CHAPTER 3

OTHER OBSERVATIONS

3.1 General. In addition to aerial reconnaissance data, the observational system used in support of the *National Winter Storms Operations Plan* includes land surface, ship, radar, buoy, upper air, and satellite data. The routine operations of these various data sources are detailed in the following Federal Meteorological Handbooks and plans:

- Federal Meteorological Handbook No. 1, *Surface Weather Observations and Reports*
- Federal Meteorological Handbook No. 2, *Surface Synoptic Codes*
- Federal Meteorological Handbook No. 3, *Rawinsonde and Pibal Observations*
- Federal Meteorological Handbook No. 11, *Doppler Radar (Parts A, B, C, and D)*
- *Operations of the National Weather Service*
- *Federal Plan for Environmental Data Buoys*
- The *GOES User's Guide* and operational amendments
- *The NOAA Polar Orbiter Data Users Guide*
- *National Operations Plan for Drifting Data Buoys*
- *The Coastal Marine Automated Network (C-MAN) NWS Users Guide*
- *Tide/Water Level Information Data and Evaluation System (TIDES) NWS Users Guide*

Procedures for obtaining special or non-routine observations required in support of winter storm detection and forecasting, while covered to some extent in these documents, are described in detail in *National Weather Service Operations Manual*, Chapter B-90, "Special Warning Program Observations." The chapter covers observational programs of several agencies involved. The only two observational programs that will be covered in any detail here are the two data sources that provide unique capabilities to support winter storm analysis and forecasting.

3.2 Satellite Observations.

3.2.1 Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), the National Environmental Satellite, Data, and Information Service (NESDIS).

3.2.1.1. Geostationary Operational Environmental Satellite (GOES). The GOES system currently consists of a two operational satellite constellation over the U.S. and adjacent waters. GOES-8, which introduced a 3-axis stabilized geosynchronous satellite to NOAA operations, is positioned at 75 degrees West; GOES-10, the successor to GOES-9, is positioned at 135 degrees West. The principal GOES-8 and GOES-10 products (see Table 3-1) are half-hourly pictures with navigation and calibration files included. During the daylight hours, one, two, four, and eight kilometer resolution visible fixed standard sectors are produced for AWIPS/NOAAPORT distribution; equivalent infrared sectors, including water vapor, for all channels are available 24 hours a day. Satellite raw and remapped imagery, with navigation and calibration, is available to RAMSDIS users within the NWS and NESDIS community.

GOES-10 was launched in May 1997 and, after a difficult and extended checkout, was moved to 135 degrees West to replace the failing GOES-9. GOES-10 was declared operational on July 18, 1998, while stationed at 90 degrees West and then was subsequently moved to its operational location at 135 degrees West. GOES-9 was moved to 105 degrees West to serve as a short-term replacement for GOES-8 in the event of a catastrophic failure. The next GOES satellite is scheduled to be launched in May 1999.

GOES-8 and GOES-10 host an imager capable of detecting atmospheric temperature and moisture measurements in five spectral bands at high resolutions, including the new 3.9 micron and 12.0 micron wavelengths. GOES-8 and GOES-10 also have the feature of transmitting these five spectral bands simultaneously, affording the user community continuous views of atmospheric measurements in various wavelengths, each with its own meteorological and hydrological applications. The GOES-8 and GOES-10 spacecraft were also designed for flexible scanning of the Earth; any variation of scan or sector coverage at regular time intervals can be scheduled in a 30-minute time frame. The five channels and respective resolutions are as follows:

- Channel 1 (Visible, 0.55 to 0.75 microns) - one kilometer resolution.
- Channel 2 (Infrared, 3.8 to 4.0 microns) - four kilometer resolution.
- Channel 3 (Water vapor, 6.5 to 7.0 microns) - eight kilometer resolution.
- Channel 4 (Infrared, 10.2 to 11.2 microns) - four kilometer resolution.
- Channel 5 (Infrared, 11.5 to 12.5 microns) - four kilometer resolution.

For AWIPS/NOAAPORT and RAMSDIS applications, the flexible scanning of GOES-8 and GOES-10 allows transmissions of 15-minute imagery in combination with 30-minute imagery. The analog data formerly provided via GOES-TAP has been replaced with digital data for the new data distribution. The digital data provides the user with the flexibility to customize gridding and enhancement curves for the data. The new GOES-series satellites provide increased resolution for the visible and infrared channels. As compared with their predecessors, GOES-8 and GOES-10 provide double the resolution in water vapor imagery at eight kilometers as well as double the infrared resolution at four kilometers. An important tool in forecasting stratus and fog trends, channel 2 data is available from GOES-8 and GOES-10 to users.

The sounder on GOES-8 and GOES-10, consisting of 19 spectral channels, is used for measurements of atmospheric temperature and moisture profiles, surface and cloud-top temperature, and ozone distribution. Products derived from the sounder include precipitable water and lifted index--a measurement of atmospheric stability. Comparable to the imager, the sounder is capable of providing various scan coverage such as full Earth imagery, sectorized imagery, and local imagery. An independent sounder platform, governed under its own schedule, leads to an expansion of sounder data coverage and an increase in the frequency of transmissions. GOES-8 and GOES-10 also carry vital subsystems; such as, the SEM, DCS, WEFAX, and SAR operations.

3.2.1.2 NOAA Polar-Orbiting Satellites. Currently, NOAA-12 and NOAA-14 provide data for direct readout (Automatic Picture Transmission (APT)) and High Resolution Picture Transmission (HRPT). NOAA-15 is scheduled to begin operations in November 1998. NOAA-15 carries the same instrumentation as the earlier satellites with the addition of the Advanced Microwave Sounding Unit (AMSU), which is scheduled to become operational in early to mid 1999. The AMSU will provide total precipitable water and rain rate information to analysts. It has not been determined which satellite will be replaced by NOAA-15.

3.2.1.3 AWIPS/NOAAPORT, RAMSDIS, and the Satellite Analysis Branch (SAB). Under the NESDIS support concept, satellite imagery, in support of the *National Storms Operations Plan*, is distributed by the Environmental Satellite Distribution/Interactive Processing Center in Camp Springs, Maryland, to the national centers (NCEP), NWS field offices, and to SAB and other NESDIS units. Data from the polar-orbiting satellites is available to SAB and the NCEP national centers, but not to NWS field sites.

NESDIS operates 24 hours a day to provide a myriad of satellite services and products to NCEP and NWS field sites. Internally at the NOAA Science Center, SAB meteorologists provide satellite interpretation and analyses to NCEP meteorologists, relating valuable information on present locations and intensities of winter storms, as well as the projected movement and development of all these storms. In addition, snowfall estimates are derived from satellite signatures and reported to NCEP and the NWS field sites to assist forecasters in determining fall rates and projected accumulations. As conditions warrant, winter storm precipitation analyses and estimates are disseminated to the appropriate NWS forecast offices and

Table 3-1. Satellites and Satellite Data Availability for the National Winter Storms Operations Plan.

Geosynchronous Orbit

SATELLITE	TYPE OF DATA	LOCAL TIME	REMARKS
GOES-8	Imager and Sounder: 5 channels from the imager and 19 channels from the sounder.	Every 30 minutes partial full disk; CONUS views available every 15 minutes (2 CONUS views/half-hour.) In rapid scan operations, for detection of rapidly changing weather conditions, 4 CONUS views are available/half-hour including coverage to the equator.	1. 1, 2, 4, and 8 km visible standard sectors covering most of the Americas and the adjacent central and eastern Atlantic Ocean 2. 4 km resolution infrared imagery; 8 km resolution water vapor imagery 3. Same coverage in equivalent infrared sectors with special enhancement curves for primarily nighttime operations, at 1, 2, and 4 km resolutions 4. Independent imager and sounder platforms (eliminates time sharing) 5. Full disk IR imagery every 3 hours 6. Routine imagery animation at 15 minute and 30 minute intervals 7. Interactive wind analysis 8. Cloud top heights 9. Satellite precipitation estimates 10. Sounder data products including derived product imagery
GOES-10	Imager and Sounder: 5 channels from the imager and 19 channels from the sounder.	Every 30 minutes, northern hemisphere; PACUS (combination of western CONUS and Pacific) views every 15 minutes (2 PACUS views/half hour). In rapid scan operations, northern hemisphere views and 4 western CONUS views are provided every half-hour.	

Polar Orbit

SATELLITE	TYPE OF DATA	LOCAL TIME*	REMARKS
NOAA-12	AVHRR GAC and LAC (recorded) HRPT and APT (direct) TOVS	0158D/1358A	1. Mapped digitized data (cloud cover) 2. Unmapped imagery (all data types) at Direct Readout sites 3. Sea-surface temperature analysis 4. Moisture analysis 5. Soundings 6. Remap GAC Sectors
NOAA-14	(Same as NOAA-12)	1051D/2251A	
NOAA-15 (Operational Nov 98)	(Same as NOAA-12) plus AMSU (operational in early to mid 1999)	0331D/1531A	
DMSP F-11	OLS(SGDB), SSM/T-2, SSM/I, SSM/T-1	0643D/1843A	1. Unmapped imagery (DMSP sites only) 2. Mapped imagery (SGDB) 3. Snow and ice coverage 4. Precipitable water 5. Wind speeds 6. Precipitation rates 7. Moisture analysis
DMSP F-12	OLS, SSM/T-2	0921D/2121A	
DMSP F-13	OLS, SSM/I, SSM/T-1	0544D/1744A	
DMSP F-14	OLS, SSM/I, SSM/T-2	0842D/2042A	

* Local time/equatorial crossing time
D = Daylight descending
A = Daylight ascending

offices and River Forecast Centers (RFC) across the United States via the Automation of Field Operations and Services (AFOS) system.

Prior to the full deployment of AWIPS products by the end of the decade via the communication NOAAPORT, a point to multi-point satellite broadcast, NOAA is conducting experimental transmissions of digital GOES products to selected NWS field sites. This display medium, RAMSDIS, is used to process digital GOES data from terrestrial networks and enables users to perform a myriad of operations including designed overlays, local remapping, looping, and temperature retrievals. RAMSDIS, a viable workstation, affords the user a preview and familiarization of digital satellite data including its many applications. The evolution of these higher resolution data represents a break through in satellite data quality, thereby improving observations, analyses, and forecasts of mid-latitude storm systems.

3.2.1.4 Points of contact 24 hours/day.

- NCEP/NCO Senior Duty Forecaster (SDM)--301-763-8298
- NCEP/HPC Senior Branch Forecaster--301-763-8201
- SAB--301-763-8444

3.2.2 Department of Defense (DOD) Defense Meteorological Satellite Program (DMSP). The DMSP constellation consists of at least two spacecraft placed in sun-synchronous orbits best suited to support military operations. In addition to the very high resolution visible and infrared imagery, DMSP provides a variety of remotely sensed terrestrial and space environmental data. A suite of microwave radiometers provides microwave imagery as well as surface characteristics and upper air temperature and moisture soundings. The DMSP data capabilities in the area of concern are provided in Table 3-1. Special requests for DMSP support will be addressed to CARCAH.

3.3 Automated Coastal Marine and Ocean Observations.

3.3.1 Moored Data Buoys and Coastal Marine Automated Network.

3.3.1.1 Procedures. Moored buoy and C-MAN stations routinely acquire and transmit data every hour. Buoy observations include sea-level pressure, wind speed, peak 5-second wind, wind direction, air temperature, sea-surface temperature, significant wave height and period, and wave spectral data. A description of the data from a typical moored buoy payload is provided in Table 3-2; data from a typical C-MAN station are shown in Table 3-3. Refer to figures 3-1, 3-2, and 3-3 for the locations and station identifiers of moored buoys and C-MAN stations. Consult NDBC's web site at *www.ndbc.noaa.gov* for the latest station status or more site specific information.

3.3.1.2 Communications. Data are transmitted by ultra high frequency (UHF) communications via the GOES satellite to NESDIS and then are relayed to National Weather Service Telecommunications Gateway (NWSTG) for processing and dissemination. Data from moored buoys are formatted into World Meteorological Organization (WMO) FM13-IX SHIP code. From C-MAN sites, the data are formatted in a modified form of the FM12-IX SYNOP code.

3.3.2 Drifting Data Buoys.

3.3.2.1 Procedures. These buoys are deployed by ship or aircraft in data-sparse areas. Their movements are largely dependent upon ocean currents and winds. Data available include position, sea-level pressure, wind speed and direction, air temperature, and sea-surface temperature. Six drifting buoys were deployed in the North Central Pacific by NDBC and AES Canada in September 1998. They are expected to continue transmitting through the winter of 2000. Additional drifters are expected to be deployed in the area in 1999 and 2000 to maintain the observation network.

3.3.2.2 Communications. Data are transmitted by UHF communications via the NOAA polar-orbiting satellites to NESDIS ground receiving stations and then relayed to the U.S. Argos Global Processing Center in Landover, Maryland, and to the NWSTG for processing and dissemination. Data from drifting buoys are formatted into WMO FM18-IX BUOY code.

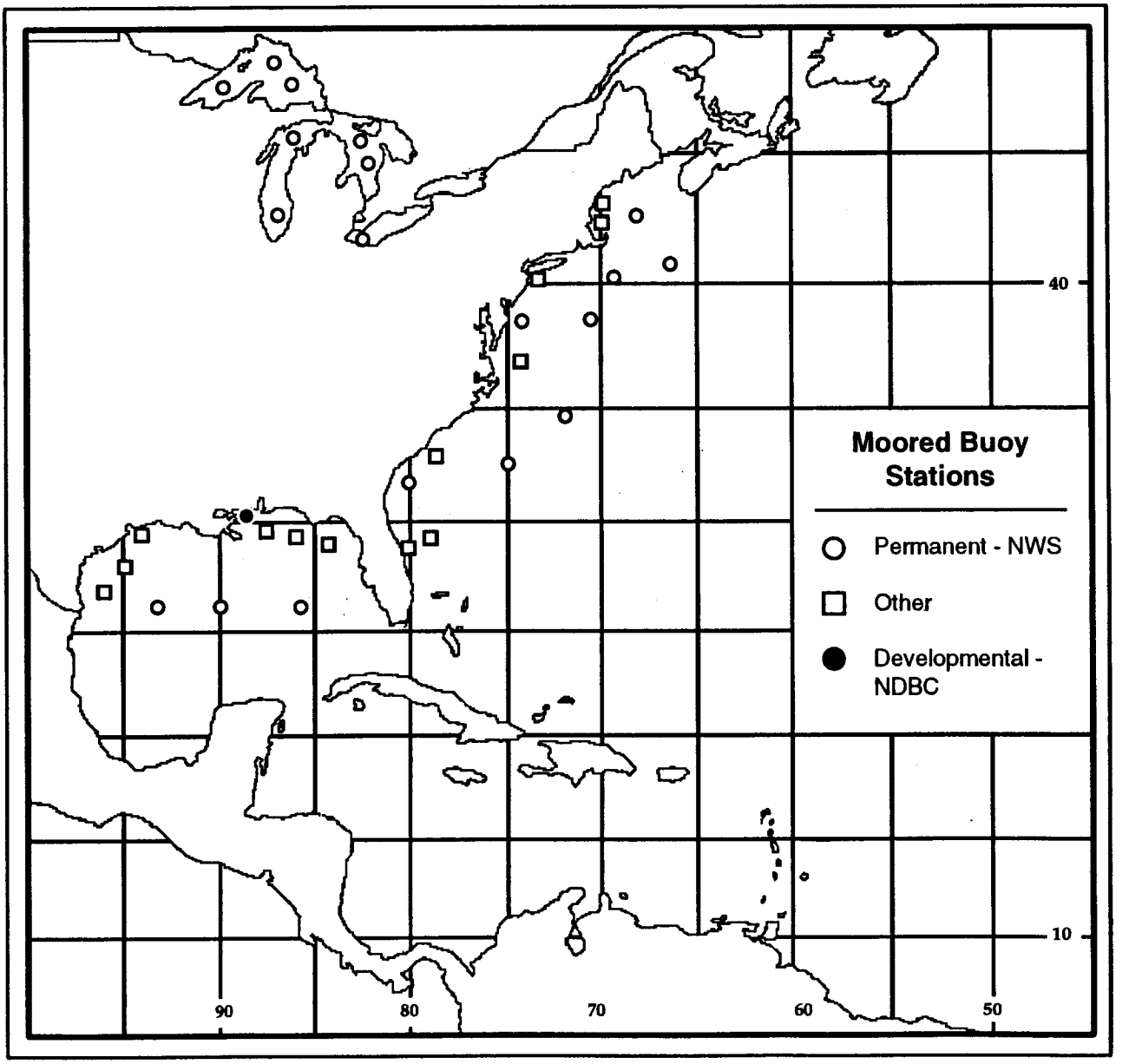

Figure 3-1. Map showing the location of NDBC moored buoys - Atlantic basin.

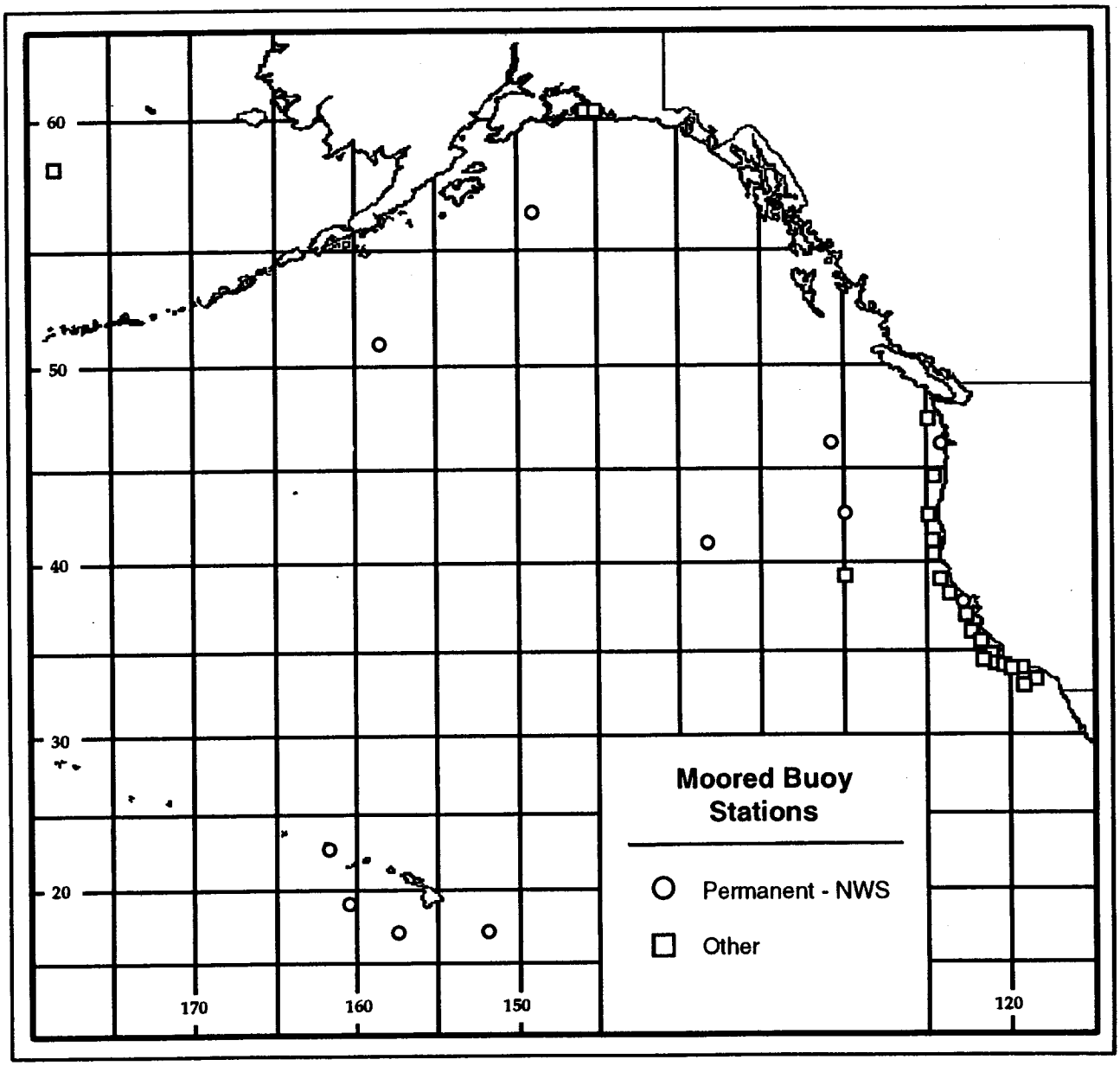

Figure 3-2. Map showing the location of NDBC moored buoys - Pacific basin.

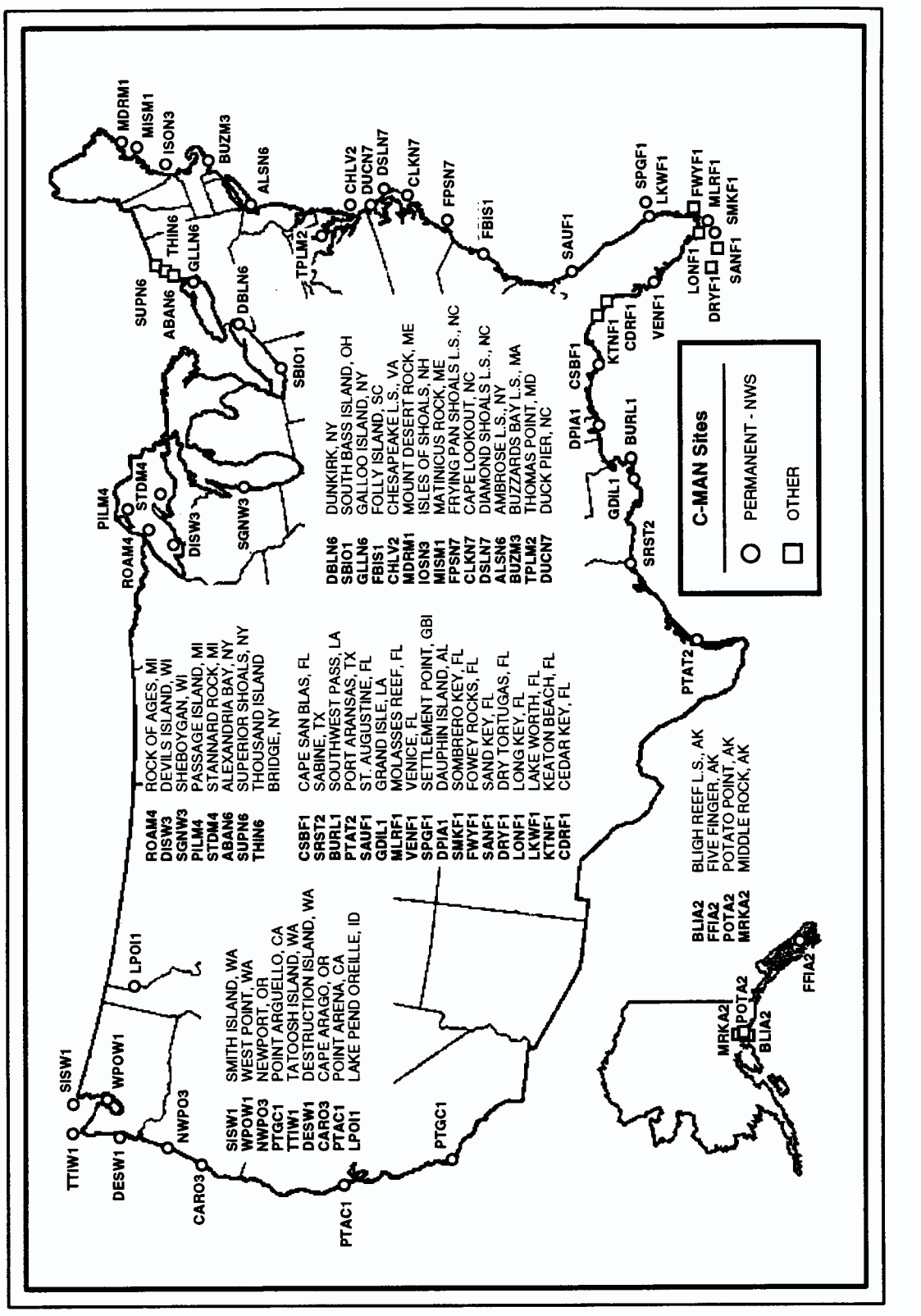

Figure 3-3. Map showing the location of NDBC fixed C-MAN stations in North America, including USCG Navigational Buoys.

a le 3- . Moored uoy payload data.

PARAMETER	REPORTING RANGE	REPORTING RESOLUTION	SAMPLE INTERVAL	SAMPLE PERIOD	TOTAL SYSTEM ACCURACY
WIND SPEED	0 TO 62 m/s	0.1 m/s	1 s	8-10 min	±1 m/s or 10%
WIND DIRECTION	0 TO 360°	1°	1 s	8-10 min	±10°
PEAK WIND	0 TO 82 m/s	1 m/s	1 s	8-10 min	±1 m/s or 10%
AIR TEMPERATURE	-40 TO 50 °C	0.1 °C	90 s	8-10 min	±1 °C
BAROMETRIC PRESSURE	800 TO 1100 hPa	0.1 hPa	4 s	8-10 min	±1 hPa
SURFACE WATER TEMPERATURE	-7 TO 41 °C	0.1 °C	1 s	8-10 min	±1 °C
SIGNIFICANT WAVE HEIGHT	0 TO 35 m	0.1 m	0.39 s	20 min	±0.2 m or 5%
WAVE PERIOD	3 TO 30 s	0.1 s	0.39 s	20 min	±1 s
NONDIRECTIONAL WAVE SPECTRA	0.03 TO 0.40 Hz	0.01 Hz	0.39 s	20 min	—
SOLAR RADIATION*	0 TO 2150 W/m^2	0.5 W/m^2	1 s	8-10 min	±5%
DEW POINT TEMPERATURE*	-35 TO 30 °C	0.1 °C	1 s	8-10 min	±1 °C
PRECIPITATION RATE (ORG)*	0.5 TO 1600 mm/hr	1 mm	15 s	15 min	±5%
DIRECTIONAL WAVES*	0.03 TO 0.35 Hz	0.01 Hz	0.5 s	20 min	±5°
HORIZONTAL OCEAN CURRENTS (ADCP)*	0 TO 1000 cm/s	0.5 cm/s	1.5 s	20 min	±2 cm/s

*PARAMETER REPORTED ON SELECTED BUOYS

a le 3-3. Data from a typical fixed C-MAN station.

MEASURANDS (NOTE 1)	REPORTED DATA	REPORTING RANGE	REPORTING RESOLUTION	MINIMUM AVERAGING PERIOD (SELECTABLE)	TOTAL SYSTEM ACCURACY
WIND DIRECTION	TRUE WIND DIRECTION	0° – 360°	1.0°	2 min	±15° TRUE (±10° DESIRED)
WIND SPEED	AVG. WIND SPEED	0 – 120 kn	1.0 kn	2 min	±2.0 kn or 5%
	PEAK WIND GUST	0 – 160 kn	1.0 kn	(SELECTABLE)	±2.0 kn or 5%
WAVES	SIGNIFICANT WAVE HEIGHT ($H_{1/3}$)	0 – 49 m	0.5 m	(SELECTABLE)	0.5 m
	WAVE PERIOD (T)	2.5 – 5 s	1 s	(SELECTABLE)	±1 s
	PROBABLE MAXIMUM WAVE HEIGHT	0 – 49 m	0.5 m	(SELECTABLE)	0.5 m
BAROMETRIC PRESSURE	SEA LEVEL PRESSURE	900 – 1100 hPa	0.2 hPa	2 min	±1.0 hPa ABSOLUTE
AIR TEMPERATURE	AIR TEMPERATURE	-40 to +50 °C	0.1 °C	1 min	±1.0 °c
SEA SURFACE TEMPERATURE*	SEA SURFACE TEMPERATURE	-6 to +40 °C	0.5 °C	lmin	±1.0 °c
DEW POINT	DEW POINT TEMPERATURE	-35 to +30 °C	0.5 °C	1 min	-35 to -24°C: ±2 °C -23.5 to -1.5°C: ±1.5 °C -1.5 to +30 °C: ±1.0 °C
SECTOR VISIBILITY	VISIBILITY RANGE	0 – 8 statute mi		2 min	0 to 3 mi: ±10% 3 to 8 mi: ±1 mi
WATER LEVEL	WATER LEVEL	0 – 99.99 ft	0.01 ft	(PERIODICALLY RESET TO ZERO)	TBD
PRECIPIPITATION	CUMULATIVE PRECIPITATION	0 – 999 mm	1 mm	(PERIODICALLY RESET TO ZERO)	±1 mm or 4%