Overview of the NextGen Weather Research and Development Program

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NextGen Weather Program R&D Overview

What is "NextGen" at the National Weather Service?

…a *transformational* program within the National Weather Service

…seeks to improve services, *change behaviors*, and develop new ideas

…*invests* in the research enterprise to create "game changing" knowledge and technologies

NextGen Weather Program R&D Overview

NOAA NextGen Weather Program

|	
IT Services Project	• Aviation weather data discoverability, translation and dissemination services • Discoverable single access point for weather information in common formats
Single Authoritative Source Project	• Primary source of "Official" weather information for aviation decisions • Dynamically determined set of most accurate weather information sources
Verification Project	• Network-Enabled system for determination of quality of weather information
Forecast Applications Project	• Forecaster Applications allowing manipulation of high res, rapidly updated data sources • Enables forecaster intervention to correct for poor performance of automated forecasts
Model Project	• High resolution, rapidly updated models • Probabilistic models for forecasting uncertainty
Aviation Weather Elements Projects	• Scientific improvements to weather information critical to aviation operations

NextGen Weather Program R&D Overview

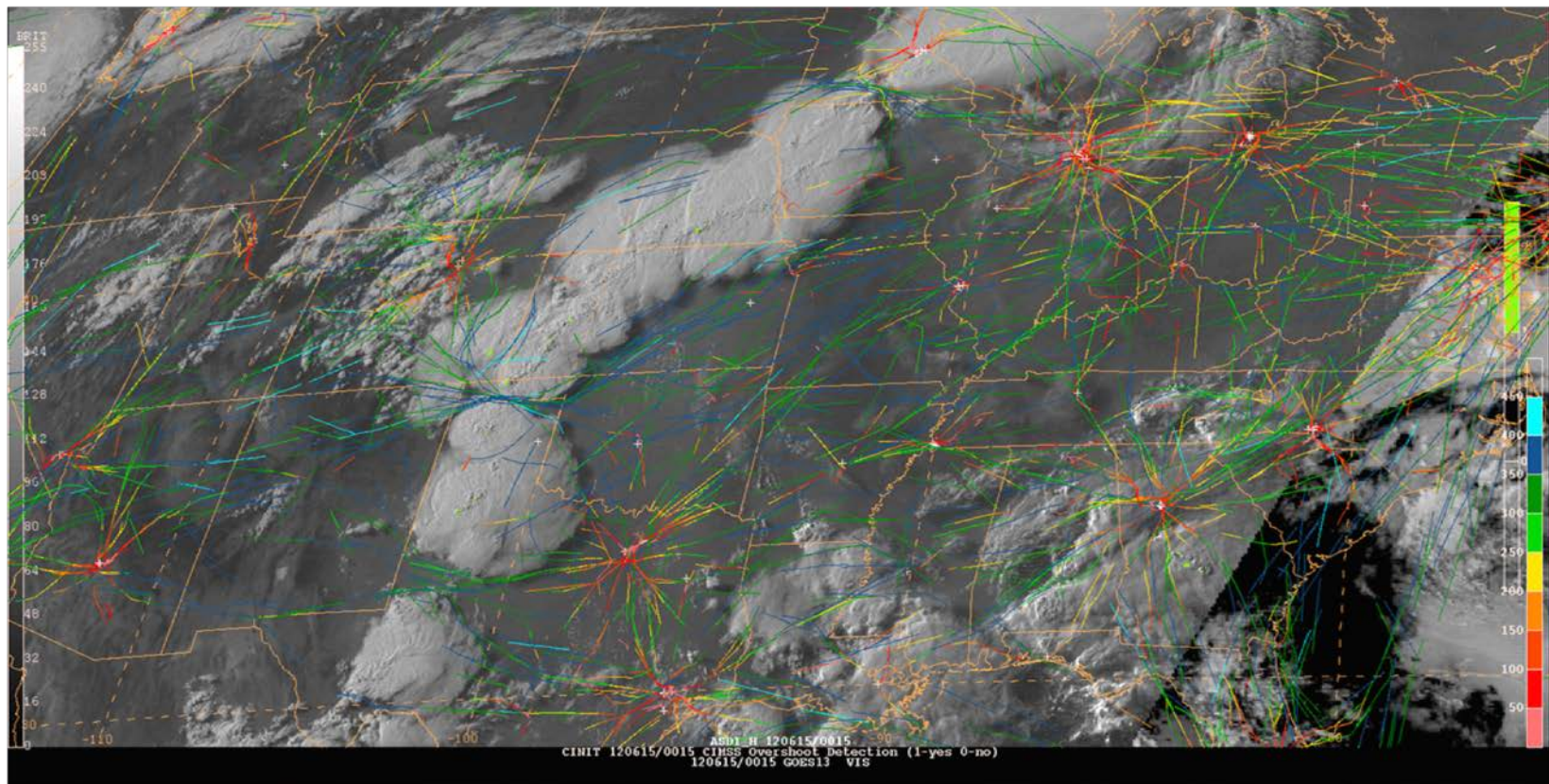## NextGen research matrix for FY12 and FY13

Operations to Research
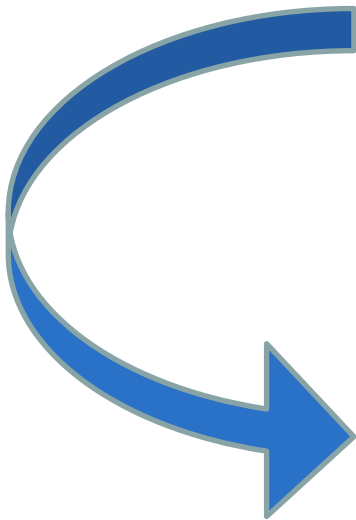
Convection	Ceiling and Visibility	Visualization
Icing	Turbulence	Verification
Analytics	Modeling & Probabilistic Output	Human Factors/Decision Support

Research to Operations

NextGen Weather Program R&D Overview

"Weather is just an uncontrolled user of airspace!"

NextGen Weather Program R&D Overview

The 2012 Aviation Weather Testbed Summer Experiment

| June 4-15, 2012 at the AWT in Kansas City, MO

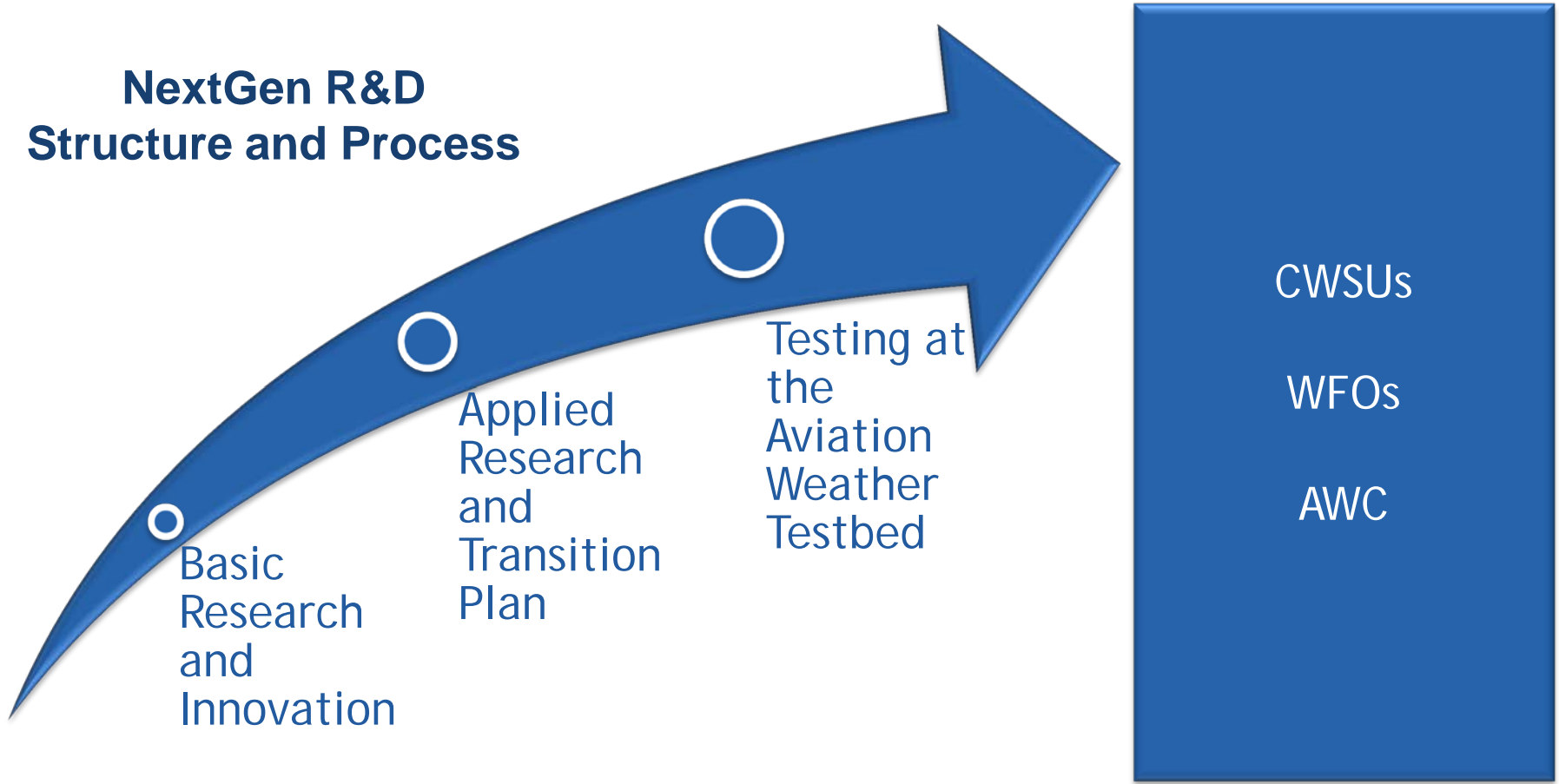Over 60 participants	Tested the Aviation Weather Statement	GOES-R Applications	Integrated ASDI Information
	High Resolution Models	Verification	Translation to Impact

http://testbed.aviationweather.gov

NextGen Weather Program R&D Overview

NextGen R&D Structure and Process

Basic Research and Innovation

Applied Research and Transition Plan

Testing at the Aviation Weather Testbed

CWSUs

WFOs

AWC

NextGen Weather Program R&D Overview

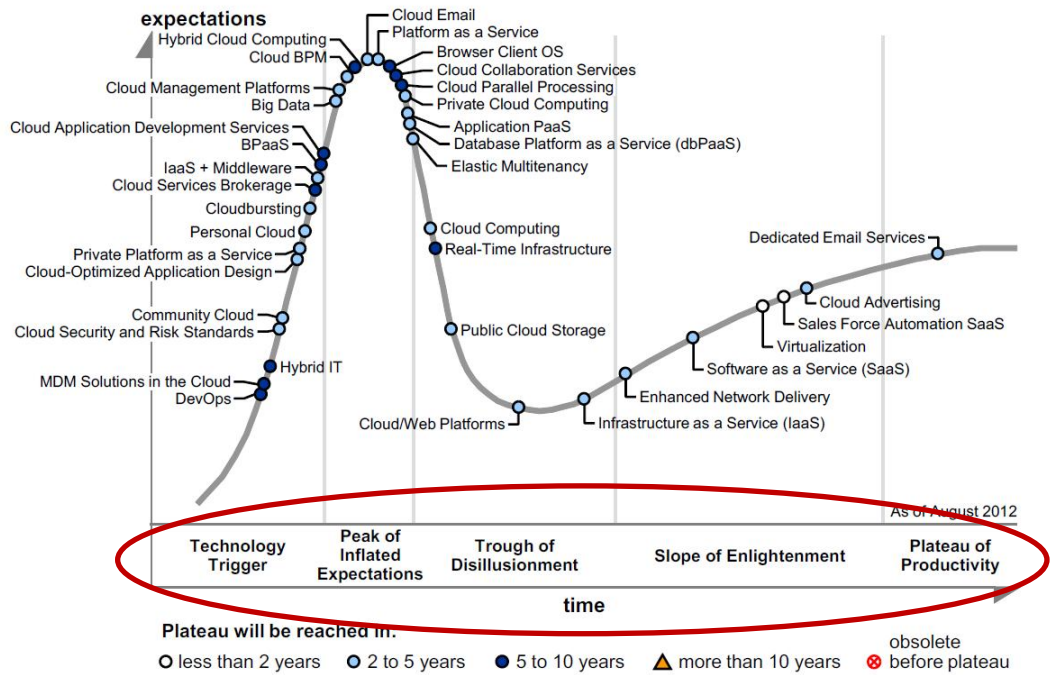## Reality check – we need to find the right questions.

4529 days until FOC as of today, August 8th, 2012.

647 weeks.

Uncertain budget cycles.

Much to discover and innovate in that time.

Figure 1. Hype Cycle for Cloud Computing, 2012
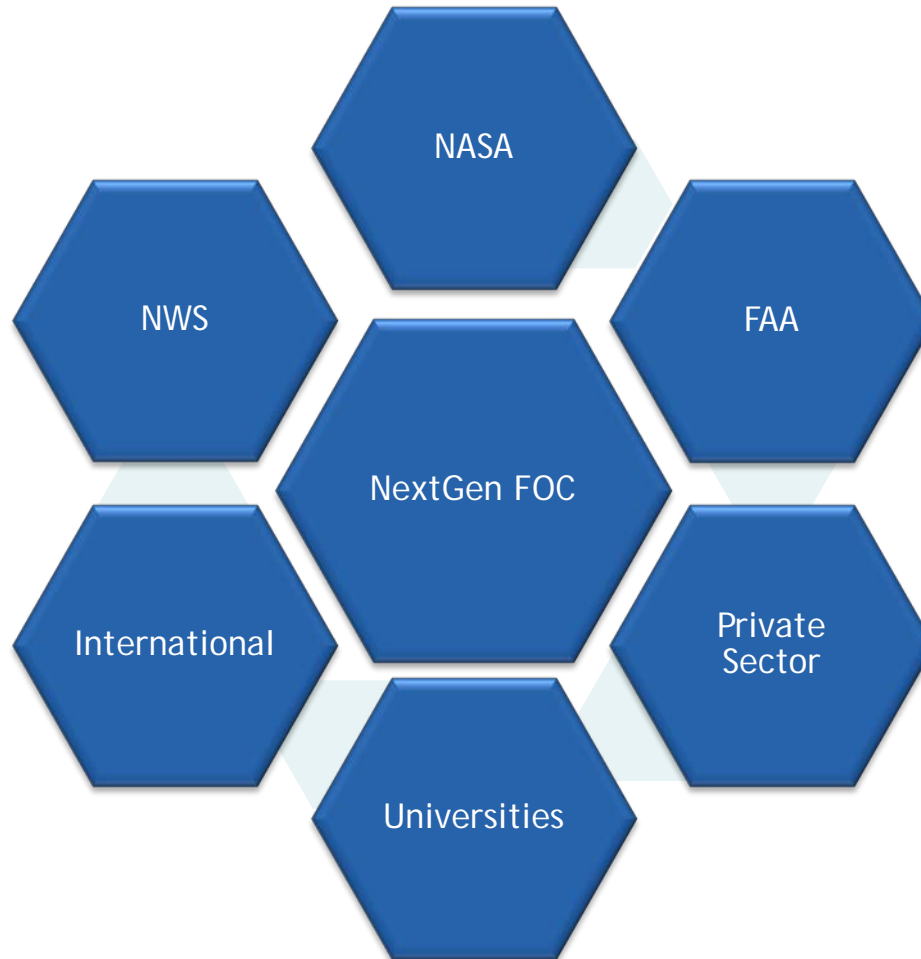
Source: Gartner (August 2012)

"It's no longer hard to find the answer to a given question; the hard part is *finding the right question* and as questions evolve, we gain better insight into our ecosystem and our business." – Kevin Weil

NextGen Weather Program R&D Overview

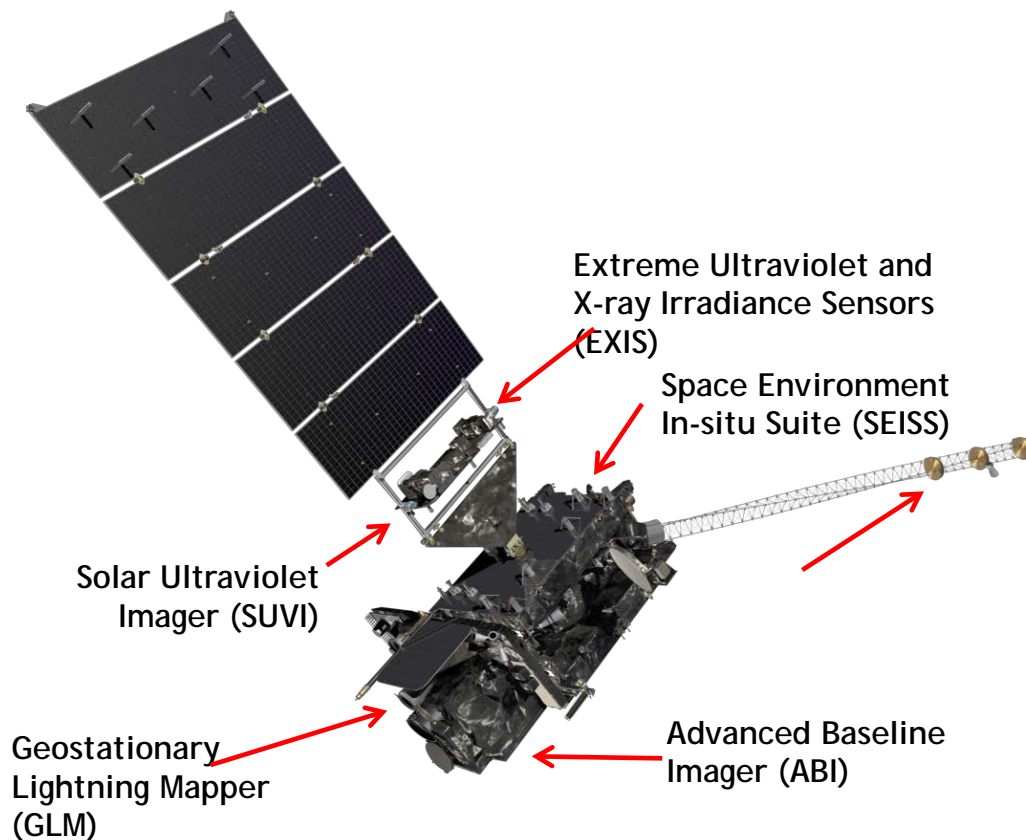**Path forward – continued and targeted collaboration.**

GOES-R

Specifications

- **Size** ~5.5 meters (from launch vehicle interface to top of ABI)

- **Mass** Satellite (spacecraft and payloads) dry mass <2800kg

- **Power Capacity** >4000W at end-of-life (includes accounting for limited array degradation)

- Spacecraft on-orbit life of 15 years with orbit East-West and North-South position maintained to within +/-0.1 degree

- 3-axis stabilized

Current Status

- Design activities progressing well

- Preliminary Design Review (PDR) held January 18-20, 2011

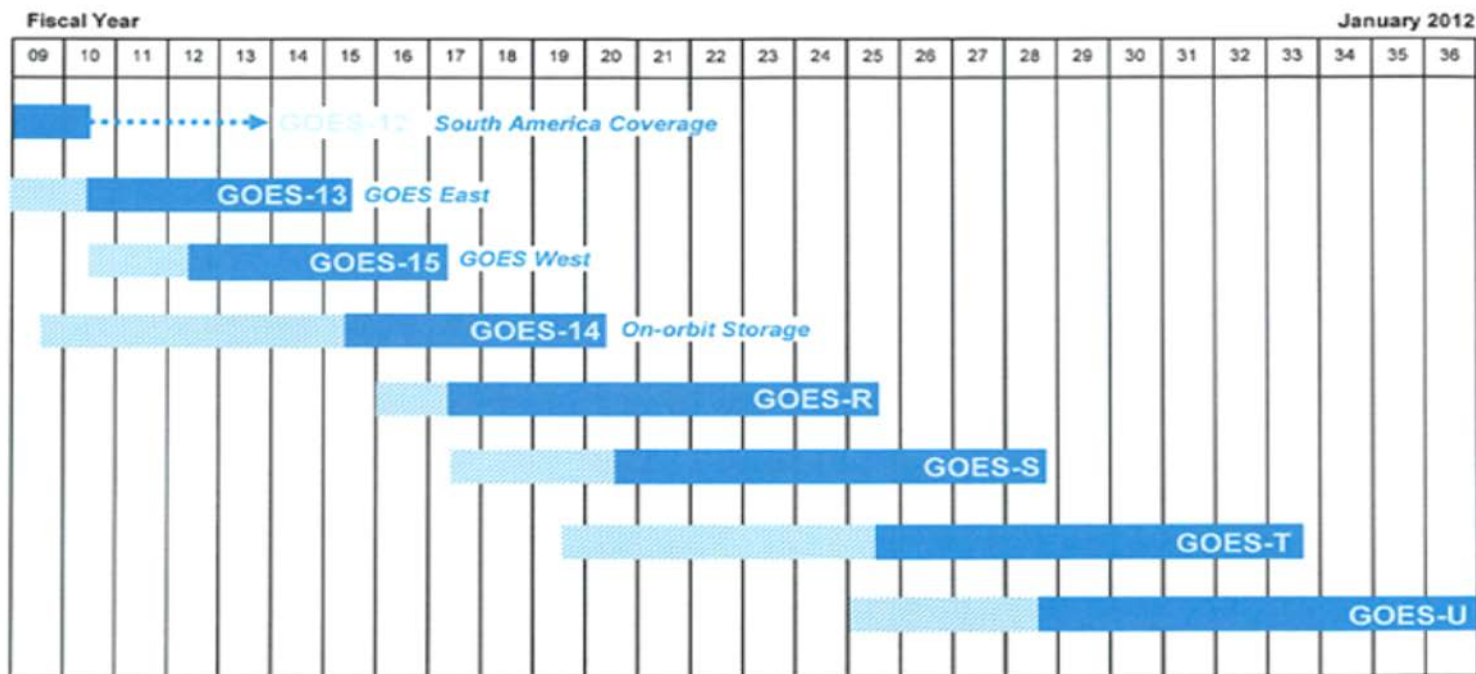- Proceeding toward Critical Design Review (CDR) in April 2012

Extreme Ultraviolet and X-ray Irradiance Sensors (EXIS)

Space Environment In-situ Suite (SEISS)

Solar Ultraviolet Imager (SUVI)

Geostationary Lightning Mapper (GLM)

Advanced Baseline Imager (ABI)

Lockheed Martin Space Systems Co (LMSSC) of Newtown, PA is primary contractor

GOES-R

GOES-R

Baseline Products

Future Capabilities

Advanced Baseline Imager (ABI)

- Aerosol Detection (Including Smoke and Dust)
- Aerosol Optical Depth (AOD)
- Clear Sky Masks
- Cloud and Moisture Imagery (KPP)
- 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)

coronal holes, solar flares, coronal mass ejection source regions
V Imagery

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

GOES-R Aviation Applications

AWC Summer Experiment 2012: Featured GOES-R Products

- NSSL/WRF Advanced Baseline Imager (ABI) Bands
- UW-CIMSS NearCasting Model
- WRF/HRRR Lightning Threat Forecast
- UW-CIMSS Cloud-Top Cooling (CTC)
- UAH Convective Initiation SATCAST
- Enhanced-V/Overshooting Tops (OT)
- NASA SPoRT Psuedo-Geostationary Lightning Mapper (PGLM)
- Fog and Low Cloud

Example 1: AWT Cloud Top Cooling (CTC) utility at Fort Worth Center

120606 1815 and 1832 UTC, visible imagery overlaid with the CTC algorithm is given here
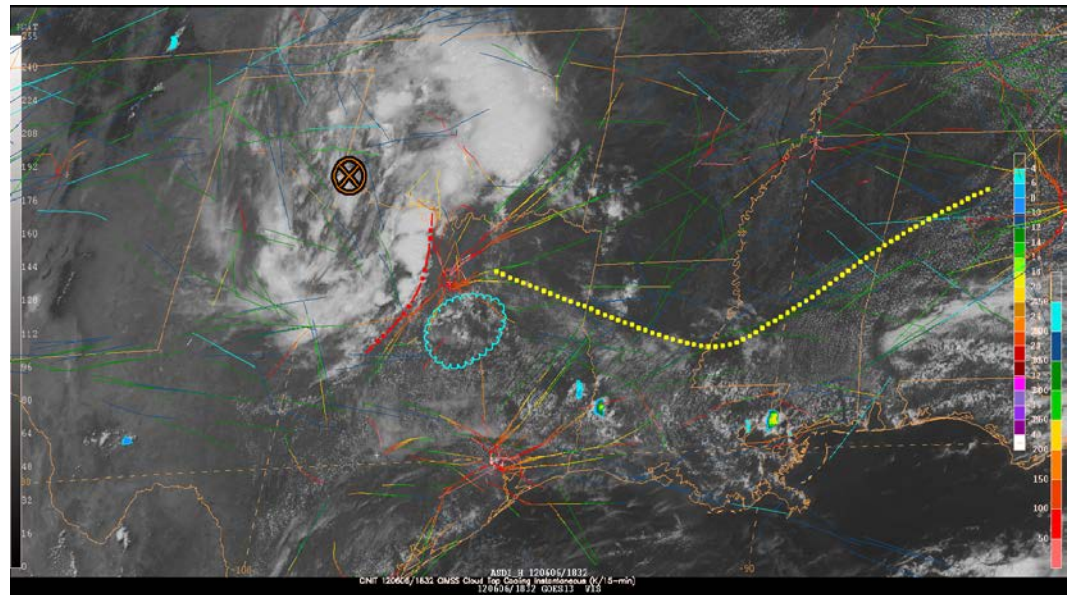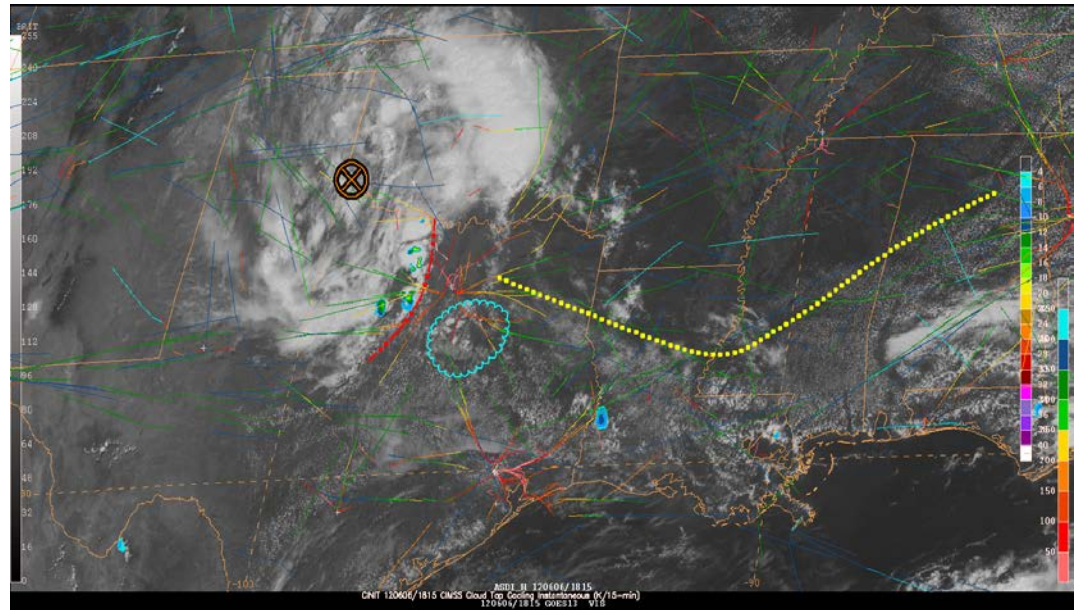
GOES-R Aviation Applications

AWT forecaster comments/feedback

- Utility:
  - Fort Worth Center MCV (Example 1) – many detections occurred just before the squall line began to develop.
    - ◦ Providing additional lead time, particularly to traffic flow managers (TFMS) as they work on diverting aircraft in/out of the center.
    - ◦ It was also noted that this may of use when planes choose to 'fly the gap'. If development is noted in a gap, an area that looks relatively docile on radar, having the CTC would give TFMs a heads up to divert any traffic
  - Radar sparse areas
    - ◦ Much discussion has occurred surrounding the utility of the CTC when also considering radar. There were a number of participating forecasters that noted how useful this would be in areas that have no coverage, i.e., the Gulf of Mexico, oceanic routes, the western Dakotas, some higher elevation areas, etc.
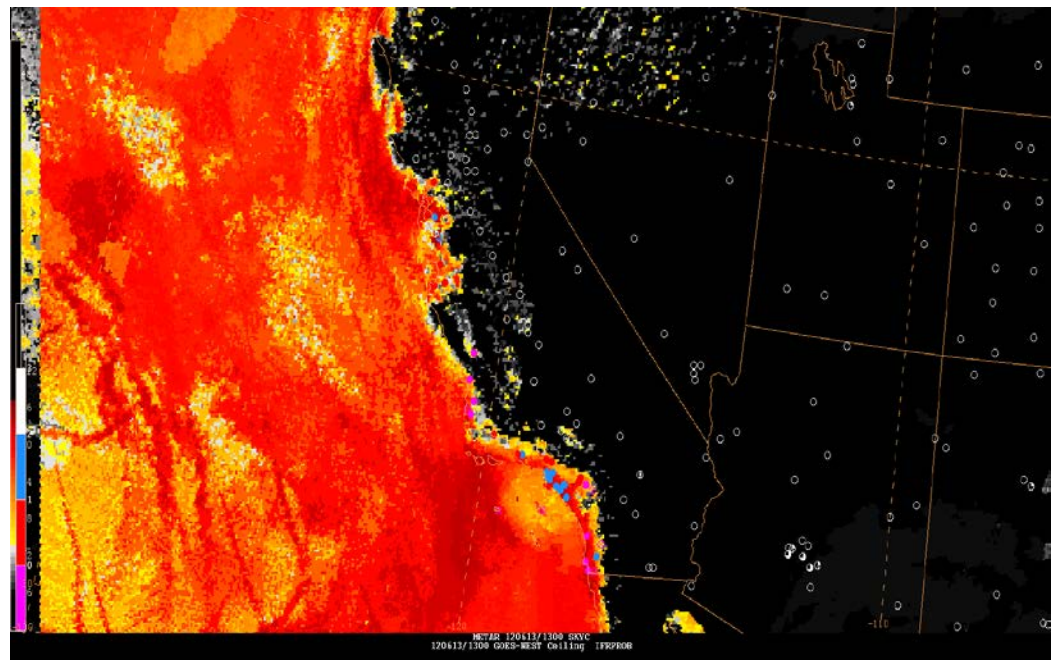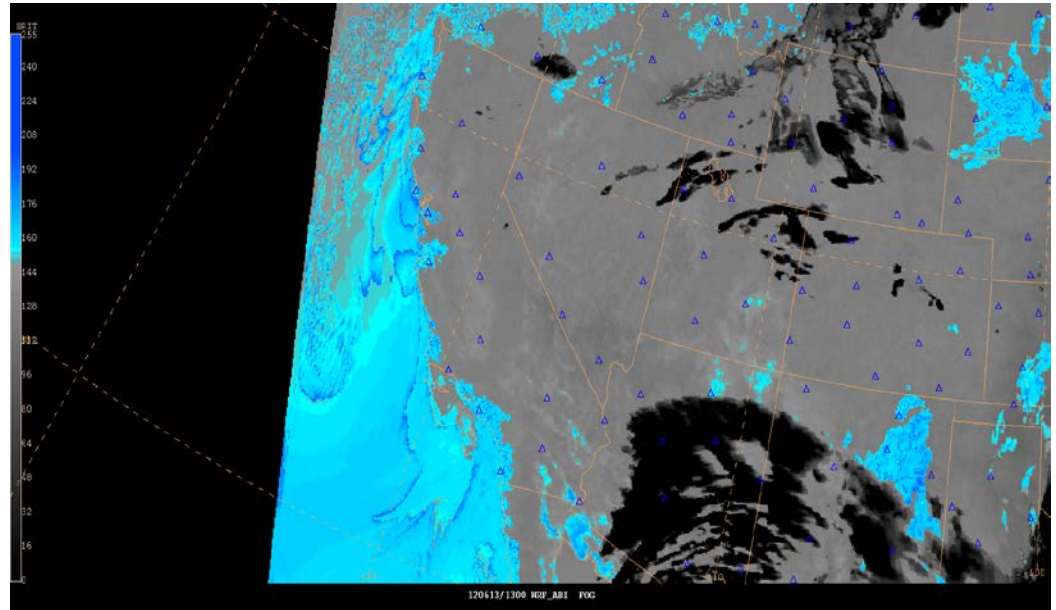
GOES-R Aviation Applications

- ## Utility (cont'd):
  - ### Situational awareness...
    - ◦ It was commented that 'this product is an excellent source of enhancing the situational awareness for future convective initiation, particularly in rapid scan mode'.
    - ◦ While typically echoes are already appearing on radar once a CTC detection is noted, this product may be useful in identifying which cell will intensify the quickest... again situational awareness
    - ◦ However, one forecaster made a very important comment, "It provide excellent situational awareness, however for the undertrained and under experienced met it could have been over detecting cloud growth prior to CI. **Therefore, it's important to know the environment and not take the detections verbatim.**"

Example 2: Low Cloud and Fog Utility

120613 1300-1800 CIRA WRF Fog product (top) and CIMSS IFR probabilities (bottom).

Forecaster comments/feedback:

- Utility:
  - West Coast fog (see example 2)
    - A forecaster from the FA desks at the AWC mentioned how much of a utility that this product would be in issuing AIRMETS in West Coast fog situations, especially given the limitations (no nighttime availability) of the current fog products being used.
  - Northeast fog
    - It was also noted that this product did a good job with East Coast fog, again showing utility for AIRMET issuance.
- Struggles/improvement areas:
  - MVFR?
    - While the IFR/LIFR probabilities were noted to have great utility by a number of forecasters, they also wondered why there is not MVFR. Having the comparison between IFR and MVFR would also be very useful in issuing AIRMETS.
- **NOTE:** this product has been pushed to AWC operations