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INITIAL DATA BANK REPORT (FALL 1978) WINTER/SPRING/SUMMER/FALL --ETC(U)
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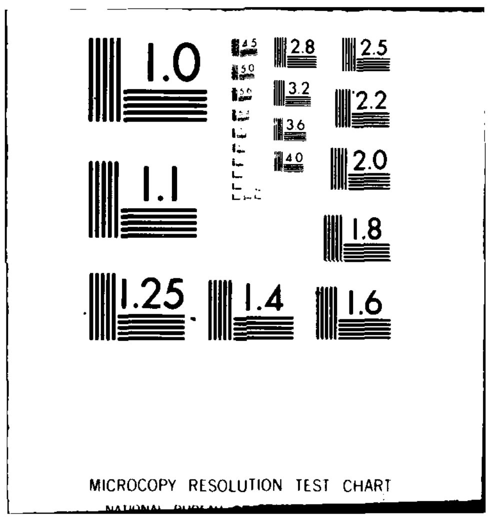
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4.0
MICROCOPY RESOLUTION TEST CHART

Report No. FAA-RD-80-83
FAA-CT-80-189

2 (12)

INITIAL DATA BANK REPORT

(FALL 1978; WINTER/SPRING/SUMMER/FALL 1979; WINTER 1980)

AD A088204

Lorraine Rzonca

FEDERAL AVIATION ADMINISTRATION TECHNICAL CENTER
Atlantic City, N. J. 08405

DEPARTMENT OF TRANSPORTATION · UNITED STATES OF AMERICA

DATA REPORT

JULY 1980

Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

Prepared for

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FEDERAL AVIATION ADMINISTRATION
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Washington, D. C. 20590

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16. Abstract

The International Bank for airborne-Omega data has begun operation at the Federal Aviation Administration (FAA) Technical Center. This first report issued by the Data Bank is based upon preliminary data for Pacific flights in fall 1978 and winter/spring 1979 and upon data from North Atlantic flights in summer/fall 1979 and winter 1980.

At least three Omega stations were received during all phases of these flights. No significant seasonal variations or effects due to solar activity were noted in the signal-to-noise values. These values were highly repeatable (under the same con-tions) with major drops due to ice cap attenuation and operation in areas of normally high very low frequency (VLF) noise. Differences in signal-to-noise between signals traversing daylight/night ice cap (for both Greenland and Antarctica) were noted.

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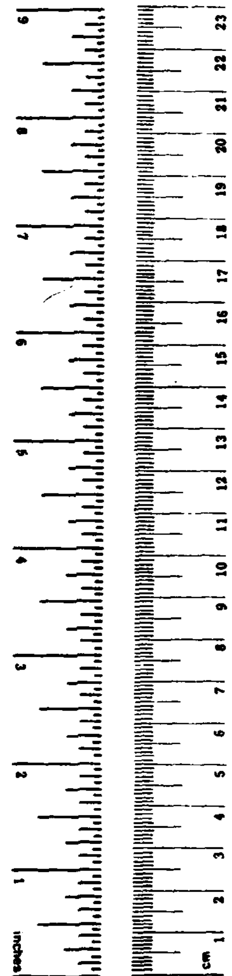
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

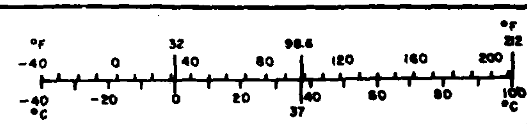
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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INTRODUCTION

PURPOSE.

This report is the first in a series of periodic technical reports which provide a standardized data presentation of Omega signal coverage (as measured by production airborne-Omega navigation systems over routes of commercial interest) under various signal environments (propagation problem regions, high solar activity). If an independent onboard position reference system is available and recorded, then Omega position differences are also presented.

BACKGROUND.

An International Bank for airborne-Omega data has begun operation at the Federal Aviation Administration (FAA) Technical Center. This data bank is designed to: (1) produce empirical signal coverage charts, based upon data obtained from several different airborne-Omega navigation systems over routes of commercial interest; (2) provide a measure of the range of signal-to-noise levels possible due to factors which include type of Omega set, aircraft installation configuration, geographic location, seasonal changes, and effects of high solar activity; (3) help define coverage "holes" and marginal areas where certain circumstances may produce a "hole"; (4) examine the role that the "very low frequency (VLF) option" plays in those Omega Navigation Systems (ONS) equipped to receive the United States (U.S.) Navy VLF stations as a backup to Omega; (5) provide "real-world" information to enhance theoretical inputs for simulation of proposed new routes; and (6) provide the capability to develop a statistical data base on Omega accuracy along world-wide air routes if contributors exercise the option to allow the recording of the inertial navigation system (INS) for later position comparison with the Omega data.

The Data Bank is required to handle large quantities of Omega data from various types of aircraft and from several models of Omega navigation systems. Therefore, standardization of data recording, data processing, and reporting procedures is mandatory. To optimize the efficiency of the bank, members of the Omega navigation project team at the FAA Technical Center concentrated their efforts upon the design of an airborne interface and recording set which could be easily installed and operated by commercial air carrier operators. Detailed design requirements for an airworthy cassette recorder were conceived by the principal design engineer on the Omega team. Since the ONS data output varied among ONS manufacturers, it was necessary to specially design the interface boards for each type of ONS. The specified design for the recording system was then applied by Base Ten Systems, Incorporated to manufacture 20 cassette recorders which the FAA Technical Center can lend to Data Bank contributors. Once a recorder is installed on a contributor aircraft, data is collected along normal air routes and the cassette data tapes are mailed to the FAA Technical Center for processing and analysis. A procedure for logging-in the contributor tapes and transcribing the data to 9-track tape has been devised by Omega team engineers and technicians. In addition, equipment has been set up to erase the cassette tapes (after transcription to 9-track and verification of data copy) so that they may be recycled.

The principal scientist on the Omega team has specified the overall data storage scheme which divides the flight data according to geographic location (648 cells as shown in figure 1), date, time of day, season, propagation path illumination, known problem regions, time correlations with solar-geophysical events, and with transmitter outages. The Technical Center mathematicians have

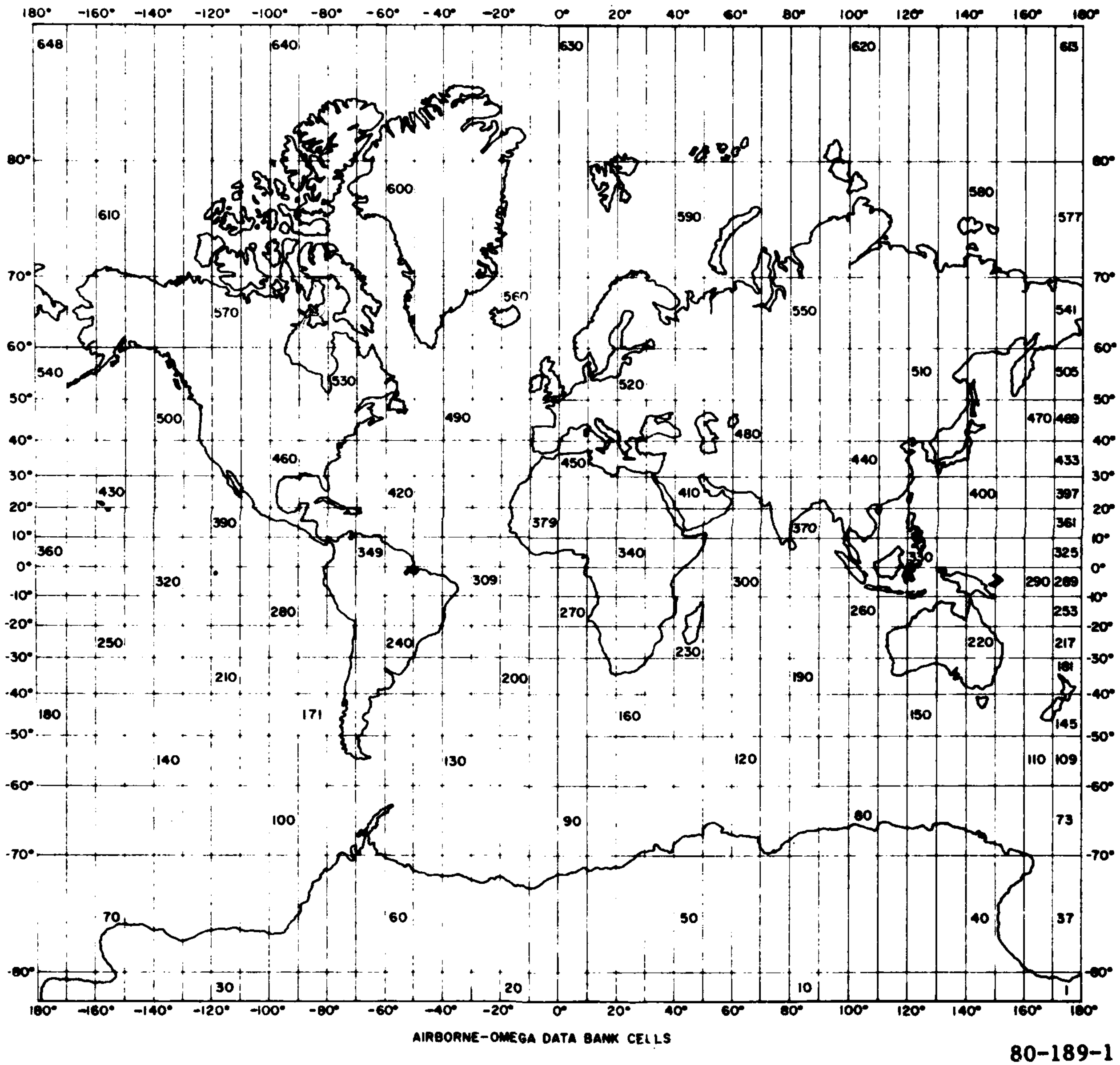


FIGURE 1. AIRBORNE-OMEGA DATA BANK CELLS

contributed their expertise in designing the software which produces the required data base structure in the Honeywell 66/60 computer. The data linking structure designed by these mathematicians provides easy extraction of any required data or combinations of data.

Data collected during each season from all contributors are analyzed by the FAA Technical Center Omega team, with results presented in a periodic Data Bank report. The Data Bank also offers three standardized data listings and plots for individual flights. Contributors may submit written requests to obtain the listings/plots desired and/or to arrange for special listings which best fit their needs. Details of the Data Bank structure and procedures are provided in a separate report published by the FAA Technical Center (Report No. FAA-CT-80-191).

EXPLANATION OF DATA BANK REPORT FORMAT.

Data Bank reports, with contributors and ONS types identified by assigned code number only, are mailed to all contributors and to all Omega manufacturers concerned. Each report contains: (1) a summary of air routes flown, number of contributors, types of ONS providing data, total number of flight data hours; (2) table of solar-geophysical events coincident with flight times of each contributor; (3) geographic charts depicting operationally usable signals within each cell for each contributor; (4) listing of Omega crosstrack and along track differences computed with reference to an INS in a dual ONS/INS installation; and (5) highlights of problem areas or events which warrant special consideration. Details of the various data presentations are given below.

SUMMARY OF FLIGHT ACTIVITY. The number of contributors, the types of Omega sets (in alphabetical order) operated by the contributors, and the total number of flight data hours with each type of Omega set are listed for the reporting period. Track plots representing the typical air routes which were flown by contributors are included.

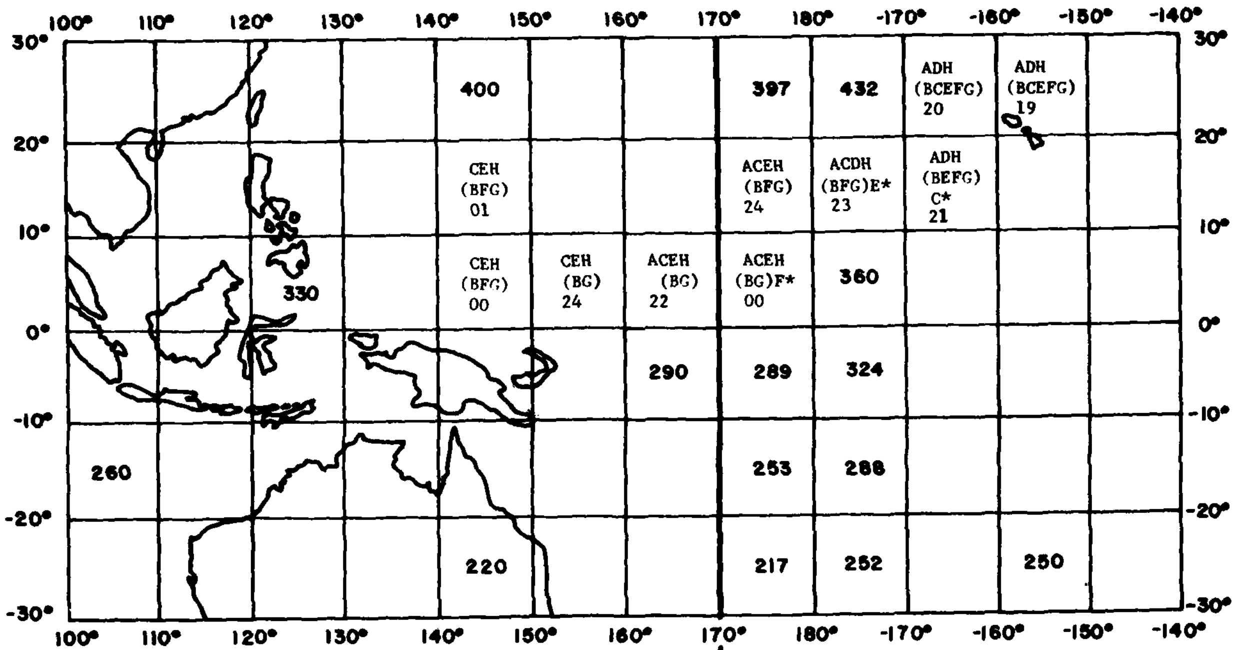
SOLAR-GEOPHYSICAL EVENTS COINCIDENT WITH FLIGHTS. A list of solar-geophysical events (1=solar x-ray, 2=polar cap disturbance (PCD), 3=magnetic storms, 4=transmitter outages of duration greater than 5 minutes) which are coincident with flight times (table 1) is provided for each contributor. The date and magnitude of each event is given (there may be multiple events on a given day). Solar x-rays are classified according to their peak flux. "M" events have flux between 10^{-5} and 10^{-4} watt/m^2; "X" events have flux greater than 10^{-4} watt/m^2 (the number following M or X acts as a multiplier). Only x-rays of flux M2 or greater are included in the list. The magnitude of a PCD is denoted by the maximum expected Omega position error, expressed in fractions of a 10.2 kilohertz (kHz) lane. Magnetic storms are classified according to their Anchorage (high-latitude) K-index (ranges from 6 for minor storms, to 9 for major storms). For transmitter outages, the identifying station letter (A through H) is printed under the "magnitude" column. The Data Bank contains a listing of the above events beginning on March 1, 1979.

OPERATIONALLY USABLE SIGNALS. Geographic charts (see figure 2), which include the air routes flown by each contributor, portray the stations which are normally used for navigation within each cell and the stations which are normally "deselected" automatically by the ONS. At any given time, within a particular cell, the combination of stations which are usable for navigation depends upon various factors which alter the Omega signal propagation environment. (The earth-ionosphere waveguide, through which Omega signals propagate, varies in strucuture when there are changes in ground conductivity (ice cap versus seawater) or in

CONTRIBUTOR CODE: 01
AIRCRAFT CODE: 01
OMEGA CODE: 01
DATE: 9/11-14/78

10.2 kHz

(COMPOSITE DIAGRAM)



A	X-7-3	DATE: 9/13-14/78		DATE: 9/11-12/78	A	1-9-8
B	X-5-2	MDN S/N NO.		MDN S/N NO.	B	X-4-2
C	7-9-9	10-13-11		10-13-11	C	9-9-9
D	X-5-1				D	2-9-7
E	7-9-9				E	5-9-9
F	X-2-1				F	X-2-1
G	X-2-1				G	X-1-X
H	9-9-9				H	9-9-9

NOTES:
1. STATIONS FOLLOWED BY AN ASTERISK SYMBOL WERE DESELECTED AT CERTAIN LOCATIONS WITHIN THE CELL, BUT NOT WITHIN THE ENTIRE CELL.
2. STATIONS IN PARENTHESES WERE DESELECTED THROUGHOUT THE ENTIRE CELL ALONG THE ROUTE FLOWN.
3. TWO DIGIT NUMBER BELOW STATIONS REPRESENTS GMT HOUR.

80-189-2

FIGURE 2. OPERATIONALLY USABLE SIGNALS: WESTERN PACIFIC

TABLE 1. EVENTS DURING FLIGHTS

Contributor	Date	Event	Magnitude	Date	Event	Magnitude
1	3-26-79	1	M2	3-20-79	4	A
1	5-22-79	3	6	5-17-79	4	E
2	9-22-79	1	X1	2-6-80	3	8,6
2	1-14-80	2	1/3	2-3-80	4	B

ionospheric composition (diurnal, seasonal, geographic variations and changes due to increased solar activity and magnetic storms). When the Omega signal encounters changing waveguide structure, higher order modes of propagation may begin to compete with the dominant first order mode (modal interference) and produce anomalous phase and amplitude values for the Omega signal.) Some factors have been mathematically modeled and are accounted for in the ONS software causing the ONS to deselect certain stations depending upon date, Greenwich Mean Time (GMT), and geographic location. For this reason, the dates and GMT of the flights appearing on each chart are noted. If signals have been deselected due to poor reception, the "signal quality number" (S/N) listed for that particular station (A through H) will show an X, indicating the S/N is below receiver threshold level. The strongest signals will show S/N pegged at 9; marginal signals will show relatively low S/N values. It should be noted that the S/N values presented here are not directly comparable among the different types of ONS; the S/N values are provided for relative comparisons between stations and frequencies received by the particular ONS operated by the contributor.

CROSSTRACK/ALONG TRACK POSITION DIFFERENCES FOR DUAL ONS/INS INSTALLATIONS.

For aircraft recording with ONS and INS, the mean and standard deviation of crosstrack and along track components of the position difference between ONS and the INS are computed (in nautical miles). The differences are calculated from all data points (collected during the reporting period) within a given cell for each contributor. (ONS, INS types, and contributors are identified by code numbers only.)

HIGHLIGHTS OF PROBLEM AREAS AND PROPAGATION EVENTS. The structure of this section is not rigidly defined but depends upon events or conditions (see table 2) which have affected Omega reception/navigation data collected by the contributors during the reporting period. Special plots may be generated to illustrate effects which have been noted in one or more flights and which may indicate the need for additional study.

COMMENTS. Includes comments on the data, data collection methods, and overall effort.

INITIAL DATA BANK REPORT

The Data Bank is not yet receiving cassette data on a regular basis from all of its contributors. In order to augment the content of this initial report, the reporting period extends from Fall 1978 through Winter 1980.

SUMMARY OF FLIGHT ACTIVITY.

There were two contributors for the reporting period, September 1978 through February 1980. The ONS type included a

TABLE 2. REGIONS/EVENTS WHICH AFFECT OMEGA PROPAGATION

PROPAGATION PROBLEM REGIONS	INFORMATION SOURCE
1. Greenland Ice Cap Shadow	Westinghouse Conductivity Map
2. Antarctica Ice Cap Shadow	Westinghouse Conductivity Map
3. Nightime Modal Interference (10.2 kHz)	ONSOD
4. North Auroral Zone Shadow	Davies: Ionospheric Radio
5. South Auroral Zone Shadow	Propagation, April 1965, pp. 34-35 (NBS monograph 80).
6. High VLF-Noise Area	CCIR 322 publication
EVENTS	**INFORMATION SOURCE**
1. Solar X-Rays	NOAA "Preliminary Report and Forecast of Solar & Geophysical Data" (PRF) (weekly)
2. Polar Cap Disturbance (PCD)	ONSOD teletypes
3. Magnetic Storm	NOAA "PRF" (weekly)
4. Station Power Reduction/Outage	ONSOD teletype (weekly)

Note: ONSOD = Omega Navigation System Operations Detail (U.S. Coast Guard)
NOAA = National Oceanic and Atmospheric Administration
CCIR = International Radio Consultative Committee

Bendix ONS-20 (172 flight data hours) and a Tracor 7640 (268 flight data hours). The air routes flown include North Atlantic, continental USA, Western Pacific, and Indian Ocean tracks (see figure 3).

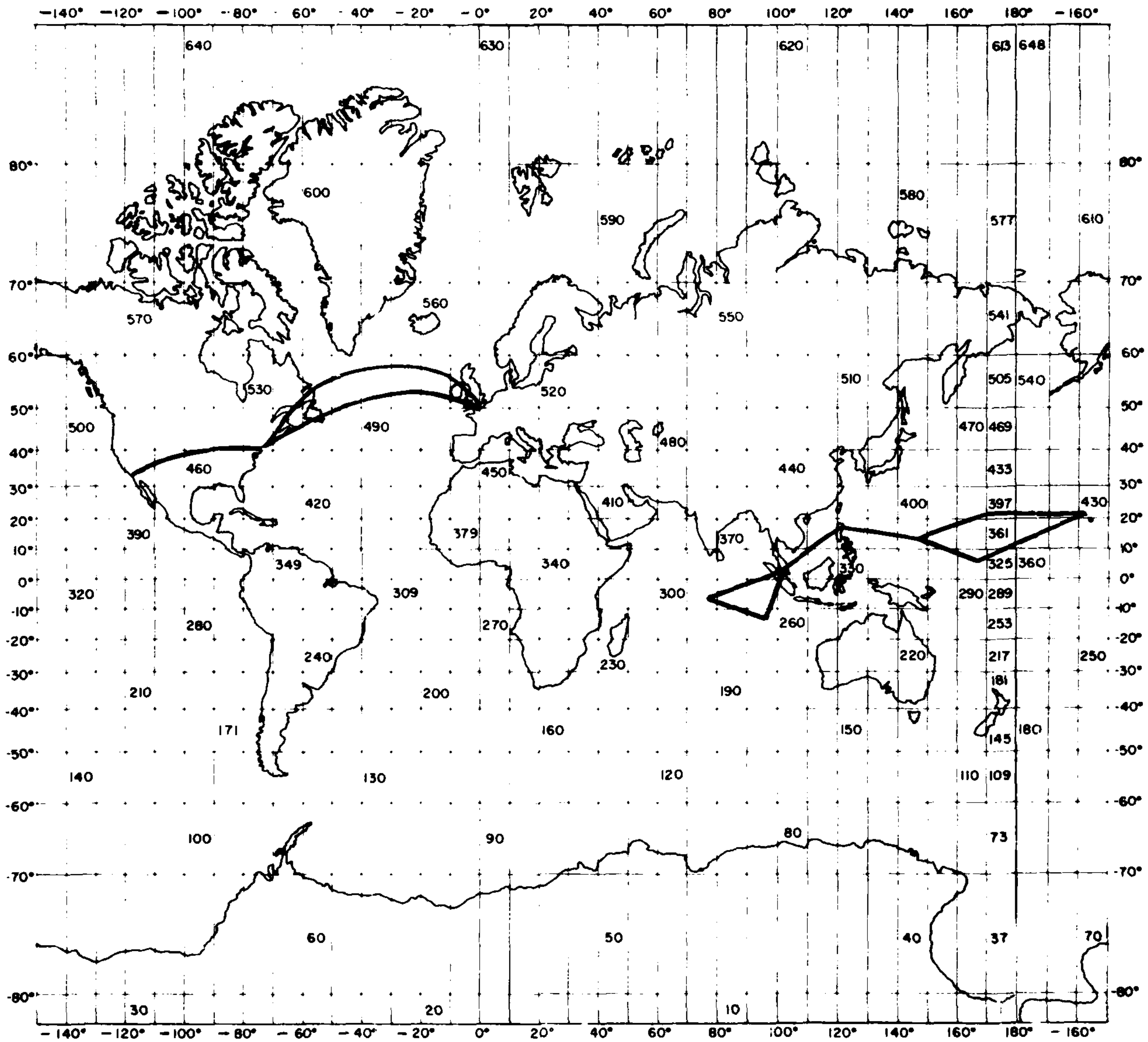
SOLAR-GEOPHYSICAL EVENTS COINCIDENT WITH FLIGHTS.

The events coincident with flight times for each contributor are listed in table 3 (from March 1979 only). The event code is: 1=solar x-ray, 2=polar cap disturbance, 3=magnetic storm, 4=transmitter outage $\geq$ 5 minutes.

The largest solar flare, X1 on September 22, 1979, occurred during takeoff maneuvers of the aircraft; no effects were discernible. The other solar-geophysical events produced no noticeable adverse effects on navigation capabilities.

OPERATIONALLY USABLE SIGNALS.

Pacific Ocean flights made by Contributor No. 1 during fall 1978, winter and spring 1979 followed the typical flight path shown in figure 4. Usable signals for September 1978 flights are presented in figures 2 and 5, together with median S/N values for the three frequencies (10.2, 13.6, and 11.3 kHz) for each flight. Within each cell, the top line shows stations usable throughout the entire cell during the flight; parenthesis enclose stations which were deselected throughout the entire cell along the route flown. Coverage diagrams for flights during winter 1979 and spring 1979 were similar with no significant seasonal changes noticed. The flight on September 19-20 (in the Philippines area) shows S/N for A, F, and G lower than what would be expected from the normal trend evident from the other flights. It is probable that high



AIRBORNE-OMEGA DATA BANK CELLS

FIGURE 3. CONTRIBUTOR AIR ROUTES

80-189-3

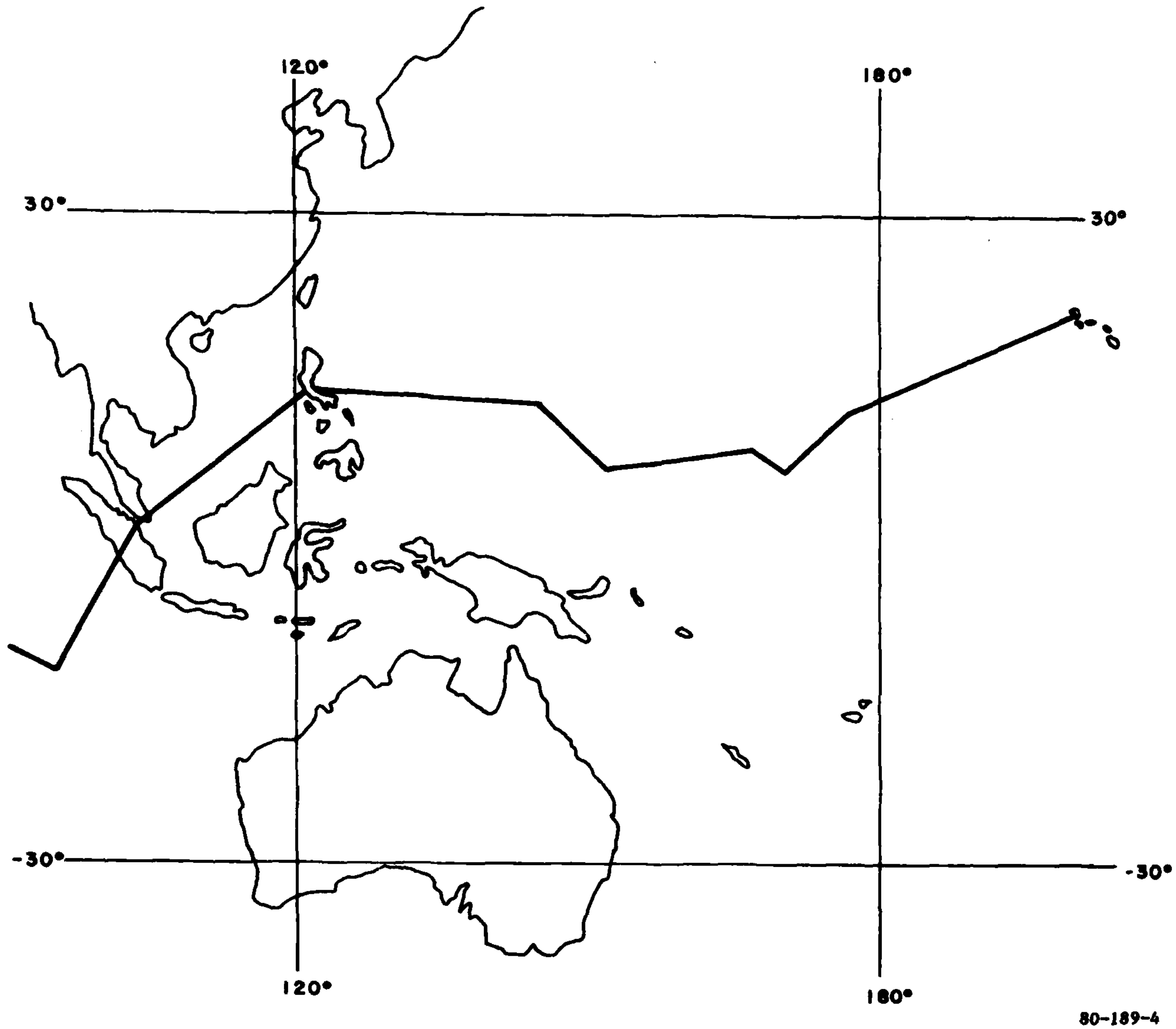


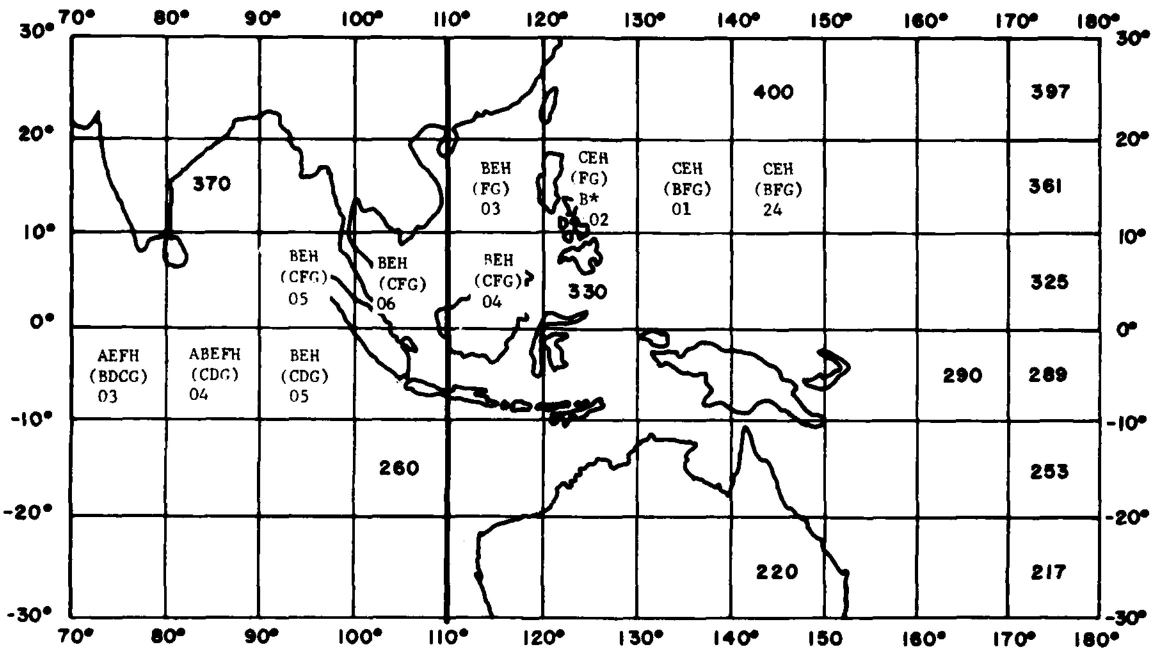
FIGURE 4. FLIGHTPATH FOR CONTRIBUTOR NUMBER 1: FALL 1978

AIRBORNE-OMEGA DATA BANK
OPERATIONALLY USABLE SIGNALS: PACIFIC & INDIAN OCEANS

10.2 kHz

(COMPOSITE DIAGRAM)

CONTRIBUTOR CODE: 01
AIRCRAFT CODE: 01
OMEGA CODE: 01
DATE: 9/19-22/78



A	1-4-4	DATE: 9/22/78	DATE: 9/19-20/78	A	x-3-2
B	5-9-8	MDN S/N NO.	MDN S/N NO.	B	2-5-4
C	X-1-X	10-13-11	10-13-11	C	x-3-3
D	X-X-X			D	x-1-x
E	9-9-9			E	9-9-9
F	1-9-4			F	x-x-x
G	1-4-2			G	x-x-x
H	4-9-9			H	9-9-9

NOTES:
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2. STATIONS IN PARENTHESES WERE DESELECTED THROUGHOUT THE ENTIRE CELL ALONG THE ROUTE FLOWN.
3. TWO DIGIT NUMBER BELOW STATIONS REPRESENTS GMT HOUR.

80-189-5

FIGURE 5. OPERATIONALLY USABLE SIGNALS: PACIFIC AND INDIAN OCEANS

TABLE 3. EVENTS DURING FLIGHTS: MARCH 1979 - FEBRUARY 1980

CONTRIBUTOR	DATE	EVENT	MAGNITUDE	DATE	EVENT	MAGNITUDE
1	3/20/79	4	A,F	3/29/79	4	A,D
	3/26/79	1	M2	5/17/79	4	E
	3/26/79	4	A	5/19/79	3	6
	3/27/79	4	A	5/22/79	3	6
	3/28/79	4	A,D			
2	9/12-9/13/79	2	1/5	1/14/80	2	1/3
	9/18-9/22/79	2	1/3	1/21/80	4	F
	9/18/79	3	6	1/28-1/30/80	2	1/3
	9/19/79	1	M3,M2	2/3/80	4	B
	9/20/79	1	M4	2/6/80	4	B
	9/20/79	3	7	2/6/80	3	8,6
	9/21/79	3	6	2/6-2/7/80	2	1/4
	9/22/79	1	X1	2/6/80	1	M2,M2
	12/14/79	1	M2,M2	2/7/80	4	B
	1/13/80	1	M3,M3,M2	2/10/80	4	B
	1/13/80	3	7,6	2/10/80	2	1/4
	1/14/80	1	M3	2/10/80	1	M2

VLF-noise was present and caused F and G signals to drop below threshold.

During North Atlantic flights made by contributor No. 2, usable signals corresponded to those indicated in figure 6; no significant seasonal changes have been noticed. The effect of the Greenland Ice Cap is evident in this diagram where (1) S/N for H is much lower on the left side of the diagram (where the signal crosses the Ice Cap), and (2) S/N for C is much lower on the right side of the diagram (where this signal crosses the Ice Cap).

POSITION DIFFERENCES FOR DUAL ONS/INS INSTALLATIONS.

No data since an INS was not recorded by either contributor.

HIGHLIGHTS OF PROBLEM AREAS AND PROPAGATION EVENTS.

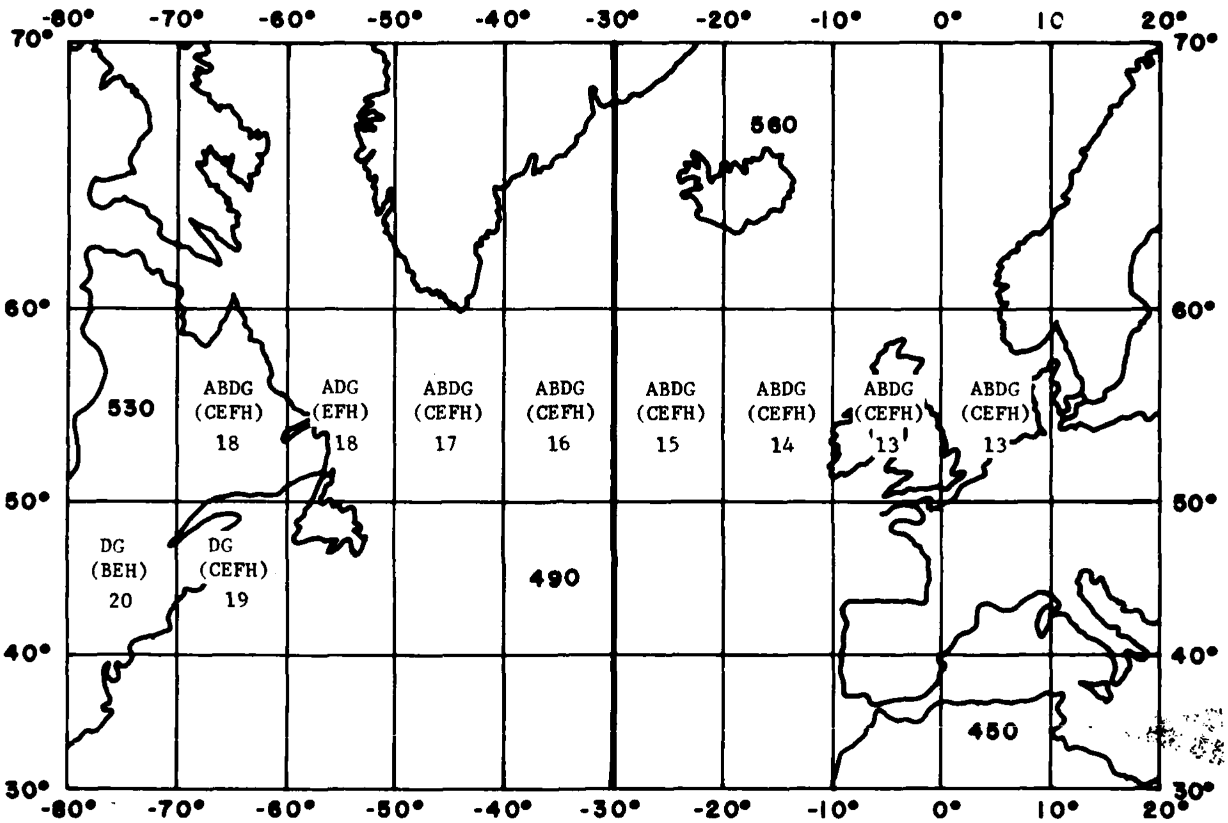
1. Pacific flights of 1978-79 by Contributor No. 1: An indication of the magnitude of the effects due to Antarctica Ice Cap and high VLF noise is shown in table 4. The average values of the Argentina 13.6 kHz S/N values from all flights made between September 19, 1978 and May 5, 1979 were computed for the data points at the center of each cell; individual S/N values usually varied by ± 1 unit (S/N=0 to 9). Only six flights contributed to each cell due to limited data collection; none of the flights occurred at times when the entire propagation path was in darkness. In table 4, D denotes distance from the center of the cell to the station F (nmi), d denotes distance traversed by the F signal over the Antarctica Ice Cap (nmi). The 13.6 kHz signal from Argentina (F) shows a large S/N in cell 298 where the signal has not traversed any part of the Ice Cap. Cell 297, with a longer propagation path of which 17 percent is over the Ice Cap, shows a marked decrease in S/N with larger S/N for ice cap in darkness compared to ice cap in full daylight. Cell 261, with a shorter propagation path than 298 or 297, but with 20 percent over the Ice Cap, shows a further decrease in S/N and a more dramatic difference between night/daylight ice cap. Cell

AIRBORNE-OMEGA DATA BANK
OPERATIONALLY USABLE SIGNALS: NORTH ATLANTIC

10.2 kHz

(COMPOSITE DIAGRAM)

CONTRIBUTOR CODE: 02
AIRCRAFT CODE: 03
OMEGA CODE: 02/02
DATE: 8/19 AND 9/13/79



A	6-7-8	DATE: 8/19/79	DATE: 9/13/79	A	6-7-8
B	7-8-9	MDN S/N NO.	MDN S/N NO.	B	7-8-9
C	3-4-4			C	0-1-1
D	9-8-6			D	6-6-5
E	X-X-X			E	X-X-X
F	4-7-5			F	5-8-6
G	8-7-6			G	8-7-6
H	1-1-1			H	5-5-5

NOTES:
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2. STATIONS IN PARENTHESES WERE DESELECTED THROUGHOUT THE ENTIRE CELL ALONG THE ROUTE FLOWN.
3. TWO DIGIT NUMBER BELOW STATIONS REPRESENTS GMT HOUR.

80-189-6

FIGURE 6. OPERATIONALLY USABLE SIGNALS: NORTH ATLANTIC

TABLE 4. 13.6 KHZ S/N FOR ARGENTINA

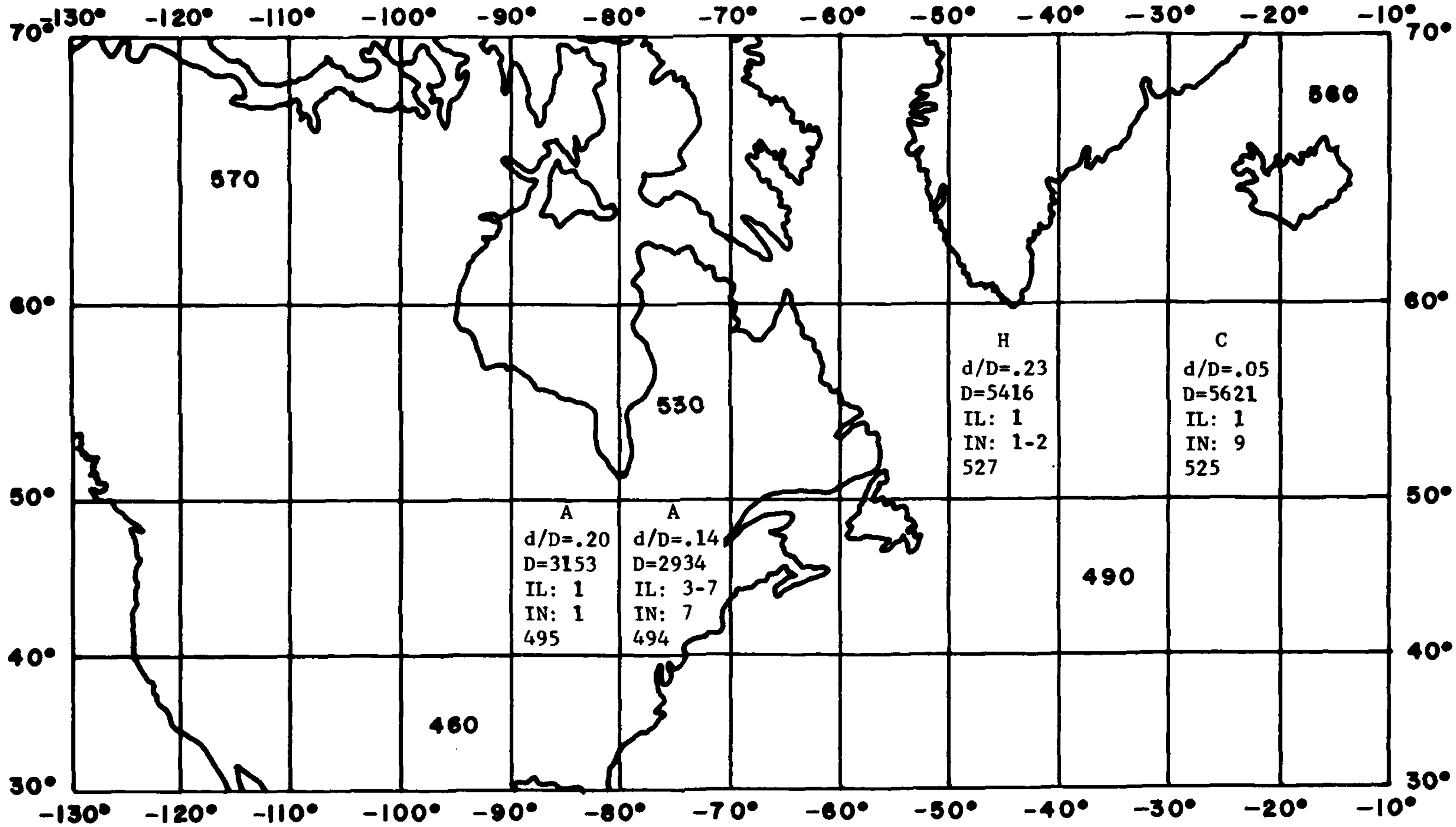
	Ice Cap Illumination					GMT	
Cell No.	Day	Night	Both	D	d	(Hrs)	Comment
298	9	9	9	7494	0	4,5	
297	-	-	3	7723	1280	5	
297	4	5	-	7723	1280	6	
297	0	0	0	7723	1280	8,9	High VLF Noise
261	-	4	-	7150	1390	2	
261	1	-	-	7150	1390	3	
261	-	-	3	7150	1390	4	
261	-	0	-	7150	1390	9	High VLF Noise
331	0	0	0	8517	2880	2,4,6	

331, with 34 percent of the signal path over ice, has S/N below threshold under all conditions. Table 4 also shows effects of high VLF noise which occurs in this region between 0800 and 1200 GMT from September through May. Note the dramatic drop in S/N below threshold level in cells 297 and 261 after 0800.

2. North Atlantic flights of summer/fall 1979 and winter 1980 by Contributor No. 2: To illustrate the differences in S/N when the Ice Cap is in night/daylight, figure 7 compares the median S/N for 13.6 kHz from flights during which the Ice Cap was in night (N) and daylight (L). Cell 525, for which the C signal crosses only a small portion of the Ice Cap, shows a sharp drop in S/N (from 9 to 1) when the Ice Cap goes from darkness to light. For cell 527, where the H signal crosses a substantially greater portion of ice cap, the daylight ice S/N is 1; whereas, the night ice S/N rises only to 2. Within cell 494, where 14 percent of the signal A path crosses the Ice Cap, the night ice S/N is 7; whereas, the daylight ice S/N varies between 3 and 7. In cell 495, where 20 percent of the signal A path crosses the Ice Cap, daylight and night ice S/N both drop to 1. Additional comparisons of daylight/night ice cap are presented in figure 8 for the 13.6 kHz C signal. Median S/N values for the center of each cell from North Atlantic flights (August 1979 to January 1980) are plotted against "percentage darkness along the propagation path." S/N decreases as: percentage darkness decreases, distance from station increases, or percentage signal path over ice increases. For each cell, the S/N values were found to be highly repeatable with the only significant spread occurring when the day/night terminator was crossing the Ice Cap (unpredictable mode conversions taking place). The daylight ice cap caused a significantly low S/N for cells 525 and 524; this value seemed to remain constant for the daylight ice even though the percent of darkness along the total propagation path varied from 15 to 22 to 70 percent for the data which were available.

In examining the nighttime F signal from the North Atlantic flights in September 1979, an anomaly was observed which suggests possible modal interference. Of five flights traversing cell 494, the 13.6 kHz median S/N value for the Argentina signal for a completely dark propagation path was approximately 6; the sixth flight, on September 22, 1979,

MEDIAN VALUES OF 13.6 kHz S/N NO.
CONTRIBUTOR NO. 2, FALL 1979/WINTER 1980



CODE: THE FIRST LINE GIVES THE OMEGA STATION LETTER; LAST LINE IS THE CELL NUMBER.
d= NMI TRAVERSED BY THE SIGNAL OVER THE GREENLAND ICE CAP.
D= NMI TRAVERSED BY THE SIGNAL BETWEEN THE LISTED OMEGA STATION AND THE CENTER OF THE CELL.
IL:n AND IN:n = MEDIAN S/N NO. FOR FLIGHTS DURING WHICH ICE CAP WAS IN DAYLIGHT(L)/NIGHT(N).

80-189-7

FIGURE 7. GREENLAND ICE CAP IN DAYLIGHT/NIGHT

PROBLEM AREA HIGHLIGHT

13.6 kHz SIGNAL FROM HAWAII (C): GREENLAND ICE CAP EFFECT

CODE: D = DISTANCE FROM CENTER OF CELL TO STATION C (NMI).
d = DISTANCE TRAVERSED BY C SIGNAL OVER GREELAND ICECAP (NMI).
FLTS = NUMBER OF FLIGHTS WHICH CROSSED THE CELL = NUMBER OF DATA POINTS USED FOR THE COMPILATION; S/N = SIGNAL-TO-NOISE.
□ = ICE CAP IN DAYLIGHT; ○ = ICE CAP IN DARKNESS; △ = TERMINATOR PASSING THROUGH GREENLAND ICE CAP; DAP = % DARKNESS ALONG PROPAGATION PATH.

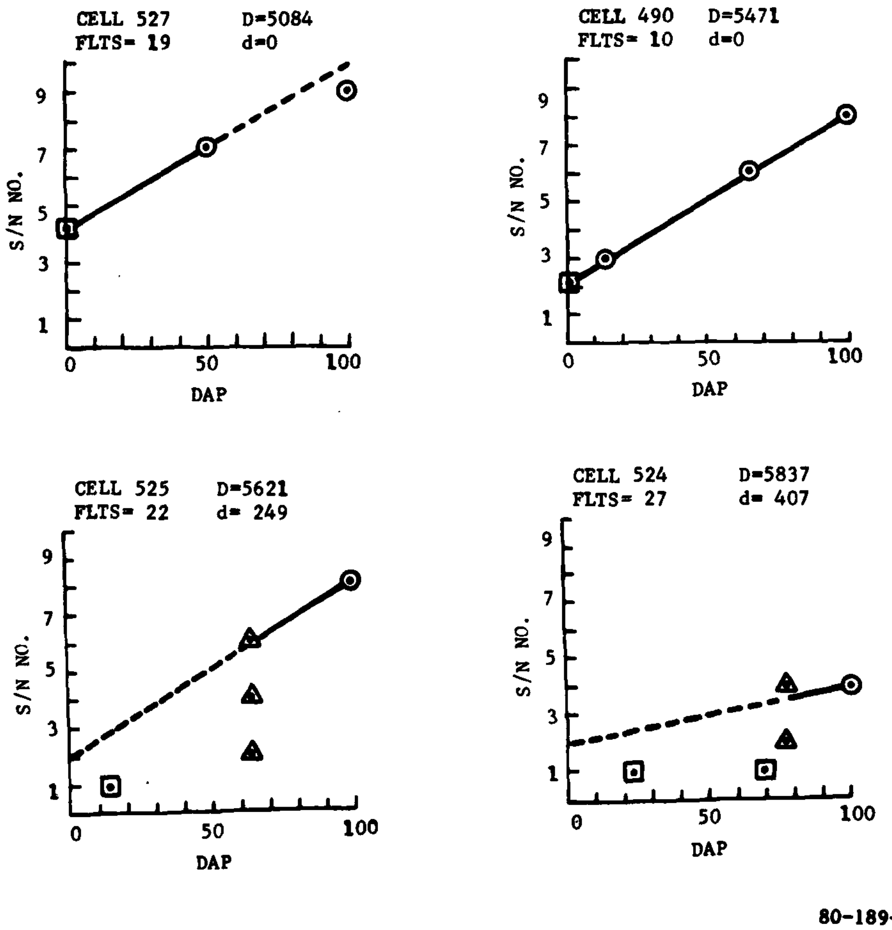


FIGURE 8. 13.6 KHZ SIGNAL FROM HAWAII (C): GREENLAND ICE CAP EFFECT

TABLE 5. MEDIAN S/N NUMBER FOR THREE FREQUENCIES FOR NIGHT PATH (ARGENTINA)

Date	Cell	10.2 kHz	13.6 kHz	11.3 kHz
9/18	494	2	6	6
	493	4	7	6
	528	5	8	7
9/21	494	3	8	7
	493	4	7	7
	528	5	9	7
9/22	494	2	3	5
	493	2	4	6
	528	2	6	6

had a significantly lower value, 3. Upon examining the median S/N values for the three frequencies (10.2, 13.6, and 11.3 kHz) on 3 separate days for three neighboring cells, an anomaly was noted for September 22, 1979 as shown in table 5.

Table 5 shows the usual order of S/N (highest for 13.6 and lowest for 10.2) in each cell on September 18 and 21; however, it shows *an overall* drop in S/N for all frequencies in each cell of September 22, together with a lower value for 13.6 than for 11.3 kHz. This may have been due to modal interference (or to an unconfirmed power reduction at the transmitter).

COMMENTS.

1. The first report issued by the Data Bank is based upon 440 hours of data collected during the period from fall 1978 through winter 1980. During the months when the above flights were made, there were 141 solar flares (of magnitude M2 or greater), but only 14 were coincident with recorded flight data; no significant effects were observed in S/N values.

2. The only "blunder error" which was apparent in data collected to date occurred when the ONS operator inadvertently entered the incorrect date during system initialization. Such errors may not always be obvious when data is scanned prior to entry into the Data Base and would produce erroneous time-correlations with "events" listed in the Data Base.

3. S/N values seem to be highly repeatable under the same conditions; major drops which were noted in S/N were due to ice cap attenuation and operation in areas of normally high VLF noise.

4. Ice cap (either Greenland or Antarctica) in daylight produces a significant decrease in S/N compared to ice cap in total darkness.

5. Possible modal interference was suggested by an anomaly noted in comparisons of S/N values in the same cells over a period of several days. An overall decrease in S/N for all three frequencies, coupled with a lower value of S/N for 13.6 kHz than for 11.3 kHz, seemed to indicate modal interference.

6. The number and quality of usable signals was sufficient for navigation for the seasons/time-of-day/routes flown by the two data contributors included in this report.

7. The repeatability of S/N values within cells (evident when generating the information on ice cap effects) engenders confidence in the Omega

system. It also corroborates the feasibility of: developing useful empirical signal-coverage charts, drawing meaningful comparisons between different aircraft installations of each Omega set, and generating realistic S/N values which, when combined with measured values of Omega phase, can provide simulators with "real-world" information for analyzing proposed new routes. The S/N values may also provide a means to detect gradual deterioration of a given Omega/aircraft installation during long term operation.

8. The next periodic technical report will combine spring and summer 1980 data since recorder deployment and installation has been slower than expected (one contributor for spring 1980, three contributors scheduled for summer 1980). The report will also include Omega/INS position differences obtained during flights in an FAA Convair CV-880 in the South Atlantic.