Unidata Policy Committee
NOAA/NWS Update

July 16, 2007

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NOAA's National Weather Service

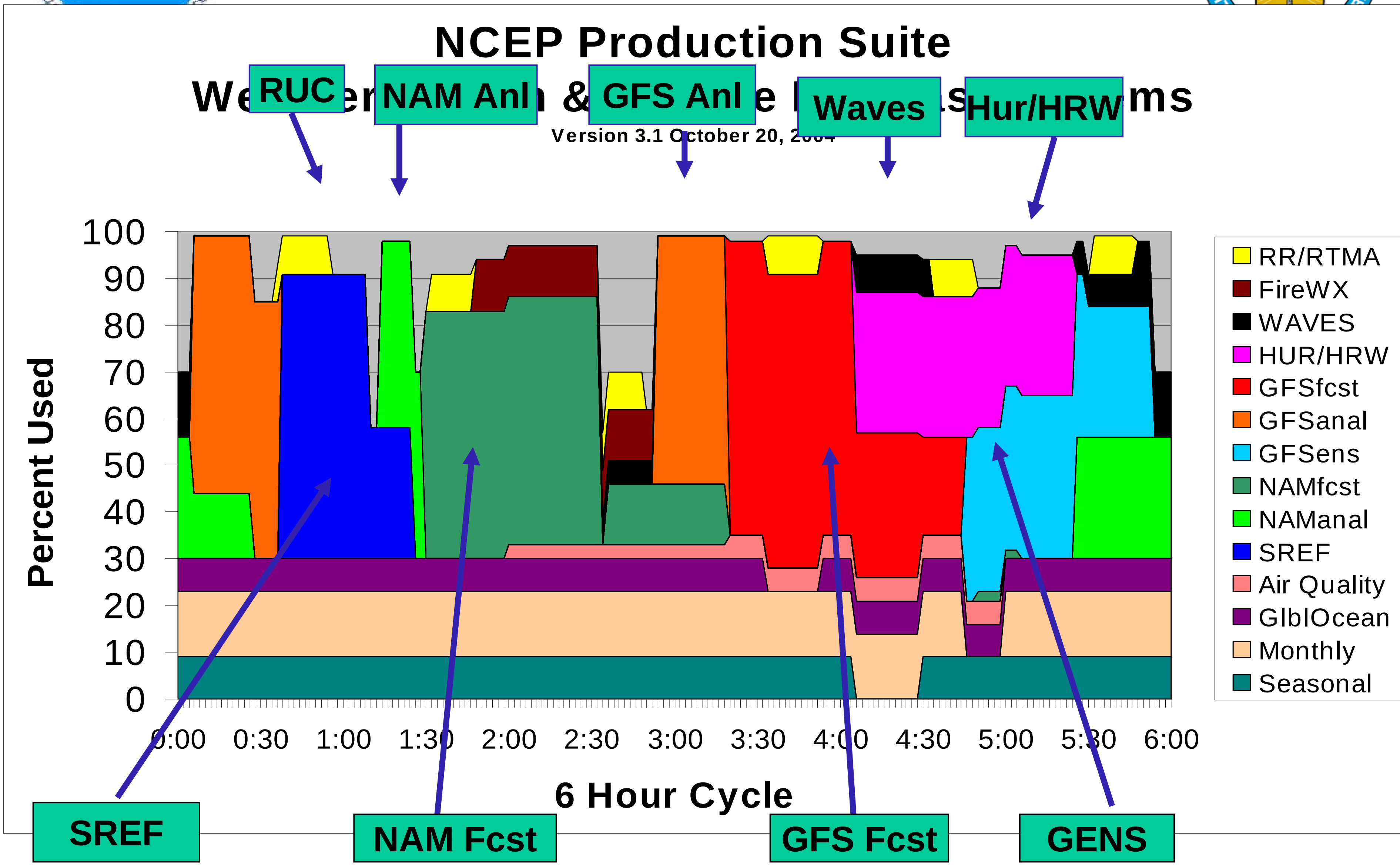
Outline

- NCEP Model plans
- CONDUIT
- MADIS – surface data
- NOAAPort plans
- AWIPS II plans
- NOAA Satellite plans

Trade-Offs in Operational NWP

- Where to apply increased computer power
  - *Physics – complexity, frequency of calls …*
  - *Dynamics – semi-Lagrangian, finite volume …*
  - *Resolution – seems more is always better*
  - *Data assimilation – 3+DVar, 4DVar, ETKF …*
  - *Update frequency – every 6, 3 or 1 hourly …*
  - *Size of ensemble – is bigger always better …*
  - *Reforecasting +/or Reanalysis*
- Many of these decisions have been dictated by The Jigsaw Puzzle, e.g. no room for 4DVar.

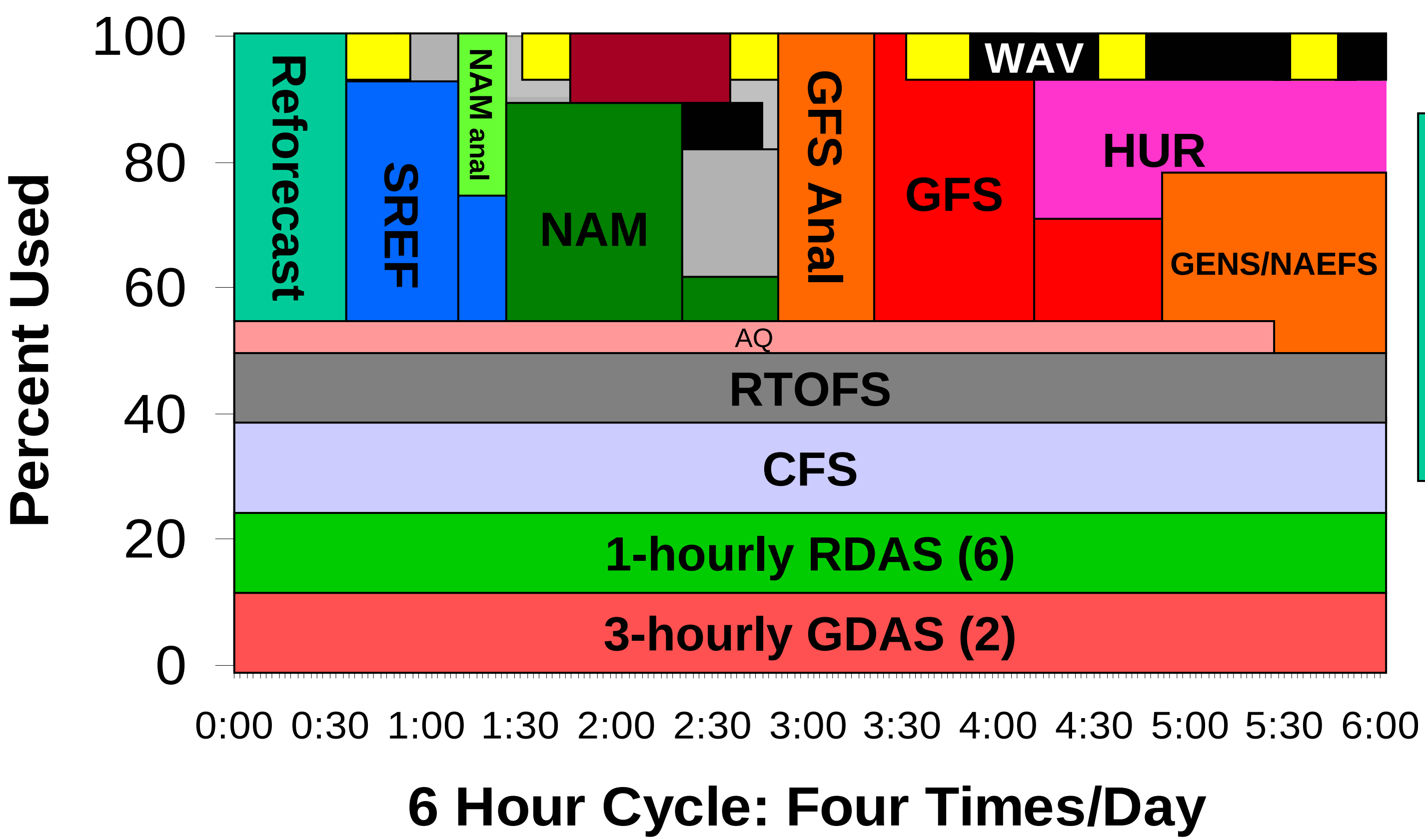
The Jigsaw Puzzle



NCEP Production Suite
Weather, Ocean, Land & Climate Forecast Systems

Next Generation Prototype
Phase 1 - 2009

Computing factor: 3

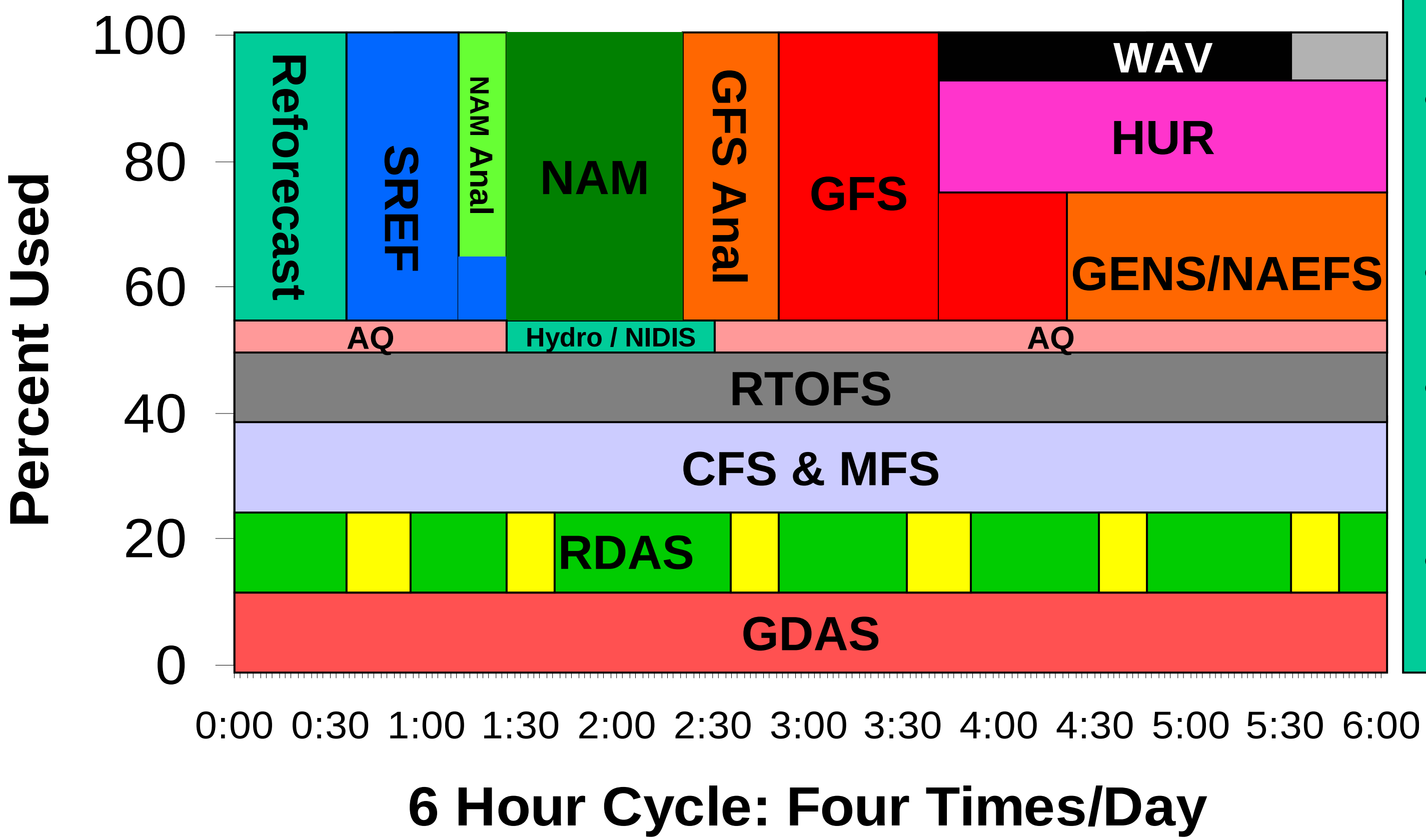


Added
- 1-Hourly RDAS
- 3-Hourly GDAS
- Reanalysis/ Reforecast

NCEP Production Suite
Weather, Ocean, Land & Climate Forecast Systems

Next Generation Prototype
Phase 2 - 2011

Computing factor: 9



Added
- Hydro/NIDIS products

Moved
- GFS ½ h earlier

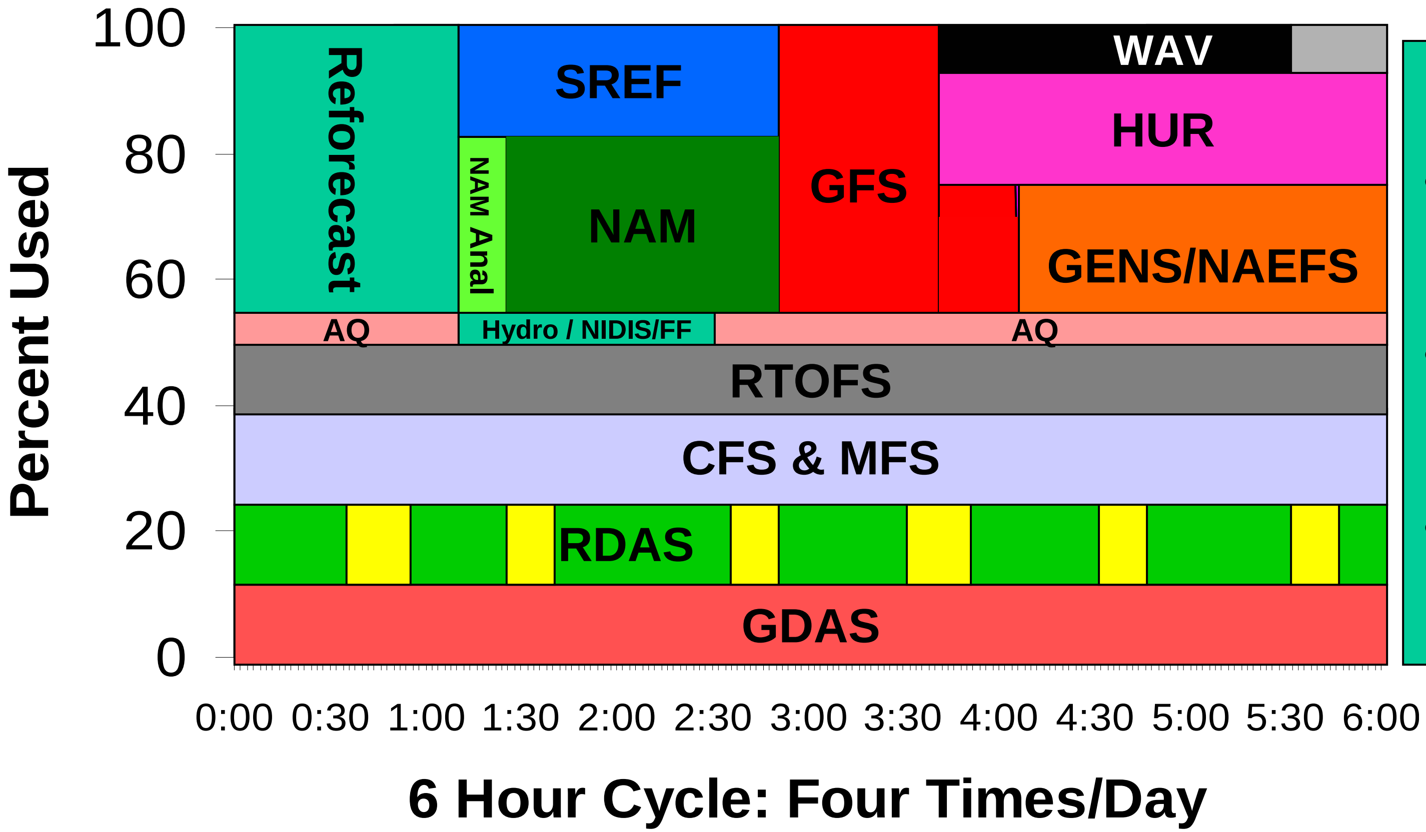
Expanded
- Hurricane & wave products

Incorporated
- Multi-domain rapid updating

NCEP Production Suite
Weather, Ocean, Land & Climate Forecast Systems

Next Generation Prototype
Phase 3 - 2013

Computing factor: 27



Added
- Flash flood products

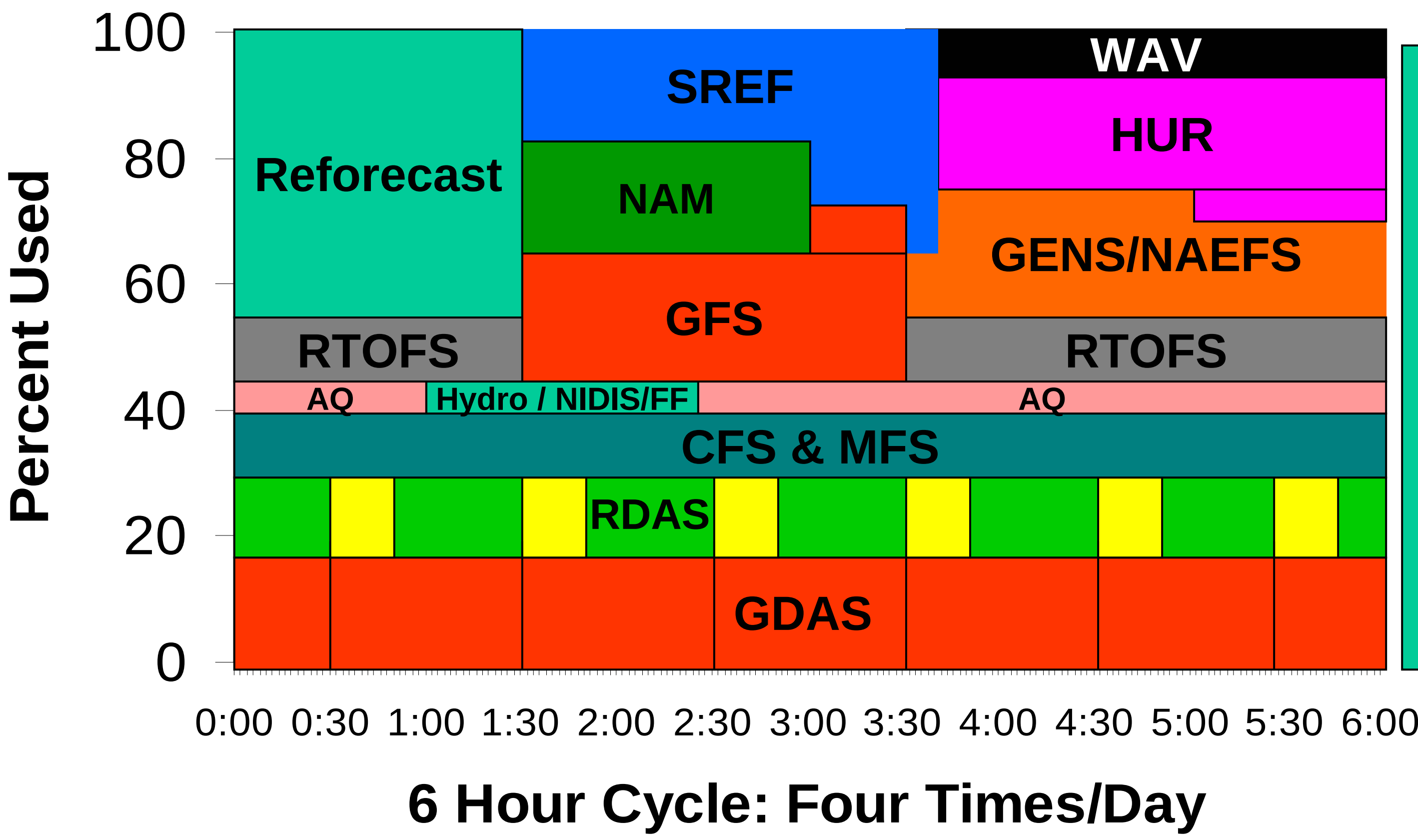
Moved
- SREF concurrent to NAM

Expanded
- Reforecast capability

NCEP Production Suite
Weather, Ocean, Land & Climate Forecast Systems

Next Generation Prototype
Phase 4 - 2015

Computing factor: 81

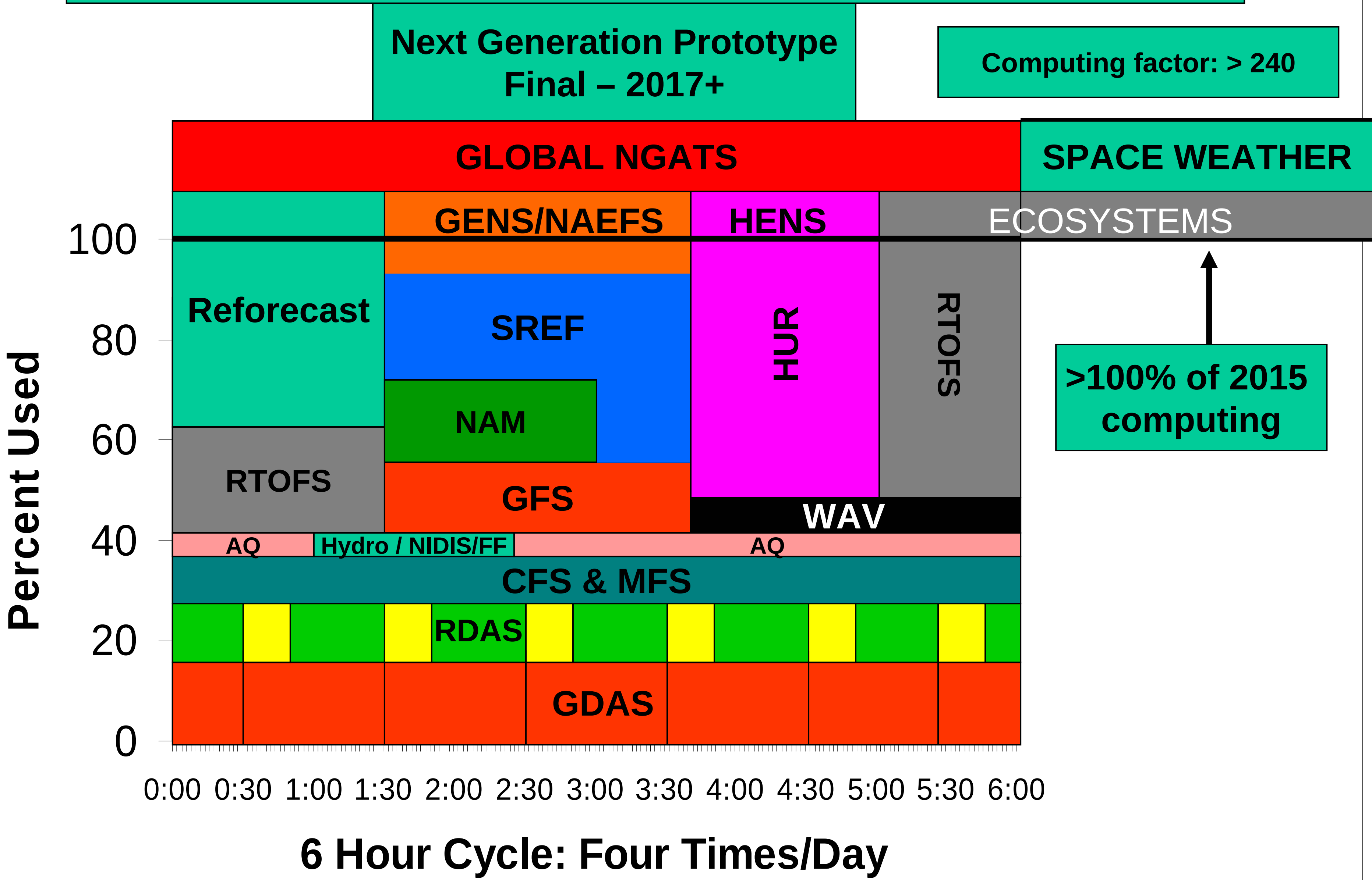


Added
- Hourly GDAS

Moved
- GFS concurrent to NAM & SREF

Expanded
- Hurricane capability (hires)

NCEP Production Suite
Weather, Ocean, Land & Climate Forecast Systems



WRF Lessons Learned

- The burden of community modeling involvement by any institution is substantial but especially so for an operational one
- Nearly all NMM enhancements must be done or finished by NCEP (DTC may off-load some of this … eventually)
- Community directions and rate of evolution are not always in sync with operational needs
- Operational needs are not high on the priority list of community developers (unless operations can provide a big part of the $upport)
- Community needs are often driven by foreign partners and/or the funding sources

The Downsides of WRF & Why NCEP is Moving to ESMF

- WRF: Must take / use all of it
- WRF: Not most efficient
- WRF: Highly complex, deeply layered code, not well suited for nearly continuous development & enhancement of NCEP Operational environment
- ESMF: Can choose only the parts you want and NCEP is choosing to take just a minimum
- ESMF: Vast majority of code is being written by NCEP with simplicity, clarity and efficiency as guides

Community-based ESMF Development

- **Strategy and roles:**
  - ***Focus on single component instead of entire model system***
  - ***Collaborative, not competitive***
  - *NCEP/EMC*
    - Maintains primary components for each part of Production Suite and for each application
    - Supports ESMF applications that are used in operations
    - In collaboration with community
      - *Integrates new ESMF-based components into operations*
      - *Performs final testing and preparation of upgrades of supported components in operations*
  - ***Collaborators***
    - Provide
      - *Component upgrades to be tested in operational setting*
      - *Institutional support for their contributed components*
      - *Diversity and expertise complementary to operations*
    - Work through DTC, JCSDA, CTB, etc.

Preparing for the Future

- **Observations (number and availability)**
  - *Advanced Polar and Geostationary sounders (~100 X greater)*
    - NPOESS (delivered <60 minutes globally) – 2012-2015 (or later)
    - METOP (1-4) – 2007
    - NPP (delivered 90-120 minutes globally) – 2009
    - GOES-R – 2013 (or later)
  - *Next-generation Doppler radar*
- **Advanced post-processing techniques for multi-model ensemble (e.g. NAEFS project)**
  - *Bias correction*
  - *2nd moment correction*
  - *CPC "consolidation" to quantify "value-added"*
- **Advanced dissemination strategies**
  - *E.g. NOMADS ("Fat server/Thin Client" technology)*
- **Next-Generation Air Traffic-control System (NGATS)**
  - *Geographically consistent solutions*
  - *Global to terminal scales*
  - *At least hourly updating globally*

Preparing for the Future

- **Three principals for moving forward**

1. *Maturing, ensemble-based, probabilistic systems offer the most potential benefits across wide spectrum of forecast services*
2. *Ensemble composition*
   a. Managed component diversity
   b. Components must be institutionally supported (operational or major research institution)
3. *Product delivery*
   a. Time is critical (perishable product)
   b. Information availability must be maximized

CONDUIT

- In-Situ, Radar and Model Data Requirements will be increasing
- Need a backup capability given increasing real-time use by Partners
- More observations from mesonets and MADIS
- Higher resolution global and regional, climate, water, weather, air quality models
- Increasing reliance on ensembles (NAEFS and SREF)
- Potential IDD backup to NOAAPORT data stream

- Need increasing dialogue with NOAA and community on what CONDUIT could provide

NOAAPORT

- Currently 10 Megabits/sec of bandwidth
- We peak out at about 75% of this
- Plans to add bandwidth linked to Satellite programs in Budget process
- +10 MB/sec in 2010 to support NPOESS/NPP
- +20 MB/sec (40MB/sec total) in 2014 to support GOES R

MADIS – An Overview

- MADIS – Meteorological Assimilation Data Ingest System
  - *Developed by FSL in 2001*

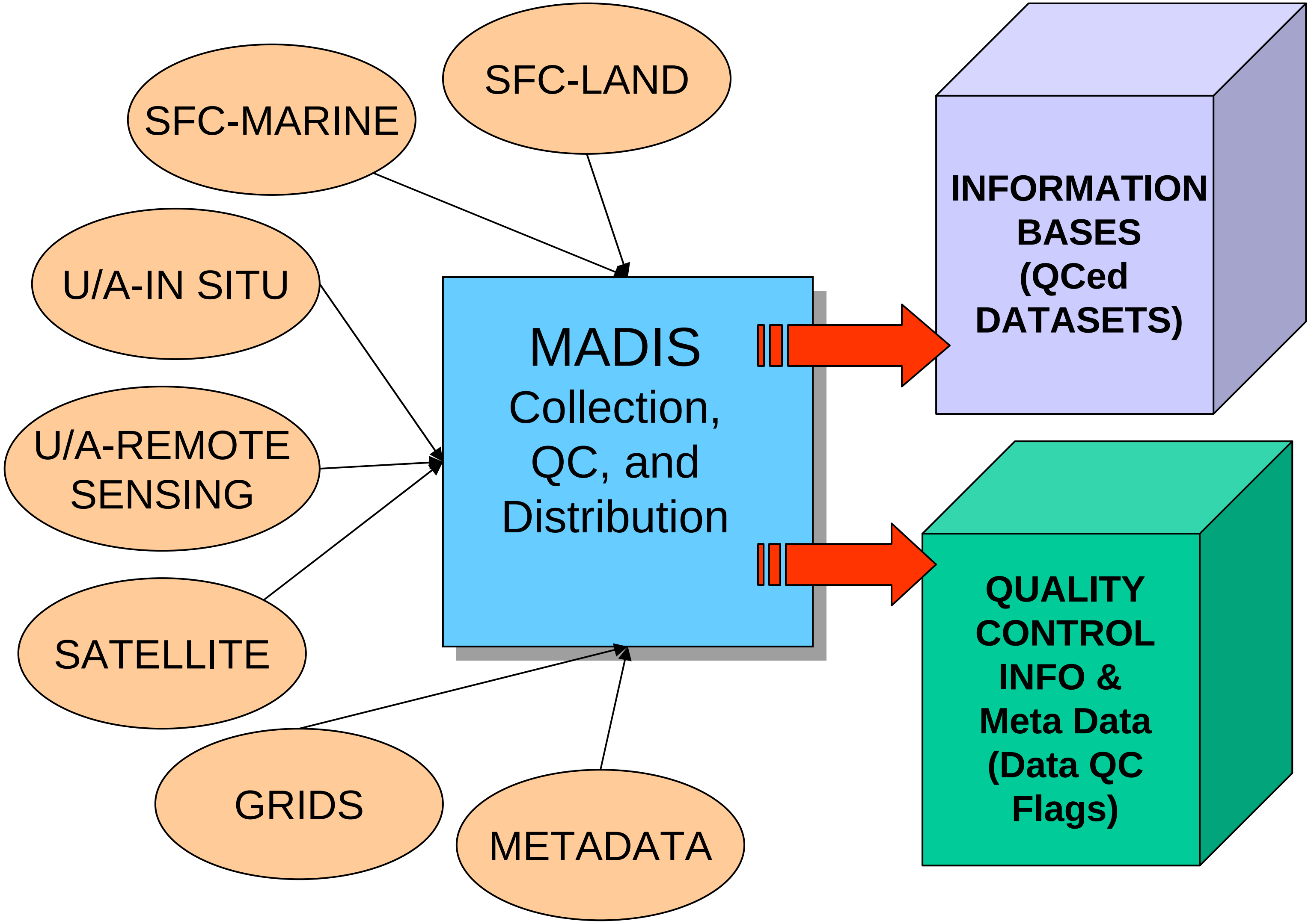
- Data management system / architecture that is flexible, expandable and interoperable

- Provides government and non-government mesonet, upper-air, and coastal data and QC to NOAA and the enterprise

- Data are informed by metadata

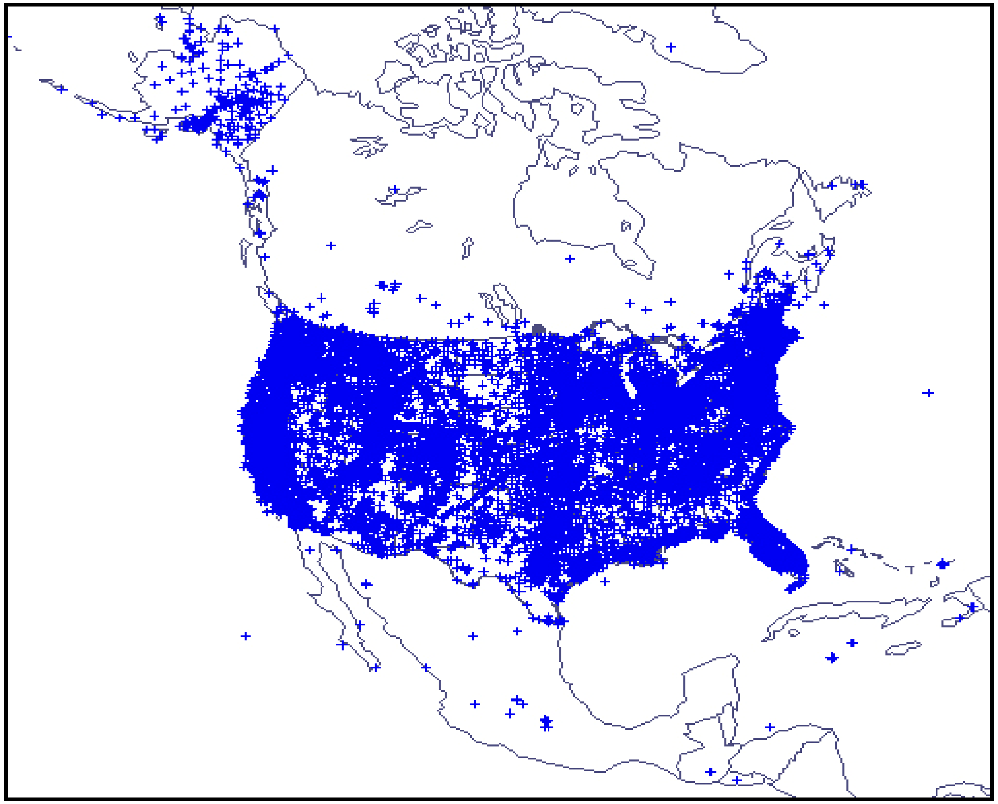
- Transitioning MADIS to NWS operations will provide 24x7 maintenance support with offsite system backup
  - *Leverages NOAA's extensive data management infrastructure and investment*

MADIS Data Sources and Outputs



MADIS Observations

(as of June 13, 2007)



- Current MADIS Sites

Meteorological Mesonet =	21,147
Hydrological Mesonet =	6,978
Modernized COOP =	199
UrbaNet =	886
Total =	29,210

- Current Networks > 150
- Largest Networks
  - > Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS)
  - > AWS Convergence Tech. Inc.
  - > Citizen Weather Observing Program (CWOP)
  - > Interagency Fire Center's Remote Automated Weather System (RAWS)

MADIS – NWS Transition (con't)

- Initial Operating Capability – FY09, Q1-Q2
  - *Provides "current" functionality for real-time MADIS abilities, about 20K surface and upper air obs baselined*

- Final Operating Capability – end FY10 / early FY11
  - *Expanded NOAA and select non-NOAA datasets, offsite backup*

What is AWIPS Evolution?

- AWIPS Evolution
  - *A long-term project which delivers a modern, robust software infrastructure that provides the foundation for future system level enhancements*
- AWIPS II
  - *Implements a modern Services Oriented Architecture (SOA) infrastructure*
  - *First output of AWIPS Evolution and provides the foundation for all subsequent improvements*
- AWIPS Evolution System Improvements
  - *Integration of "orphan" systems (e.g., Weather Event Simulator)*
  - *Migration of N-AWIPS into the SOA to create a seamless weather enterprise that supports all levels of NWS operations from National Centers to WSOs*
  - *Data Delivery Enhancements*
    - "Smart push-smart pull" data access
    - Katrina satellite WAN back up
  - *Integrated visual collaboration*
    - Graphical collaboration at all levels of the weather enterprise extending to trusted external partners
  - *Visualization Enhancements*
  - *Information Generation Enhancements*
    - Re-architecture of the generation of all NWS products and services

AWIPS Evolution Outcomes

- Short-term (1-3 years)
  - *Shorten transition of research to operations*
  - *Improve software O&M and technology refresh*
    - Fewer DRs and TTs
    - Focus on hardening and productionizing for life cycle support
  - *Minimize adverse impacts on operations from software and hardware upgrades*
- Long-term (3-10 years)
  - *Increase integration of AWIPS and National Center AWIPS*
  - *Improve performance and functionality of AWIPS*
  - *Improve collaboration at all levels of NWS operations*
  - *Increase access to all environmental data for decision making*

AWIPS II
Re-Architecture Approach

- Perform “black-box” conversion
  - *Preserve existing functionality, look and feel on top of new infrastructure*
- Thorough field validation and acceptance before deployment
- No loss of functionality
  - *Deployed system current with deployed AWIPS capability (i.e., OB9)*
- Use open source projects - No proprietary code
  - *JAVA and open source projects enable AWIPS II to be platform and OS independent*
    - No plans to move from Linux
- Objective is to make AWIPS II available for collaborative development
  - *OS, Platform independence allows non-Linux based research to be easily integrated into AWIPS II*

AWIPS II
Features

- AWIPS Development Environment (ADE)
  - *Used by all AWIPS developers (National, Regional, & Local)*
  - *Developers concentrate on new capabilities, not re-implementing existing ones (i.e. screen I/O, communications protocols, data access routines, logging routines, or other previously developed capabilities)*
  - *Software can be developed on a variety of platforms*
- Robust infrastructure for improved software O&M
  - *Use of plug-ins: visualization extensions; new data types and transforms*
  - *System level, remediation, core services reduce system complexity*
  - *Improved support for local requirements (e.g., local apps, scripts, plug-ins)*
- Common AWIPS Visualization Environment (CAVE)
  - *Provides a common development and execution environment for AWIPS GUIs (e.g. D2D, NMAP, GFE, etc.)*
  - *Ability to pan/zoom large data sets (Raster & Vector) with flexibility over data rendering*
  - *GIS tools*
  - *Thin Client (Web Browser) enabled*
- Dynamic Load balancing
  - *Processing dynamically allocated among available CPUs*

AWIPS II
What gets us excited so far…

- Dynamic load balancing
  - *Failover handled automatically*
  - *Enables consideration of tailored hardware configurations*
- Mathematically intensive calculations handed off to the graphics card
  - *Significant performance improvements*
- Progressive disclosure of all data
  - *Imagery via quad tree tiling, grids and observations*
- Integrated thin client
  - *Allows baseline solution to be extended to CWSUs, WSOs, and IMETs*
- Integrated drawing and graphical collaboration
  - *Tools built into the infrastructure, implemented in 2011*
- Built in GIS via geotools library
- Scripting level access to practically all system level services and functions
- LESS CODE
  - *Potential order of magnitude reduction in amount of software with increase in functionality (current software has over 4,000,000 lines of code)*

AWIPS II
What does it mean to you?

- Transition (Mid 2009 - mid 2010)
  - *Limited changes during transition*
  - *Only minor updates to products and services*
- AWIPS II – 2010
  - *More robust infrastructure*
  - *Faster software installations – less downtime while delivering new software*
  - *Ability to develop and implement new applications more quickly*

AWIPS Evolution

What does it mean to you?

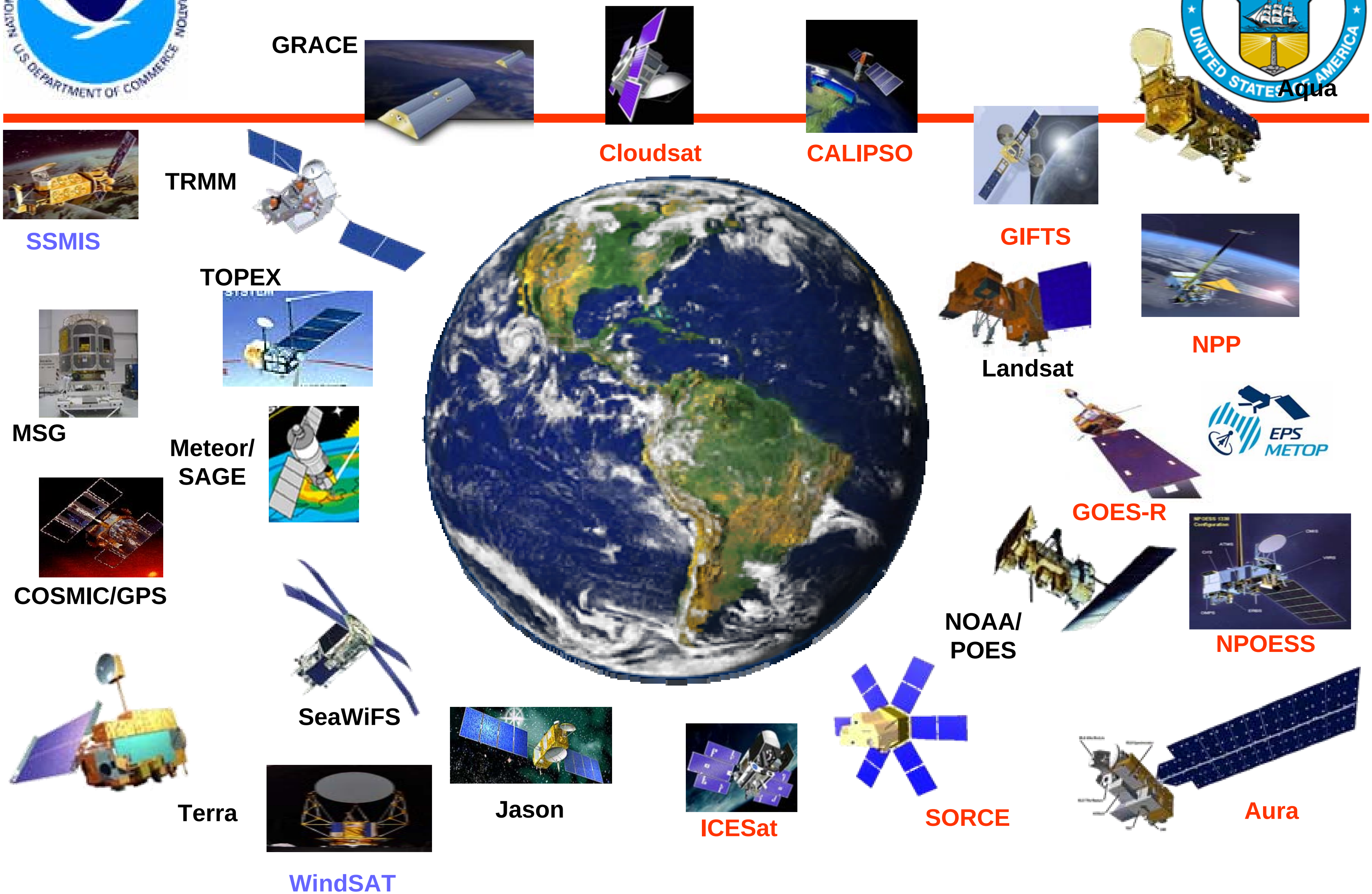
- AWIPS II – 2011
  - *Thin client support*
    - Integrates CWSUs, WSOs and Incident Meteorologists
  - *NAWIPS migrated to SOA*
    - One infrastructure for meteorological applications spanning operations from National Centers to WSOs
  - *Improved satellite back up for terrestrial network*
    - Improves continuity of operations during Katrina-like events
  - *Smart push-smart pull data delivery*
    - Improved access to broader sets of data than is currently delivered over the SBN
  - *Integrated graphical collaboration*
    - Improved coordination at all levels of NWS weather enterprise

AWIPS Evolution

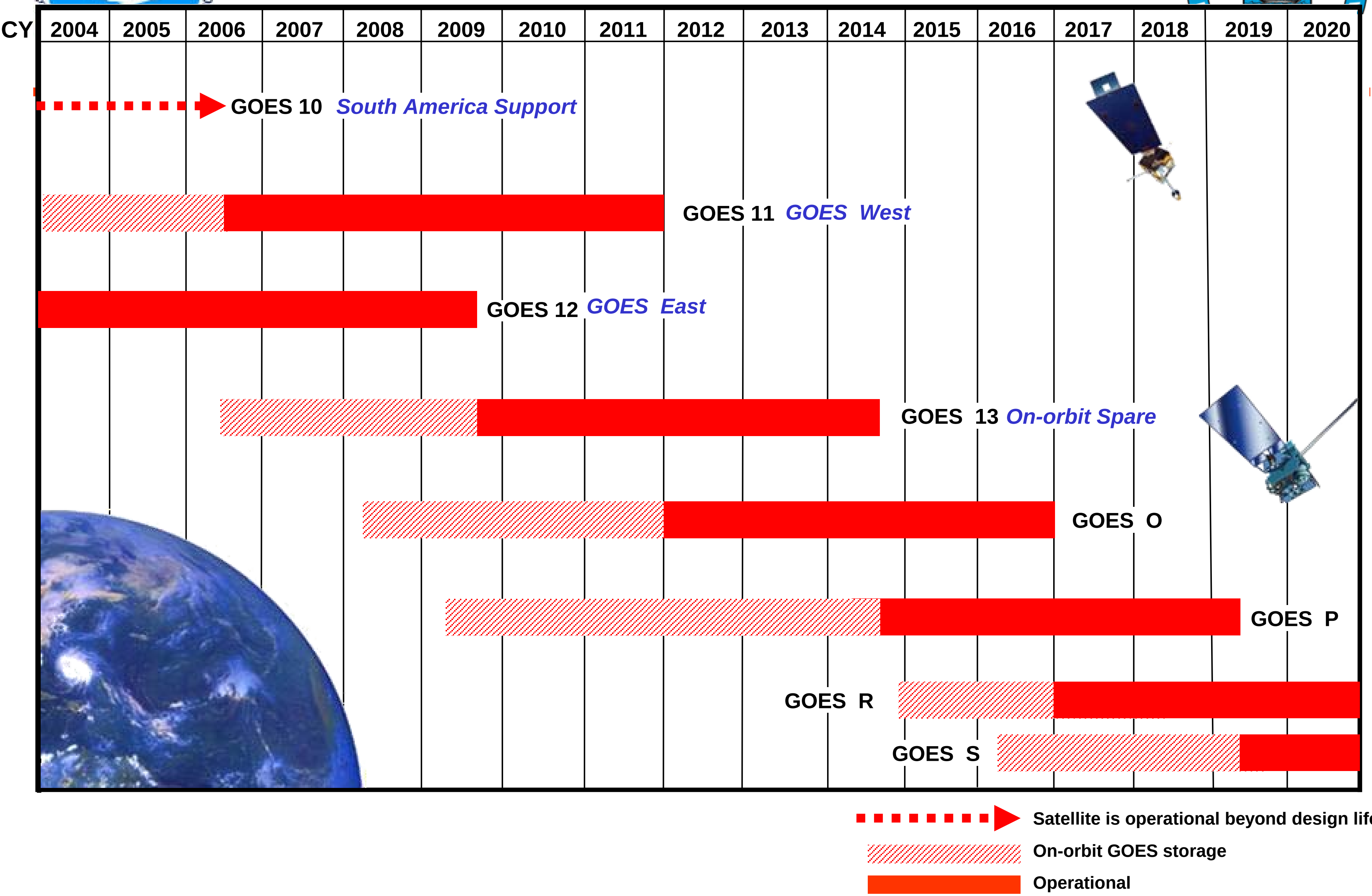
What does it mean to you?

- AWIPS II – 2012-2014
  - *Extend graphical collaboration*
    - NOAA offices
    - Trusted external partners, e.g., DHS and Emergency Managers
  - *Smart push-smart pull data delivery*
    - Extend data services to other NWS services for product delivery
  - *Re-architect generation of products and services*
    - More responsive to customer requests, e.g. CAP
    - Streamline process so developers and meteorologists focus on content vice format

The Challenge
Satellite Systems/Global Measurements



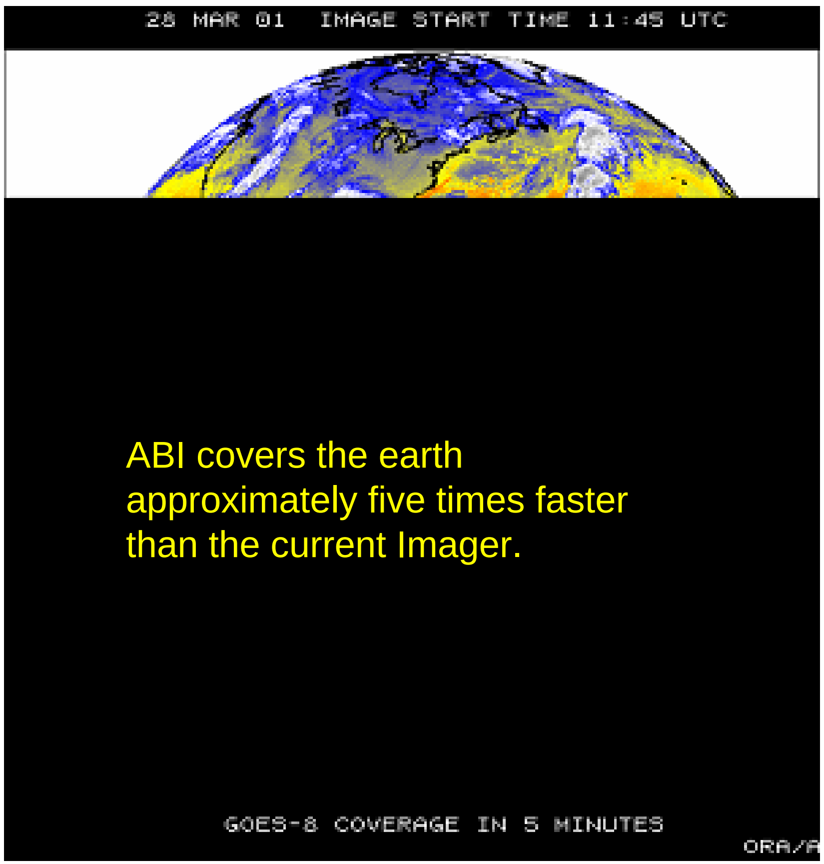
Continuity of GOES Operational Satellite Program



ABI Improvements

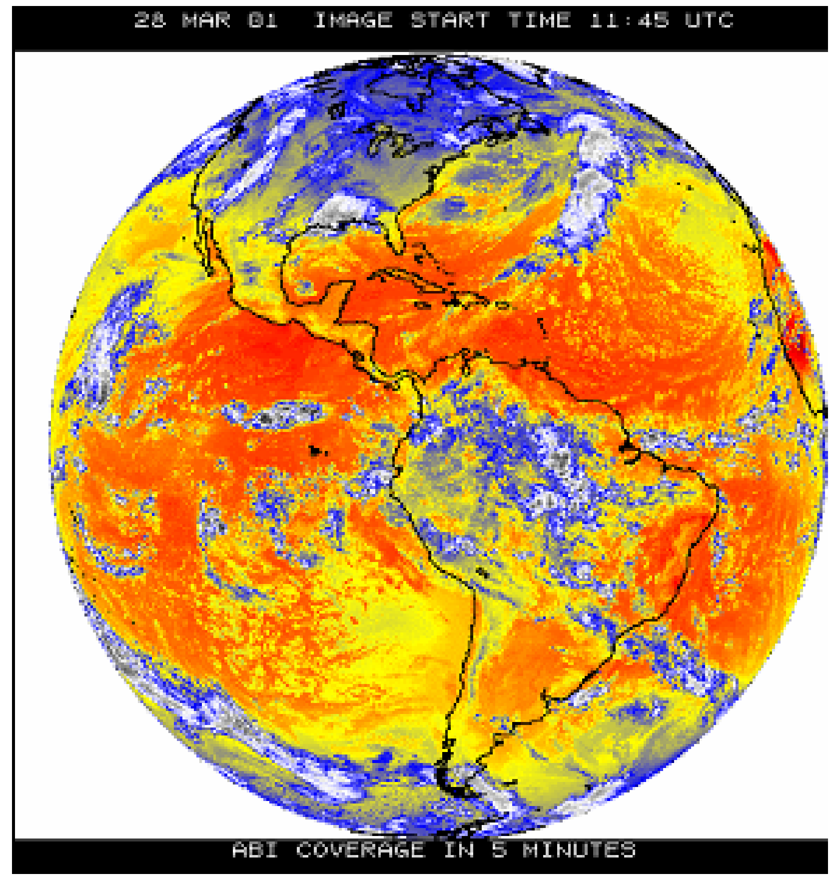
5 Minute Coverage

GOES-I/P



1/5 Disc

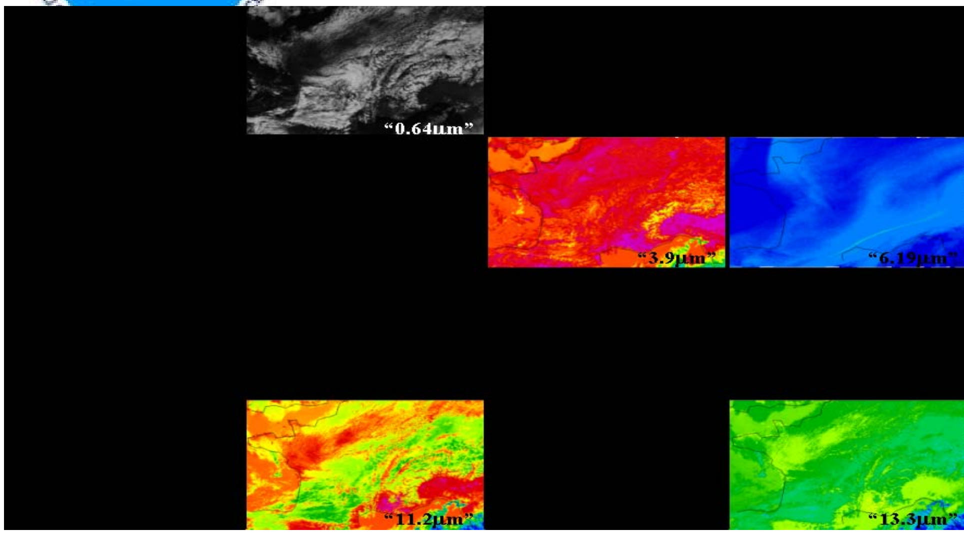
GOES-R



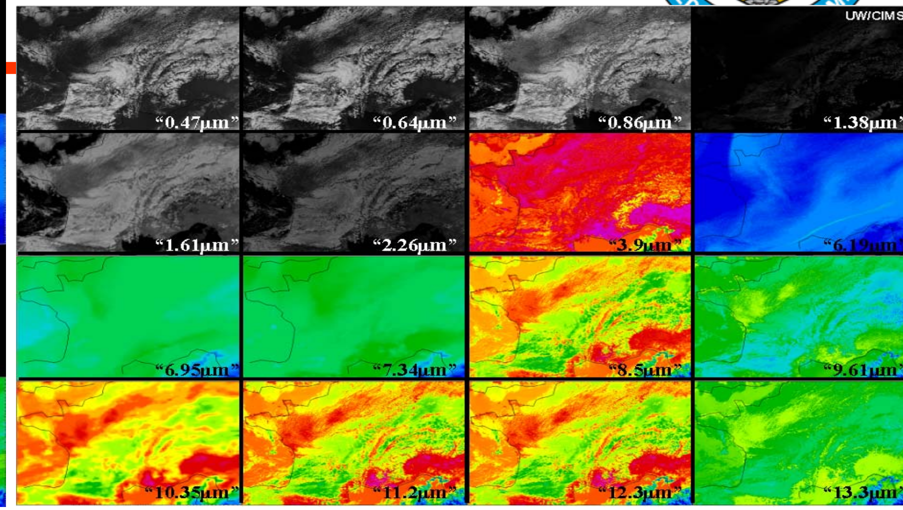
Full Disc

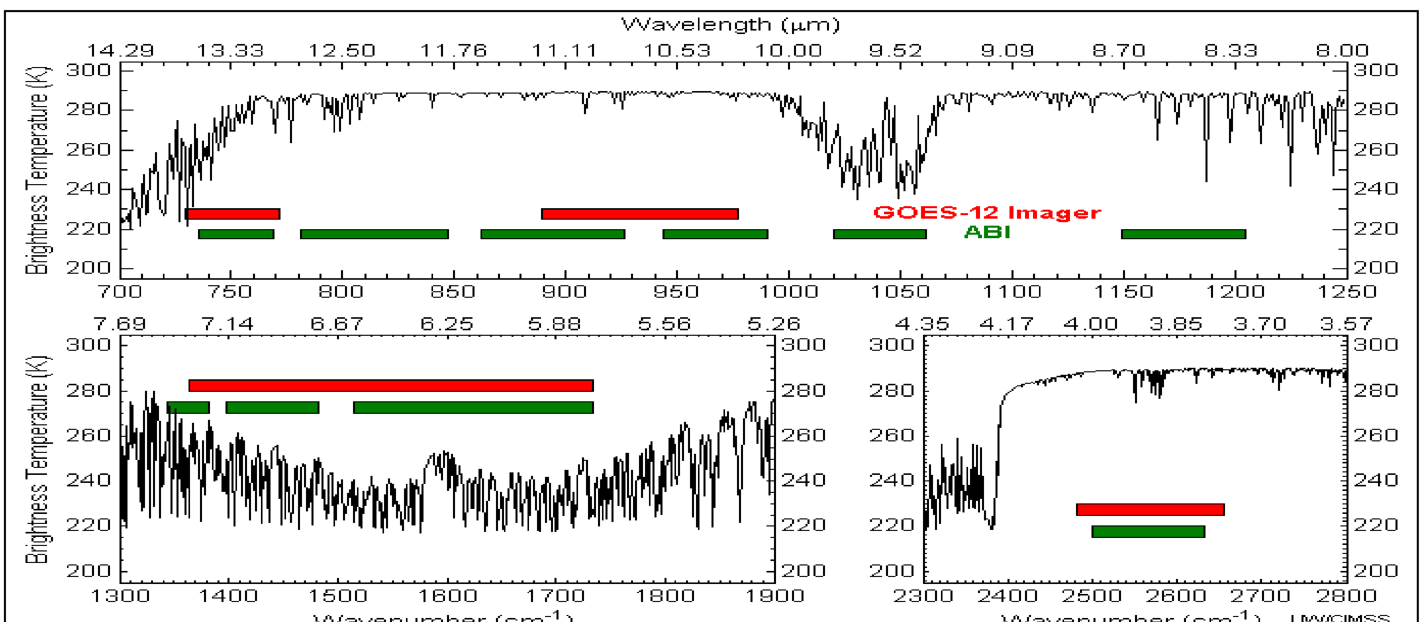
ABI: Improved Resolution . . .

Corresponding Simulated GOES Imager Spectral Bands:



Simulated "ABI" Spectral Bands:

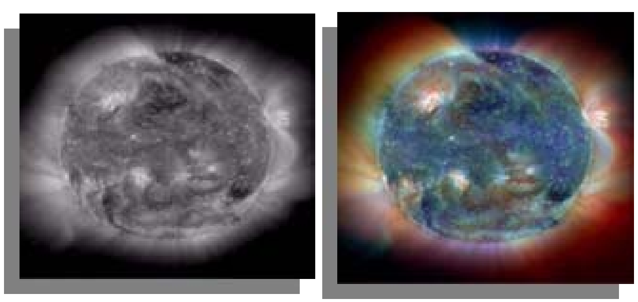




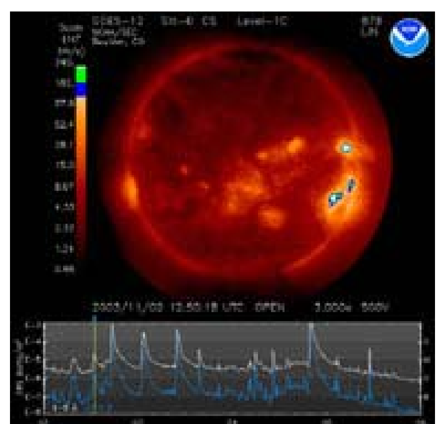
. . . over a wider spectrum

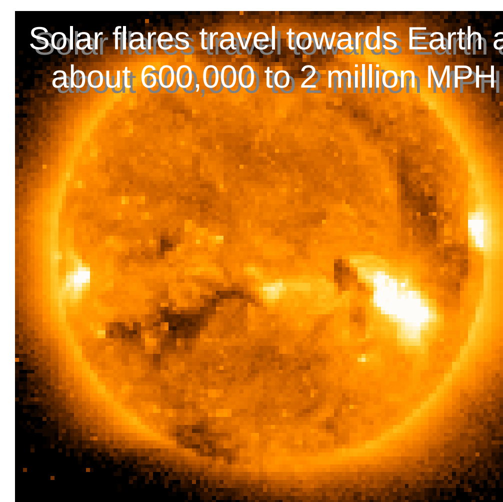
Space Weather Instruments

- **GOES-R Space Weather Instruments**
  - Space Environmental In Situ Suite (SEISS):
    - provides charged particle population measurements including proton, electron, and heavy ion fluxes
    - contribute to the global observations used in NOAA's Space Weather Operations to continuously specify and forecast conditions in the space environment
  - Solar Imaging Suite (SIS)
    - Solar X-ray flux magnitude; solar EUV flux from 5 to 129 nm; coronal holes locations; solar flares; coronal mass ejections
  - Magnetometer
- **GOES-R Improvements**
  - Solar X-ray image dynamic range, resolution, and sensitivity
  - EUV measurements for improved modeling of ionosphere and thermosphere
  - Medium energy radiation environment responsible for spacecraft charging



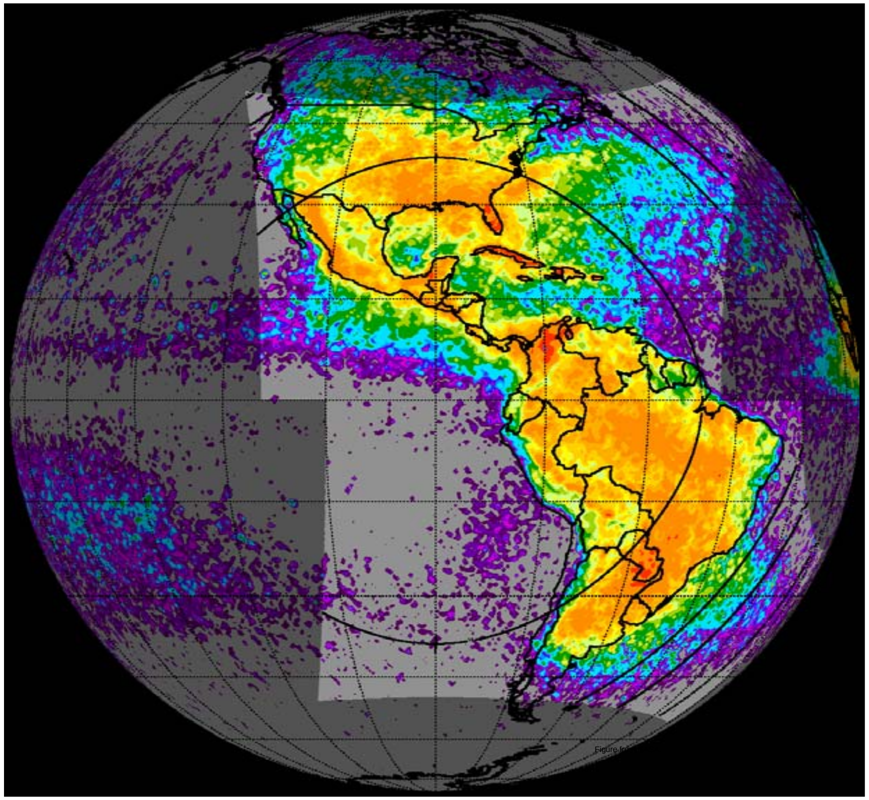
Simulated SXI (Solar X-ray Imager) images: GOES R will produce multi-band "color" images at the same rate as GOES N/P produces single band images. (Images from NGDC website





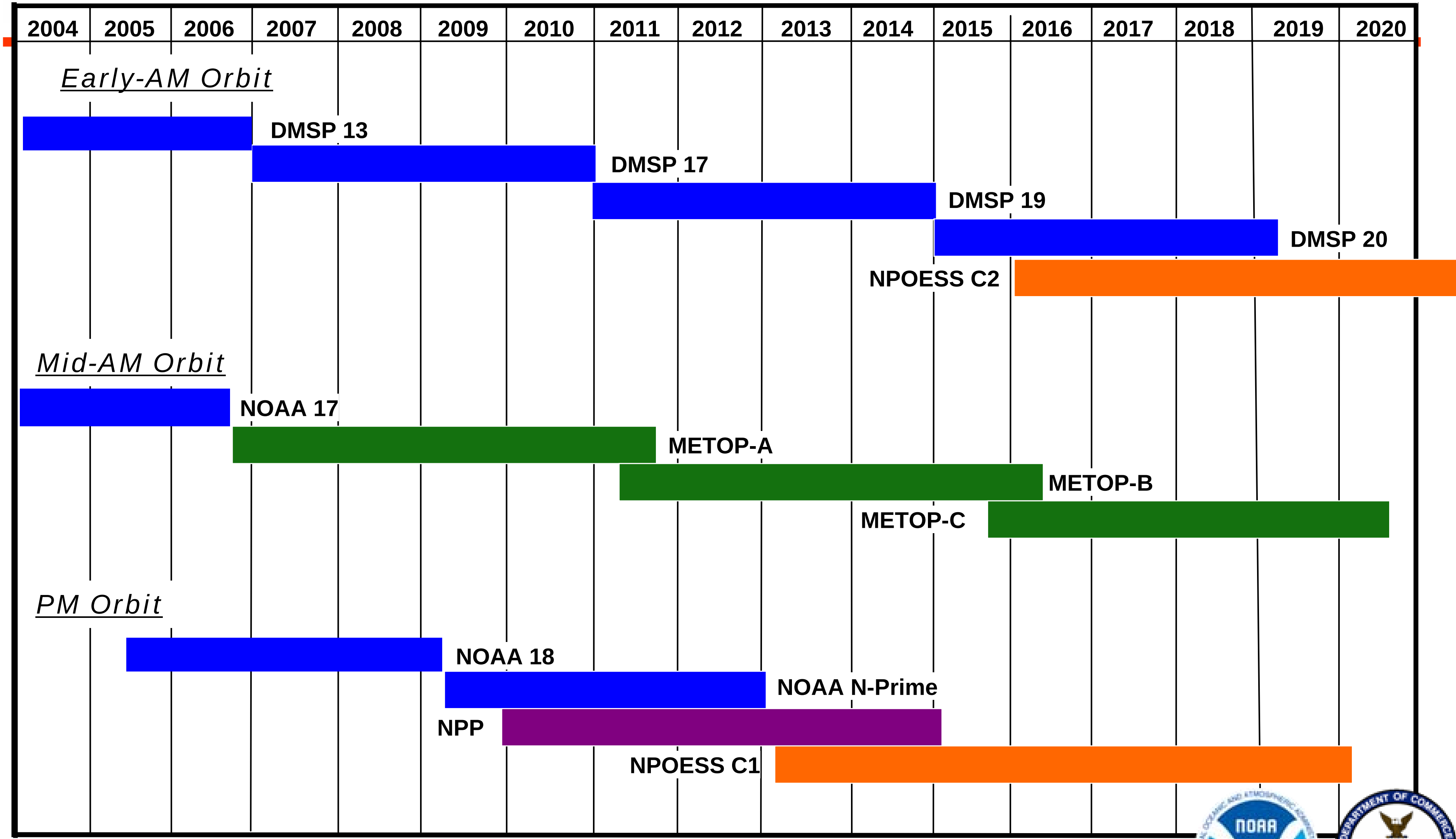
Geostationary Lightning Mapper (GLM)

- **Detects total strikes: in cloud, cloud to cloud, and cloud to ground**
  - **Compliments today's land based systems that only measures cloud to ground (about 15% of the total lightning)**



- **Increased coverage over oceans and lands**
  - **Currently no ocean coverage, <u>and</u> limited land coverage in dead zones**

NOAA Planned Missions - Polar



Summary

- NOAA's data production from NWP, radars, satellites, surface obs will continue to grow at a phenomenal pace
- The Nation needs a robust Unidata to fully exploit this technology investment and ensure all members of the community can work together to advance the science and improve weather, water and climate services to the public