OVERVIEW OF CIMSS ACTIVITIES IN SUPPORT OF THE U.S. GOES-R Algorithm Working Group

Allen Huang & Colleagues
Cooperative Institute for Meteorological Satellite Studies
Space Science & Engineering Center
University of Wisconsin-Madison, USA

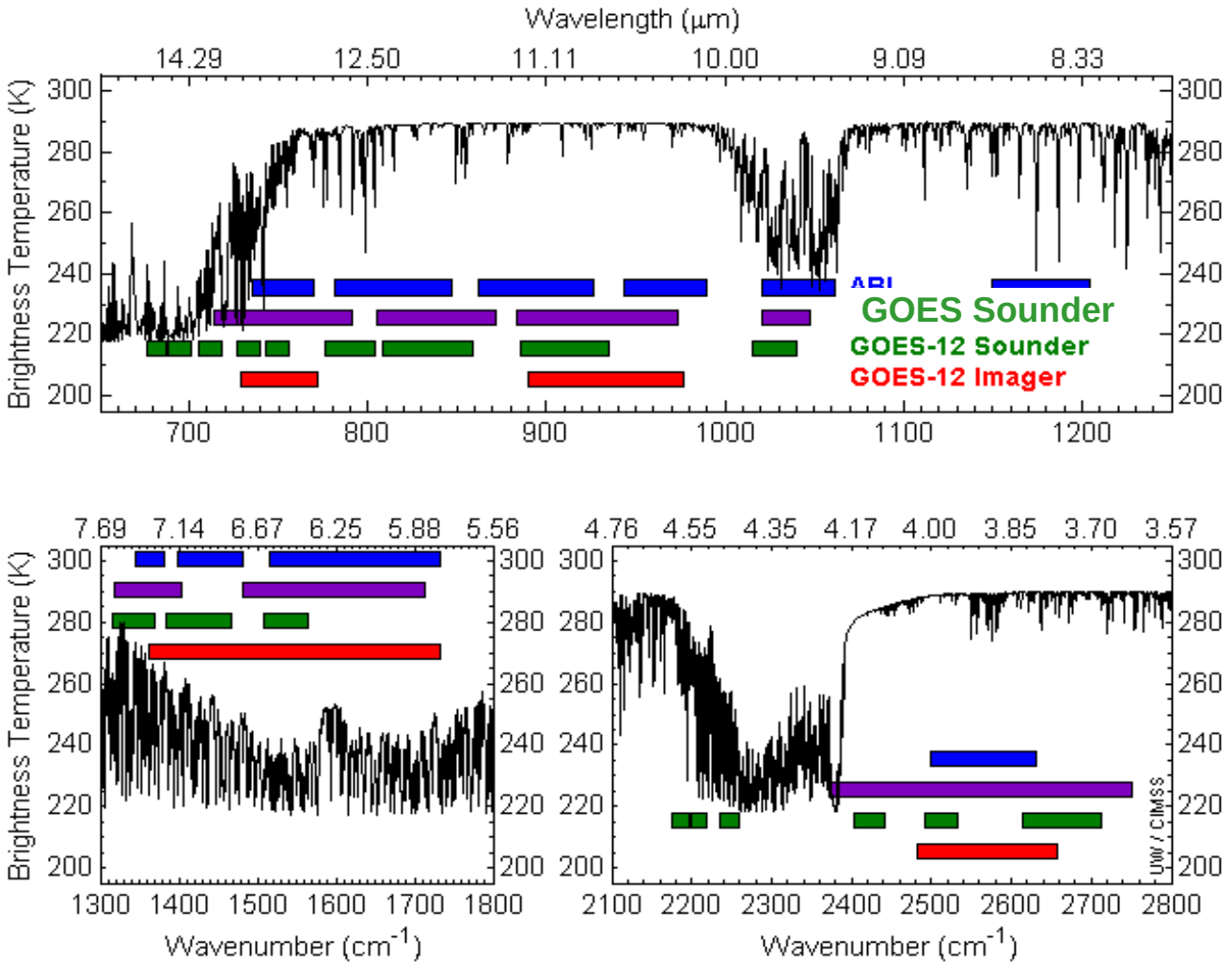
The joint
2007 EUMETSAT Meteorological Satellite Conference And the
15th American Meteorological Society (AMS) Satellite Meteorology & Oceanography Conference
24-28 September 2007
Amsterdam, The Netherlands

GOES-R baseline instruments/Systems

- ABI Advanced Baseline Imager
- GLM Geostationary Lightning Mapper
- SIS Solar Imaging Suite
- SEISS Space Environment In-Situ Suite
- MAG Magnetometer
- AUX Auxiliary Services
- LRIT--Low Rate Information transmission
- EMWIN--Emergency Managers Weather
- Information Network
- DCS--Data Collection System
- SAR-- Search and Rescue

GOES Current & -R Imagers

Spectral Band and Coverage



ABI (blue) and current GOES sounder (green) spectral coverage over a high spectral resolution brightness temperature spectrum.

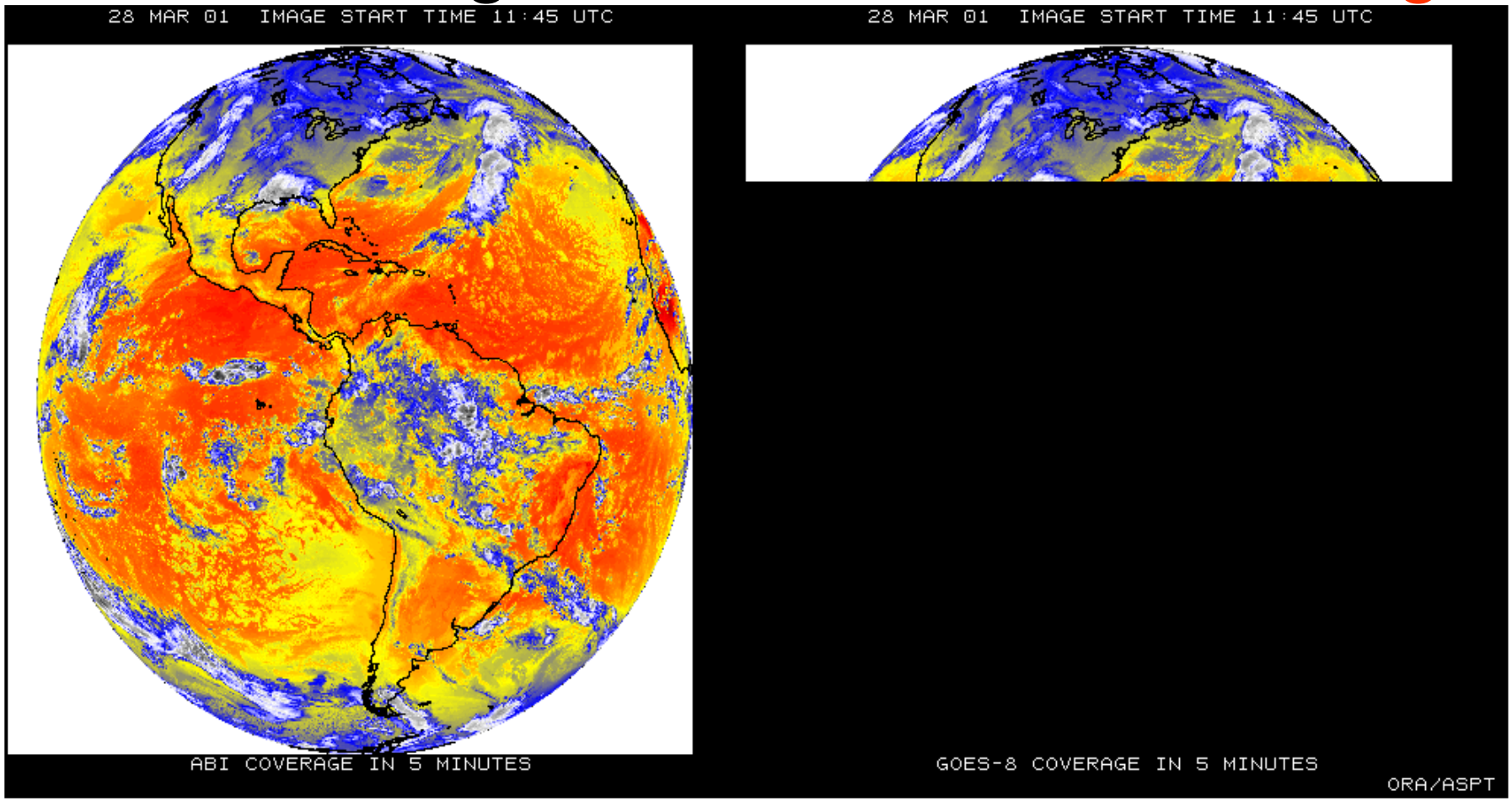
GOES-R ABI: An Improved Environmental Imaging Capability

Parameter	Current GOES Imager	Future GOES Imager	Comments
Number of Visible bands	1	3	**Cloud cover, plant health and surface features during the day, etc.**
Number of Near IR bands	0	3	**Cirrus clouds, Low cloud/fog and fire detection, etc.**
Number of Infrared bands	4	10	**Upper-level water vapor, clouds, SO_2, SST, etc.**
Coverage Rate	25 minutes for full disk	15 minutes for full disk, plus CONUS images every 5 minutes, plus meso-scale scans	ABI is approximately five times faster
Spatial resolutions of the 0.6 um visible band	Approximately 1 km	0.5 km	At the sub-satellite point
Spatial resolutions of the infrared bands	Approximately 4-8 km	2 km	At the sub-satellite point
On-orbit visible calibration	No	Yes	

GOES-R ABI: An Improved Environmental Imaging Capability

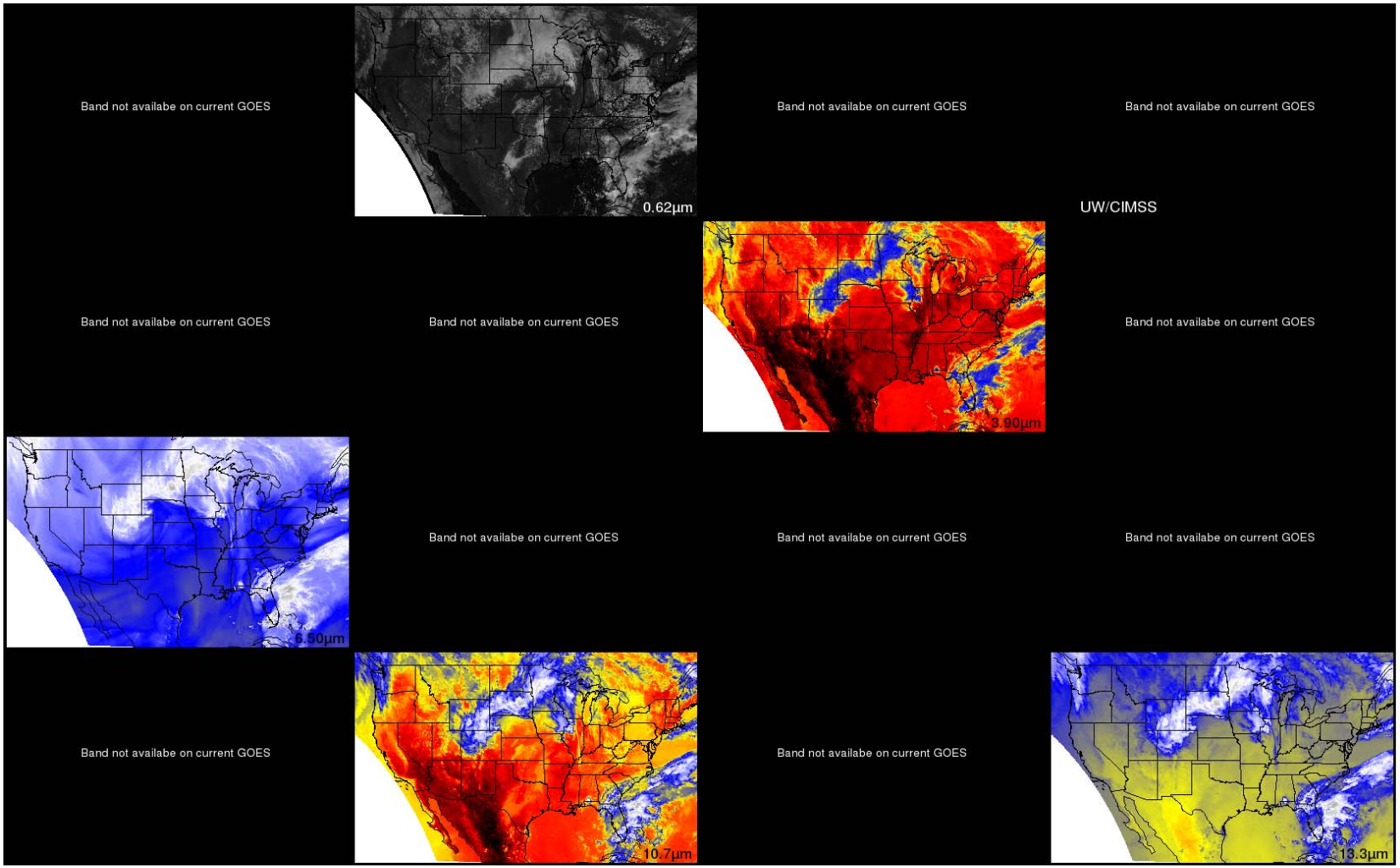
GOES-R Imager ABI

Current GOES Imager



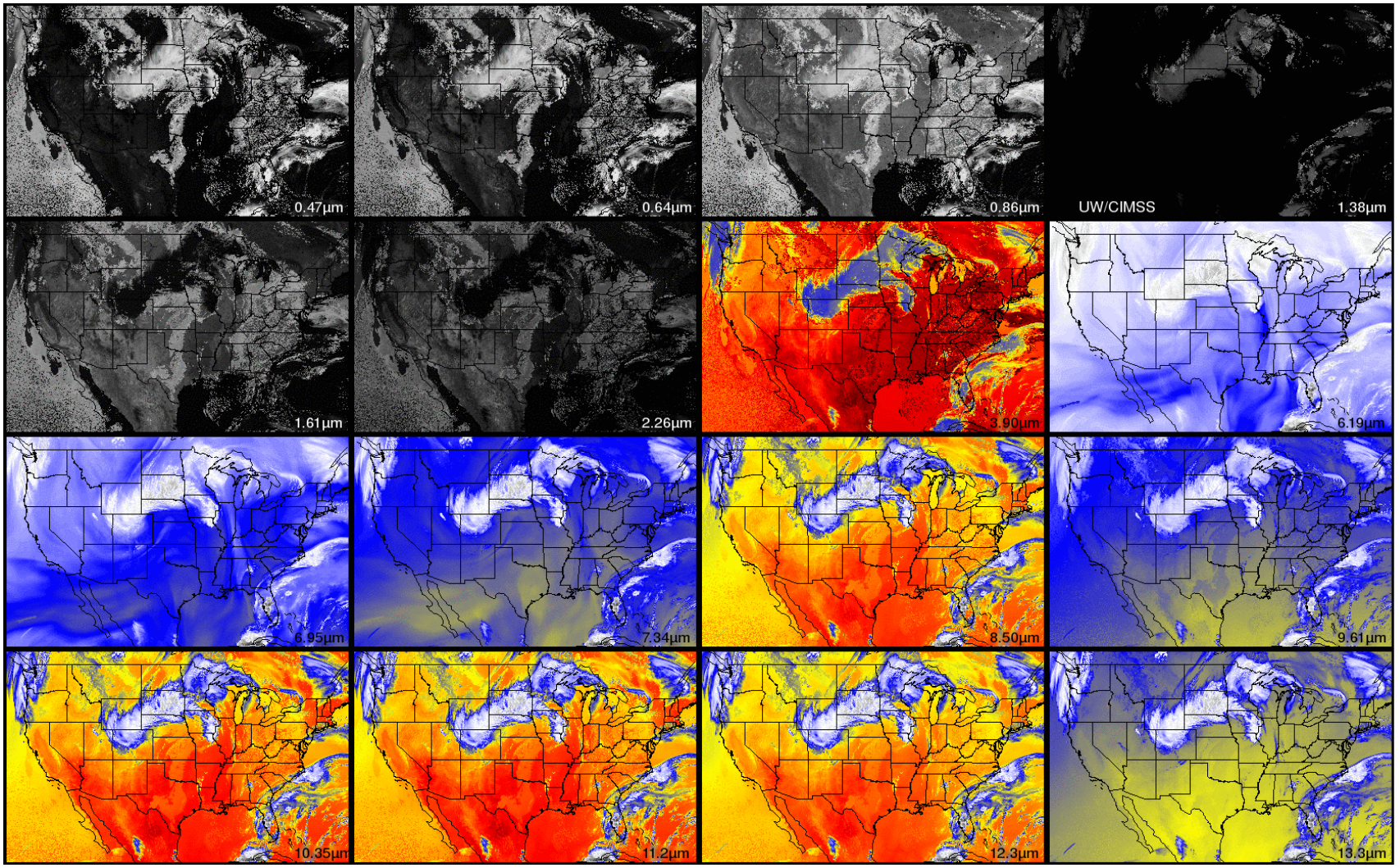
Coverage within 5 minutes

GOES-12 Imager Observation - CONUS



GOES band data for 2005 0604 17:02 UTC

Simulated ABI 16 Band Image Loop



ABI band data for 2005 June 04 15:00 UTC

GOES-R Observational Requirements: Alternative 1 (no sounder)

Aerosol Detection
Aerosol Particle Size
Suspended Matter
Volcanic Ash *
Aircraft Icing Threat
Cloud Imagery
Cloud & Moisture Imagery
Cloud Layers / Heights & Thickness *
Cloud Ice Water Path *
Cloud Liquid Water
Cloud Optical Depth
Cloud Particle Size Distribution
Cloud Top Phase
Cloud Top Height *
Cloud Top Pressure *
Cloud Top Temperature *
Cloud Type
Convection Initiation
Enhanced "V"/Overshooting Top Detection
Hurricane Intensity
Imagery: All-Weather / Day - Night
Lightning Detection
Low Cloud & Fog
Turbulence *
Visibility
Geomagnetic Field

Dust/Aerosol *
Probability of Rainfall
Rainfall Potential
Rainfall Rate
Derived Stability Indices *
Total Precipitable Water *
Total Water Content *
Clear Sky Masks
Radiances *
Absorbed Shortwave Radiation
Downward Longwave Radiation
Downward Solar Insolation
Reflected Solar Insolation
Upward Longwave Radiation *
Ozone Total *
SO_2 Detection *
Derived Motion Winds *
Fire / Hot Spot Imagery
Flood / Standing Water
Land Surface (Skin) Temperature

Surface Albedo
Surface Emissivity *
Vegetation Fraction
Vegetation Index
Currents
Sea & Lake Ice / Displacement & Direction
Sea & Lake Ice / Age
Sea & Lake Ice / Concentration
Sea & Lake Ice / Extent & Characterization
Sea & Lake Ice / Extent & Edge
Sea & Lake Ice / Surface Temp
Sea & Lake Ice / Motion
Sea & Lake Ice / Thickness
Ice Cover / Landlocked
Snow Cover
Snow Depth
Sea Surface Temps
Energetic Heavy Ions
Mag Electrons & Protons: Low Energy
Mag Electrons & Protons: Med & High Energy
Solar & Galactic Protons
Solar Flux: EUV
Solar Flux: X-Ray
Solar Imagery: X-Ray

*D1 = Degraded from original GOES-R requirements in Alternative 1 (no HES, nor Sounder)

ABI – Advanced Baseline Imager	SEISS – Space Env. In-Situ Suite	SIS – Solar Instrument Suite	GLM – Geostationary Lightning Mapper	Magnetometer

CIMSS GOES-R AWG Tasks (17) (1/2)

Task 1. GOES-R Proxy Data Sets and Models to Support a Broad Range of Algorithm Working Group (AWG) Activities

Task 2. GOES-R Analysis Facility Instrument for Impacts on Requirements (GRAFIIR)

Task 3. Development of Generalized Radiative Transfer Model for Multilayer Clouds

Task 4. Algorithm Integration Team (AIT) Technical Support

Task 5. Total Ozone retrieval from ABI

Task 6. Cloud Products

Task 7. Development of Static Libraries for Retrieval of Cloud Optical and Microphysical Properties

Task 8. GEOCAT Enhancements and Documentation

CIMSS GOES-R AWG Tasks (17) (2/2)

Task 9. GOES-R ABI Fire Detection and Characterization Algorithm Development and Evaluation

Task 10. GOES-R Legacy Profile Algorithm Evaluation and Selection

Task 11. Sounding Product Evaluation and Validation

Task 12. Winds from GOES-R ABI

Task 13. Hurricane Intensity Estimation from GOES-R ABI

Task 14. Aviation Weather Products

- **A. Turbulence**
- **B. Volcanic Ash/SO2 Detection**
- **C. Low Cloud and Fog**

Task 15. Snow and Ice Products

Task 16. Aerosol imagery from GOES-R ABI

Task 17. Data Analysis and Visualization for GOES-R

ABI Proxy Data Animations
UW/CIMSS
June 4, 2005 15:00 & 20:00 UTC

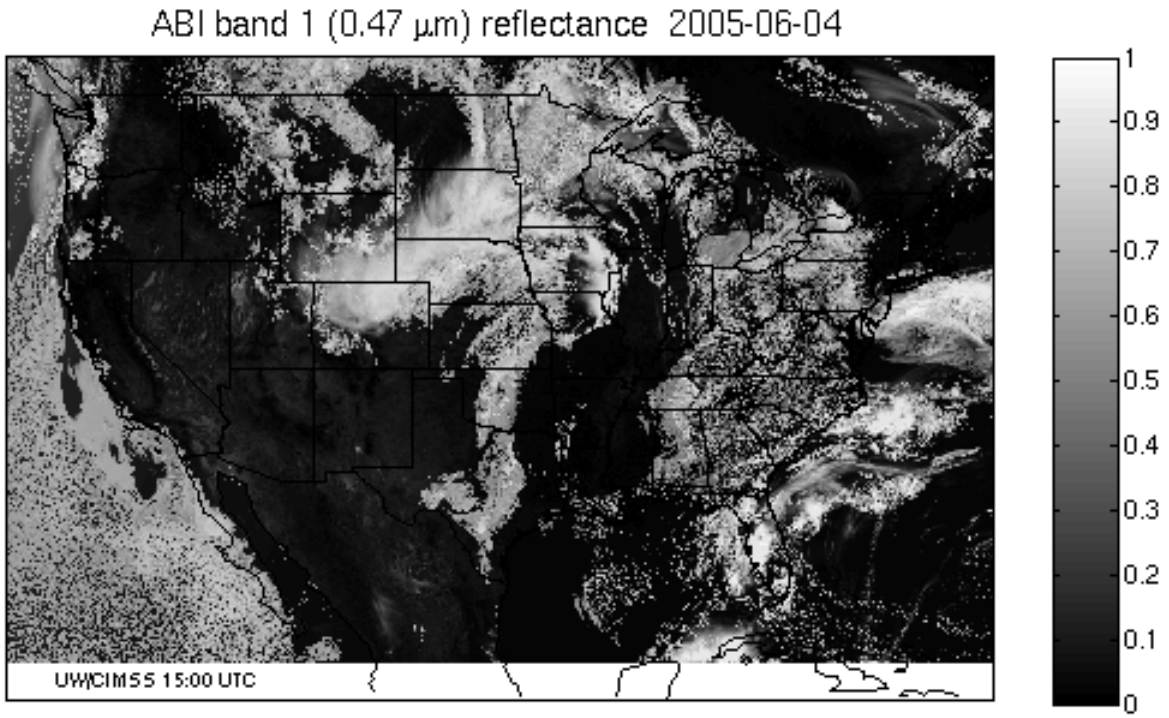
Updated
September 10, 2007

Continental US (CONUS)
Visible (VIS), Near IR & Infrared (IR)

Date: June 4, 2005
Time: 15:00 and 20:00 UTC
Spectral Loop
Bands 1-16

All Bands 15:00 UTC
June 4, 2005

Band	μm
1	0.47
2	0.64
3	0.86
4	1.38
5	1.61
6	2.26
7	3.90
8	6.19
9	6.95
10	7.34
11	8.50
12	9.61
13	10.4
14	11.2
15	12.3
16	13.3



All Bands 20:00 UTC
June 4, 2005

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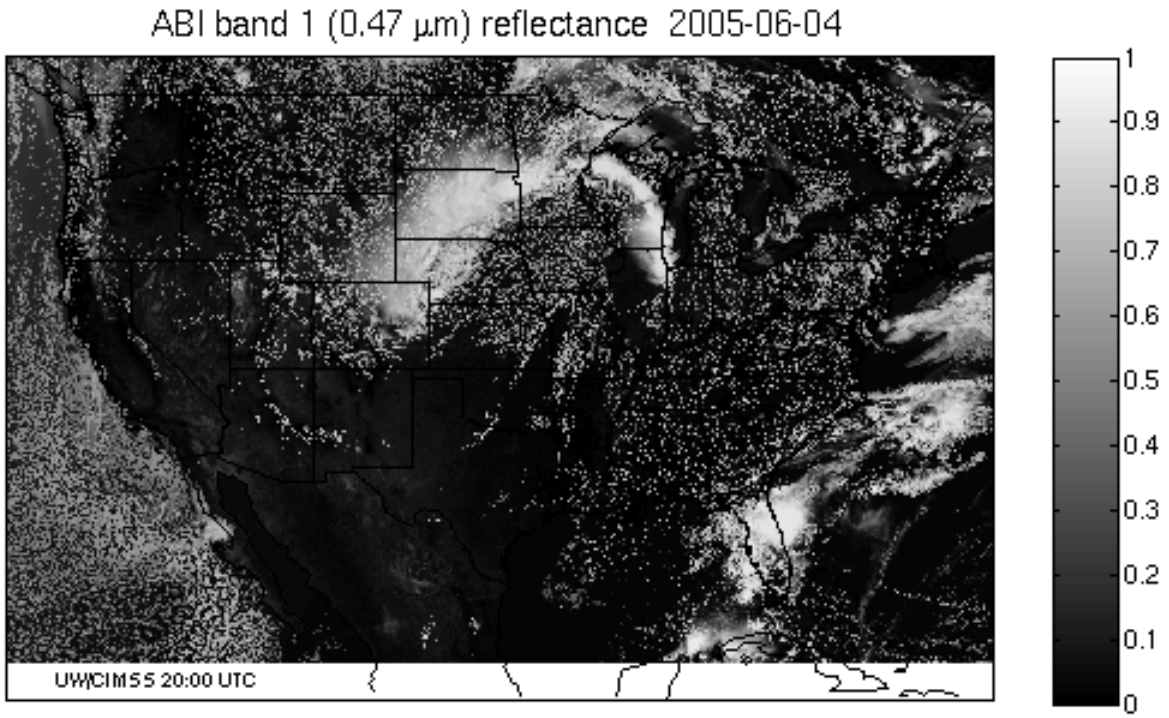
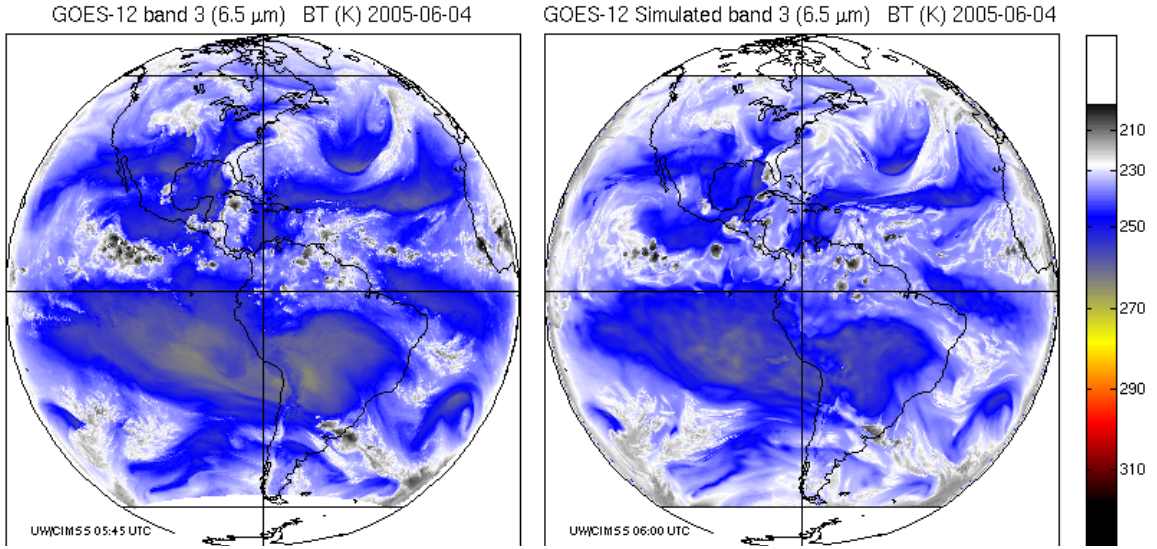
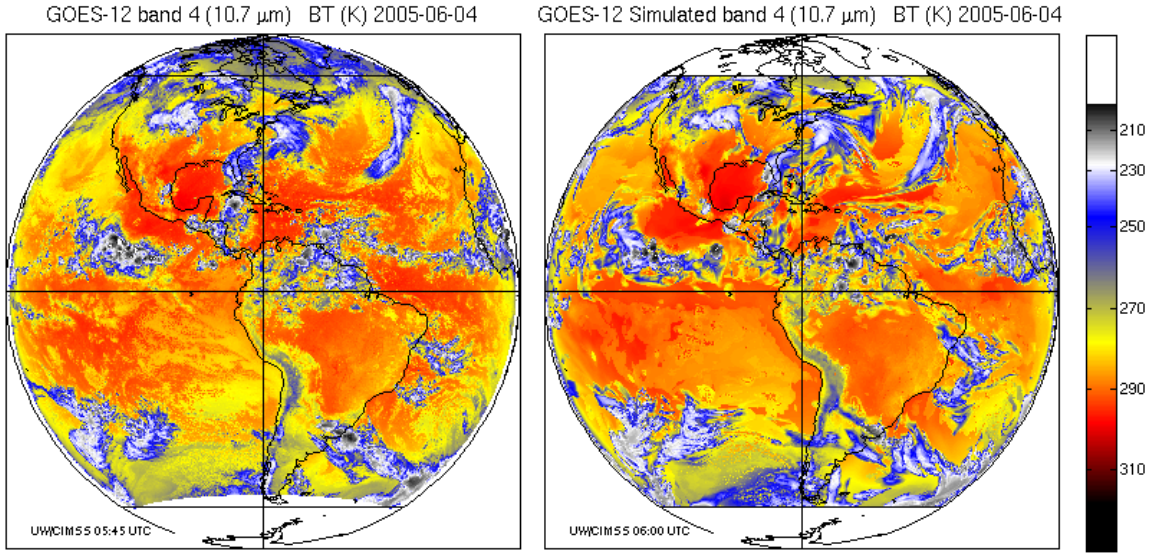
10	7.34
11	8.50
12	9.61
13	10.4
14	11.2
15	12.3
16	13.3



ABI Full-disk Animations

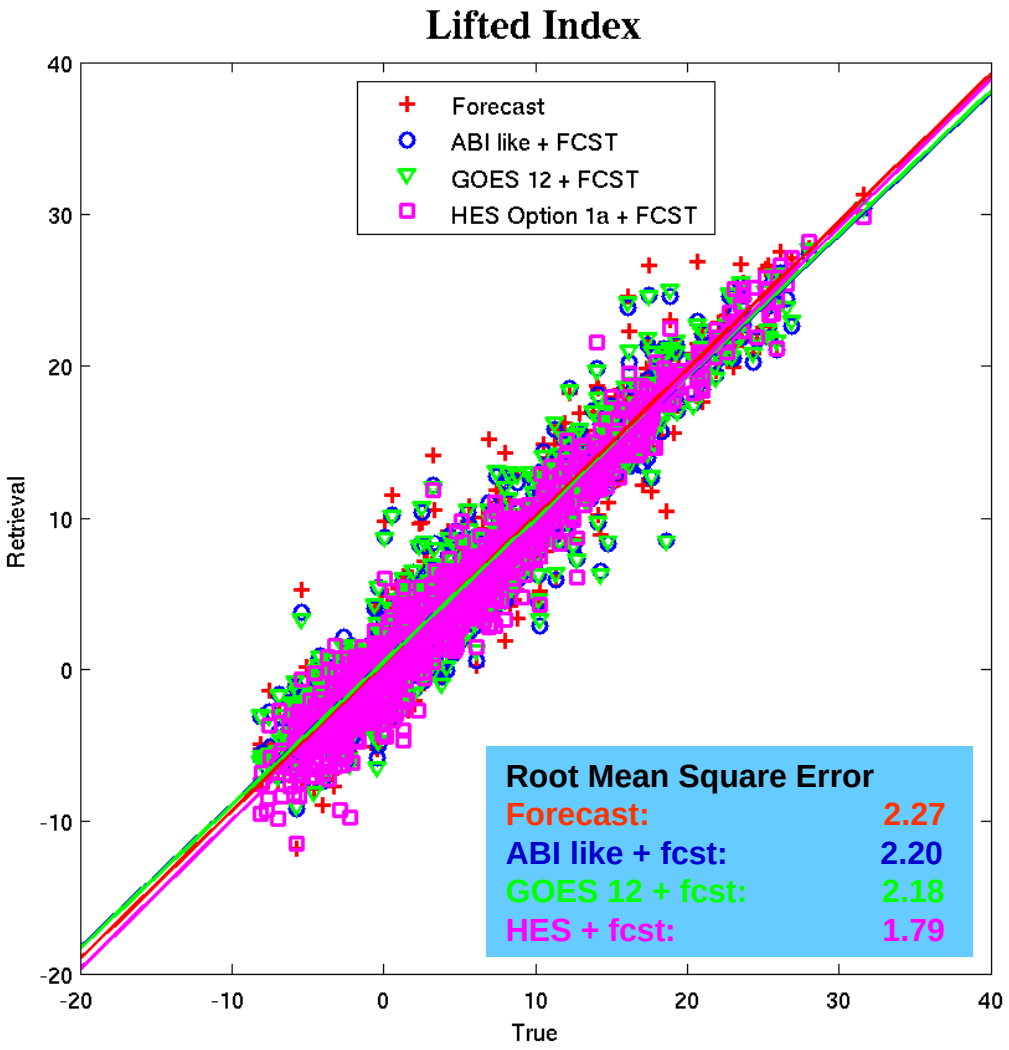
Observed Left





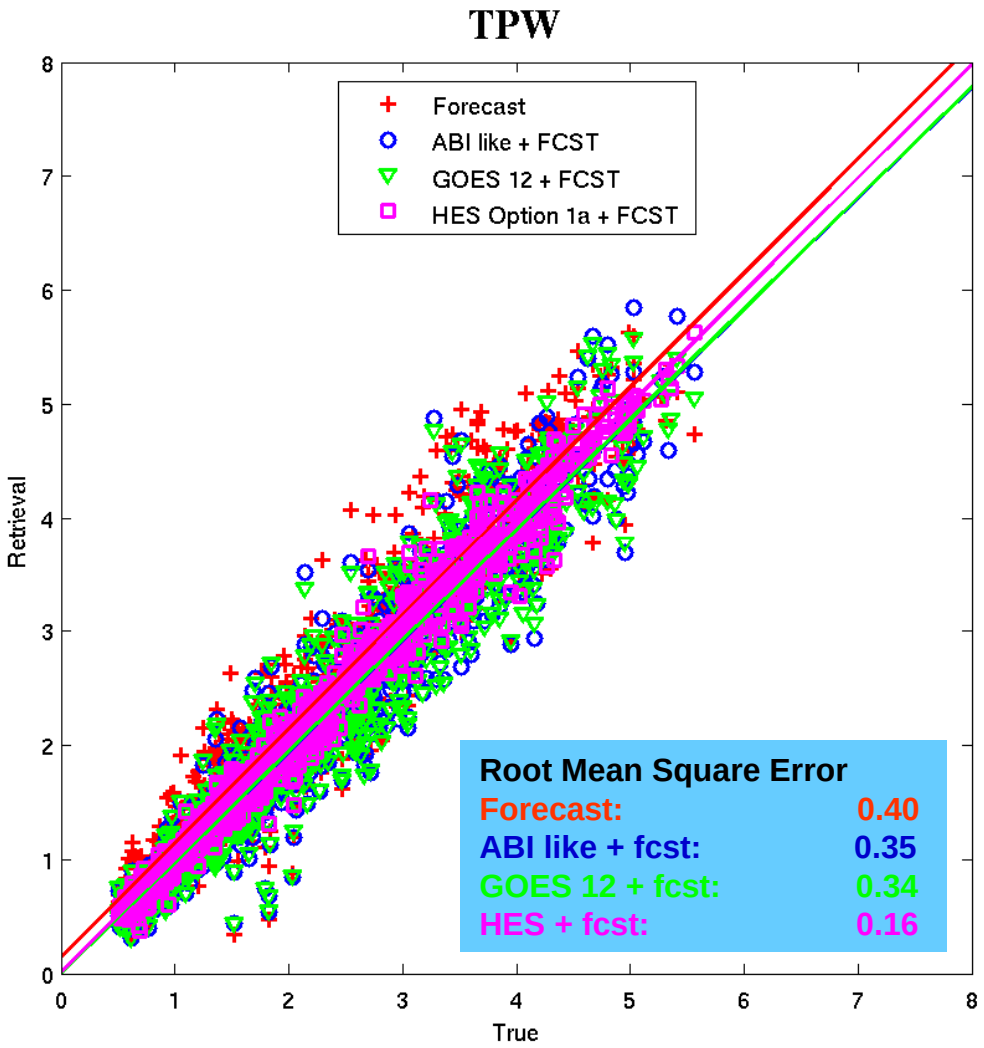
Simulated Right

Using ABI for continuation of GOES-N class sounder legacy products

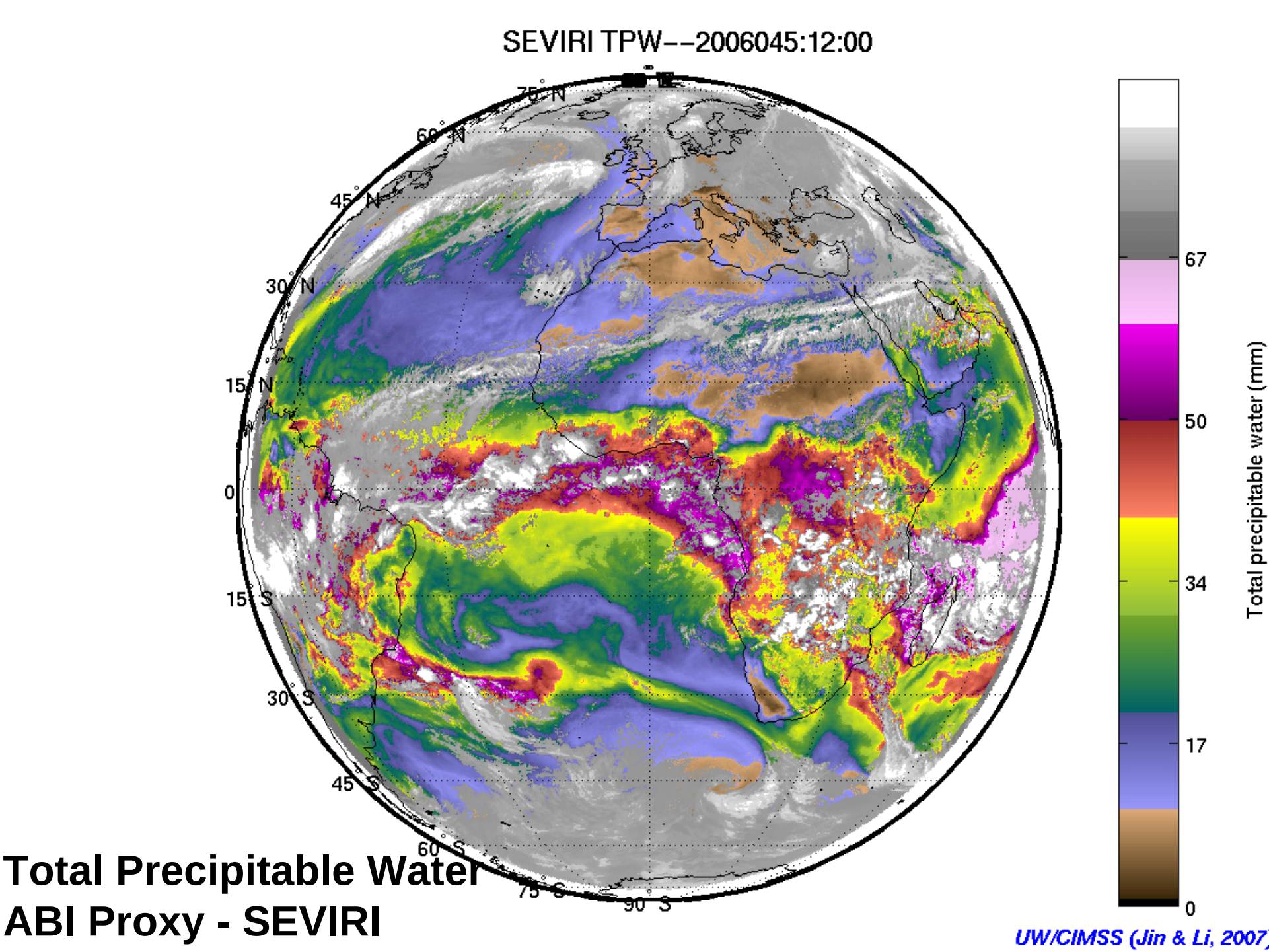


Experiments show that retrievals of atmospheric instability from high-spectral (e.g., HES) data are much improved over current broadband (GOES-12+forecast).

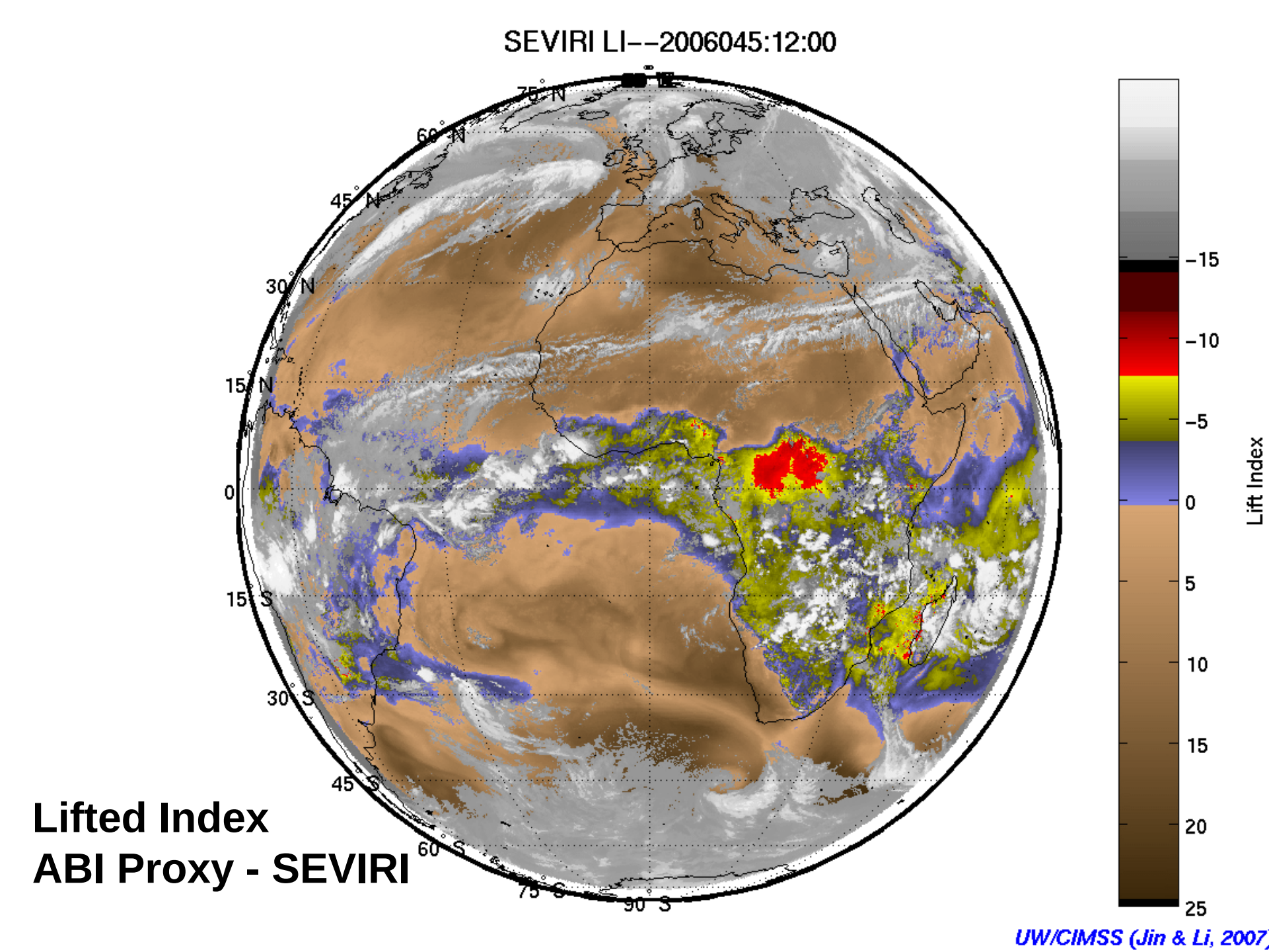
Using ABI for continuation of GOES-N class sounder legacy products

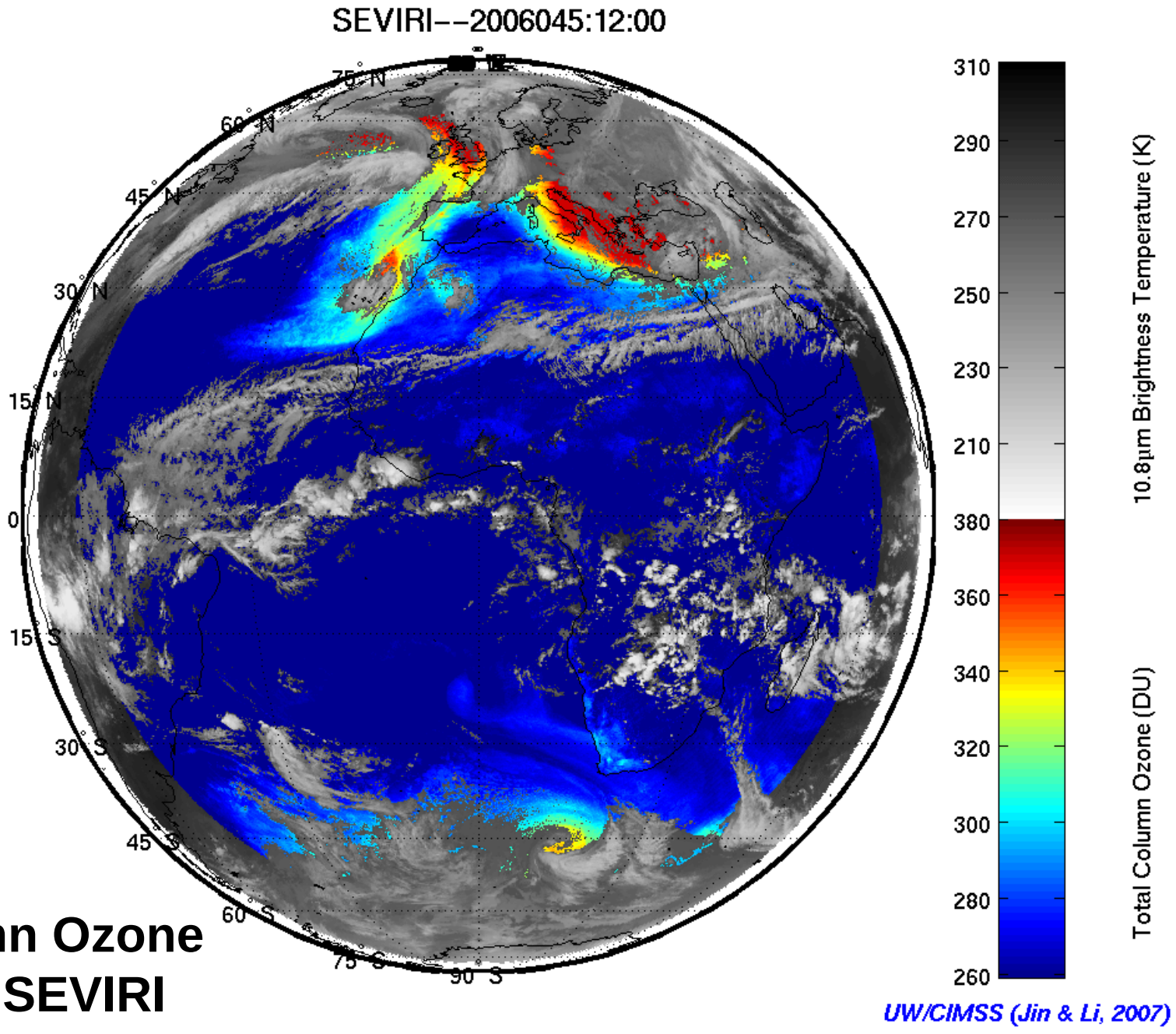


Experiments show that retrievals of Total Precipitable Water (TPW) from high-spectral (e.g., HES) data are much improved over current broadband (GOES-12+forecast).



Total Precipitable Water
ABI Proxy - SEVIRI


SEVIRI LI--2006045:12:00
75° N
60° N
45° N
30° N
15° N
0
15° S
30° S
45° S
60° S
75° S
90° S
−15
−10
−5
0
5
10
15
20
25
Lift Index
Lifted Index
ABI Proxy - SEVIRI
UW/CIMSS (Jin & Li, 2007)

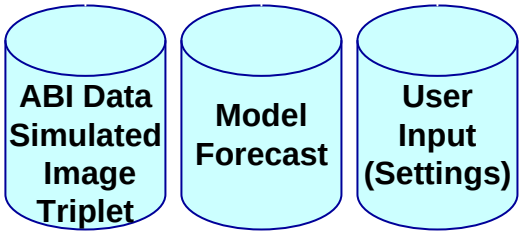


Total Column Ozone
ABI Proxy - SEVIRI

GOES-R AWG Applications Software and Products

Atmospheric Motion Vectors (AMV) – Processing Overview

Obtain inputs



Pre-processing

Check Image Registration

- Find clear landmarks
- Determine average shift between images
- Adjust images if necessary

Target Selection and Height Assignment

- Sectorize middle image into target scenes
- Analyze scenes; select suitable targets
- Estimate target heights

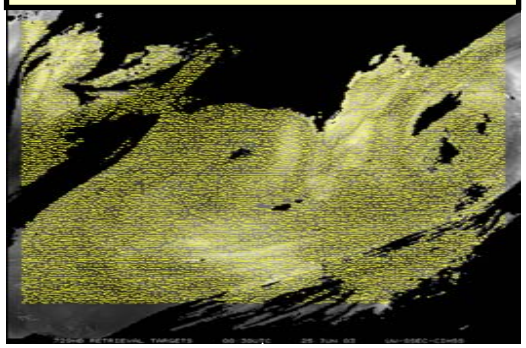
Feature Tracking

- Read in targets
- Use forecast to guide match search
- Find best match in first and third images
- Calculate displacements and compute average vector and final AMV

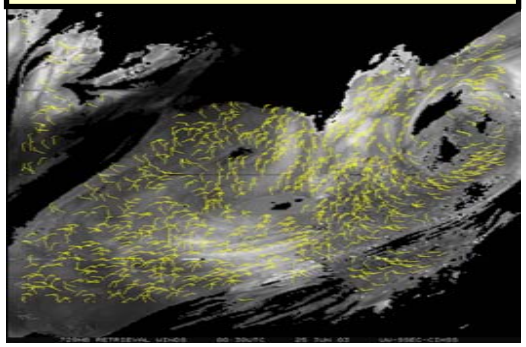
Quality Control

- Apply acceleration and gross error checks
- Compute Quality Indicators (QI)
- Recursive filter editing
- Assign final vector heights
- Compute Expected Error (EE) values

Target Field

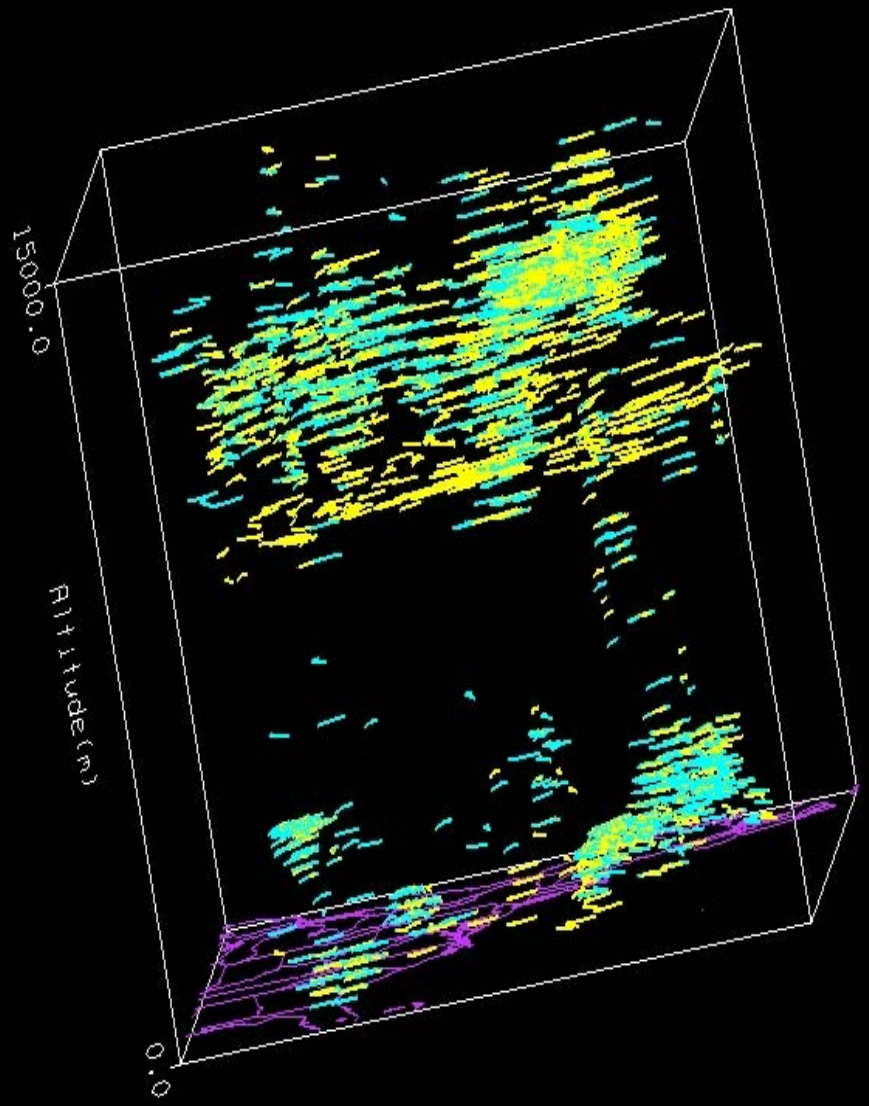


AMV Field

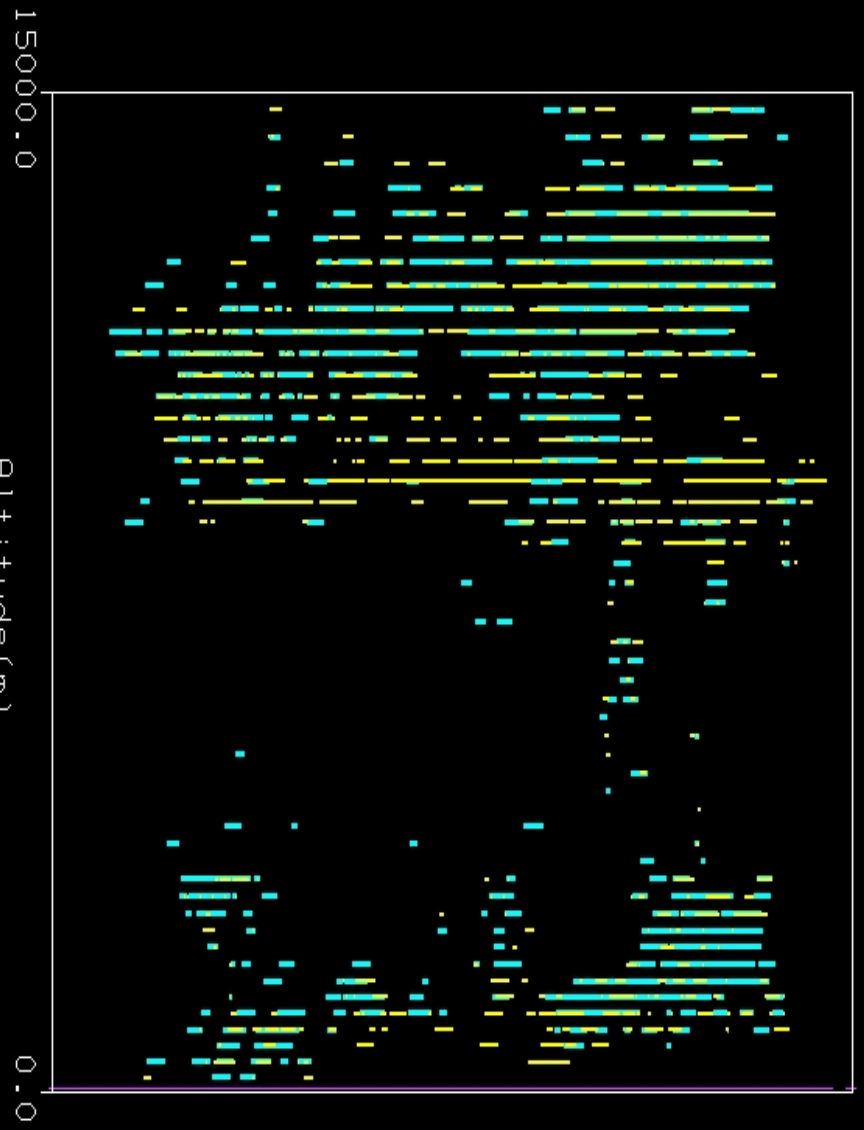


Simulated ABI AMVs from heritage and new channels

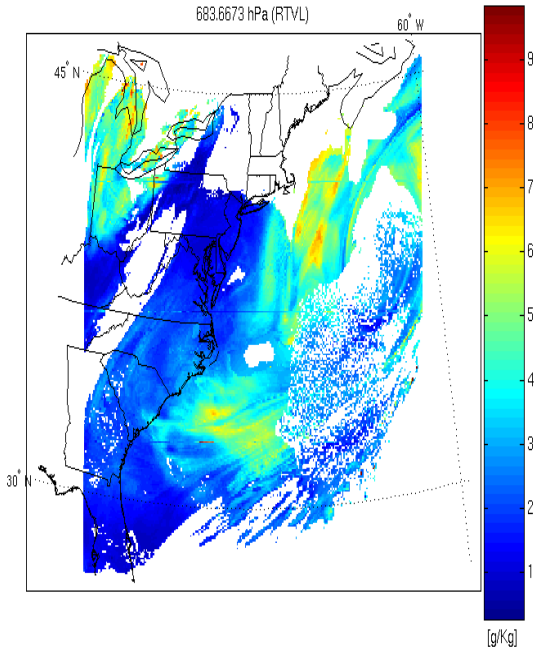
3D view



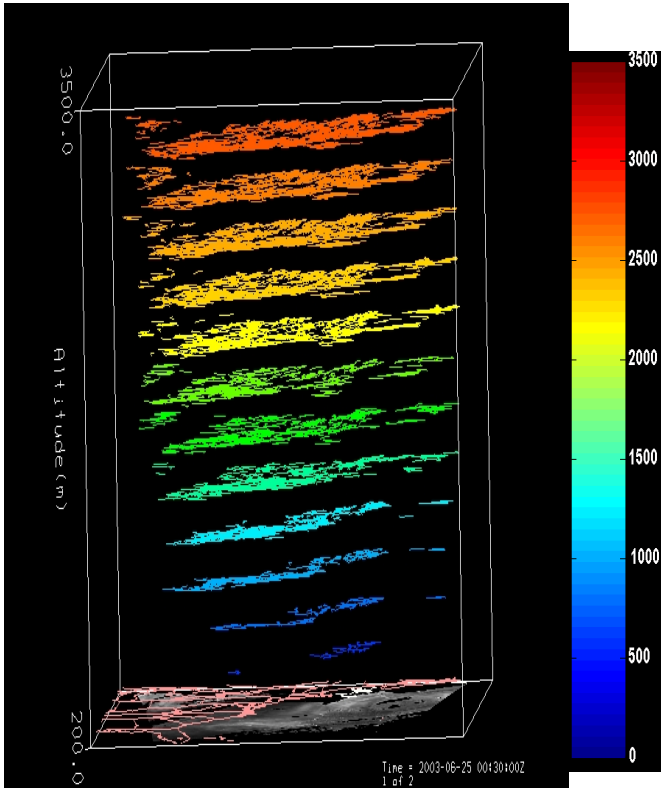
Vertical distribution



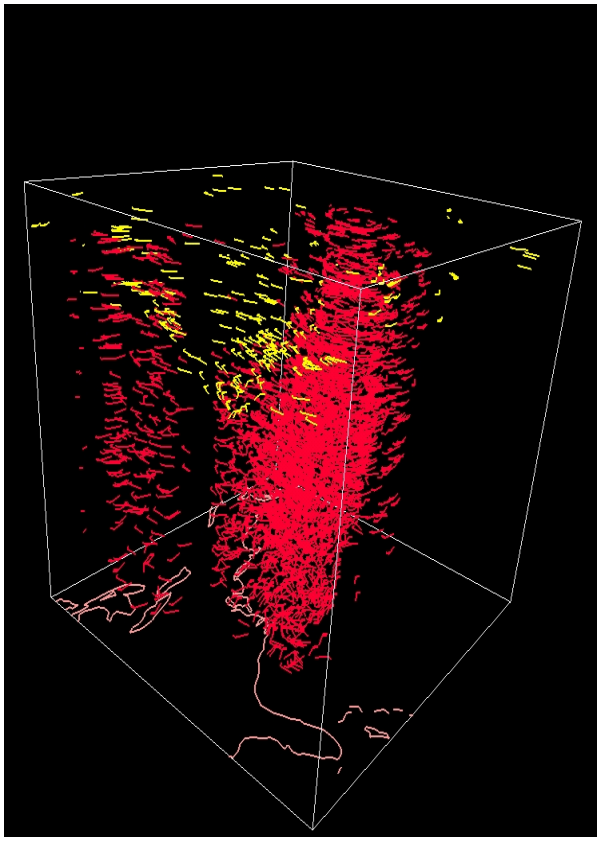
Simulated HES AMVs from retrieval height-resolved moisture analyses



Simulated HES retrieval moisture field (683hPa)



Marine boundary layer vertical distribution of height-resolved AMVs derived from the simulated HES moisture fields

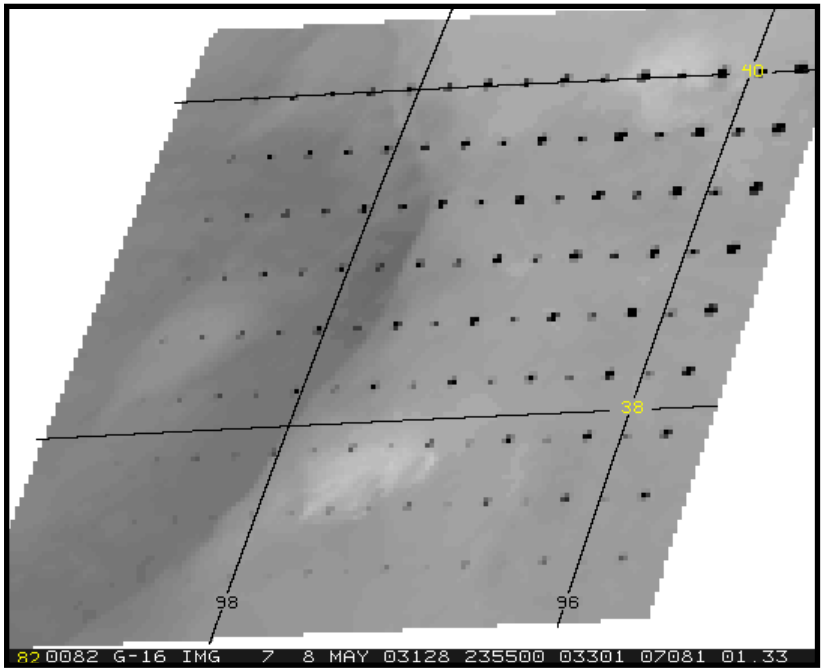


3D view of simulated HES AMVs compared to operational GOES clear sky WV AMVs

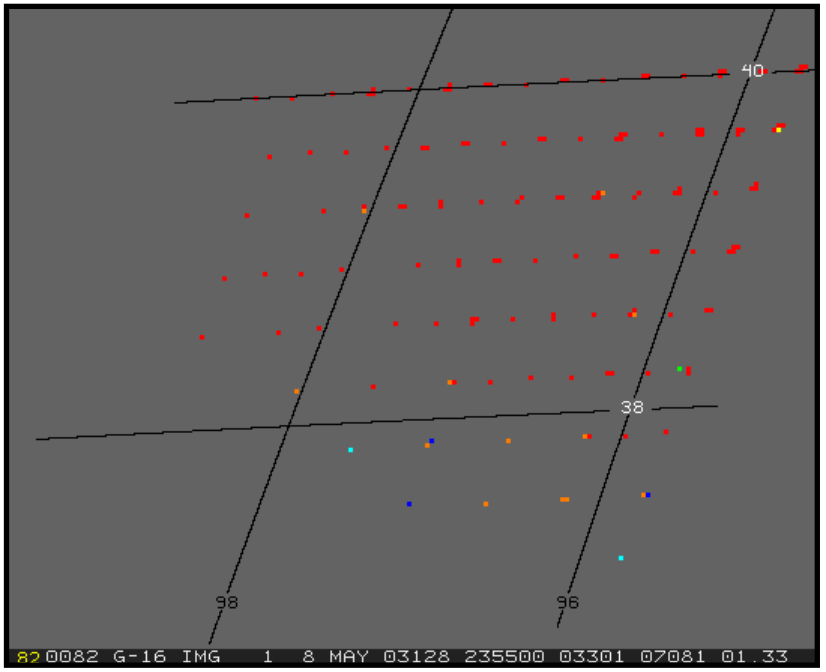
- **Adapt WF_ABBA contextual algorithm/code to GOES-R ABI**
  - Build on current contextual algorithms (WF_ABBA, MODIS)
  - Utilize GOES-RRR research efforts (CIMSS and UMD) to update current techniques that address emissivity, transmissivity, and solar reflectivity corrections.
  - Update WF_ABBA code for sub-pixel characterization requirements (Dozier technique and Fire Radiative Power). Base changes on user needs and current specs for ABI measurement range, spectral response, data quantization, band-to-band co-registration, MTF, etc.
  - Update code to provide meta data with fire mask (opaque cloud coverage; block-out zones due to solar reflectance, clouds, extreme view angles, biome type, etc..)
- **Identify proxy test data sets (e.g. GOES, MODIS, SEVIRI, MTSAT (2km), model simulated ABI, biome data, model output of TPW, etc.) and apply modified WF_ABBA to these data sets. Coordinate with Cloud and Proxy Team AWGs.**
- **Iterate algorithm/code and assess capabilities using proxy data case studies and higher resolution data (MODIS, ASTER, etc). Coordinate with NPOESS VIIRS fire team and UMD (Justice, Csiszar, Giglio).**

Application of Prototype ABI WF_ABBA to Simulated ABI Data in North America

Variable Fire - No Cloud Case Study



CIRA Model Simulated ABI
3.9 µm band



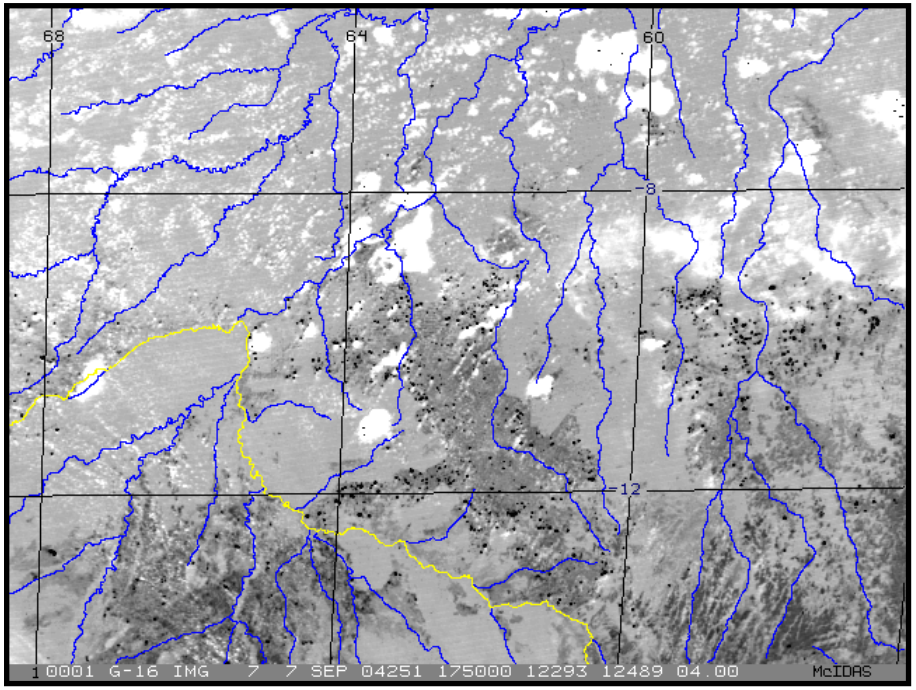
CIMSS ABI WF_ABBA Fire Product
Biome Block-Out Zone

Experimental ABI WF_ABBA Fire Legend

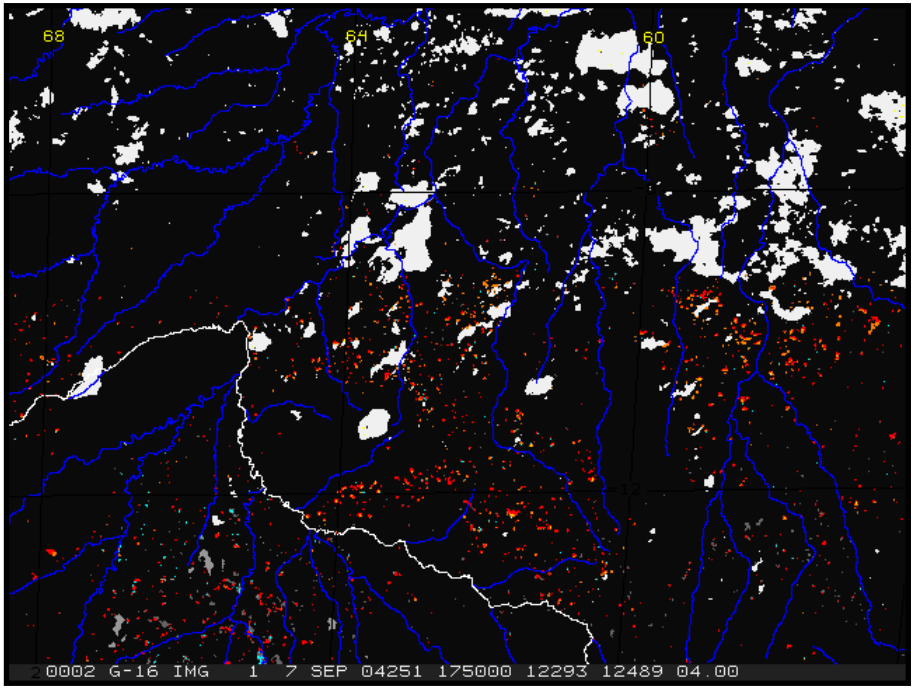
Processed Fire	Saturated Pixel	Cloudy Fire
High Possibility Fire	Medium Possibility Fire	Low Possibility Fire

Application of Prototype ABI WF_ABBA to MODIS Simulated ABI Data in South America

Date: 7 September 2004 **Time: 17:50 UTC**

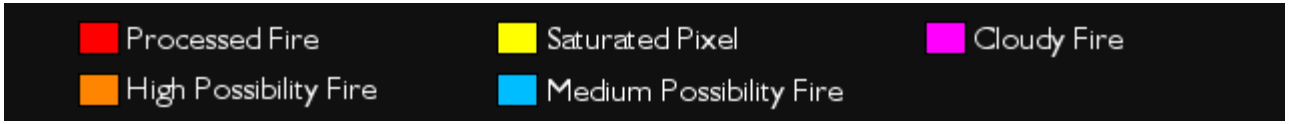


CIMSS MODIS Simulation of ABI 3.9 µm band



CIMSS ABI WF_ABBA Fire Mask Product

Experimental ABI WF_ABBA Fire Legend



GOES-R Analysis Facility for Instrument Impacts on Requirements (GRAFIIR)

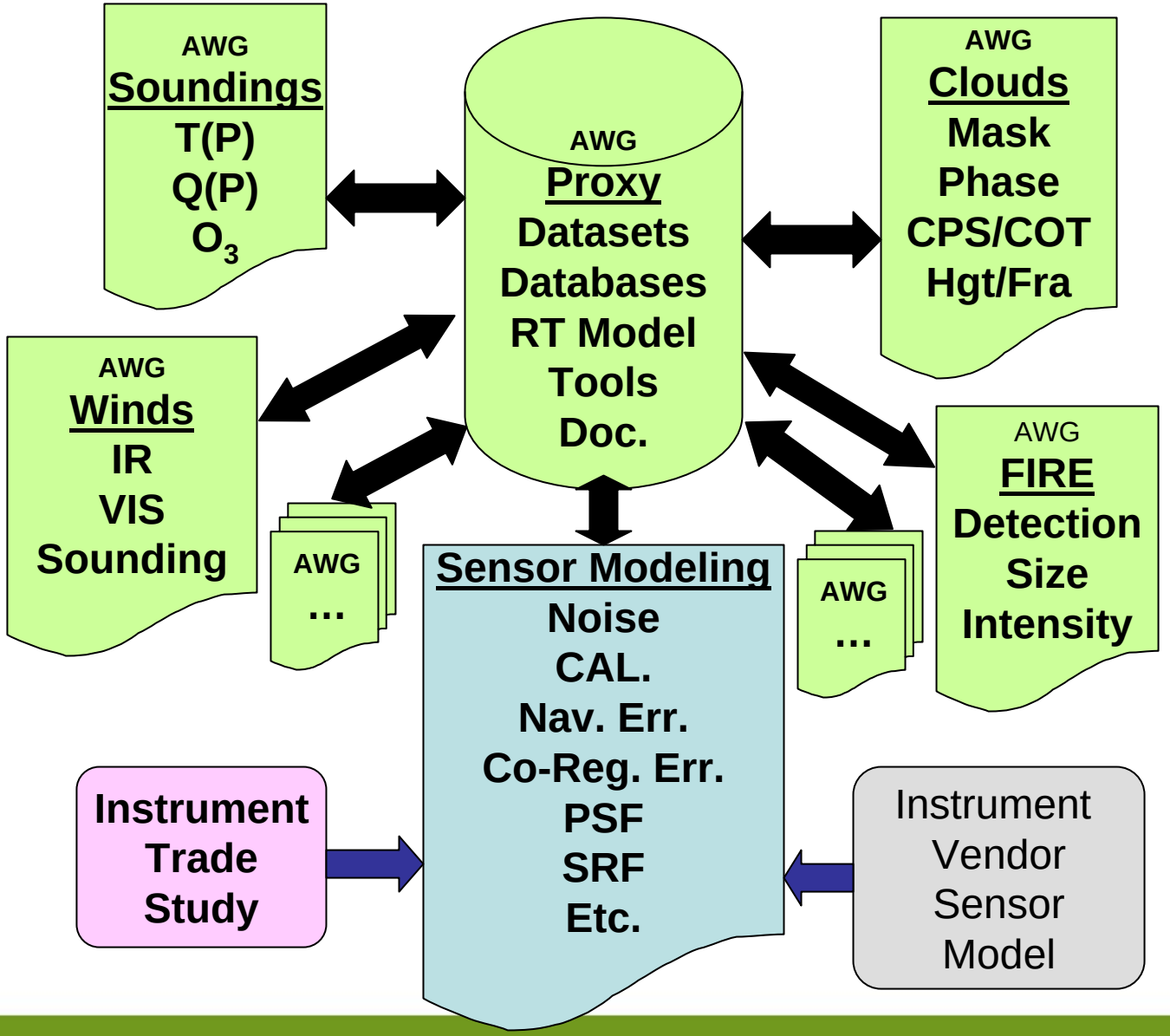
GRAFIIR is a facility established to leverage existing capabilities and those under development for both current GOES and its successor in data processing and product evaluation to support GOES-R analysis of instruments impacts on meeting user and product requirements.

GRAFIIR is for "connecting the dots", the components that have been built and/or are under development, to provide a flexible frame work to effectively adopt component algorithms toward analyzing the sensor measurements with different elements of sensor characteristic (i.e. noise, navigation, band to band co-registration, diffraction, etc.) and its impact on products.

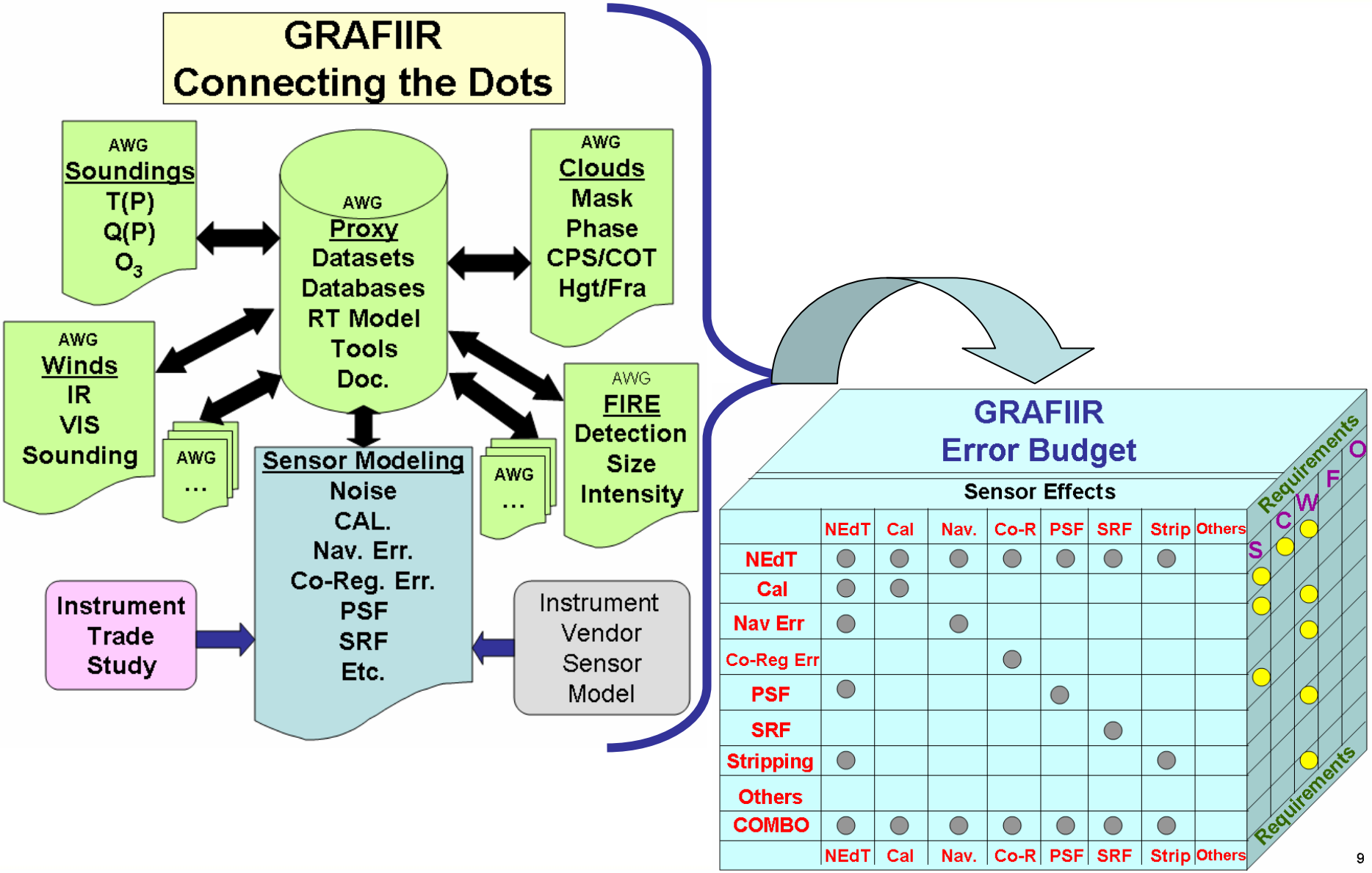
GRAFIIR is to assess and evaluate many of the GOES-R data and products (i.e. imagery, clouds, derived products, soundings, winds, etc.) in a consistent way to ensure the instrument effects on the products can be fully accounted for, characterized and product performance could be optimized.

GRAFIIR is a coordinated team effort from GOES-R Risk Reduction and Algorithm Working Group and other related projects. It will not independently develop any new algorithms or processing that are available or already under developed.

GRAFIIR
Connecting the Dots



GRAFIIR Error Budget



CIMSS/UW Working with NOAA GOES-R AWG Chairs

NOAA AWG Chair – Mitch Goldberg

Tim Schmit, Sounding

Jaime Daniels, Wind

Mark Demaria, Tropical Cyclone

Andy Heidinger, Cloud

Jeff Key, Cryosphere

Shoba Kondragunta, Aerosol

Mike Pavolonis, GEOCAT, Cloud

Dan Tarpley, Land

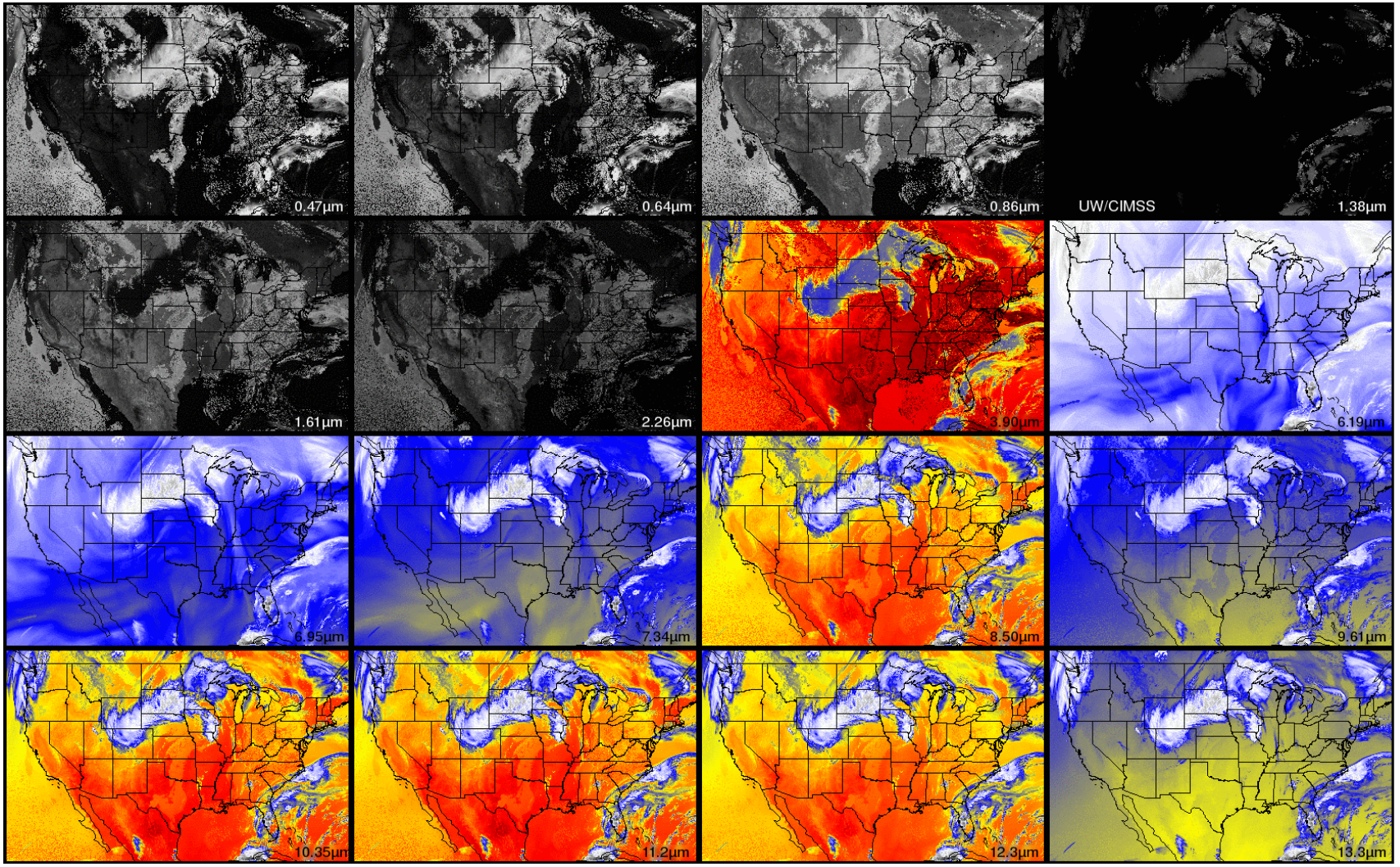
Gary Wade, Sounding Study

Fuzhong Weng, Proxy

CIMSS/UW-Madison (47)

Proxy/Model: 10; Sounding: 4; Ozone: 3; Cloud Pro.: 3; Validation: 2; Cloud Micro.: 1; Aerosol: 1; Fires: 4; Winds: 3; Tropical Cyclone: 3; Aviation Wx: 4; Snow/Ice: 3; Visualization: 3; Algo. Eval.: 3

Simulated ABI 16 Band Image Loop



ABI band data for 2005 June 04 15:00 UTC