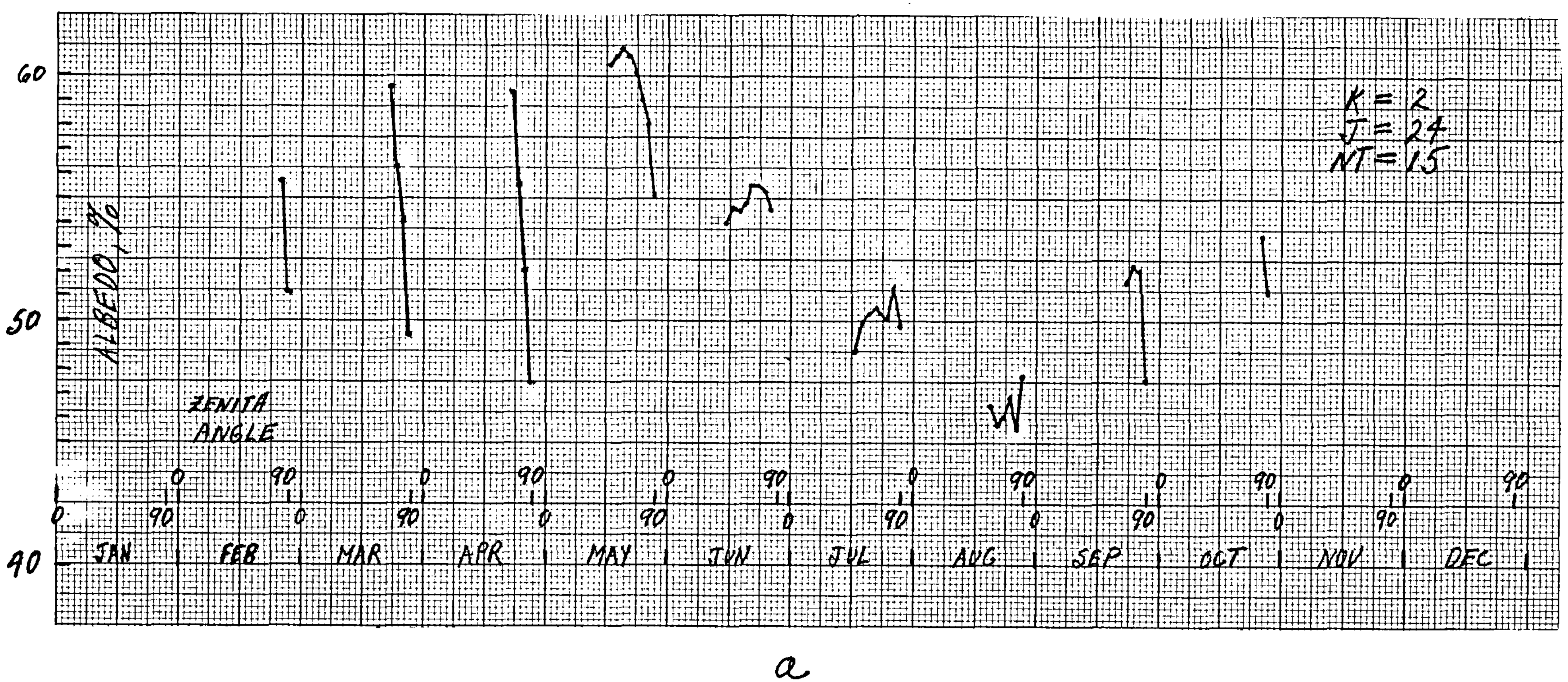


Fig. 7a. Selected monthly average 10°-10° area albedos vs. zenith angle, K = 2, J = 24, cloud type NT = 15.

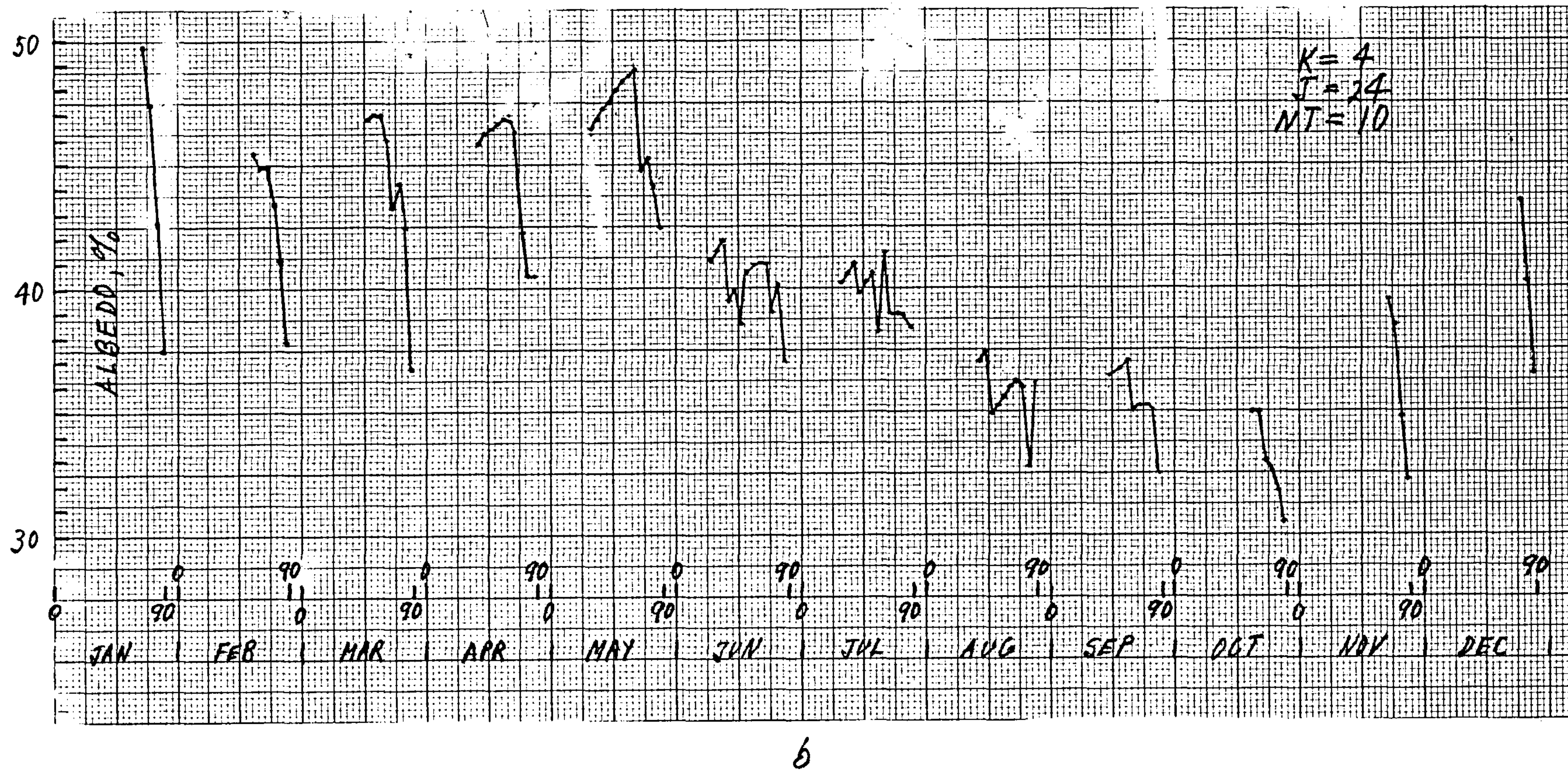
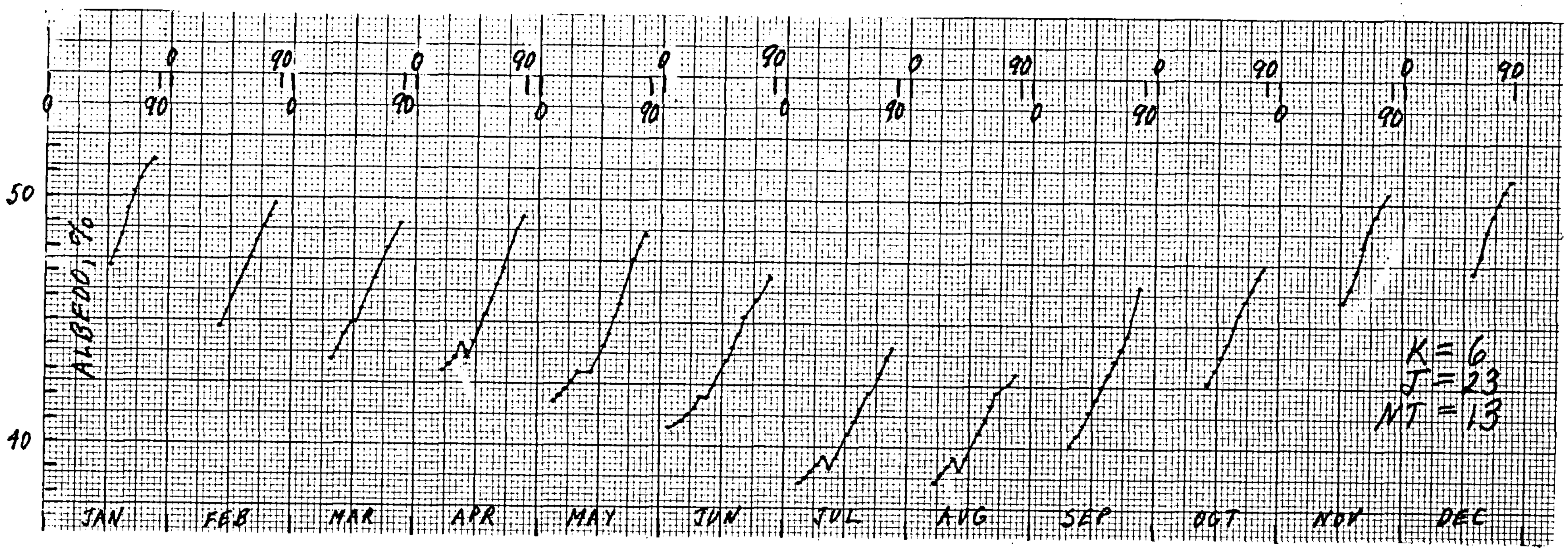


Fig. 7b. Selected monthly average 10°-10° area albedos vs. zenith angle, K = 4, J = 24, cloud type NT = 10.



C

Fig. 7c. Selected monthly average 10^{o}- 10^{o} area albedos vs. zenith angle, K = 6, J = 23, cloud type NT = 13.

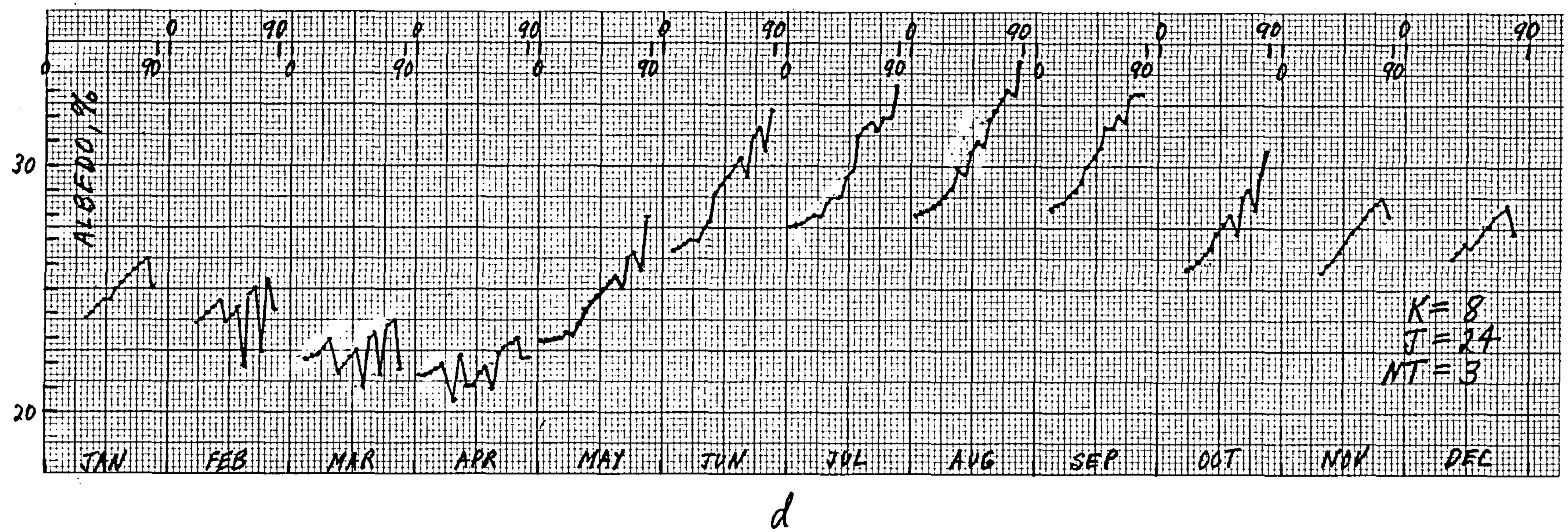
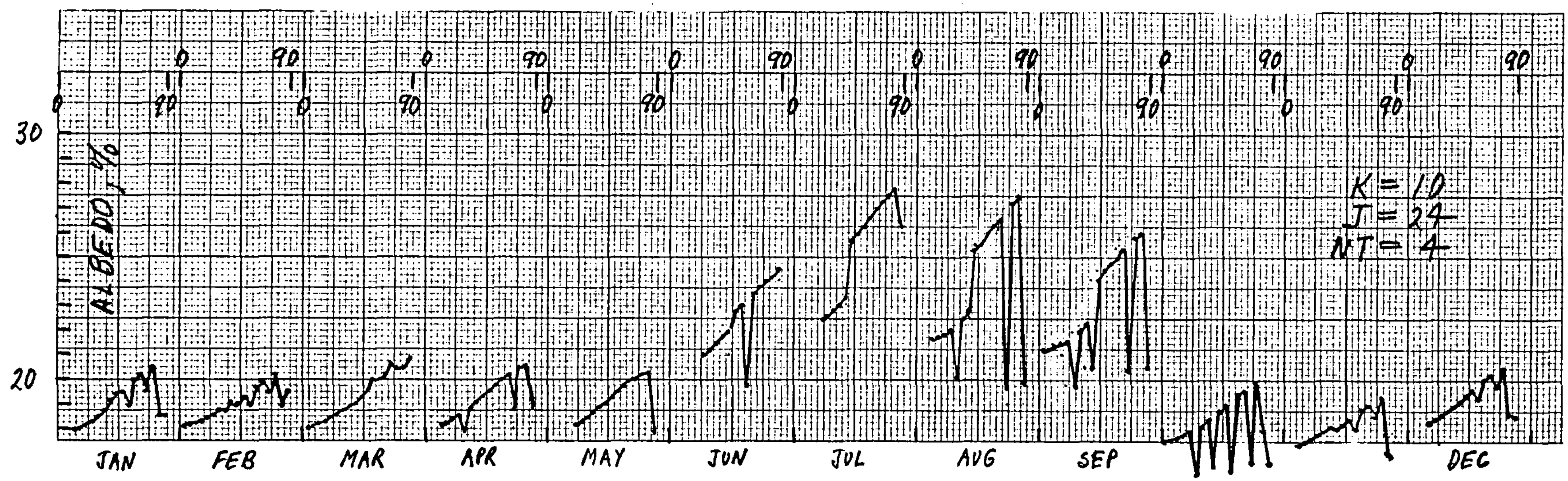


Fig. 7d. Selected monthly average 10°-10° area albedos vs. zenith angle, K = 8, J = 24, cloud type NT = 3.



e

Fig. 7e. Selected monthly average 10°-10° area albedos vs. zenith angle, K = 10, J = 24, cloud type NT = 4.

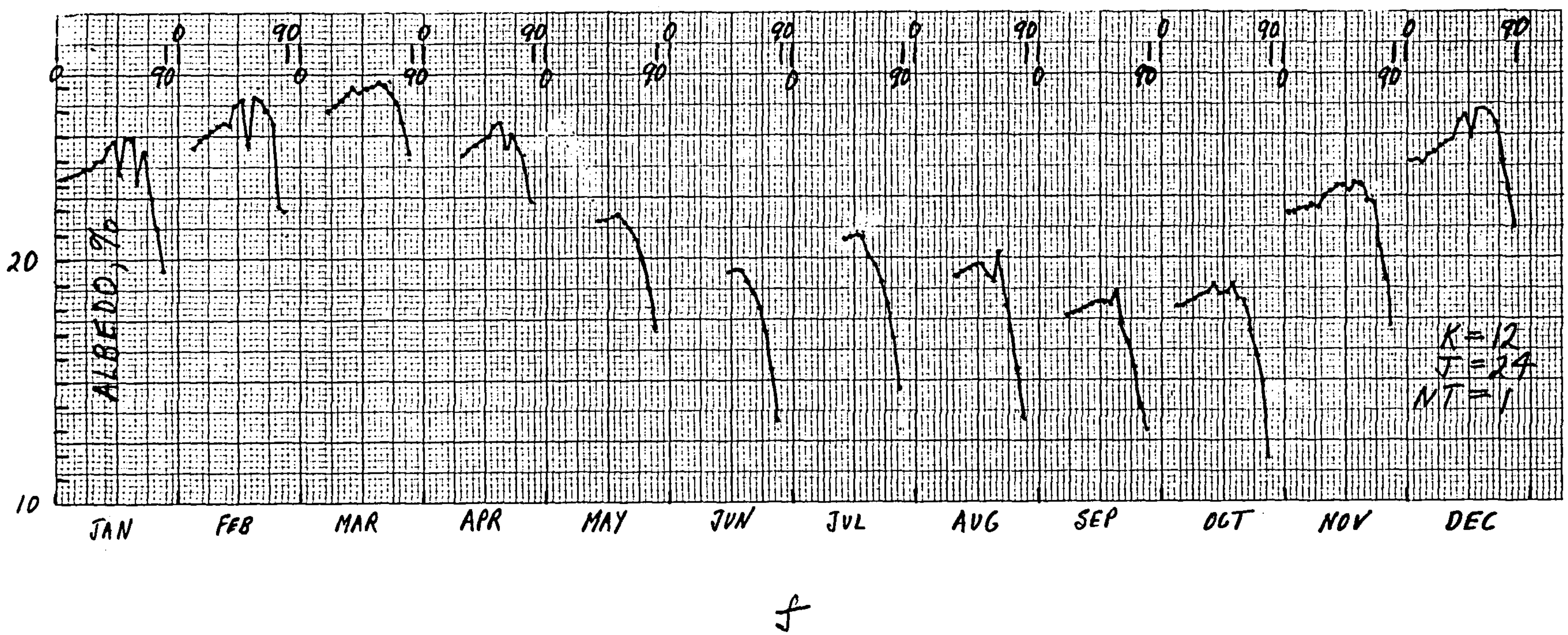


Fig. 7f. Selected monthly average 10°-10° area albedos vs. zenith angle, K = 12, J = 24, cloud type NT = 1.

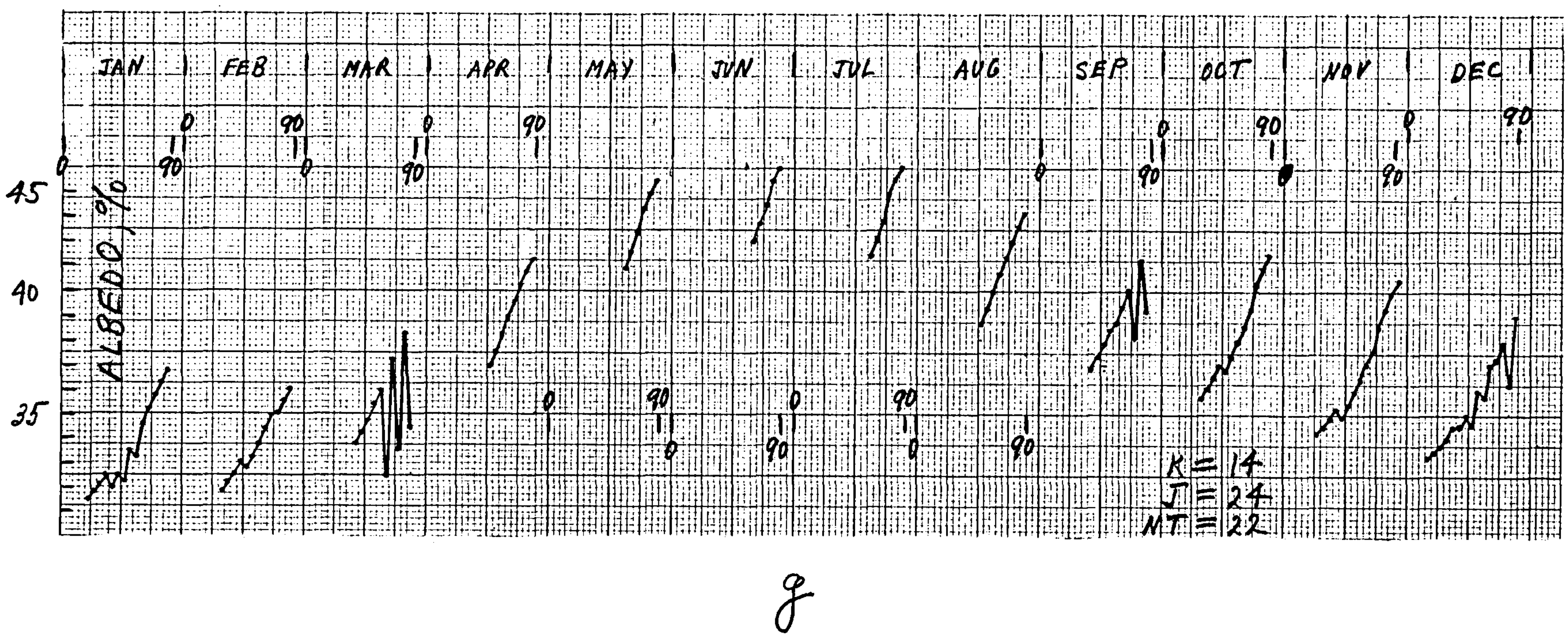


Fig. 7g. Selected monthly average 10°-10° area albedos vs. zenith angle, K = 14, J = 24, cloud type NT = 22.

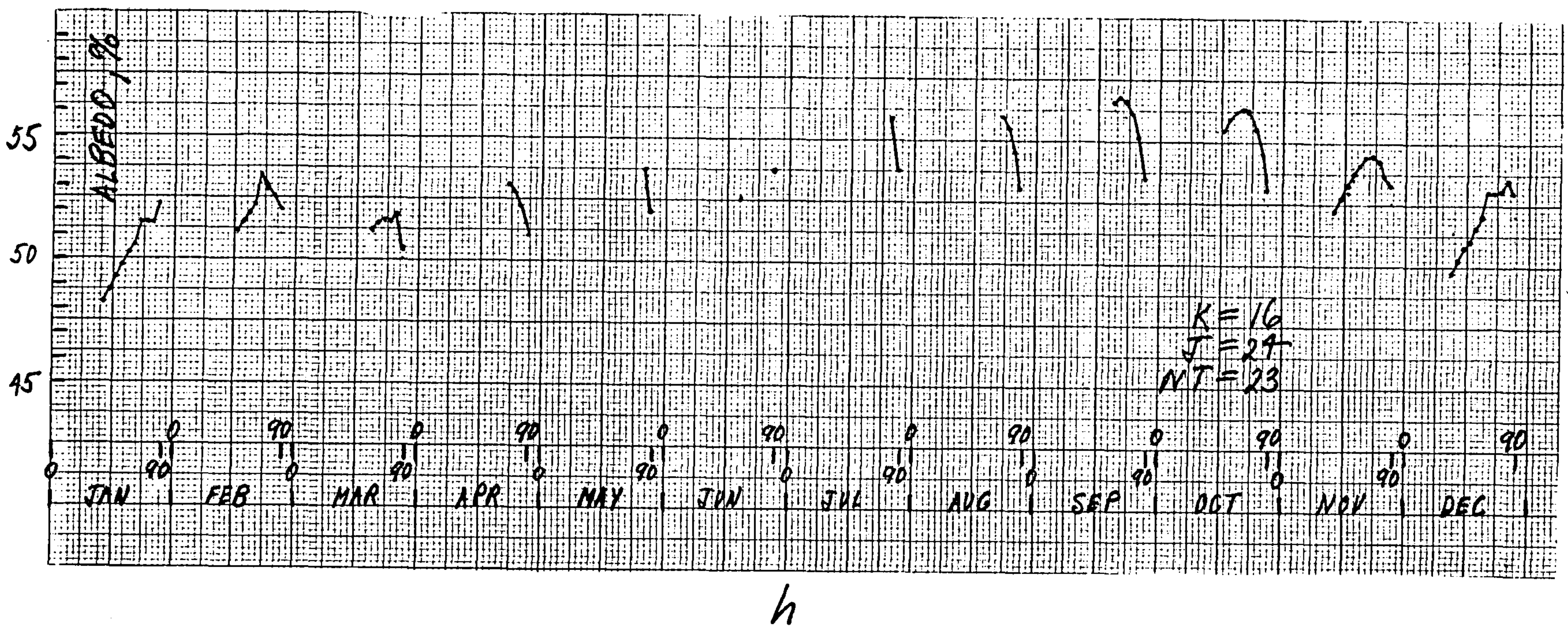


Fig. 7h. Selected monthly average 10°-10° area albedos vs. zenith angle, K = 16, J = A, cloud type NT = 23.

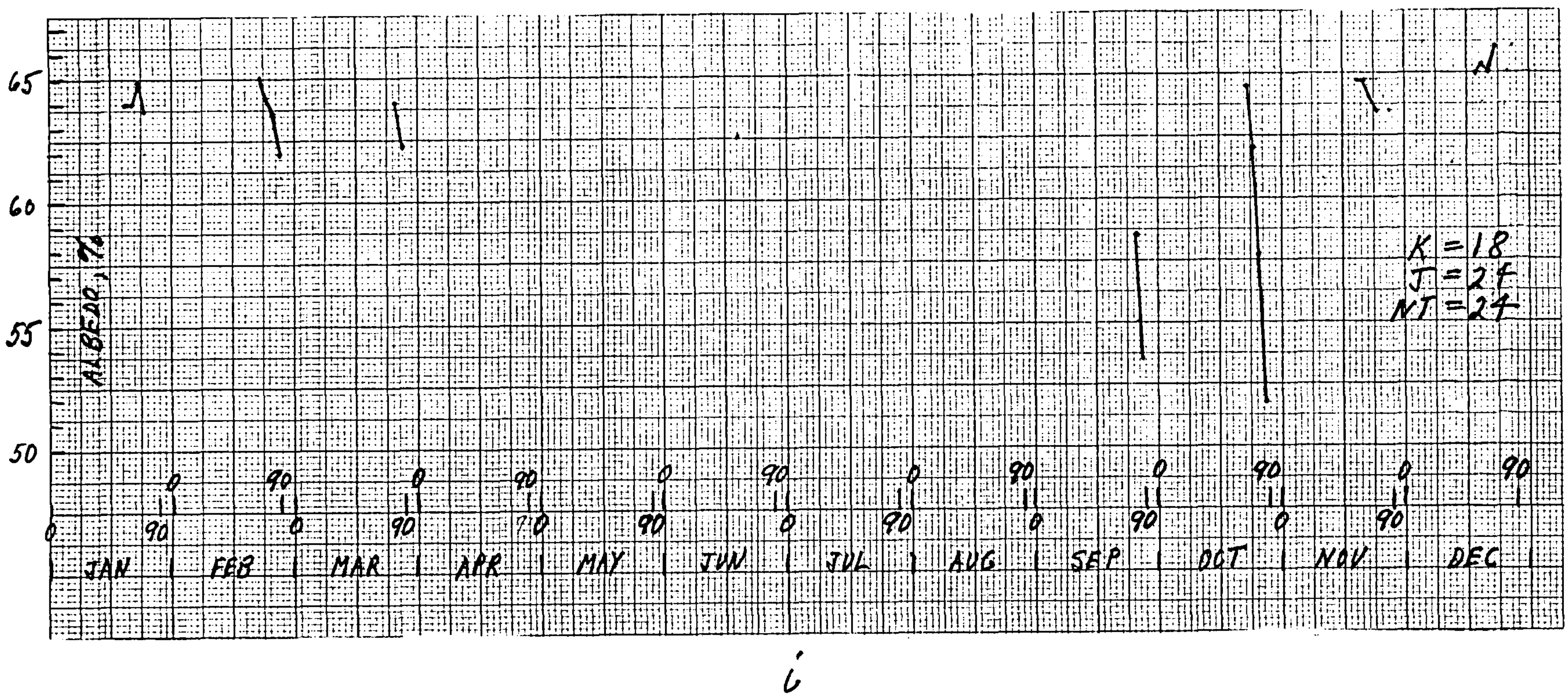


Fig. 7i. Selected monthly average 10°-10° area albedos vs. zenith angle, K = 18, J = 24, cloud type NT = 24.

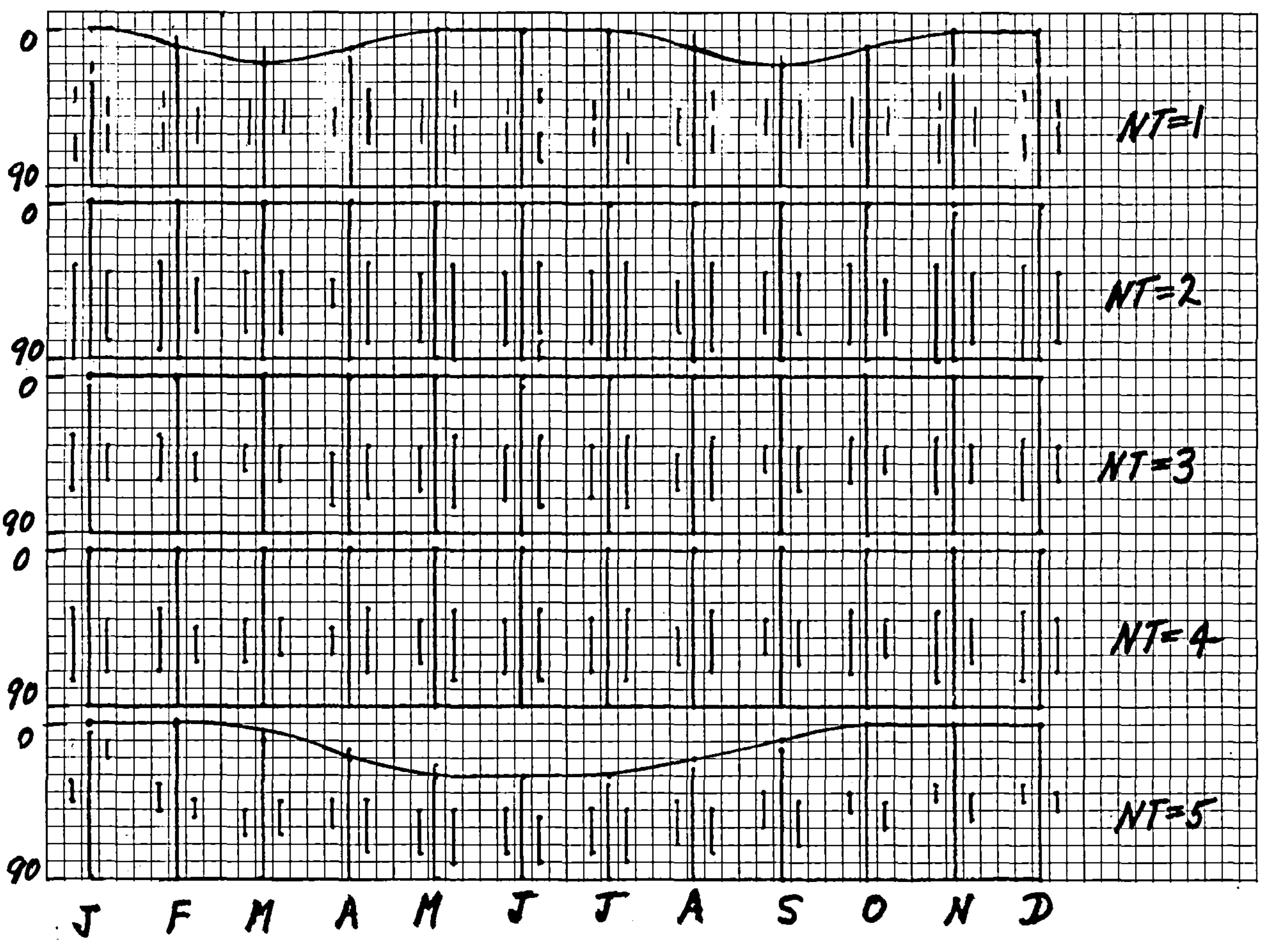


Fig. 8a. Satellite zenith angle sampling for the 29 cloud type areas for each month of the year, NT = 1 to 5.

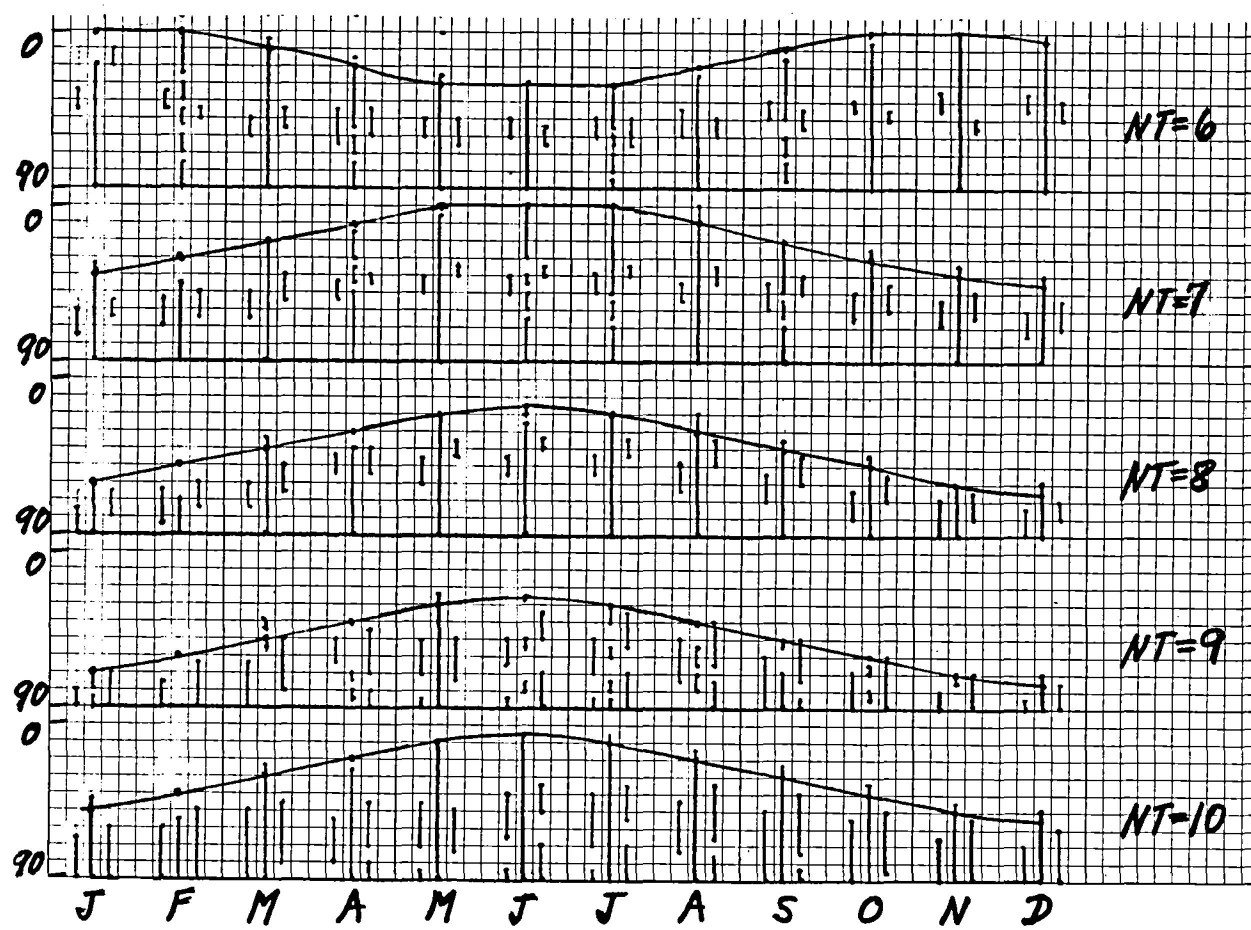


Fig. 8b. Satellite zenith angle sampling for the 29 cloud type areas for each month of the year, NT = 6 to 10.

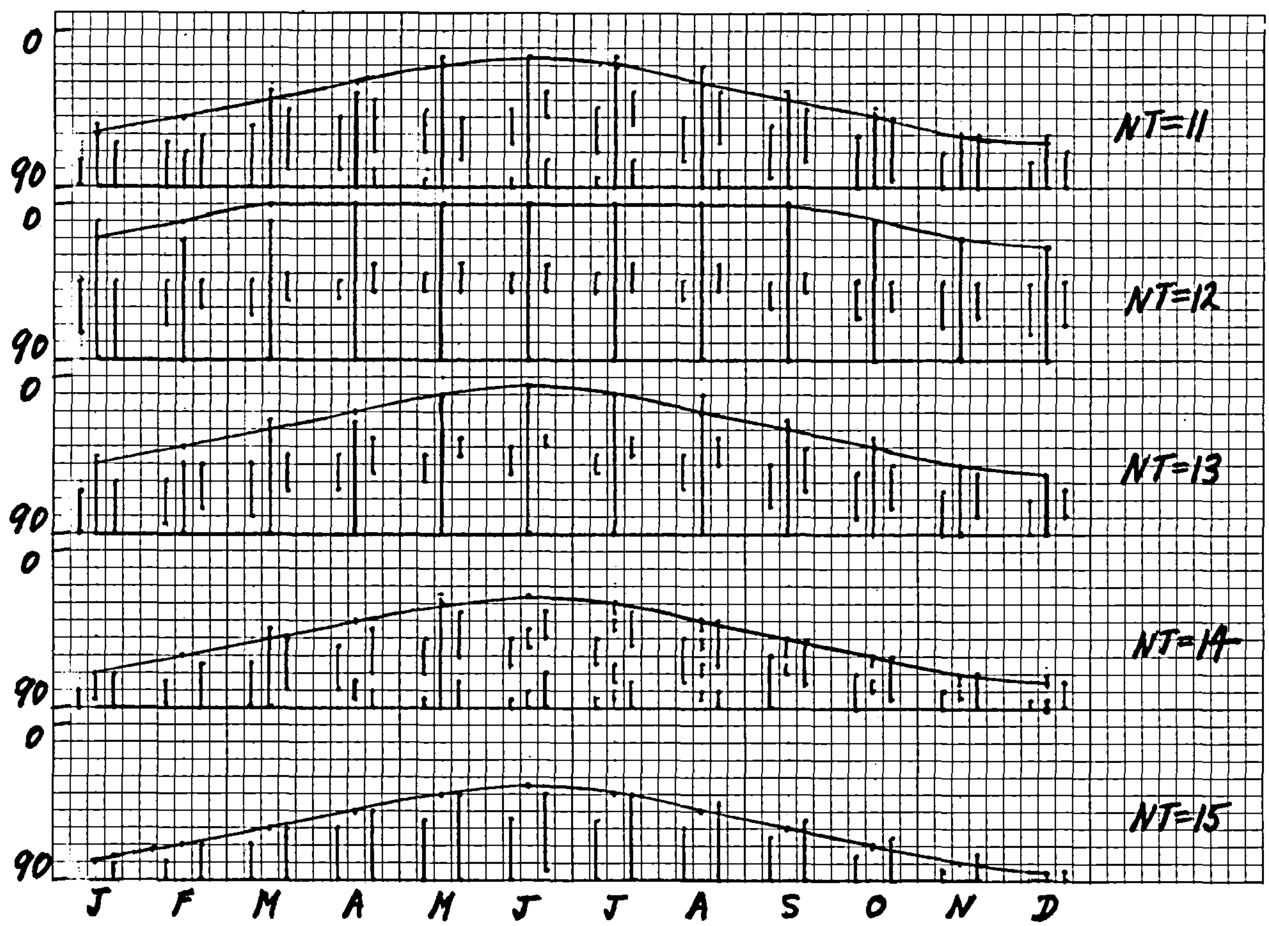


Fig. 8C. Satellite zenith angle sampling for the 29 cloud type areas for each month of the year, NT = 11 to 15.

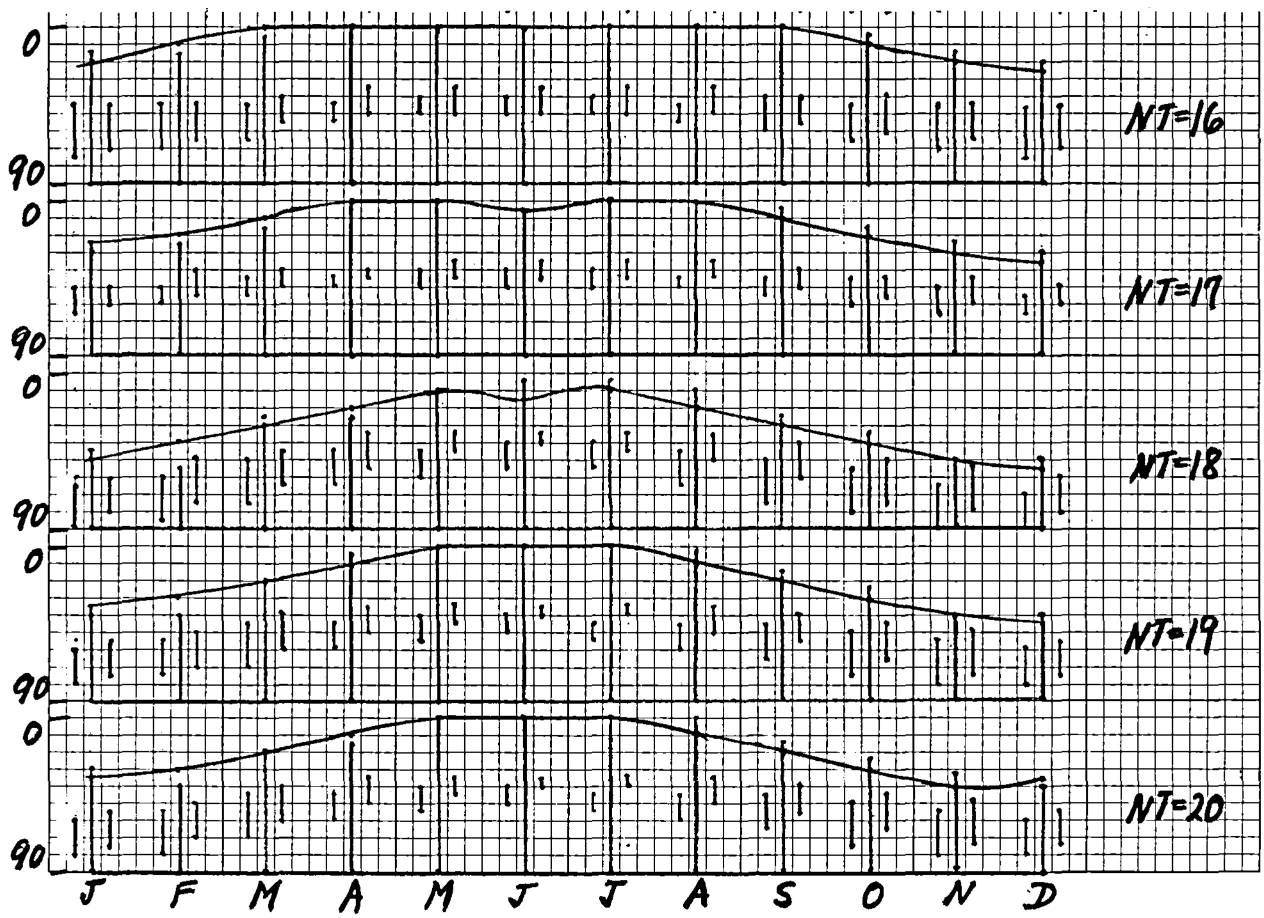


Fig. 8d. Satellite zenigh angle sampling for the 29 cloud type areas for each month of the year, NT = 16 to 20.

Fig. 8e. Satellite zenith angle sampling for the 29 cloud type areas for each month of the year, NT = 21 to 25.

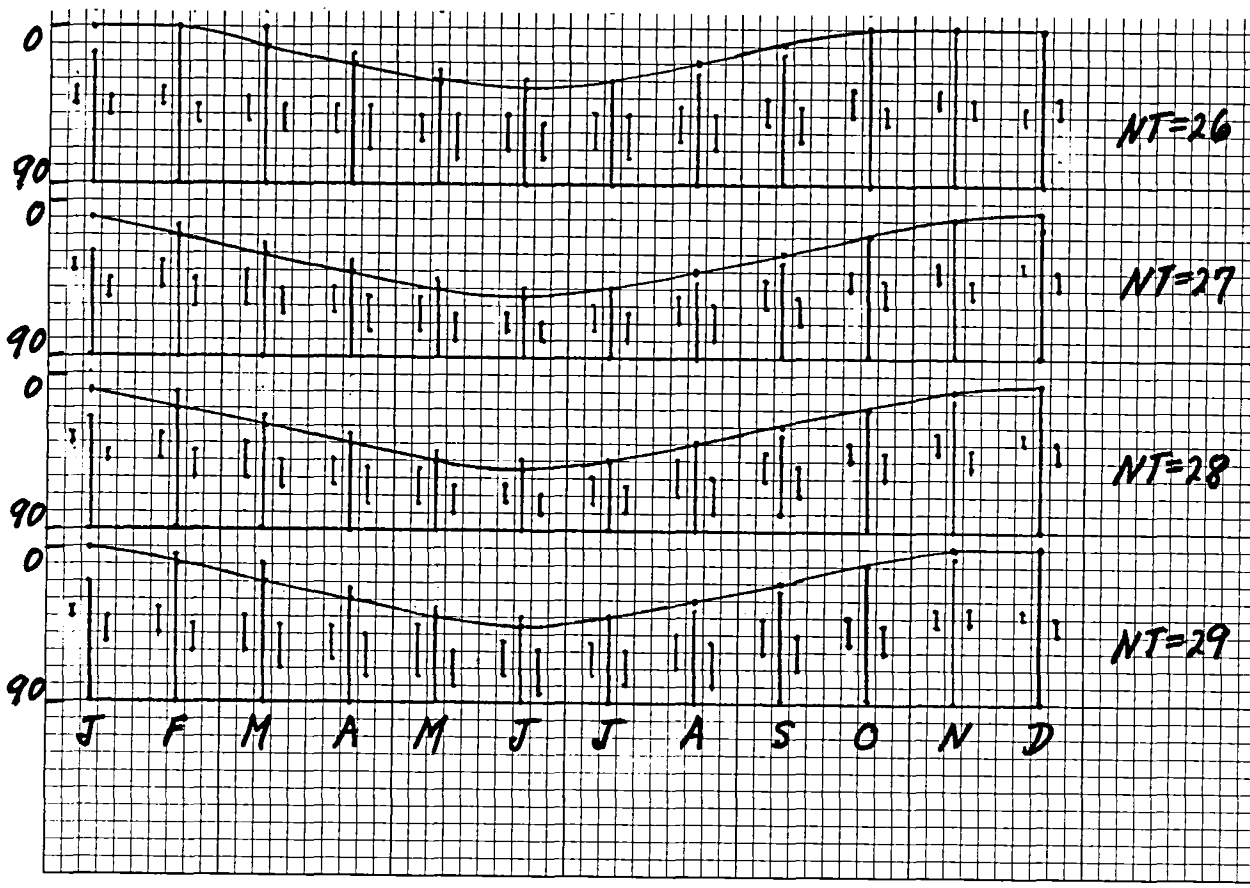


Fig. 8f. Satellite zenith angle sampling for the 29 cloud type areas for each month of the year, NT = 26 to 29.

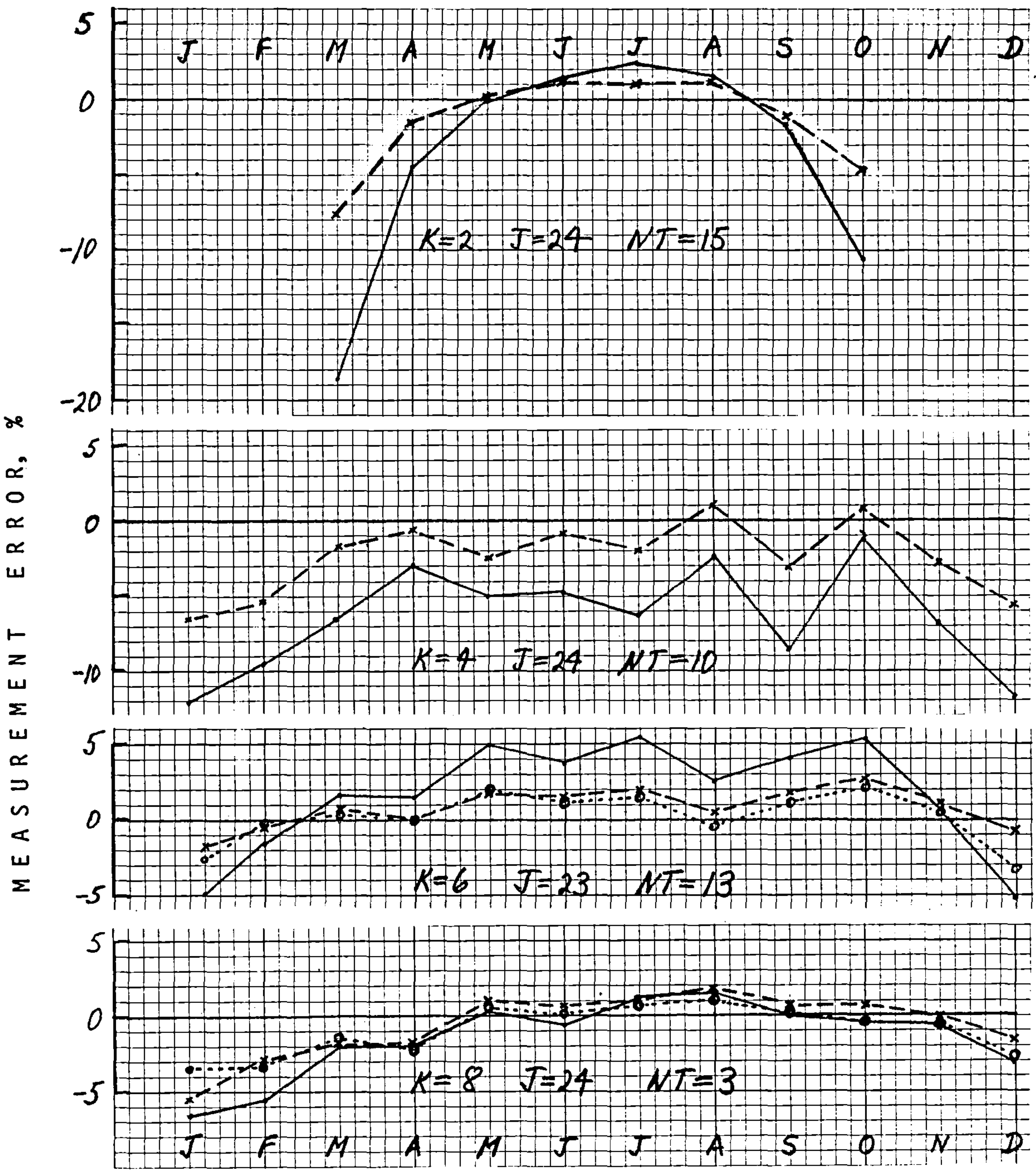


Fig. 9a. Sampling errors for four selected 10^{o}-10^{o} regions in the northern hemisphere. —— for satellite 1 "measurements," --- for the average of the "measurements" of satellites 1 and 2, ····for the average of the "measurements" of satellites 1,2, and 3.

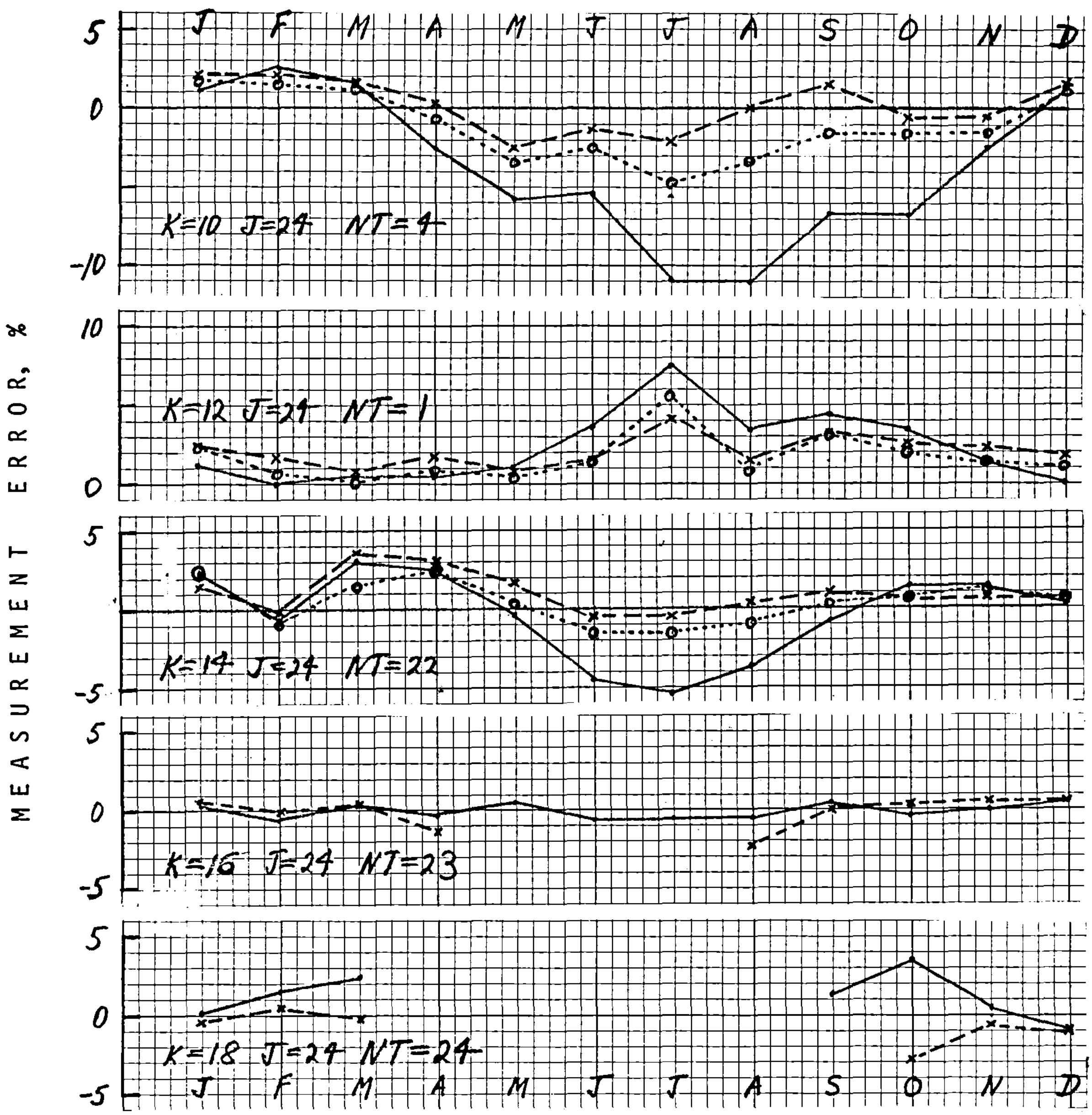


Fig. 9b. Sampling errors for five selected 10^0-10^0 regions in the southern hemisphere. ——for satellite 1 "measurements," --- for the average of the "measurements" of satellites 1 and 2, ····for the average of the "measurements" of satellites 1, 2, and 3.

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Final Report

16. Abstract

Characteristics of the "time variable Earth albedo" model are described. With the cloud cover multiplying factor adjusted to produce a global annual average albedo of 30.3, the global annual average cloud cover is 45.5 percent. Global annual average Sunlit cloud cover is 48.5 percent; nighttime cloud cover is 42.7 percent. Month-to-month global average albedo is almost sinusoidal with maxima in June and December (highest) and minima in April (lowest) and October. Month-to-month variation of Sunlit cloud cover is similar, but not in all details. The diurnal variation of global albedo is greatest from November to March; the corresponding variation of Sunlit cloud cover is greatest from May to October. Annual average zonal albedos and monthly average zonal albedos are in good agreement with satellite-measured values of Ellis and Vonder Haar (1976) with notable differences in the polar regions in some months and at 15°S. The albedo of some 10° x 10° areas of the Earth versus zenith angle are described.

Satellite albedo measurement sampling effects are described in local time and in Greenwich Mean Time. Regions of the Earth are shown where satellite samples are obtained at 00:00 and 12:00 GMT (synoptic sampling times). Errors in satellite measured monthly average albedos of local areas are determined to be under 3.5 percent for 66 percent of the measurements obtained for the one-satellite system, 92 percent for a two-satellite system, and 97 percent for a three-satellite system.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
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