The GOES-R Proving Ground, GPM, and Water Cycle Science

Steve Goodman

GOES-R Series Chief Scientist

http://www.goes-r.gov

3rd NOAA GPM User Workshop
College Park, MD
April 2-4, 2013

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

Water cycle observations from GOES-R

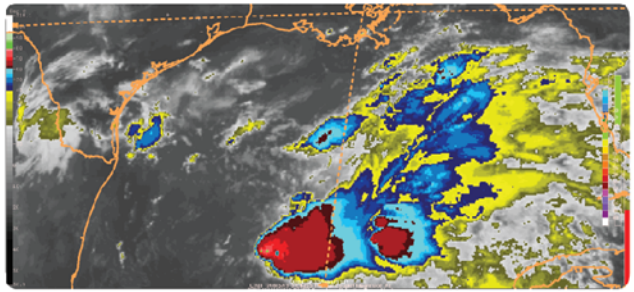
GOES-R Proving Ground

The GOES-R Proving Ground engages NWS in pre-operational demonstrations of selected capabilities of next generation GOES

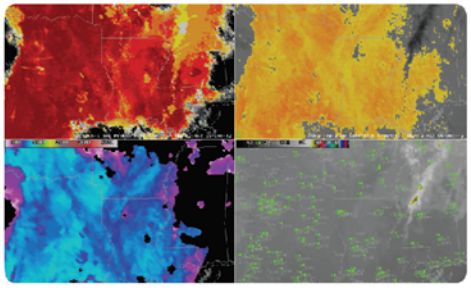
- Objective is to bridge the gap between research and operations by:
  - Utilizing current systems (satellite, terrestrial, or model/synthetic) to emulate future GOES-R capabilities
  - Infusing GOES-R products and techniques into NWS operations with emphasis on AWIPS and transitioning to AWIPS-II.
  - Engaging in a dialogue to provide feedback to developers from users
- The Proving Ground accomplishes its mission through:
  - Sustained interaction between developers and end users for training, product evaluation, and solicitation of user feedback.
  - Close coordination with GOES-R Algorithm Working Group (AWG) and Risk Reduction programs as sources of demonstration products, promoting a smooth transition to operations

Intended outcomes are Day-1 readiness and maximum utilization for both the developers and users of GOES-R products, and an effective transition to operations

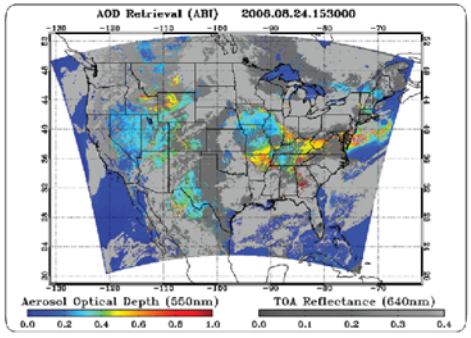
GOES-R Proving Ground Partners



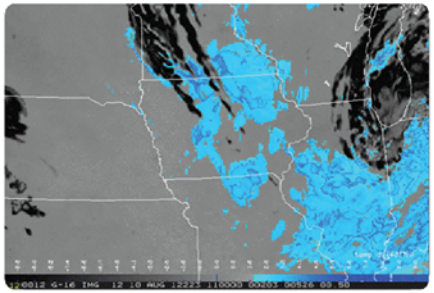
AWC – Kansas City, MO IR Imagery of Oceanic Storms



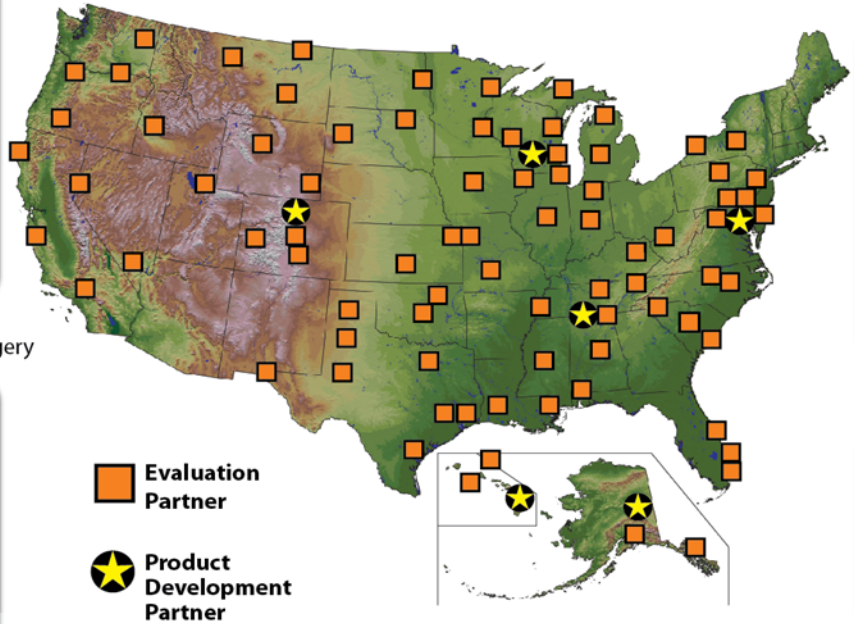
CIMSS/STAR – Madison, WI
Fog/Low Stratus Product

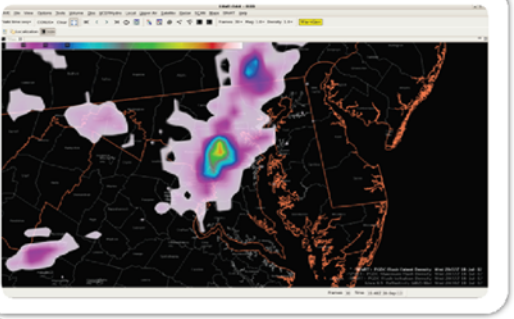


STAR/UMBC – College Park, MD
Aerosol Optical Depth

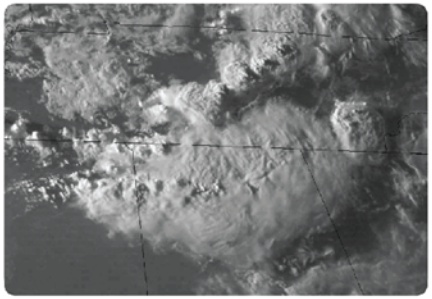


CIRA/STAR – Ft. Collins, CO
ABI Synthetic Low Cloud Enhancement Imagery

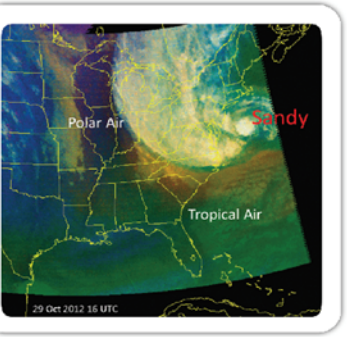




SPoRT/NASA – Huntsville, AL
GLM Lightning Density



SPC – Norman, OK
Severe Storms 1-Min Visible Imagery of Overshooting Tops



NHC – Miami, FL
RGB Air Mass for Hurricane Sandy

2012 Demonstrations

- Hazardous Weather Testbed
  - Focus on Severe Storms
- NHC/Joint Hurricane Testbed
  - Focus on tropical cyclones/hurricane intensity and track
- Aviation Weather Testbed
  - Focus on High Impact Convective Weather
- OPC and SAB (Camp Springs MD)
  - Focus on offshore thunderstorms
- High Latitude and Arctic Experiment (Alaska Region)
  - Focus on precipitation/snow/cloud/ash/aviation
- HPC and SAB (Camp Springs MD)
  - Focus on precipitation/QPF
- Air Quality (UMBC)
  - Focus on aerosol detection
- Pacific Region (Hawaii)
  - Focus on tropical cyclones/heavy rainfall/aviation
- Space Weather (NWS SWPC: Boulder CO)
  - Focus on GOES-R like level 2 products

GOES-R Proving Ground Reports

THE GOES-R PROVING GROUND

Accelerating User Readiness for the Next-Generation Geostationary Environmental Satellite System

BY STEVEN J. GOODMAN, JAMES GURKA, MARK DEMARIA, TIMOTHY J. SCHMIT, ANTHONY MOSTEK, GARY JEDLOVEC, CHRIS SIEWERT, WAYNE FELTZ, JORDAN GERTH, RENATE BRUMMER, STEVEN MILLER, BONNIE REED, AND RICHARD R. REYNOLDS

By demonstrating the advanced capabilities of the next generation of geostationary satellites, the proving ground addresses user readiness and the research-to-operations-to-research loop.

The Geostationary Operational Environmental Satellite R series (GOES-R) Proving Ground (PG) is an initiative to accelerate user readiness for the next generation of U.S. geostationary environmental satellites. The GOES-R system is a joint development between the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA), with NASA responsible for the space segment (spacecraft and instruments) and NOAA responsible for the overall program and ground segment. The GOES-R PG is a collaborative effort between the GOES-R Program Office (GPO); NOAA Cooperative Institutes; NASA's Short-Term Prediction Research and Transition Center (SPoRT); National Weather Service (NWS) Weather Forecast Offices (WFOs); NWS National Centers for Environmental Prediction (NCEP); National Environmental Satellite, Data, and Information Service (NESDIS) Office of Satellite and Product Operations (OSPO) and the Center for Satellite Applications and Research (STAR); and NOAA test beds to conduct demonstration activities to gain early experience with GOES-R capabilities in an operational environment. Improved spacecraft and instrument technology will support expanded detection of environmental phenomena, resulting in more timely and accurate forecasts and warnings. The Advanced Baseline Imager (ABI), described by Schmit et al. (2005), is a 16-channel imager with 2 visible channels, 4 near-infrared channels, and 10

AFFILIATIONS: GOODMAN AND GURKA—NOAA/NESDIS/GOES-R Program Office, Greenbelt, Maryland; DEMARIA—NOAA/NESDIS/Center for Satellite Applications and Research, Fort Collins, Colorado; SCHMIT—NOAA/NESDIS/Center for Satellite Applications and Research, Madison, Wisconsin; MOSTEK—NOAA/National Weather Service, Boulder, Colorado; JEDLOVEC—NASA Short-Term Prediction Research and Transition Center, Huntsville, Alabama; SIEWERT—Cooperative Institute for Mesoscale Meteorological Studies, Norman, Oklahoma; FELTZ AND GERTH—Cooperative Institute for Meteorological Satellite Studies, Madison, Wisconsin; BRUMMER AND MILLER—Cooperative Institute for Research in the Atmosphere, Fort Collins, Colorado; REED—General Dynamics Information Technology, Fairfax, Virginia; REYNOLDS—Short and Associates, Inc., Silver Spring, Maryland
CORRESPONDING AUTHOR: Steven J. Goodman, GOES-R Program Senior Scientist, NOAA/NESDIS GOES-R Program Office, NASA GSFC Code 417, Greenbelt, MD 20771
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The abstract for this article can be found in this issue, following the table of contents.
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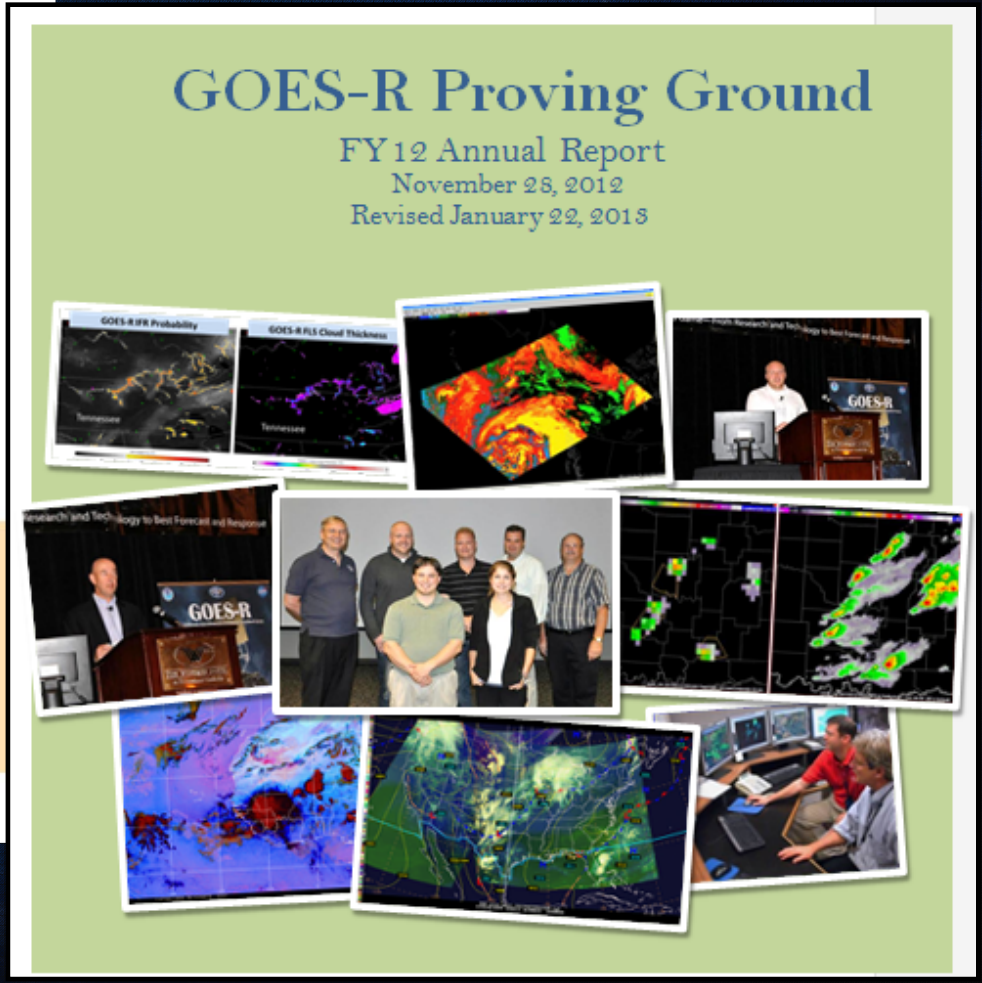
In final form 13 January 2012



NWS Operational Advisory Team (NOAT) Yearly Guidance Memorandum for the Science and Demonstration Executive Board (SDEB) – FY13

- **Overarching NWS Science and Technology Themes**
  - Convective initiation/Warn on Forecast
  - Best state of the Atmosphere (e.g., 3-d analysis)
  - Next Generation Forecast System
  - Decision Support Information Systems
  - Integration of Social Science into the forecast process
  - Risk Reduction as a core validation activity
- **NWS Weather Ready Nation (WRN)**

*NOAT Priorities for GOES-R Future Capabilities

- 1. Convective Initiation
- 2. Fog and Low Stratus
- 3. Icing Threat plus Cloud Properties (cloud ice water path, cloud layers heights, cloud liquid water, cloud type). Note: these are all interrelated – cloud properties integral to this and other efforts. Also, specific guidance to pursue integrated NWP-centric approaches.
- 4. SO_2 Detection
- 5. Land Surface Model Related (emissivity, vegetation index, vegetation fraction)
- 6. **Precipitation: probability of rainfall, rainfall potential, QPE (Rain Rate)**
- 7. Ice Cover
- 8. Flood and Standing Water (at full resolution)
- 9. Other Priority 2 Products not specifically noted (includes tropopause folding turbulence prediction, enhanced V overshooting top detection, visibility, and all others not covered above).

Although demonstration of products should meet these priorities, NOAT accepts the demonstration of non-baseline products as acceptable if short-term value to operations is expected.

*NOAT- NWS Ops Advisory Team

*IAC Recommendation
Science Week March 2013

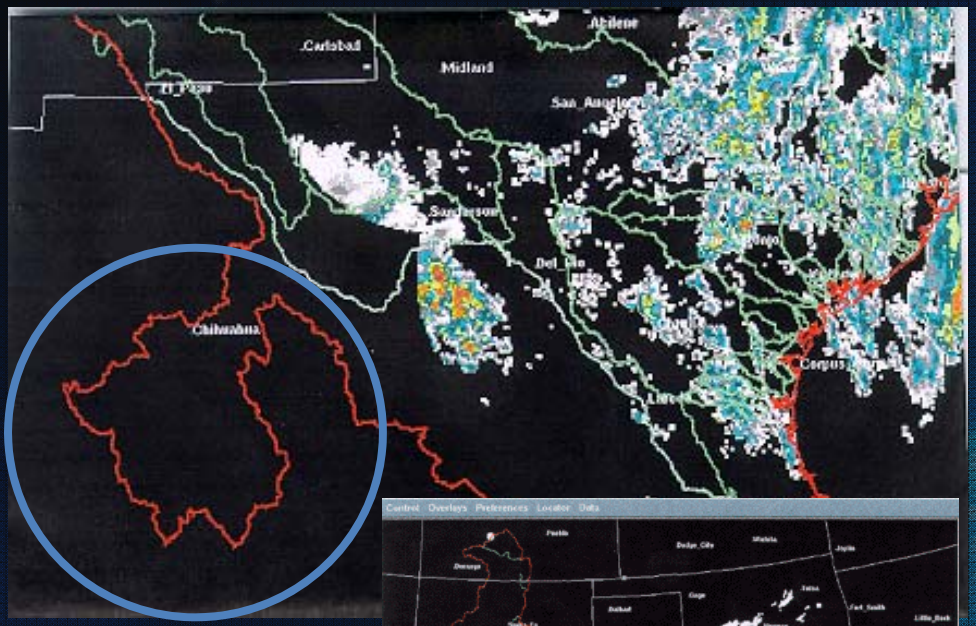
… Utilization of the LEO high spectral resolution data rendering of moisture vertical and horizontal distributions needs to be encouraged.

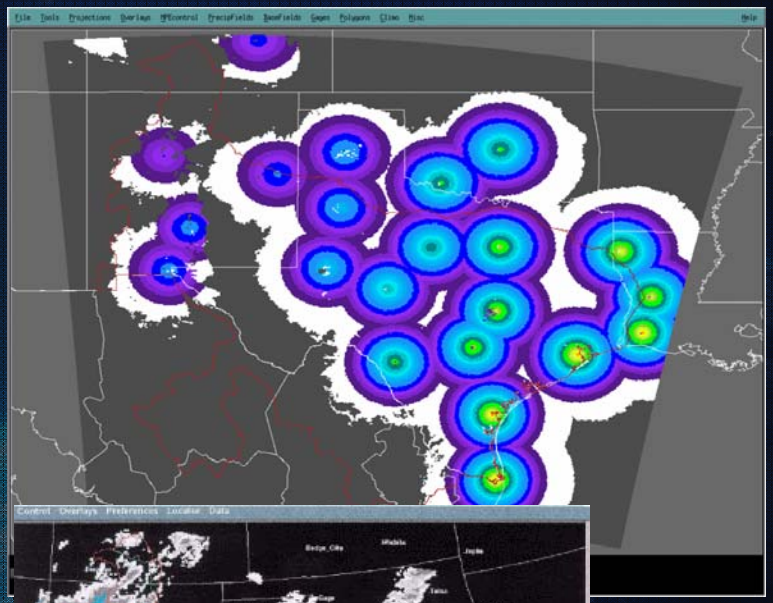
Recommendation: Regional forecasts and nowcasts necessary for a Weather Ready Nation will have to make better use of the information content from AIRS, CrIS, and IASI data; GPS data should also be included. Between LEO sounding coverage, GOES-R data should be used to monitor temporal profile changes (atmospheric stability, dq/dt, $V \bullet \nabla q$, $\nabla \bullet q$, etc).

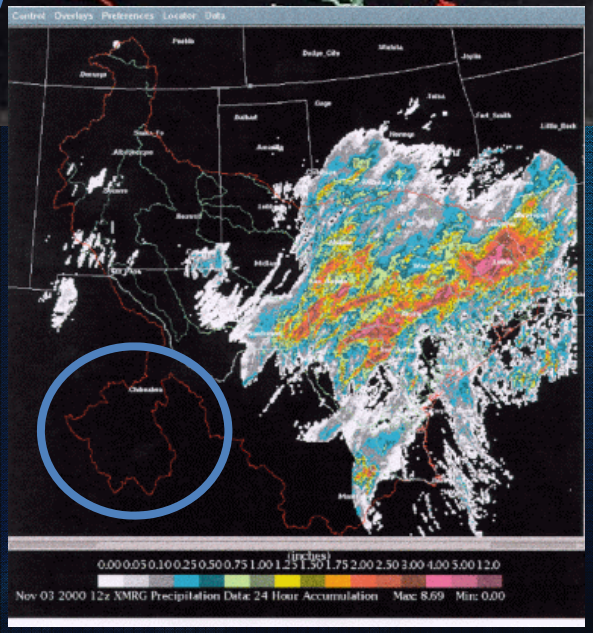
*IAC- GOES-R Independent Advisory Committee

West Gulf RFC Data Gaps

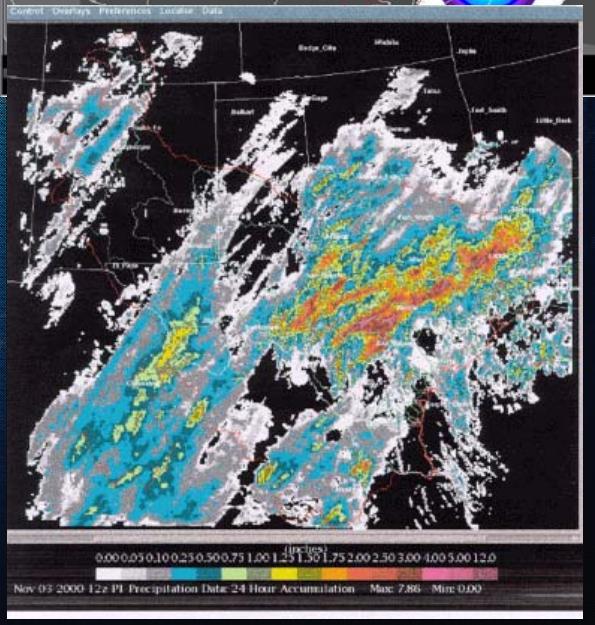
WGRFC is responsible for deriving basin averaged areal precipitation for every location inside the red outline- this is outside the range of the WSR-88D, and there are roughly 15 real-time rain gauges over this region.







Multi-sensor Mosaic



Multi-sensor Mosaic and Satellite Estimates

Satellite QPE is used where there is no dependable radar estimates or rain gauge data

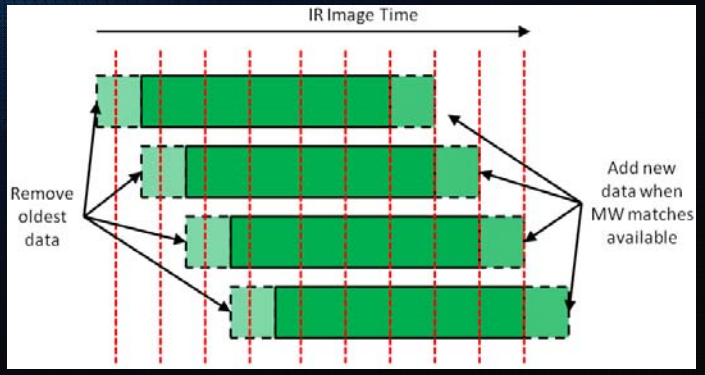
Greg Story
NWS/WGRFC

GOES-R Rain Rate Algorithm- SCaMPR

Self-Calibrating Multivariate Precipitation Retrieval

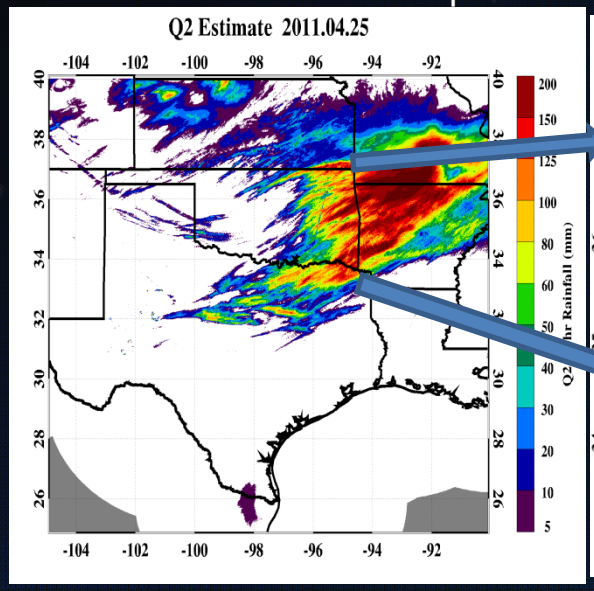
- The GOES-R Rainfall Rate algorithm (developed from SEVERI proxy data) estimates instantaneous rain rate every 15 min on the ABI full disk at the IR pixel resolution (~ 2 km) with a latency of less than 5 min from image time.
  - Primary focus is operational flash flood forecast support
- The rain rates will be derived from the ABI IR bands, calibrated against rain rates from MW instruments.
- This will allow the rapid refresh and high spatial resolution of IR data from GEO while attempting to capture the accuracy of MW rain rates from LEO.
- A 2-channel version of this algorithm modified for current GOES has been running in real time since August 2011 in support of GOES-R Proving Ground
  - Current GOES Imager does not have the 6.2, 8.5, and 12.0 µm bands

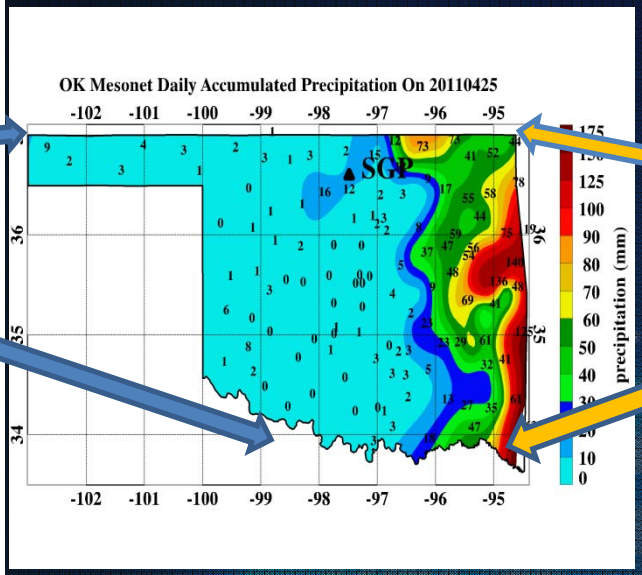
~~$T_{6.19}$~~ $T_{6.7}$	~~$T_{8.5}$~~ - ~~$T_{7.34}$~~
$S = 0.568-(T_{min,11.2}-217\ K)$	~~$T_{11.2}$~~ - ~~$T_{7.34}$~~ $T_{11.2}$- $T_{6.7}$
$T_{avg,11.2} - T_{min,11.2} - S$	~~$T_{8.5}$~~ - ~~$T_{11.2}$~~
~~$T_{7.34}$~~ - ~~$T_{6.19}$~~	~~$T_{11.2}$~~ - ~~$T_{12.3}$~~

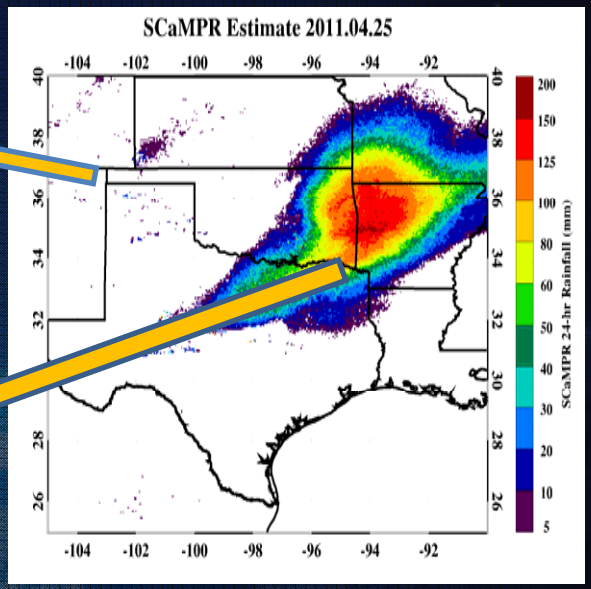


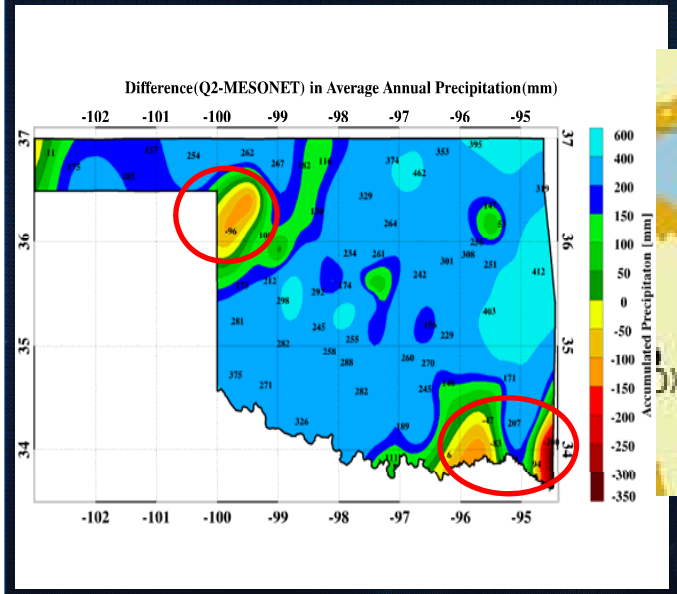
SCaMPR Comparisons

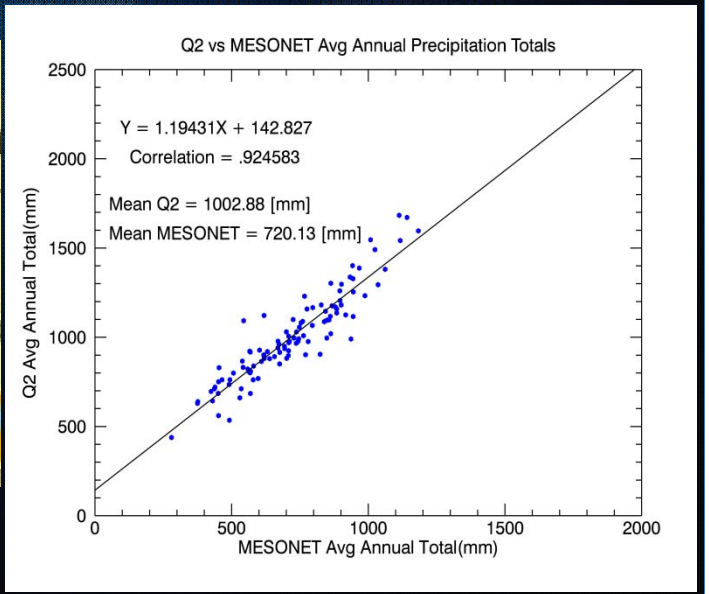
Dong et al.- SCaMPR estimates lack the detailed structure of Q2 estimates, regions with Q2 underestimates are representative of poor radar coverage (VCP12 coverage provided by NSSL)











GOES-R Precipitation Projects: FY11-13 GOES-R Risk Reduction

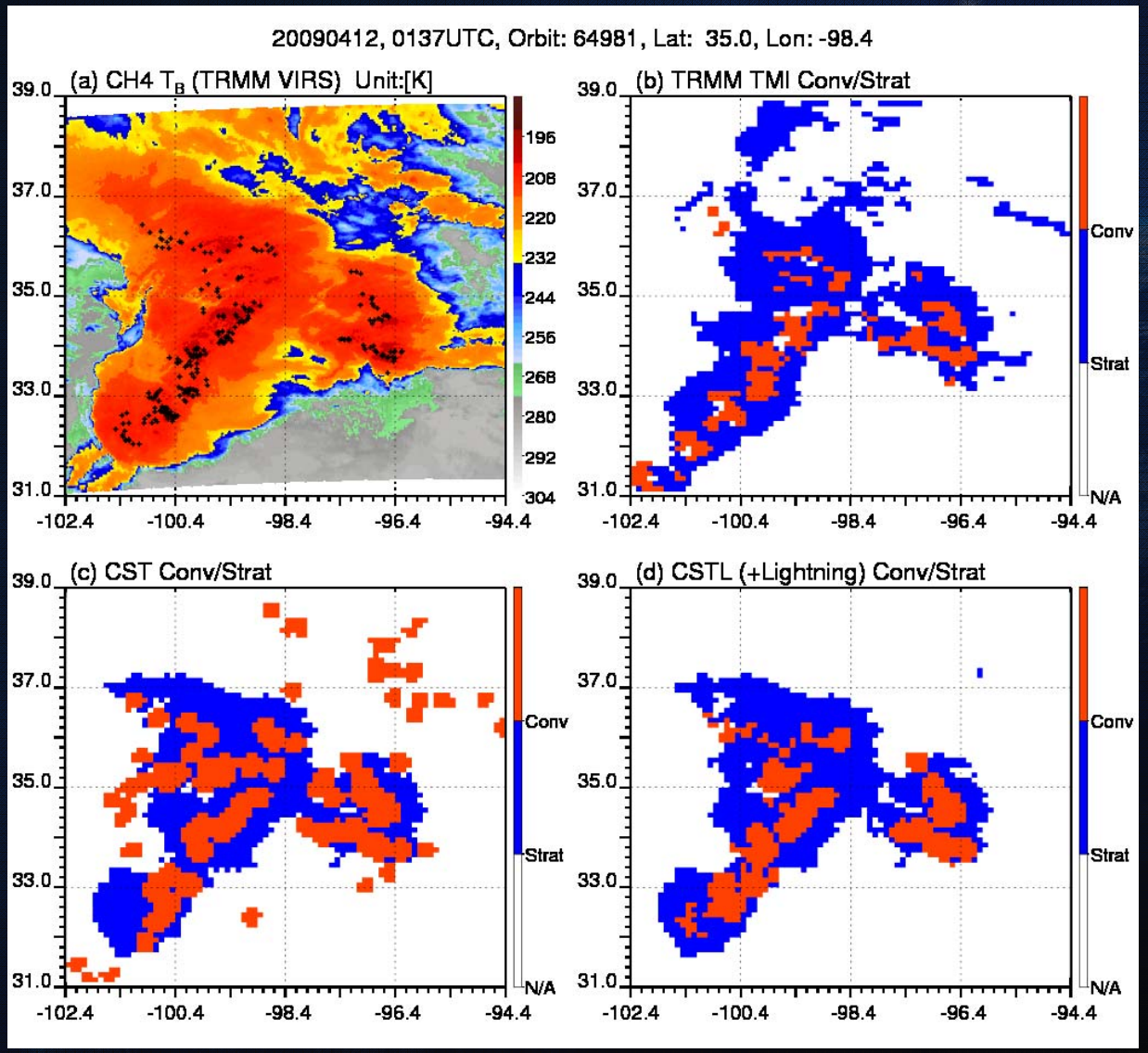
PI	Project
Bob Adler CICS	Combining GLM and ABI Data for Enhanced GOES-R Rainfall Estimates
Xiquan Dong UND	Improving GOES-R Cloud and Precipitation Products Associated with Deep Convective Systems by using NEXRAD Radar Network over the Continental U.S
Bob Rabin NSSL	Improvements to QPE using GOES visible ABI and model data

CST Comparisons

Adler et al.- CST confused by thick cirrus, thick anvil debris, or large MCS cloud shield. Lightning info. (2002-2008) consistently improved the convective detection (POD) by 8%, lowers the false alarm (FAR) by 30%.

IR Tb

PMW (Conv/Strat 10 mm/hr)



CST (Conv/Strat)

CST + Lightning (Conv/Strat)

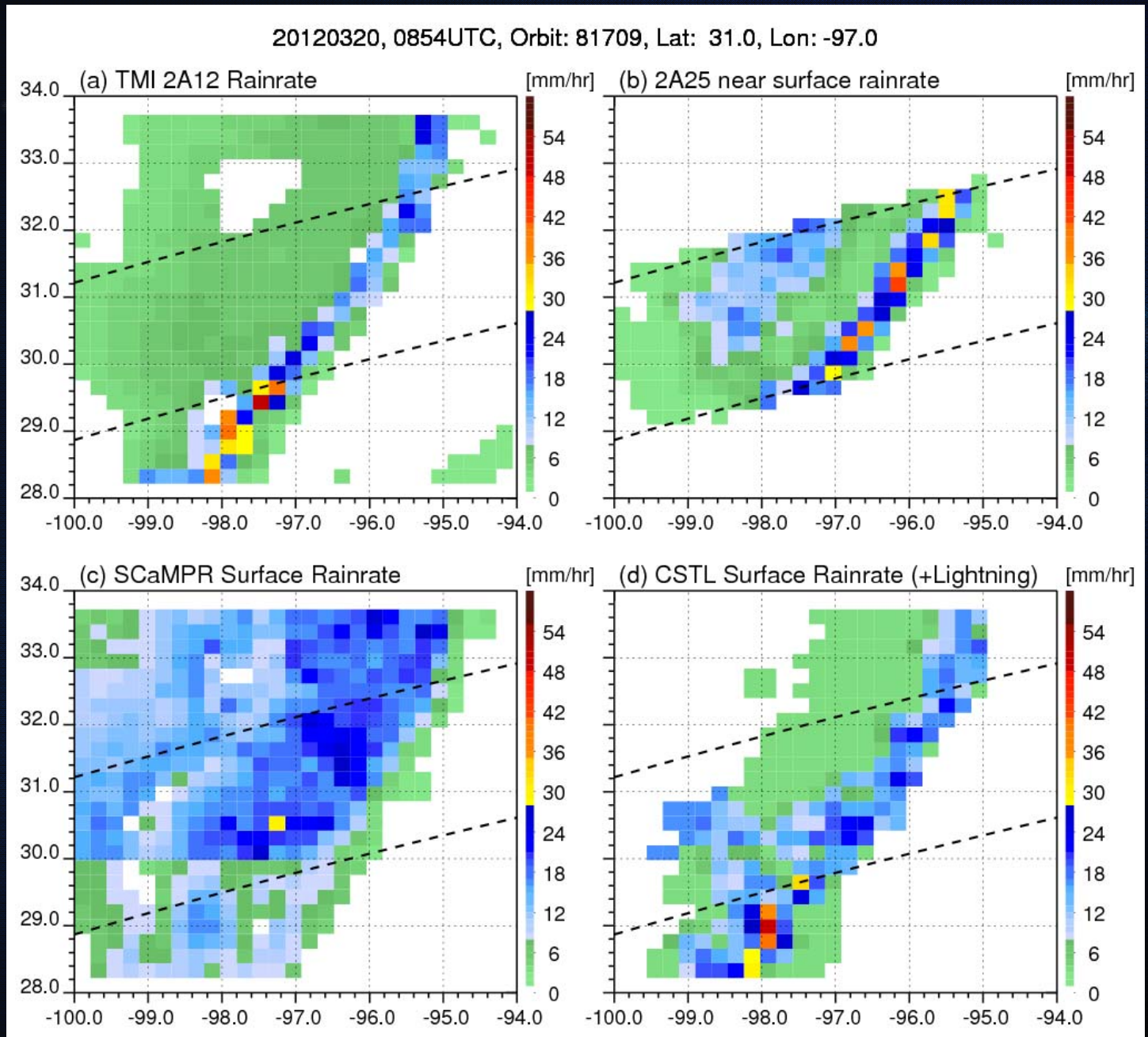
CSTL RR - SCaMPR Comparison

PMW

SCaMPR

Radar

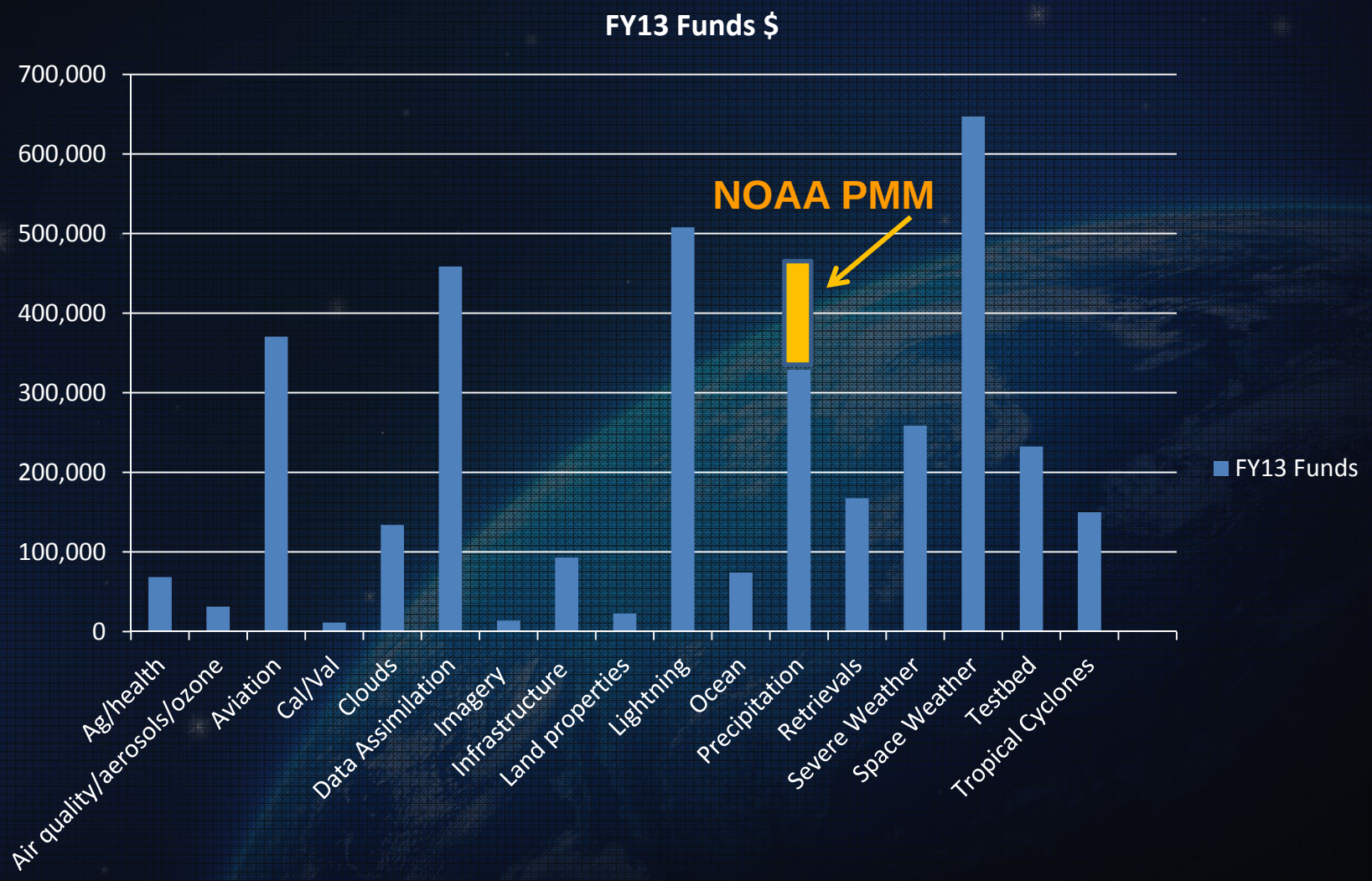
CSTL (Final Product)



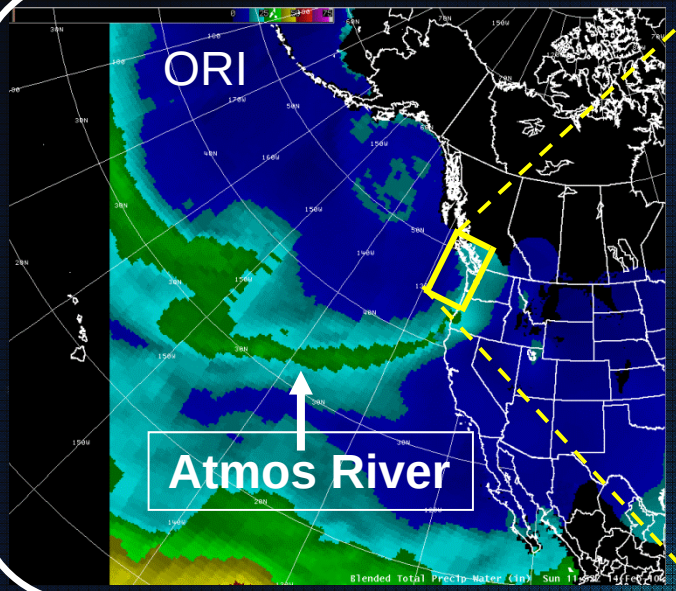
GOES-R Precipitation Projects: New Starts for NOAA Members of the NASA PMM (GPM) Science Team

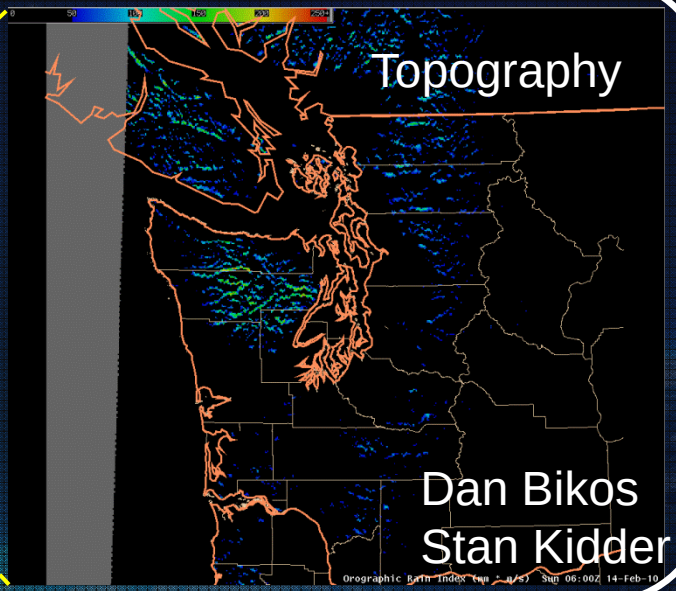
PI	Project
Pingping Xie NWS/CPC	Development of CMORPH and GPM Day-1 Level 3 Precipitation Products for Improved Weather, Climate, and Water Applications
Jonathan Gourley NSSL	WiMerge: Research and Development of Unified CONUS 3-D Mosaics and QPE products

FY13 R3 Funding by Topic

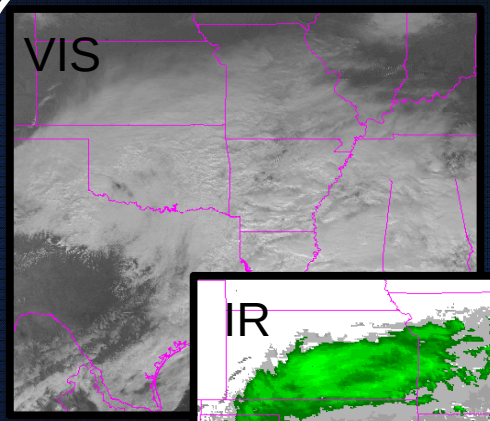


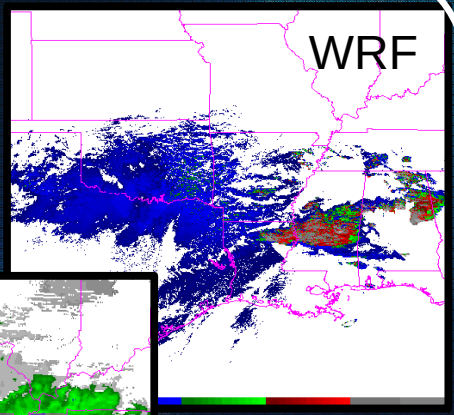
GOES-R Clouds, Moisture

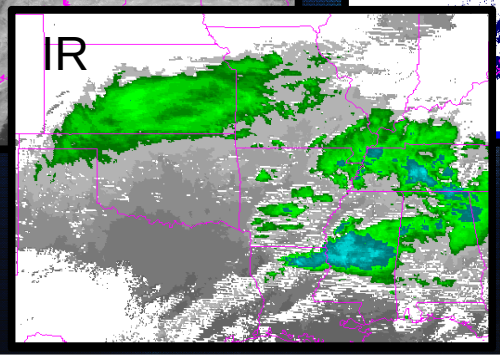




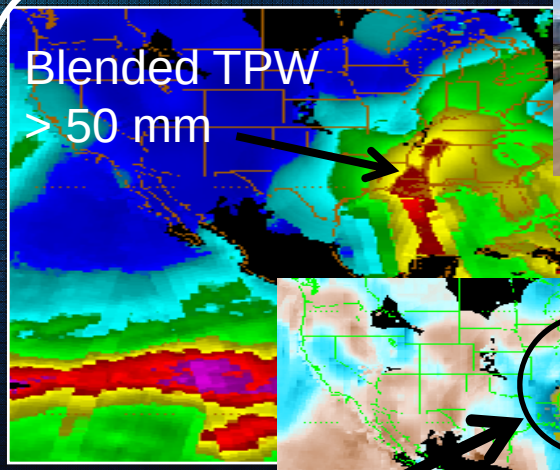
Dan Bikos
Stan Kidder

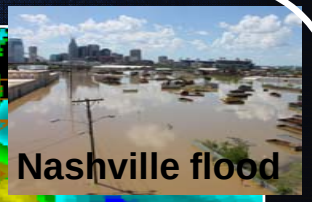


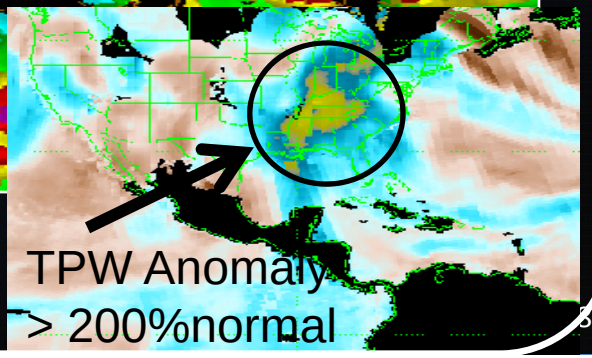




Bob Rabin







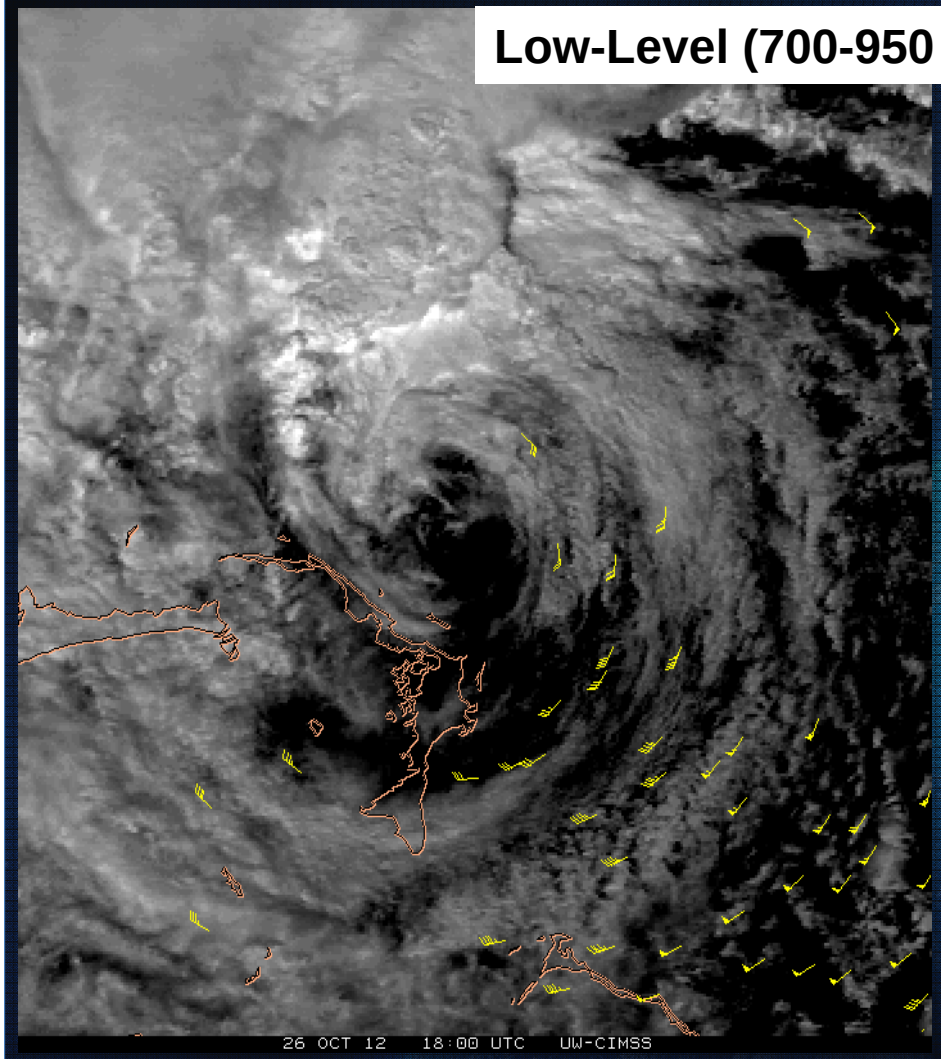
Sheldon
Kusselson

Atmospheric Motion Vectors from GOES-R

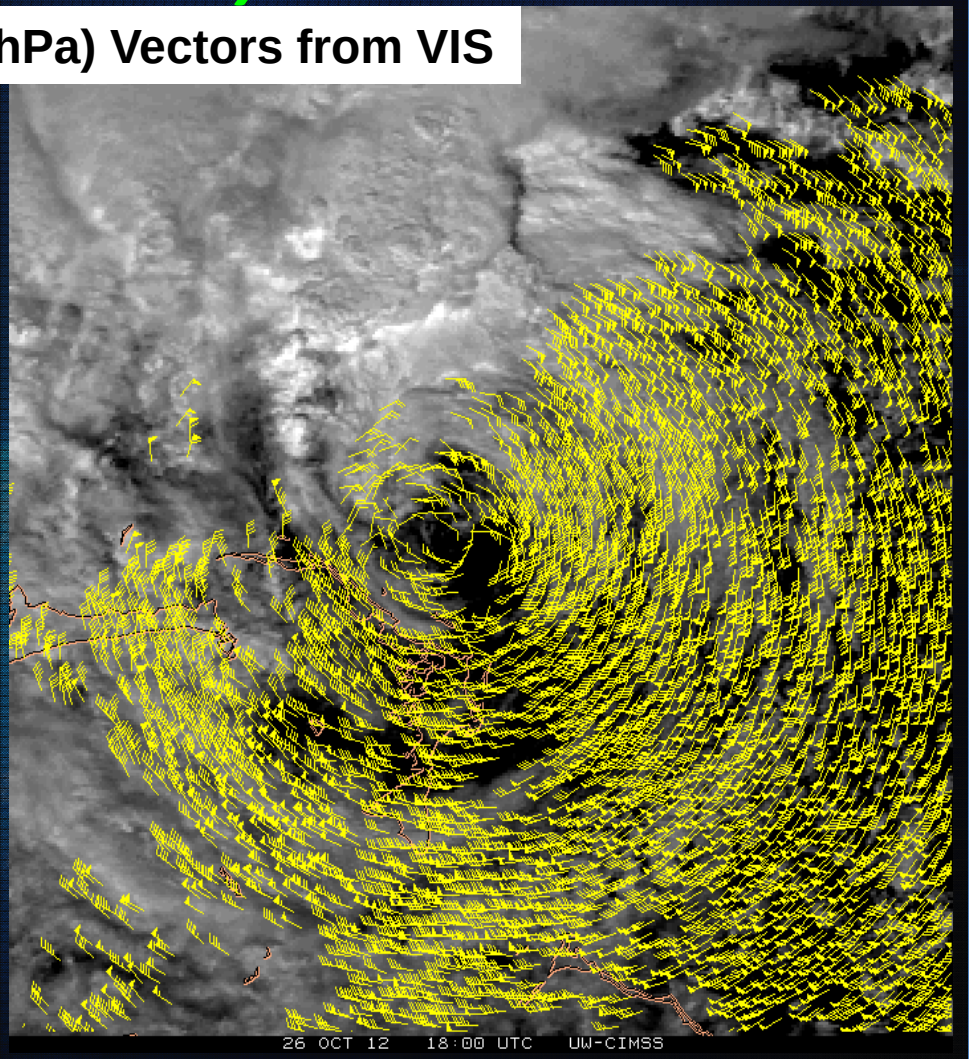
Proxy: AMVs from special GOES-14, 1-min super-rapid-scan operations

Hurricane Sandy

Low-Level (700-950 hPa) Vectors from VIS



AMVs from **15-min images** (routine **GOES** sampling)

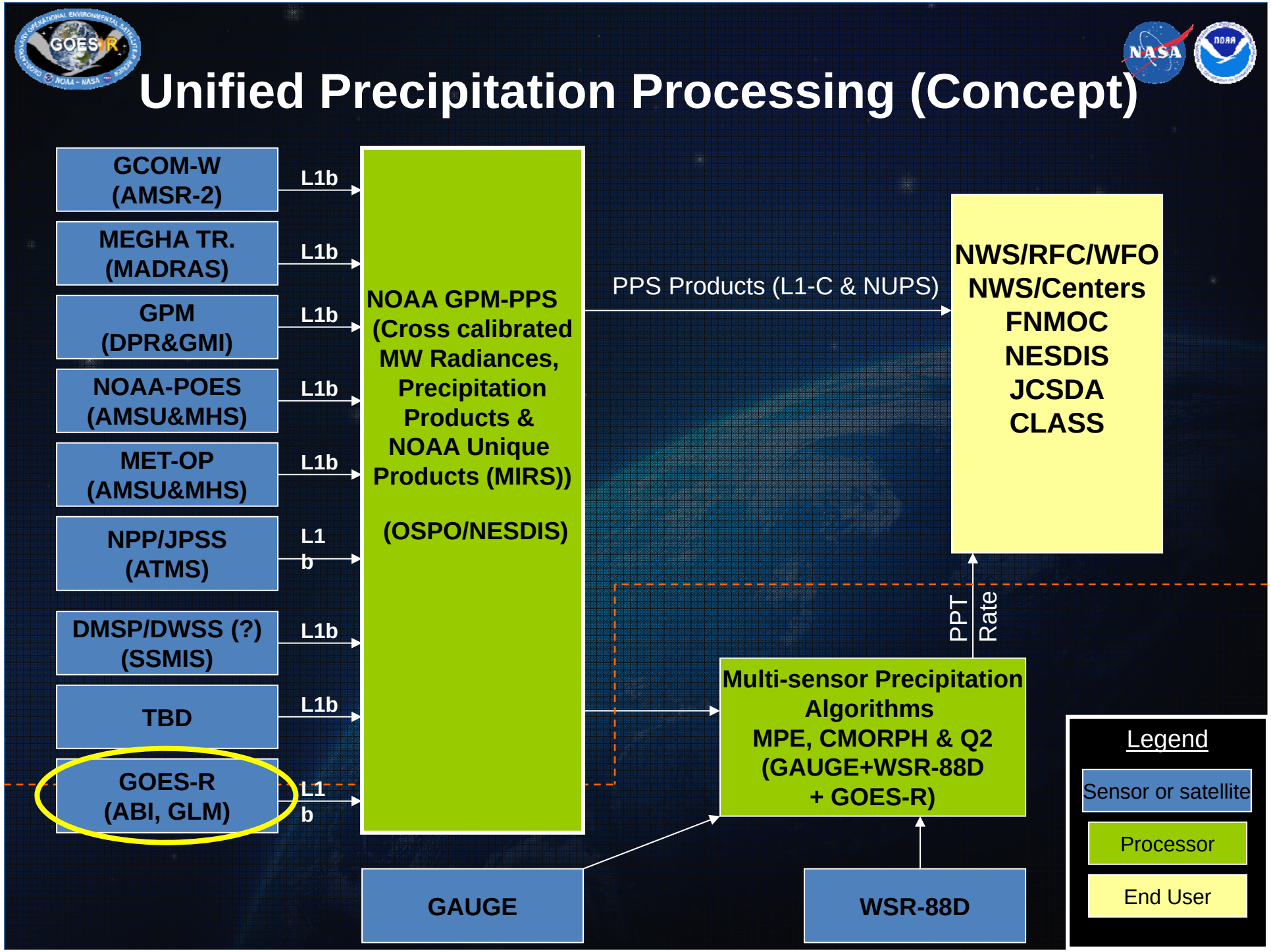


AMVs from **1-min images** (meso **GOES-R** sampling)

1800 UTC 26 Oct, 2012

C. Velden (CIMSS)

Unified Precipitation Processing (Concept)



Summary

Pre-launch demonstrations with proxy data benefits users to prepare them to fully exploit all GOES-R instruments and capabilities

- Continue to apply lessons learned to incorporate new improvements each year.
- Demonstrate products and decision aids in NOAA Testbeds, NCEP Centers, WFOs, and the NWS Proving Ground at Training Center
- Transition of Water Cycle/Hydrology Future Capabilities, fused products, Impact-based Decision Aids, Decision Support Services
- Continue to develop, demonstrate, and test as part of decision support services
- Enhanced collaboration with JPSS, international, and private sector community