GOES-R versus Current GOES

Timothy J. Schmit

NOAA/NESDIS/ORA Advanced Satellite Products Team (ASPT)

James J Gurka

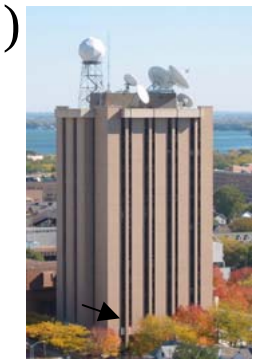
NOAA/NESDIS/OSD

W. P. Menzel

NOAA/NESDIS/ORA

Jun Li, Mat Gunshor and many others

Cooperative Institute for Meteorological Satellite Studies (CIMSS)



GOES-R Discussion
February, 2005

UW-Madison

GOES R Baseline Instruments

- Advanced Baseline Imager (ABI)
- Hyperspectral Environmental Suite (HES)
  - Disk Sounding
  - Severe Weather Mesoscale
  - Coastal Waters
- Geostationary Lightning Mapper (GLM)
- Solar Instrument Suite (SIS)
- Space Environment In Situ Suite (SEISS)

BASELINE INSTRUMENTS PLANNED FOR THE GOES-R SERIES

James J. Gurka
NOAA/NESDIS/OSD (Office of Systems Development)
Timothy J. Schmit
NOAA/NESDIS/ORA (Office of Research and Applications)

Payload key:

ABI
HES
GLM
SIS
SEISS
MAG
AUX

NOAA Goals

Protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Serve society's needs for weather and water information

Understand climate variability and change to enhance society's ability to plan and respond

Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation

GOES-R measurements will help fulfill such goals

SIS — Solar Imaging Suite

SEISS — Space Environment In-Situ Suite

ABI — Advanced Baseline Imager

HES — Hyperspectral Environmental Suite — Infrared (IR)

AUX — Auxiliary Services

LRIT—Low Rate Information transmission
EMWIN—Emergency Managers Wx Information Network
DCS—Data Collection System
SAR—Search and Rescue

GLM — Geostationary Lightning Mapper

HES — Hyperspectral Environmental Suite — Visible/Near IR

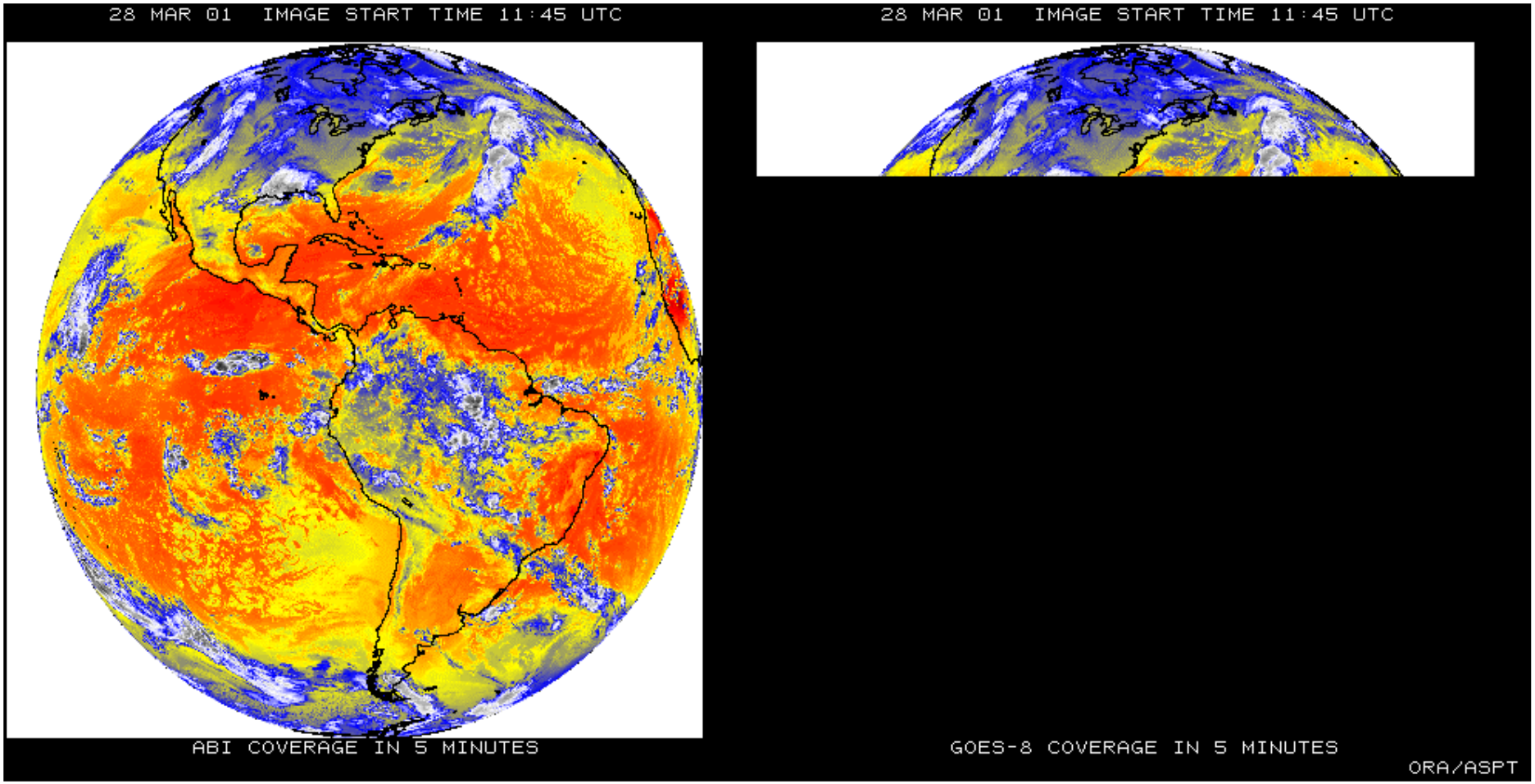
Coastal Waters (CW) applications

The great amount of information from the GOES-R series will both offer a continuation of current product and services, but also allow for improved or new capabilities. These products, based on validated requirements, will cover a wide range of phenomena. This includes applications relating to: weather, climate, ocean, coastal zones, land, hazards, solar and space. The geostationary perspective offers a rapid refresh rate and constant viewing angles. The Advanced Baseline Imager (ABI), the Hyperspectral Environmental Suite (HES), the Geostationary Lightning Mapper (GLM), the space and solar instrument suites (Solar Imaging Suite (SIS) and the Space Environment In-Situ Suite (SEISS), as well as the auxiliary services on GOES-R will enable much improved monitoring compared to current capabilities.

The Advanced Baseline Imager:

	ABI	Current
Spectral Coverage		
	16 bands	5 bands
Spatial resolution		
0.64 μm Visible	0.5 km	Approx. 1 km
Other Visible/nearIR	1.0 km	n/a
Bands (>2 μm)	2 km	Approx. 4 km
Spatial coverage		
Full disk	4 per hour	Every 3 hours
CONUS	12 per hour	~4 per hour
Visible		
On-orbit calibration	Yes	No

ABI spatial coverage rate versus the current GOES Imager



ABI coverage in ~5 minutes Current GOES coverage in 5 minutes

There are two anticipated scan modes for the ABI:

1) full disk images every 15 minutes + CONUS images every 5 minutes + mesoscale.

2) Full disk every 5 minutes.

ABI Bands

Future GOES Imager (ABI) Band	Wavelength Range (μm)	Central Wavelength (μm)	Sample Objective(s)
1	0.45-0.49	**0.47**	Daytime aerosol-over-land, Color imagery
2	0.59-0.69	**0.64**	Daytime clouds fog, insolation, winds
3	0.84-0.88	**0.86**	Daytime vegetation & aerosol-over-water, winds
4	1.365-1.395	**1.38**	Daytime cirrus cloud
5	1.58-1.64	**1.61**	Daytime cloud water, snow
6	2.235 - 2.285	**2.26**	Day land/cloud properties, particle size, vegetation
7	3.80-4.00	**3.90**	Sfc. & cloud/fog at night, fire
8	5.77-6.6	**6.19**	High-level atmospheric water vapor, winds, rainfall
9	6.75-7.15	**6.95**	Mid-level atmospheric water vapor, winds, rainfall
10	7.24-7.44	**7.34**	Lower-level water vapor, winds & SO_2
11	8.3-8.7	**8.5**	Total water for stability, cloud phase, dust, SO_2
12	9.42-9.8	**9.61**	Total ozone, turbulence, winds
13	10.1-10.6	**10.35**	Surface properties, low-level moisture & cloud
14	10.8-11.6	**11.2**	Total water for SST, clouds, rainfall
15	11.8-12.8	**12.3**	Total water & ash, SST
16	13.0-13.6	**13.3**	Air temp & cloud heights and amounts

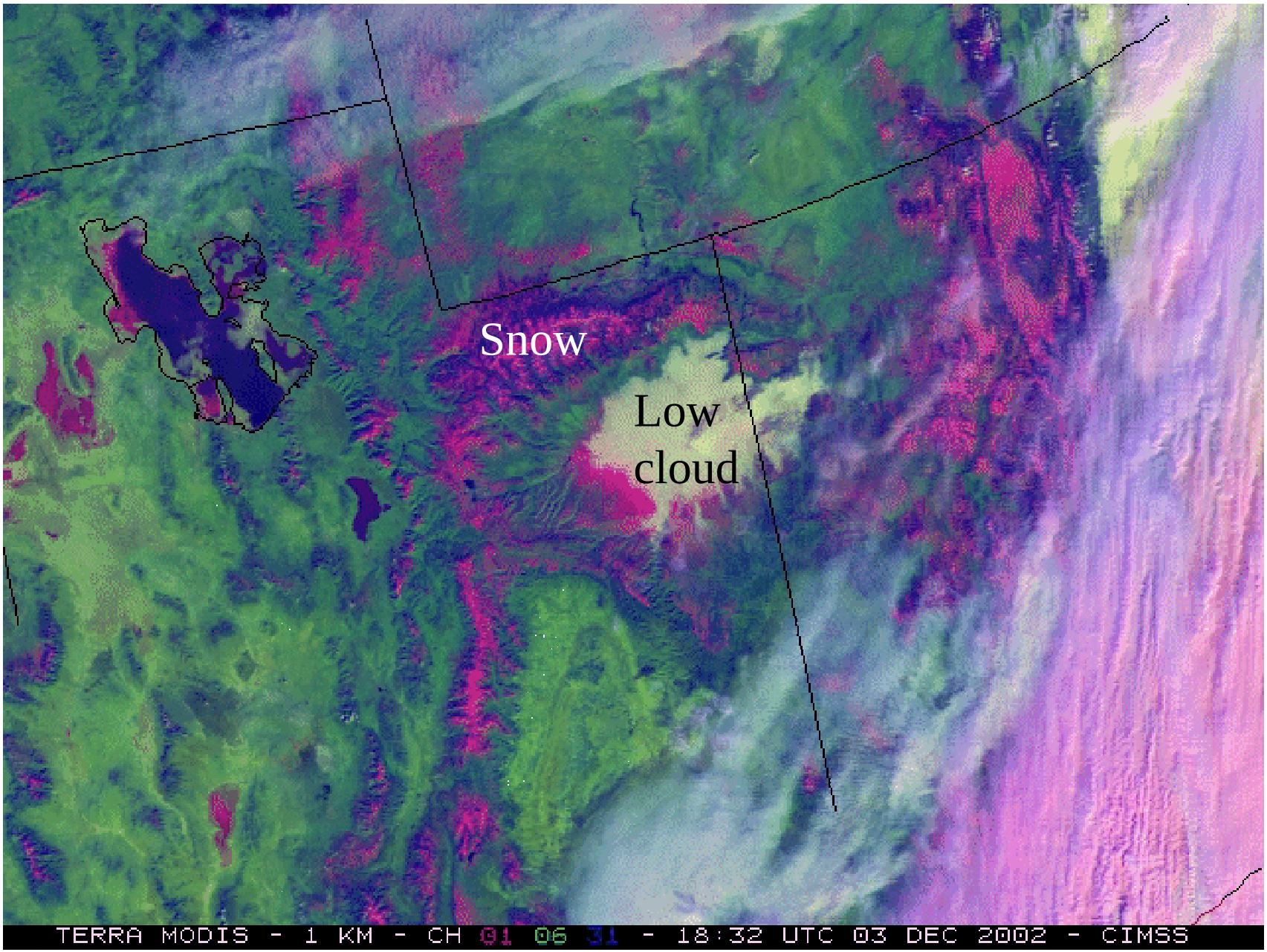
Based on experience from:

Current GOES Imagers

MSG/AVHRR/ Sounder(s)

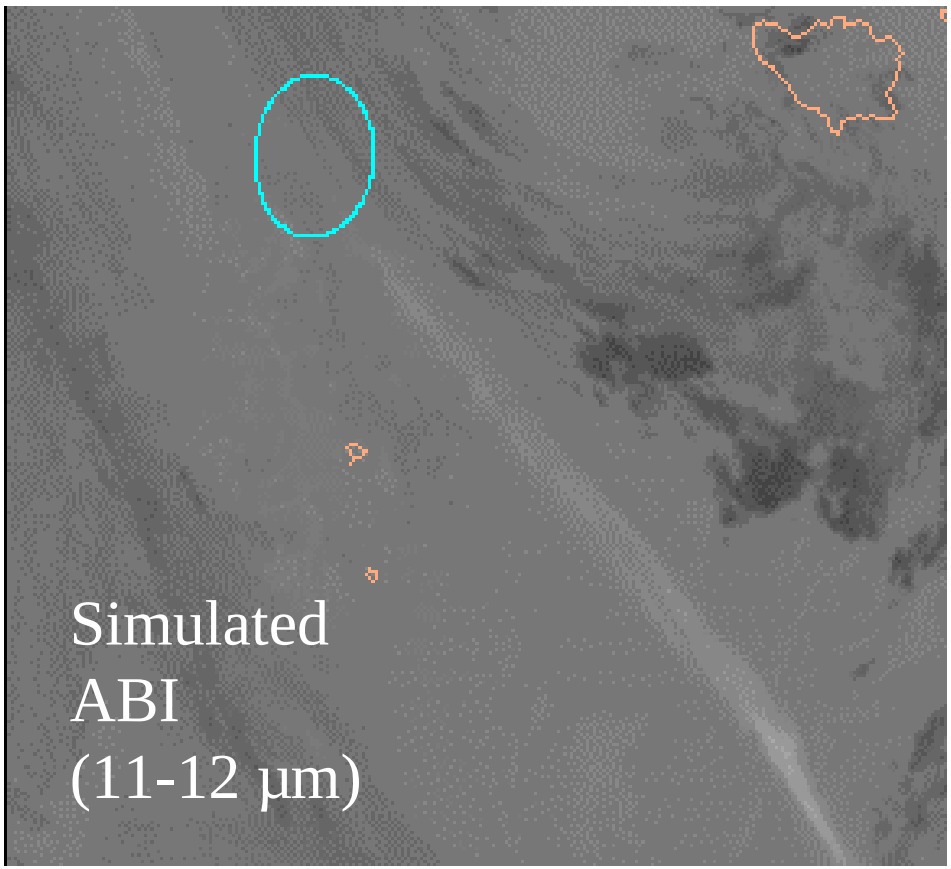
MODIS, Aircraft, etc

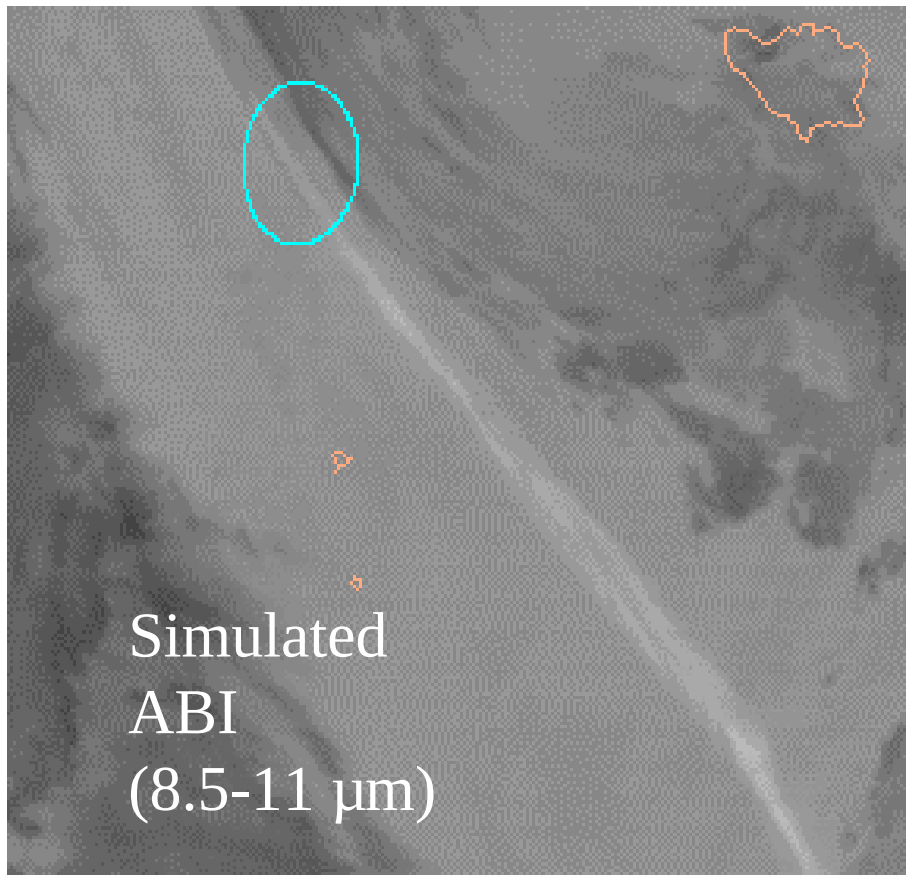
Three-color composite (0.64, 1.6 and 11 μm) shows the low cloud over the snow and the water versus ice clouds.



Volcanic Ash Plume: 11-12 and 8.5-11 µm images

One day after the Mt. Cleveland eruption
20 February 2001, 0845 UTC



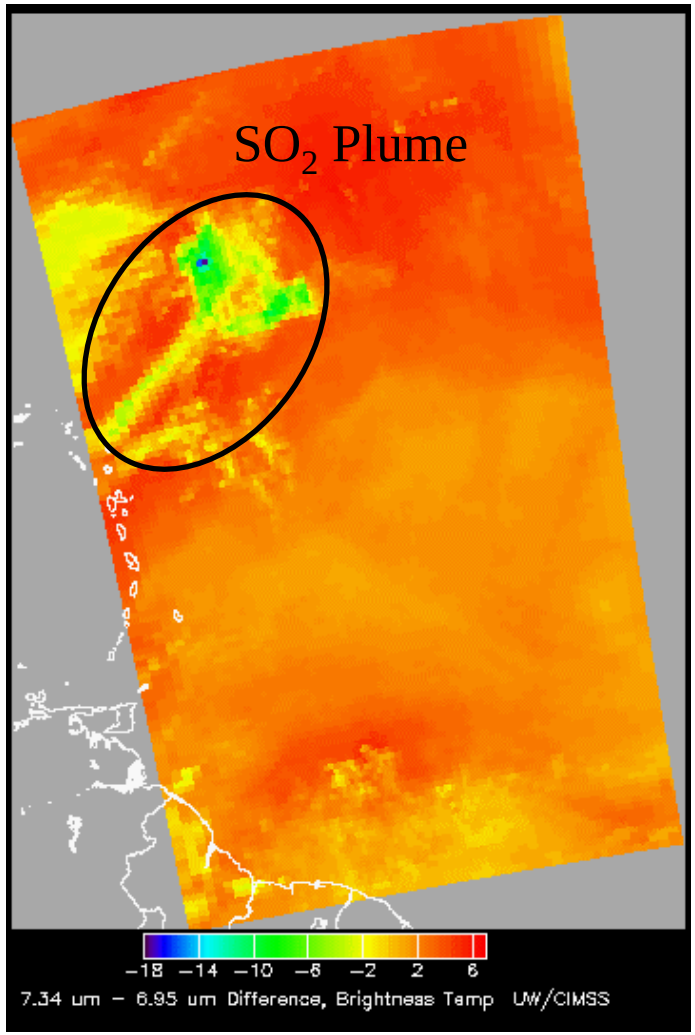


GOES-R ABI detects SO2 plumes

Water Vapor Band Difference convolved from AIRS data
sees SO_2 plume from Montserrat Island, West Indies

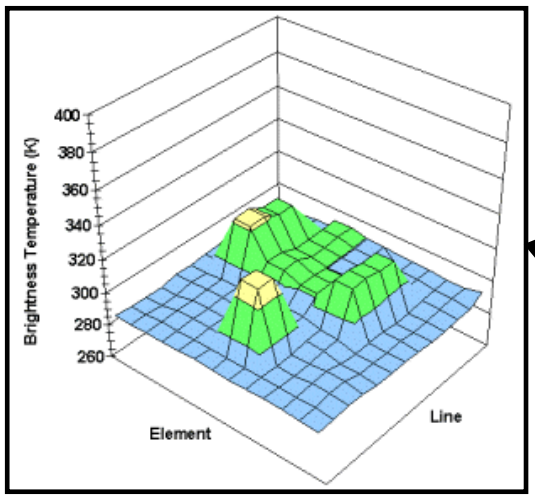
Current GOES Imager
No skill in monitoring

Current GOES Imager can not detect SO_2

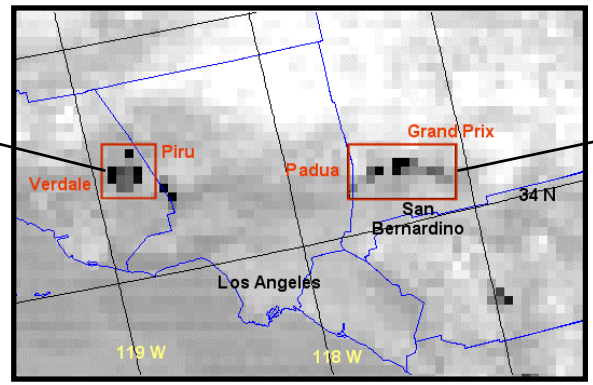


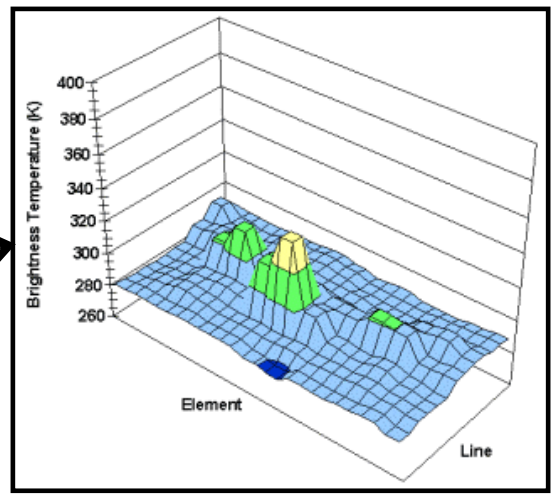
ABI 7.34 µm - 6.95 µm

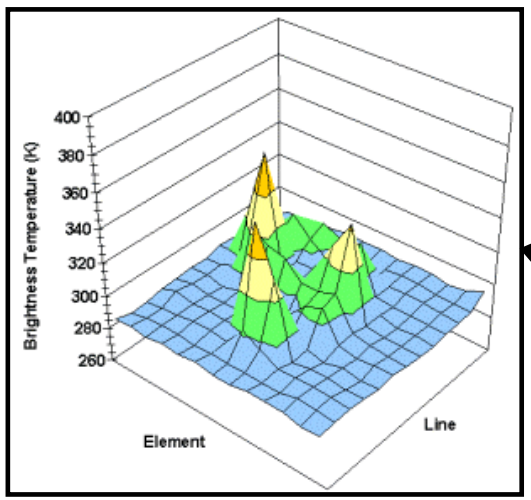
GOES-R and GOES-I/M Simulations of Southern California Fires



GOES-12 Simulated 3.9 micron Data
Padua/Grand Prix Fires
Date: 27-Oct-03 Time: 09:50 UTC







GOES-R Simulated 3.9 micron Data
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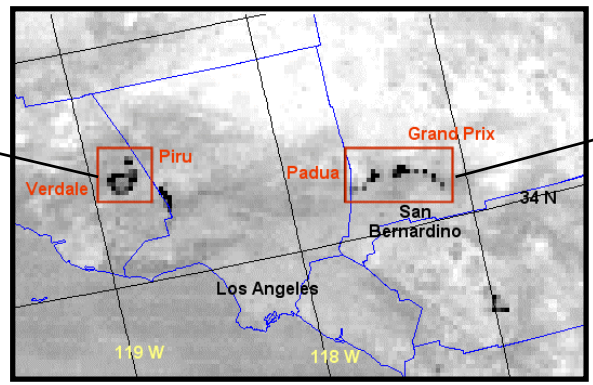
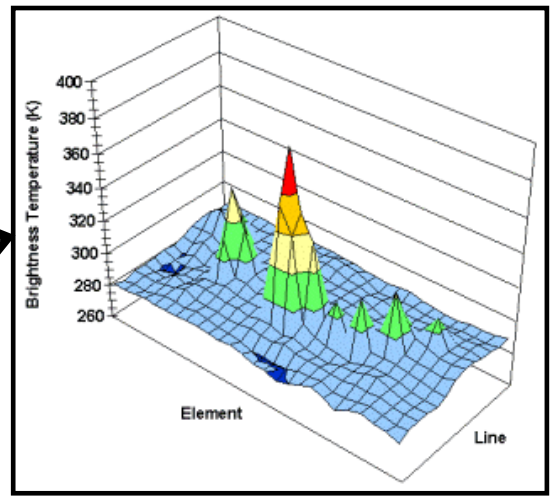




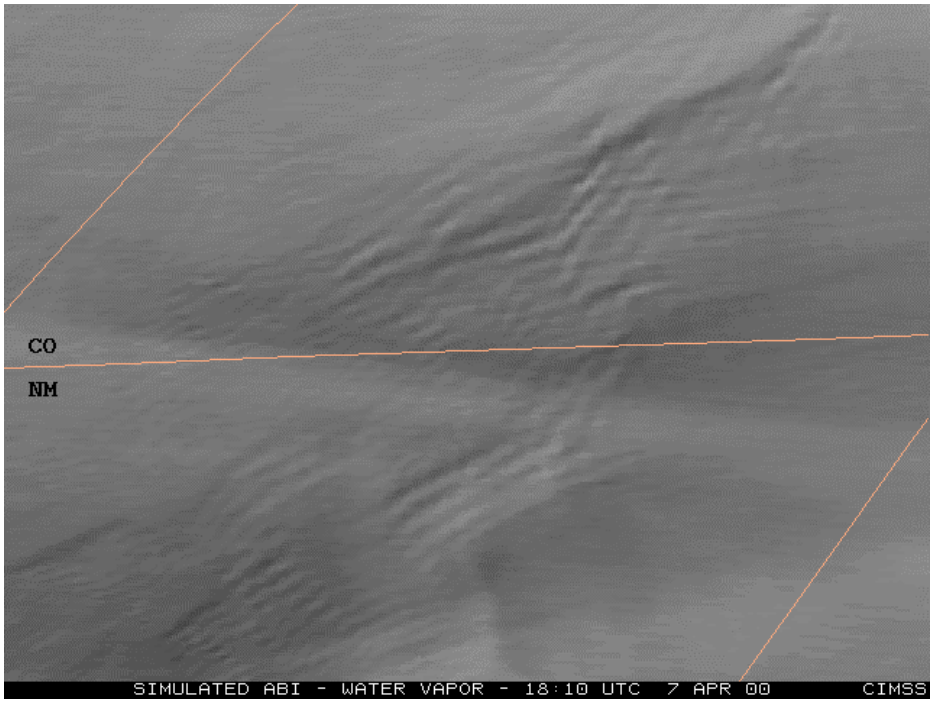
Brightness Temperature (K)

260-280 | 280-300 | 300-320 | 320-340 | 340-360 | 360-380 | 380-400

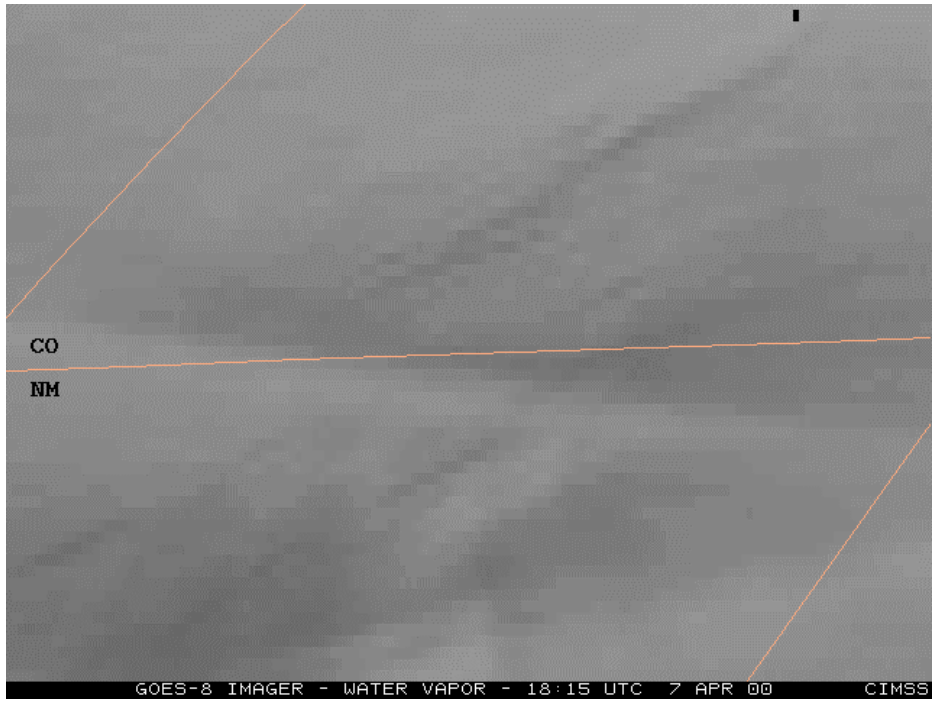
Mountain Waves in WV channel (6.7 µm)

7 April 2000, 1815 UTC

Simulated ABI



Actual GOES-8



Mountain waves over Colorado and New Mexico were induced by strong northwesterly flow associated with a pair of upper-tropospheric jet streaks moving across the elevated terrain of the southern and central Rocky Mountains. The mountain waves appear more well-defined over Colorado; in fact, several aircraft reported moderate to severe turbulence over that region.

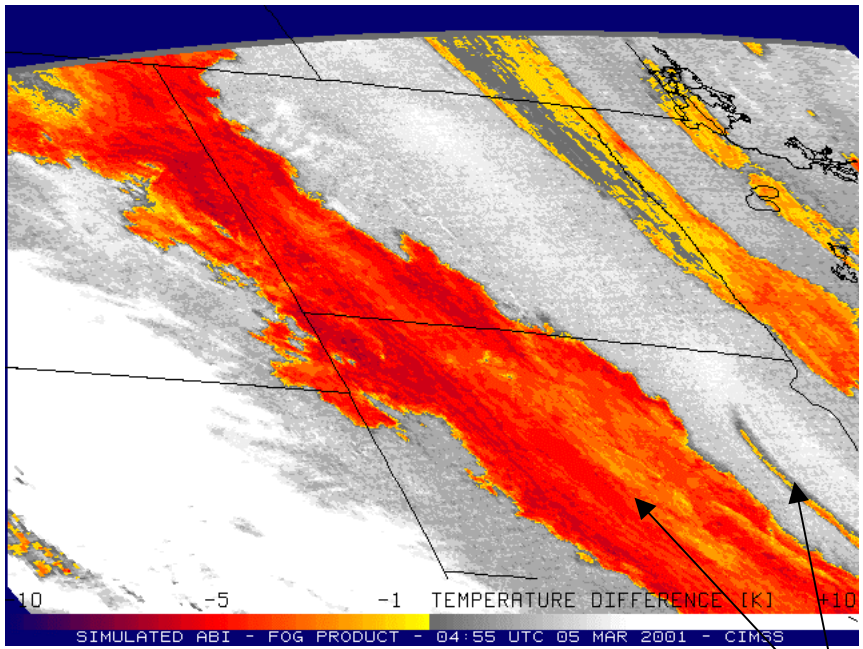
Both images are shown in GOES projection.

UW/CIMSS

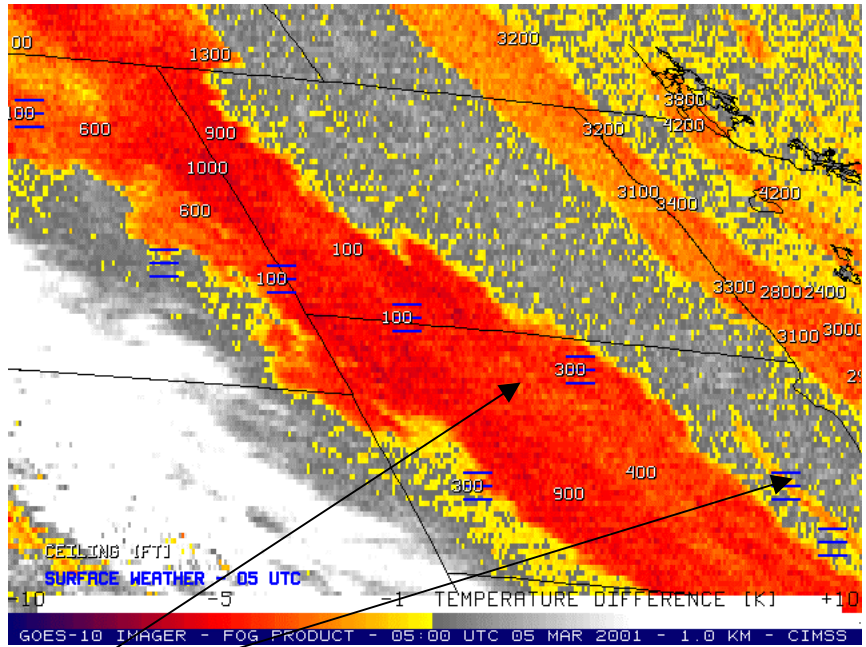
Fog -- Based on GOES Imager 3.9 µm

5 March 2001 - Nocturnal Fog/Stratus Over the Northern Plains

ABI 4 minus 11 µm Difference



GOES-10 4 minus 11 µm Difference



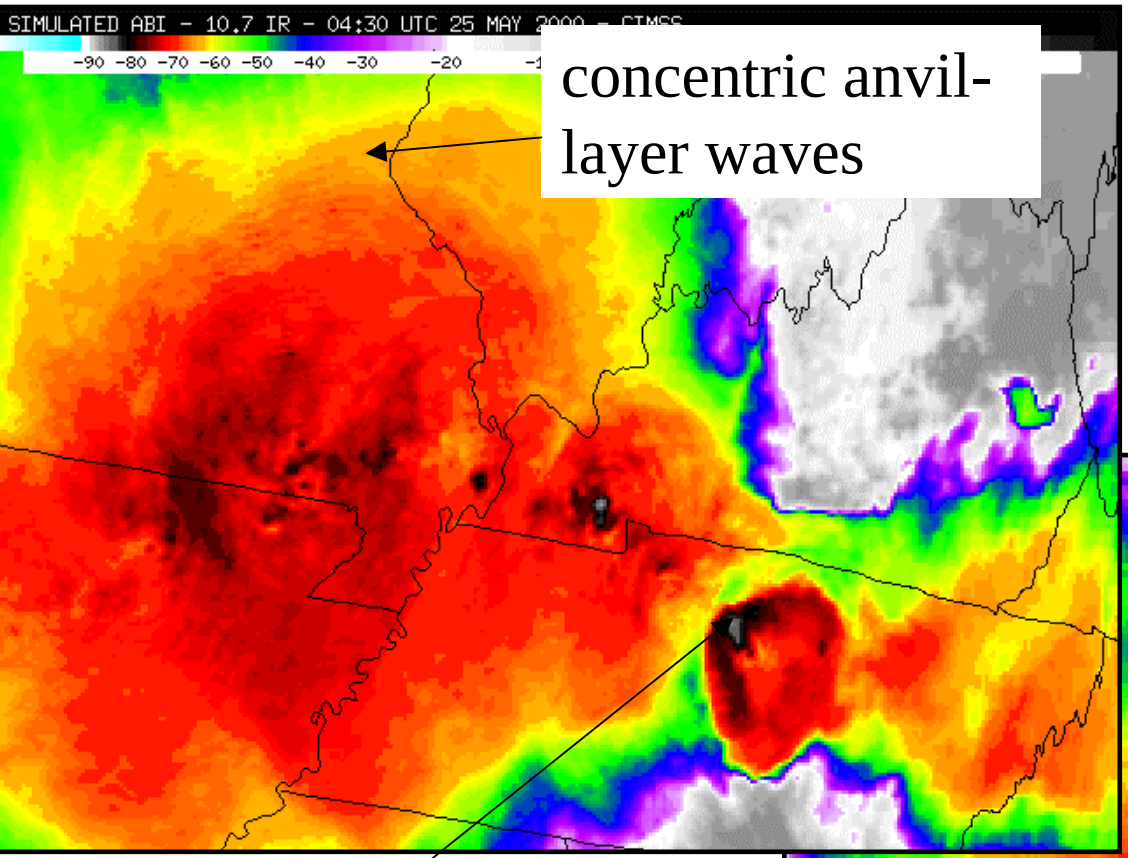
Both images are shown in the GOES projection.

Fog

UW/CIMSS

ABI image (from MODIS) shows greater detail in structure of fog.

Higher Spatial Resolution GOES Channels



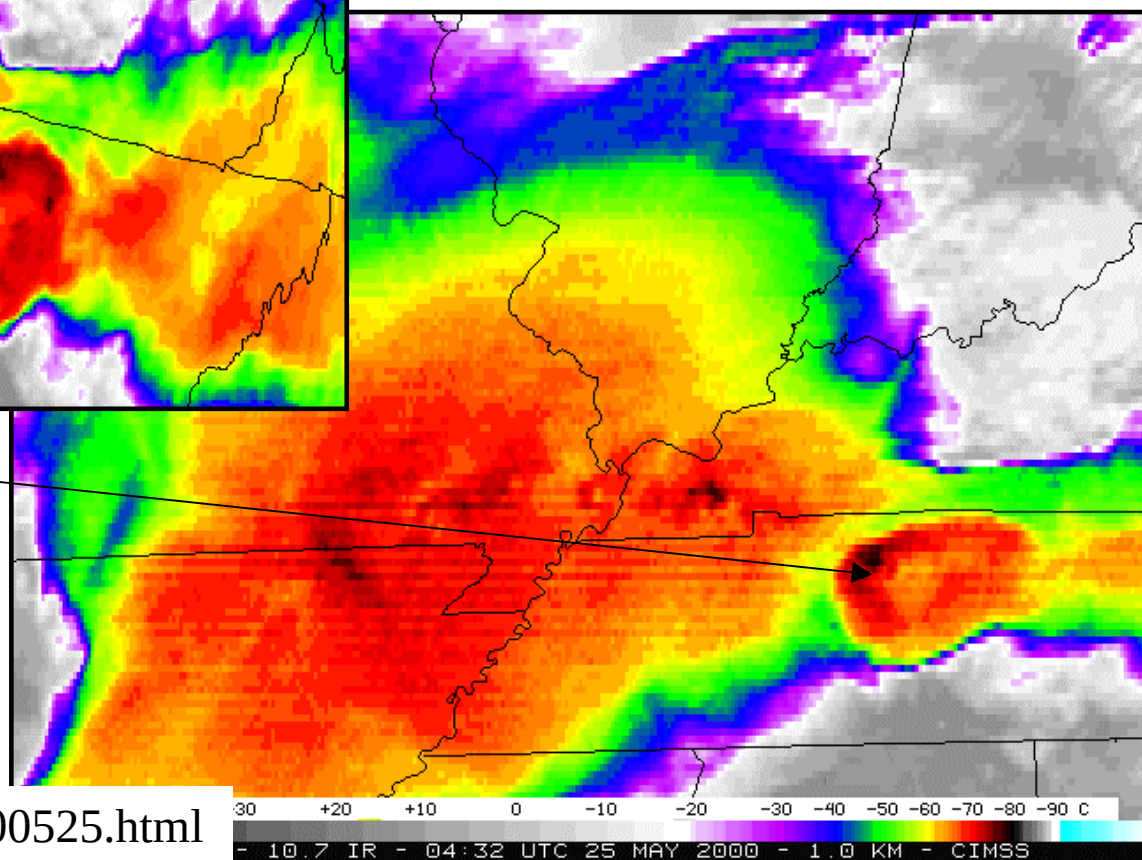
concentric anvil-layer waves

Simulated ABI (from MODIS)

Enhanced "V": IR windows May 25, 2000

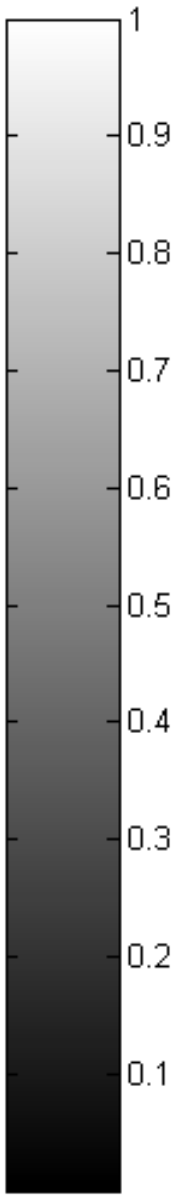
Enhanced "V"

Actual GOES



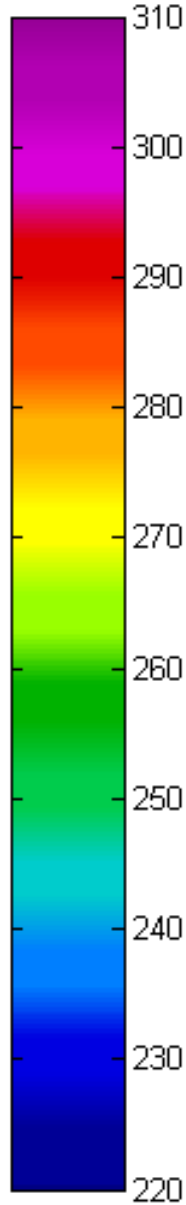
http://cimss.ssec.wisc.edu/goes/misc/000525.html

Using MODIS, MET-8 and AIRS to simulate the spectral bands on the Advanced Baseline Imager (ABI)



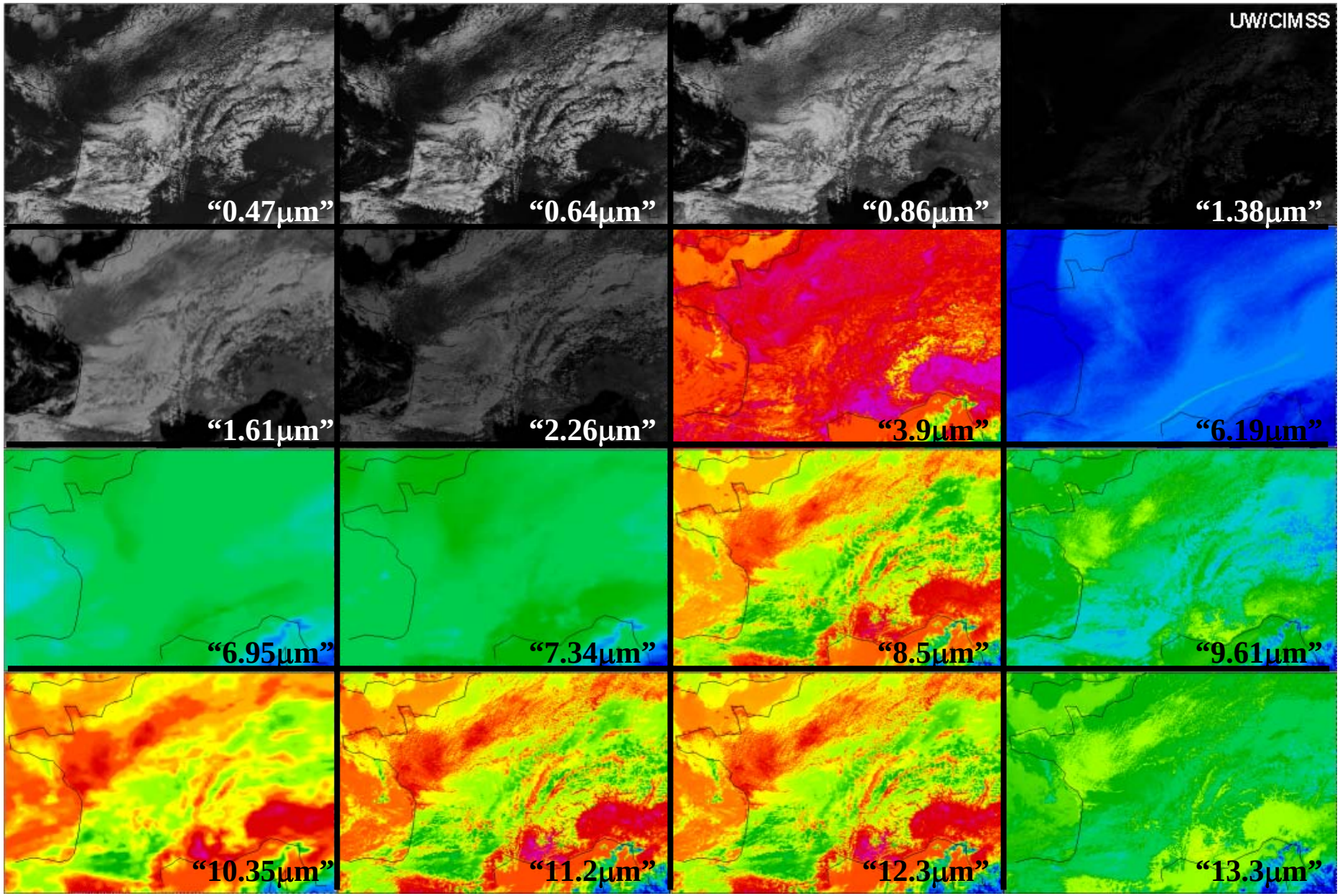
(reflectance)

“0.47μm” (MODIS)	**“0.64μm” (MODIS)**	**“0.86μm” (MODIS)**	**“1.38μm” (MODIS)**
“1.61μm” (MET-8)	**“2.26μm” (MODIS)**	**“3.9μm” (MODIS)**	**“6.19μm” (MET-8)**
“6.95μm” (AIRS)	**“7.34μm” (AIRS)**	**“8.5μm” (MODIS)**	**“9.61μm” (MODIS)**
“10.35μm” (AIRS)	**“11.2μm” (MODIS)**	**“12.3μm” (MODIS)**	**“13.3μm” (MODIS)**

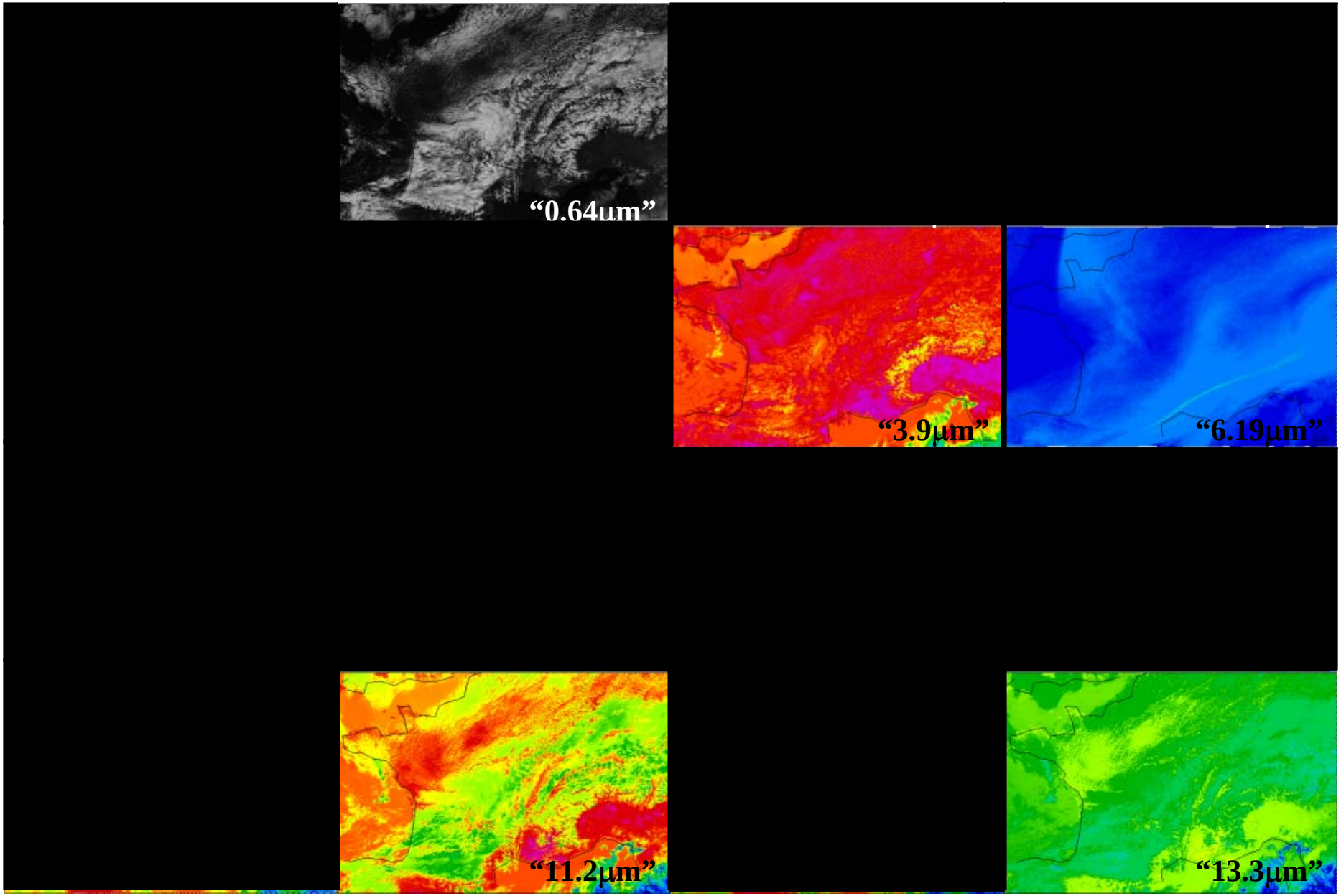


(K)

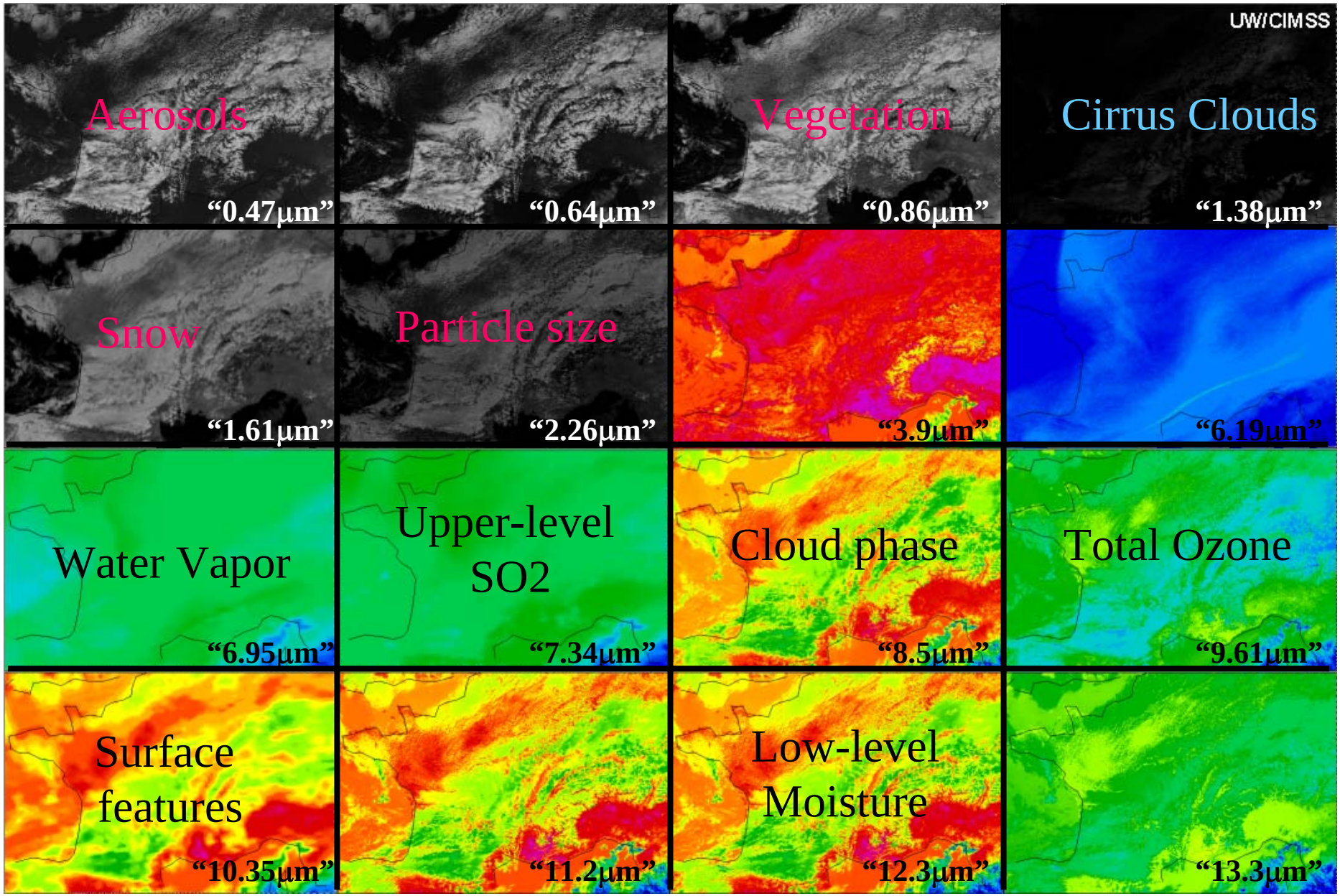
Using MODIS, MET-8 and AIRS to simulate the spectral bands on the Advanced Baseline Imager (ABI)



Similar bands on the GOES-12 Imager

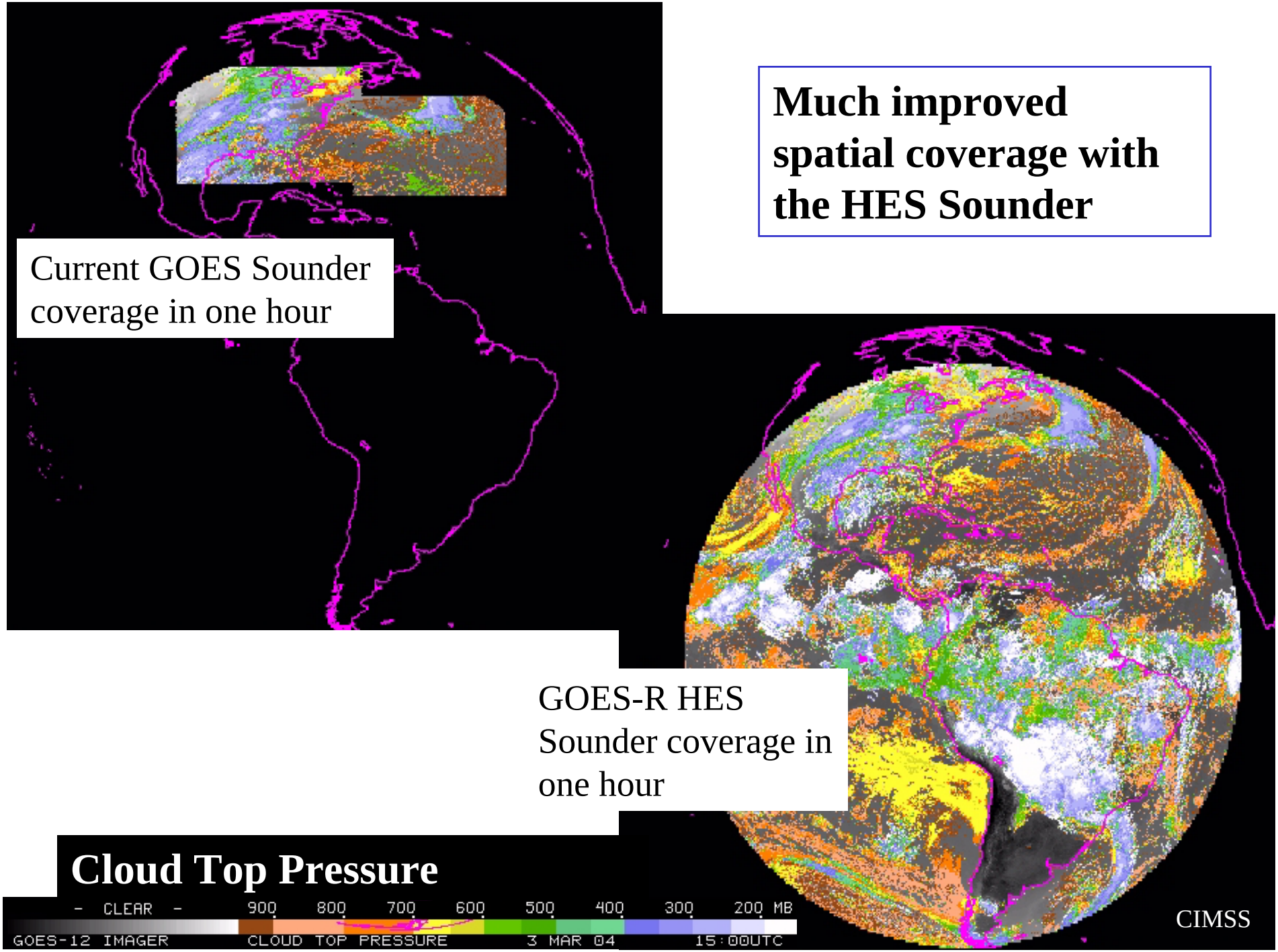


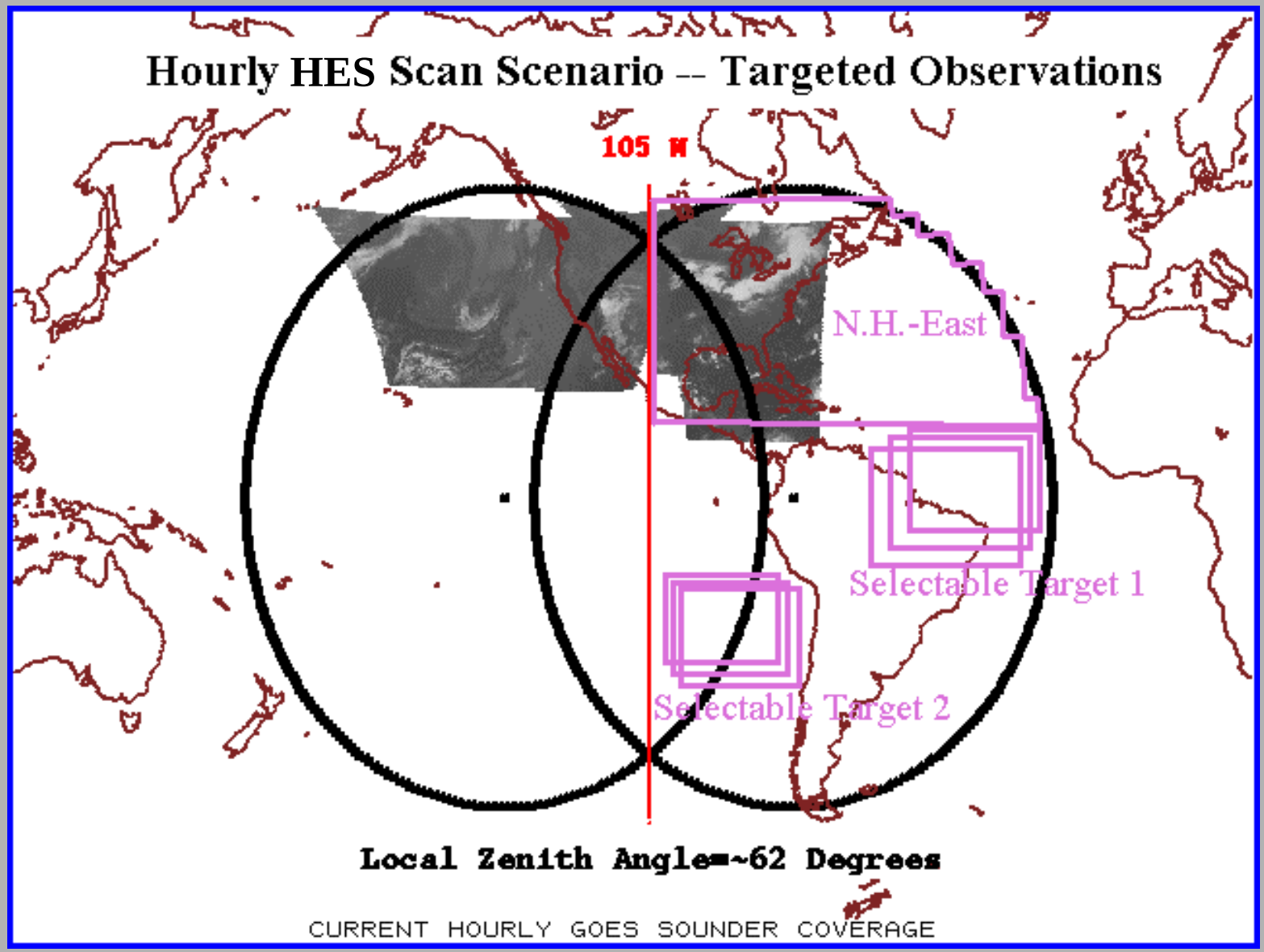
Using MODIS, MET-8 and AIRS to simulate the spectral bands on the Advanced Baseline Imager (ABI)



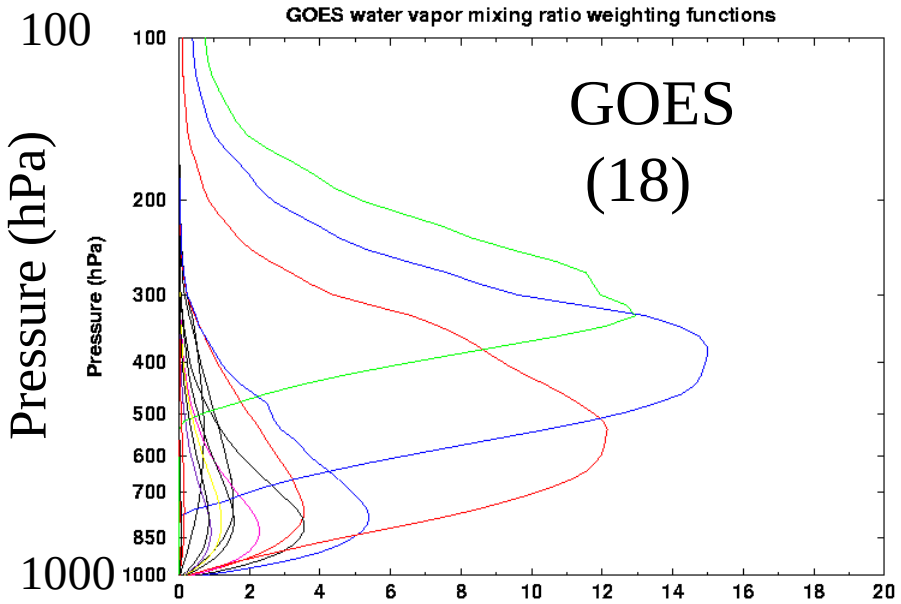
Sounder Comparison (GOES-Current to HES-Req)

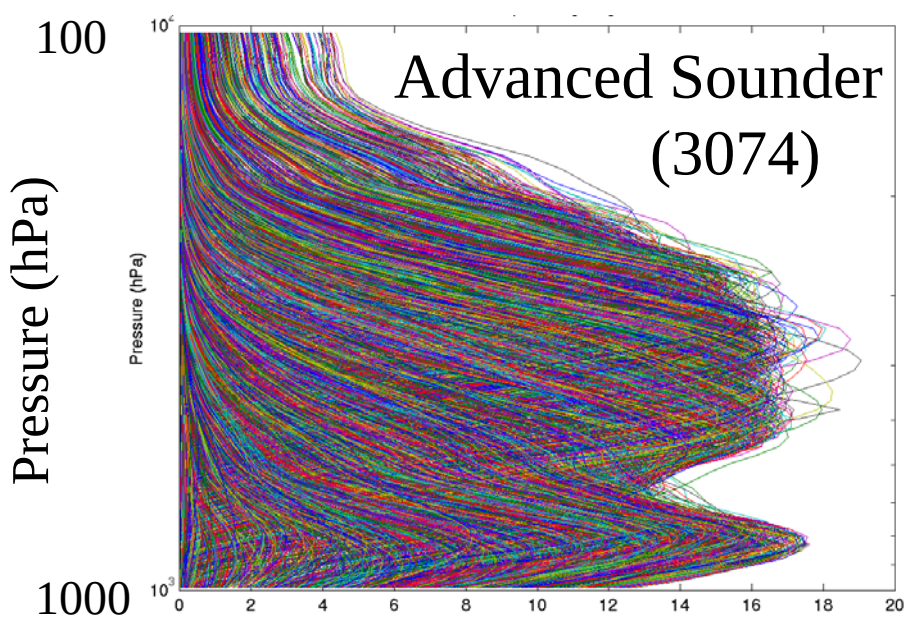
	Current	Requirement
Coverage Rate	CONUS/hr	Sounding Disk/hr
Horizontal Resolution		
- Sampling Distance	10 km	10 km
- Individual Sounding	30-50 km	10 km
Vertical resolution	~3 km	1 km
Accuracy		
Temperature	2 deg. K	1 deg. K
Relative Humidity	20%	10%


Much improved spatial coverage with the HES Sounder
Current GOES Sounder coverage in one hour
GOES-R HES Sounder coverage in one hour
Cloud Top Pressure
- CLEAR -
900
800
700
600
500
400
300
200 MB
GOES-12 IMAGER
CLOUD TOP PRESSURE
3 MAR 04
15:00UTC
CIMSS



Targeted observations -- look where we need the information

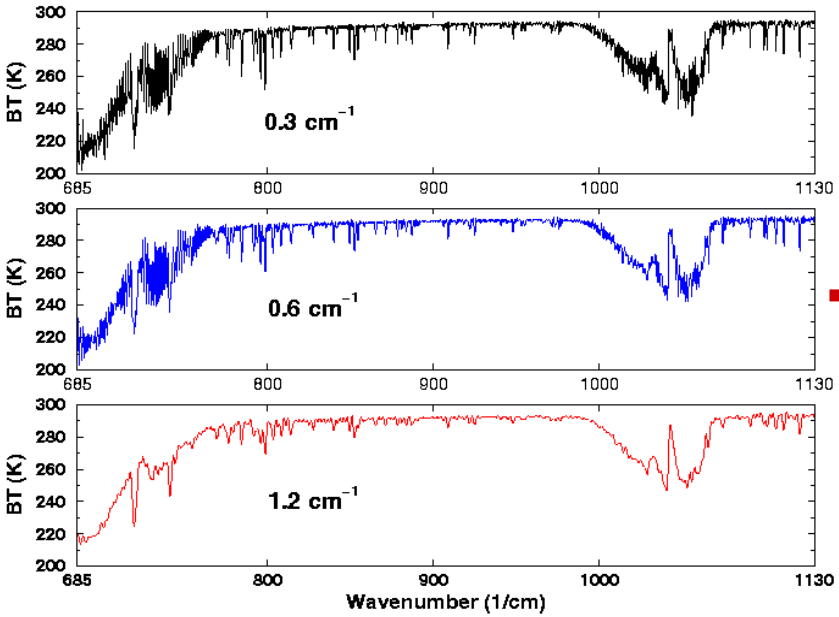




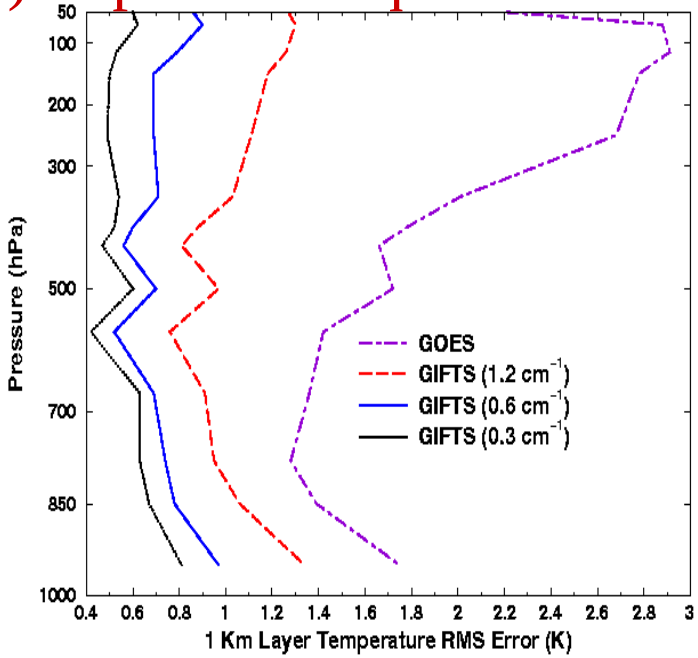
Moisture Weighting Functions

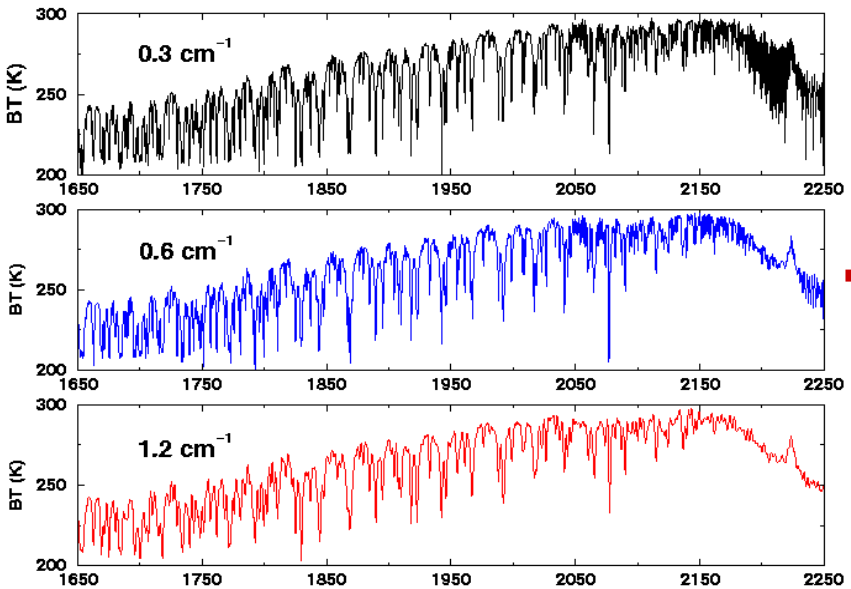
High spectral resolution advanced sounder will have more and sharper weighting functions compared to current GOES sounder. Retrievals will have better vertical resolution.

Spectral resolution (0.3, 0.6, 1.2 cm**-1) impact on T/q retrieval

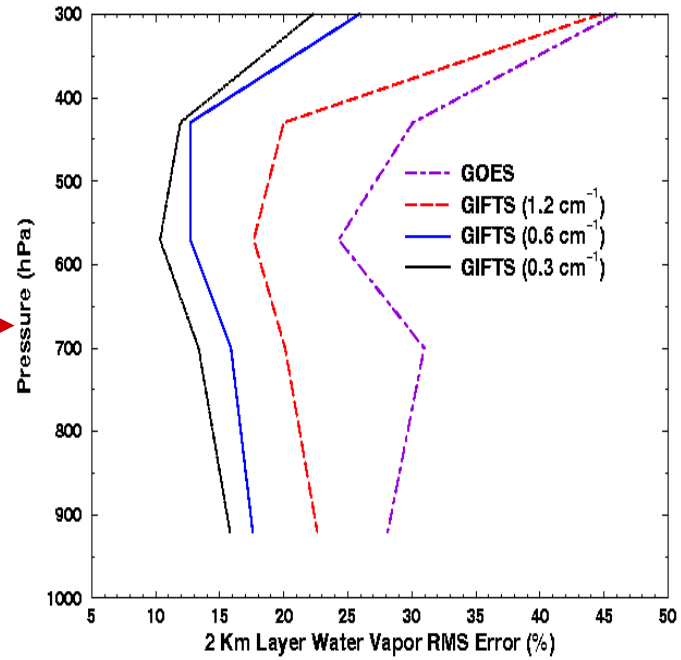


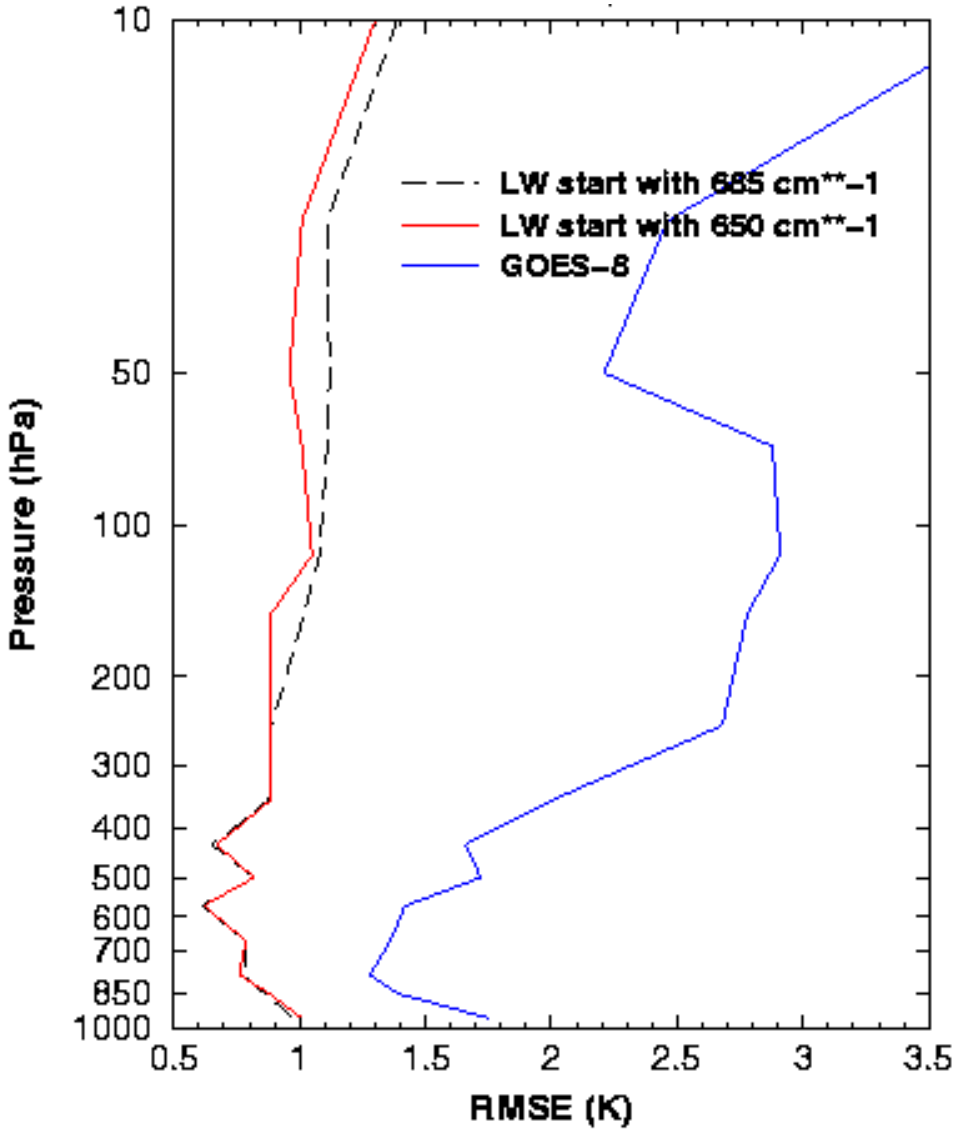
LW





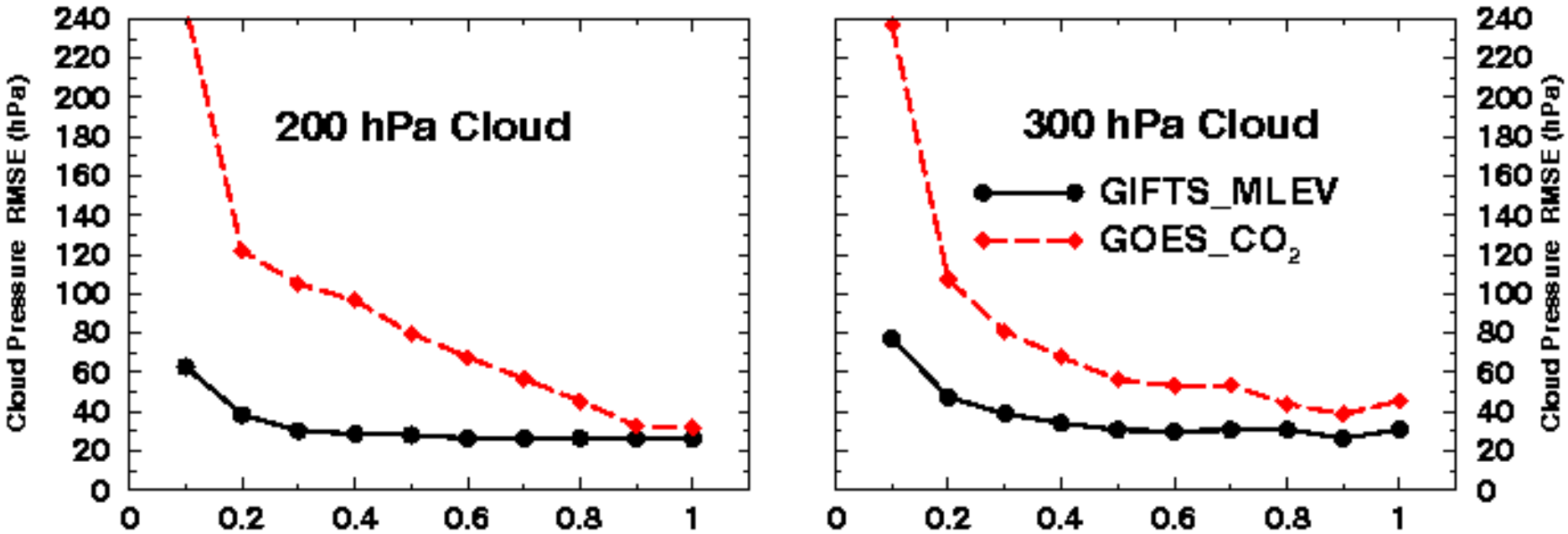
SMW




LW start with 685 cm**-1
LW start with 650 cm**-1
GOES-8
Pressure (hPa)
10
50
100
200
300
400
500
600
700
850
1000
0.5
1
1.5
2
2.5
3
3.5
RMSE (K)

Clouds.

Simulations and real data have shown that cloud-top properties are improved with high spectral data. This is especially the case for thin clouds. The HES will be able to distinguish between ice and water cloud-tops and identify cloud particle sizes.



GOES-R HES Coastal Waters Capability

Christopher W. Brown, Michael Ondrusek and Richard P. Stumpf

Current GOES: None

- Hazardous material and harmful algal blooms
- Water quality and clarity
- Health of shallow water corals
- Bathymetry relevant to navigation safety and locate coastal hazards
- Initialize and validate coastal ocean models
- Quantify the response of marine ecosystems
- Enhance the development and implementation of new products for coastal fisheries

True-color image with high resolution MODIS imagery.

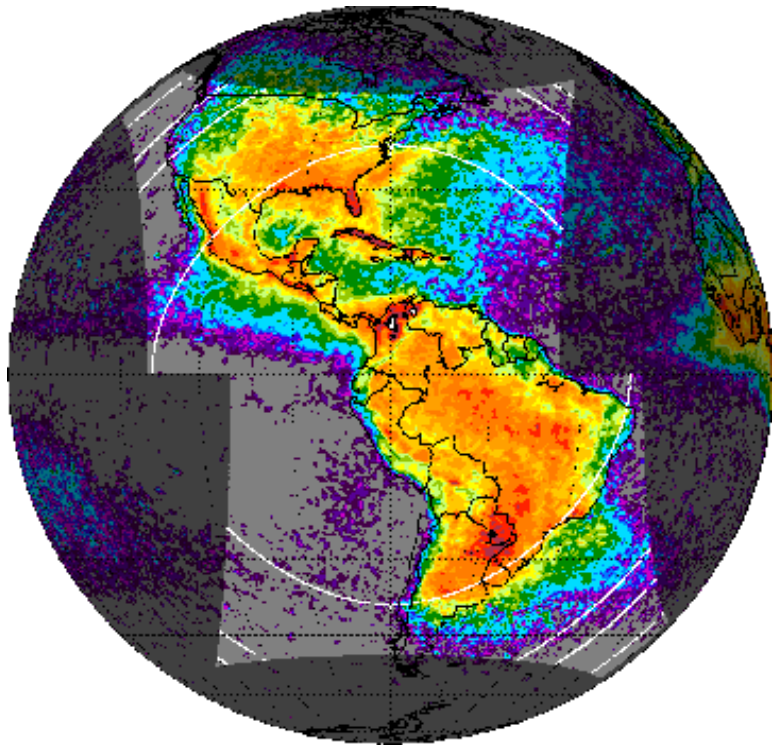
Geostationary Lightning Mapper (GLM)

H J Christian
Huntsville, Alabama

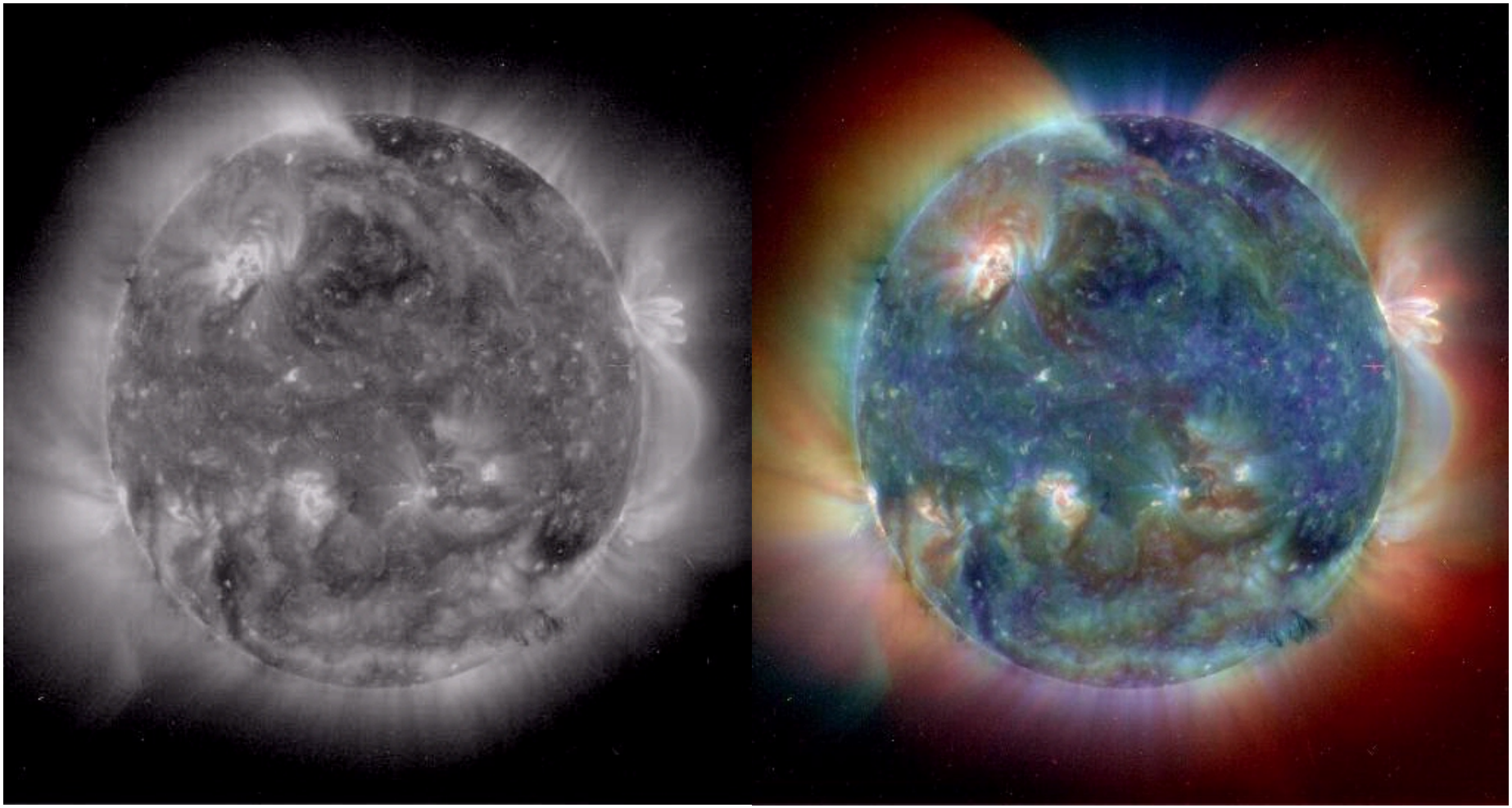
GLM : Field of View at GOES

(climatology indicates lightning density)

Current GOES: None



GOES E (135ºW)



Simulated SXI (Solar X-ray Imager) images: GOES R will produce multi-band "color" images at the same rate as GOES N/P produces single band images. (Images courtesy of SOHO EIT, a joint NASA/ESA program; and Steve Hill/NOAA SEC).

- **GOES-R Space Weather Instruments**
  - Space Environmental In Situ Suite (SEISS)
    - proton, electron, and heavy ion fluxes
  - Solar Imaging Suite (SIS)
    - solar X-ray flux magnitude
    - solar EUV flux from 5 to 129 nm
    - coronal holes locations
    - solar flares
    - coronal mass ejections
  - Magnetometers

- **GOES-R Improvements**
  - Solar X-ray image dynamic range, resolution, and sensitivity
  - EUV measurements for improved modeling of ionosphere and thermosphere
  - Medium energy radiation environment responsible for spacecraft charging

AUX – Auxiliary Services

LRIT--Low Rate Information transmission

EMWIN--Emergency Managers Wx Information Network

DCS--Data Collection System

SAR--Search and Rescue

http://water.usgs.gov/nsip/

GOES-R will support improved AUX services

http://cimss.ssec.wisc.edu/goes/hes/
http://osd.goes.noaa.gov/
http://www.osd.noaa.gov/
http://goespoes.gsfc.nasa.gov/goesr_industry.htm

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