An Overview of the GOES-R Program

Greg Mandt
GOES-R System Program Director

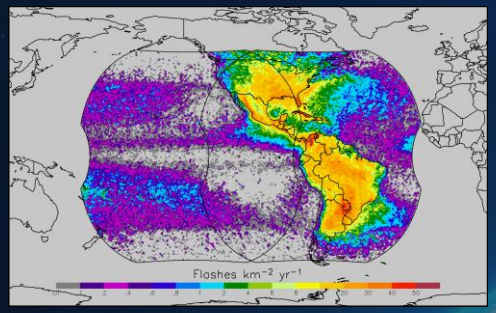
AMS 92st Annual Meeting
8th Annual Symposium on Future National Operational Environmental Satellite Systems

January 24, 2012

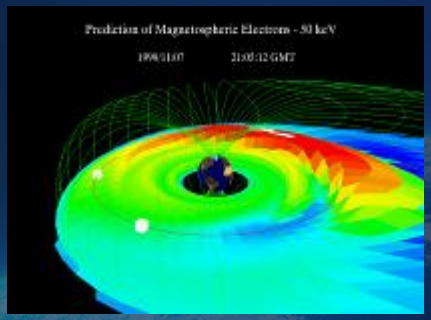
Why GOES-R?

GOES-R will provide improved detection and observations of meteorological phenomena that directly impact public safety, protection of property, and economic health and development

Visual & IR Imagery



Lightning Mapping

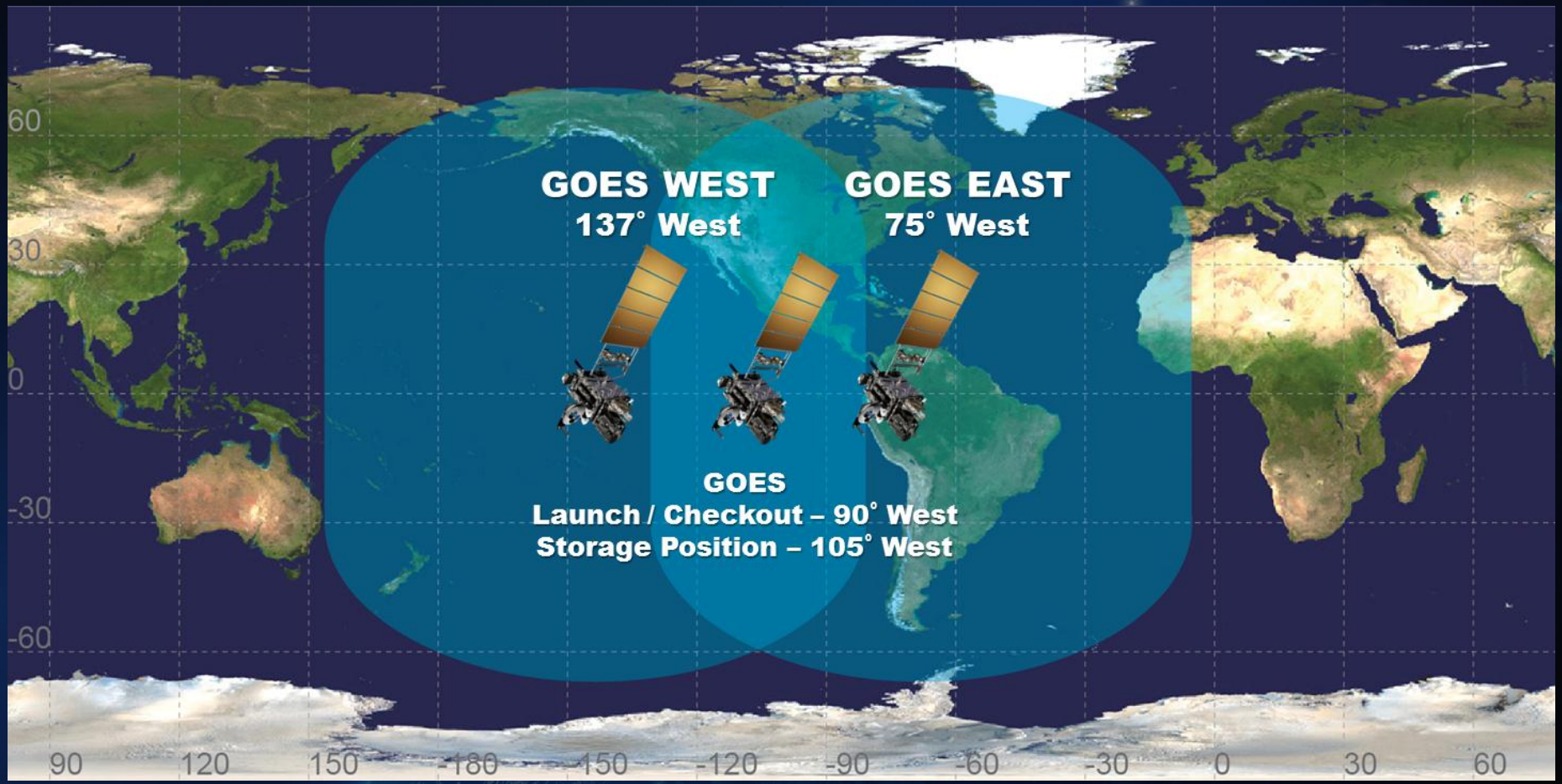


Space Weather Monitoring

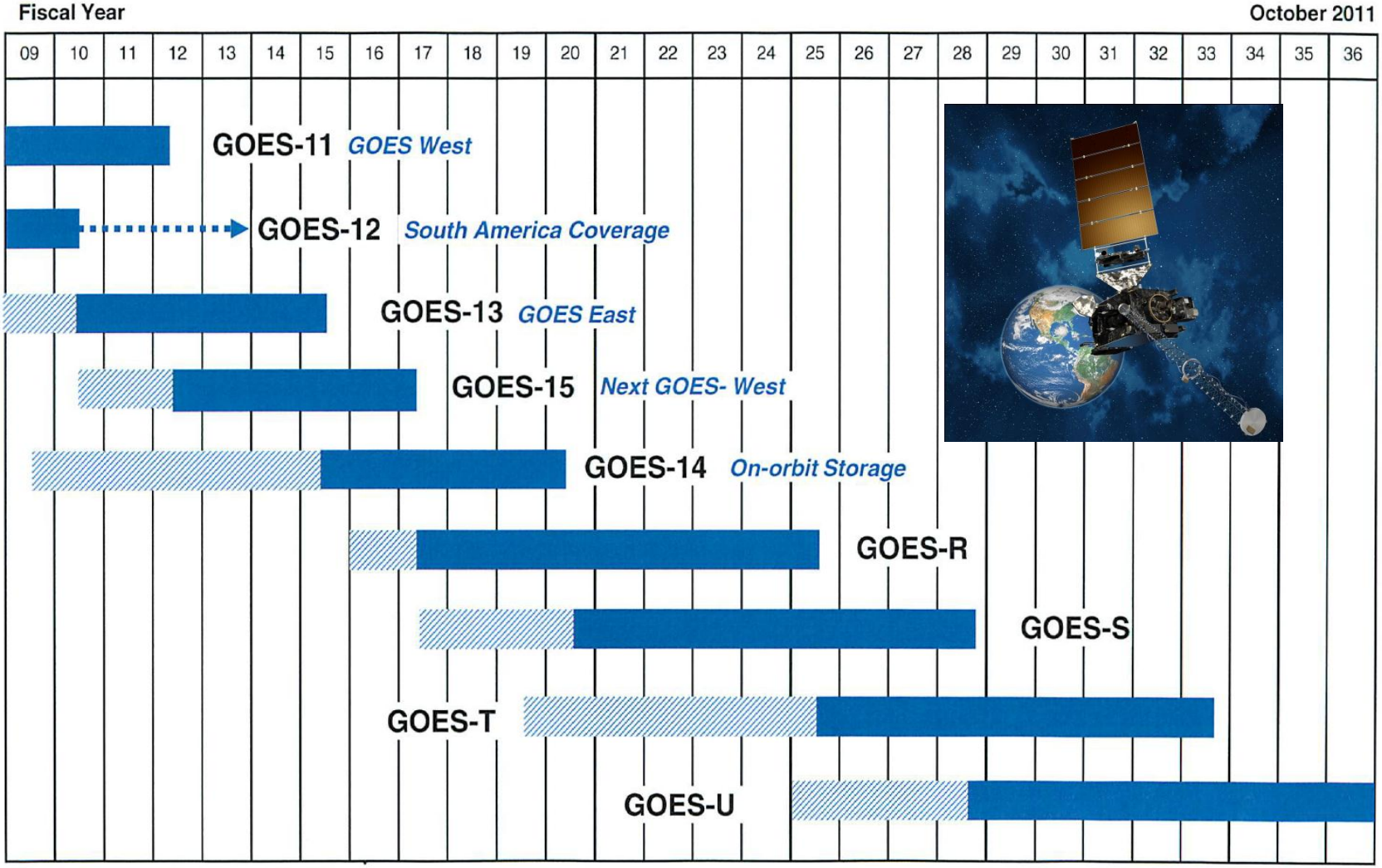
Solar Imaging

- ✓ Improve hurricane track & intensity forecasts
- ✓ Increase thunderstorm & tornado warning lead time
- ✓ Improve aviation flight route planning
- ✓ Data for long-term climate variability studies
- ✓ Improve solar flare warnings for communications and navigation disruptions
- ✓ More accurate monitoring of energetic particles responsible for radiation hazards to humans and spacecraft
- ✓ Better monitoring of Coronal Mass Ejections to improve geomagnetic storm forecasting

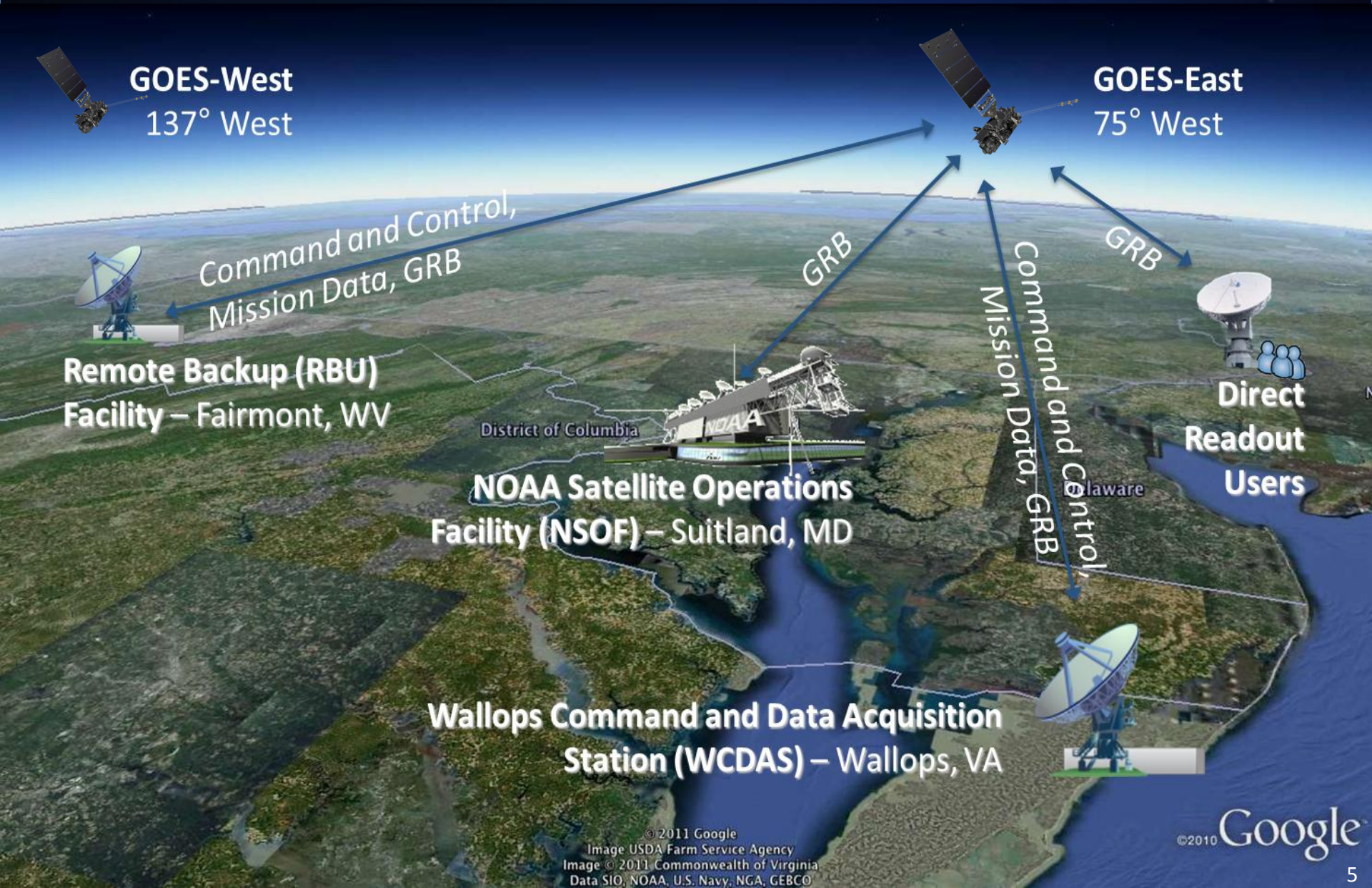
GOES Fleet


GOES WEST
137° West
GOES EAST
75° West
GOES
Launch / Checkout – 90° West
Storage Position – 105° West
60
30
0
-30
-60
90
120
150
-180
-150
-120
-90
-60
-30
0
30
60

Continuity of GOES Operational Satellite Program



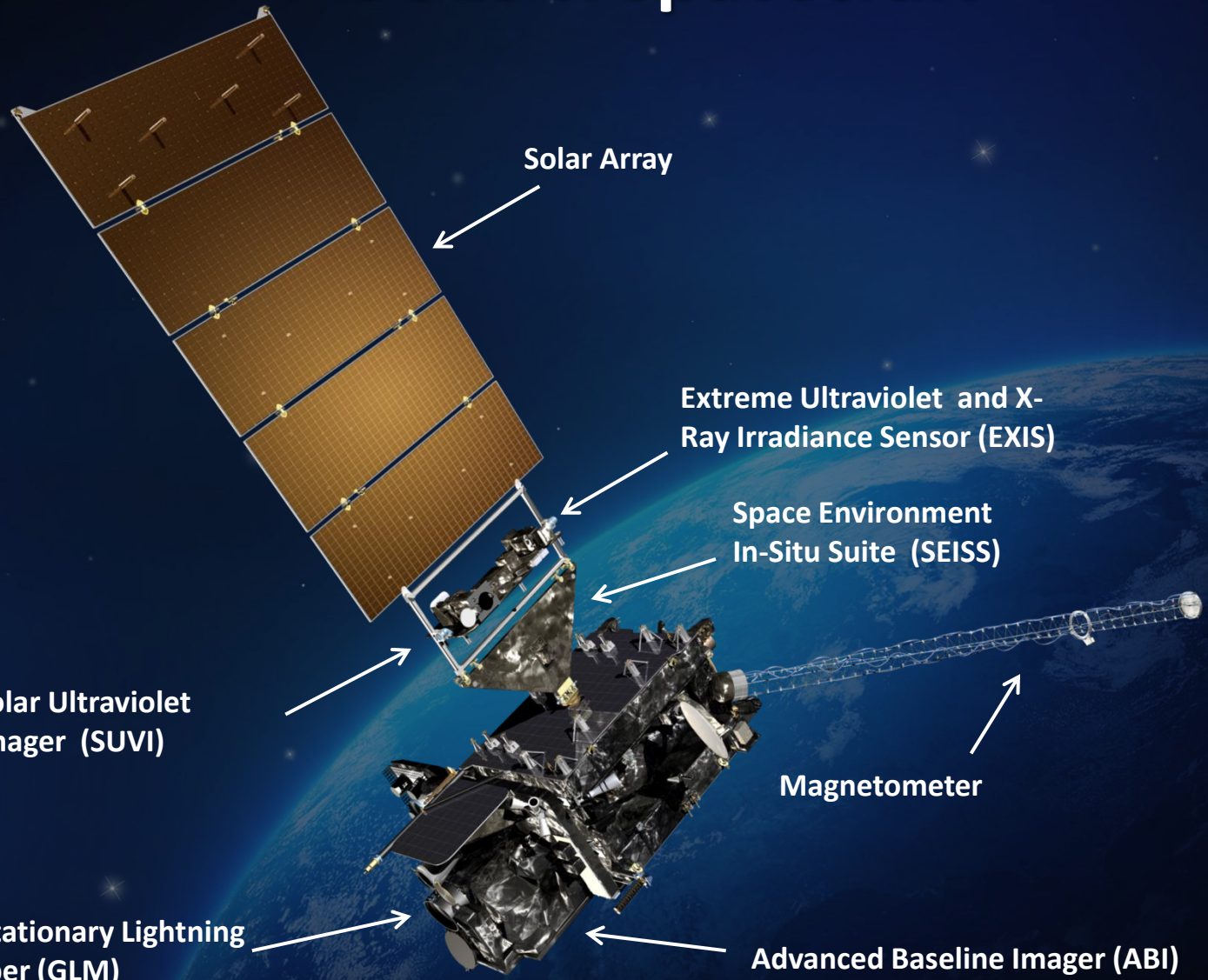
GOES-R Architecture



GOES-R Unique Payload Services

- **GOES Rebroadcast (GRB)**
  - GRB will contain the Level 1b data from each of the GOES-R Series instruments and is the GOES-R Series version of today's GOES Variable format (GVAR).
- **Information Network (HRIT/EMWIN)**
  - New high data rate (400 Kbps)
  - Combination of today's LRIT (Low Rate Information Transmission) and EMWIN services;
  - Delivers selected imagery, charts, other environmental data products, and text messages (NWS Watches and Warnings) to hemispheric users.
- **Data Collection System (DCS)**
  - GOES-R spacecraft relay data transmissions for nearly 30,000 in-situ environmental data platforms from across the hemisphere.
  - GOES-R will support 300 bps, 1200 bps, and CDMA platforms.
- **Search and Rescue Satellite Aided Tracking (SARSAT)**
  - All GOES-R satellites support the SARSAT system by relaying distress signals from 406 MHz emergency beacons.

GOES-R Spacecraft

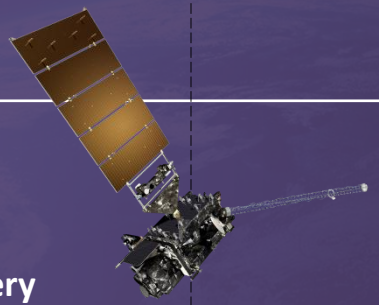


The Advanced Baseline Imager (ABI) on the GOES-R Series: Tim Schmit– Tue, Jan 24, 2:15 PM

Geostationary Lightning Mapper (GLM), GOES-R Series: Karen Gheno – Tue, Jan 24, 2:30 PM

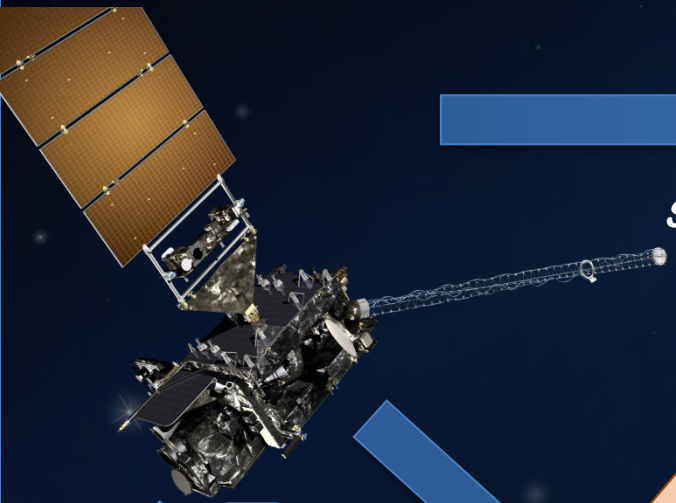
GOES–R Milestones

	2010	2011	2012	2013	2014	2015
Program/ System	✓ System Design Review complete	✓ Mission PDR Part I	○ Mission PDR Part II ○ Mission CDR		Launch Readiness Oct. 2015	
Flight Segment – Spacecraft	✓ S/C SDR complete	✓ S/C PDR complete	○ S/C CDR			
Flight Segment – Instruments	✓ All instruments have passed CDR	✓ ABI Delta CDR complete	○ ABI Delivery ○ SEISS Delivery ○ EXIS Delivery	○ SUVI Delivery ○ GLM Delivery		
Ground Segment	✓ 100 % delivery of baseline product algorithms	✓ Antenna System PDR completed ✓ Core GS PDR complete ✓ GS Project PDR complete	✓ Antenna System CDR ○ ESPDS CDR ○ CLASS CDR ○ GS CDR	○ RBU/NSOF/WCDAS installation ○ WCDAS complete ○ RBU complete ○ NSOF complete		



Development → Integration and Testing

GOES-R Data Distribution



GRB

Direct Broadcast Community

Sectorized Cloud and Moisture Imagery

AWIPS NCFs

NOAA Port

NOAAPort Community

GRB

L1B and L2+ Derived Products

Mission Data

GRB

GOES-R GS

ESPDS/ PDA

NSOF

L2+

WCDAS

GOES-R GS

RBU

L0, L1B

CLASS

L0, L1B and L2+ Derived Products

Operational User Community (NOAA Centers, DOD, NCEP, Int'l Partners

Climate Research & Academia

Fastest

Access Speed

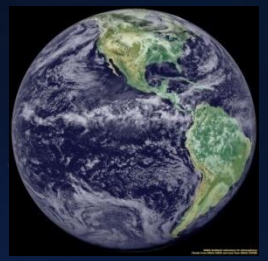
Slowest

Product Algorithm Development

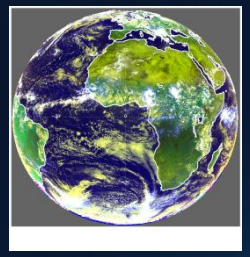
Algorithm Development → Calibration, Validation, and Verification → Algorithm Sustainment and Product Tailoring

"Real" ABI PROXY Data Sources

Current GOES

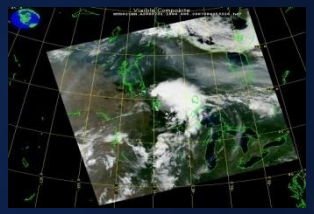


Meteosat/ SEVIRI

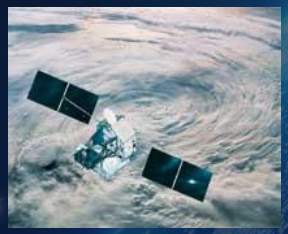


AVHRR

MODIS

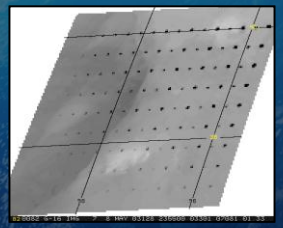


TRMM/LIS

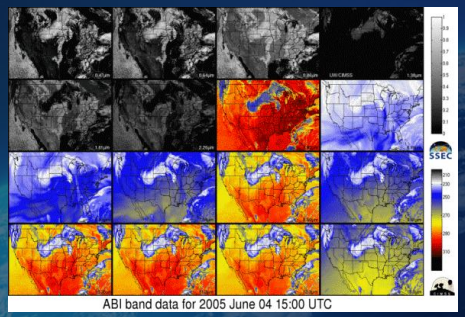


Lightning Mapping

3.9um (for fires)



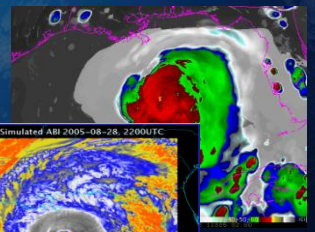
"Simulated" ABI Proxy Data Sources



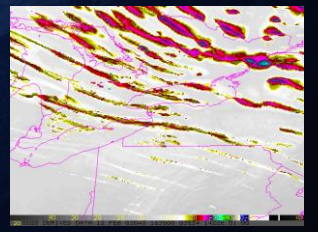
(FD, CONUS, Meso)

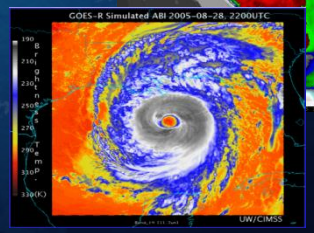
Case Studies

10.35um (Hurricane Lili)



10.35um (Lake Effect Snow)

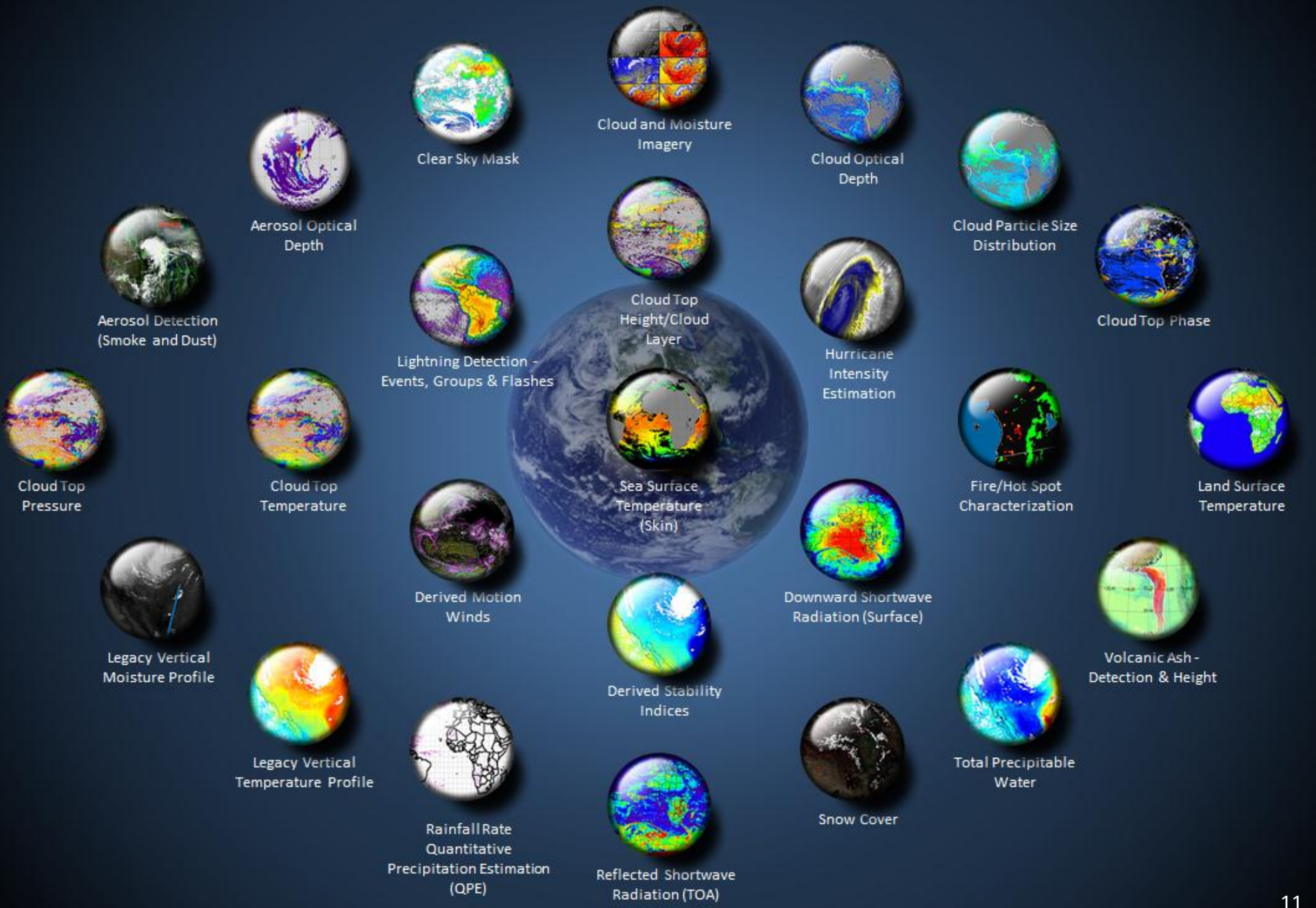




11.2 um (Hurricane Katrina)

AWG Proxy and Product Application Teams have assembled a wide variety of instrument proxy and simulated datasets to use for algorithm development, testing, and validation activities

GOES-R Baseline Products



GOES-R Products

Baseline Products

Advanced Baseline Imager (ABI)

Aerosol Detection (Including Smoke and Dust)
Aerosol Optical Depth (AOD)
Clear Sky Masks
Cloud and Moisture Imagery
Cloud Optical Depth
Cloud Particle Size Distribution
Cloud Top Height
Cloud Top Phase
Cloud Top Pressure
Cloud Top Temperature
Derived Motion Winds
Derived Stability Indices
Downward Shortwave Radiation: Surface
Fire/Hot Spot Characterization
Hurricane Intensity Estimation
Land Surface Temperature (Skin)
Legacy Vertical Moisture Profile
Legacy Vertical Temperature Profile
Radiances
Rainfall Rate/QPE
Reflected Shortwave Radiation: TOA
Sea Surface Temperature (Skin)
Snow Cover
Total Precipitable Water
Volcanic Ash: Detection and Height

Geostationary Lightning Mapper (GLM)

Lightning Detection: Events, Groups & Flashes

Space Environment In-Situ Suite (SEISS)

Energetic Heavy Ions
Magnetospheric Electrons & Protons: Low Energy
Magnetospheric Electrons: Med & High Energy
Magnetospheric Protons: Med & High Energy
Solar and Galactic Protons

Magnetometer (MAG)

Geomagnetic Field

Extreme Ultraviolet and X-ray Irradiance Suite (EXIS)

Solar Flux: EUV
Solar Flux: X-ray Irradiance

Solar Ultraviolet Imager (SUVI)

Solar EUV Imagery

Future Capabilities

Advanced Baseline Imager (ABI)

Absorbed Shortwave Radiation: Surface
Aerosol Particle Size
Aircraft Icing Threat
Cloud Ice Water Path
Cloud Layers/Heights
Cloud Liquid Water
Cloud Type
Convective Initiation
Currents
Currents: Offshore
Downward Longwave Radiation: Surface
Enhanced "V"/Overshooting Top Detection
Flood/Standing Water
Ice Cover
Low Cloud and Fog
Ozone Total
Probability of Rainfall
Rainfall Potential
Sea and Lake Ice: Age
Sea and Lake Ice: Concentration
Sea and Lake Ice: Motion
Snow Depth (Over Plains)
SO_2 Detection
Surface Albedo
Surface Emissivity
Tropopause Folding Turbulence Prediction
Upward Longwave Radiation: Surface
Upward Longwave Radiation: TOA
Vegetation Fraction: Green
Vegetation Index
Visibility

Overview of GOES-R Level 2 Products: Jaime Daniels – Tue, Jan 24, 3:30 PM

GOES-R Space Weather Observations and Products: Steven Hill – Wed, Jan 25, 8:30 AM

New Quantitative Volcanic Cloud and Fog Products for GOES-R: Mike Pavolonis – Wed, Jan 25, 9:00 AM

Future Capability Products: Path Forward

- **GOES-R working on post launch product evolution/addition process**
  - The algorithm development will complete, and the GOES-R AWG will deliver tested Algorithm Theoretical Basis Documents (ATBDs)
  - These materials are available to users at NOAA's discretion
  - NWS assessing its priorities for future product algorithms "as is" or as fused/integrated services and capabilities
- **All data necessary to produce these future capability products are available to users**
  - GOES-R produced data into Environmental Satellite Processing and Distribution System (ESPDS)/Product Distribution and Access (PDA)
    - L-1b, calibration, spacecraft specific data, etc.
  - Ancillary Data (external sources) into ESPDS/Ancillary Data Relay System (ADRS)

GOES-R User Readiness

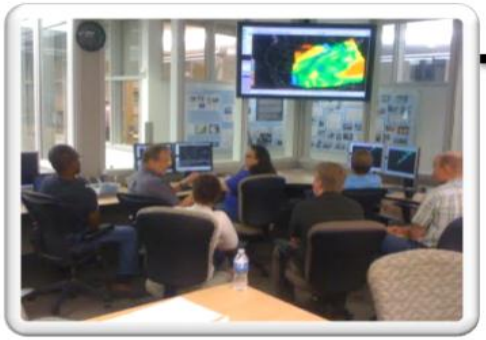
- Re-launched **www.goes-r.gov** in May 2011 with expanded User Community content
- GOES-R Facebook page launched June 2011 (**https://www.facebook.com/GOESRsatellite**)
- GOES-R Proving Ground
  - Demonstrations
  - CIMMS, CIRA, SPoRT, HWT blogs
- Visiting Scientist Program
- Forecaster Feedback
- Training and Outreach
- Fact sheets
- Tri-fold brochure
- User Readiness Plan under development

The GOES-R Proving Ground

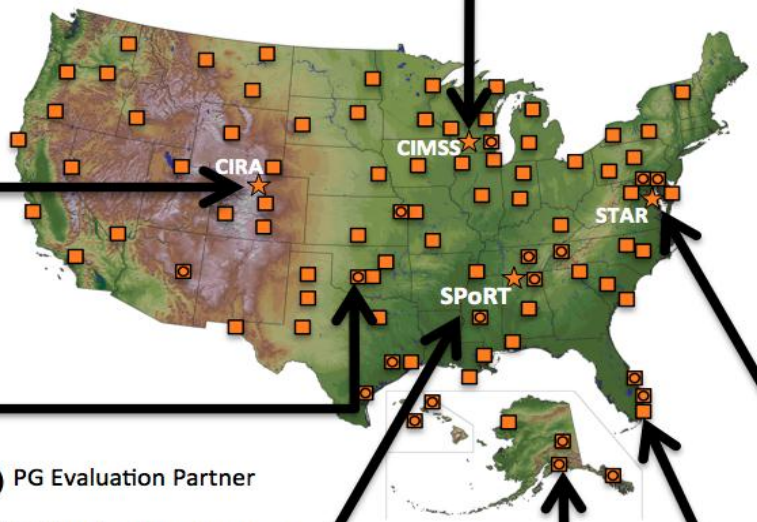
- Collaborative effort between the GOES-R Program Office, selected NOAA Cooperative Institutes, NWS forecast offices, NCEP National Centers, NASA SPoRT, JCSDA, and NOAA Testbeds
- Responsible for user readiness testing of GOES-R baseline products and future capabilities prior to launch
- Where proxy and simulated GOES-R products are tested, evaluated, and integrated into operations before the GOES-R launch
  - Satellite Champions at NWS National Centers
  - Develop training for users
  - Prepare for display within AWIPS/AWIPS-II/N-AWIPS
  - Initial focus on High Impact Weather and warning related products requested by NWS
- A key element of GOES-R User Readiness (Risk Mitigation)
- Proving Ground activities are having an impact **NOW!**

The GOES-R Proving Ground

CIRA - Ft. Collins, CO
ABI Simulated Natural Color



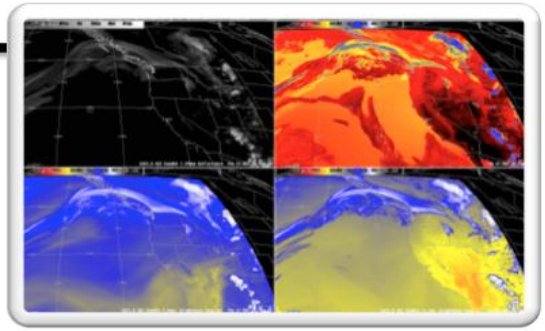
SPC – Oklahoma City, OK
Nearcast Training at the Hazardous Weather Testbed



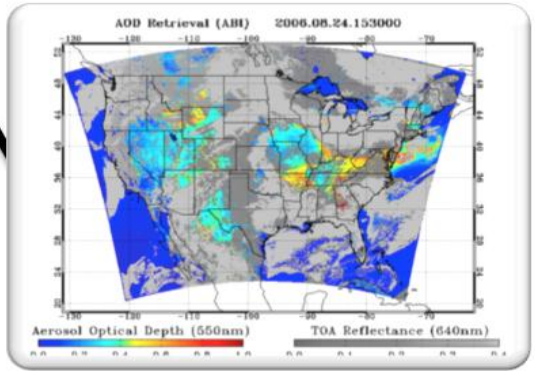
PG Evaluation Partner

PG Product Development Partner

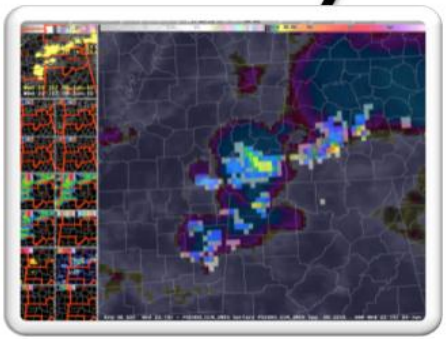
Cooperative Institute



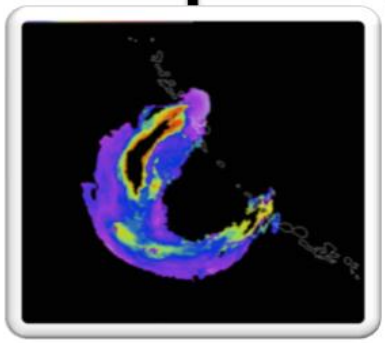
CIMSS – Madison, WI
Simulated ABI Bands



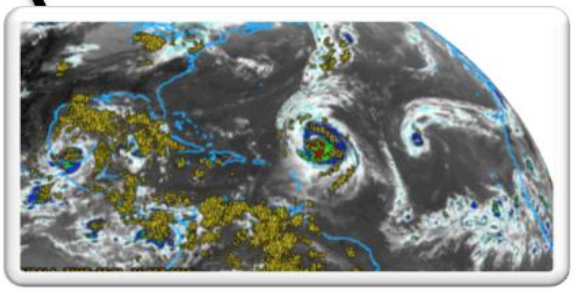
STAR – Camp Springs, MD
Aerosol Optical Depth Product



SPoRT – Huntsville, AL
GLM Lightning Flash Density



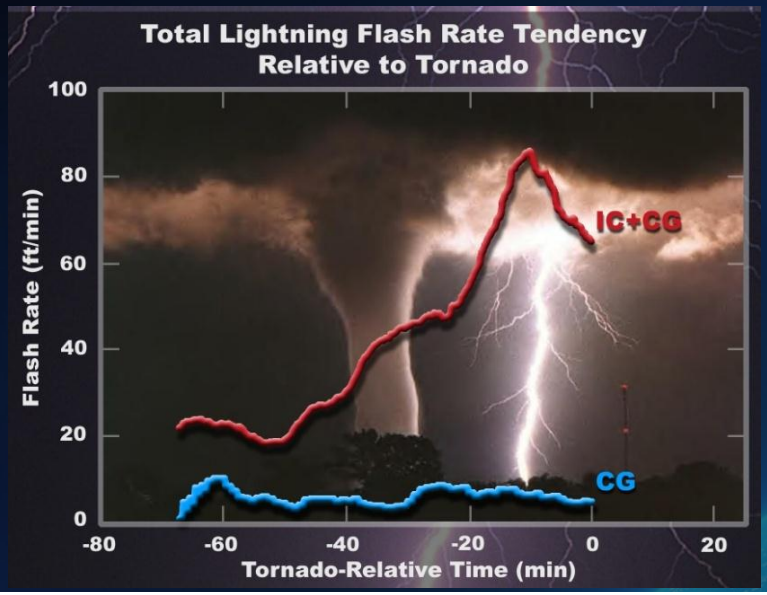
AFC – Anchorage, AK
Volcanic Ash Product



NHC – Miami, FL Rapid Intensification Index

GOES-R Proving Ground – Demonstrating GOES-R Products in 2011: Bonnie Reed – Wed, Jan 25, 5:00 PM
GOES-R Air Quality Proving Ground: Raymond Hoff – Thu, Jan 26, 2:45 PM

Lightning Detection



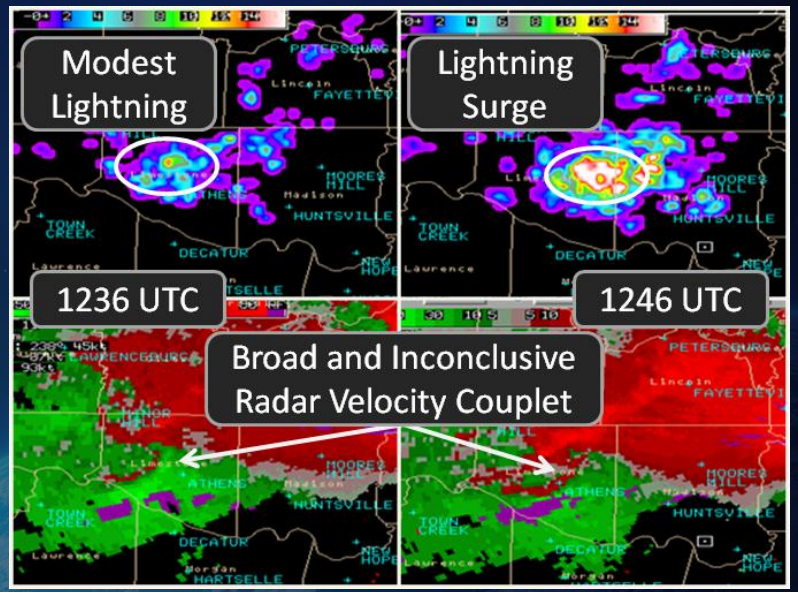


TABLE 3. Skill scores and average lead times using the sample set of 711 thunderstorms for both total lightning and CG lightning, correlating trends in lightning to severe weather.

	POD	FAR	CSI	HSS	lead time (all)	lead time (tornado)
Total lightning	79%	36%	55%	0.71	20.65 mins	21.32 mins

National Average for Tornado warning lead-time is only 13 minutes

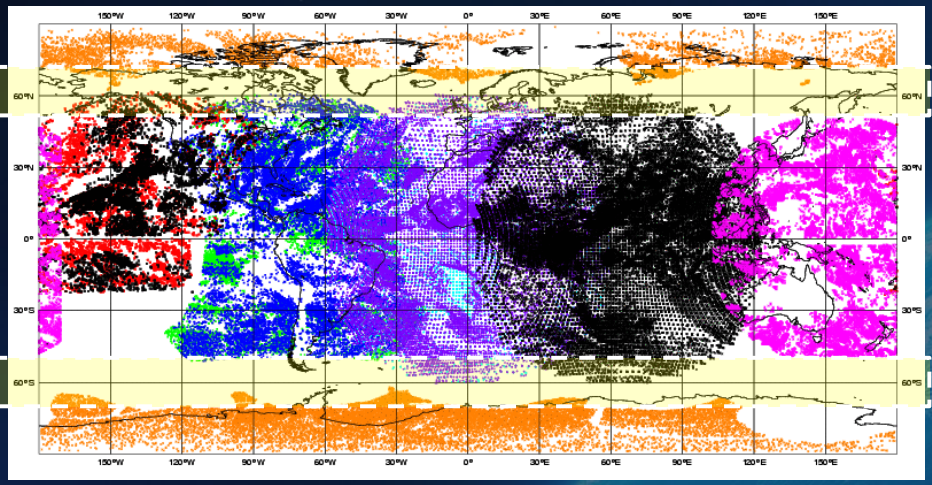
Experiment Design developed for an operational demonstration of the total lightning algorithm at the Hazardous Weather Testbed (at request of NWS)

Initial Results From Pre-Launch Algorithm Development and Testing for the GOES-R GLM: Jim Gurka– Wed, Jan 25, 8:30 AM

Example of Geo-LEO blended Product

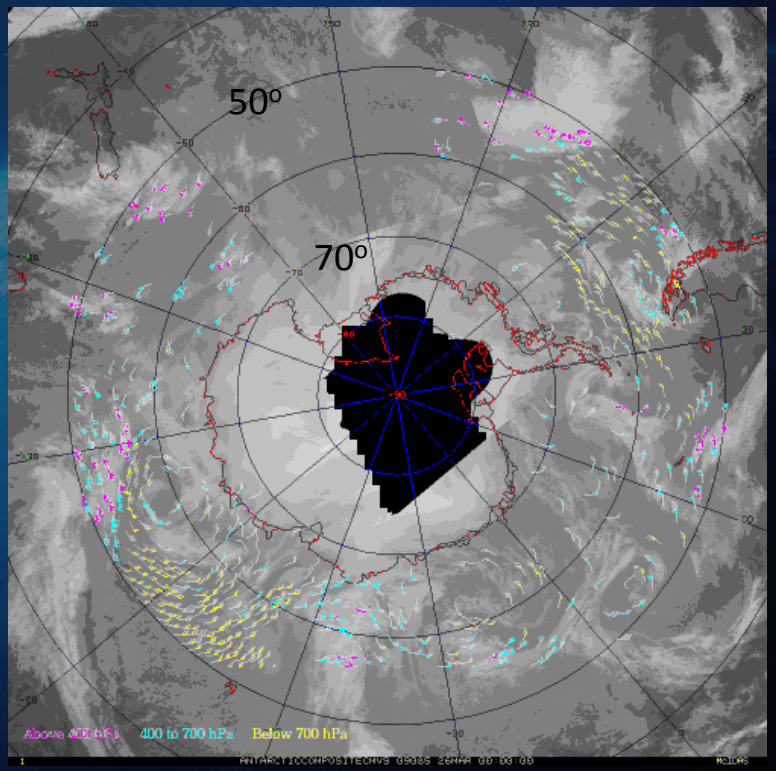
High Latitude Atmospheric Motion Vectors

Geostationary satellites provide Atmospheric Motion Vectors (AMV) equatorward of ~60° latitude; polar satellites provide AMVs poleward of ~70° latitude.



Developing novel ways to fill this gap is the next step in providing complete wind coverage for NWP applications.

Multiple satellite data are blended and used for AMV generation. The images are composites of the Geo (GOES, Meteosat-7 and -9, FY-2C, MTSAT-1R, Kalpana-1) and Leo satellites (NOAA-15 through NOAA-19, Metop-A, NASA's Terra and Aqua).



Animation: Example of winds from composite GEO/LEO satellite data over Antarctica.

Slide courtesy of Matthew Lazzara/SSEC

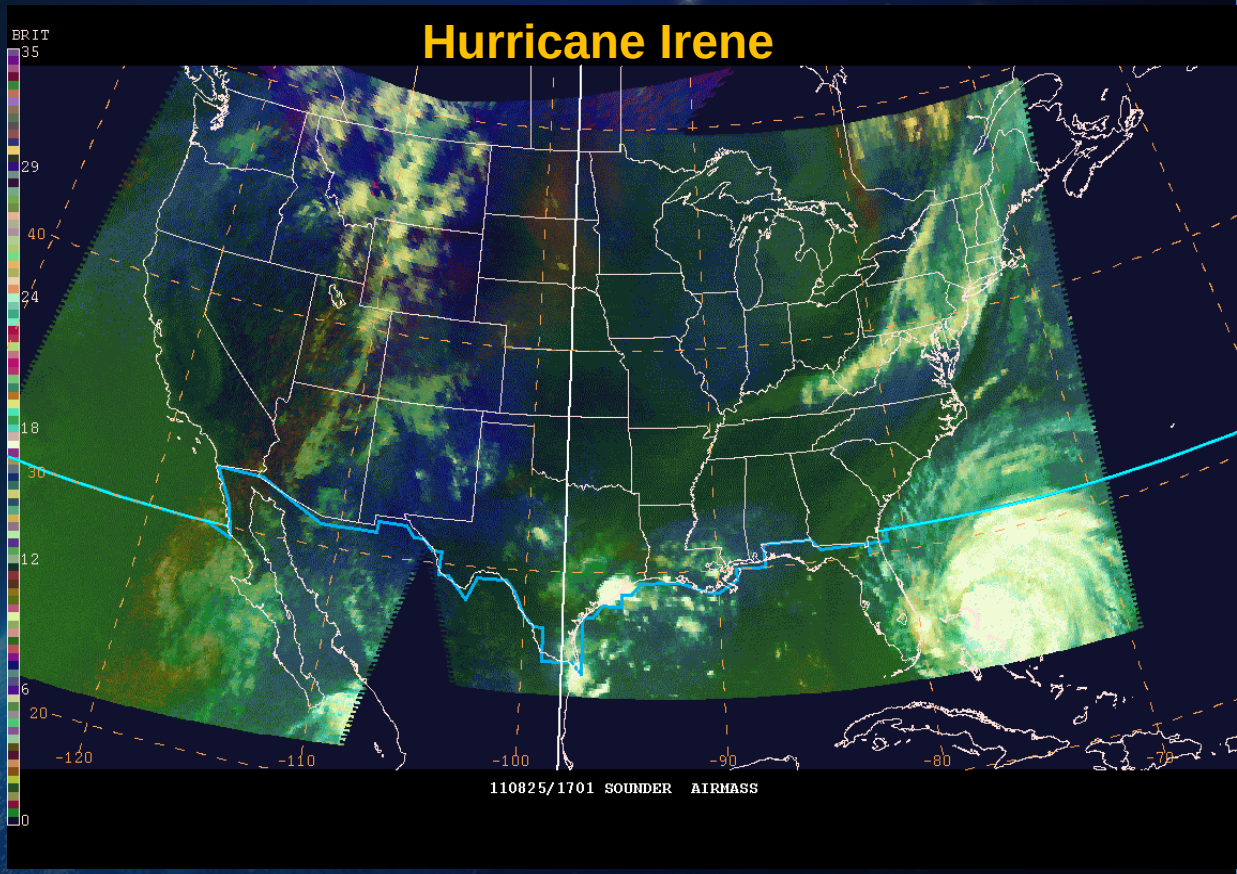
RGB Air Mass Product

Future Capability

"The RGB airmass and dust products were very useful in showing that the pre-Irene disturbance was going to have dry air issues initially. I think this helped us give the system a low chance of development in the early tropical weather outlooks."

Jack Beven, NHC

As the hurricane is approaching Cape Lookout, NC, the RGB product shows evidence of synoptic-scale dry air on the south-southeast side of the circulation. Synoptic –scale dry air is present to the northwest on the periphery of the storm. This dry air is caught in the southwest inflow channel, effectively cutting off convective development by introducing stably stratified air.



From John Knaff/CIRA, NASA SPoRT ,and Michael Folmer (CICS Satellite Champion at HPC/OPC/SAB)

GOES-R Visiting Scientist Program

- 10 Visiting Scientists have been selected in 2012 for 1-4 week visits to exchange ideas and initiate/continue collaborations applicable to their current research with other scientists and end users

- Scientist exchanges among NWS Centers and regions, NOAA Cooperative Institutes, national laboratories, and other partners
  - Continuing cooperation with EUMETSAT, Environment Canada, and others

GOES-R Science Team member Dan Lindsey of NESDIS and Visiting Scientist Martin Setvak of CHMI (circled) participated in Convection Working Group meeting in Prague.

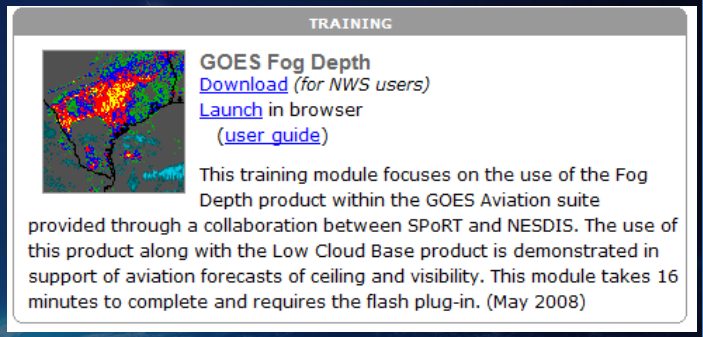
The 2011 HPC/OPC/SAB GOES-R Proving Ground Demonstration: GOES-R Satellite Champion Michael Folmer – Tue, Jan 24, Poster Session

The Impact of the Saharan Air Layer on the Development of Eastern Atlantic Tropical Cyclones: Michael Folmer – Wed, Jan 25, Poster Session

Training and Education

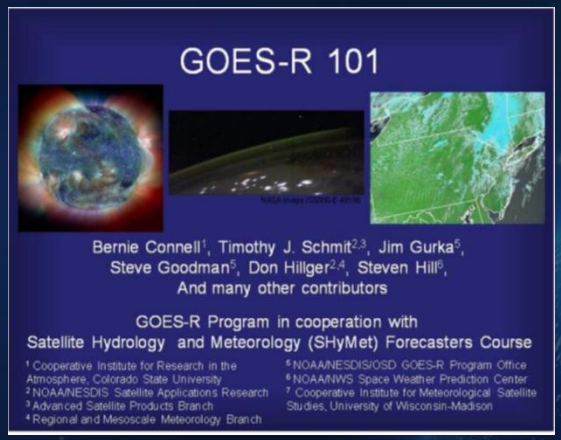
Online Training Modules

- GOES-R: Benefits of Next-Generation Environmental Monitoring (COMET)
- GOES-R 101
- Satellite Hydrology and Meteorology for Forecasters (SHyMet)
- SPoRT product training modules
- Commerce Learning Center



Printed Materials

- GOES-R Fact Sheets (17)
- GOES-R Tri-fold



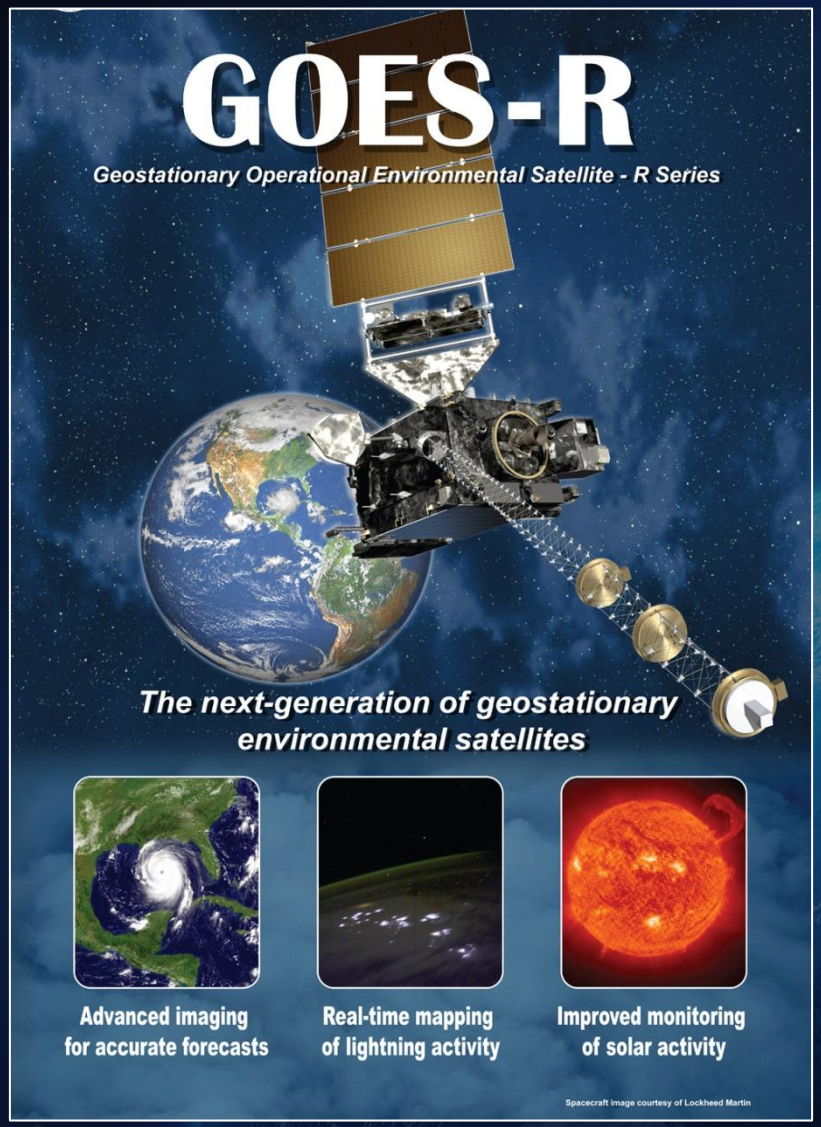
Outreach Projects (with NWSFOs)

- COMET will reach out to the GOES-R Proving Ground Partners and connect them with university faculty to use current and prototype data products for the purpose of building a bridge from products that are currently available to those that will become available when GOES-R is launched.

Training in the NOAA Satellite Proving Ground: Tony Mostek– Wed, Jan 25, 5:15 PM

Training University Faculty to Teach Future Meteorologists to Incorporate GOES-R Data in the Forecast Process: Elizabeth Page – Thu, Jan 26, 11:00 AM

Satellite Meteorology Educations Resources Freely Available from COMET: Patrick Dills – Thu, Jan 26, 11:15 AM



Thank you!

Any ???

For more information visit www.goes-r.gov

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