



Operational Environmental Satellites in the era of Big Data: Progress Report for 2012 and beyond

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My Discussion Outline

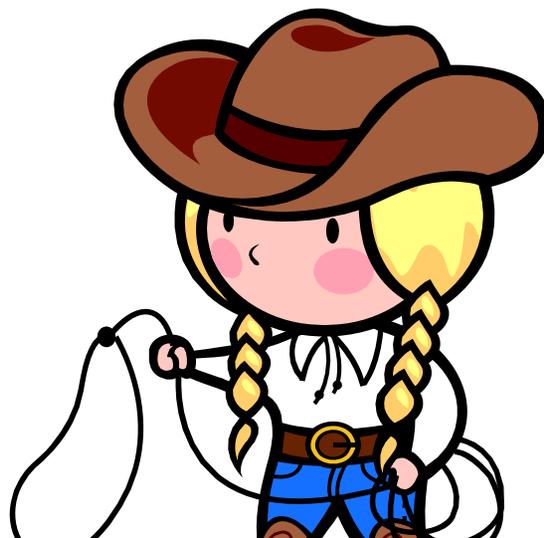
Overview of Current and Future Data Processing, Access, Distribution, and Archiving of Environmental Satellite Data

Current and expected satellite data volumes for numerical predictions

Big Data? How best to process the amounts of data that are coming through?

Contact Information

Questions?



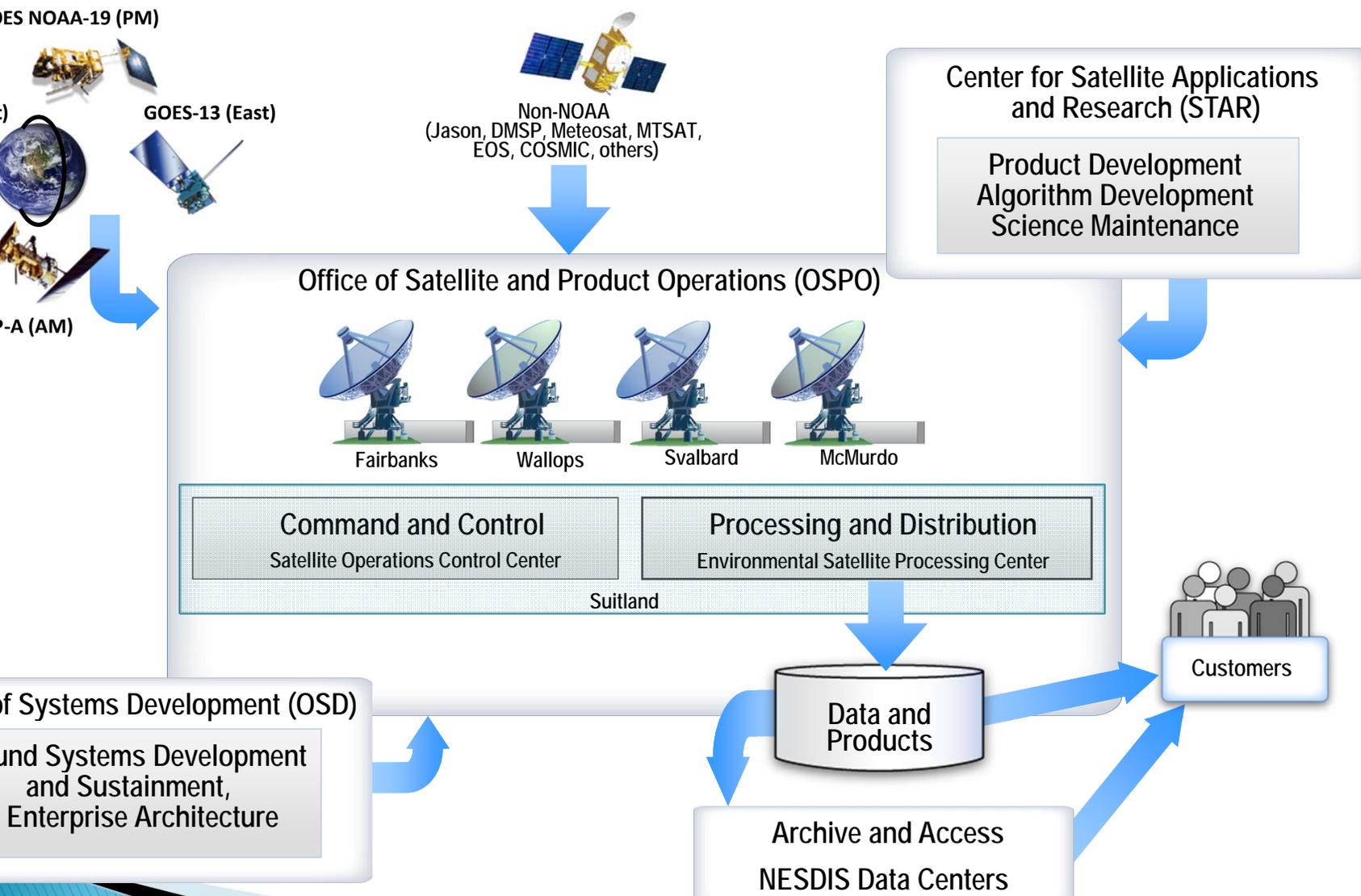
NOAA Satellite and Information Service: National Environmental Satellite, Data, and Information Service (NESDIS)

NESDIS Office of Satellite and Product Operations (OSPO) Key Roles

Ground System Command & Control, Ingest, Product Generation and Distribution for the nation's **19** environmental satellites

- 4 Geostationary (GOES) by NOAA
- 5 Polar-Orbiting (POES) by NOAA
- 2 MetOp Polar-orbiting Joint EUMETSAT and NOAA
- 6 Defense Meteorological Satellite Program (DMSP) operated by NOAA
- 1 OSTM Jason-2 (Ocean Surface Topography Mission) Joint NOAA, NASA, CNES, EUMETSAT effort
- 1 Suomi National Polar-orbiting Partnership (S-NPP) by NOAA & NASA

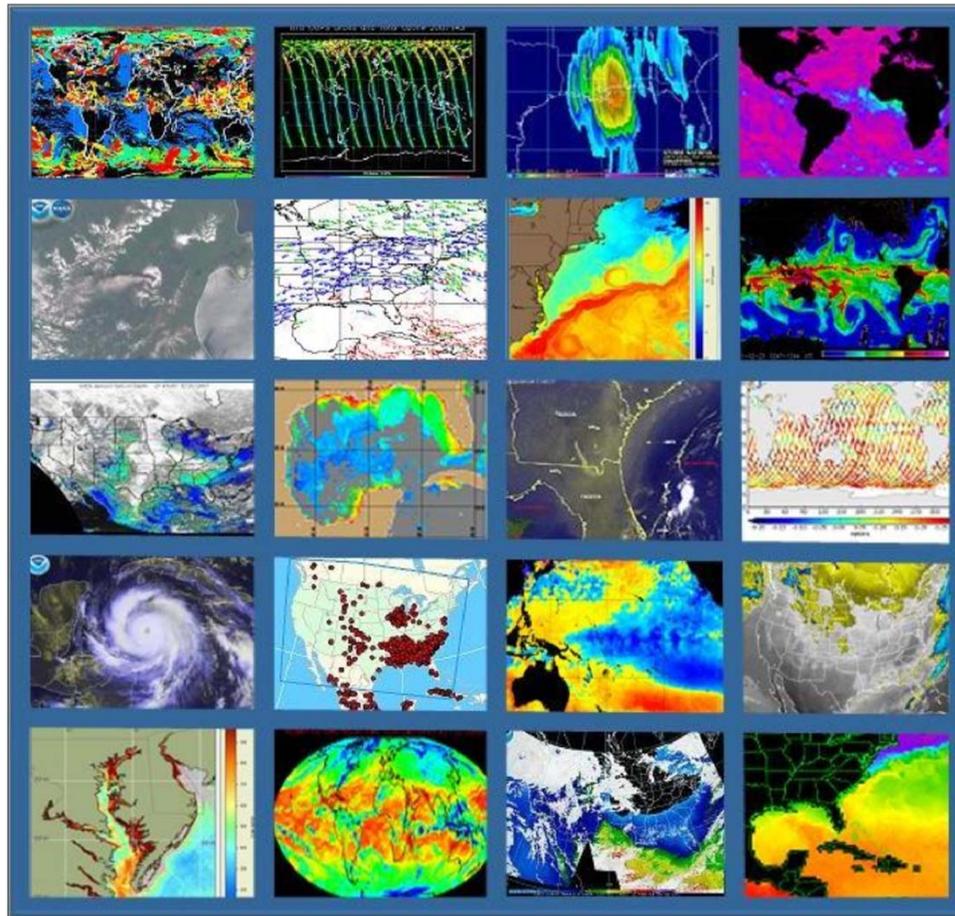
Satellite Information Flow



NOAA Satellite and Information Service: National Environmental Satellite, Data, and Information Service (NESDIS)

Products (Derived & Interpretive)

Atmospheric Chemistry
Atmospheric Temperature/Moisture
and Smoke
Hurricane Intensity and Position
Imagery (e.g. Visible, IR, WV)
Ice Cover – Ice, Snow, Vegetation
Sea Surface Temperature in Color
Satellite Derived Winds (WS,WD,H)
Sea Surface Height & Temperature
Vertical Profiles and Imagery
Weather
Volcanic Ash and many more...



12:

Requests for New Products

Promotions of New or Enhanced Products

NOAA Satellite and Information Service: National Environmental Satellite, Data, and Information Service (NESDIS)

Data Access Services

Current Access Services

Data Distribution Service – sFTP push/pull from secure accounts

NOAA Telecommunications Gateway – in BUFR (Binary Universal Format)

NOAA INI (GOES Ingest and NOAAPORT Interface) / NOAAPORT for Advanced Weather Interactive Processing System

NOAA ATEPSDIST – GOES, POES, and Derived Products

Direct Broadcast – GVAR (GOES Variable), LRIT (Low Rate Information Transmission), EMWIN (Emergency Managers Weather Information Network), DCS (Data Collection System), Argos, SARSAT (Search and Rescue Satellite Aided Tracking), Geonetcast

Web portals, direct connections

Consolidation of Future Access Services

Product Distribution and Access (PDA) and Suomi NPP Data Exploitation

NOAA (NCEP/NCAR) data and products

NOAA

NOAA ODC, NGDC, and NCDC archive data products using CLASS



NOAA Satellite and Information Service: National Environmental Satellite, Data, and Information Service (NESDIS)

User Community Data Access

Weather Service (NWS)

via N-AWIPS, AWIPS, Direct Broadcast, sFTP, Internet, direct connections, ADDE (Abstract Data Distribution Environment)

Ocean Service (NOS)

via Internet and sFTP (secure File Transfer Protocol)

Marine Fisheries Service (NMFS)

via Internet and sFTP

DoD, DoI, DoT, USDA, EPA, NASA, FEMA, NTSB, USGS, USFS

via Shared Processing (DAPE), Internet, sFTP, Direct Broadcast, NOAAPORT, ADDE

International EUMETSAT, ECMWF, UKMET, JMA, KMA, CNES, ESA, ISRO, CMA, NPSO, CSA

via Direct Broadcast, Internet, direct connections, ADDE

Industry Forecasters, Airlines, Research Organizations

via Direct Broadcast, NOAAPORT, Internet, ADDE

Universities and Cooperative Institutes

via Direct Broadcast, NOAAPORT, Internet, Internet2, ADDE

via Direct Broadcast, NOAAPORT, GeoNetCast

Public Public demand for GOES imagery during a land falling hurricane can be as high as 300 million web site "hits" per week, and over 10 Tb of data

via Internet, ADDE (with approved Data Access Request or via anonymous FTP servers or via McIDAS-V)

NOAA Satellite and Information Service: National Environmental Satellite, Data, and Information Service (NESDIS)

Data Access & Distribution Policy

Contact: NESDIS.data.access@noaa.gov

To consistently vet user requests for near real-time satellite data and products based on organizational affiliation or type of application

To effectively manage **data distribution resources** to ensure effective system performance

To be in compliance with policy, procedures and required **interconnection agreements** with NIST/DOC IT security regulations

To factor ESPC **IT system planning** and future distribution resource availability and capacity needs into data access decisions

NOAA Satellite and Information Service: National Environmental Satellite, Data, and Information Service (NESDIS)

CLASS: the Comprehensive Large Array-data Stewardship System

CLASS web access is www.class.noaa.gov

Normal searches allow users to see file listing, review granule metadata and any browse files and to choose which files to order

Quick Searches allow users to place large orders of consecutive files by skipping the inventory listing and associated metadata

Users can request “block order” access to order even greater volumes of data. Please submit request via the CLASS Help Desk . **Subscriptions near real-time data offered.**

To access high volumes of Suomi-NPP global datasets (SDRs and EDRs) users can go directly to the FTP server to retrieve the most recent 3 months. Data are compressed and tarred by datatypes.

- The ftp address is: <ftp://ftp-npp.class.ngdc.noaa.gov>

CLASS Help Desk: class_help@noaa.gov

NOAA Satellite and Information Service: National Environmental Satellite, Data, and Information Service (NESDIS)

NCEP: the NWS National Centers for Environmental Prediction

Virtually all the meteorological data collected over the globe arrives at NCEP, where environmental scientists analyze this information and generate a wide variety of environmental guidance information.

NCEP delivers national and global weather, water, climate and space weather guidance, forecasts, warnings and analyses to a broad range of users and partners

NCEP Central Operations (NCO) sustains and executes the operational suite of numerical analyses and forecast models and prepares NCEP products for dissemination.

NOAA Satellite and Information Service: National Environmental Satellite, Data, and Information Service (NESDIS)

Bridge Contract

Current NOAA Weather and Climate Operational Supercomputer System

ion

ary

Gaithersburg, MD (IBM provided facility)

up

Fairmont, WV (GFE NASA IV&V facility)

Configuration

IBM Power Systems (per site)

IBM Power 6/P575/AIX

3.9 trillion calculations/sec

3,314 processing cores

0.8 petabytes of storage

Performance Requirements

Minimum 99.0% Operational Use Time

Minimum 99.0% On-time Product Generation

Minimum 99.0% Development Use Time

Minimum 99.0% System Availability

Failover tested regularly

Inputs and Outputs

Processes 3.5 billion observations/day

Produces over 15 million products/day

Significance

Where our Nation's weather forecast process starts for the protection of lives and livelihood

Produces model guidance at global, national, and regional scales

Examples:

- Hurricane Forecasts
- Aviation / Transportation
- Air Quality
- Fire Weather

Contract ensures no gap in operations



NOAA Satellite and Information Service: National Environmental Satellite, Data, and Information Service (NESDIS)

WCROSS Contract

Structure NOAA Weather and Climate Operational Supercomputer System

Location

Reston, VA (IBM provided facility)

Orlando, FL (IBM provided facility)

Configuration

IBM iDataPlex/Intel Sandy Bridge/Linux

208 trillion calculations/sec

10,048 processing cores

2.59 petabytes of storage

Performance Requirements

Minimum 99.9% Operational Use Time

Minimum 99.0% On-time Product Generation

Minimum 99.0% Development Use Time

Minimum 99.0% System Availability

Failover tested regularly



Operational Model Data Ingest

global suite of environmental data is input into models
Observations are ingested continuously | 24x365

Observations summary

~93% of all input to the NCEP global models is from weather satellites.

Polar orbits contribute ~85% of all data input to the models.

Afternoon polar orbits contribute ~30% of all data input to the models

- Operational geostationary and polar orbiters
- Research satellites

Non-satellite sources – ~580 thousand observations are received each day

- Surface reports
- Land
- Marine
- Upper-air profiles
- Land Soundings
- Aircraft

CEP Data Overview

Ingest over 3.5 billion observations per day

Totaling about 6 TB per day

Use about 9.25% of total supercomputer processing power to ingest, process and QC incoming data and disseminate output

Generate over 5TB of raw output daily

Includes work files and experimental output

Generate over 15 million operational products daily

Operational data volume is 1.5TB

CEP supported servers disseminate over 20 TB daily to millions of customers globally

Customers include other Government agencies, Commercial entities, NWS dissemination systems (to get to NWS Field offices), International Partners and U.S. public

▶ **Archive 2 TB of data daily**

◦ Observations and output

CEP Data Ingest

Data is ingested from multiple sources (other State and Federal Government agencies, international partners, commercial providers)

- Data is ingested onto both production and development systems independently

Data is decoded, processed and quality controlled and prepared for model use

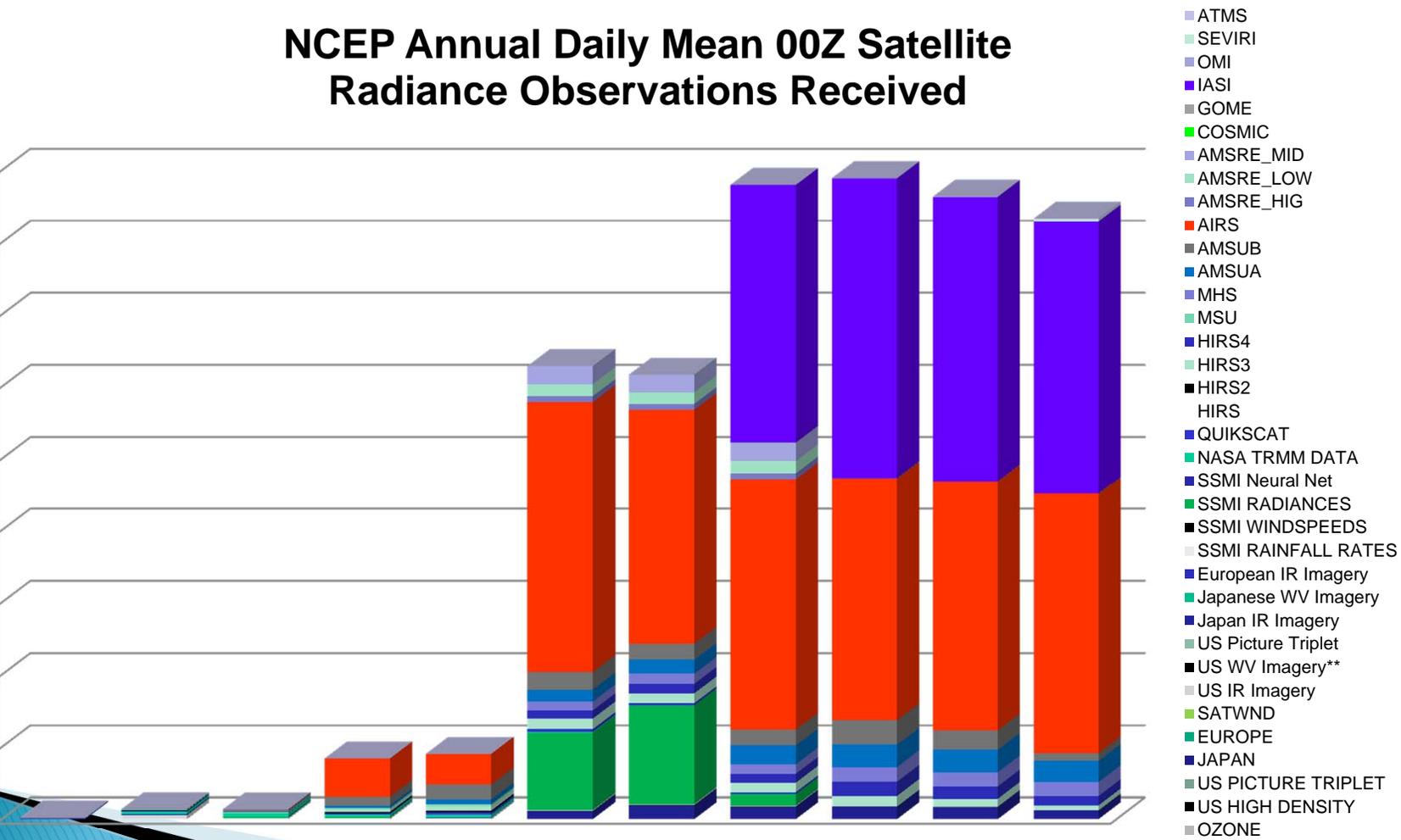
- Only about 7.5% of raw ingested data is assimilated into the models

Total Number of Observations

Summary Table			
	<i>Total Received</i>	<i>Total Selected</i>	<i>Total Assim</i>
Non Satellite	576907	576907	576907
GEO	26738378	1767443	1561426
Polar	1709401167	48696568	11015435
Other Satellite	373582	342687	159507
Totals	1737090034	51383605	13313275

Non-Conventional Data Received

NCEP Annual Daily Mean 00Z Satellite Radiance Observations Received



Satellite Data (Radiances) Used by Assimilation

Satellite	GFS	NAM	RAP
NOAA-15 (AMSU-A)	Yes	Yes	Yes
NOAA-15 RARS (AMSU-A)	Yes	No	NO
NOAA-17 (HIRS-3)	No	No	Yes
NOAA-18 (AMSU-A, MHS)	Yes	Yes	Yes
NOAA-19 (HIRS-4, AMSU-A, MHS)	Yes	Yes	No
METOP-A (HIRS-4, AMSU-1, MHS)	Yes	Yes	Yes
AQUA (AIRS, AMSU-A, IASI)	Yes	Yes	No
GOES-13 (SOUNDER)	Yes	No	No
GOES-15 (SOUNDER - over water only)	Yes	No	No
METEOSAT-9 (SEVIRI)	Yes	No	No
S-NPP (ATMS)	Yes	No	No

Satellite Data Retrieved

Products/Ozone/Radar/GPSRO

Satellite	GFS	NAM	RAP
TRMM (TMI - rain rate, clw, cloud ice)	Yes	No	No
GOES-13 and GOES-15 (IMAGER - ctp, ctt, cloud fraction clw, cloud levels)	No	No	Yes
NOAA-17, -18, -19 (SBUV-2 - ozone)	Yes	No	No
AURA (OMI - ozone)	Yes	No	No
WSR-88D (Level 2 radial wind, level 2.5 radial wind superobs, level 3 (NIDS) radial wind superobs)	No	Yes	No
WSR-88D - Reflectivity	No	No	Yes
COSMIC-1 to COSMIC-6, GRACE-A and METOP-2(A) - refraction/bending angle	Yes (b)	Yes (r)	No
SAC-C ,TerraSAR-X, and C/NOFS-bending angle	Yes	No	No

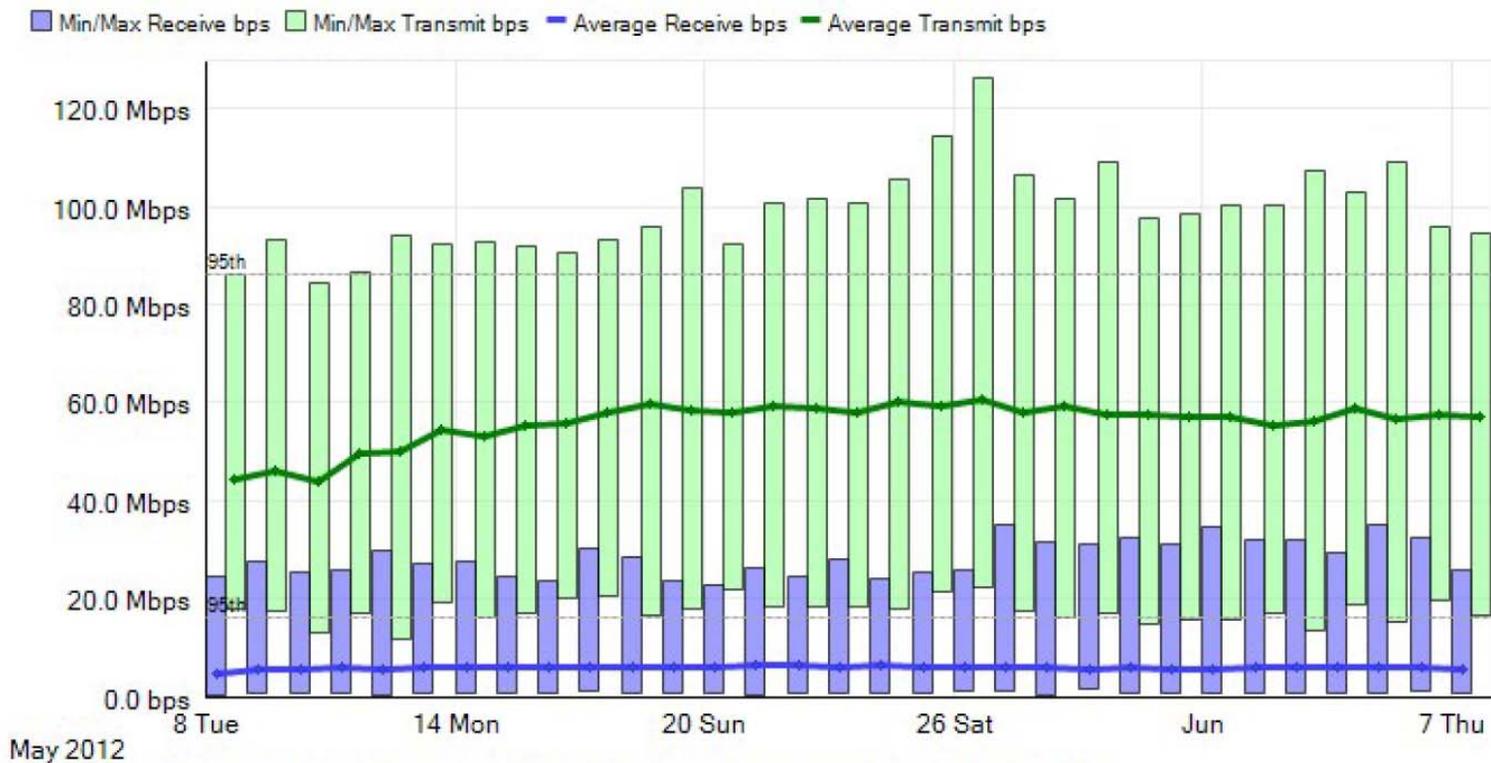
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SAC-C ,TerraSAR-X, and C/NOFS-bending angle	Yes	No	No

Volume Volumes: Existing Legacy Systems (from the ESPC to NCEP Interface):

Average data volumes from the ESPC to NCEP Interface are ~60 Mbps

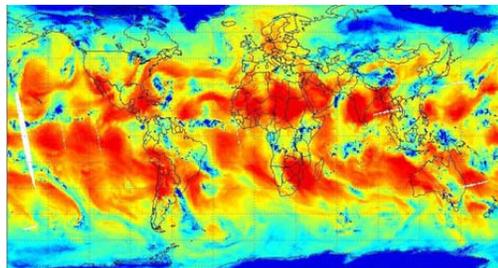


Data Volumes: Current S–NPP (from the ESPC to NCEP Interface)

Current S–NPP data volumes going to NCO for EMC include only ATMS and CrIS radiance data in BUFR format.

ATMS BUFR:

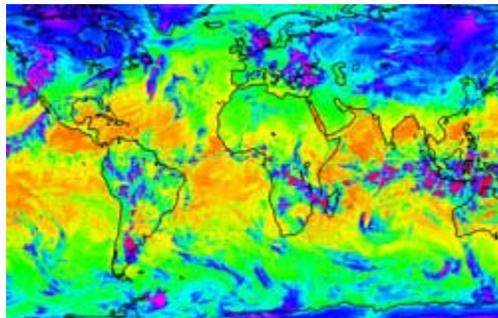
- granule size 0.12 MB,
- orbital size 0.02 GB
- daily size: 0.33 GB



ATMS channel 18 data. Image credit: NASA/NOAA

CrIS BUFR:

- granule size 0.78 MB,
- orbital size 0.15 GB
- daily size: 2.07 GB.



Composite of three days of CrIS data. Image credit: NASA/NOAA

Data Volumes: Future S-NPP (from the ESPC to NCEP Interface)

Destination	Maximum Daily Volume (GB)	Maximum Daily Files	Required Bandwidth 101 minute transmission (Mbps)	Required Bandwidth 30 minute transmission (Mbps)	Required Bandwidth 10 minute transmission (Mbps)
NO/EMC	2463	55926	255	862	2586
	1097	36014	113	382	1146
	413	13400	43	144	432
	860	18647	89	300	899
	380	40927	39	132	396
	1293	31508	133	450	1351
	296	3120	30	103	309

Data Volumes: Future GOES-R

Source	Format	Size/Range	Frequency/Range
Advanced Baseline Imager (ABI)	NetCDF4	0.81–1190.56 MB	30 sec – 15 min
Extreme UV/X-Ray Imagers (EXIS)	NetCDF4	0.011 MB	3 sec – 30 sec
Magnetometer (MAG)	NetCDF4	0.011 MB	1 min (aggregate)
Space Environment In-Situ Sensor Suite (SEISS)	Net CDF4	0.011 MB–0.13 MB	30 sec – 1 min
Solar Ultra-Violet Imager (SUVI)	NetCDF4 FITS	70.64 MB	240 sec

Product made from calibrated, navigated and registered sensor data with associated metadata

1b products are distributed for ABI, EXIS, MAG, SEISS, SUVI

GOES-R: Advanced Baseline Imager (ABI)

	ABI	Current GOES Imager
Spectral Coverage	16 bands	5 bands
Spatial Resolution		
4 μm Visible	0.5 km	~ 1 km
near visible/near-IR	1.0 km	n/a
IR bands ($>2 \mu\text{m}$)	2 km	~ 4 km
Spatial Coverage		
Full Disk	4 per hour	Scheduled (3 hrly)
CONUS	12 per hour	~ 4 per hour
Microscale	Every 30 sec	n/a
Visible (reflective bands)		
Pre-orbit calibration	Yes	No

Data Volumes: Future GOES-R

Data Store	Size Estimate
Configuration Store	500 MB per site, two satellites
Event Log and Metrics Store	1 GB per site, two satellites
Operational Configuration Store	100 KB per site, two satellites
Two Day Store	23.2 TB NSOF 13.8 TB WCDAS 13.7 TB RBU
Mission Life Storage	79.7 TB per site, two satellites
Working Storage	500 GB

Why discuss Big Data now?

Volume, velocity, variety of big data keep increasing!

- **Critical to plan and prepare now for future handling of these data sets**

Science is increasingly driven by data (large and small)

- **Think Sensors: remote sensing, environmental sensing, scientific instruments, etc.**

- Large data sets are here!

The use of statistical analysis, data mining, forecasting, and optimization to make critical decisions and add value based on customer and operational data

Data analytics and other big data services are major opportunities for business and government

Big data is not just about the Data: Data processing and analysis, data lineage and provenance

Challenges – Systems Level

Consolidate Platforms to Improve Sustainability

“As is architecture”: Mix of Legacy and Modern Virtual Systems (total ~1100 physical devices).

Multiple Operating Systems

Legacy Systems typically one application/server

Increase ESPC Network Speed

Mix of ESPC Network Speeds (1 Gbit/sec, 10 Gbit/sec)

Use “Conveyor Belt” upgrade process

Planned Hardware (HW) refresh approximately every 5 years

Multicasting some (possibly all) of the near real-time satellite data over Internet2 and peering international networks.

NOAA Satellite and Information Service: National Environmental Satellite, Data, and Information Service (NESDIS)

NOAA Satellite Conference

[//satelliteconferences.noaa.gov/2013/](http://satelliteconferences.noaa.gov/2013/)

gathering together researchers, scientists, operational forecasters and broadcasters, and applications developers interested in better understanding and maximizing the use and impact of environmental satellite data, information and products.

conference registration

deadline: March 15, 2013

deadline for poster abstracts:

February 21, 2013

hope to see you in College Park, MD!



NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION | NOAA SATELLITE AND INFORMATION SERVICE

NOAA Satellite Conference

"Strengthening Partnerships to Enhance User Readiness, Reception, and Utility"

You are cordially invited to join us for this engaging event

Save the Date

April 8-12, 2013

NOAA Center for Weather and Climate Prediction (NCWCP)
College Park, MD

Scan the QR code with your mobile phone or tablet QR reader to learn more about this upcoming event



This innovative joint conference will merge past Satellite Direct Readout and GOES Users' Conferences, and expand to include JPSS customers and users as well.



satelliteconferences.noaa.gov/2013



Contact Information

24/7 Help Desk	ESPCOperations@noaa.gov
User Services	SPSD.UserServices@noaa.gov
Data Access	NESDIS.Data.Access@noaa.gov
Webmaster	SSDWebmaster@noaa.gov
Web	www.ospo.noaa.gov
 Find us on Facebook	www.facebook.com/NOAANESDIS
 Follow us on twitter	www.twitter.com/noaasatellites

Questions?

Thank you!



Image source: