



Fleet Numerical Meteorology & Oceanography Center

Operational Data Workshop 13 – 14 September 2011

*This briefing is **UNCLASSIFIED***

James A. Vermeulen
Leslie Baran

Fleet Numerical Meteorology and Oceanography Center
7 Grace Hopper Ave., Stop 1
Monterey, CA 93943





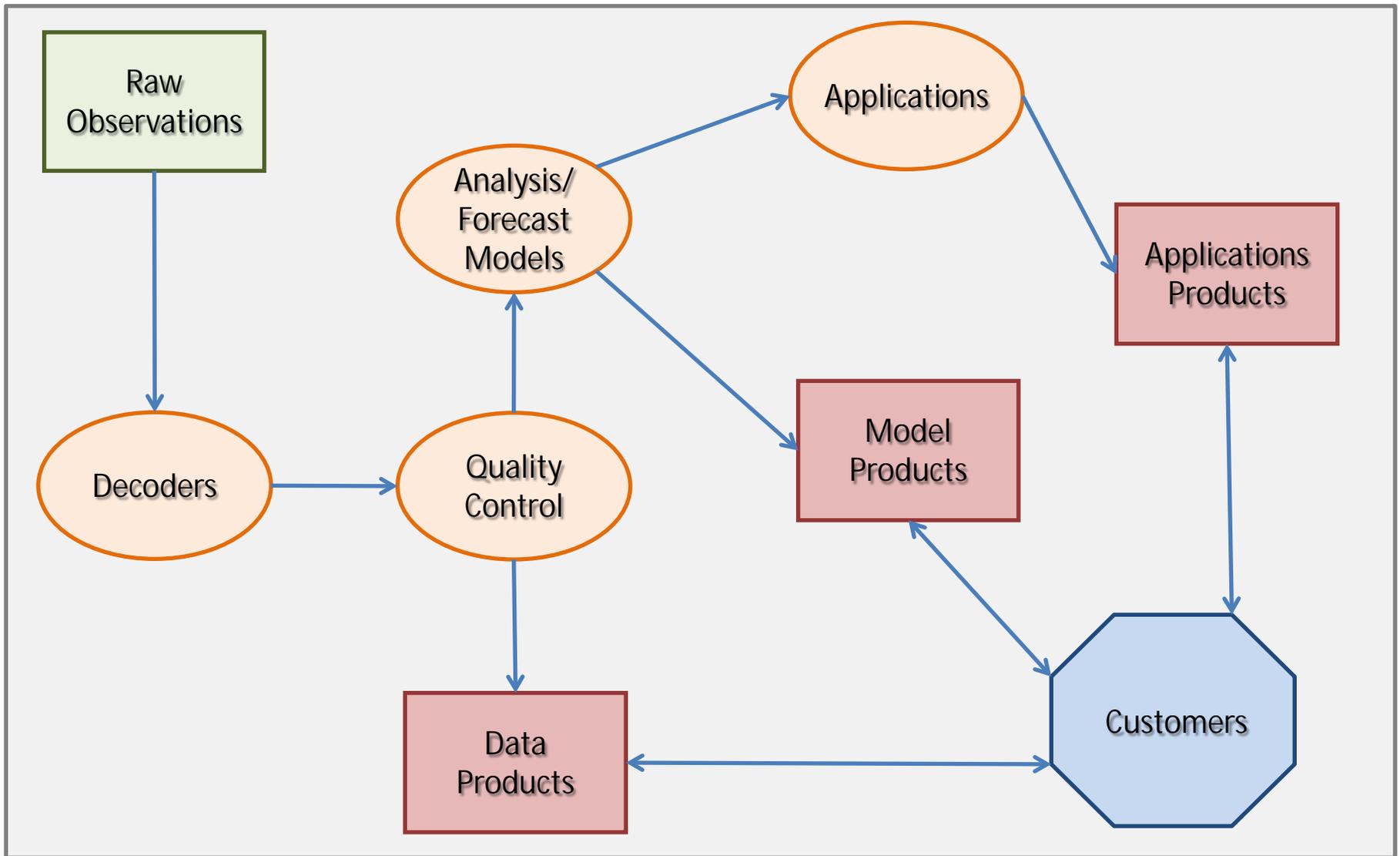
FNMOC Presentation Outline

- Data used and sources of data
 - Separator/decoder process
 - Data quality control and preparation
 - Coverage plots
- Data assimilation and acquisition needs
 - Model input
- Models and products we provide
 - Models overview
 - Tactical imagery
 - Satellite data we provide
 - FNMOC website
- Projects in progress





METOC Data Flow





Data Received

Text Sources

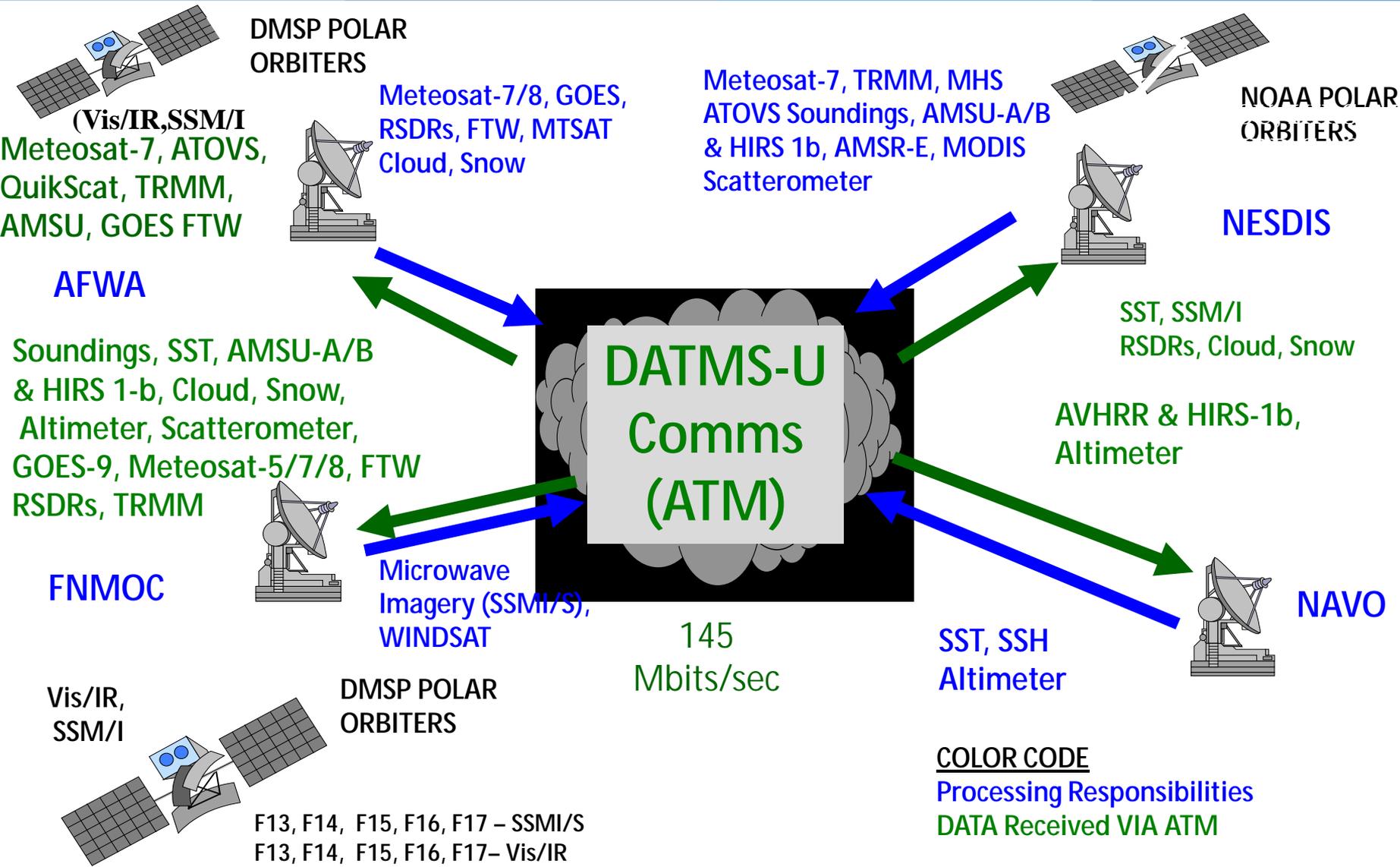
Data types	Text Sources						
	awn	dms	gts	j-obs	kqs	noaaport	navo
airep	X						
amdar	X		X	X		X	
AWA	X		X			X	
bathy	X	X	X	X		X	X
buoy	X	X	X			X	X
glider							X
HDOB	X		X			X	
METAR	X	X	X		X	X	
mobob					X		
PIBAL	X	X	X			X	
PIREP	X		X				
RAOB	X	X	X	X		X	
RECCO	X	X	X			X	
surface	X	X	X	X		X	
TAF	X	X	X	X			
TESAC	X	X	X	X		X	X
Trackob		X	X			X	X
Waveob		X	X			X	

Bufr Sources

Data types	Bufr Sources		
	gts-buf	noaaport	spp
amdar	X	X	
buoy	X	X	
Canada, Japan, Hong Kong, Korea amdar	X	X	
cosmic	X		
CSR	X	X	
Rad Alt			X
FTW-AFWA			X
FTW-EU	X	X	
FTW	X	X	
GOES-FTW			X
GRACE	X		
GRAS	X		
GOES winds	X	X	
Storm track forecast	X	X	
MDCRS	X	X	
profiler	X	X	
RAOB	X	X	
RARS	X	X	
Sfc land, ship	X	X	
ATOVS			X



Data Acquisition Processing Exchange



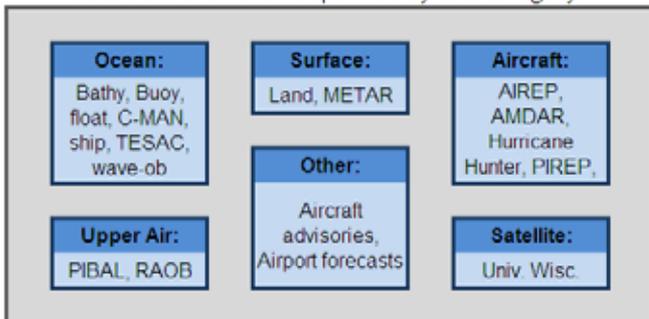


MODS Decoder Process

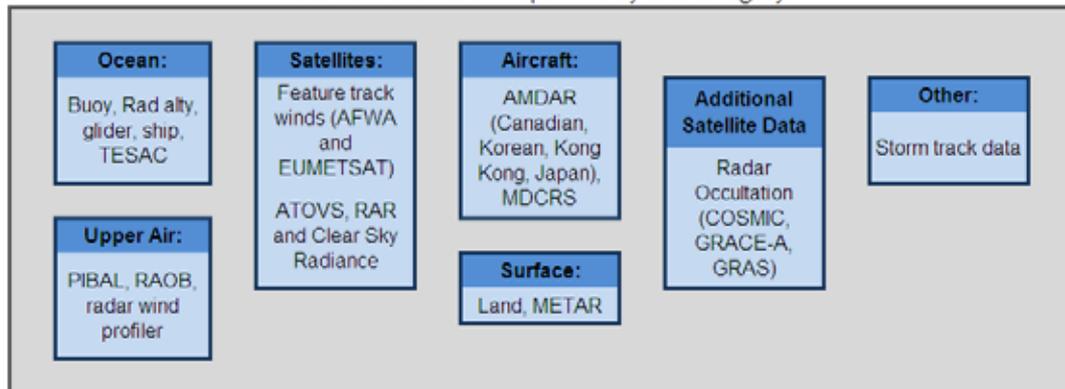
TEXT sources
awn, gts, jbs,
kqs, nat, nav,
sip, swa, uav

BUFR sources
gts, nab, spp

Data from circuits are separated by data category.



Data from circuits are separated by data category.

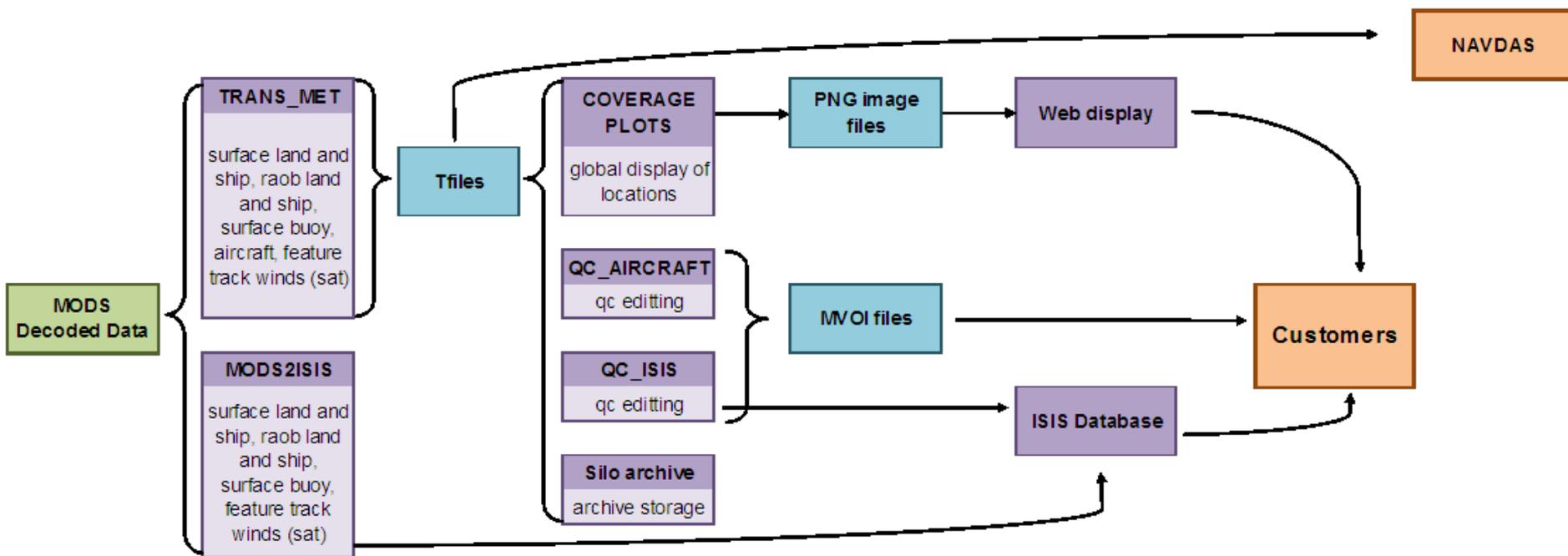


When data is available, DEC_MON runs decoders to produce decoded output.

Decoded data (to Models, ISIS)



DATA-QC Process





Conventional data coverage plots



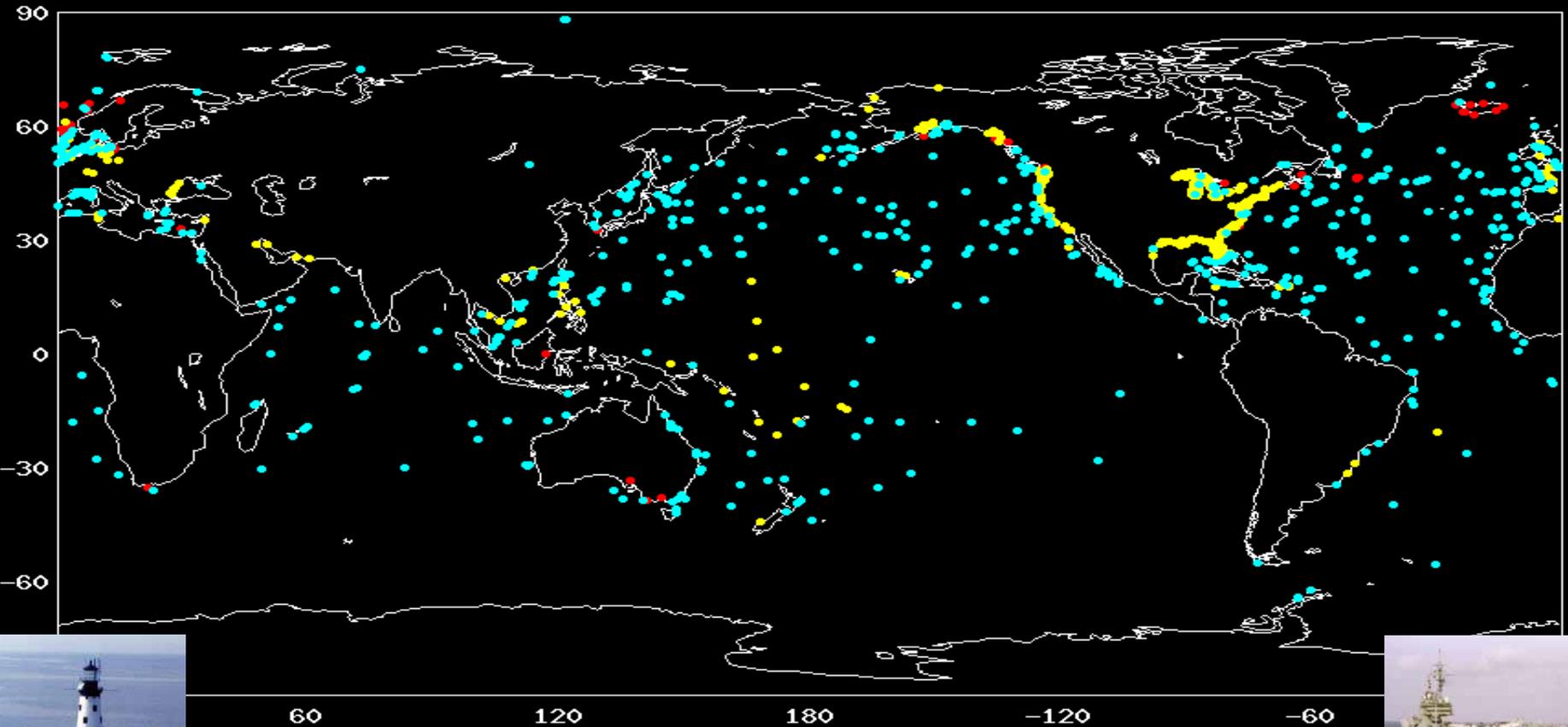


Ship Weather Reports



Ship/Coastal Coverage 2007050100 late

Fixed Ship	Coastal Surface/Marine	Mobile Ship
count ----- 215	count ----- 9776	count ----- 700
locations --- 75	locations --- 340	locations --- 647



UNCLASSIFIED



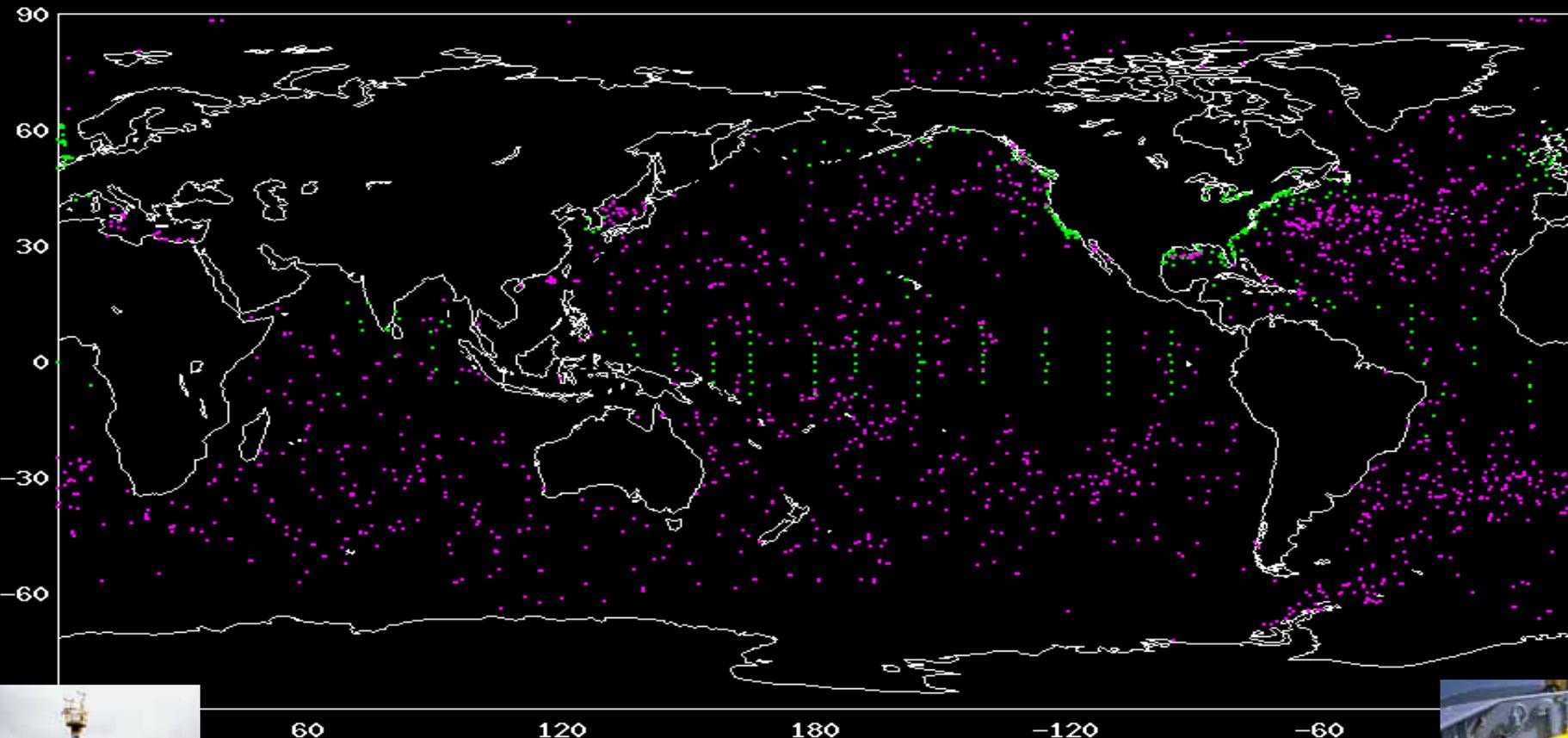
Buoy Observations



Buoy Coverage
2007050100 late

Fixed
count ----- 2178
locations --- 433

Drifting
count ----- 8114
locations --- 4366



UNCLASSIFIED

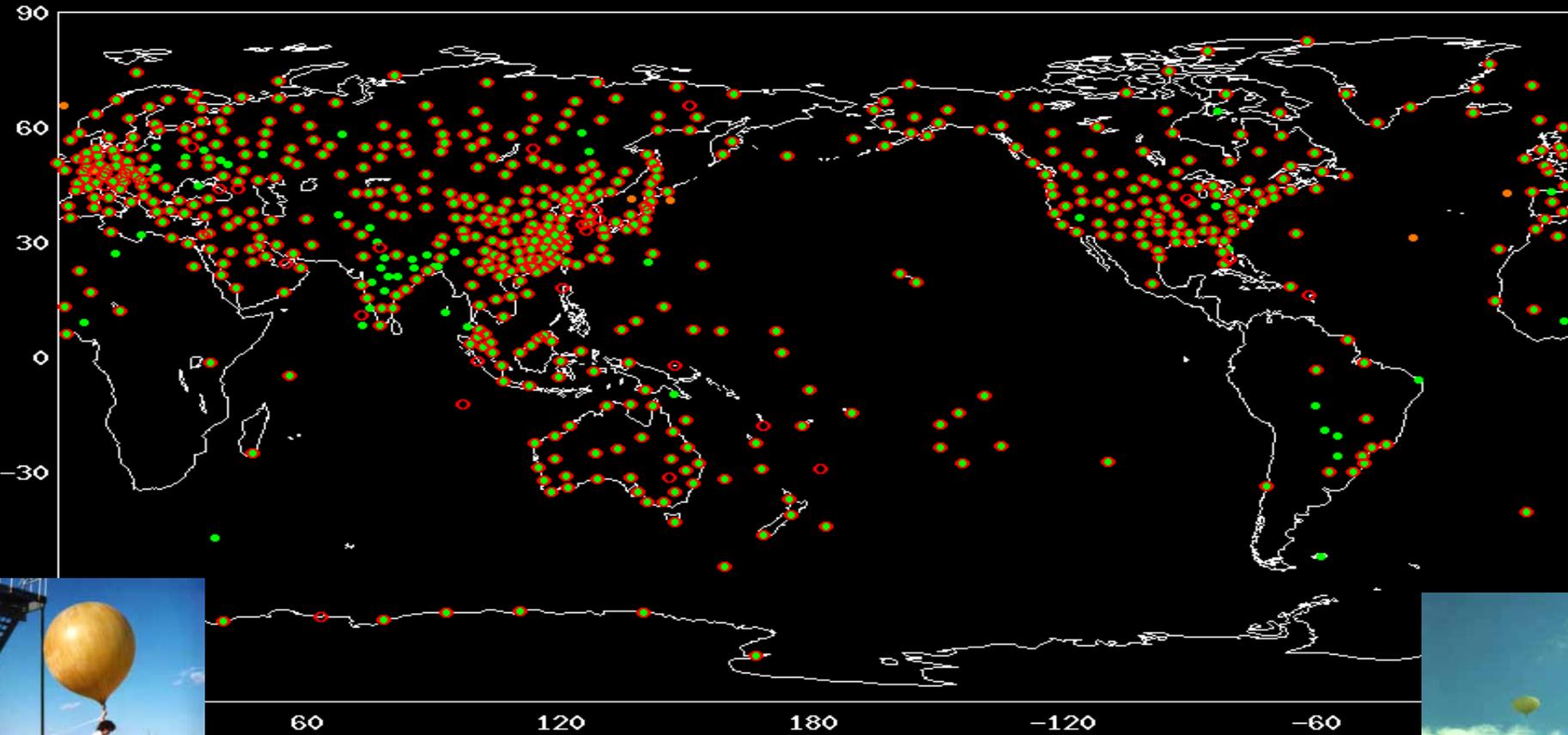


Radiosonde Observations



Raob Coverage
2007050100 late

Dropsonde		Ship		Land		75% Land, past 30 days	
count -----	0	count -----	6	count -----	618	count -----	588
locations ---	0	locations ---	6	locations ---	613	locations ---	588



UNCLASSIFIED

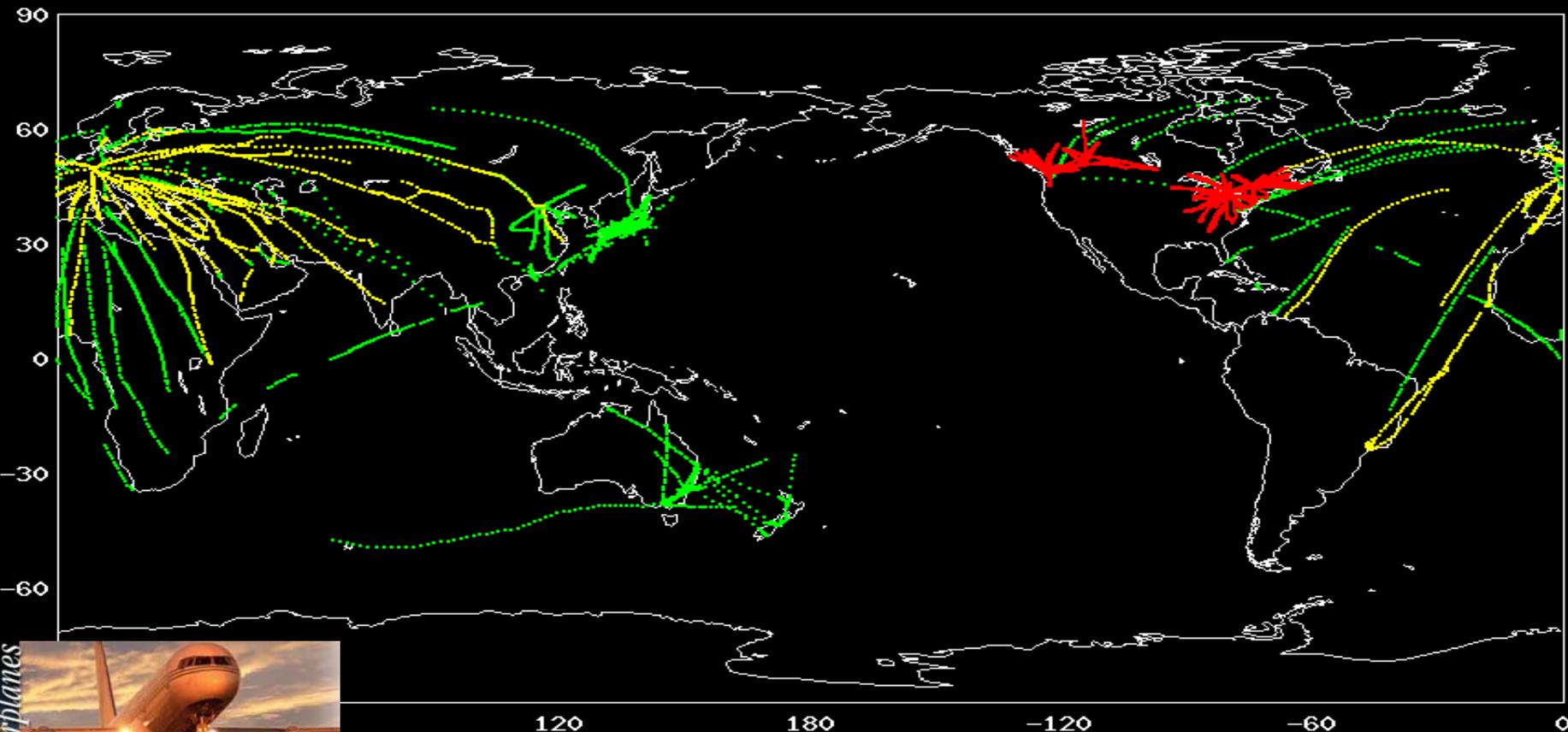


Aircraft Reports



AMDAR Coverage
2007050100 late

AMDAR	German AMDAR	Canadian AMDAR
count ----- 9234	count ----- 2923	count ----- 11459
locations --- 8107	locations --- 2733	locations --- 9925



UNCLASSIFIED



Satellite data coverage plots



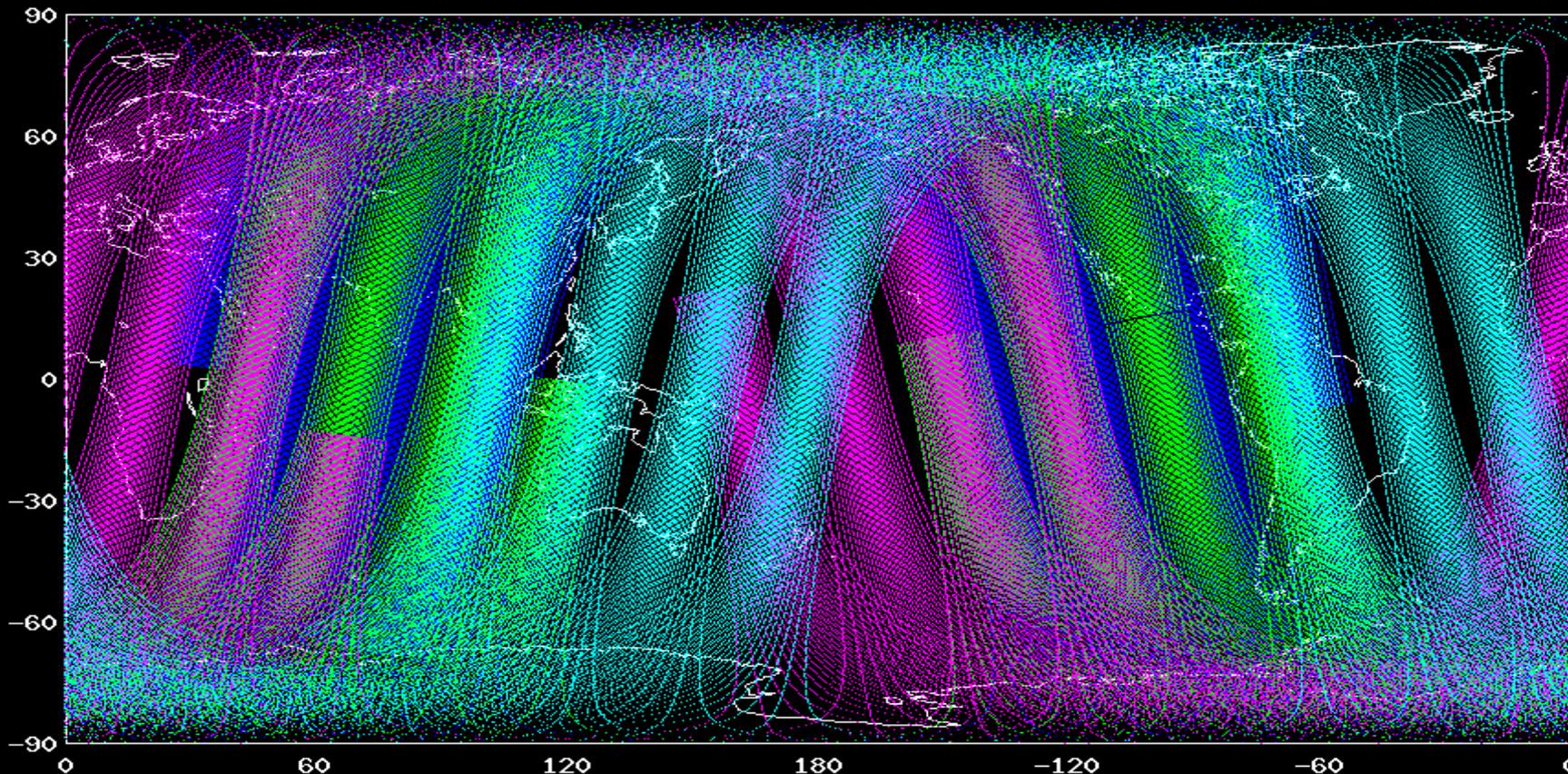


FNMOC AMSUA Polar Coverage

AMSUA Radiance Scan Locations Coverage
2008091200 late



NOAA 15		NOAA 16		NOAA 18		METOP-A	
count -----	82920	count -----	83820	count -----	84420	count -----	79380
locations ---	79976	locations ---	81055	locations ---	81032	locations ---	79117



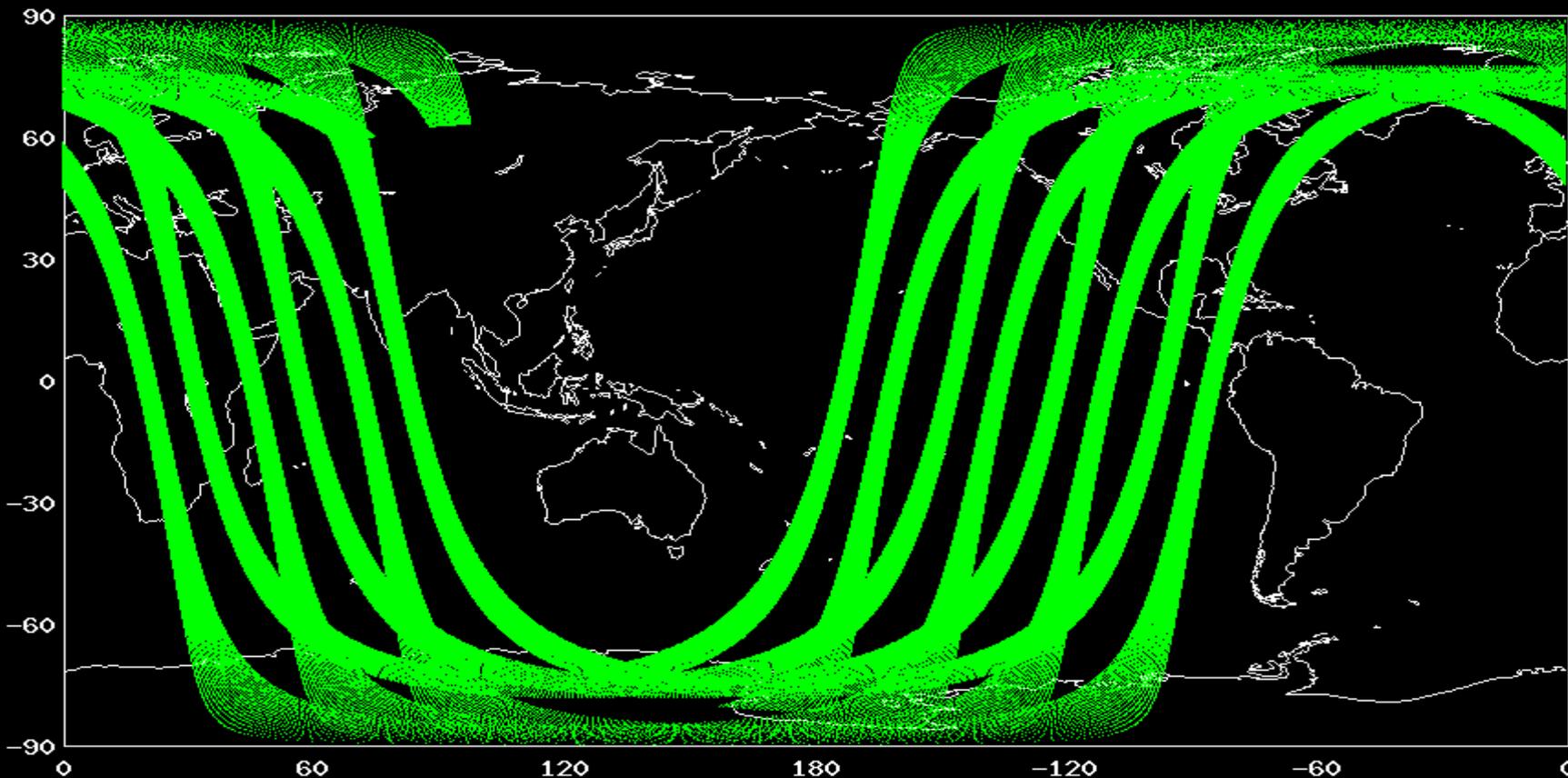
UNCLASSIFIED



FNMOC ASCAT METOP Polar Coverage

Advanced Scatterometer (MetOp) Coverage
2008090918 late

count ----- 241542
locations --- 241511



UNCLASSIFIED

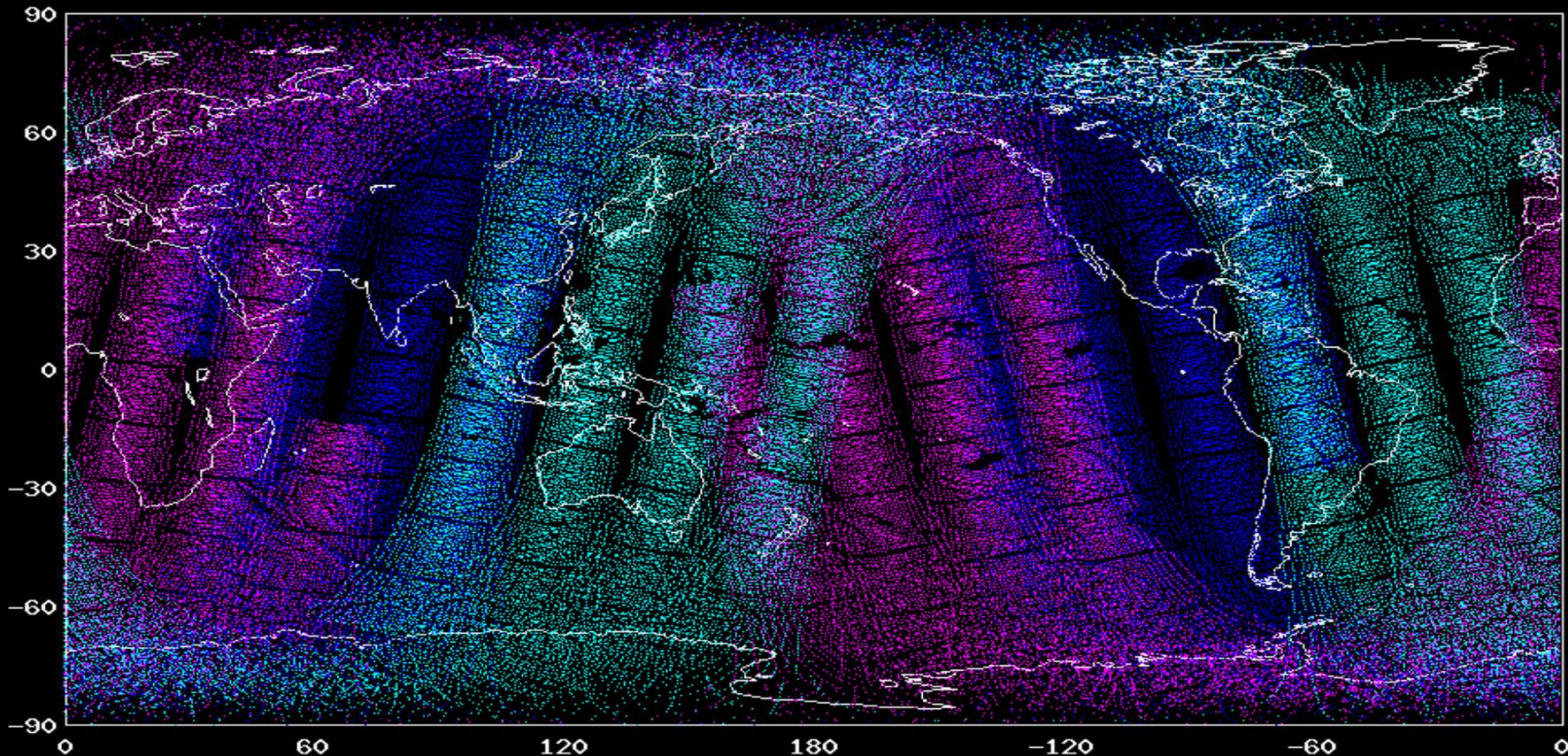


FNMOC ATOVS Polar Coverage



ATOVS Soundings Coverage
2008091200 late

ATOVS 15		ATOVS 16		ATOVS 18		METOP-A	
count -----	44297	count -----	0	count -----	44224	count -----	41971
locations ---	44297	locations ---	0	locations ---	44224	locations ---	41971



UNCLASSIFIED

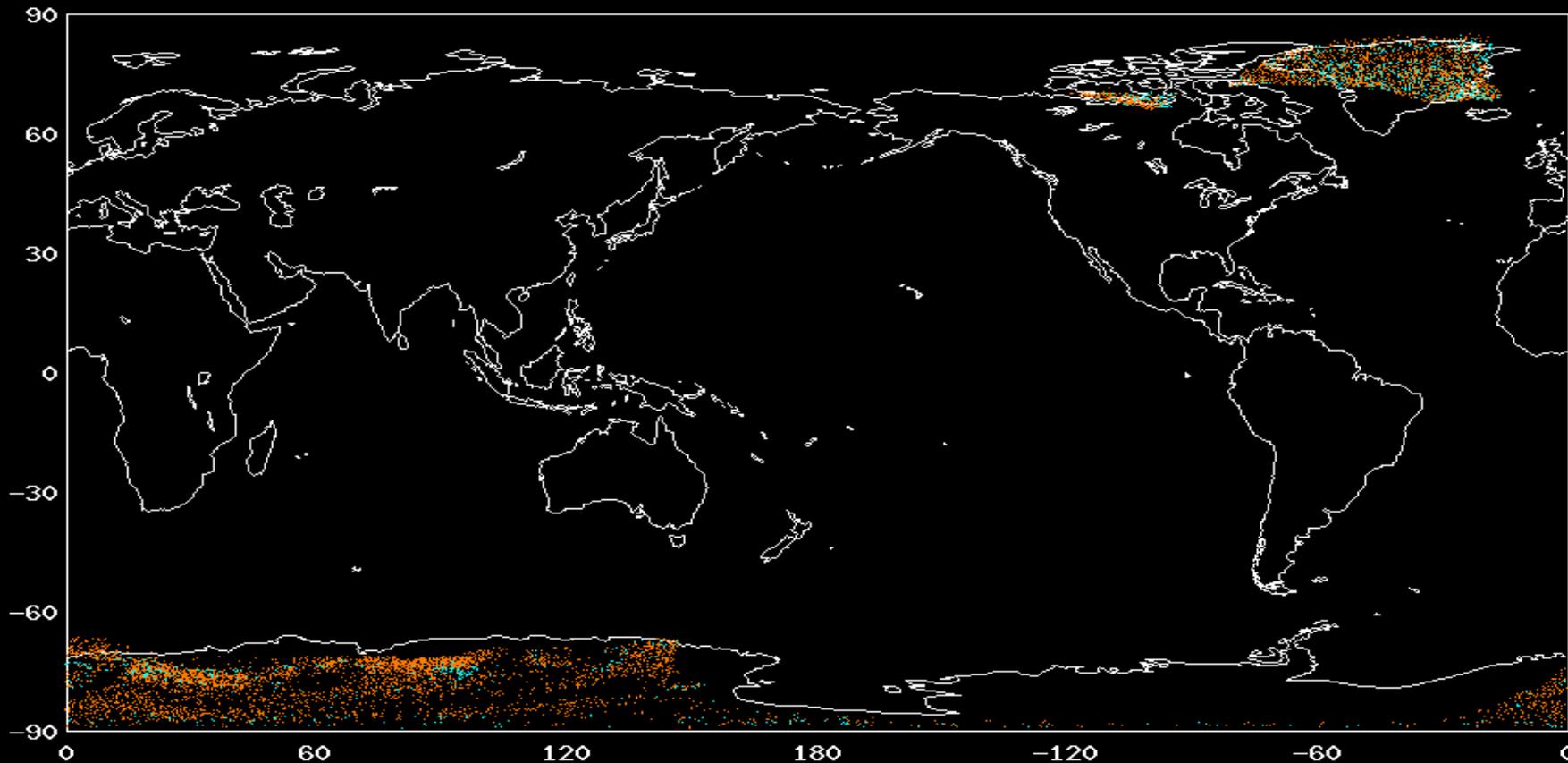


FNMOC MODIS Polar Feature Track Winds Coverage

MODIS, Satellite Feature Tracked Winds Coverage
2008091200 late



AQUA IR	TERRA IR	AQUA WV	TERRA WV
count ----- 0	count ----- 1656	count ----- 0	count ----- 5105
locations --- 0	locations --- 1653	locations --- 0	locations --- 5102



UNCLASSIFIED

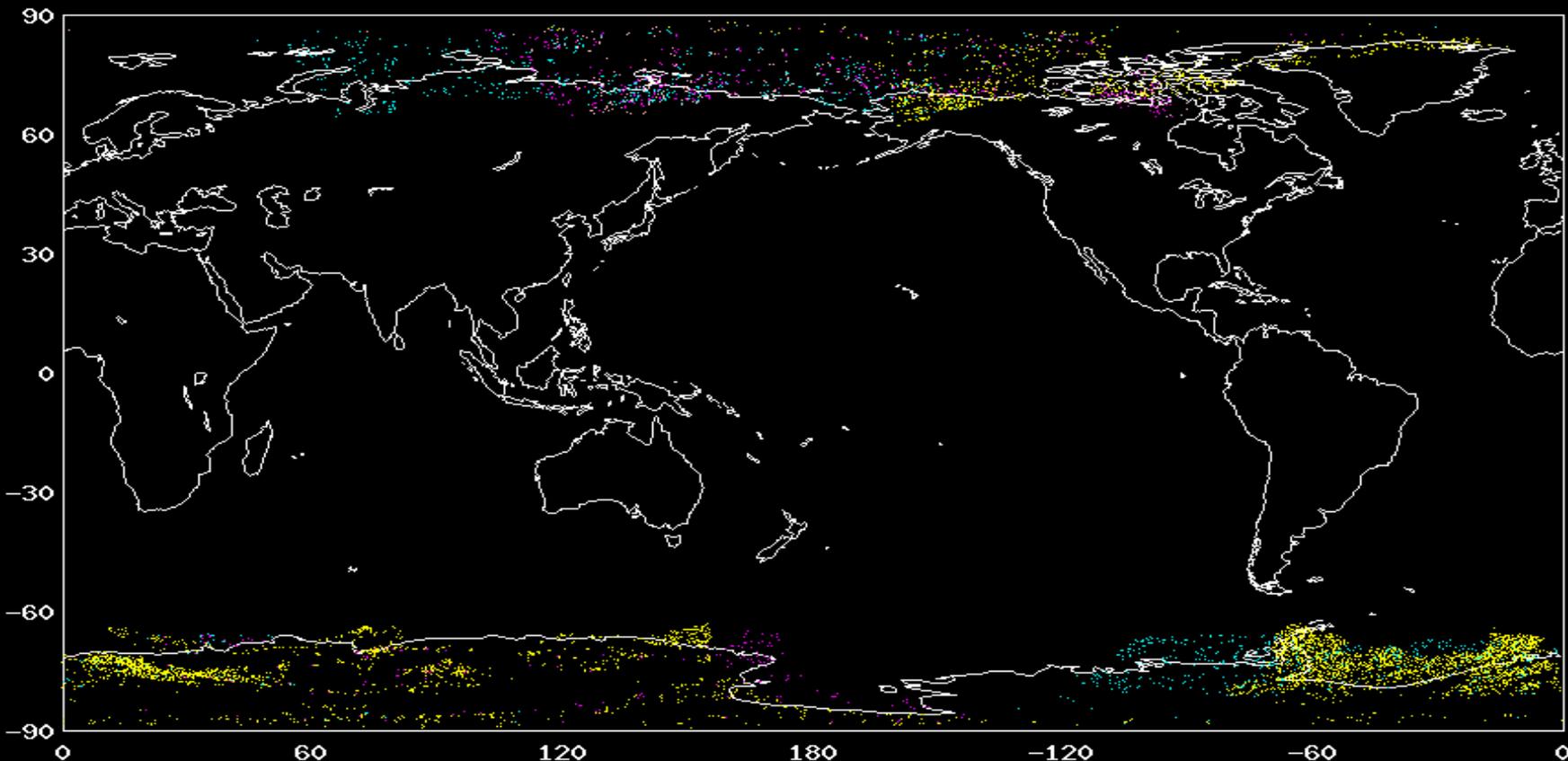


FNMOC AVHRR Polar Feature Track Winds

AVHRR, Satellite Feature Tracked Winds Coverage
2008091200 late



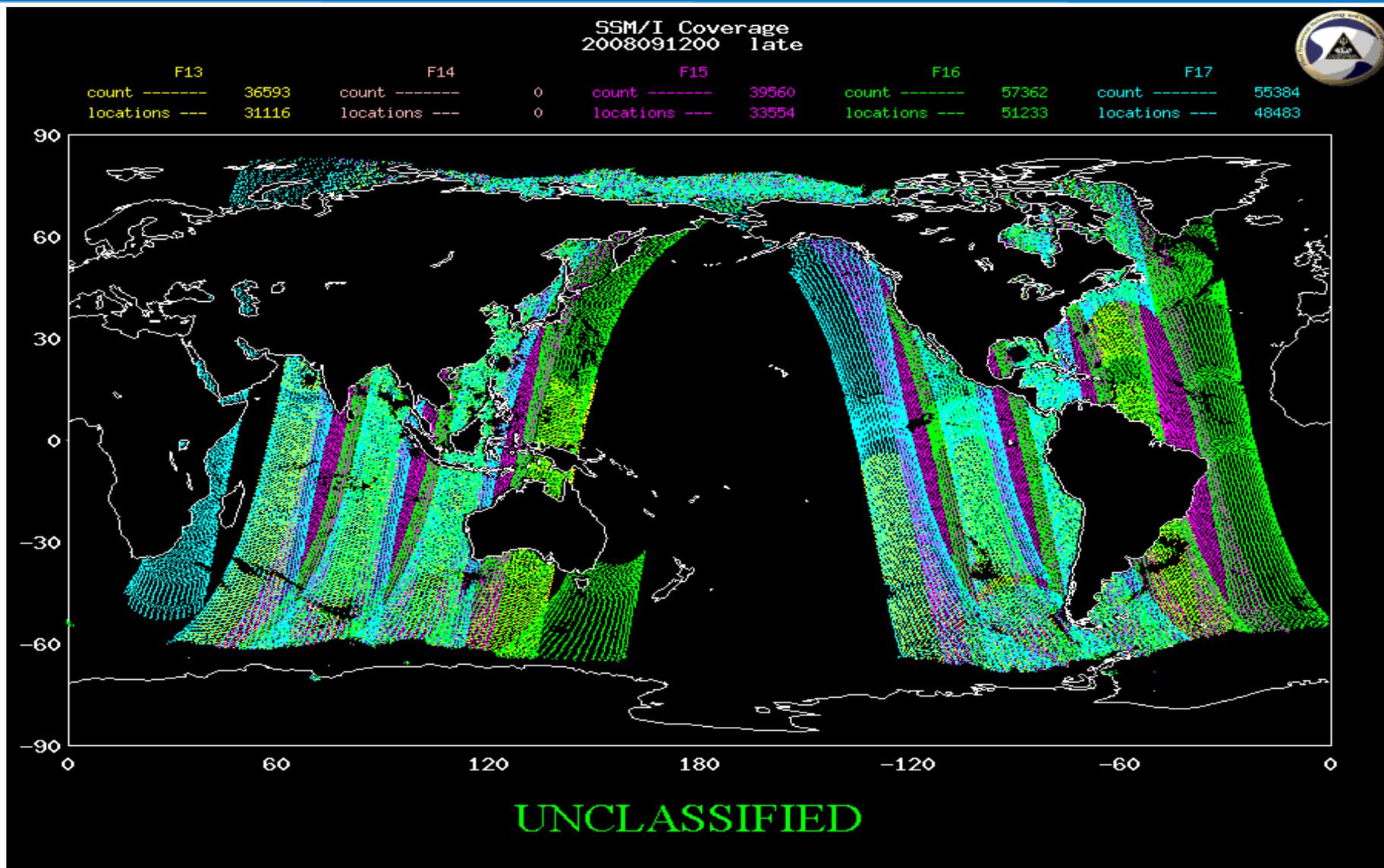
NOAA 15 IR	NOAA 16 IR	NOAA 17 IR	NOAA 18 IR	METOP IR
count ----- 391	count ----- 0	count ----- 616	count ----- 1127	count ----- 4221
locations --- 391	locations --- 0	locations --- 616	locations --- 1127	locations --- 4214



UNCLASSIFIED



FNMOC DMSP Polar SSMI/S Coverage



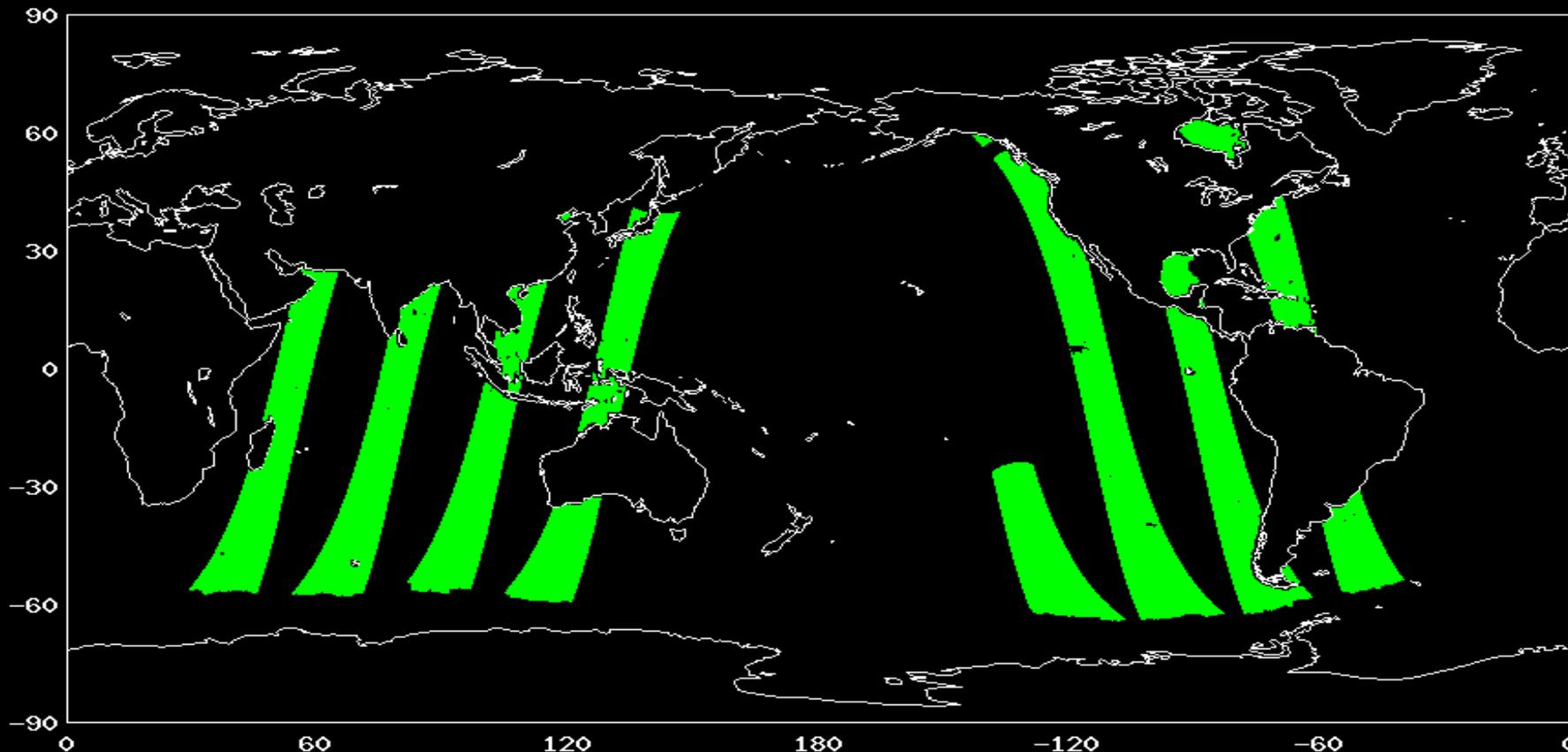


FNMOC WINDSAT Polar Wind and TPW Coverage



WindSat (Coriolis) Coverage
2008091200 late

count ----- 371385
locations --- 370304



UNCLASSIFIED

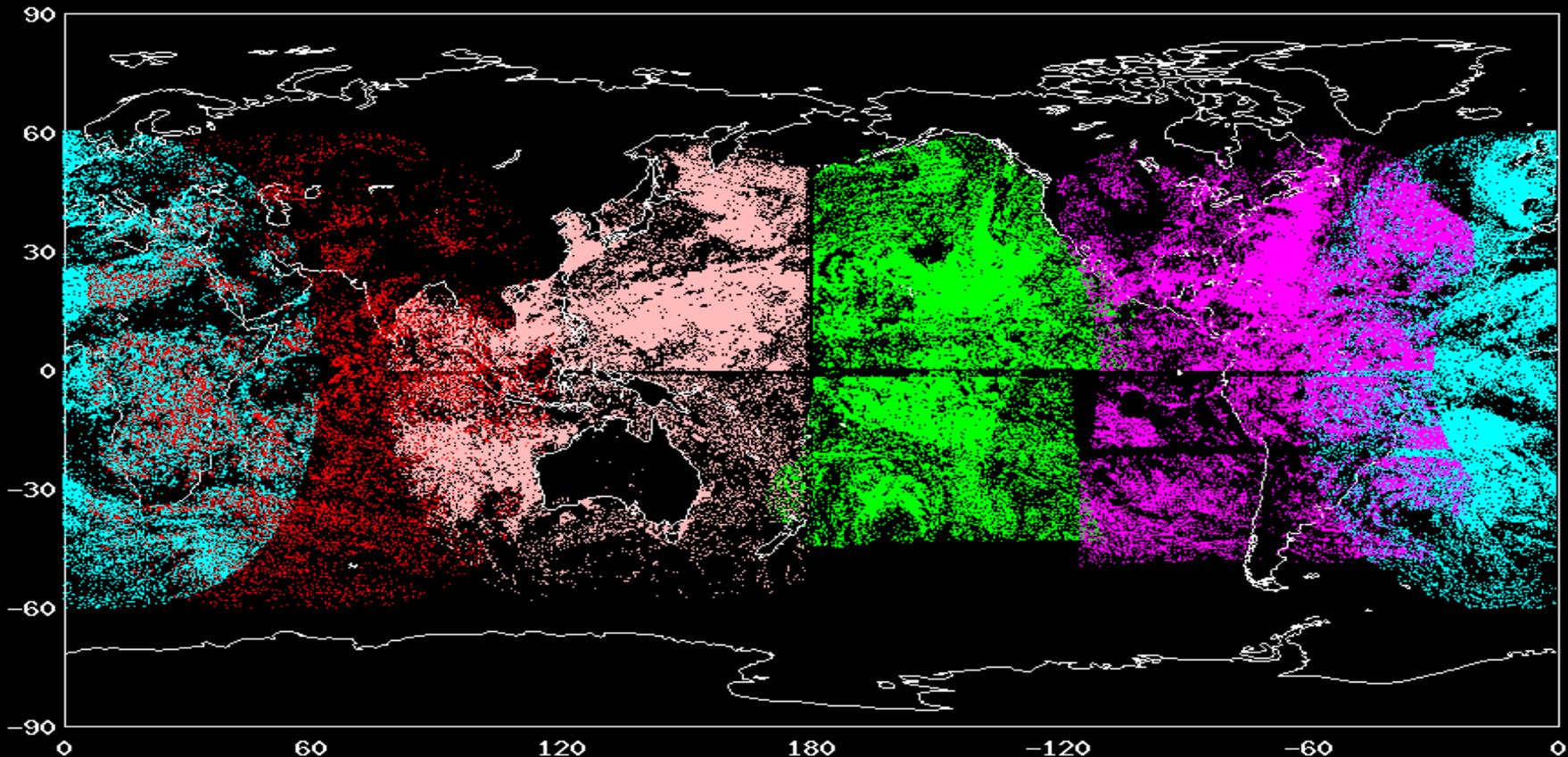


FNMOC Global Geostationary Coverage

CIMSS/Univ. of Wis., Satellite Feature Tracked Winds Coverage
2008112418 main



METEOSAT 9	METEOSAT 7	MTSAT-1R	GOES-11	GOES-12
count ----- 69068	count ----- 17916	count ----- 43335	count ----- 61032	count ----- 63300
locations --- 66205	locations --- 17425	locations --- 41773	locations --- 53742	locations --- 50504



UNCLASSIFIED



FNMOC Presentation Outline

- Data used and sources of data
 - Separator/decoder process
 - Data quality control and preparation
 - Coverage plots
- **Data assimilation and acquisition needs**
 - **Model input**
- Models and products we provide
 - Models overview
 - Tactical imagery
 - Satellite data we provide
 - FNMOC website
- Projects in progress





NOGAPS/NAVDAS-AR Data Types Assimilated

Conventional Data Types

Vertical Profilers

- Radiosondes
- Pibals
- Dropsondes

Buoys and Driftsonde (Concordiasi)

Land and Ship Surface Obs

Aircraft Obs

- AIREPS
- AMDAR
- MDCRS

RAW SATELLITE DATA

Radiances and Bending Angles Assimilation Requires Forward Models

Hyper-Spectral IR Sounding Radiances

- IASI and AIRS

MW Sounding Radiances

- 6 AMSU-A (Ch 4-14)
- 3 SSMIS (Ch 2-7, 9-11, 22-24)
- SSMIS/AMSU-B/MHS
183 GHz (Operational)

GPS-RO Bending Angle

- Cosmic: FM1 - FM6
- Grace, GRAS, TRSX,
CORISS, SAC-C

PRODUCTS

Surface Winds

- Scatterometer, ASCAT
- SSMI/SSMIS
- WindSat

Feature Tracked Winds

- Geostationary (6 satellites)
- Polar Orbiters (AVHRR and MODIS)
- Combined polar/geo winds (CIMSS)

Total Water Vapor

- SSMI/SSMIS TVAP
- WindSat TVAP

ATOVS Temperature Retrievals (COAMPS)



Satellite Data Used in NWP

* List is not all inclusive

- HIRS sounder radiances
- AMSU-A sounder radiances
- AMSU-B sounder radiances
- GOES sounder radiances
- GOES, Meteosat, MTSAT winds
- GOES precipitation rate
- SSMI /S precipitation rates (TPW)
- TRMM precipitation rates
- SSMI/S ocean surface wind speed
- SSMIS UPP (upper air sounder)
- AIRS
- MODIS Winds
- COSMIC
- ASCAT ocean surface wind vectors
- Windsat (TPW) and osw vectors
- AVHRR SST
- AVHRR vegetation fraction
- AVHRR surface type
- Multi-satellite snow cover
- Multi-satellite sea ice
- SBUV/2 ozone profile and total ozone
- Altimeter sea level obs (ocean data assimilation)
- IASI
- GRACE
- GRAS off METOP
- CHAMP
- MTSAT radiances
- MTSAT winds
- Meteosat radiances
- GOME ozone

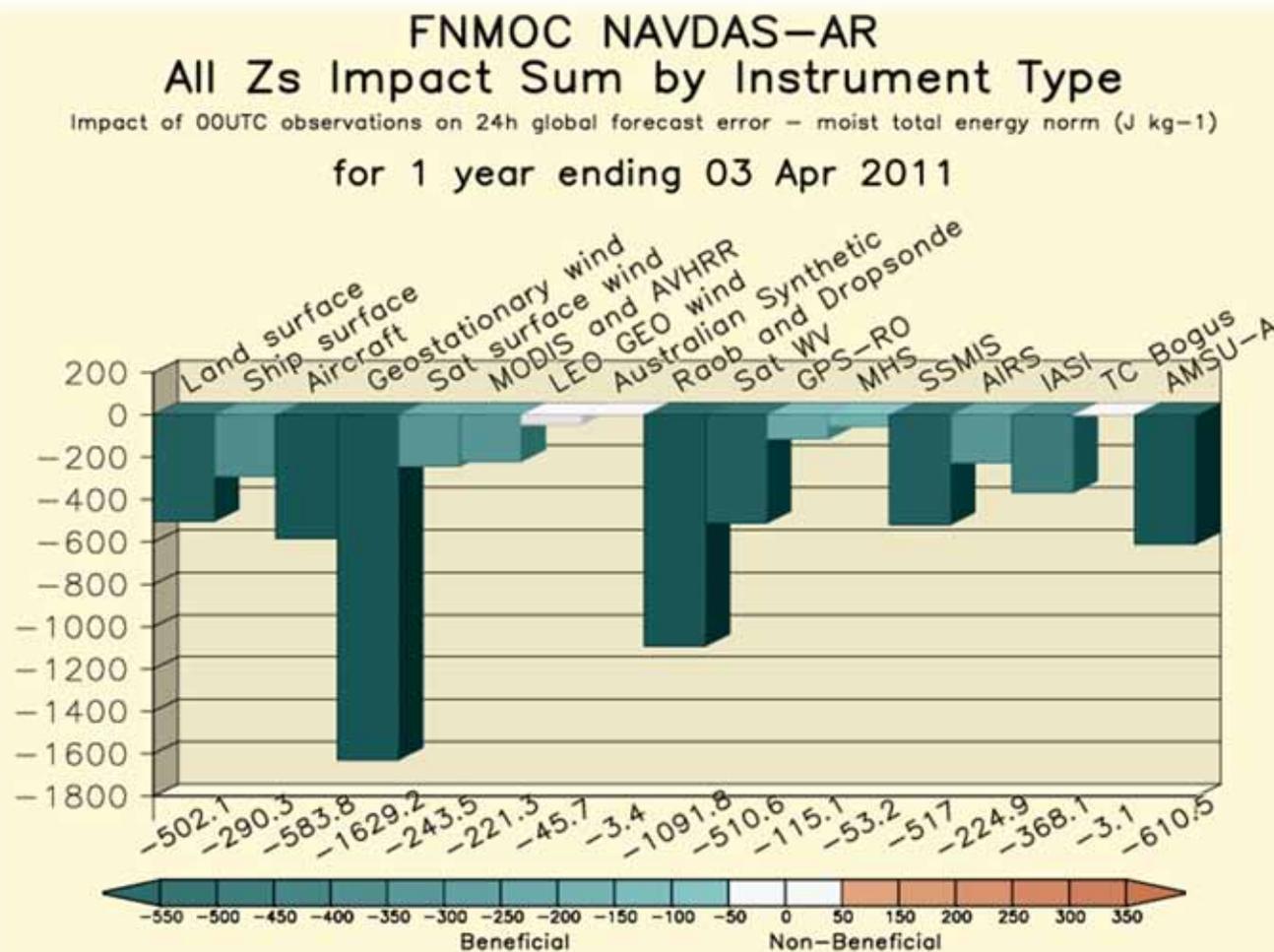
37 instruments used in US operational global NWP systems (NCEP &/or Navy)

5 additional instruments used in European global NWP systems (ECMWF &/or UKMO)



FNMOC NWP and Data Assimilation

Satellite data has become the single most important component of the global observing network for NWP.





Satellite Capabilities Needed

Navy NWP requires sensors that are sensitive to:

- Ozone (O_3)
- Sulfur Dioxide (SO_2)
- Liquid & Solid H_2O
- Humidity sensitive radiances (H_2O Vapor)
- Temperature
 - Sensitive to Carbon Dioxide (CO_2)
 - Sensitive to Oxygen (O_2)
- Sea Surface Temperature
- Sea-ice/ice-concentration
- Surface wind speed and direction
- Land surface information (such as soil type, soil moisture, & others)
- Total precipitable water (globally and at the mesoscale)
- Clouds

Designed to help models perform calculations using Radiative Transfer Model (RTM)
Help the FNMOC assimilation system fine-tune the values used by the model.

These satellite measurements will help improve the values of...



Model Parameters to be Targeted

- **Pressure/altitude at various vertical levels**
 - *Surface pressure*
 - *Geopotential (φ)*
 - *Various vertical pressure levels*
- **Virtual potential temperature (θ)**
 - *Implies knowledge of temperature at various vertical levels*
 - *Needs channels sensitive to temperature at different levels*
- **Specific humidity (q) at all vertical levels**
- **Diabatic forcing (Q_9)**
 - *Due to radiation*
 - *Due to latent heat release processes*
 - *Due to vertical mixing*
- **Horizontal winds to calculate vorticity and divergence**
 - *Wind speed/direction at various vertical levels*
 - *Need to determine the “u/v” components of wind*
 - *The ability to be more sensitive/accurate in determining the pressure level or altitude of the winds.*
- **Kinetic energy and vertical/horizontal fluxes of kinetic energy**
- **Potential energy and vertical/horizontal fluxes of potential energy**
- **Total precipitable water**



Model Parameters to be Targeted (cont'd)

Parameterizations are used to account for various physical phenomena in FNMOC NWP models. These Physical parameterizations include:

- Gravity wave drag due to mountain
- Vertical turbulent diffusion
- Shallow cumulus mixing
- Cumulus convection
- Large scale stable precipitation
- Heating due to longwave radiation
- Solar radiation
- Interaction between land and atmosphere (e.g. turbulent boundary layer)



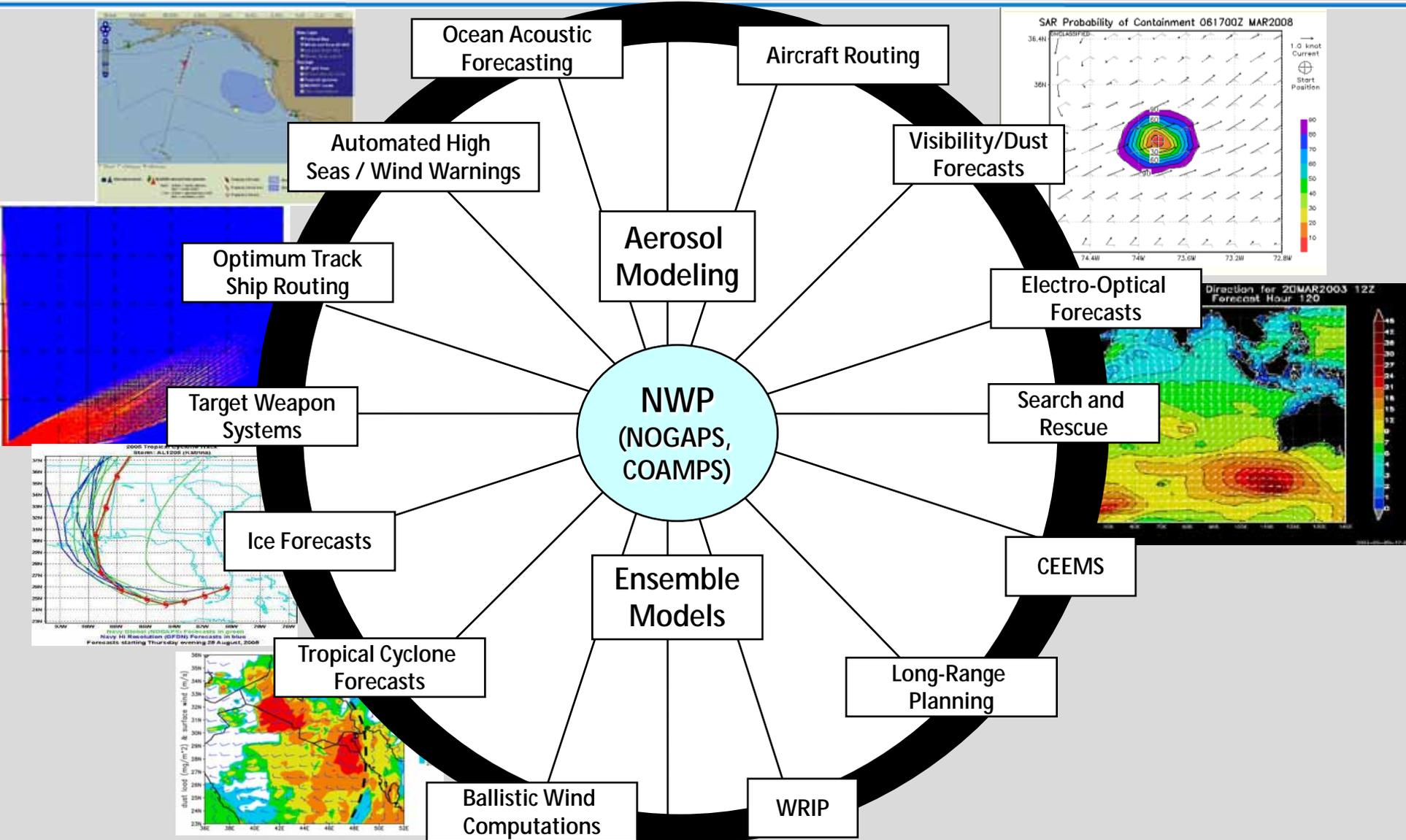
FNMOC Presentation Outline

- Data used and sources of data
 - Separator/decoder process
 - Data quality control and preparation
 - Coverage plots
- Data assimilation and acquisition needs
 - Model input
- **Models and products we provide**
 - Models overview
 - Tactical imagery
 - Satellite data we provide
 - FNMOC website
- Projects in progress





FNMOC Models and Applications





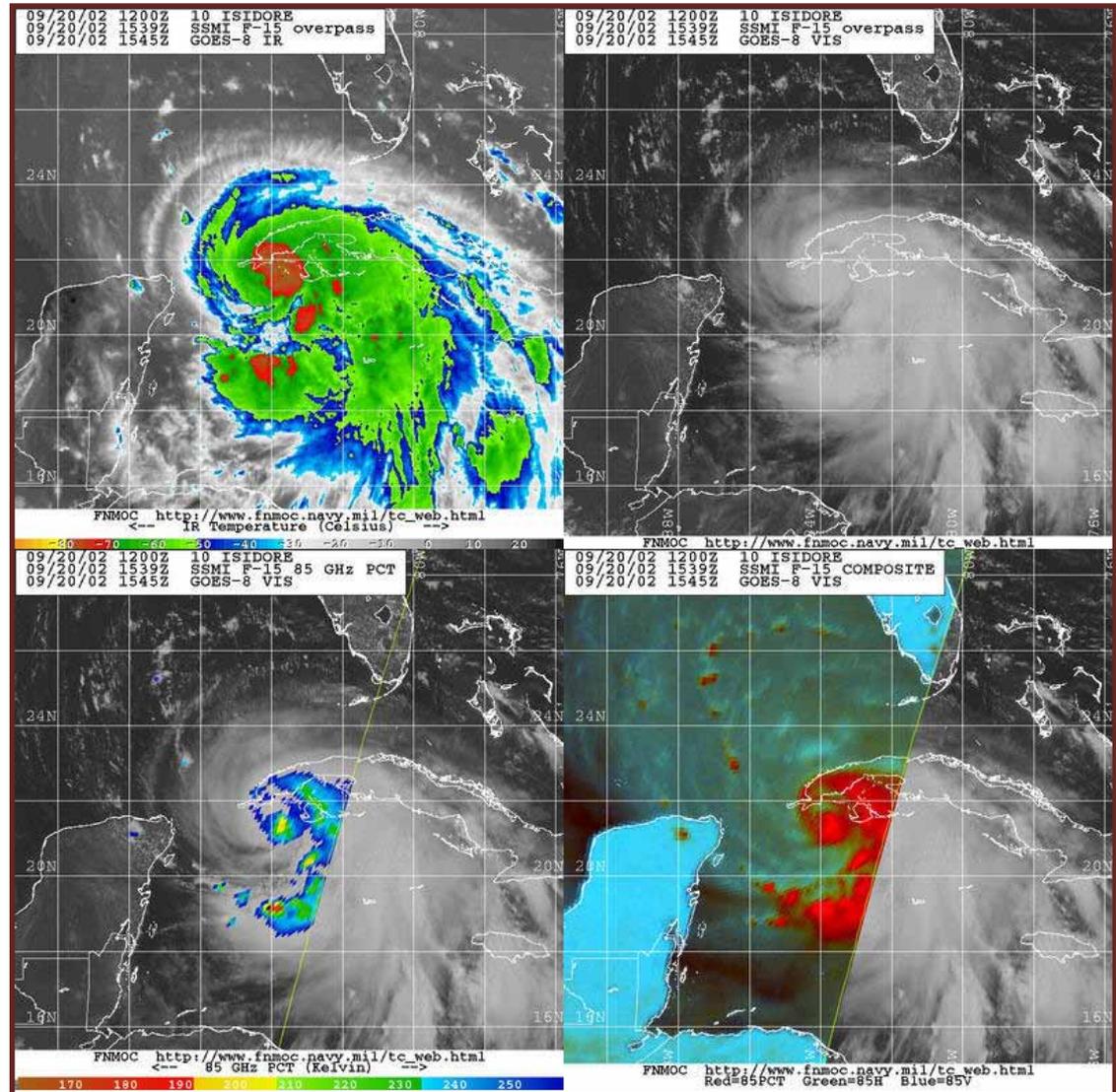
Models Overview

- NOGAPS – Navy Operational Global Atmospheric Prediction System; T319L42 global spectral model, at the center of FNMOC production.
- COAMPS-OS – Coupled Ocean/Atmosphere Mesoscale Prediction System; regional mesoscale model, multi-nested to < 1 km resolution within NOGAPS.
- NAVDAS-AR – Navy Atmospheric Variational Data Assimilation System – Accelerator Representer; 4D-VAR Weak Constraint global data assimilation for NOGAPS and COAMPS.
- GFDN – Navy implementation of the GFDL TC model; only moveable-nest TC model operational in all ocean basins (critical part of 4-member CONW for extended TC forecasts). Nested within NOGAPS.
- WW3 – WaveWatch III spectral ocean wave model; global and regional implementations, driven by NOGAPS and COAMPS.
- EFS – NOGAPS-based global 20-member 16-day Ensemble Forecast System (part of NAEFS and JEFS collaborations); includes 20-member global WW3 ensemble 10 days.
- NAAPS – Navy Atmospheric Aerosol Prediction System; only operational global aerosol assimilation system. Atmospheric optical properties output feeds Target Acquisition Weapons Software (TAWS). Driven by NOGAPS.



Tactical Imagery: Tropical Cyclone Web Page (TCWeb)

- Multi sensor , data and imagery fusion
 - Aids JTWC and NHC forecasters and analysts in determining more accurate storm positions and intensities
 - Available to the public
 - u.l. – GOES IR (color enhance)
 - u.r. –GOES VIS
 - l.l. - SSMI PCT/ GOES VIS
 - l.r. – SSMI Composite/ GOES VIS
- New data types include AMSR-E, MSG, AQUA, TERRA, ASCAT, WINDSAT, SSMIS





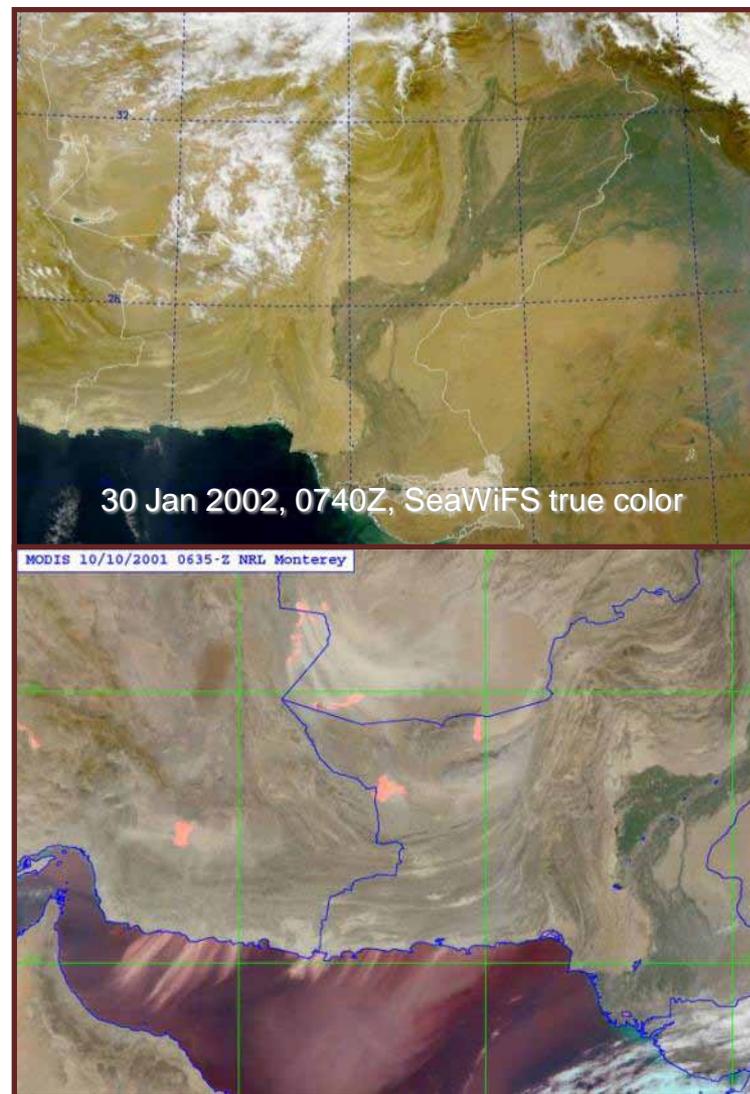
Satellite Products Available on FNMOC TC Web Page

Satellite Instrument	Products
<u>Geostationary:</u> GOES-11/13, Meteosat-7/9, MTSAT-2	Visible, Infrared
WindSat	37h, 37v, Wind Vectors.
ASCAT	Wind Vectors: w/ NCEP model, w/o model, ambiguities.
MODIS	IR, VIS, Water Vapor
AMSU – Advanced Microwave Sounding Unit	89 GHz T _B , 89 GHz Color, Rain Rate
TMI – TRMM Microwave Imager SSM/I – Special Sensor Microwave Imager	Multi-sensor, 85 GHz T _B , 85 GHz PCT, 85 GHz Color, Rain rate, Wind Speed, 37H GHz T _B , 37V GHz T _B , 37 GHz Color, 37 GHz PCT, Vapor (SSM/I), Cloud Liquid Water (TMI)
SSMIS– Special Sensor Microwave Imager Sounder	Multi-sensor, 91 GHz T _B , 91 GHz PCT, 89 GHz Color, Rain rate, Wind Speed, 36H GHz T _B , 36V GHz T _B , 36 GHz Color, 36 GHz PCT, Vapor
AMSRE – Advanced Microwave Sounding Radiometer	Multi-sensor, 89 GHz T _B , 89 GHz PCT, 89 GHz Color, 36H GHz T _B , 36V GHz T _B , 36 GHz Color



Tactical Imagery: SIPRNET Satellite Focus

- FNMOC presentation of operational satellite products
- In response to user request, region specific
 - Arabian Sea, Afghanistan, Persian Gulf
 - Where next?
- MODIS true color/dust enhancement, feature tracking winds
- New products – low cloud over snow, low clouds at night, convective cloud top heights
- MODIS dust enhancement over the Northern Arabian Sea, true color over land. Dust over the ocean appears as shades of pink. Dry lakebeds over land (often representing sources of dust) are also indicated in pink.
- Horizontal resolution of the data is 0.5 km.





Satellite Data Provided

- DMSP SSMI/S Temperature Data Records (TDRs)
- DMSP SSMI/S Sensor Data Records (SDRs)
- DMSP SSMI/S Environmental Data Records (EDRs)

- DMSP SSMIS UPP Radiance data both in raw and BUFR

- WINDSAT xDRs in raw format



FNMOC Website: <http://www.fnmoc.navy.mil>

The Fleet Numerical Meteorology and Oceanography Center (FNMOC) — Naval Oceanography Portal - Microsoft Internet Explorer provi

http://www.usno.navy.mil/FNMOC/

File Edit View Favorites Tools Help

The Fleet Numerical Meteorology and Oceanography ...

Accessibility Help/ Contact

Naval Oceanography Portal

Search Site

only in current section

Home Time Earth Orientation Astronomy Meteorology Oceanography Ice

You are here: Home → FNMOC

**FNMOC**

- Meteorology Products
- Oceanography Products
- Tropical Applications
- Climatology and Archived Data
- Southern Partnership Station 2010 Support

The Fleet Numerical Meteorology and Oceanography Center (FNMOC)

The Fleet Numerical Meteorology and Oceanography Center (FNMOC) provides the highest quality, most relevant and timely worldwide meteorology and oceanography support to U.S. and coalition forces from its Operations Center in Monterey, California.

- Meteorology Products**

This area provides Global & Regional Weather Prediction Charts (WXMAP) and Global Ensemble Weather Prediction Charts (EFS). WXMAP depictions of NCEP global NWP model (GFS) predictions for side-by-side comparison with NOGAPS are also available.
- Oceanography Products**

This area provides Global & Regional Ocean Wave Prediction Charts (WW3), Global Ensemble Ocean Wave Prediction Charts (WW3 Ensemble), and Global Sea Surface Temperature and Sea Surface Temperature Anomaly Charts (NCODA).
- Tropical Applications**

This area provides links to satellite imagery of tropical cyclones (TCWEB) and current tropical storm forecast tracks.
- Climatology & Archived Data**

This area provides links to the Global Ocean Data Assimilation Experiment (GODAE) for climatological products.

USNO Master Clock Time

Wed, 7 Sep 2011 19:51:34 UTC

The Sky This Week

The Sky This Week, 2011
September 6 - 13

More...

Tropical Warning Information

Hurricane 12L (KATIA) Warning #38
Wed, Sep 07, 2011

Tropical Storm 14L (MARIA) Warning #04
Wed, Sep 07, 2011

Tropical Storm 17W (Kulap) Warning #02

More...



FNMOC Presentation Outline

- Data used and sources of data
 - Separator/decoder process
 - Data quality control and preparation
 - Coverage plots
- Data assimilation and acquisition needs
 - Model input
- Models and products we provide
 - Models overview
 - Tactical imagery
 - Satellite data we provide
 - FNMOC website
- **Projects in progress**





Data Acquisition Work in Progress...

- A. Conventional Observations New Data Types
 - a. UAVs/GLIDERS - (Unmanned Aerial/Oceanographic Vehicles) - NAVO
 - b. Navy AMDARS - (Reporting Systems for Broad Area Maritime Surveillance (BAMS) Unmanned Aircraft Systems and new P8 aircraft - CNMOC
 - c. European AMDARS - Aircraft Meteorological Data Relay System - AFWA
 - d. J-OBS - (Joint Observations Submission) – web based
 - e. RRS - (Radiosonde Replacement System) GPS based - NWS TOC
 - f. NSW Directorate Iridium Wave Buoys/Atmospheric Sensors - CNMOC
 - g. Weather Extractor Computer - LBSF&I Volumetric Radar scans from the SHIP to SHORE - Communication SFTP IA constraints - SPAWAR
- B. Transition of ATOS2C functionalities to Ruby
- C. Elimination of WMO ASCII message form replacement with BUFR reports
 - Issues:
 - JPSS/DWSS program cuts, 3rd satellite, DQM functionality, McMurdo METOP, IDPS Linux trade study, future O&S costs and POM14.



Satellite Work in Progress...

New Satellite Data Types

- a. METOP – 3rd polar satellite in the JPSS/DWSS constellation (McMurdo)
- b. NOAA - IJPS follow on with METOP C,D,E program
- c. MODIS, AIRS, IASI, ASCAT, AVHRR 1km – NESDIS via DATMS-U
 - Issue: Bandwidth upgraded completed to 28 mbps.
- d. DMSP F19 – Launch TBD, DMSP SLEP program, DWSS program starting.
- e. DMSP F19/20 – UPP data for NWP, cal/val going, DWSS requirements planning
- e. Altimetry – Jason1/2/Envisat wave height and sea surface height, prepare for GFO-2

Satellite Programs

- a. Defense Meteorological Satellite Program – SSMI/S Cal/Val Team
 - Integrating DMSP ingest upgrade for continued real time backup
- b. WindSAT – NRL DC Risk Reduction for former JPSS and current DWSS MIS sensor
- c. Joint Polar Satellite System (JPSS) P.M. afternoon satellite and Common Ground System (CGS) with DWSS A.M. morning satellite sensor and C3 IDPS coordination
 - Issues: Facilities, DQM/E, NOGAPS/NAAPS ancillary data source, IDPS Linux trade study for O&S.
 - NPP data access and POM14 alignment, IDPS Installation Dates
- d. FMO-17 and CNMOC Satellite CONOPS planning



Fleet Numerical Meteorology & Oceanography Center

Thank you