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GEOS-3

PHASE B

GROUND TRUTH SUMMARY

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16. Abstract

This document is a summary of all ground truth data collected during the Experiment Systems Calibration and Evaluation Phase of the Geodynamics Experimental Ocean Satellite (GEOS-3) experiment. Both National Weather Service analyses and aircraft sensor data are included. The report is structured to facilitate the use of the various data products in calibrating the GEOS-3 radar altimeter and in assessing the altimeter's sensitivity to geophysical phenomena. Brief statements are made concerning the quality and completeness of the included data.

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At NASA Wallops Flight Center, discussions with N. Huang and E. Walsh have been especially helpful in assessing the quality and usefulness of the various data products.

CONTENTS

INTRODUCTION

The GEOS-3 Mission Plan (ref. 1) spelled out the requirement for a period of time called Phase B early in the life of the satellite during which a concentrated effort would be made to calibrate and evaluate the altimeter and to obtain a variety of "ground truth" data for comparison purposes. The term "ground truth" originated in the field of aerial photography and, if applied strictly, means direct "in situ" data taken for verification of remote measurements. For satellite applications, the definition has been extended to encompass all reference data (including remote sensing by aircraft and, in some cases, even other satellites). With regard to the Geodynamics Experimental Ocean Satellite (GEOS-3), the term is meant to include knowledge of all ocean surface and atmospheric parameters which must be known to both calibrate the altitude measurements and to verify the sea state measurement capability of the Radar Altimeter. The marine geoid, pelagic tides, solid earth tides, geostrophic heights of ocean currents, atmospheric loading, sea water density variation, tropospheric refraction, combined sea state, and synoptic weather must be known as well as possible. Some of these parameters can be mathematically modeled, while others require measurements to be taken at the same time and the same geographic position as the satellite altimeter measurements.

Out of the Mission Plan ground truth requirements evolved a complete description of the program needed for the orderly assimilation of these data. This description became the GEOS-3 Ground Truth Program Description Document (GTPDD) (ref. 2), which outlined a plan for the systematic collection of sea state and synoptic weather data in synchronization with the passage of the satellite.

This document, a follow-up to the GTPDD, presents a summary of the sea state and weather data collected under this system during the first month of operation of GEOS-3 previously defined as Phase B. Plans contained either in the Ground Truth Program Description Document or the Mission Plan are not reviewed herein, and the reader is directed to the references for any necessary particulars.

The contents of this document are intended to serve as both the calibration data packages (CDP) and investigator data packages (IDP), which were described in the GTPDD. Although it is virtually certain that the contents will not fulfill <u>all</u> the requirements for ground truth calibration data for the GEOS-3 instrumentation, the work involved in this effort was well spent in refining the requirements and procedures for any additional intensive calibration mission that may be required in the future. It may also be that an investigator will wish to supplement the data presented in this report with a more detailed study of his own. This is indeed expected, because emphasis has been placed

during this ground-truth gathering project on the support of the altimeter calibration. If, additionally, this report does further a geophysical research investigation, then the Phase B effort has been optimized.

DOCUMENT ORGANIZATION

The total data package is organized into two sections in this document. Products that are in direct support of a single orbital track of the satellite are compiled as Ground Truth Data Sets. Products that are applicable to the analysis of several tracks in close temporal proximity are included as Miscellaneous Data Sets. The composition of both data sets is discussed more completely in the following section.

The utilization of this document is dependent upon the ease with which needed data products can be located. If the track of interest is known, the appropriate Ground Truth Data Set can be found by consulting the Table of Contents. The particular products contained in the set can be identified by referring to Table 6. Supporting data from the Miscellaneous Data Sets can also be located using Table 7. The GEOS-3 Altimeter on and off times, operational modes, and longitudes and latitudes for every pass are found in Table 8.

The section of this document entitled Data Summary is intended to provide alternate means of reaching the needed data. Table 2 lists the track numbers of those GEOS-3 orbits that passed over sea states of certain magnitudes. This modified histogram should aid the reader in locating the data products that support tracks through 8 m seas, for example. Additionally, the Data Summary contains Table 3, a listing of those orbital tracks supported by aircraft underflights. If it is desired to study those Ground Truth Data Sets with such support, they can be found in this way.

DATA DESCRIPTION: GROUND TRUTH DATA SETS

WFC C-54 Data

A total of 13 NASA Wallops Flight Center (WFC) C-54 aircraft missions were flown out of NASA/WFC from April 22 to May 18, 1975 during Phase B in an area bounded roughly by the 30th and 40th parallels north and 68th and 80th meridians west. Eight of the thirteen can be grouped as pairs. The ground tracks of the orbits supported by these pairs of missions crossed within the calibration area approximately ten hours apart in

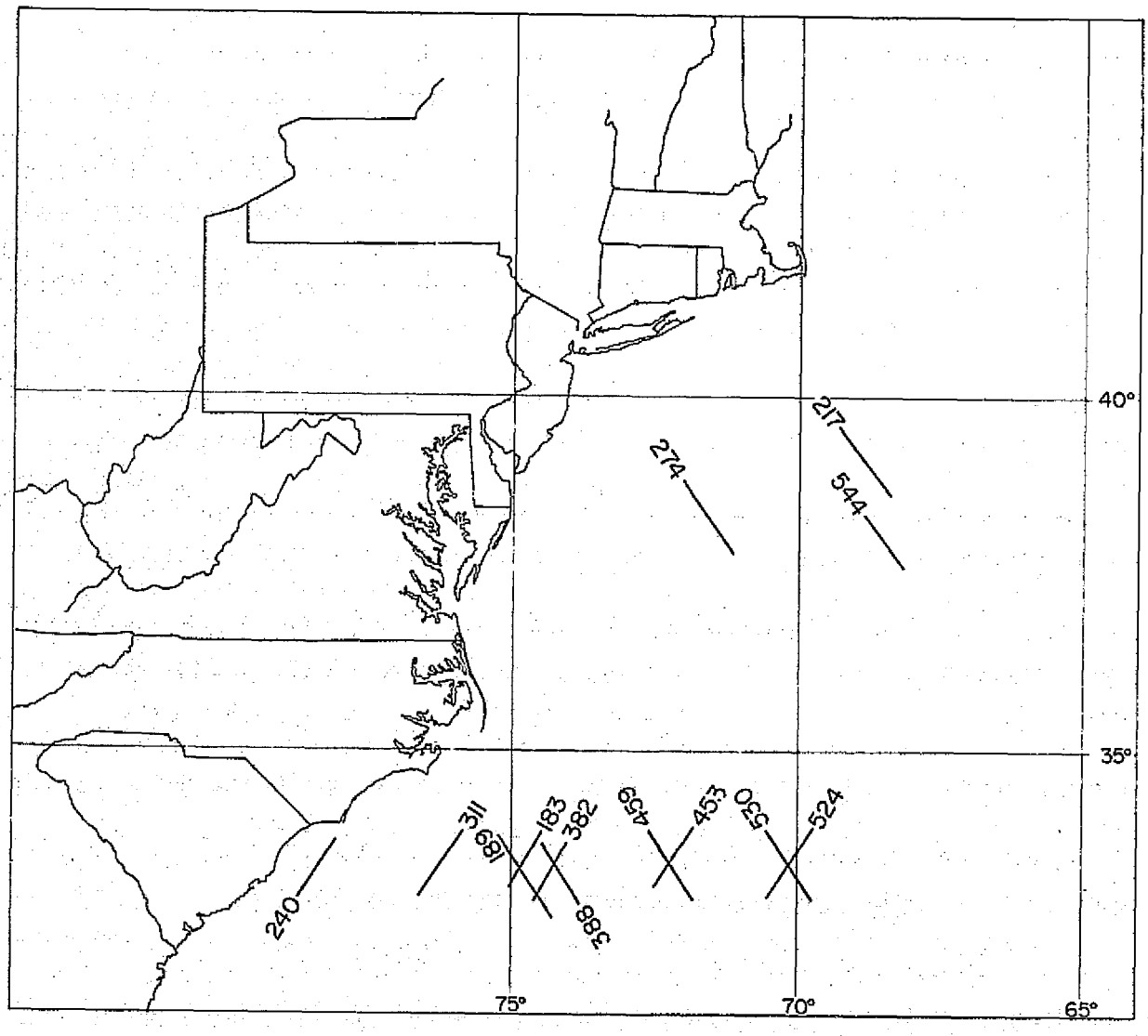


Figure 1. - GEOS-3 orbits covered by NASA/WFC ground-truth aircraft during Phase-B intensive altimeter calibration period.

time. Figure 1 is a map identifying the four crossing pairs and the remaining five single missions. Additionally, Table 1 contains the data and the start and stop times and locations of the thirteen flights. The detailed flight logs are included in this document in Appendix A.

The flight plan for the best possible synchronous coverage of the spacecraft ground track consisted of 30 minutes of level flight at 3,000 meters altitude to synchronize with the spacecraft at the midpoint of the mission (target area), followed by a ten-minute spiralling descent to 150 meters altitude, during which time atmospheric conditions were monitored, and completed with a retrograde horizontal flight involving crosswind, upwind, and downwind runs of four to five minutes duration each with all instruments operating. The low altitude operation was about one-half to one hour past spacecraft time of transit over the target area. Night time low level flights over the target area were restricted to a minimum altitude of 300 meters for safety reasons.

The NASA/WFC C-54 aircraft flown on these missions carried the following instrumentation: a 2-nanosecond radar, a laser profilometer (LP), two upward and two downward looking passive microwave radiometers, an assortment of meteorological instruments, a 35-mm strip-film camera, and an Inertial Navigation System (INS), not all of which were in operation simultaneously. There was a malfunction in an analog to digital converter which resulted in erroneous recording of the nanosecond radar output, and the relevant tapes are being reviewed for possible recovery of data. The laser profilometer functioned predictably well and the data has been analyzed to yield significant wave heights (SWH) and filtered energy spectra. The atmospheric sensors, namely a dewpoint hydrometer, an outside thermistor temperature probe, and a barometric pressure transducer, were all operational and the recorded data were used to calculate atmospheric propagation error for each flight. The operation of the passive microwave radiometers and the data obtained thereof will be described in a later report. Appendix B contains a discussion of the processing performed by personnel at NRL to yield the filtered laser profilometer energy spectra and atmospheric propagation errors presented in this document.

One product in the Ground Truth Data Sets therefore is the spectrum produced by the LP. It is presented both as a frequency and as a wavenumber spectrum in this document. Significant wave heights and atmospheric error corrections are found in Table 3 of the Data Summary section. A more complete flight log is available from Mr. D. Hammond of the Naval Research Laboratory as well as both the raw and preprocessed laser profilometer data.

Spacefl' ıt Meteorology Group Data

The major portion of each Ground Truth Data Set is comprised of products provided by the Spaceflight Meteorology Group (SMG) of the National Weather Service, Suitland, Maryland.

TABLE 1. GEOS-3 GROUND-TRUTH AIRCRAFT FLIGHT DATA, 22 APRIL-18 MAY 1975

TRACK	DATE	DATA START (GMT)	DATA END (GMT)	LOCATION				HIGH ALT (METERS)	LOW ALT (METERS)
				LAT	LONG		LAT LONG		
183	Tues Apr 22, 75	2152	2245	33°46'	74°29'	→	33°22' 74°44'	None	300
189	Wed Apr 23, 75	0755	0834	33°24'	74°56'	→	32°45' 74°28'	None	300
217	Fri Apr 25, 75	0730	0829	39°35'	69°18'	→	38°41' 68°24'	3,000	300
240	Sat Apr 26, 75	2254	0010	33°39'	78°10'	→	32°58' 78°39'	3,000	150
274	Tues Apr 29, 75	0805	0909	38°53'	72°02'	→	38°11' 71°29'	3,000	300
311	Thur May 1, 75	2353	0030	32°50'	76°40'	→	33°50' 75°53'	1,500	150
382	Tues May 6, 75	2354	0049	33°35'	74°06'	→	32°57' 74°32'	2,700	300
388	Wed May 7, 75	0932	1031	33°43'	74°35'	→	32°47' 73°52'	2,700	150
453	Mon May 12, 75	0005	0132	33°46'	71°55'	→	33°03' 72°38'	3,000	300
459	Mon May 12, 75	1002	1130	33°49'	72°36'	→	32°48' 71°48'	3,000	150
524	Fri May 16, 75	0038	0227	33°50'	69°43'	→	32°48' 70°33'	3,000	300
530	Sat May 17, 75	1015	1152	33°50'	70°32'	→	32°48' 69°44'	3,000	150
544	Sun May 18, 75	1014	1158	38°23'	68°51'	→	37°39' 68°07'	3,000	150

The SMG's combination of experience in the fields of wave height forecasting and marine synoptic weather analysis and proximity to the various data products available in NOAA make their data products in the Ground Truth Data Sets unique and valuable. SMG analyses were provided for forty GEOS-3 tracks. These either support aircraft flights, analyze high sea state conditions in the Northern Hemisphere beyond the range of the WFC C-54 aircraft, or in response to specific requests for ground-truth information by GEOS-3 project personnel.

Each Ground Truth Data Set contains a reproduction of the appropriate portion of the National Meteorological Center's (NMC) surface analysis chart, an SMG-produced overlay containing the ground-track and along-track estimates of wind and sea conditions, and available NOAA-4 and SMS/GOES-1 satellite photographs. Surface weather analysis charts are produced by the NMC for 0000, 0600, 1200, and 1800 GMT daily. Each chart is a 1:2,000,000 polar stereographic projection which includes a plot of all applicable synoptic weather reports from ships, land stations, and buoys, and a meteorological analysis of the area. Surface wind field patterns are approximately delineated in the analysis by the isobaric contours. The sea state information contained in the overlay has been derived from all available meteorological data such as sea state (and/or wind) reports from ships and wind fields derived from the surface atmospheric pressure gradients. Sea and swell estimates, surface wind, cloud cover, and areas of precipitation along the track are annotated.

Photographs reproduced in this document were taken by either the synchronous meteorological satellite SMS/GOES-1 or the polar orbiting meteorological satellite NOAA-4. SMS-1 is located approximately 22,000 nautical miles over its sub-point on the equator at 75 degrees west longitude. At this altitude, the orbital period is 24 hours and the satellite remains stationary with respect to the earth's surface. At present, available products include:

a. visual images of 1/2 nm resolution, and
b. infrared images of 1 nm resolution.

NOAA-4 crosses the equator from north to south at approximately 0930 Eastern Standard Time and makes 12 revolutions per day. Pictures are stored on tape until the satellite comes within range of one of three readout stations. Photographic products include:

a. visual images of 2 nm resolution, and
b. infrared images of 4 nm resolution.

DATA DESCRIPTION: MISCELLANEOUS DATA SETS

Other products furnished by the SMG include maps of the location of the Gulf Stream's western wall and maps of ice boundaries in the Arctic. The former product contains up to three different boundaries. The location of the current at the time of the previous analysis is given. When available, the location as revealed in satellite photography is presented. The current location at the time of the report is provided, of course, and is a smoothed result based upon data from the photography, from ship reports, Coast Guard studies, and other sources.

The Arctic ice boundaries are based on photography from the NOAA-4 satellite. This product is of such low resolution that an alternate source for ice boundary information was sought. Maps produced during Phase B by the ice section of the Navy Fleet Weather Facility (FLEWEAFAC) in Suitland, Maryland were found to satisfy the resolution requirements for the Phase B calibration period and are included to complete the meteorological data set assembled in this document.

Miscellaneous surface station reports and wind wave analyses are available through the GEOS-3 Project Office, NASA Wallops Flight Center.

DATA SUMMARY

Table 2 contains the distribution of tracks analyzed by the SMG with the maximum estimated sea state in meters. This can be used to identify tracks of high sea state for further study. Several tracks can be conveniently grouped together in certain cases for special investigation. Tracks 267, 270, and 271 all passed over a storm in the North Atlantic during April 28 and 29, 1975. Tracks 281, 282, 283, and 284 passed over the same low pressure system on the following day. Tracks 368, 369, 370, and 371 traversed a storm on May 5 and 6, 1975, near Greenland.

There are two peaks in the histogram reflecting the two main criteria used in selecting the data. Significant wave heights ($H_{1/3}$) of 2-3 m are typical of conditions in the calibration area where the crossing track missions were flown. The peak at 7-8 m reflects the presence of a second distribution resulting from the high sea state passes. The tracks supported by the C-54 are noted by asterisks. Note the dominance of these missions in the low sea state portion of the histogram.

Table 3 contains a summary of the pertinent aircraft data results obtained including significant wave height, windspeed, time, track number, and atmospheric propagation range error.

TABLE 2. DISTRIBUTION OF TRACKS FOR VARIOUS MAXIMUM SEA HEIGHTS

Maximum Sea Heights	Tracks
0	374
1/2	388*
1	189*, 246
1 1/2	459*
2	160, 186, 203, 282, 524*, 530*, 544*
2 1/2	311*, 274*
3	183*, 197, 217, 240*, 248, 342, 349
3 1/2	281, 291
4	212
4 1/2	
5	324, 329, 453*
5 1/2	267
6	
6 1/2	271, 371
7	270, 373
7 1/2	404
8	253, 368, 369, 370
8 1/2	283
9	284
9 1/2	
10	382*

*tracks supported by aircraft missions

TABLE 3. LASER PROFILOMETER SIGNIFICANT WAVE HEIGHT (SWH) RESULTS AND ATMOSPHERIC RANGE CORRECTIONS, APRIL 22 - MAY 18, 1975

Track	Date	Time (GMT)	SWH (Meters)	Windspeed* (Knots)	Altitude (Meters)	Wind Direction	Atmos. Corr. (Meters)
183	Apr 22	2242	0.88	7	300	Upwind	--
189	Apr 23	0828	0.73	15	300	Downwind	--
217	Apr 25	0823	3.51	57	300	Downwind	2.59
240	Apr 26	0001	0.70	5	150	Upwind	2.46
274	Apr 29	0858	0.61	18	300	Downwind	2.42
311	May 2	0004	1.40	18	150	Downwind	2.45
382	May 7	0036	2.30	15	300	Downwind	2.45
388	May 7	1025	2.00	25	150	Downwind	--
453	May 12	0130	1.19	13	300	Upwind	2.53
459	May 12	1106	0.91	8	150	Downwind	--
524	May 16	0150	0.98	25	300	Upwind	2.59
530	May 17	1109	1.11	20	150	Downwind	2.57
544	May 18	1100	2.66	25	150	Downwind	2.58

*at altitude

Significant wave heights (SWH) greater than two meters were encountered on four of the flights (tracks 217, 382, 388, and 544) with a maximum of three and half meters in the case of track 217.

Table 4 summarizes the sea state sensing capability of the SMG and the laser profilometer for the thirteen aircraft-supported tracks, and Table 5 contains the SWH contrasts for the crossing tracks in the calibration area. Good agreement is seen to exist between the SMG and LP SWH results. The SMG results are particularly reasonable considering the granularity of the reporting network data upon which their analyses are based.

Examination of the LP spectra included in the Ground Truth Data Sets reveals that the dominant frequency is invariant from pass to pass. The data processing has been studied and found to be reliable. An adequate understanding of this phenomenon can apparently be reached only after further analysis of the data contained in this report.

Data analysis has been purposefully avoided in this document. The purpose is only to present data which may prove to be useful in later studies and which is necessary for an accurate calibration of the altimeter. Comments concerning the document are welcomed.

DATA INDEX

Table 6 lists the Ground Truth Data Set products received from instrumentation aboard the aircraft and/or from the SMG for each orbit during the Phase B period. The availability of a product for a certain GEOS-3 orbit is signified in the table by the insertion of the page number where it has been chronologically sequenced in this document. Table 7 is similar except that only Miscellaneous Data Set products are tabulated. Table 8 summarizes the behavior of the altimeter during the forty orbits of concern. For each orbit, the time the instrument was operationally turned on, the latitude and longitude of the sub-satellite point, the time the instrument was turned off, the latitude and longitude then, and the mode of operation in which the data was collected are all listed.

TABLE 4. COMPARISON OF SPACEFLIGHT METEOROLOGY GROUP (SMG) AND LASER PROFILOMETER (LP) SIGNIFICANT WAVE HEIGHT (SWH) RESULTS

	SWH (Meters)	
Track	SMG	LP
183	0.5	0.88
189	0.5	0.73
217	3.0	3.51
240	0.5	0.70
274	0.5	0.61
311	0.5	1.40
382	1.0	2.30
388	0.5	2.00
453	0.5	1.19
459	0.5	0.91
524	1.0	0.98
530	0.5	1.11
544	1.0	2.66

TABLE 5. COMPARISON OF SIGNIFICANT WAVE HEIGHT (SWH) RESULTS FOR CROSSING TRACKS

	SWH (Meters)	
Crossing Tracks	North-South Track	South-North Track
	Laser Profilometer	
183, 189	0.88	0.73
382, 388	2.30	2.00
453, 459	1.19	0.91
524, 530	0.98	1.11
	Spaceflight Meteorology Group	
183, 189	0.5	0.5
382, 388	1.0	0.5
453, 459	0.5	0.5
524, 530	1.0	0.5

TABLE 6. SUMMARY OF GROUND TRUTH DATA SET PRODUCTS

Track No.	DATA PRODUCT Overlay	NMC Surface Analysis	Satellite Photography NOAA-4 VIS	NOAA-4 IR	SMS-1 VIS	SMS-1 IR	Laser Profilometer Spectra
160	16	17		18			
183	20,22	21, 23		25-27	24		28,29
186	32	33	34	35			
189	38	39				40	41, 42
197	44, 46	45, 47		48, 50, 51	49		
203	54	55				56	
212	58	59		60			
217	62	63				64	65, 66
240	68, 70	69, 71		72, 74	73		75, 76
246	78	79				80	
248	82	83	85	84, 86			
253	88	89		90			
267	92	93		98			
270	94	95		98			
271	96	97		98			
274	100	101				102	103, 104
281	106	107		114			
282	108	109		114			
283	110	111		114			
284	112	113		114			
291	116	117	119	118, 120			
311	122, 124	123, 125		127, 128	126		129, 130
324	132	133		134, 135			
329	138	139	140	141			
342	144	145		146			
348	148	149	150	151			
368	154	155		156			
369	158	159		160			
370	162	163		166			
371	164	165		166			
373	168	169		170			
374	172	173				174	
382	176, 178	177, 179		180, 181			182, 183
388	186	187				188	189, 190
404	192	193	194	195			
453	198, 200	199, 201		202-204			205, 206
459	208	209				210	211, 212
524	214, 216	215, 217		219, 220	218		221, 222
530	224	225			226		227, 228
544	230	231				232	233, 234

TABLE 7. SUMMARY OF MISCELLANEOUS DATA SET PRODUCTS

Data Product	Dates	Page No.
SMG Gulf Stream Western Wall Location	April 21, 1975	236
	April 29, 1975	237
	May 1, 1975	238
	May 6, 1975	239
	May 8, 1975	240
	May 11, 1975	241
	May 15, 1975	242
NOAA-4 Arctic Snow and Ice Boundaries	April 21 - 27, 1975	244
	April 28 - May 4, 1975	245
	May 5 - 11, 1975	246
	May 12 - 18, 1975	247
FLEWEAFAC Arctic Ice Boundaries	May 6, 1975	249, 250
FLEWEAFAC Antartic Ice Boundaries	May 8, 1975	252
	May 15, 1975	253

TABLE 8. SUMMARY OF ALTIMETER OPERATION

Track No.	Data	Mode-Data Rate	START Long. (°E)	START Lat. (°N)	START Time (GMT)	STOP Long. (°E)	STOP Lat. (°N)	STOP Time (GMT)
160	4/21	G-LO	- 47.35	13.06	064908	- 70.04	43.79	065857
183	4/22	I-HI	11.25	64.79	221015	- 91.96	6.06	223500
186	4/23	I-HI	- 8.11	43.47	030516	- 31.94	58.23	031149
189	4/23	I-HI	- 58.53	7.33	075918	- 76.64	35.49	080756
197	4/23	I-HI	11.69	65.04	215550	- 83.77	10.99	221820
203	4/24	I-HI	- 53.06	7.34	074446	- 74.52	39.35	075412
212	4/24	G-LO	8.45	63.52	232036	- 61.35	56.10	232958
217	4/25	I-HI	- 49.38	10.57	073024	- 11.30	41.69	074000
240	4/26	G-LO	10.82	64.57	225140	- 87.69	19.56	231234
246	4/27	I-HI	- 64.11	11.20	084159	- 78.69	33.77	084908
248	4/27	I-HI	-138.27	43.58	120610	179.41	63.15	122432
253	4/27	G-LO	10.03	64.02	205837	- 27.87	51.61	210500
267	4/28	I-HI	5.00	62.29	204500	- 29.82	46.19	205200
270	4/29	I-HI	8.73	54.76	031927	- 40.19	65.11	014634
271	4/29	I-HI	- 1.14	43.97	031712	- 41.60	62.90	032525
274	4/29	G-LO	- 53.22	11.29	081200	- 69.90	36.41	082000
281	4/29	I-HI	5.22	61.04	203046	- 24.35	46.18	203700
282	4/29	I-HI	11.61	65.10	220829	- 43.14	51.04	221700
283	4/29	I-HI	9.71	63.68	234738	- 60.33	55.62	235657
284	4/30	I-HI	8.96	57.19	012530	- 40.20	65.08	013212
291	4/30	I-HI	-144.86	41.31	131200	175.62	62.16	132037
311	NO DATA							
324	5/2	I-HI	9.85	63.73	212540	- 47.50	30.67	213900
329	5/3	I-HI	- 14.61	25.55	053441	- 57.11	59.60	054700
342	5/4	I-HI	- 0.80	45.48	034431	- 41.55	63.24	035227
348	5/4	I-HI	-146.12	39.03	135300	-174.04	61.74	140207
368	5/5	I-HI	10.55	64.46	000004	- 56.56	53.69	000931
369	5/6	I-HI	5.14	61.02	013911	- 40.84	64.68	014455
370	5/6	I-HI	2.67	51.11	031634	- 40.60	64.51	032342
371	5/6	I-HI	- 9.02	39.52	045414	- 43.08	60.34	050223
373	5/6	I-HI	- 46.32	21.61	081200	- 64.42	44.24	081925
374	5/6	I-HI	- 72.07	22.29	095400	- 79.54	33.07	095727
382	5/6	G-LO	11.27	64.83	234538	- 85.82	15.85	000716
388	5/7	G-LO	- 59.93	11.01	093528	- 75.96	35.44	094314
404	5/8	I-HI	-124.27	39.06	125300	-153.64	58.67	130027
453	5/12	G-LO	11.37	64.94	001231	- 82.03	18.75	003300
459	5/12	I-LO	- 57.67	10.68	100200	- 75.86	37.77	101038
524	5/17	I-LO	12.12	64.99	003925	- 84.16	11.57	010200
530	5/17	I-LO	- 52.53	5.05	102700	- 75.31	39.42	103756
544	5/18	I-LO	- 48.83	8.29	101300	- 71.74	41.41	102337

GROUND TRUTH DATA SET 1

(Track 160)

Track 160 passes from the southeast to the northwest into Maine crossing a cold frontal zone with scattered showers near 35 degrees North. Winds south of the front are for the most part less than 15 knots. North of the front they range from 15 to 20 knots. The ½ meter swell indicated for the southern part of the track was generated by a storm which was located near Nova Scotia on April 19.

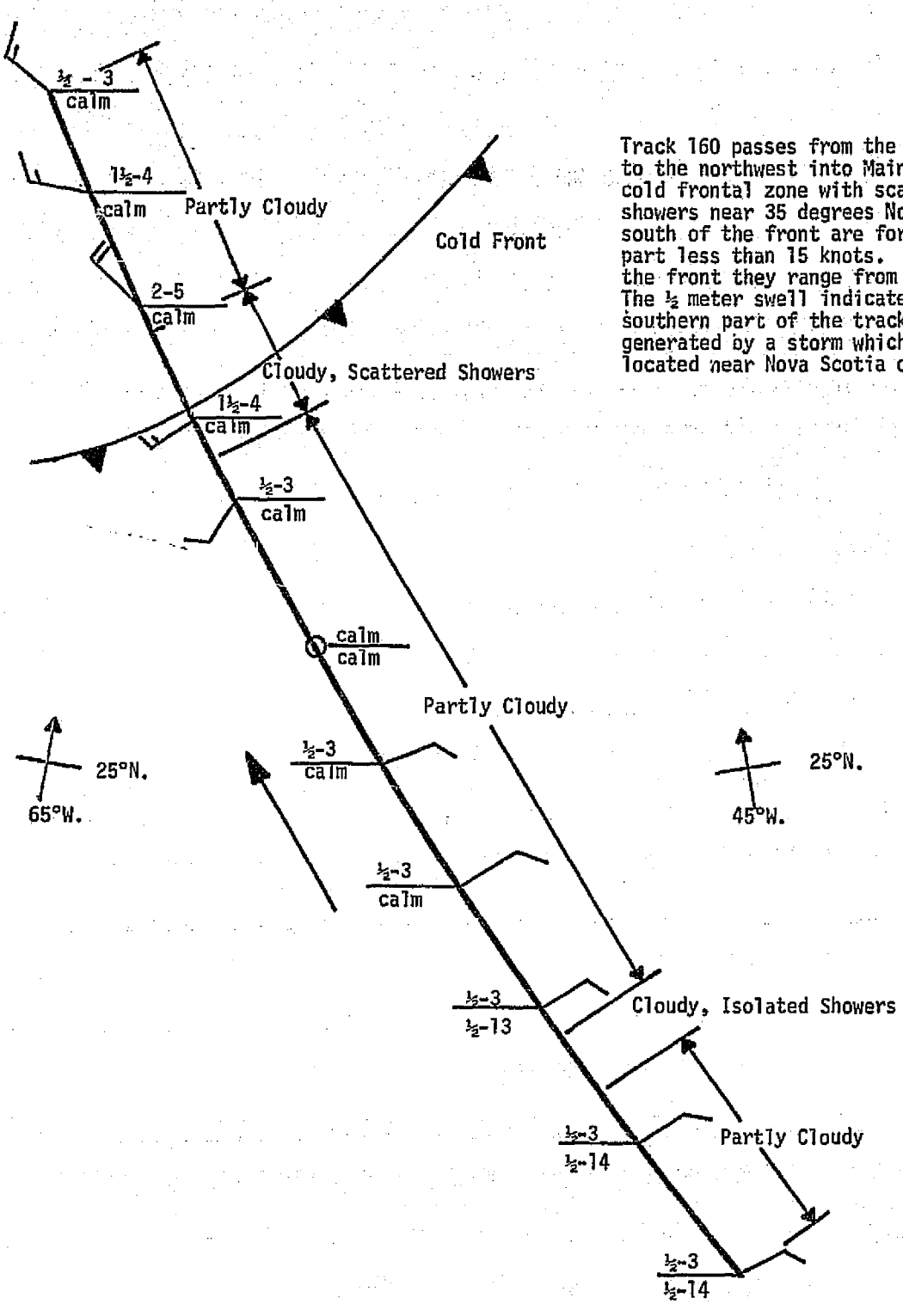
OVERLAY SYMBOLISM

Wind Conditions

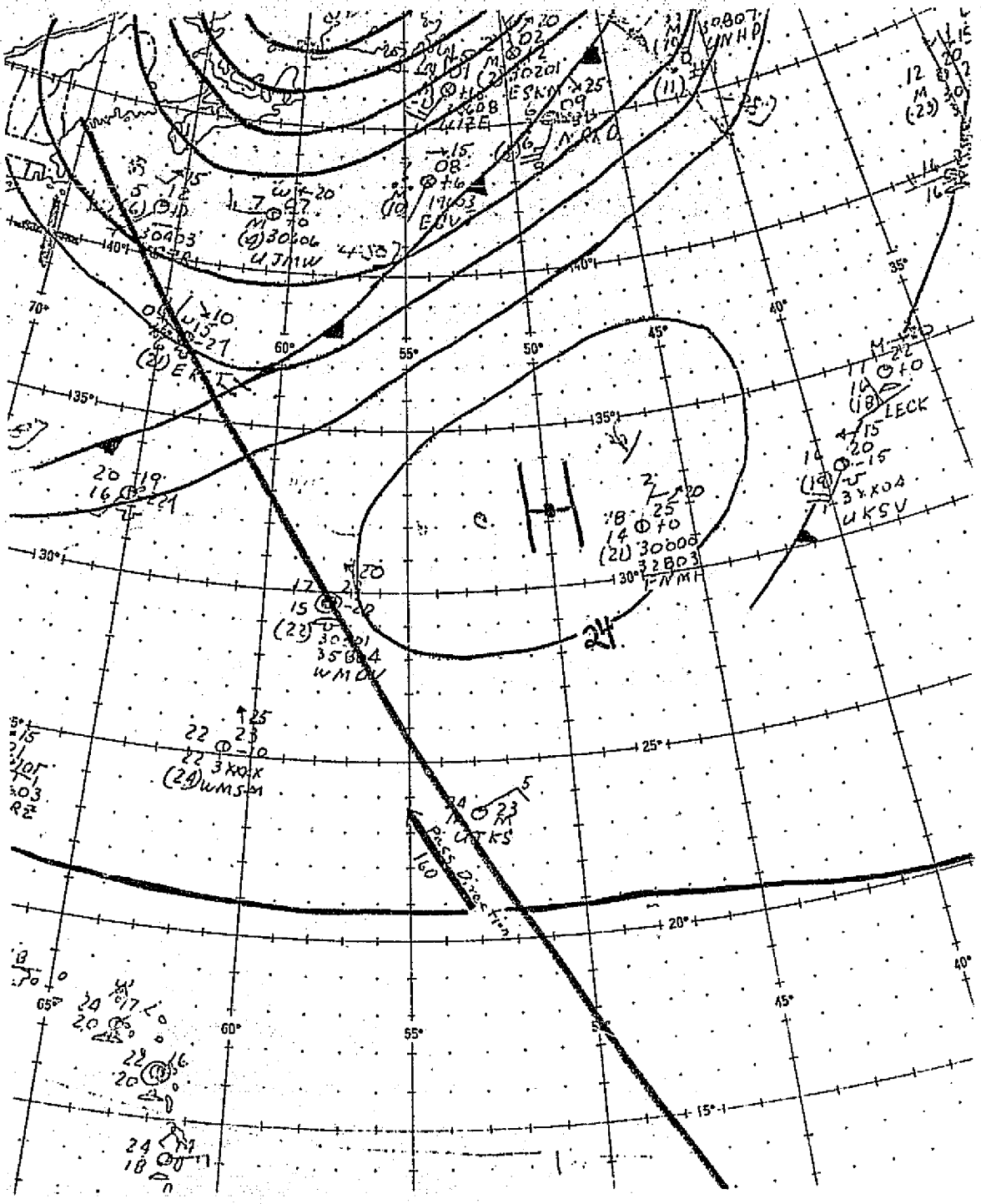
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

Sea Conditions

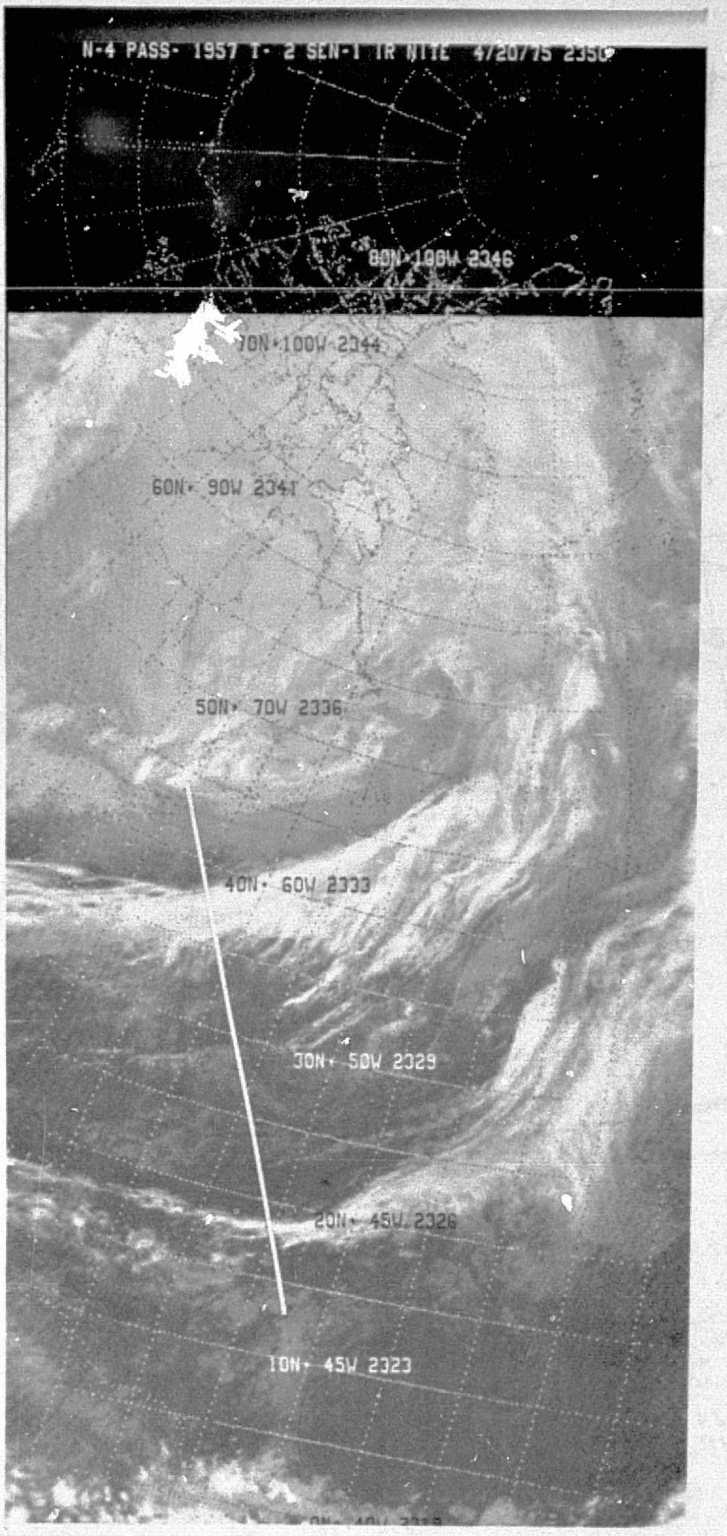
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.



Track 160 passes from the southeast to the northwest into Maine crossing a cold frontal zone with scattered showers near 35 degrees North. Winds south of the front are for the most part less than 15 knots. North of the front they range from 15 to 20 kts. The ½ meter swell indicated for the southern part of the track was generated by a storm which was located near Nova Scotia on April 19.



REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR



GROUND TRUTH DATA SET 2

(Track 183)

Track 183 extends from Norway across the Atlantic through Newfoundland and down the east coast of the U.S. across Cuba into Central America. Winds vary from calm near the center of the high pressure area off the east coast to 25 knots in the north Atlantic near the Greenwich Meridian. Seas range from calm to three meters. The only area affected by swell is the extreme northeastern portion of the track.

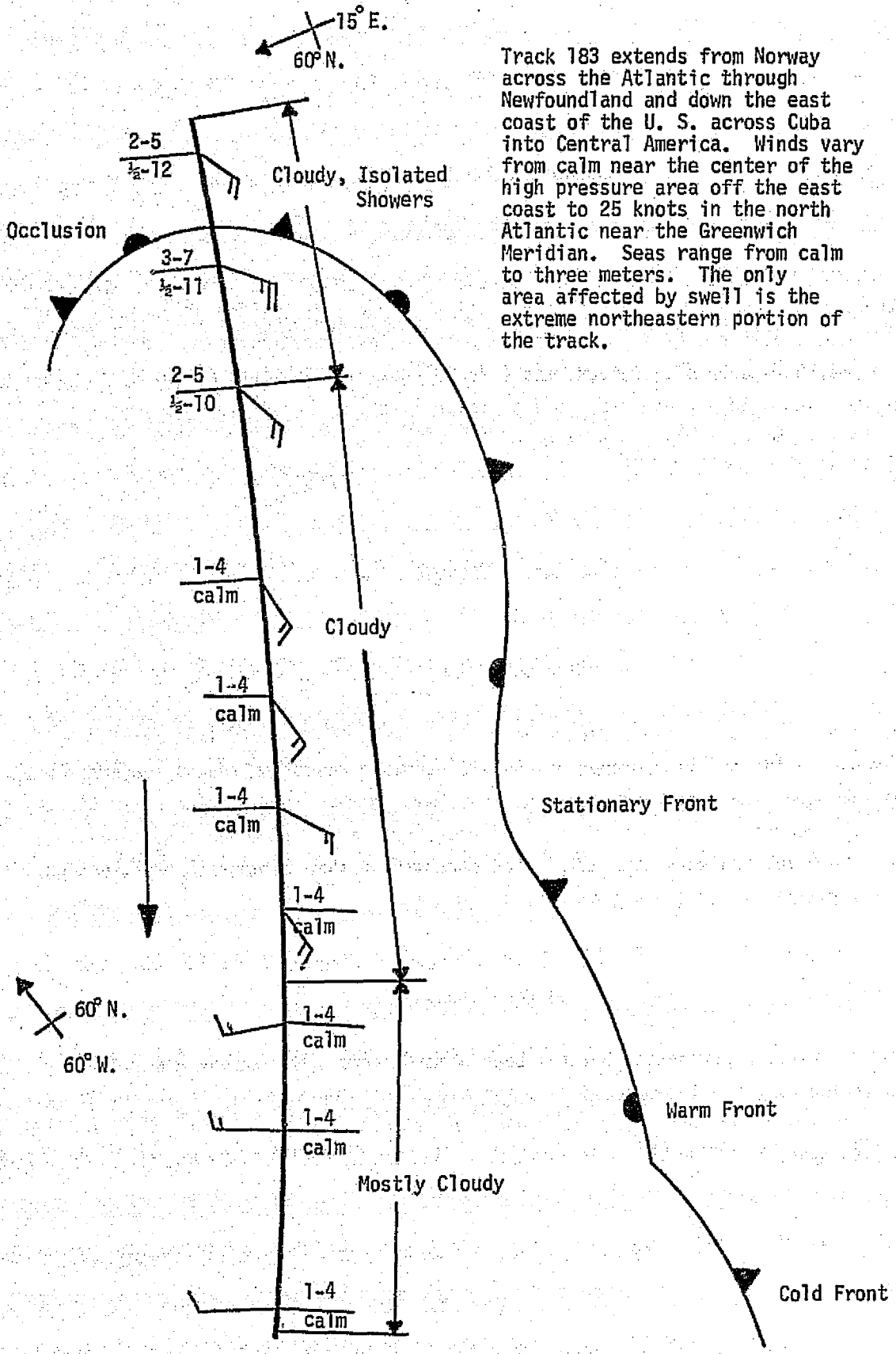
OVERLAY SYMBOLISM

Wind Conditions

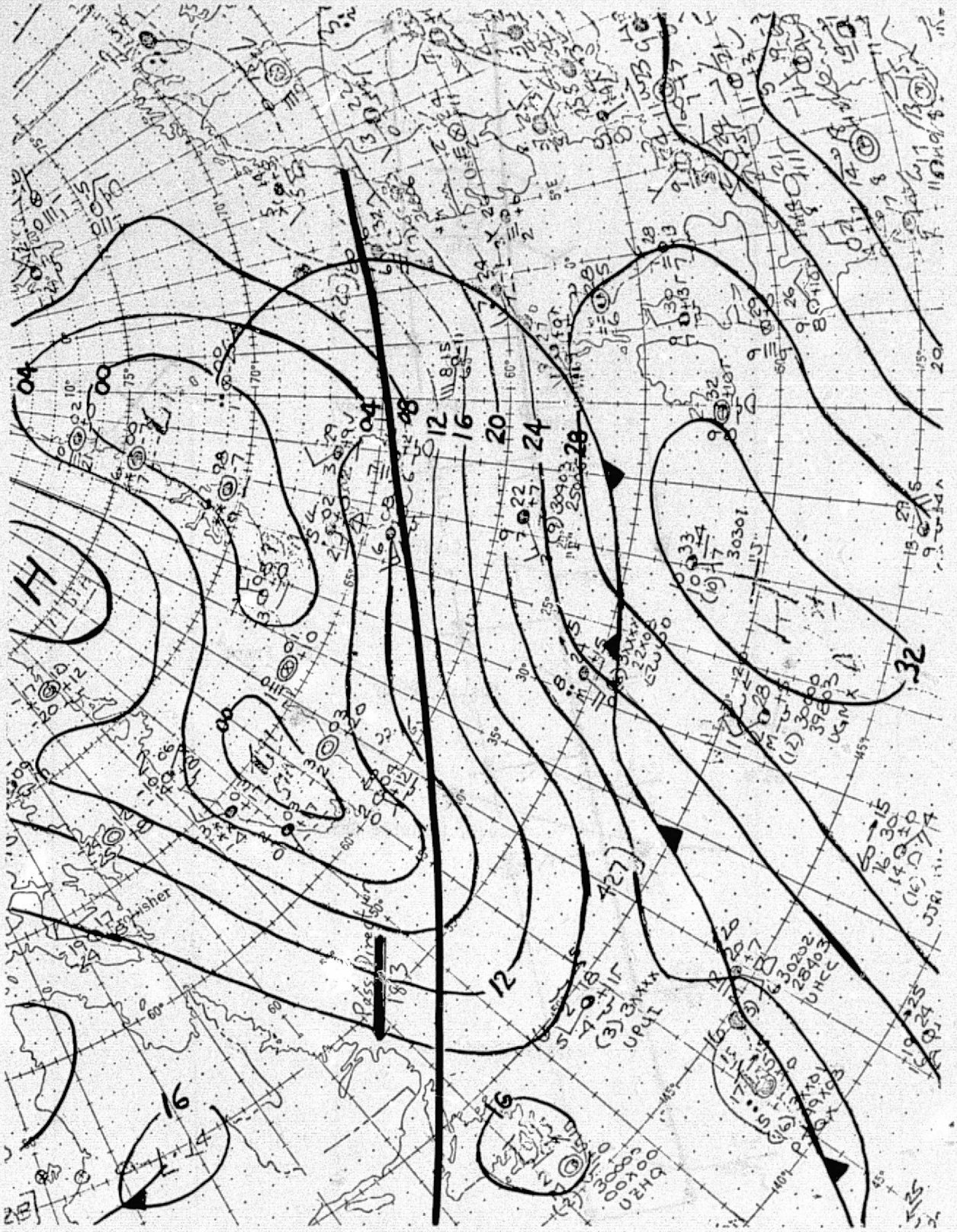
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

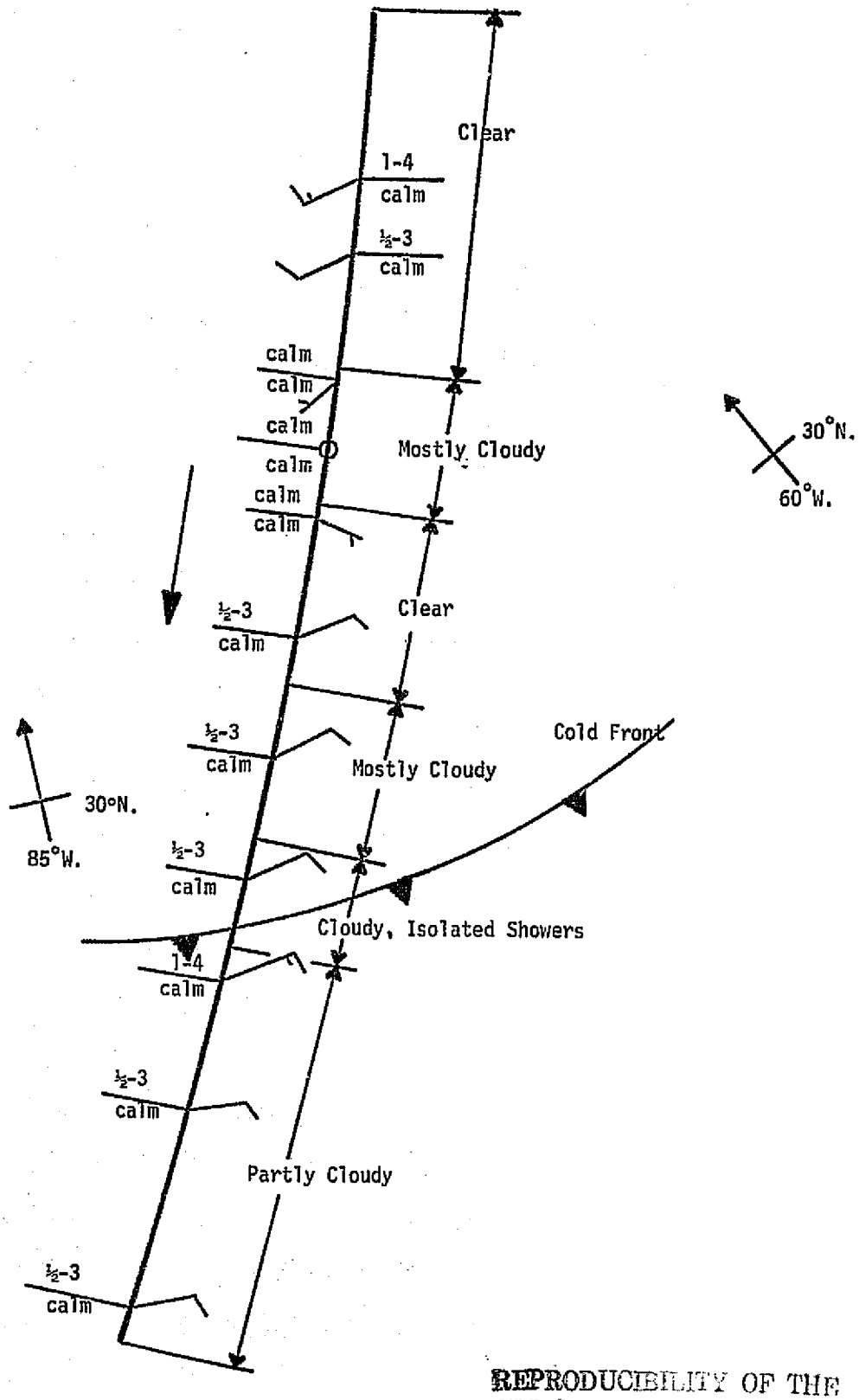
Sea Conditions

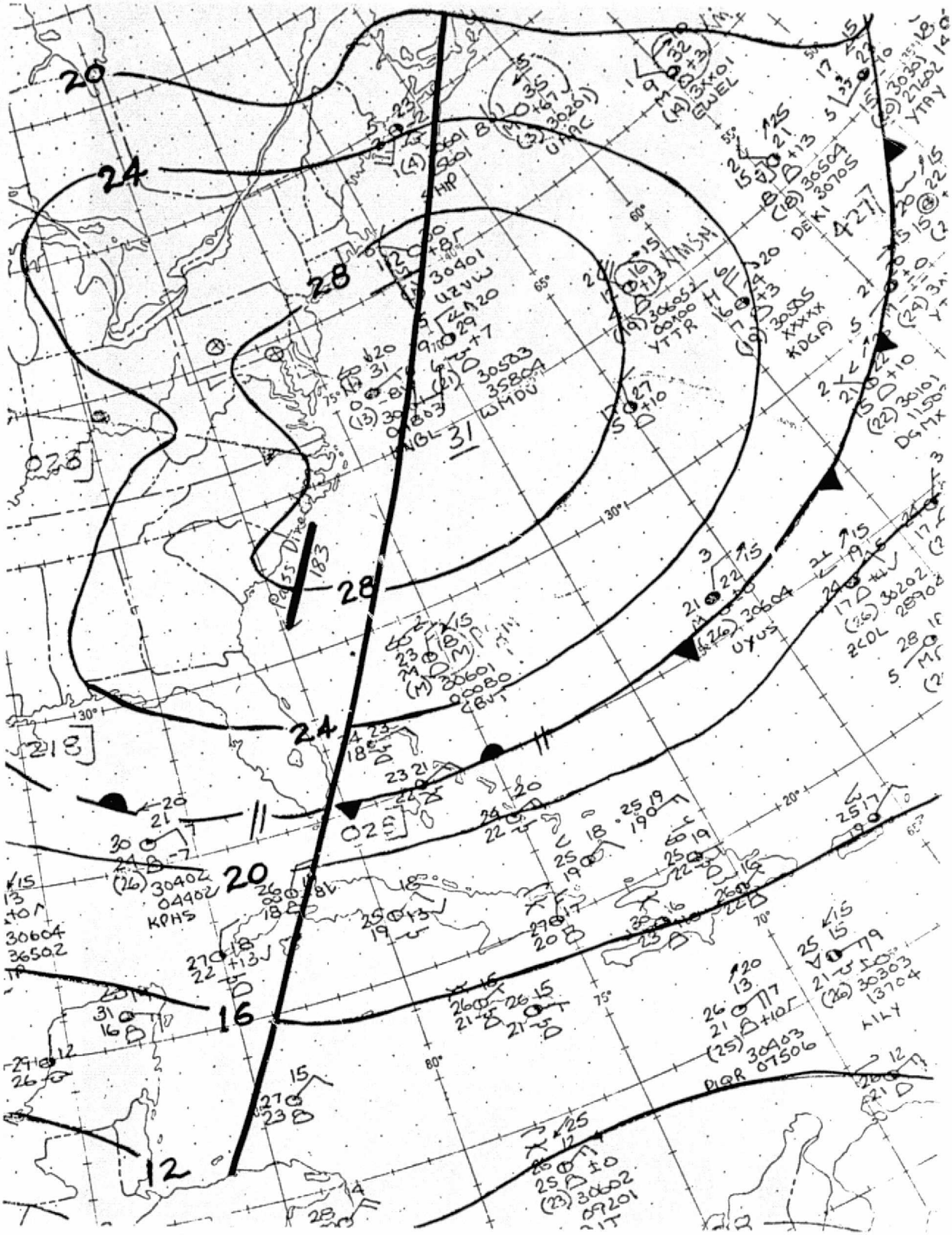
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

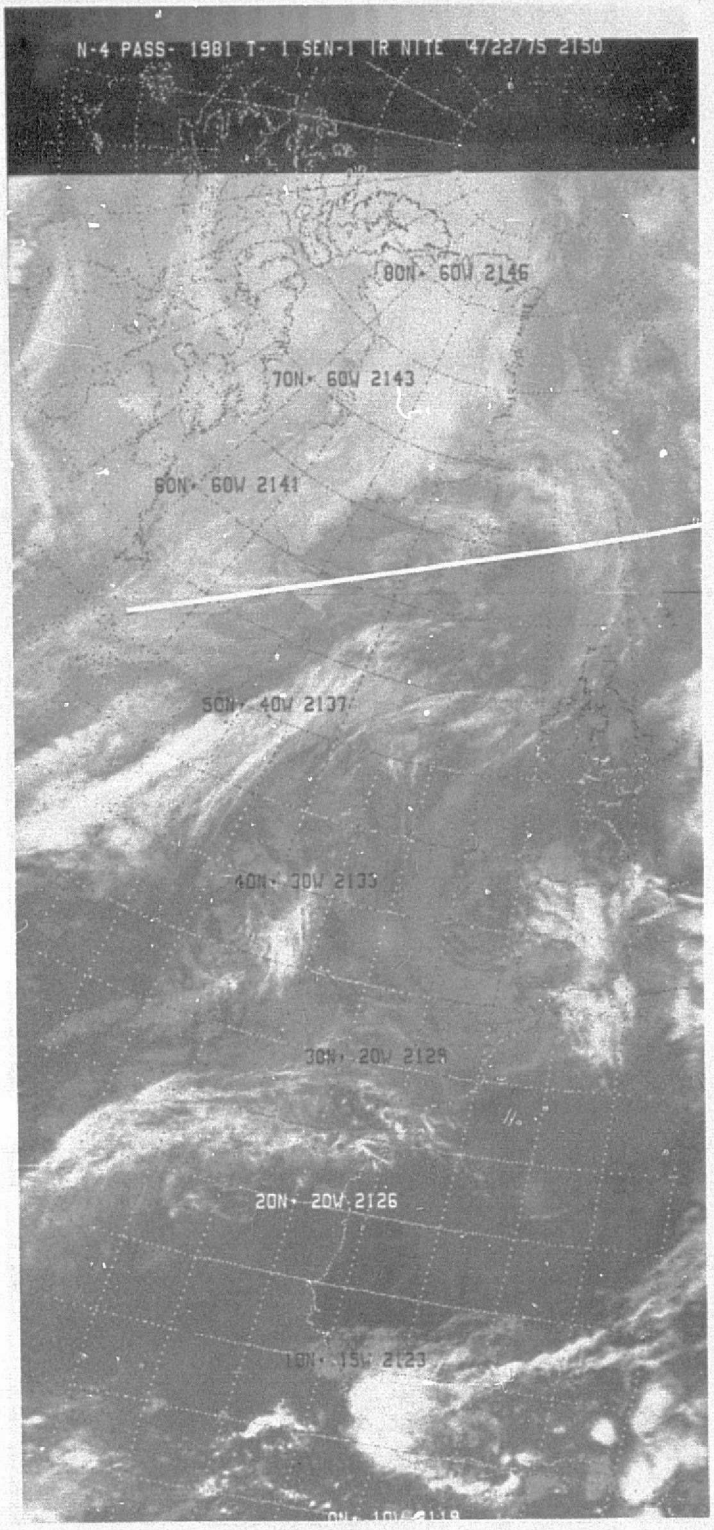


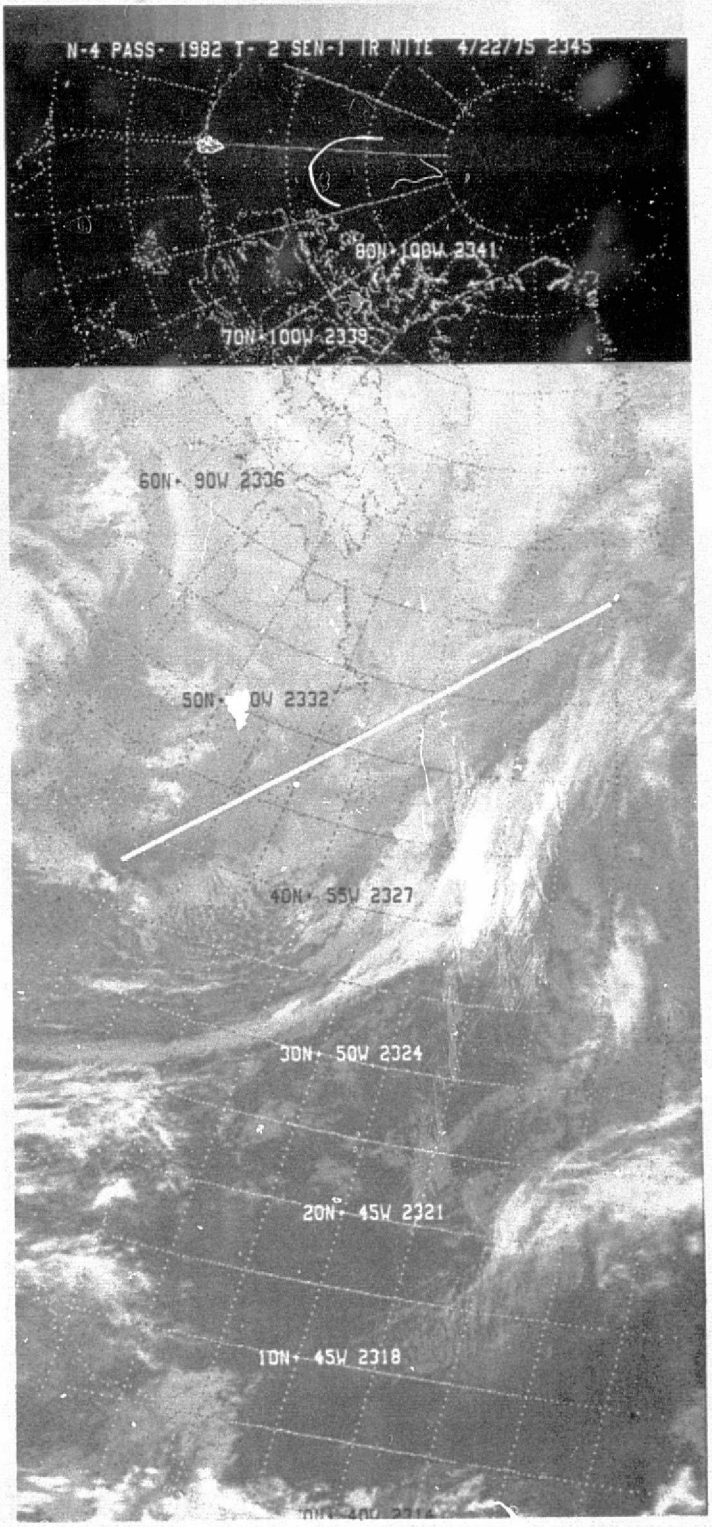
Track 183 extends from Norway across the Atlantic through Newfoundland and down the east coast of the U. S. across Cuba into Central America. Winds vary from calm near the center of the high pressure area off the east coast to 25 knots in the north Atlantic near the Greenwich Meridian. Seas range from calm to three meters. The only area affected by swell is the extreme northeastern portion of the track.

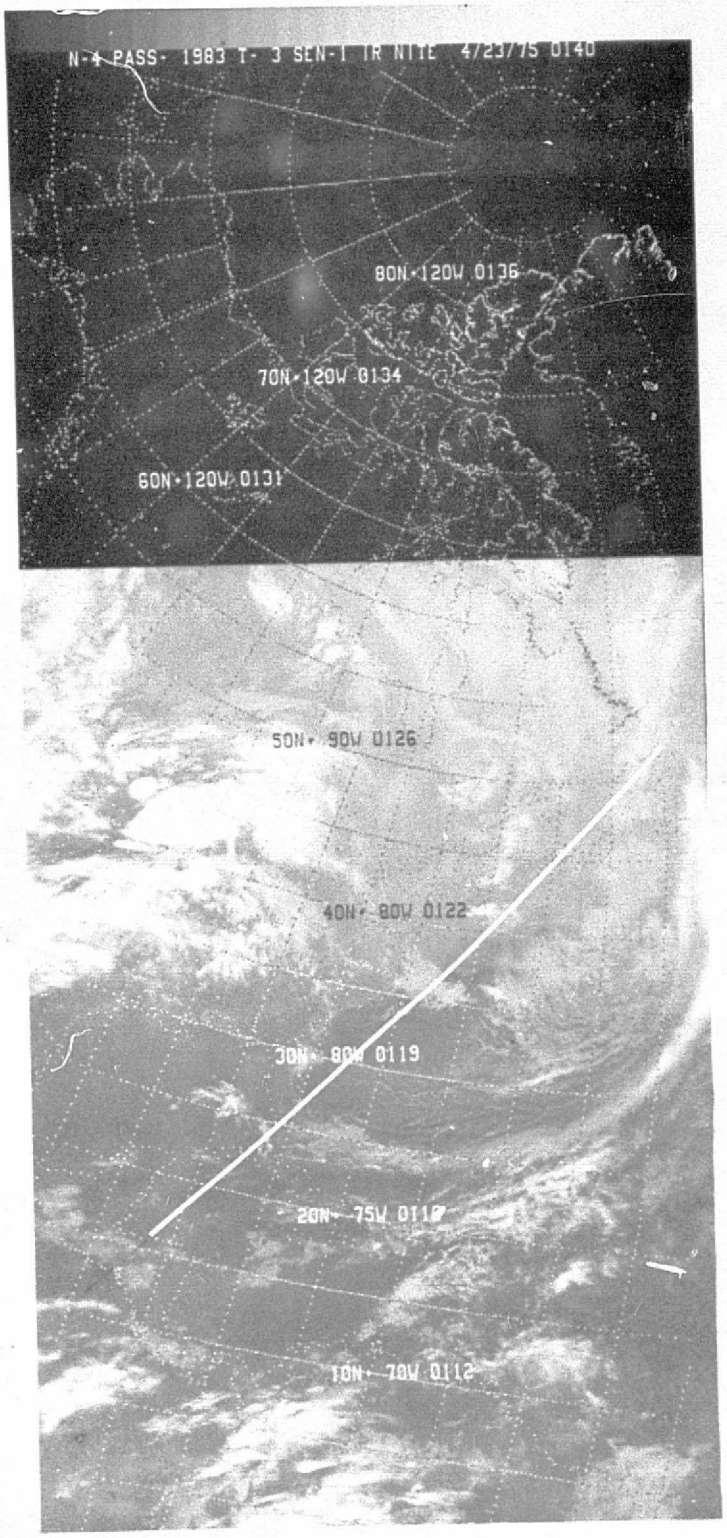


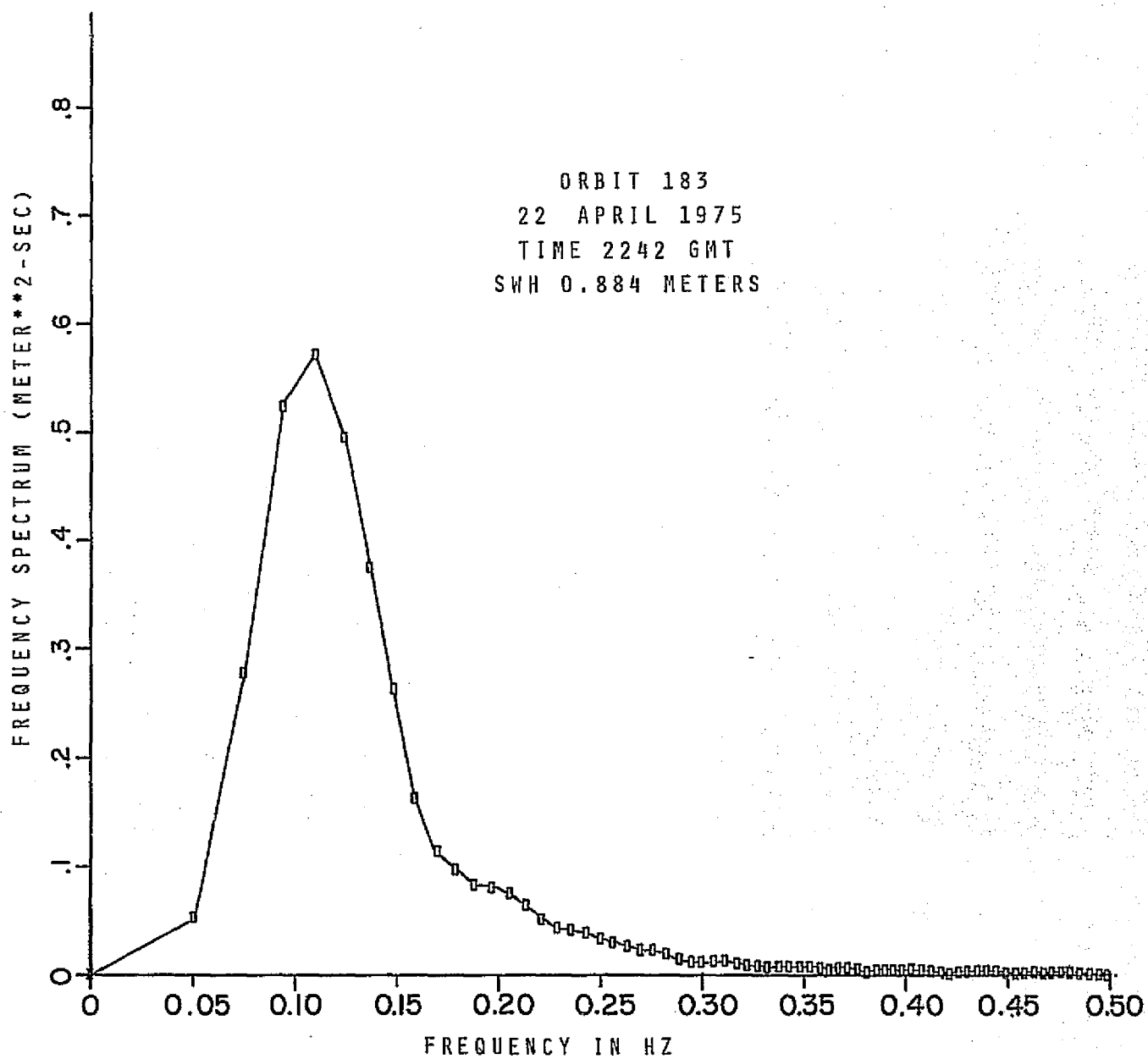


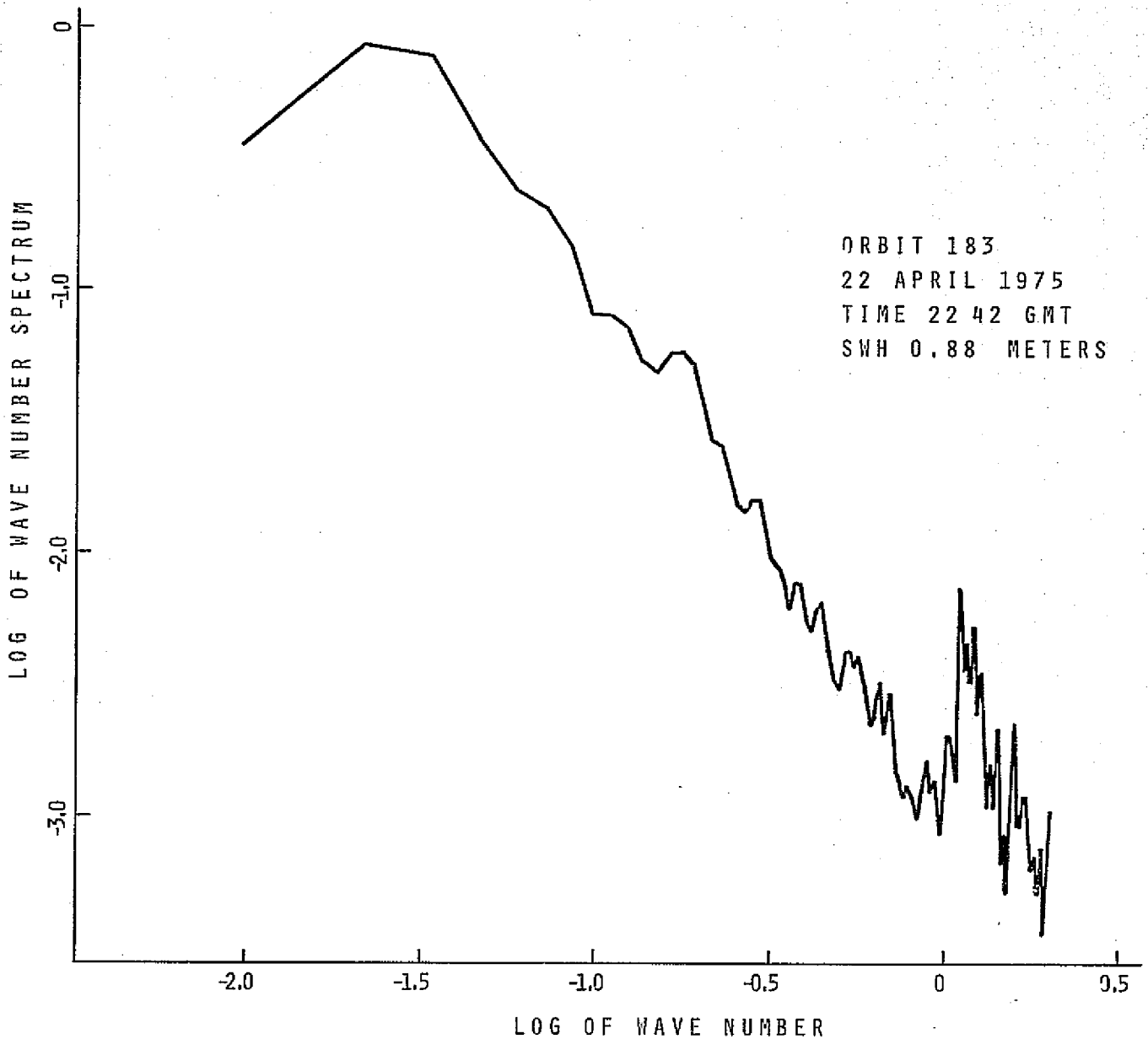









ORBIT 183
22 APRIL 1975
TIME 2242 GMT
SWH 0.884 METERS
FREQUENCY SPECTRUM (METER**2-SEC)
0
.1
.2
.3
.4
.5
.6
.7
.8
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
FREQUENCY IN HZ


LOG OF WAVE NUMBER SPECTRUM
0
-1.0
-2.0
-3.0
ORBIT 183
22 APRIL 1975
TIME 22 42 GMT
SWH 0.88 METERS
-2.0
-1.5
-1.0
-0.5
0
0.5
LOG OF WAVE NUMBER

GROUND TRUTH DATA SET 3

(Track 186)

Track 186 passes from the northwestern tip of the Iberian Peninsula toward the southern end of Greenland. Winds range from 10 to 20 knots and seas from ½ to 1½ meters. Swell in the northwestern area is from a storm which was located south of Greenland two days earlier. The track segment is over a cloudy area with a few small open areas.

OVERLAY SYMBOLISM

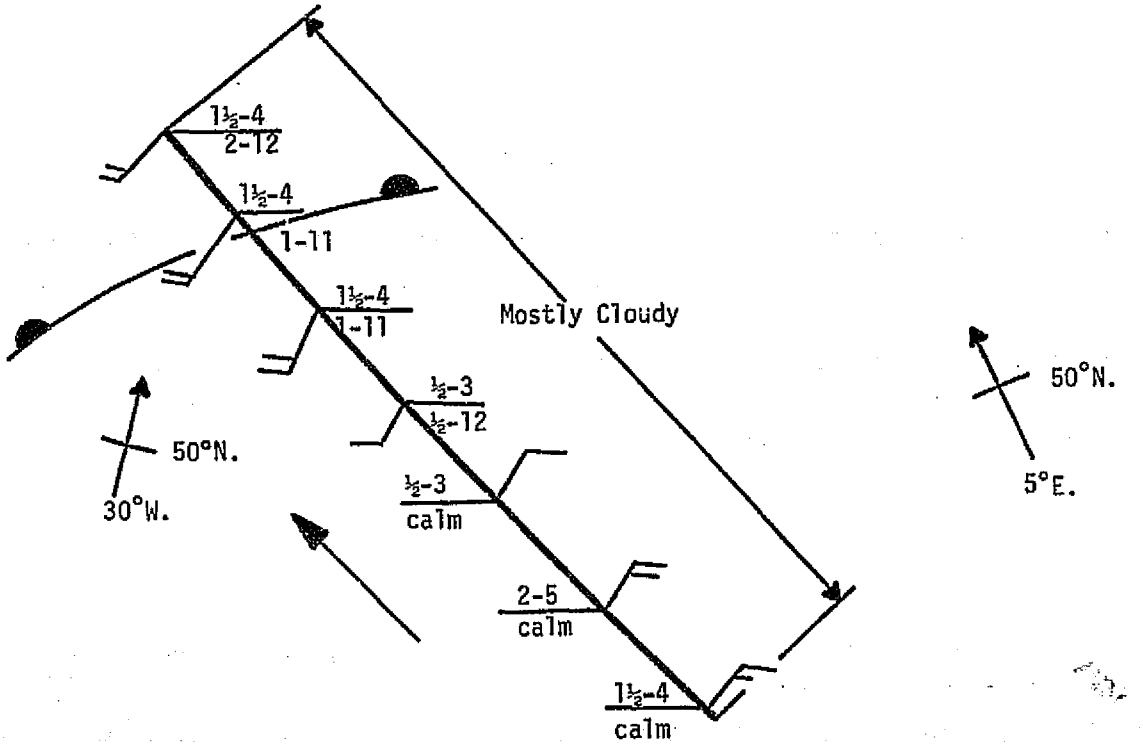
Wind Conditions

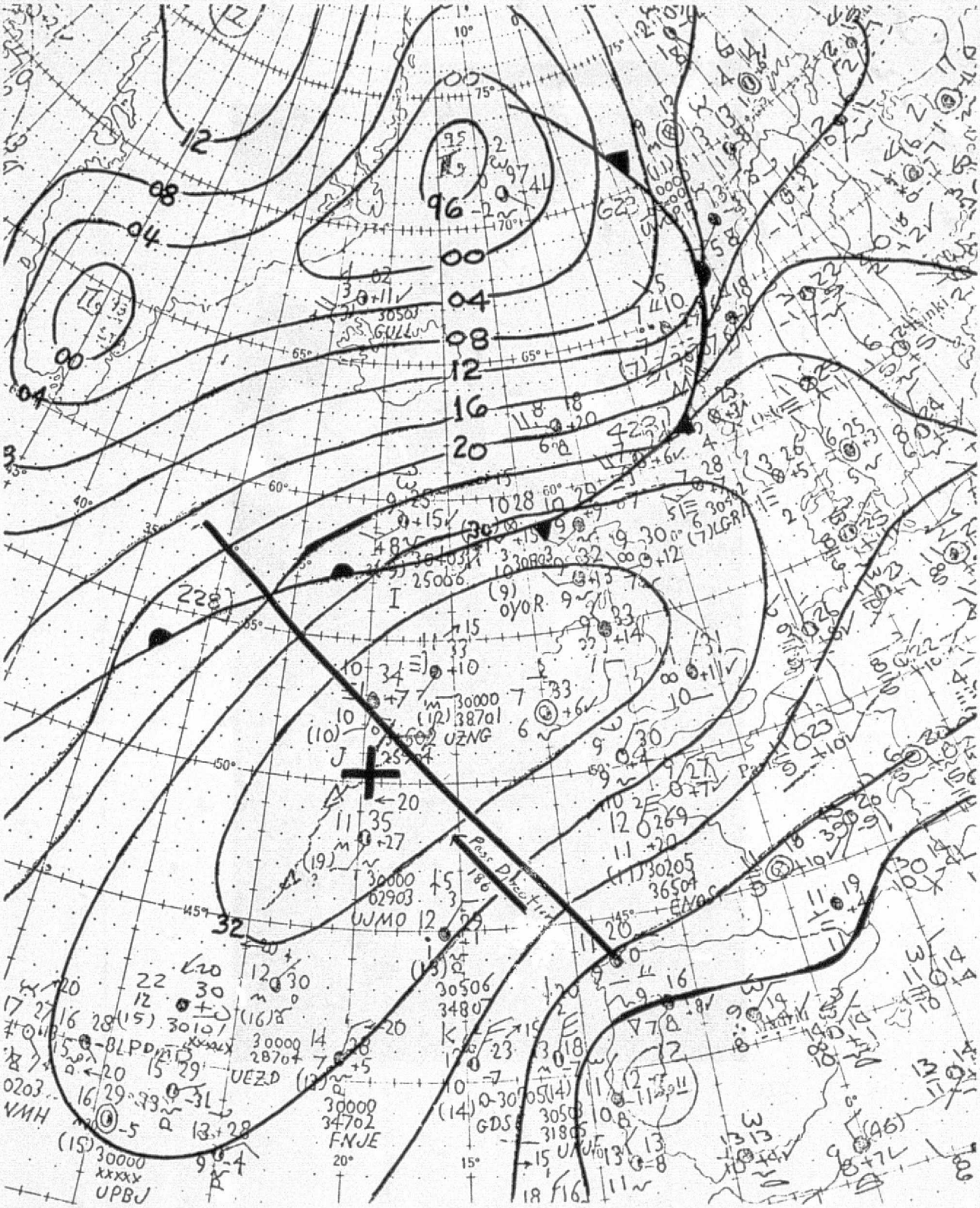
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

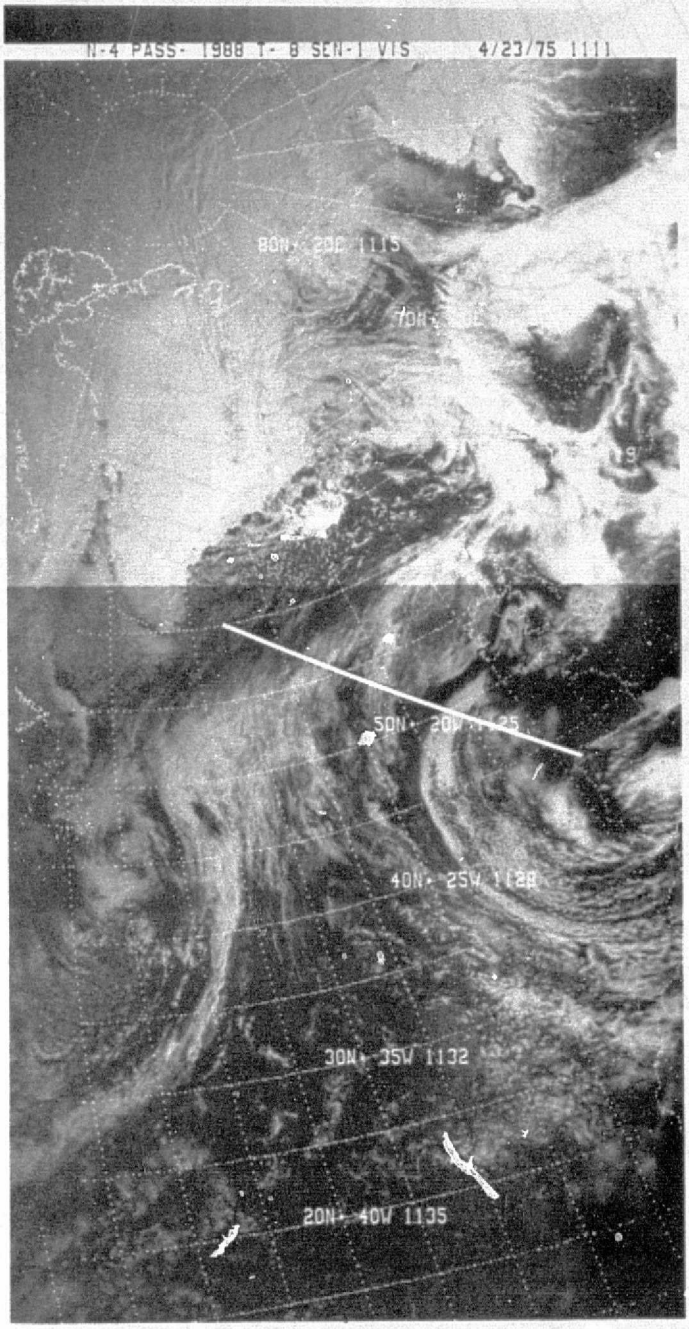
Sea Conditions

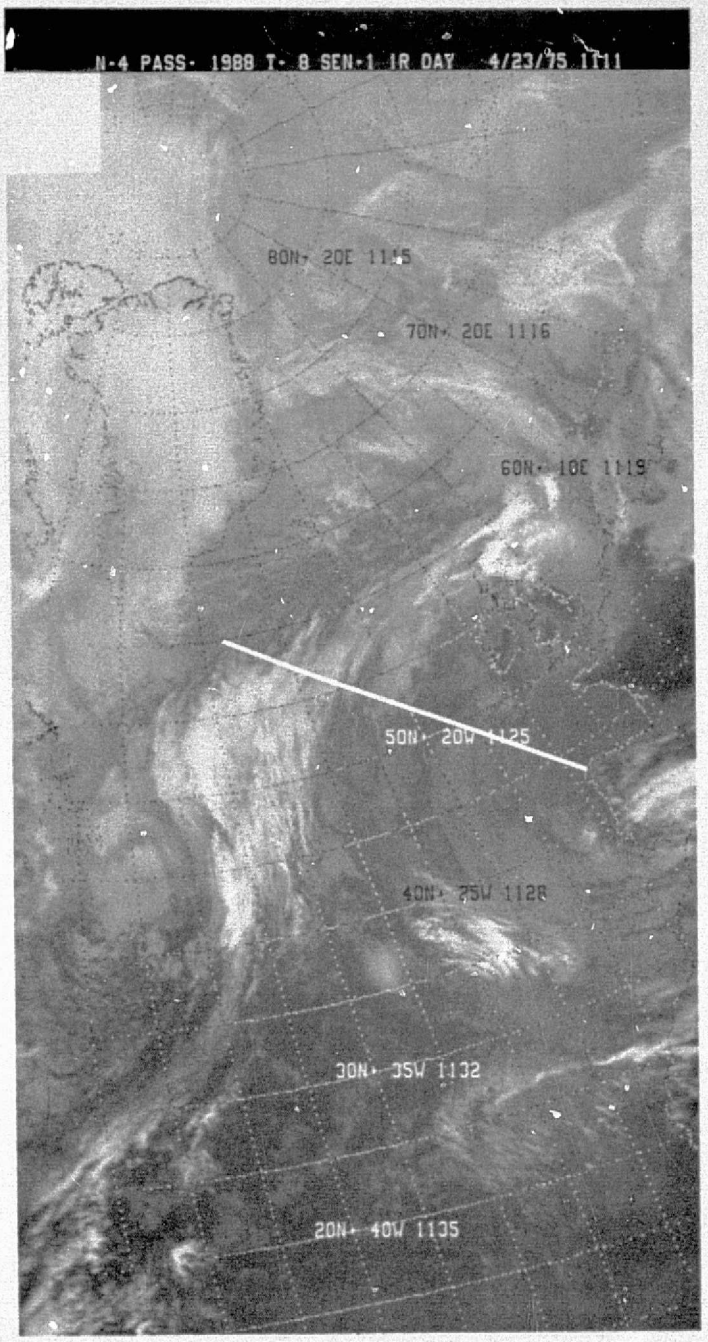
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

Track 186 passes from the northwestern tip of the Iberian Peninsula toward the southern end of Greenland. Winds range from 10 to 20 knots and seas from ½ to 1½ meters. Swell in the northwestern area is from a storm which was located south of Greenland two days earlier. The track segment is over a cloudy area with a few small open areas.









GROUND TRUTH DATA SET 4

(Track 189)

Track 189 passes through two areas of isolated showers. Approximately 20% can be seen in mostly cloudy areas and about 50% in the partly cloudy area. There is no swell affecting the track.

OVERLAY SYMBOLISM

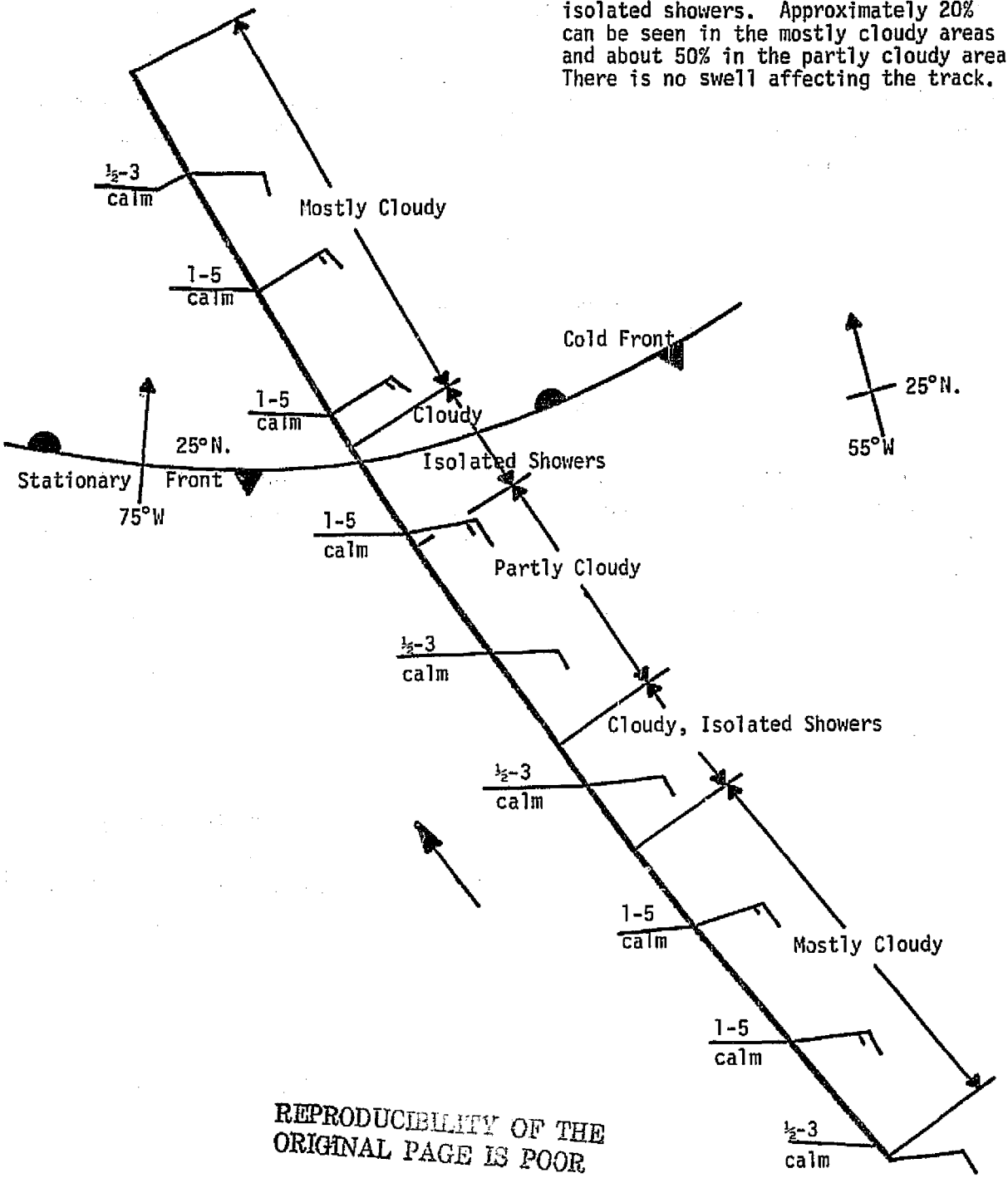
Wind Conditions

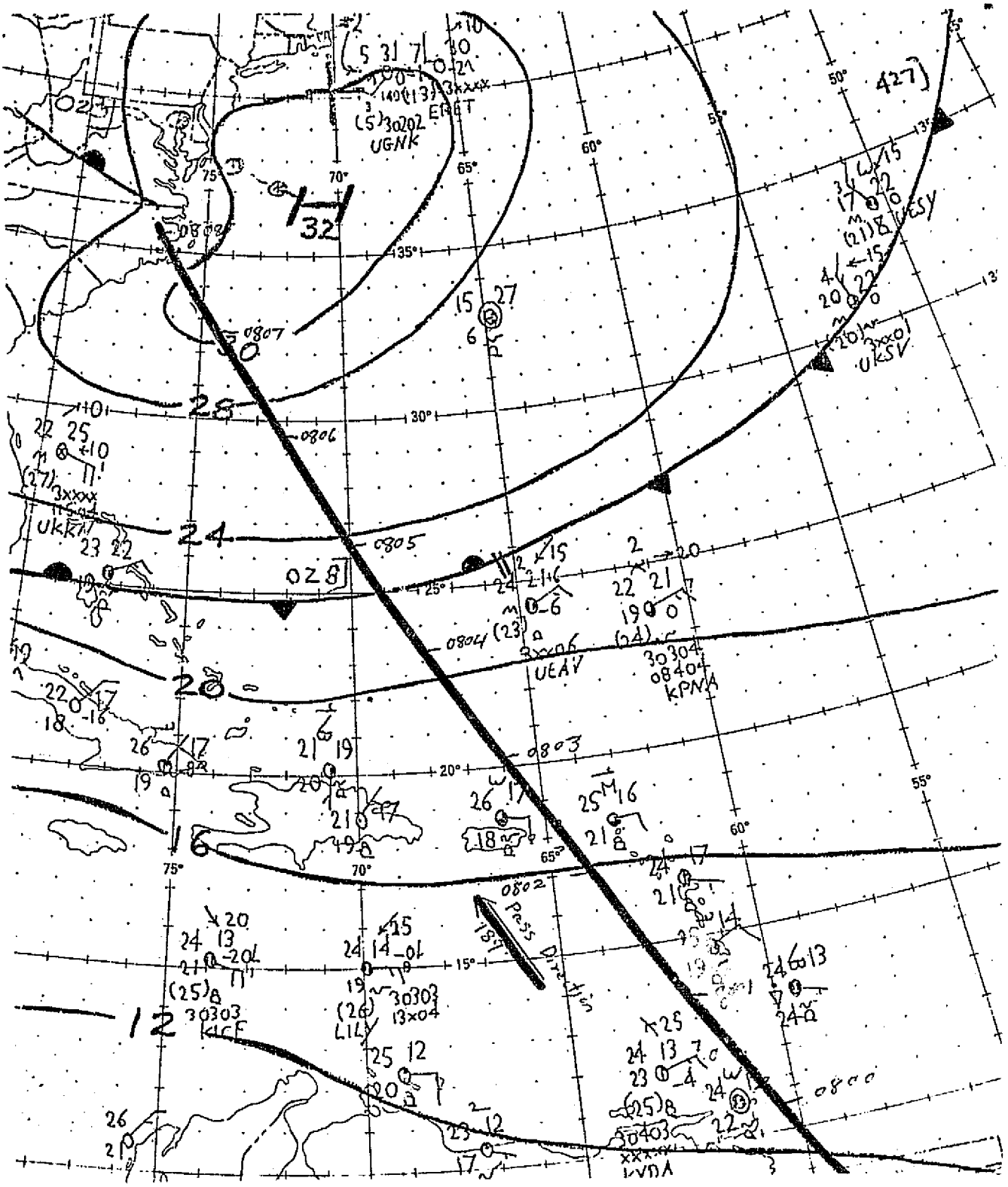
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

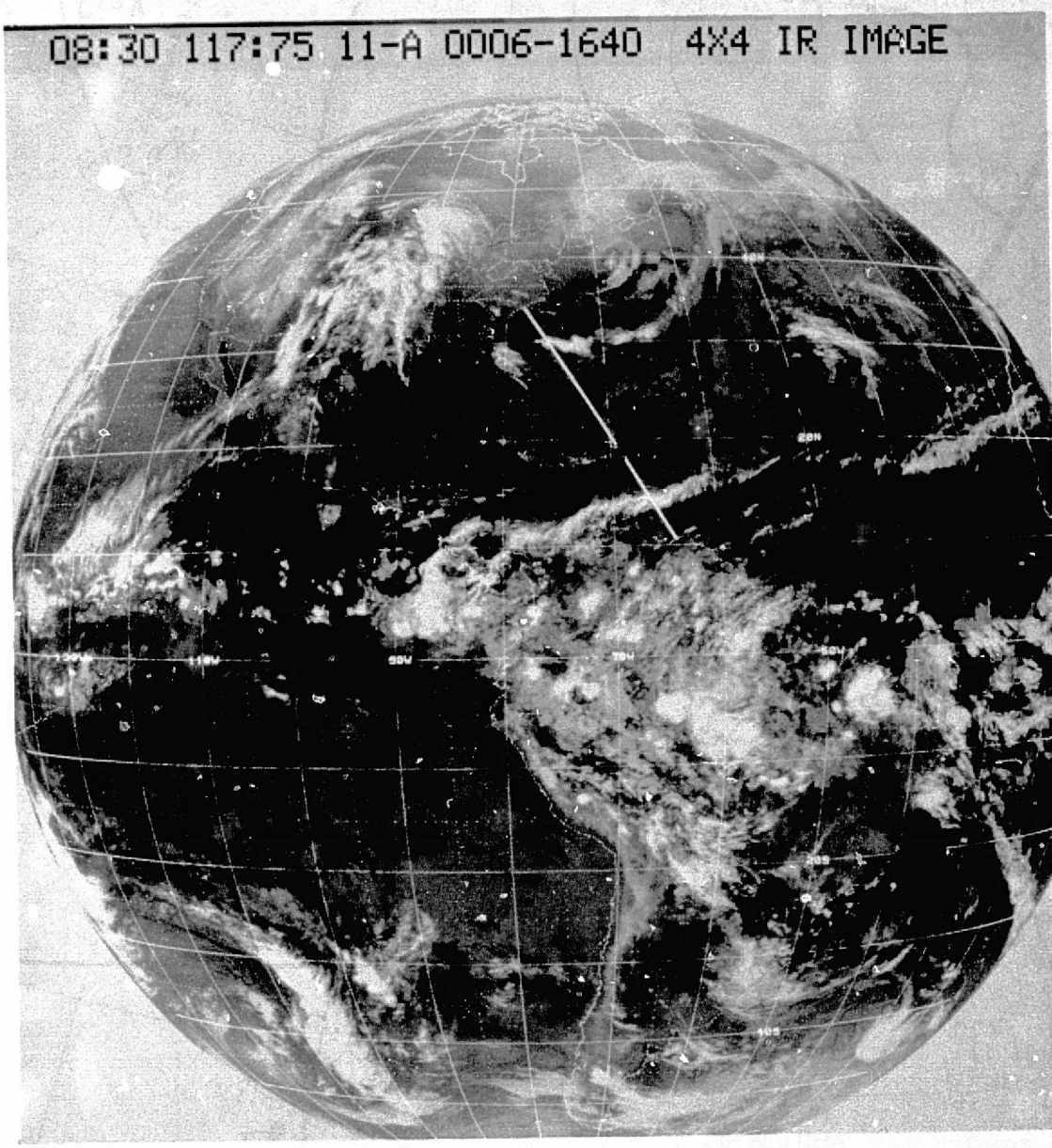
Sea Conditions

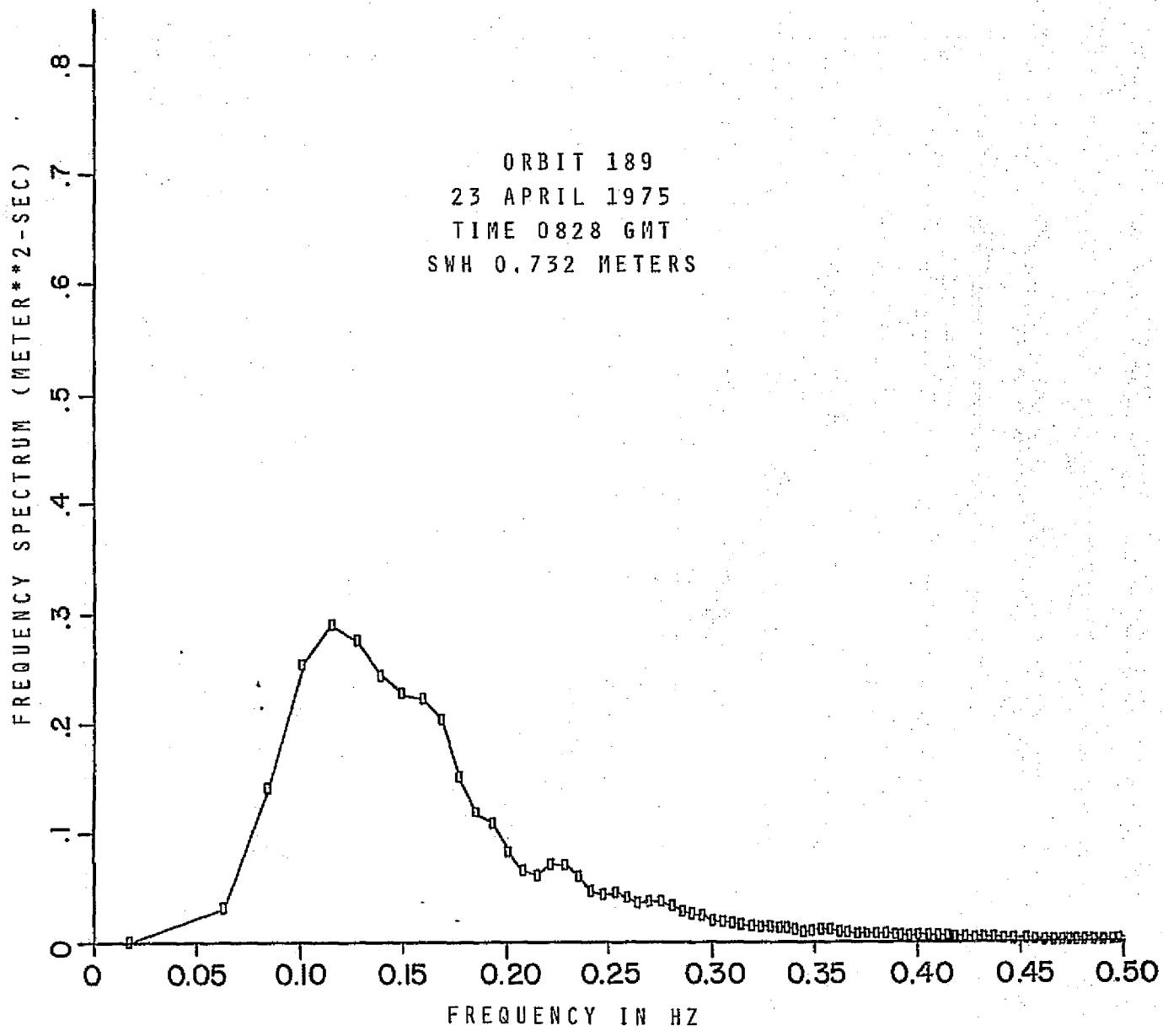
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

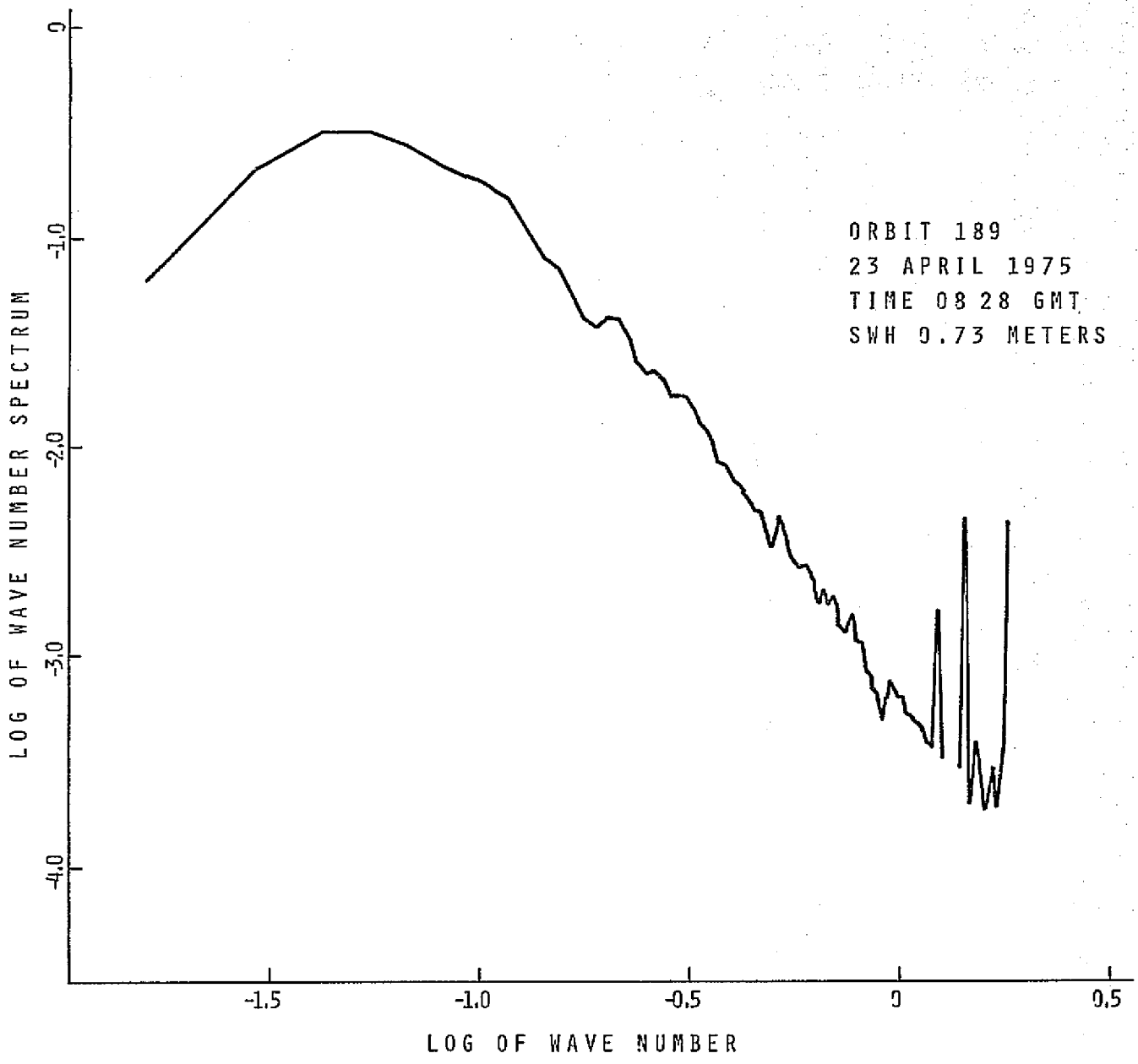
Track 189 passes through two areas of isolated showers. Approximately 20% can be seen in the mostly cloudy areas and about 50% in the partly cloudy area. There is no swell affecting the track.








ORBIT 189
23 APRIL 1975
TIME 0828 GMT
SWH 0.732 METERS
FREQUENCY SPECTRUM (METER**2-SEC)
0
.1
.2
.3
.4
.5
.6
.7
.8
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
FREQUENCY IN HZ


ORBIT 189
23 APRIL 1975
TIME 08 28 GMT
SWH 0.73 METERS
LOG OF WAVE NUMBER SPECTRUM
0
-1.0
-2.0
-3.0
-4.0
-1.5
-1.0
-0.5
0
0.5
LOG OF WAVE NUMBER

GROUND TRUTH DATA SET 5

(Track 197)

Track 197 is a long track extending from Norway across the Atlantic and then parallel to the east coast of the U.S. Winds vary from calm to 25 knots and seas from calm to as high as 3 meters are found in the extreme northeast portion of the track. No part of the track is affected by significant swell.

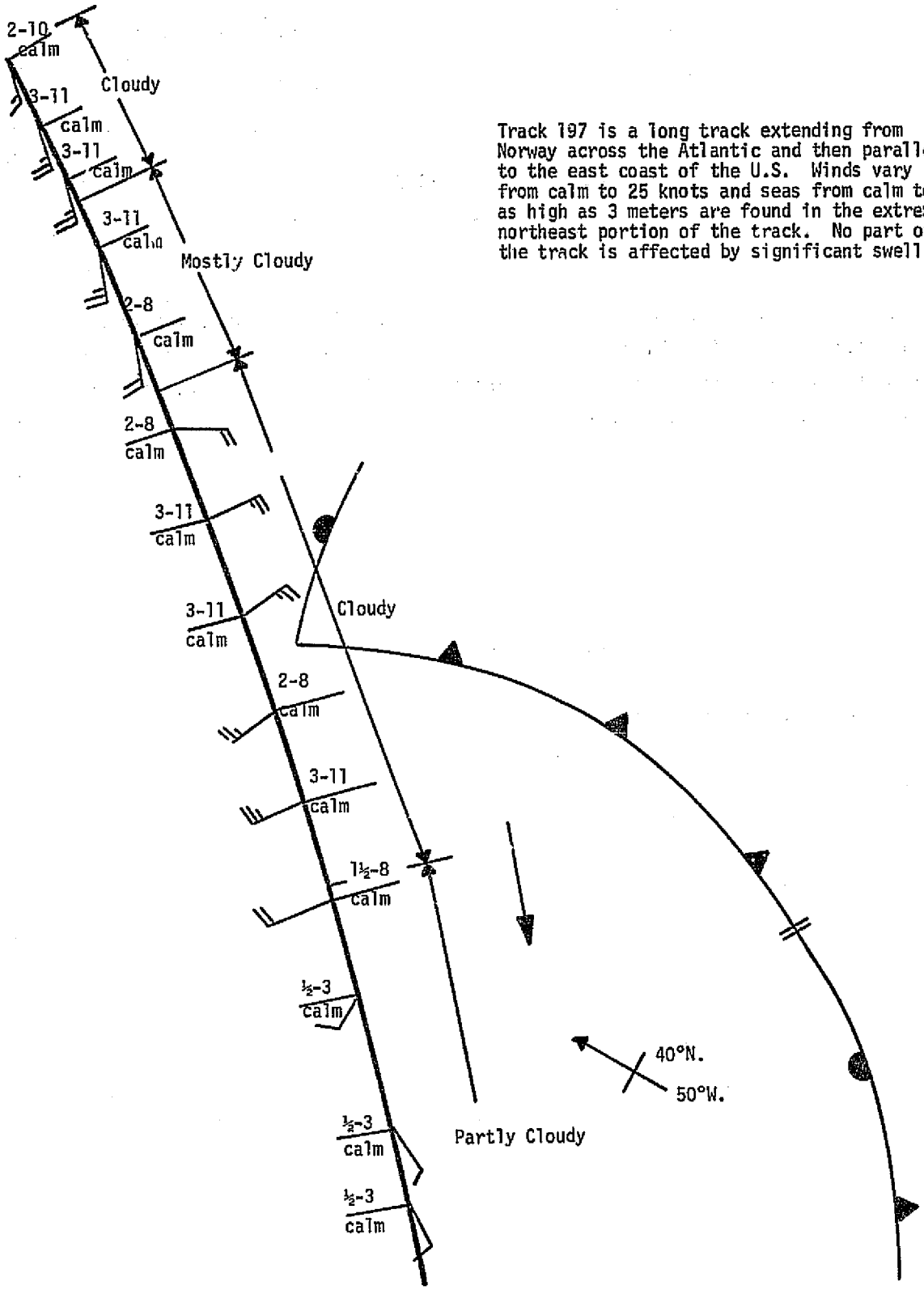
OVERLAY SYMBOLISM

Wind Conditions

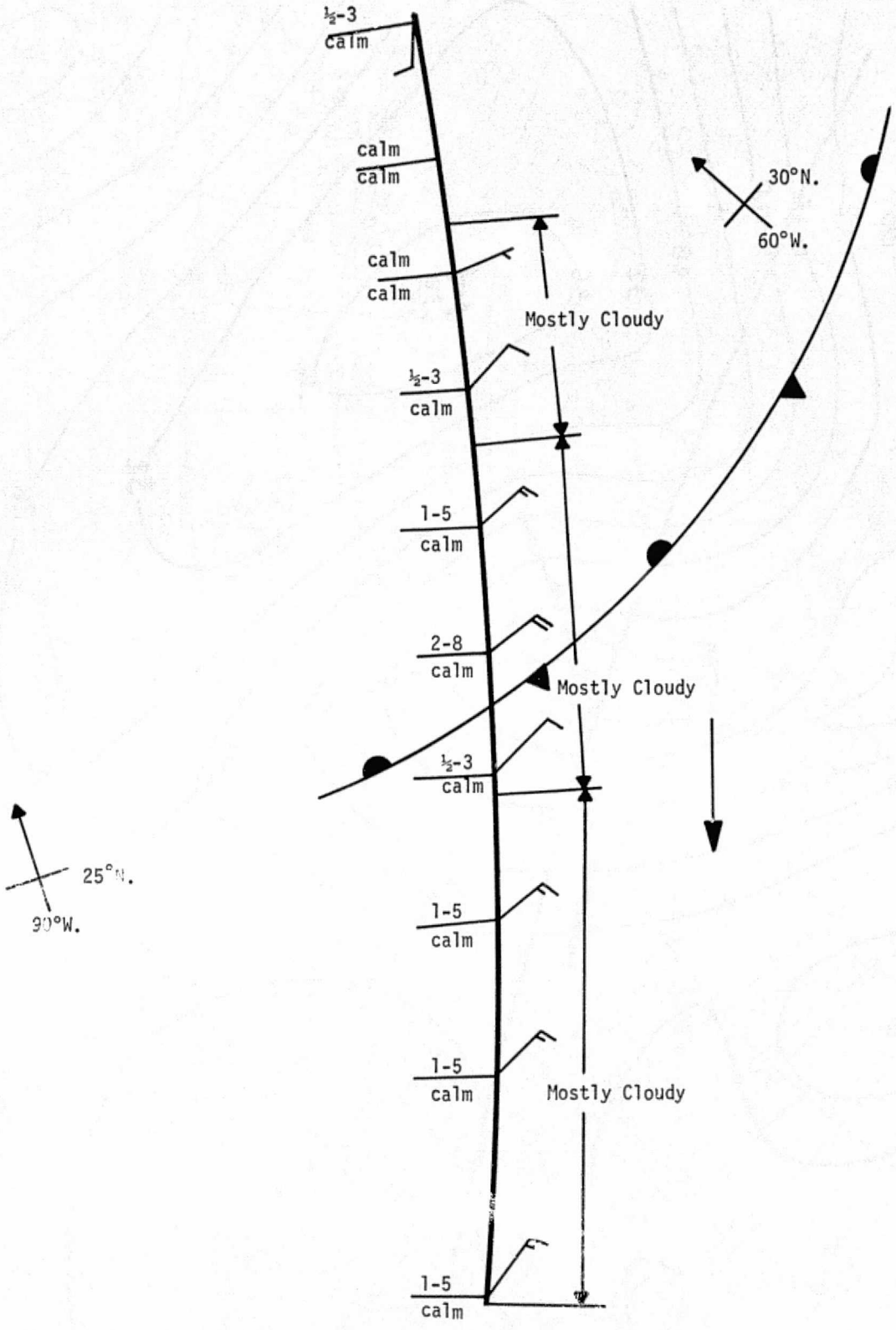
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

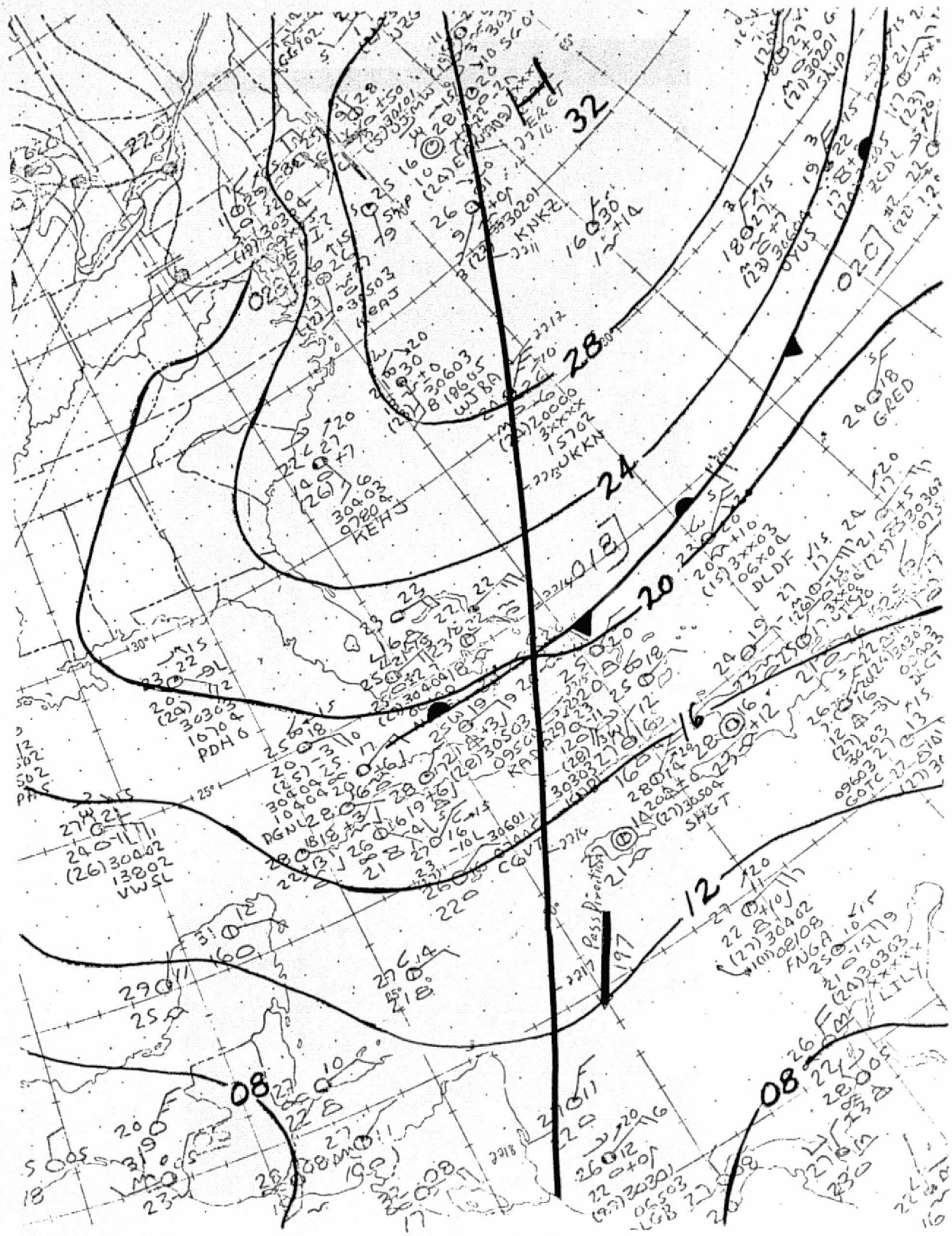
Sea Conditions

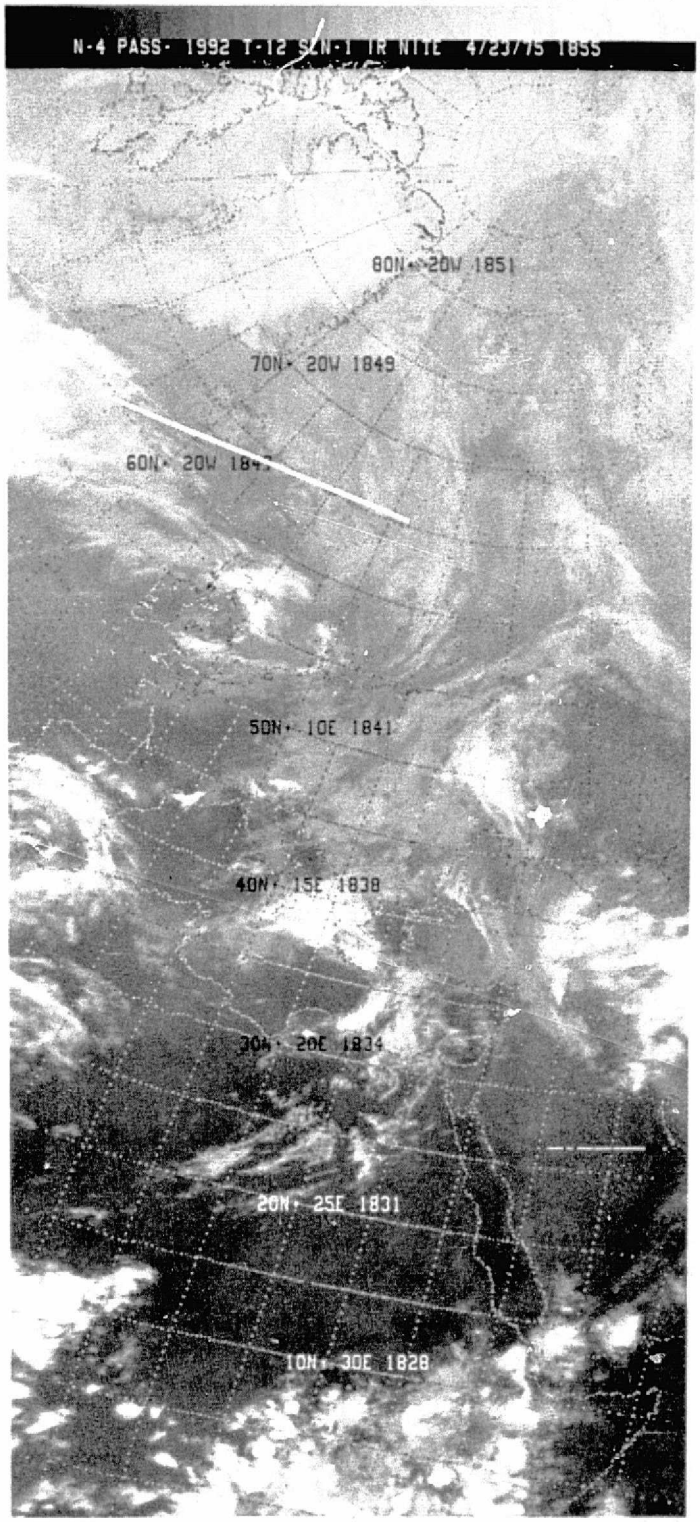
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

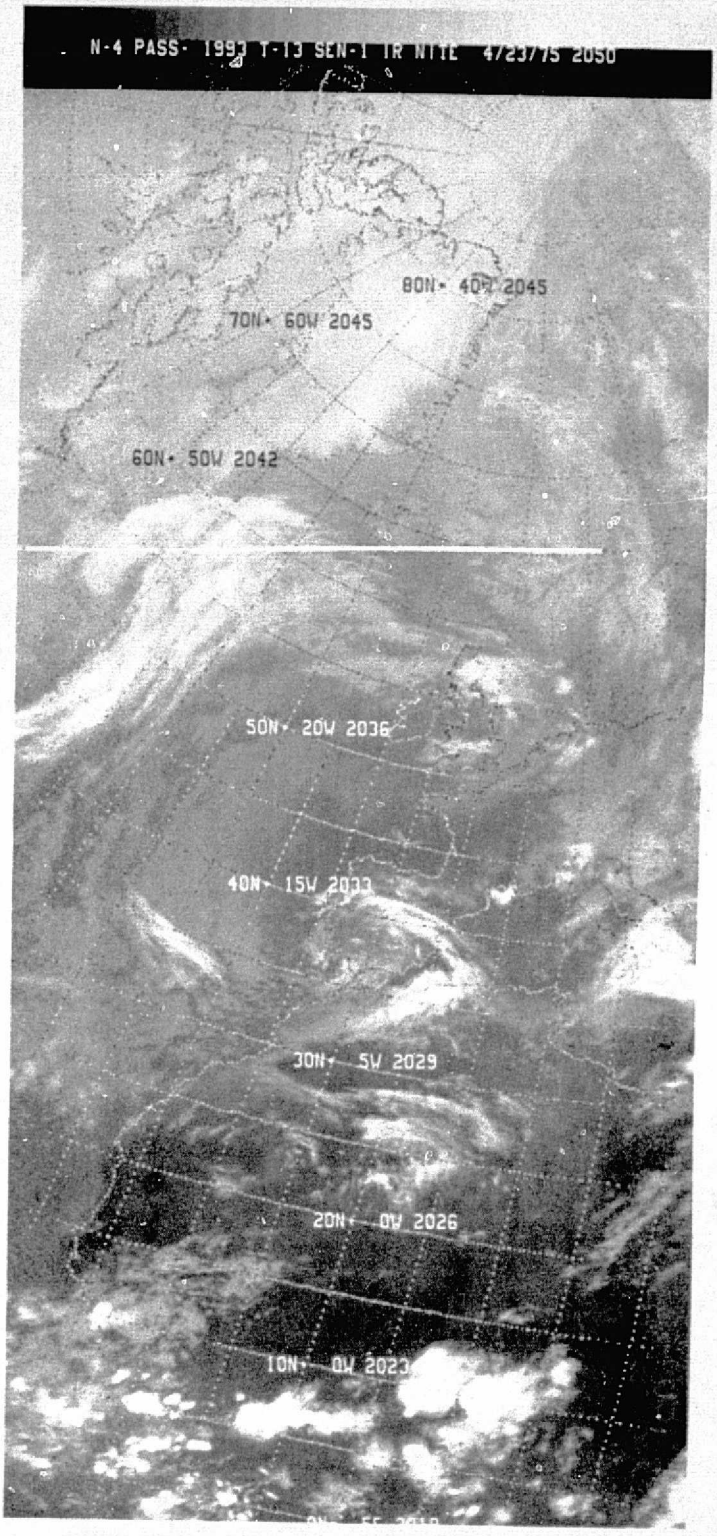


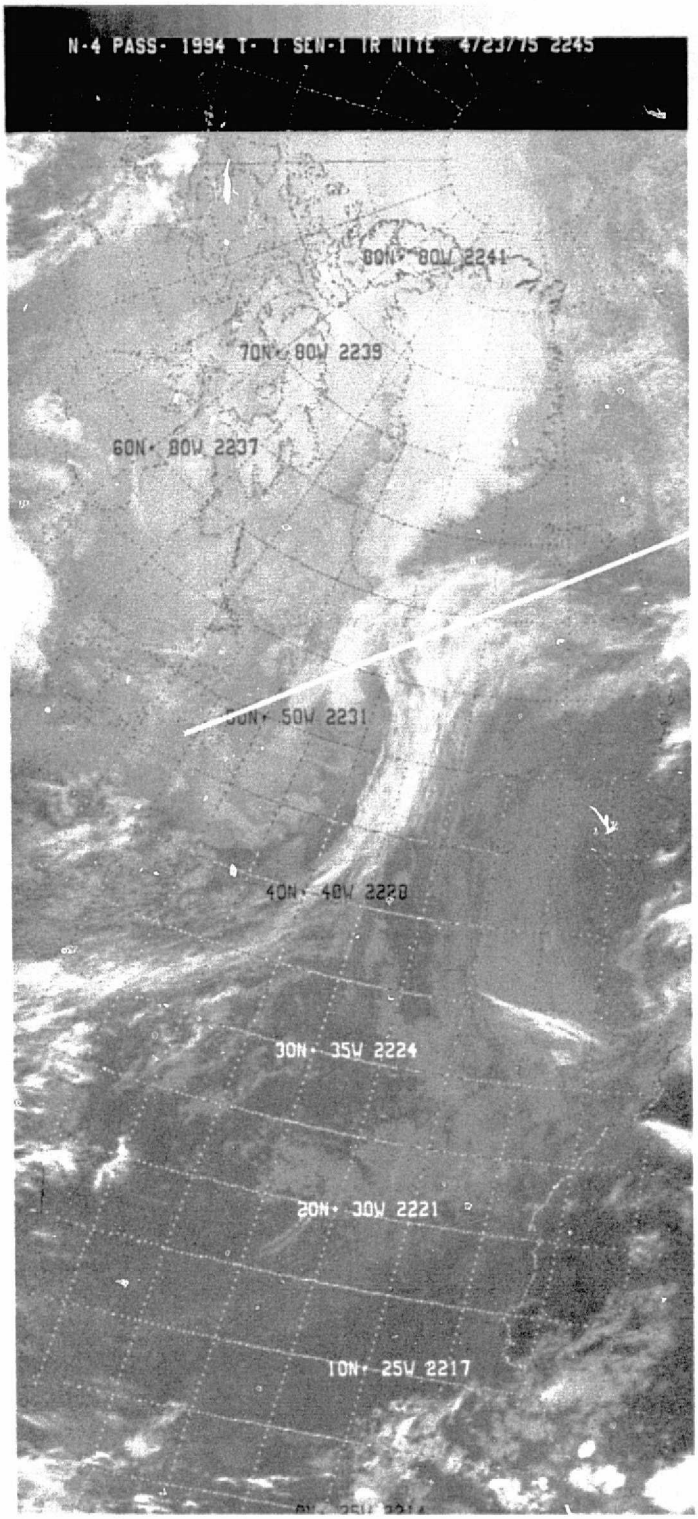
Track 197 is a long track extending from Norway across the Atlantic and then parallel to the east coast of the U.S. Winds vary from calm to 25 knots and seas from calm to as high as 3 meters are found in the extreme northeast portion of the track. No part of the track is affected by significant swell.


½-3
calm
calm
calm
calm
calm
Mostly Cloudy
½-3
calm
1-5
calm
2-8
calm
Mostly Cloudy
½-3
calm
1-5
calm
1-5
calm
Mostly Cloudy
1-5
calm
30°N.
60°W.
25°N.
90°W.









GROUND TRUTH DATA SET 6
(Track 203)

Track 203 except for the extreme northern part passes over light winds and seas. Except for areas of isolated showers, about half of the surface should be visible through the clouds.

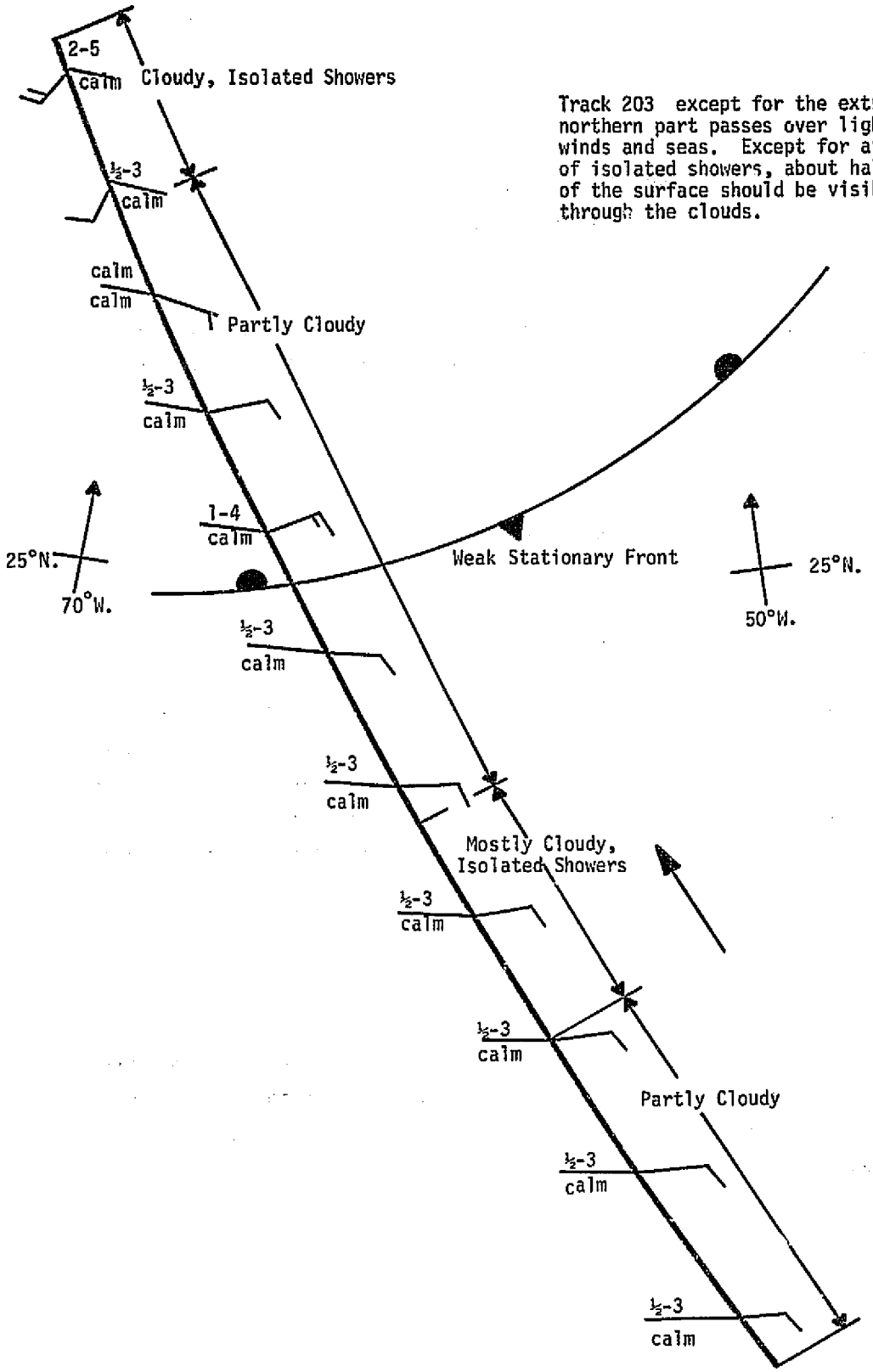
OVERLAY SYMBOLISM

Wind Conditions

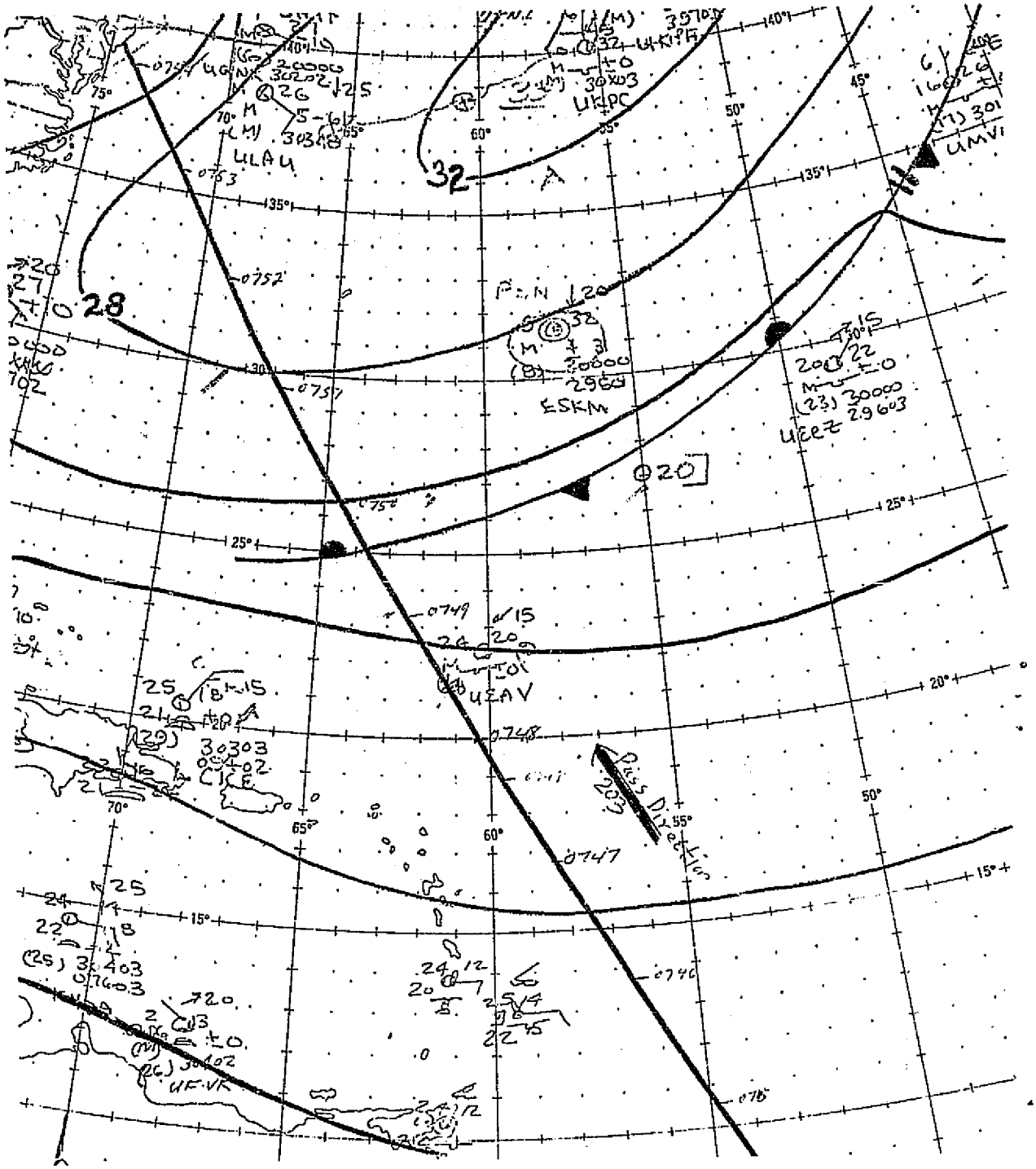
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

Sea Conditions

At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.



Track 203 except for the extreme northern part passes over light winds and seas. Except for areas of isolated showers, about half of the surface should be visible through the clouds.



REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

GROUND TRUTH DATA SET 7

(Track 212)

Track 212 leaves the coast of Norway, passes over Iceland and Greenland, and enters Labrador. A low pressure center is located approximately 150 miles north of the track on the east coast of Greenland. An occluded front extends from the low south-eastward across Iceland.

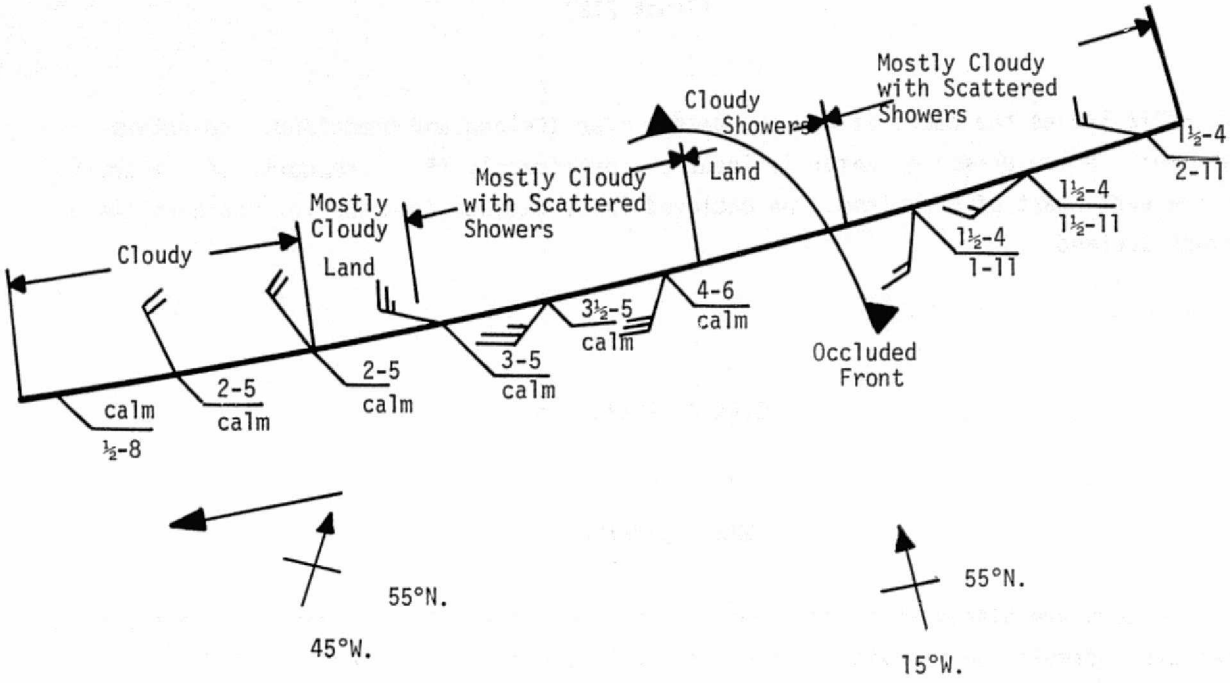
OVERLAY SYMBOLISM

Wind Conditions

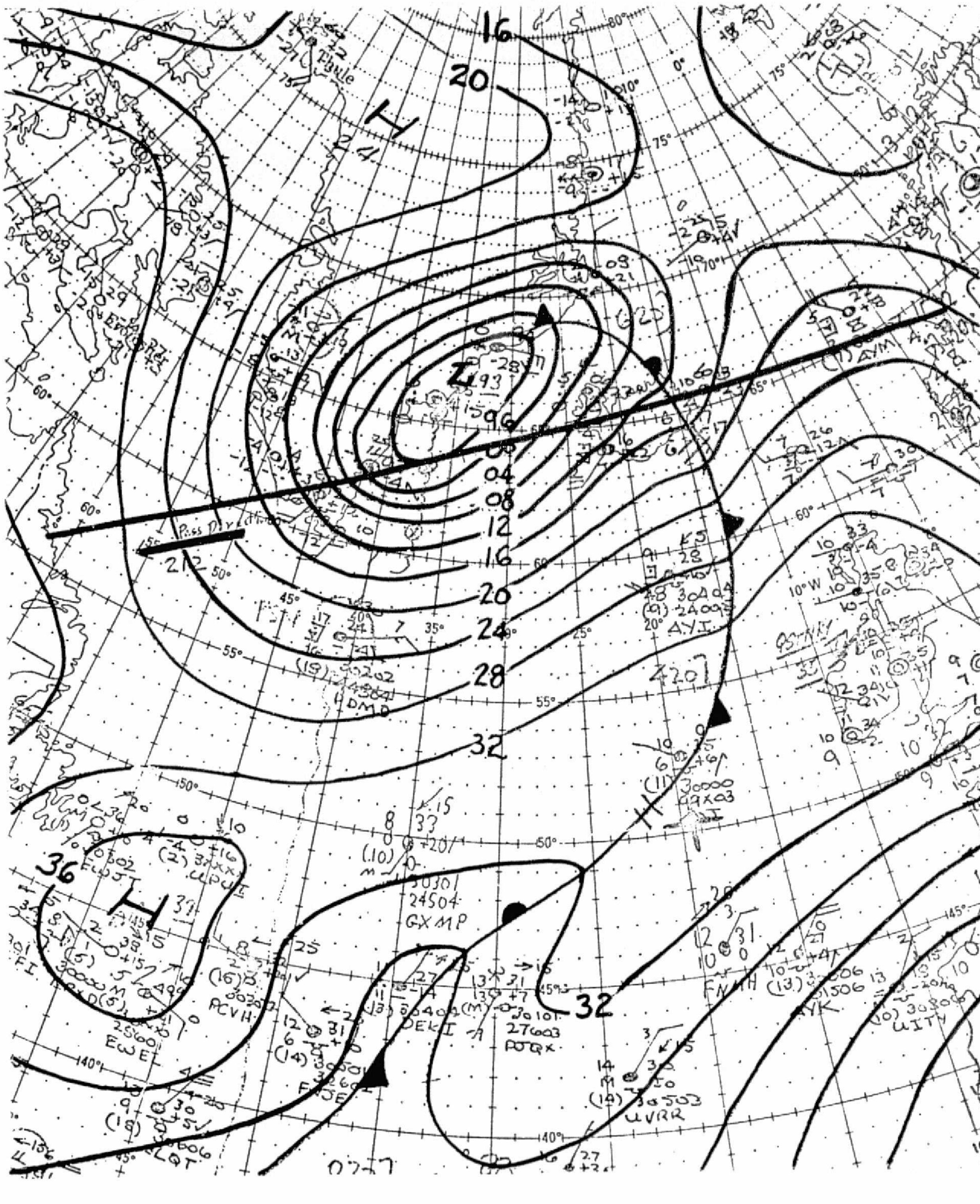
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

Sea Conditions

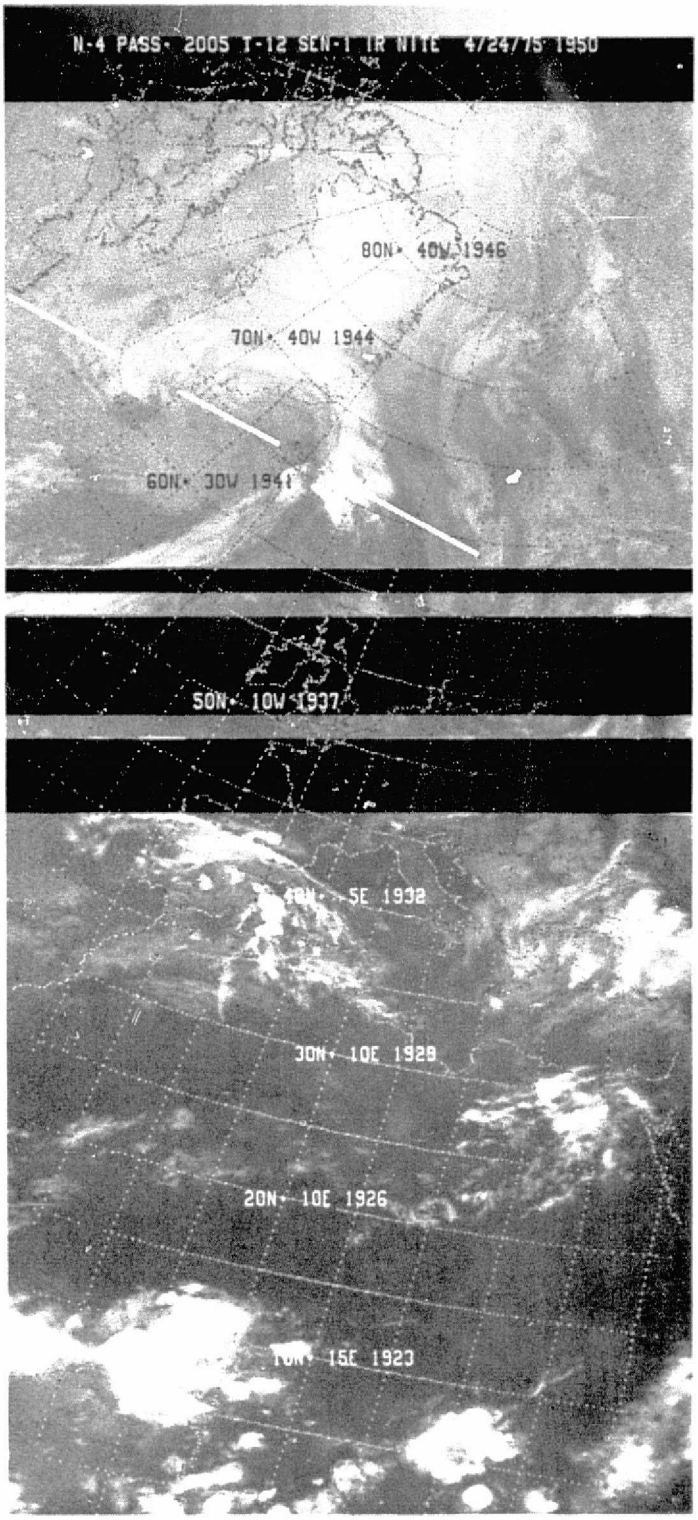
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.



Track 212 leaves the coast of Norway, passes over Iceland and southern Greenland and enters Labrador. A low pressure center is located approximately 150 miles north of the track on the east coast of Greenland. An occluded front extends from the low southeastward across Iceland.



Thule
16
20
24
28
32
36
96
04
08
12


N-4 PASS- 2005 I-12 SEN-1 IR NITE 4/24/75 1950
80N- 40W 1946
70N- 40W 1944
60N- 30W 1941
50N- 10W 1937
40N- 5E 1932
30N- 10E 1928
20N- 10E 1926
10N- 15E 1923

GROUND TRUTH DATA SET 8

(Track 217)

Track 217 passes from the central Atlantic Ocean towards the New England coastline in a northwesterly fashion. Winds are light in the first three-quarters of the track with seas estimated to be one meter or less. Near land, winds increase to 25 knots and shift from the northeast to the southwest as the groundtrack passes from one side of a high pressure system in the North Atlantic to the other. Seas build up to 3 meters near the coast but are fetch and duration limited. No swell is present. Showers are found only near the New England coast.

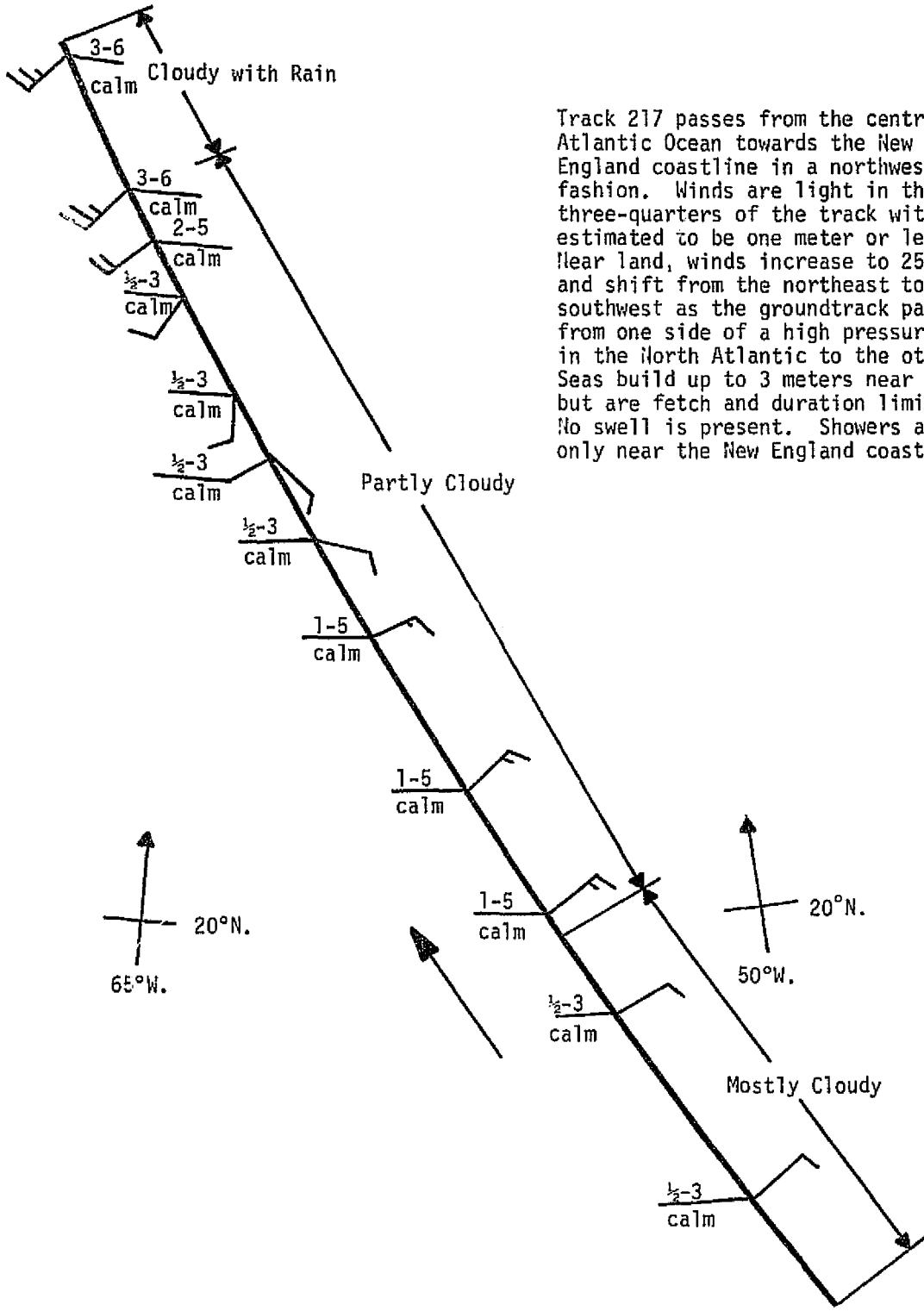
OVERLAY SYMBOLISM

Wind Conditions

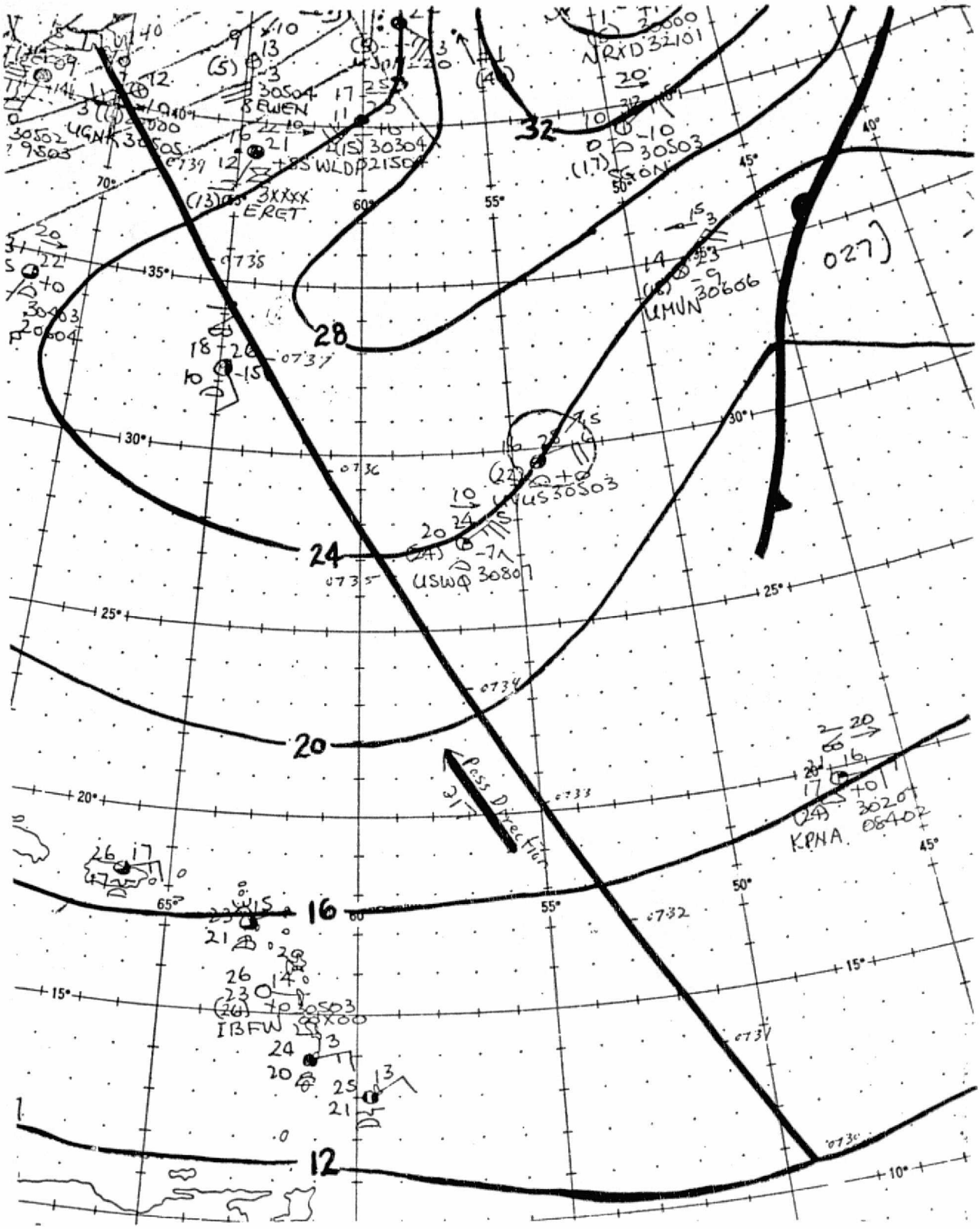
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

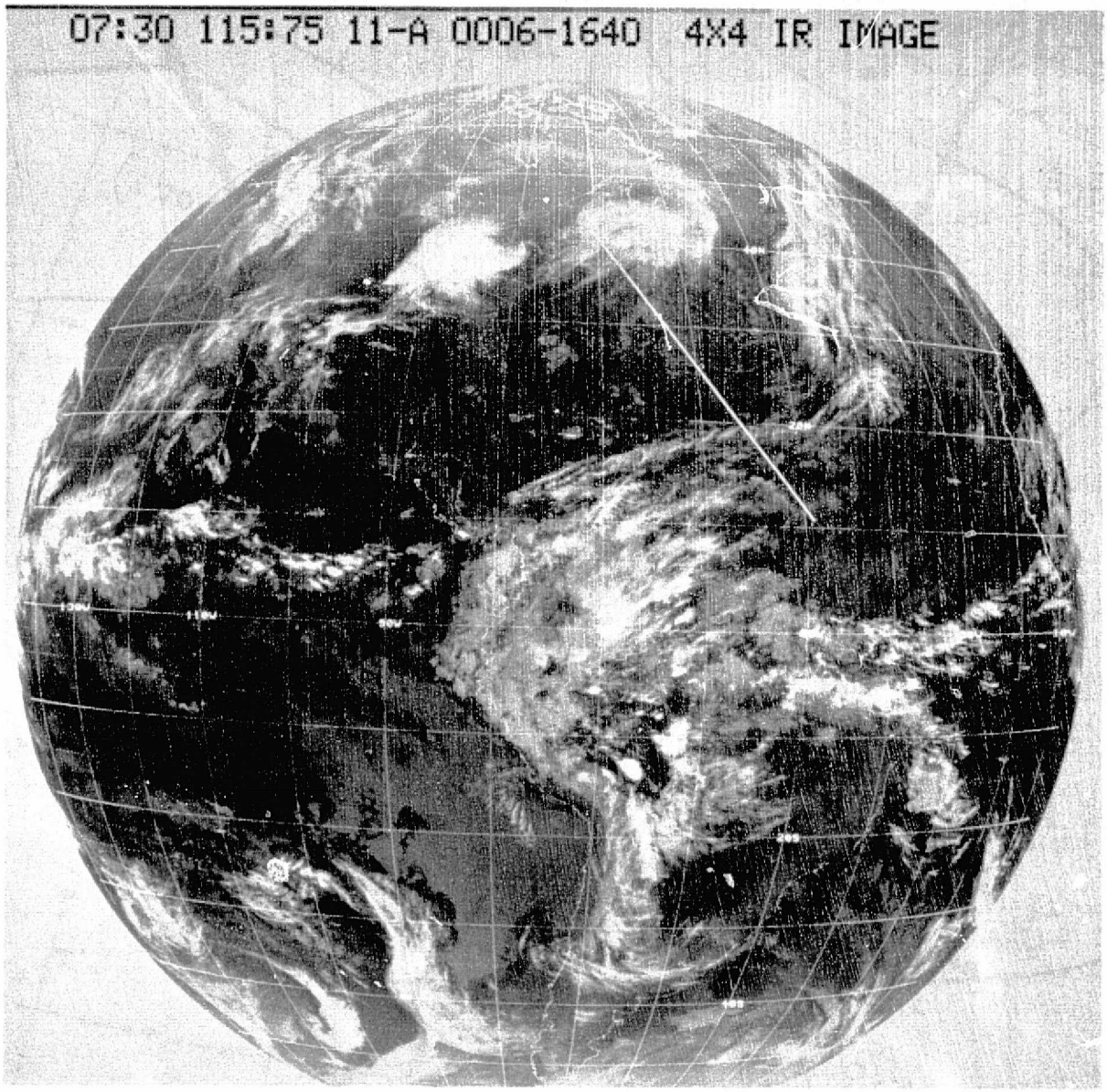
Sea Conditions

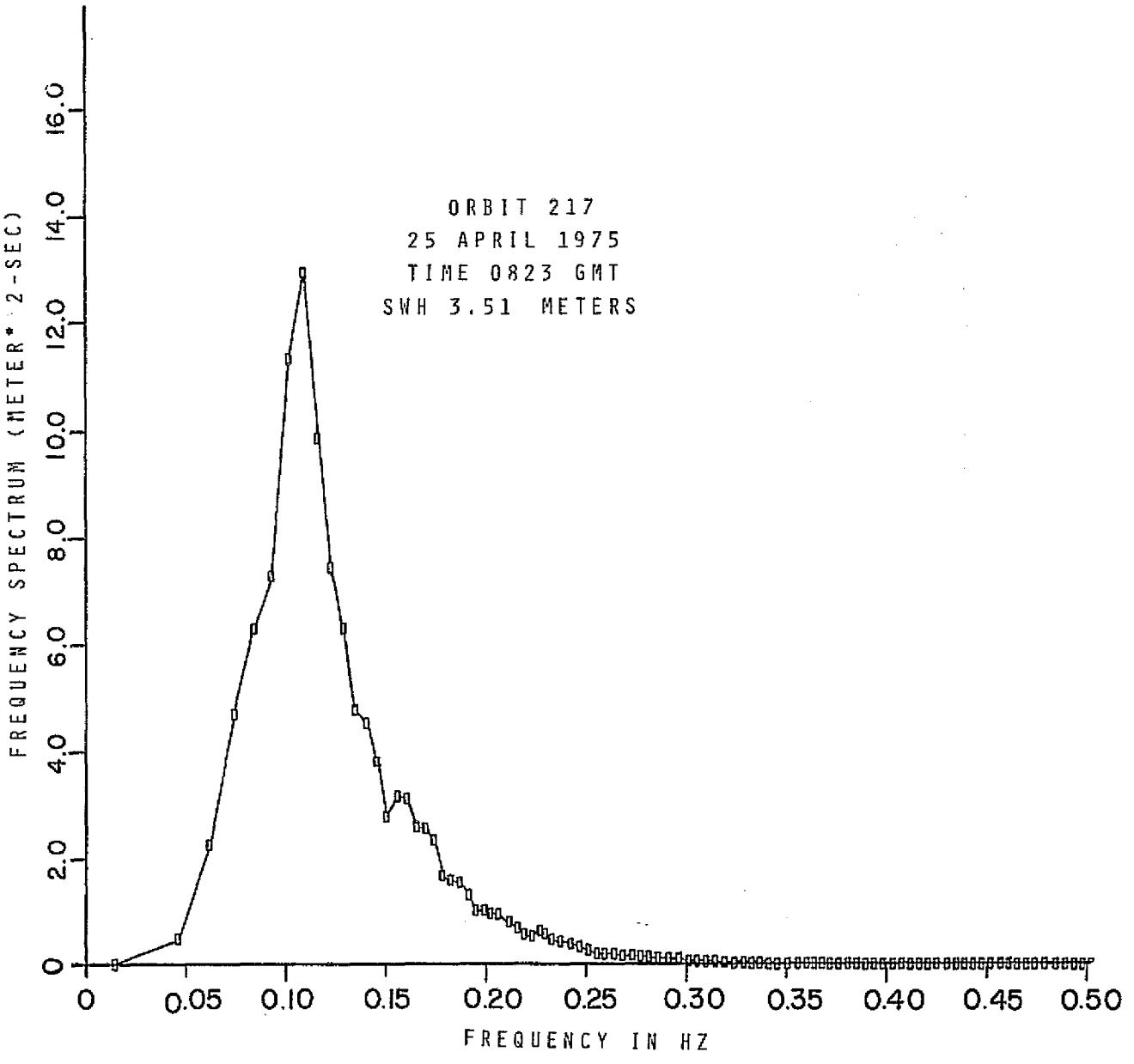
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

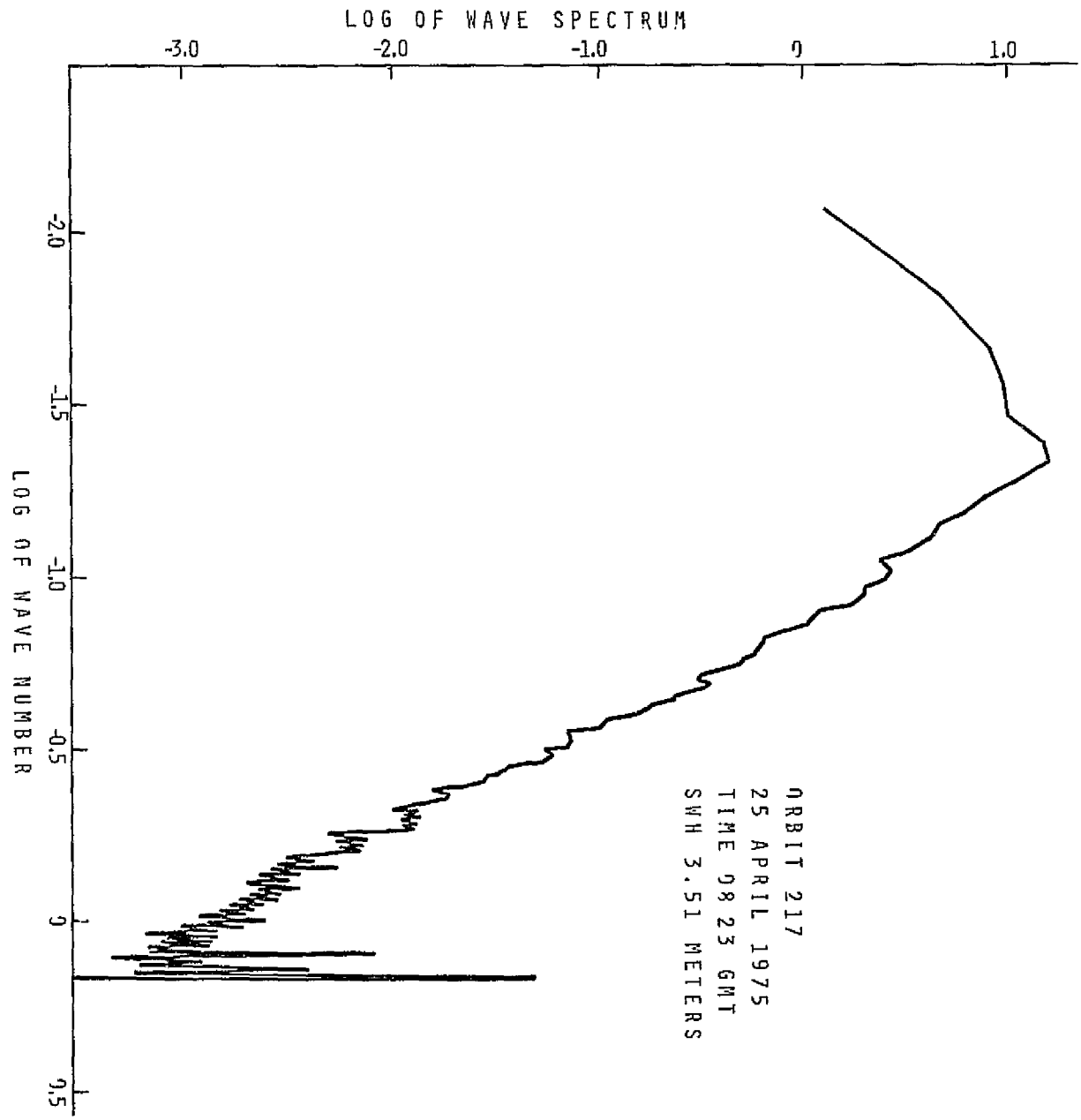


Track 217 passes from the central Atlantic Ocean towards the New England coastline in a northwesterly fashion. Winds are light in the first three-quarters of the track with seas estimated to be one meter or less. Near land, winds increase to 25 knots and shift from the northeast to the southwest as the groundtrack passes from one side of a high pressure system in the North Atlantic to the other. Seas build up to 3 meters near the coast but are fetch and duration limited. No swell is present. Showers are found only near the New England coast.






ORBIT 217
25 APRIL 1975
TIME 0823 GMT
SWH 3.51 METERS
FREQUENCY SPECTRUM (METER* 2-SEC)
0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
FREQUENCY IN HZ


LOG OF WAVE SPECTRUM
-3.0
-2.0
-1.0
0
1.0
LOG OF WAVE NUMBER
-2.0
-1.5
-1.0
-0.5
0
0.5
ORBIT 217
25 APRIL 1975
TIME 08 23 GMT
SWH 3.51 METERS

GROUND TRUTH DATA SET 9

(Track 240)

Track 240 has two areas of overcast skies with precipitation. The area near Europe has rain whereas the one in eastern Canada has both rain and snow. The mostly clear areas should have 10 to 20% of the area covered with clouds. The mostly cloudy areas would have 70 to 80% cloud cover and the partly cloudy areas 30 to 50%.

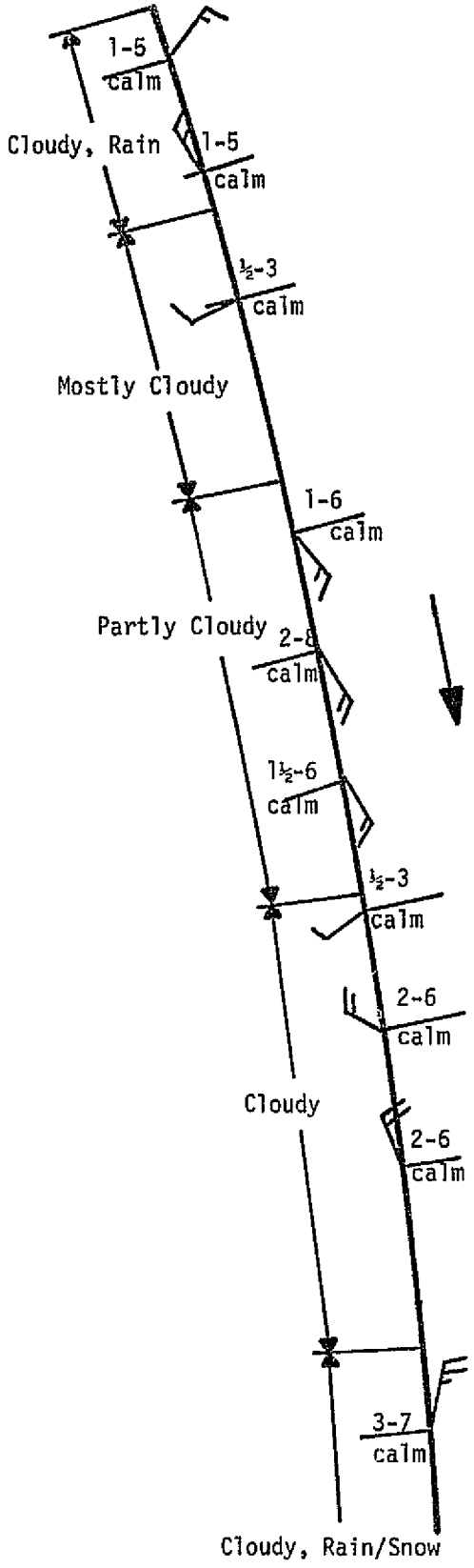
OVERLAY SYMBOLISM

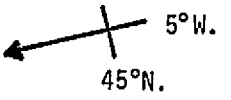
Wind Conditions

Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

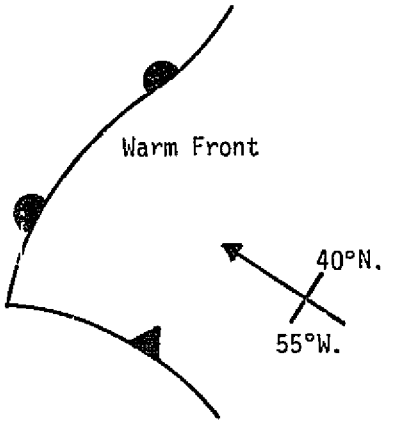
Sea Conditions

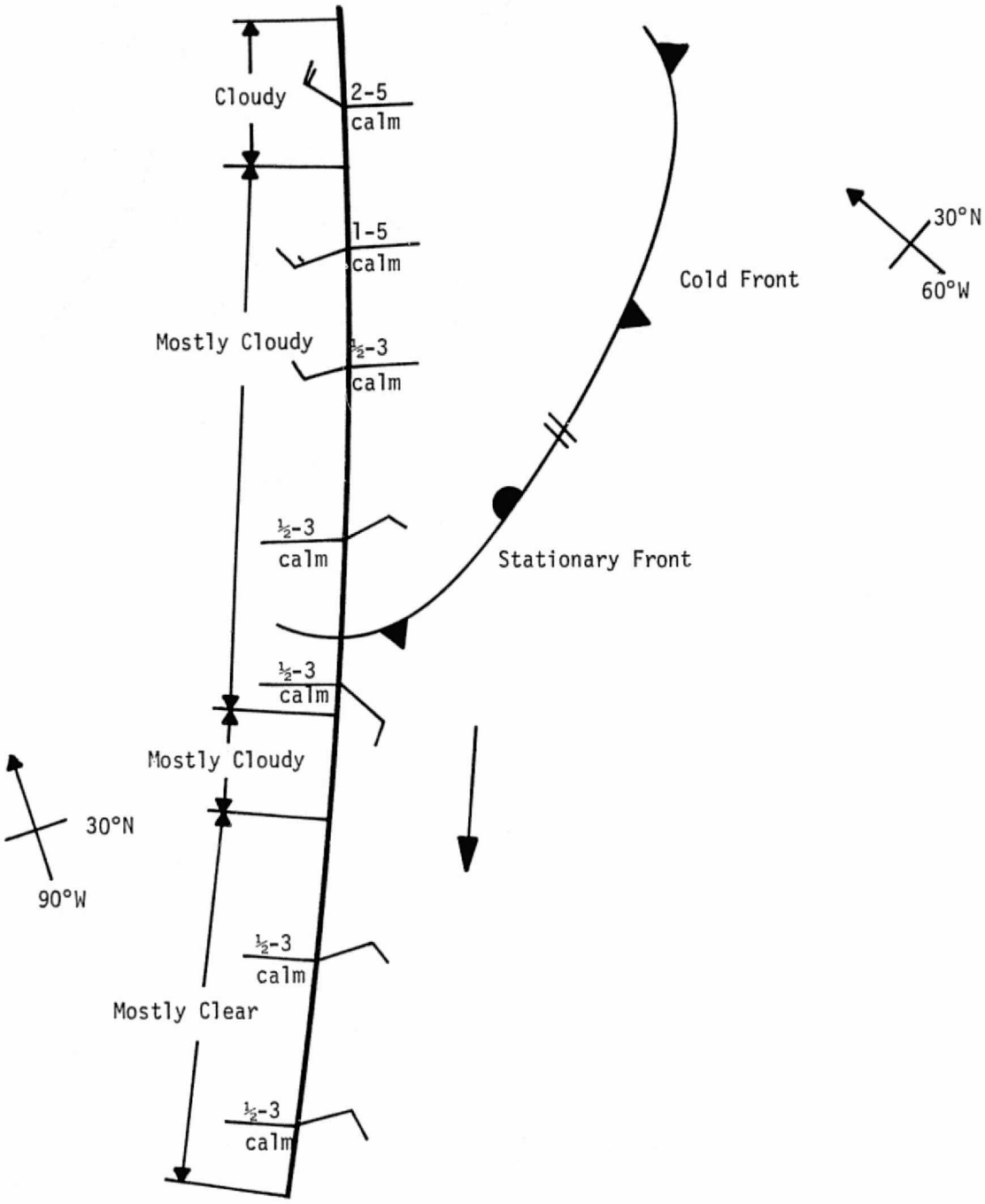
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

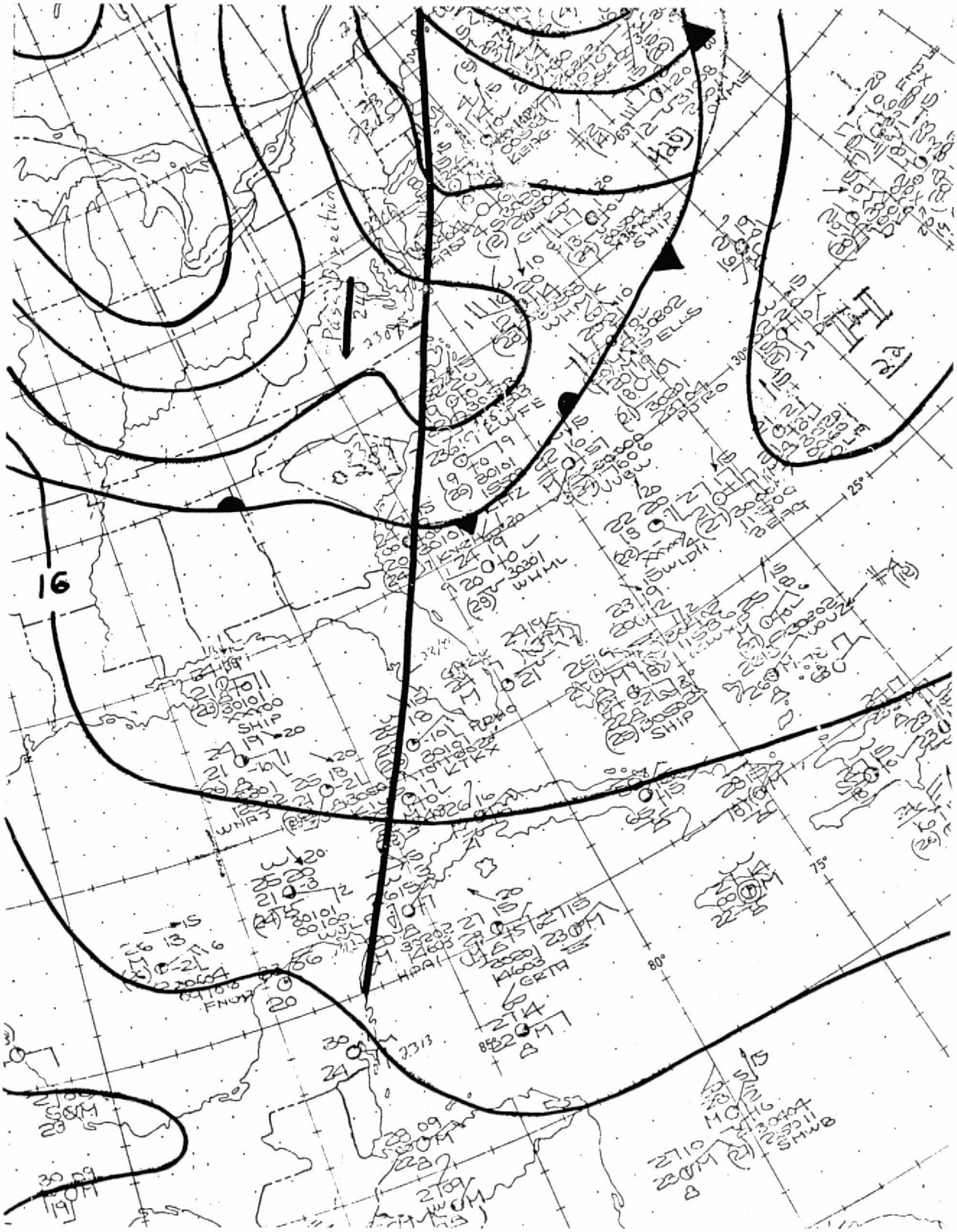


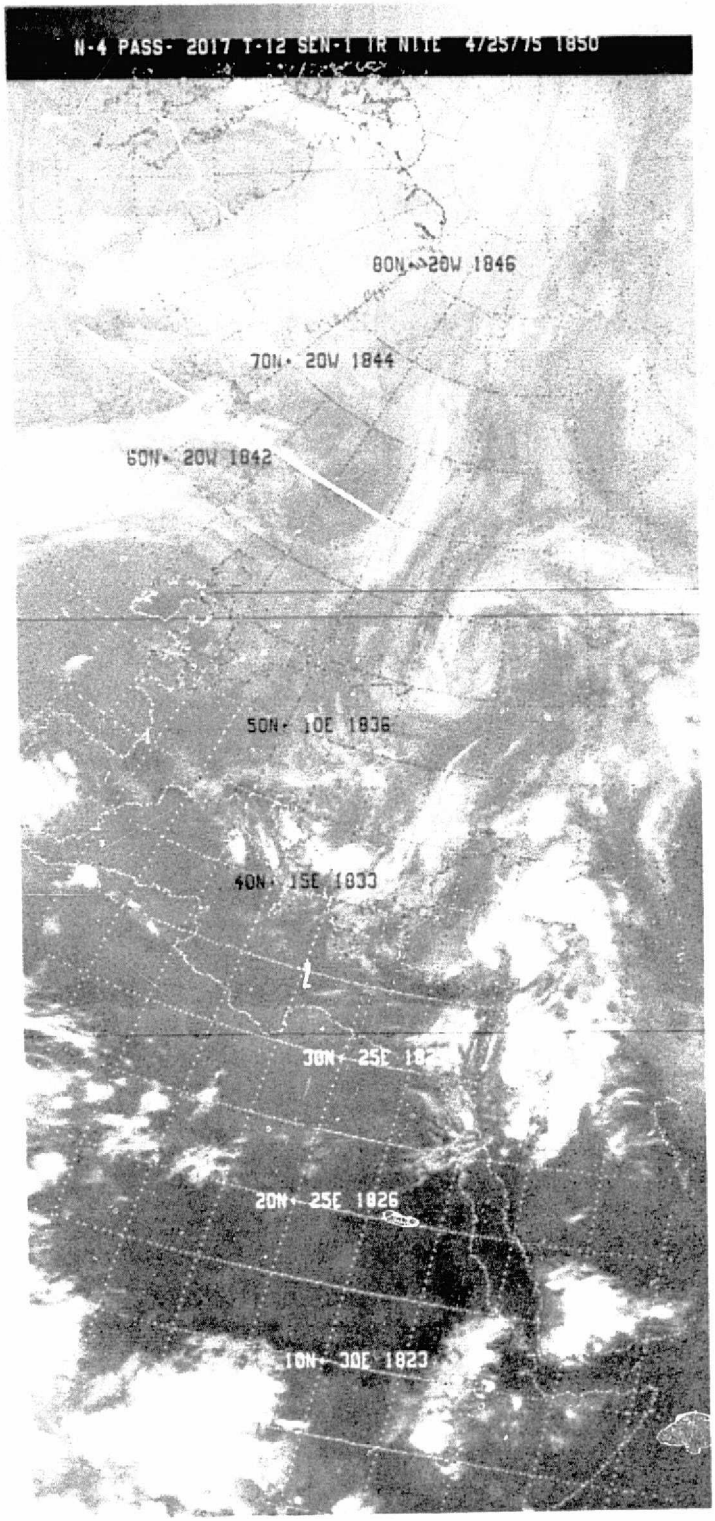


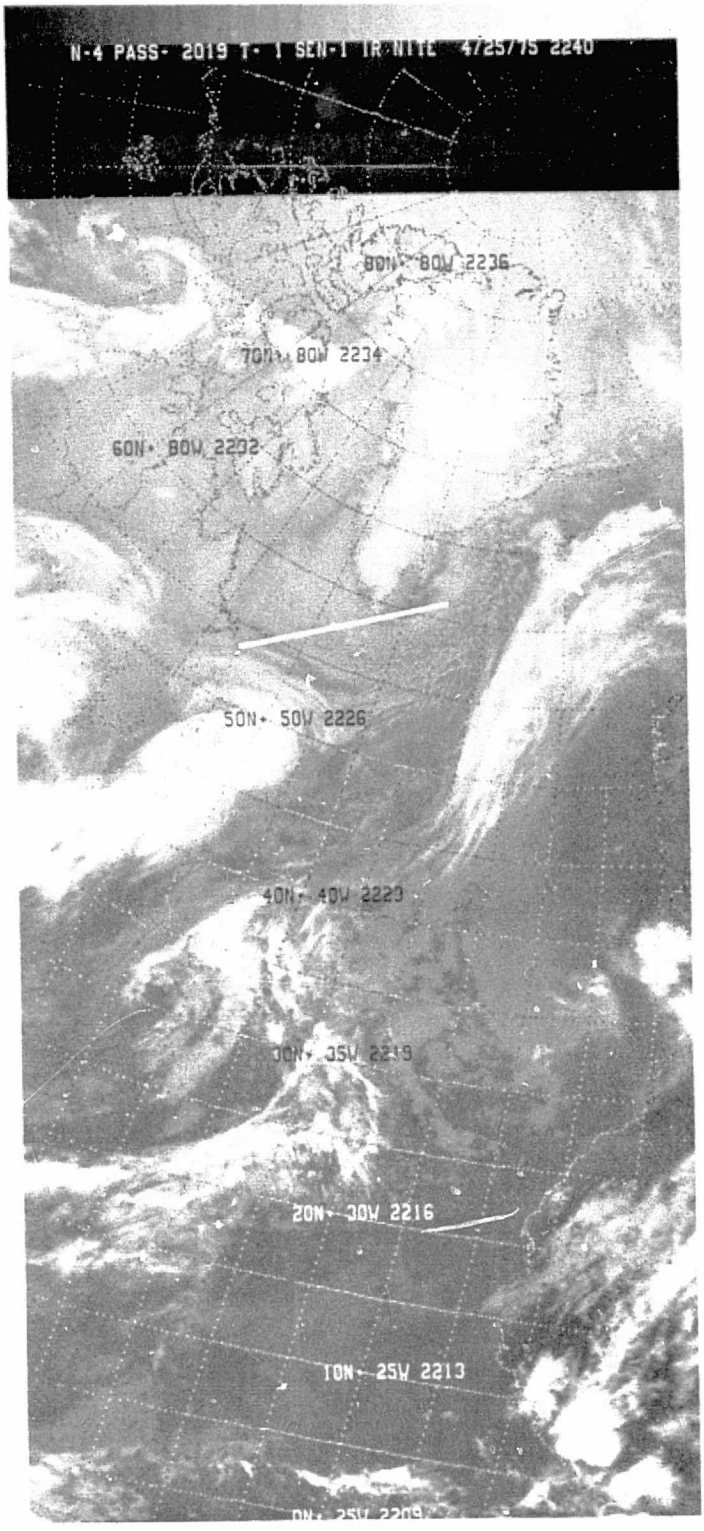
Track 240 has two areas of overcast skies with precipitation. The area near Europe has rain whereas the one in Eastern Canada has both rain and snow. The mostly clear areas should have 10 to 20% of the area covered with clouds. The mostly cloudy areas would have 70 to 80% cloud cover and the partly cloudy areas 30 to 50%.




Cloudy
2-5
calm
1-5
calm
Mostly Cloudy
½-3
calm
½-3
calm
Stationary Front
Cold Front
30°N
60°W
½-3
calm
Mostly Cloudy
30°N
90°W
½-3
calm
Mostly Clear
½-3
calm


16
30°
25°
75°
80°





ORBIT 240
26 APRIL 1975
TIME 0001 GMT
SWH 0.70 METERS
FREQUENCY SPECTRUM (METER**2-SEC)
0
.1
.2
.3
.4
.5
.6
.7
.8
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
FREQUENCY IN HZ

ORBIT 240
26 APRIL 1975
TIME 09 01 GMT
SWH 0.70 METERS
LOG OF WAVE NUMBER SPECTRUM
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-1.5
-1.0
-0.5
0
0.5
LOG OF WAVE NUMBER

GROUND TRUTH DATA SET 10

(Track 246)

Track 246 passes over an area of light winds, the strongest of which is about 15 knots just south of Puerto Rico. There are two shower areas. One is associated with the cold front near 31°N. The other is 250 to 300 miles south of Puerto Rico. Except for an area south of the cold front, there should be no swell encountered.

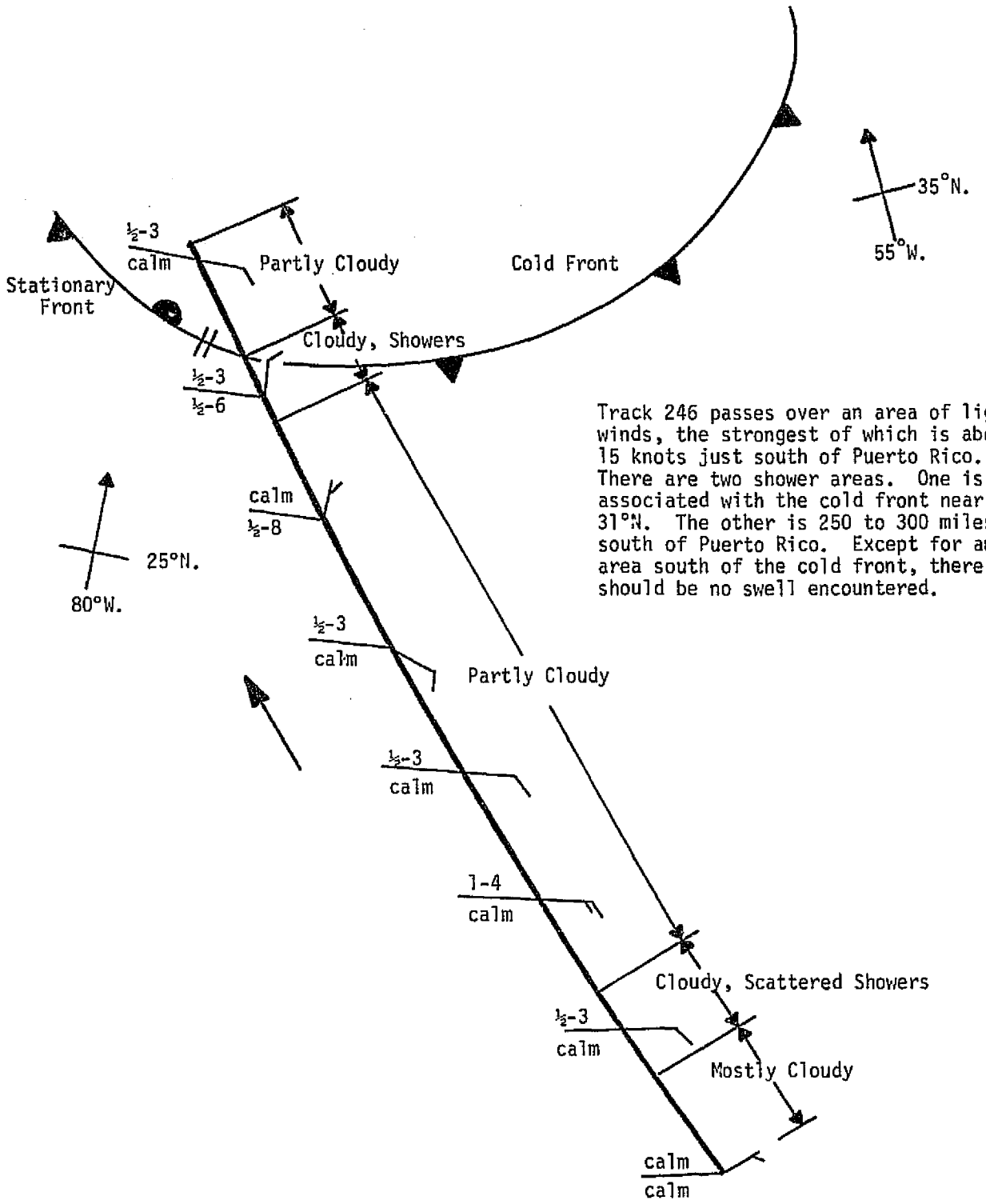
OVERLAY SYMBOLISM

Wind Conditions

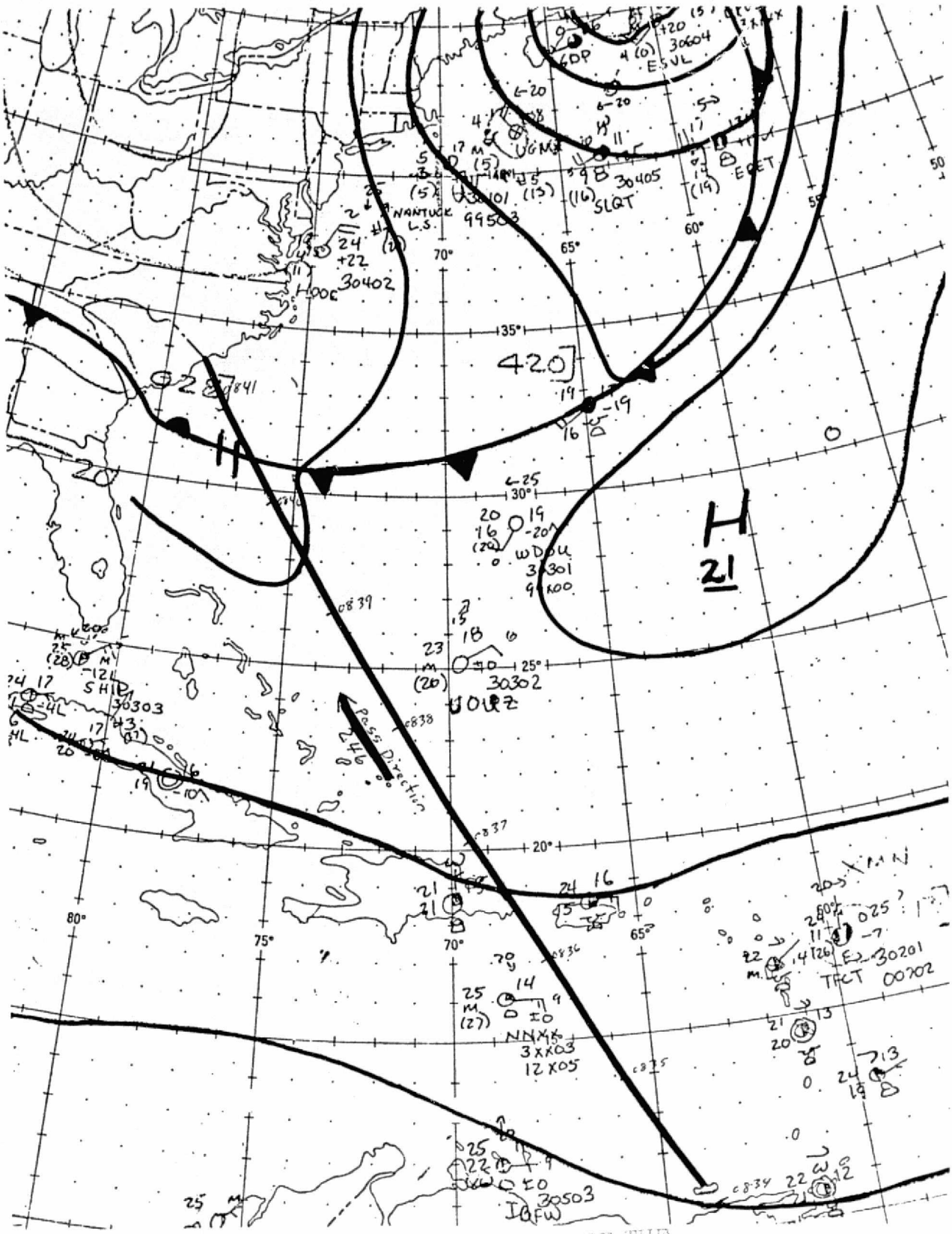
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

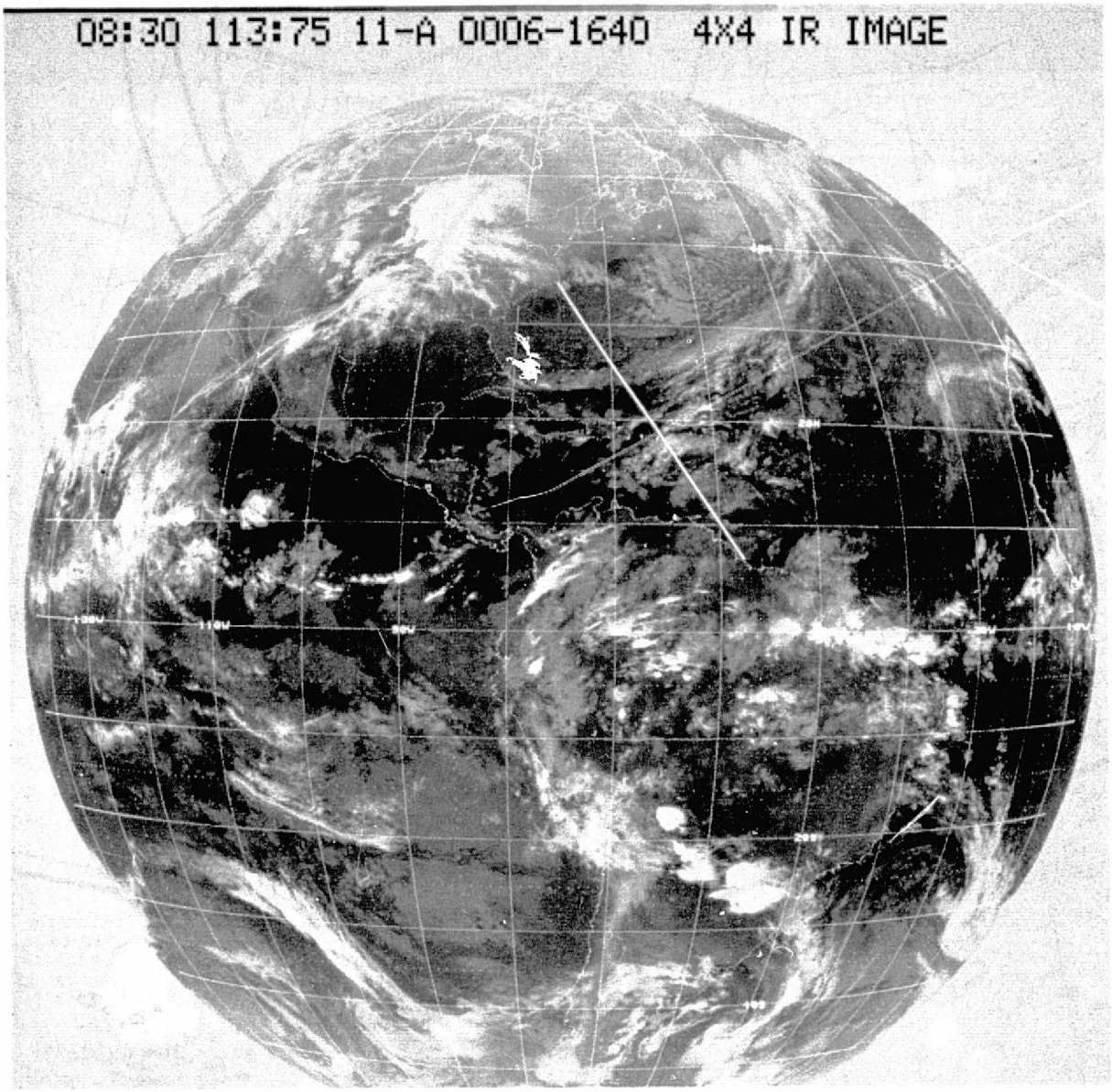
Sea Conditions

At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.



Track 246 passes over an area of light winds, the strongest of which is about 15 knots just south of Puerto Rico. There are two shower areas. One is associated with the cold front near 31°N. The other is 250 to 300 miles south of Puerto Rico. Except for an area south of the cold front, there should be no swell encountered.





GROUND TRUTH DATA SET 11
(Track 248)

Track 248 extends from a point about 600 miles west of Portland, Oregon northwest across the Alaskan Peninsula to Point Navairn in Russia. The ground track is overcast with the exception of the area about 200 miles southeast from the Alaskan Peninsula. The high swells along the ground track have been generated by a series of storms which moved through the north Pacific during the past few days.

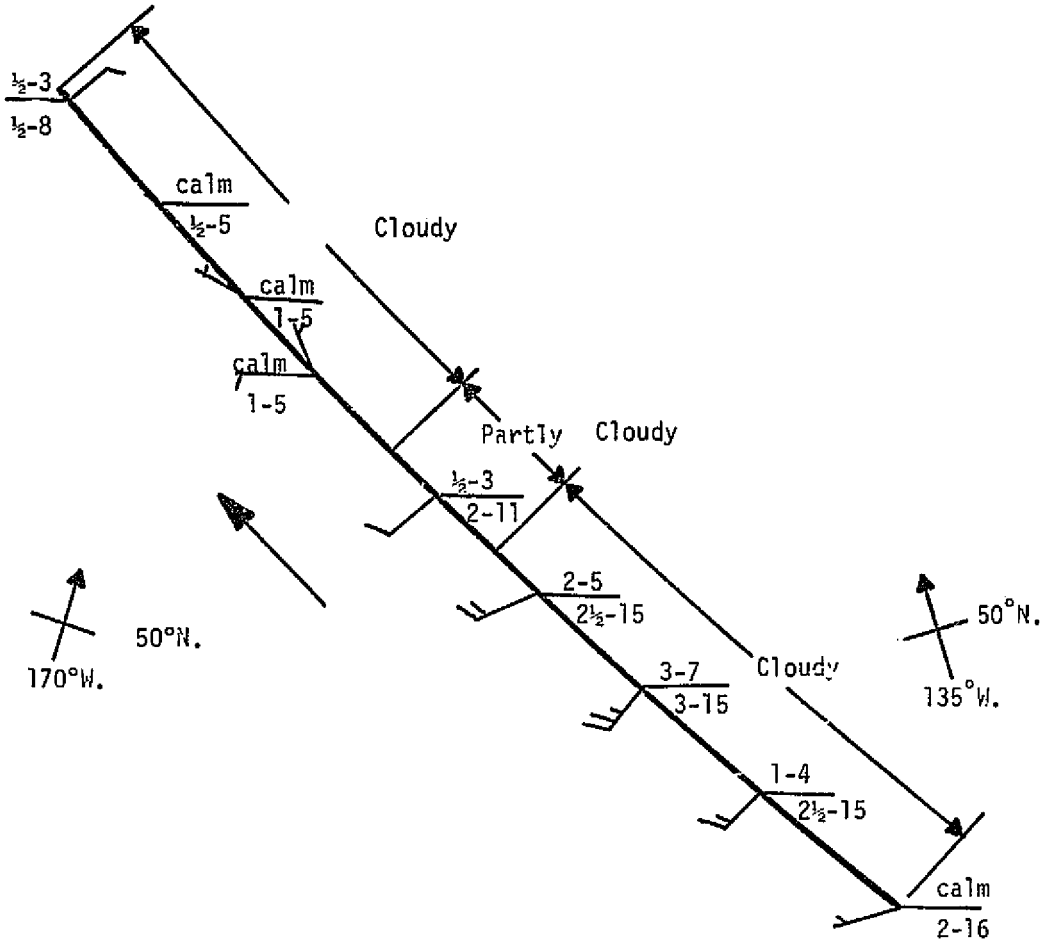
OVERLAY SYMBOLISM

Wind Conditions

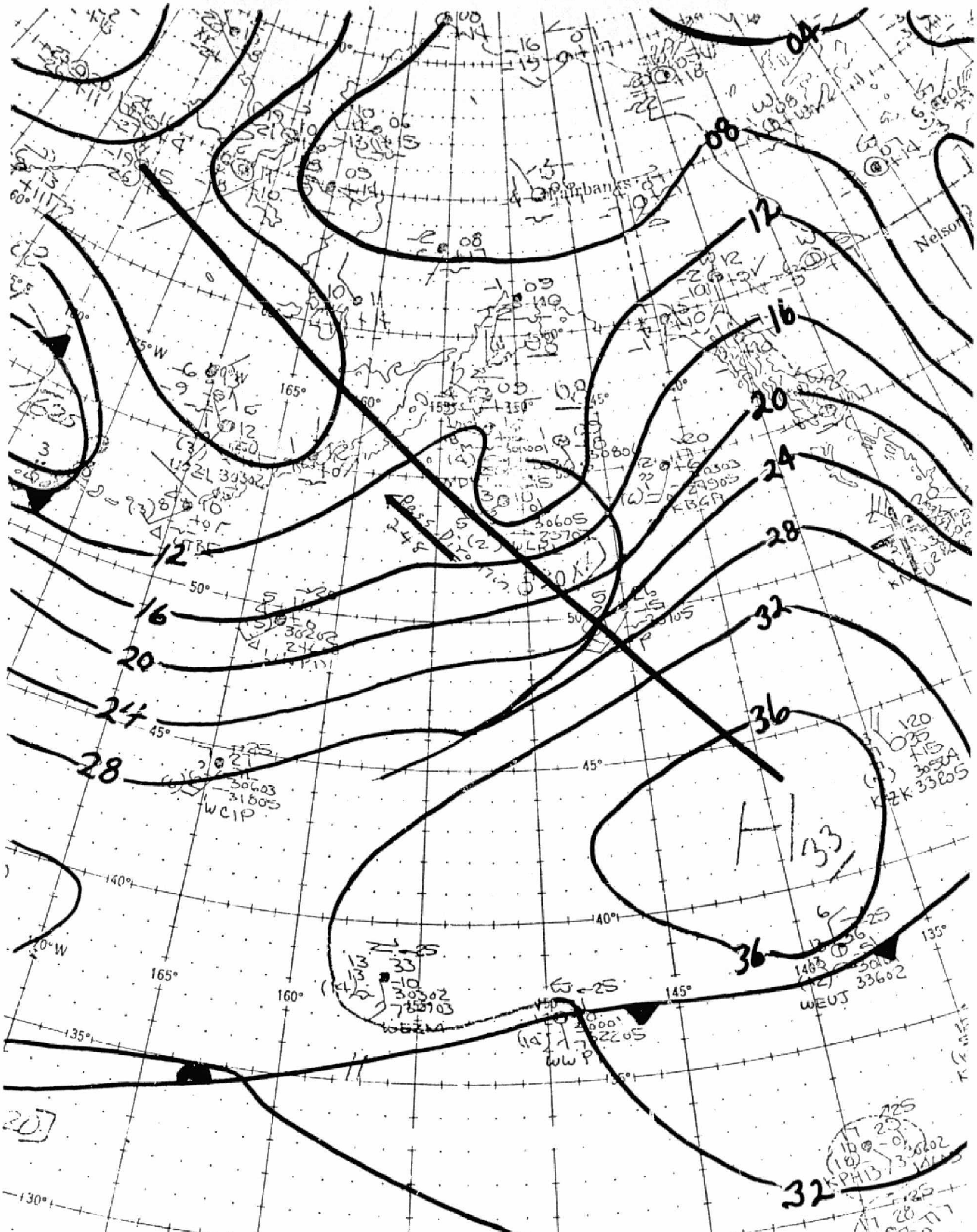
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

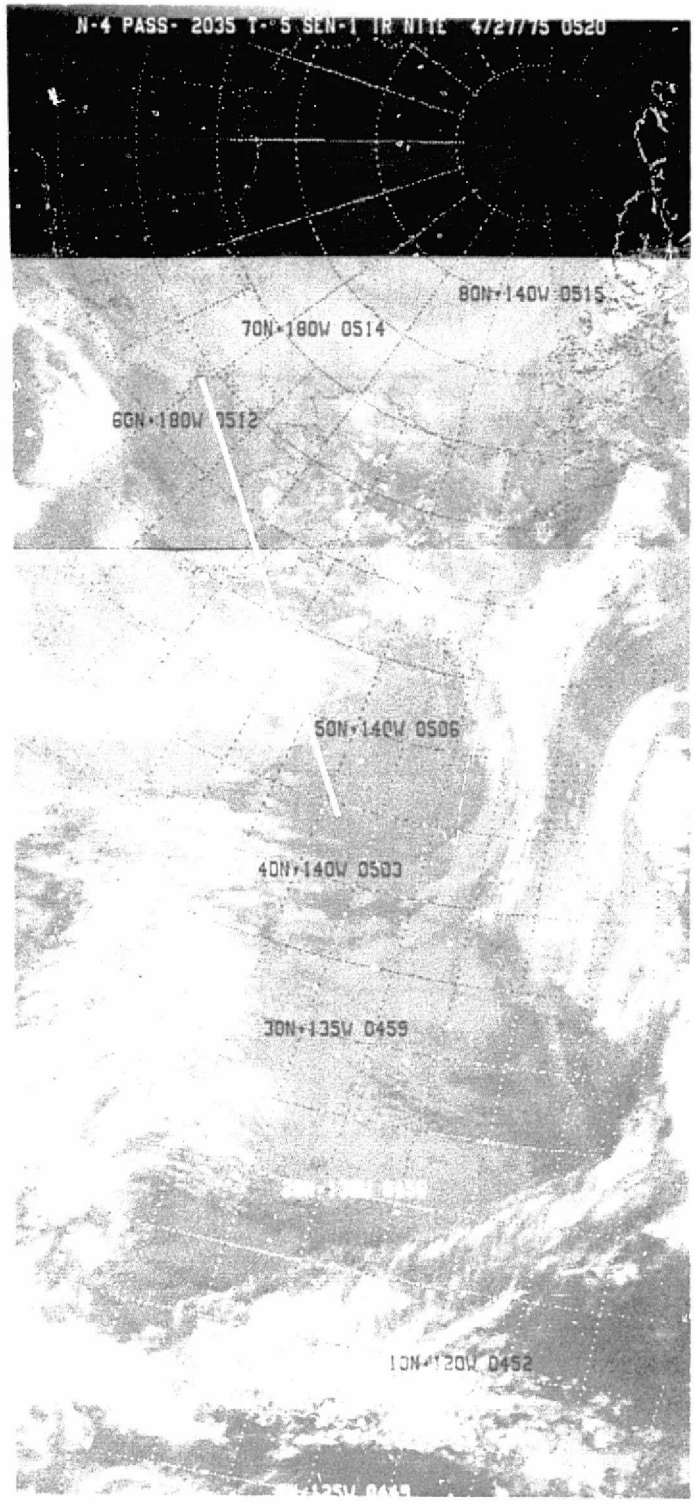
Sea Conditions

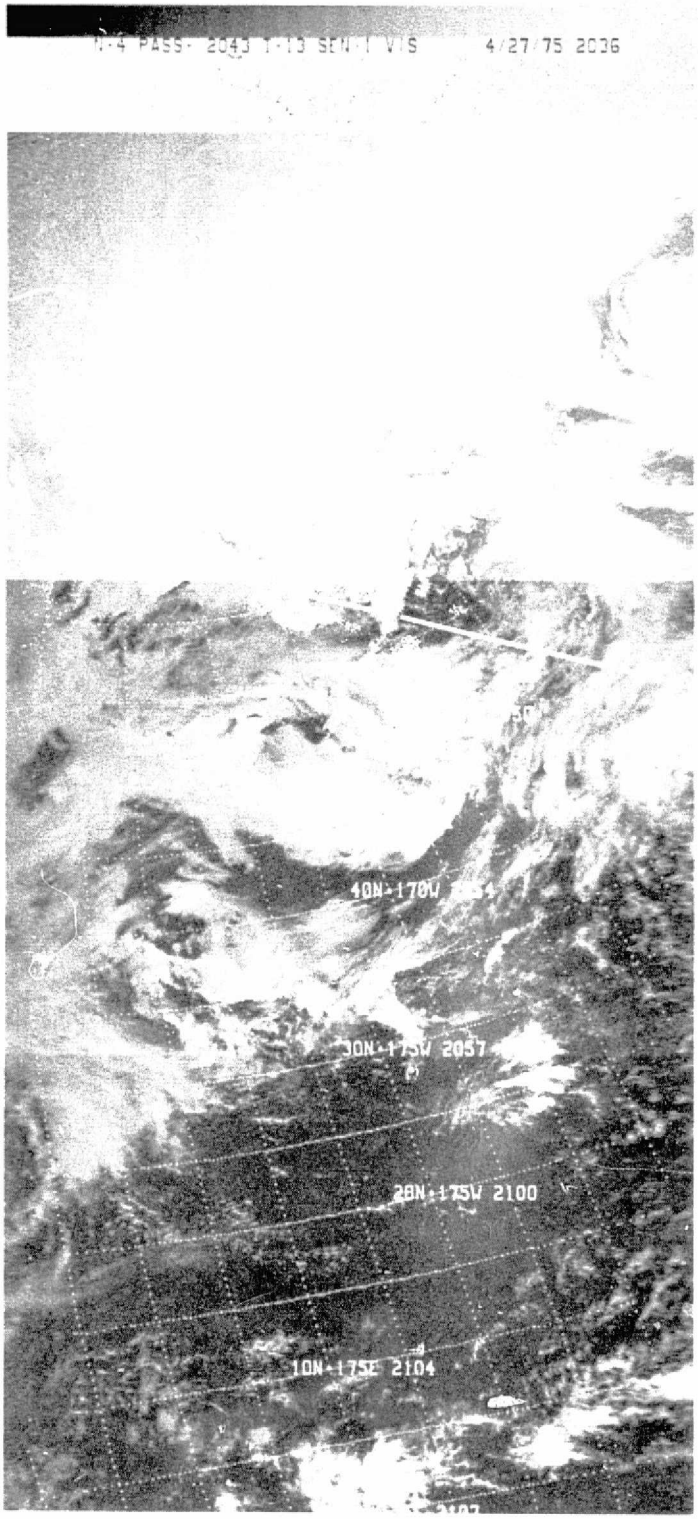
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

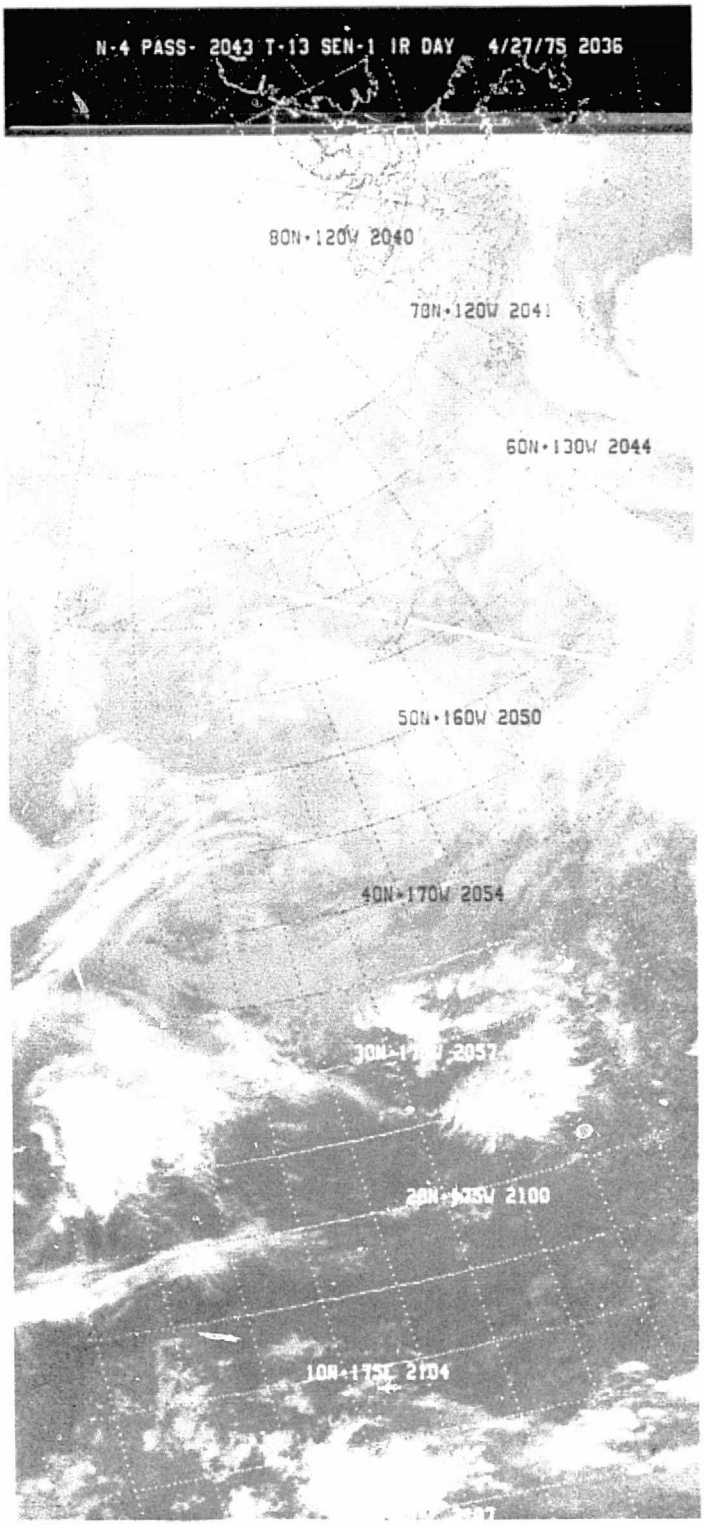


Track 248 extends from a point about 600 miles west of Portland, Oregon northwest across the Alaskan Peninsula to Point Navairn in Russia. The ground track is overcast with the exception of the area about 200 miles southeast from the Alaskan Peninsula. The high swells along the ground track have been generated by a series of storms which moved through the north Pacific during the past few days.


04
08
12
16
20
24
28
32
36
Fairbanks
Nelson
H
33







GROUND TRUTH DATA SET 12

(Track 253)

Track 253 leaves the central Norwegian coast,passes approximately 150 miles northwest of Scotland and on into the central north Atlantic. The track passes over portions of two storms with winds up to 40 knots and seas up to 8 meters.

OVERLAY SYMBOLISM

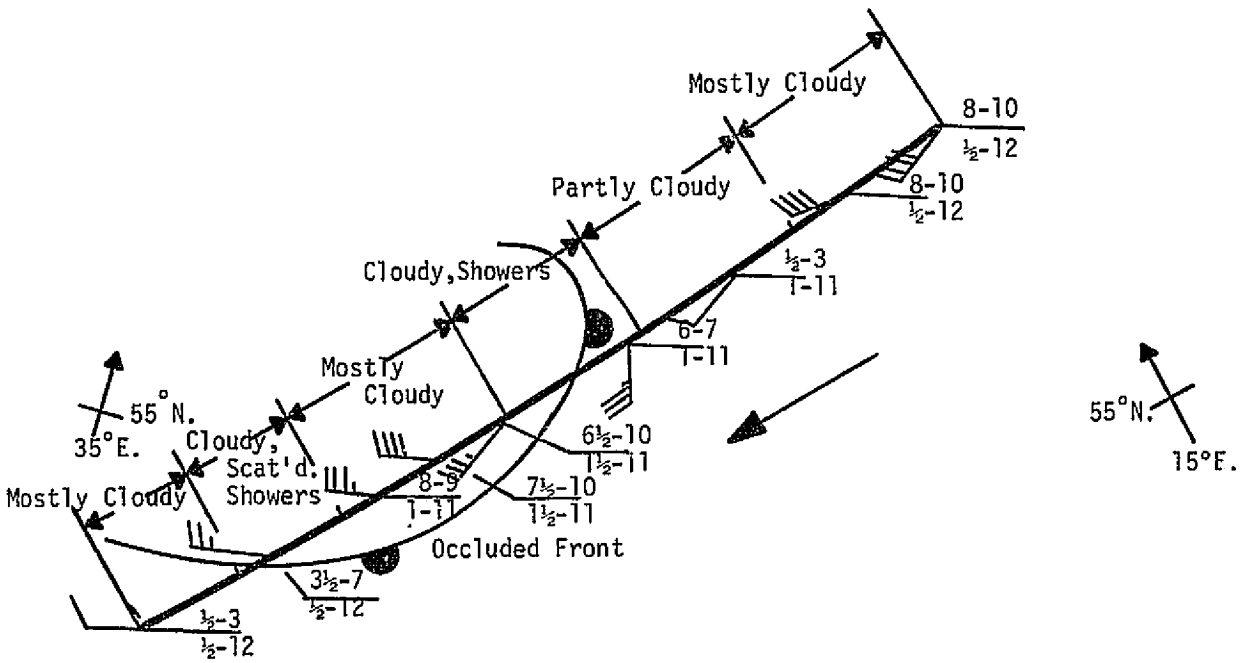
Wind Conditions

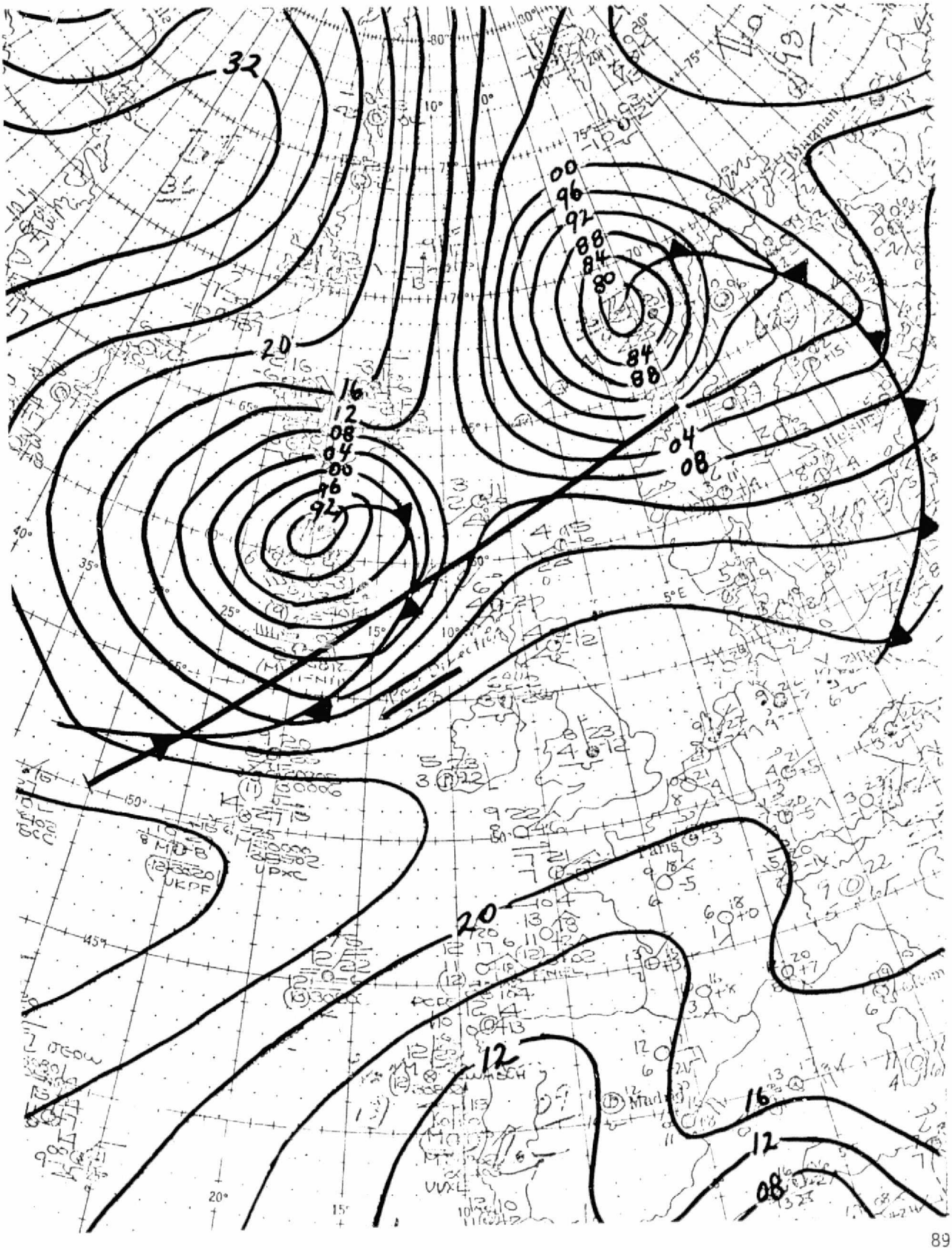
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

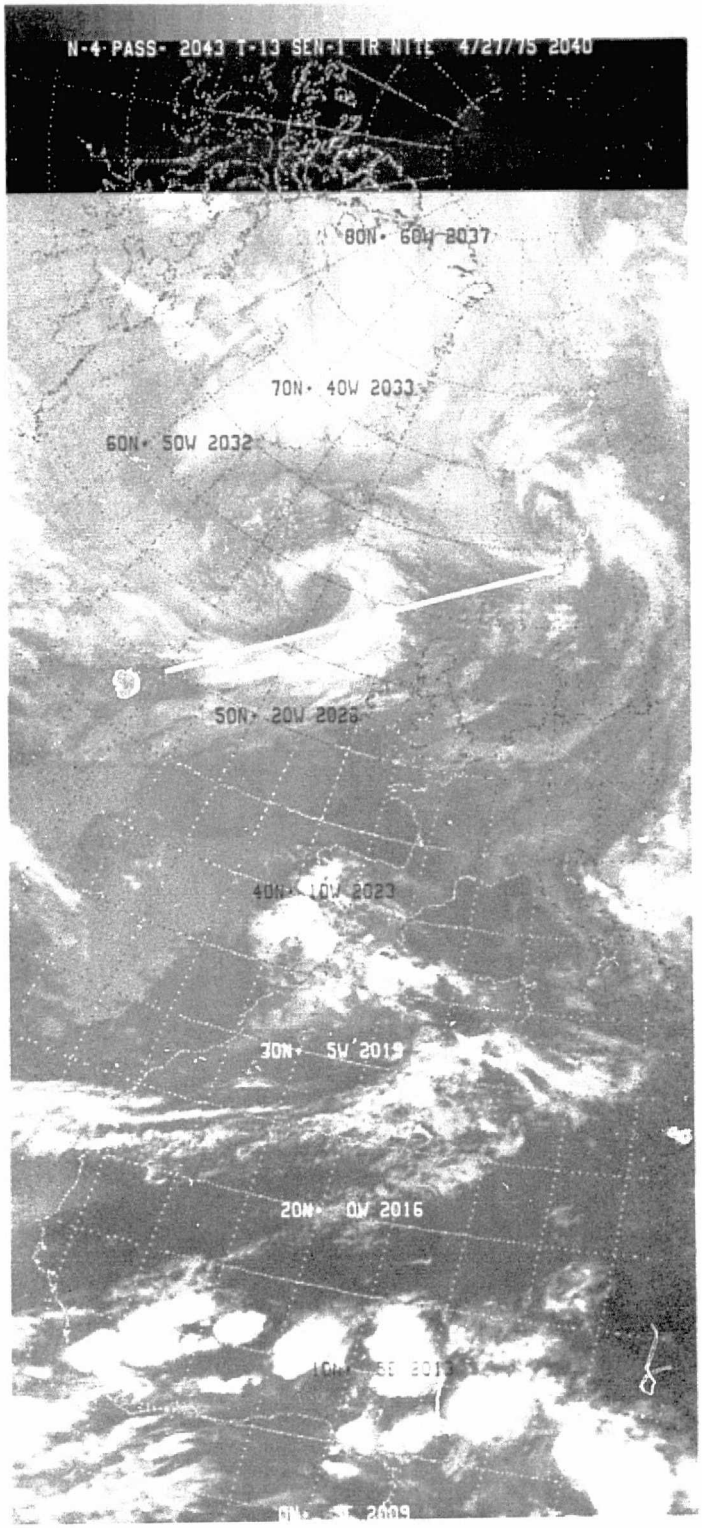
Sea Conditions

At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

Track 253 leaves the central Norwegian coast passes approximately 150 miles northwest of Scotland and on into the central North Atlantic. The track passes over portions of two storms with winds up to 40 knots and seas up to 8 meters.







GROUND TRUTH DATA SET 13
(Tracks 267, 270 and 271)

Tracks 267, 270 and 271 passed over the same North Atlantic low pressure system during April 29 and 30, 1975, within one 7 hour time period. The storm had a central core minimum pressure of 984 mb. on the 0000 GMT NMC surface analysis charts with maximum winds of 40 knots. The three passes provide a good study set because of the pair of intersection points within the storm itself. Tracks 267 and 270 crossed at approximately 60°N latitude at 2046 and 0142 GMT, respectively. Tracks 267 and 271 intersected near 55°N. latitude at 2048 and 0321 GMT, respectively. The NOAA-4 IR photograph enclosed illustrates the geometry of the storm's position at 2135 GMT. Some of the sea heights indicated are not the maximum values for the associated winds because of the mobile nature of this cyclonic system. The duration of the wind was not in general sufficient to develop a fully arisen sea.

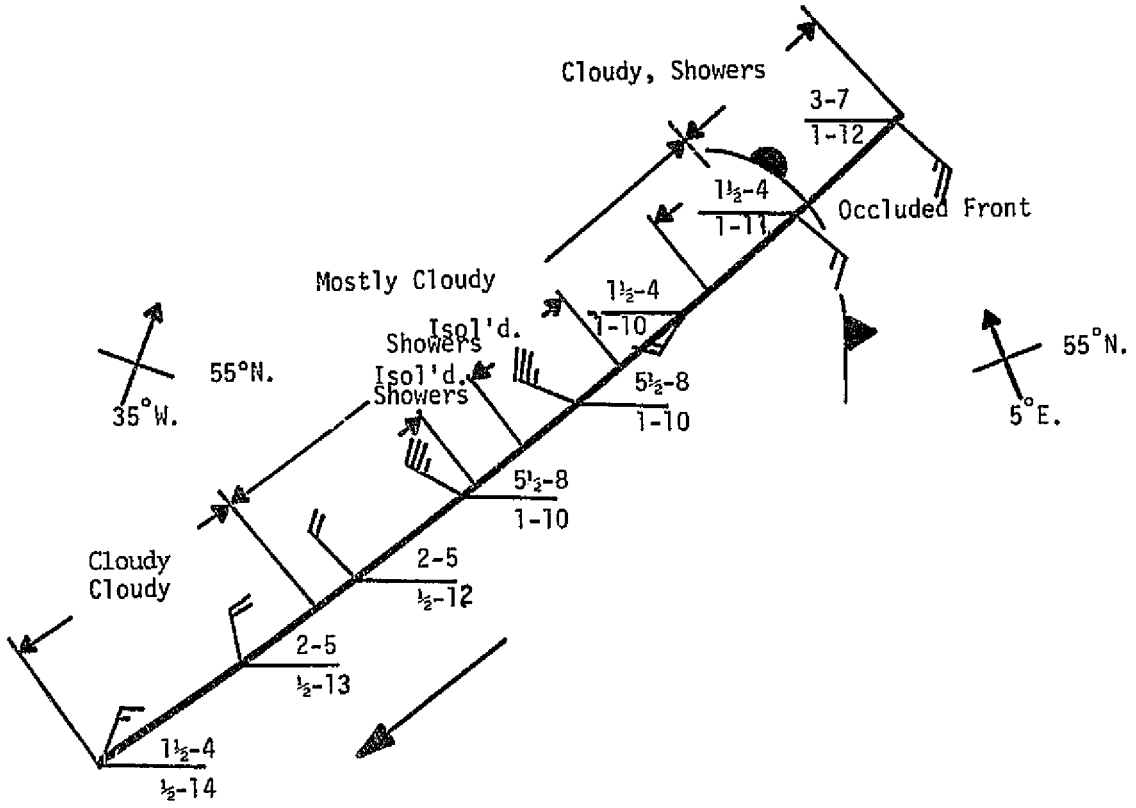
OVERLAY SYMBOLISM

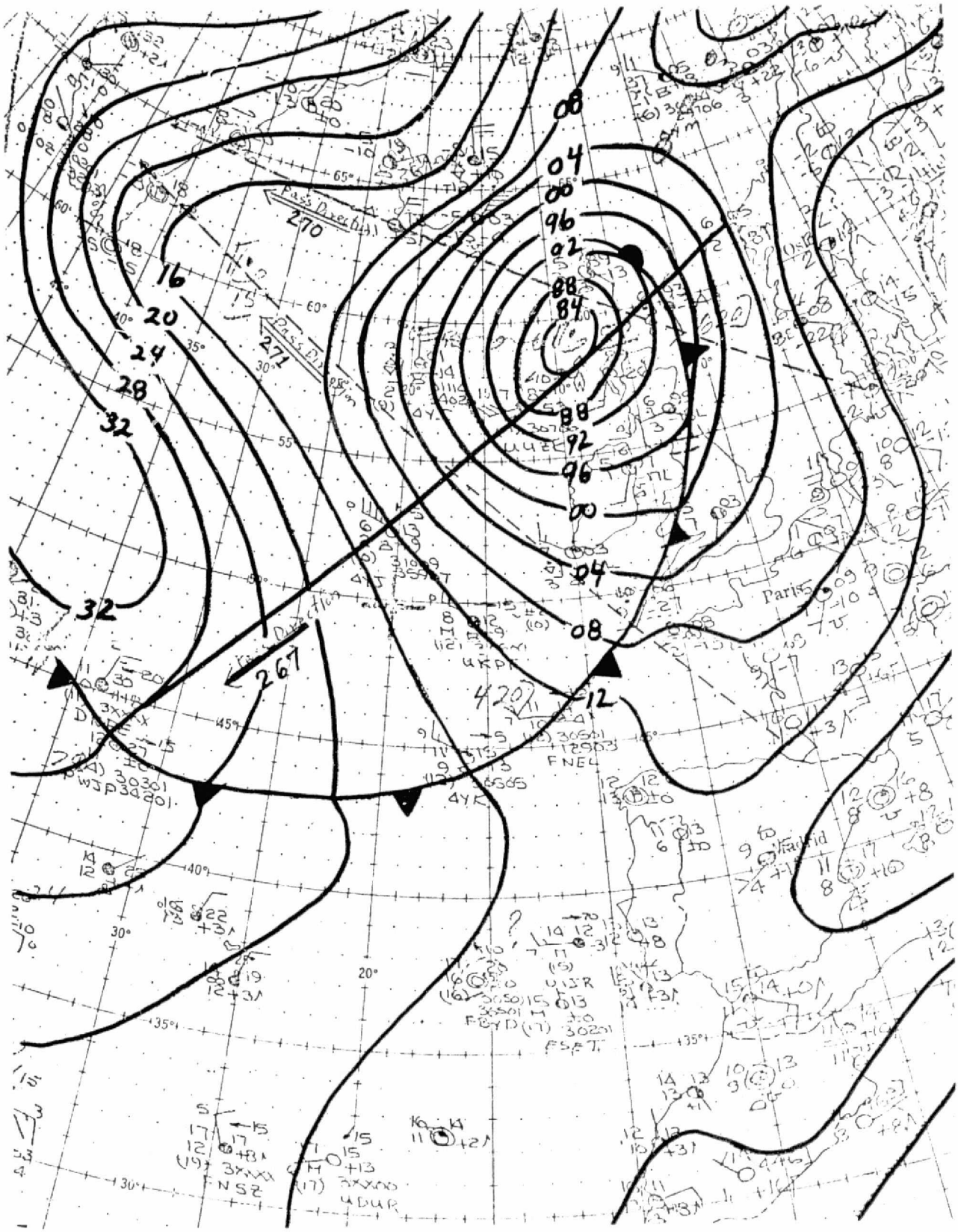
Wind Conditions

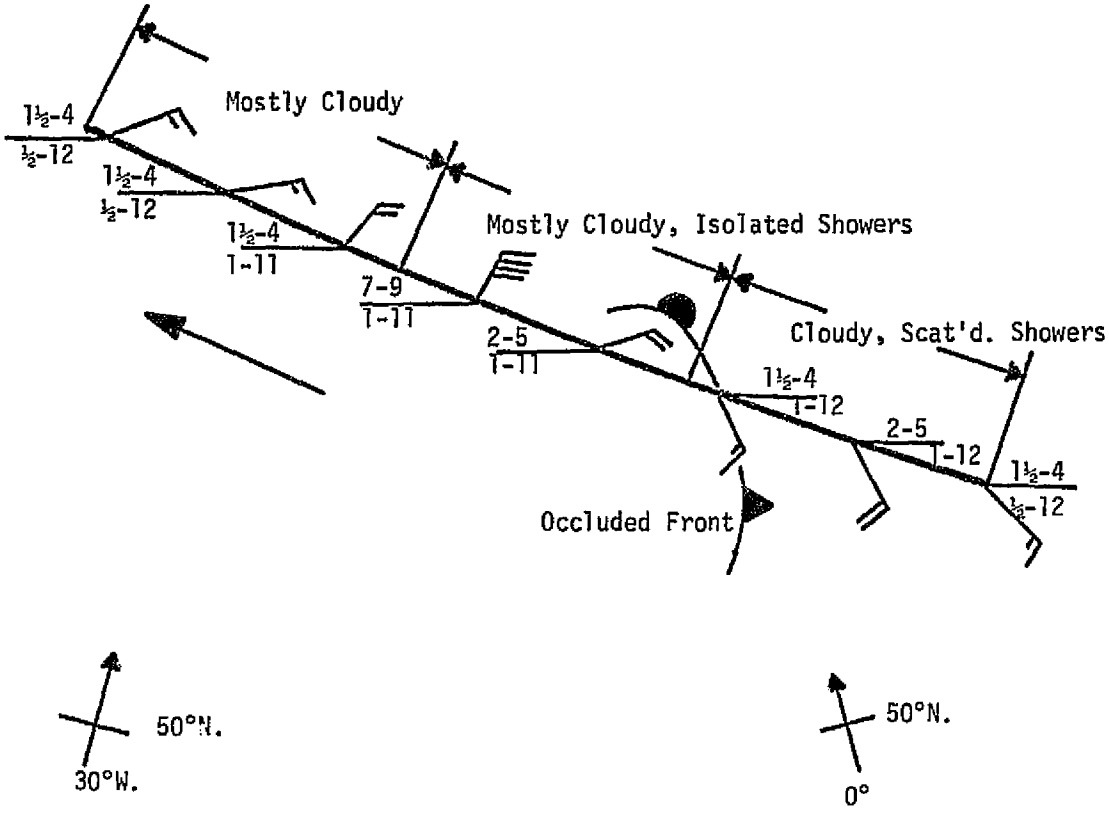
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

Sea Conditions

At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

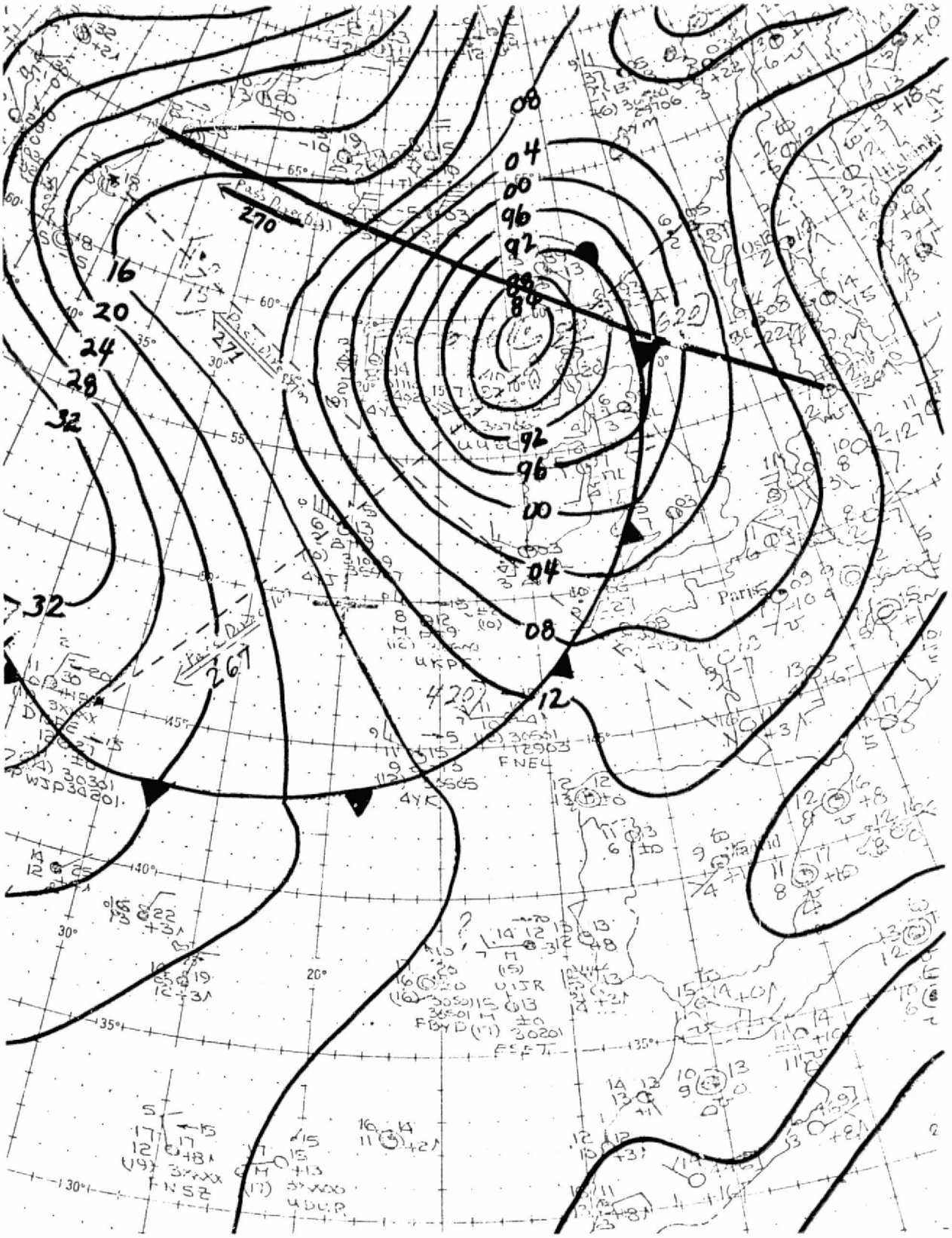

Cloudy, Showers
3-7
1-12
1½-4
1-11
Occluded Front
Mostly Cloudy
1½-4
1-10
Isol'd.
Showers
Isol'd.
Showers
5½-8
1-10
55°N.
35°W.
55°N.
5°E.
5½-8
1-10
Cloudy
Cloudy
2-5
½-12
2-5
½-13
1½-4
½-14

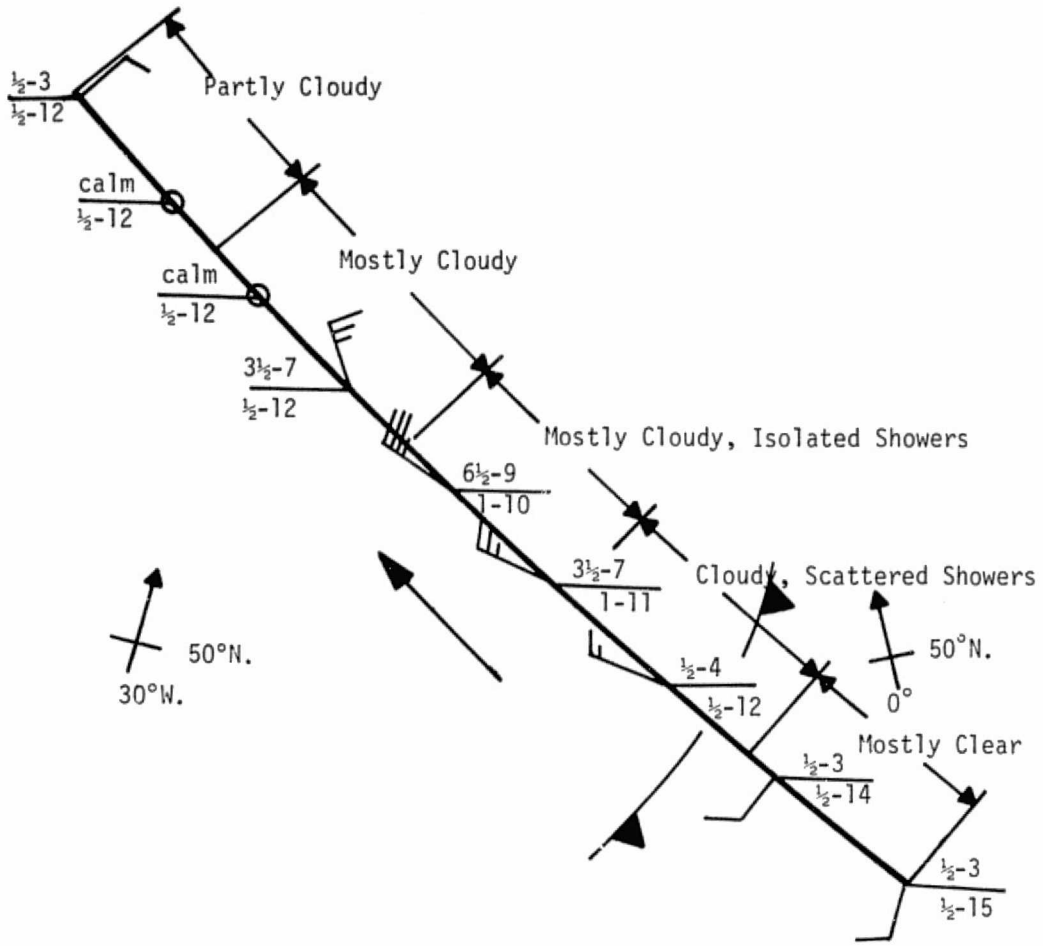



Mostly Cloudy
Mostly Cloudy, Isolated Showers
Cloudy, Scat'd. Showers
Occluded Front
1½-4
½-12
1½-4
½-12
1½-4
1-11
7-9
1-11
2-5
1-11
1½-4
1-12
2-5
1-12
1½-4
½-12

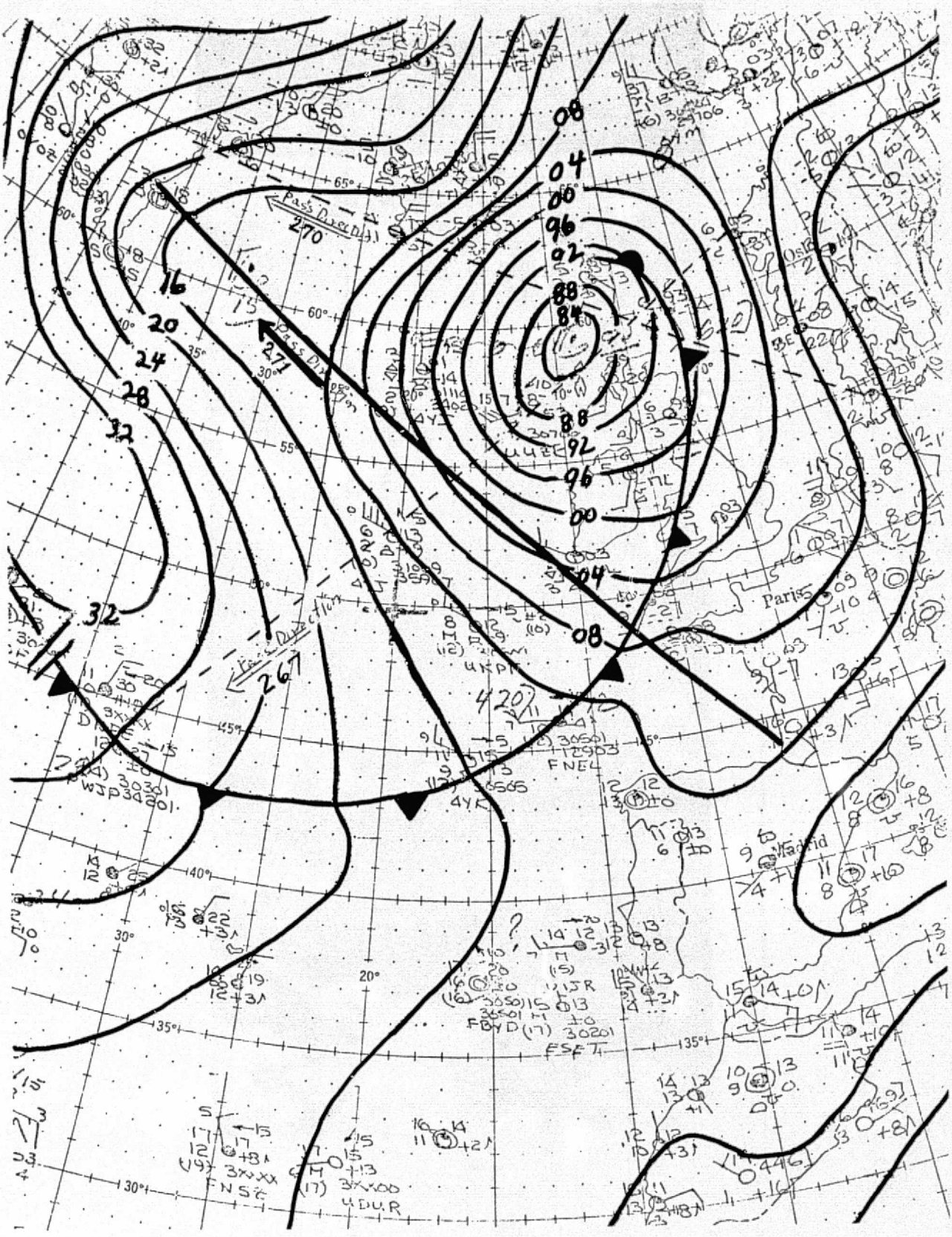
50°N.
30°W.

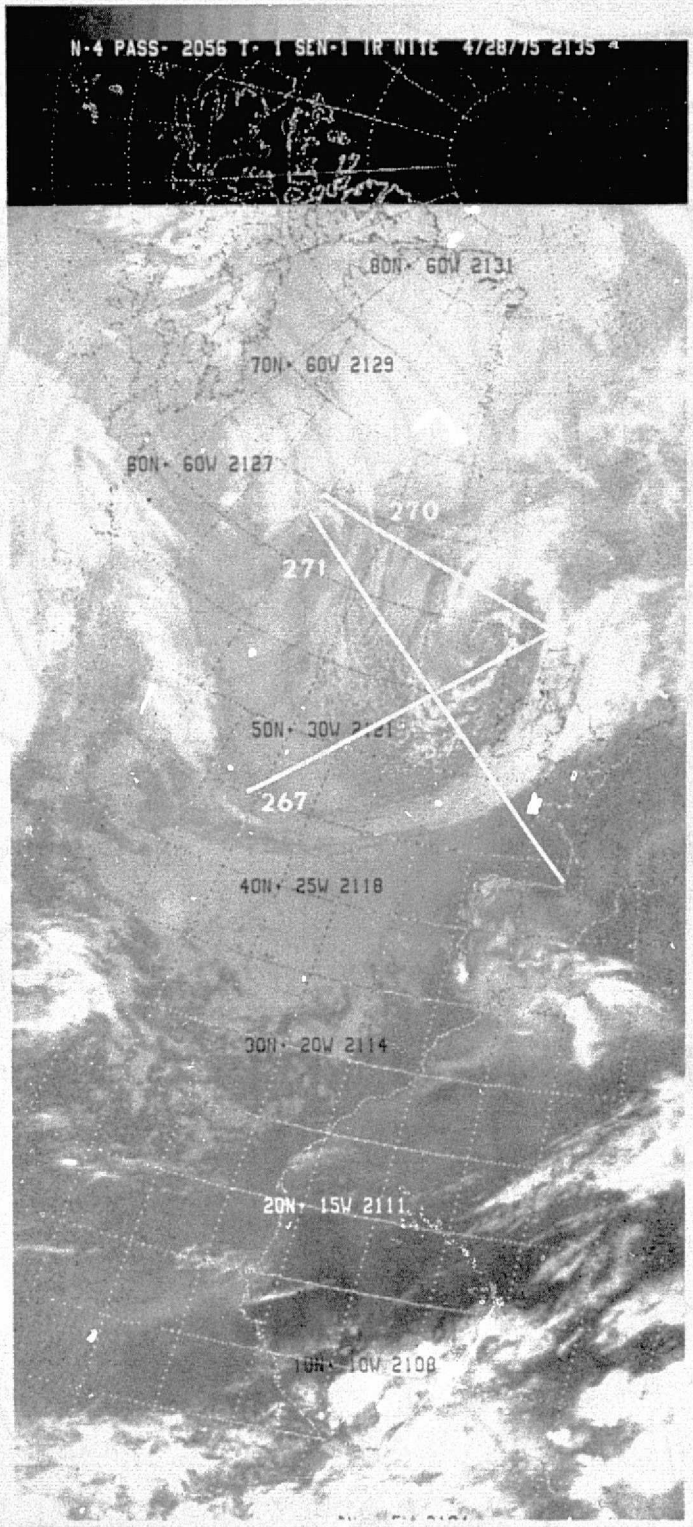
50°N.
0°




½-3
½-12
Partly Cloudy
calm
½-12
calm
½-12
Mostly Cloudy
3½-7
½-12
Mostly Cloudy, Isolated Showers
6½-9
1-10
3½-7
1-11
Cloudy, Scattered Showers
50°N.
30°W.
½-4
½-12
50°N.
0°
Mostly Clear
½-3
½-14
½-3
½-15

C-2


08
04
00
96
92
88
84
88
92
96
00
04
08
16
20
24
28
32
32
Pass Dir
270
271
267
Paris
Madrid



GROUND TRUTH DATA SET 14

(Track 274)

Track 274 extends from southeast to northwest toward New York passing over a frontal system near the northern end of the track. Associated with the frontal system are clouds and scattered showers. The wind just south of the front is 30 knots. Seas associated with this wind are duration limited and not fully developed. The remainder of the track has winds of 15 knots or less. There is no significant swell present.

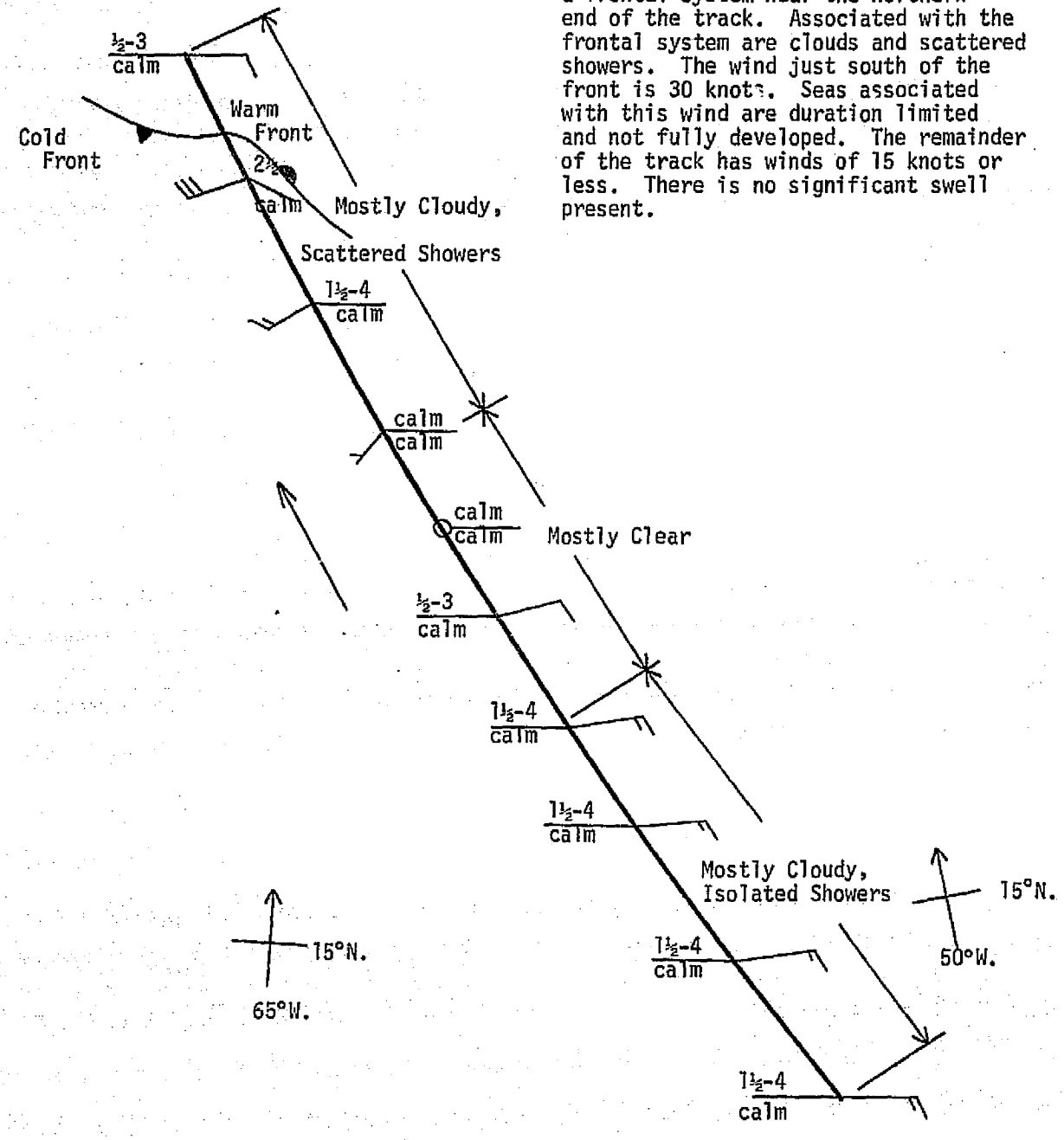
OVERLAY SYMBOLISM

Wind Conditions

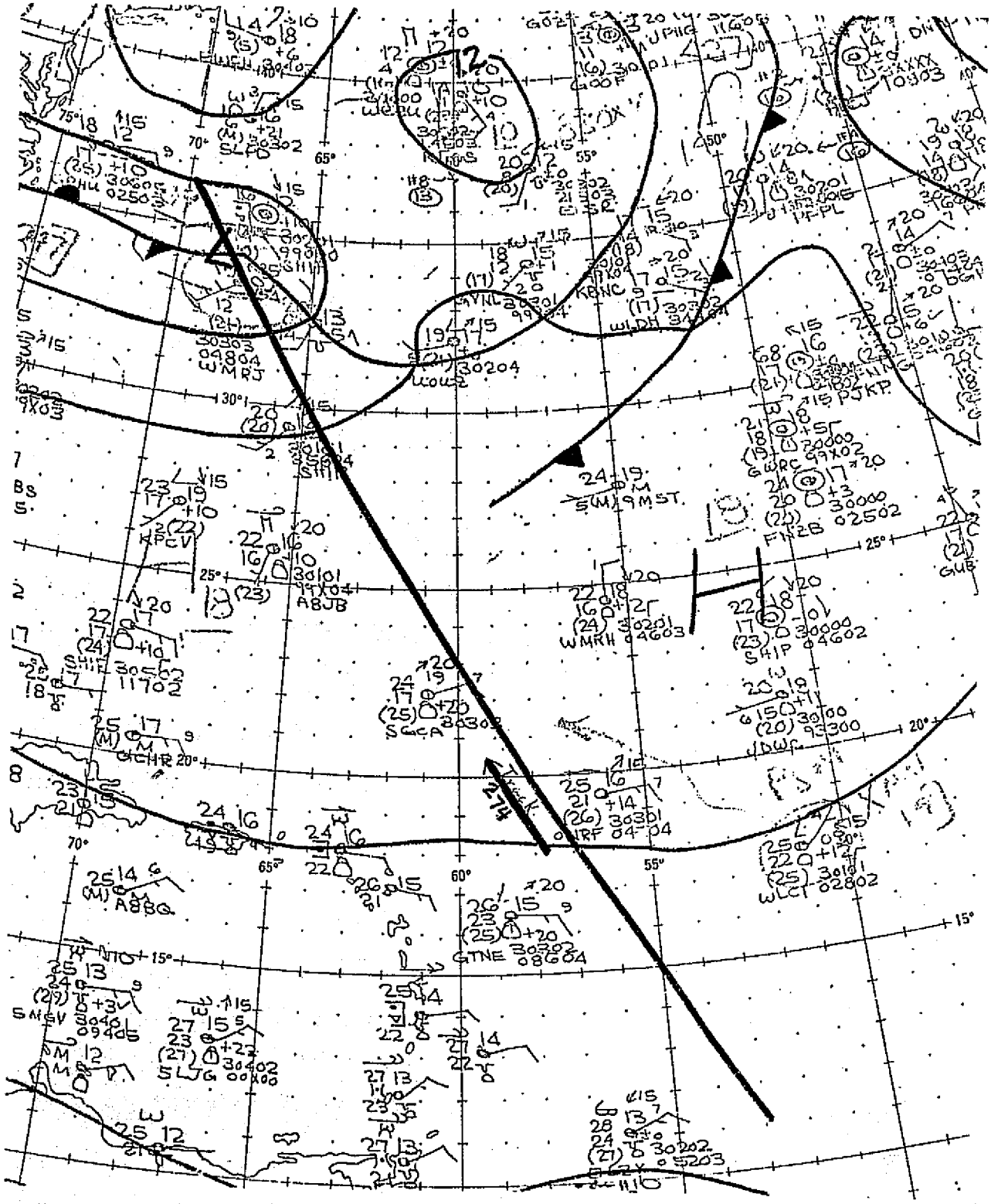
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

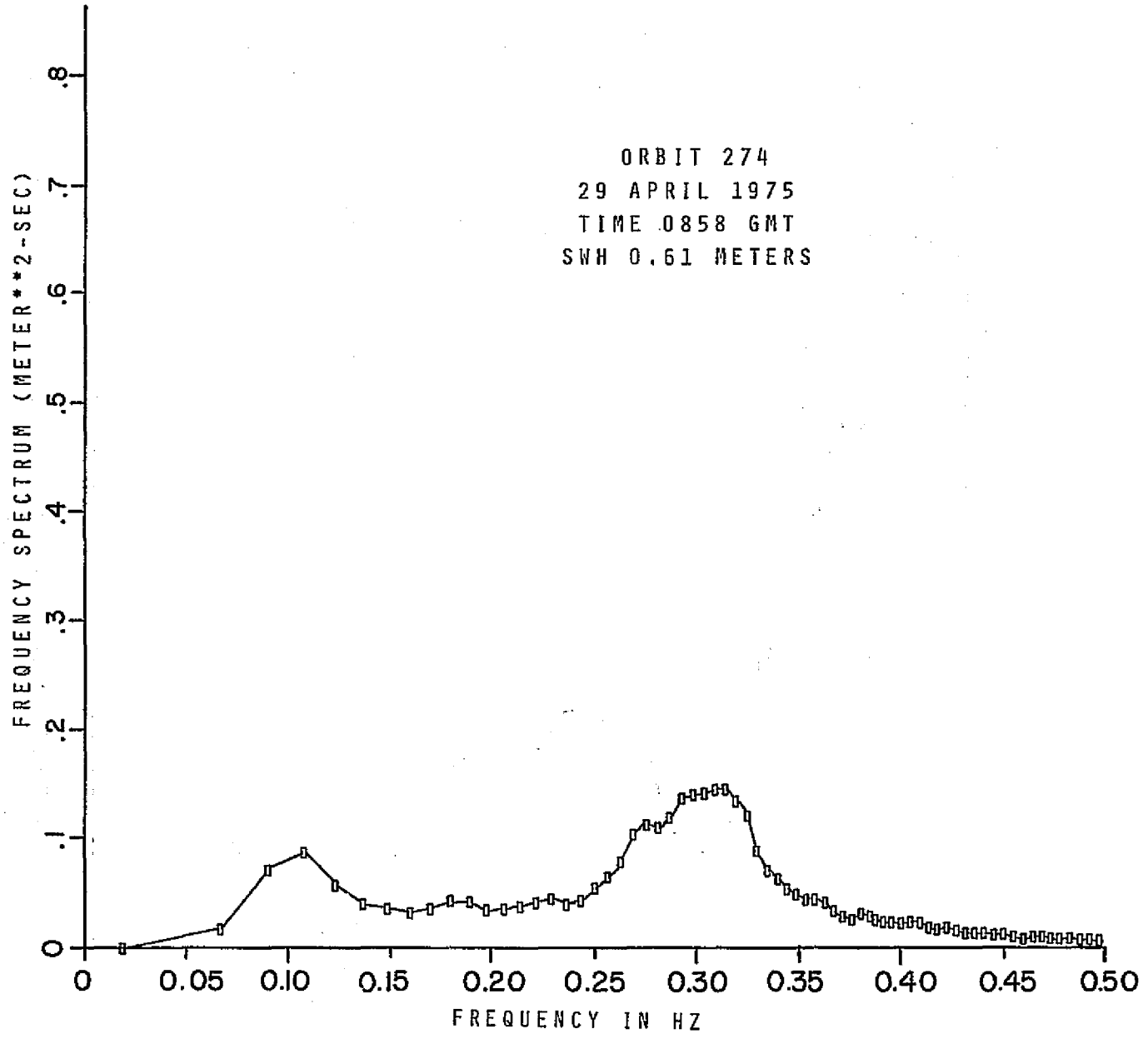
Sea Conditions

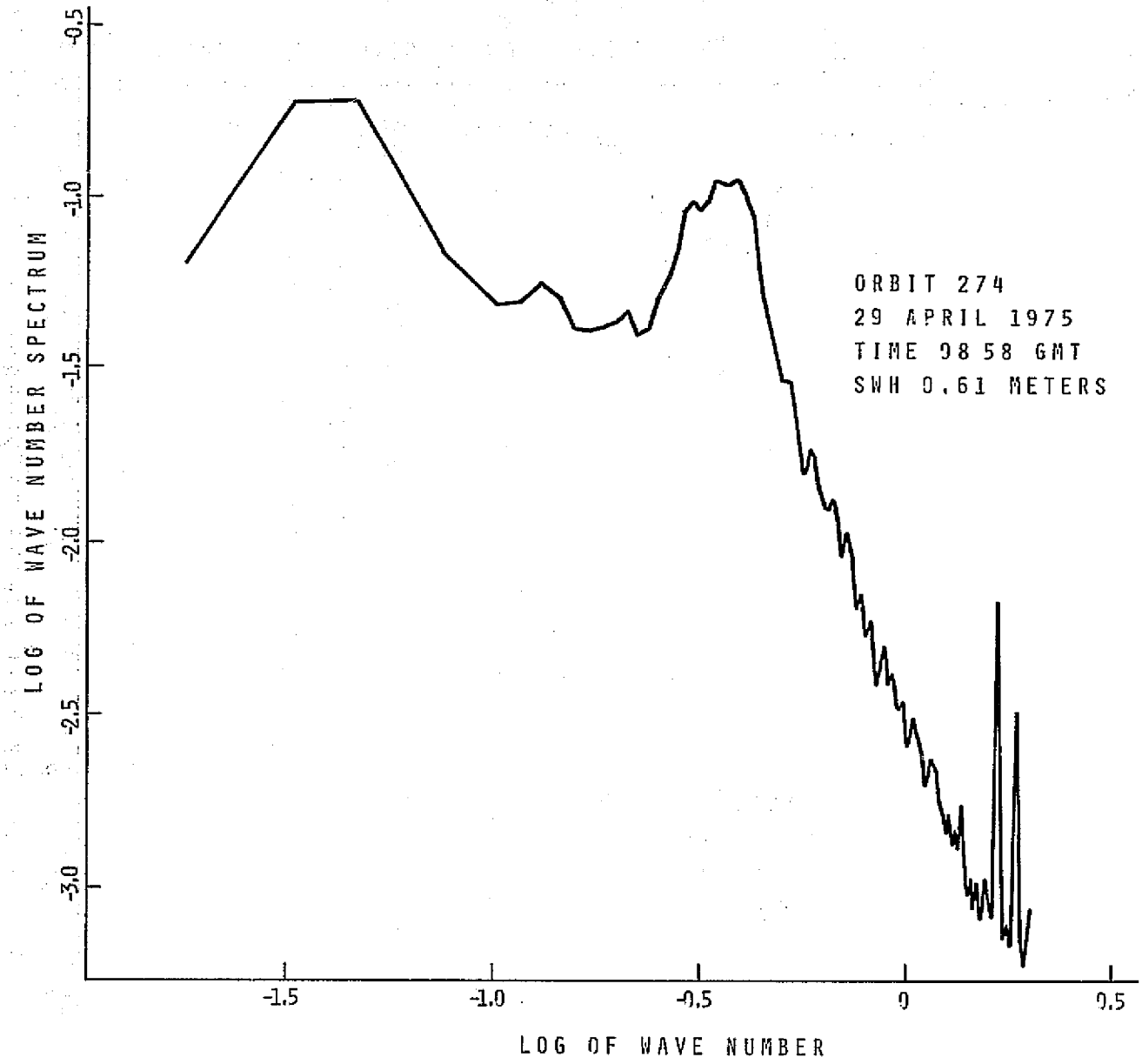
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.



Track 274 extends from southeast to northwest toward New York passing over a frontal system near the northern end of the track. Associated with the frontal system are clouds and scattered showers. The wind just south of the front is 30 knots. Seas associated with this wind are duration limited and not fully developed. The remainder of the track has winds of 15 knots or less. There is no significant swell present.




ORBIT 274
29 APRIL 1975
TIME 0858 GMT
SWH 0.61 METERS
FREQUENCY SPECTRUM (METER**2-SEC)
0
.1
.2
.3
.4
.5
.6
.7
.8
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
FREQUENCY IN HZ


LOG OF WAVE NUMBER SPECTRUM
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-1.5
-1.0
-0.5
0
0.5
LOG OF WAVE NUMBER
ORBIT 274
29 APRIL 1975
TIME 08 58 GMT
SWH 0.61 METERS

GROUND TRUTH DATA SET 15
(Tracks 281, 282, 283 and 284)

Tracks 281, 282, 283 and 284 pass over the same cyclonic system as did 267, 270, and 271 but one day later. The storm has moved in a northeasterly direction to a position about 120 miles southeast of Iceland. Tracks 281, 283, and 283 are all crossed by 284 and tracks 282 and 283 also intersect. The times when the geographic locations of the various tracks coincided are tabulated below.

Latitude	Longitude	Crossing Time (GMT)			
		281	282	283	284
60°N.	.5°E.	203130			012700
63°N.	13.0°W.		221120		012900
65°N.	6.0°E.		220900	234800	
65°N.	30.0°W.			235200	013100

The 0000 GMT, April 30, NMC surface analysis map indicates that the system has intensified somewhat to a low pressure reading at the core of 980 mb. Winds have been sustained at 40 knots and the seas have increased to a maximum of 9 meters at locations that are not either fetch or duration limited. In the vicinity of Iceland, tracks 283 and 284 both crossed regions where snow showers were reported. Again, the geometry of the four tracks in relationship to the location of the storm at 2035 GMT is shown in the NOAA-4 IR photograph.

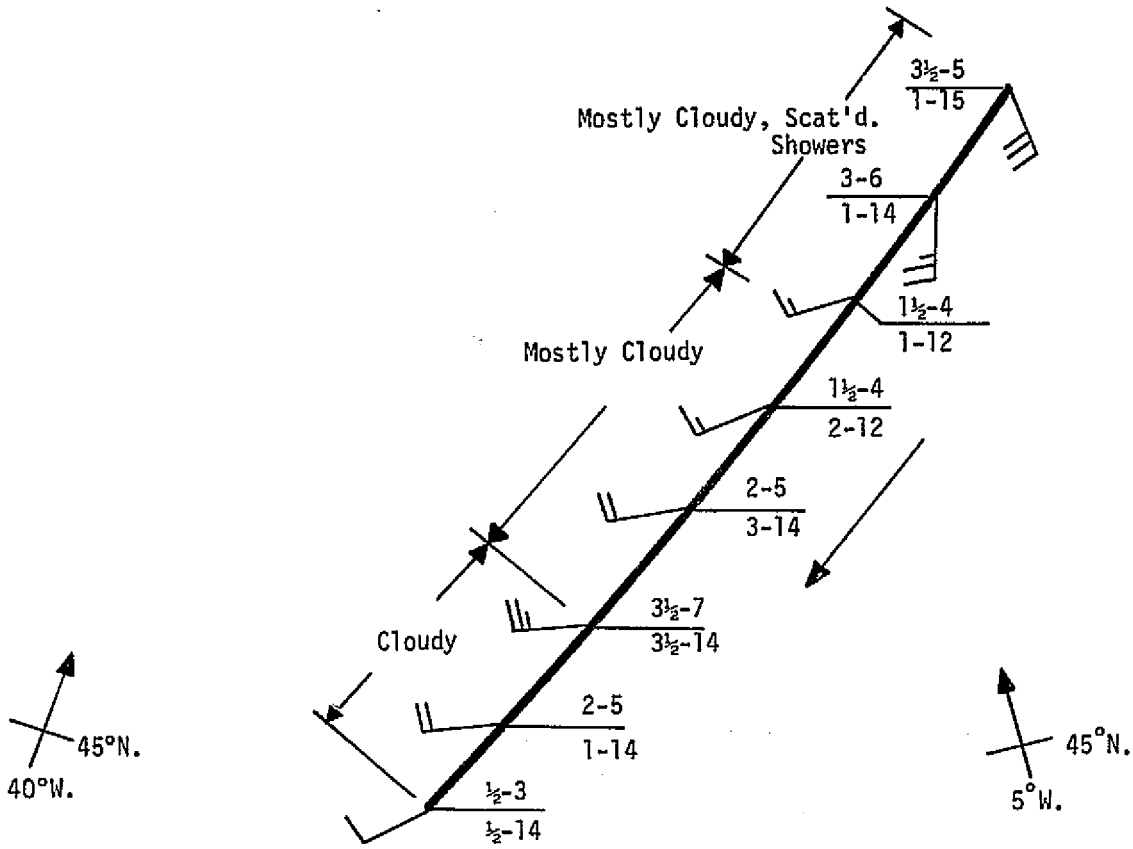
OVERLAY SYMBOLISM

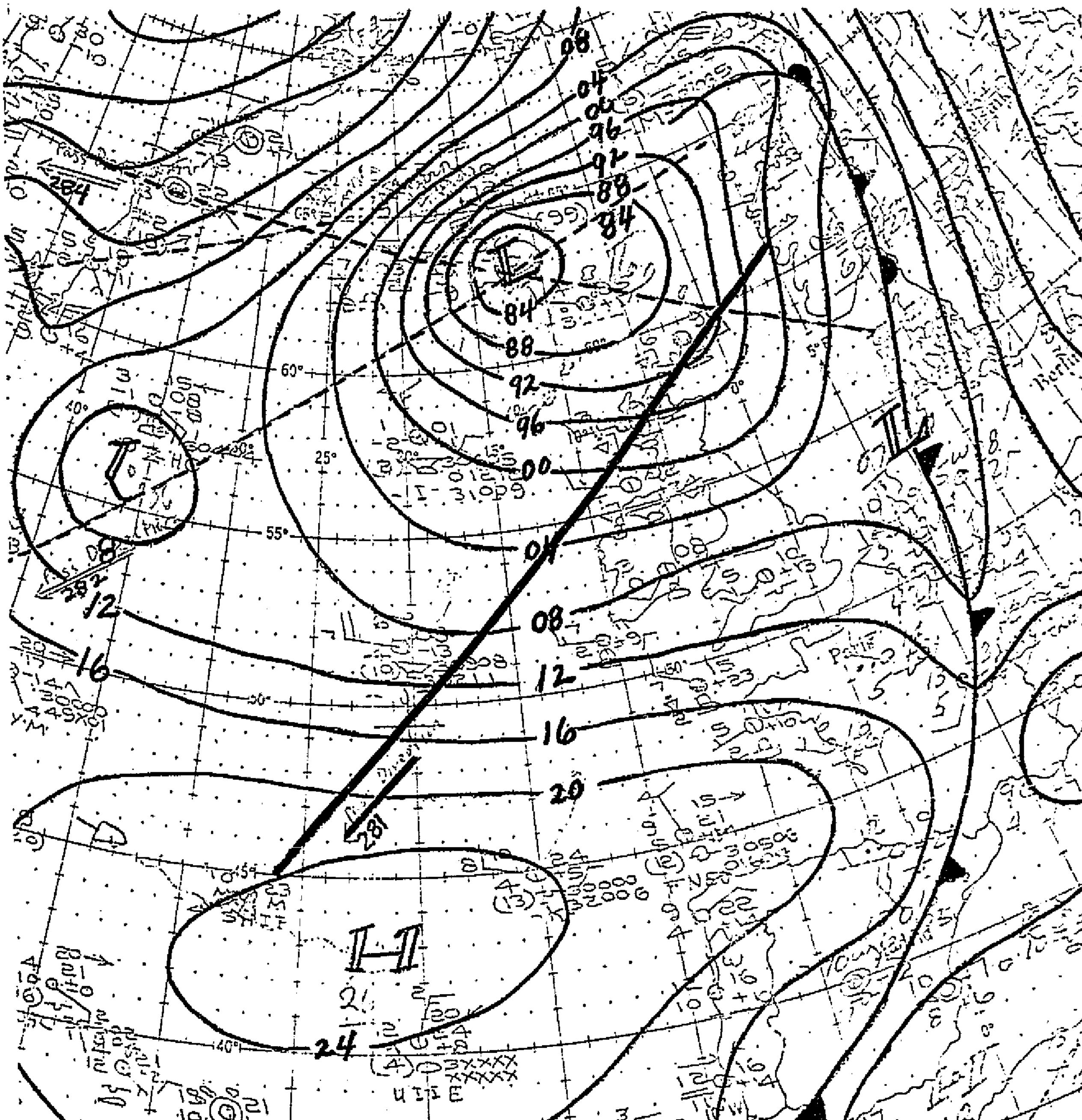
Wind Conditions

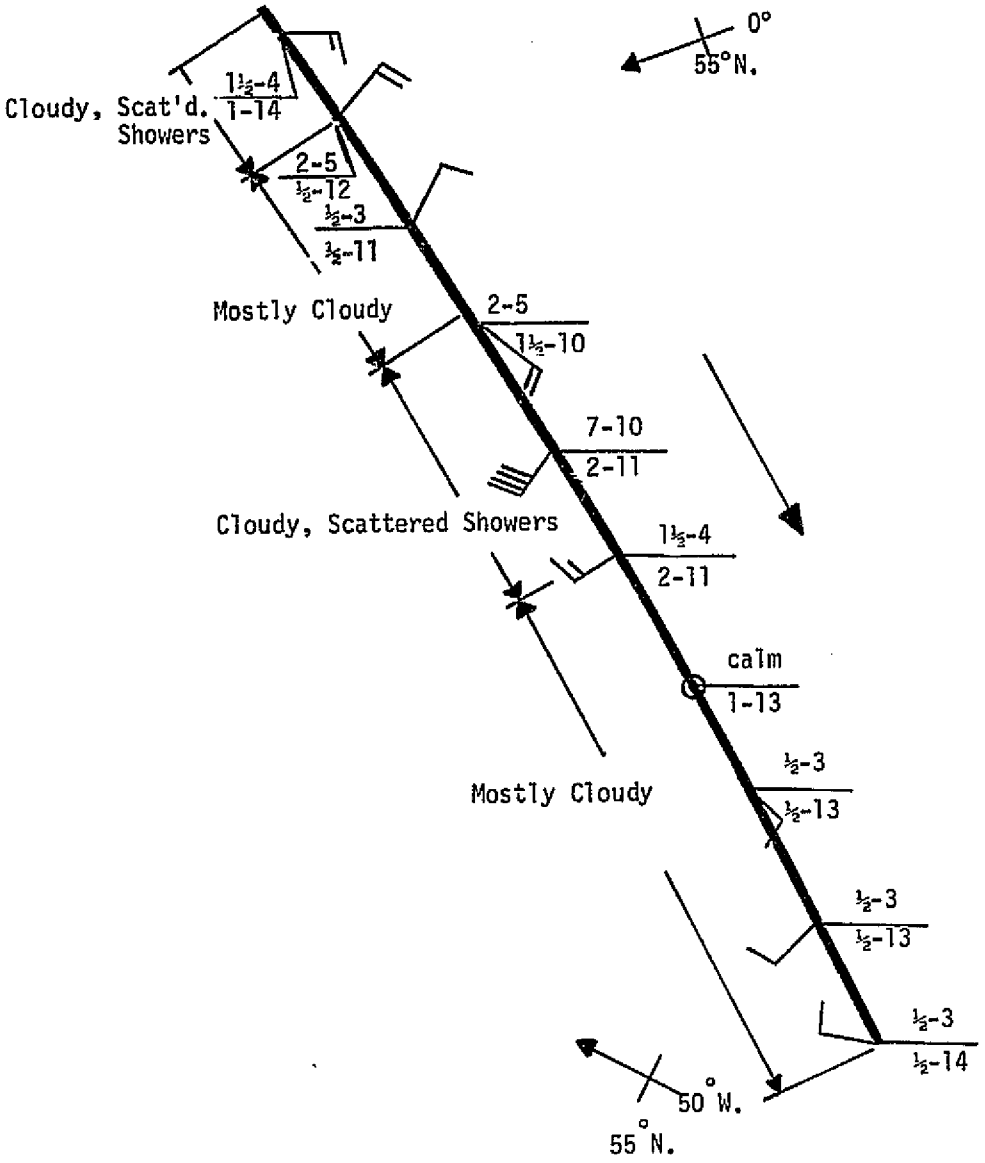
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

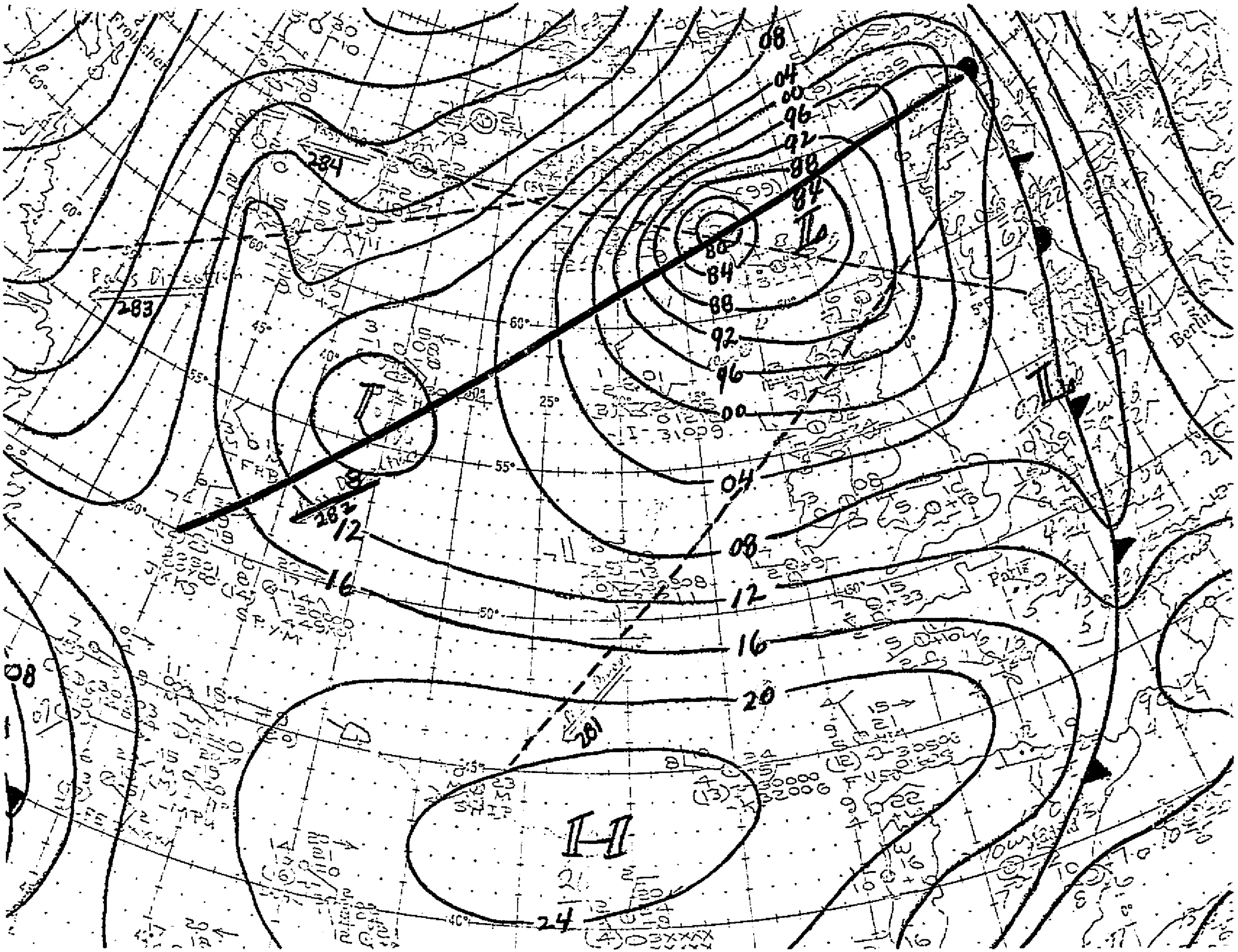
Sea Conditions

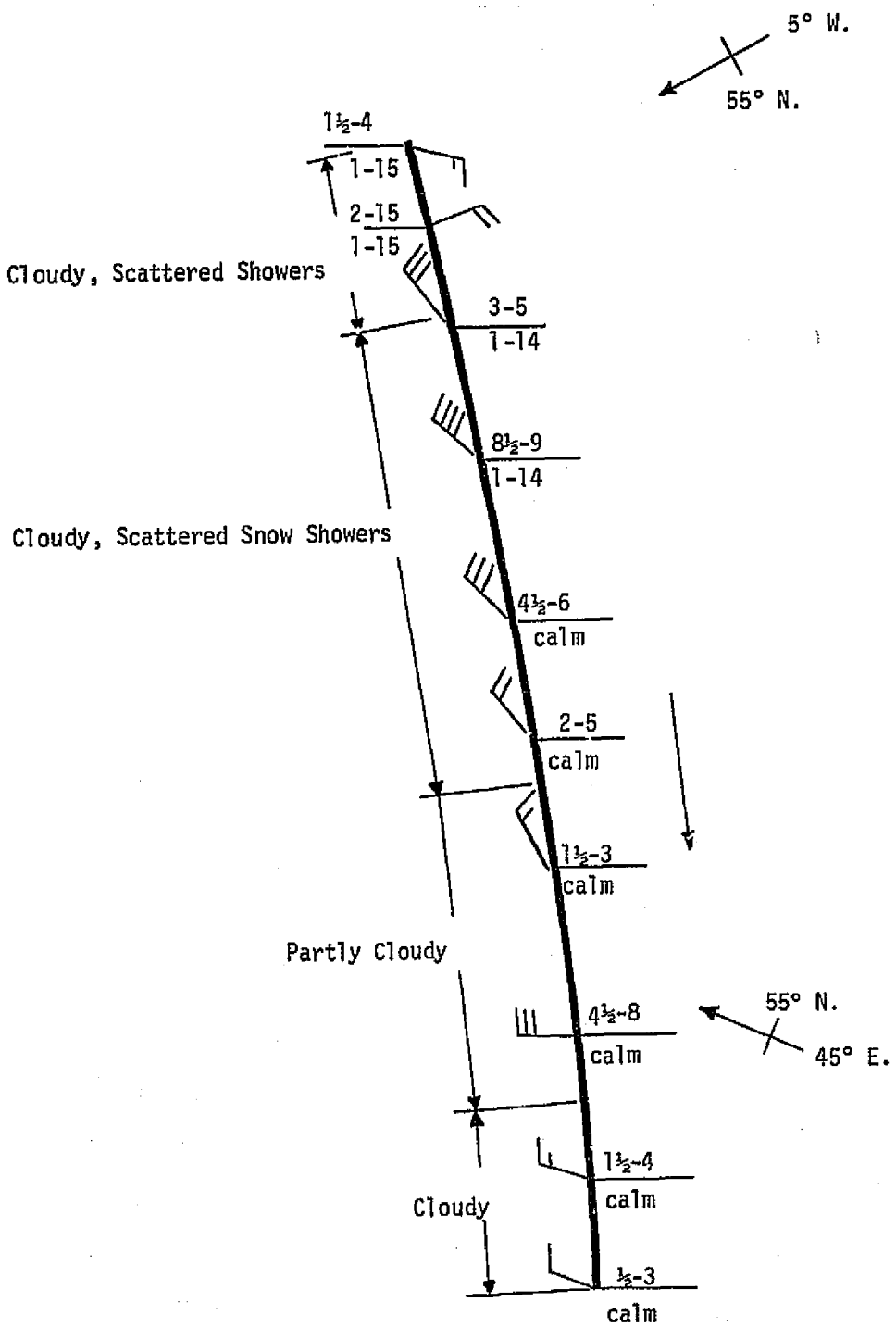
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

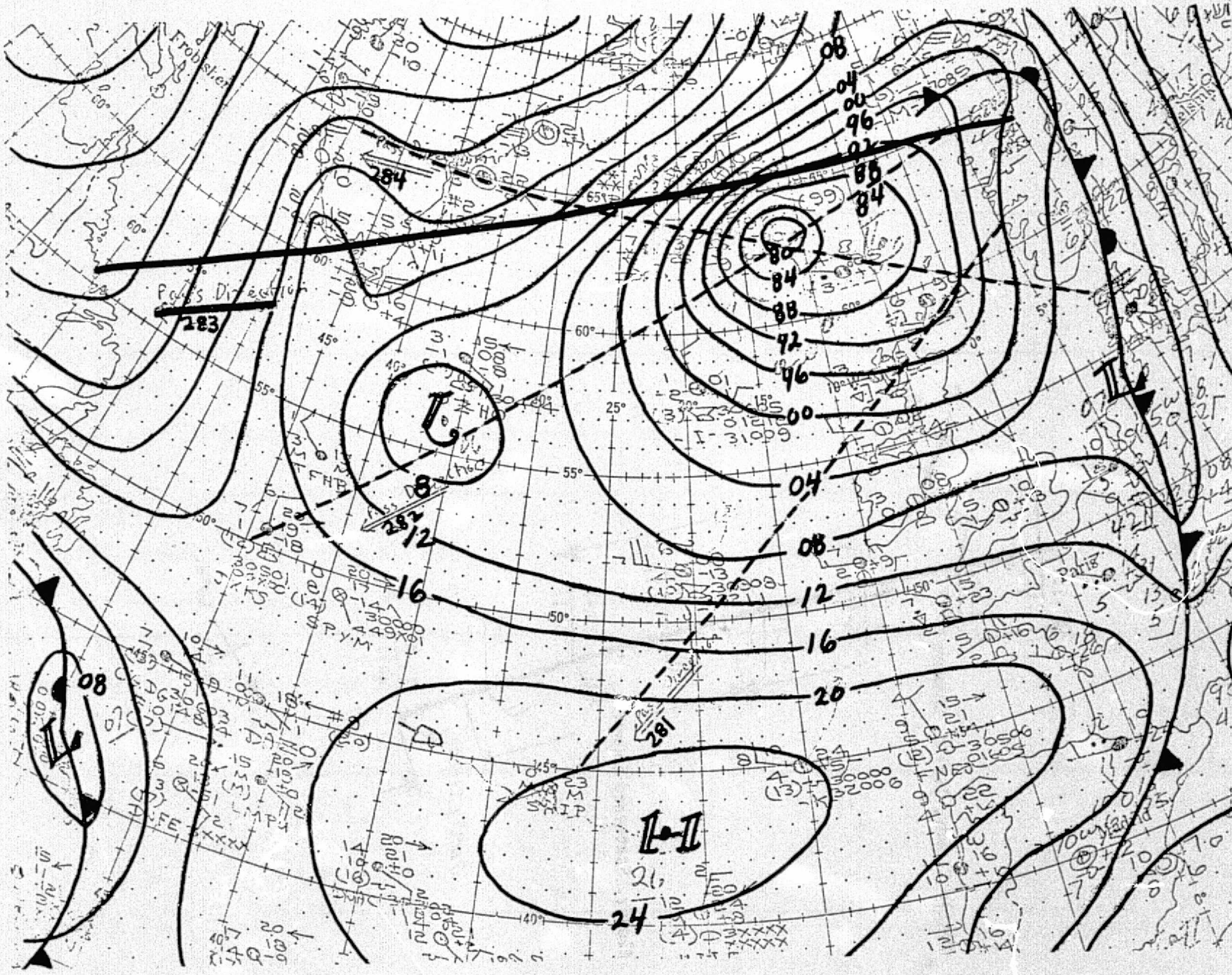

Mostly Cloudy, Scat'd. Showers
3½-5
1-15
3-6
1-14
1½-4
1-12
Mostly Cloudy
1½-4
2-12
2-5
3-14
Cloudy
3½-7
3½-14
2-5
1-14
½-3
½-14
45°N.
40°W.
45°N.
5°W.

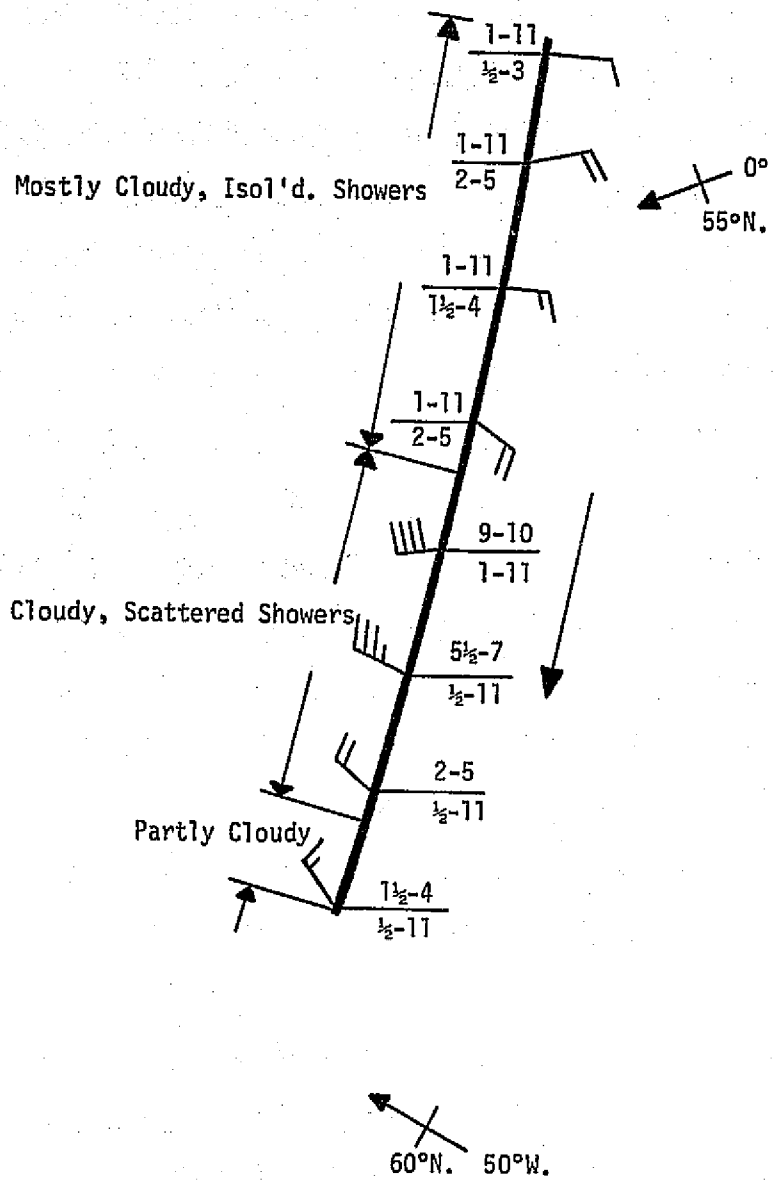

H
L
L
24
20
16
12
08
04
00
96
92
88
84
284
282
281

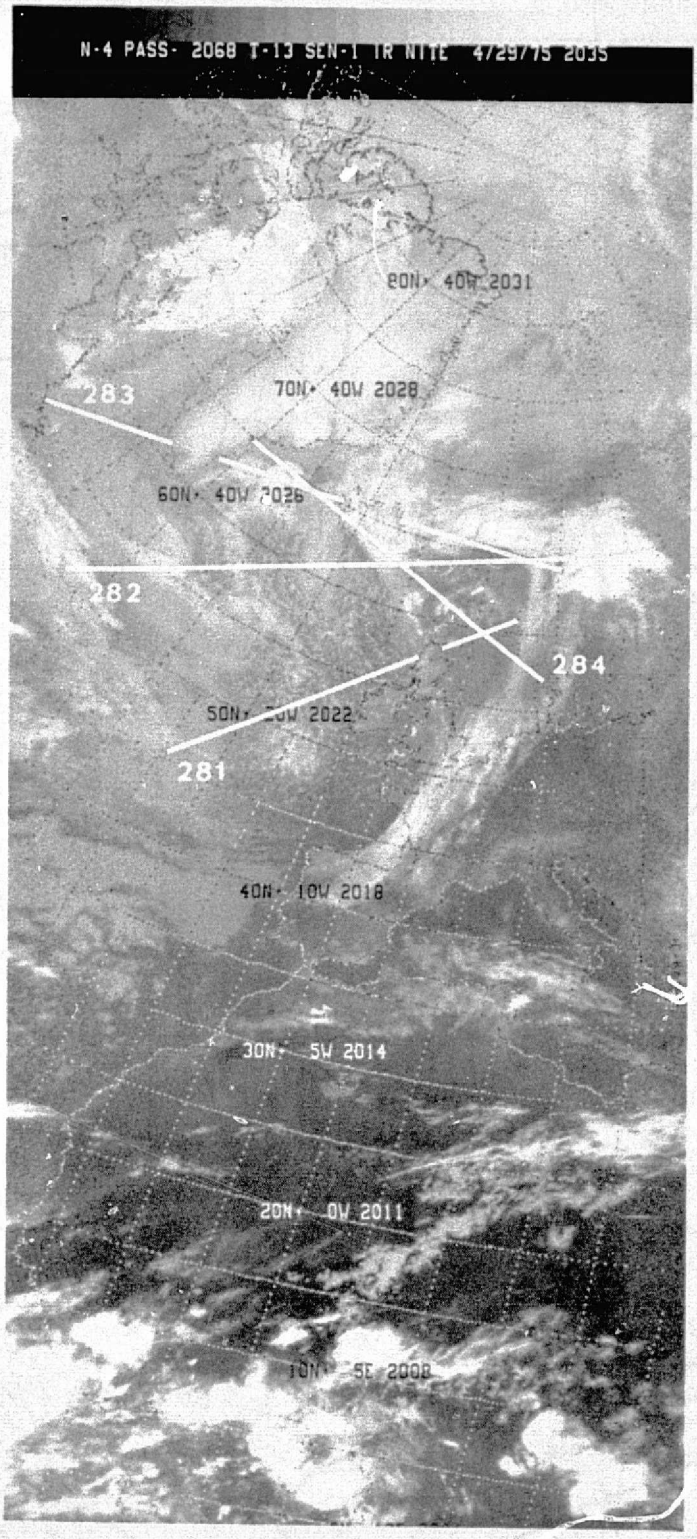



08
04
00
96
92
88
84
80
L
H
283
284
282
281
12
16
20
24
Paris




Frobisher
Pass Direction
283
284
282
281
Paris
08
04
00
96
92
88
84
80
12
16
20
24
8


1-11
½-3
1-11
2-5
Mostly Cloudy, Isol'd. Showers
0°
55°N.
1-11
1½-4
1-11
2-5
9-10
1-11
Cloudy, Scattered Showers
5½-7
½-11
2-5
½-11
Partly Cloudy
1½-4
½-11
60°N.
50°W.



GROUND TRUTH DATA SET 16
(Track 291)

Track 291 passes from the central northeastern Pacific across the Alaskan Peninsula into Russia. Maximum winds along the ground track are 25 knots. The area is mostly cloudy to cloudy with isolated showers across the cold front.

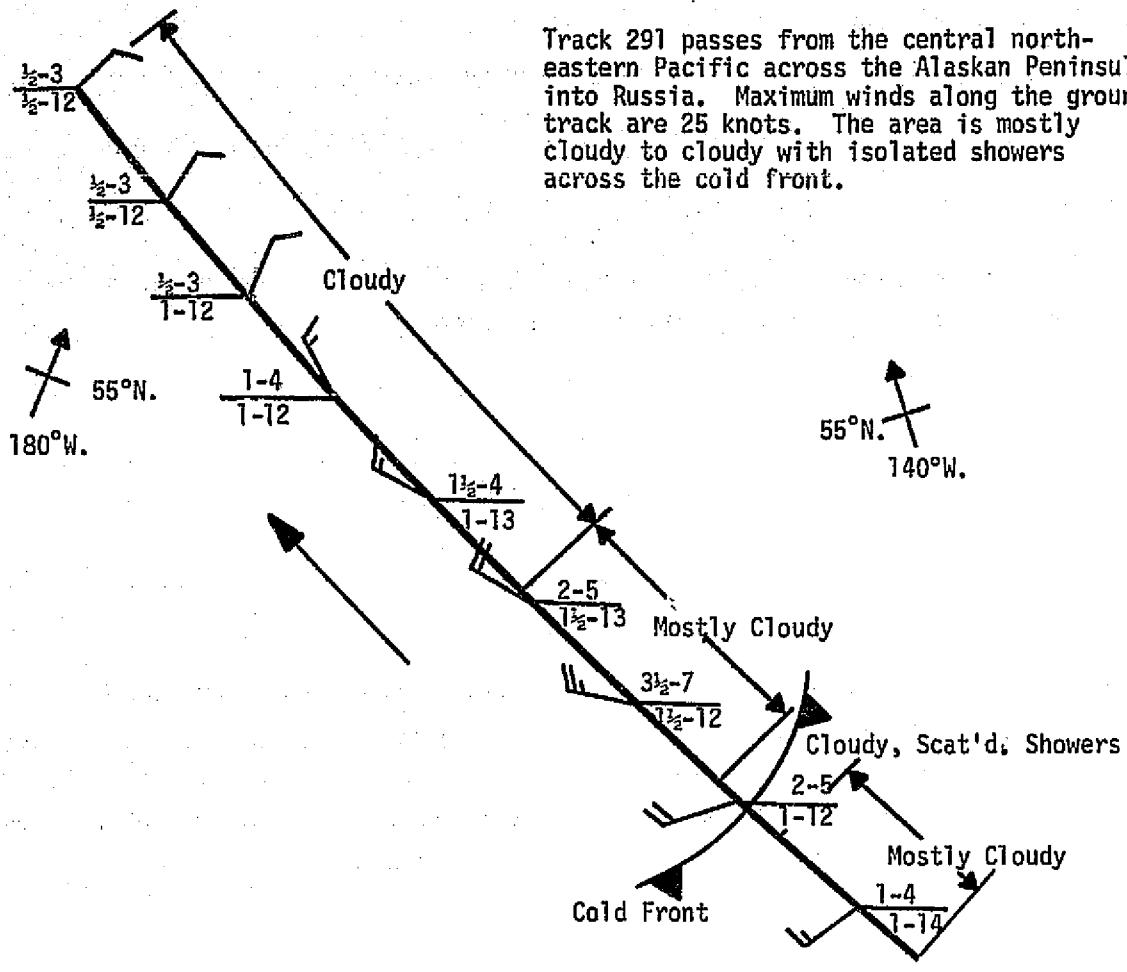
OVERLAY SYMBOLISM

Wind Conditions

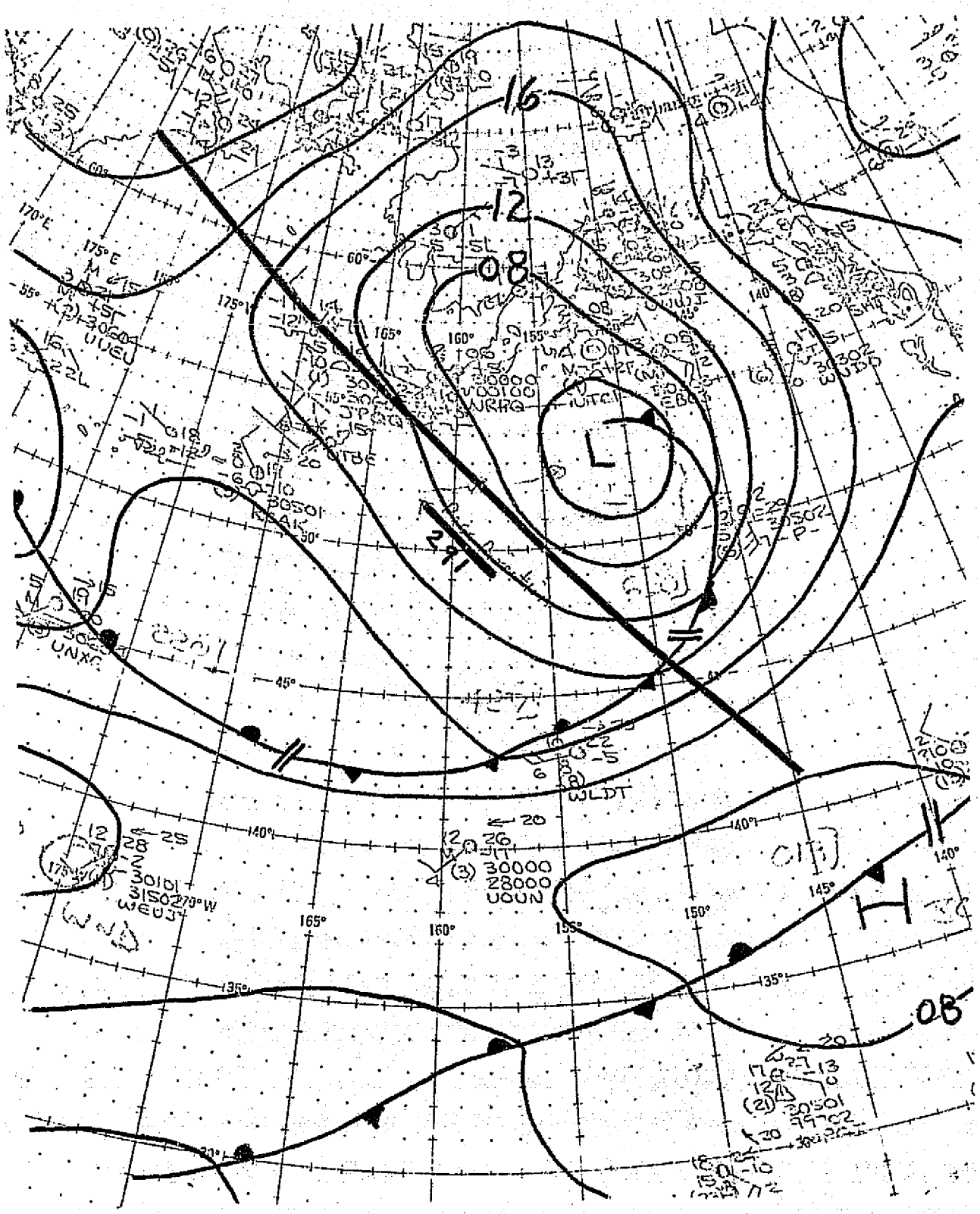
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

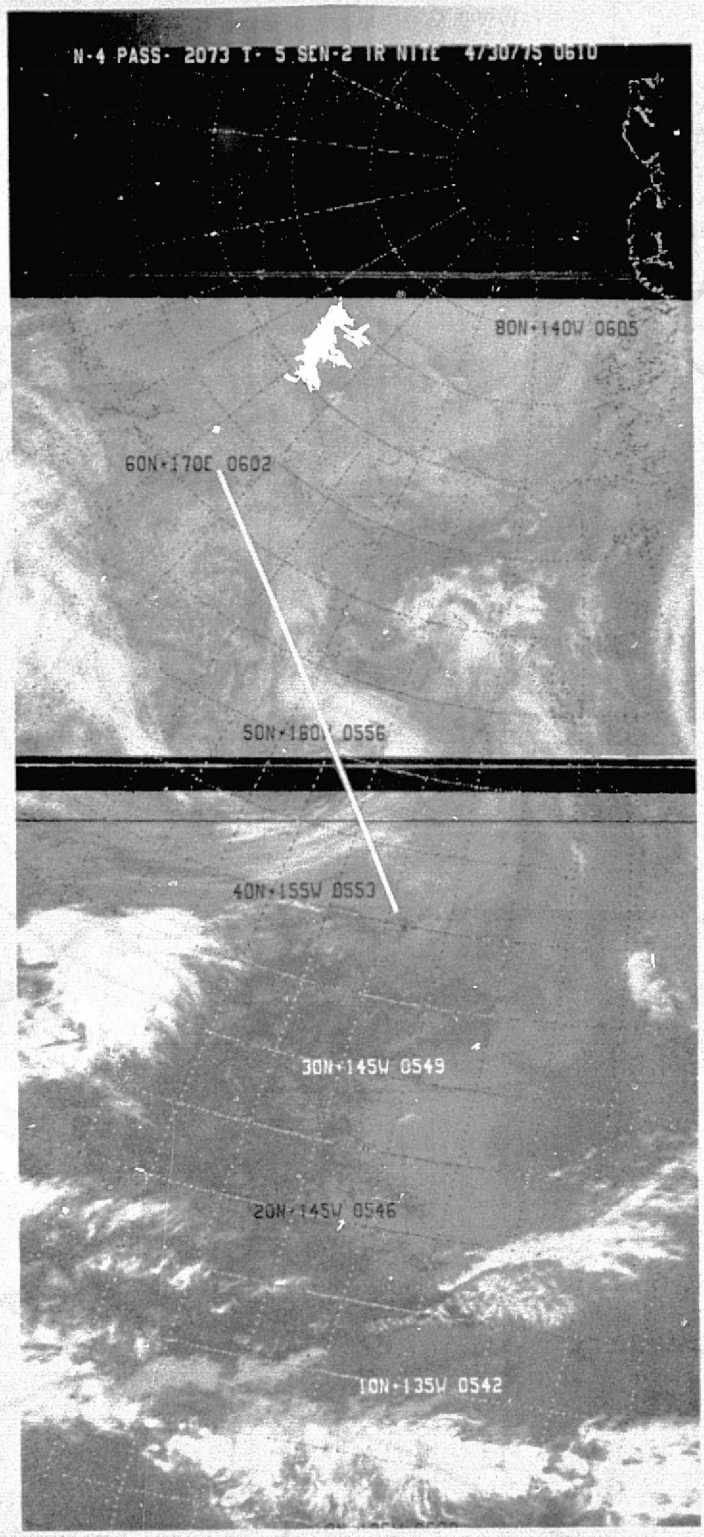
Sea Conditions

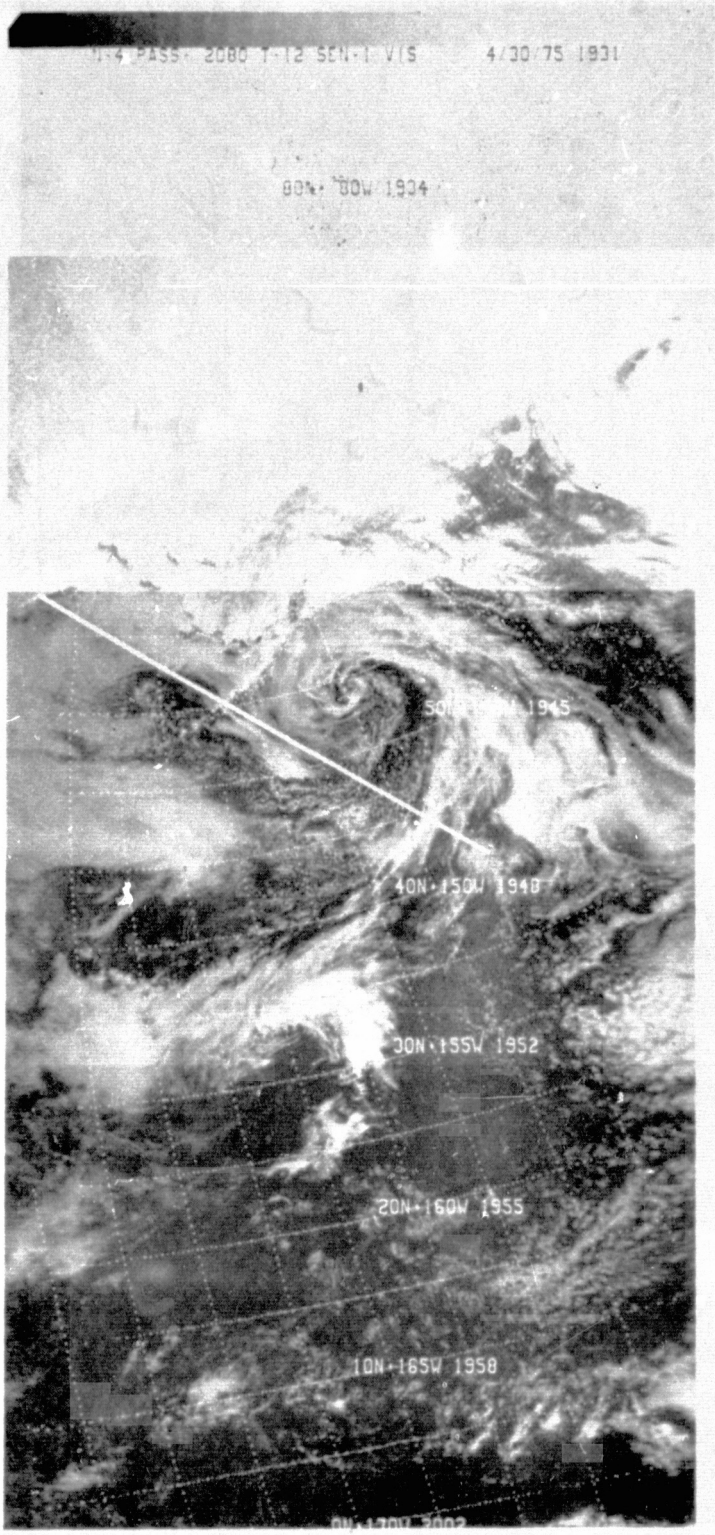
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

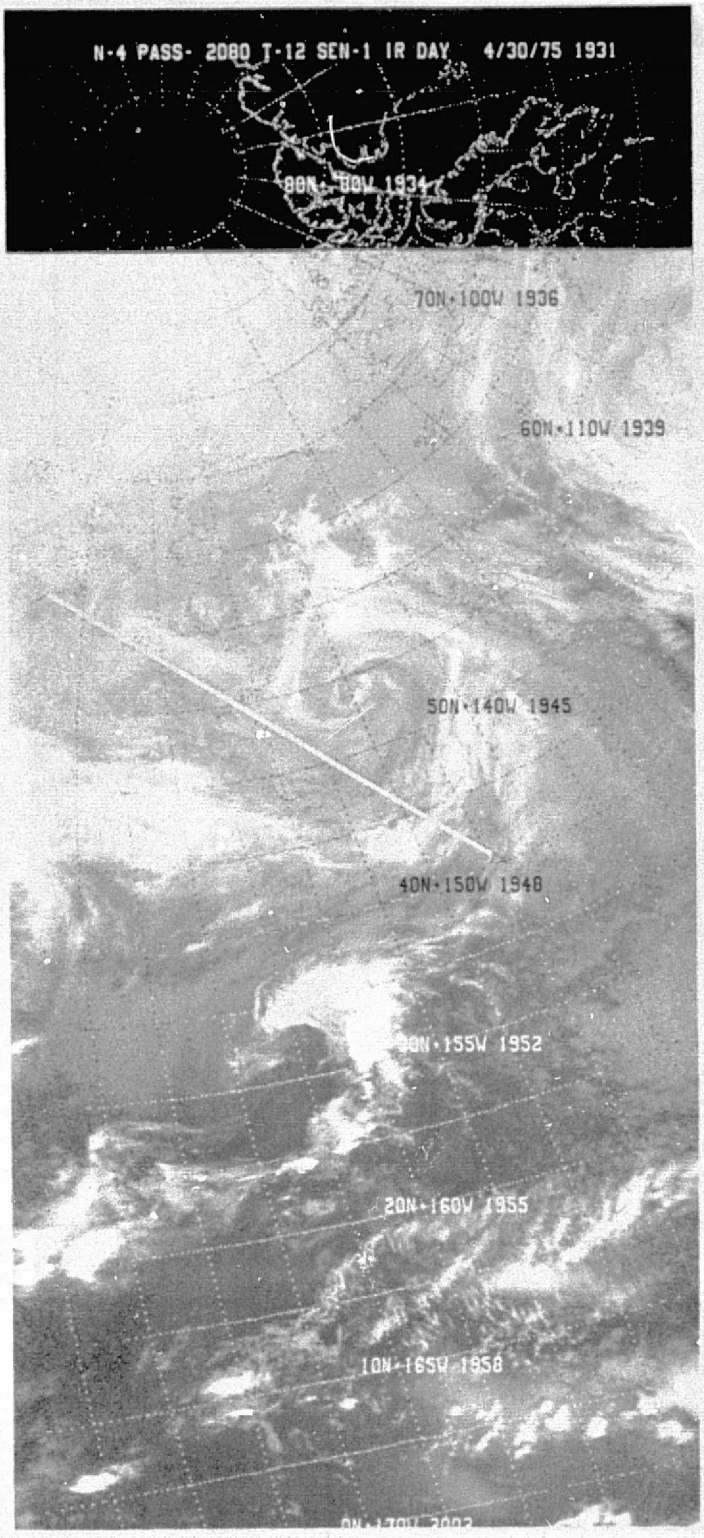


Track 291 passes from the central northeastern Pacific across the Alaskan Peninsula into Russia. Maximum winds along the ground track are 25 knots. The area is mostly cloudy to cloudy with isolated showers across the cold front.









GROUND TRUTH DATA SET 17

(Track 311)

Track 311 extends from Norway to eastern Canada and down the east coast of the U.S. across Florida and Cuba into Central America. For the most part winds are light and reach 25 knots at two locations south of Greenland. One-half meter swells are encountered south of Greenland and north of Great Britain.

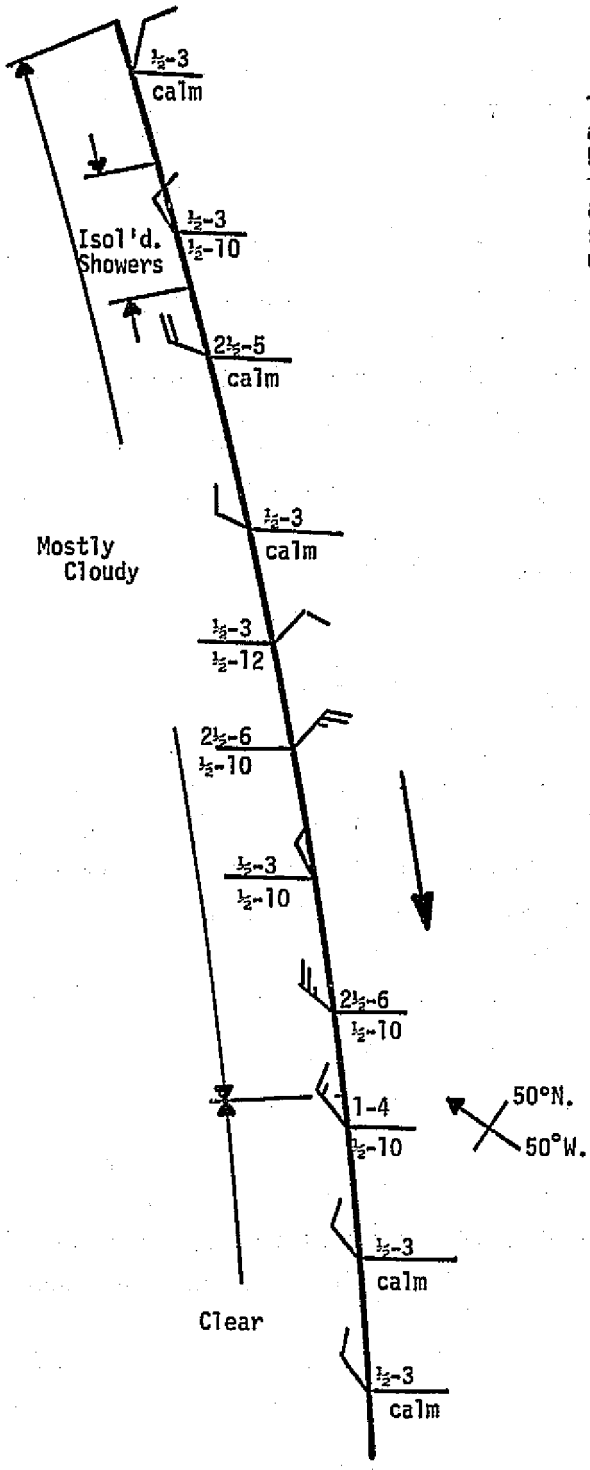
OVERLAY SYMBOLISM

Wind Conditions

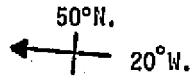
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

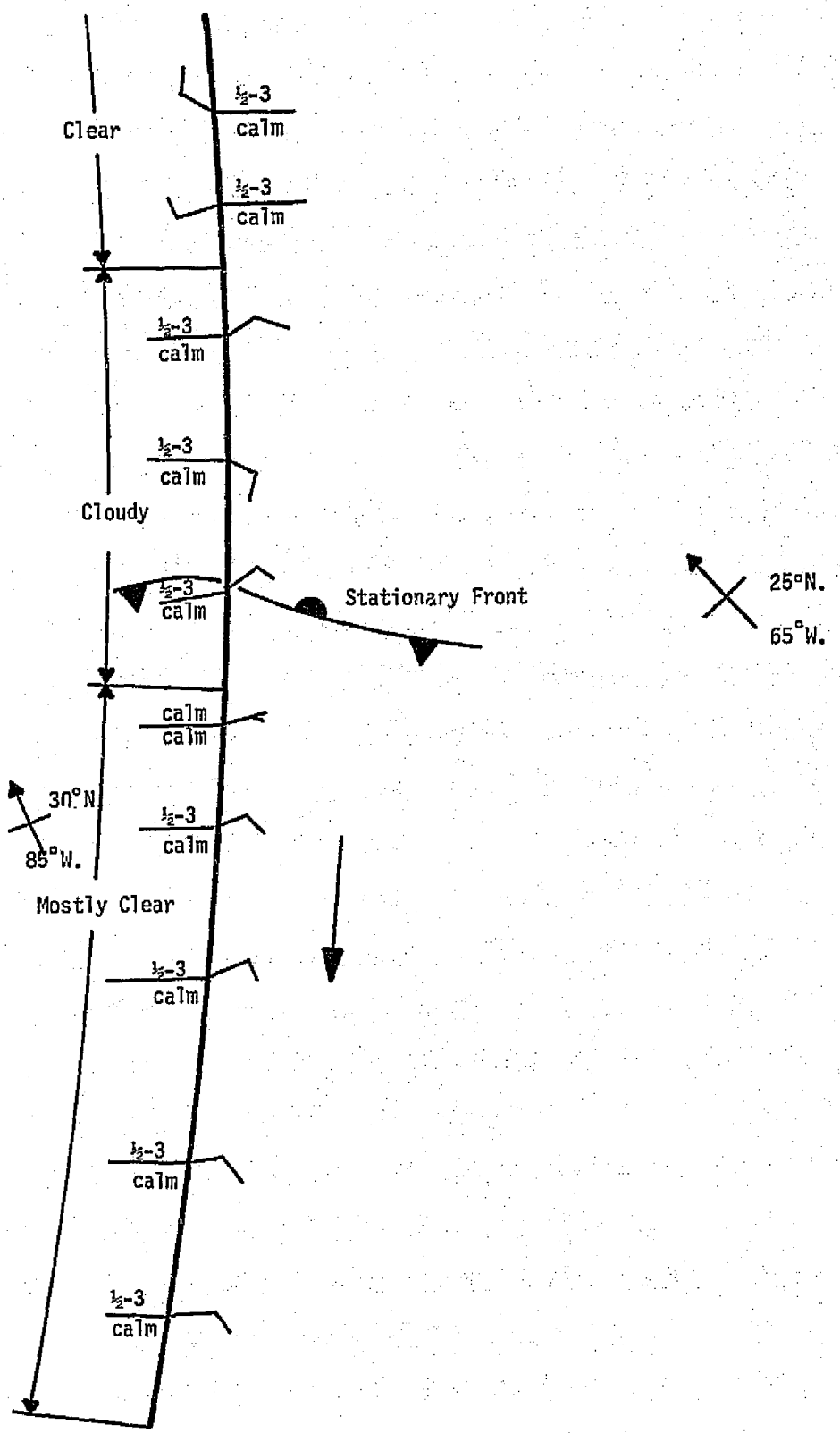
Sea Conditions

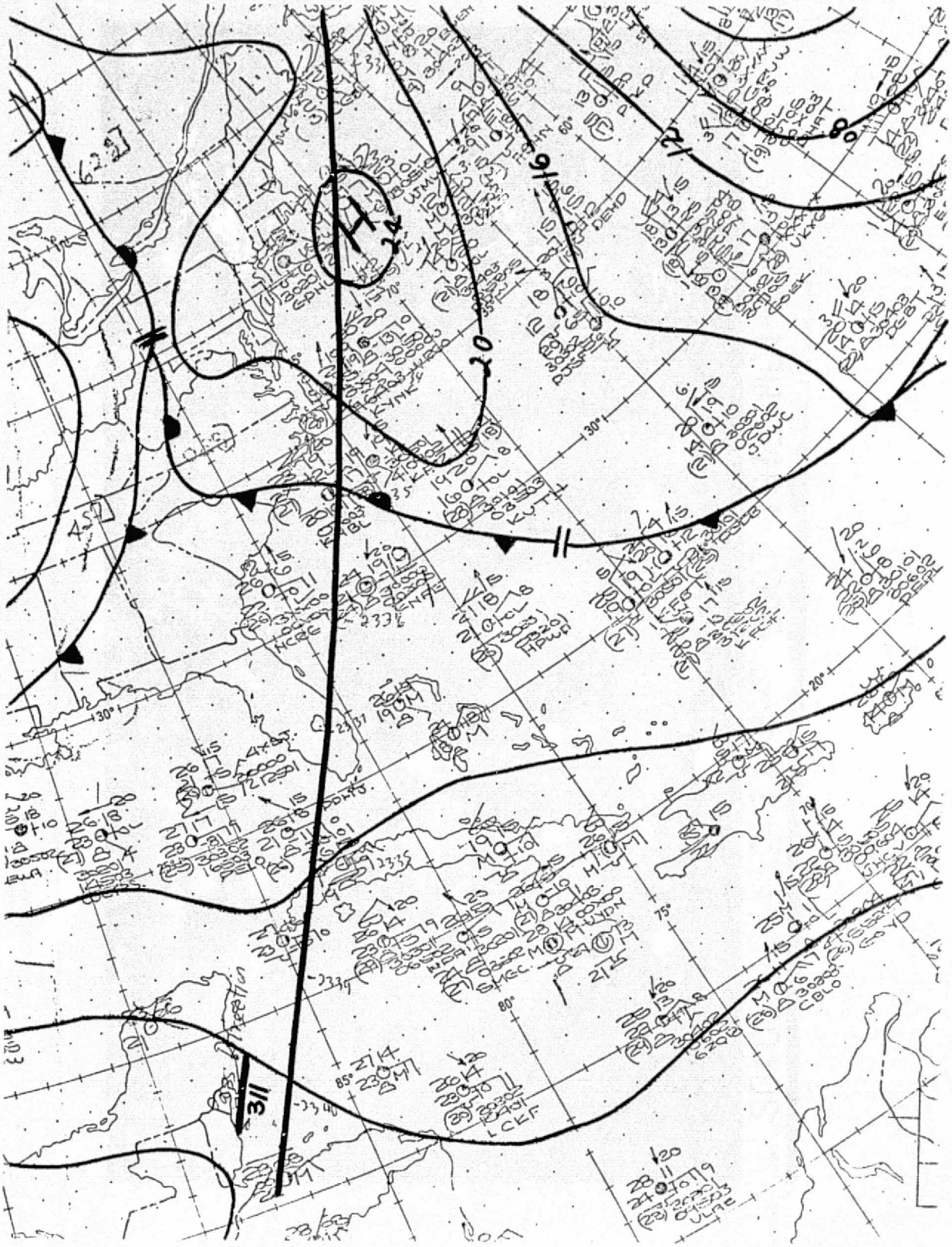
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

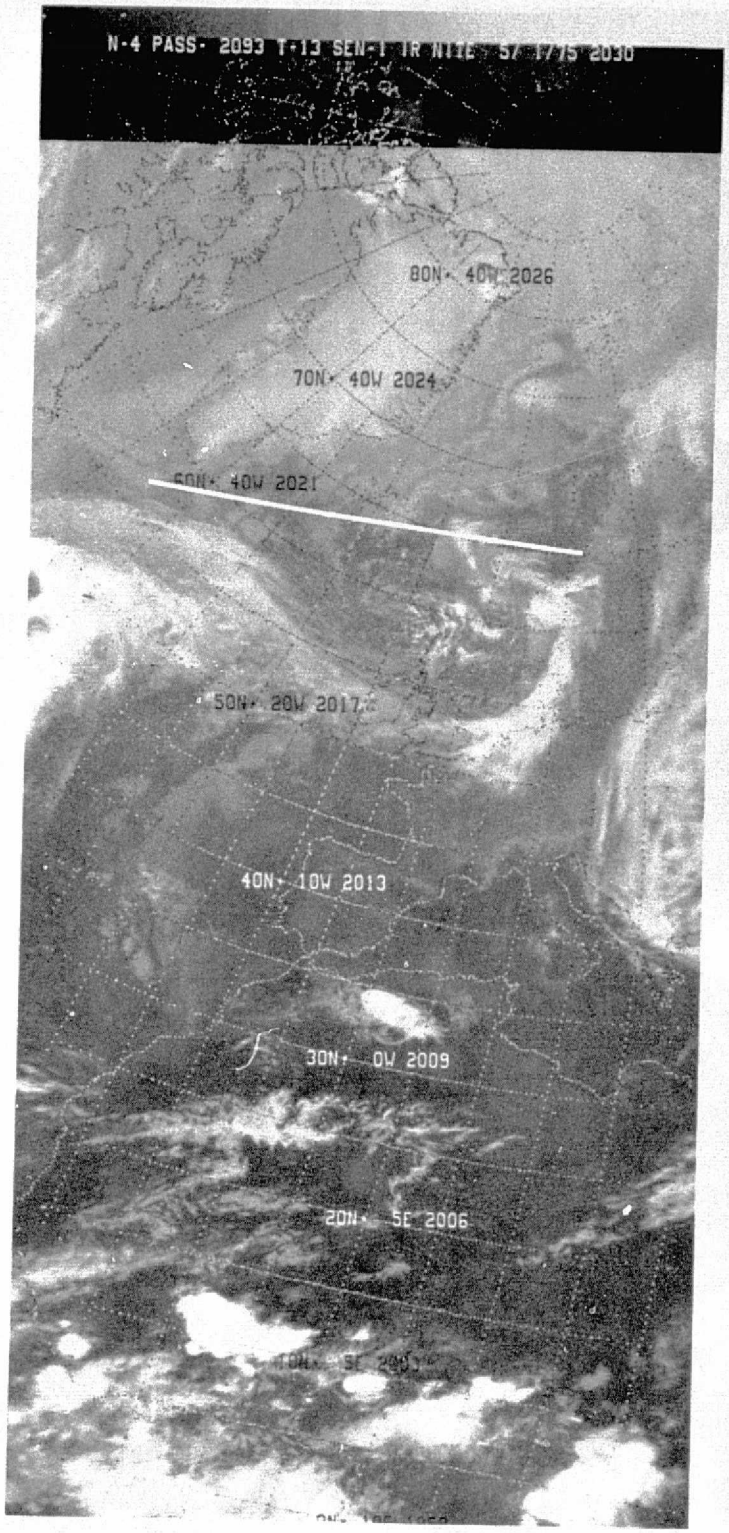


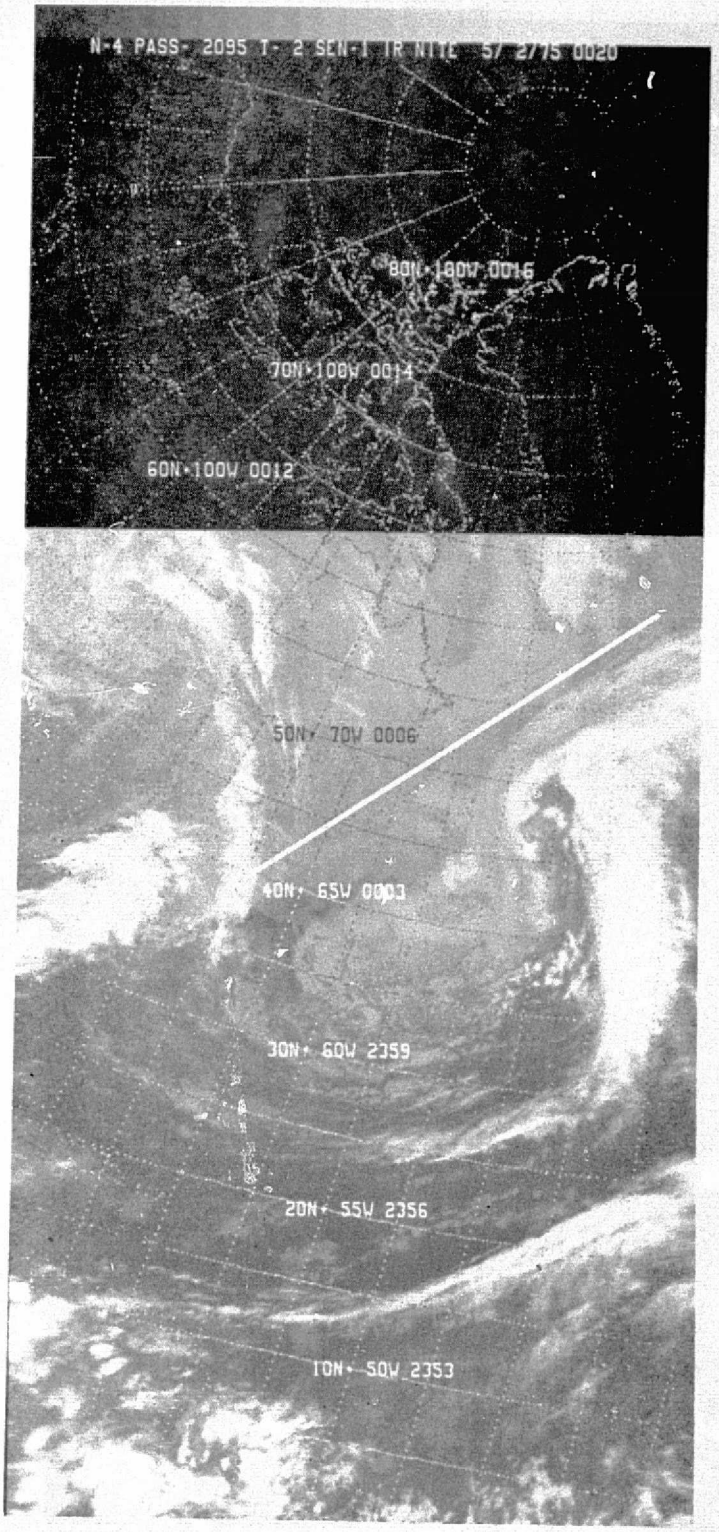
Track 311 extends from Norway to eastern Canada and down the east coast of the U. S. across Florida and Cuba into Central America For the most part winds are light and reach 25 knots at two locations south of Greenland . ½ meter swells are encountered south of Greenland and north of Great Britain.

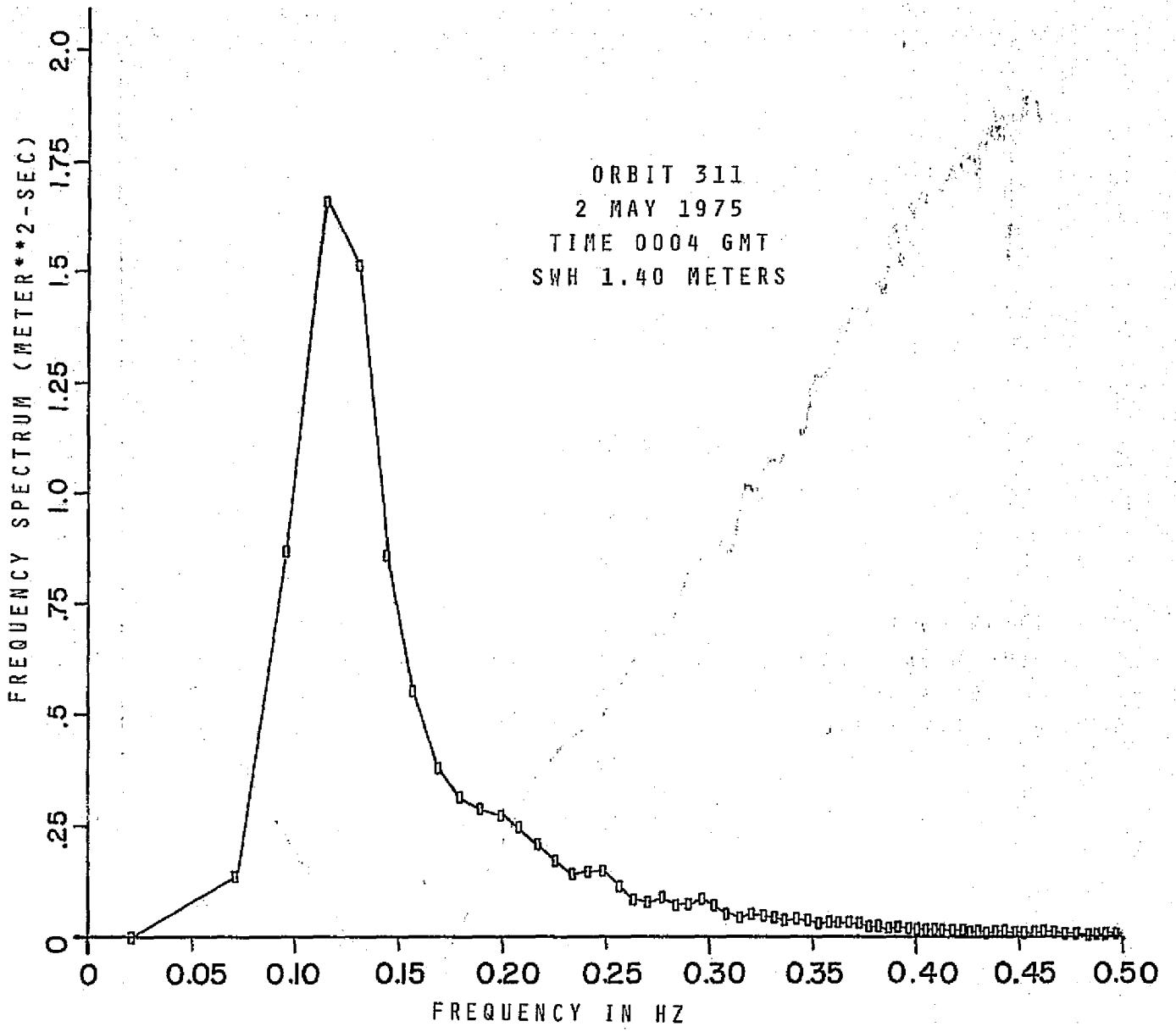


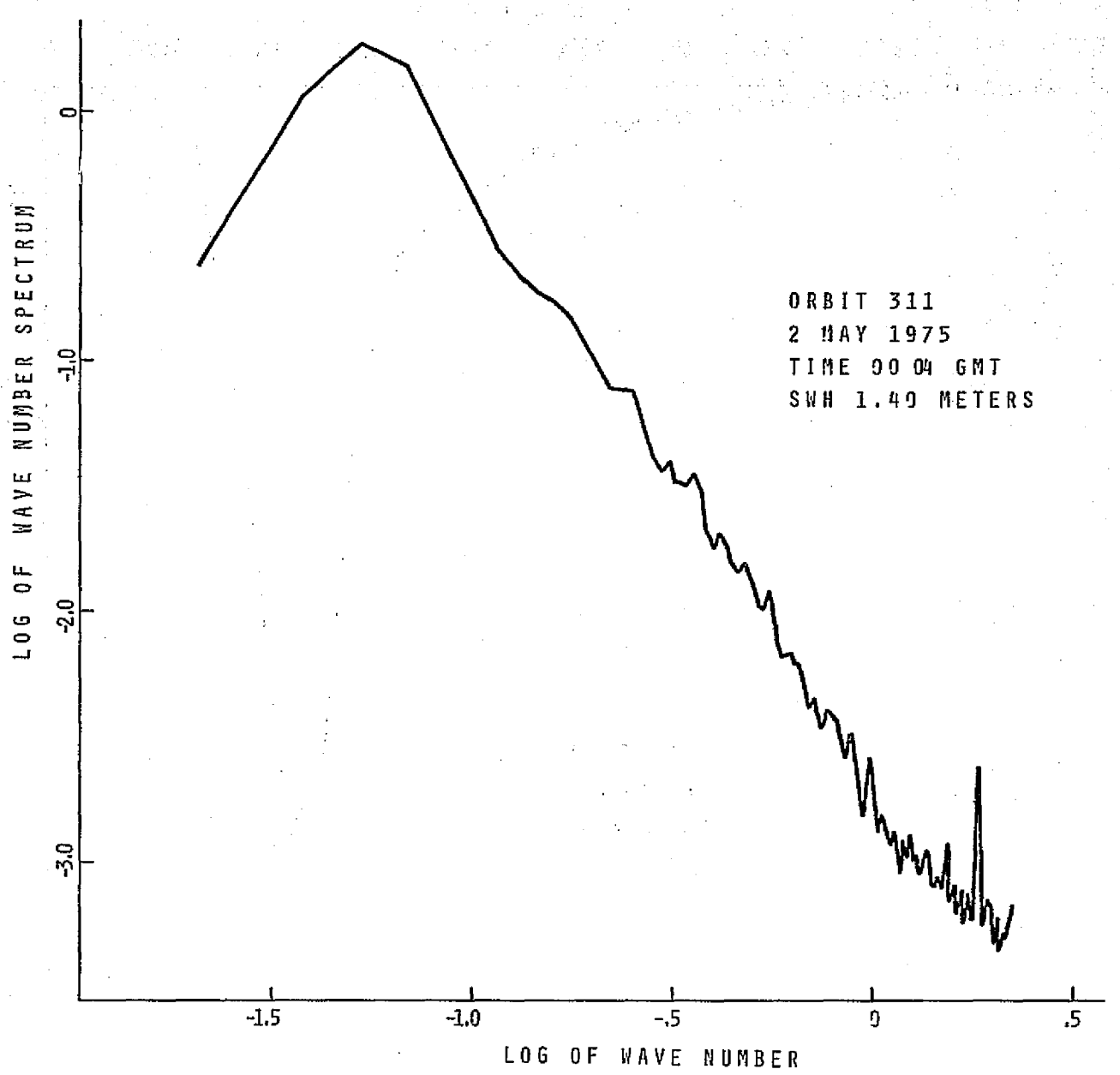

Clear
½-3
calm
½-3
calm
½-3
calm
½-3
calm
Cloudy
½-3
calm
Stationary Front
25°N.
65°W.
calm
calm
30°N.
85°W.
½-3
calm
Mostly Clear
½-3
calm
½-3
calm
½-3
calm




N-4 PASS- 2093 T-13 SEN-1 IR NITE 57 1775 2030
80N- 40W 2026
70N- 40W 2024
60N- 40W 2021
50N- 20W 2017
40N- 10W 2013
30N- 0W 2009
20N- 5E 2006




ORBIT 311
2 MAY 1975
TIME 0004 GMT
SWH 1.40 METERS
FREQUENCY SPECTRUM (METER**2-SEC)
0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
FREQUENCY IN HZ


LOG OF WAVE NUMBER SPECTRUM
0
-1.0
-2.0
-3.0
-1.5
-1.0
-.5
0
.5
LOG OF WAVE NUMBER
ORBIT 311
2 MAY 1975
TIME 00 04 GMT
SWH 1.40 METERS

GROUND TRUTH DATA SET 18

(Track 324)

Track 324 extends southwest from Norway into the central North Atlantic passing over an area of 20-30 knots of southerly winds with seas up to 5 meters in height. There are three small areas of scattered showers along the track.

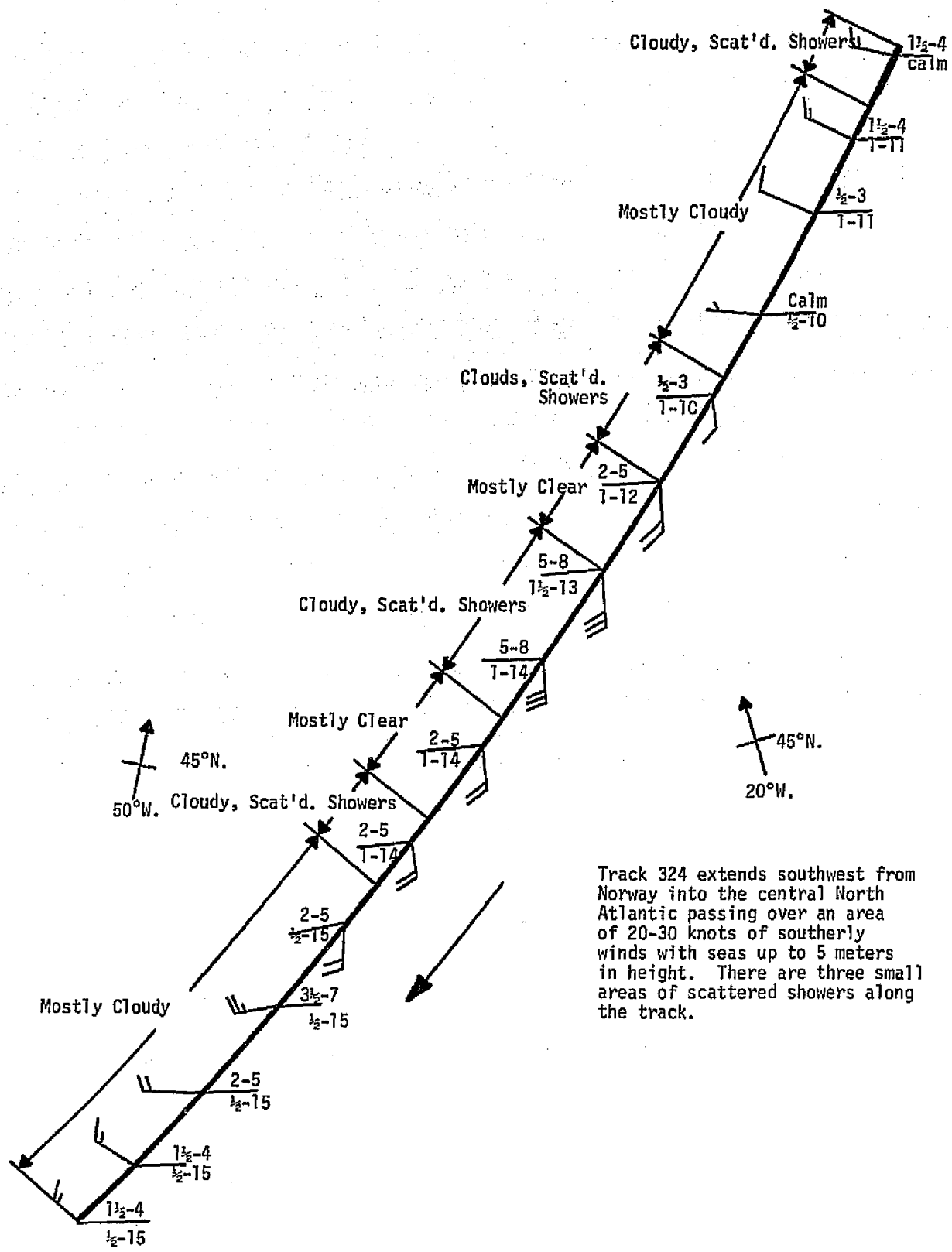
OVERLAY SYMBOLISM

Wind Conditions

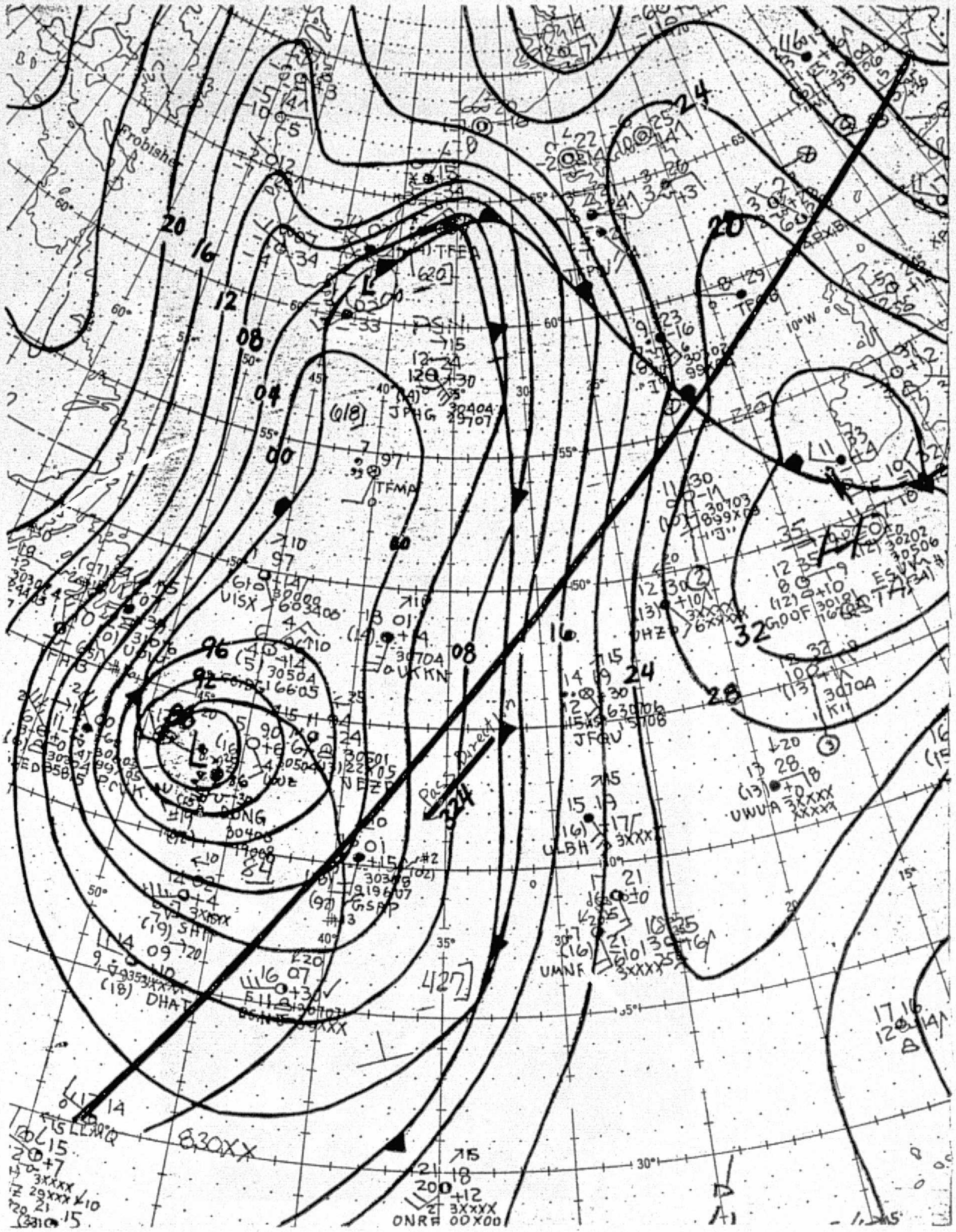
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

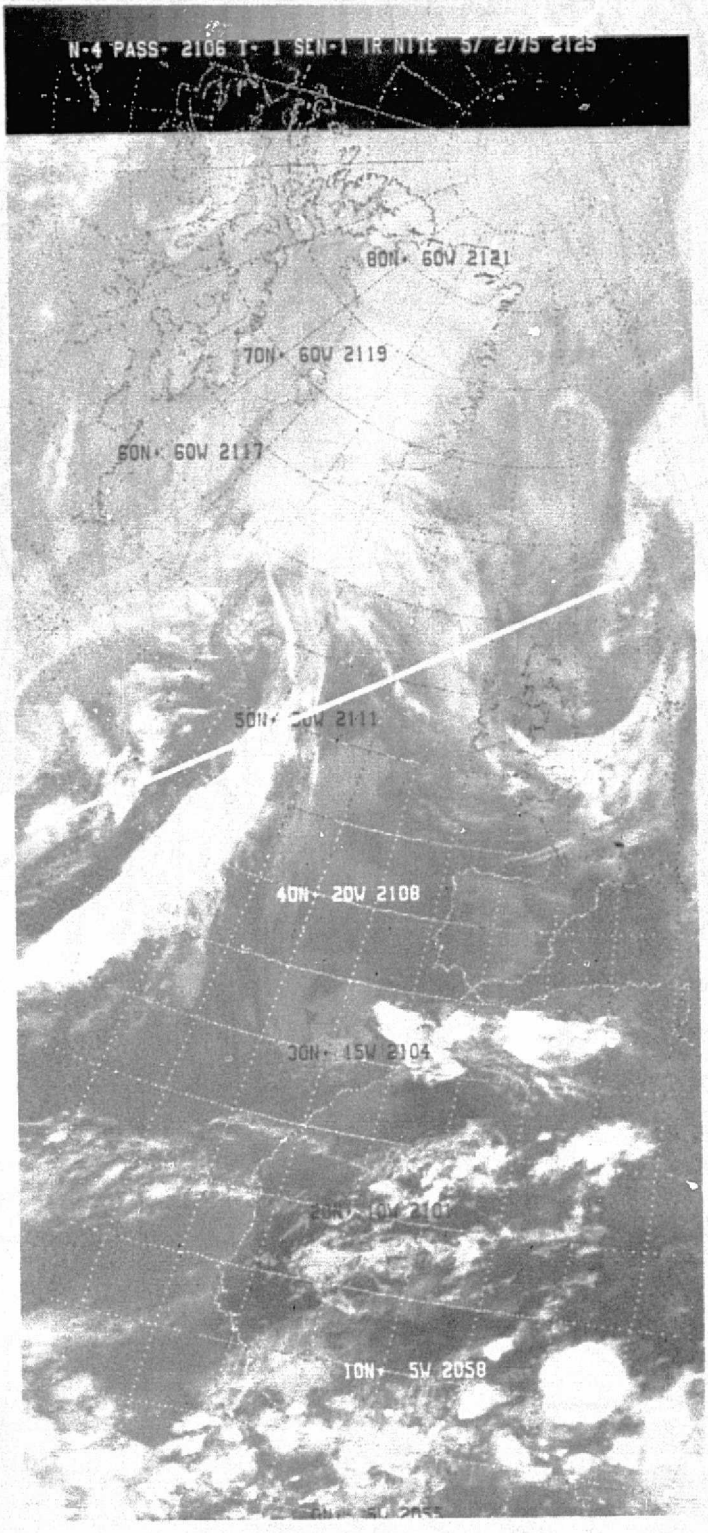
Sea Conditions

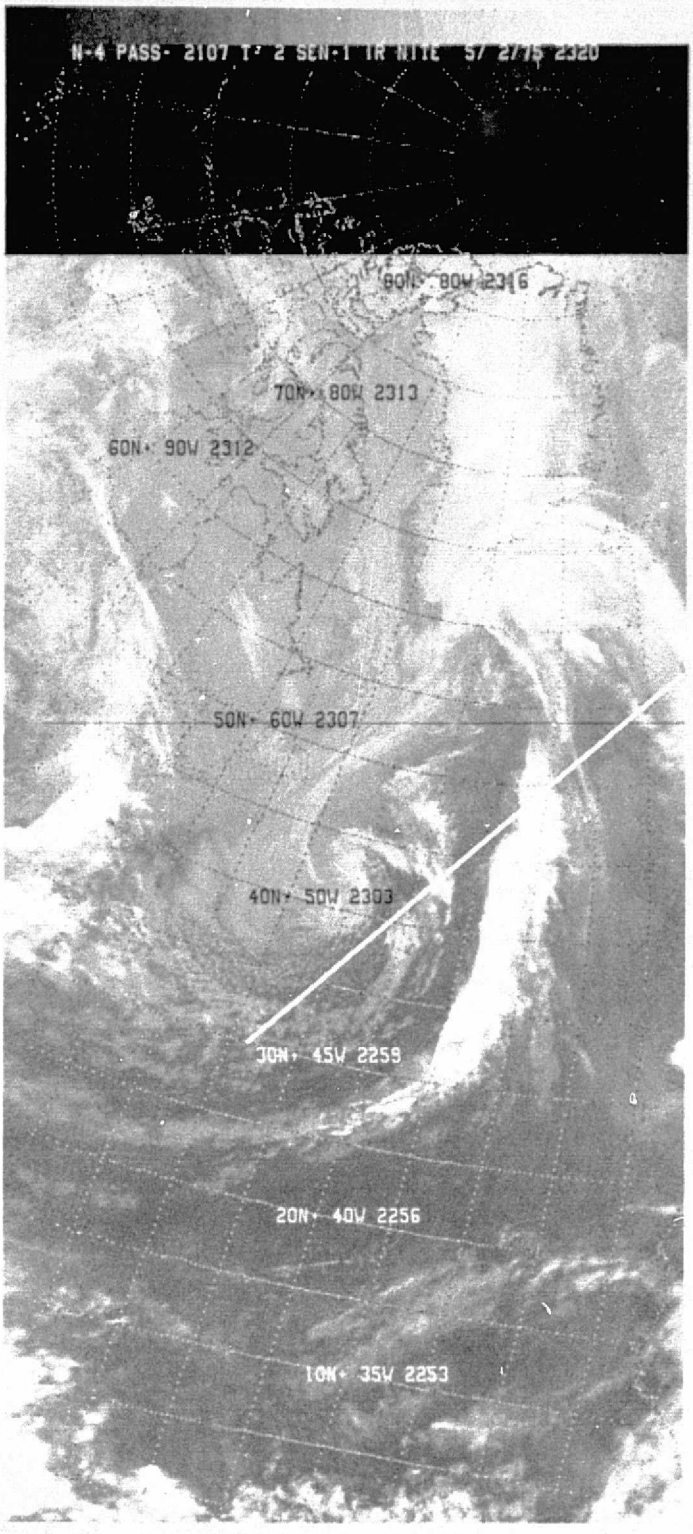
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.



Track 324 extends southwest from Norway into the central North Atlantic passing over an area of 20-30 knots of southerly winds with seas up to 5 meters in height. There are three small areas of scattered showers along the track.


Frobisher
TFEA
JPHG
TFMA
UKKN
PCUK
DONG
GSAP
UMNF
ULBH
UWUA
JFQU
Past Direction
324
ONRF





GROUND TRUTH DATA SET 19

(Track 329)

Track 329 passes from the northwestern African coast toward the northeastern Canadian coast. It passes over two areas of strong winds (up to 30 knots). The 30 knot wind off the African coast is duration and fetch limited and therefore did not develop fully arisen seas. The mid-North Atlantic case is not fetch limited and fully arisen seas are indicated.

OVERLAY SYMBOLISM

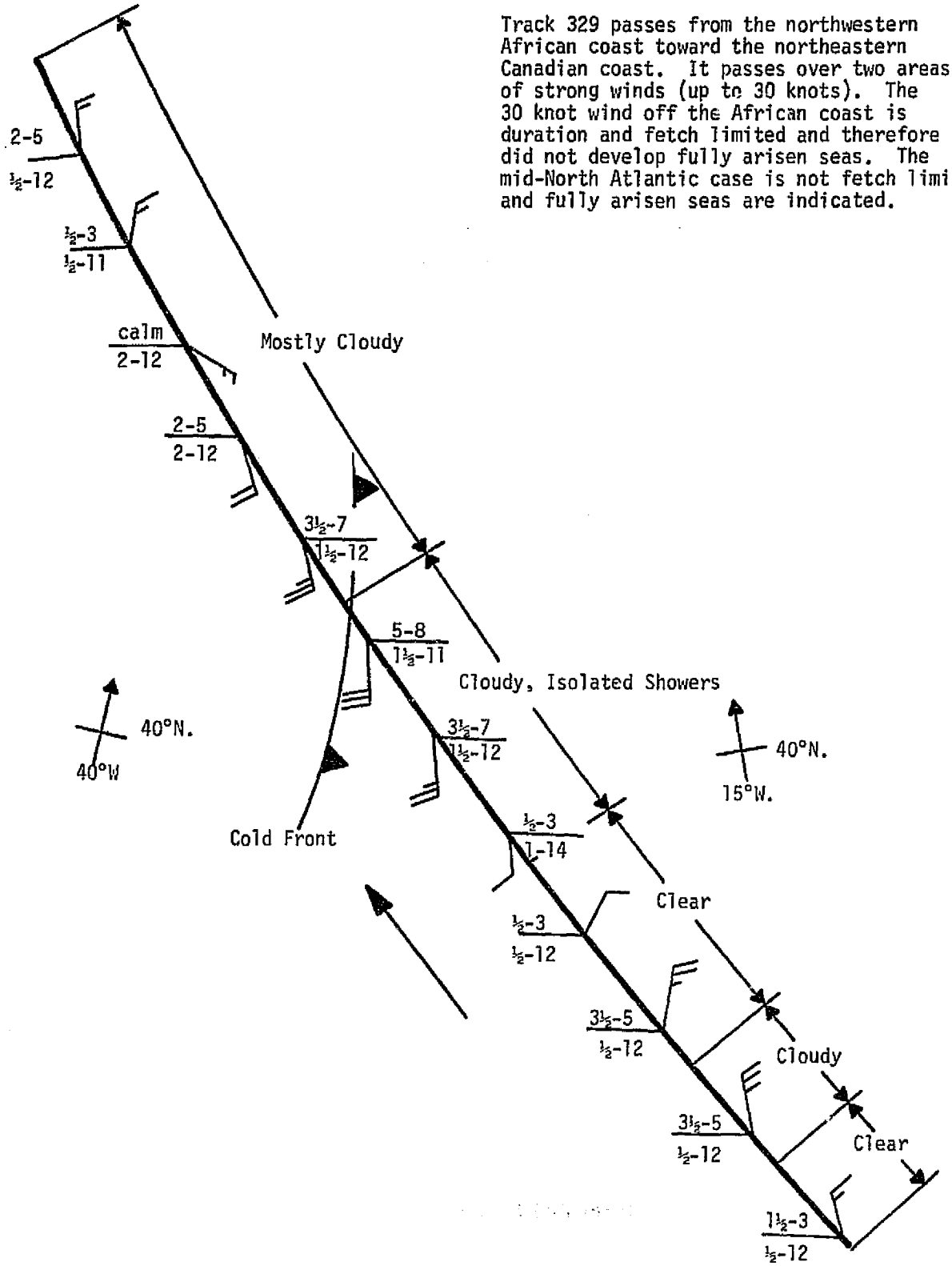
Wind Conditions

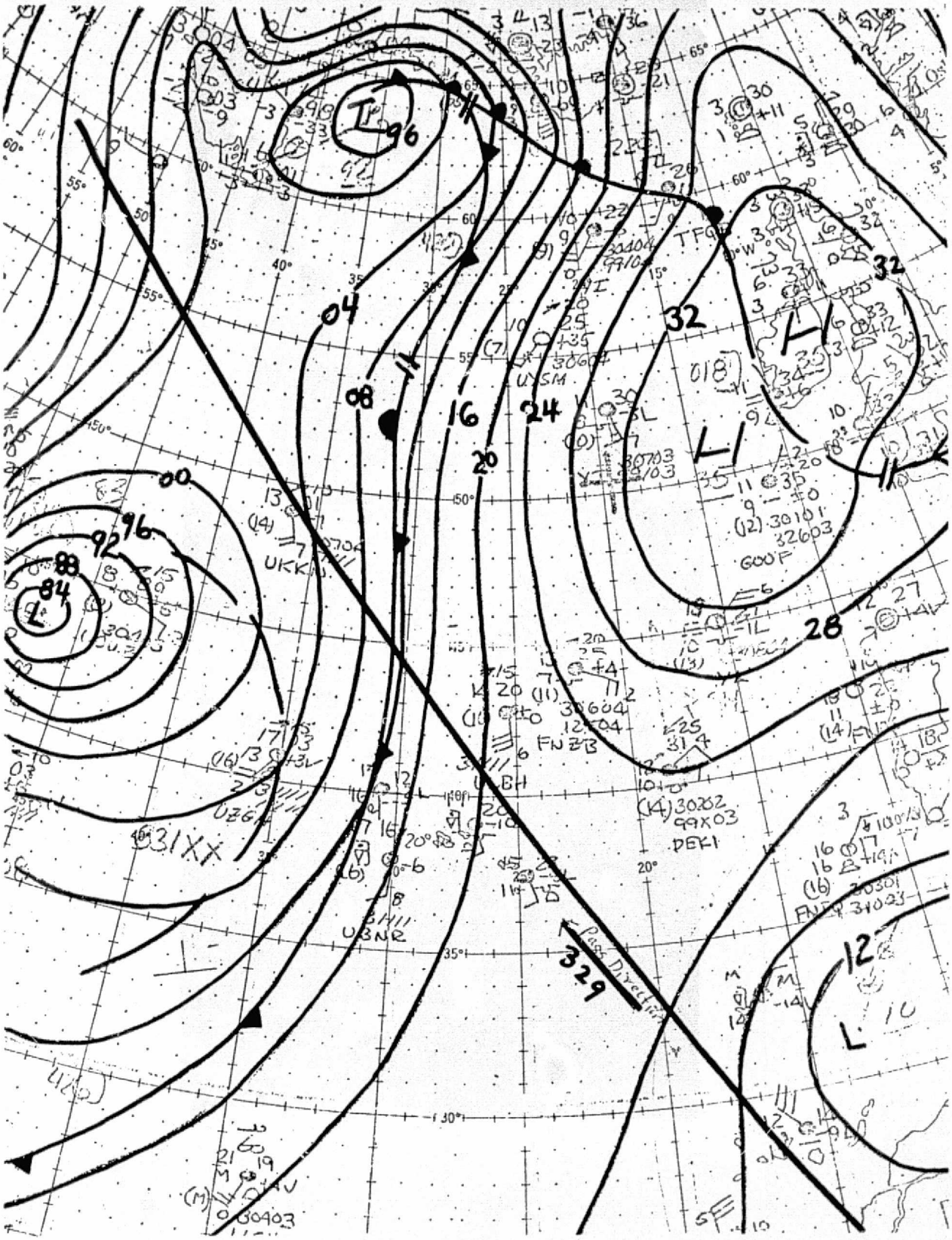
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

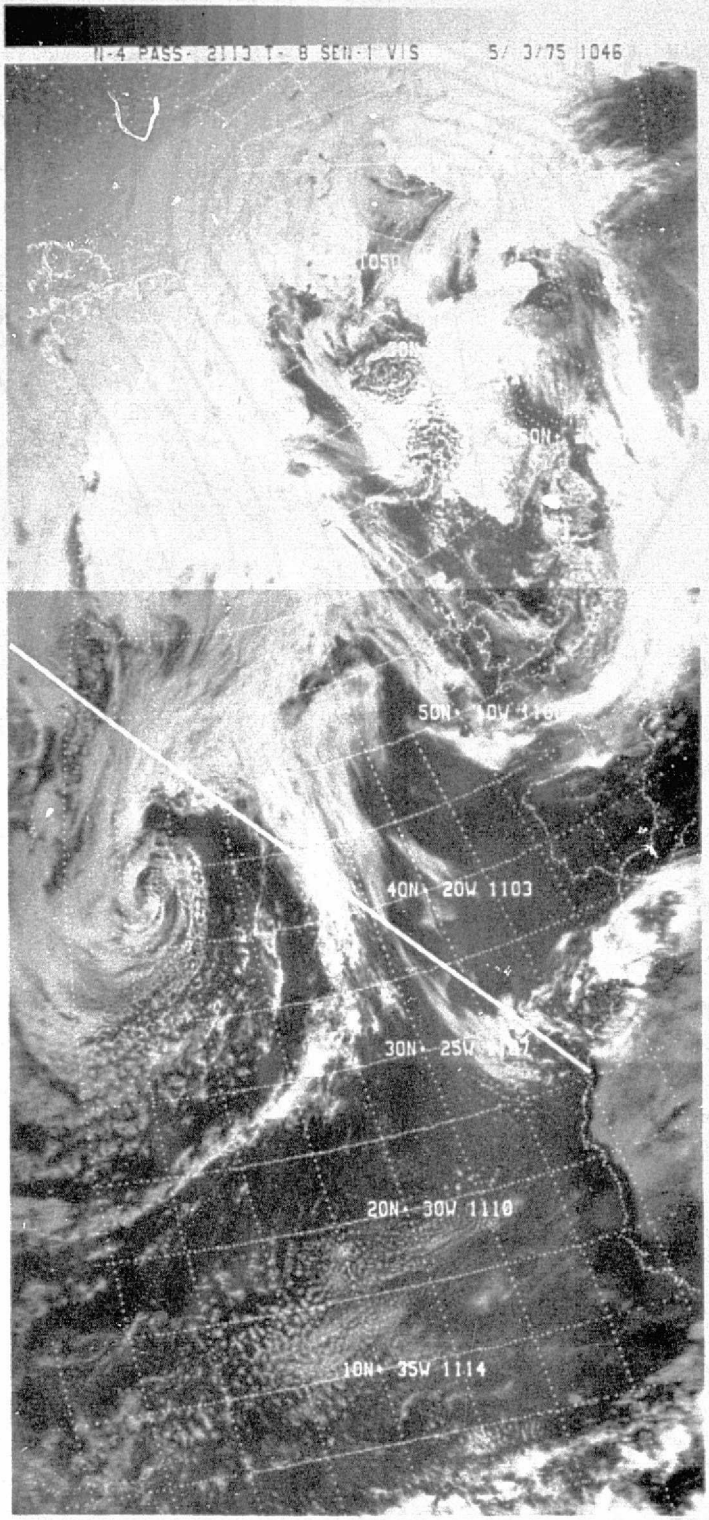
Sea Conditions

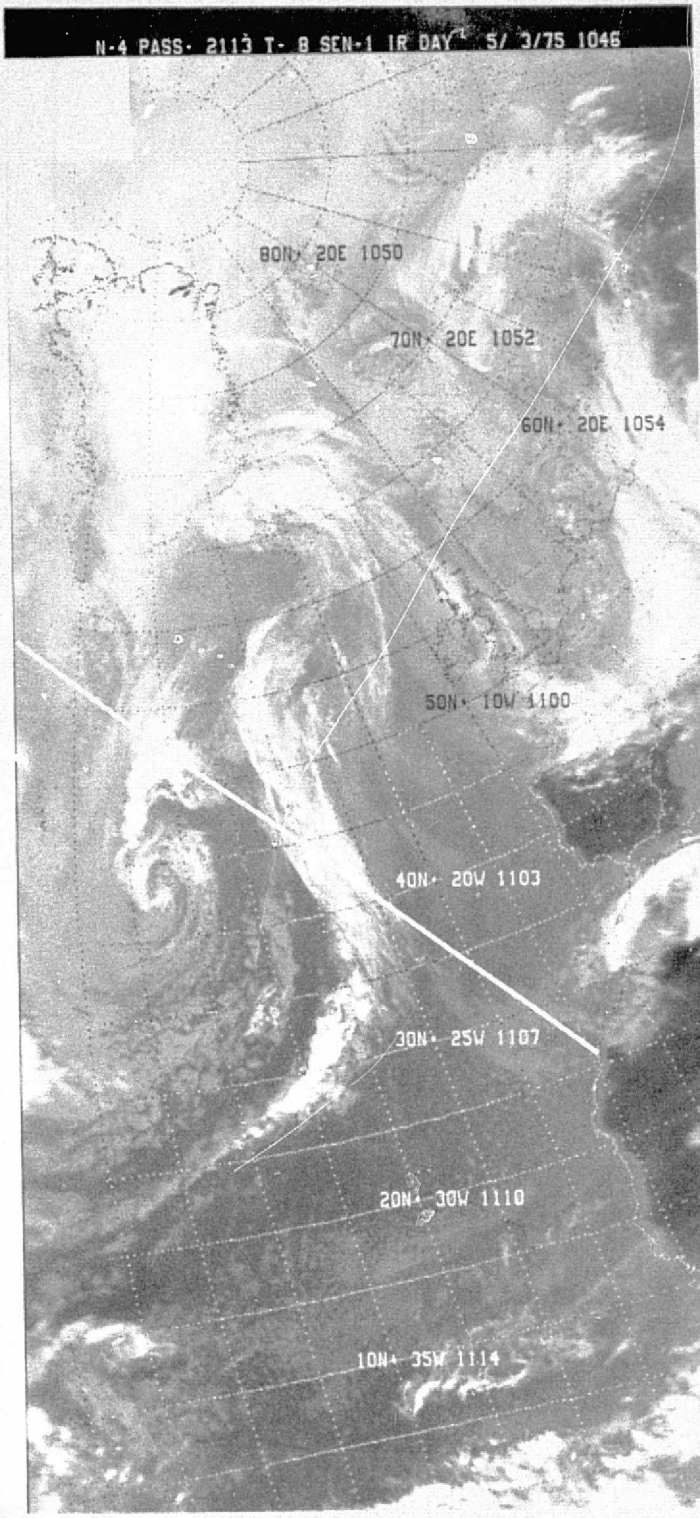
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

Track 329 passes from the northwestern African coast toward the northeastern Canadian coast. It passes over two areas of strong winds (up to 30 knots). The 30 knot wind off the African coast is duration and fetch limited and therefore did not develop fully arisen seas. The mid-North Atlantic case is not fetch limited and fully arisen seas are indicated.









GROUND TRUTH DATA SET 20

(Track 342)

Track 342 passes off the west central coast of France, then over southern Ireland and into southern Greenland. The weather in this area provides a combination of seas up to three meters and swell up to two meters.

OVERLAY SYMBOLISM

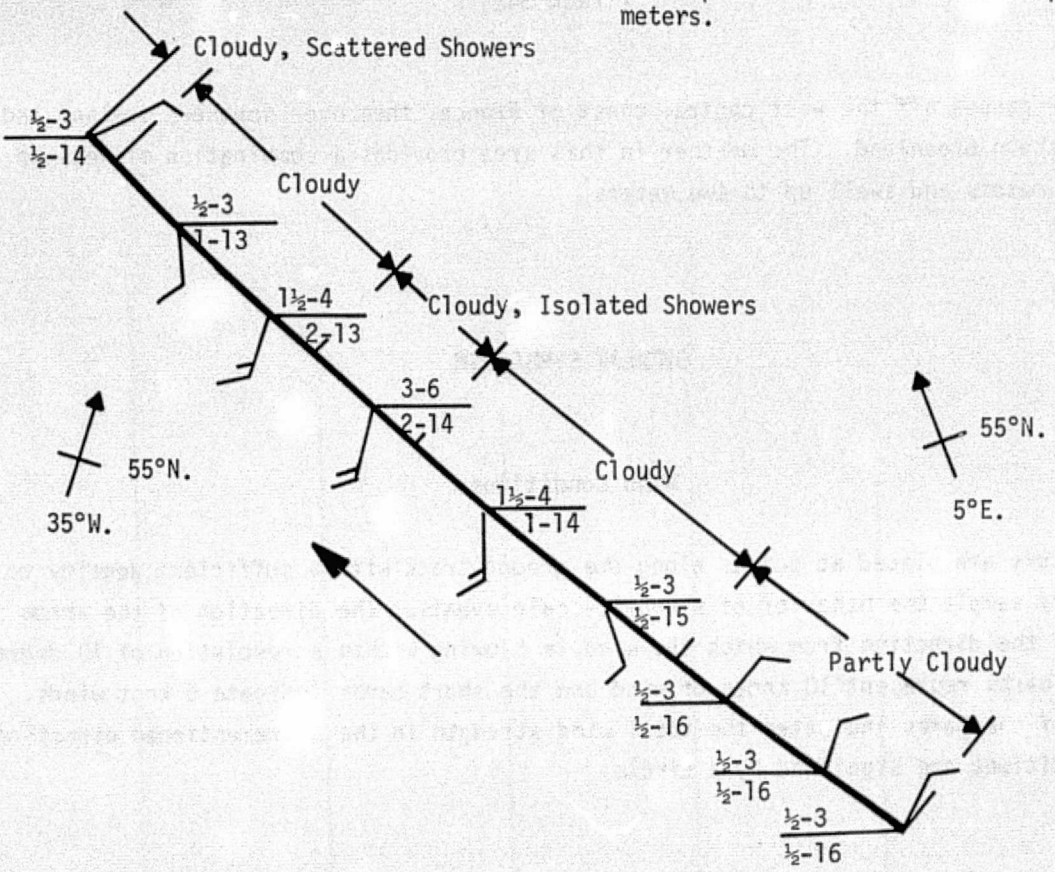
Wind Conditions

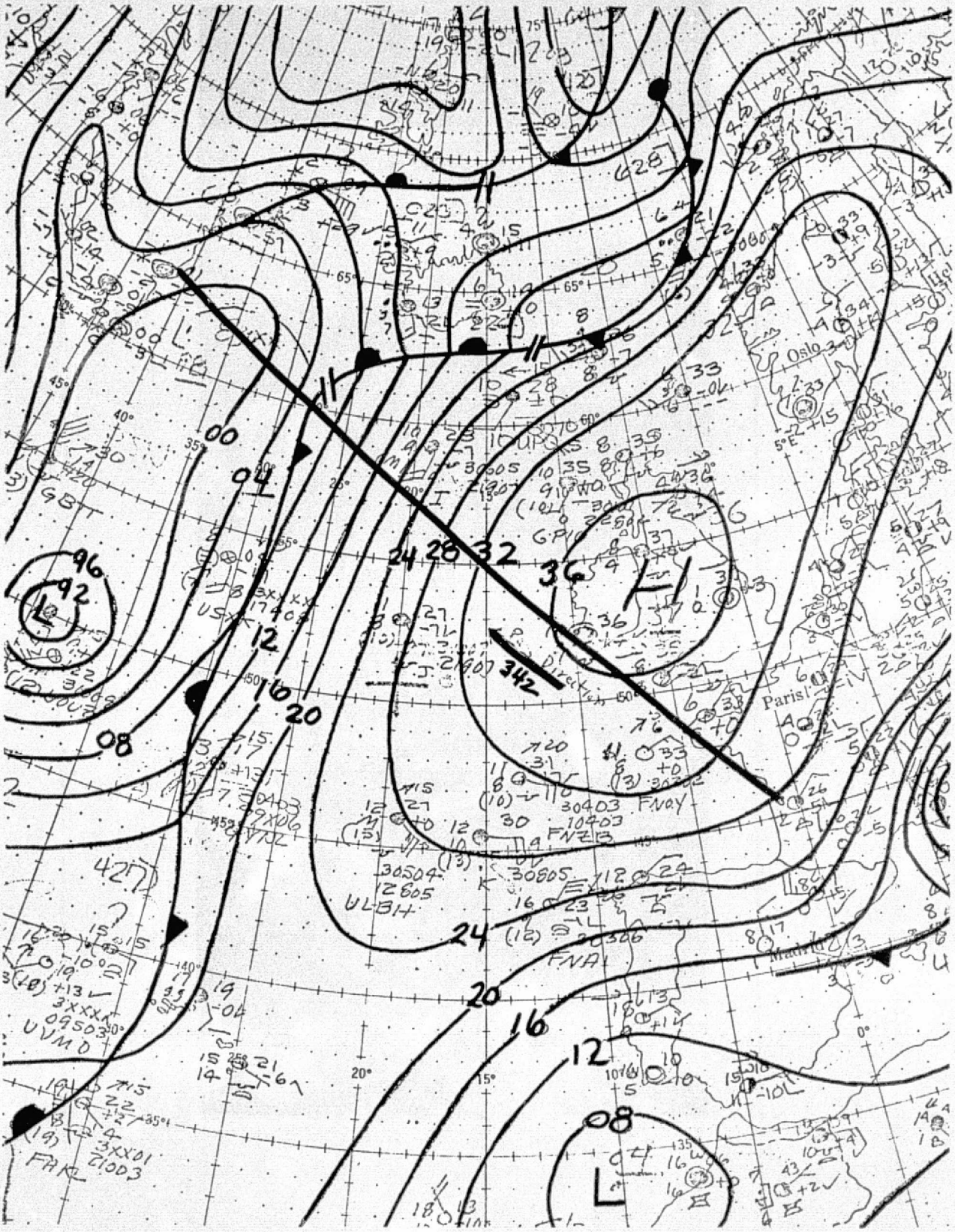
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

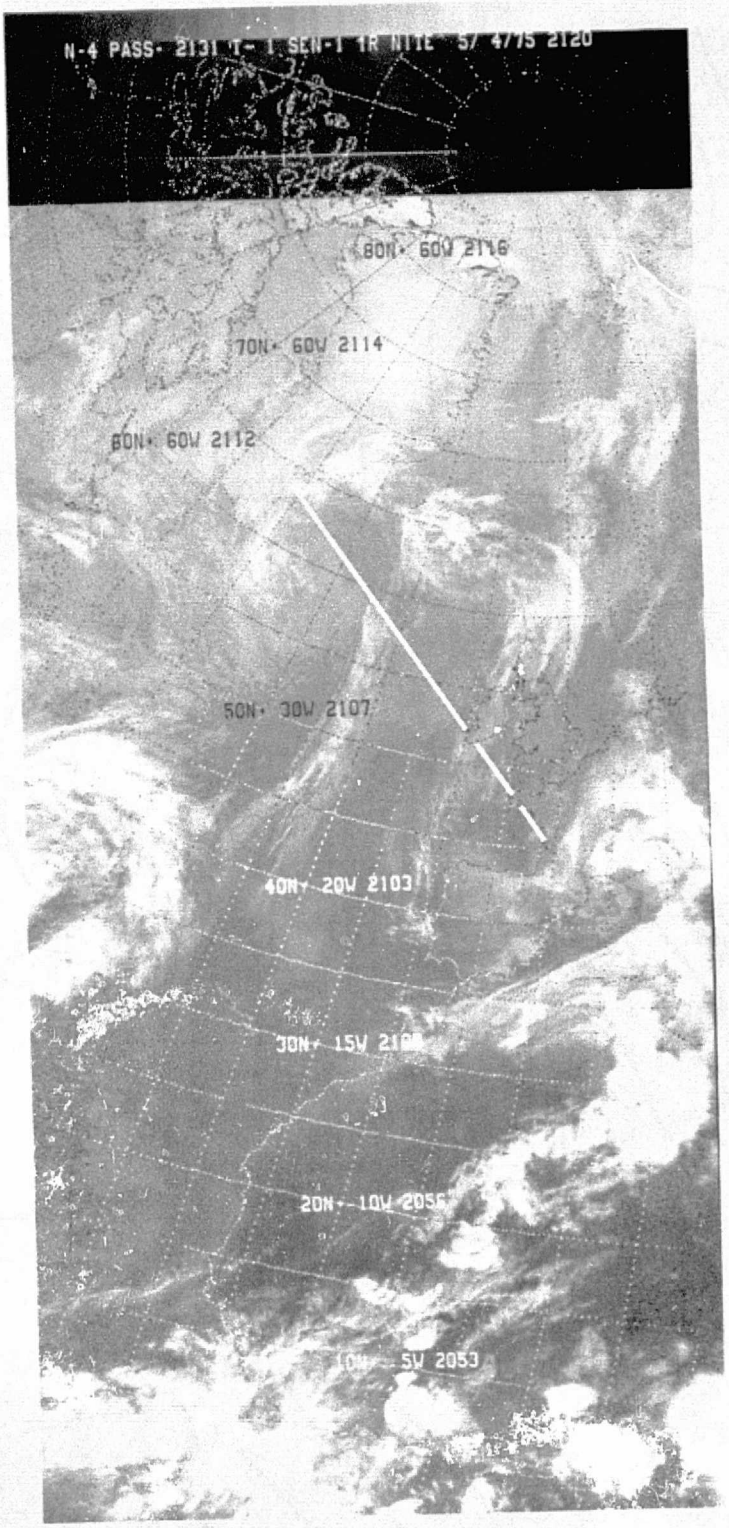
Sea Conditions

At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

Track 342 passes off the west central coast of France, then over southern Ireland and into southern Greenland. The weather in this area provides a combination of seas up to 3 meters and swell up to two meters.







GROUND TRUTH DATA SET 21
(Track 348)

Track 348 passes from the eastern North Pacific northwest across the Aleutian Islands to Russia. Maximum winds along the track are about 25 knots with seas up to three meters. Swell also as high as three meters is found at one point on the track.

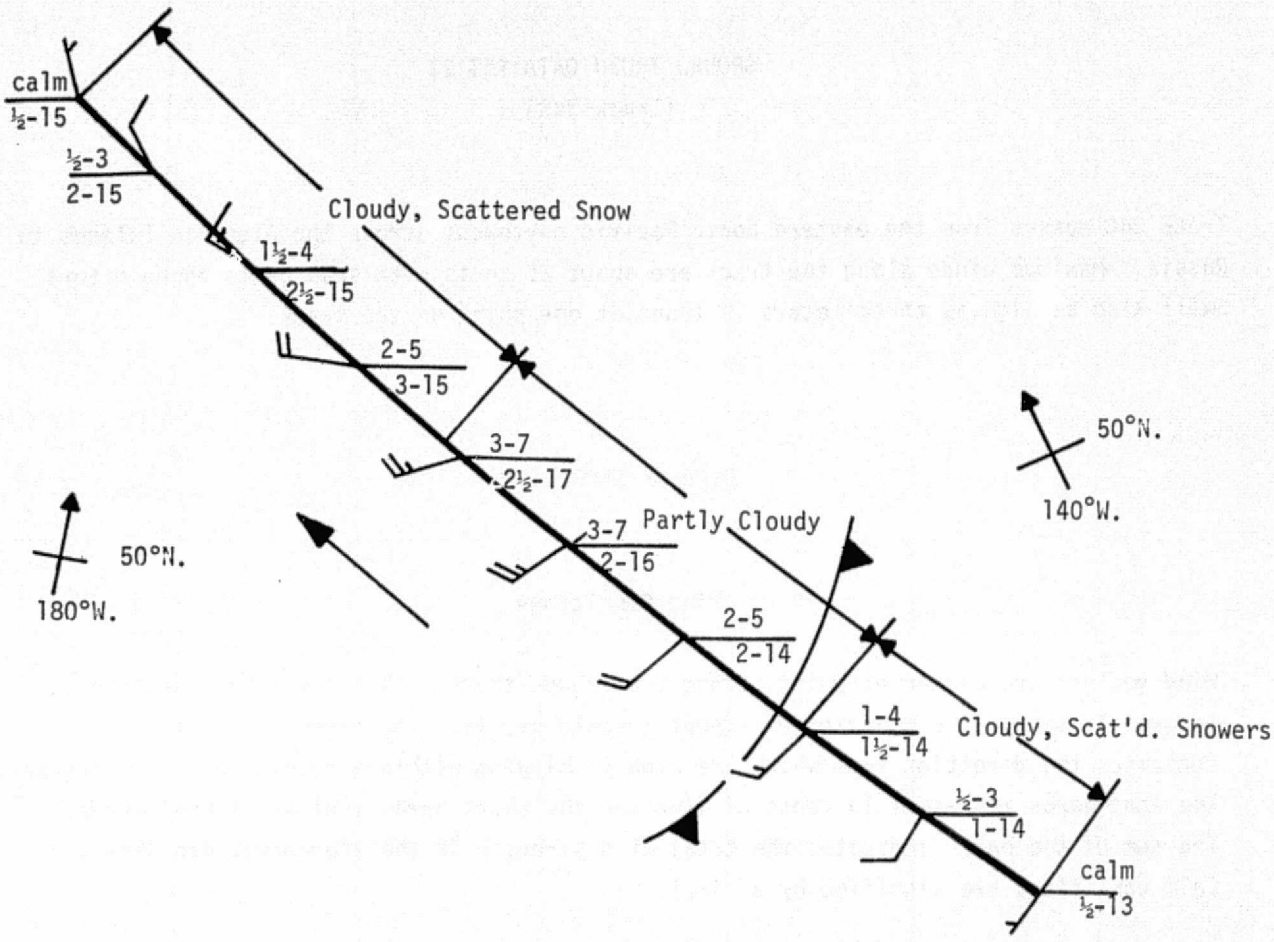
OVERLAY SYMBOLISM

Wind Conditions

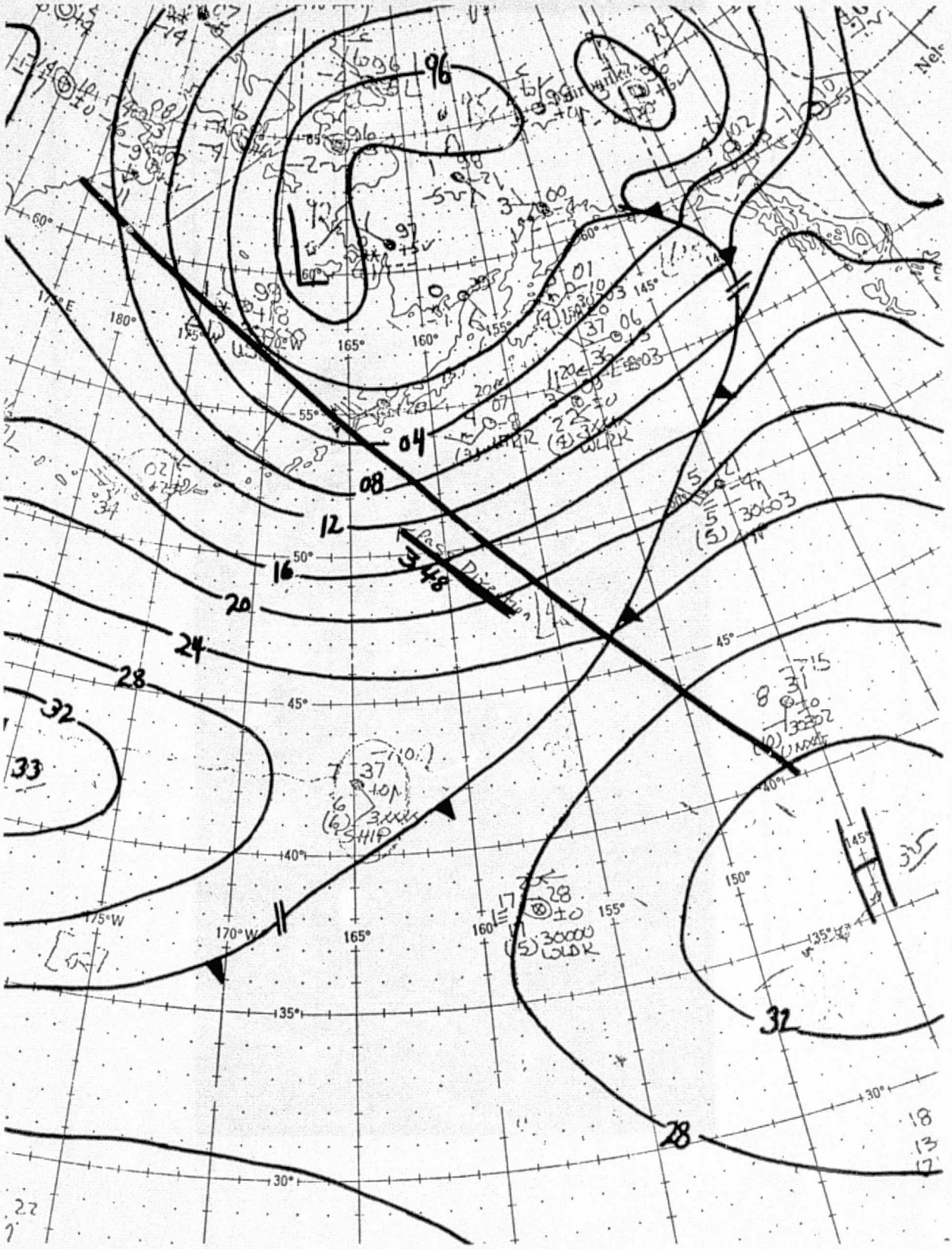
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

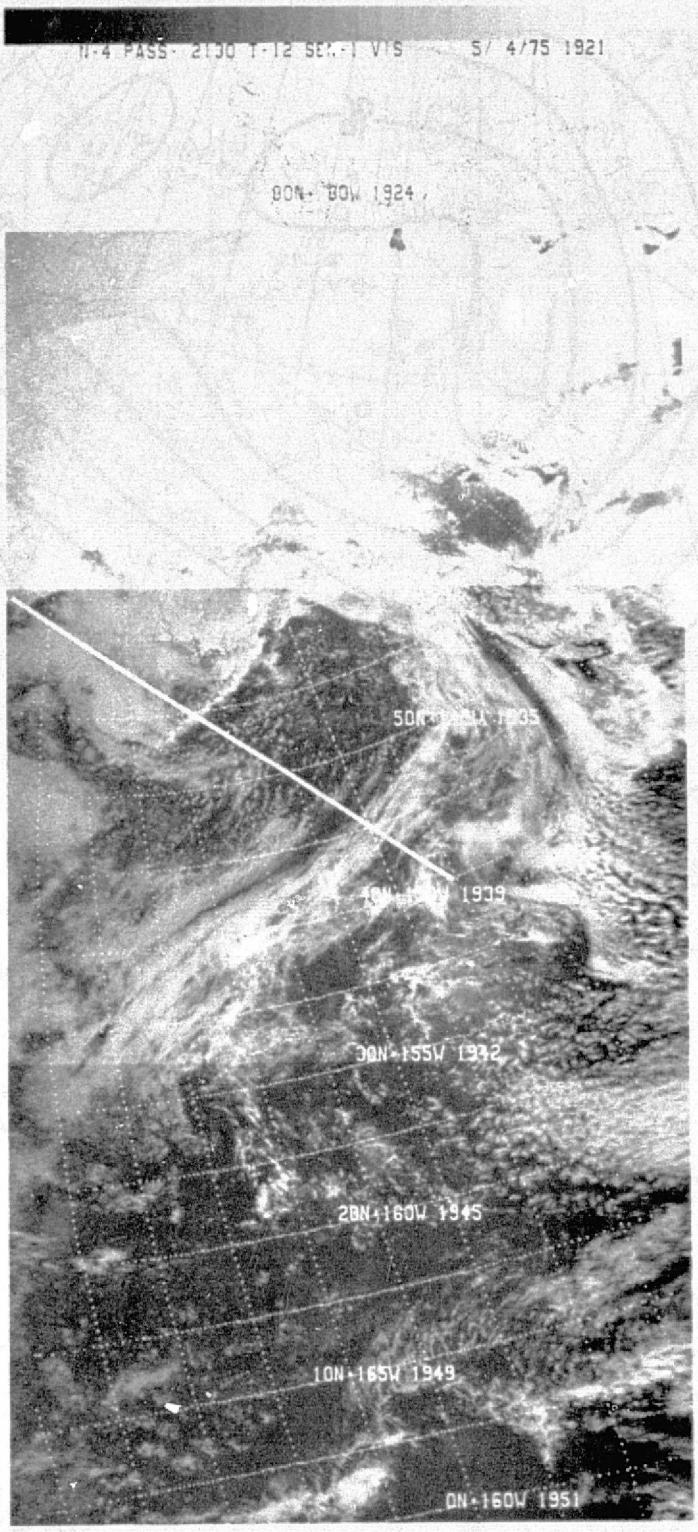
Sea Conditions

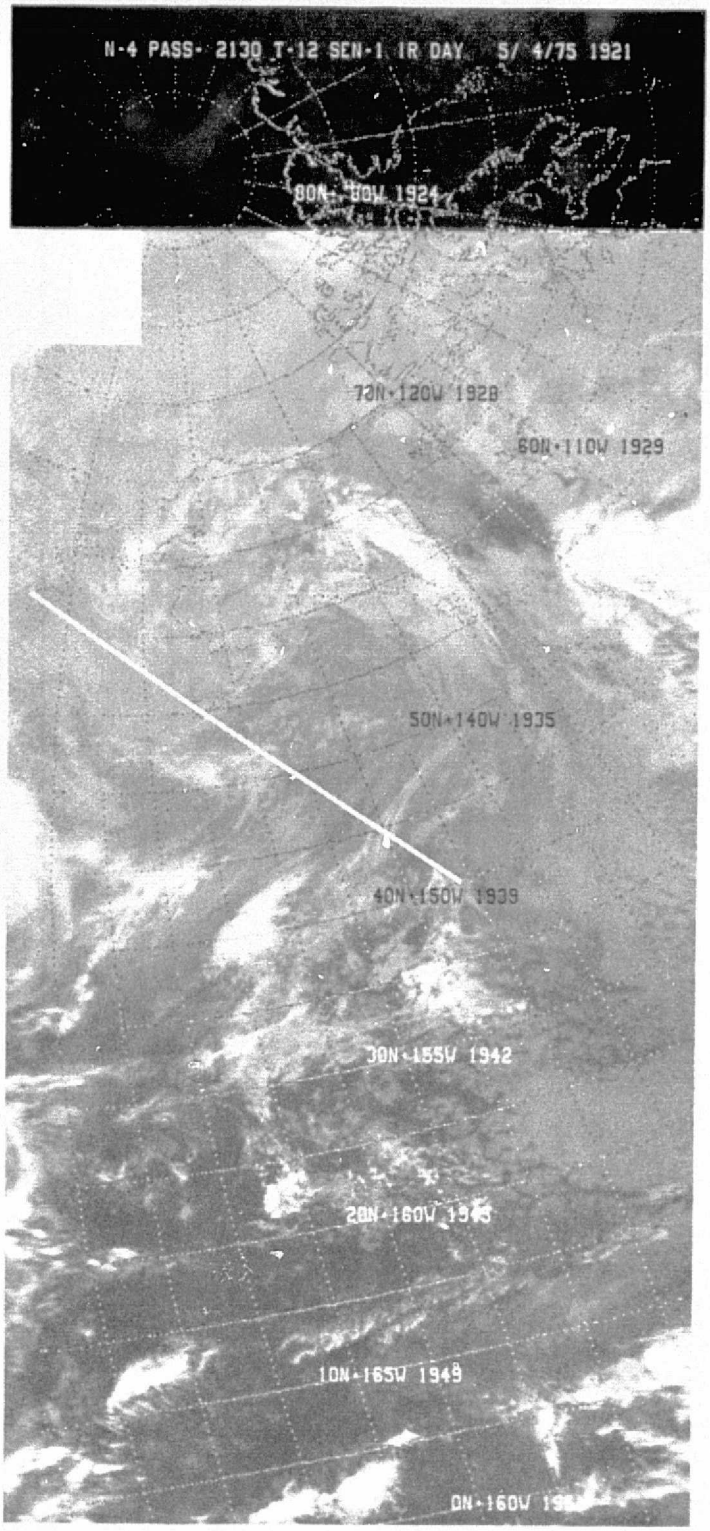
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.



Track 348 passes from the eastern North Pacific northwest across the Aleutian Islands to Russia. Maximum winds along the track are about 25 knots with seas up to three meters. Swell also as high as three meters is found at one point on the track.


96
04
08
12
16
20
24
28
32
33
60°
55°
50°
45°
40°
35°
30°
175°E
180°
175°W
170°W
165°
160°
155°
150°
145°





GROUND TRUTH DATA SET 22

(Track 368)

Track 368 extends westward from Norway through Iceland, ending at Labrador. A deep low pressure system is located on the southeast coast of Greenland causing winds up to 45 knots between Greenland and Iceland. The 7½ and 8 meter seas in this area are duration limited and therefore not fully developed.

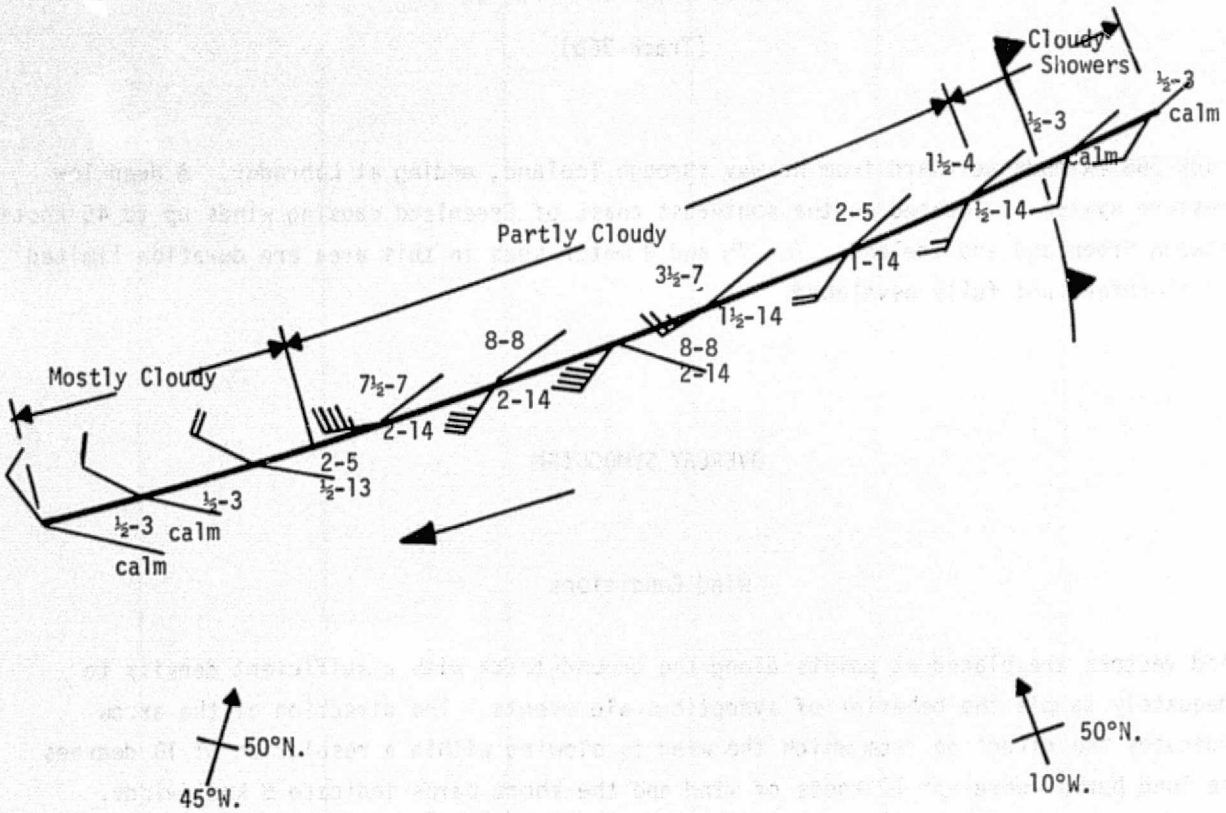
OVERLAY SYMBOLISM

Wind Conditions

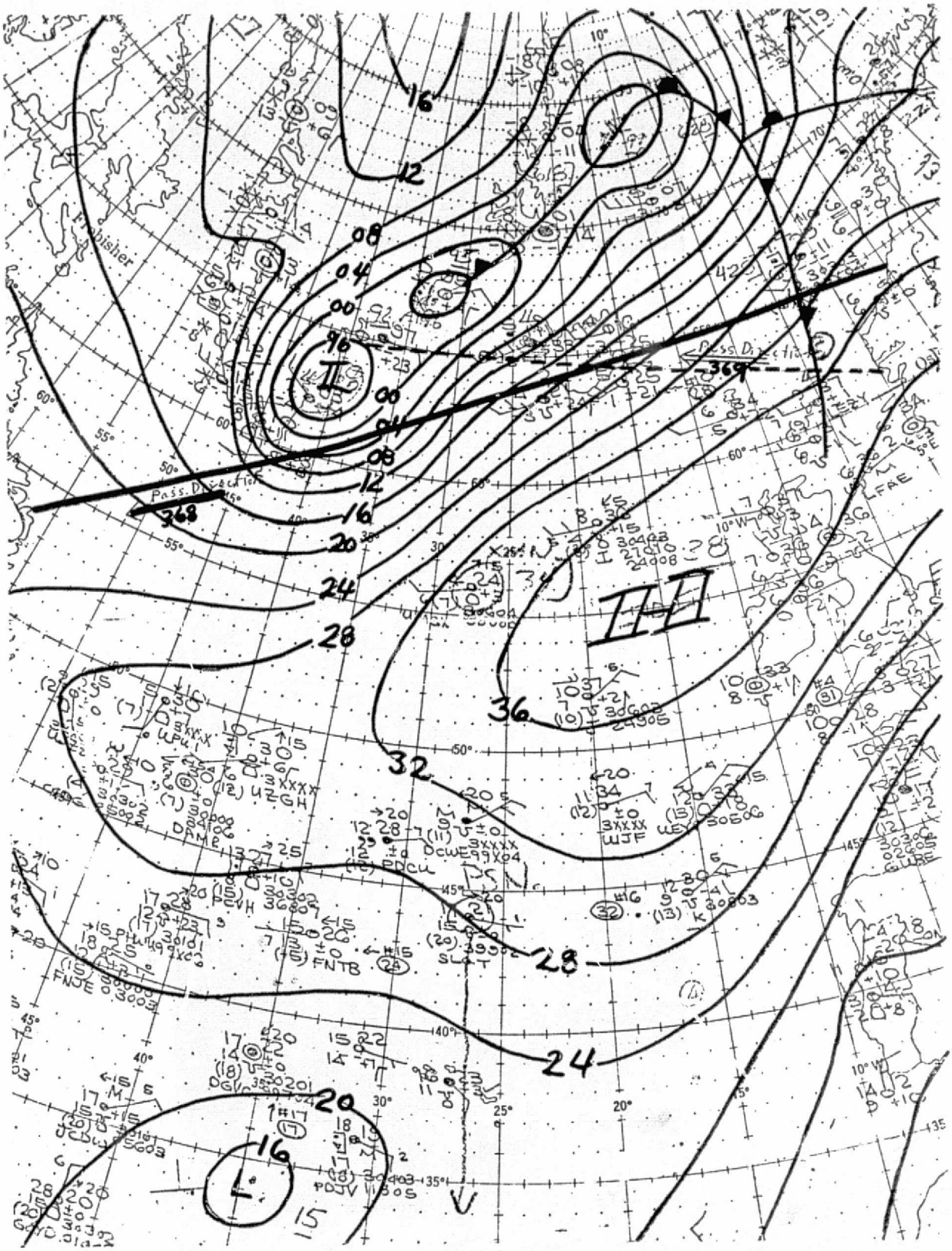
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

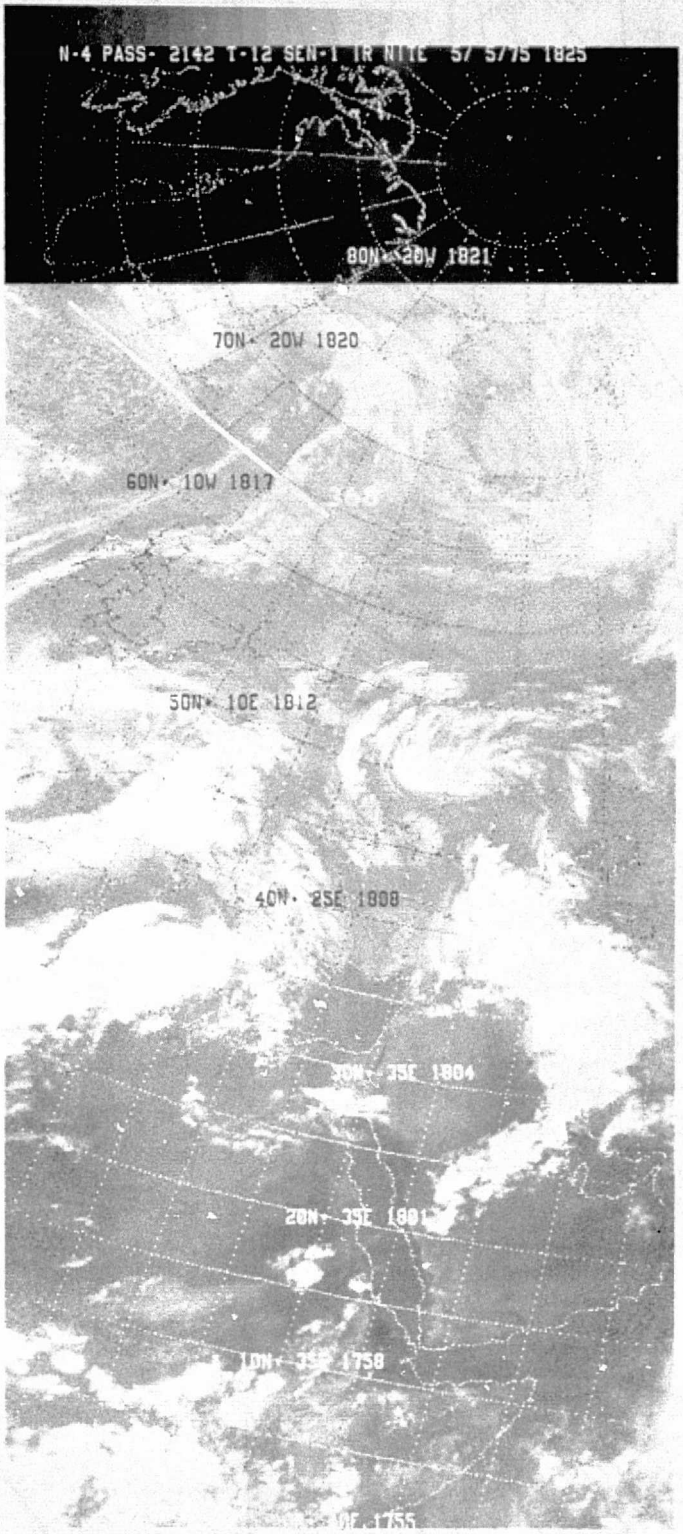
Sea Conditions

At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.



Track 368 extends westward from Norway through Iceland, ending at Labrador. A deep low pressure system is located on the southeast coast of Greenland causing winds up to 45 knots between Greenland and Iceland. The 7½ and 8 meter seas in this area are duration limited and therefore not fully developed.





GROUND TRUTH DATA SET 23

(Track 369)

Track 369 passes from Norway in a westerly direction crossing over Iceland and ending over southern Greenland. A deep low pressure system is located on the southeast coast of Greenland causing winds up to 45 knots between Greenland and Iceland. The 7½ and 8 meter seas in this area are duration limited and therefore not fully developed.

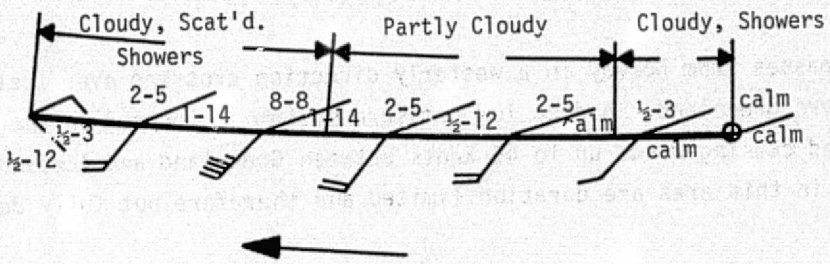
OVERLAY SYMBOLISM

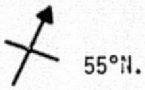
Wind Conditions

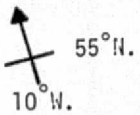
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

Sea Conditions

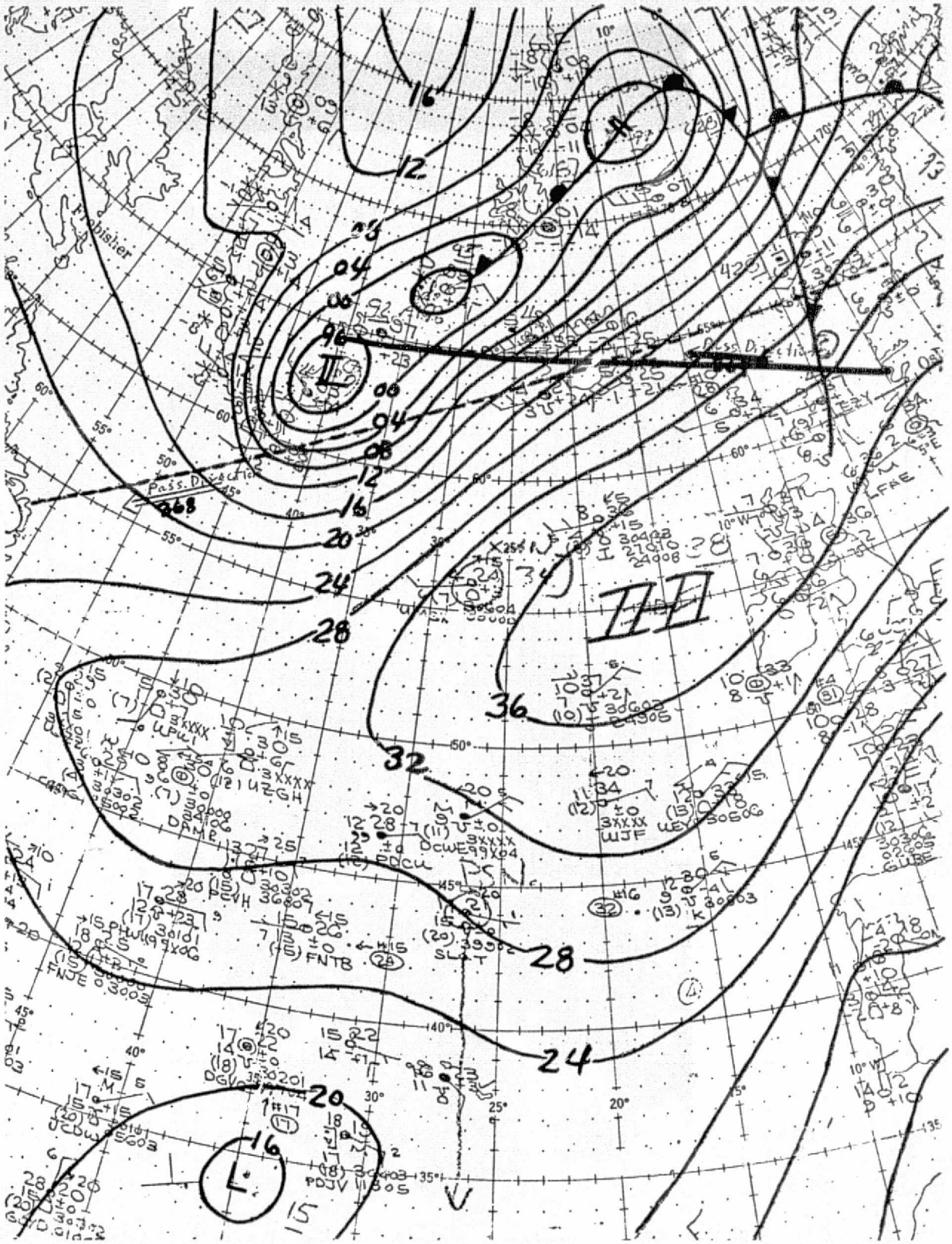
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

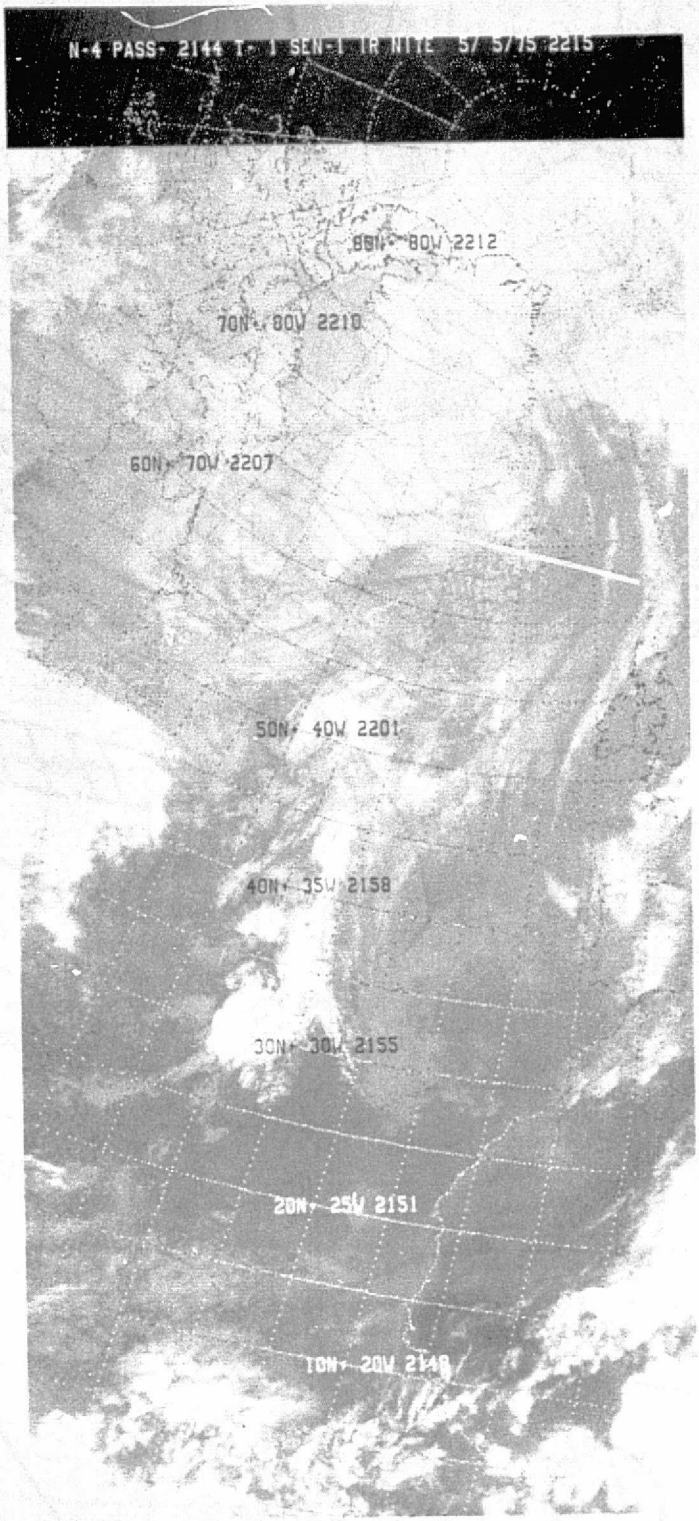






Track 369 passes from Norway in a westerly direction crossing over Iceland and ending over southern Greenland. A deep low pressure system is located on the southeast coast of Greenland causing winds up to 45 knots between Greenland and Iceland. The 7½ and 8 meter seas in this area are duration limited and therefore not fully developed.





GROUND TRUTH DATA SET 24

(Tracks 370 and 371)

Tracks 370 and 371 are non-intersecting orbital paths that approach from the southeast a low pressure system near the coast of Greenland. For track 370, the 30 knot wind in the English Channel is fetch limited, and the seas are not fully developed. Likewise, the seas for the two 35 knot wind arrows southeast of Greenland on track 371 are fetch limited and not fully developed.

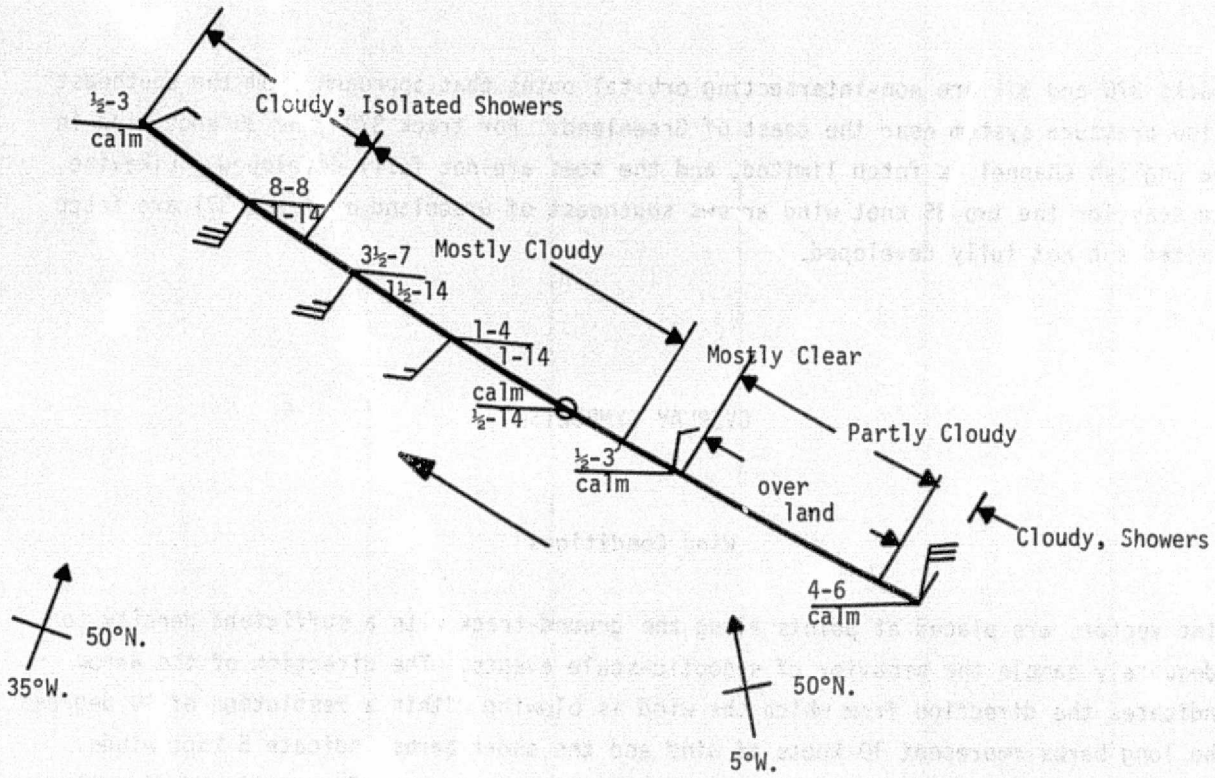
OVERLAY SYMBOLISM

Wind Conditions

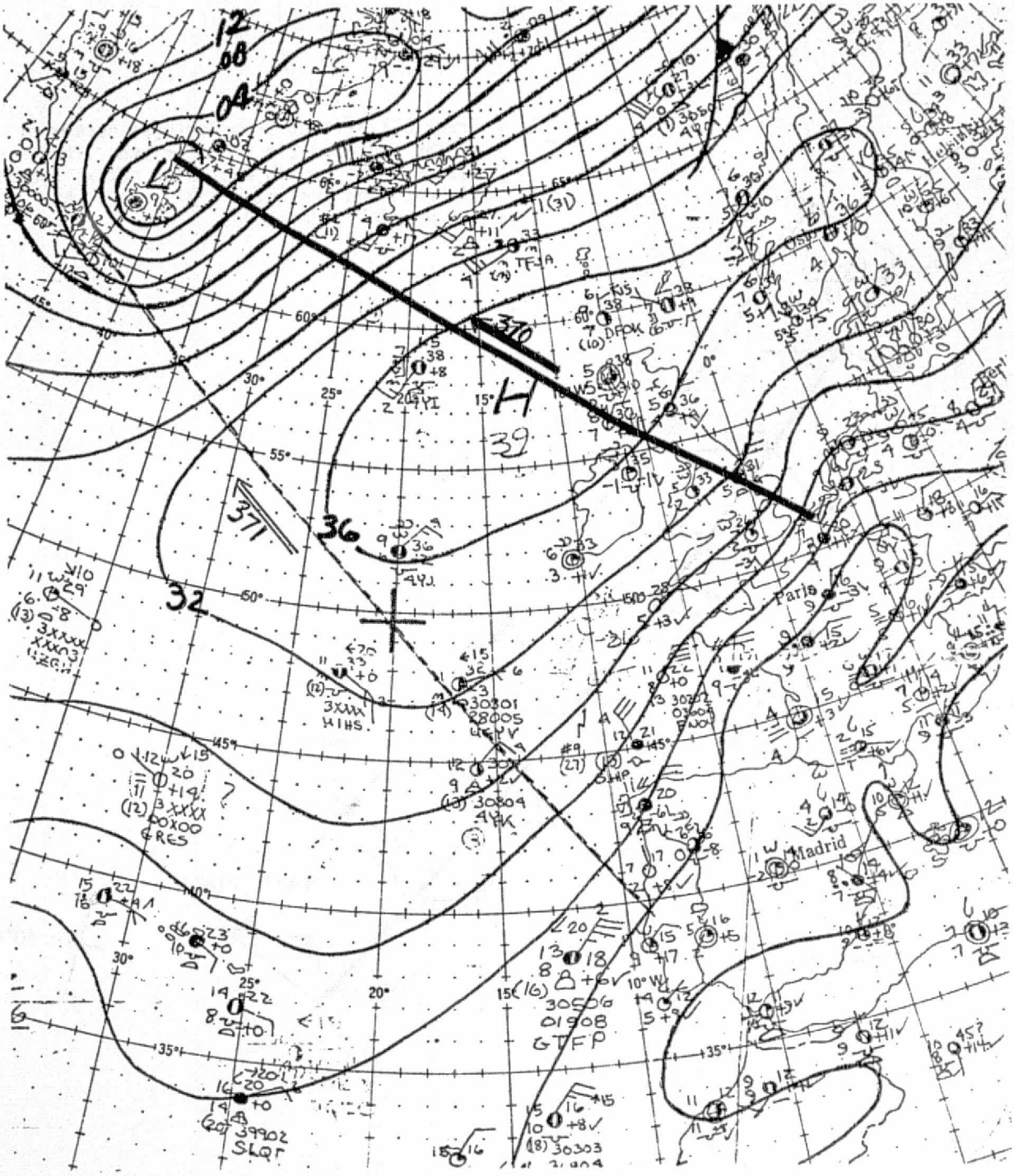
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

Sea Conditions

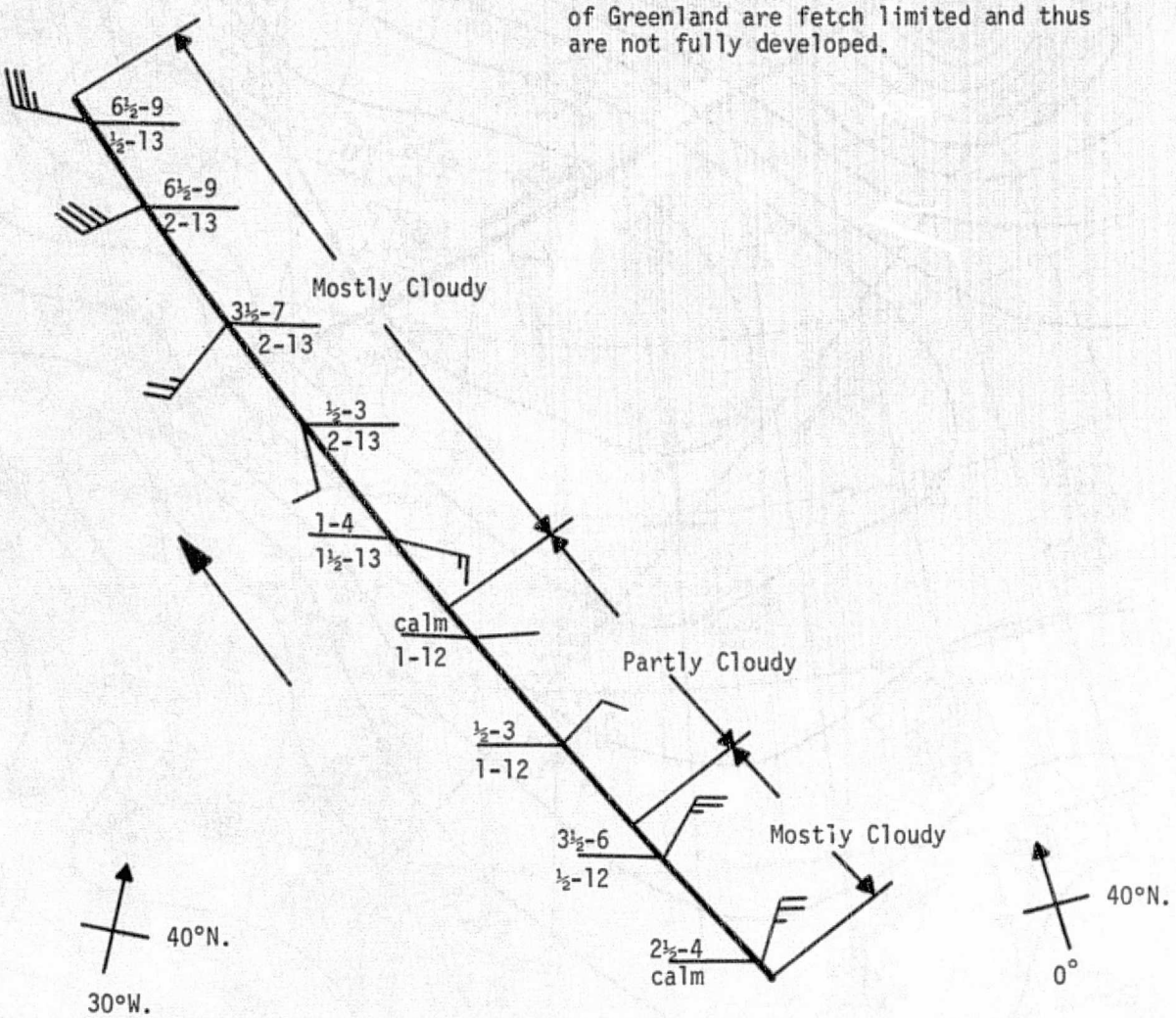
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

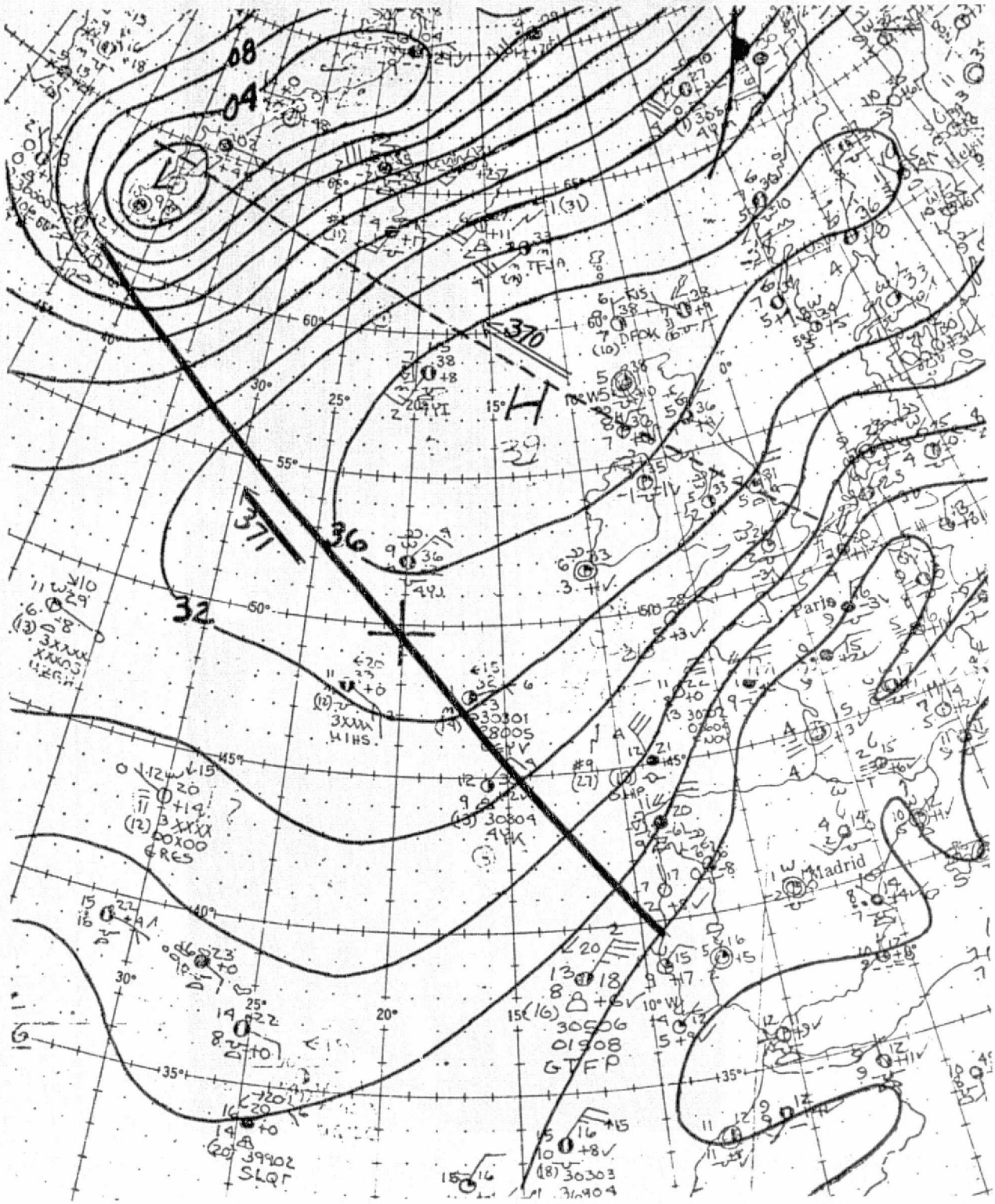


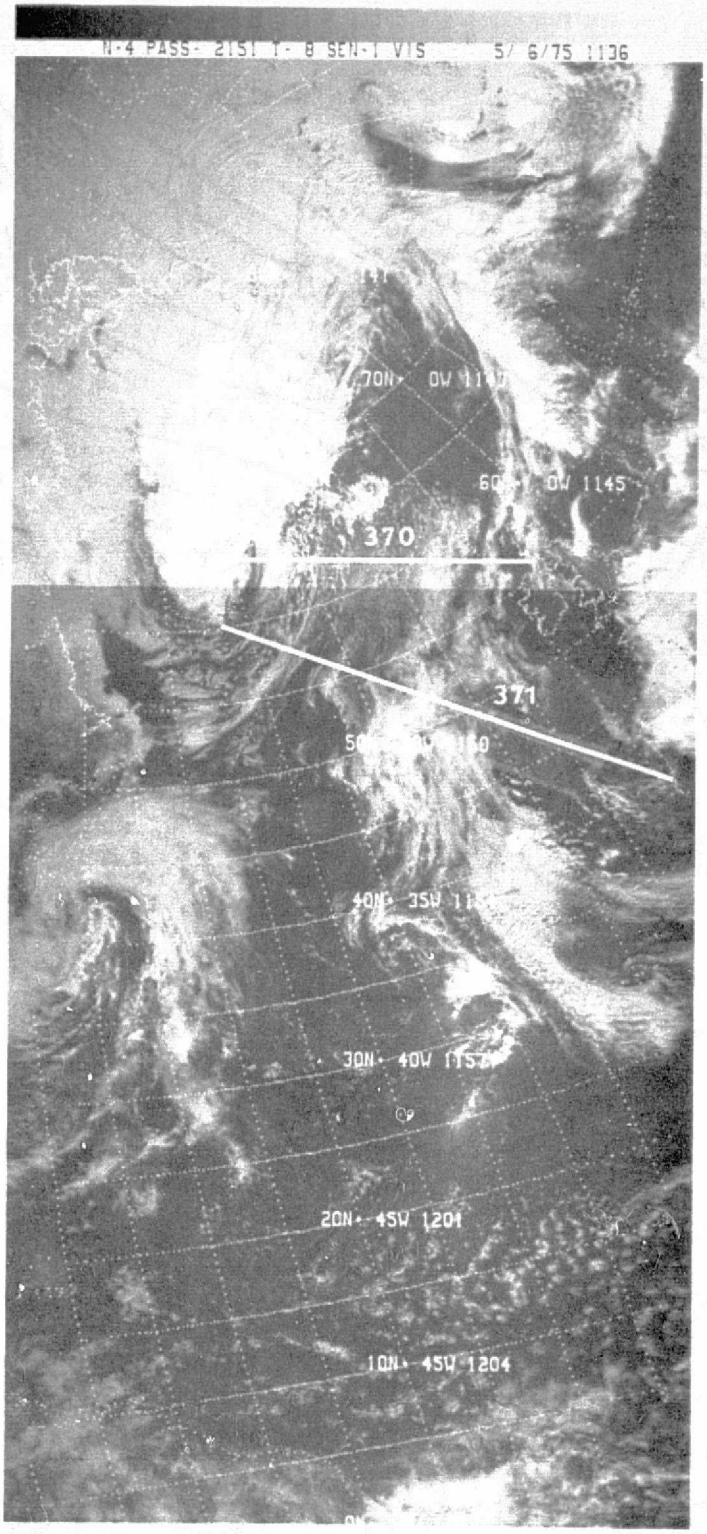
Track 370 extends from northern France across England to the southeastern coast of Greenland. The 30 knot wind in the English Channel is fetch limited; therefore seas are not fully developed.



Track 371 extends from Portugal northwest to the southern tip of Greenland. The seas for the two 35 knot wind arrows southeast of Greenland are fetch limited and thus are not fully developed.







GROUND TRUTH DATA SET 25

(Track 373)

Track 373 passes from the southeast across Nova Scotia. A deep low pressure area is located about 250 miles southeast of Nova Scotia with winds up to 45 knots in the northwest quadrant. Seas for the extreme northwest point on the track can not be determined because of the proximity of land masses. The 45 knot wind next to the occluded front is duration limited and seas are not fully developed.

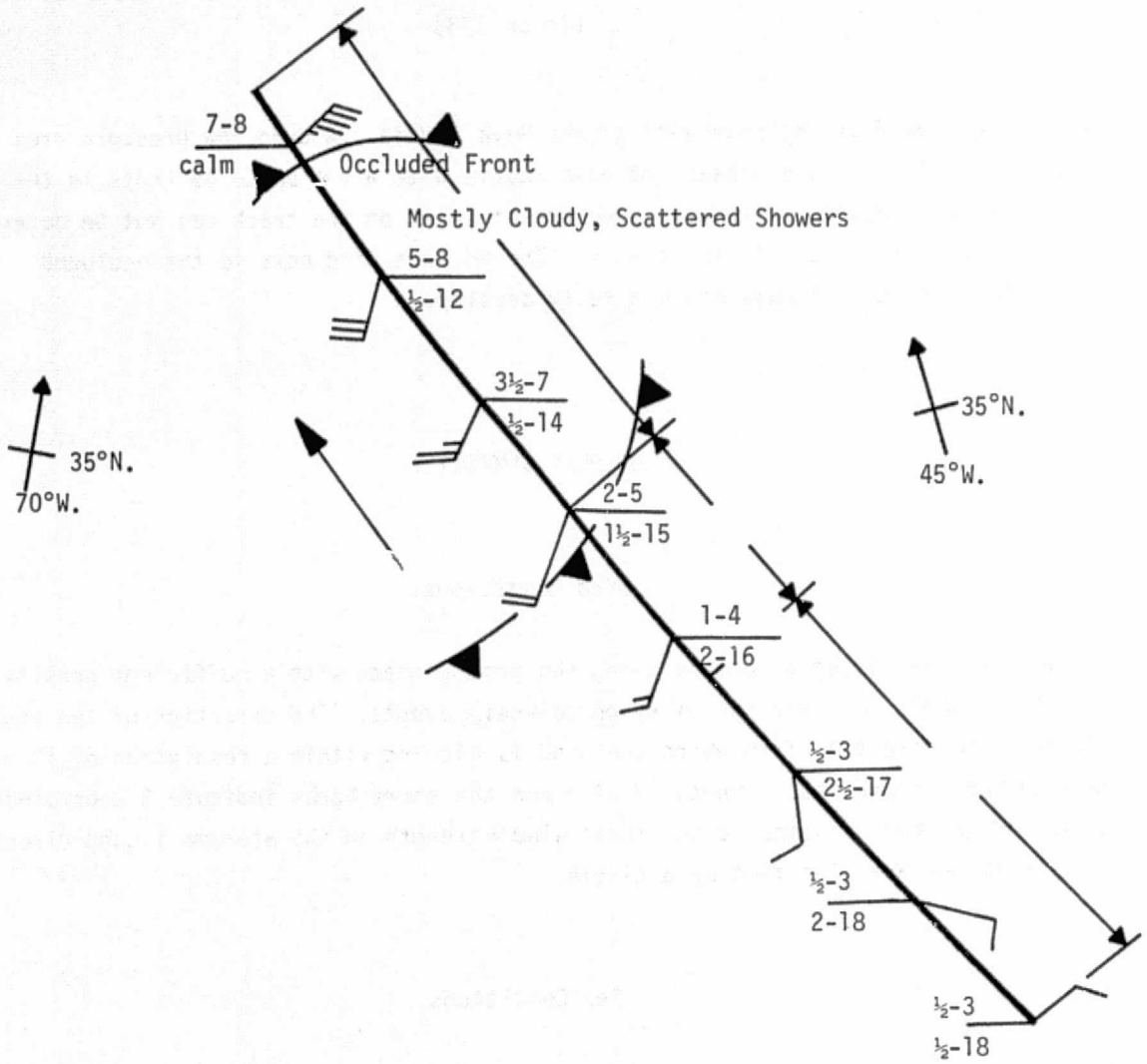
OVERLAY SYMBOLISM

Wind Conditions

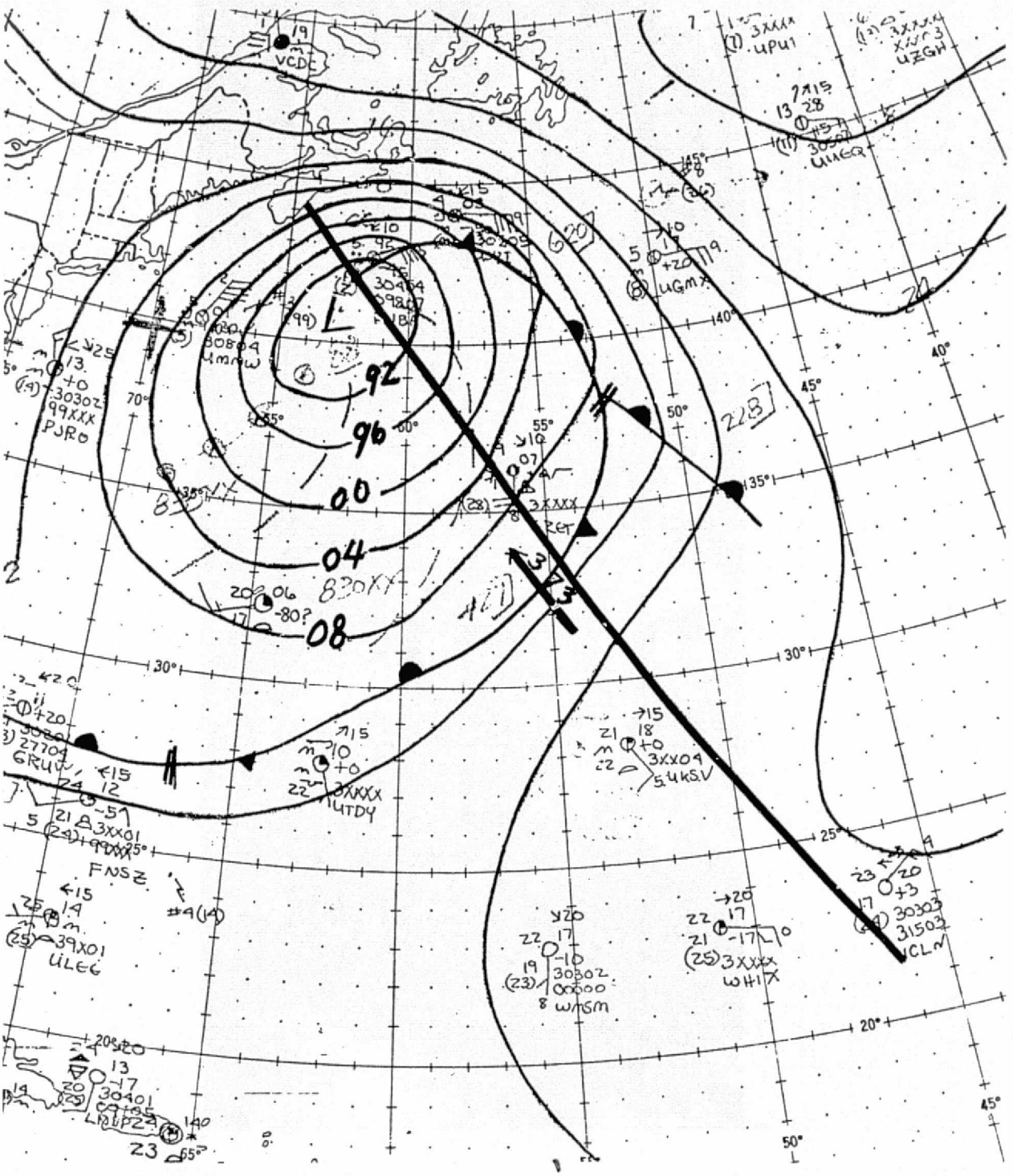
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of syroptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

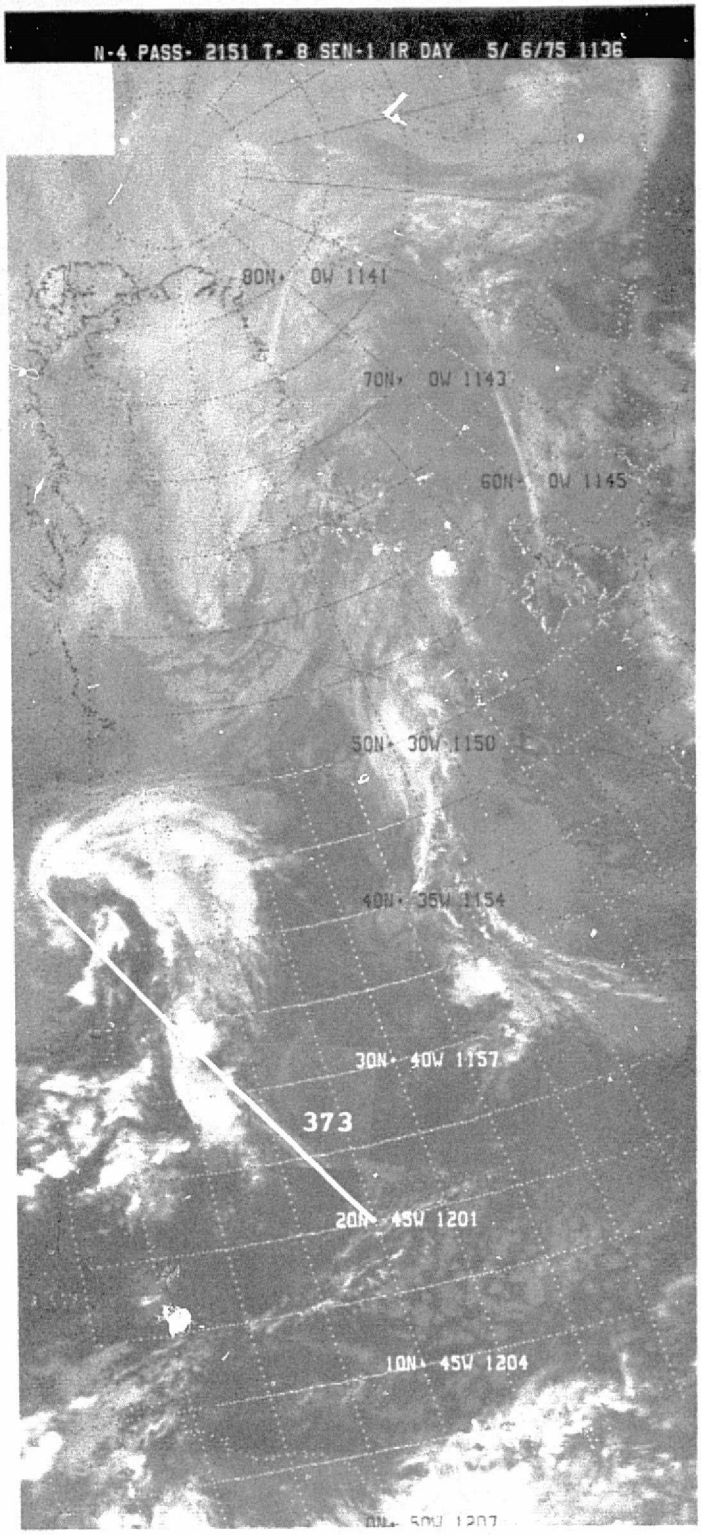
Sea Conditions

At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.



Track 373 passes from the southeast across Nova Scotia. A deep low pressure area is located about 250 miles southeast of Nova Scotia with winds up to 45 knots in the northwest quadrant. Seas for the extreme northwest point on the track can not be determined because of the proximity of land masses. The 45 knot wind next to the occluded front is duration limited and seas are not fully developed.





GROUND TRUTH DATA SET 26

(Track 374)

Track 374 passes from a point about 120 miles north of Haiti northwest into South Carolina. Winds along the track are calm or very light with calm seas. A low pressure system located approximately 500 miles east of New York City is causing swell of one half to one meter along the track. Scattered showers are associated with the cold front passing across the track east of Miami.

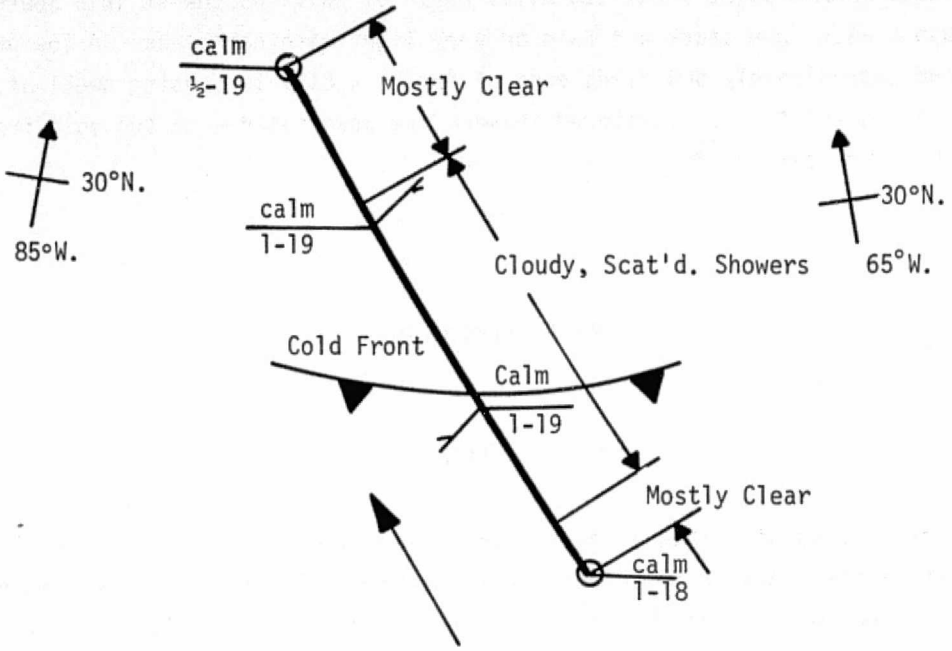
OVERLAY SYMBOLISM

Wind Conditions

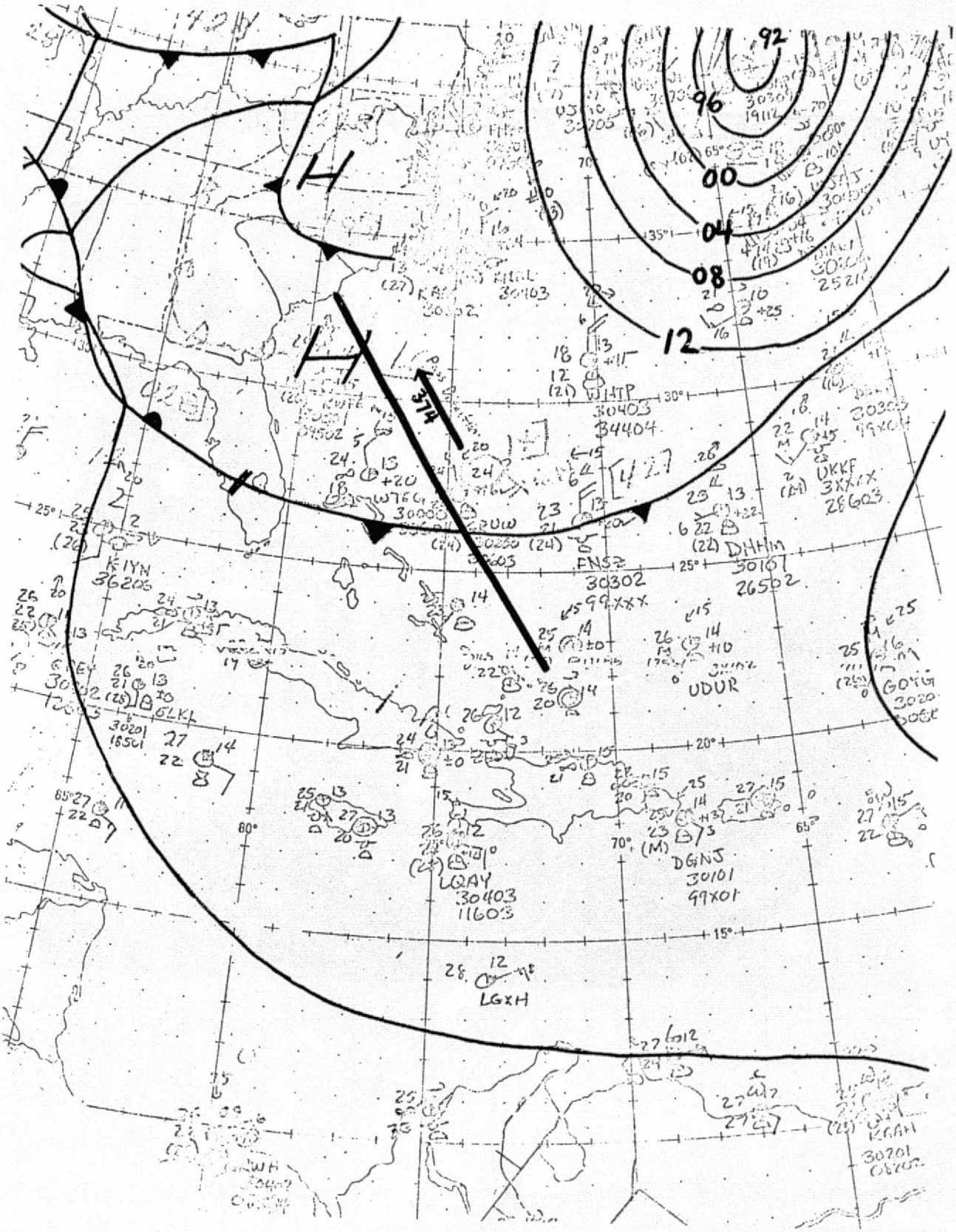
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

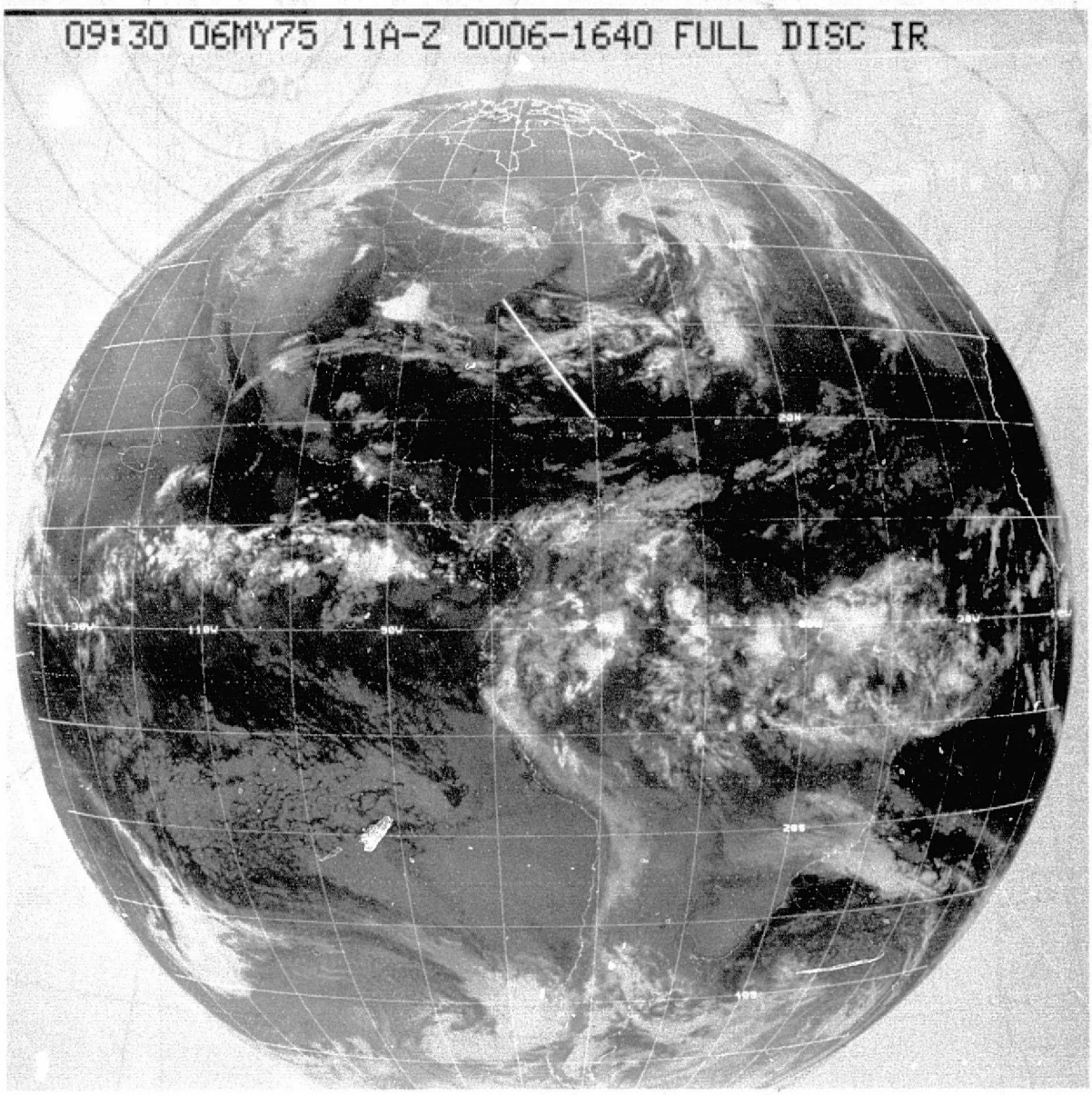
Sea Conditions

At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.



Track 374 passes from a point about 120 miles north of Haiti northwest into South Carolina. Winds along the track are calm or very light with calm seas. A low pressure system located approximately 500 miles east of New York City is causing swell of one half to one meter along the track. Scattered showers are associated with the cold front passing across the track east of Miami.





GROUND TRUTH DATA SET 27
(Track 382)

Track 382 extends from Norway across Iceland, Newfoundland and Nova Scotia southwest across Cuba and Central America passing over two low pressure areas. The entire track is mostly cloudy to cloudy with three separate zones of scattered showers. Maximum winds of 45 knots can be found south of Greenland with seas of 10 meters. A second wind maximum is located east of Long Island. Winds in this area are up to 35 knots with seas of 6½ meters.

OVERLAY SYMBOLISM

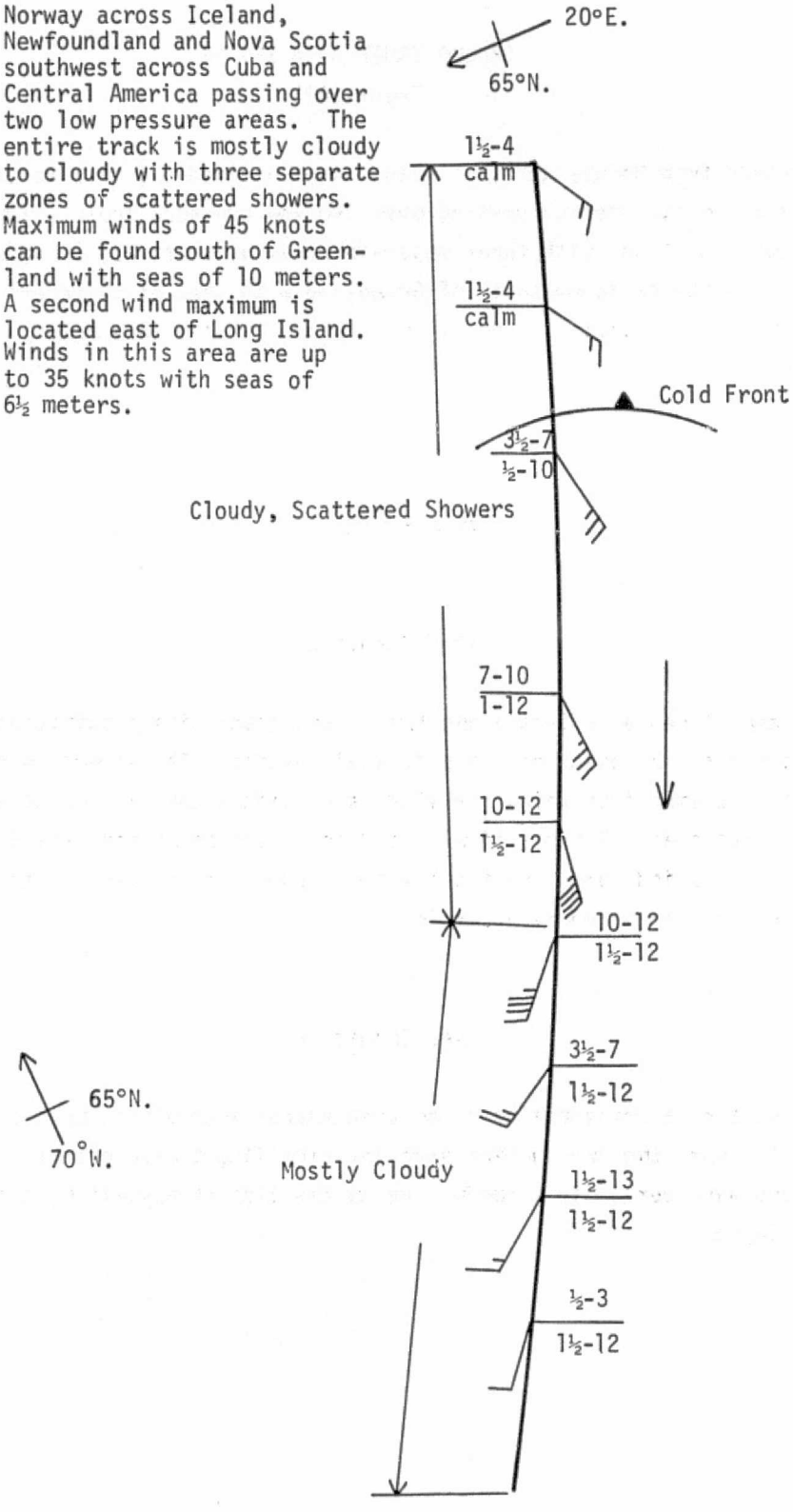
Wind Conditions

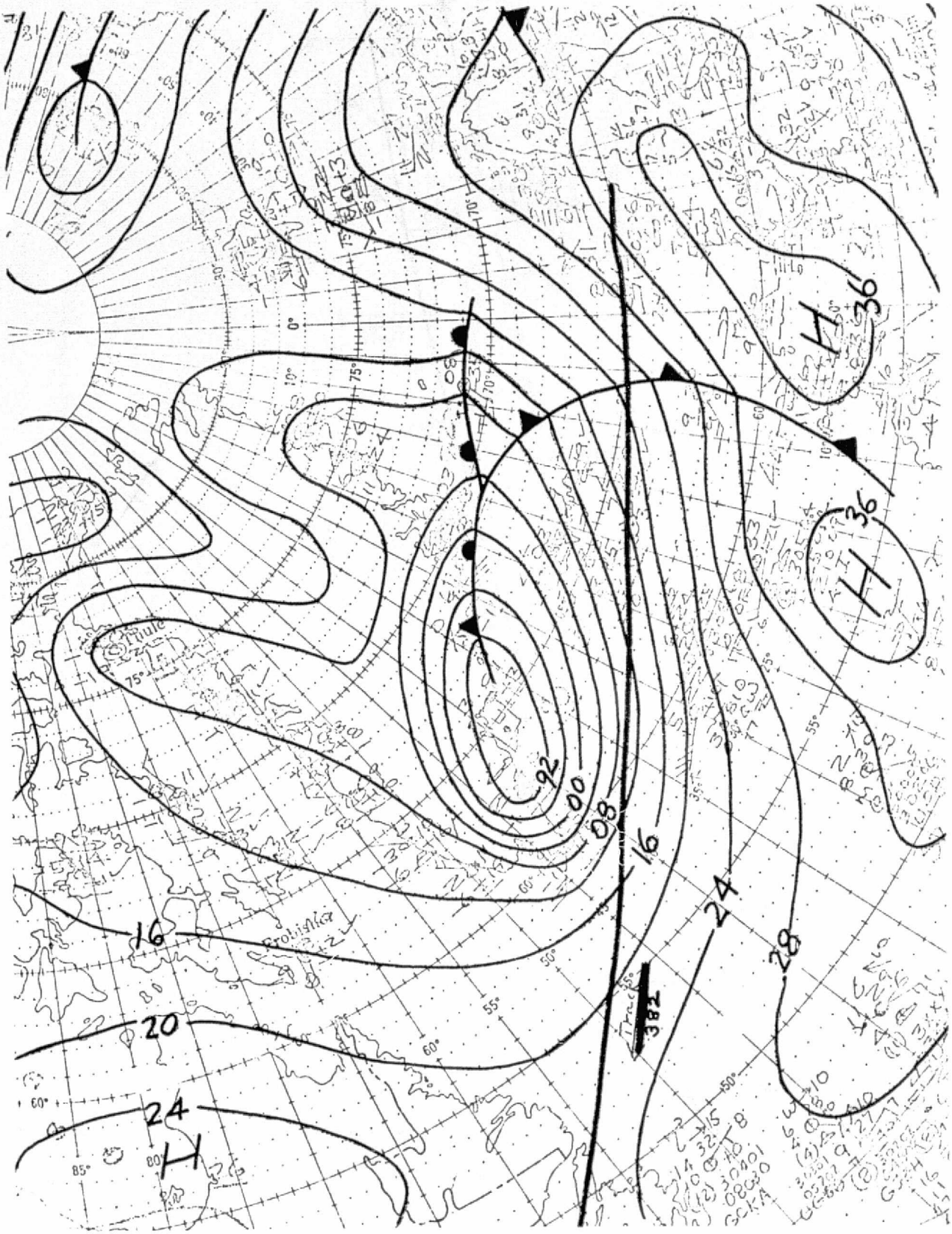
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

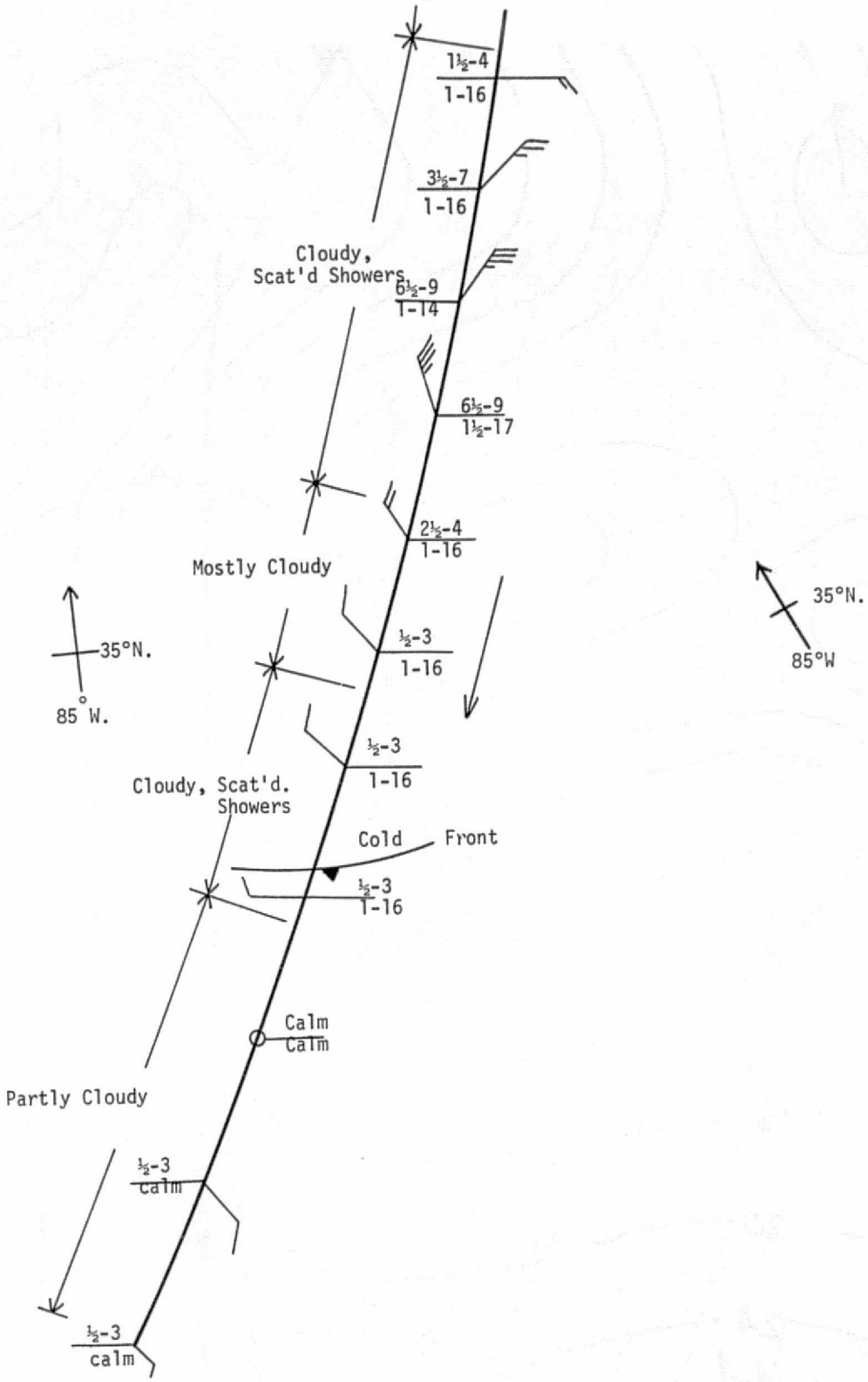
Sea Conditions

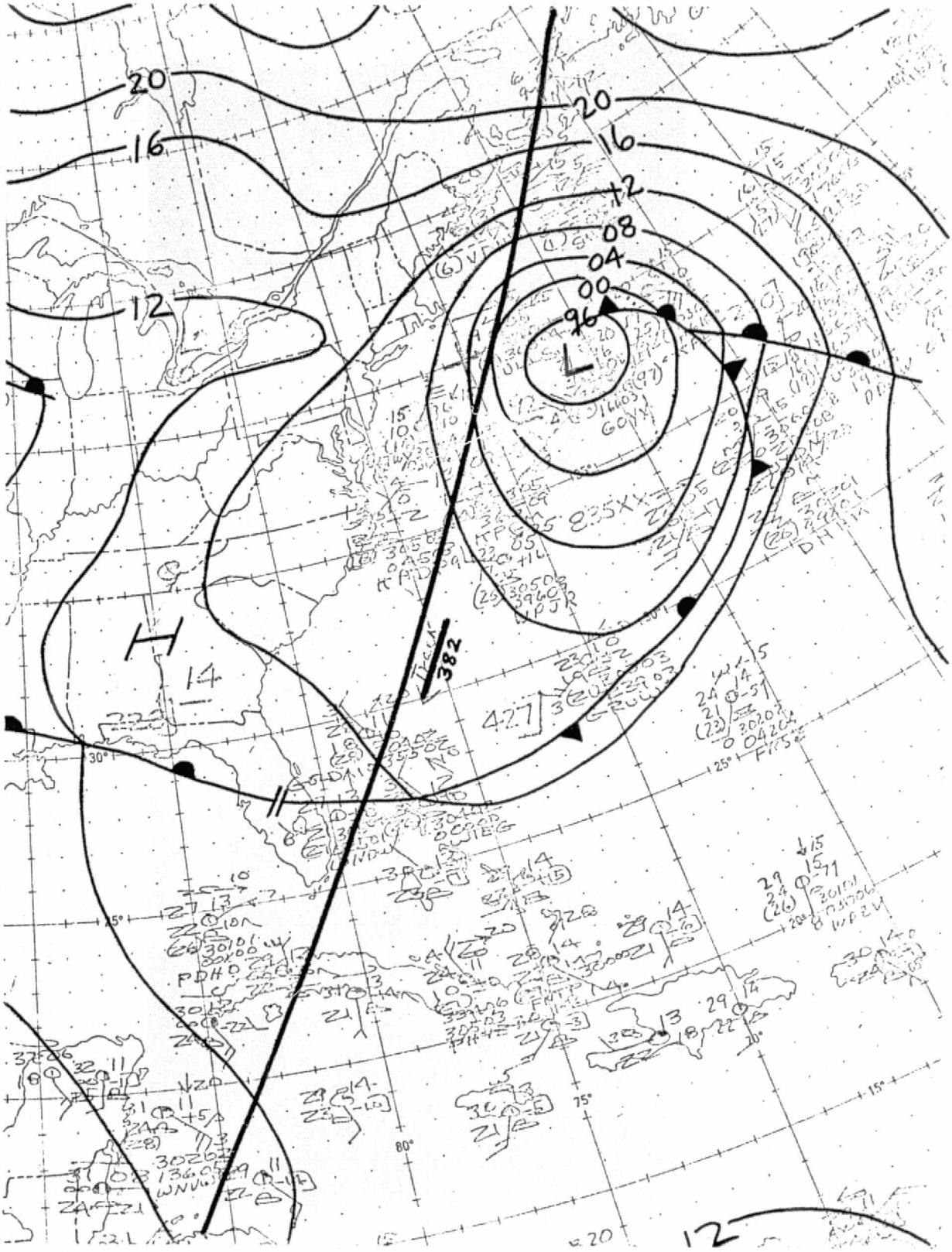
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

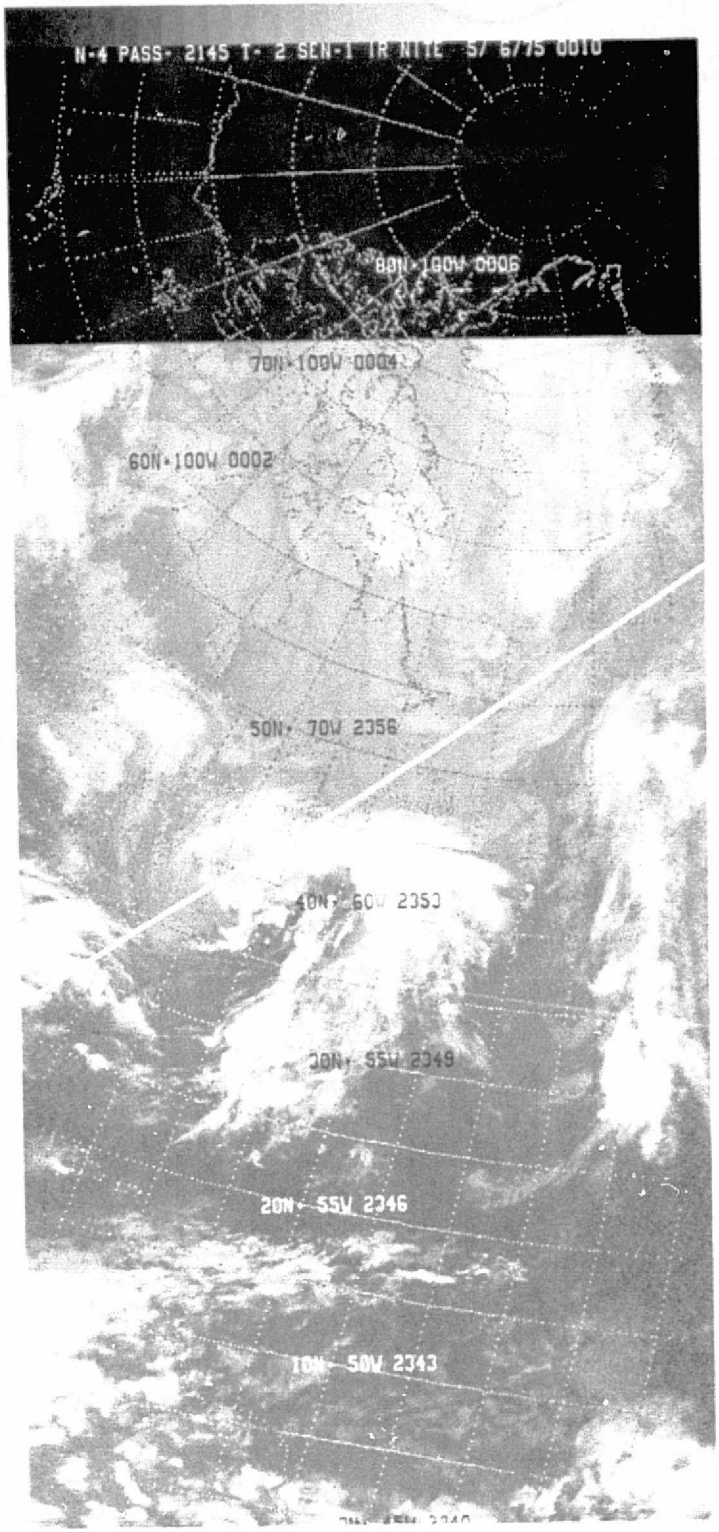
Track 382 extends from Norway across Iceland, Newfoundland and Nova Scotia southwest across Cuba and Central America passing over two low pressure areas. The entire track is mostly cloudy to cloudy with three separate zones of scattered showers. Maximum winds of 45 knots can be found south of Greenland with seas of 10 meters. A second wind maximum is located east of Long Island. Winds in this area are up to 35 knots with seas of 6½ meters.

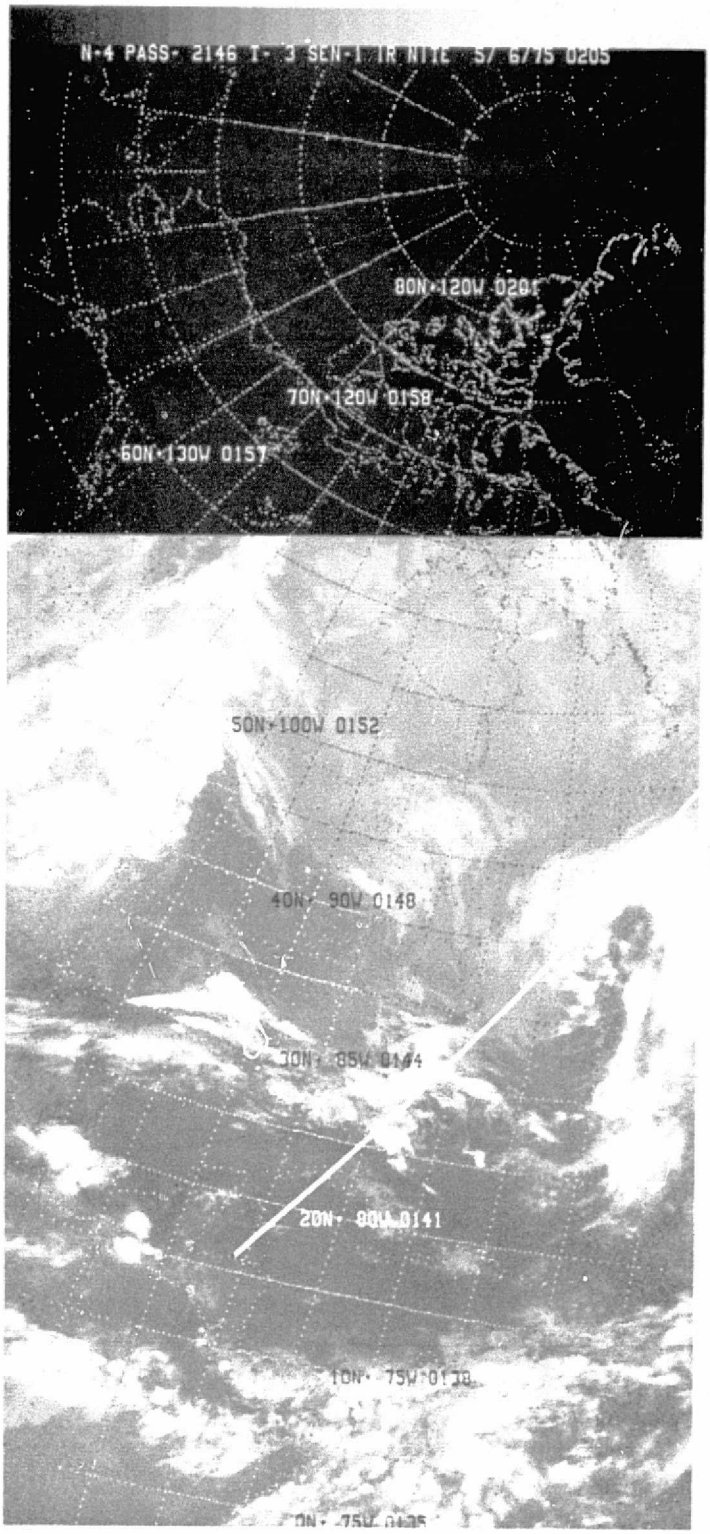




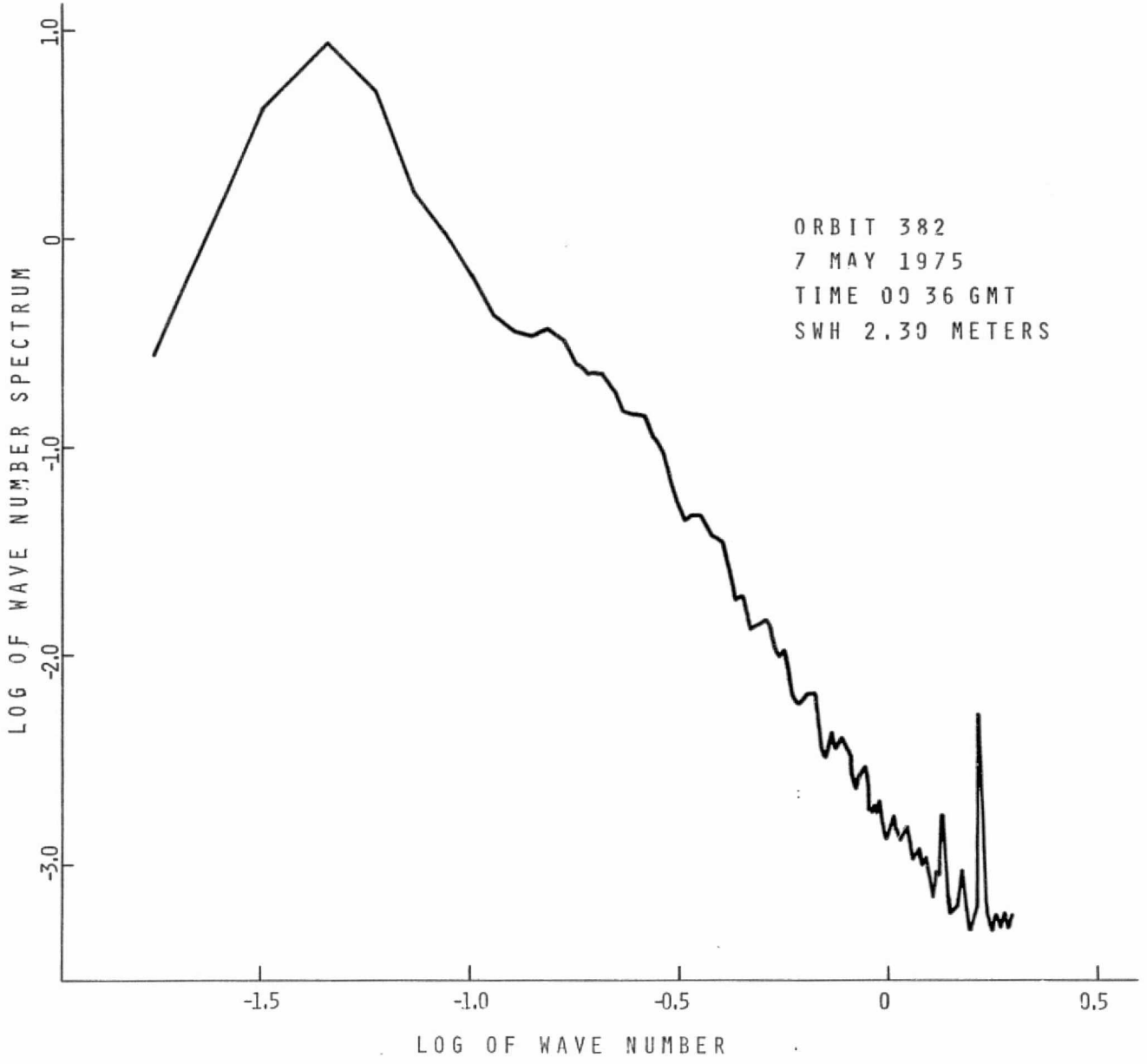

1½-4
1-16
3½-7
1-16
Cloudy,
Scat'd Showers
6½-9
1-14
6½-9
1½-17
2½-4
1-16
Mostly Cloudy
35°N.
85° W.
½-3
1-16
½-3
1-16
Cloudy, Scat'd.
Showers
Cold Front
½-3
1-16
Calm
Calm
Partly Cloudy
½-3
Calm
½-3
calm
35°N.
85°W







ORBIT 382
7 MAY 1975
TIME 0036 GMT
SWH 2.30 METERS
FREQUENCY SPECTRUM (METER**2-SEC)
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
FREQUENCY IN HZ


ORBIT 382
7 MAY 1975
TIME 09 36 GMT
SWH 2.30 METERS
LOG OF WAVE NUMBER SPECTRUM
1.0
0
-1.0
-2.0
-3.0
-1.5
-1.0
-0.5
0
0.5
LOG OF WAVE NUMBER

GROUND TRUTH DATA SET 28

(Track 388)

Track 388 extends from southeast to northwest across Cape Hatteras; a warm front crosses the track near the mid-point. Winds are light with a maximum of ten knots and seas are at most one-half meter.

OVERLAY SYMBOLISM

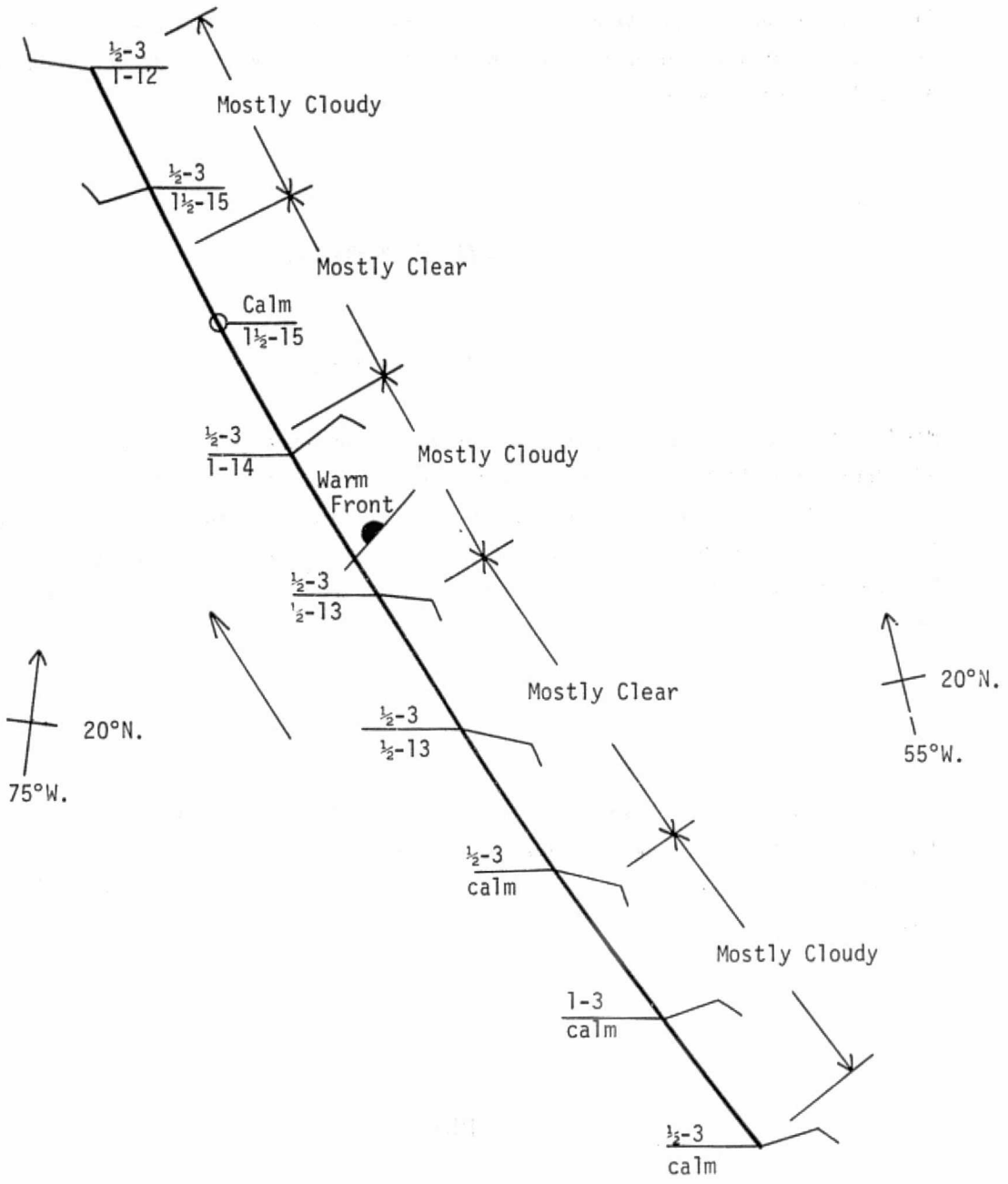
Wind Conditions

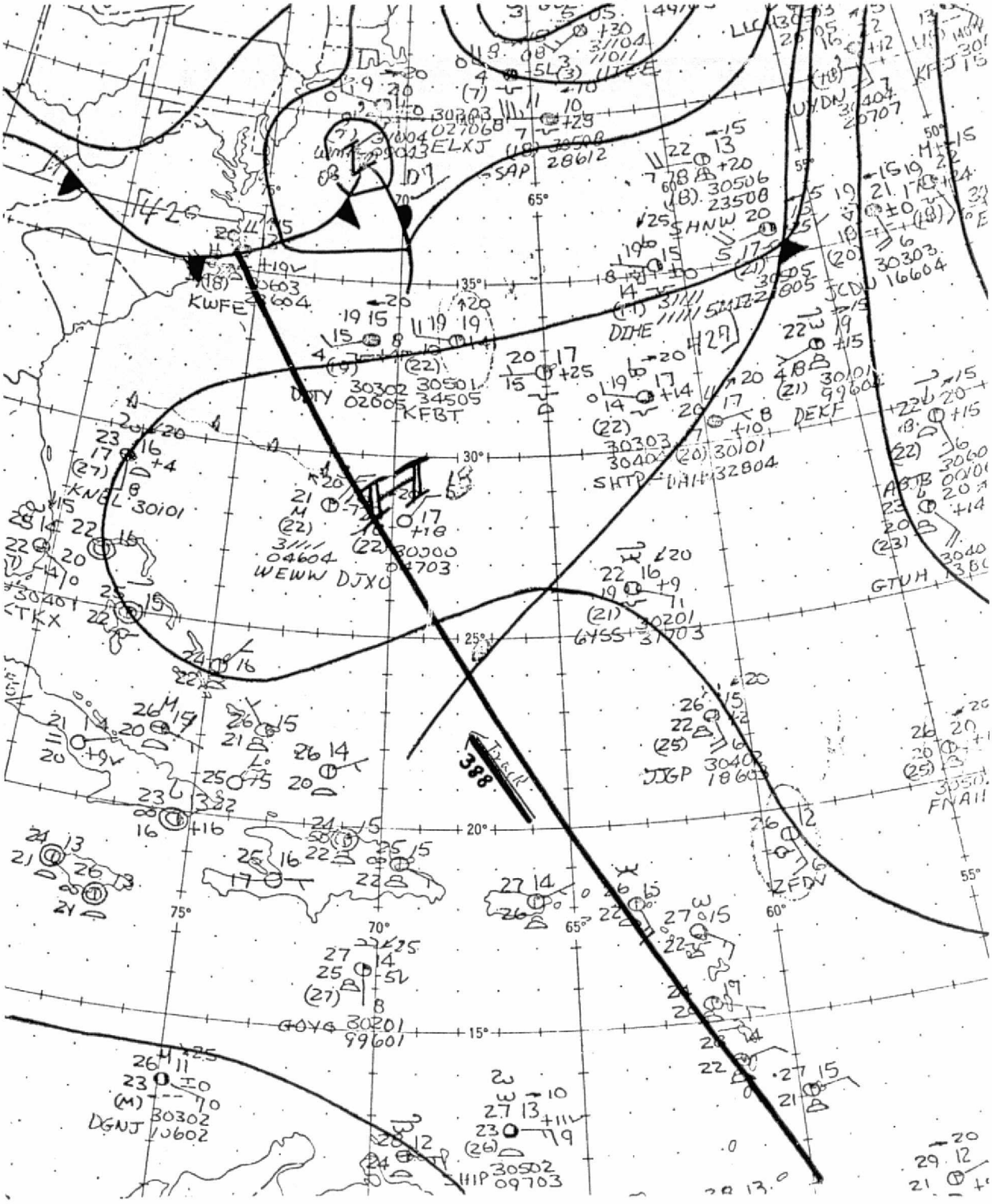
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

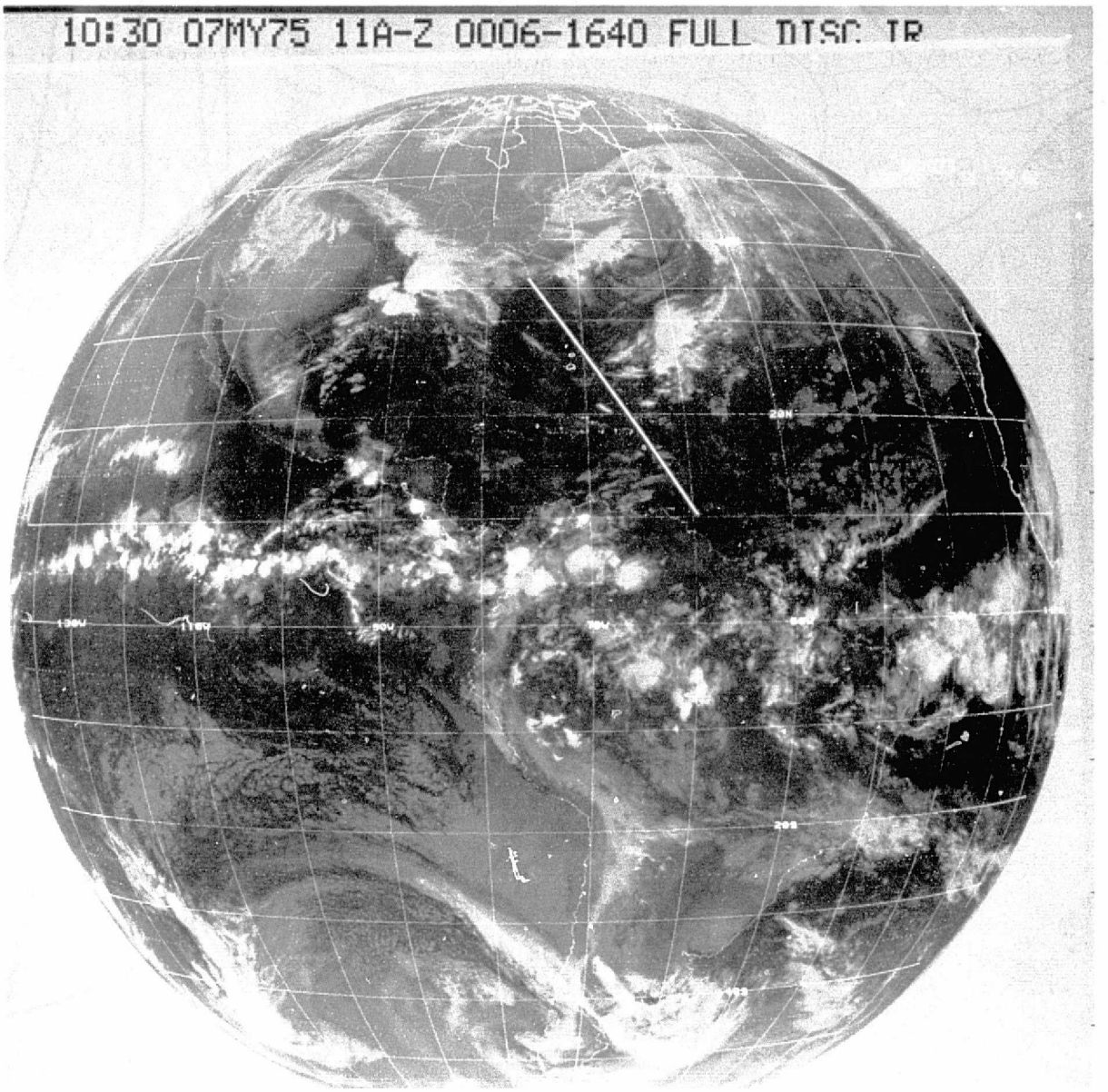
Sea Conditions

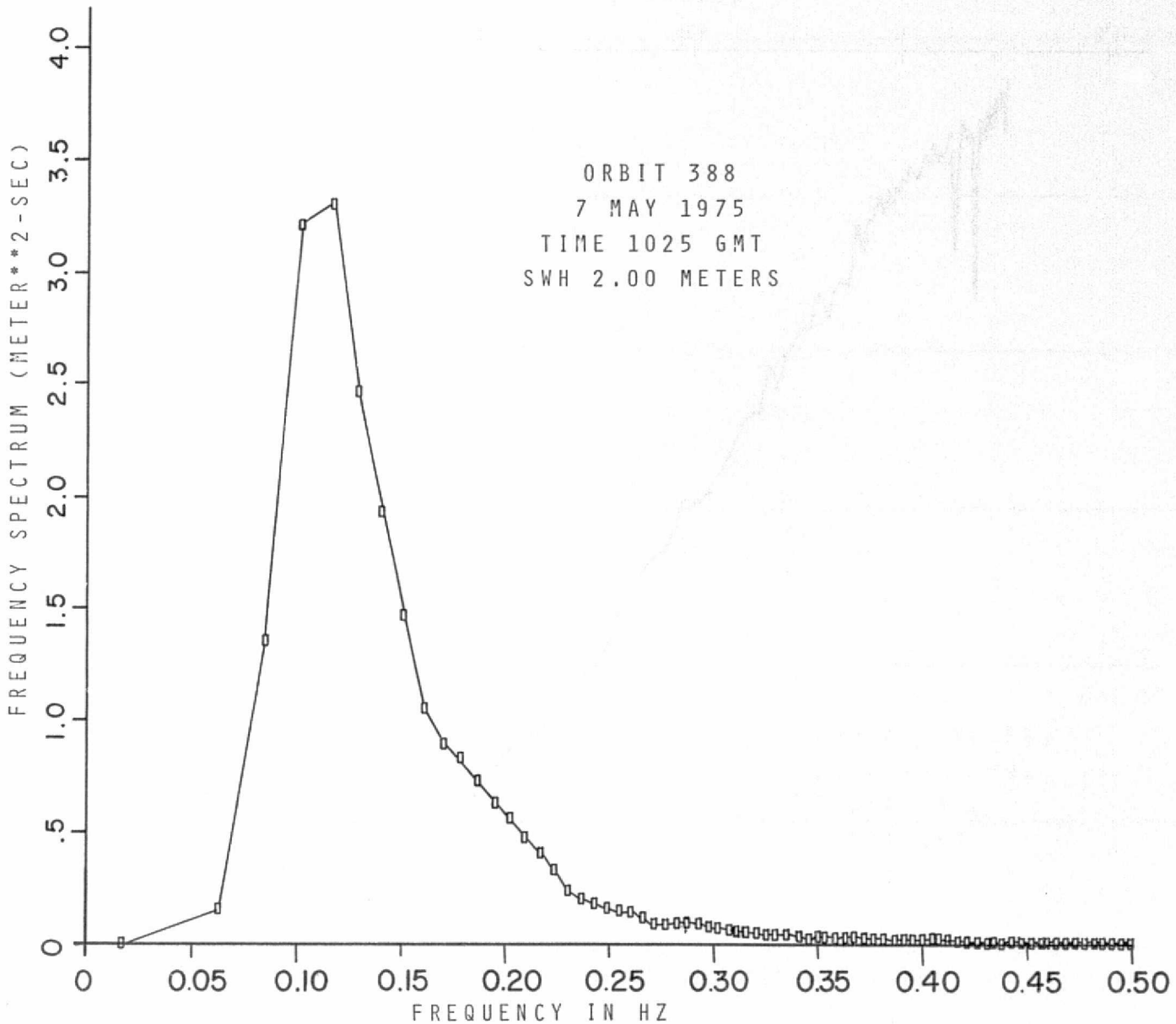
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

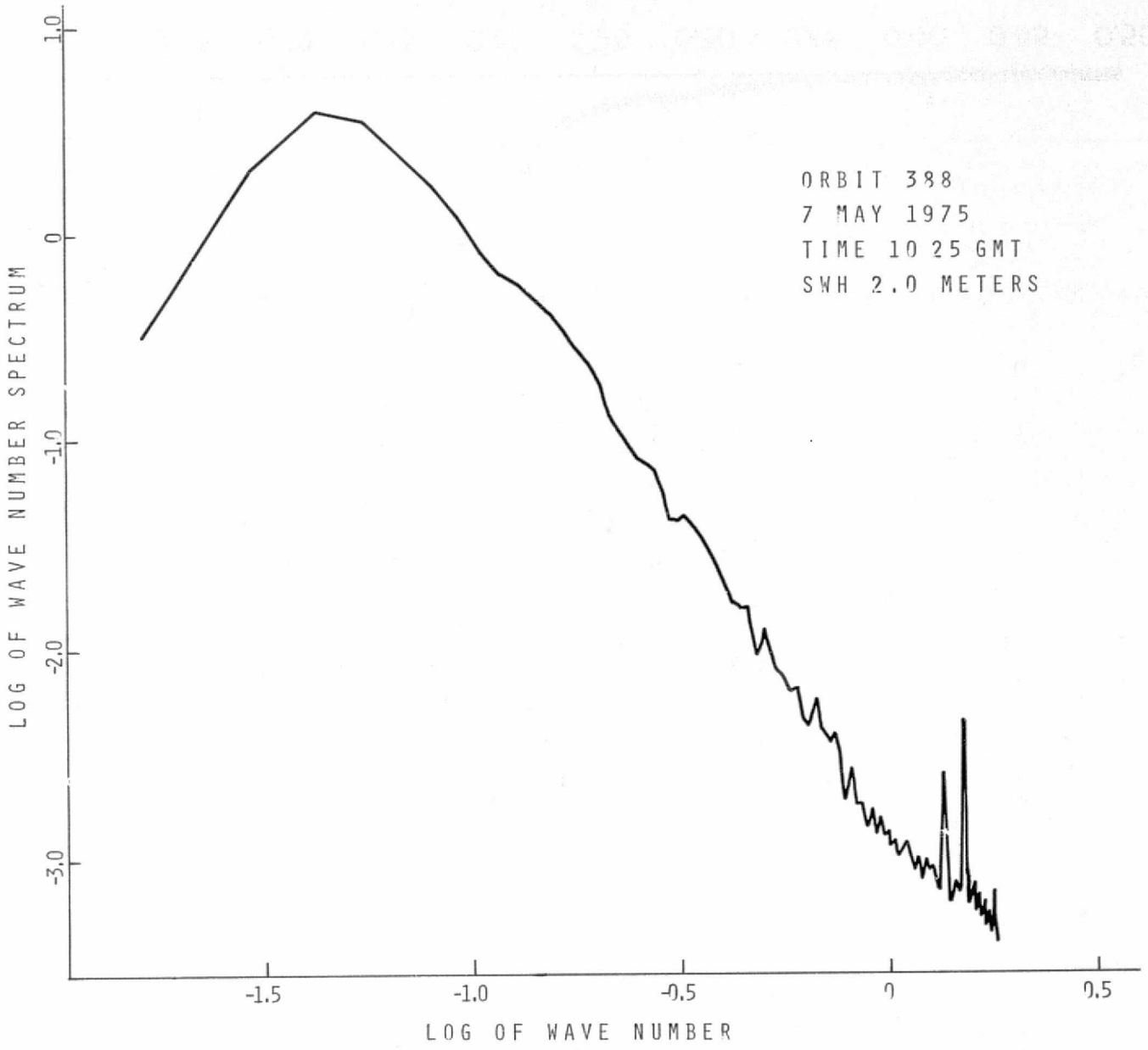
Track 388 extends from southeast to northwest across Cape Hatteras. A warm front crosses the track near the mid point. Winds are light with a maximum of 10 knots and seas are at most ½ meter.








ORBIT 388
7 MAY 1975
TIME 1025 GMT
SWH 2.00 METERS
FREQUENCY SPECTRUM (METER**2-SEC)
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
FREQUENCY IN HZ


ORBIT 388
7 MAY 1975
TIME 10 25 GMT
SWH 2.0 METERS
LOG OF WAVE NUMBER SPECTRUM
1.0
0
-1.0
-2.0
-3.0
-1.5
-1.0
-0.5
0
0.5
LOG OF WAVE NUMBER

GROUND TRUTH DATA SET 29

(Track 404)

Track 404 extends from northern California northwest to the Alaskan peninsula passing over a low pressure system with winds up to 40 knots. The low which is causing these winds was located about 400 miles further west 24 hours earlier and winds along the track were considerably less. Seas are therefore not fully developed.

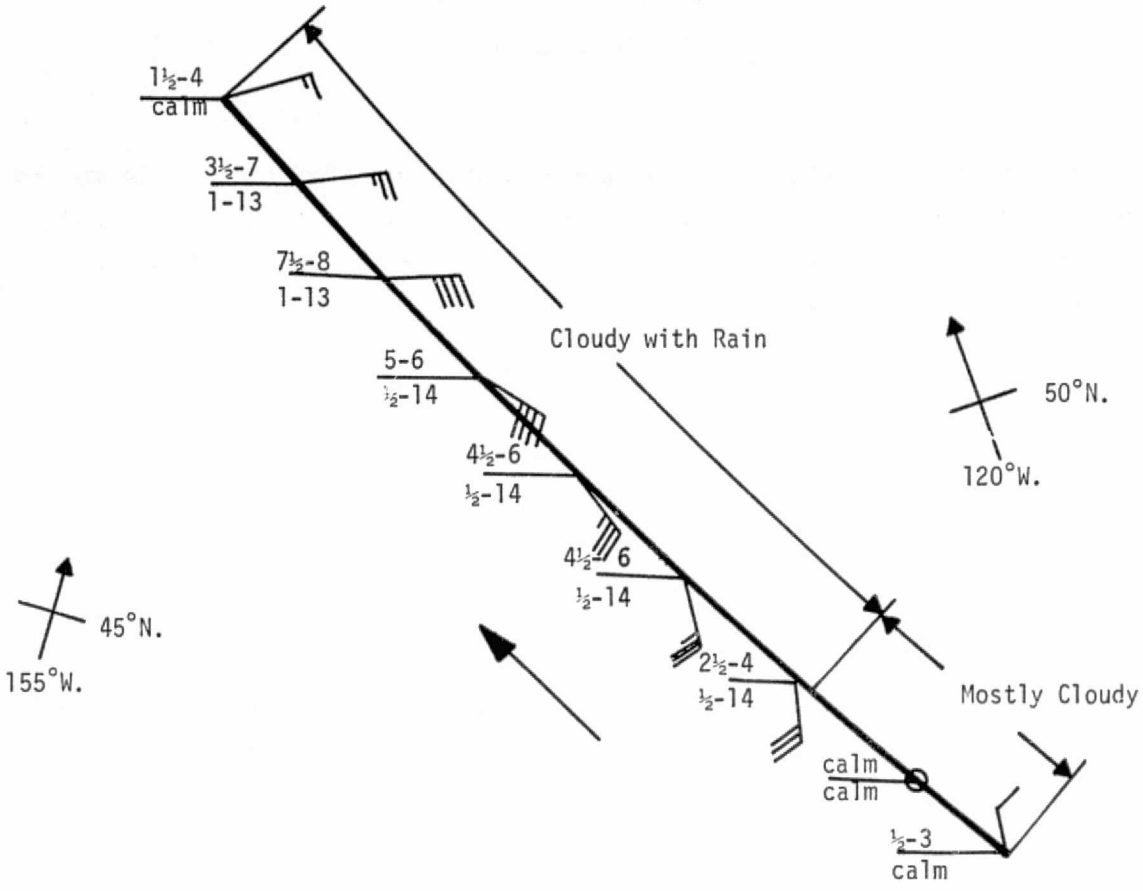
OVERLAY SYMBOLISM

Wind Conditions

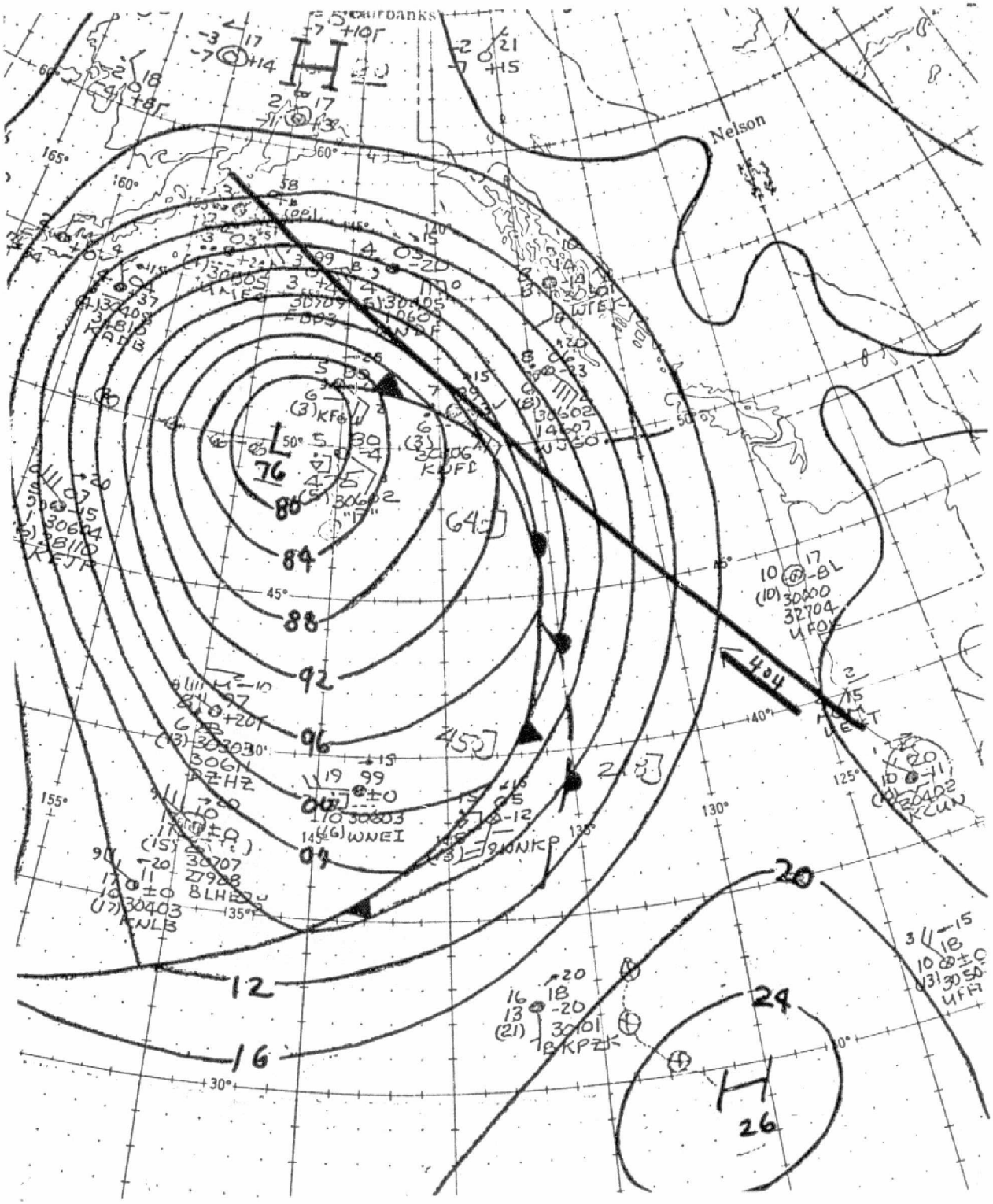
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

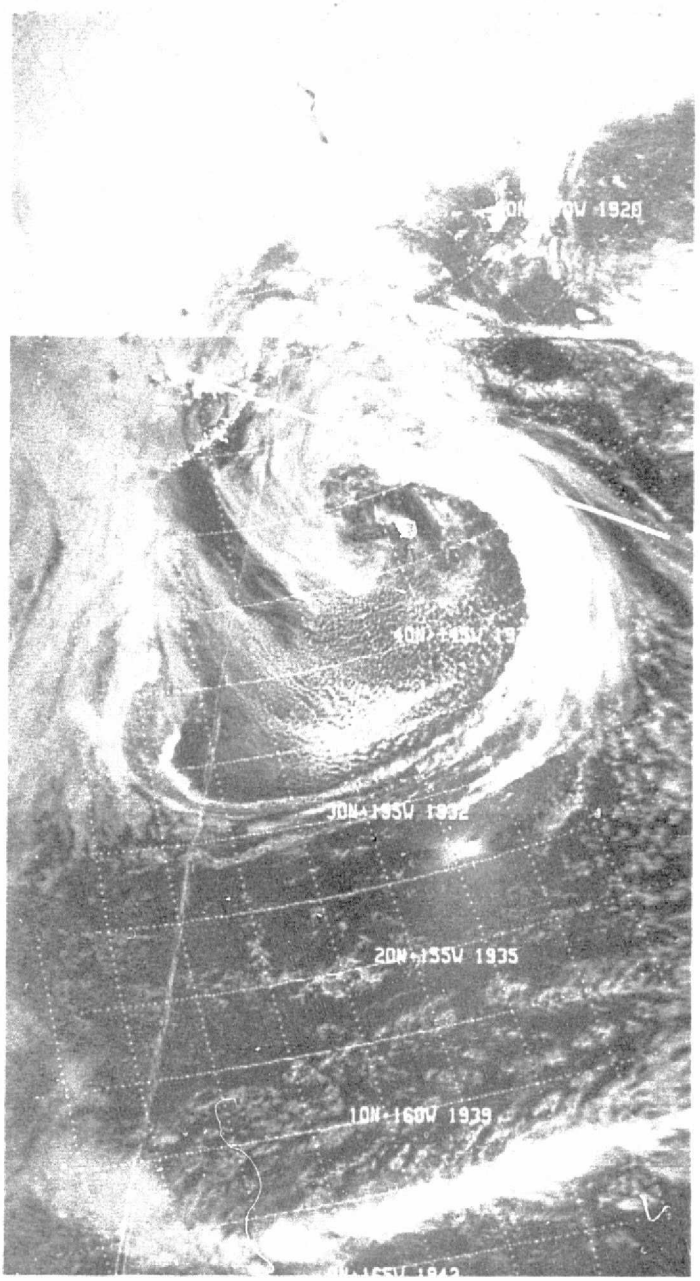
Sea Conditions

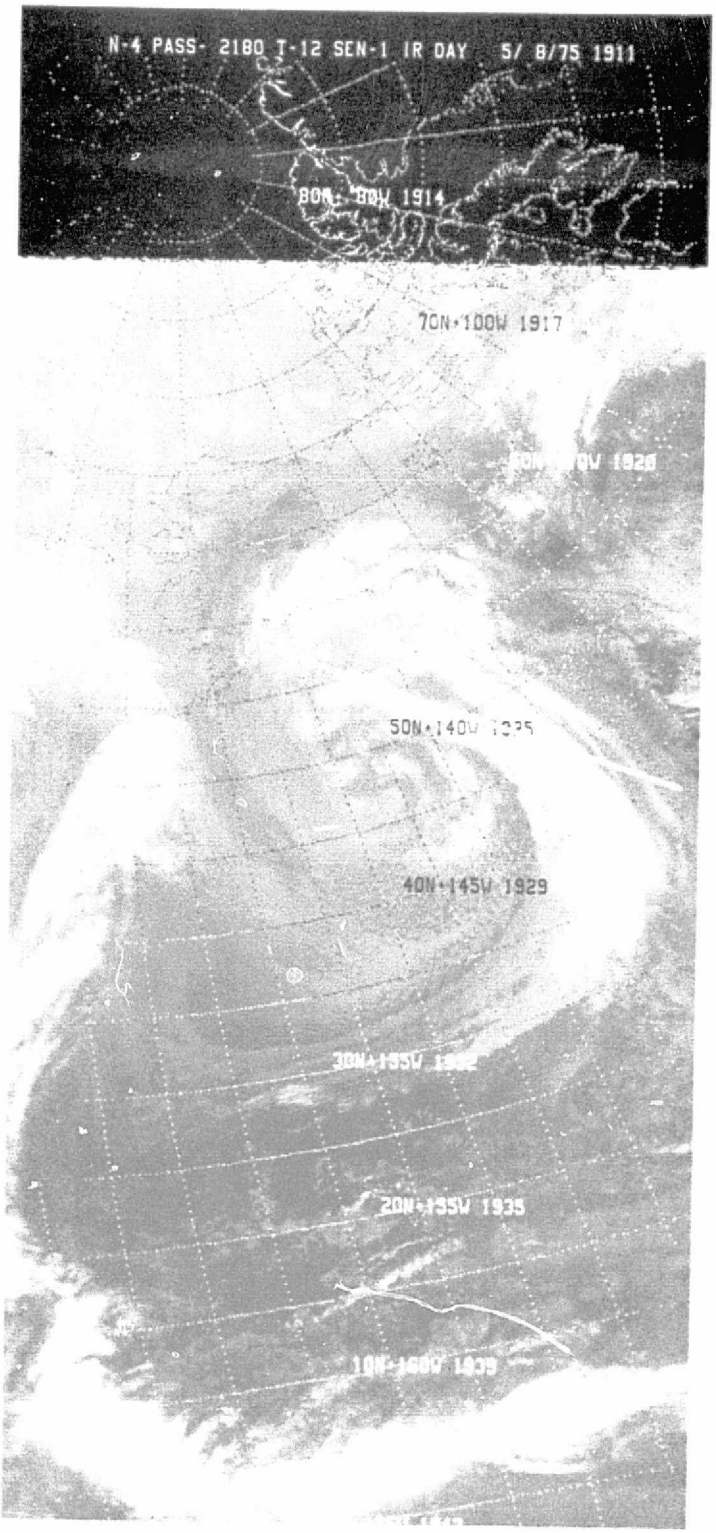
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.



Track 404 extends from northern California northwest to the Alaskan peninsula passing over a low pressure system with winds up to 40 knots. The low which is causing these winds was located about 400 miles further west 24 hours earlier and winds along the track were considerably less. Seas are therefore not fully developed.




20N-135W 1935
10N-160W 1939



GROUND TRUTH DATA SET 30

(Track 453)

Track 453 extends from Norway westward across Iceland,then southwest across Newfoundland and Nova Scotia continuing across Cuba into the Caribbean Sea. Scattered showers are occurring from Norway to a point south of Greenland and over Newfoundland. A narrow zone of thundershowers is found on the south coast of Cuba. Maximum winds are 30 knots with seas of five meters. There is no significant swell present.

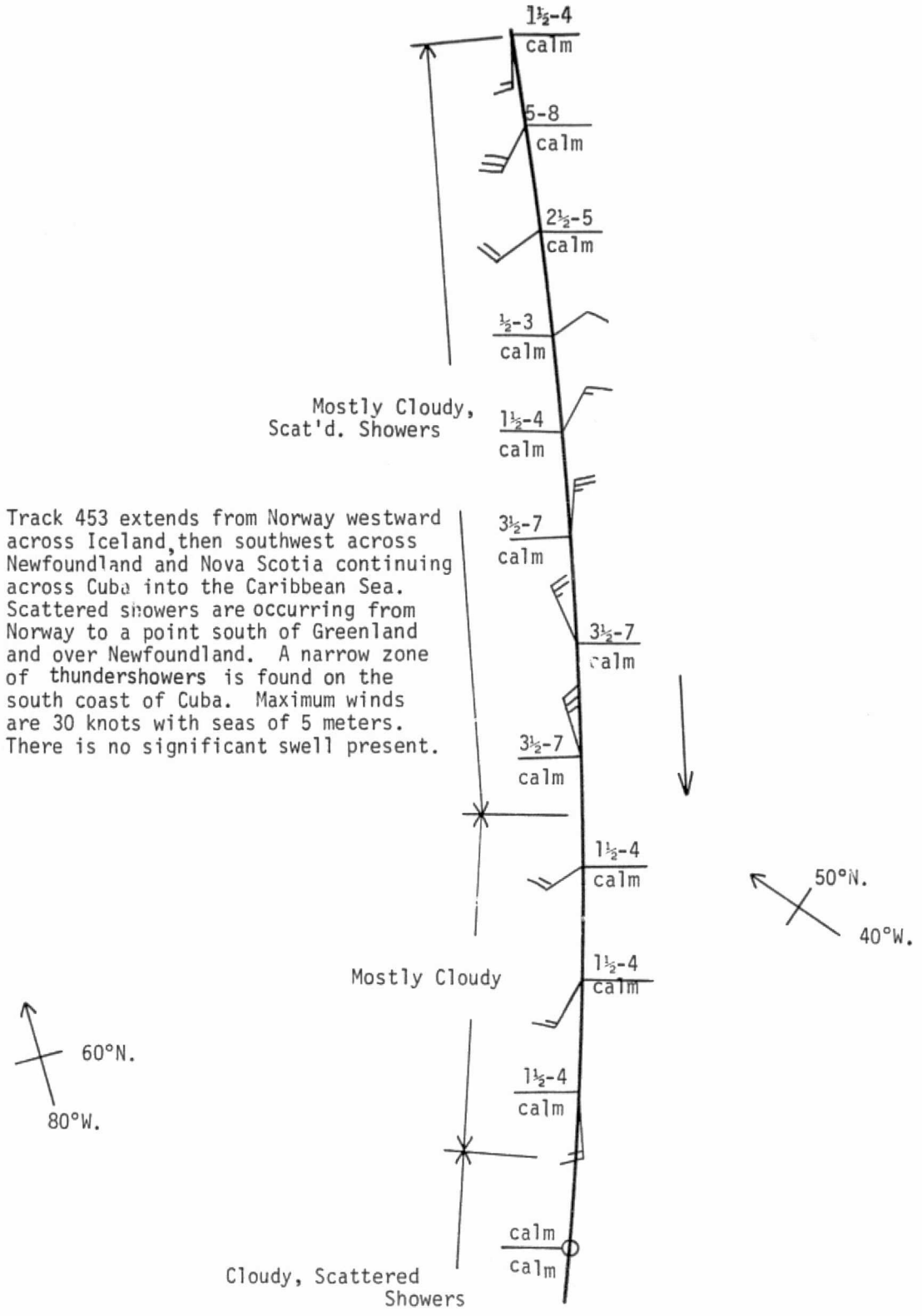
OVERLAY SYMBOLISM

Wind Conditions

Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

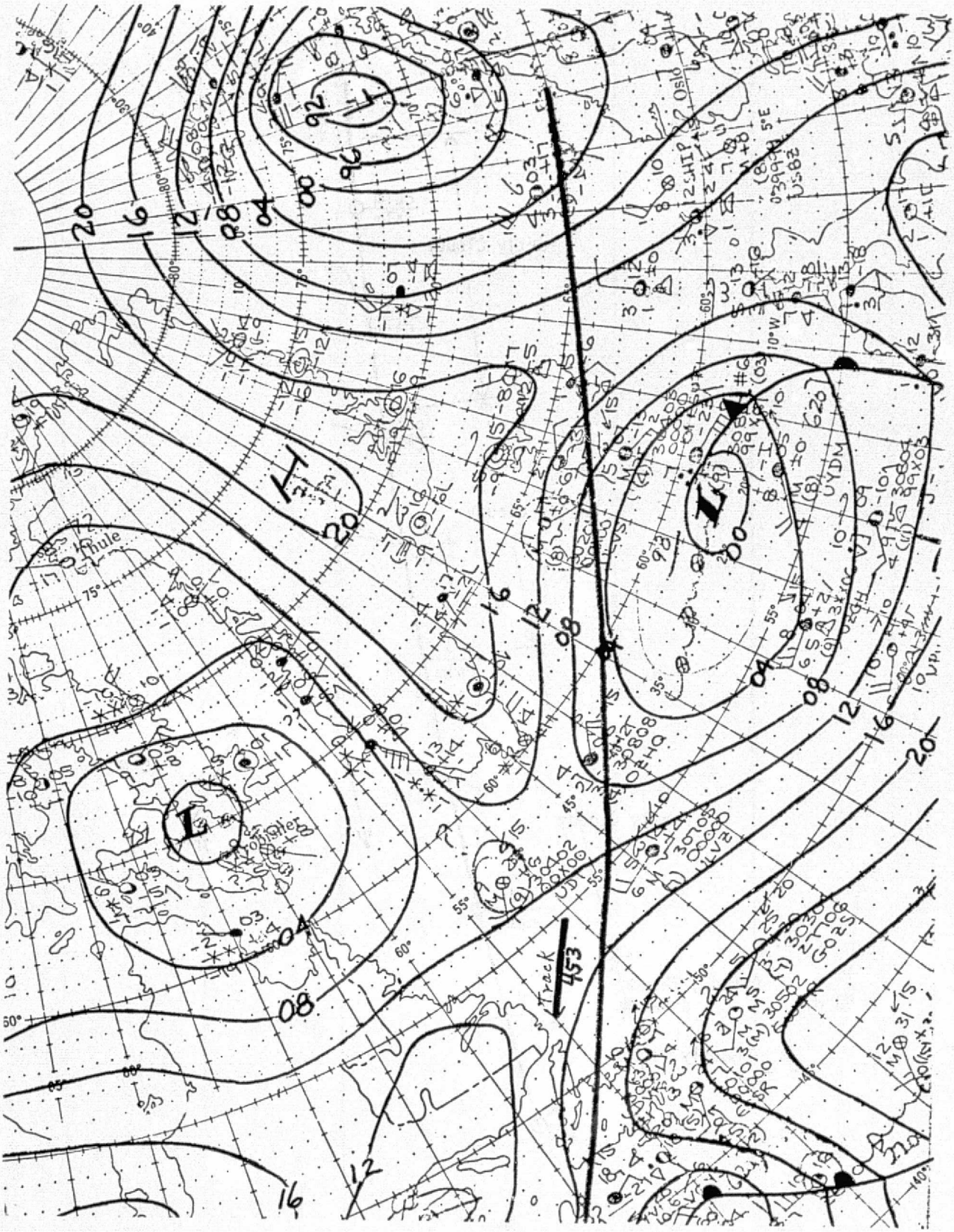
Sea Conditions

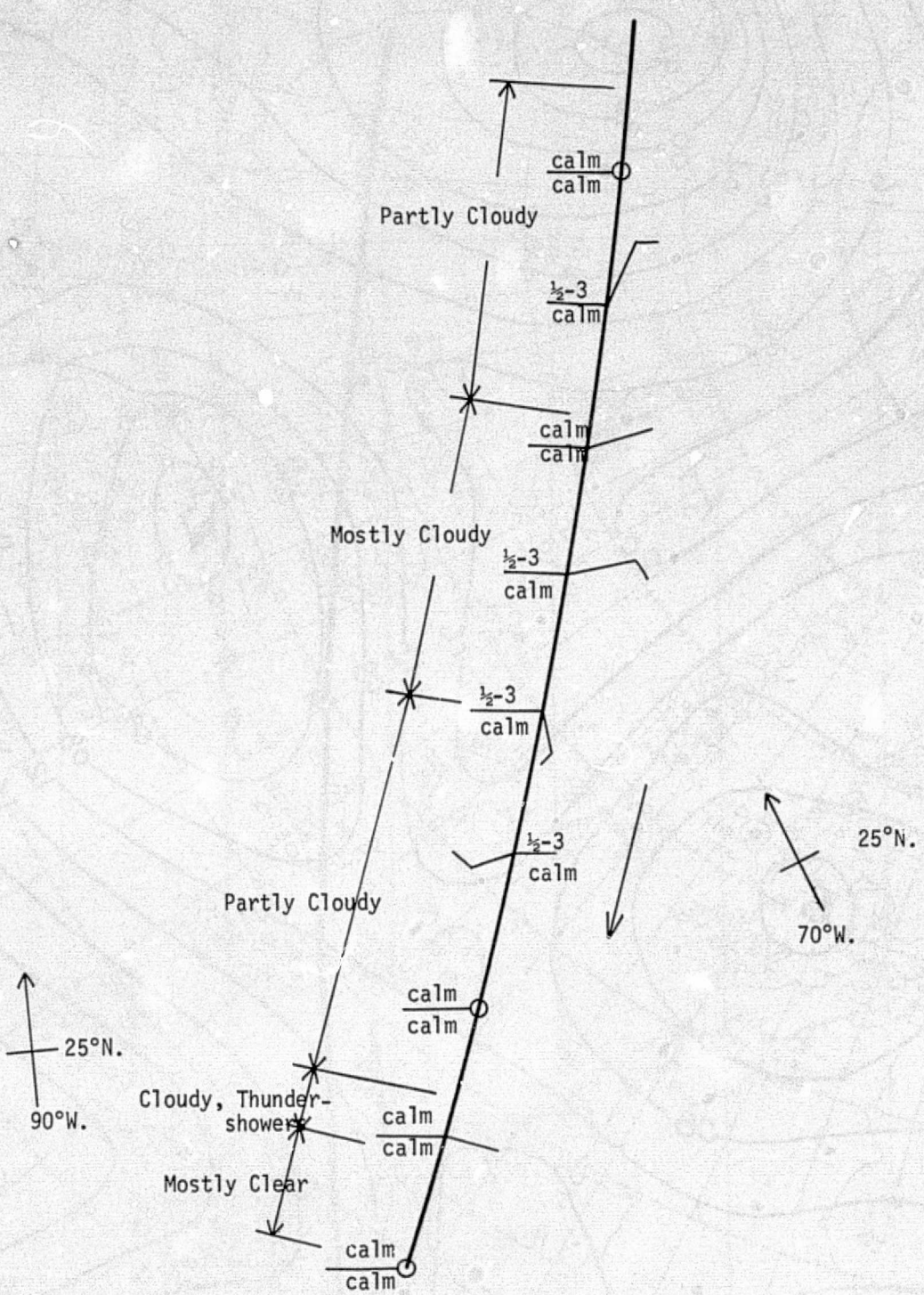
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

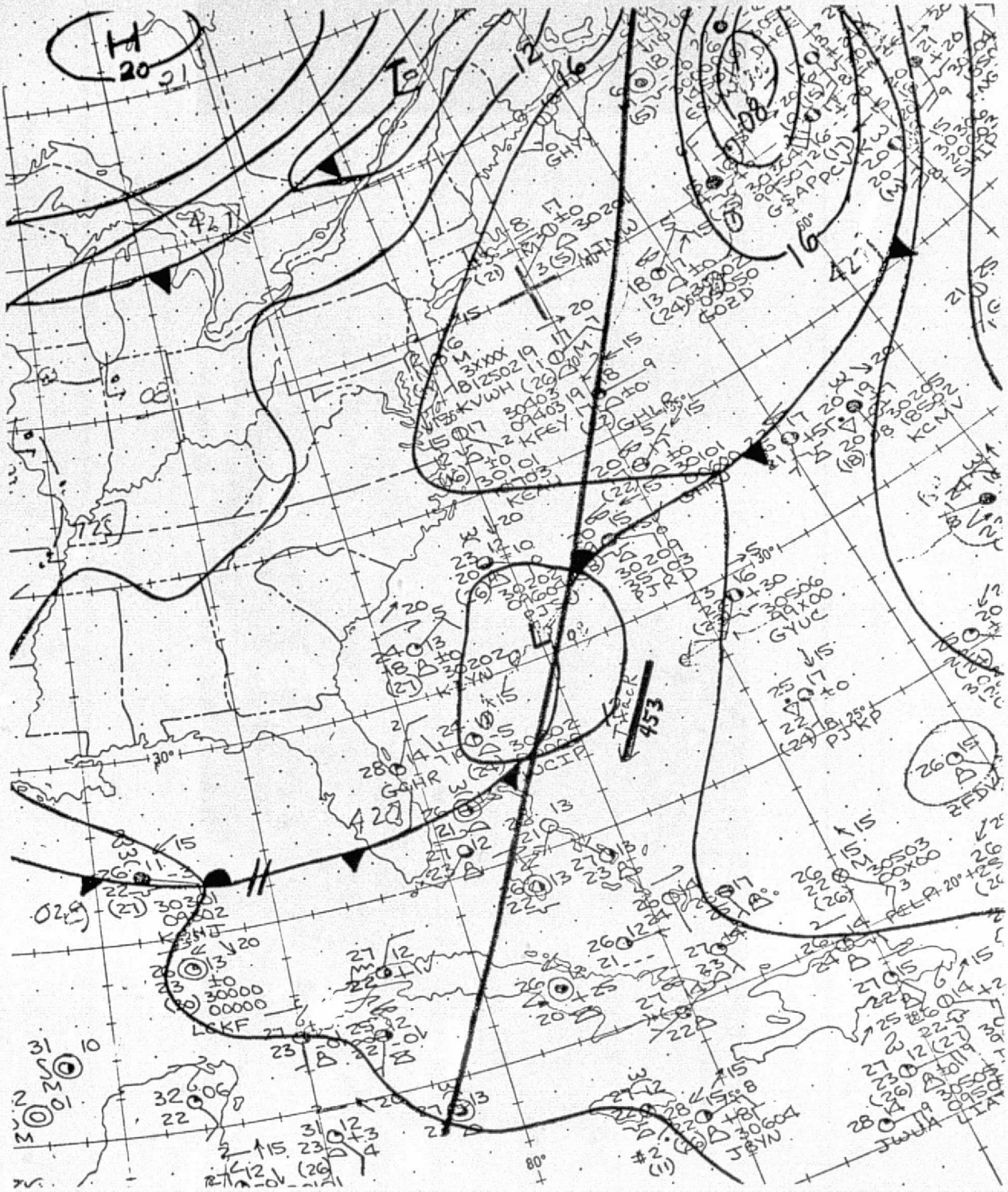


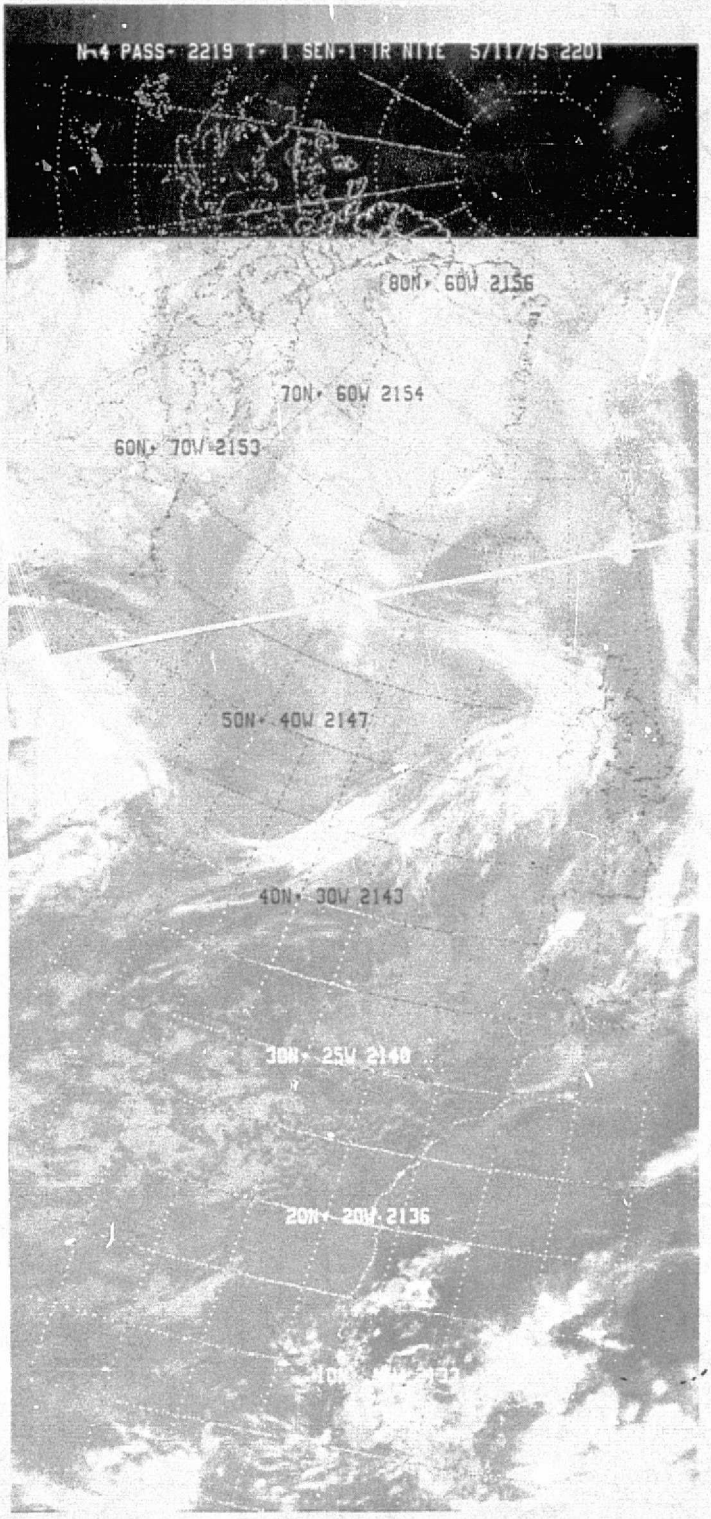
Track 453 extends from Norway westward across Iceland, then southwest across Newfoundland and Nova Scotia continuing across Cuba into the Caribbean Sea. Scattered showers are occurring from Norway to a point south of Greenland and over Newfoundland. A narrow zone of thundershowers is found on the south coast of Cuba. Maximum winds are 30 knots with seas of 5 meters. There is no significant swell present.

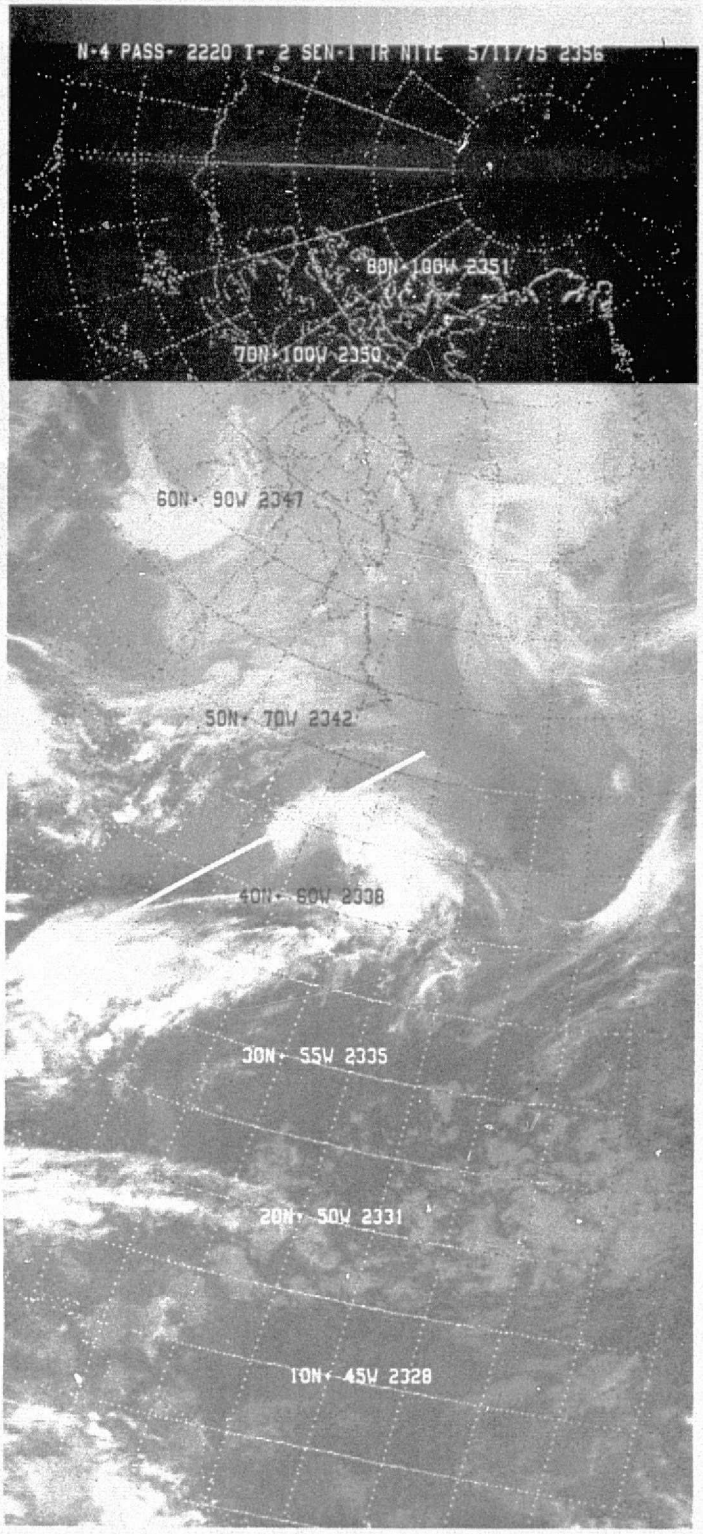
C-3

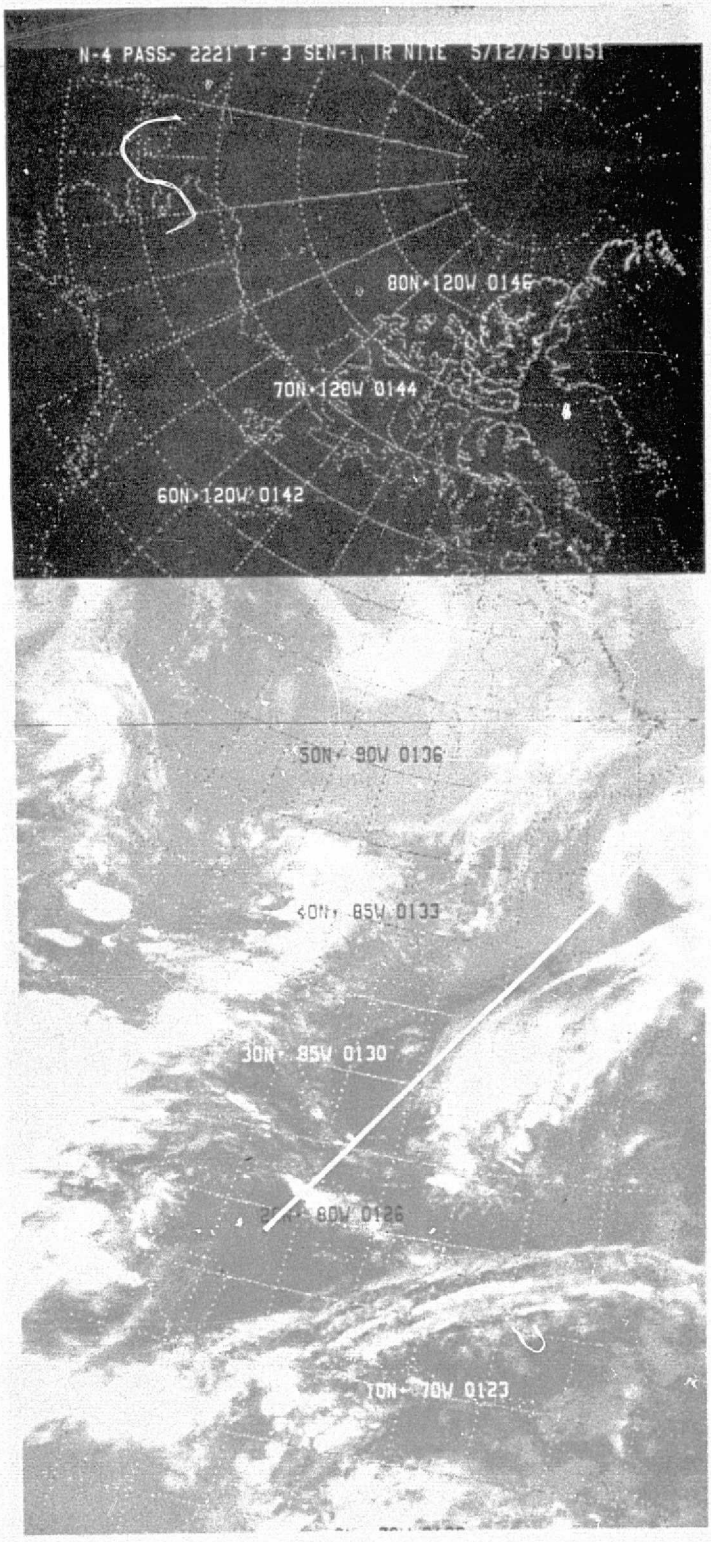


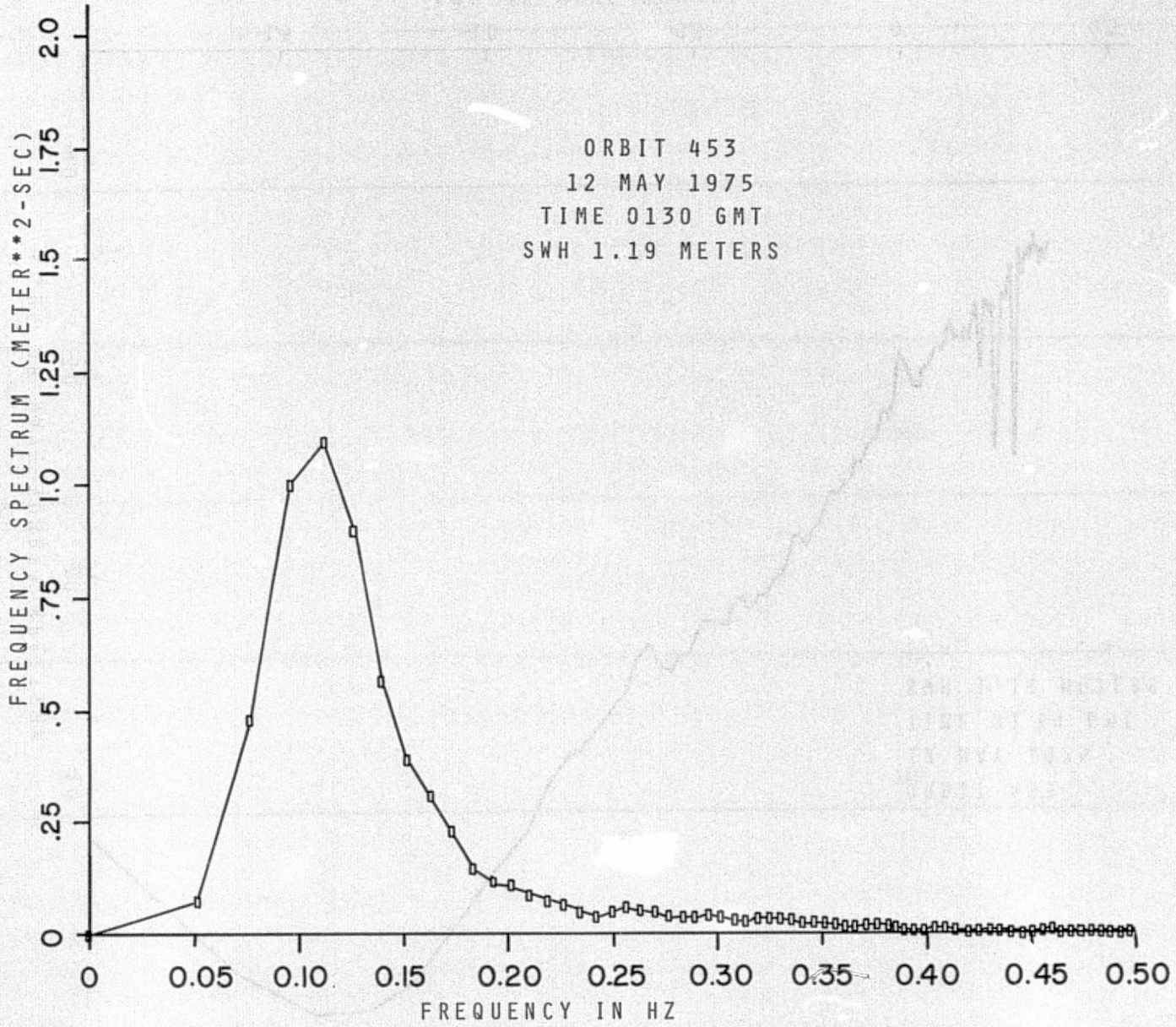

calm
calm
Partly Cloudy
½-3
calm
calm
calm
Mostly Cloudy
½-3
calm
½-3
calm
½-3
calm
Partly Cloudy
25°N.
70°W.
calm
calm
25°N.
90°W.
Cloudy, Thunder-
shower
calm
calm
Mostly Clear
calm
calm

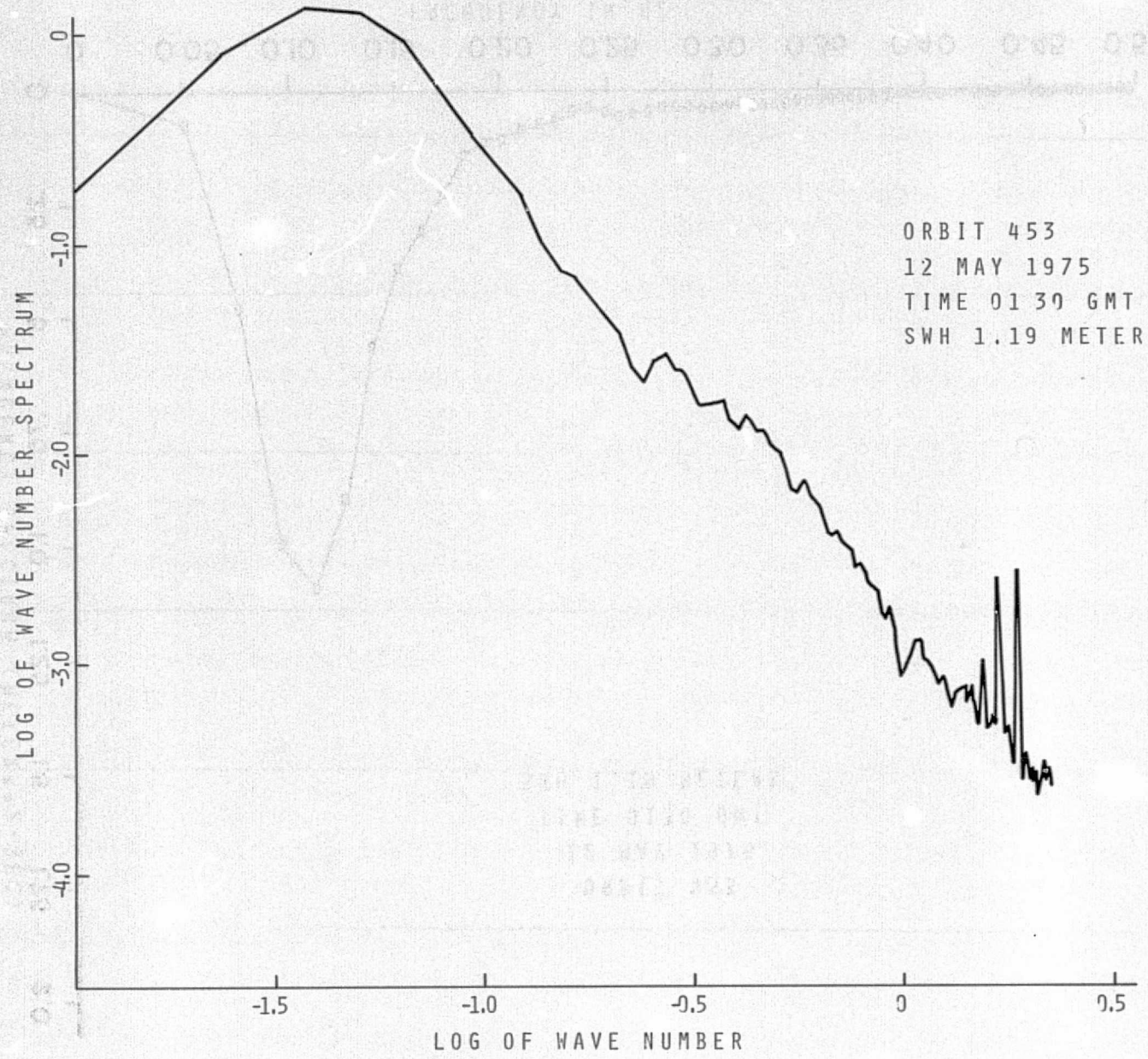







N-4 PASS- 2221 I- 3 SEN-1 IR NITE 5/12/75 0151
80N-120W 0146
70N-120W 0144
60N-120W 0142
50N- 90W 0136
40N- 85W 0133
30N- 85W 0130
80W 0126
70W 0123


ORBIT 453
12 MAY 1975
TIME 0130 GMT
SWH 1.19 METERS
FREQUENCY SPECTRUM (METER**2-SEC)
0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
FREQUENCY IN HZ


ORBIT 453
12 MAY 1975
TIME 01 30 GMT
SWH 1.19 METERS
LOG OF WAVE NUMBER SPECTRUM
0
-1.0
-2.0
-3.0
-4.0
-1.5
-1.0
-0.5
0
0.5
LOG OF WAVE NUMBER

GROUND TRUTH DATA SET 31

(Track 459)

Track 459 extends from southeast to northwest across the Delmarva Peninsula. A cold front crosses the track east of Jacksonville, Florida. There are scattered showers in the vicinity of the front and near the Windward Islands. Maximum winds along the track are 15 knots with seas one and one-half meters. There is no significant swell present.

OVERLAY SYMBOLISM

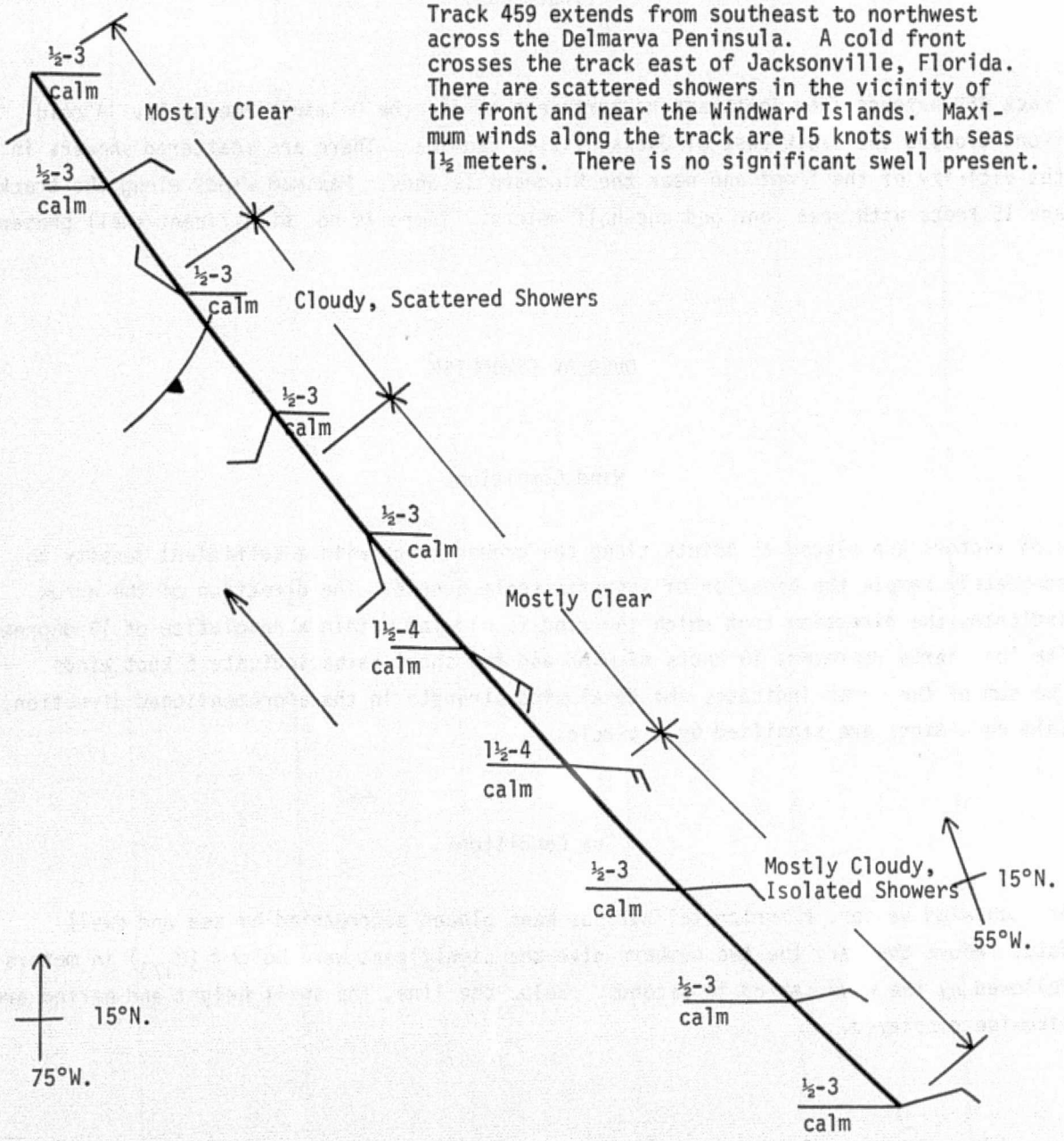
Wind Conditions

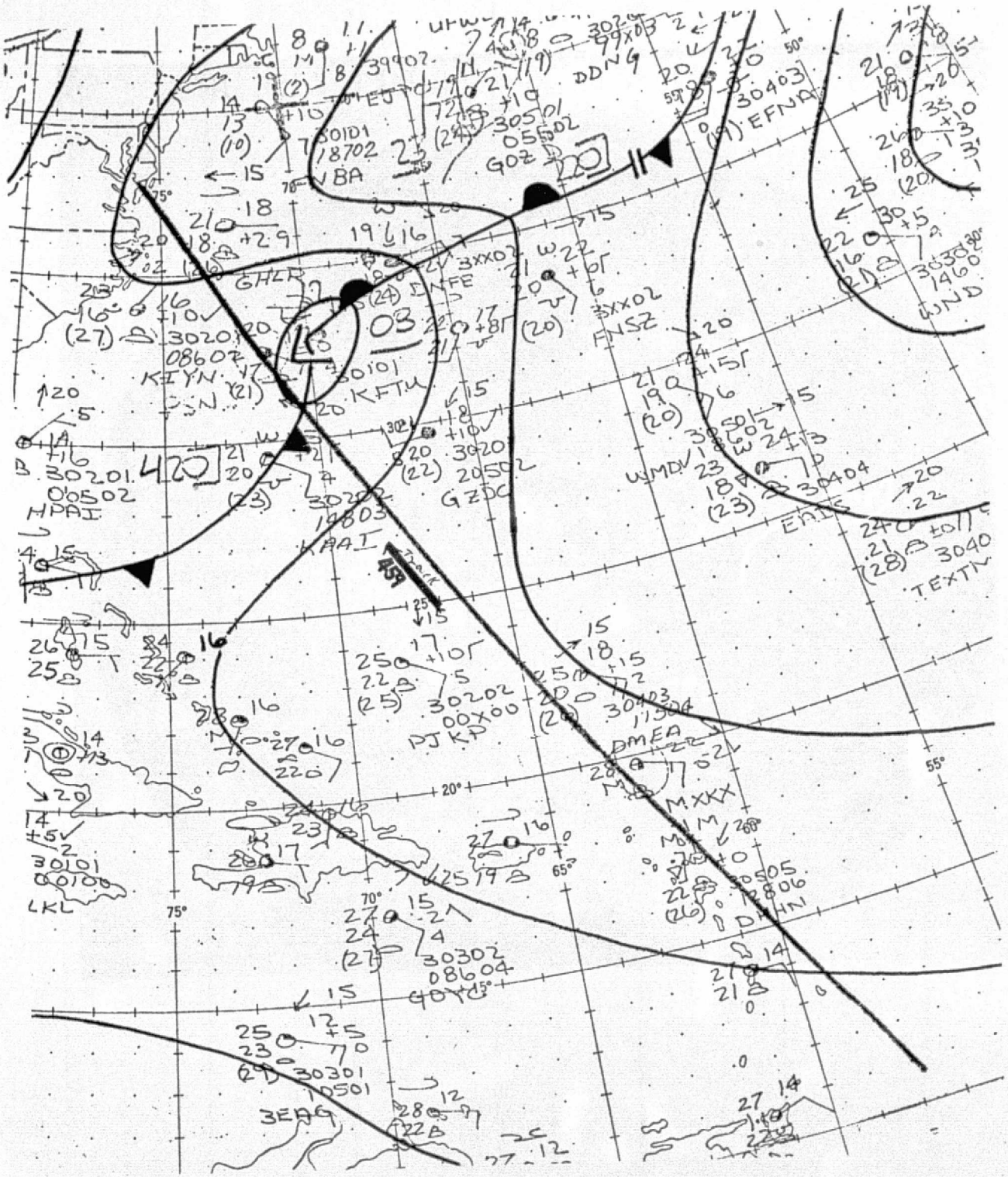
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

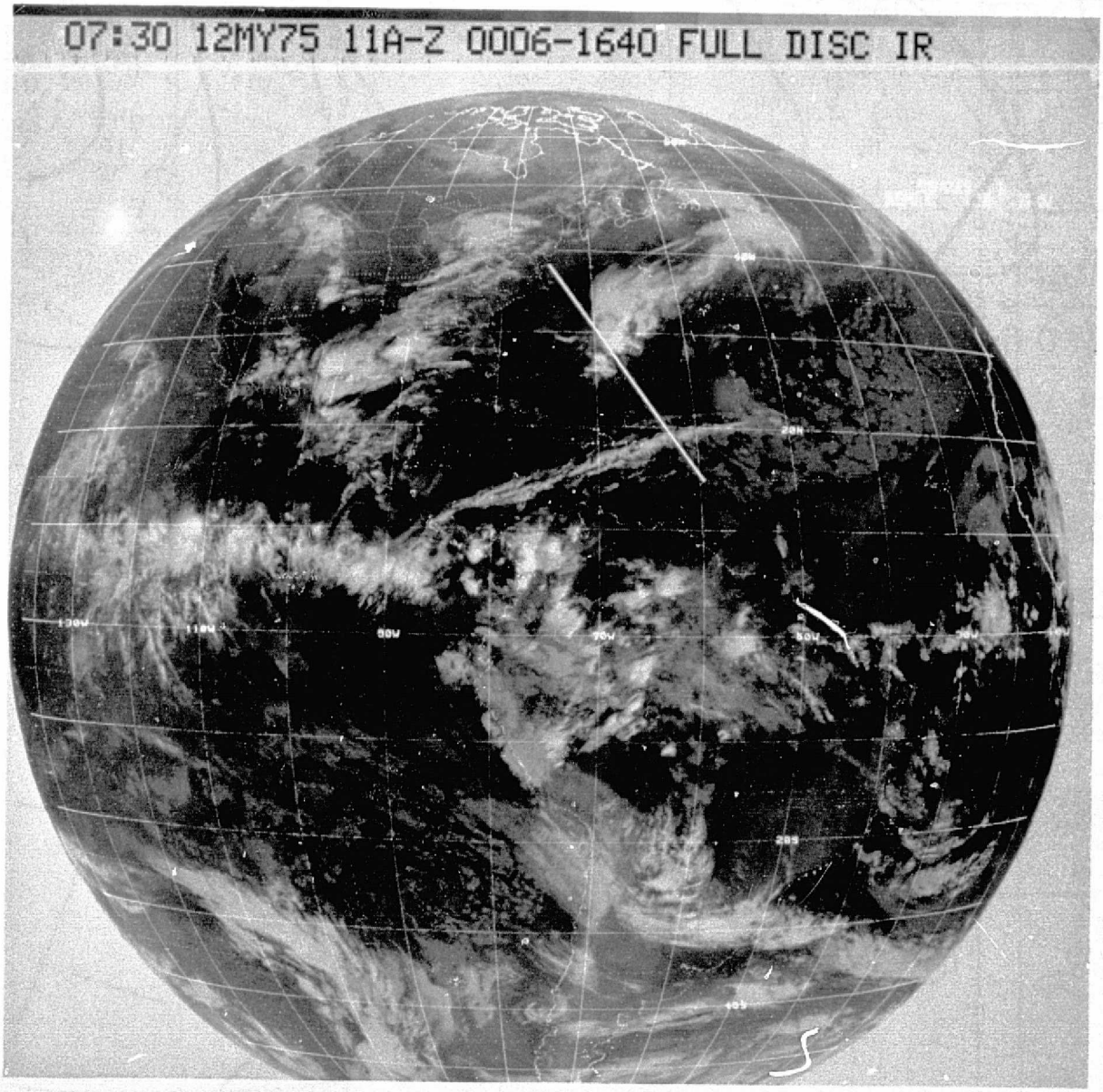
Sea Conditions

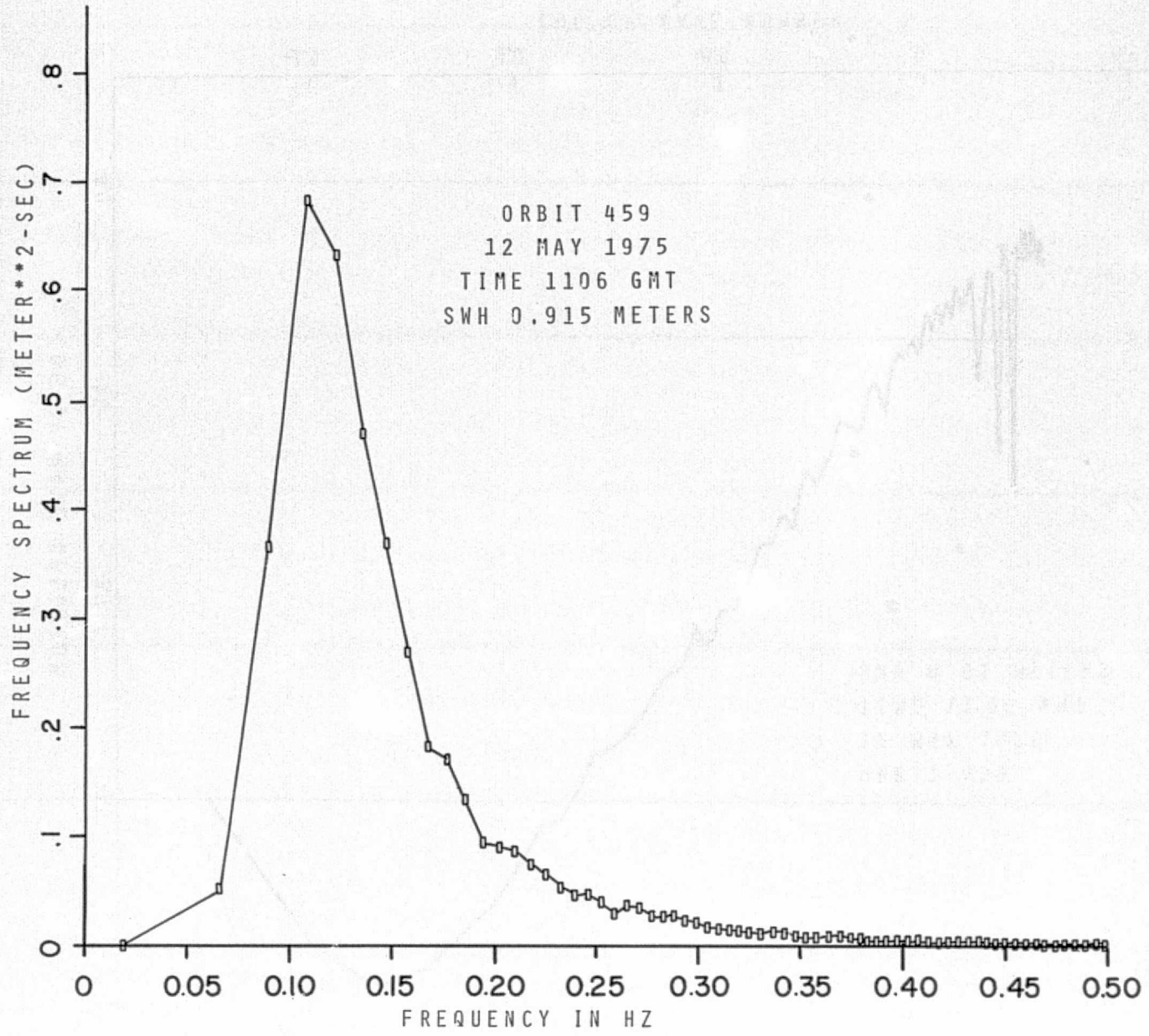
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

Track 459 extends from southeast to northwest across the Delmarva Peninsula. A cold front crosses the track east of Jacksonville, Florida. There are scattered showers in the vicinity of the front and near the Windward Islands. Maximum winds along the track are 15 knots with seas 1½ meters. There is no significant swell present.








ORBIT 459
12 MAY 1975
TIME 1106 GMT
SWH 0.915 METERS
FREQUENCY SPECTRUM (METER**2-SEC)
0
.1
.2
.3
.4
.5
.6
.7
.8
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
FREQUENCY IN HZ

ORBIT 459
12 MAY 1975
TIME 11 06 GMT
SWH 0.91 METERS
LOG OF WAVE SPECTRUM
0
-1.0
-2.0
-3.0
-4.0
-1.5
-1.0
-0.5
0
0.5
LOG OF WAVE NUMBER

GROUND TRUTH DATA SET 32

(Track 524)

Track 524 comes from Europe, passes a few miles south of Greenland, crosses over Newfoundland and central Cuba and then over central America. Maximum winds for this track are near 40°N with a speed of 25 knots. These winds are of short duration having been blowing for only 4-6 hours and therefore the sea is not fully arisen. The ship report of an east wind of 30 knots just east of the track at 45°N is not a valid report as it does not fit the pressure pattern. Rain is occurring over Cuba and isolated showers may be found from 34°N to 50°N.

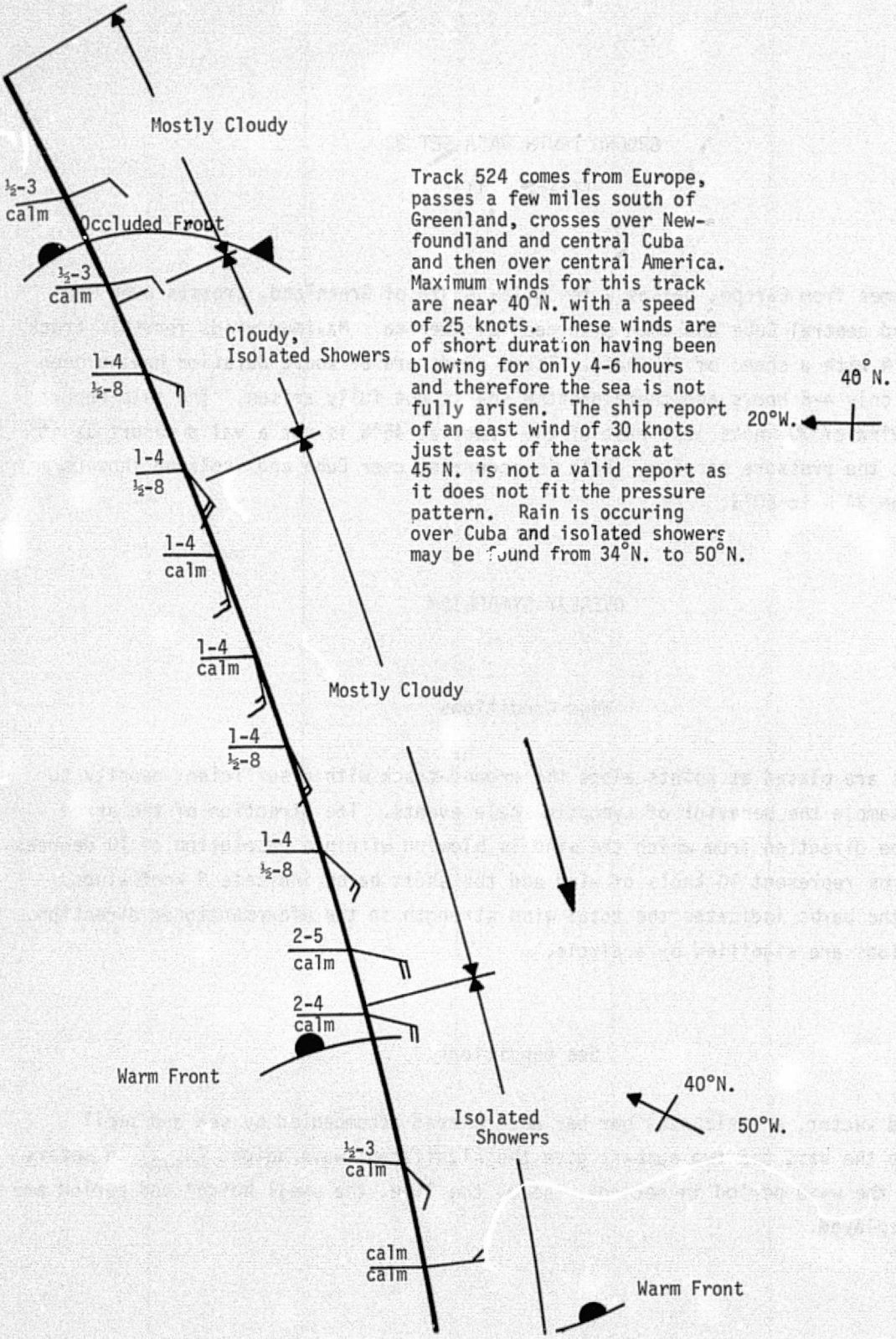
OVERLAY SYMBOLISM

Wind Conditions

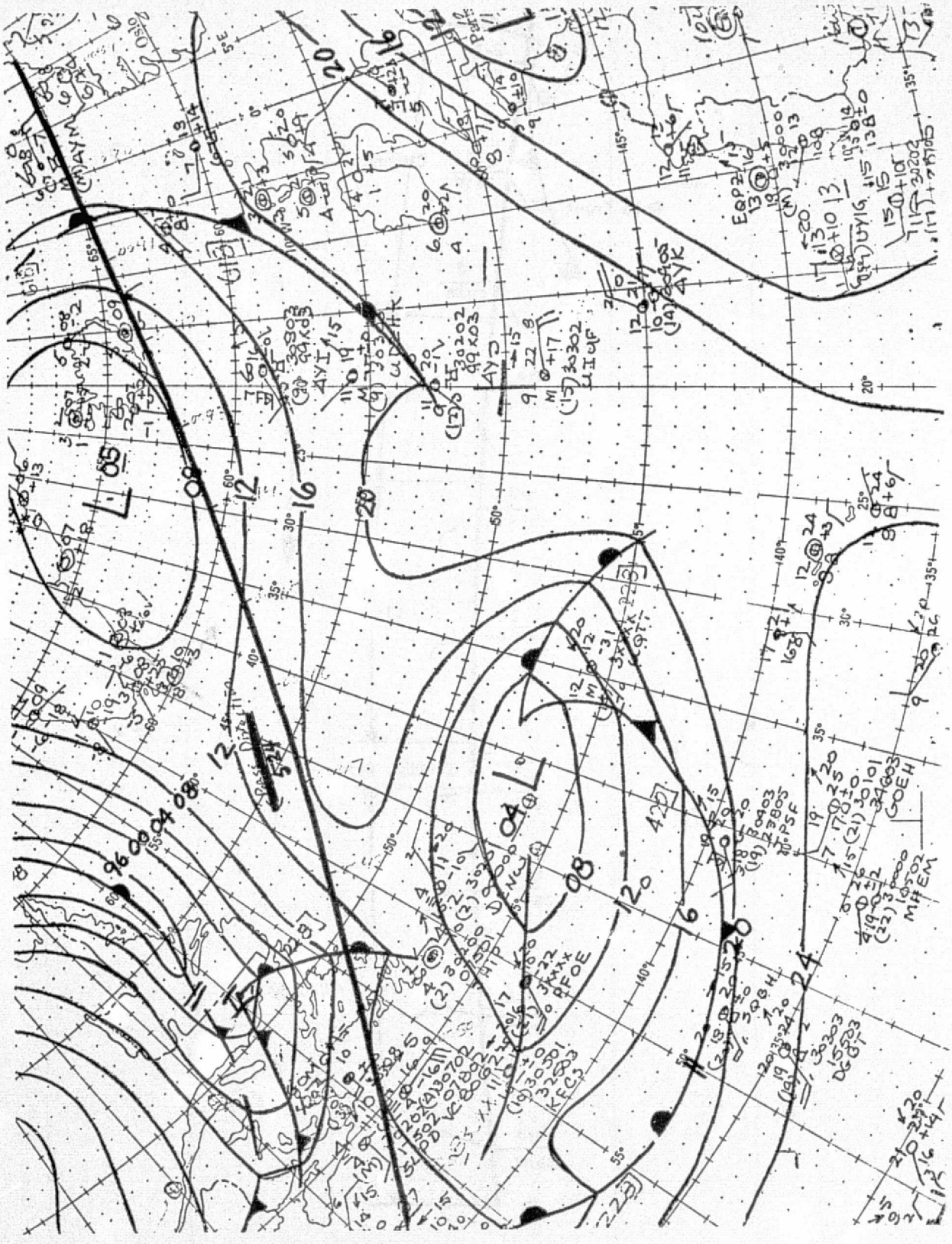
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

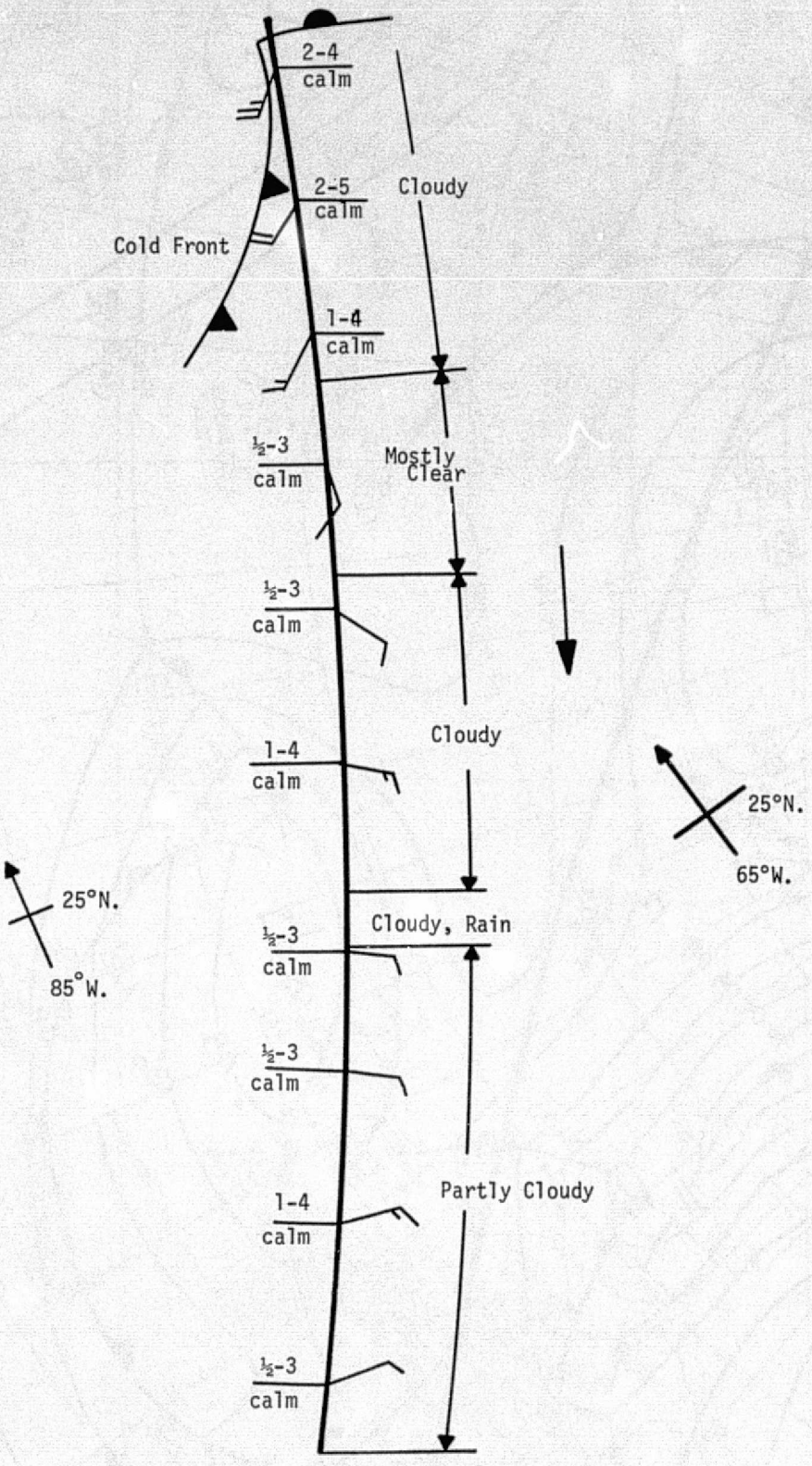
Sea Conditions

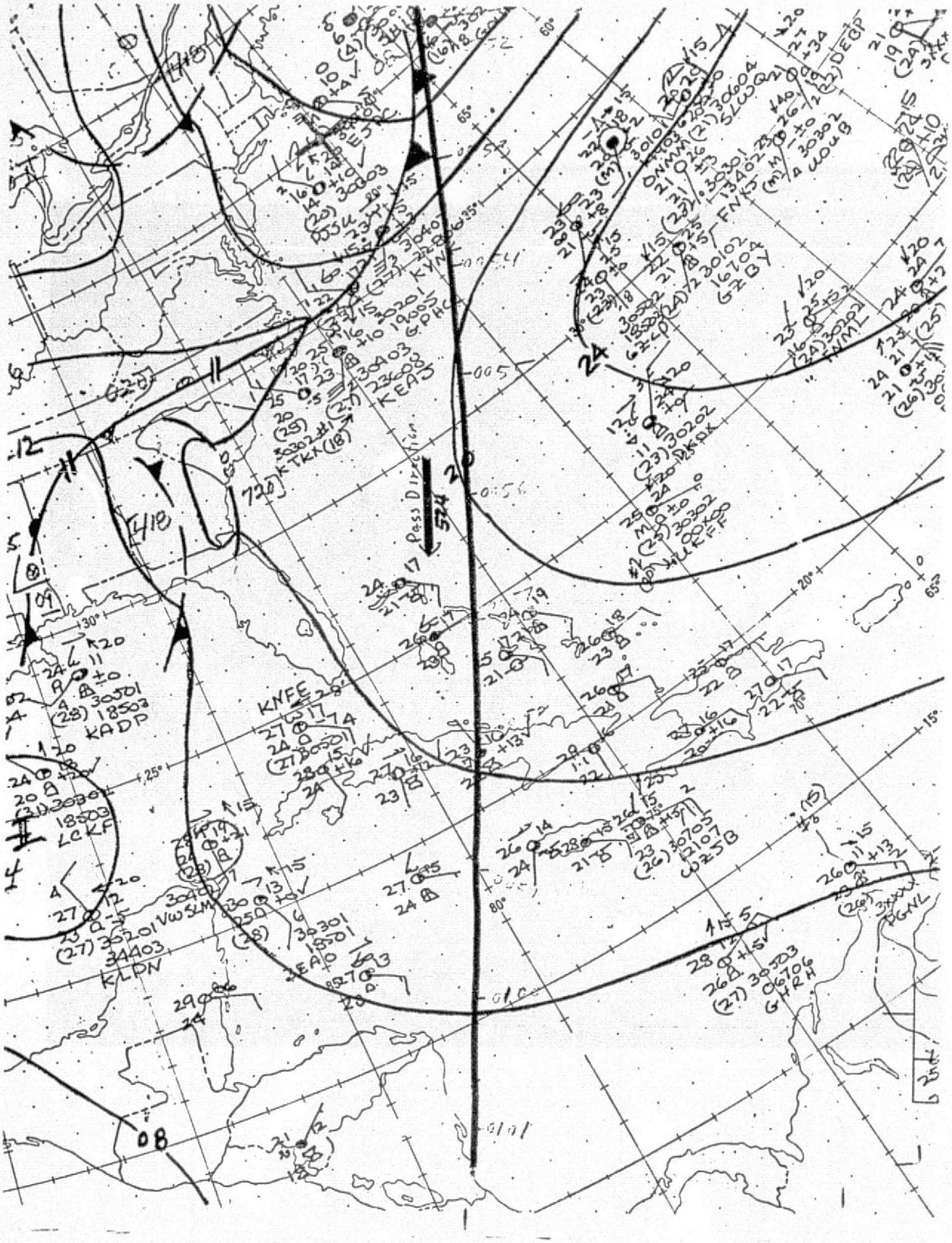
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

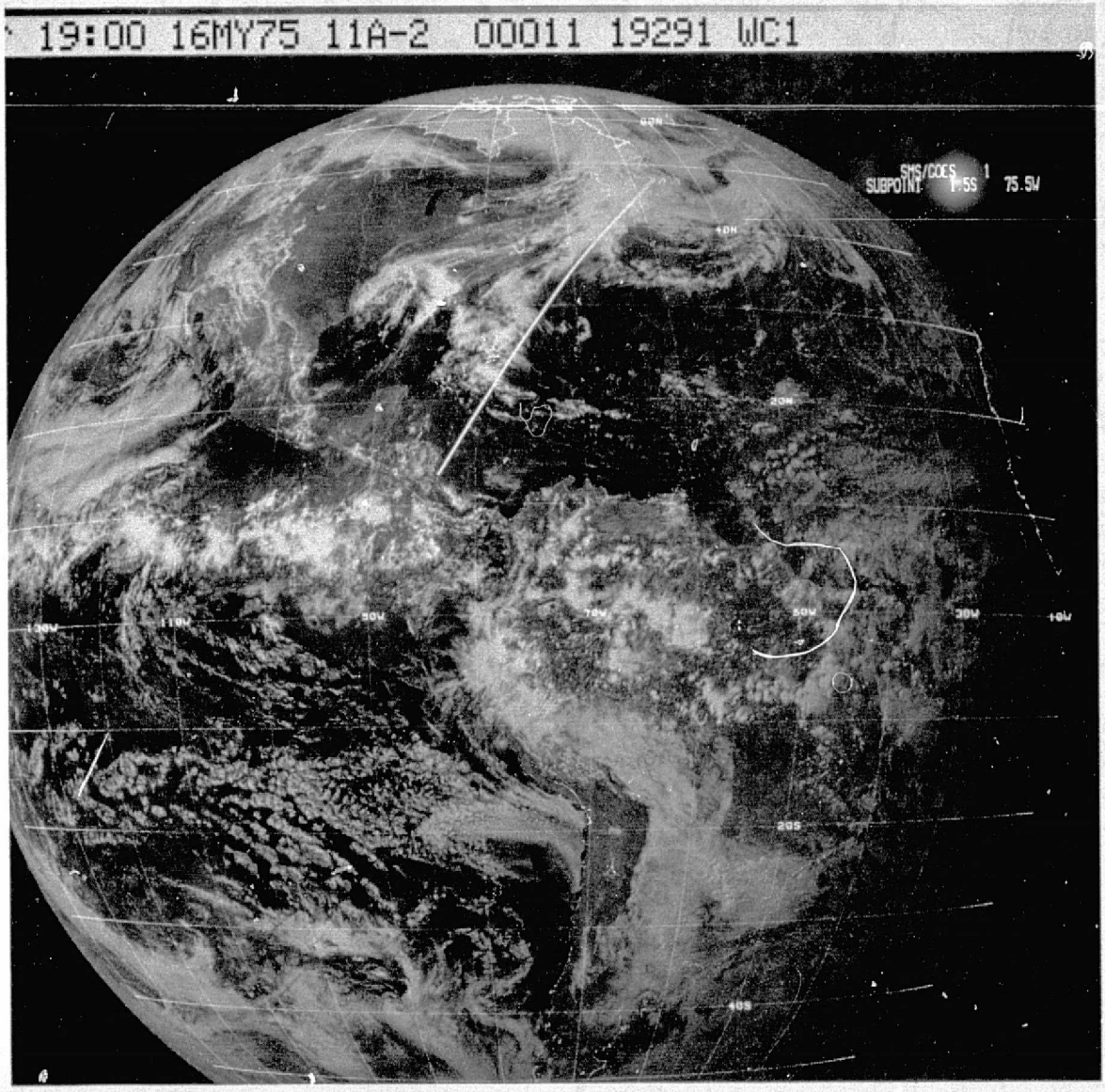


Track 524 comes from Europe, passes a few miles south of Greenland, crosses over Newfoundland and central Cuba and then over central America. Maximum winds for this track are near 40°N. with a speed of 25 knots. These winds are of short duration having been blowing for only 4-6 hours and therefore the sea is not fully arisen. The ship report of an east wind of 30 knots just east of the track at 45 N. is not a valid report as it does not fit the pressure pattern. Rain is occuring over Cuba and isolated showers may be found from 34°N. to 50°N.



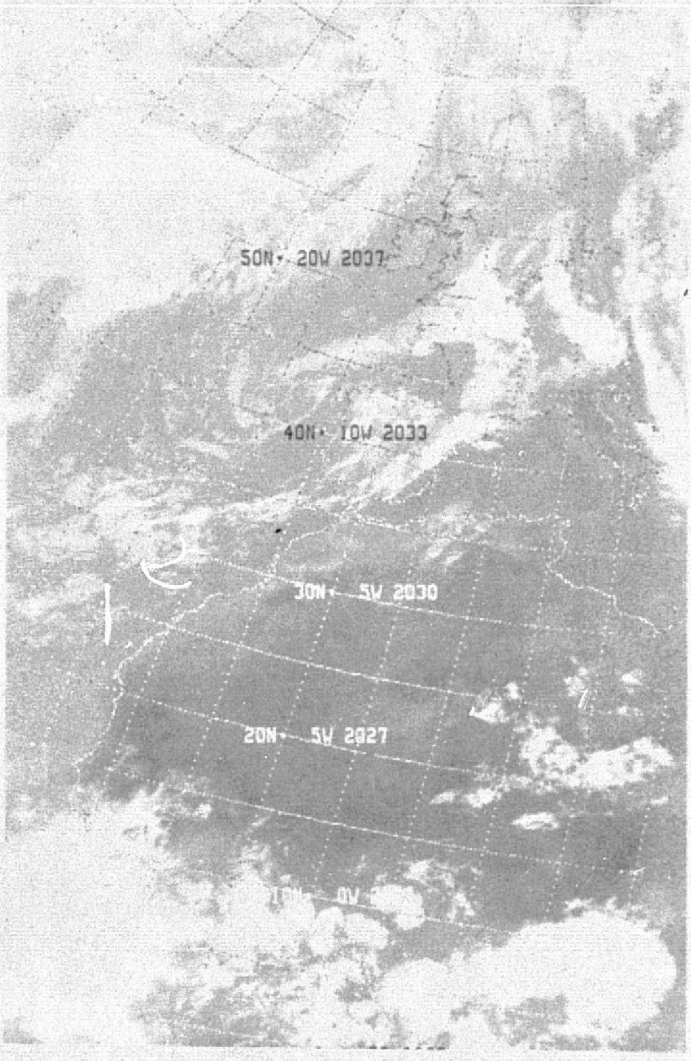

2-4
calm
2-5
calm
Cloudy
Cold Front
1-4
calm
½-3
calm
Mostly
Clear
½-3
calm
Cloudy
1-4
calm
25°N.
65°W.
25°N.
85°W.
½-3
calm
Cloudy, Rain
½-3
calm
Partly Cloudy
1-4
calm
½-3
calm

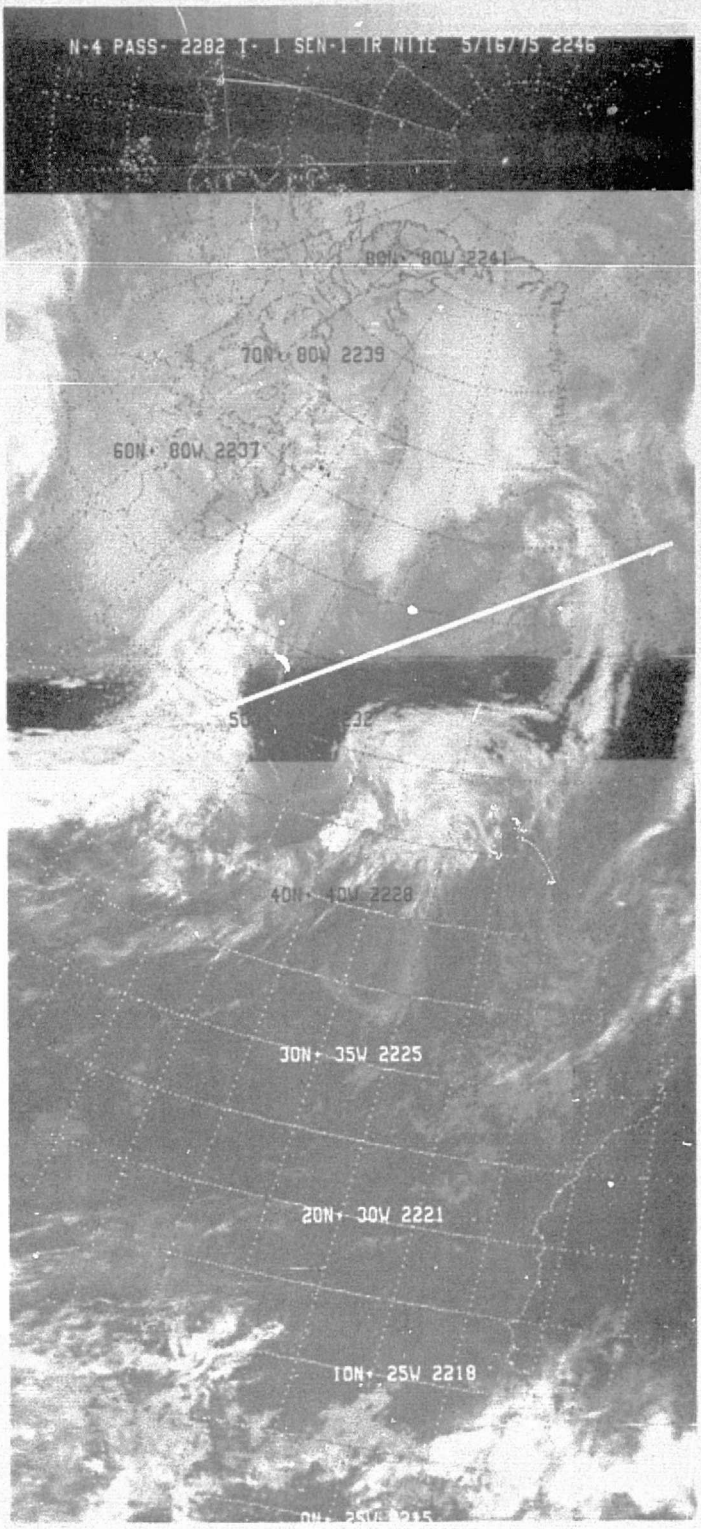


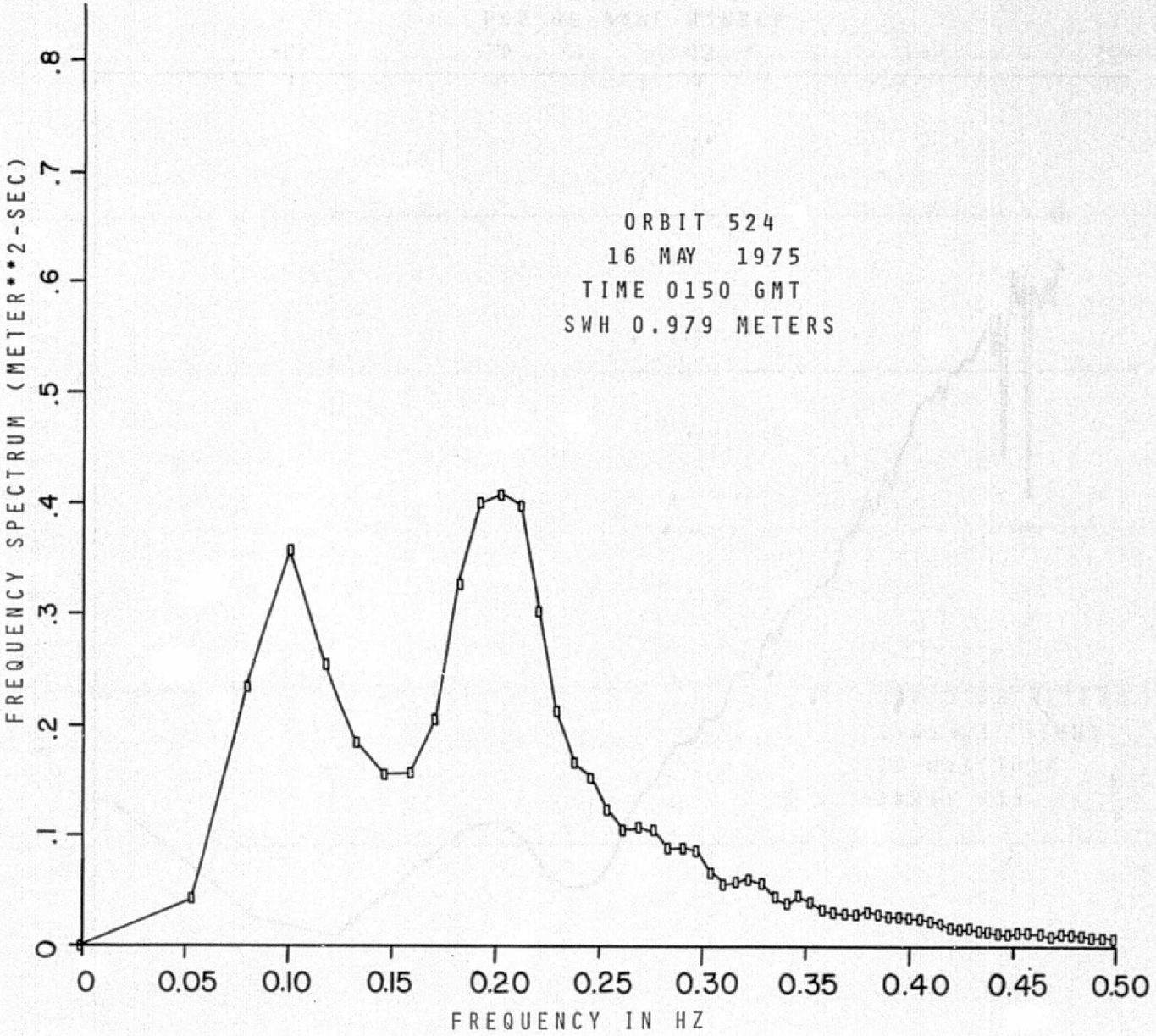


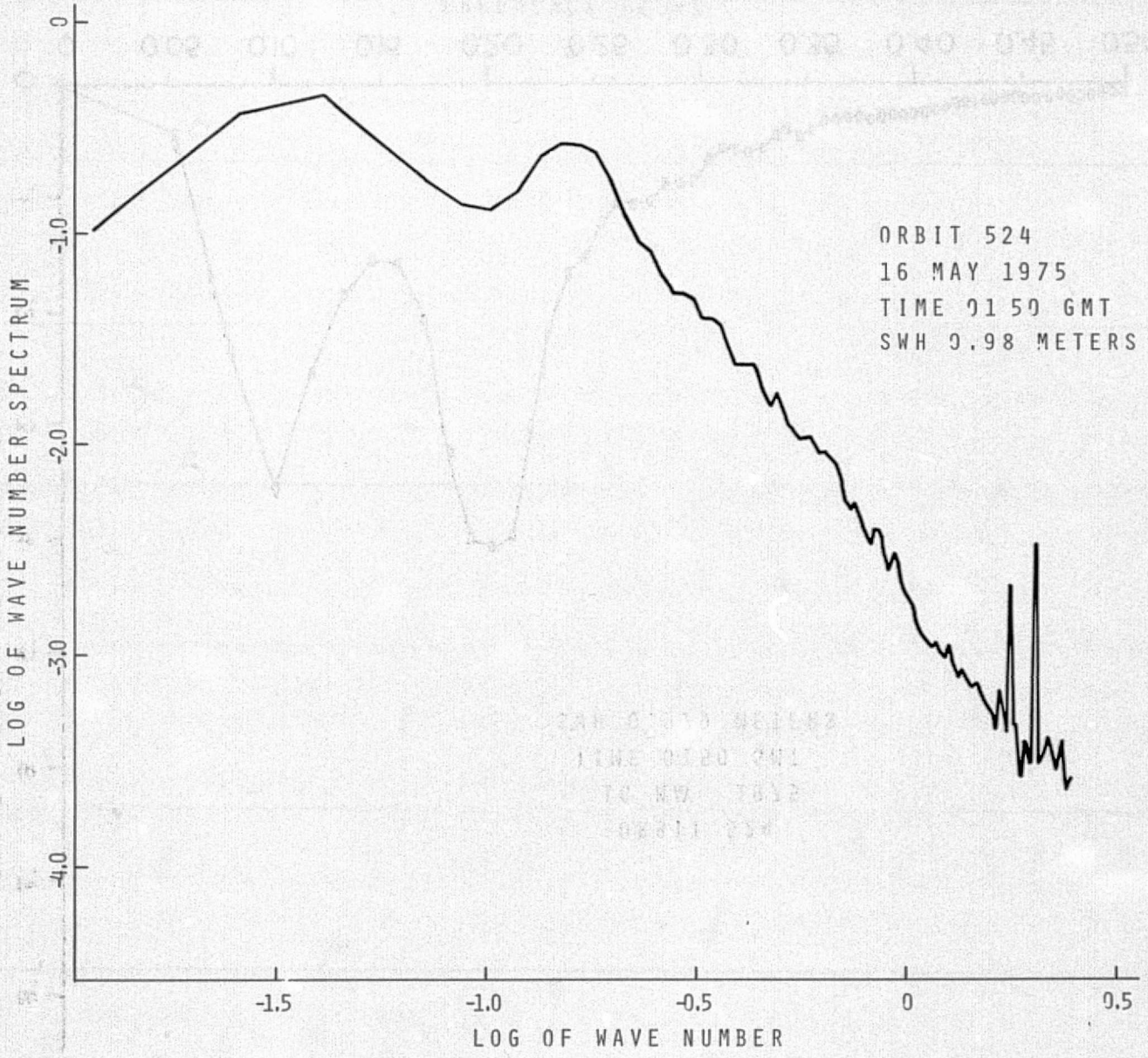
70N 60W 2045

60N 50W 2042






ORBIT 524
16 MAY 1975
TIME 0150 GMT
SWH 0.979 METERS
FREQUENCY SPECTRUM (METER**2-SEC)
0
.1
.2
.3
.4
.5
.6
.7
.8
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
FREQUENCY IN HZ


ORBIT 524
16 MAY 1975
TIME 01 59 GMT
SWH 9.98 METERS
LOG OF WAVE NUMBER SPECTRUM
0
-1.0
-2.0
-3.0
-4.0
-1.5
-1.0
-0.5
0
0.5
LOG OF WAVE NUMBER

GROUND TRUTH DATA SET 33
(Track 530)

Track 530 extends from the central northeastern coast of South America northwest to New Jersey passing over a band of scattered showers about 300 miles wide off the South American coast. A broad band of low, middle and high clouds with scattered showers is encountered off Georgia and the Carolinas. A cirrus overcast covers the track further north.

Winds along the ground track range from 10 knots or less over the northern half to 15 to 20 knots further south. There has been no recent storm which would have produced significant swell in the western Atlantic.

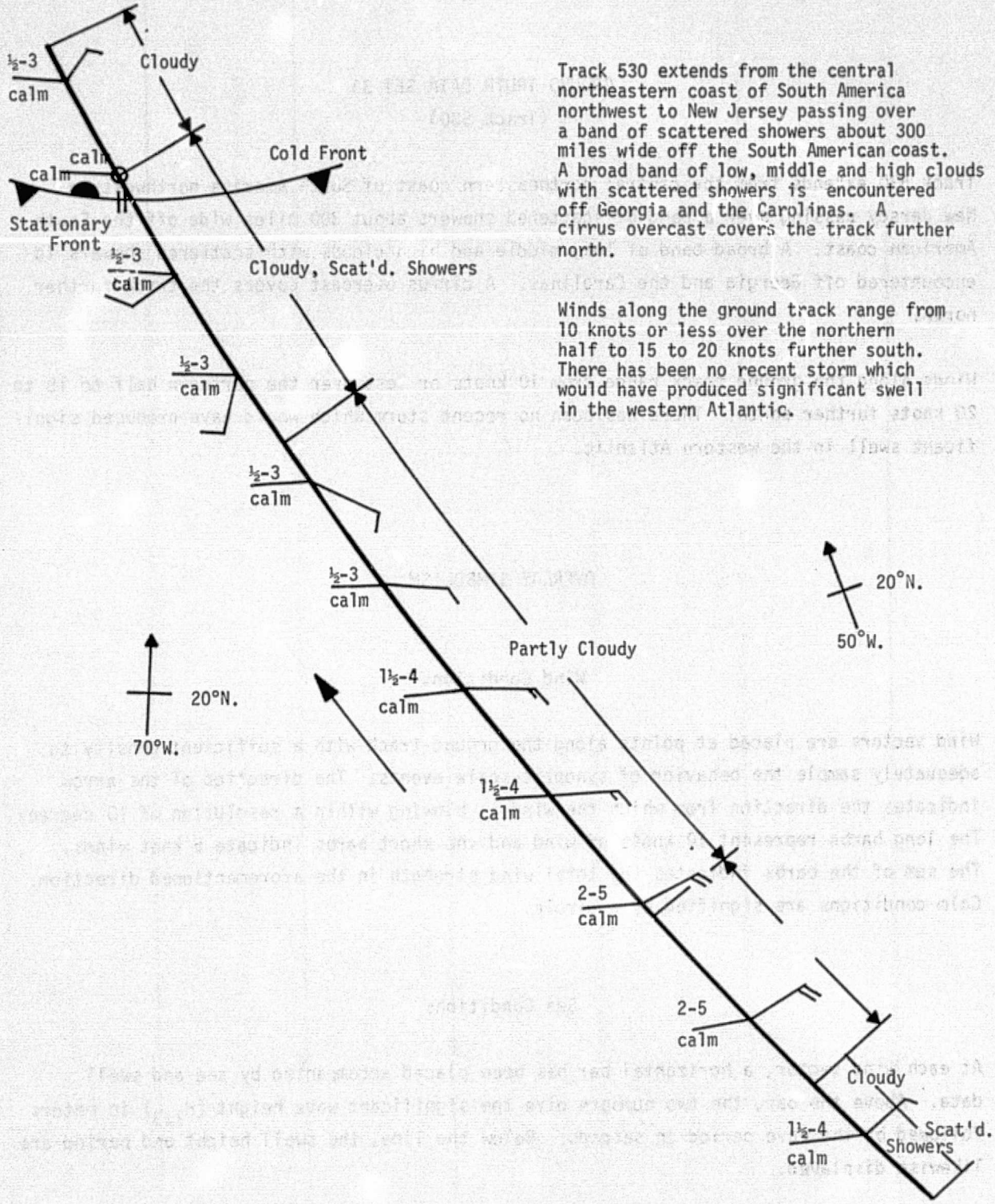
OVERLAY SYMBOLISM

Wind Conditions

Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

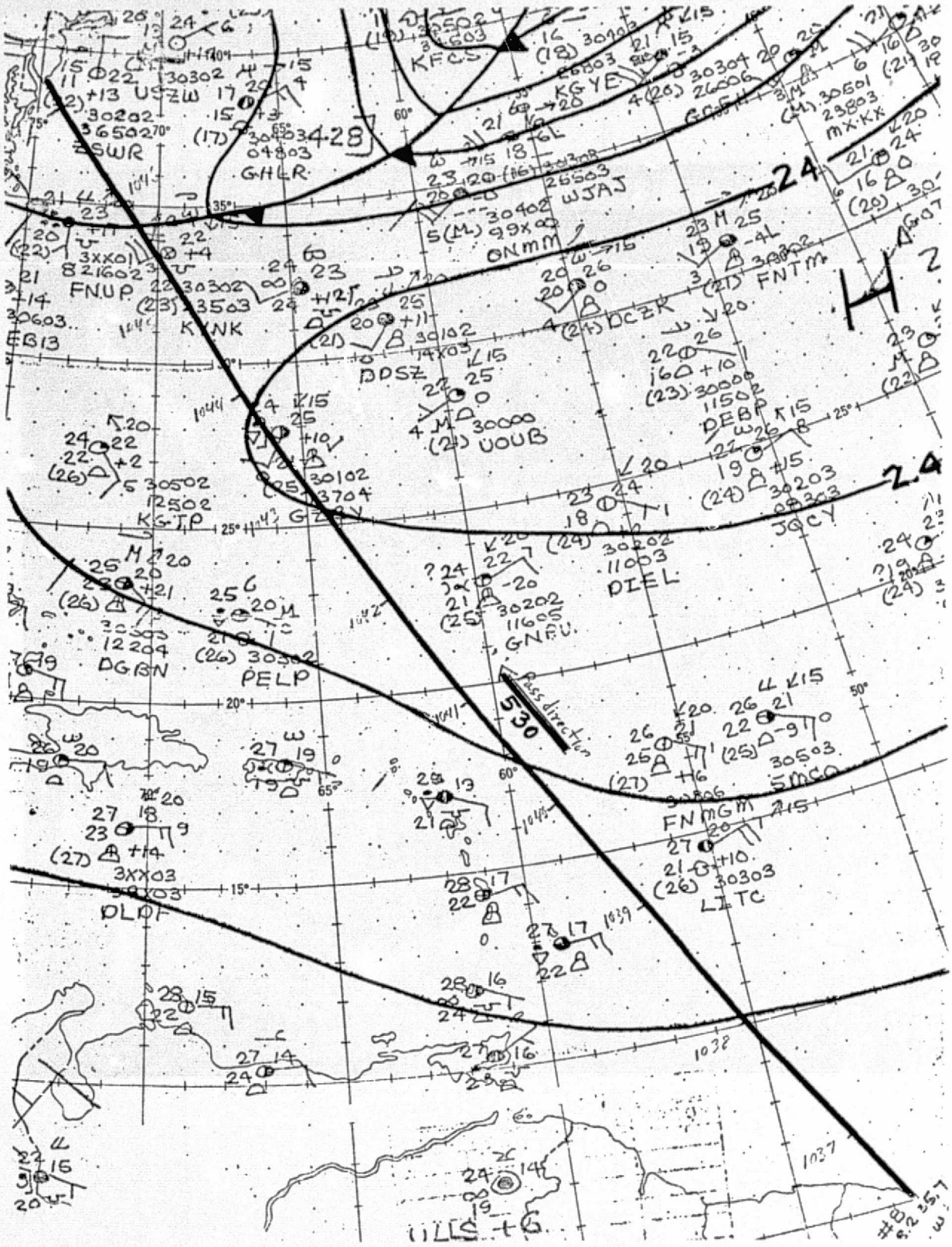
Sea Conditions

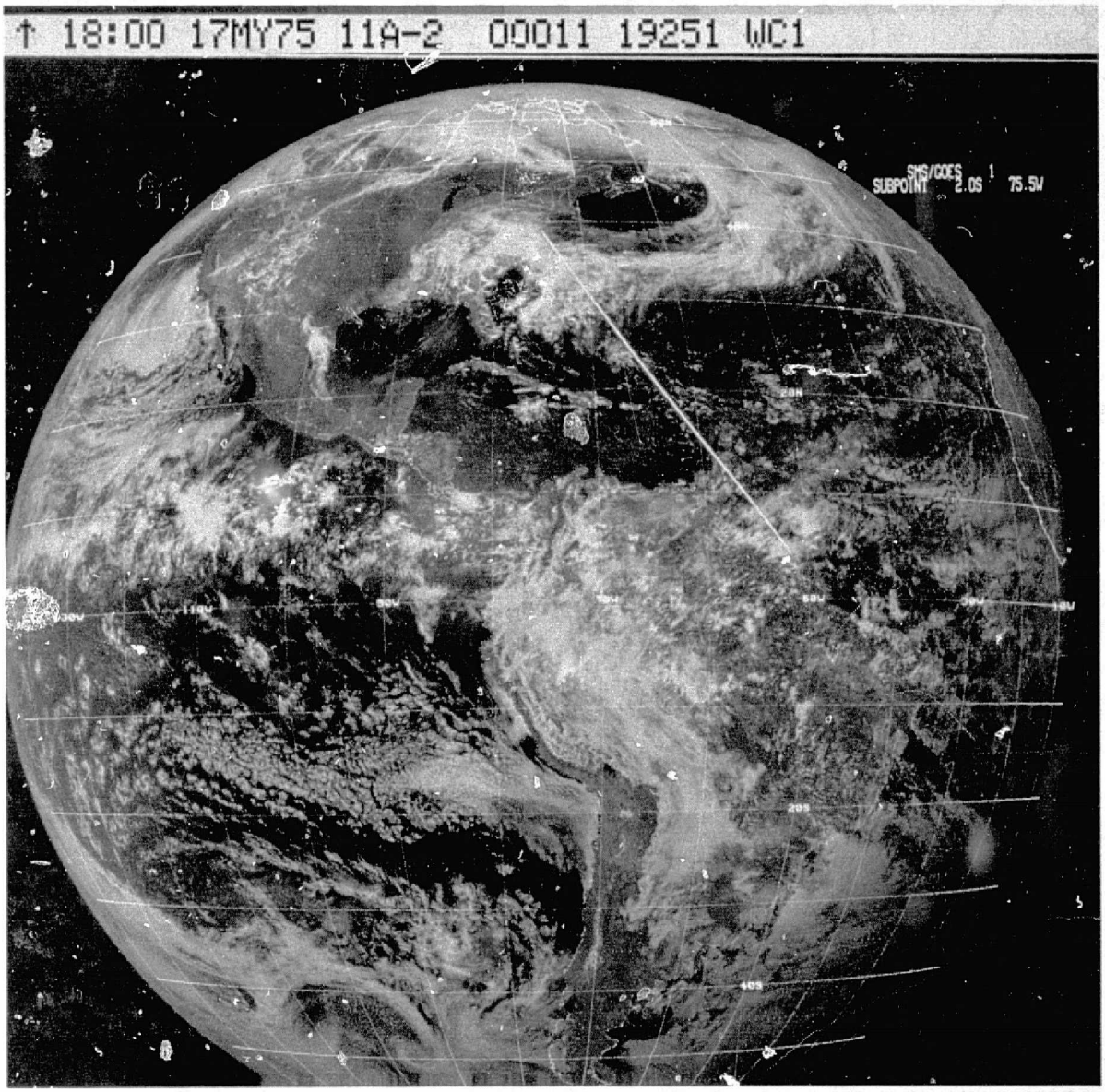
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.

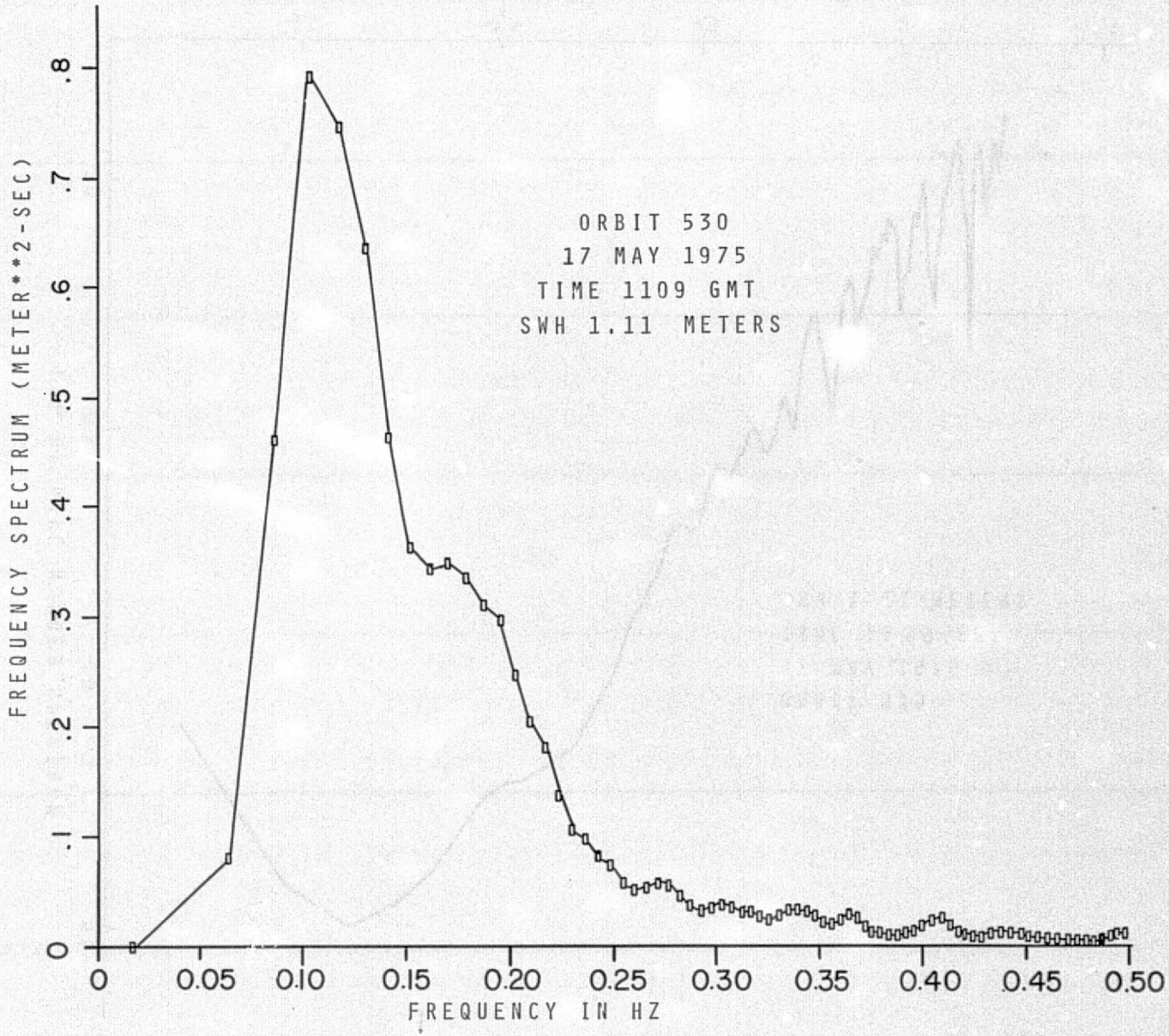


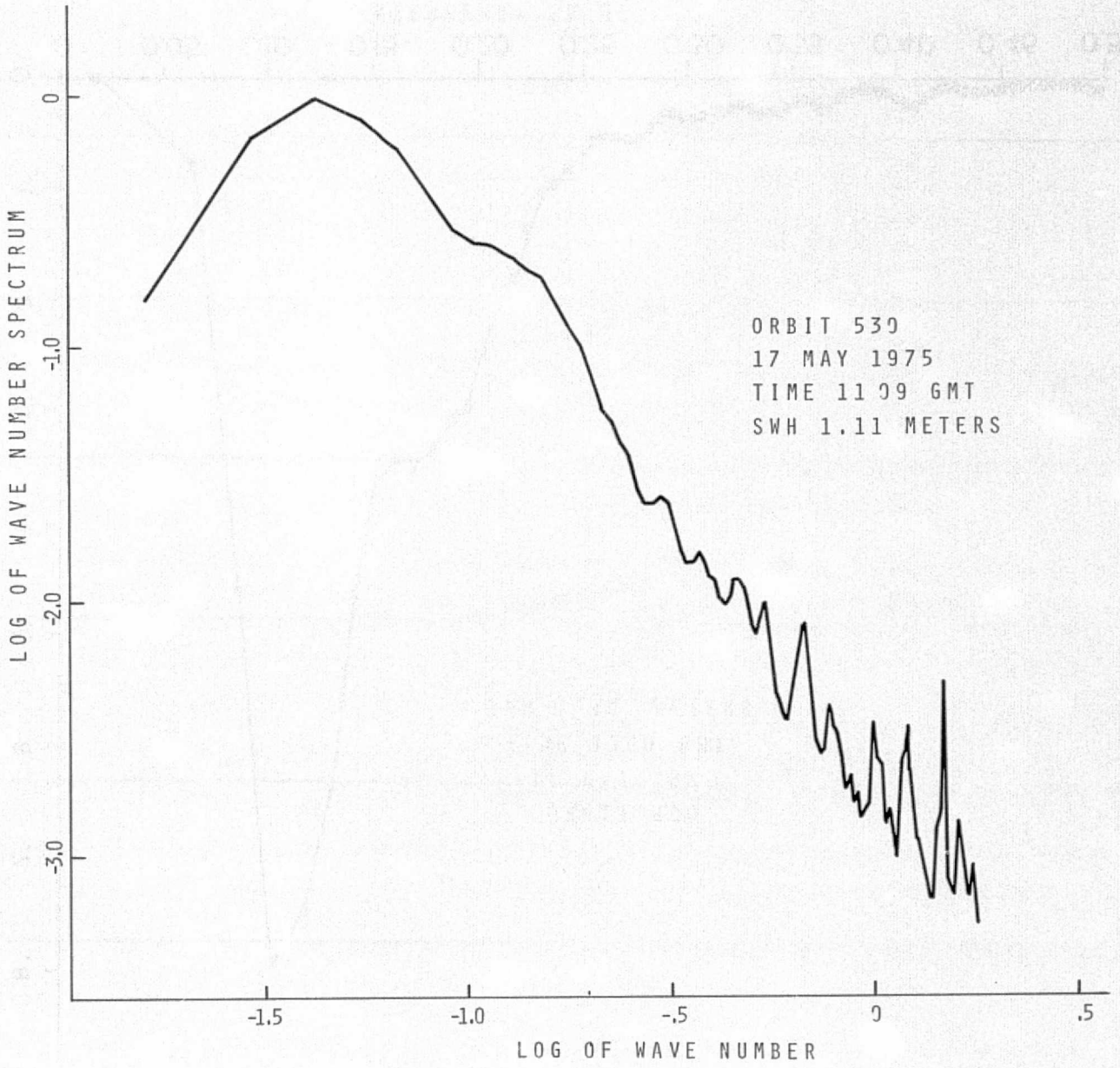
Track 530 extends from the central northeastern coast of South America northwest to New Jersey passing over a band of scattered showers about 300 miles wide off the South American coast. A broad band of low, middle and high clouds with scattered showers is encountered off Georgia and the Carolinas. A cirrus overcast covers the track further north.

Winds along the ground track range from 10 knots or less over the northern half to 15 to 20 knots further south. There has been no recent storm which would have produced significant swell in the western Atlantic.






ORBIT 530
17 MAY 1975
TIME 1109 GMT
SWH 1.11 METERS
FREQUENCY SPECTRUM (METER**2-SEC)
0
.1
.2
.3
.4
.5
.6
.7
.8
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
FREQUENCY IN HZ


LOG OF WAVE NUMBER SPECTRUM
0
-1.0
-2.0
-3.0
-1.5
-1.0
-.5
0
.5
LOG OF WAVE NUMBER
ORBIT 539
17 MAY 1975
TIME 11 09 GMT
SWH 1.11 METERS

GROUND TRUTH DATA SET 34
(Track 544)

Track 544 passes a few miles east of the eastern tip of Long Island. The southern and northern thirds of the track are covered with clouds and there are scattered showers located within the cloud shields. The middle third of the track has some clouds but is mostly clear. There has been no weather system in the north Atlantic during the previous 4 or 5 days which would have caused any significant swell along track.

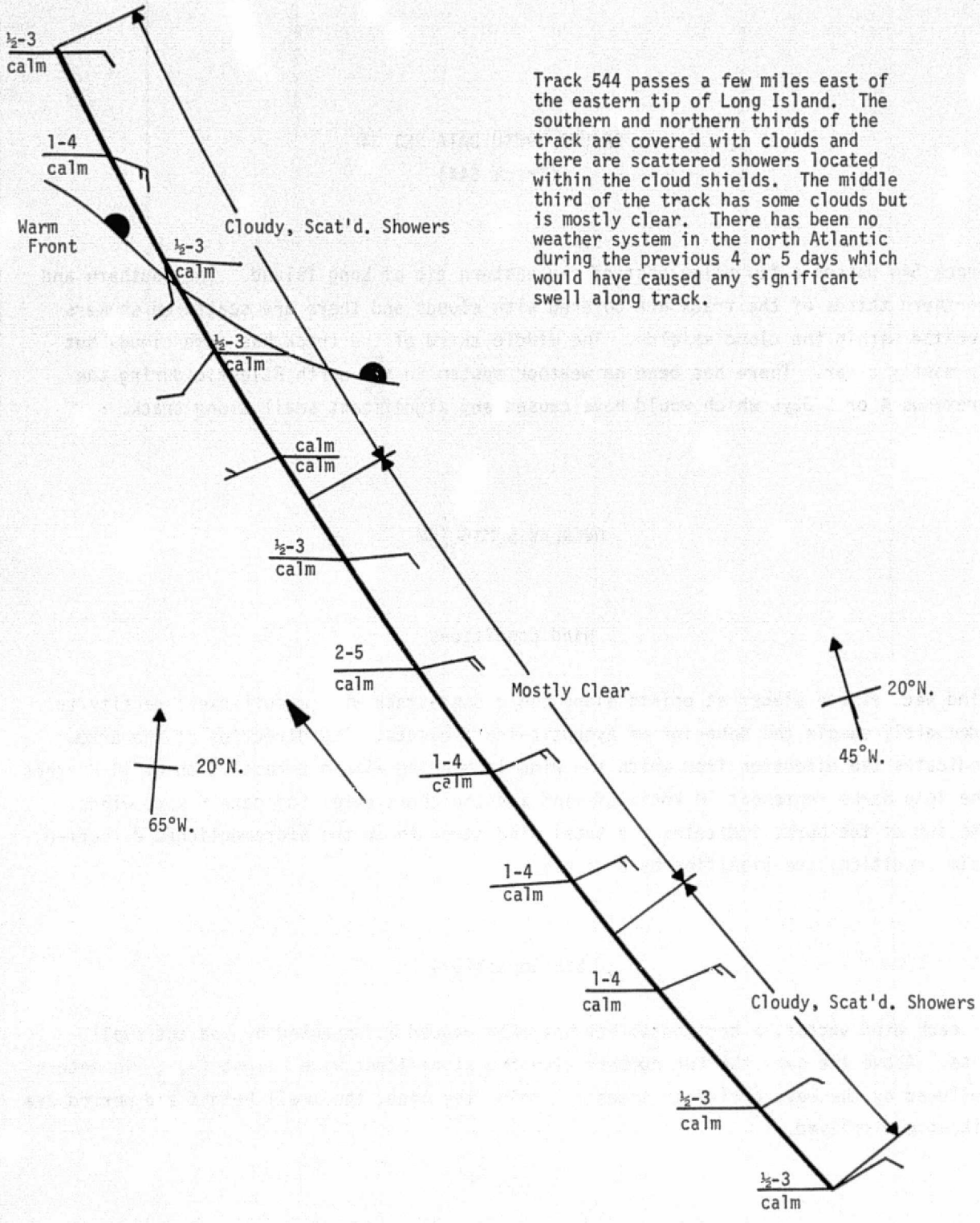
OVERLAY SYMBOLISM

Wind Conditions

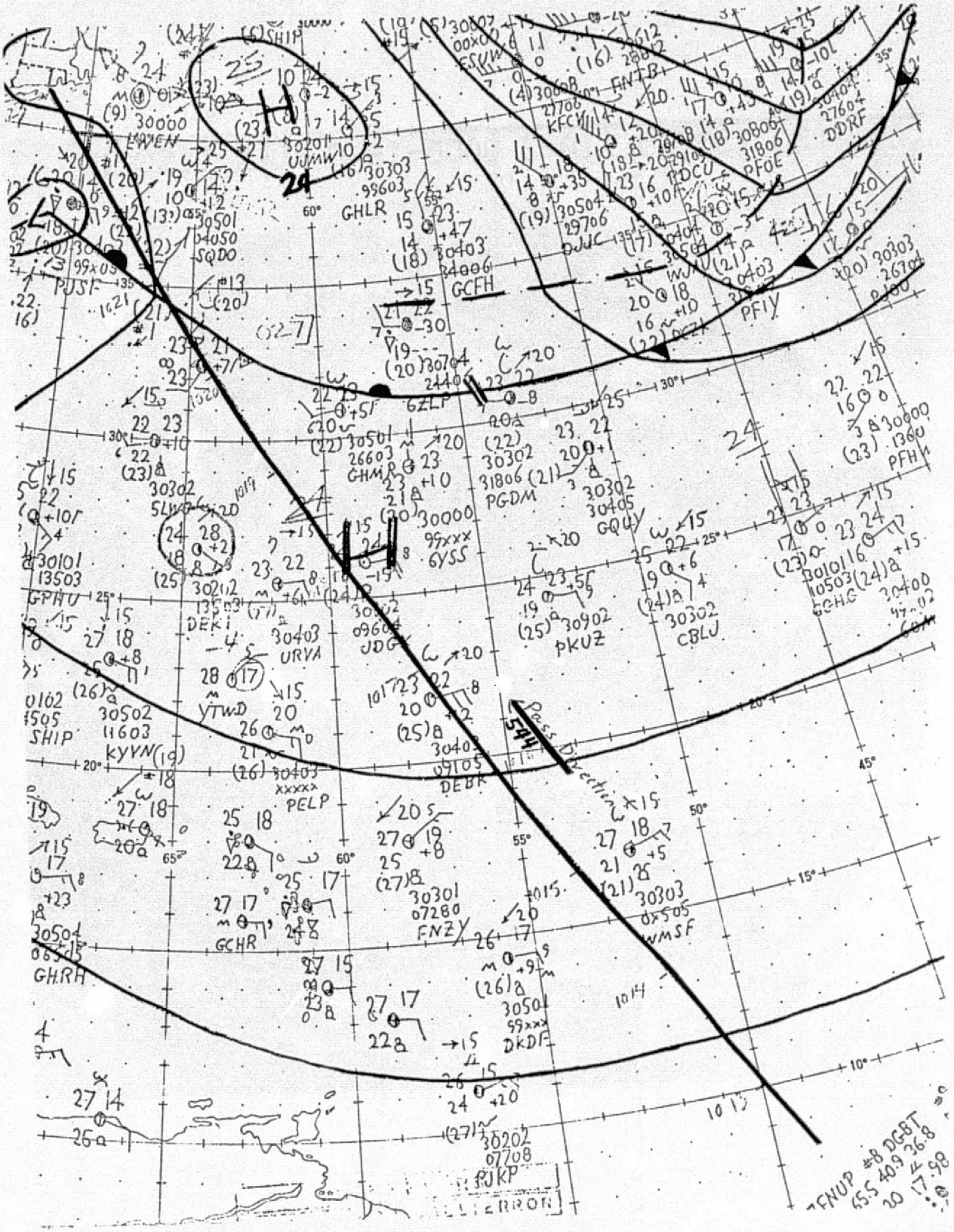
Wind vectors are placed at points along the ground-track with a sufficient density to adequately sample the behavior of synoptic-scale events. The direction of the arrow indicates the direction from which the wind is blowing within a resolution of 10 degrees. The long barbs represent 10 knots of wind and the short barbs indicate 5 knot winds. The sum of the barbs indicates the total wind strength in the aforementioned direction. Calm conditions are signified by a circle.

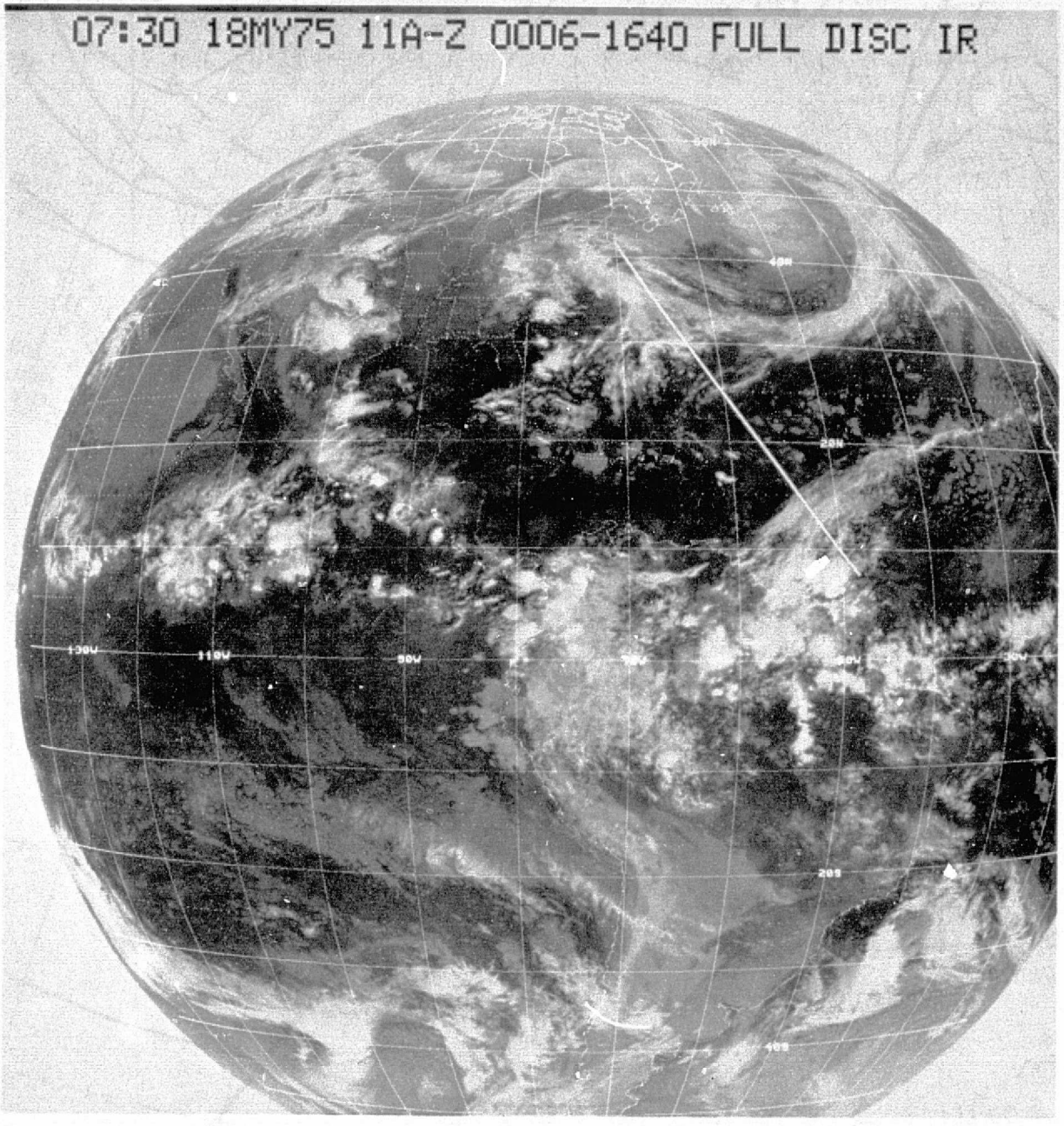
Sea Conditions

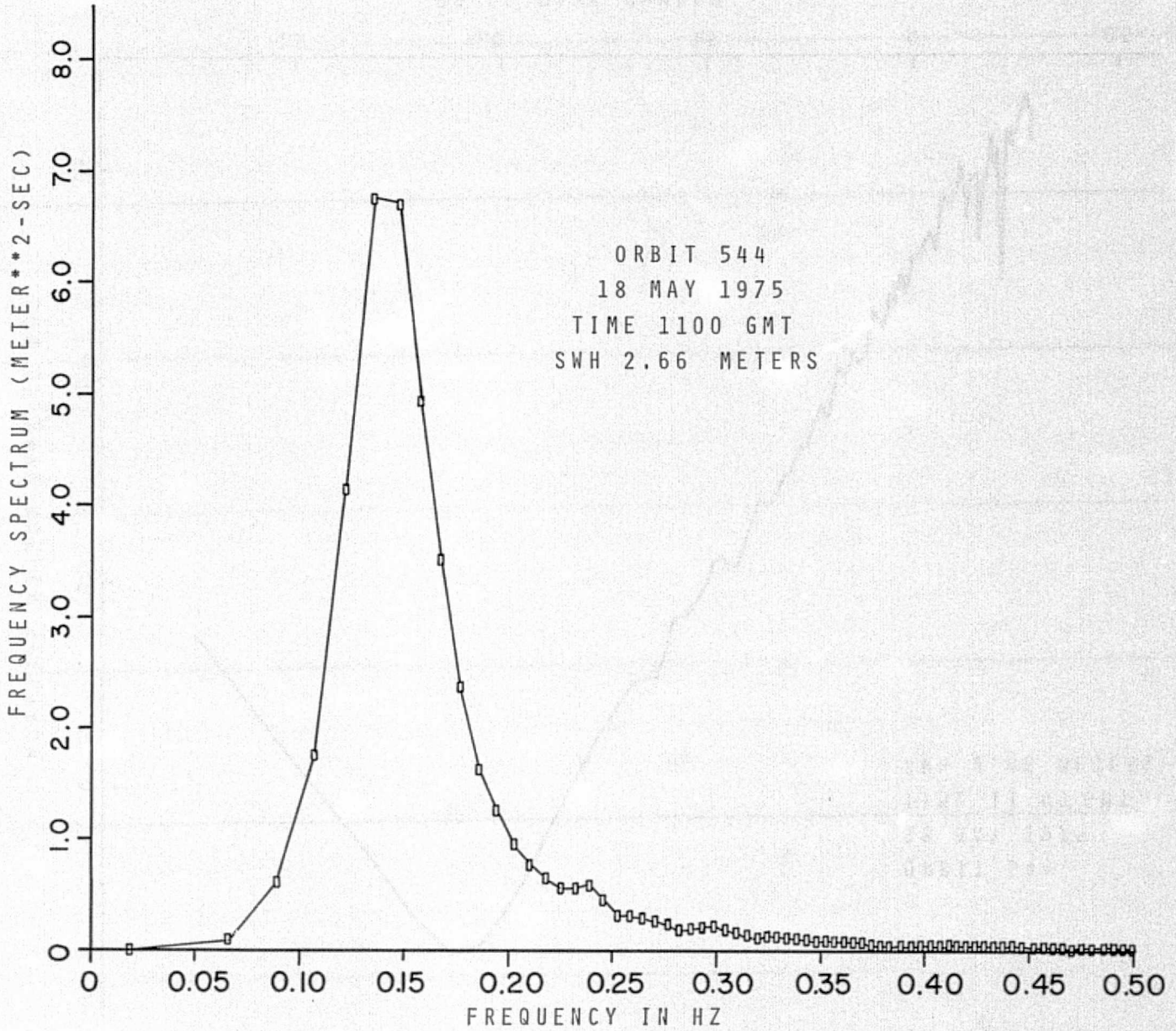
At each wind vector, a horizontal bar has been placed accompanied by sea and swell data. Above the bar, the two numbers give the significant wave height ($H_{1/3}$) in meters followed by the wave period in seconds. Below the line, the swell height and period are likewise displayed.



Track 544 passes a few miles east of the eastern tip of Long Island. The southern and northern thirds of the track are covered with clouds and there are scattered showers located within the cloud shields. The middle third of the track has some clouds but is mostly clear. There has been no weather system in the north Atlantic during the previous 4 or 5 days which would have caused any significant swell along track.



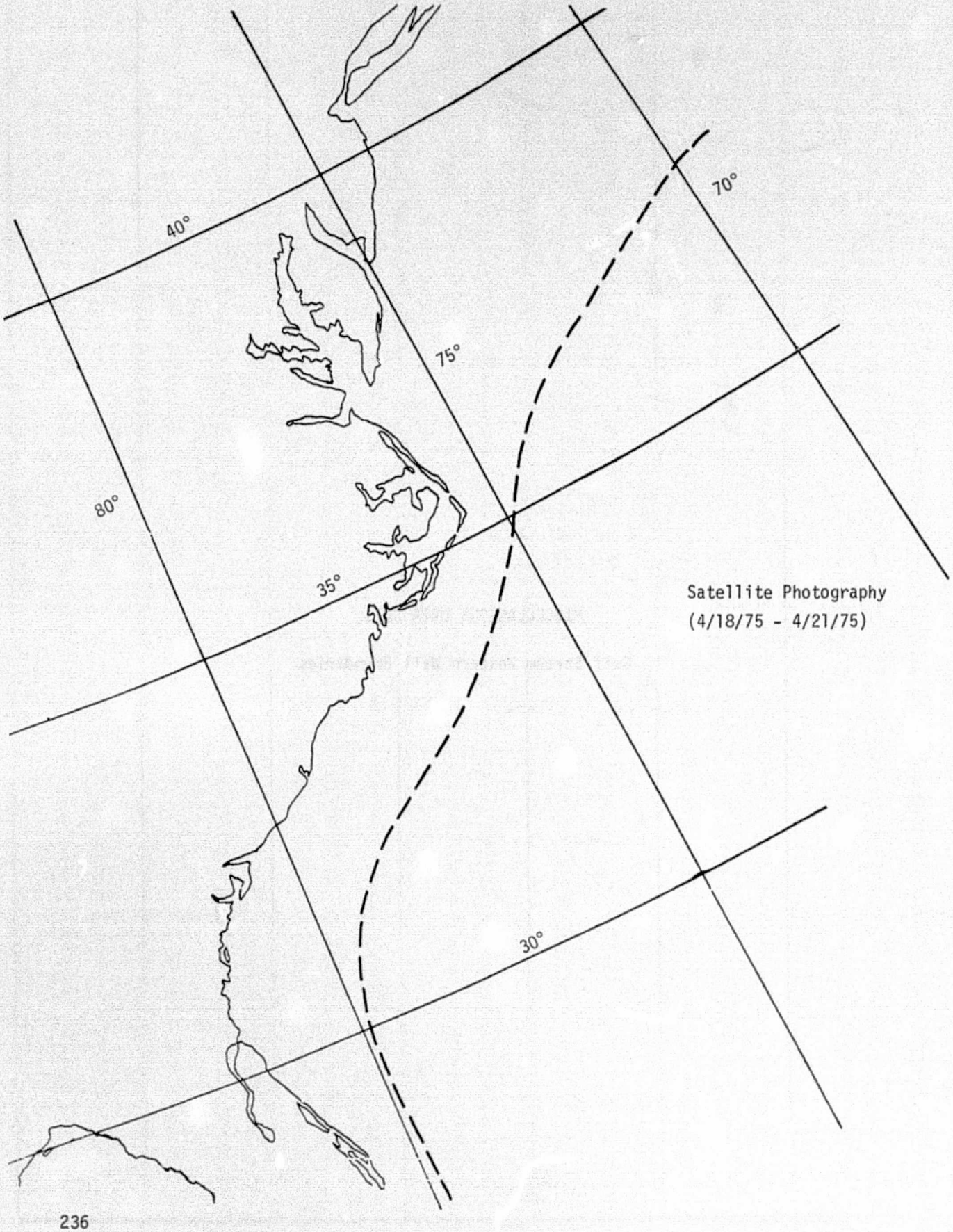



ORBIT 544
18 MAY 1975
TIME 1100 GMT
SWH 2.66 METERS
FREQUENCY SPECTRUM (METER**2-SEC)
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
FREQUENCY IN HZ

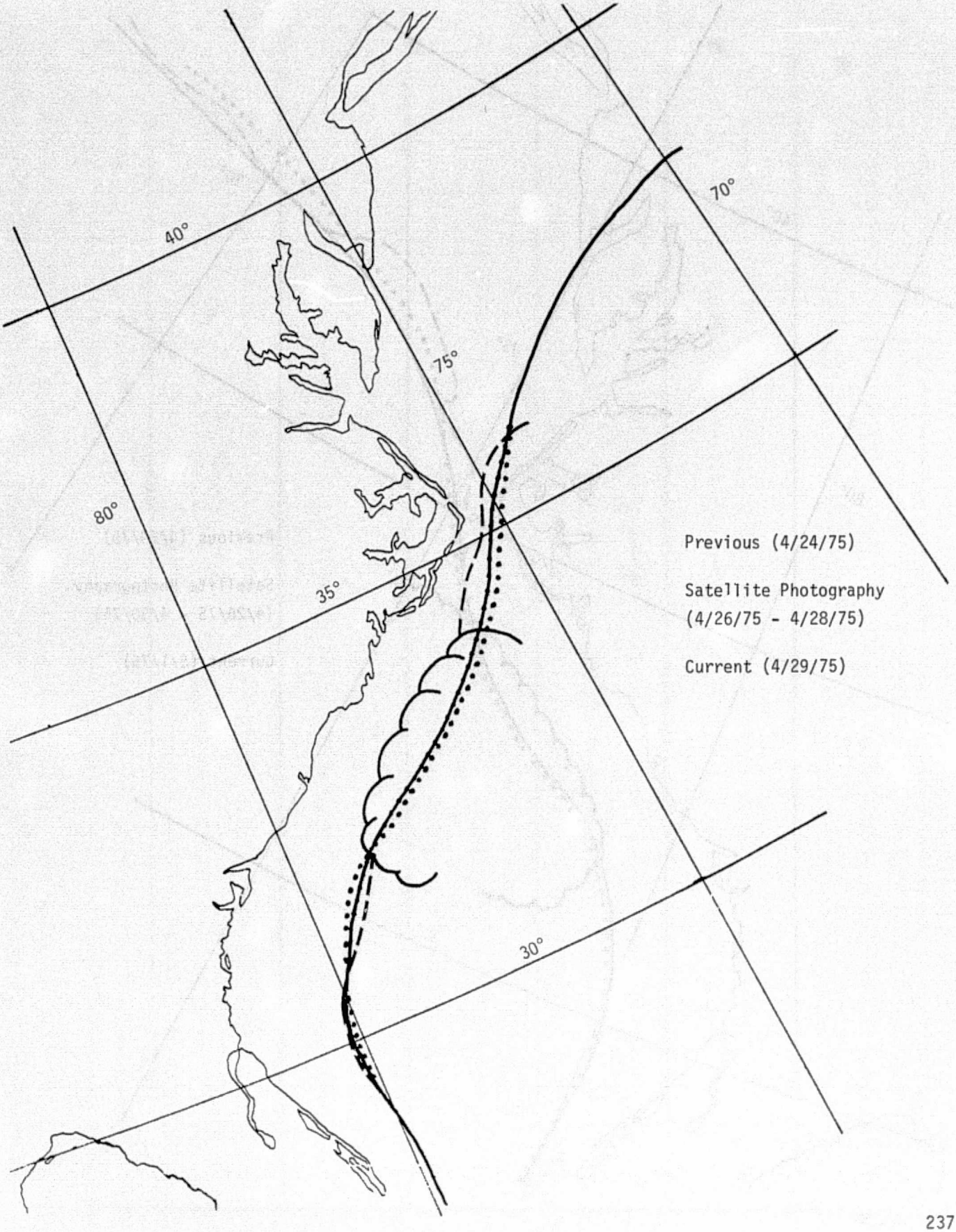
ORBIT 544
18 MAY 1975
TIME 11 00 GMT
SWH 2.66 METERS
LOG OF WAVE NUMBER SPECTRUM
1.0
0
-1.0
-2.0
-3.0
-1.5
-1.0
-0.5
0
0.5
LOG OF WAVE NUMBER

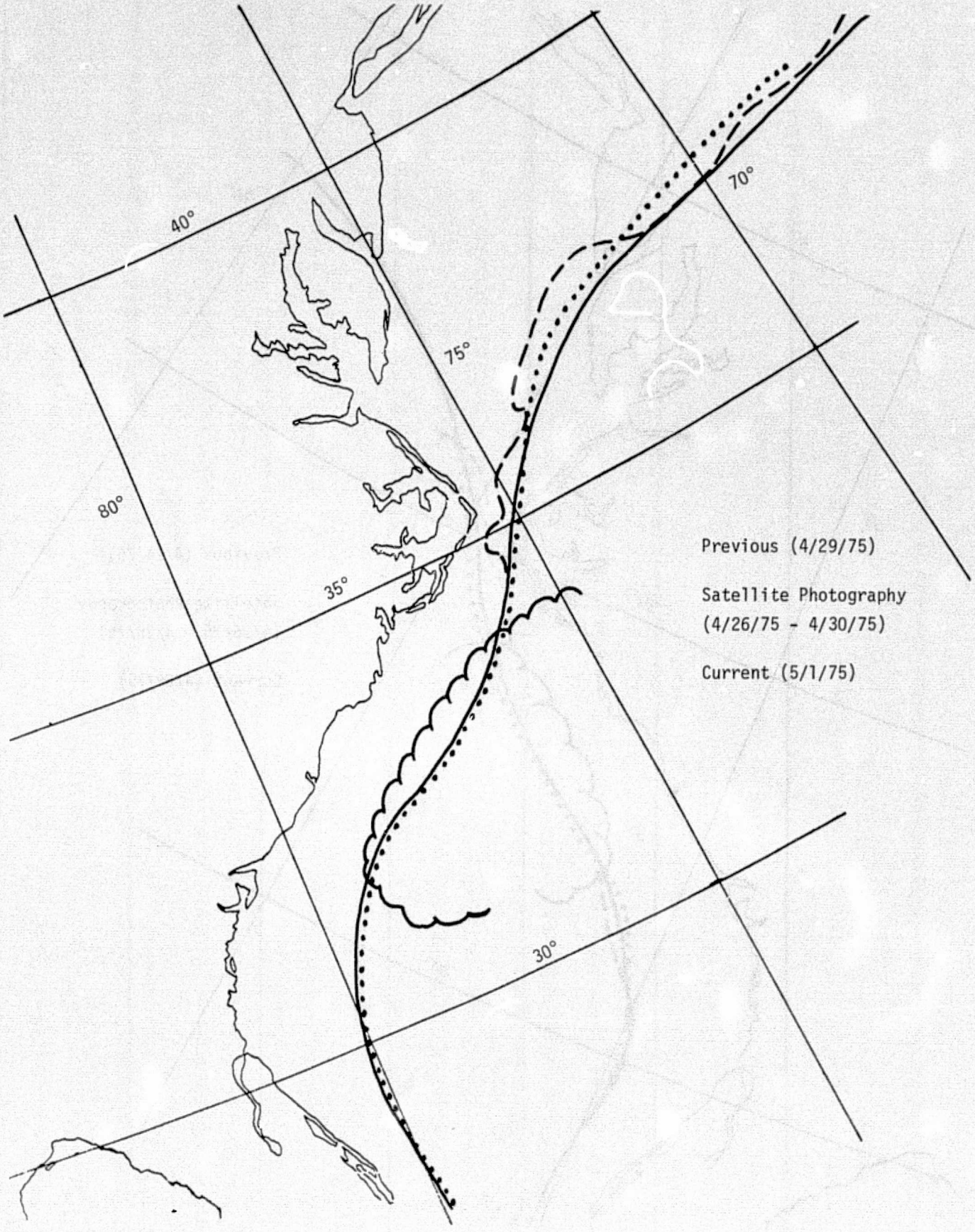
MISCELLANEOUS DATA SETS

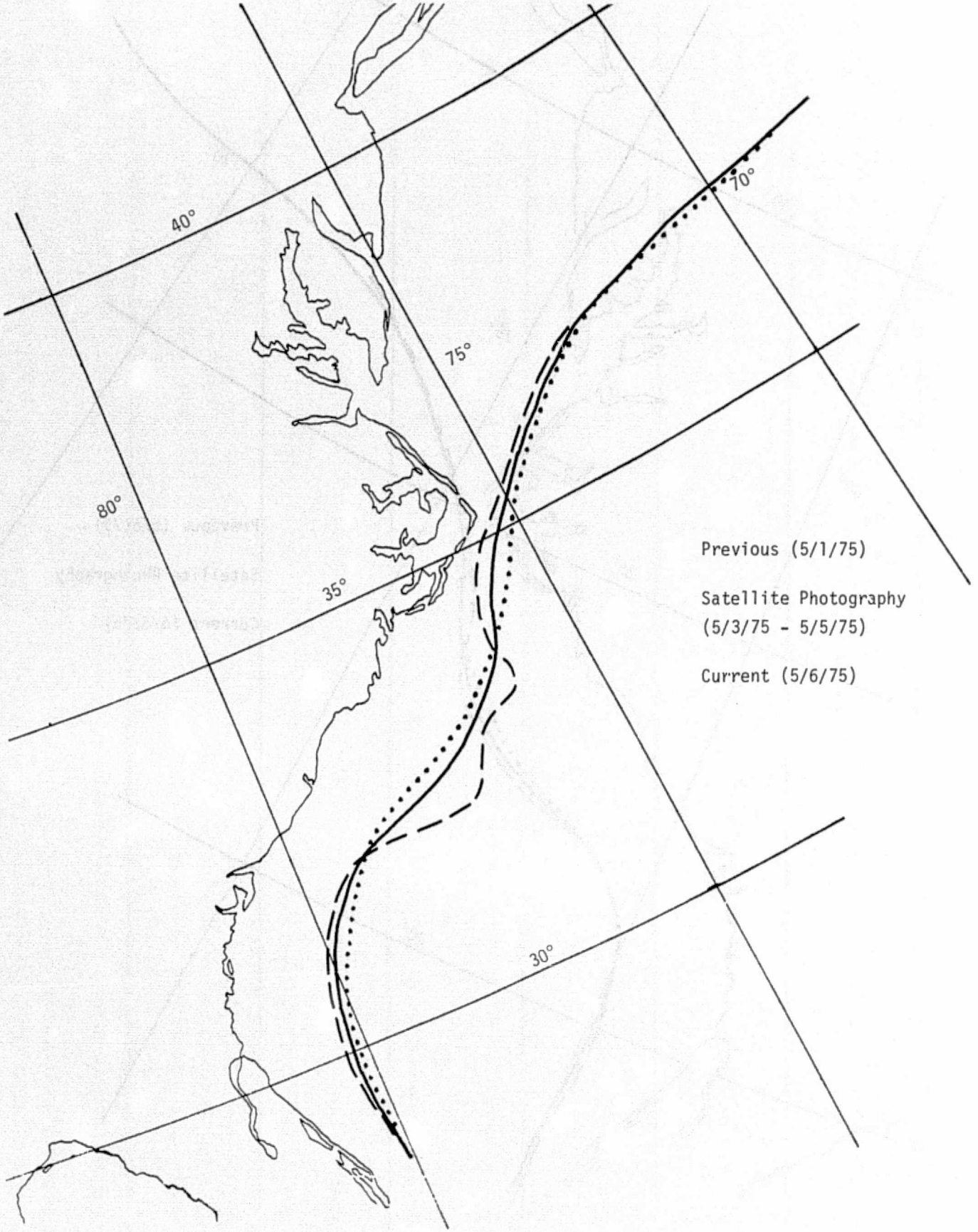
Gulf Stream Western Wall Boundaries

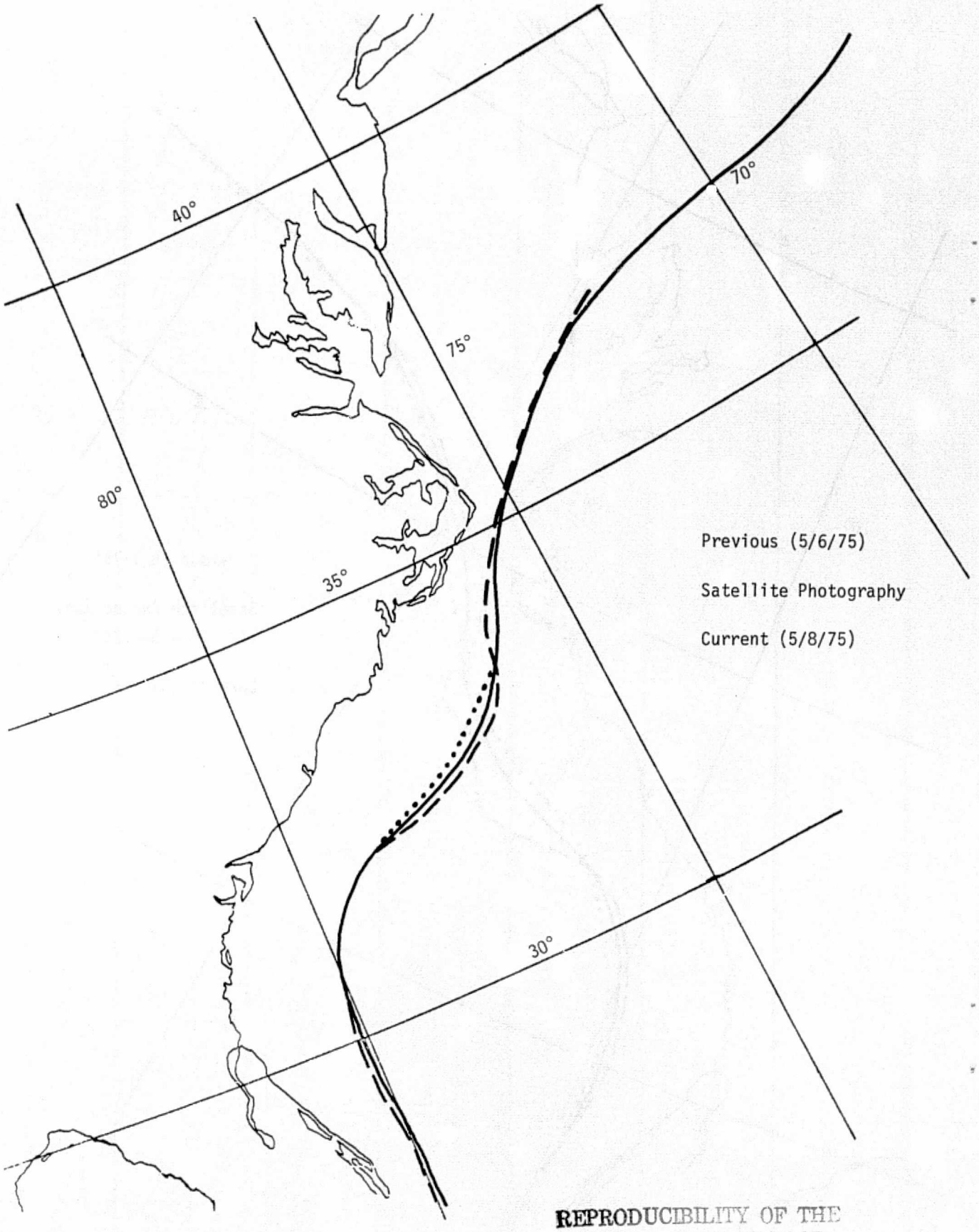


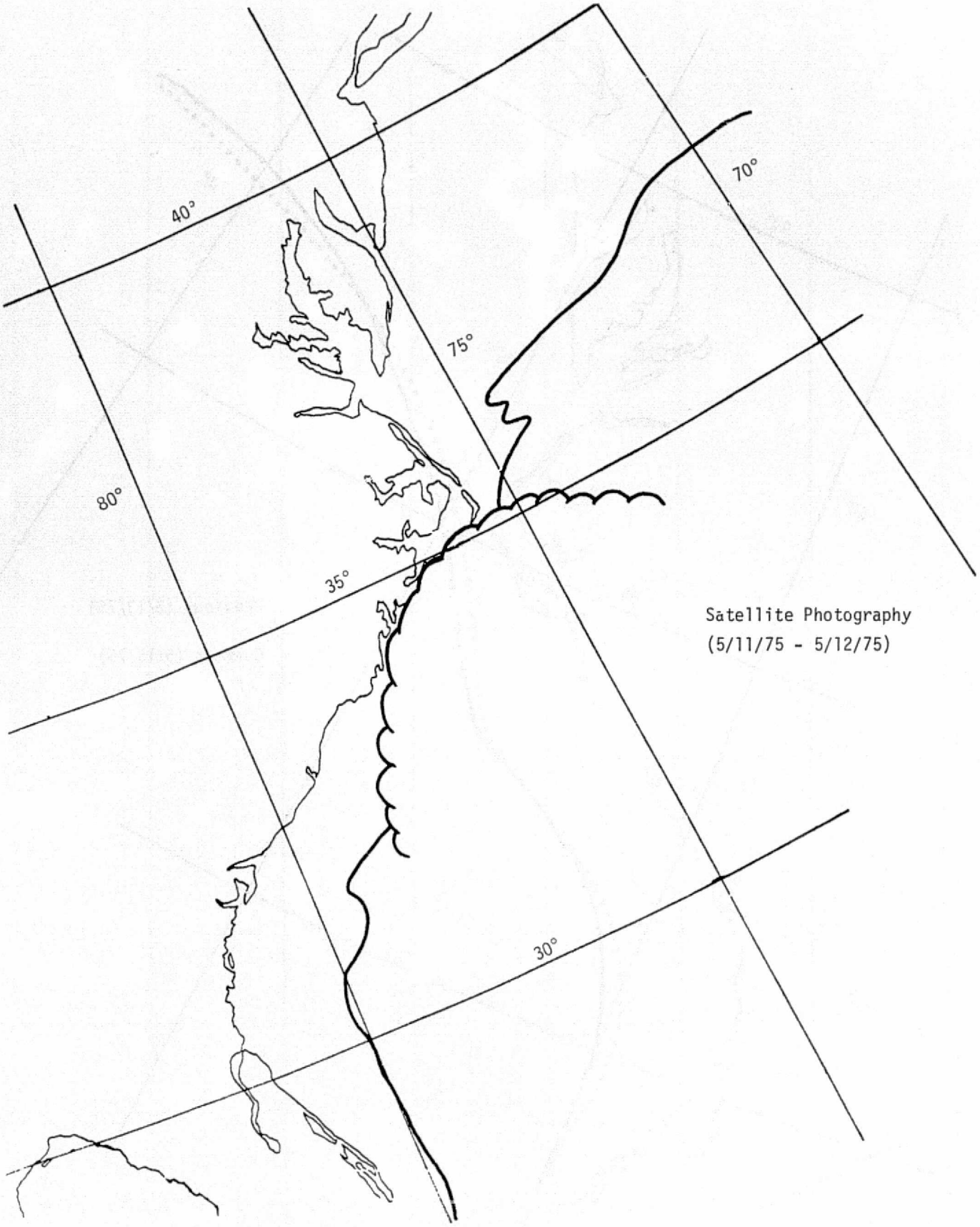
Satellite Photography
(4/18/75 - 4/21/75)


40°
70°
75°
80°
35°
30°
Previous (4/24/75)
Satellite Photography
(4/26/75 - 4/28/75)
Current (4/29/75)

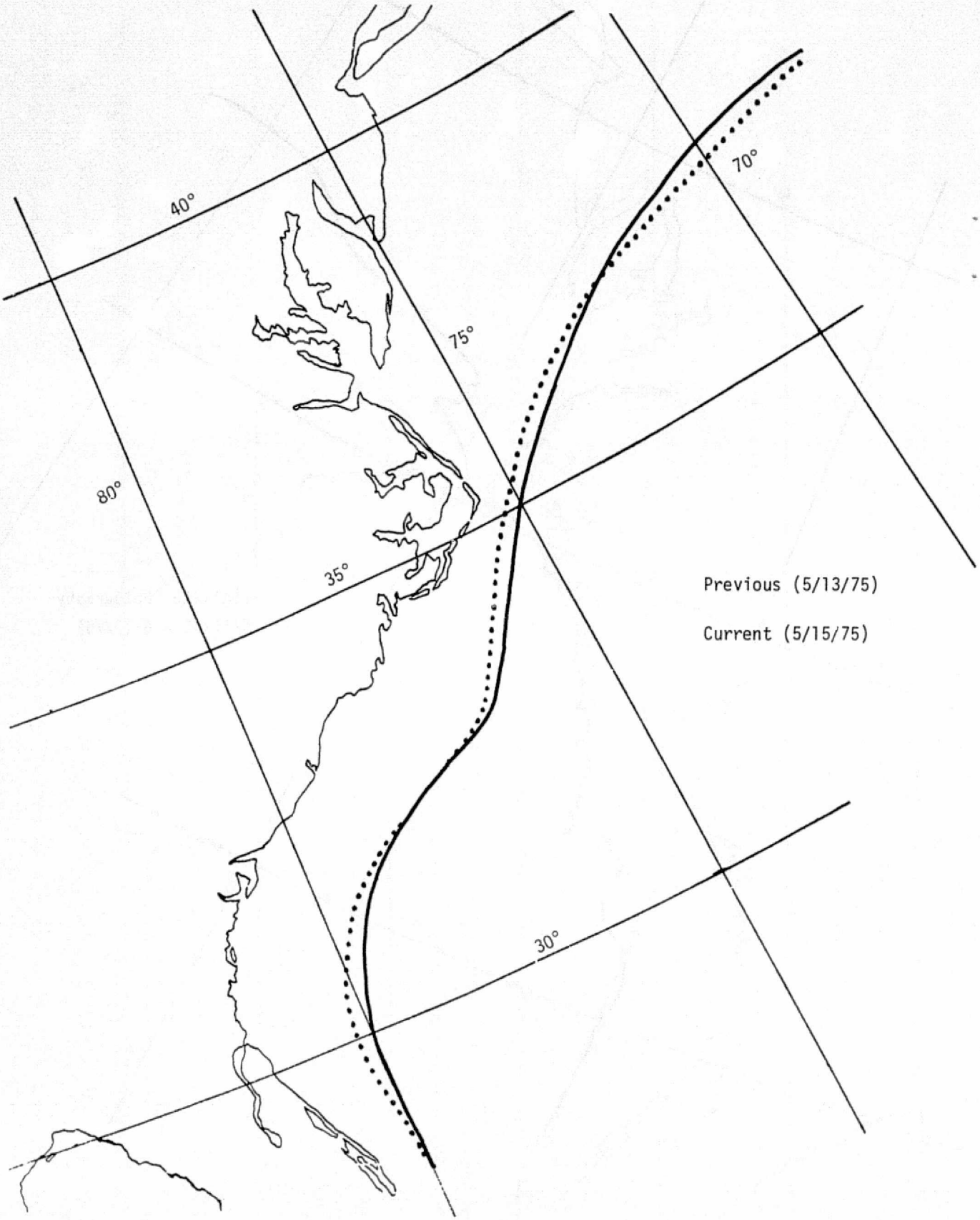

40°
70°
75°
80°
35°
30°
Previous (4/29/75)
Satellite Photography
(4/26/75 - 4/30/75)
Current (5/1/75)


40°
70°
75°
80°
35°
30°
Previous (5/1/75)
Satellite Photography
(5/3/75 - 5/5/75)
Current (5/6/75)

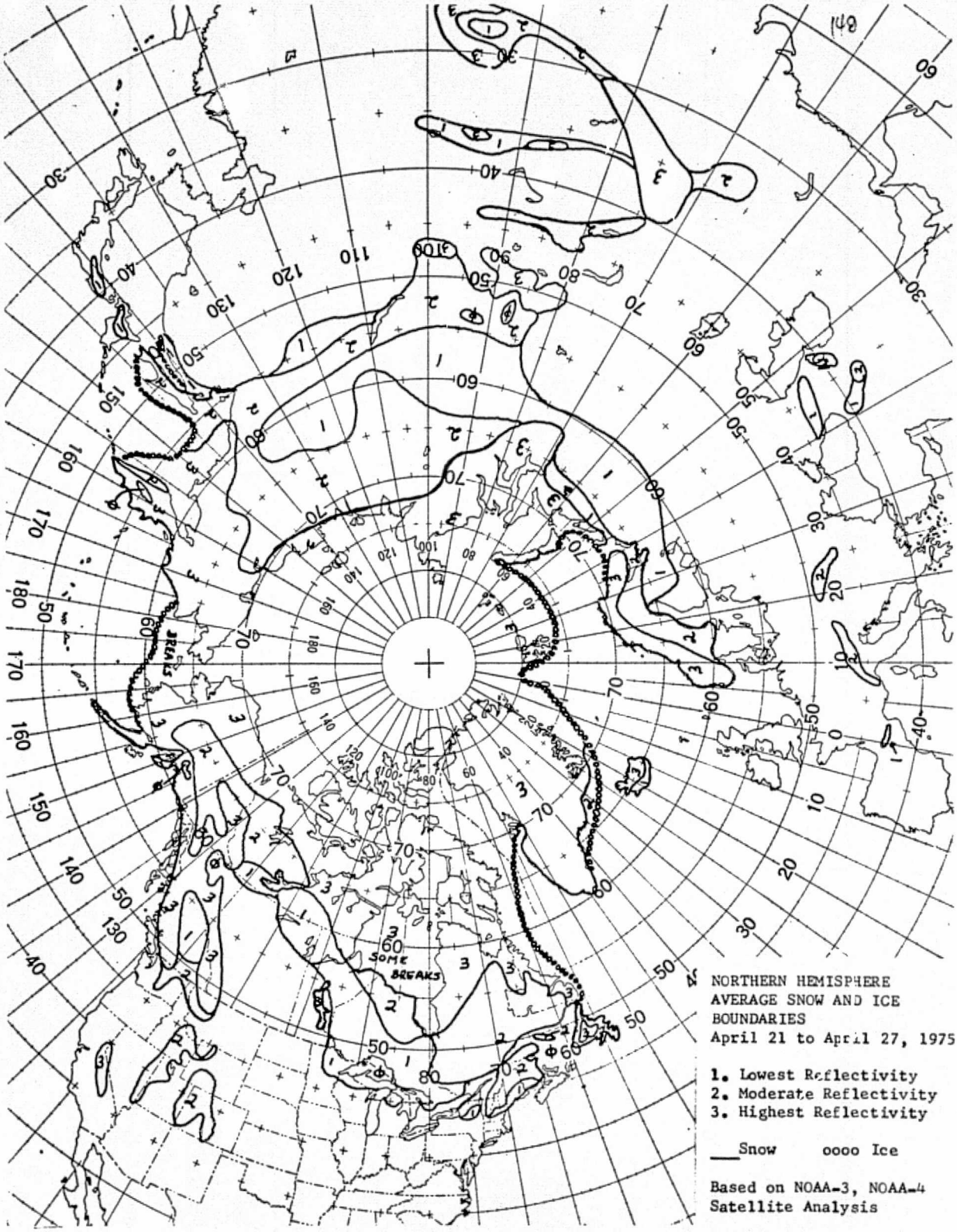




Satellite Photography
(5/11/75 - 5/12/75)


40°
75°
70°
80°
35°
30°
Previous (5/13/75)
Current (5/15/75)

NOAA-4 ARCTIC ICE BOUNDARIES

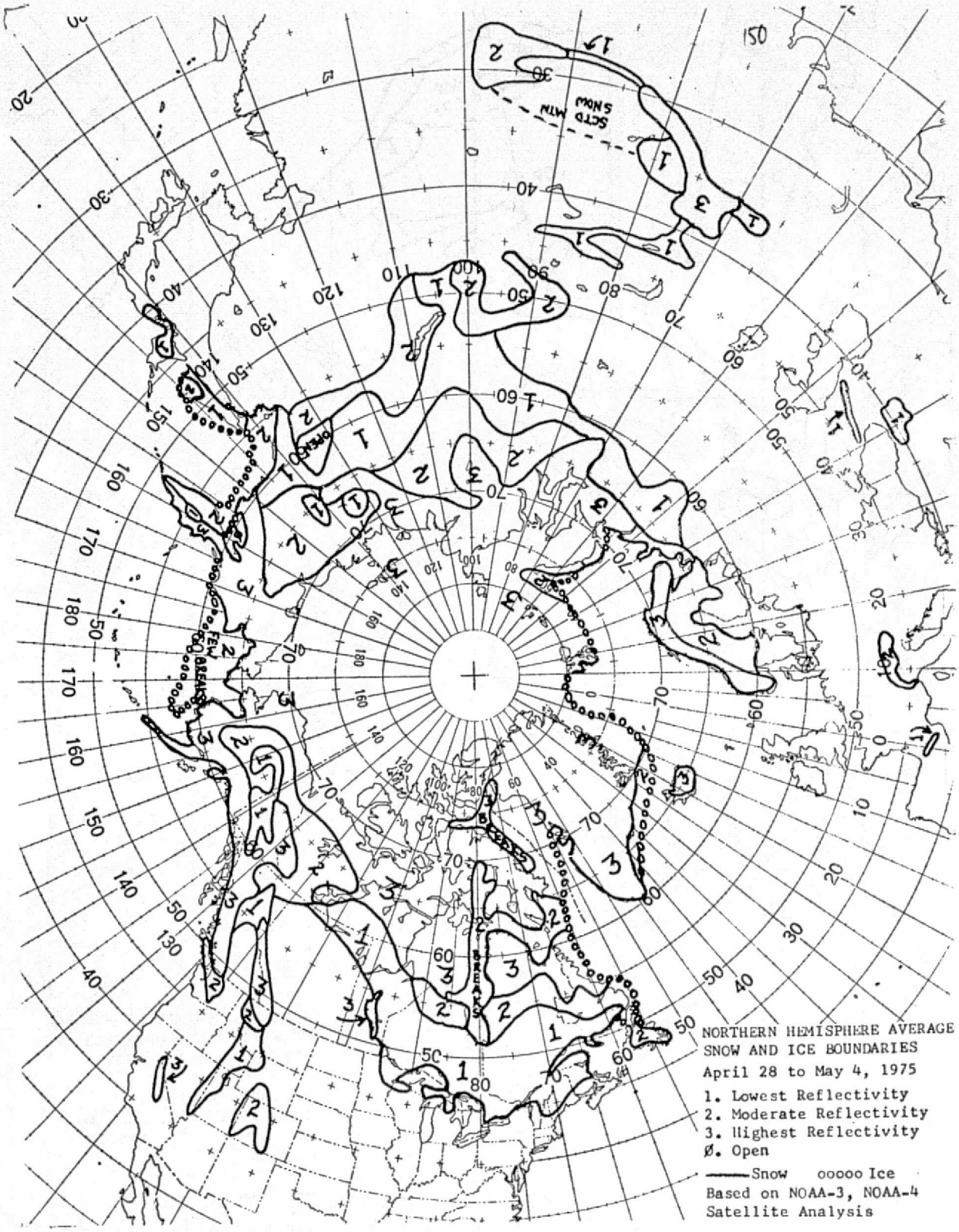


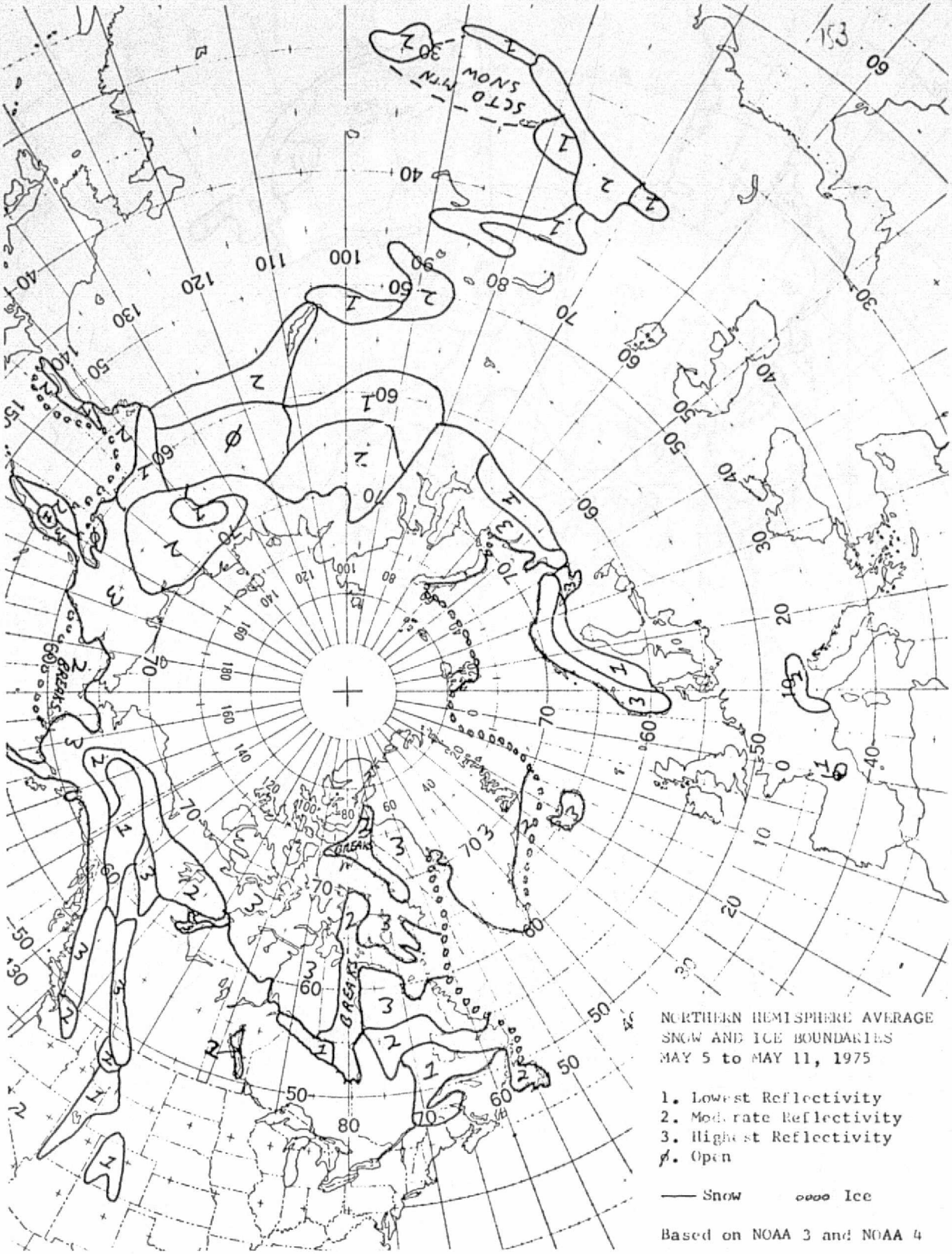
NORTHERN HEMISPHERE
AVERAGE SNOW AND ICE
BOUNDARIES
April 21 to April 27, 1975

1. Lowest Reflectivity
2. Moderate Reflectivity
3. Highest Reflectivity

___Snow oooo Ice

Based on NOAA-3, NOAA-4
Satellite Analysis


NORTHERN HEMISPHERE AVERAGE
SNOW AND ICE BOUNDARIES
April 28 to May 4, 1975
1. Lowest Reflectivity
2. Moderate Reflectivity
3. Highest Reflectivity
Ø. Open
——Snow ooooo Ice
Based on NOAA-3, NOAA-4
Satellite Analysis

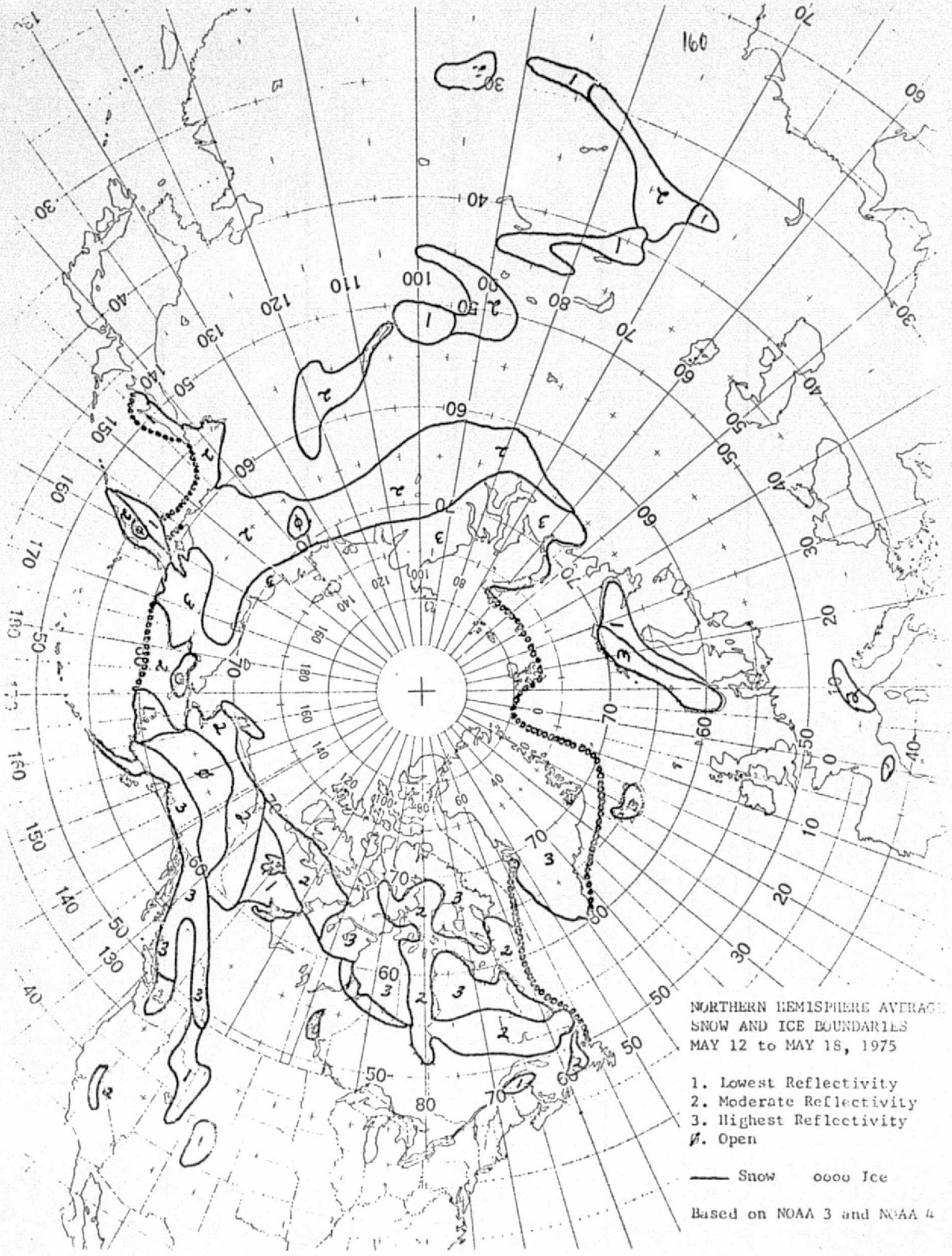


NORTHERN HEMISPHERE AVERAGE
SNOW AND ICE BOUNDARIES
MAY 5 to MAY 11, 1975

1. Lowest Reflectivity
2. Moderate Reflectivity
3. Highest Reflectivity
ϕ. Open

—— Snow ooooo Ice

Based on NOAA 3 and NOAA 4



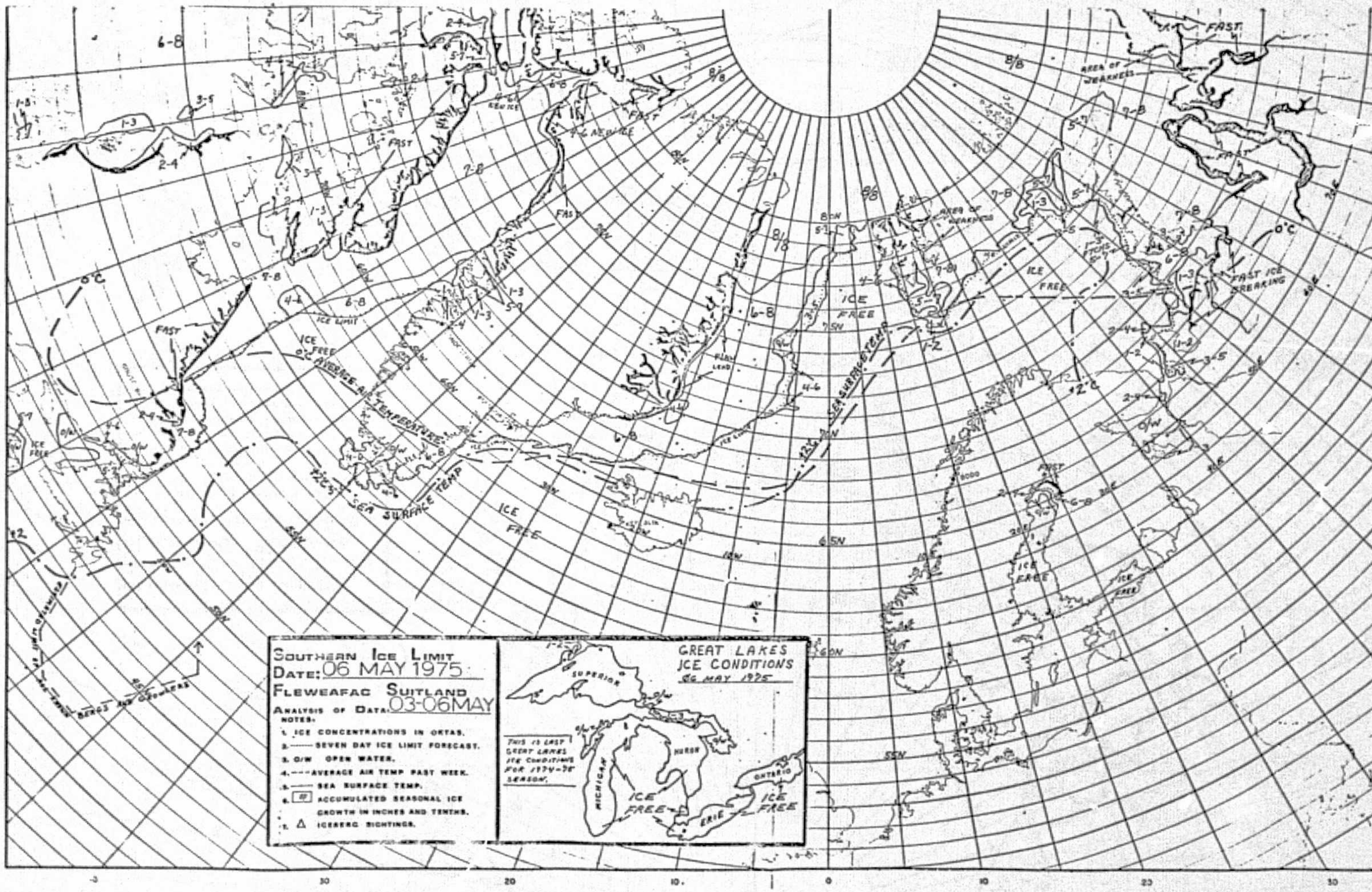
NORTHERN HEMISPHERE AVERAGE
SNOW AND ICE BOUNDARIES
MAY 12 to MAY 18, 1975

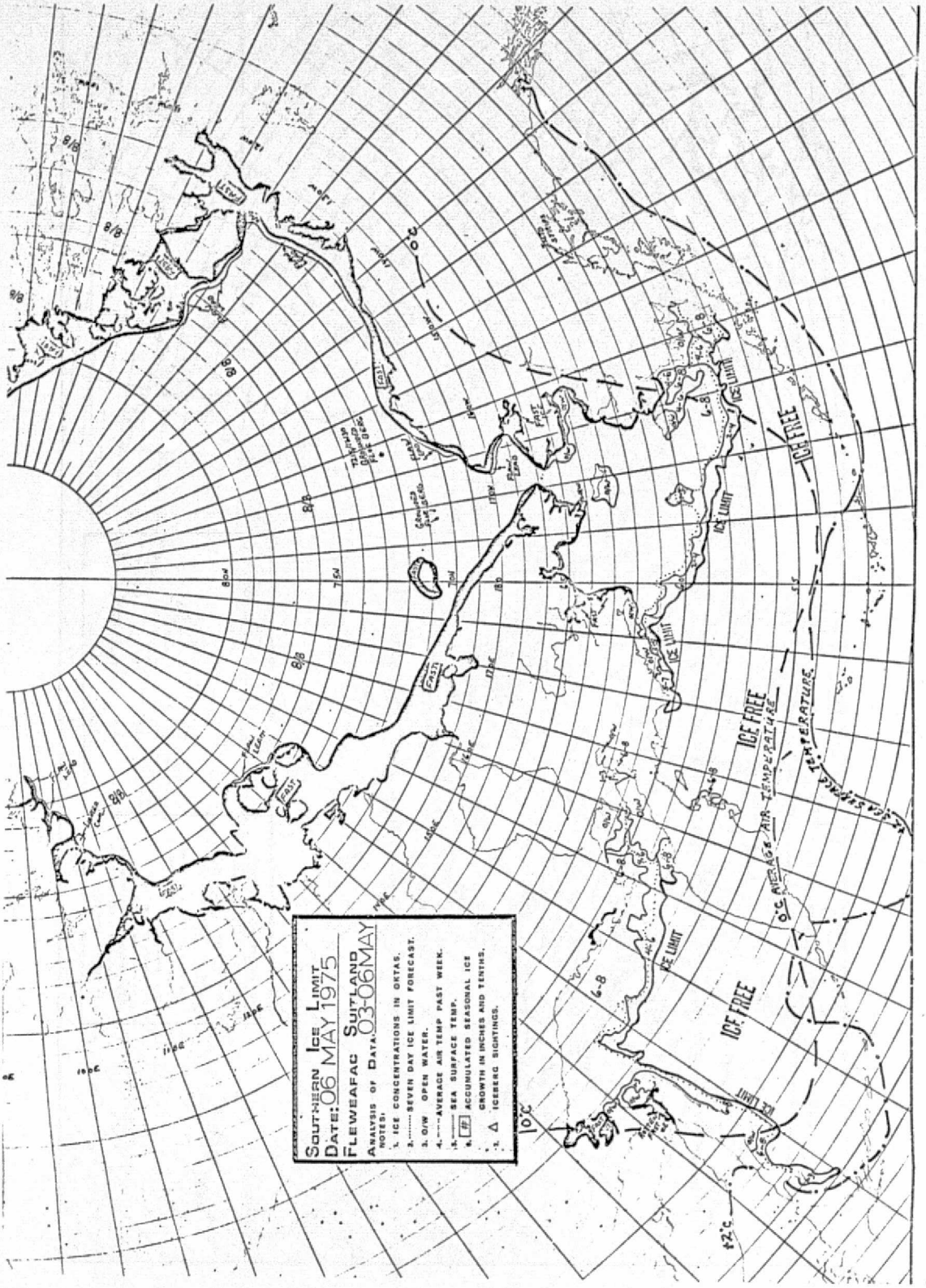
1. Lowest Reflectivity
2. Moderate Reflectivity
3. Highest Reflectivity
0. Open

—— Snow oooo Ice

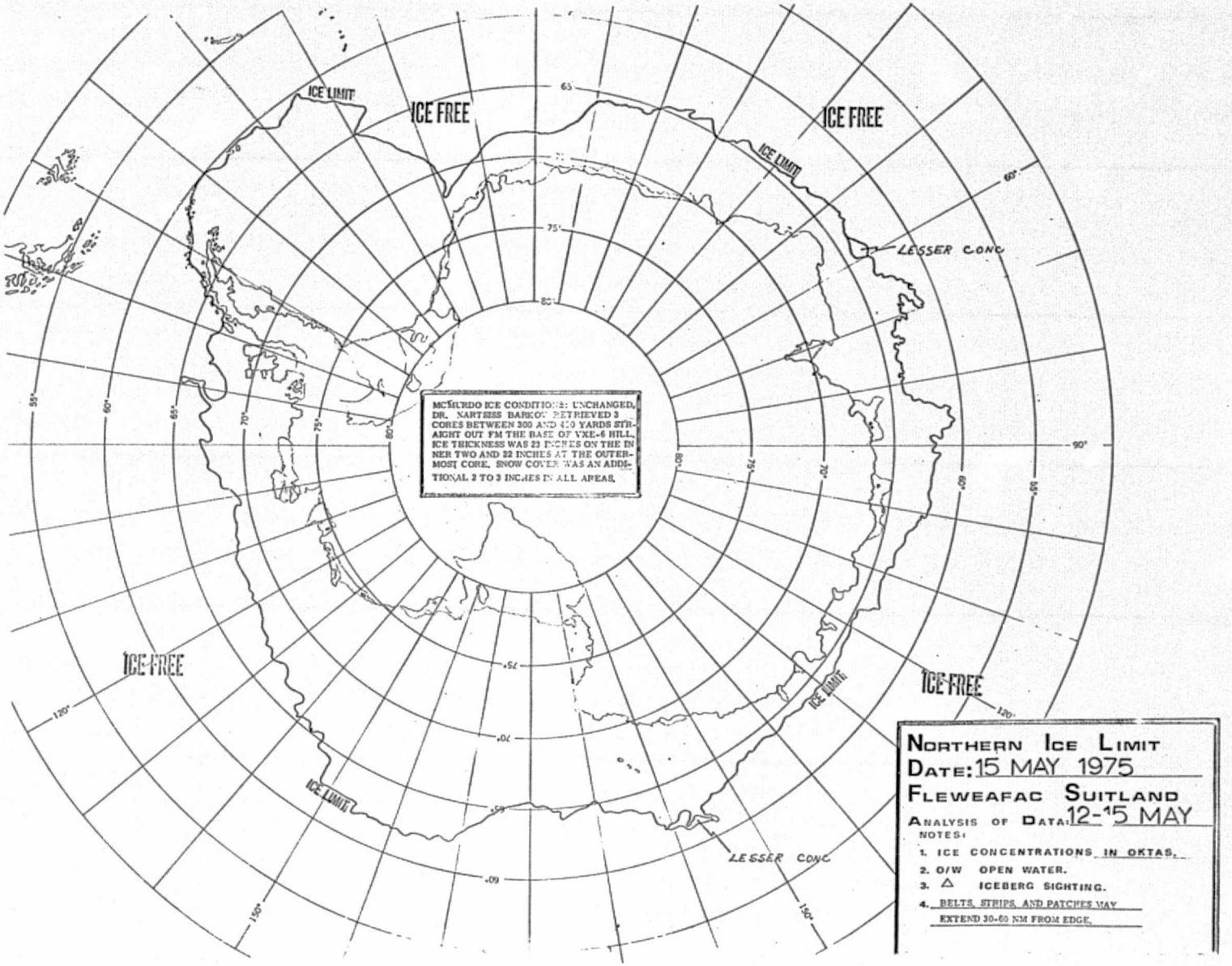
Based on NOAA 3 and NOAA 4

FLEWEAFAC ARCTIC ICE BOUNDARIES





FLEWEAFAC ANTARTIC ICE BOUNDARIES


ICE LIMIT
ICE FREE
ICE FREE
ICE LIMIT
LESSER CONC
ICE FREE
ICE FREE
ICE LIMIT
ICE LIMIT
LESSER CONC
MCMURDO ICE CONDITIONS: UNCHANGED. DR. NARTSISS BARKOV RETRIEVED 3 CORES BETWEEN 300 AND 400 YARDS STRAIGHT OUT FM THE BASE OF VXE-6 HILL. ICE THICKNESS WAS 23 INCHES ON THE INNER TWO AND 22 INCHES AT THE OUTERMOST CORE. SNOW COVER WAS AN ADDITIONAL 2 TO 3 INCHES IN ALL AREAS.
NORTHERN ICE LIMIT
DATE: 15 MAY 1975
FLEWEAFAC SUITLAND
ANALYSIS OF DATA: 12-15 MAY
NOTES:
1. ICE CONCENTRATIONS IN OKTAS.
2. O/W OPEN WATER.
3. △ ICEBERG SIGHTING.
4. BELTS, STRIPS, AND PATCHES MAY EXTEND 30-60 NM FROM EDGE.

APPENDIX A: WFC C-54 FLIGHT LOGS

The following tables provide pertinent portions of the handwritten in-flight logs. The data was read from the time-code generator and the inertial navigator nixie-tube display located in the instrumentation section of the aircraft.

Additional entries taken at other times are available on request.

The abbreviations on the columnar headings of the parameters are as follows:

TK(Ground-Track): Actual ground-track of the aircraft along which the ground-speed vector is aligned. Track is measured in degrees from True North.

GS(Ground-Speed): The actual ground-speed, in knots, that the aircraft was attaining.

HD(Heading): The aircraft's true heading with respect to True North. It is the heading (in degrees) of the longitudinal axis of the aircraft. Heading plus (or minus) the drift angle will be the ground-track.

DA(Drift Angle): The drift of the aircraft in degrees right(R) or left(L) is the angle between the heading angle and the track angle.

TRACK	DATE	TIME	TK (DEG)	GS (KNOTS)	HD (DEG)	DA (Δ DEG)	LATITUDE NORTH (DEG/MIN)	LONG. WEST (DEG/MIN)	AIR SPEED (KNOTS)	ALTITUDE (METERS)	WIND DIRECTION
183	22 April	22:13	214.1	156	212.8	R01.5	33 41.1	74 33.6	150	150	Cross
		22:15	156.2	145	155.1	R00.2	33 29.5	74 39.6	150	150	Upwind
		22:17	154.9	144	-	-	33 26.0	74 37.3	-	150	Upwind
		22:24	326:3	161	330.3	L03.9	33 23.3	74 40.2	-	150	Down
		22:25	331.6	-	330.0	-	33 27.1	74 42.8	-	150	Down
		22:26	331.6	158	333.3	L01.8	33 28.8	74 43.9	-	150	Down
		22:26	66.9	150	70.1	L03.0	33 28.8	74 56.3	150	150	Cross
		22:39	156.7	144	155.2	R01.7	33 30.1	74 48.2	150	150	Upwind
		22:44	158.6	149	155.8	R01.8	33 22.1	74 44.3	150	150	Upwind
189	23 April	07:55	147.6	151	149.9	L02.3	33 24.4	74 56.5	-	300	Upwind
		07:56	147.8	150	149.7	L02.1	33 21.0	74 54.3	-	300	Upwind
		07:57	147.7	150	149.8	L01.7	33 18.9	74 52.7	160	300	Upwind
		08:21	144.6	151	144.3	R00.3	32 57.9	74 44.8	-	---	Upwind
		08:22	144.3	151	143.8	R00.6	32 54.4	74 41.7	161	300	Upwind
		08:22	144.7	150	144.1	R00.7	32 52.4	74 40.3	-	300	Upwind
		08:24	145.2	151	140.7	L01.4	32 49.5	74 37.7	-	300	Upwind
		08:30	317.2	180	317.4	L00.3	32 59.6	74 42.0	-	300	Down
		08:32	317.4	181	317.4	L00.1	33 03.0	74 45.7	-	300	Down
		08:33	317.8	179	317.2	R00.3	33 05.0	74 47.9	162	300	Down
		08:34	317.5	178	317.5	R00.8	33 08.4	74 51.7	162	300	Down
		08:43	148.8	149	148.3	R00.4	33 09.4	74 56.7	-	300	Upwind
		08:46	147.8	152	147.2	R00.6	33 05.7	74 54.1	-	300	Upwind
		08:47	148.0	149	146.9	R00.7	33 03.4	74 52.3	158	300	Upwind
		08:48	147.7	151	147.1	R01.2	33 00.2	74 49.8	-	300	Upwind
		08:51	54.0	161	58.0	L03.8	32 59.1	74 45.0	-	300	Cross
		08:52	52.8	164	57.1	L04.1	33 01.6	74 41.0	-	300	Cross
		08:53	52.2	165	56.3	L03.9	33 02.9	74 38.8	159	300	Cross
		08:55	51.2	166	55.3	L04.1	33 05.5	74 35.0	-	300	Cross
		08:56	51.1	165	54.8	L03.6	33 06.9	74 32.8	-	300	Cross
		08:57	50.9	165	54.7	L03.6	33 09.6	74 28.9	-	300	Cross
217	25 April	08:17	207.0	94	209.7	L03.2	39 07.7	68 57.5	156	300	Upwind
		08:20	203.6	95	208.5	L05.1	39 03.2	69 00.4	150	300	Upwind
		08:23	26.9	210	25.4	R01.0	39 05.4	69 01.5	150	300	Down
		08:35	314.0	150	296.8	R01.7	39 33.4	69 11.4	156	300	Cross
		08:46	227.7	99	229.9	L01.9	39 47.3	69 34.0	155	300	Upwind
		08:51	225.5	98	229.8	L04.4	39 40.1	69 43.9	-	300	Upwind

240	26 April	23:29	31.4	154	36.2	L04.8	33 00.7	78 40.4	150	150	--
		23:30	31.0	156	34.8	L03.9	33 04.5	78 37.6	150	150	--
		23:38	66.1	153	70.1	L00.4	33 14.3	78 23.2	150	150	Upwind
		23:42	251.2	157	247.9	R03.5	33 17.5	78 21.0	150	150	--
		23:43	251.5	159	248.1	R03.4	33 16.5	78 24.5	150	150	--
		23:44	251.4	159	248.4	R03.1	33 15.9	78 26.4	150	150	--
		23:46	251.9	159	248.8	R03.1	33 14.6	78 30.9	150	150	--
		23:48	336.8	165	337.9	L01.0	33 17.9	78 36.4	150	150	Down
		23:49	337.0	168	337.9	L00.9	33 21.9	78 38.4	150	150	Down
		23:51	337.4	167	337.6	L00.0	33 25.4	78 40.2	150	150	Down
		23:52	338.0	167	337.8	R00.2	33 27.9	78 41.4	150	150	Down
		00:01	75.4	157	78.9	L03.4	33 51.7	78 26.8	150	150	Upwind
		00:02	75.4	157	--	L03.4	33 52.9	78 22.0	150	150	Upwind
		00:10	75.8	156	79.0	L03.2	33 53.2	78 20.4	-	150	Upwind
		00:12	--	-	--	-	33 54.1	78 15.7	-	150	Upwind
274	29 April	08:49	100.0	125	101.0	L00.6	38 10.4	71 24.1	142	300	Upwind
		08:51	102.7	127	102.8	R00.1	38 09.6	71 19.5	-	300	Upwind
		08:57	275.8	160	275.2	R00.9	38 09.8	71 11.4	-	300	Down
		08:58	274.8	160	274.0	R00.4	38 10.2	71 16.4	-	300	Down
		09:00	276.1	163	275.0	R00.6	38 10.9	--	-	300	Down
		09:03	--	-	275.0	R00.6	38 11.4	71 31.9	-	300	Down
311	2 May	23:56	30.5	173	33.4	L03.1	32 56.3	76 38.7	-	150	--
		23:58	33.5	171	35.1	L01.7	33 01.5	76 34.2	-	150	--
		00:00	32.8	173	34.9	L02.5	33 05.5	76 31.6	-	150	--
		00:05	191.1	144	193.4	L02.2	33 03.5	76 26.6	-	150	--
		00:07	191.1	145	193.4	L01.9	32 56.3	76 28.4	-	150	--
		00:11	9.0	169	9.1	L00.7	32 58.5	76 30.2	-	150	--
382	7 May	00:31	25.8	155	25.6	R00.0	32 54.8	74 37.6	-	300	Down
		00:33	26.6	160	26.1	R01.0	33 01.6	74 33.6	-	300	Down
		00:35	24.7	165	25.3	L01.4	33 05.9	74 31.2	-	300	Down
		00:36	23.9	167	25.8	L01.9	33 08.8	74 29.6	-	300	Down
		00:37	23.8	166	25.2	L01.5	33 12.9	74 27.5	-	300	Down
		00:42	190.9	135	188.8	R01.5	33 14.6	74 28.9	147	300	Upwind
		00:44	189.6	135	188.7	R01.4	33 11.3	74 29.6	-	300	Upwind
		00:45	189.6	135	188.7	R01.4	33 11.3	74 29.6	-	300	Upwind
		00:46	189.6	137	188.8	R00.0	33 07.6	74 30.5	-	300	Upwind
388	7 May	10:15	252.1	131	250.9	R01.8	33 07.5	74 11.7	150	150	Upwind
		10:16	252.1	130	251.0	R01.3	33 06.6	74 15.6	-	150	Upwind
		10:17	252.1	130	250.8	R01.5	33 06.1	74 17.3	-	150	Upwind

		10:18	252.8	127	250.8	R02.8	33 05.2	74 21.1	-	150	Upwind
		10:23	62.0	177	63.0	L00.9	33 08.2	74 22.0	-	150	Down
		10:25	62.8	178	62.7	R00.2	33 10.4	74 17.0	-	150	Down
		10:26	61.9	180	61.9	R00.2	33 12.1	74 13.4	-	150	Down
		10:27	60.9	181	61.0	L00.2	33 14.2	74 08.7	152	150	Down
453	11 May	01:14	282.1	161	283.7	L01.5	33 06.3	72 19.6	-	300	Down
		01:15	282.4	163	283.9	L01.9	33 07.1	72 24.6	-	300	Down
		01:27	101.5	136	101.9	L00.7	33 29.6	72 30.8	145	300	Upwind
		01:28	101.7	136	102.5	L00.5	33 29.6	--	-	300	Upwind
		01:30	102.8	137	102.9	L00.0	33 27.8	72 20.6	-	300	Upwind
		01:32	102.6	137	102.8	R00.2	33 27.3	72 18.3	-	300	Upwind
459	12 May	11:01	307.0	162	306.0	R01.7	32 31.3	71 04.1	-	150	Down
		11:02	307.6	164	306.1	R01.3	32 33.9	71 08.0	-	150	Down
		11:03	307.1	164	305.8	R01.4	32 35.5	71 10.4	155	150	Down
		11:05	306.8	165	305.7	R01.0	32 38.0	71 14.3	-	150	Down
		11:06	306.5	165	305.6	R00.7	32 39.6	71 17.0	-	150	Down
		11:07	305.9	166	305.5	R00.1	32 42.1	71 21.0	-	150	Down
		11:08	305.3	165	305.5	L00.0	32 44.1	71 24.1	-	150	Down
		11:10	305.1	164	305.6	L00.5	32 46.4	71 28.2	-	150	Down
524	16 May	01:27	50.5	173	50.8	L00.3	33 03.8	70 16.8	145	300	Down
		01:28	50.2	175	50.6	L00.3	33 06.8	70 12.5	-	300	Down
		01:42	228.9	127	229.2	L00.2	33 09.4	70 12.4	-	300	Upwind
		01:43	228.5	125	229.4	L00.9	33 07.1	70 15.4	-	300	Upwind
		01:44	228.4	124	229.4	L00.9	33 06.0	70 17.0	-	300	Upwind
		01:46	228.5	123	229.6	L01.1	33 04.0	70 19.7	145	300	Upwind
530	17 May	11:08	35.4	178	32.6	R02.4	33 21.0	69 58.0	-	150	Down
		11:09	36.7	174	32.3	R03.4	33 25.4	69 54.1	-	150	Down
		11:11	36.3	173	32.8	R03.2	33 28.4	69 51.6	-	150	Down
		11:13	37.0	174	32.9	R03.7	33 31.9	69 48.4	-	150	Down
		11:16	211.4	136	216.7	L04.4	33 36.0	69 47.0	-	150	Upwind
		11:18	214.0	137	217.8	L03.7	33 33.0	69 49.2	-	150	Upwind
		11:19	213.3	138	216.9	L04.0	33 30.1	69 51.6	-	150	Upwind
544	18 May	10:56	305.4	165	306.6	L01.3	37 43.6	68 15.4	144	150	Down
		10:58	306.0	162	307.6	L01.5	37 46.1	68 19.6	-	150	Down
		10:59	306.6	167	307.4	L00.9	37 48.4	68 23.2	-	150	Down
		11:01	304.1	169	307.8	L03.3	37 57.1	68 28.4	-	150	Down
		11:02	303.6	171	308.2	L04.9	37 53.4	68 32.9	144	150	Down
		11:08	88.0	120	88.8	L00.7	38 00.5	68 36.9	-	150	Upwind
		11:10	91.5	118	90.3	R01.3	38 00.6	68 33.2	-	150	Upwind
		11:11	89.3	122	88.4	R00.6	38 00.5	68 29.4	-	150	Upwind
		11:13	89.8	120	89.6	R00.6	38 00.6	68 25.7	-	150	Upwind

APPENDIX B: LASER PROFILOMETER AND RANGE ERROR PROCESSING

Laser Profilometer Data

The Spectro-Physics Geodolite-3A laser has a footprint of about .15 meters at an aircraft altitude of 150 meters and a static range resolution of about .025 meters. The continuous analog output voltage is digitized and recorded on magnetic tape for subsequent computer processing. Software available at NRL was used to phase match the signal for continuity in amplitude, to remove the effects of aircraft motion by way of a high pass filter, and to calculate wave energy spectra. The computer program allows a choice of filter cut-off frequency and the number of lags used in the auto-correlation estimate. The auto-correlation estimates were made for 150 lags using 2.9 minutes of laser data sampled 50 times a second for a total of 8,700 samples. The Fourier transform of the auto-correlation function was used to get the wave energy spectra which are contained in the text. The results are most representative of the ocean waves when the data is taken while flying in an upwind and a downwind direction.

Error Calculations

Range error (R.E.) caused by propagation of the radar altimeter signal through the troposphere is derived by integrating (n-1), where n is the refractive index of the atmosphere, from sea level to the GEOS-3 altimeter altitude. Using Smith and Weintraub's (ref. 3) formula for n, one has,

$$\text{R. E. (m)} = 77.6\times10^{-6}\left[\int_0^h (P/T)\,dz + 4810\int_0^h (e/T^2)\,dz\right]$$

e = partial pressure of water vapor (mb)

T = ambient temperature (°K)

P = atmospheric pressure (mb)

Assuming an ideal gas, a linear temperature lapse rate, and an exponential water pressure distribution, one has,

$$\text{R. E. (m)} = 0.227\,P_s + 1.72\,(\rho_s/T_s)(h_w + h_w^2\,\alpha)$$

where P_s = local sea surface atmosphere pressure (mb)

ρ_s = local sea surface water vapor density (g/m^{-3})

T_s = local sea surface air temperature (°K)

α = temperature lapse rate normalized by local surface temperature (°K/km °K)

h_w = water vapor pressure scale height (km).

The variables in the above equation were determined from in-situ measurement of atmospheric parameters during the ground truth flights. The temperature lapse rate and water vapor pressure scale height were obtained by a least squares fit to vertical profiles of the temperature and the water vapor pressure measured during the spiral descent segment of the data acquisition flight pattern previously described. The temperature-versus-elevation profile yields the local surface temperature for zero radar altitude and a lapse rate determined by the gradient of the profile normalized by T_s. The water vapor pressure profile similarly yields a value ρ_s for the local sea surface and an exponential scale height, h_w. The pressure for the local sea surface was obtained from the measured value, corrected for the difference between barometric and radar altitudes.

REFERENCES

1. Rossi, L. C.; and Stanley, H. R.: GEOS-C Mission Plan. NASA TM-X-69358, 1974.
2. GEOS-C Project Staff: GEOS-C Ground Truth Program Description Document. NASA TM-X-69359, 1975.
3. Smith, E. K.; and Weintraub, S.: "The Constants in the Equation for Atmospheric Refractive Index at Radio Frequencies." Proceedings of IRE, Vol. 41, August 1953, pp 1035-1037.