NOAA Technical Memorandum NOS NGS 33

THE 3.5-YEAR GEOS-3 DATA SET

Rockville, Md.
January 1982

U.S. DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration / National Ocean Survey

NOAA Technical Publications

National Ocean Survey/National Geodetic Survey subseries

The National Geodetic Survey (NGS) of the National Ocean Survey (NOS), NOAA, establishes and maintains the basic national horizontal and vertical networks of geodetic control and provides governmentwide leadership in the improvement of geodetic surveying methods and instrumentation, coordinates operations to assure network development, and provides specifications and criteria for survey operations by Federal, State, and other agencies.

NGS engages in research and development for the improvement of knowledge of the figure of the Earth and its gravity field, and has the responsibility to procure geodetic data from all sources, process these data, and make them generally available to users through a central data base.

NOAA geodetic publications and relevant geodetic publications of the former U.S. Coast and Geodetic Survey are sold in paper form by the National Geodetic Information Center. To obtain a price list or to place an order contact:

National Geodetic Information Center
OA/C18x2
National Ocean Survey, NOAA
Rockville, MD 20852

(301) 443-8316

Publications can also be purchased over the counter at the National Geodetic Information Center, 11400 Rockville Pike, Room 14, Rockville, Md. (Do not send correspondence to this address.)

An excellent reference source for all Government publications is the National Depository Library Program, a network of about 1,300 designated libraries. Requests for borrowing Depository Library material may be made through your local library. A free listing of libraries in this system is available from the Library Division, U.S. Government Printing Office, 5236 Eisenhower Ave., Alexandria, VA 22304 (703-557-9013).

NOAA Technical Memorandum NOS NGS 33

THE 3.5-YEAR GEOS-3 DATA SET

Russell W. Agreen

National Geodetic Survey
Rockville, Md.

January 1982

For sale by the National Geodetic Information Center,
Rockville, MD 20852 $2.20

UNITED STATES DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
John V. Byrne, Administrator

National Ocean Survey
Herbert R. Lippold, Jr., Director

CONTENTS

THE 3.5-YEAR GEOS-3 DATA SET

Russell W. Agreen
National Geodetic Survey
National Ocean Survey, NOAA
Rockville, Md. 20852

ABSTRACT. A revised GEOS-3 altimeter data set has been produced by the National Ocean Survey/National Geodetic Survey (NOS/NGS). The resulting surface heights are smoothed over a shorter time (1 second) than the "G" tape data set produced by the National Aeronautics and Space Administration (NASA), Wallops Flight Center. It also differs from the "G" tape by not having a "unique number" field, while possessing additional fields for the satellite height, Schwiderski ocean-tide height, Cartwright solid-tide height, and automatic gain control.

INTRODUCTION

GEOS-3 data have been provided to the National Oceanic and Atmospheric Administration (NOAA), Environmental Data and Information Services (EDIS) in two different forms by NASA/Wallops (NOAA 1980). These include a complete 10-per-second set of "I" tapes and a compressed 1-per-second set of "G" tapes (Stanley and Dwyer 1980). The "I" tapes have been reprocessed and edited to one of two uniform rates of roughly 1 per second to form a new NOAA NOS/NGS 3.5-year data set. This set contains 5,006,956 altimetric sea surface heights and supporting information such as sea state, wind speed, Schwiderski (1980) ocean tide height, and Cartwright solid-tide height (Cartwright and Edden 1973). Because some of the "I" tape data were not available, roughly 6 weeks of observations are missing. The data are contained on seven 1600 BPI tapes, and may be obtained by writing to:

Satellite Data Services Division
NOAA Environmental Data and Information Services
World Weather Building (Room 100)
Washington, D.C. 20233

PROCESSING

The "I" tapes contain smoothed sea surface heights at the rate of 10 per 1.024 seconds. However, each record represents one frame of data and contains either 20 or 32 samples depending on whether the data were taken in the low- or high-rate mode. In deciding how to compress these values to 1 per second, simplicity and placement of evenly spaced observations were given priority. With the belief that no information existed under 1 second in the GEOS-3 observations, and at the same time wishing to disregard occasional outliers, a trim mean filter was selected to compress the "I" tape heights. Multiples of 20 or 32 observations per frame led to selecting a 10-point filter for low-rate data and an 8-point filter for high-rate data.

In both cases, the largest and smallest values were removed and the remaining 8 or 6 points meaned. The means were assigned times at the midpoint of the 10- or 8-point span to preserve equal spacing. Consequently, passes of low- and high-rate data have different spacing of about 1.024 and 0.8192 seconds, respectively.

Since no further attention was given to the "I" tape observations beyond each 8 or 10 points, there were occasions when a group of partially or completely bad heights was compressed to a single bad height. Thus, users of the data must be cautious of these spurious values. The decision to keep these values on the tape was primarily based on the consideration of simplicity and respect for the other data fields which might be useful to investigators. Users are intentionally placed in a position of editing the compressed sea surface heights to their own satisfaction.

Figure 1a shows the heights resulting from a pass of altimeter data in the northwestern Atlantic ocean. The approximate geoid undulation along the pass has been removed so that the "noise" in the heights can be seen. The compressed observations which are contaminated with several outliers appear to have an uncertainty of about 20 cm. Further smoothing is required. Figure 1b shows the heights after smoothing with a 7-point trimmed mean running filter. The trimming was confined to the largest and smallest values.

The other quantities on the data tapes were computed in a manner that maintains the original precision. The latitude and east longitude values were linearly interpolated from frame values; satellite heights were quadratically interpolated. The Schwiderski ocean- and Cartwright solid-tide heights are computed independently of the altimeter tapes using software developed by Clyde E. Goad of NGS. The ocean tide computation consists of the M2, S2, K1, O1, N2, P1, K2, Q1, and MF components. The solid-Earth tide ignores the zero frequency term and uses values of H2 = 0.61 and H3 = 0.29. The remaining fields of each compressed data record are frame values except for the automatic gain control (AGC) and the status bits. The AGC is a mean of the eight or six values corresponding to the trimmed set of sea heights. There are two or four relevant status samples per frame for the low- or high-rate data. As a result of the compression selected, either two or four compressed records occur per frame to which the status samples are attached. For a more complete description of the fields in each record, refer to Stanley and Dwyer (1980).

STORAGE

The compressed records (fig. 2a) are stored on 9-track, nonlabeled, 1600 bit-per-inch magnetic tapes. They were written under the control of an IBM System/360 operating system (OS) using a variable, blocked, spanned (VBS) record format (IBM 1972). Seven chronological tapes exist with starting days of April 14 and October 22, 1975; April 20 and November 9, 1976; June 21 and December 6, 1977; and August 19, 1978. The data end on December 1, 1978. They have a logical record length of 56 bytes and a block size of 30804 bytes. As required of VBS tapes, the first four bytes of each block and the first four bytes of each logical record are reserved for use by OS. These bytes must be skipped over when reading the tapes on systems other than OS. In addition, users must be aware that all blocks except the last will be full; each full block will contain 550 records [550 = (30804 - 4)/56]. The fields of all records are binary integers with negative numbers in the 2's complement form, the only exception being field 19. Values for fields 8 through 18 having excessive magnitudes were set to -32767. To obtain the magnitude of a negative integer in 2's complement form, flip all the bits and add one. Thus, if field 8 in octal contained 177724, it would indicate an ocean tide height of -44 mm (000053 + 1 = 54 octal = 44 decimal).

The records appear on the tapes in chronological order and are separated into passes by the presence of header records (fig. 2b) before the first data record of each pass. The header records were inserted when either a time gap exceeding 15 seconds occurred in the data or the pass traversed more than the physical limit of 22 blocks (fig. 3), approximately 12,400 km^2 each (Agreen 1980).

REFERENCES

Agreen, R. W., Dec. 1980: Storage of satellite altimeter data. NOAA Technical Memorandum NOS NGS 28. U.S. Department of Commerce, NOAA, Rockville, Md., 11 pp.

Cartwright, D. E. and Edden, A. C., 1973: Corrected tables of tidal harmonics. Geophysical Journal, 33, 253-264.

International Business Machines Corp. 1972: IBM System/360 Operating System Job Control Language Reference. File no. S360-36, Order No. GC28-6704-x, IBM Corporation, P.O. Box 390, Poughkeepsie, NY 12602.

Morrison, F. F., 1977: Algorithms for computing the geopotential using a simple-layer density model. NOAA Technical Report NOS 67 NGS 3, U.S. Department of Commerce, NOAA, Rockville, Md., 6-7.

National Oceanic and Atmospheric Administration, 1980: Satellite Data Users Bulletin, 2 (1), June. U.S. Department of Commerce, NOAA, Environmental Data and Information Services, National Climatic Center, Satellite Data Services Division, Washington, D.C.

Schwiderski, E. W., 1980: On charting global ocean tides, Reviews of Geophysics and Space Physics, 18 (1), 243-268.

Stanley, H. R. and Dwyer, R. E., 1980: NASA Wallops Flight Center GEOS-3 altimeter data processing report. NASA Reference Publication 1066. National Aeronautics and Space Administration, Washington, D.C., 130 pp.

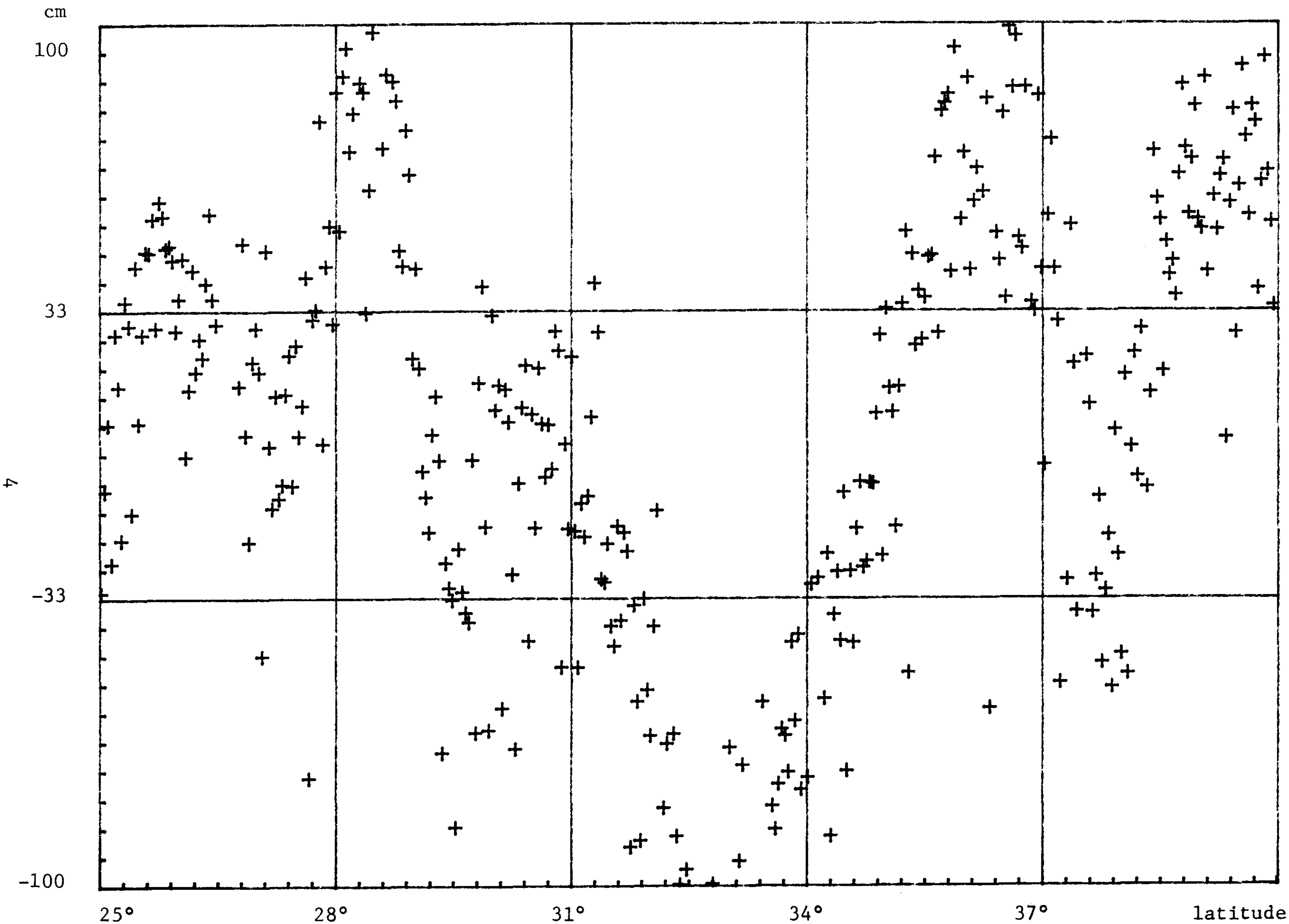

Figure 1a.--Compressed surface heights, April 19, 1976.

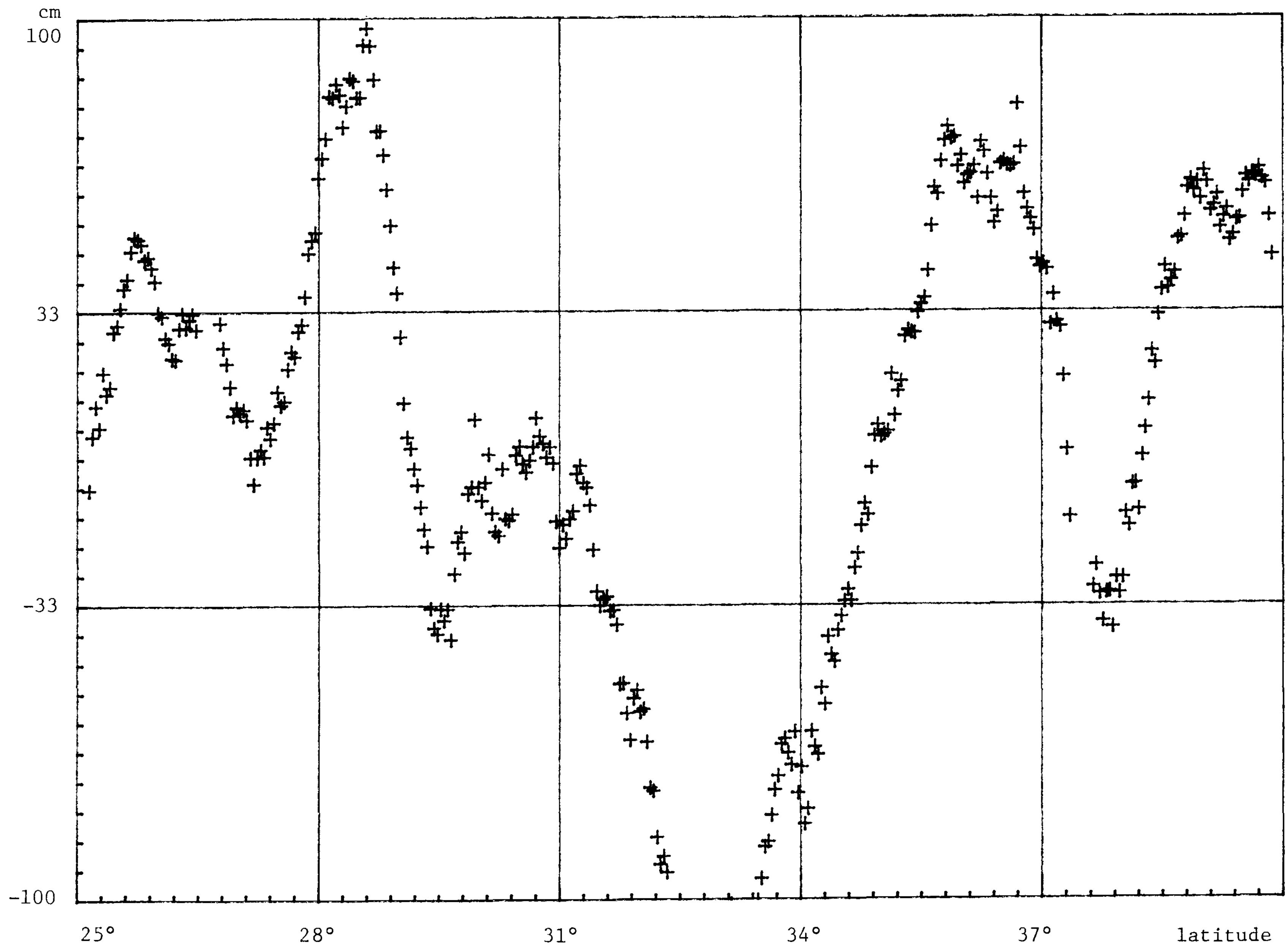

Figure 1b.--Smoothed surface heights, April 19, 1976.

EACH RECORD CONSISTS OF 52 BYTES COMPOSED OF 4 BYTE AND 2 BYTE INTEGER FIELDS

FD	BYTES	UNITS	CONTENT
1	1-4	DAYS	MODIFIED JULIAN DATE OF OBSERVATION (JULIAN DATE - 2,400,000.5 DAYS)
2	5-8	SECONDS	TIME FROM BEGINNING OF DAY
3	9-12	10**-6 SECS.	CONTINUATION OF TIME TO THE MICROSECOND
4	13-16	10**-6 DEG.	GEODETIC LATITUDE
5	17-20	10**-6 DEG.	EAST LONGITUDE
6	21-24	MM.	SMOOTHED SEA SURFACE HEIGHT ABOVE ELLIPSOID WITHOUT TIDE OR OTHER MODEL CORRECTIONS (A = 6378145 METERS, F = 1/298.255)
7	25-28	MM.	SATELLITE HEIGHT ABOVE ELLIPSOID
8	29-30	MM.	SCHWIDERSKI TIDE HEIGHT ABOVE MEAN SURFACE WITH 9 TERMS INCLUDED (M2, S2, K1, O1, N2, P1, K2, Q1, MF)
9	31-32	MM.	CARTWRIGHT'S SOLID TIDE HEIGHT WITH ZERO FREQUENCY TERM NOT INCLUDED, H2 = .61, AND H3 = .29
10	33-34	CM.	H 1/3, SIGNIFICANT WAVE HEIGHT
11	35-36	10**-3	SURFACE REFLECTIVITY (SIGMA NAUGHT)
12	37-38	CM./SEC.	WIND SPEED
13	39-40	10**-2	SWELL COEFFICIENT (GAMMA)
14	41-42	10**-4 DEGREES	POINTING ANGLE
15	43-44	10**-2	FRAME AVERAGE MEAN SQUARED SLOPE
16	45-46	10**-2 DB.	AUTOMATIC GAIN CONTROL
17	47-48		INDEX OF ICE PROBABILITY
18	49-50		REVOLUTION NUMBER OF ORBIT
19	51-52		STATUS BITS (1,2,3,...,16)
			1 0 (INTENSIVE), 1 (GLOBAL) MODE
			2 0 (), 1 (MODIFIED KALMAN EDIT)
			3 0 (LOW), 1 (HIGH) DATA RATE
			4 0 (ALL), 1 (ANY/ALL NON) AUTO TRACK
			5 0 (NO), 1 () APG/AASG EDIT
			6 0 (NO), 1 (ORIGINAL) KALMAN EDIT
			7-16 0 (WATER), 1 (LAND OR ICE) THIS 10 BIT FIELD REPRESENTS LOCATIONS ALONG THE GROUND TRACK SPACED AT .1024 SECONDS

Figure 2a.--GEOS-3 altimeter data records.

THE HEADER RECORD CONSISTS OF 52 BYTES COMPOSED OF 4 BYTE AND 2 BYTE INTEGER FIELDS

BYTES	CONTENT
1-2	1ST EQUAL AREA BLOCK NUMBER
3-4	2ND EQUAL AREA BLOCK NUMBER OR ZERO
:	:
43-44	22ND EQUAL AREA BLOCK NUMBER OR ZERO
45-48	THE NUMBER OF DATA RECORDS WHICH FOLLOW
49-52	VACANT

Figure 2b.--GEOS-3 altimeter header records.

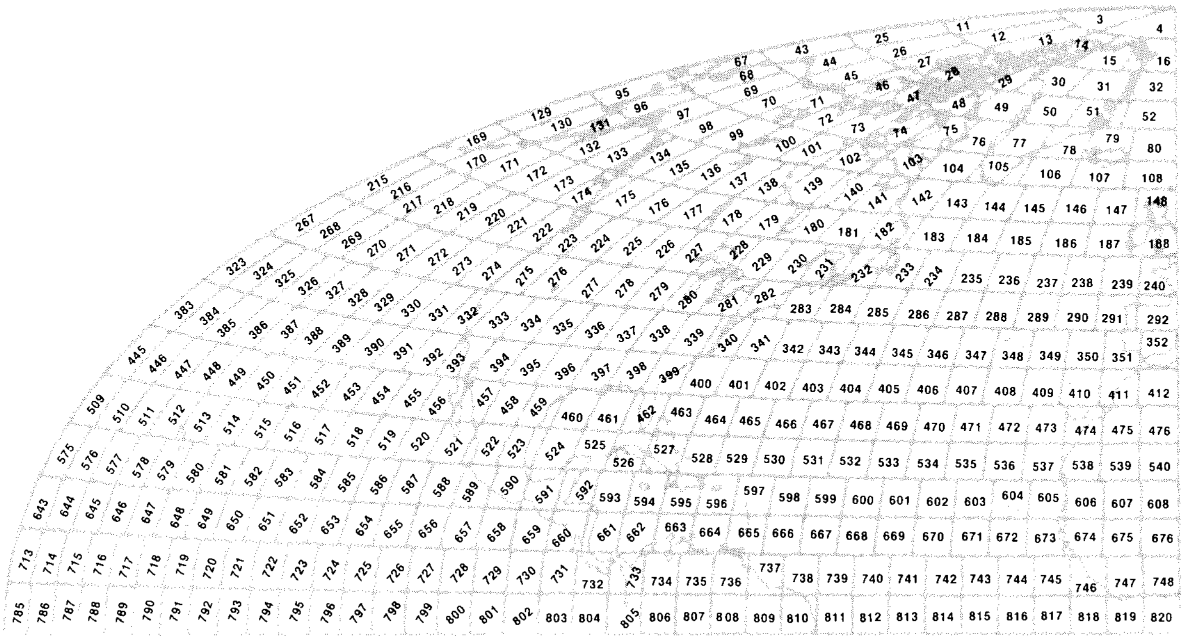

Figure 3a.--Equal-area blocks with index numbers, NW quadrant (Morrison 1977).

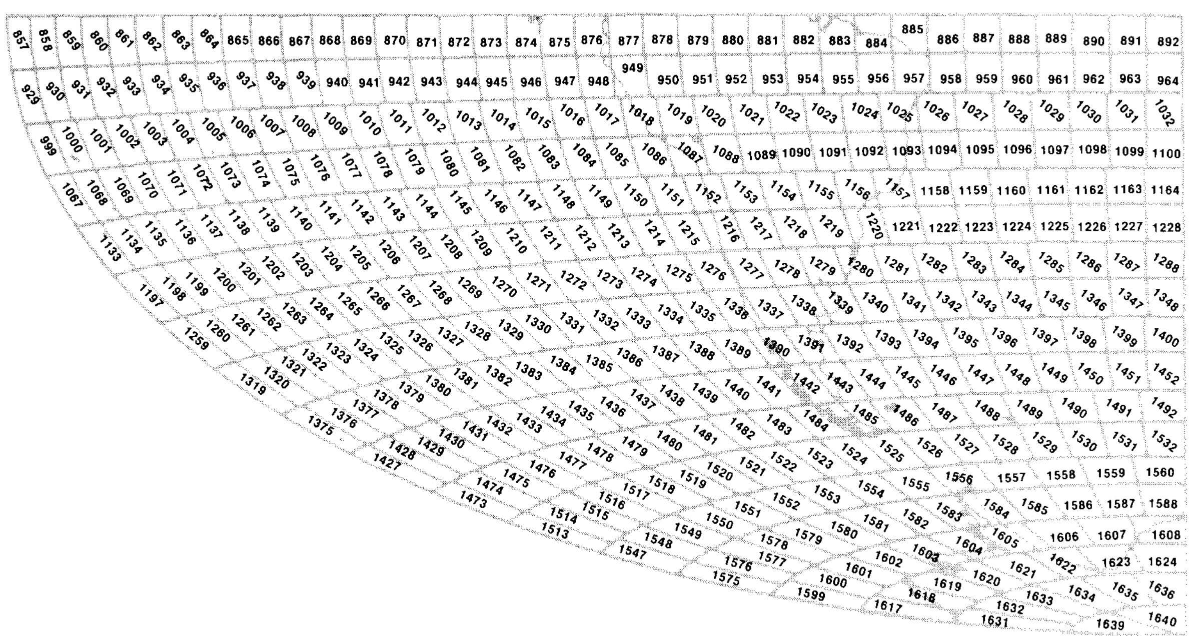

Figure 3b.--Equal-area blocks with index numbers, SW quadrant (Morrison 1977).

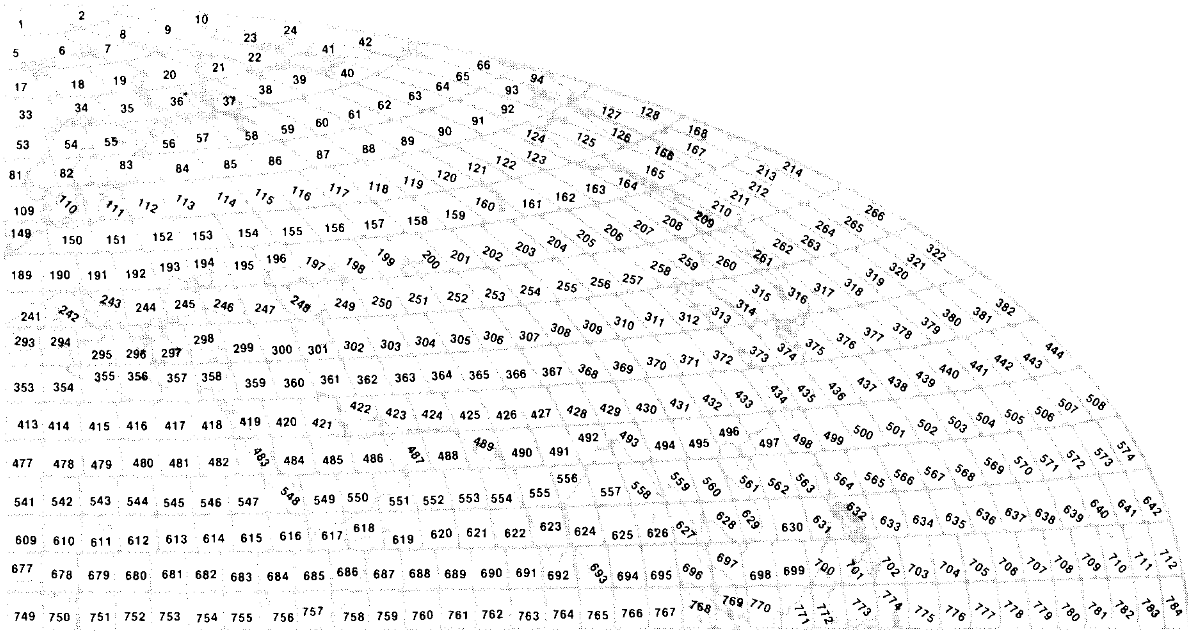

Figure 3c.--Equal-area blocks with index numbers, NE quadrant (Morrison 1977).

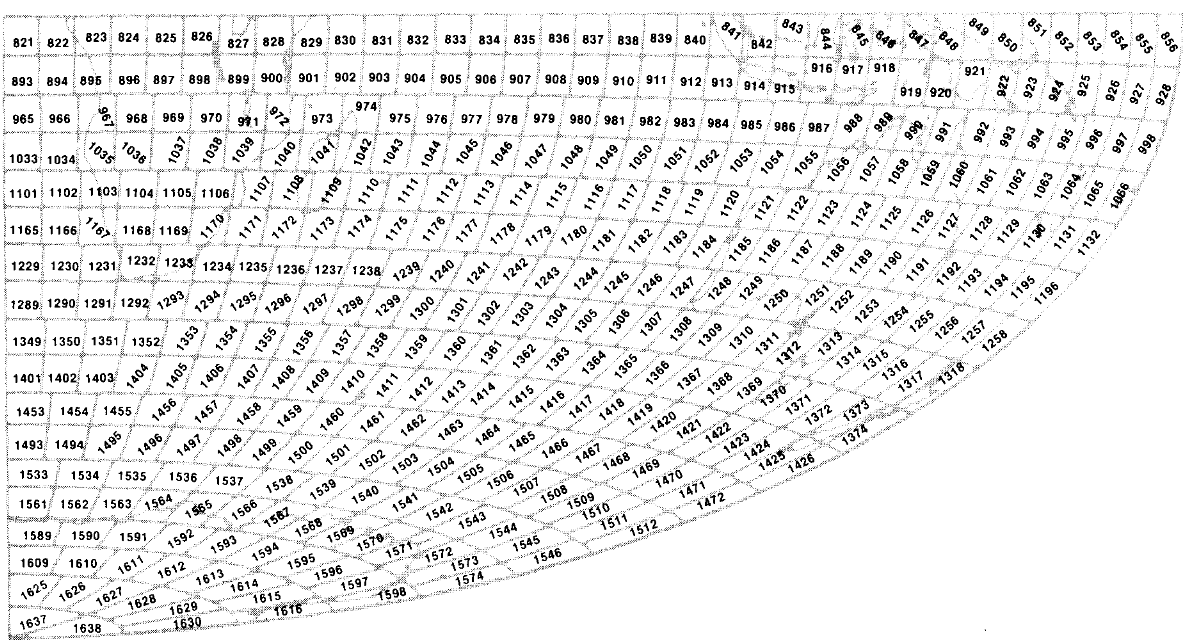

Figure 3d.--Equal-area blocks with index numbers, SE quadrant (Morrison 1977).

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Geodetic Survey , OA/C18x2
Rockville, Maryland 20852

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-210
THIRD CLASS MAIL

U.S.MAIL