

### The National Data Buoy Center

# Introduction, Overview, and the OceanSITES Global Data Assembly Center

National Data Buoy Center

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# There has been a need for a DAC from the very beginning of NDBC:







NDBC's platforms (buoys and coastal stations) are placed in harsh and hard to reach environments.





Failing anemometers, inaccurate barometer readings, low power levels, and irregular wave spectrums all contribute to poor marine weather/ocean observations, and the need for trained eyes to stop the data before they are released to the public.

Once a buoy is placed on station, NDBC personnel usually have to wait a few years before visiting the station. Therefore, all platforms and instruments must be in excellent condition before deployment – and the data carefully monitored during station operations.



- Established in 1967 as the National Data Buoy Development Programs as part of the US Coast Guard.
- After NOAA formed in 1970 became the National Data Buoy Office under the National Ocean Service.
- In 1982, renamed the National Data Buoy Center and placed under the National Weather Service.
- The first buoys deployed by NDBC were large 12-m discus hulls, constructed of steel, and deployed in the deep waters off the U.S. East Coast and in the Gulf of Mexico.
- By 1979, NDBC maintained 26 stations 16 in the Pacific, seven in the Atlantic and three in the Gulf of Mexico. NDBC deployed eight more stations in the Great Lakes during the 1980s.

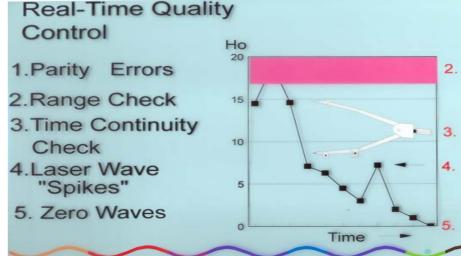
# NDBC's Quality Control



- Started with NDBC in 1970s
  - Focus on "Top Five"
  - Wind Direction, Wind Speed, Atmospheric Surface Pressure, Wave Height and Dominant Period
- Algorithms perform check at NWS Gateway
- Quality Assurance Group at NDBC provided daily check of marine observations – usually 8 hours to two days after
  - dissemination

National Data Buoy Center

Approx. 110 platforms

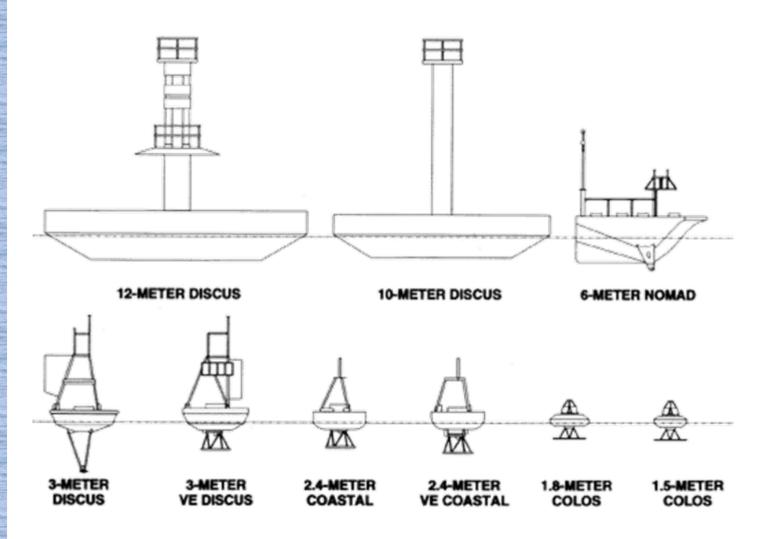




- One Hundred and six (106) meteorological buoys moored off East, West, Gulf, Alaska, and Hawaiian coasts and Great Lakes.
- Fifty-five (55) oceanographic buoys located in the tropical Pacific [TAO].
- Fifty-six (56) meteorological stations located on East, West, Gulf and Alaskan coasts, Lake St. Clair and St. Lawrence Seaway.
- Thirty-nine (39) Deep-ocean Assessment and Reporting of Tsunami (DART) stations in Pacific and Atlantic Oceans, Caribbean Sea, and Gulf of Mexico.
- Four hundred plus (400+) vessels routinely reporting meteorological observations worldwide.
- Collect, QC and distribute data from ~400 partner stations.

#### Observing System Platform Types

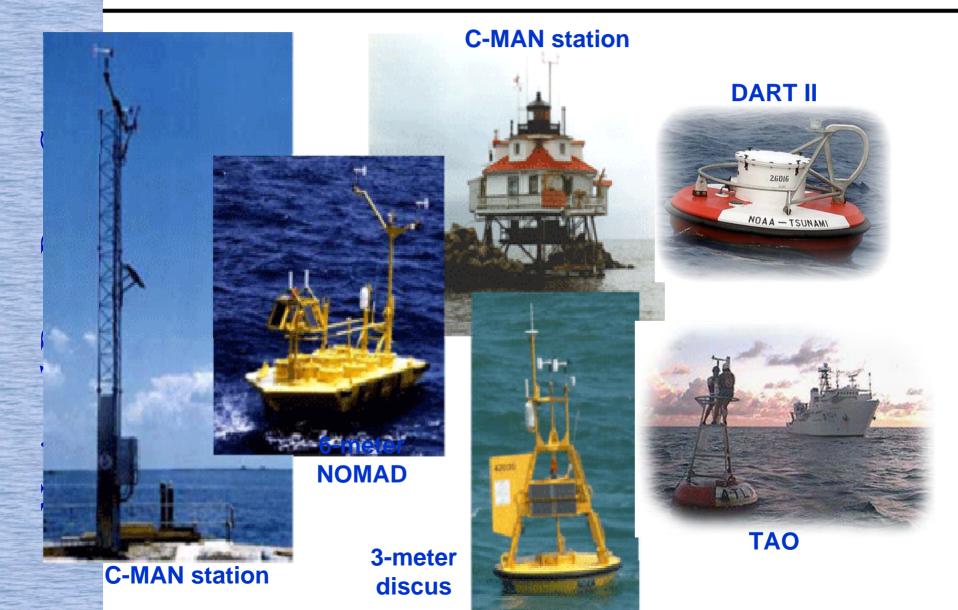


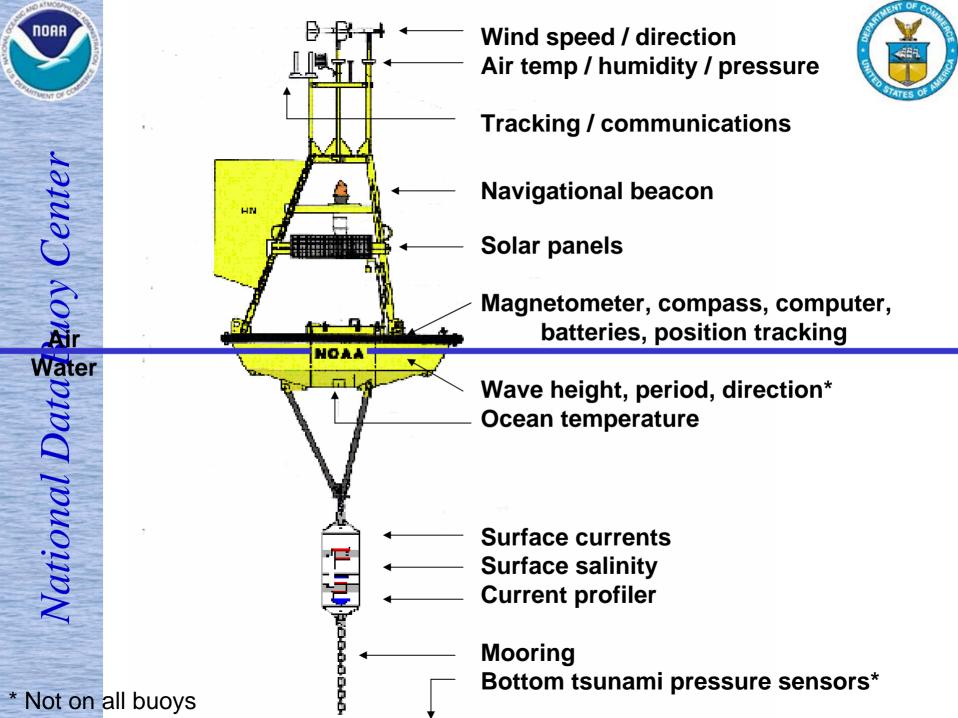


#### **Observing System Platform Types**

NOAA







# NDBC Data Assembly Center



- 24/7/365 support of
  - Data Quality Control
  - Communications
  - Operations
- Daily Operations Brief
- More than 600 stations currently supported
  - NDBC Buoys
  - NDBC C-MAN Stations
  - NOS Stations
  - DART
  - ΤΑΟ
  - VOS
  - Partner Stations
    - OOSs
    - MMS ADCP



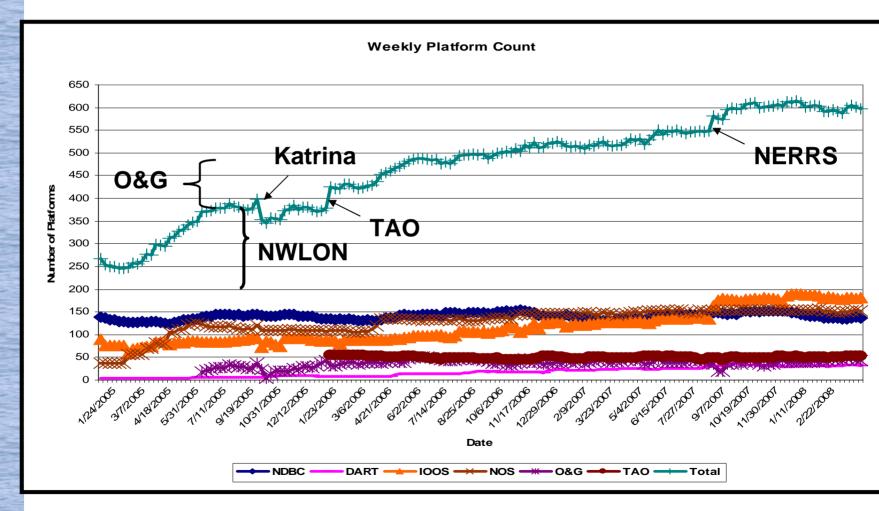






- Reevaluates the data collected and ensures that <u>monthly archive data sets</u> contain only accurate data.
- <u>Analyzes data acquired during integration, test and deployment</u> activities to ensure proper operation of all systems.
- <u>Forecasts weather and sea-state</u> prior to and during these field missions. These five day forecasts assign a "Go," "No Go," or "Marginal" status for each deployment or service operation to be used for guidance only.
- <u>Support integration and testing of buoy payloads</u>. Once a payload has been refurbished, the buoy is thoroughly tested before deployment.
- <u>Maintain a centralized library of current parameter load files</u> using interactive configuration management applications for all operations.
- For newer payloads, DAC personnel <u>work with software engineering and</u> <u>Combined Operations, Maintenance, Engineering, Technicians personnel</u> on the development and testing of their parameter load files.
- <u>Monitor battery voltages and input (charging) currents</u> for each operational NDBC station as well as those in integration or staged for development.
- Finally, on a monthly basis, the DAC group <u>sends data</u> to the National Environmental Satellite, Data, and Information Service (NESDIS) for archival at the National Climatic Data Center (NCDC) or the National Oceanographic Data Center (NODC) based on data type.

#### Growth of Platforms

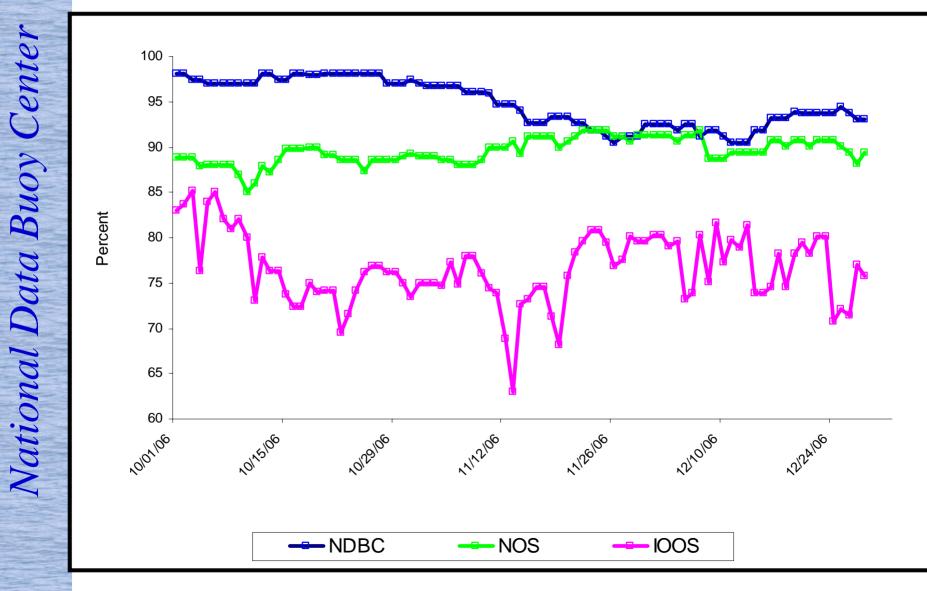


National Data Buoy Center

# **Platform Availability Variance**

DOAR





# **IOOS** Partners



- Carolina COOPS
- Chesapeake Bay
   Interpretive
- Chesapeake Biological Lab
- CICORE
- U.S. Army Corps of Engineers
- COMPS
- CORIE
- CORMPS
- Delaware Coastal Programs
- Dauphin Island Sea Lab
- WFO Green Bay
- Great Lakes ERL
- NWS Great Lakes Central Region
- NWS Great Lakes Eastern Region
- Gulf of Maine GOMOOS
- LSU WAVCIS
- LUMCON
- MBARI
- MMS Gulf of Mexico

- MYSOUND
- North Carolina NCCOOS
- NERRS Water Quality
- National Estuarine Research
- National Ocean Service
- NWS Alaska
- NWS Columbia, SC
- NWS Detroit
- OR-COOS
- SCCOOS
- Scripps
- Skidaway
- Stevens Institute
- TCOON
- Univ. of Californina at Davis
- Univ. of Michigan
- Univ. of So. Carolina Nearshore
- Univ. of So. Mississippi
- Woods Hole Oceanographic Instit

#### Data Assembly Center Partner Support



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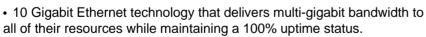
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#### Data Assembly Center Capabilities





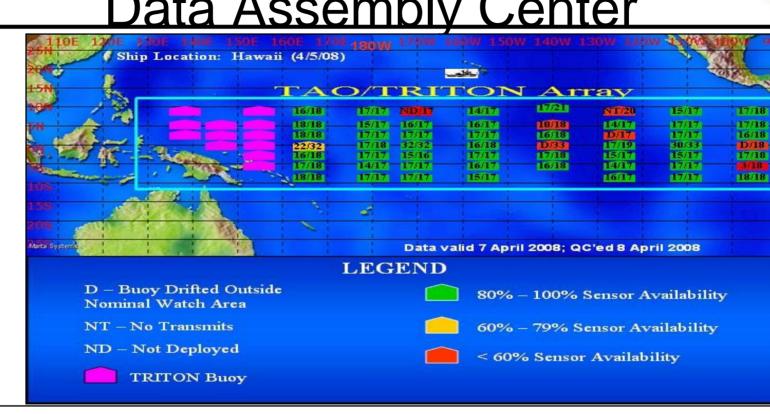
• Designed around high-end enterprise class systems. Their minimum standards include Dual-Core 1.8Ghz systems, 4GB RAM, redundant Gigabit network interface cards, and redundant power.

• Firewalls deliver multi-gigabit wire-speed security at the perimeter of the network protecting resources from compromise attempts. Intrusion detection systems provide wire-speed in-line inspection of all network traffic. This provides an additional layer of security that coupled with firewalls ensures the NDBC network is well-defended and is capable of staying online even in the event of compromise attempts.



### Tropical Atmosphere Ocean Data Assembly Center





• Processing of Automated Distribution Service messages from Service Argos. It uses both the TAO calibration database and calibration files to convert raw data to engineering units and also calculates buoy positions. An automated real-time QC is performed for gross error checking and then the TAO database is updated with the corrected data.

• The TAO Real-time Data Monitoring Subsystem supports daily, weekly, and monthly QA/QC activities by providing on-demand data checking functionality to the DAC. In addition to the automated gross error checking, the real-time data monitoring subsystem provides on-demand reports for once-daily, thorough examination of all current buoy data and detailed review of the real-time data.

• The reports cover daily QC, platform transmissions, deployment, present positions, Argos positions, latitude/longitude time series, data plots, etc. The TAO DAC may request any data checking reports through the subsystem's web interface and make decisions to flag or not to flag the real-time data according to the analysis.

### Tsunameter Data Assembly Center

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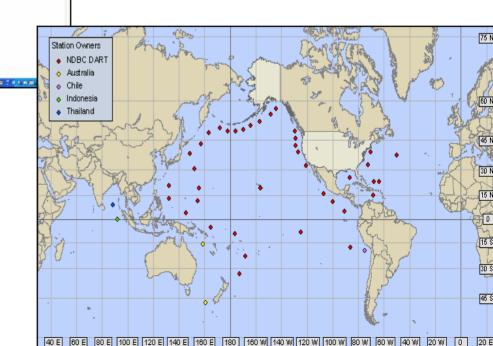


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Transmission of real-time water level heights occurs when the tsunami detection algorithm is triggered by a seismic event, when interrogated by the NOAA Tsunami Warning Centers (TWCs) or NDBC, or at pre-scheduled intervals. The bottom unit transmits the messages to the surface buoy via underwater acoustics systems. The surface buoy is equipped with duplicate and independent communications systems to transmit data to the Iridium satellite and then on to the Iridium Gateway in Arizona, U.S., where the data to routed to the NDBC server. The worldwide tsunami observation network also requires a real-time, data assembly center to provide continual monitoring and quality control of Deepocean Assessment and Reporting of Tsunamis (DART®) water pressure/height observations. The DART Data Assembly Center monitors the various real-time transmission of DART messages depending on the operating mode of the bottom pressure recorder.



#### Volunteer Observing Ship





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	SHIP		48.6	-5.6		14.0	-	-	-	29.73 +0.06 29.77 +0.01	49.1	54.1	41.2		-	-	-	-	-	-					
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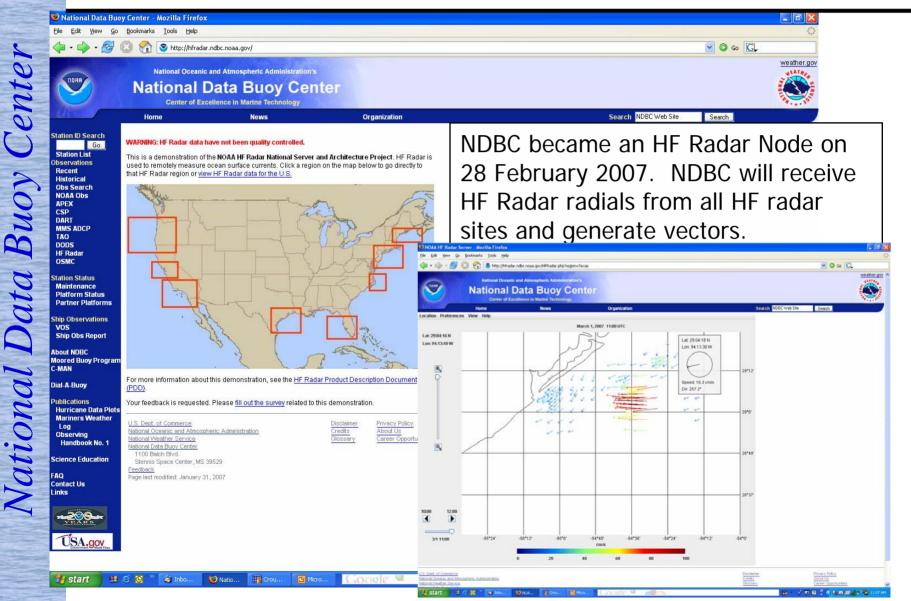
#### **High Frequency Radar**

Cente

Data

Vational





#### Oil and Gas Ocean Vectors

Station Legend

Anadarko Petroleum

Amerada Hess

ATP Oil & Gas

Conoco Phillips

ENI Petroleum

Mariner Energy

Murphy Exploration

Newfield Exploration

Remington Oil & Gas

Walter Oil and Gas

Tana Exploration Company

ExxonMobil

Kerr-McGee

Marathon

Neven

Shell

Petrobras

Total USA

Williams

W&T Offshore

Dominion Exploration

BHP

BP Inc.

Chevron

Search NDBC Web Site

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Ocean Current Data for 42367

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Apply quality control

to real-time ADCP

water oil platforms

data from deep-

and rigs

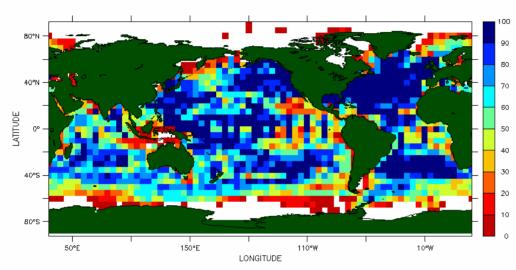
NDBC - Station 42367 - Mozilla Firefox Edit View Go Bookmarks Tools Help Center Shttp://www.ndbc.noaa.gov/station\_page.php?station=42363 SNDBC - Deep-ocean Assessment and Repor... SNDBC - Station 42367 National Oceanic and Atmospheric Administration NORA National Data Buoy Center Center of Excellence in Marine Technology Home Station ID Search Go Station List Station 42367 - Matterhorn - Mississippi Canyon Block 243 National Data Buoy Observations Station operated by Total USA, Inc. Recent Fixed Drilling Platform 28.74 N 88.83 W (28°44'33" N 88°49'32" W) Historical **Obs Search** NOAA Obs Water depth: 860 m APEX CSP Meteorological Observations from Nearby Stations and Ships DART MMS ADCP Latest Satellite Wind Map for this Area TAO DODS HF Radar OSMC Unit of Measure: English 🔽 Time Zone: Station Local Time Station Status Maintenance 9:24 am CST Platform Status Depth Dir Sneed Dir Speed Partner Platforms 310.7 Ship Observations 409.1 VOS Ship Obs Report 607 F 606.0 About NDBC 704 4 Moored Buoy Program C MAN 802.8 901 2 Dial-A-Buov 9997 Publications Hurricane Data Plots **Mariners Weather** 1204 0 Log 1393 4 Observing Handbook No. 1 1600.0 Science Education 1688.6 FAQ Contact Us inks 1983.9 2082.3 65 0.07 Previous (up to 48) reports of ocean current data for 4236 Ocean Current Stick Plots are available in metric units only USA.gov 1-day plot 3-day plot

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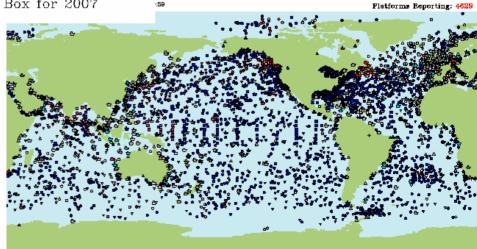
### OSMC / OPeNDAP

TIME : 01-JAN-2007 to 28-DEC-2007



Will serve as the backbone of the NDBC's OceanSITES GDAC

Percent of Weeks with 10 sst obs in 5x5 Box for 2007



Suppressing ship observations for most recent 48 hours



- Quality Assurance of Real-Time Ocean Data (QARTOD) – Collaborative effort between a number of U.S. organizations to standardize QA/QC procedures for "real-time" data
- Q20 QARTOD to OGC Open Geospatial Consortium (OGC) Sensor Web Enablement (SWE)
- NOAA IOOS Data Integration Framework standardize all marine observations using web services
- META-T Metadata for Ocean Temperature standardize ocean temperature metadata that are included within the observations using BUFR – joint server with NMDIS China

### Maintaining OceanSITES



#### Appendix No. 1 (Obtaining Your OceanSITES ID)

The OceanSITES Global Data Assembly Centers (GDAC) will store and post the reported OceanSITES data on their OceanSITES ftp / websites. You should contact XXXXX via e-mail at XXXXX and provide the following information for each of your locations. After you have submitted this information, the selected GDAC will issue an FTP Account ID, a Station ID, and GTS Routing Identifiers (anything else?)

1. OceanSITES Information
---------------------------

OceanSITES Name	
OceanSITES URL (Optional, will be hyperlinked from website to Owner)	
Name of OceanSITES Contact	
Phone Number of OceanSITES Contact	
E-mail address for future notification of outages and for contact	
IP address of FTP delivery server	

2. Unique Station Information	XXXXX
Station Type (e.g., SPAR, TLP, SEMI, MODU, Mooring)	
Platform/MODU/Project Name	
OCS-G Block and Area (e.g., High Island - HI-334B)	
OCS-G Lease Number	
Latitude (deg min sec)	
Longitude (deg min sec)	
Datum used for Lat/Long	
Water depth (ft)	

3. Instrument Information (for each unit at the site)

e. Instantent mornadon for caon and at the step	
Instrument ID or Serial Number	
Instrument model (e.g., RDI 75 kHz BB)	
Recovery time (real-time; recovered bi-annually, etc.)	
Transducer depth (meters – if ocean acoustic modern is used)	
Coordinate system of data (beam, inst or earth)	
Compass reference (True required)	
Specify if the heading of the instrument is fixed. If fixed, specify if the	
actual compass value is used for orientation or if it is manually set.	
Vertical Datum Reference - Degrees from vertical looking down (i.e., 0	
degrees = downward, 90 degrees = horizontal, 180 degrees = upward)	
Specify if the angle of the instrument is fixed and the tilt value is calculated	
when installed or if the tilt sensor value is used for orientation.	
Number of bins or levels	
Bin size (meters) – Doppler current profiler only	
Specify first bin depth (meters). Bin depth is assumed to represent center	
of bin. Indicate if otherwise (top or bottom). Doppler current profiler only	
Time data reference (GMT required)	
Number of sampling periods per hour	
Specify sampling period (minutes).	
Specify if clock time represents middle, beginning, or end of period.	
List any obstructions such as risers, moorings, tendons, or umbilicals that	
may affect the instrument information.	
Specify any instrument parts that have been taken out of service to	
a second state a batta state second	
accommodate obstructions.	

#### NDBC Sea State QC Table



http://cdip.ucsd.edu/documents/index/product\_docs/qc\_summaries/waves/waves\_table.pdf

TIME SERIES VALUES	DIR BUOY	NON-DIR
RANGE CHECK (TS): verify that values fall within established ranges.	<b></b>	<b></b>
SPECTRAL VALUES	DIR BUOY	NON-DIR
MESSAGE CHECK: verify checksums, parity of transmission.	<b></b>	<b></b>
RANGE CHECK (SP): check range of spectral wave density values.	<b>1</b>	٠
TIME CONTINUITY (SP): check continuity of spectral values over 1 hour.	<b></b>	<b></b>
PARAMETER VALUES	DIR BUOY	NON-DIR
RANGE CHECK (PM): check range of primary and ancillary parameters.	<b>1</b>	•
TIME CONTINUITY (PM): check continuity of parameter values over time.	<b>1</b>	٠
LOW ENERGY: set parameters to zero for very low energy readings.	<b>1</b>	٠
HEIGHT VS. PERIOD: check that Hs does not exceed limits for the given Ta.	<b>1</b>	٠
WIND/WAVE ENERGY: checks that wave energy corresponds to measured wind.	<b>1</b>	<b></b>
WIND/WAVE DIRECTION: checks that wave, wind directions correspond.	<b>1</b>	
SWELL DIRECTION: verifies that swell comes from non-sheltered directions.	<b>√</b>	
CHECK FACTORS: range test of directional wave check factors.	<b>√</b>	
VISUAL INSPECTION: data analyst reviews data.	<b></b>	<b></b>

# **NORR**

# **Quality Control Parameters**



Parameter	Reporting Range	Reporting Resolution	Sample Interval	Sample Period	Total System Accuracy
				<b>o</b> : 1	4 / 400/
Wind Speed	0 to 62 m/s	0.1 m/s	1 s	8 min <sup>1</sup>	±1 m/s or 10%
Wind Direction	0 to $360^{\circ}$	<b>1</b> °	1 s	8 min <sup>1</sup>	$\pm 10^{\circ}$
Peak Wind	0 to 82 m/s	1 m/s	1 s	5 s	±1 m/s or 10%
Air Temperature	-40 to 50 °C	0.1 °C	90 s	8 min	±1 °C
Atmospheric Pressure	800 to 1100 hPa	a 0.1 hPa	4 s	8 min	±1 hPa
Sea Surface Temperature	-7 to 41 °C	0.1 °C	1 s	8 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	—
Dew Point Temperature <sup>2</sup>	-35 to 30 °C	0.1 °C	1 s	8 min	±1 °C
Solar Radiation <sup>2</sup>	0 to 2150 W/m <sup>2</sup>	0.5 W/m <sup>2</sup>	1 s	8 min	±5%
Precipitation Rate <sup>2</sup>	1 to 1600 mm/h	r 1 mm	1 s	15 min	±5%
Directional Waves <sup>2</sup>	0 to $360^{\circ}$	1.0°	0.5 s	20 min <sup>3</sup>	±5°
Ocean Currents (ADCP) <sup>2</sup>	0 to 1000 cm/s	0.5 cm/s	1.5 s	20 min	±2 cm/s

<sup>1</sup>For continuous winds, successive 10-min samples <sup>2</sup>Parameter reported on selected buoys <sup>3</sup>Wave sampling period 40 min on some systems

Becoming More Standard



#### Quality Control of Observations



- No QC Done Onboard the Buoy or C-MAN
- Handbook of Automated Quality Control Checks and Procedures of the National Data Buoy Center

http://www.ndbc.noaa.gov/handbook.pdf

- Automated QC Done in Real-Time at NWSTG
- Hard-flags:
  - Stop the Release and Archive of Data unless Analyst Overrides.
    - Override in advance Storm Limits, or
    - Remove before archive
  - Hierarchical: Order of Precedence, Fail One and Stop
- Soft-flags: Climatology-based, Advisory

# **Quality Control Process Flow**



- Real-Time:
  - System Parameters (e.g., power)
  - Message Integrity
  - Automated Hard-Flag
  - Automated Soft-Flag
- Post-Release, Pre-Archive: Data Analyst

# Hard-Flags



- T Transmission parity error
- M Missing sensor data
- W Wave message is short, checksum or parity errors.
- E Spectral Density are exceeded or are in error
- Delete measurement ("permanent failure")
- **S** Invalid statistical parameter (e.g., mean > max)
- V Failed time continuity.
- L Failed range (climatological) limits
- R Related measurement has failed a hard QC check (e.g., WVHGT fails → Periods failed).

# Soft Flags for Waves



- **a:** Measurement is above monthly, regional limit.
- **b:** Measurement is below monthly, regional limit.
- c: Measurement has been adjusted, or corrected.
- f: Measurement failed hourly time continuity.
- **m**: High frequency spikes detected in the wave spectrum.
- **p:** Failed wave height to wave period comparison test.
- **q:** Swell direction is from an improbable direction.
- w: Failed wind direction verses wave direction check.
- x: Wind wave energy is too high for prevailing wind speed.
- **y:** Wind wave energy is too low for prevailing wind speed.

# Real-Time and Automated QC



- Purpose: Remove gross errors
- Data rejected: Virtually certain to be degraded
- Typical causes: Transmission errors, power degradations, broken cables
- Limitations: Won't detect minor errors, biases

# Manual Quality Control



- Sensor Evaluations
- Individual Sensor Calibrations
- Payload Software Testing
- Burn-In
- Data Evaluation at Deployment
- Real-time Q.C. Algorithms

# **Quality Control Interface**



Data Analysis System

#### DQA Data Analysis System



Select an area and click on the Start button to begin analysing data.



Enter start date of data to be analysed: 012920041100

Enter stop date of data to be analysed: 013020041030 🗖 Use Stop Date

# QC Flag Monitoring

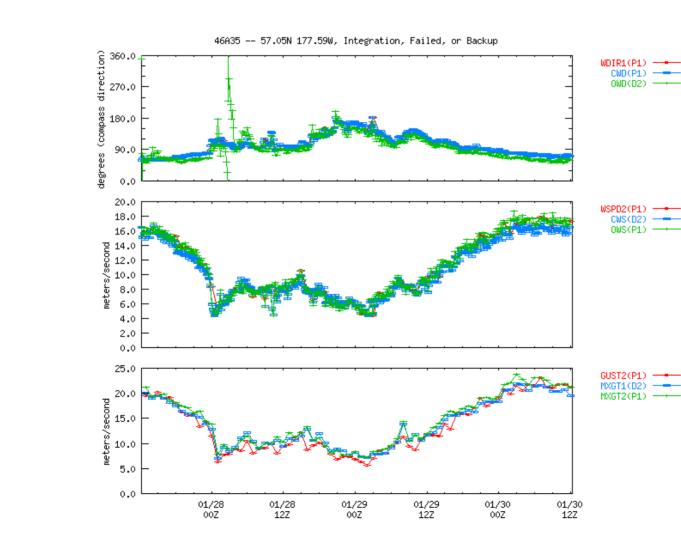
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egion Select	ion View All Notes	Maintain Coup	led Me	easurem	ents	Interactive Plo	ts View Notes	View Actions	Vie	ew All Da	ata
Payload: 464	135 🛃 Loc	ation: 46035	j	Status	Integral	iion, Failed, or E	lackup	E	dit Rar	nge of D	ata
EQC FLAG ASCII Id	S (All Flags) Measurement Date	Value	Flag		(Remo	ve Flag) (I	Keep Flag) (Re	view Later) Not	tes (Opl	tional)	
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RCOMP2	01/30/2004 16:00	233.0	D	Graph	C ARC	HIVE 💽 DO	NOT ARCHIVE 🤿 UNI	RESOLVED			
WDIR2	01/30/2004 16:00	47.0	D	Graph	C ARC	HIVE 📀 DO	NOT ARCHIVE 🦰 UNI	RESOLVED			
WSPD1	01/30/2004 16:00	16.8	D	Graph	C ARC	HIVE 💽 DO	NOT ARCHIVE 🤿 UNI	RESOLVED			
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				Graph		WVHGT	01/29/2004 18:00	2.5	У	Graph	
				Graph		WVHGT	01/29/2004 19:00	2.5	У	Graph	
						WVHGT	01/29/2004 20:00	2.7	У	Graph	-
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						and the second second	01/29/2004 21:00	2.8 2.9		Graph Graph	

National Data Buoy Center

NOAR

#### Wind Plots

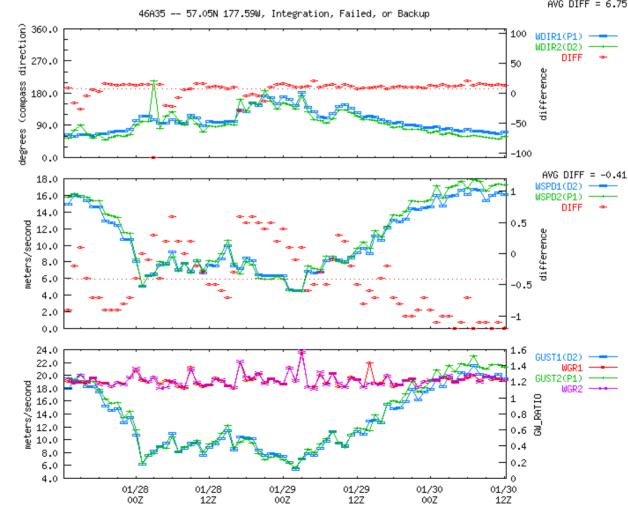






NOAA

#### More Wind Plots

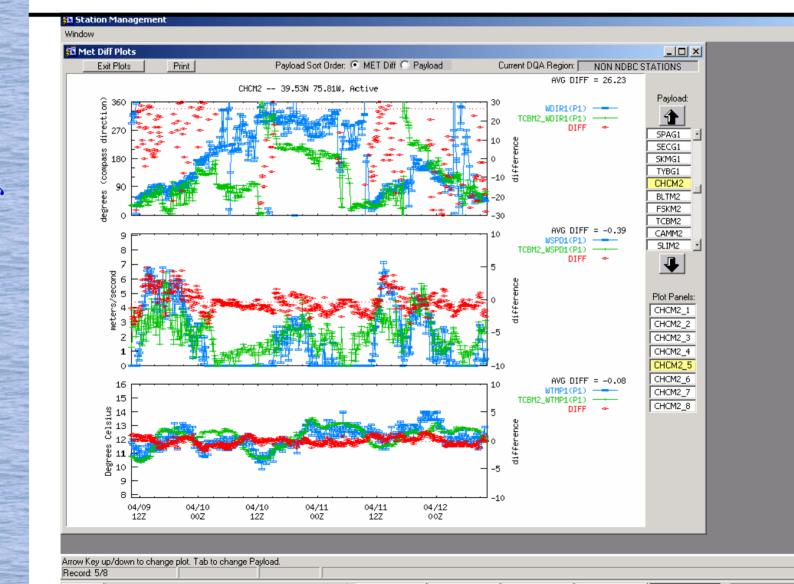


AVG DIFF = 6.75

NOAA

#### QC for Two Station Plots





Station Con...

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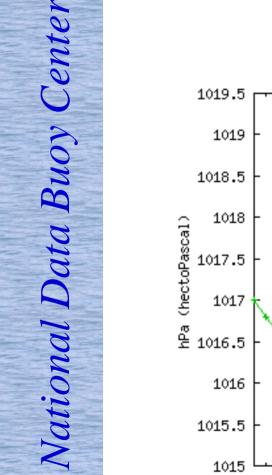
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Nearby.doc... Station M...

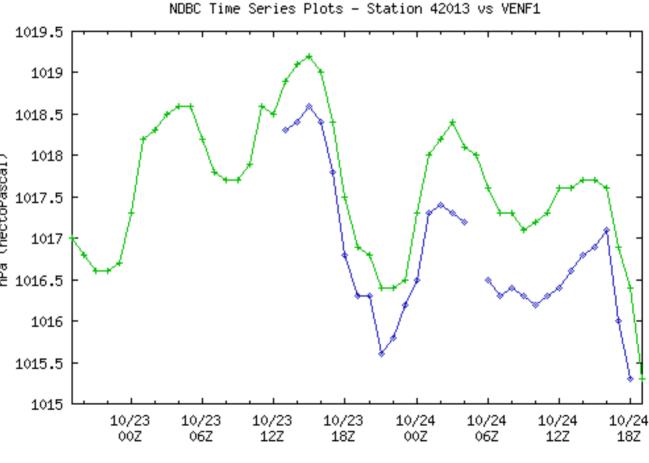
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# NDBC vs. University stations





NOAA



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VENF1\_BAR01 --+

# **Output Formats**



- FM-13 for moored buoys
- C-MAN code for coastal stations:
  - National code, but well-suited for coastal obs.
  - Contains water level & waves
  - Decoded by all (?) met. Workstations
- FM-64 TESAC (temp., salinity, current profiles)
- FM-65 WAVEOB (spectral wave data)



# Thank You!

**NOAA** 

National Data Buoy Center

Bill Burnett bill.burnett@noaa.gov