



# GOES-R is Coming- Are You Ready!

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## GOES-R Mission Overview

### Mission

The launch of the first in the series of next generation NOAA geostationary environmental satellites, the GOES-R series, is only one year away with the launch of the first satellite planned for March 2016. The NOAA Administrator announced at the 2015 AMS Annual Meeting that GOES-R will continue observations during its extended post-launch testing through the 2016 Atlantic Hurricane Season and transition immediately into operations afterward (March 2017). The instruments are all integrated on the satellite; the new ground processing system is deployed and undergoing integration testing; and the training plan for forecasters is rapidly coming into focus. The GOES-R Proving Ground has long been preparing forecasters, through the use of proxy data, for the new capabilities of GOES-R.

### Measurement and Products

Compared to the current GOES imager, the new 16-band Advanced Baseline Imager (ABI) has twice the spatial resolution, three times more spectral information, four times greater coverage, and five times faster refresh (5 or 15 min full disk, 30 sec mesoscale), as well as a new Geostationary Lightning Mapper (GLM) to detect total lightning with 8 km spatial resolution and < 20 sec latency.



## Ground System Architecture

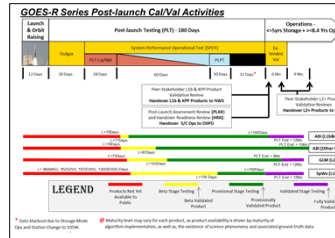


## User System Readiness and Data Operations Exercises (DOEs)

- DOEs provide incremental readiness to prepare systems, operators, processes, and teams to support mission operations
- Conducted in a "rehearse like we fly" manner
- Both nominal and anomalous conditions are exercised; Some long duration DOEs are planned to satisfy consumers' needs
- Provide risk reduction for scripted GSIT (Ground Segment Integration & Test team) requirement (functionality and capability) verification tests
- OSPO-approved Product Distribution & Access (PDA), the Enterprise GUI-based customer data access portal) users can use DOEs to validate their requirements
- NWS and PDA are engaged in the planning and execution of the DOEs
- Coordination with NWS is on-going to extend the exercises through the NWS system
- Goal is to ultimately exercise the entire ground system by processing data from end-to-end, from L0 through L2+, including PDA

## Product Validation, Pre- and Post-Launch Testing

- Primary focus is "Day-one Readiness" for GOES-R observatory post-launch tests and data post-launch product tests. This readiness includes: Planning of observatory and data product tests; Software analysis tool development and testing; Cal/Val Operational Concept development and rehearsals; and Core Ground Segment training for cal/val personnel using GS capabilities.
- Pre-Launch: L1b and L2+ algorithm implementation in the Ground Segment (GS) is verified by comparing data products produced by the GS with expected results provided by instrument vendors (L1b) and the Algorithm Working Group (ABI and GLM L2+)
- Post-Launch: The Post-Launch Testing period includes a traditional observatory checkout, but also contains a period of Post-Launch Product Tests (PLPTs) designed for limited product quality assessment before Spacecraft Handover (Launch + 6 mo). After Handover, a period of Extended Validation (Launch + 12 mo) is planned to enhance product science validation maturity.
- At Spacecraft Handover: the expectation is that all L1b products and Cloud & Moisture Imagery will be Provisionally Validated, while all other products will be Beta Validated



- Beta** - Product is minimally validated, and may still contain significant errors (identified and unidentified).
- Provisional** - Product performance (L1b or L2+) has been demonstrated through analysis of a large, but still limited (i.e., not necessarily globally or seasonally representative) number of independent measurements obtained from selected locations, time periods, or field campaign efforts.
- Validated** - Product performance has been demonstrated over a large and wide range of representative conditions (i.e., global, seasonal).

## Risk Reduction Research and New Applications

### Improving Coastal Precipitation Forecast through Direct Assimilation of GOES-R ABI Radiances in GS-NAM/HWRF

Direct assimilation of GOES-R L1, L2, L3 and L4 radiances has been ongoing since 2010. Forecast impacts on coastal QPFs has been overall moderately positive, mainly because the stronger radiance over ocean coastal areas provide key information of both temperature and lower vapor content. For the only 16-band radiance ABI radiances and only through data, 40 km resolution over the CONUS, have been used.

GOES-R L1b project will extend the direct assimilation of GOES-R radiances in the NWS HWRF.

Revisions of both the models and data handling will be required, which algorithms for cloud detection, data filtering and quality control.

The average 3-hour forecast error at 1 mm (top panel) and 15 mm (bottom panel) threshold from 0000 UTC to 2400 UTC May 25, 2008 of forecasts without (red bars) and with (black bars) GOES-R image data added to conventional data and different types of satellite data.

### Development and Optimization of Mesoscale Atmospheric Motion Vectors (AMVs) using 15 min Proxy Data, Demonstration of Readiness for GOES-R Applications via Impact Studies in Mesoscale NWP Systems

Super-rapid scan operations (SRSO) imagery (available at 5-min frequency) provided during special GOES-R tests can be used as proxy data for GOES-R radiances.

We can exploit this temporal upgrade towards the development and optimization of AMV production, particularly on operations applications. Dense datasets are needed such as in hurricane or mesoscale applications.

Case study AMV datasets will be processed and optimized, then provided to our mesoscale and hurricane NWP partners for data assimilation and model forecast impact testing.

### Diagnosis and Anticipation of Tropical Cyclone Behavior from New and Enhanced GOES-R Capabilities

Three tasks are proposed that will improve the use and interpretation of GOES-R imaging capabilities:

- Anticipation of tropical cyclone eye formation.
- Improved understanding of cloud top microphysical variations in tropical cyclones.
- Use of simulated HWRF IR imagery to improve tropical cyclone wind structure diagnosis from observed IR imagery.

Improved interpretation and use of GOES-R imaging capabilities in the vicinity of tropical cyclones.

### Using Total Lightning Data from GLM/GOES-R to Improve Real-time Tropical Cyclone Genesis and Intensity Forecasts

Dr. DeMaria and his research group at CIRES/UCR have developed a new WWSLLN lightning flash intensity product using the Earth Radiation Budget Index (ERBI) within SWIR.

WWSLLN, however, generally detects cloud-to-ground flashes, which were shown to be weakly correlated with tropical cyclone intensity. Recent studies have shown that overall increased (R2) bands indicated the presence of vertical hot towers during prior to the main eye to be a signature of the storm's intensification. The magnitude of the coefficient is proportional to the importance of that variable in the estimate of the probability of rapid intensification.

Development of new version of RR by FY18 and potential real-time demonstration by FY17.

## User Readiness- Proving Ground Demonstrations and Training

- Supports the demonstration and utilization of new capabilities by the end users thus facilitating the early transition of GOES-R to operations (R2O)
- Infuses GOES-R products and techniques into NWS operations with emphasis on AWIPS and transitioning to AWIPS-II
- Incorporates user feedback for product improvements
- Bridges the gap between research and operations using current systems (satellite-MODIS, VIIRS, Himawari, terrestrial, model, synthetic) to emulate GOES-R capabilities.

## Training and User Education

### Online Training Modules

- GOES-R User Orientation for the Observers
- GOES-R User Orientation for the Forecasters
- New Satellite Observations Impact NWS (GOES-R)
- GOES-R Air, Sea, and Inland Imaging
- GOES-R Air, Sea, and Inland Imaging
- GOES-R Air, Sea, and Inland Imaging
- GOES-R Air, Sea, and Inland Imaging
- GOES-R Air, Sea, and Inland Imaging

### Printed Materials

- GOES-R User Orientation for the Observers
- GOES-R User Orientation for the Forecasters
- GOES-R Air, Sea, and Inland Imaging
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NHC Proving Ground Product	Category	Evaluation Goals
GOES-R natural color		
RGB air mass		
RGB dust		
Saturn Air Layer (SAL)		
Pseudo natural color imagery product		
Hurricane Intensity Estimate (HIE)	Quantitative	Continued to obtain feedback, quantitative verification
Rapid Intensification Index (RII)		
RGB daytime microphysics		
RGB nighttime microphysics	Introductory	Explore and obtain feedback on tropical applications - all users introduced in late 2013, little exposure
30 sec proxy high band		
30 sec proxy high band		
CSA RGB Dust (DRBA)	Comparison	Encourage forecasters to display comparison products w/ originals, provide strengths and weaknesses
Lightning density		
Super rapid scan imagery		
Tropical overshooting tops (TOT)	Underutilized	Continue to be included, modified, or given less emphasis?

Future GOES Imager (ABI) band	Wavelength range (µm)	Central wavelength (µm)	Nominal subpixel IFOV (km)	Sample use
1	0.45-0.49	0.47	1	Daytime aerosol over land, coastal water mapping
2	0.59-0.69	0.64	0.5	Daytime cloud fog, insolation, winds
3	0.846-0.885	0.845	1	Daytime vegetation, burn scar and aerosol over water, winds
4	1.371-1.386	1.378	2	Daytime cirrus cloud
5	1.58-1.64	1.61	1	Daytime cloud-top phase and particle size, snow
6	2.225-2.275	2.25	2	Daytime land/cloud properties, particle size, vegetation, snow
7	3.80-4.00	3.90	2	Surface and cloud fog at night, fire, winds
8	5.77-6.6	6.19	2	High-level atmospheric water vapor, winds, rainfall
9	6.75-7.15	6.95	2	Mid-level atmospheric water vapor, winds, rainfall
10	7.24-7.44	7.34	2	Lower-level water vapor, winds, and SO <sub>2</sub> rainfall
11	8.3-8.7	8.5	2	Total water for stability, cloud phase, dust, SO <sub>2</sub> , rainfall
12	9.42-9.8	9.61	2	Total ozone, turbulence, and winds
13	10.1-10.6	10.35	2	Surface and cloud imagery, SST, clouds, rainfall
14	10.8-11.6	11.2	2	Surface and cloud imagery, SST, clouds, rainfall
15	11.8-12.8	12.3	2	Total water, SO <sub>2</sub> , and SST
16	13.0-13.6	13.3	2	Air temperature, cloud heights and amounts

### GOES-R PRODUCTS

#### Advanced Baseline Imager (ABI)

- Aerosol Detection (including Smoke and Dust)
- Aerosol Optical Depth (AOD)
- Clear Sky Index
- Cloud and Moisture Imagery (CMI)
- Cloud Optical Depth
- Cloud Top Size Distribution
- Cloud Top Height
- Cloud Top Pressure
- Cloud Top Temperature
- Derived Motion Winds
- Derived Stability Indices
- Derived Shortwave Radiation Surface
- Fire Hot Spot Characterization
- Haze and Intensity Estimation
- Land Surface Temperature (Skin)
- Legacy Vertical Moisture Profile
- Legacy Vertical Temperature Profile
- Radiance
- Radiance
- Reflected Shortwave Radiation: TOA
- Sea Surface Temperature (Skin)
- Snow Cover
- Total Precipitable Water
- Visible Air, Detection and Height

#### Geostationary Lightning Mapper (GLM)

- Lightning Detection: Events, Groups & Flashes

#### Space Environment to Situ Suite (SESS)

- 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 (DUVI)

- Solar Images (2 nm) coronal holes, solar flares, coronal mass ejection source regions

Atmospheric Motion Vectors (AMVs)

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