STAR Center for Satellite Applications and Research
formerly ORA — Office of Research and Applications

The GOES-R series and the Advanced Baseline Imager (ABI)

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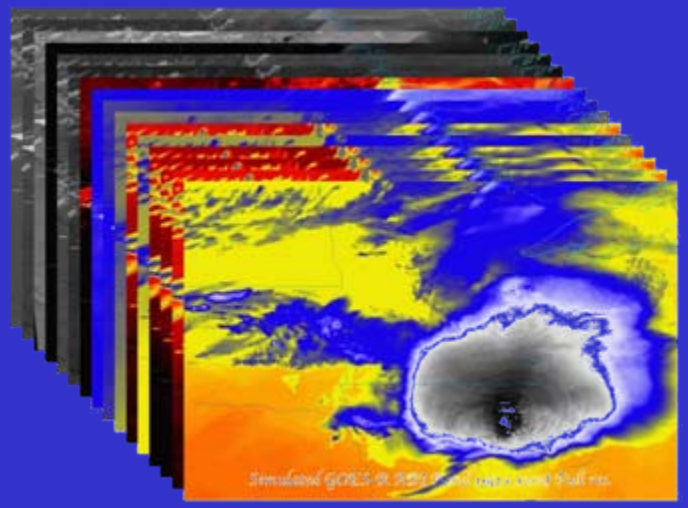
NOAA/NESDIS/Satellite Applications and Research

Advanced Satellite Products Branch (ASPB)

Madison, WI



MUG Meeting

Madison, WI

8 May 2012

CIMSS
UW-Madison

Thanks to…

- The GOES-R imagery team (Kaba Bah, Mat Gunshor, Joleen Feltz, etc.).

- William Straka, Jun Li, Scott Bachmeier, Steve Ackerman, Bob Aune, Don Hillger, Paul Menzel, Steve Ackerman, Tony Schreiner, Jason Otkin, Justin Sieglaff, Jim Jung, Elaine Prins, Shobha Kondragunta, Brad Pierce, Joleen Feltz, Wayne Feltz, Jean Phillips, Gary Wade, Don Hillger, Jinlong Li, Jing Zheng, Allen Huang, Bob Rabin, the SSEC data center, Mike Pavolonis, Jaime Daniels, ASPB, STAR, NESDIS, NSSL, MUG, Steve Weygandt, Haidao Lee, Mark DeMaria, and many others!

- GOES-R Program Office (Steve Goodman, Jim Gurka, etc.), NASA, ITT Industries, other industry partners, etc.

- You.

Outline

- ABI (Advanced Baseline Imager)
  - Temporal
  - Spatial
  - Spectral
- Products
- Summary
  - More information
  - Questions

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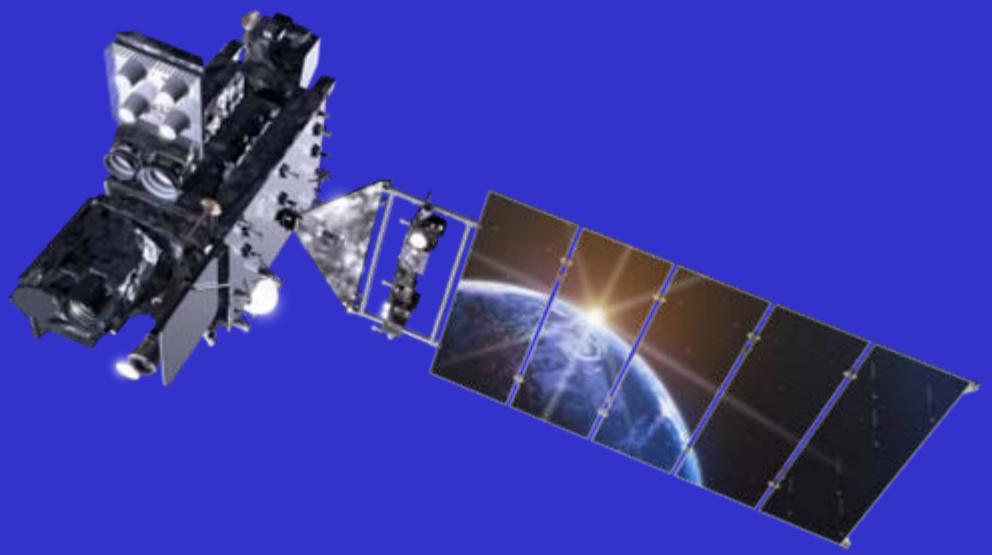


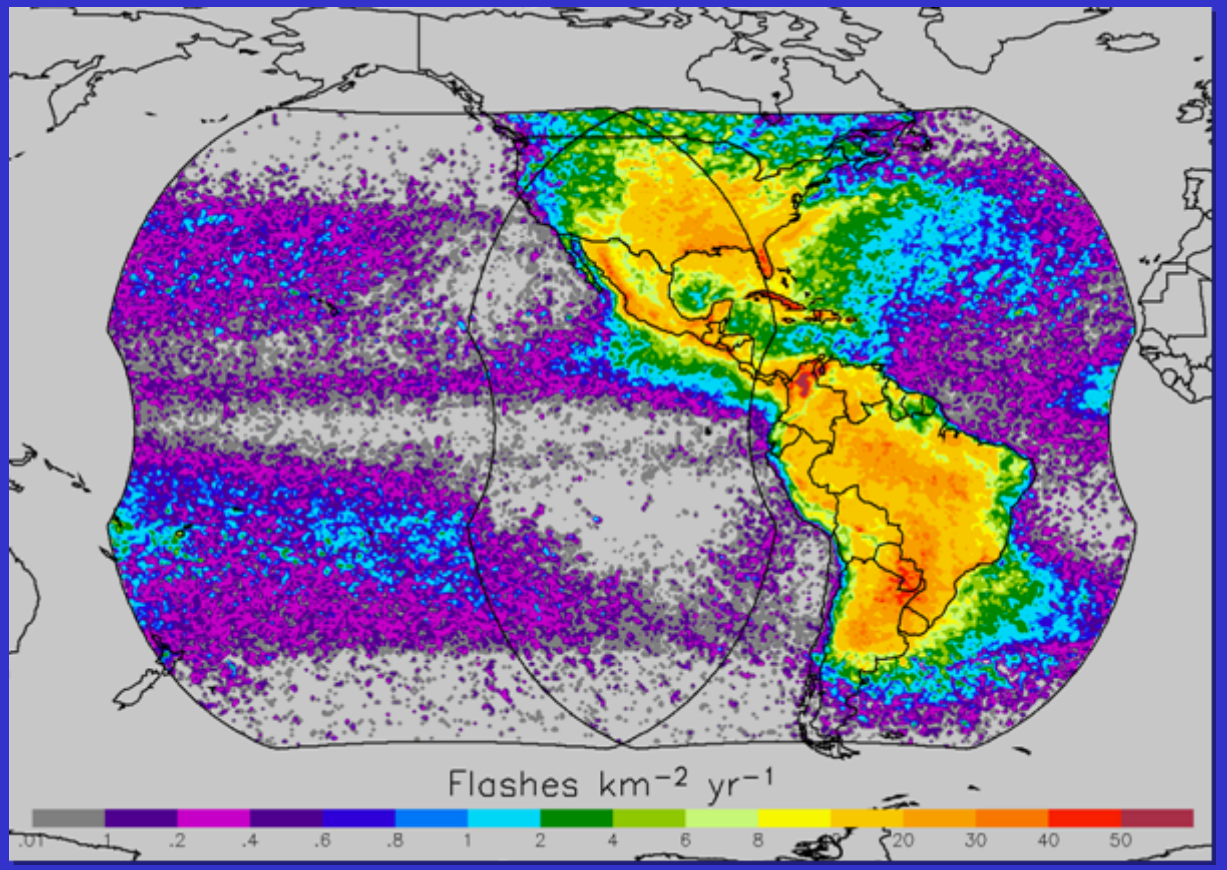
Lockheed Martin

GOES-R Overview

- Advanced Baseline Imager (ABI)
- No dedicated Sounder
- Geostationary Lightning Mapper (GLM)
- Space Weather
  - Space Environmental In-Situ Suite (SEISS)
  - Solar Ultra Violet Imager (SUVI)
  - Extreme Ultra Violet/X-Ray Irradiance Sensor (EXIS)
  - Magnetometer
- Communications
  - GOES Rebroadcast (GRB)
  - Low Rate Information Transmissions (LRIT)
  - Emergency Managers Weather Information Network (EMWIN)
  - Search and Rescue (SAR)
  - Data Collection System (DCS)

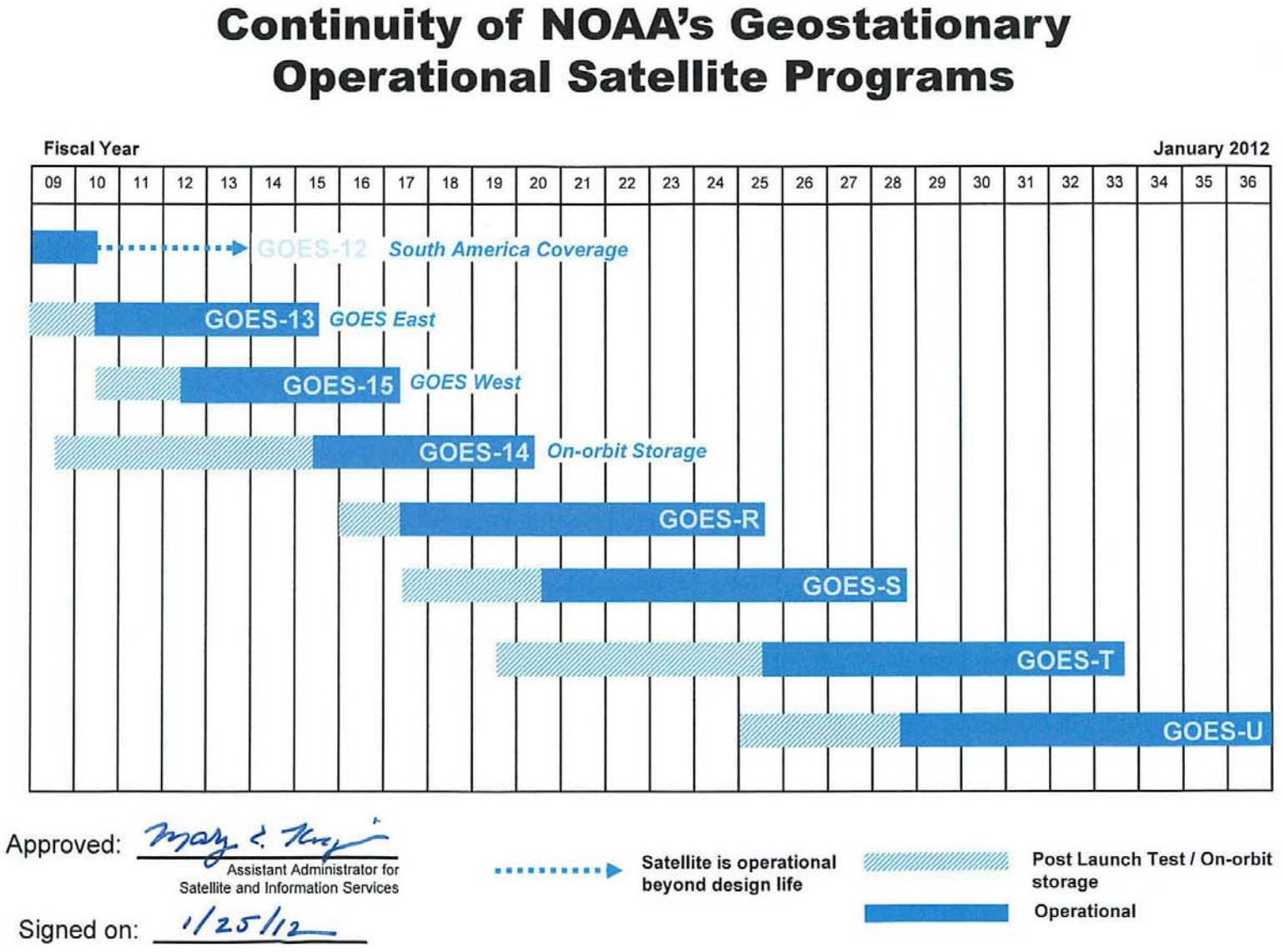
Decadal lightning data

- **GOES- East, West coverage**



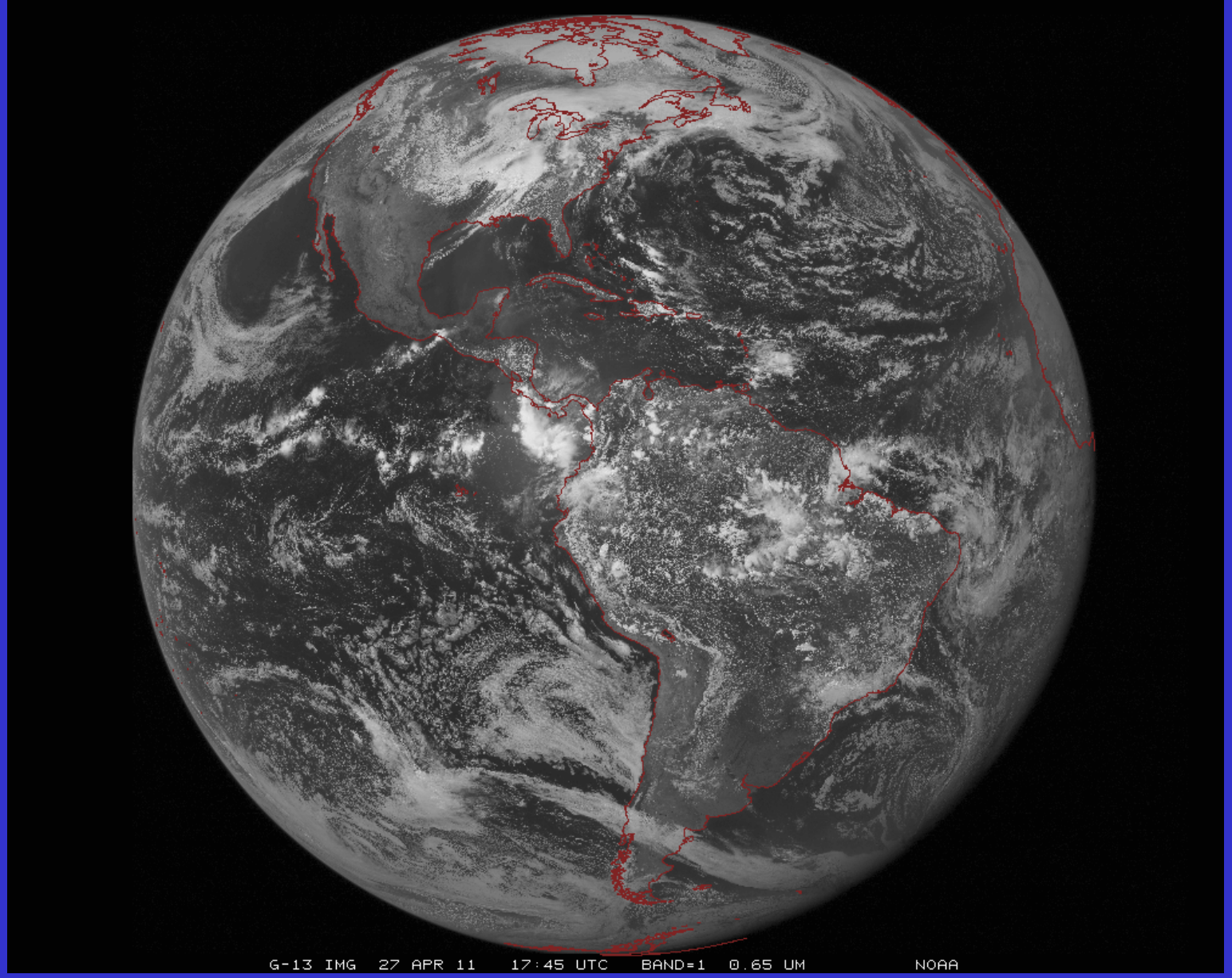
Steve Goodman

GOES-S (East?): Operational 2020



The Advanced Baseline Imager:

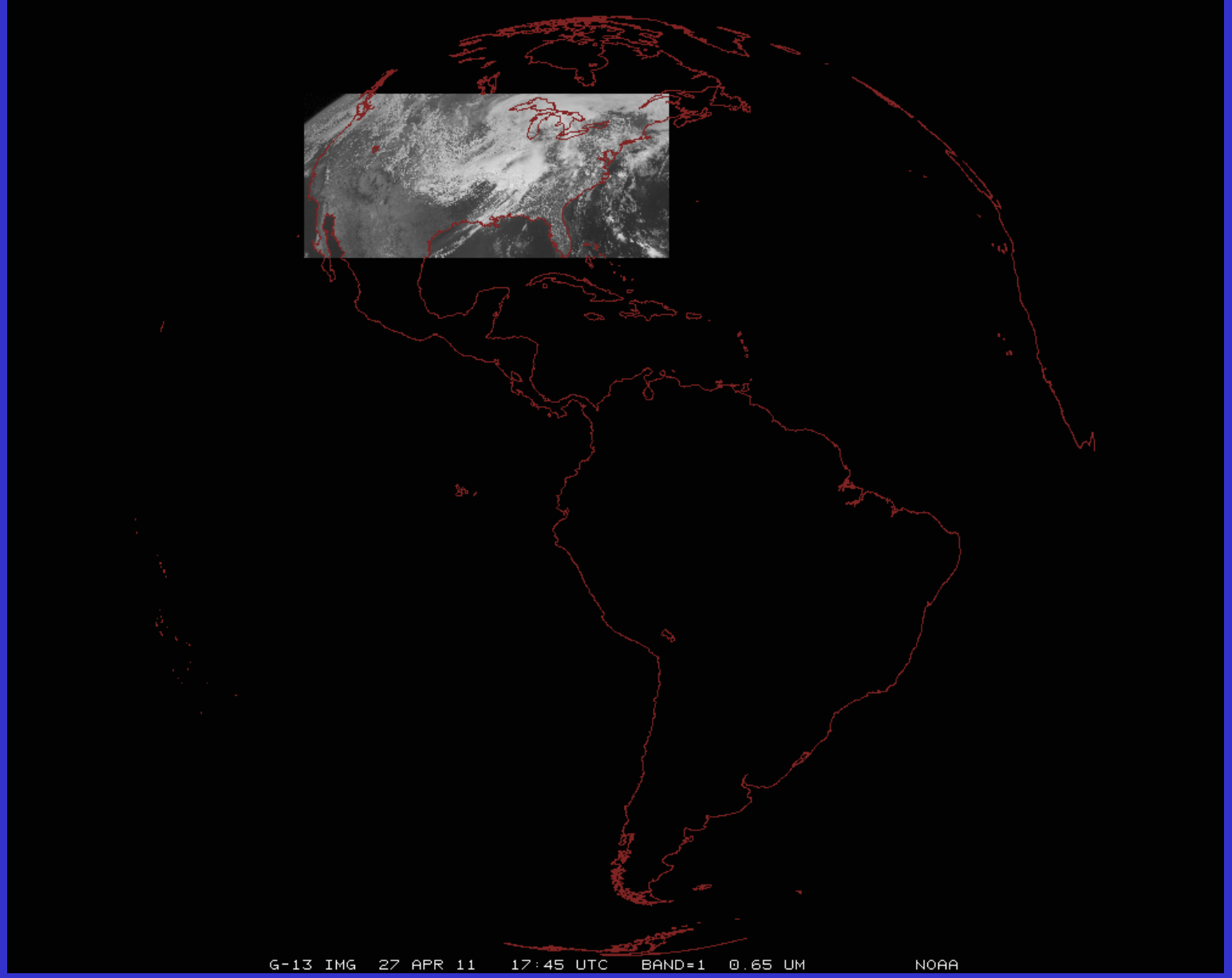
	ABI	Current
Spectral Coverage		
	16 bands	5 bands
Spatial resolution		
0.64 μm Visible	0.5 km	Approx. 1 km
Other Visible/near-IR	1.0 km	n/a
Bands (>2 μm)	2 km	Approx. 4 km
Spatial coverage		
Full disk	4 per hour	Scheduled (3 hrly)
CONUS	12 per hour	~4 per hour
Mesoscale	Every 30 sec	n/a
Visible (reflective bands)		
On-orbit calibration	Yes	No



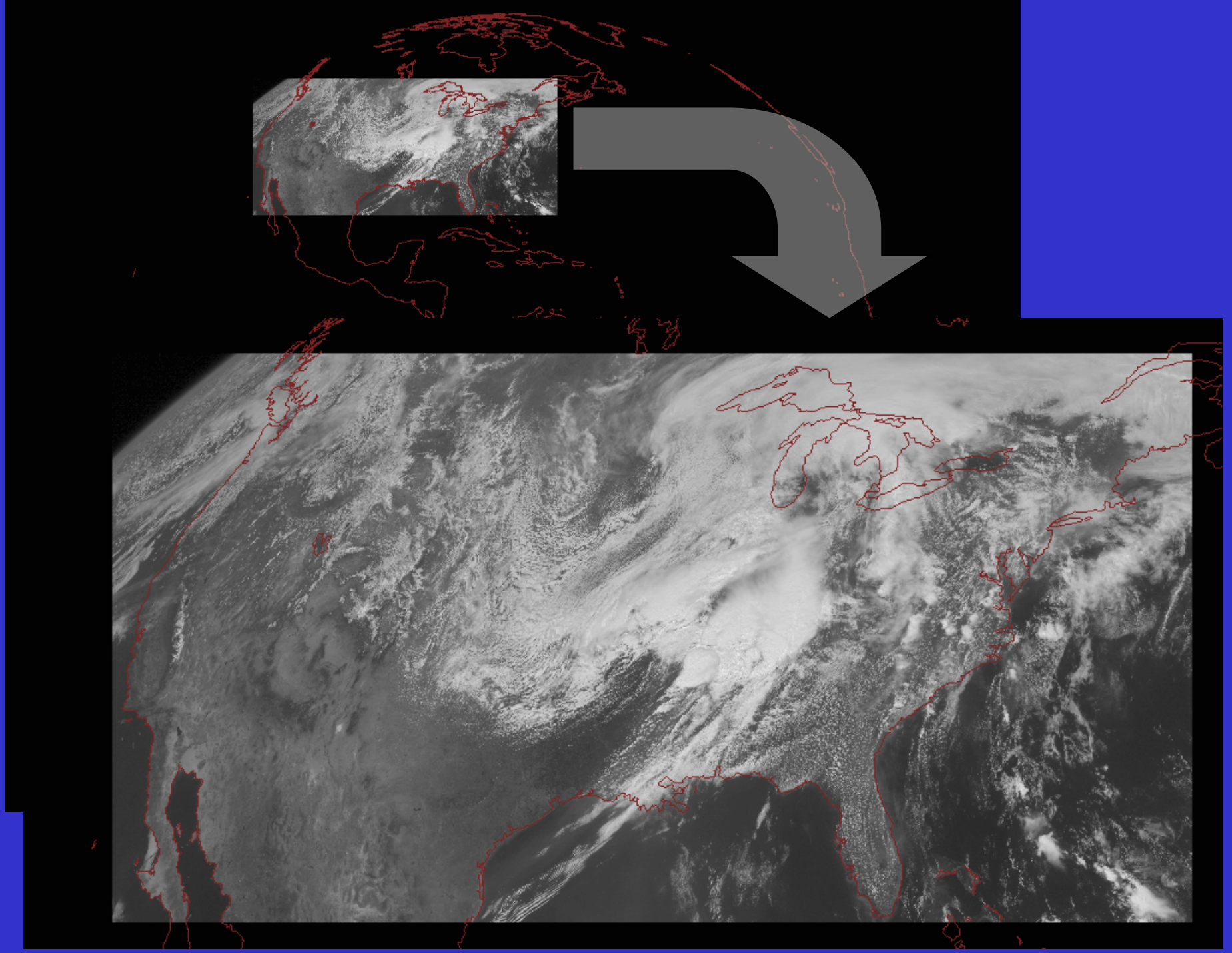
ABI scans about 5 times faster than the current GOES imager

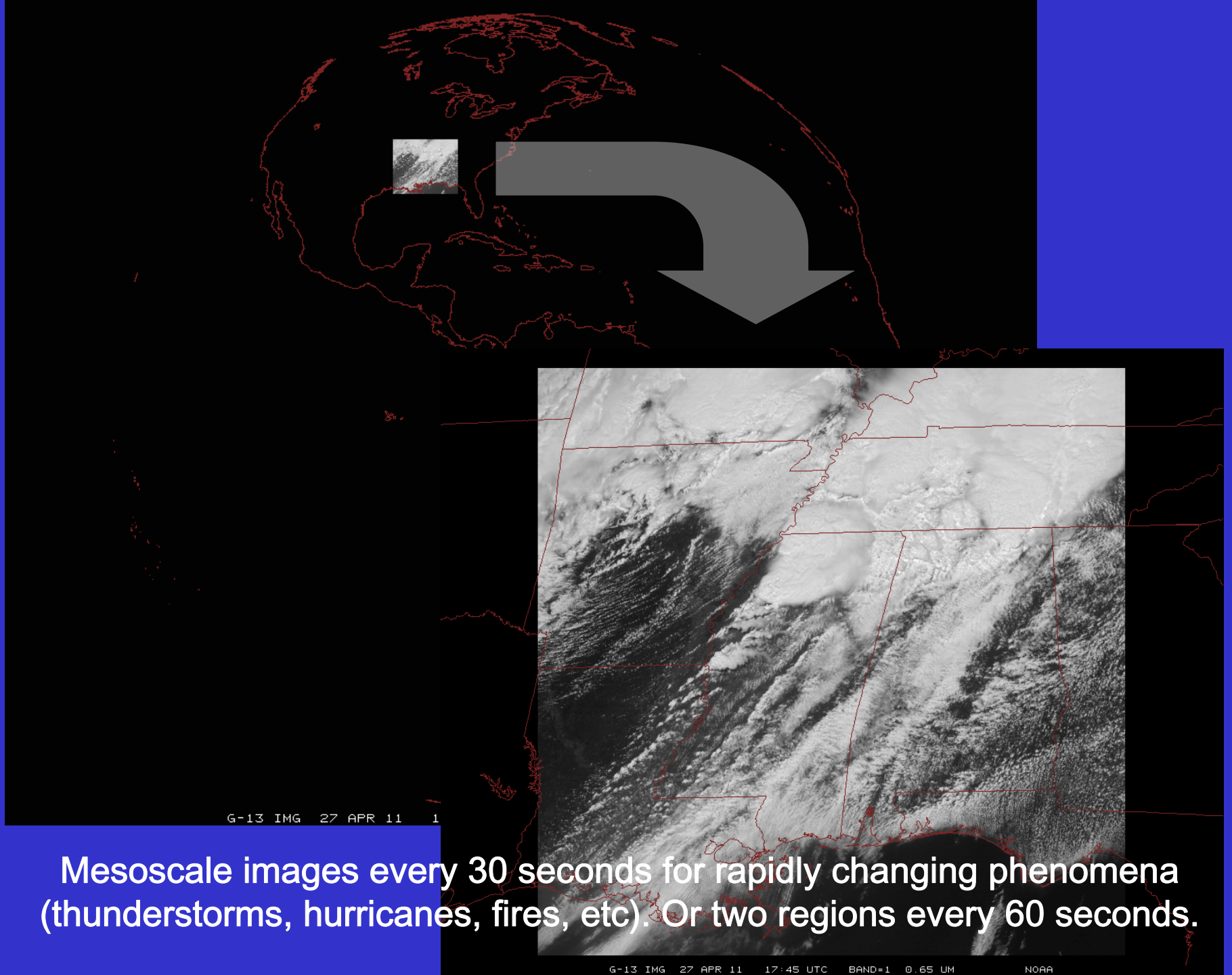
There are two anticipated scan modes for the ABI:

- Full disk images every 15 minutes + 5 min CONUS images + mesoscale.
 or - Full disk every 5 minutes.



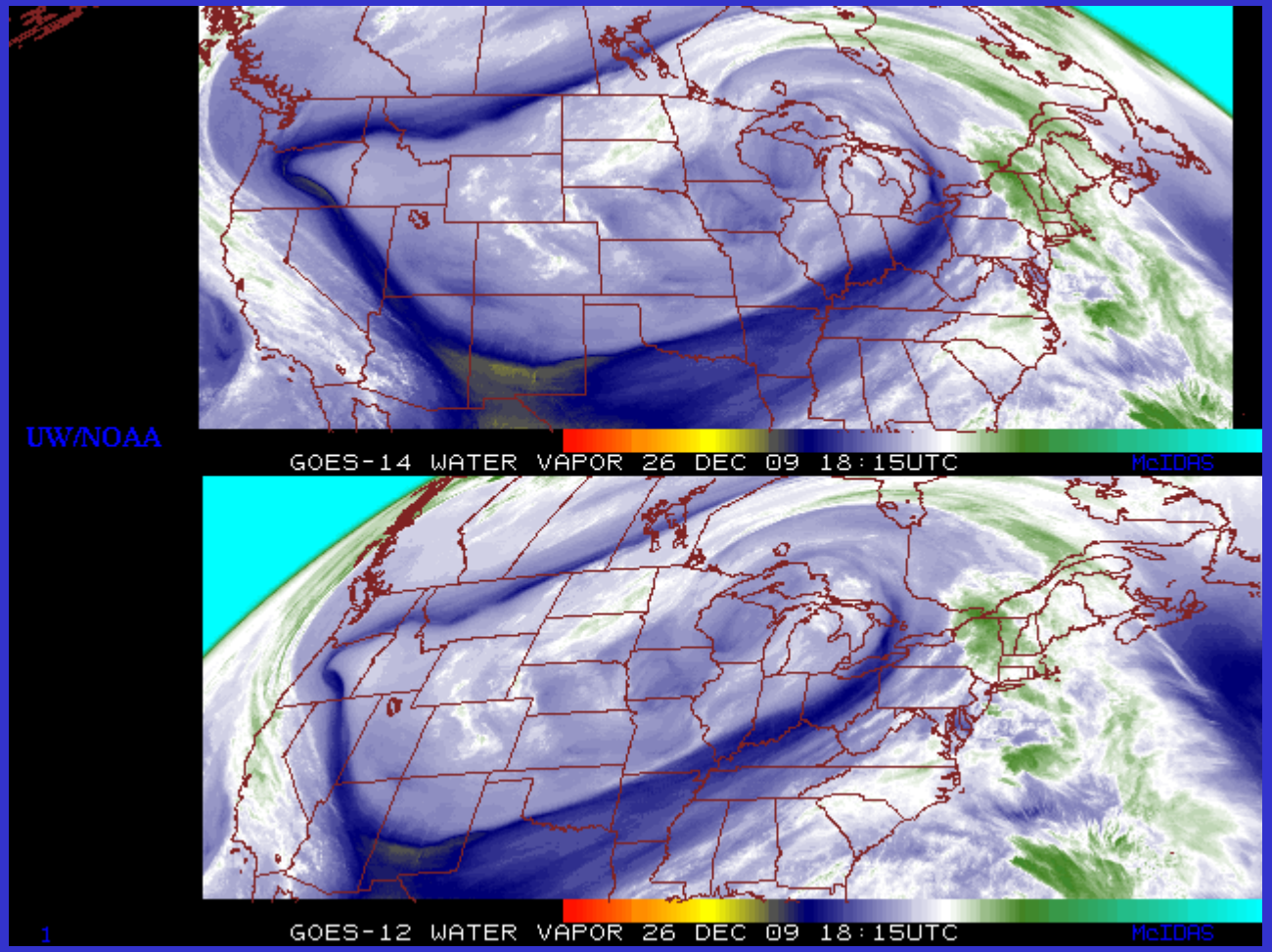
ABI can offer Continental US images every 5 minutes for routine monitoring of a wide range of events (storms, dust, clouds, fires, winds, etc).
This is every 15 or 30 minutes with the current GOES in routine mode.





Mesoscale images every 30 seconds for rapidly changing phenomena (thunderstorms, hurricanes, fires, etc). Or two regions every 60 seconds.

GOES-14: Sample “5-min” imagery

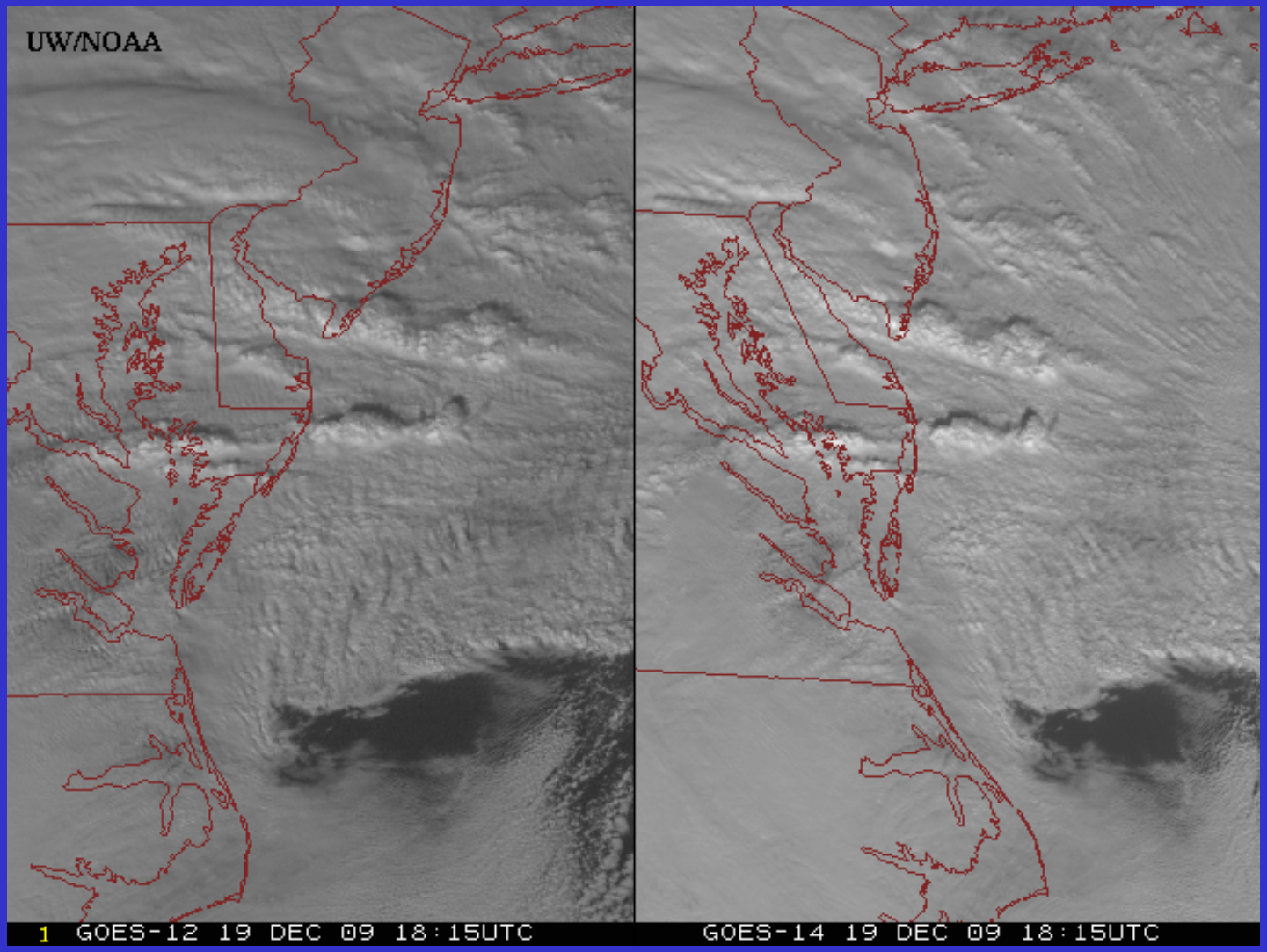


GOES-14

GOES-12

“Water vapor” data from the GOES-14 NOAA Science Test, lead by Hillger and Schmit

GOES-14: Sample “1-min” imagery



GOES-12 GOES-14

- Visible data from the GOES-14 NOAA Science Test, lead by Hillger and Schmit
- Can these type loops validate meso-scale models?

ABI Visible/Near-IR Bands

Future GOES imager (ABI) band	Wavelength range (μm)	Central wavelength (μm)	Nominal subsatellite IGFOV (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 clouds fog, inso-lation, winds
3	0.846–0.885	0.865	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

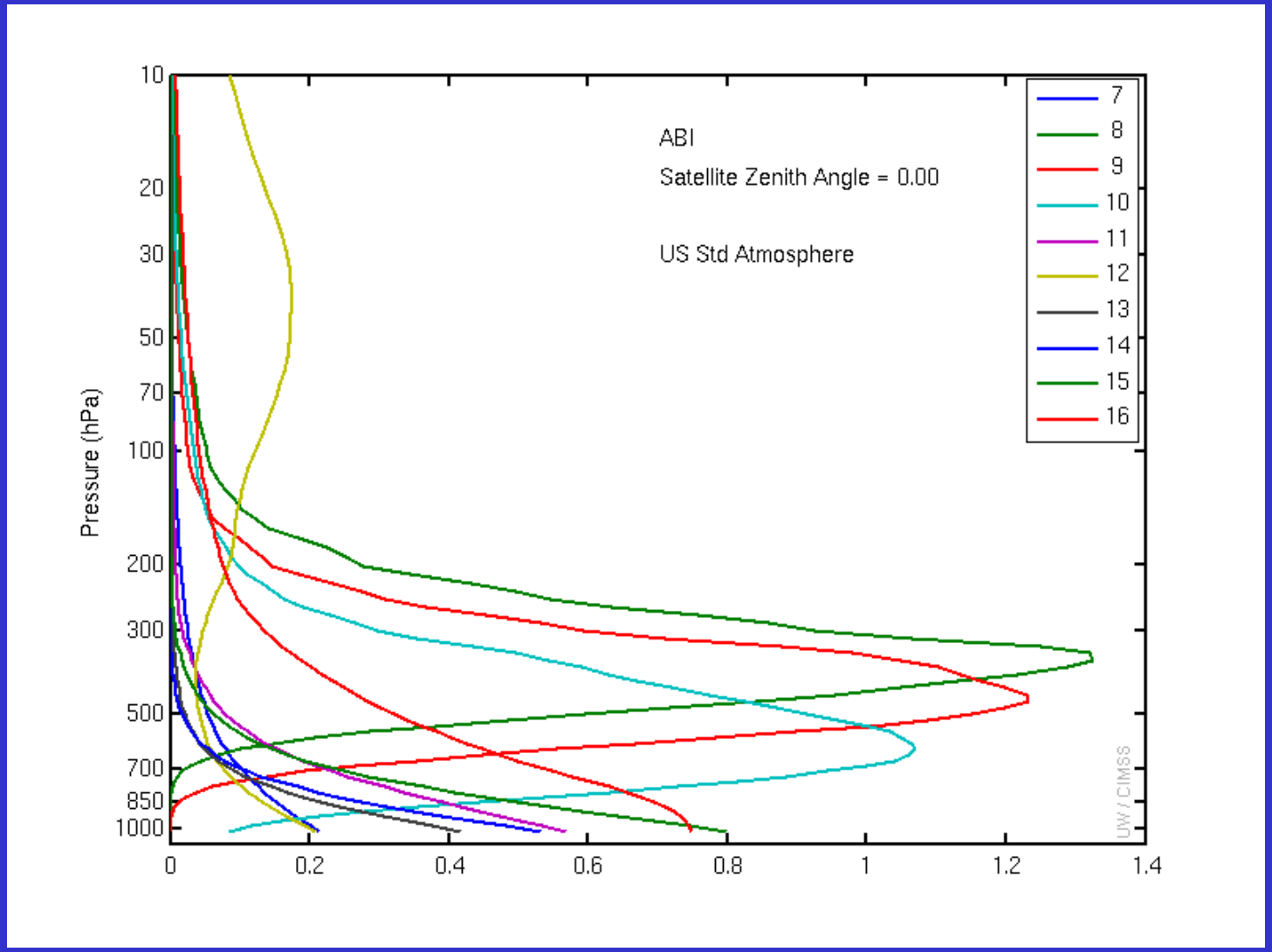
Schmit et al, 2005

ABI IR Bands

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	Midlevel atmospheric water vapor, winds, rainfall
10	7.24–7.44	7.34	2	Lower-level water vapor, winds, and SO_2
11	8.3–8.7	8.5	2	Total water for stability, cloud phase, dust, SO_2 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
14	10.8–11.6	11.2	2	Imagery, SST, clouds, rainfall
15	11.8–12.8	12.3	2	Total water, ash, and SST
16	13.0–13.6	13.3	2	Air temperature, cloud heights and amounts

Schmit et al, 2005

ABI IR Weighting Functions



Clear-sky

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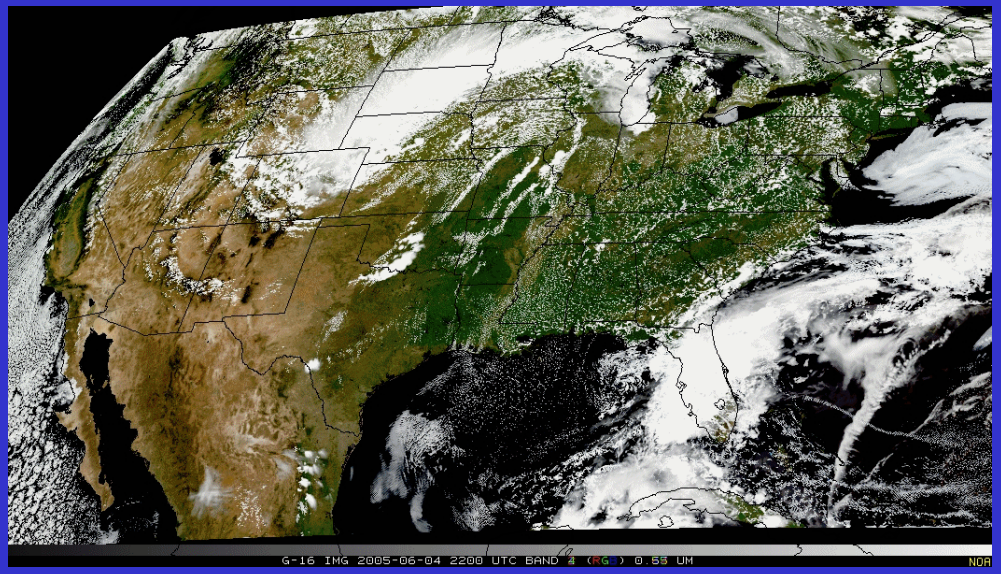


"True Color" with "synthetic" green band from ABI simulated data (from CIMSS); image from Don Hillger, RAMMB.

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)

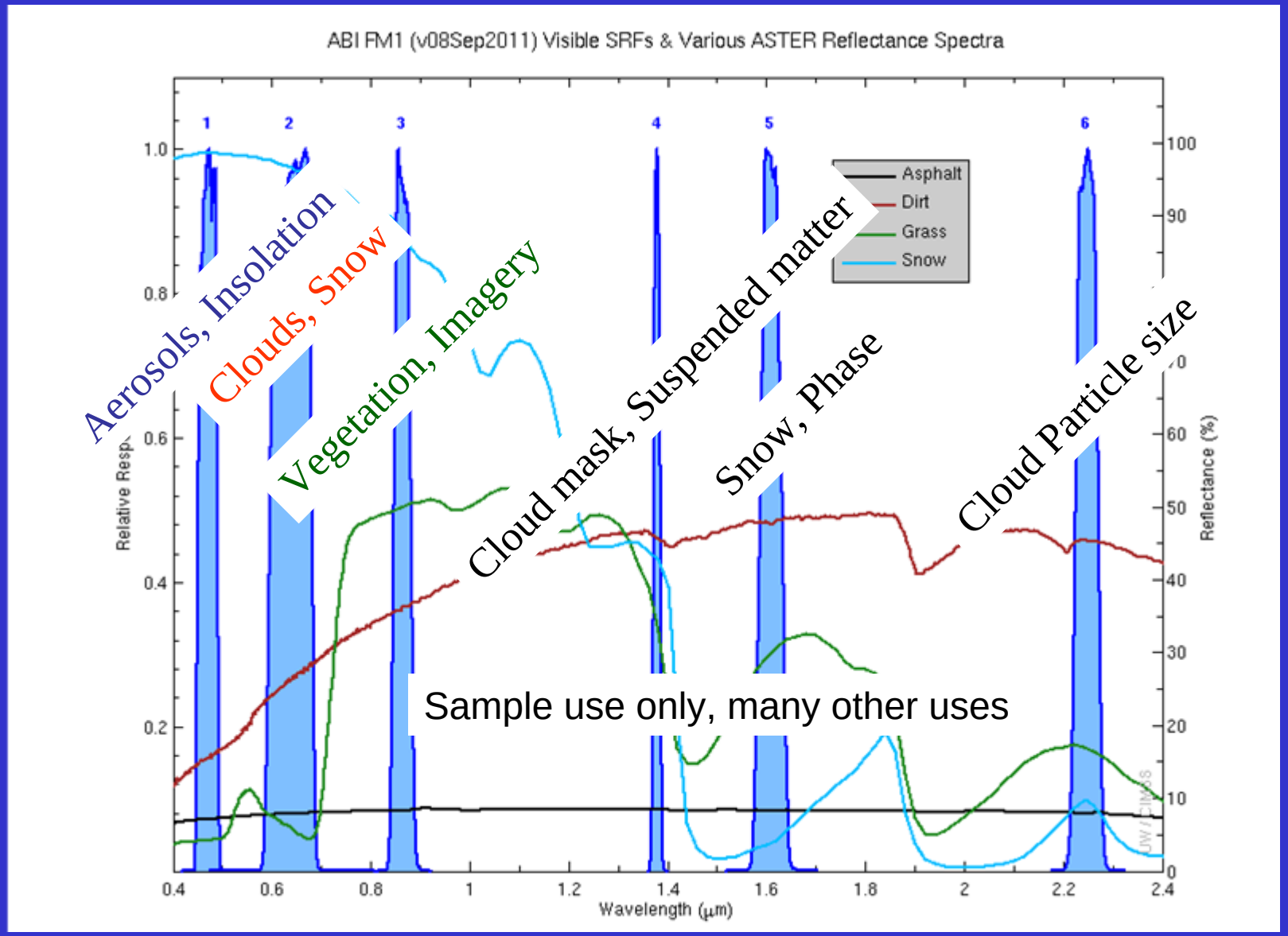
- Solar EUV Imagery

Future Capabilities

Advanced Baseline Imager (ABI)

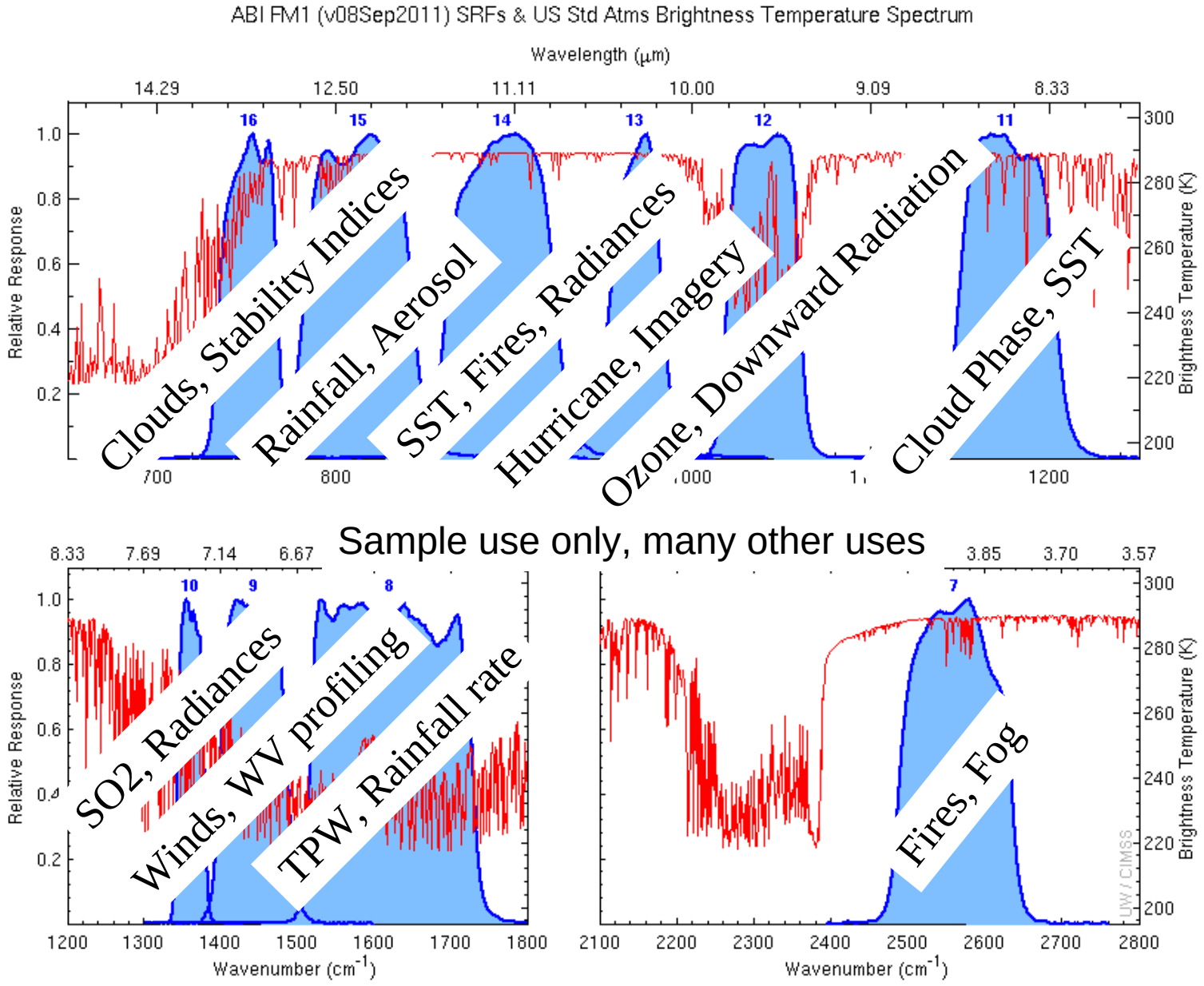
- Absorbed Shortwave Radiation: Surface
- Aerosol Particle Size
- Aircraft Icing Threat
- Cloud Ice Water Path
- Cloud Layers/Heights
- Cloud Liquid Water
- Cloud Type
- Convective Initiation
- Currents
- Currents: Offshore
- Downward Longwave Radiation: Surface
- Enhanced “V”/Overshooting Top Detection
- 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

Visible and near-IR channels on the ABI



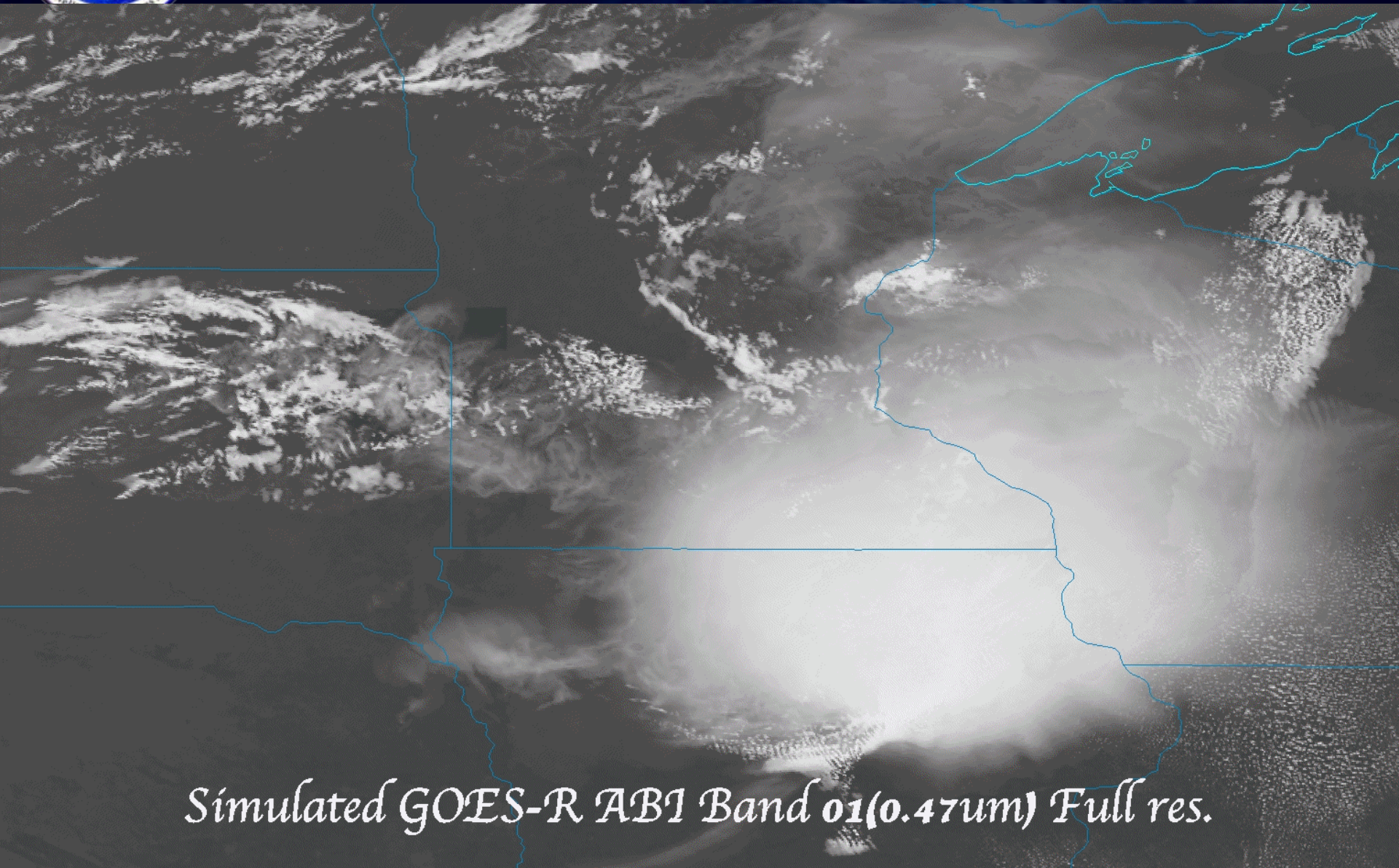
The ABI visible and near-IR bands have many uses.

The IR channels on the ABI

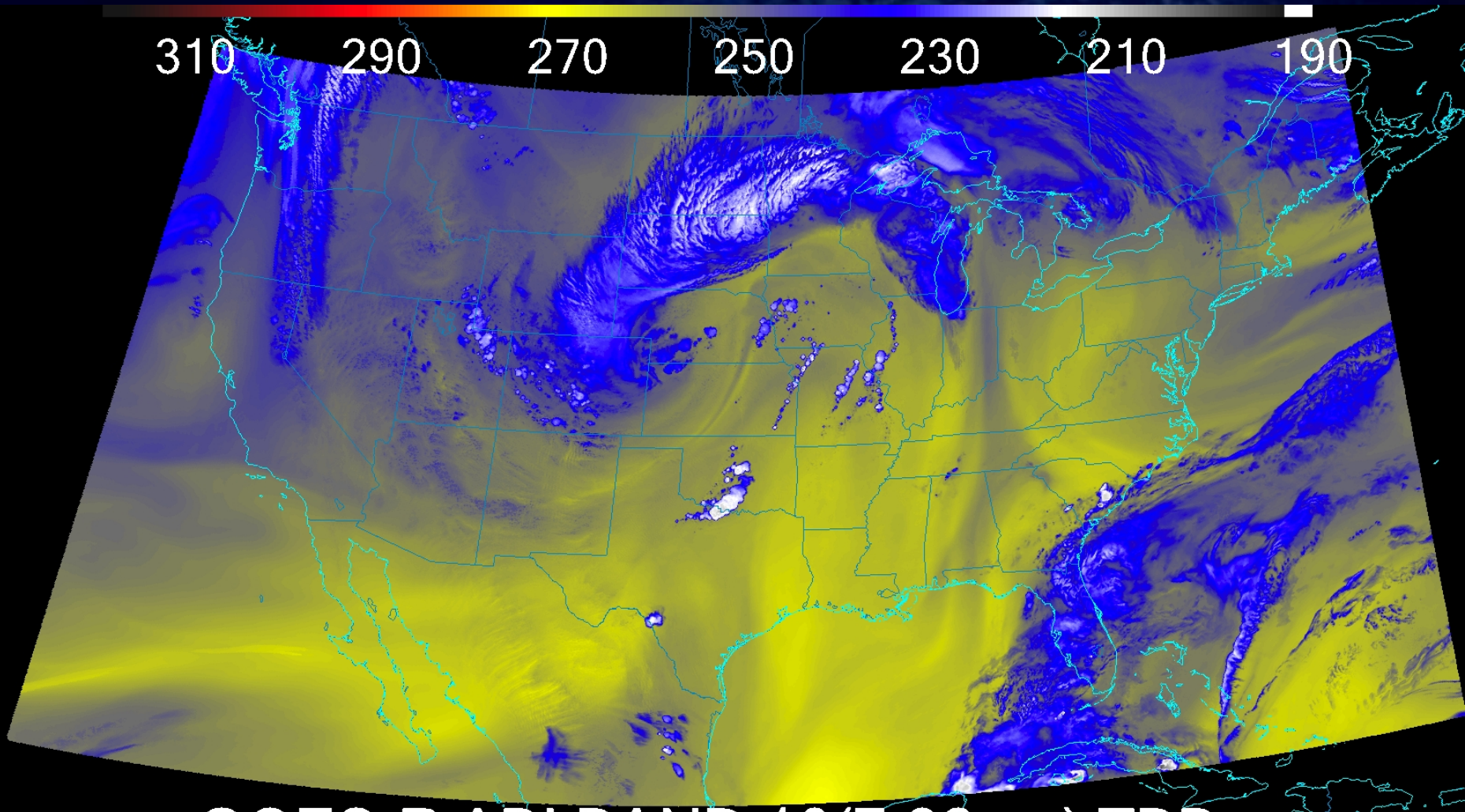


ABI has many more bands than the current operational GOES imagers.

Meso-scale (all bands)

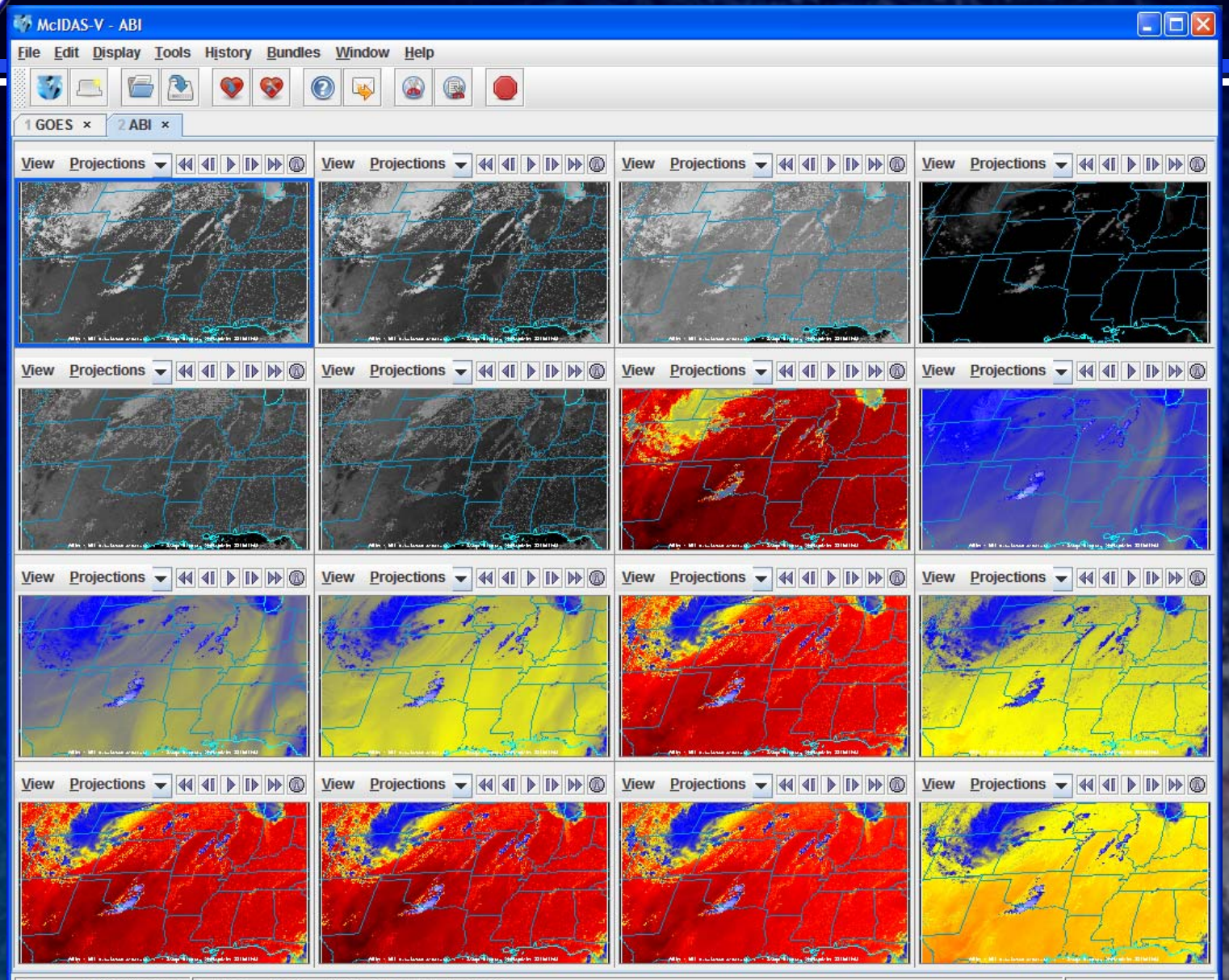


CONUS



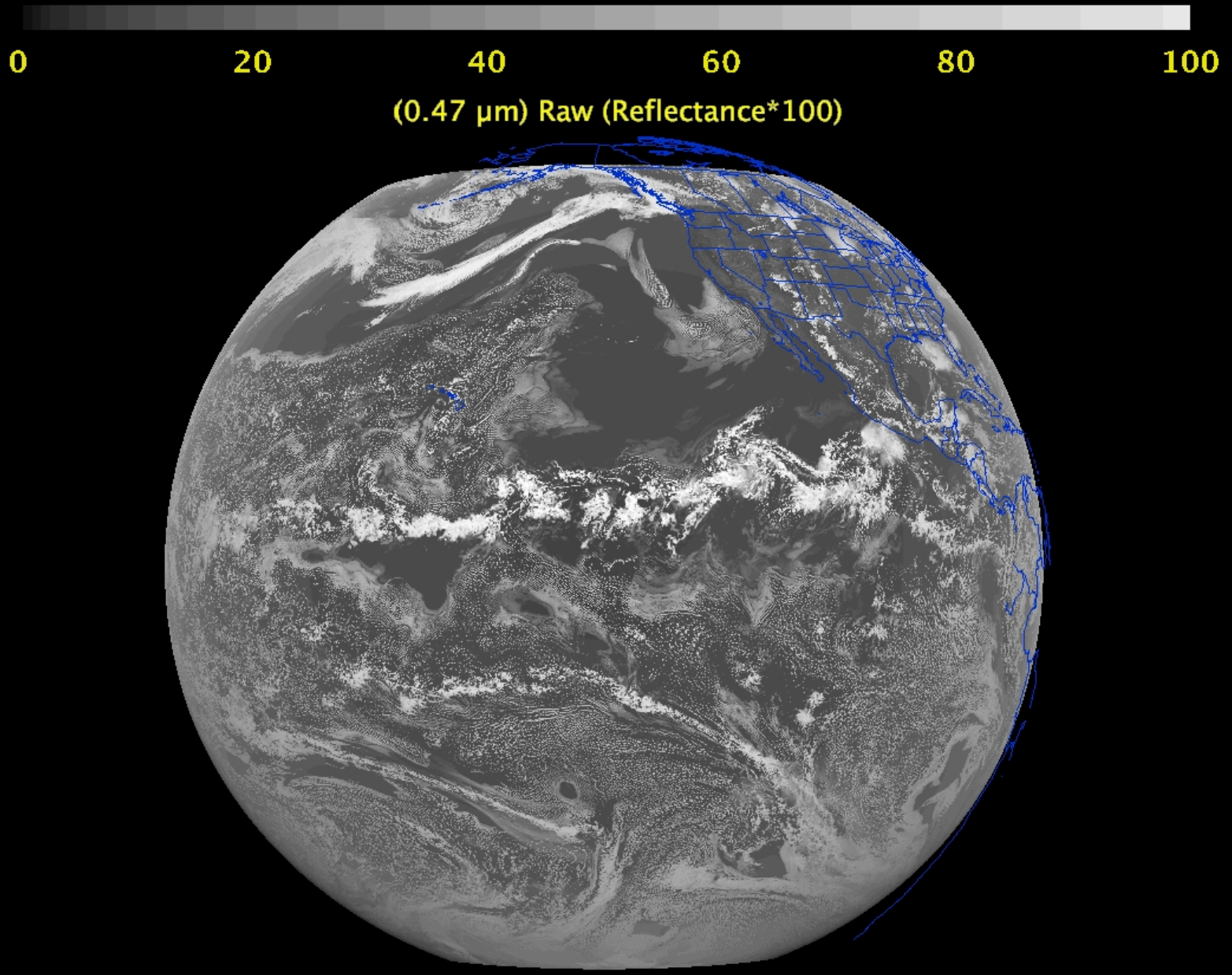
GOES-R ABI BAND 10(7.32um) TBB

Example CMIP Output ABI bands in McIDAS-V



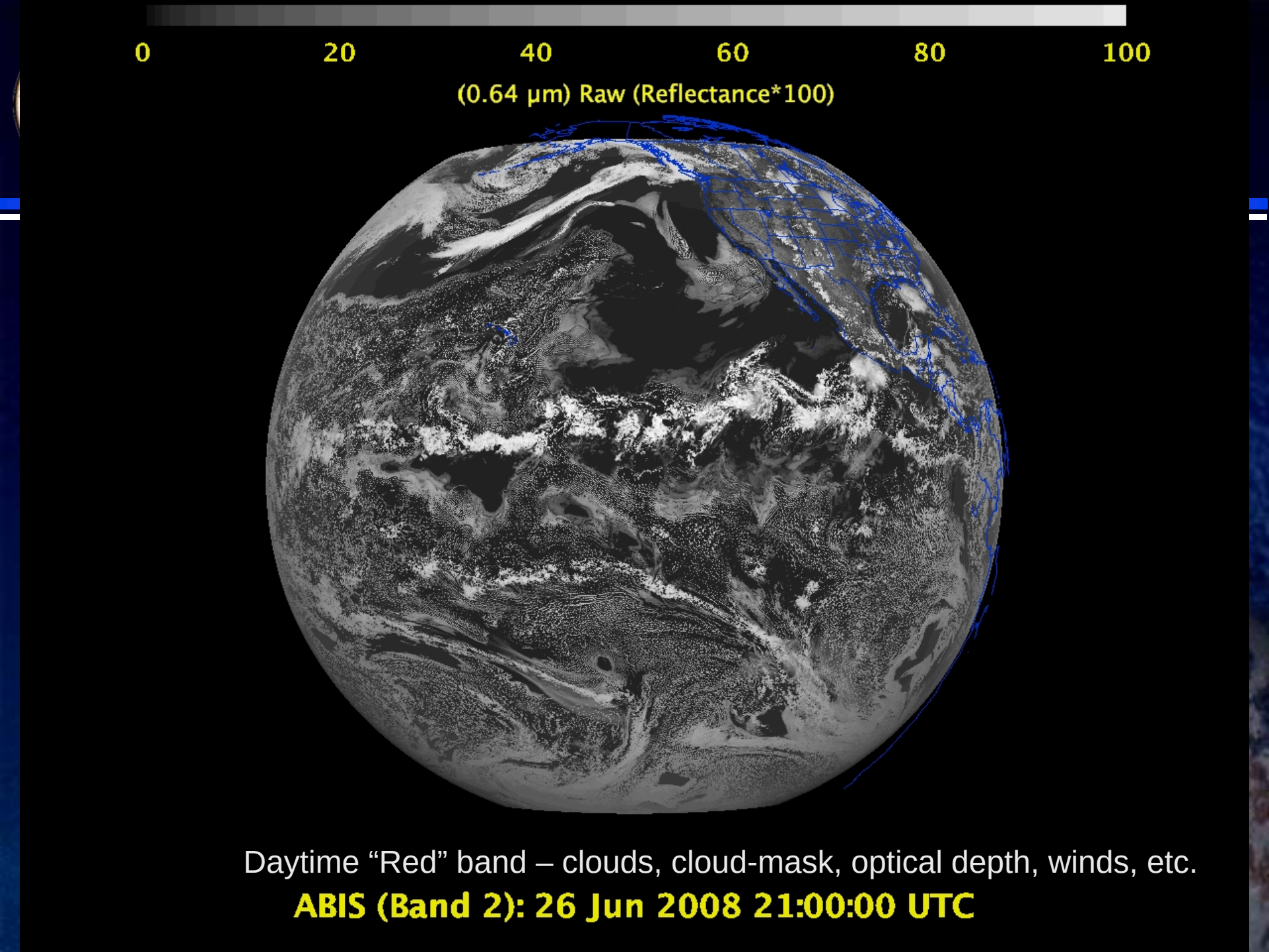
Full Disk

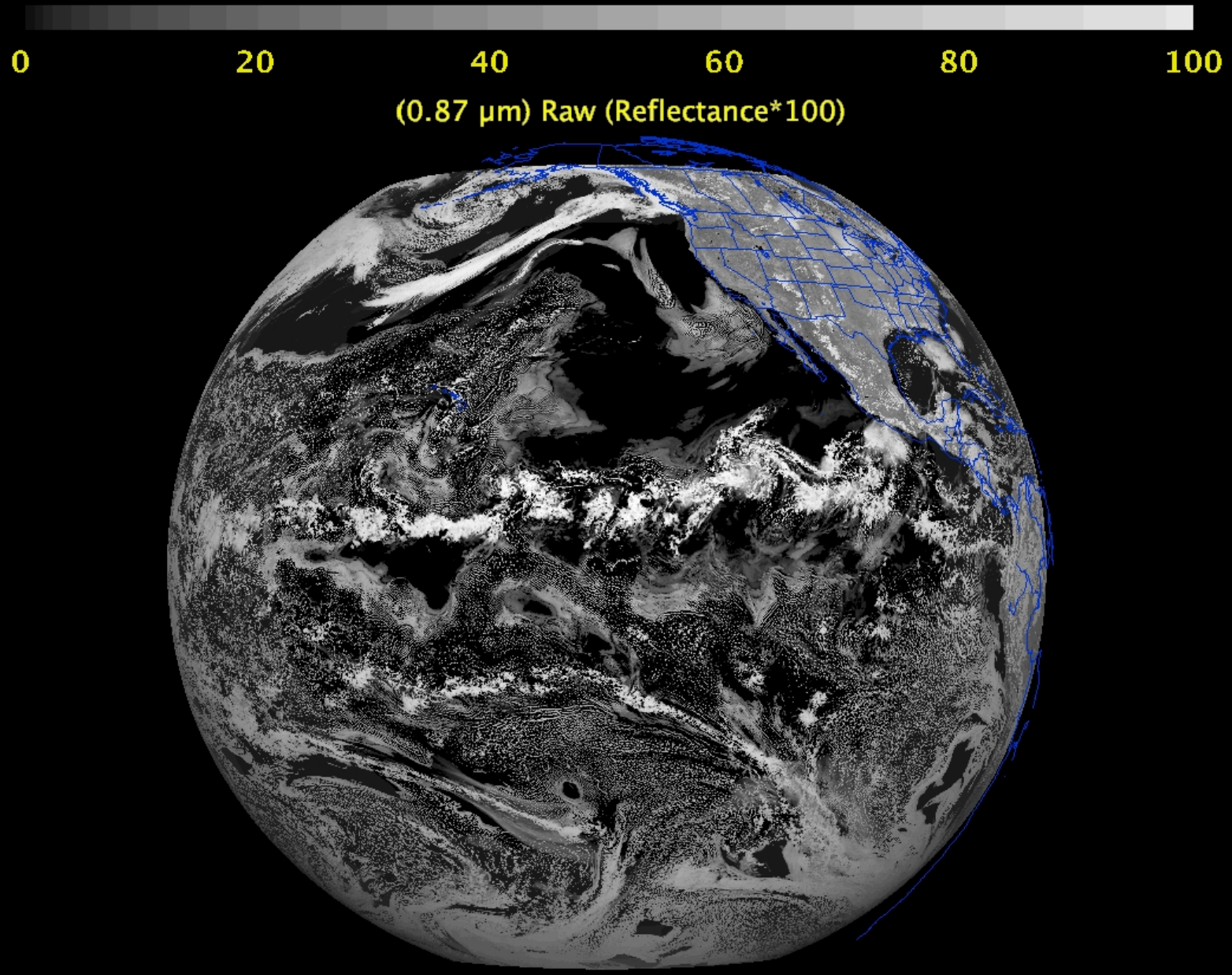
- Simulated ABI Full Disk image
- Generated with McIDAS-V
- Via a script
- Using McIDAS areas
- All bands are shown



Daytime “Blue” band – aerosols, solar insolation, snow cover

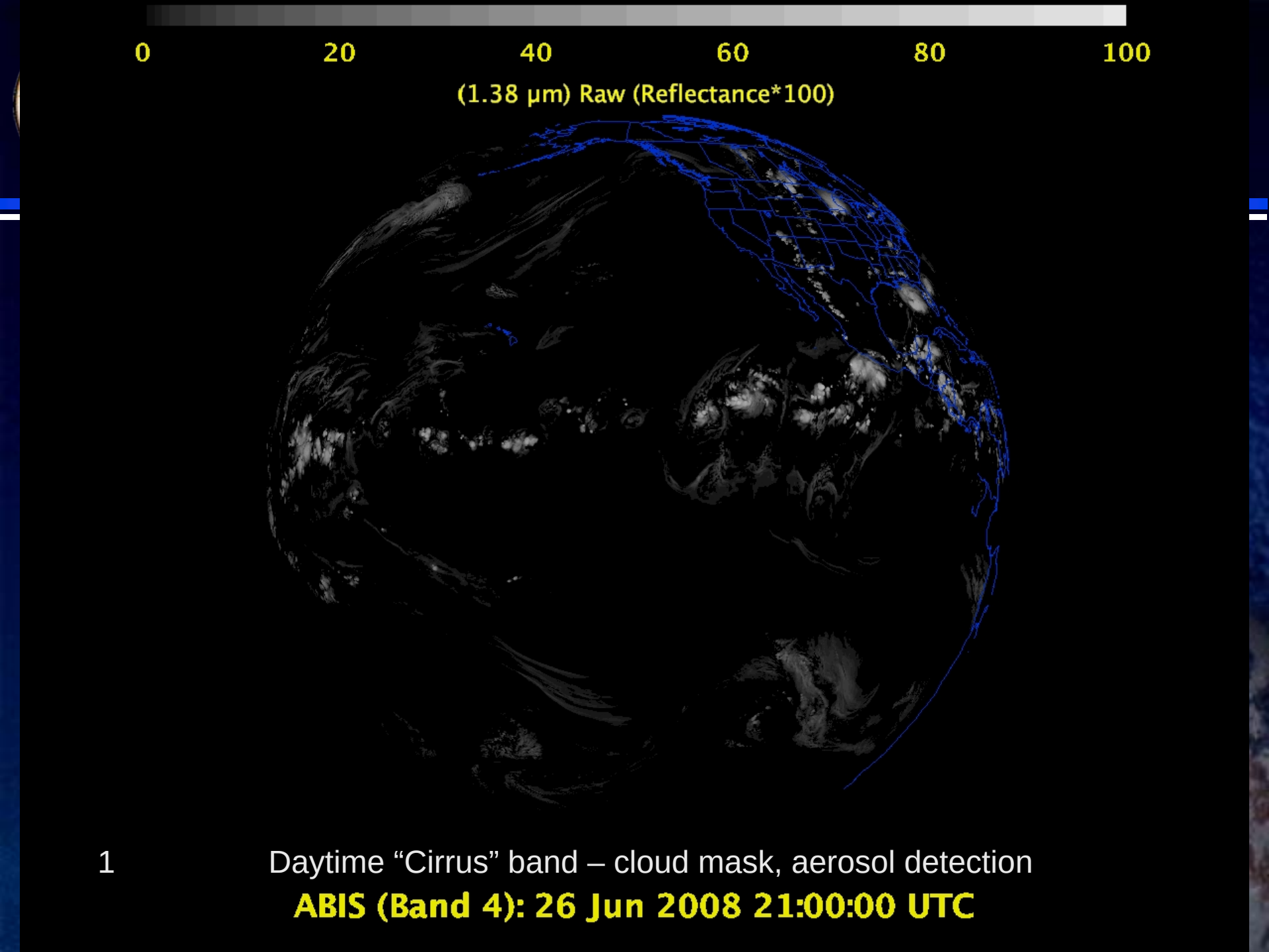
ABIS (Band 1): 26 Jun 2008 21:00:00 UTC


0
20
40
60
80
100
(0.64 μm) Raw (Reflectance*100)
Daytime “Red” band – clouds, cloud-mask, optical depth, winds, etc.
ABIS (Band 2): 26 Jun 2008 21:00:00 UTC



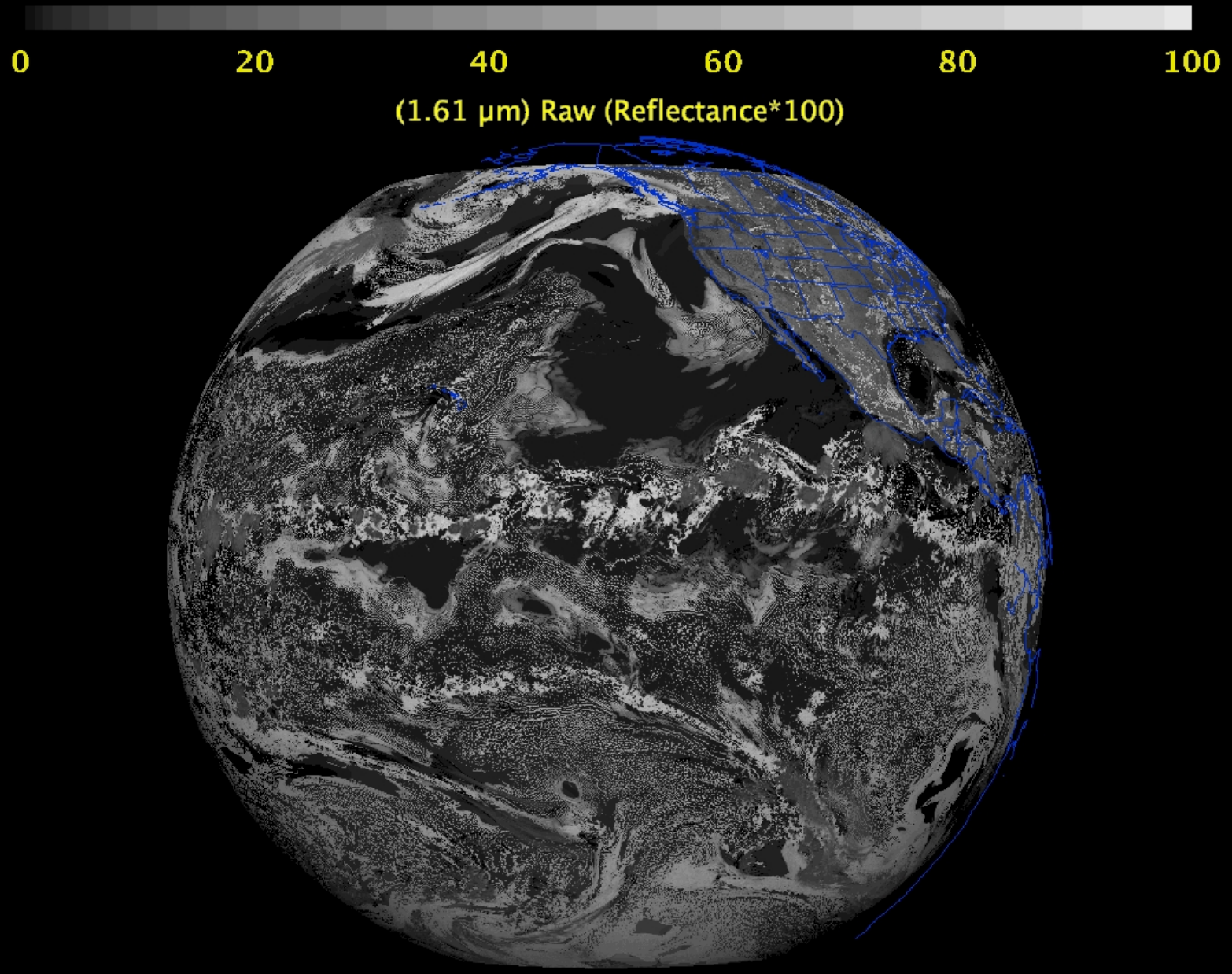
Daytime “Veggie” band – NDVI, solar insolation, snow cover

ABIS (Band 3): 26 Jun 2008 21:00:00 UTC



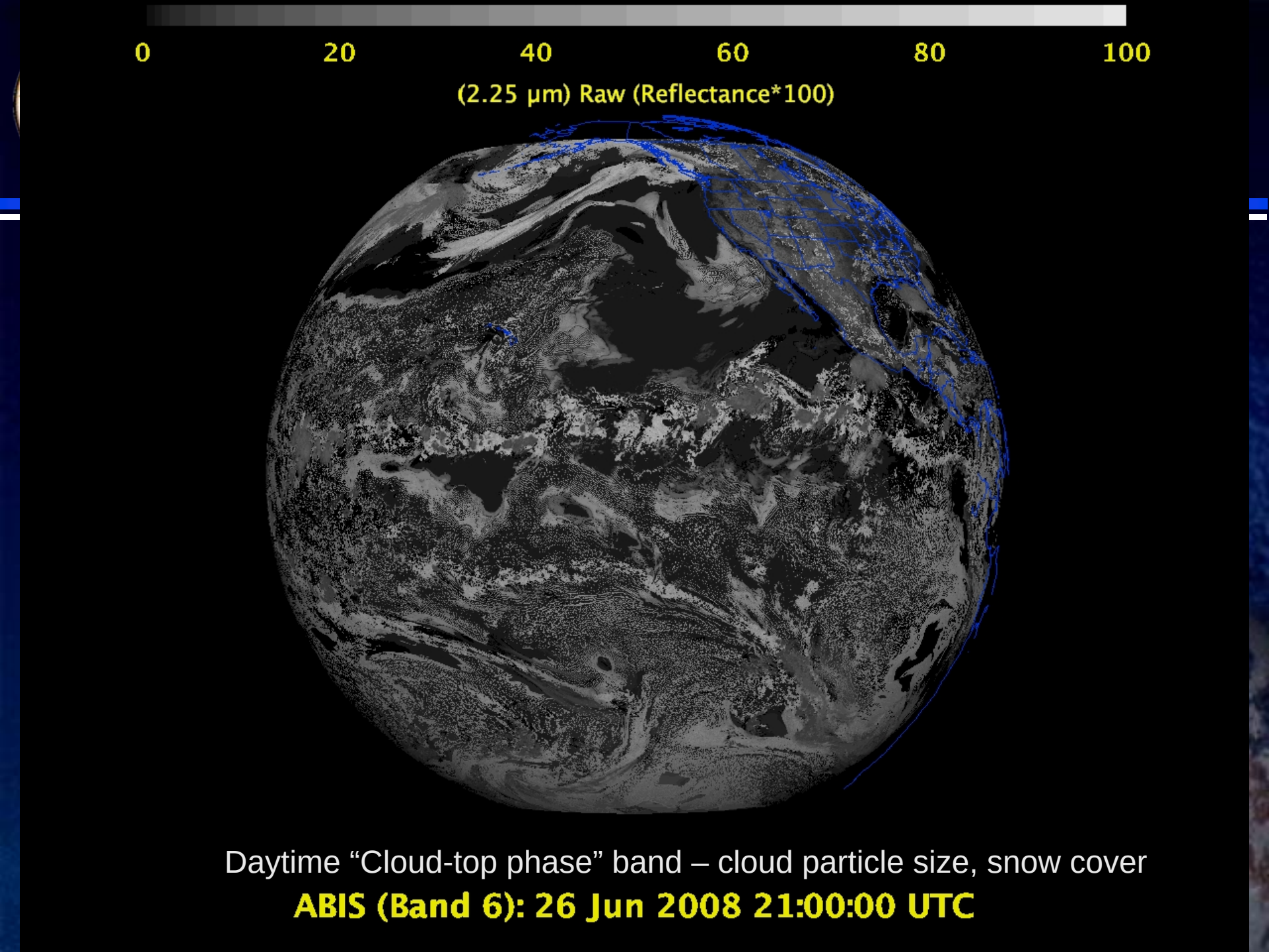
1 Daytime “Cirrus” band – cloud mask, aerosol detection

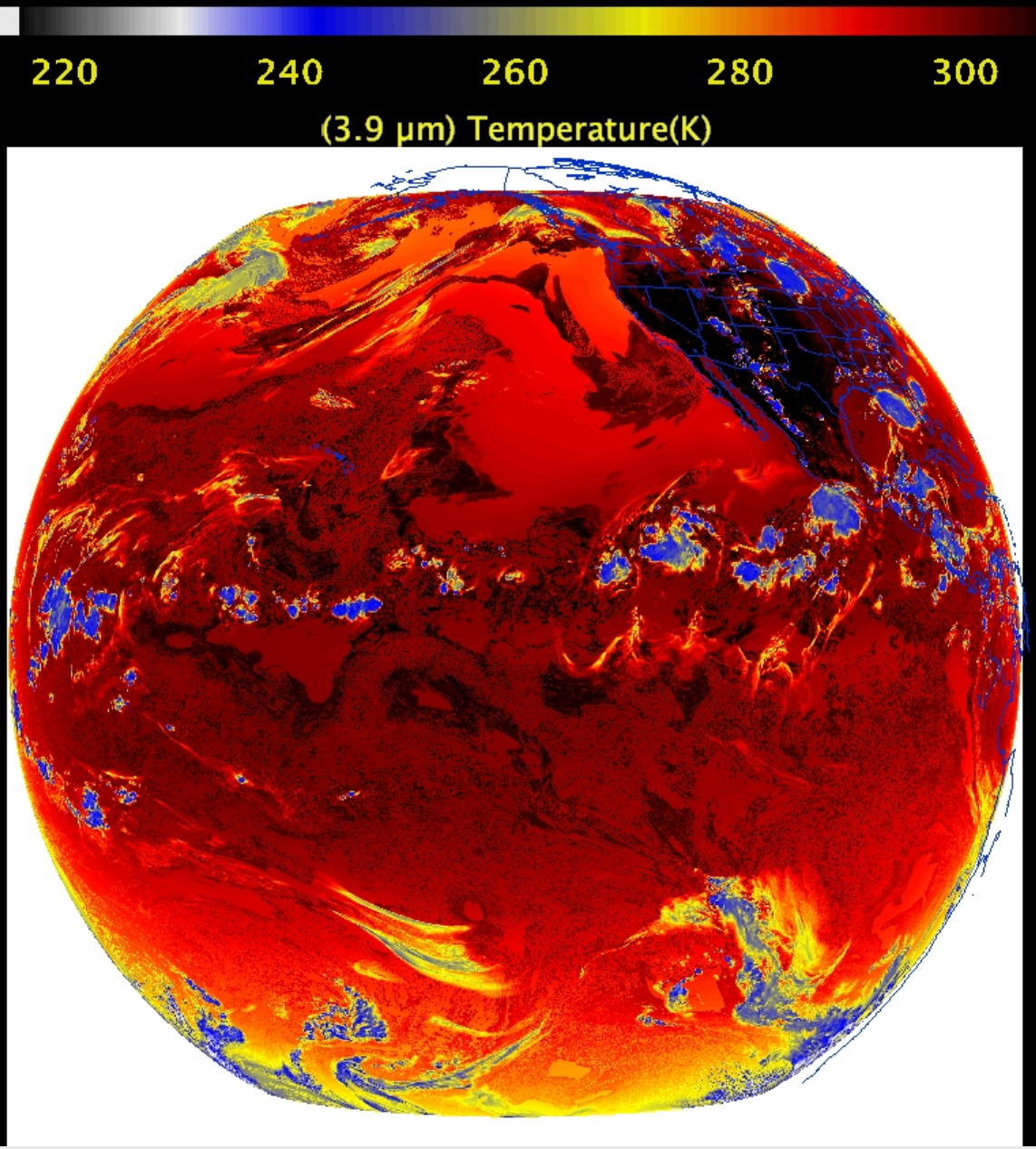
ABIS (Band 4): 26 Jun 2008 21:00:00 UTC



Daytime “Snow” band – snow cover, cloud mask, etc.

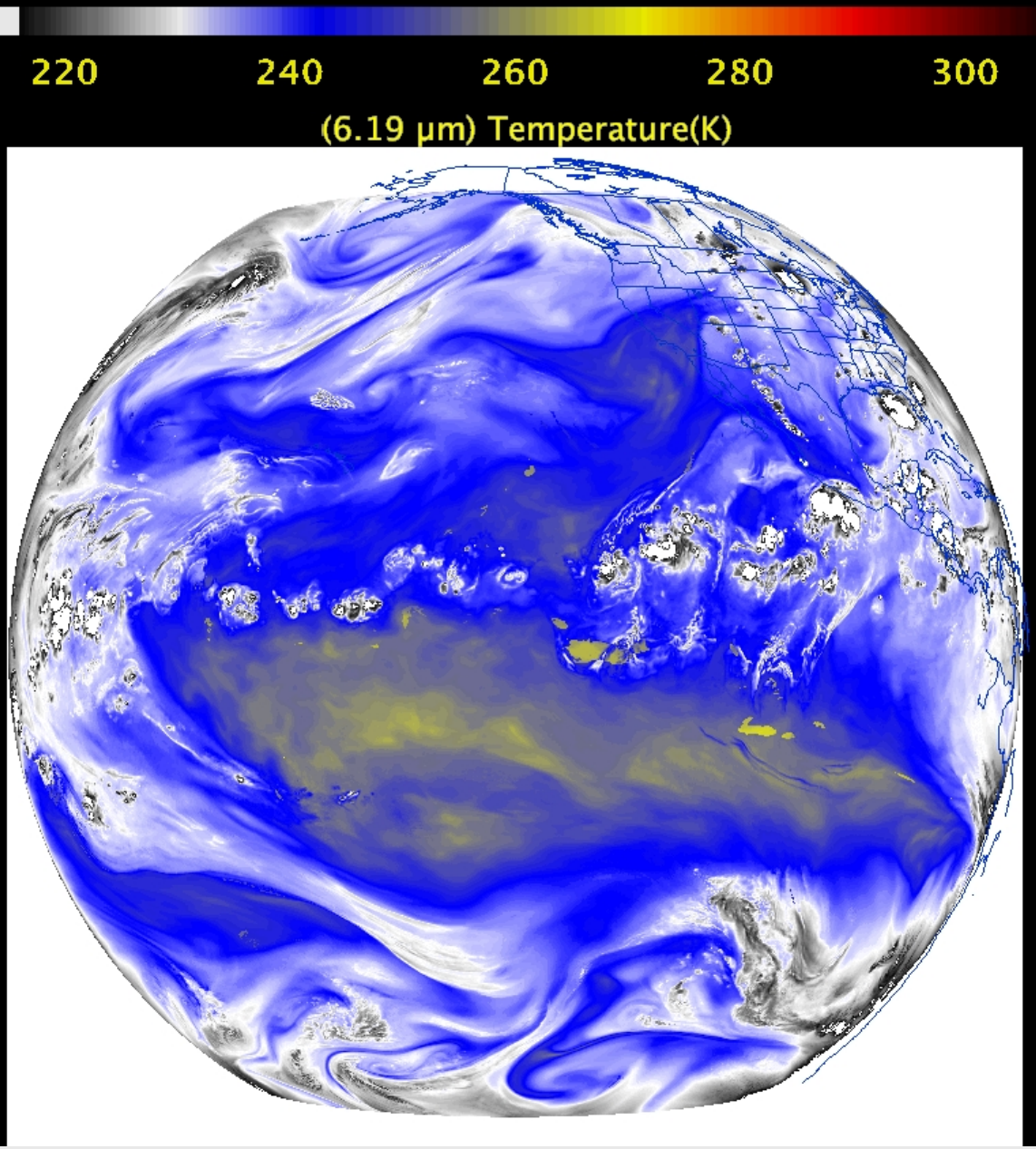
ABIS (Band 5): 26 Jun 2008 21:00:00 UTC


0
20
40
60
80
100
(2.25 μm) Raw (Reflectance*100)
Daytime “Cloud-top phase” band – cloud particle size, snow cover
ABIS (Band 6): 26 Jun 2008 21:00:00 UTC



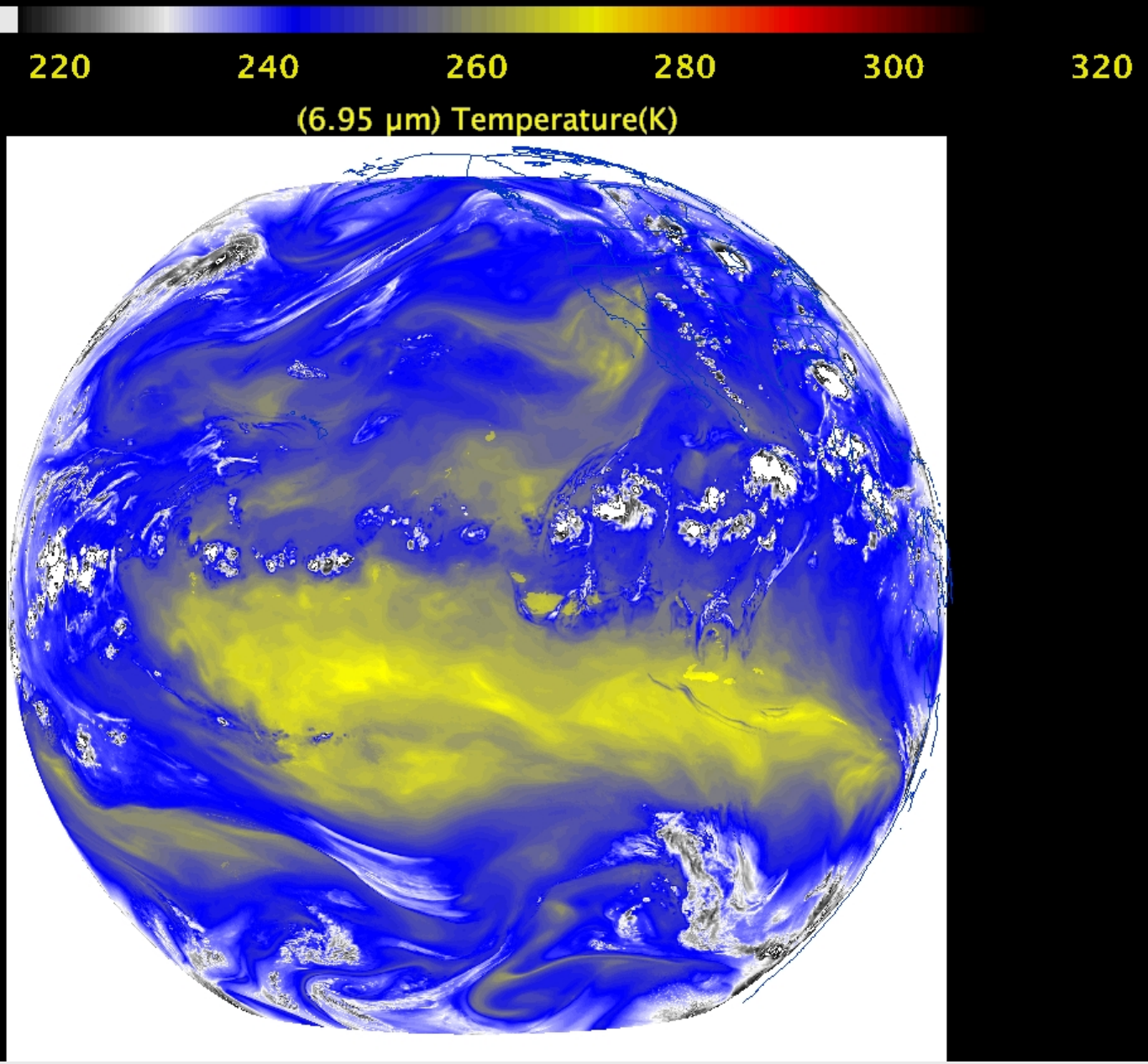
Shortwave IR window band - fog, fires, winds, SST, etc.

ABIS (Band 7): 26 Jun 2008 21:00:00 UTC



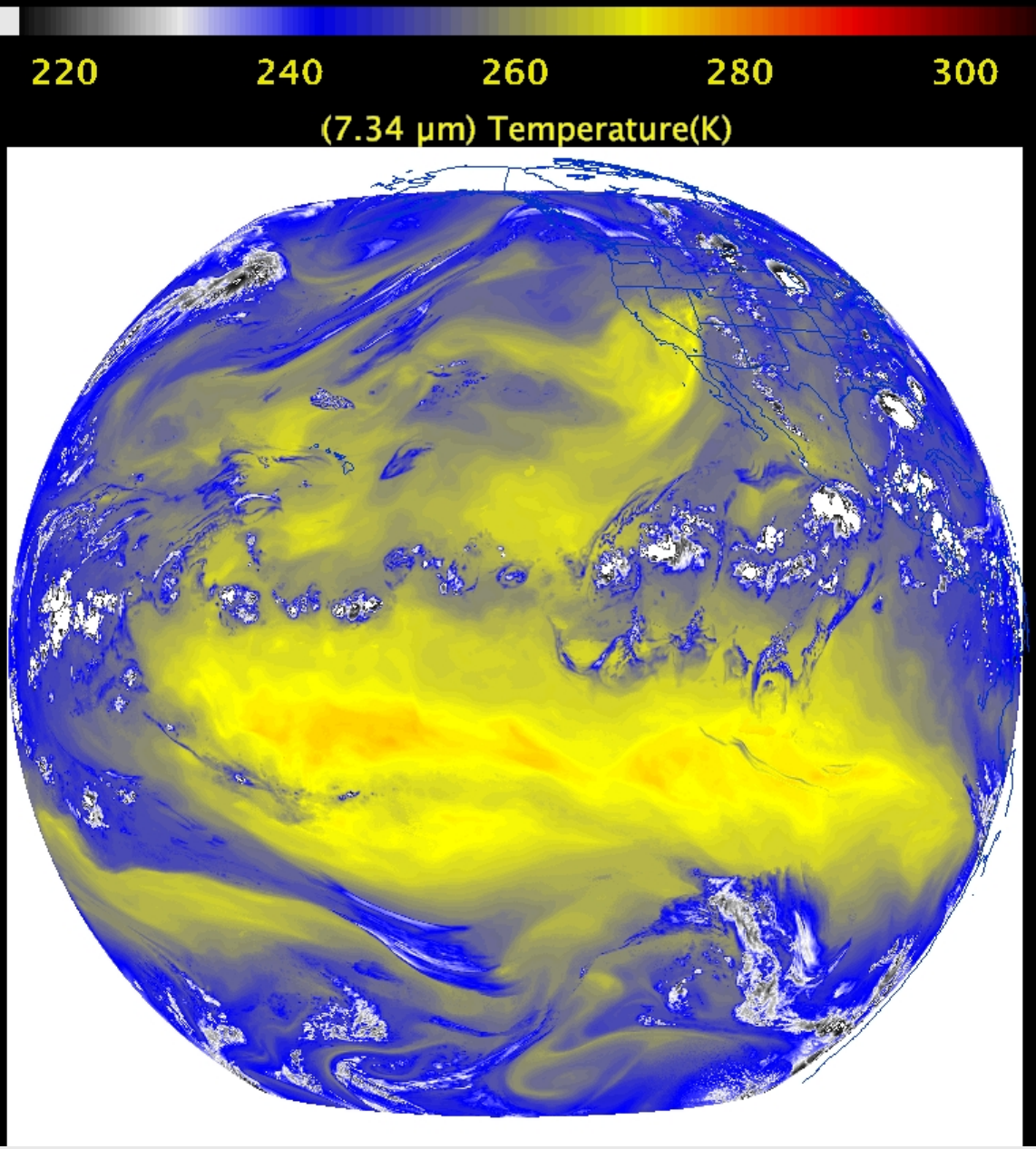
Upper-level tropospheric water vapor band – moisture, flow, winds

ABIS (Band 8): 26 Jun 2008 21:00:00 UTC



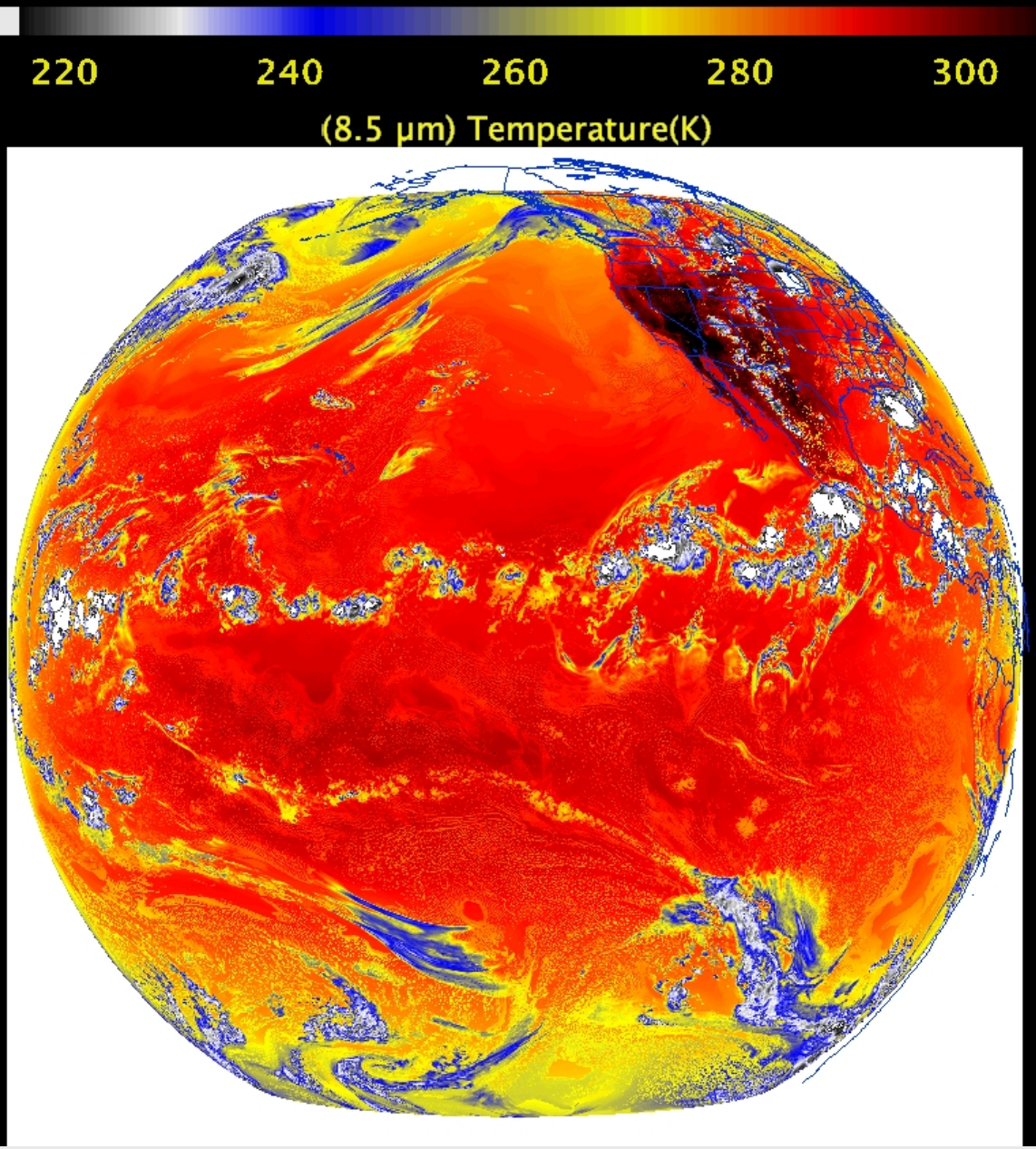
Upper/mid-level tropospheric water vapor band – moisture, flow, winds

ABIS (Band 9): 26 Jun 2008 21:00:00 UTC



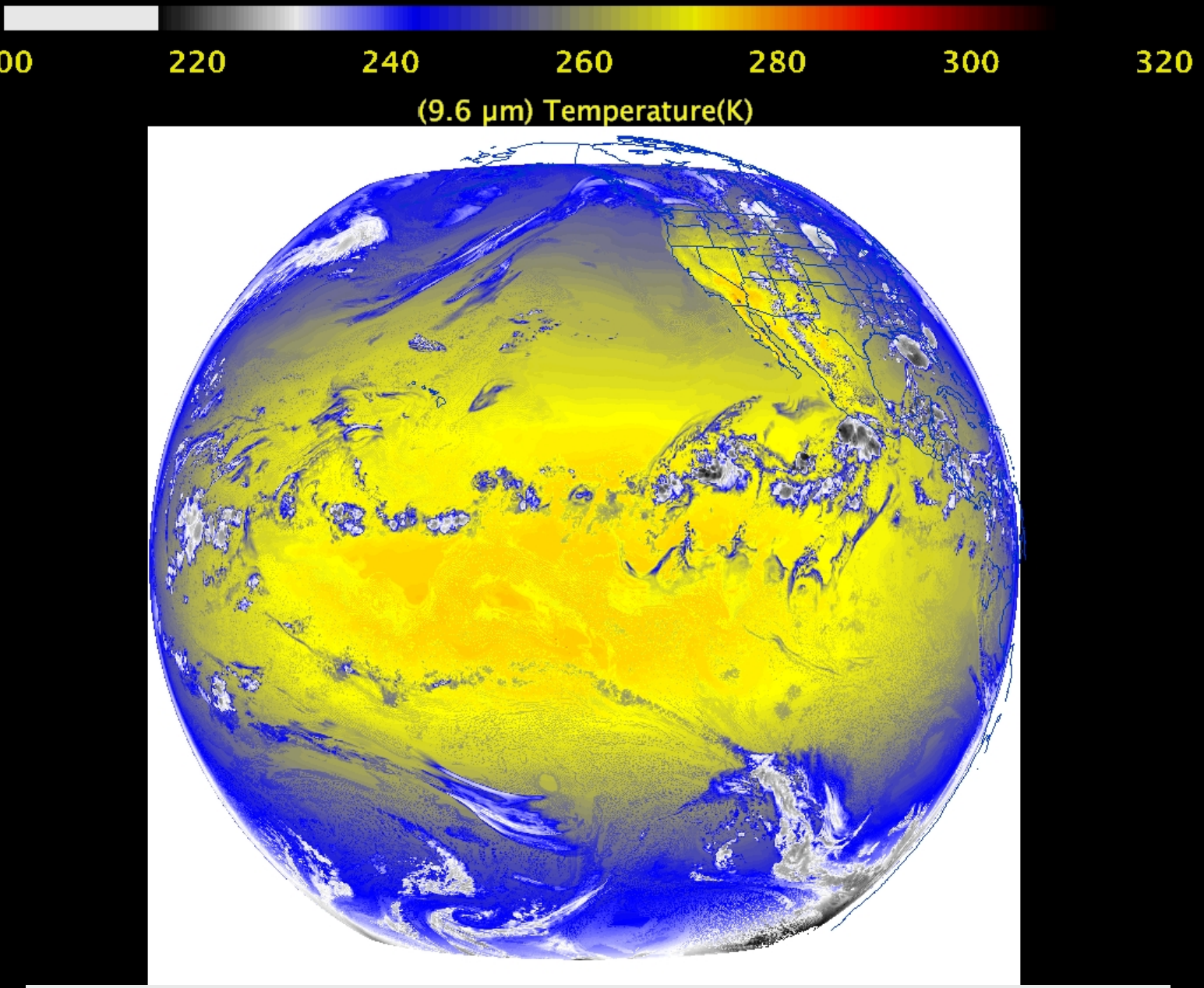
Lower mid-level tropospheric water vapor band– moisture, flow, winds

ABIS (Band 10): 26 Jun 2008 21:00:00 UTC

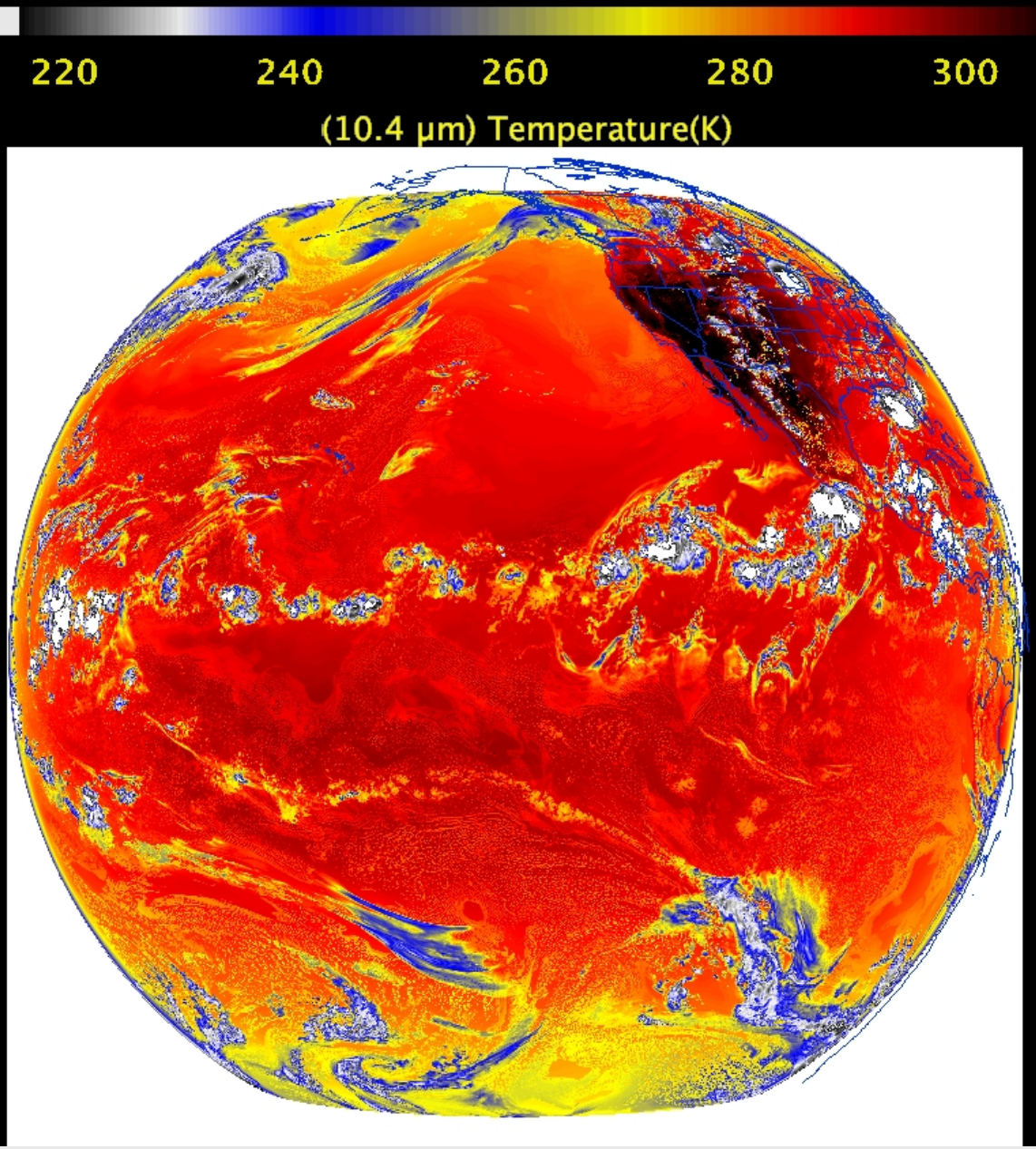


"Cloud-top phase" band – SO_2, dust, SST, stability indices, etc.

ABIS (Band 11): 26 Jun 2008 21:00:00 UTC

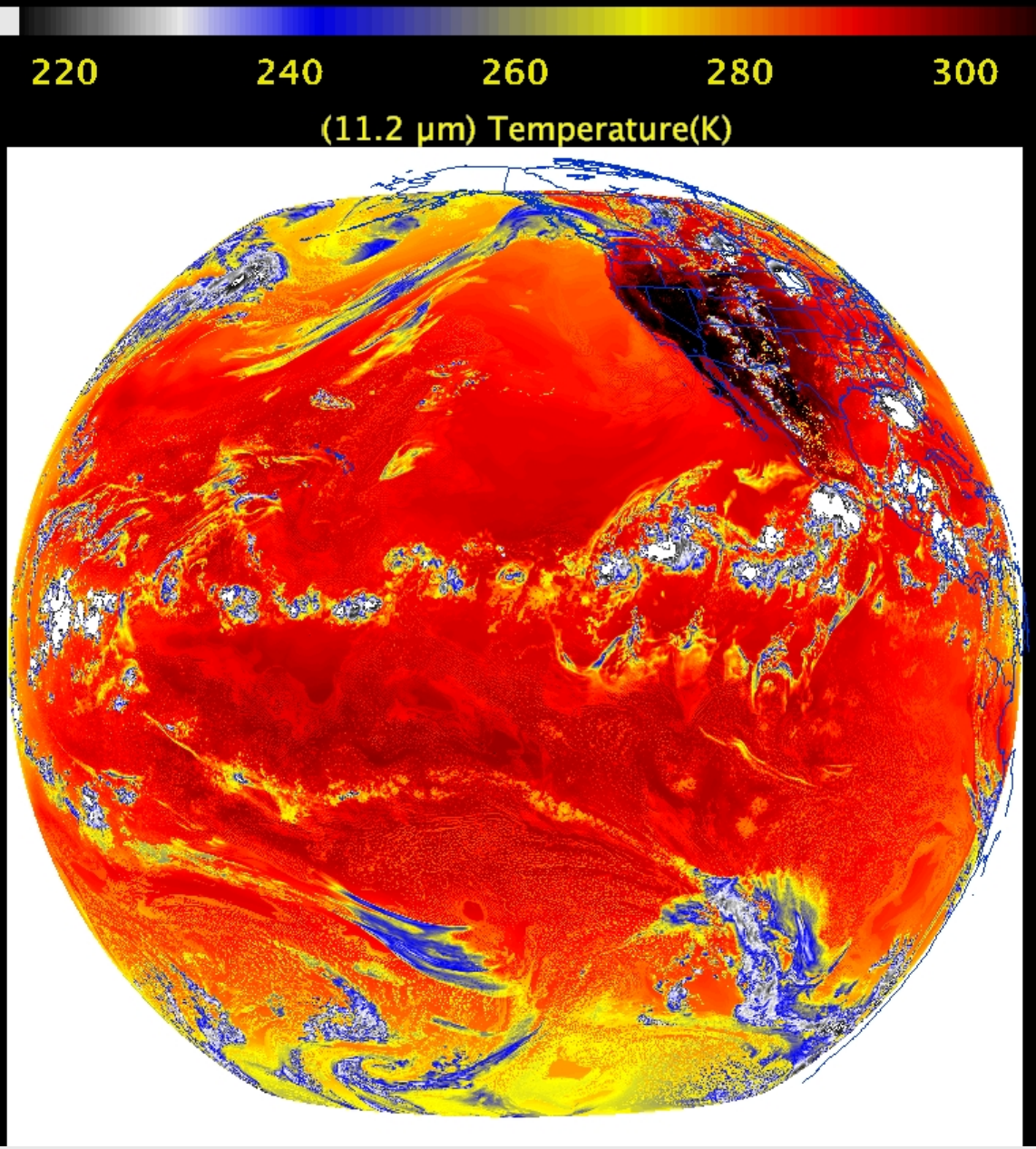

200
220
240
260
280
300
320
(9.6 μm) Temperature(K)
ABIS (Band 12): 26 Jun 2008 21:00:00 UTC

"Ozone" band



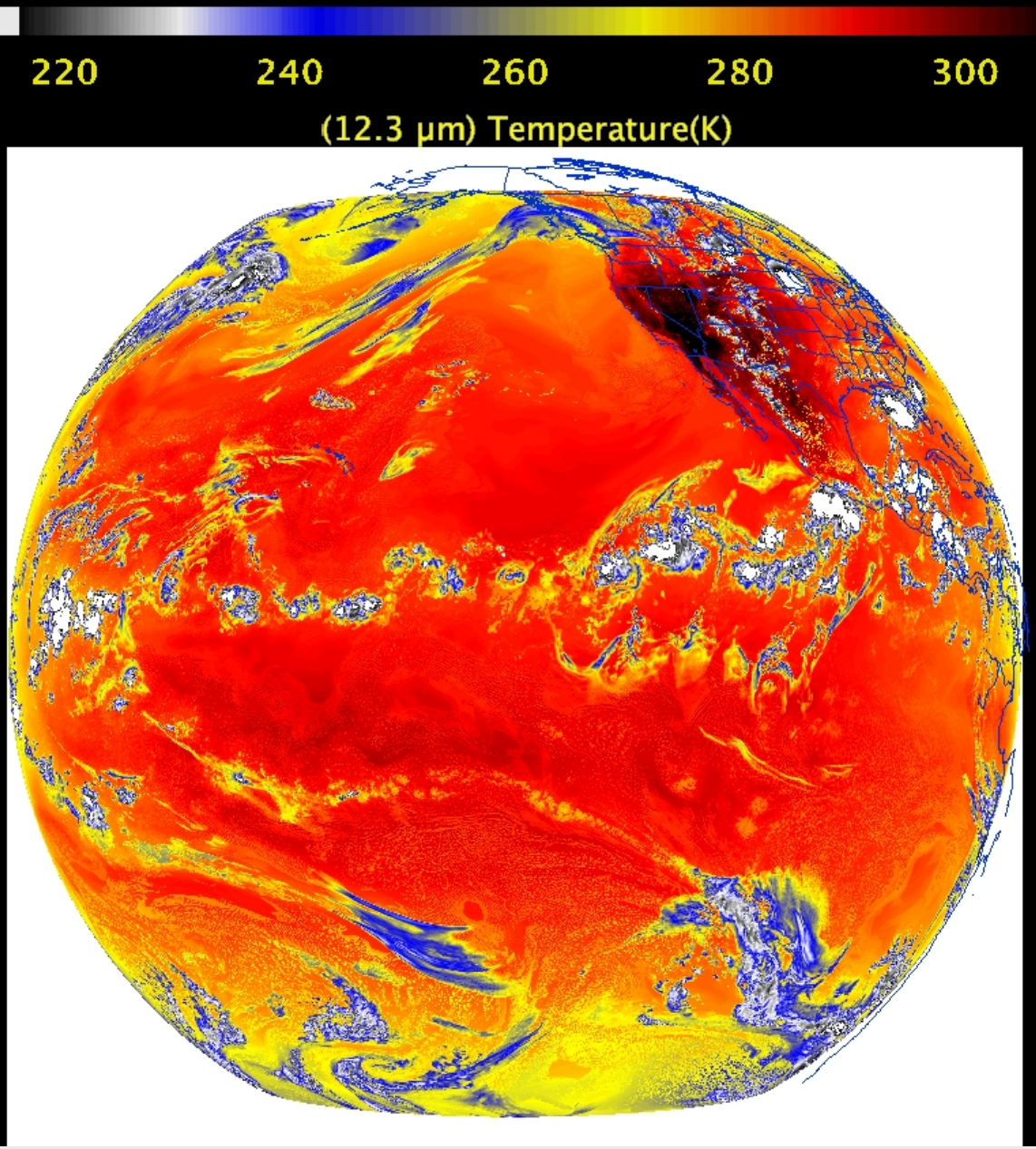
"Clean" IR longwave window band – imagery, TPW, etc.

ABIS (Band 13): 26 Jun 2008 21:00:00 UTC



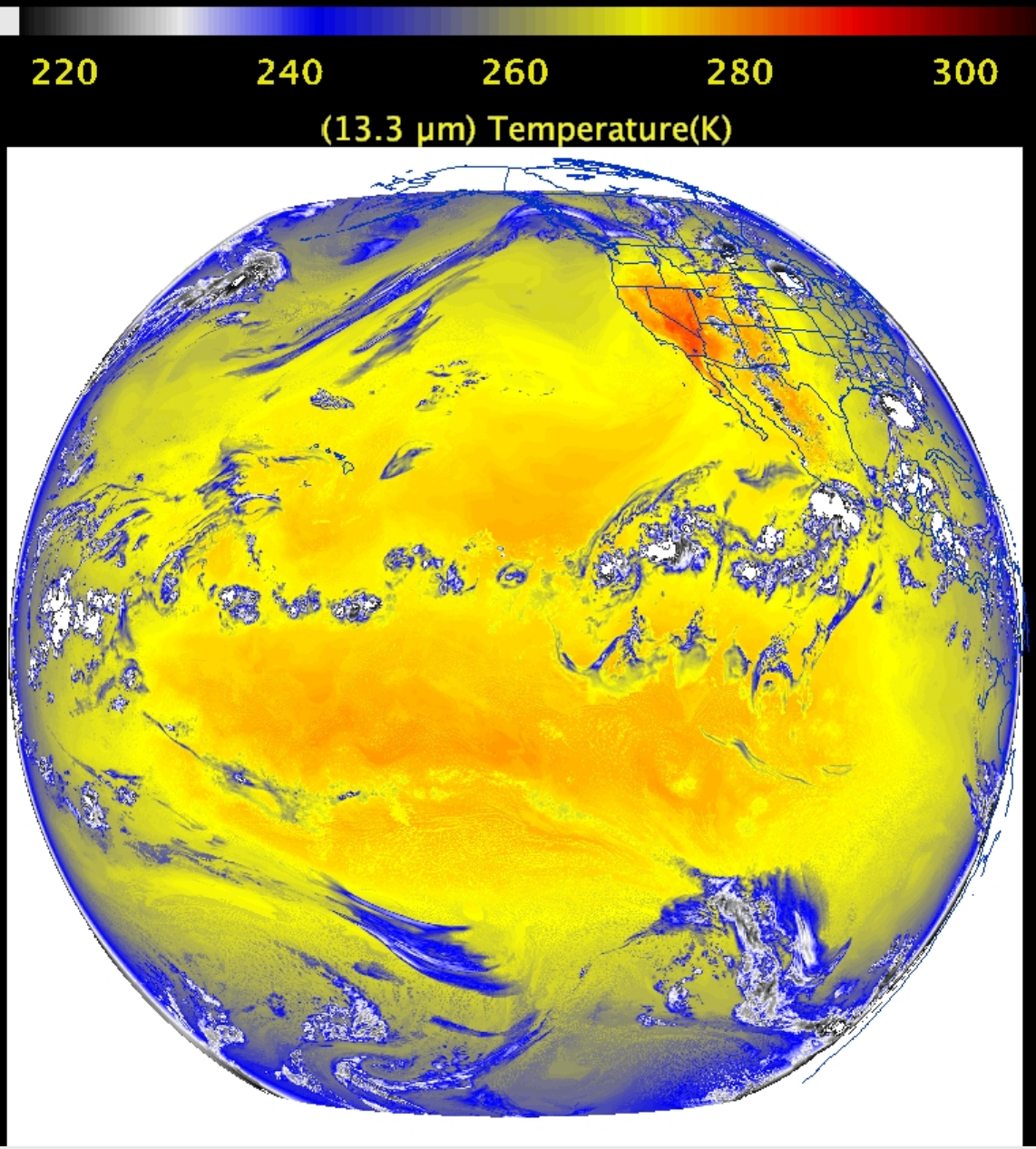
IR longwave window band – many cloud parameters, SST, snow cover

ABIS (Band 14): 26 Jun 2008 21:00:00 UTC



"Dirty" IR longwave window band – many cloud parameters, TPW

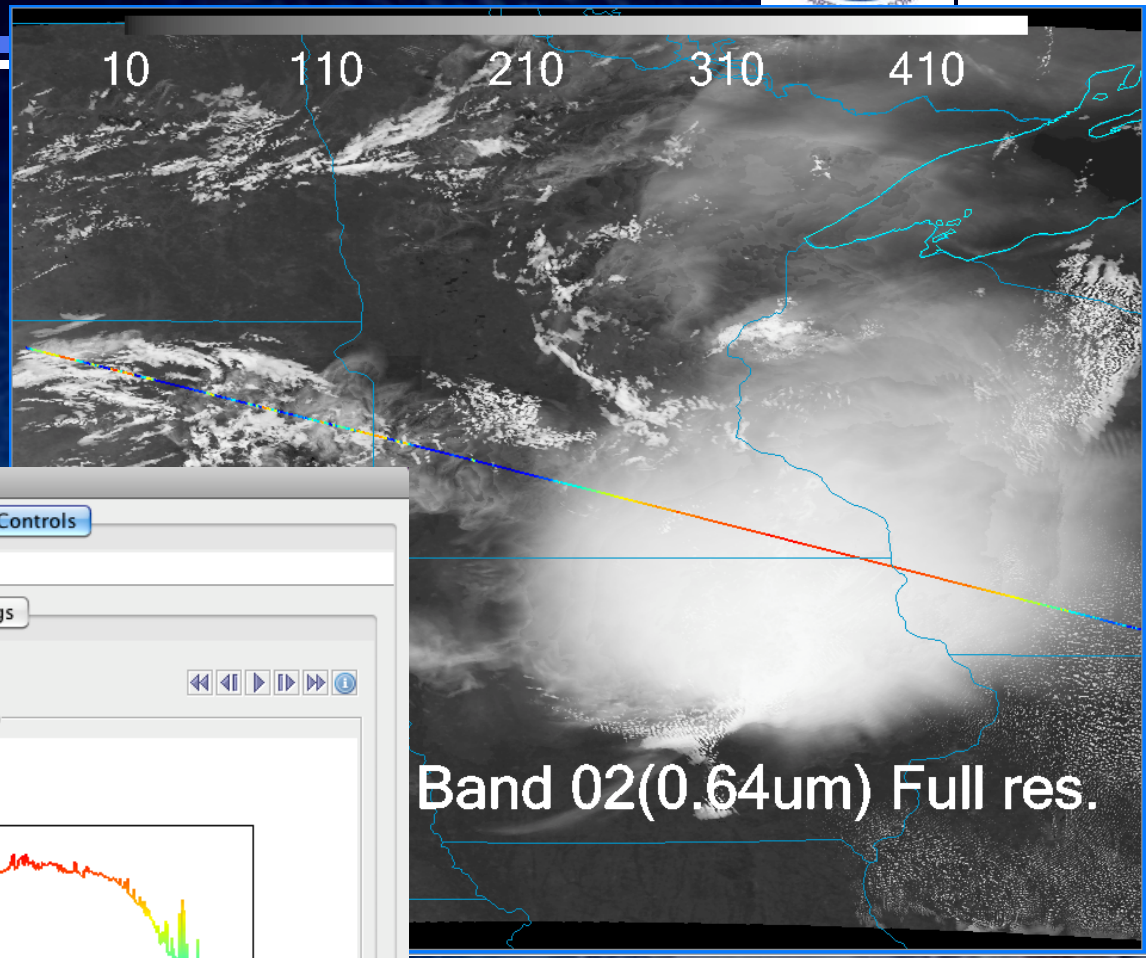
ABIS (Band 15): 26 Jun 2008 21:00:00 UTC



"CO2" longwave IR band – cloud height/pressure, stability indices

ABIS (Band 16): 26 Jun 2008 21:00:00 UTC

Transect (Mcidas-V)



McIDAS-V – Data Explorer

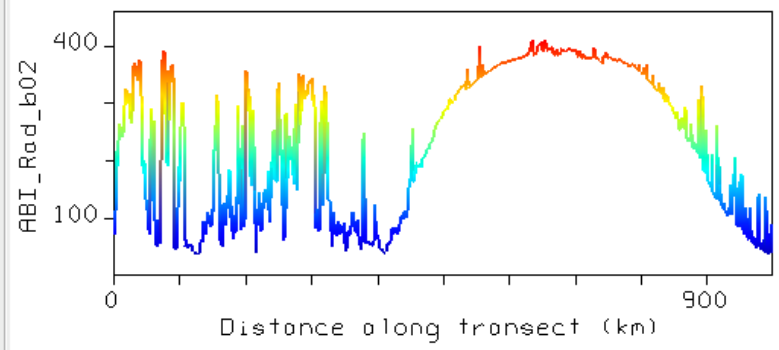
Data Sources | Field Selector | Layer Controls

File Edit View Help

untitled>Panel 1
Default Background Maps
No Display
Sub_sampled_Validation.
Sub_sampled_Validation.
Sub_sampled_Validation.
Sub_sampled_Validation.
GRB_VAL_band02_psc_h.
untitled>Panel 1
Default Background Maps
GRB_VAL_band02_psc_h.
GRB_VAL_band02_psc_.

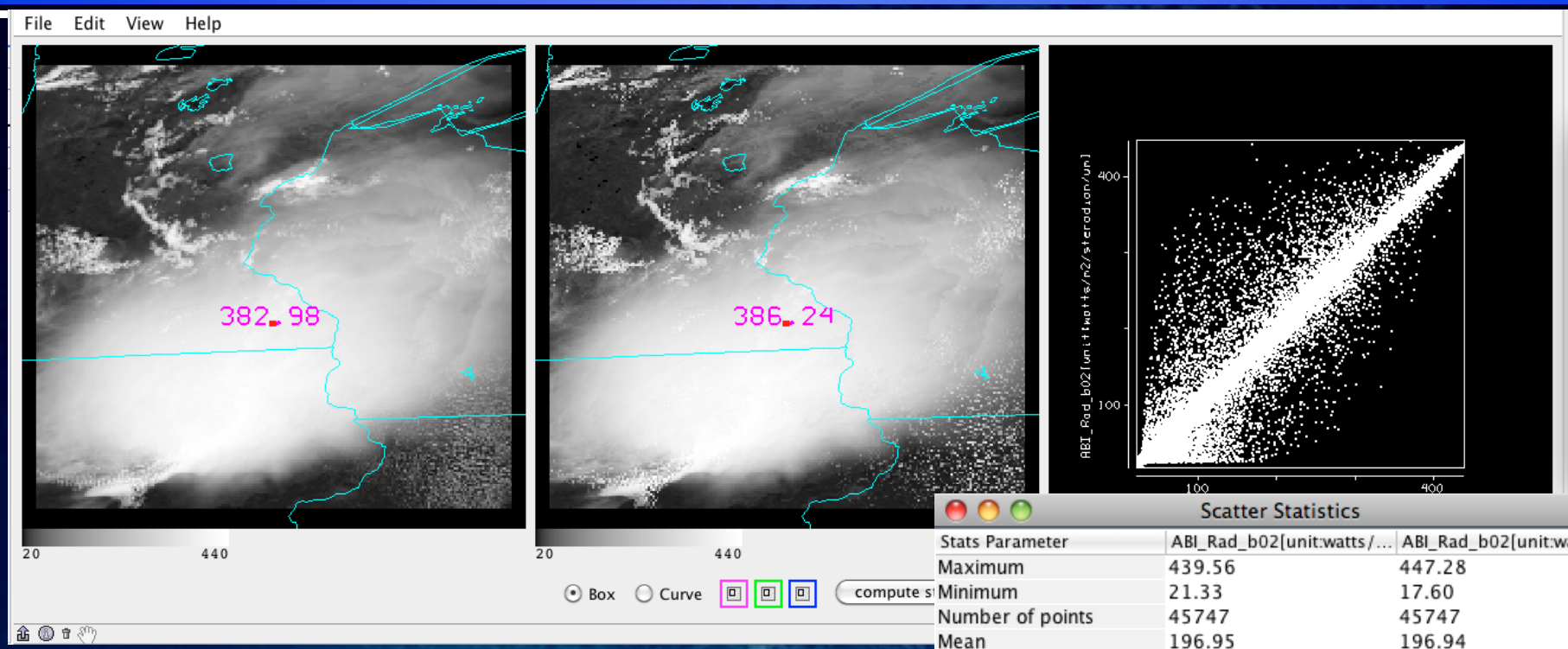
Display | Settings

Data Cross Section of ABI radiance band02 (0.64um)



Location: Lat: 45.7 Lon: -100 To Lat: 42.7 Lon: -88.2

Interactive Scatter plot and Statistics



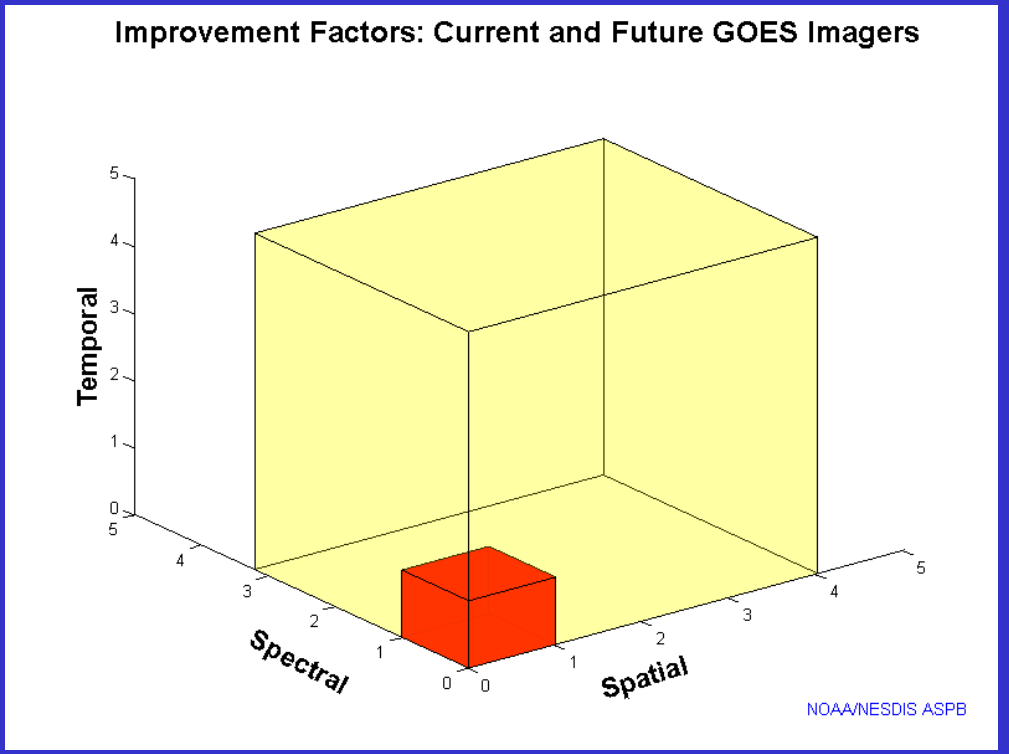
Scatter Statistics

Stats Parameter	ABI_Rad_b02[unit:watts/...	ABI_Rad_b02[unit:watts/...
Maximum	439.56	447.28
Minimum	21.33	17.60
Number of points	45747	45747
Mean	196.95	196.94
Median	188.78	191.22
Variance	1.669146e+04	1.723394e+04
Kurtosis	-1.333	-1.364
Std Dev		
Correlation	0.98193	
Difference Maximum	210.69	
Difference Minimum	-273.38	
Difference Mean	0.01082	
Area [km^2]		

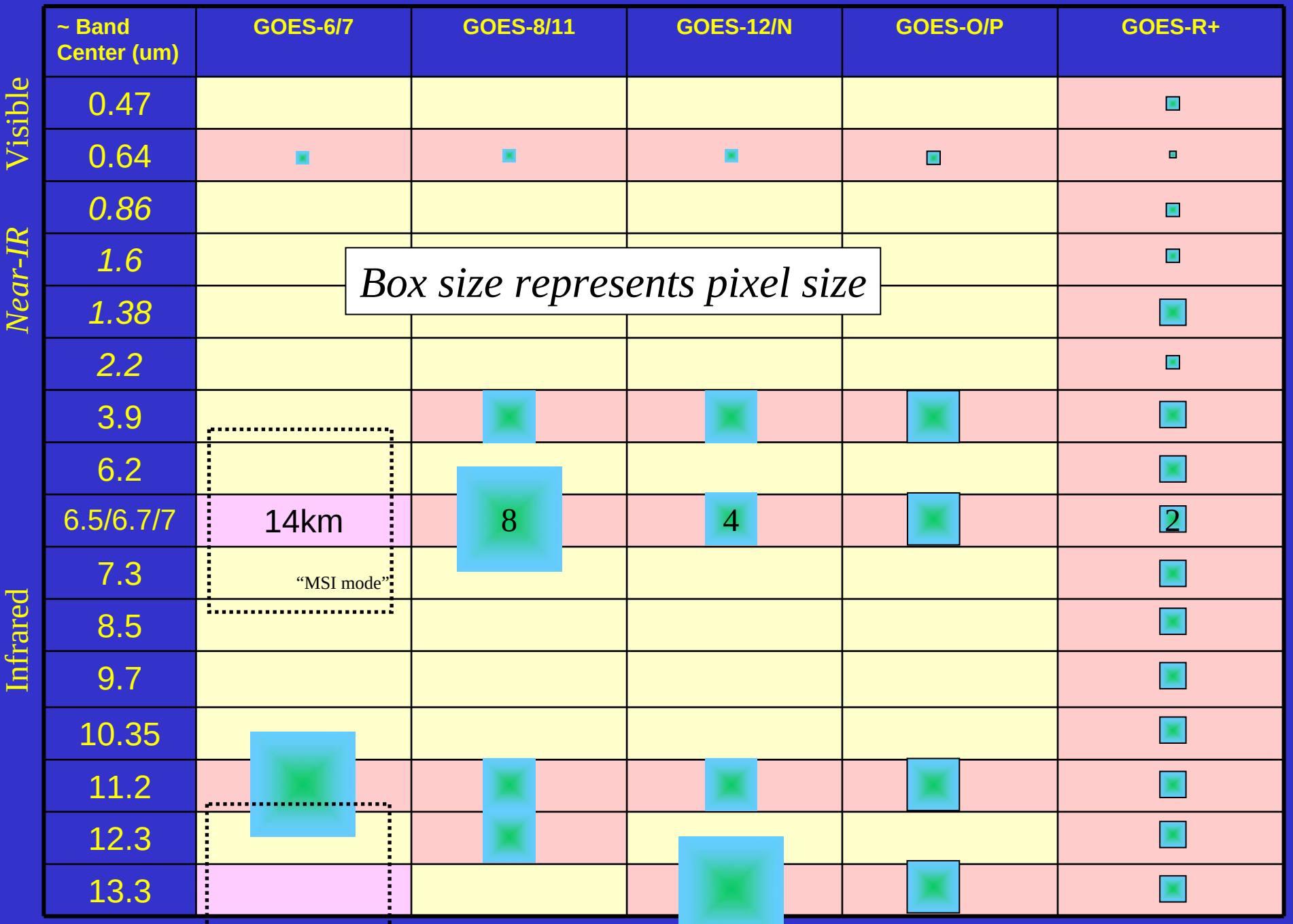
Save As CSV

Outline

- ABI (Advanced Baseline Imager)
  - Temporal
  - Spatial
  - Spectral
- Products
- Summary
  - More information
  - Questions



Approximate spectral and spatial resolutions of US GOES Imagers

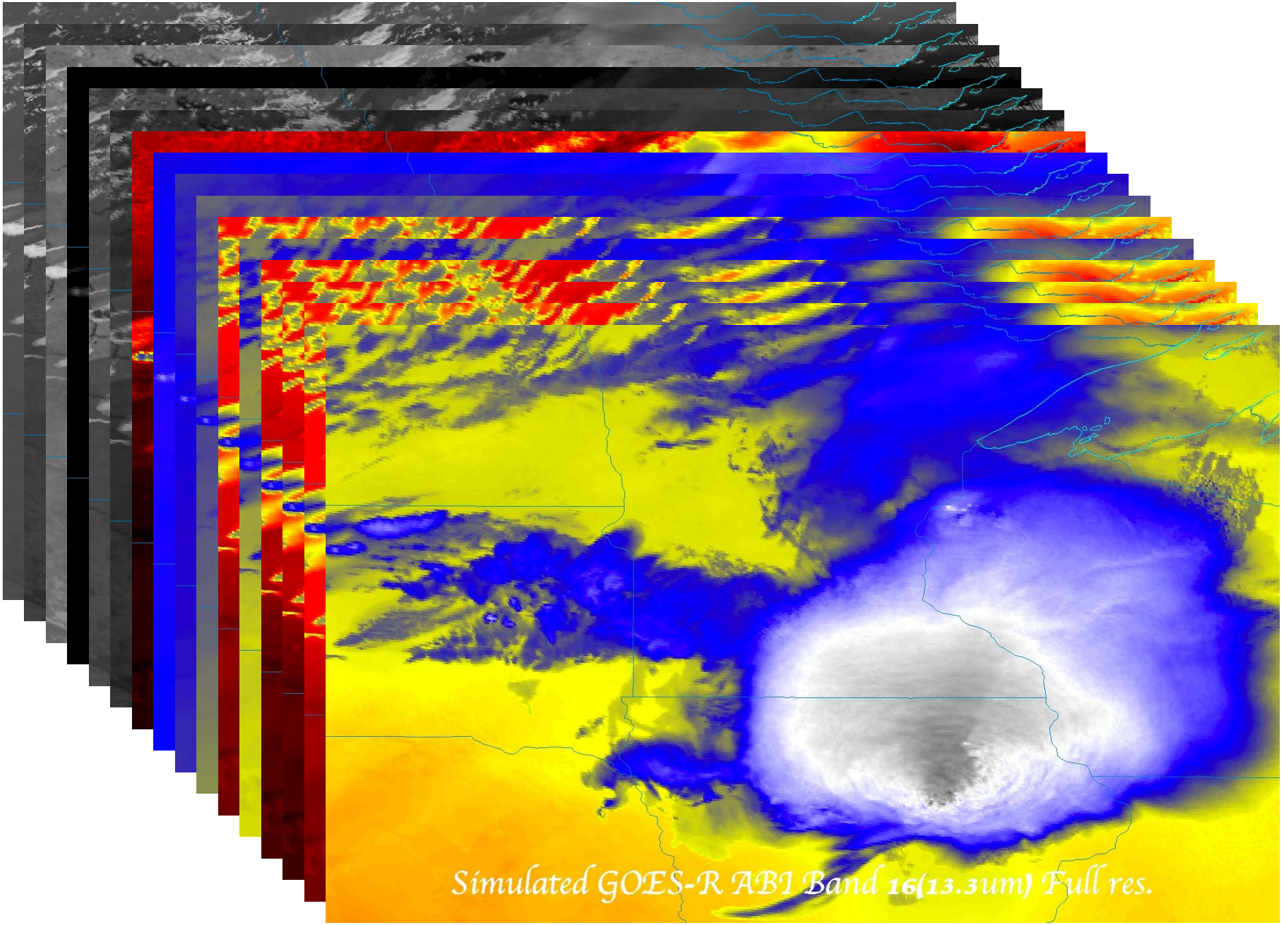


Summary

- The ABI on GOES-R will improve over the current instrument, including improved image navigation and registration and radiometer performance (colder patch temperatures, etc).

- These improvements will greatly assist a host of data assimilation, NWP applications, and other applications.

- Still need the vertical resolution of high-spectral, high-temporal observations!


Simulated GOES-R ABI Band 16(13.3um) Full res.

More information

GOES-R:

- http://www.goes-r.gov
- http://www.meted.ucar.edu/index.htm
- http://cimss.ssec.wisc.edu/goes_r/proving-ground.html

GOES and NASA:

- http://goespoes.gsfc.nasa.gov/goes/index.html
- http://goes.gsfc.nasa.gov/text/goes.databookn.html

UW/SSEC/CIMSS/ASPB:

- http://cimss.ssec.wisc.edu/goes_r/proving-ground/nssl_abi/nssl_abi_rt.html
- http://cimss.ssec.wisc.edu/goes_r/awg/proxy/nwp/
- http://cimss.ssec.wisc.edu/goes/abi/
- http://cimss.ssec.wisc.edu/goes/abi/wf
- http://cimss.ssec.wisc.edu/goes/blog/
- http://www.ssec.wisc.edu/data/geo/

AMS BAMS Article on the ABI (Aug. 2005)

Acknowledgements

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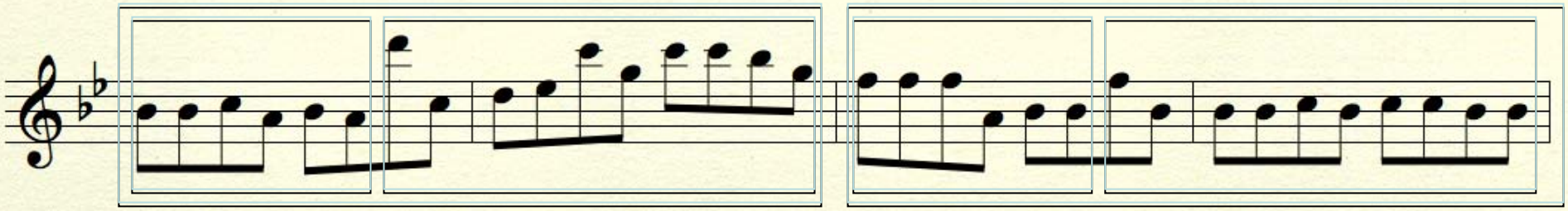
- The views, opinions, and findings contained in this presentation are those of the author and should not be construed as an official National Oceanic and Atmospheric Administration or U.S. Government position, policy, or decision.

What do these notes have to do with the ABI?



Progress!