Preparing Users for the Advanced Baseline Imager (ABI) on GOES-R

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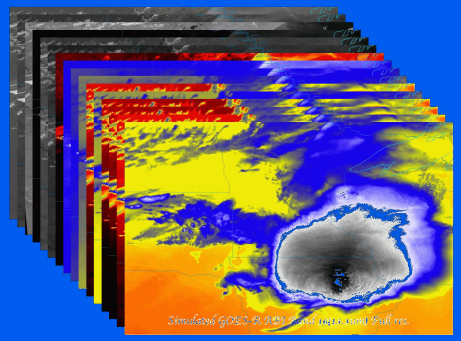
GOES-R Program Office (GPO)

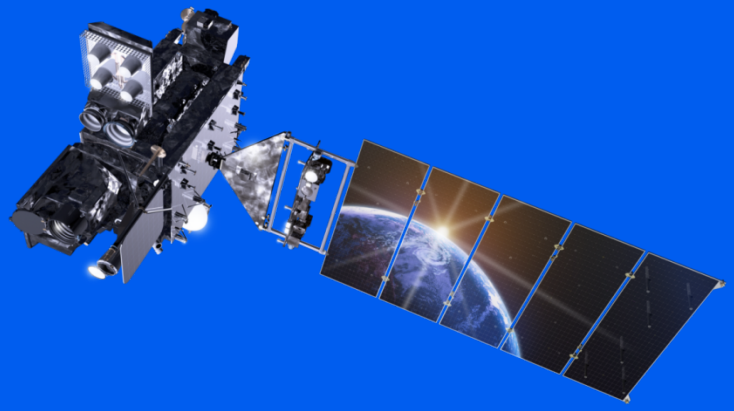


11th Annual Symposium on New Generation Operational Environmental Satellite Systems

January 6, 2015

Outline

- Background/Instrument
  - 8 to 16 spectral bands, scan options, etc.
- Simulations
  - triplets, WES, WRF Chem, NSSL-WRF



- Education/Training
  - COMET, VISIT, Weighting Functions, webapps, papers, conferences, web pages, short courses
- Other sensors
  - AVIRIS, MAS, MODIS, SEVIRI, VIIRS, AHI, and SRSOR (GOES-14)

ABI - 8

#	Wavelengths Range (μm)	Wavelengths Center	Description	Primary Use
1	0.52 – 0.72	**0.62**	Visible	Daytime clouds, fog
8	1.3 – 1.9	**1.6**	Near IR	Daytime clouds/snow, water/ice clouds
2	3.8 – 4.0	**3.9**	Shortwave IR	Nighttime low clouds, fog, fire detection
3	6.5 – 7.0	**6.75**	Water Vapor 1	Upper tropospheric flow, winds
6	7.0 – 7.5	**7.25**	Water Vapor 2	Mid tropospheric flow, winds
4	10.2 – 11.2	**10.7**	IR Window 3	Clouds, low-level water vapor, fog, winds
5	11.5 – 12.5	**12.0**	IR Window 4	Low-level water vapor, volcanic ash
7	13.2 – 13.8	**13.5**	Carbon Dioxide	Cloud-top parameters, heights for winds

ABI – circa 1999
(8 total bands, most spectrally wide)

ABI bands 1-6

Future GOES imager (ABI) band	Wavelength range (μm)	Central wavelength (μm)	Nominal subsatellite IGFOV (km)	Sample use	Heritage instrument(s)
1	0.45–0.49	0.47	1	Daytime aerosol over land, coastal water mapping	MODIS
2	0.59–0.69	0.64	0.5	Daytime clouds fog, inso-lation, winds	Current GOES imager/ sounder
3	0.846–0.885	0.865	1	Daytime vegetation/burn scar and aerosol over water, winds	VIIRS, spectrally modified AVHRR
4	1.371–1.386	1.378	2	Daytime cirrus cloud	VIIRS, MODIS
5	1.58–1.64	1.61	1	Daytime cloud-top phase and particle size, snow	VIIRS, spectrally modified AVHRR
6	2.225–2.275	2.25	2	Daytime land/cloud properties, particle size, vegetation, snow	VIIRS, similar to MODIS

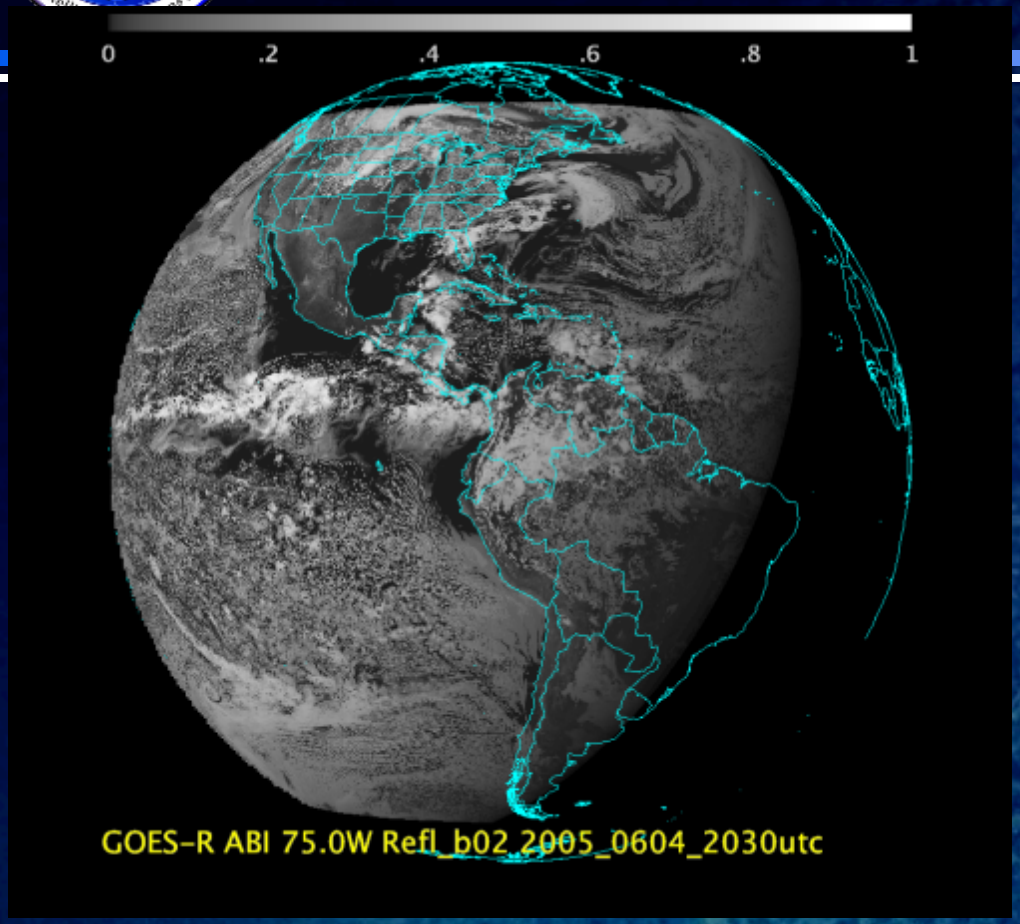
6 visible or near infrared bands on the ABI, compared to only one on today's imager

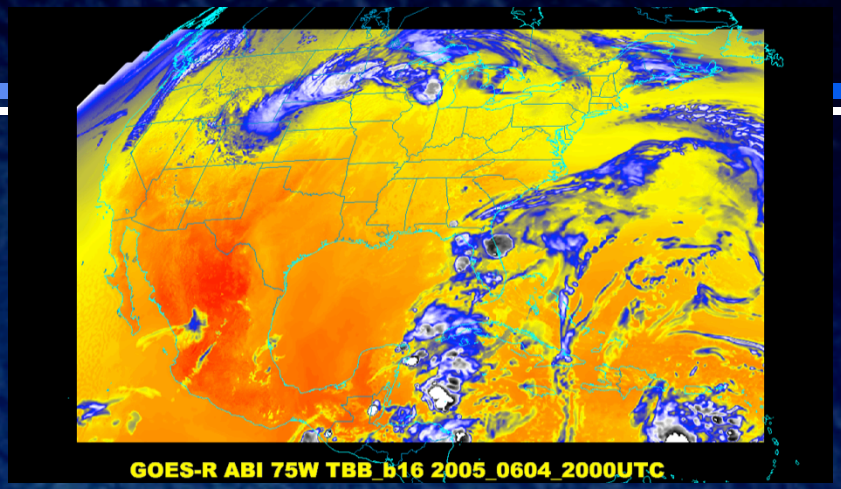
ABI bands 7-16

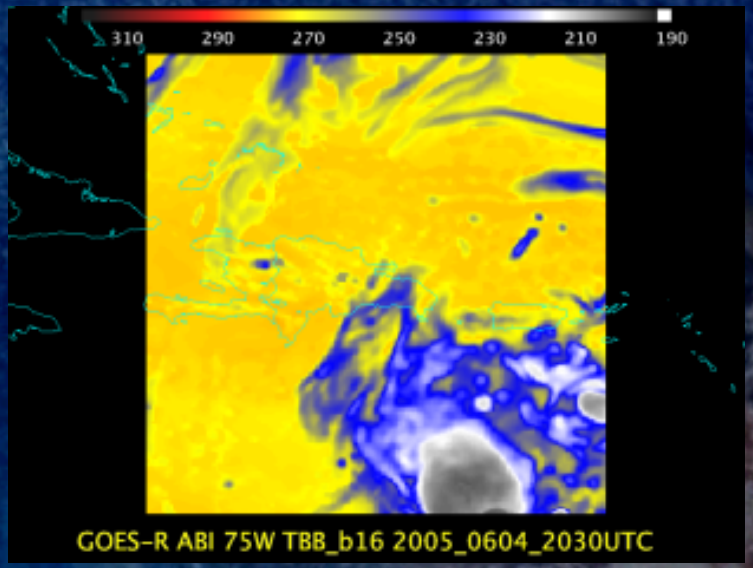
Future GOES imager (ABI) band	Wavelength range (μm)	Central wavelength (μm)	Nominal subsatellite IGFOV (km)	Sample use	Heritage instrument(s)
7	3.80–4.00	3.90	2	Surface and cloud, fog at night, fire, winds	Current GOES imager
8	5.77–6.6	6.19	2	High-level atmospheric water vapor, winds, rainfall	Current GOES imager
9	6.75–7.15	6.95	2	Midlevel atmospheric water vapor, winds, rainfall	Current GOES sounder
10	7.24–7.44	7.34	2	Lower-level water vapor, winds, and SO_2	Spectrally modified current GOES sounder
11	8.3–8.7	8.5	2	Total water for stability, cloud phase, dust, SO_2 rainfall	MAS
12	9.42–9.8	9.61	2	Total ozone, turbulence, and winds	Spectrally modified current sounder
13	10.1–10.6	10.35	2	Surface and cloud	MAS
14	10.8–11.6	11.2	2	Imagery, SST, clouds, rainfall	Current GOES sounder
15	11.8–12.8	12.3	2	Total water, ash, and SST	Current GOES sounder
16	13.0–13.6	13.3	2	Air temperature, cloud heights and amounts	Current GOES sounder/ *GOES-12+* imager

10 infrared bands on the ABI, compared to four on today's imager

Baseline ABI Scan Modes







Scan mode (3) or 'flex mode' for the ABI:
- Full disk every 15 minutes + 5 min CONUS
  + 1-min mesoscales (2 locations).

[Scan mode (4) or 'Continuous Full Disk' (CFD) is a full disk every 5 min]

Baseline Mode 3 “Time-Time” chart

Time	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29		
0		L			B				064 Star				064 Star				IR Star									Meso 1 -1			Meso 1 -2			
30						L		Full Disk Swath 1																		Meso 2 -1			Meso 2 -2			
60					L			Full Disk Swath 2							IR Star											Meso 3 -1			Meso 3 -2			
90				L				Full Disk Swath 3							064 Star				064 Star							Meso 4 -1			Meso 4 -2			
120			L					Full Disk Swath 4										CONUS 1 - Swath 1								Meso 5 -1			Meso 5 -2			
150				L				Full Disk Swath 5										CONUS 1 - Swath 2								Meso 6 -1			Meso 6 -2			
180			L					Full Disk Swath 6										CONUS 1 - Swath 3								Meso 7 -1			Meso 7 -2			
210			L					Full Disk Swath 7										CONUS 1 - Swath 4								Meso 8 -1			Meso 8 -2			
240		L						Full Disk Swath 8										CONUS 1 - Swath 5								Meso 9 -1			Meso 9 -2			
270		L						Full Disk Swath 9										CONUS 1 - Swath 6								Meso 10 -1			Meso 10 -2			
300		L						Full Disk Swath 10									064 Star				064 Star					Meso 11 -1			Meso 11 -2			
330		L						Full Disk Swath 11									064 Star				064 Star					Meso 12 -1			Meso 12 -2			
360		L						Full Disk Swath 12												IR Star						Meso 13 -1			Meso 13 -2			
390		L						Full Disk Swath 13									064 Star				064 Star					Meso 14 -1			Meso 14 -2			
420		L						Full Disk Swath 14										CONUS 2 - Swath 1								Meso 15 -1			Meso 15 -2			
450		L						Full Disk Swath 15										CONUS 2 - Swath 2								Meso 16 -1			Meso 16 -2			
480			L					Full Disk Swath 16										CONUS 2 - Swath 3								Meso 17 -1			Meso 17 -2			
510			L					Full Disk Swath 17										CONUS 2 - Swath 4								Meso 18 -1			Meso 18 -2			
540				L				Full Disk Swath 18										CONUS 2 - Swath 5								Meso 19 -1			Meso 19 -2			
570				L				Full Disk Swath 19										CONUS 2 - Swath 6								Meso 20 -1			Meso 20 -2			
600				L				Full Disk Swath 20							064 Star				064 Star							Meso 21 -1			Meso 21 -2			
630					L			Full Disk Swath 21							064 Star				064 Star							Meso 22 -1			Meso 22 -2			
660						L		Full Disk Swath 22							IR Star											Meso 23 -1			Meso 23 -2			
690		L						IR Star					IR Star													Meso 24 -1			Meso 24 -2			
720		L		064 Star				064 Star										CONUS 3 - Swath 1								Meso 25 -1			Meso 25 -2			
750		L																CONUS 3 - Swath 2								Meso 26 -1			Meso 26 -2			
780		L																CONUS 3 - Swath 3								Meso 27 -1			Meso 27 -2			
810		L		064 Star				064 Star										CONUS 3 - Swath 4								Meso 28 -1			Meso 28 -2			
840		L																CONUS 3 - Swath 5								Meso 29 -1			Meso 29 -2			
870		L																CONUS 3 - Swath 6								Meso 30 -1			Meso 30 -2			

“White space” represents time the instrument is not scanning.
Mode 3 is the ‘flex’ mode.

Covers 15 minutes

Baseline Time-Time Mode 4

Time	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
0		L			B				064 Star				IR Star							L	Full Disk Swath 1						L			
30	Full Disk Swath 2						L	Full Disk Swath 3									L	Full Disk Swath 4										L		
60	Full Disk Swath 5										L		Full Disk Swath 6											L	Full Disk Swath 7					
90								L	Full Disk Swath 8														064 Star				L			
120	Full Disk Swath 9										L	Full Disk Swath 10														L				
150	FulL Disk Swath 11										L	Full Disk Swath 12													L					
180	Full Disk Swath 13										L	Full Disk Swath 14												L		Full Disk Swath 15				
210									064 Star				L	Full Disk Swath 16													L			
240	Full Disk Swath 17										L			Full Disk Swath 18									L					Full Disk Swath 19		
270						L		Full Disk Swath 20								L		Full Disk Swath 21						L		Full Disk Swath 22				
300		L			B				064 Star				IR Star							L	Full Disk Swath 1						L			
330	Full Disk Swath 2						L	Full Disk Swath 3									L	Full Disk Swath 4										L		
360	Full Disk Swath 5										L		Full Disk Swath 6											L	Full Disk Swath 7					
390								L	Full Disk Swath 8														064 Star				L			
420	Full Disk Swath 9										L	Full Disk Swath 10														L				
450	FulL Disk Swath 11										L	Full Disk Swath 12													L					
480	Full Disk Swath 13										L	Full Disk Swath 14												L		Full Disk Swath 15				
510									064 Star				L	Full Disk Swath 16													L			
540	Full Disk Swath 17										L			Full Disk Swath 18									L					Full Disk Swath 19		
570						L		Full Disk Swath 20								L		Full Disk Swath 21						L		Full Disk Swath 22				
600		L			B				064 Star				IR Star							L	Full Disk Swath 1						L			
630	Full Disk Swath 2						L	Full Disk Swath 3									L	Full Disk Swath 4										L		
660	Full Disk Swath 5										L		Full Disk Swath 6											L	Full Disk Swath 7					
690								L	Full Disk Swath 8														064 Star				L			
720	Full Disk Swath 9										L	Full Disk Swath 10														L				
750	FulL Disk Swath 11										L	Full Disk Swath 12													L					
780	Full Disk Swath 13										L	Full Disk Swath 14												L		Full Disk Swath 15				
810									064 Star				L	Full Disk Swath 16													L			
840	Full Disk Swath 17										L			Full Disk Swath 18									L					Full Disk Swath 19		
870						L		Full Disk Swath 20								L		Full Disk Swath 21						L		Full Disk Swath 22				

This is the Continuous Full Disk (every 5 min) mode

Covers 15 minutes

Exploratory ABI Scan Modes

At some point, other ABI scan mode could be possible. Although, this requires an upgrade to the ground system.

- The ABI instrument is capable of supporting other scan modes.

Use the ‘white space’ (or idle time) of when the ABI instrument is not scanning in mode 3 (‘flex’):

– increase to an ‘extended (larger) CONUS’ image.

or

– Consider a full disk scan every 10 min, along with CONUS and meso-scale sectors. (under study)

– This would sync with the geo global constellation (EUMETSAT, AHI, AMI, AGRI, etc.).

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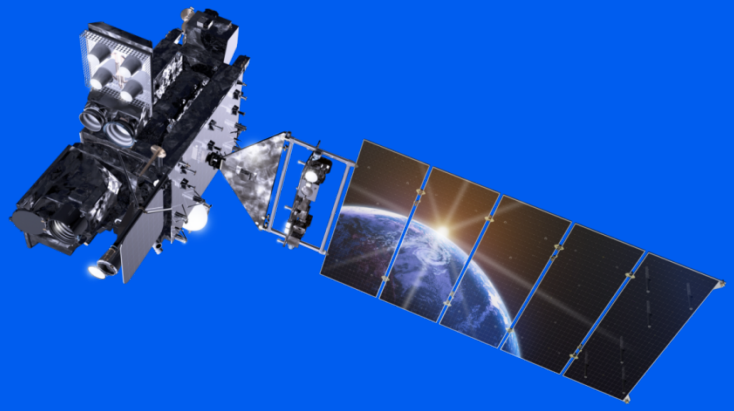

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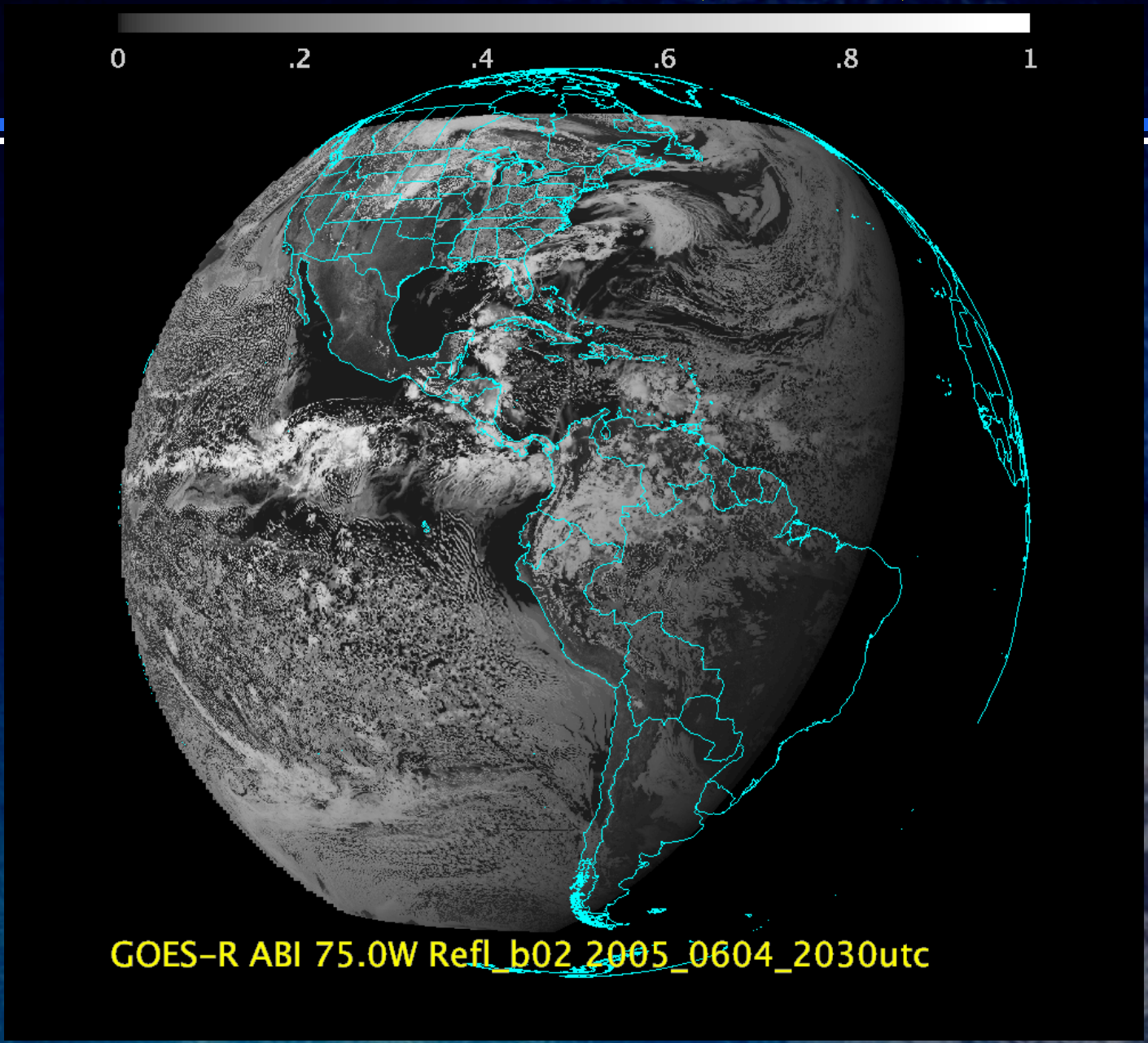
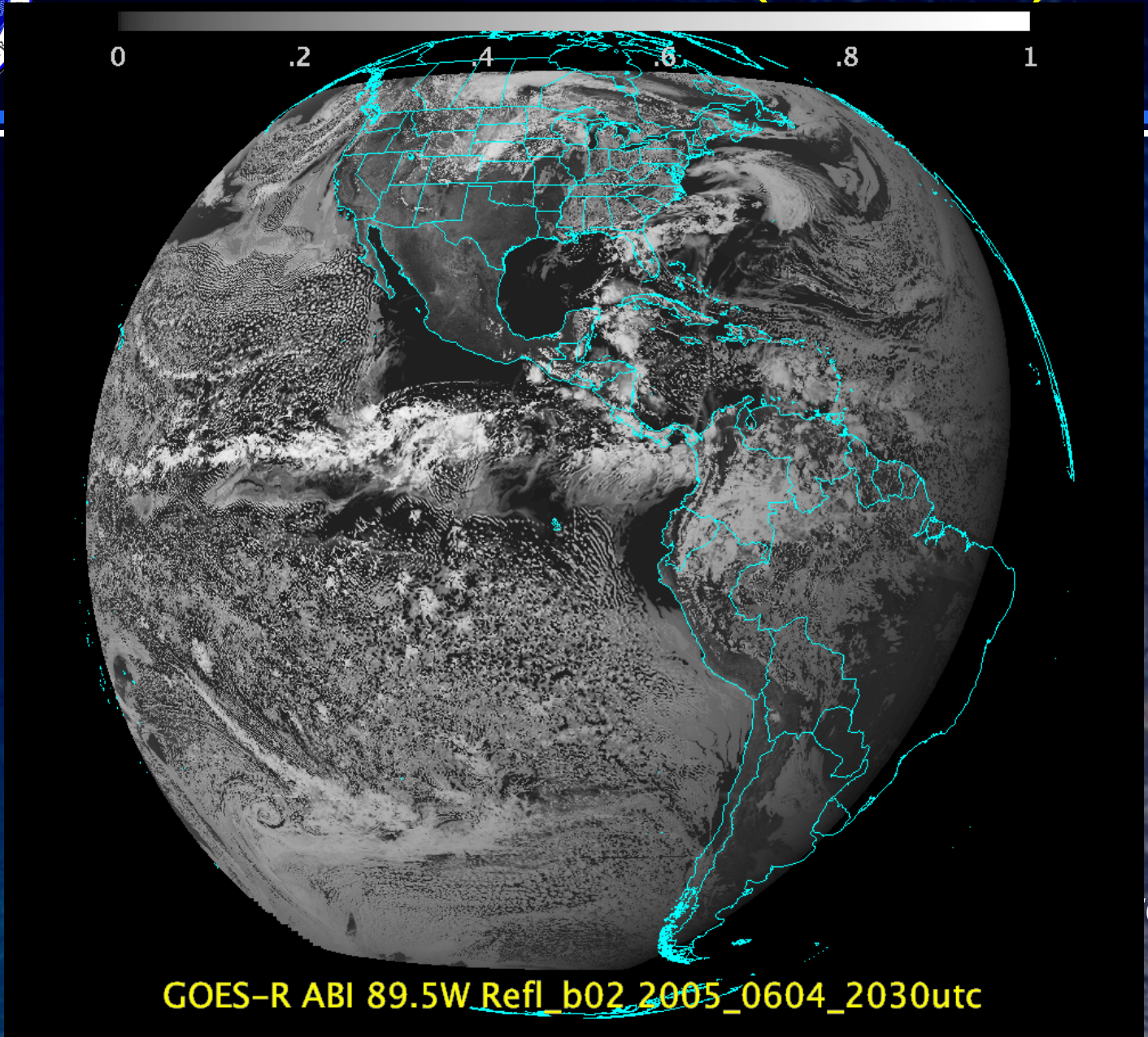
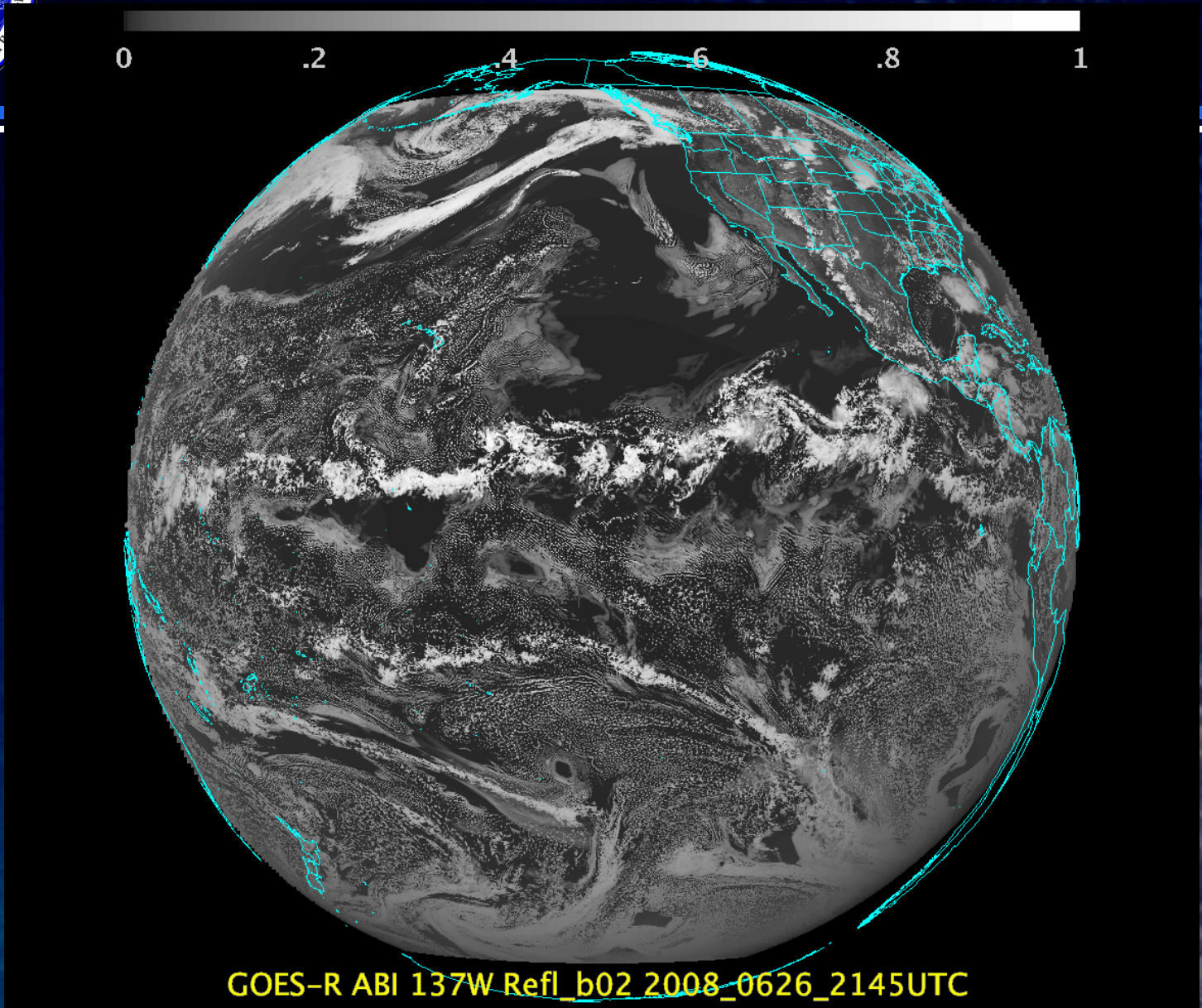
In ABI FGF (75W)



In ABI FGF (89.5W)

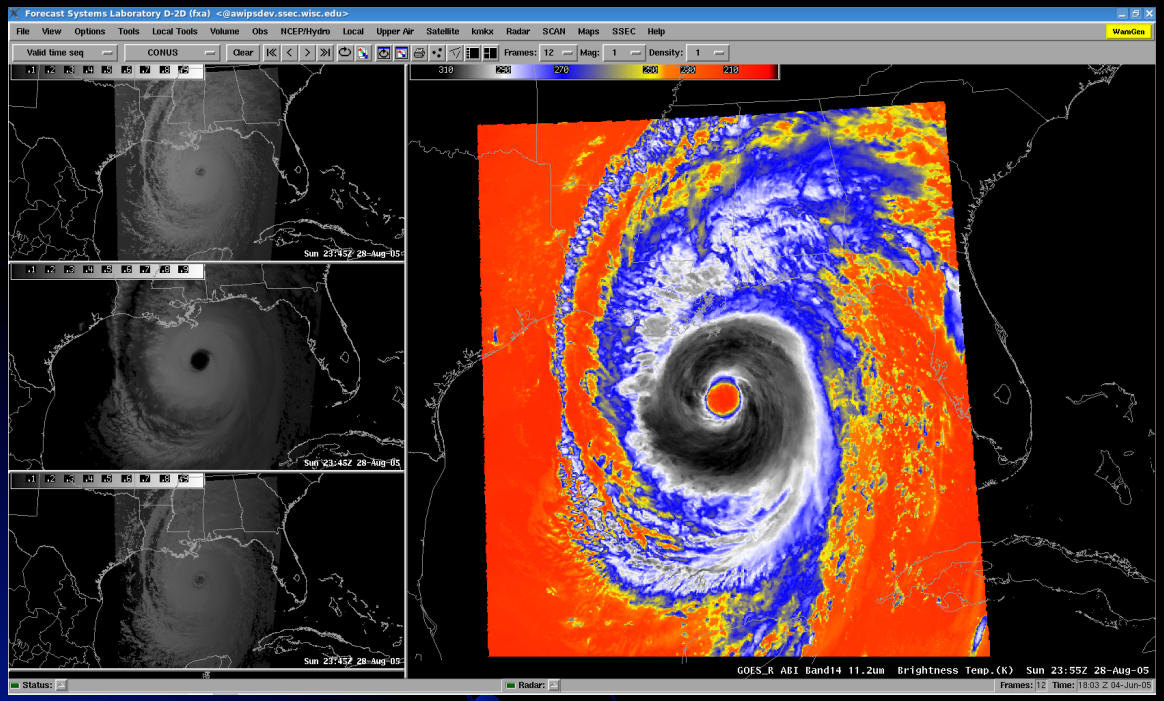


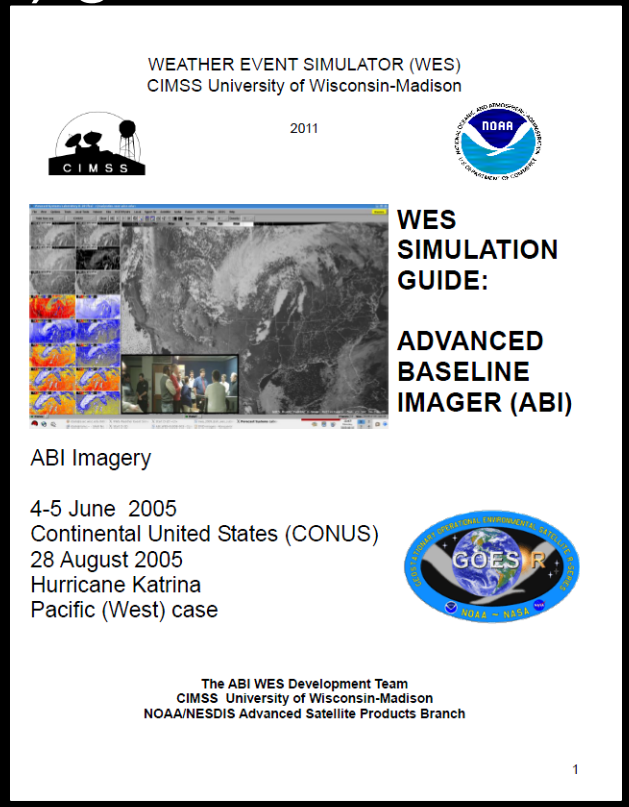
In ABI FGF (137W)



ABI WES

- Contains simulated ABI for all bands for a June-2006 convective storm (CONUS and mesoscale), Hurricane Katrina, band differences, a WES (Weather Event Simulator) guide, etc.




WEATHER EVENT SIMULATOR (WES)
CIMSS University of Wisconsin-Madison

2011

WES SIMULATION GUIDE:

ADVANCED BASELINE IMAGER (ABI)

ABI Imagery

4-5 June 2005
Continental United States (CONUS)
28 August 2005
Hurricane Katrina
Pacific (West) case

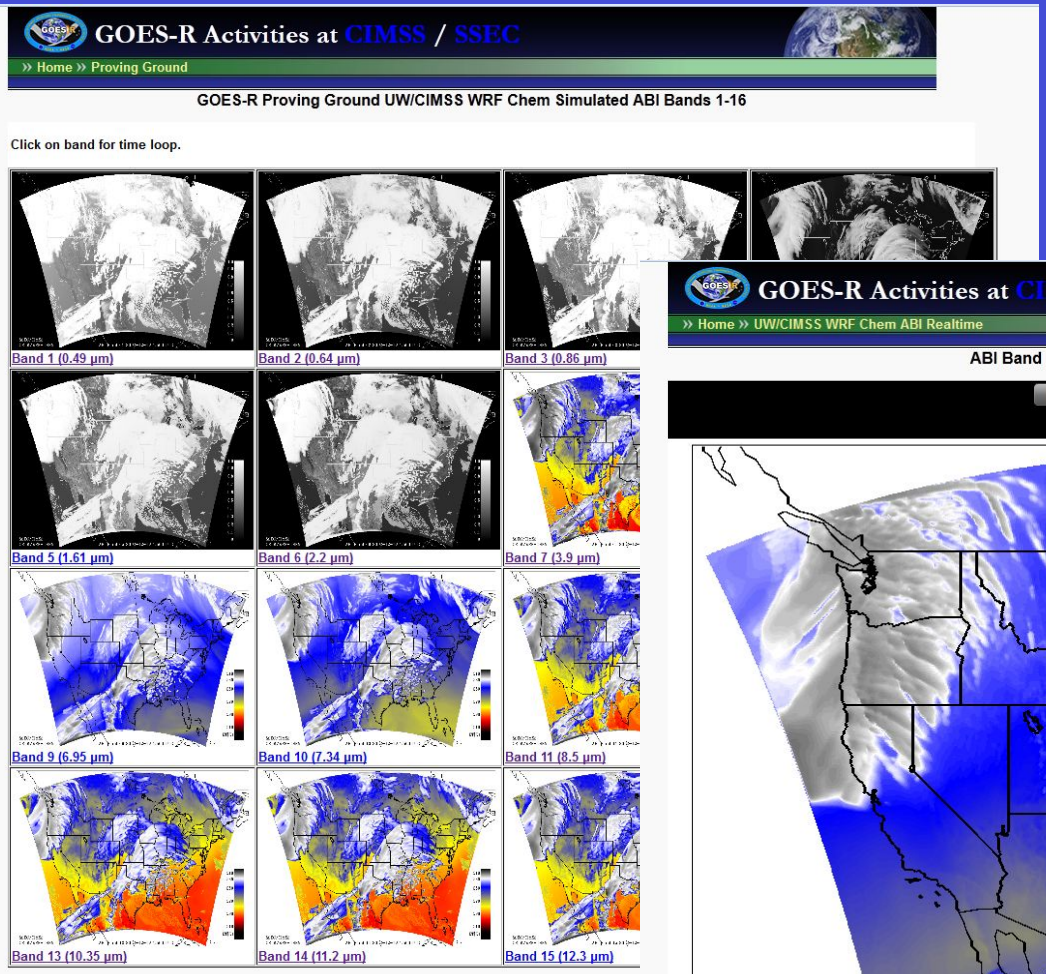
The ABI WES Development Team
CIMSS University of Wisconsin-Madison
NOAA/NESDIS Advanced Satellite Products Branch

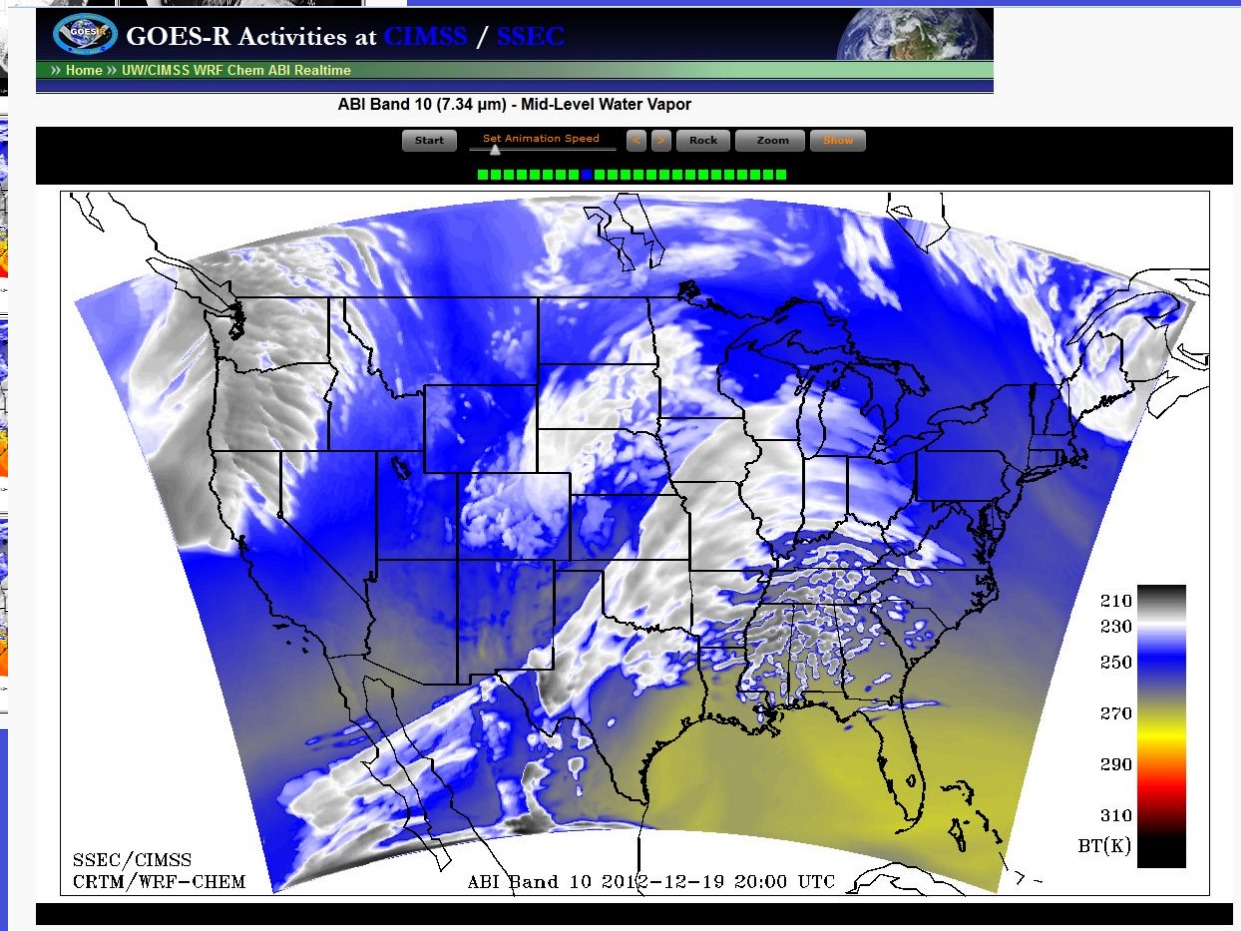
1

http://cimss.ssec.wisc.edu/goes/abi/loops/WES_for_GOES-R_ABI_2011_Version.pdf

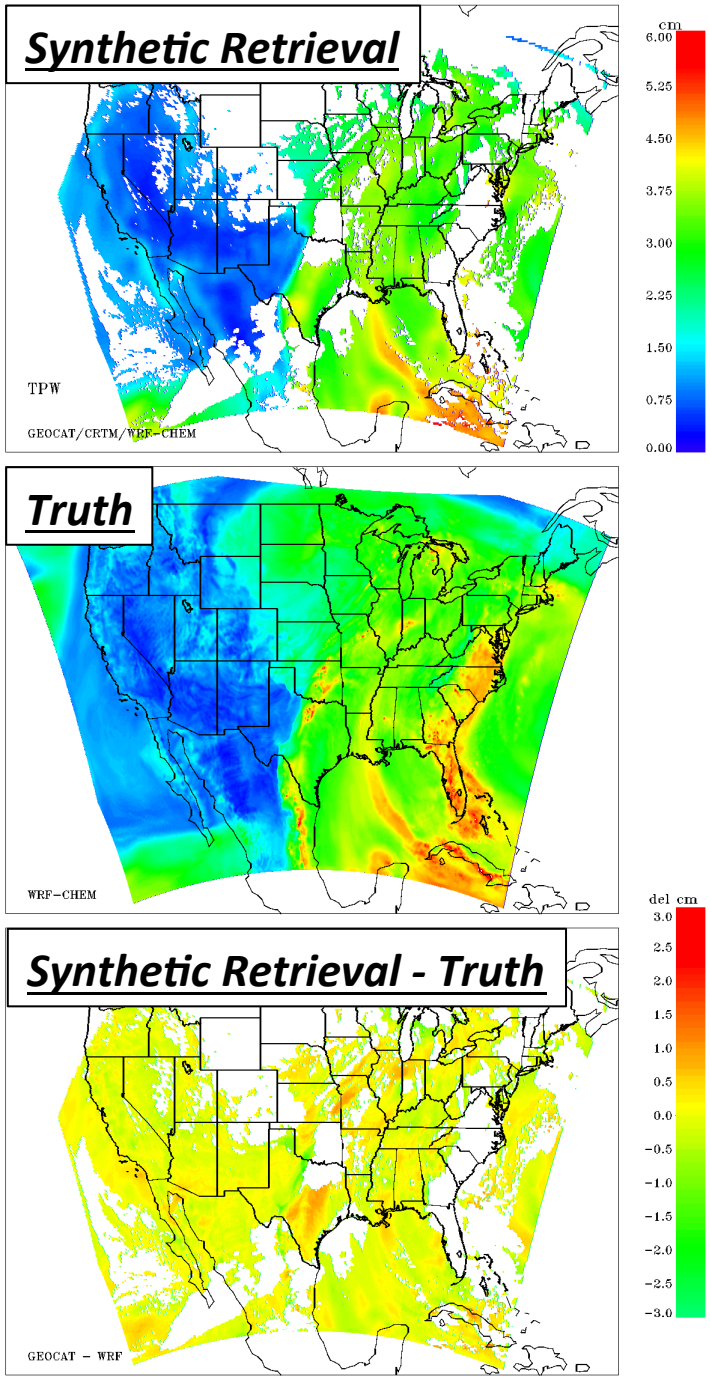
Near Realtime WRF Chem ABI runs

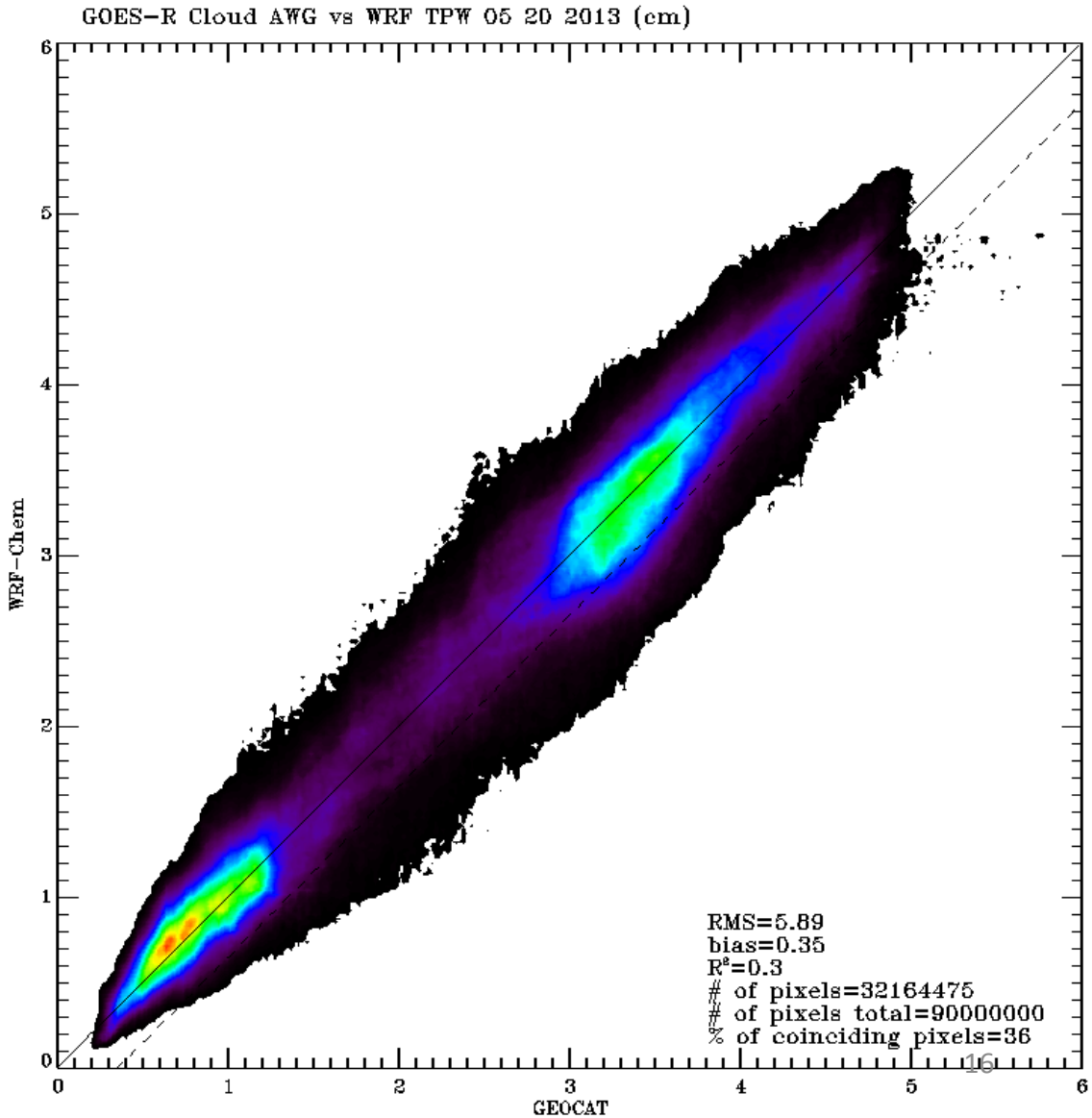
- http://cimss.ssec.wisc.edu/goes_r/proving-ground/wrf_chem_abi/wrf_chem_abi.html





Total Precip Water (TPW) Validation





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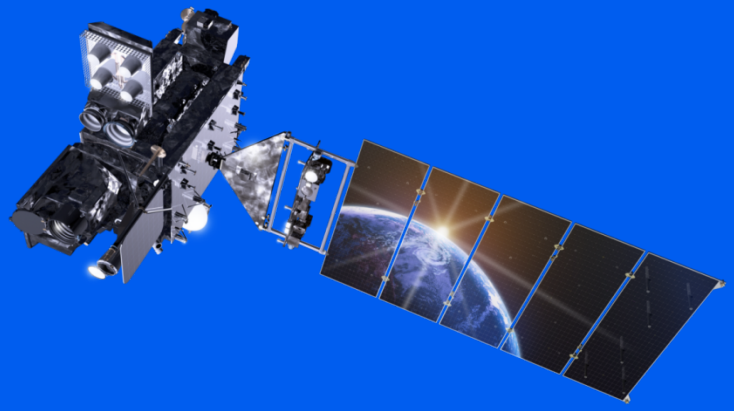

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http://cimss.ssec.wisc.edu/wxfest/

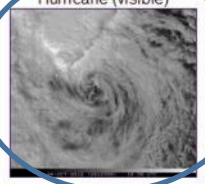
CIMSS ASPB Satellite Appl

cimss.ssec.wisc.edu/goes/applets/overview.html

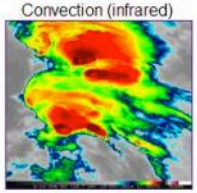
Satellite Activities to explore the effects that *time and spatial resolutions* can have when interpreting satellite images

Please note that all the applets on these pages use HTML5 and require an up-to-date browser!
These are also "touch-friendly" and should run on mobile devices.

Hurricane (visible)

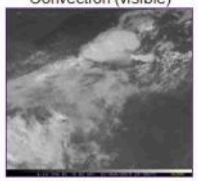


Convection (infrared)

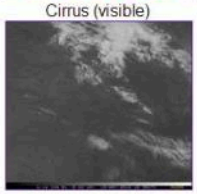


Fires (shortwave window)

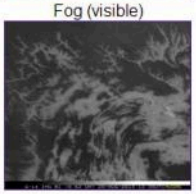
Convection (visible)



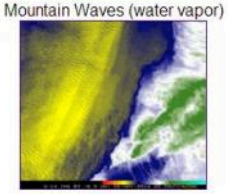
Cirrus (visible)



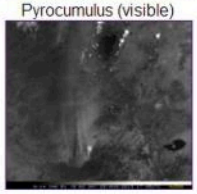
Fog (visible)



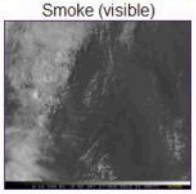
Mountain Waves (water vapor)



Pyrocumulus (visible)



Smoke (visible)



These cases each allow one to change the temporal spacing as well as the spatial resoultion for a series of satellite images.

Other Sites

Many weather related *applets*
GOES-R *web page*
Other *Rapid Scan imagery* from GOES-14

CIMSS *Satellite blog* from GOES-14

Unless otherwise noted, all these applets are Copyright© 2013 by Tom Whittaker at the University of Wisconsin-Madison. Many animations provided by Tim Schmit, NOAA NESDIS.

http://cimss.ssec.wisc.edu/goes/applets/overview.html

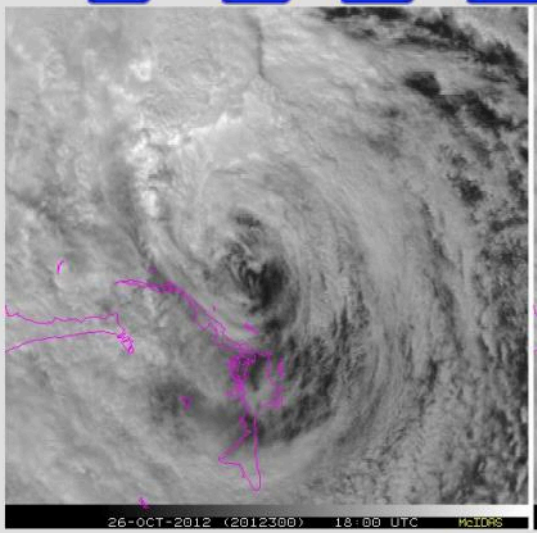
Explore the effect of time

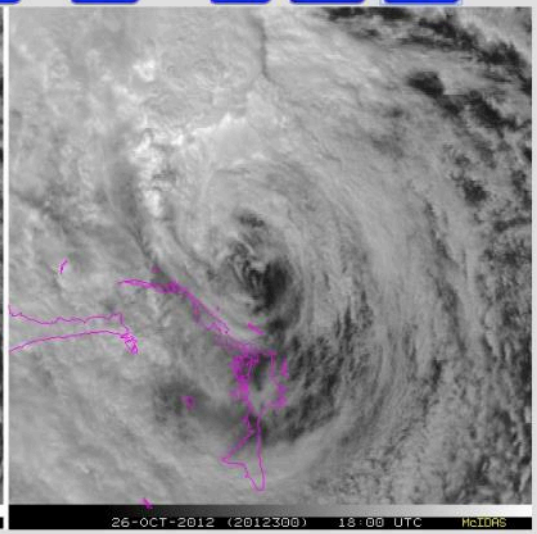
cimss.ssec.wisc.edu/goes/applets/satsquash_sandy_vis.html

Hurricane *Sandy* Visible GOES Imagery

Explore the effects that time and spatial resolutions can have when interpreting satellite images

- Res | 1:1 | + Res | - Time | 4 | + Time | Reset | Loop | < Step | Step >





***Changeable* imagery** **GOES-R like (temporal) imagery**

Can you get the hurricane to appear to rotate the other way (anticyclonic)? *(Hint: use the + Time button)*

Controls:

- **- Res** decreases the resolution; that is, fewer pixels cover the same geographic region, providing less detail.
- **+ Res** increases the resolution; that is, more pixels cover the same geographic region, providing more detail.
- **- Time** decreases the time interval between images, in effect providing images more often.
- **+ Time** increases the time interval between images, thus providing images less often.
- **Reset** resets the *resolution* and *time* increments to the default values.
- **Pause/Loop** will stop and start the animation (looping).
- **< Step** steps one time step backward (this will stop the animation if it is running)
- **> Step** steps one time step forward (stopping the animation if it is running)

NOAA Satellites and Information
National Environmental Satellite, Data, and Information Service

SSEC CIMSS

Main GOES-14 1-minute SRSOR 'explore the effects of time and space' web page

Special GOES-

This applet is C

http://cimss.ssec.wisc.edu/goes/applets/overview.html

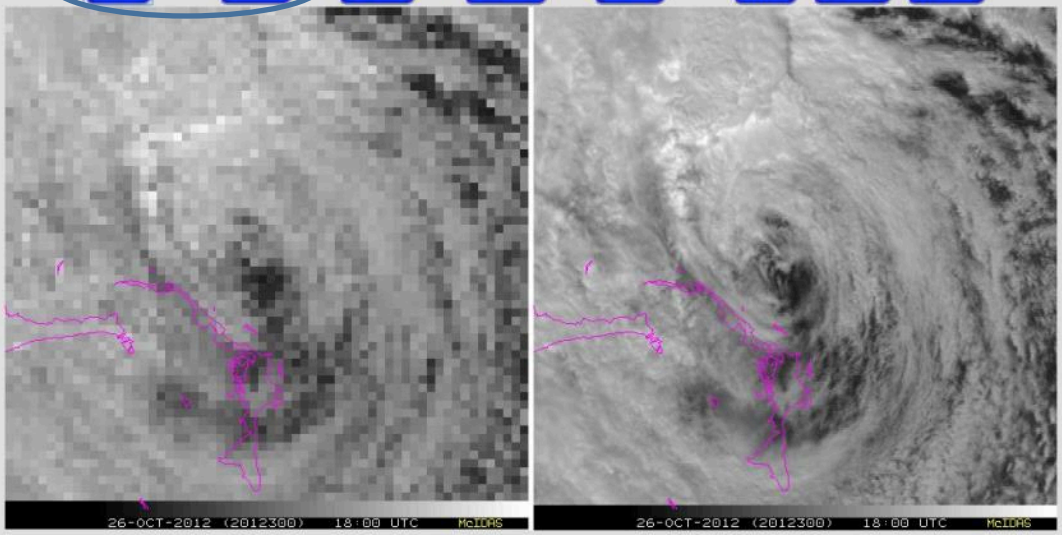
Explore the effect of time

cimss.ssec.wisc.edu/goes/applets/satsquash_sandy_vis.html

Hurricane *Sandy* Visible GOES Imagery

Explore the effects that time and spatial resolutions can have when interpreting satellite images

- Res | 1:8 | + Res | - Time | 4 | + Time | Reset | Loop | < Step | Step >



***Changeable* imagery** **GOES-R like (temporal) imagery**

Can you get the hurricane to appear to rotate the other way (anticyclonic)? *(Hint: use the + Time button)*

Controls:

- - **Res** decreases the resolution; that is, fewer pixels cover the same geographic region, providing less detail.
- + **Res** increases the resolution; that is, more pixels cover the same geographic region, providing more detail.
- - **Time** decreases the time interval between images, in effect providing images more often.
- + **Time** increases the time interval between images, thus providing images less often.
- **Reset** resets the *resolution* and *time* increments to the default values.
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File Edit View History Bookmarks Tools Help

CIMSS ASPB Satellite Applets

cimss.ssec.wisc.edu/goes/webapps/bandapp/ove

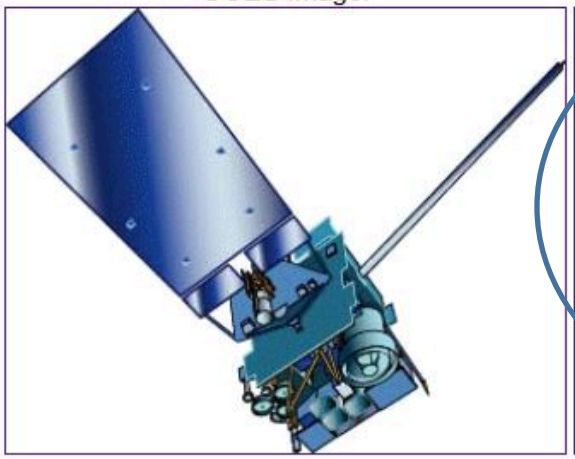
http://cimss.ssec.wisc.edu/goes/webapps/bandapp/overview.html

Satellite Band Webapp

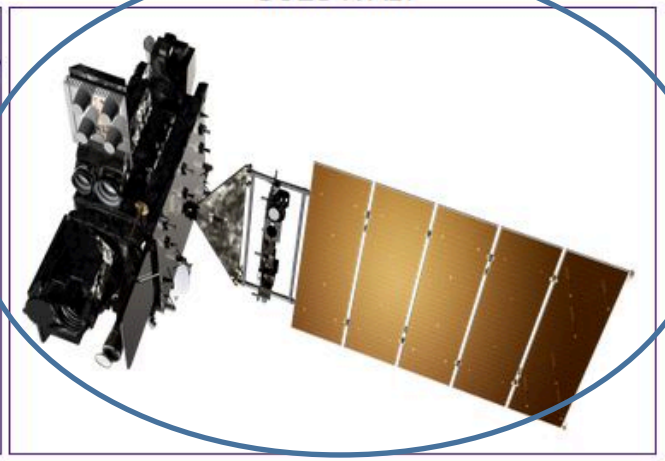
Please note that all the applets on these pages use HTML5 and require an up-to-date browser!
These are also "touch-friendly" and should run on mobile devices.

Explore the information of different bands / channels from a satellite

GOES Imager



GOES-R ABI



This webapp allows one to explore, via an interactive graph, the different spectral bands for satellites.

Related Links

Information about the *GOES Imager*
Many weather related *Webapps*
GOES-R *web page*
Other *Realtime geo satellite imagery* from around the world

CIMSS *Webapp* regarding pixel resolutions

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File Edit View History Bookmarks Tools Help

CIMSS ASPB Satellite Applets

cimss.ssec.wisc.edu/goes/webapps/bandapp/ove

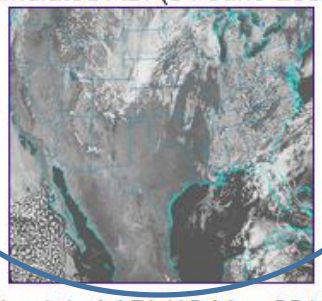
http://cimss.ssec.wisc.edu/goes/webapps/bandapp/overview.html

GOES-R ABI Satellite Band Webapp

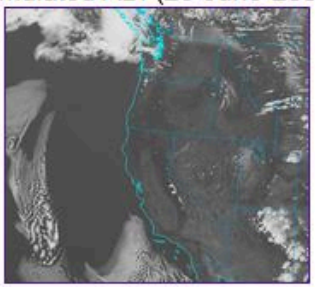
Please note that all the applets on these pages use HTML5 and require an up-to-date browser!
These are also "touch-friendly" and should run on mobile devices.

Explore the information of different bands / channels from a satellite

Simulated ABI (04-June-2005)

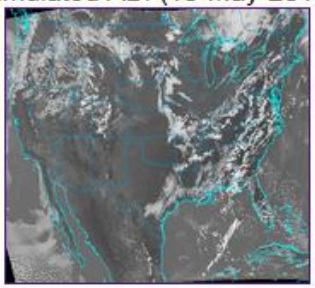


Simulated ABI (26-June-2008)

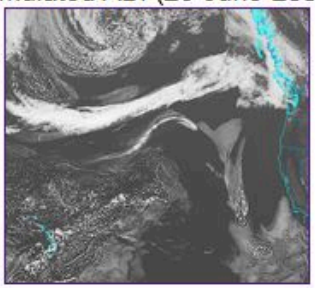


Simulated ABI (11-May-2014)

Simulated ABI (10-May-2014)



Simulated ABI (26-June-2008)



This webapp allows one to explore the different spectral bands for satellites, in this case the ABI on GOES-R.

Related Links

Information about the *GOES-R ABI*

Many weather related *Webapps*

GOES-R *web page*

Other *Realtime geo satellite imagery* from around the world

File Edit View History Bookmarks Tools Help

Explore the effect of time and s...

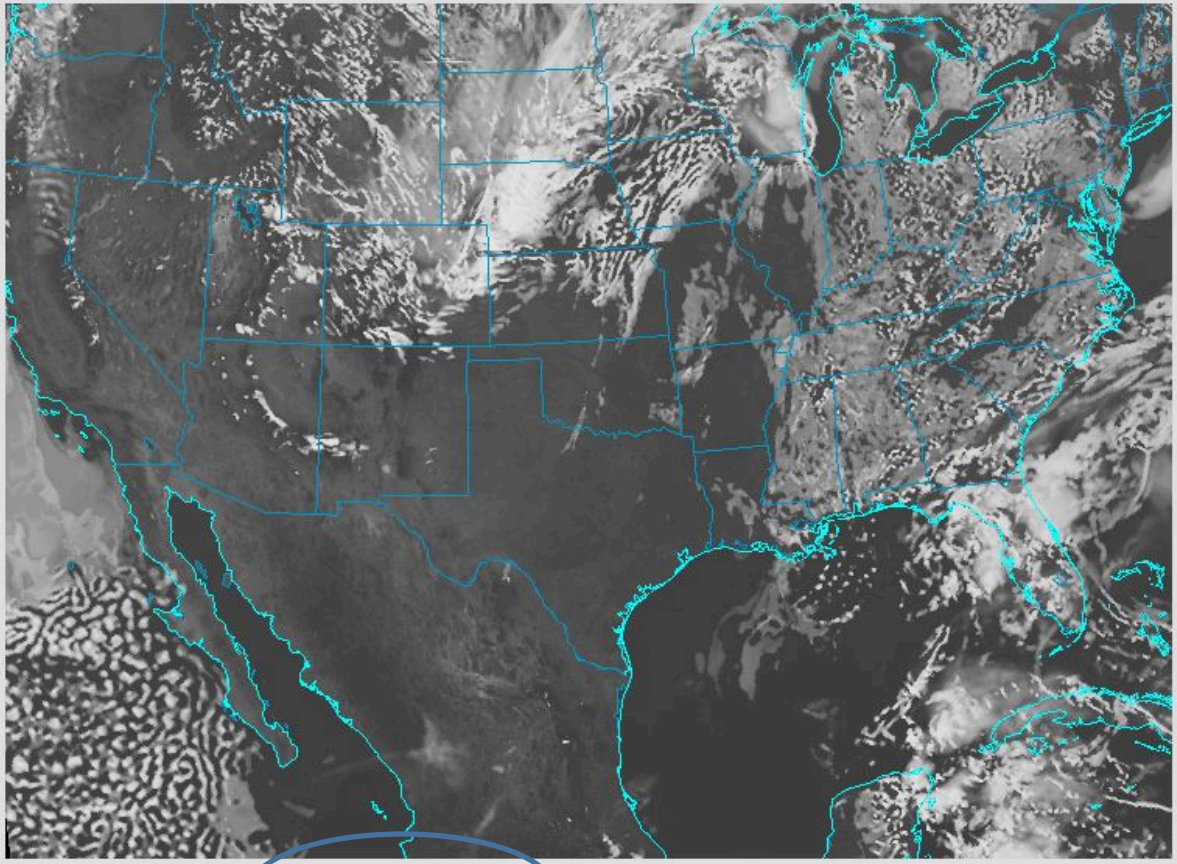
cimss.ssec.wisc.edu/goes/webapps/bandapp/im

http://cimss.ssec.wisc.edu/goes/webapps/bandapp/overview.html

Simulated GOES-R Advanced Baseline Imager Bands

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Visible (0.47 µm): 'Blue' band, Cloud and surface features during the day, smoke, etc.



Show Interactive Chart | Map Off | Show Annotation

Band	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
µm	0.47	0.64	0.86	1.37	1.6	2.2	3.9	6.2	7.0	7.4	8.4	9.6	10.33	11.2	12.3	13.3

Notes

File Edit View History Bookmarks Tools Help

Explore the effect of time and s...

cimss.ssec.wisc.edu/goes/webapps/bandapp/im

http://cimss.ssec.wisc.edu/goes/webapps/bandapp/overview.html

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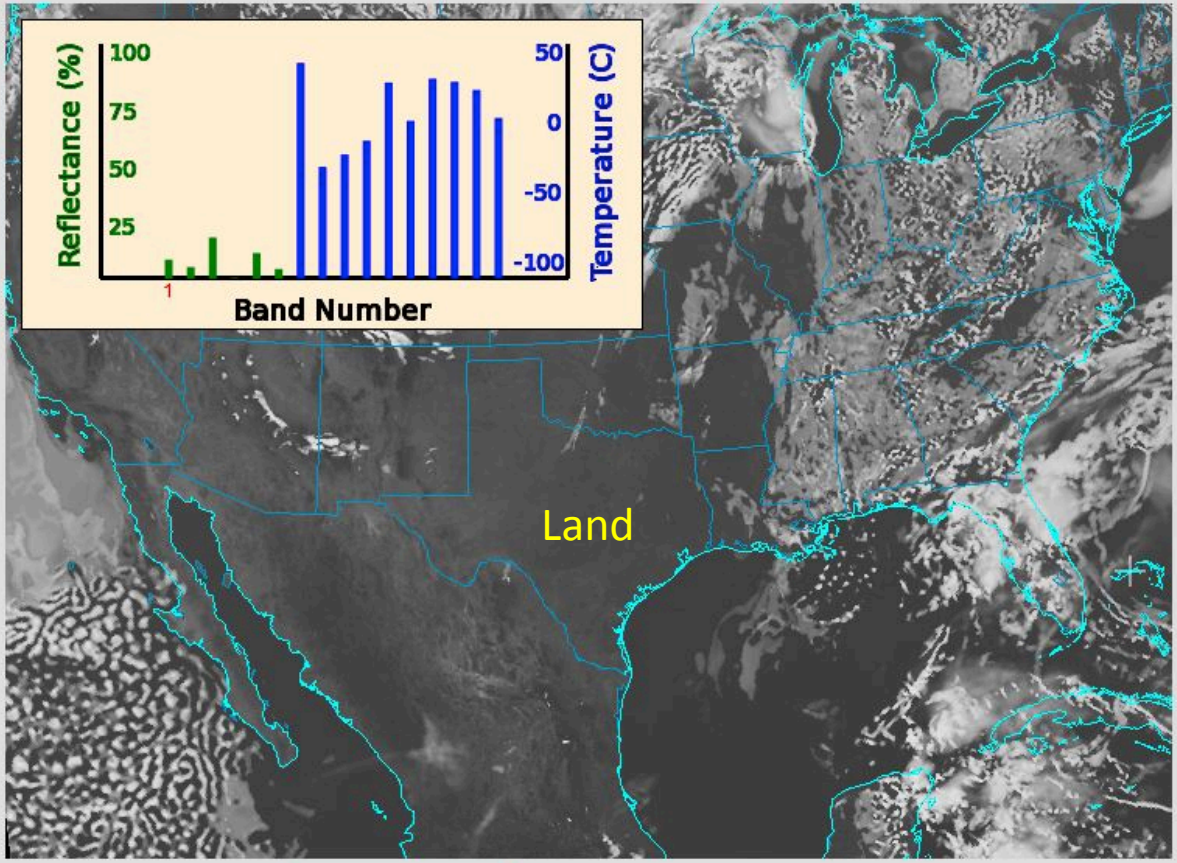

Hide Interactive Chart | Map Off | Show Annotation

Band	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
µm	0.47	0.64	0.86	1.37	1.6	2.2	3.9	6.2	7.0	7.4	8.4	9.6	10.33	11.2	12.3	13.3

Notes

File Edit View History Bookmarks Tools Help

Explore the effect of time and s...

cimss.ssec.wisc.edu/goes/webapps/bandapp/im

http://cimss.ssec.wisc.edu/goes/webapps/bandapp/overview.html

Simulated GOES-R Advanced Baseline Imager Bands

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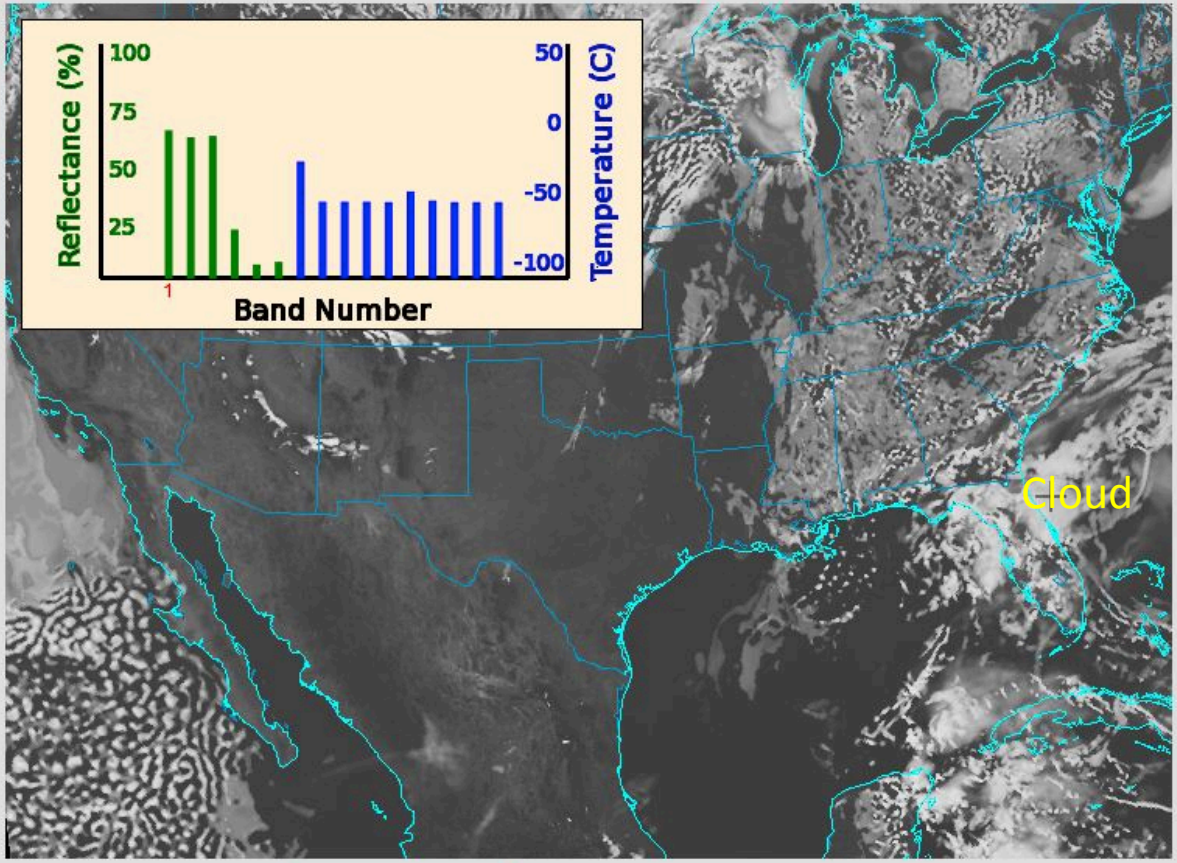
Visible (0.47 µm): 'Blue' band, Cloud and surface features during the day, smoke, etc.



Hide Interactive Chart | Map Off | Show Annotation

Band	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
µm	0.47	0.64	0.86	1.37	1.6	2.2	3.9	6.2	7.0	7.4	8.4	9.6	10.33	11.2	12.3	13.3

Notes

ABI Band Fact Sheets

http://www.goes-r.gov/education/ABI-bands-quick-info.html

GOES-R ABI Fact Sheet Band 1 ("Blue" visible)

The "need to know" Advanced Baseline Imager reference guide for the NWS forecaster

Above: Simulated image of ABI band 1 for Hurricane Katrina. This image was simulated via a combination of high spatial resolution numerical model runs and advanced 'forward' radiative transfer models. (Credit: CIMSS)

In a nutshell

GOES-R ABI Band 1 (0.47 µm central, 0.45 µm to 0.49 µm)

Also Himawari-8/9 AHI Band 1, Suomi NPP VIIRS Band M2

New for GOES-R Series, not available on current GOES

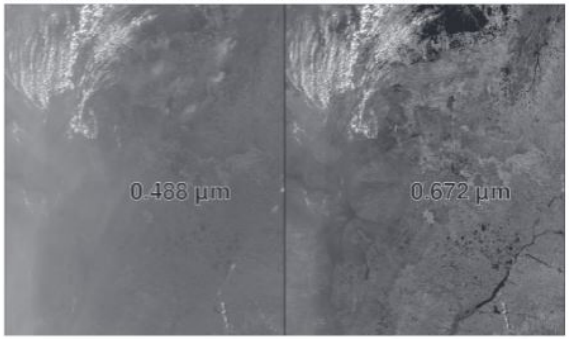
Nickname: "Blue" visible band

Availability: Daytime only

Primary purpose: Aerosols

Uses similar to: GOES-R ABI Band 2

The 0.47 µm, or "blue" band, one of the two visible bands on the ABI, will provide data for monitoring aerosols. Included on NASA's MODIS and Suomi NPP VIIRS instruments, there have been a number of well-established benefits with this band. The geostationary 0.47 µm band will provide nearly continuous daytime observations of dust, haze, smoke and clouds. Measurements of aerosol optical depths (AOD) will help air quality monitoring and tracking. This blue band, combined with a green band (which will be simulated from other bands and/or sensors) and a red band (0.64 µm), can provide "simulated natural color" imagery of the Earth. Measurements in the blue band may provide estimates of visibility. The 0.47 µm band will also be useful for air pollution studies and improve numerous products that rely on clear-sky radiances (such as land and sea surface products). Other potential uses are related to solar insolation estimates. This band is essential for a natural 'true color' RGB. *Source: Schmit et al., 2005 in BAMS and the ABI Weather Event Simulator (WES) Guide by CIMSS.*



Suomi NPP images of similar 'blue' (left-hand side) and 'red' (right-hand side) visible bands. Note how the smoke is more apparent in the 0.488 micrometer band. The image is over part of South America (August 23, 2014). Image from CIMSS.

Did You Know? There are two baseline scan modes from the ABI. The first is the 'flex' mode that consists of a full disk scan every 15 minutes, a continental U.S. (CONUS) image every 5 minutes, and two mesoscale (nominally 1,000 km by 1,000 km) images every minute. The second mode, Continuous Full Disk (CFD), consists of only a sequential Full Disk scan every 5 minutes.

New band introduced each month.

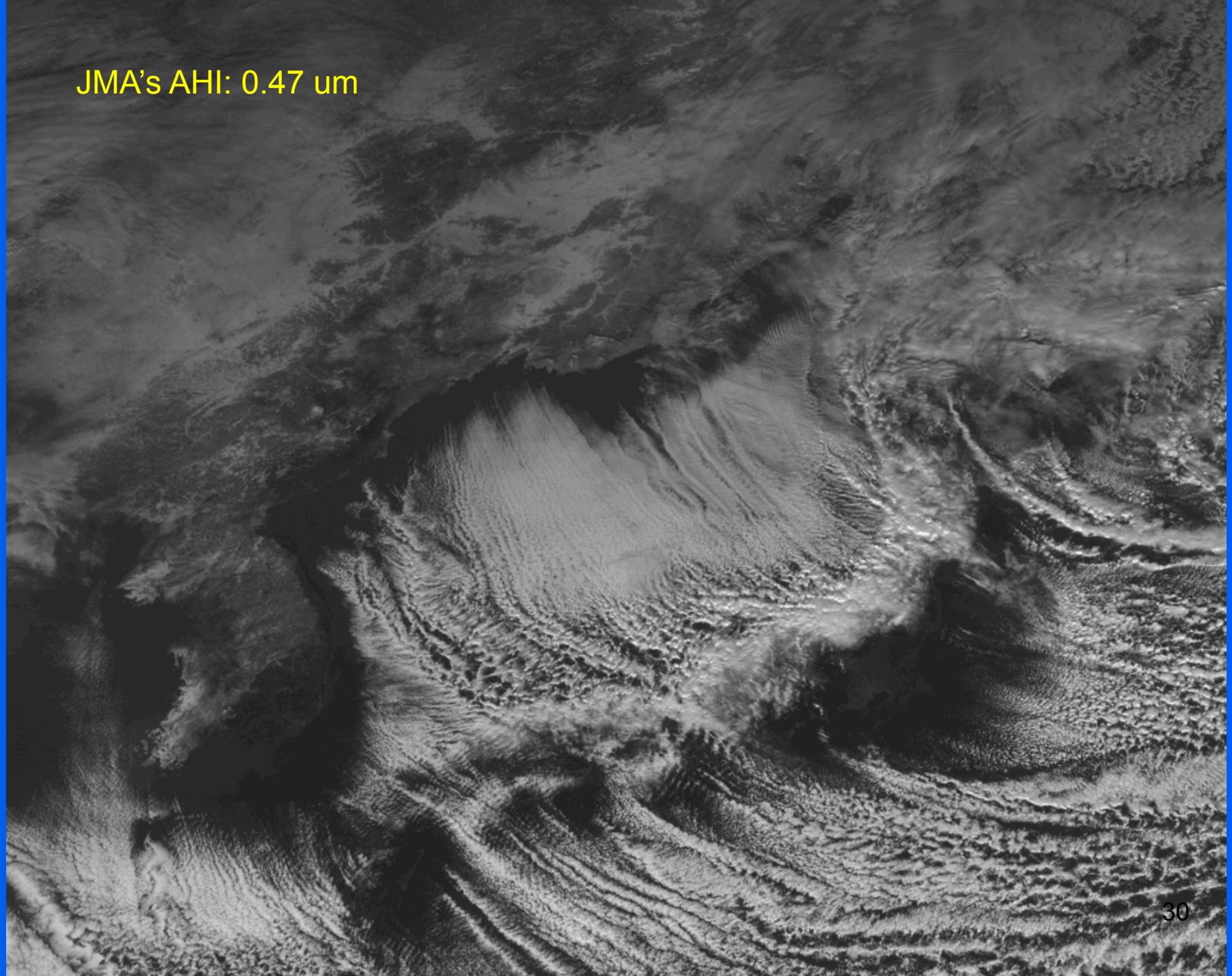
Outline

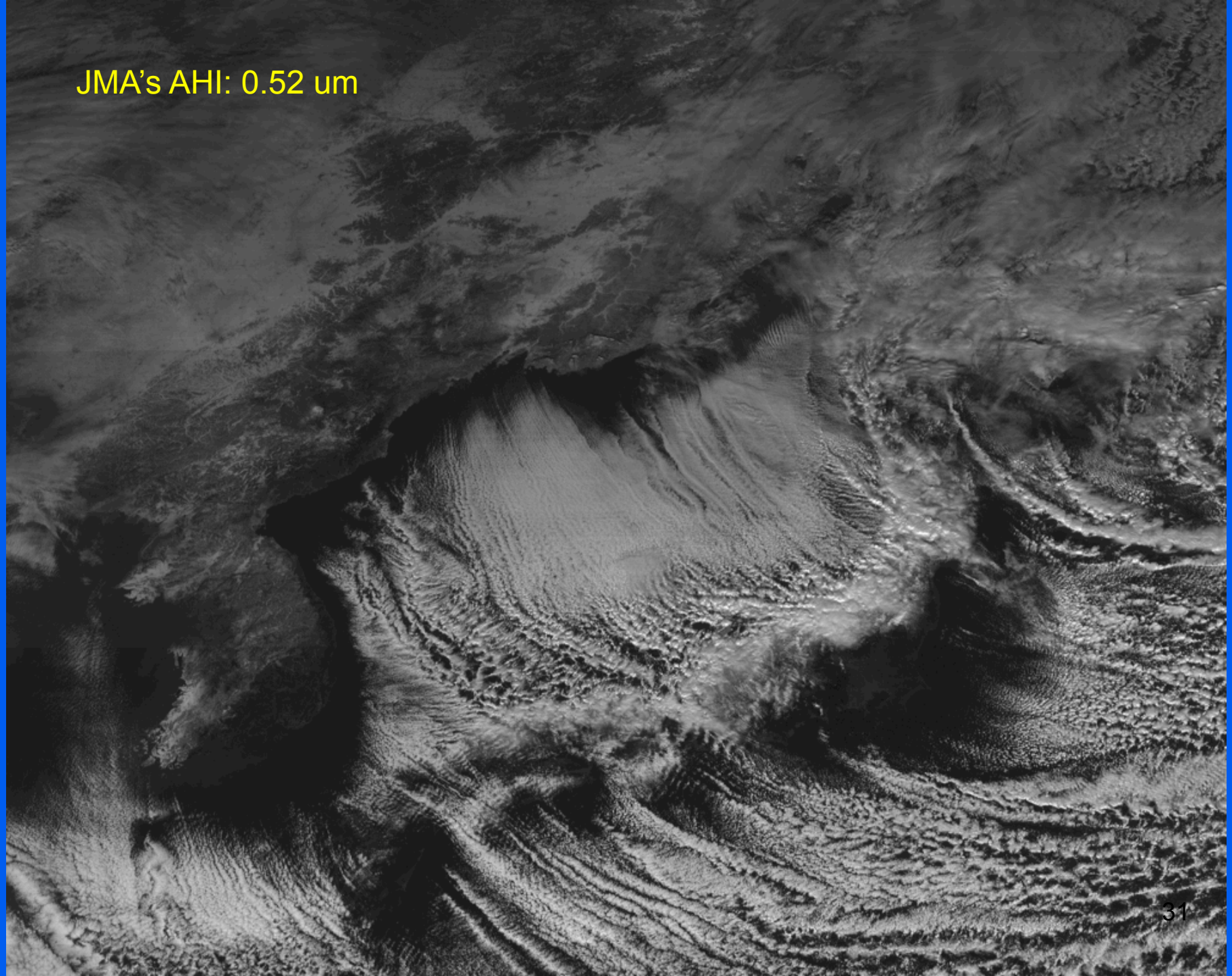
- Background/Instrument
  - 8 to 16 spectral bands, scan options, etc.
- Simulations
  - triplets, WES, WRF Chem, NSSL-WRF

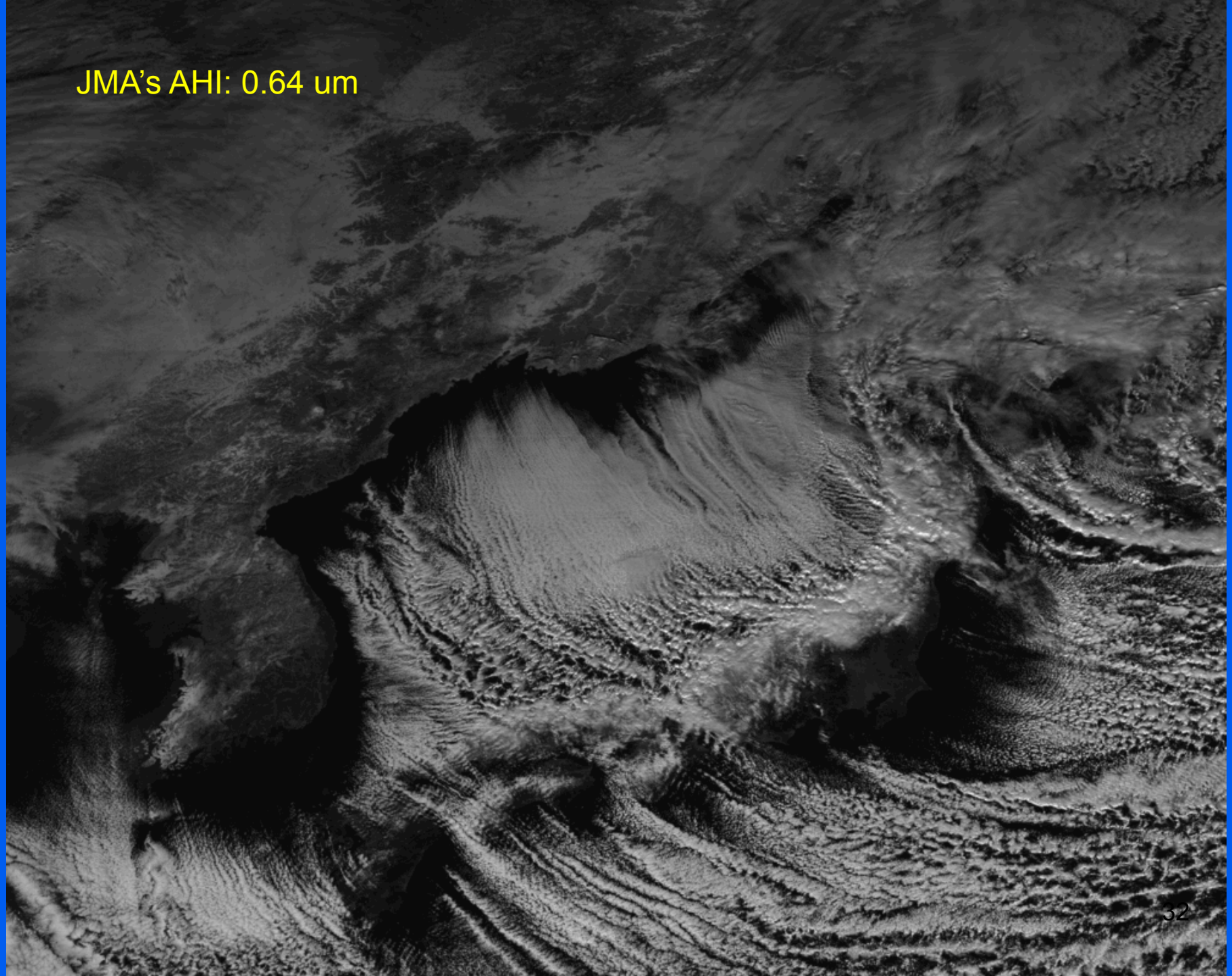
- Education/Training
  - COMET, VISIT, Weighting Functions, webapps, papers, conferences, web pages, short courses
- Other sensors
  - AVIRIS, MAS, MODIS, SEVIRI, VIIRS, AHI, and SRSOR (GOES-14)

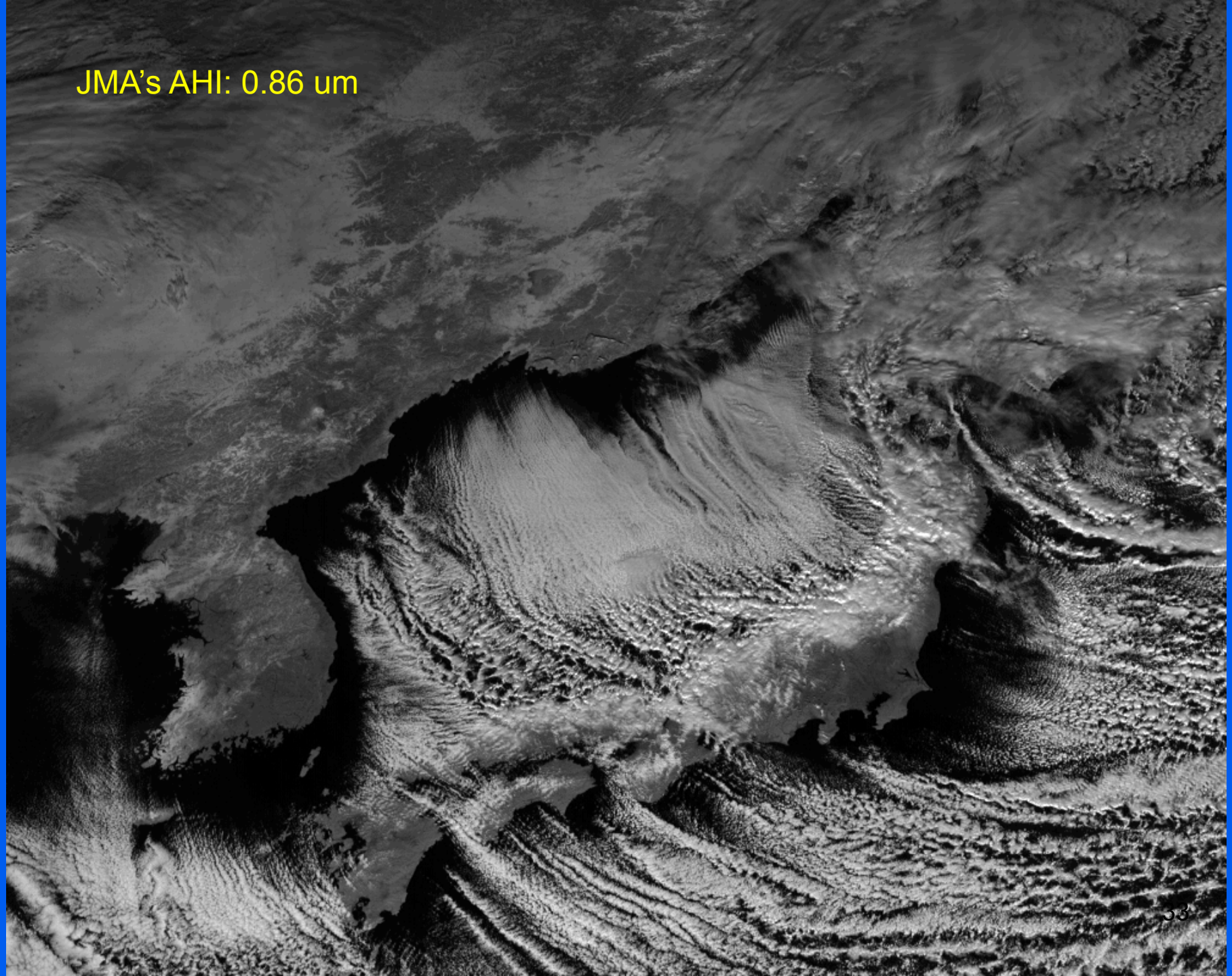
MODIS Airborne Simulator (MAS)
April 26, 1996

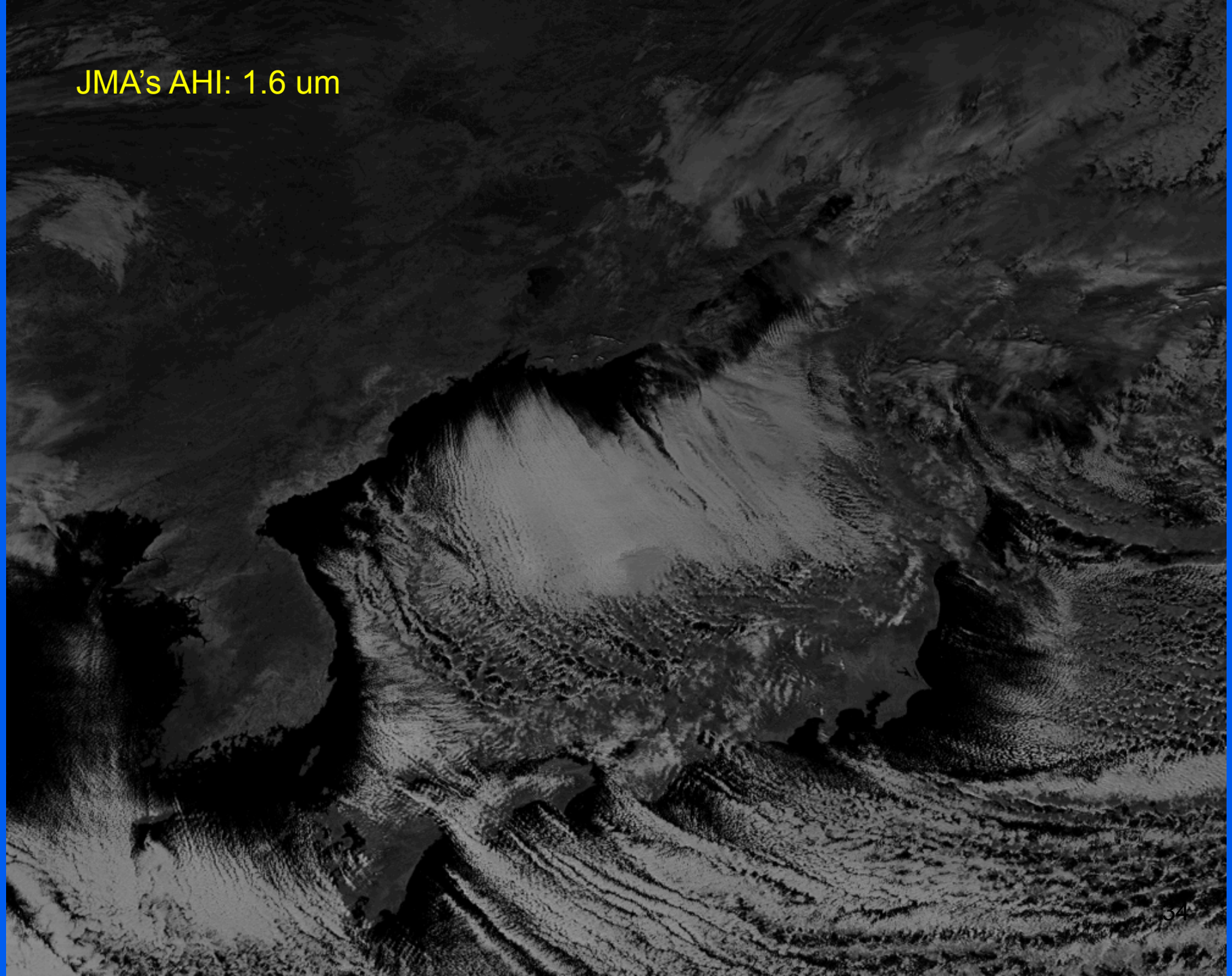
Note the cirrus clouds in the center image

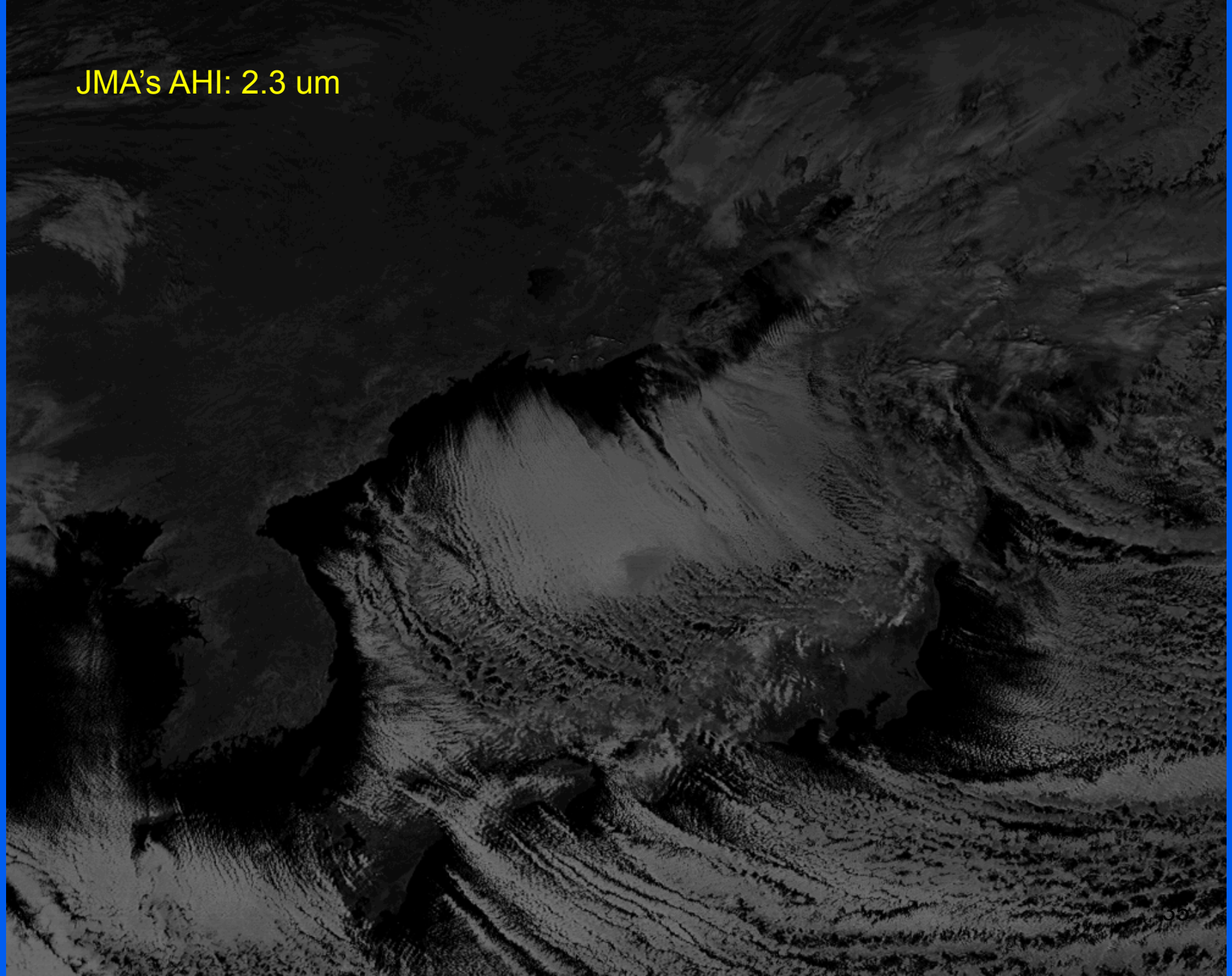

JMA's AHI: 0.47 um

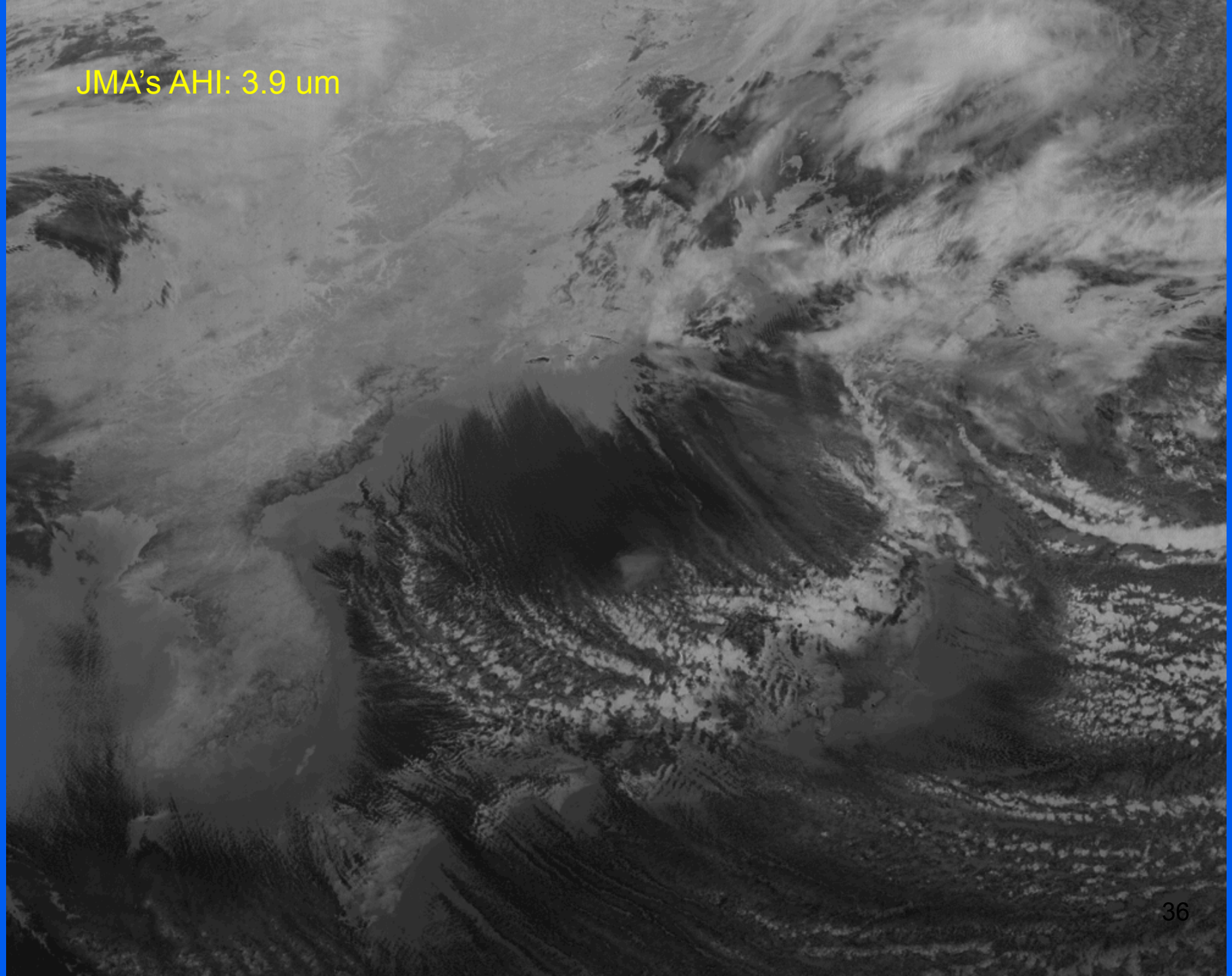

JMA's AHI: 0.52 um

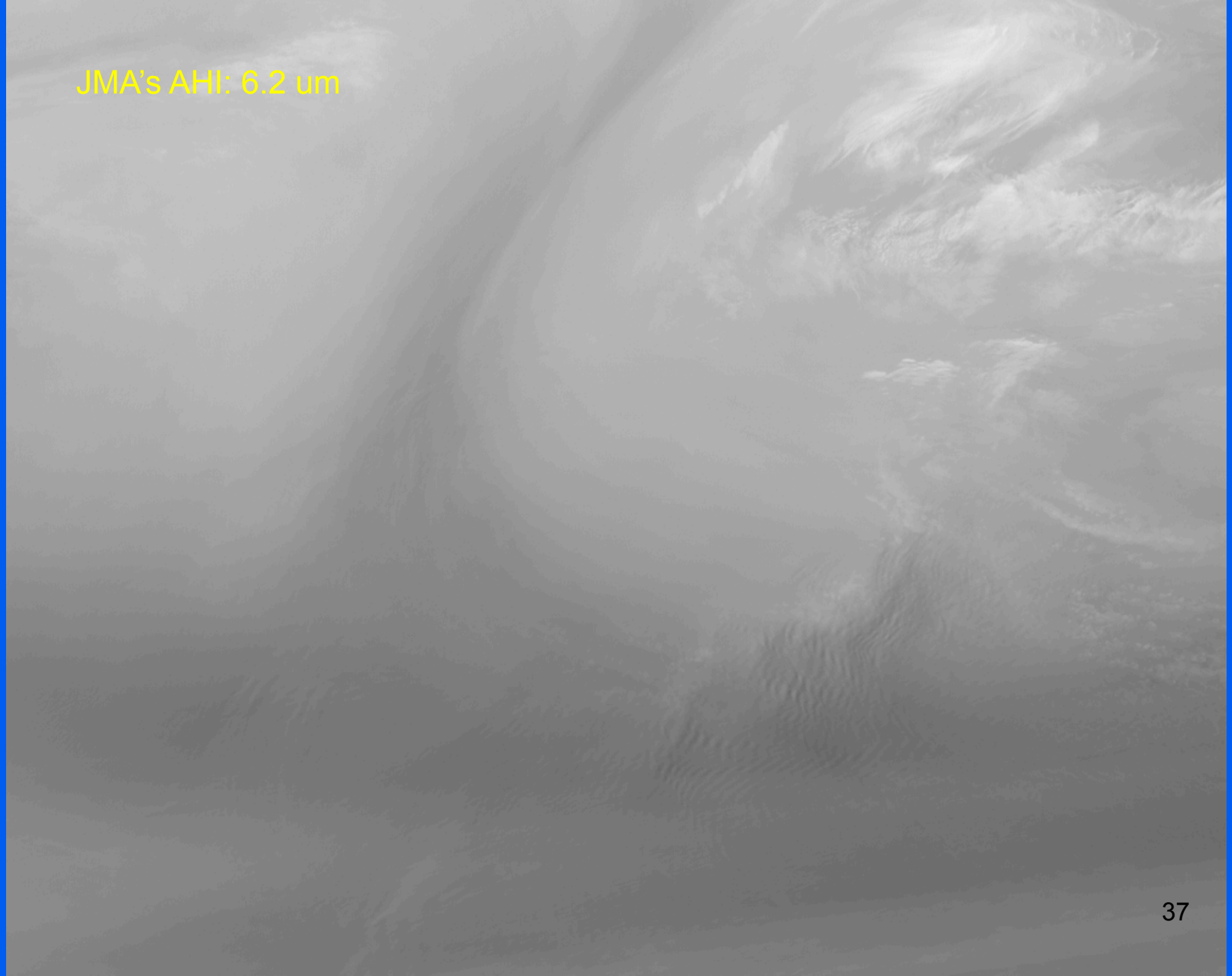

JMA's AHI: 0.64 um

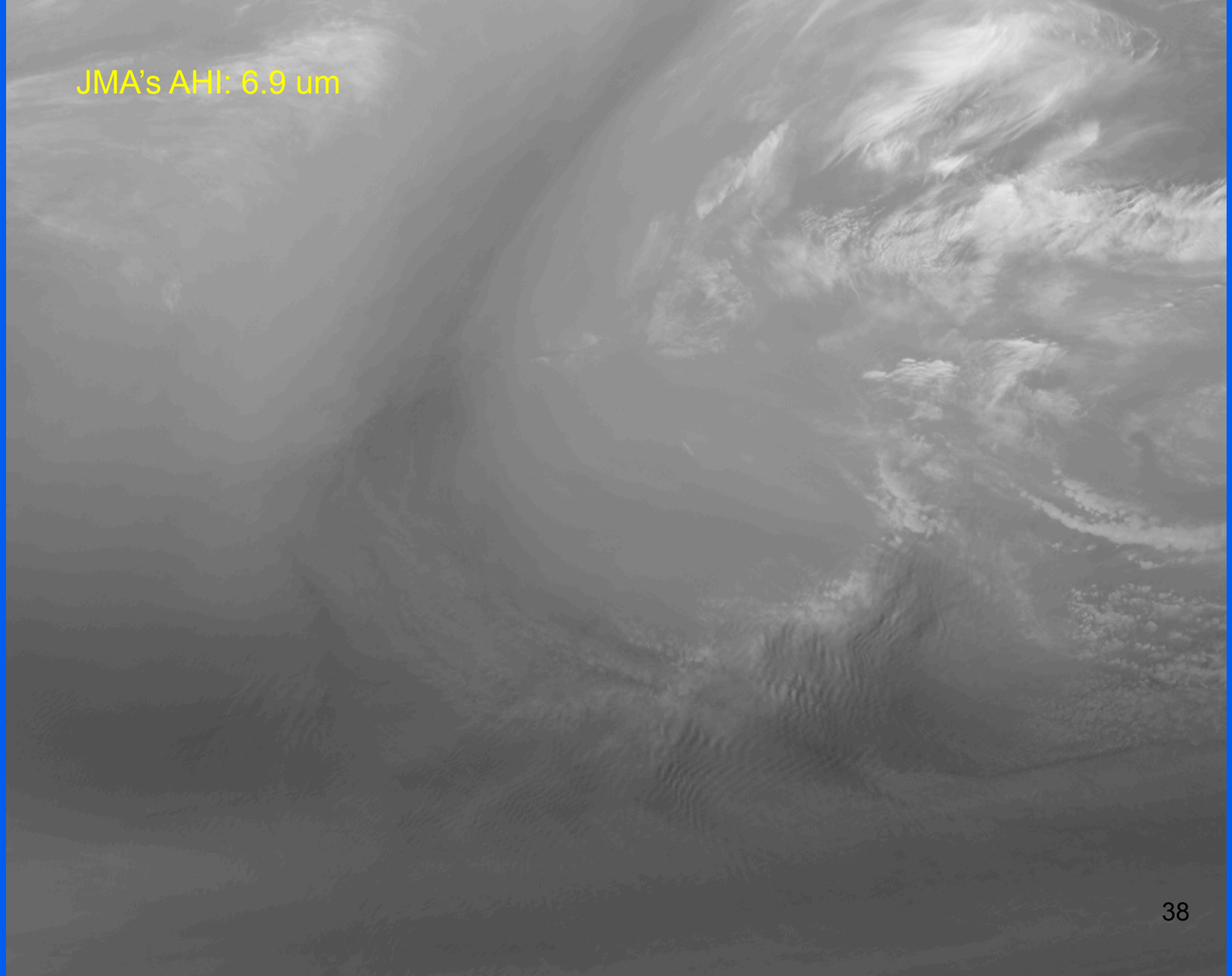

JMA's AHI: 0.86 um

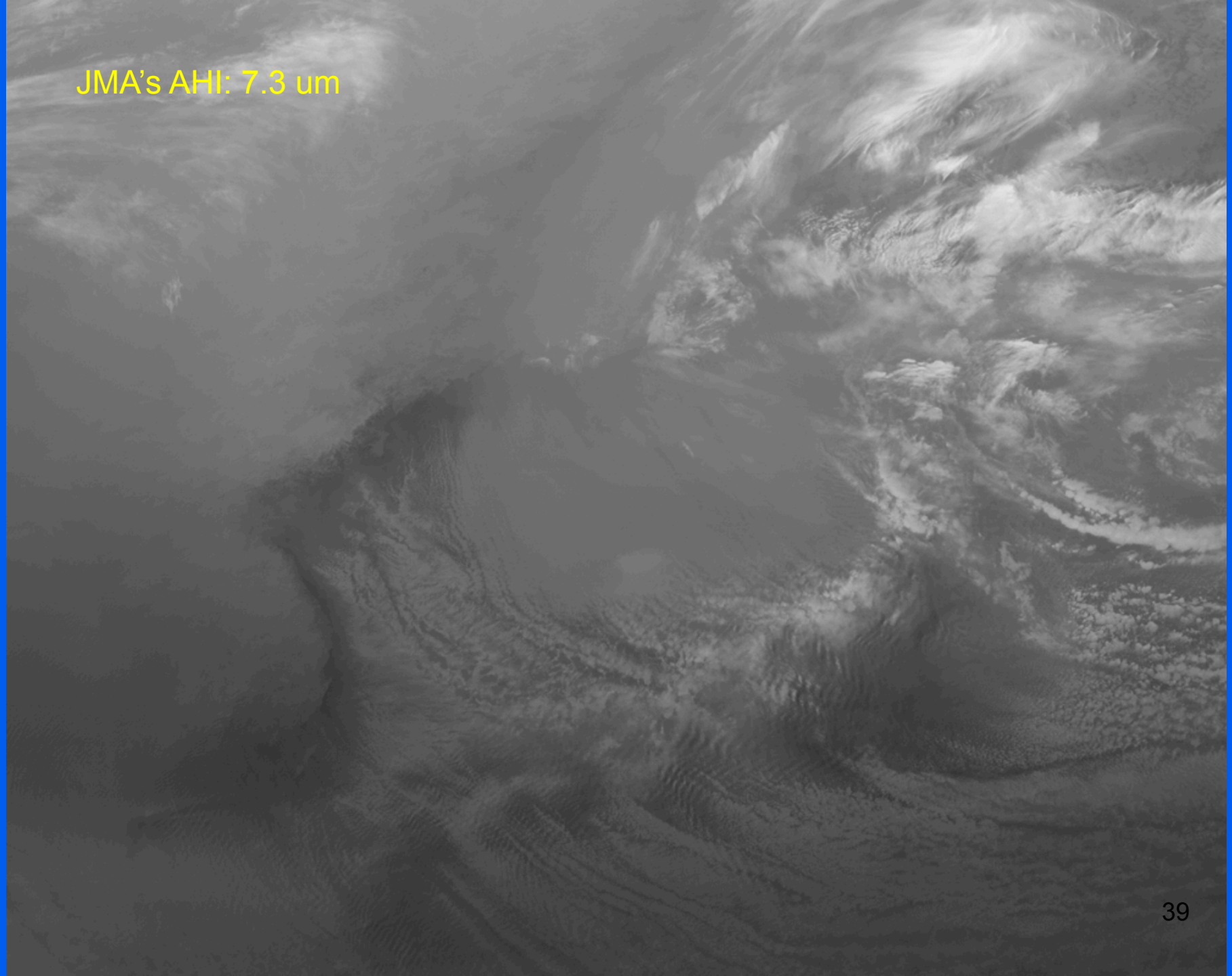

JMA's AHI: 1.6 um

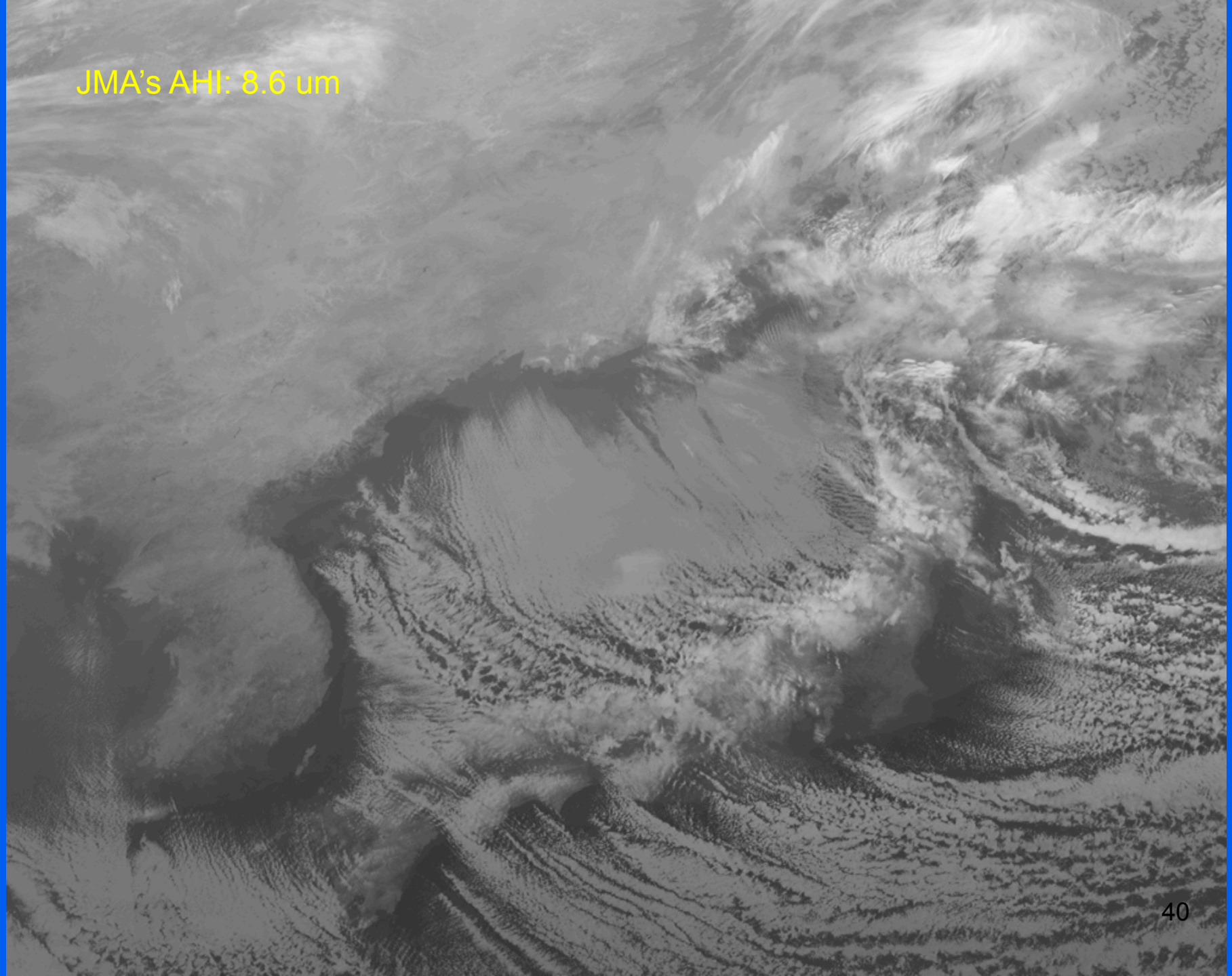

JMA's AHI: 2.3 um

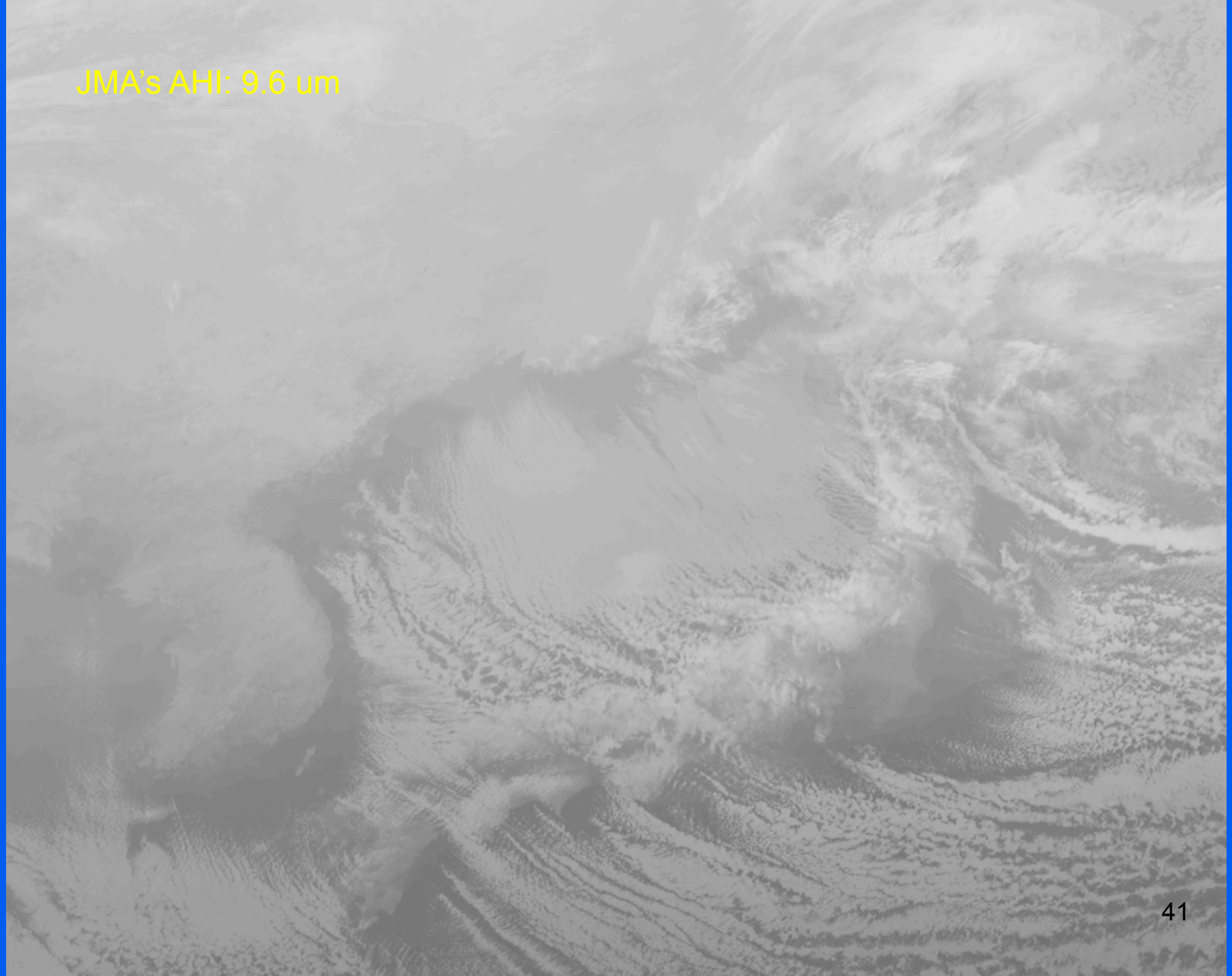

JMA's AHI: 3.9 um

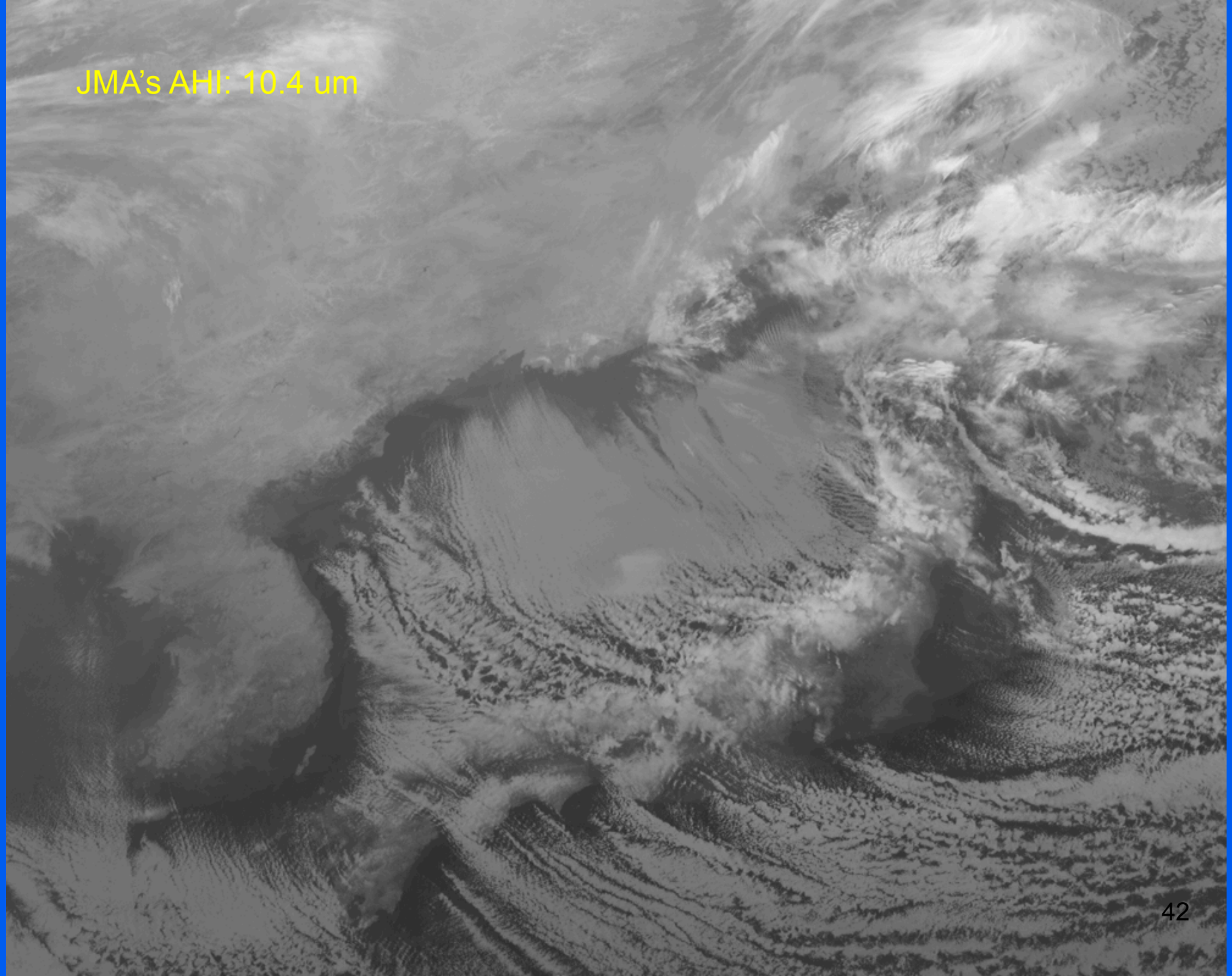

JMA's AHI: 6.2 um

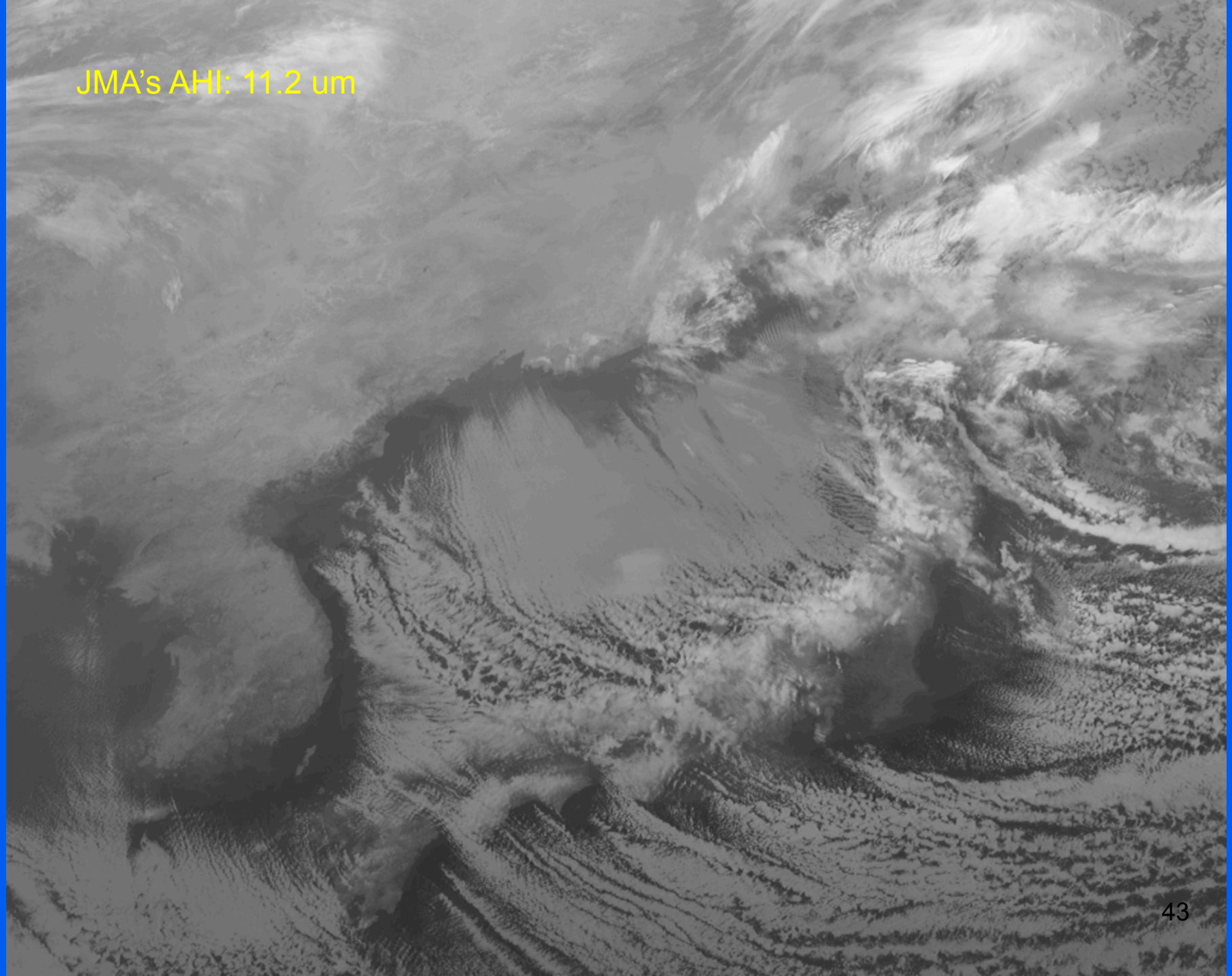

JMA's AHI: 6.9 um

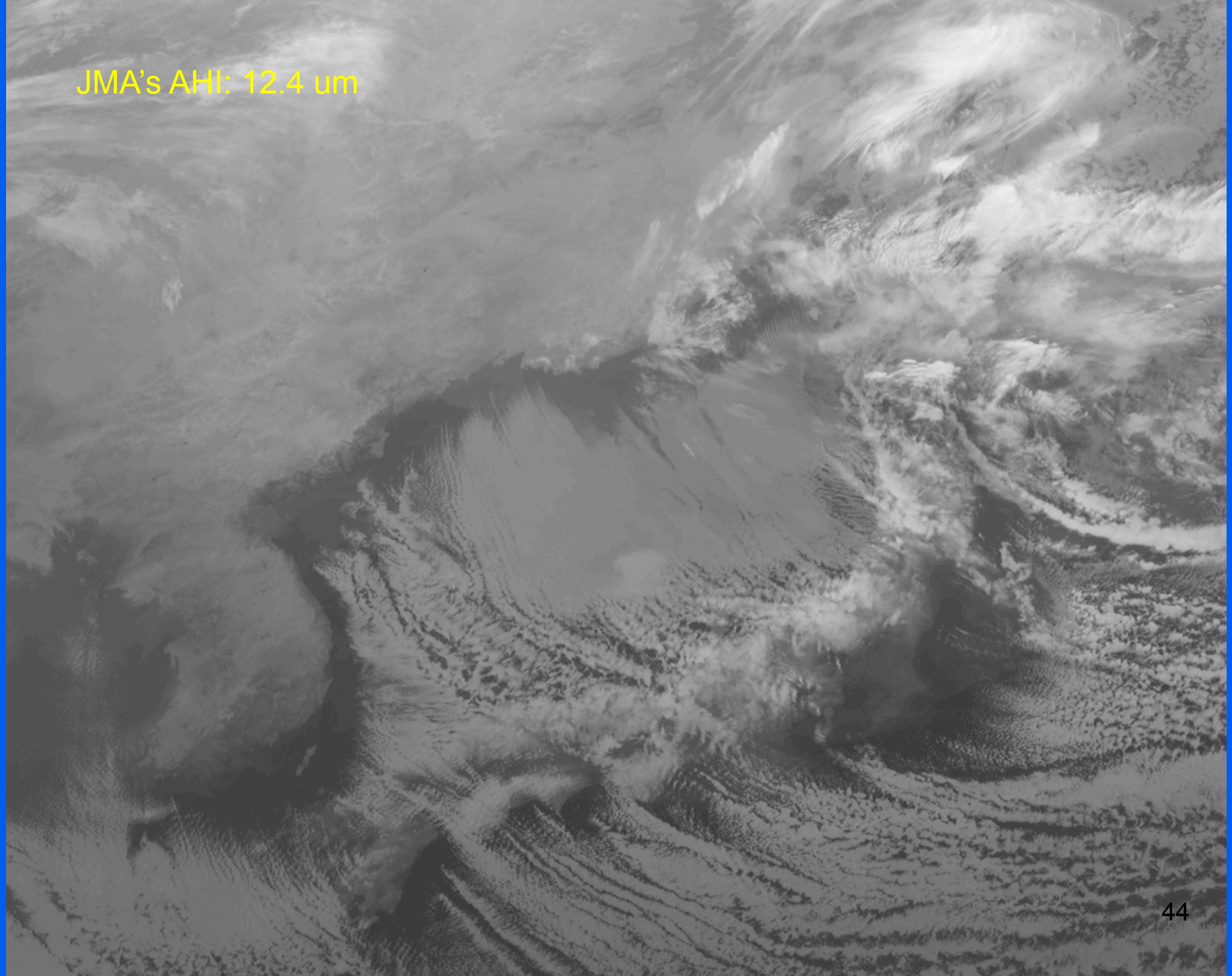

JMA's AHI: 7.3 um

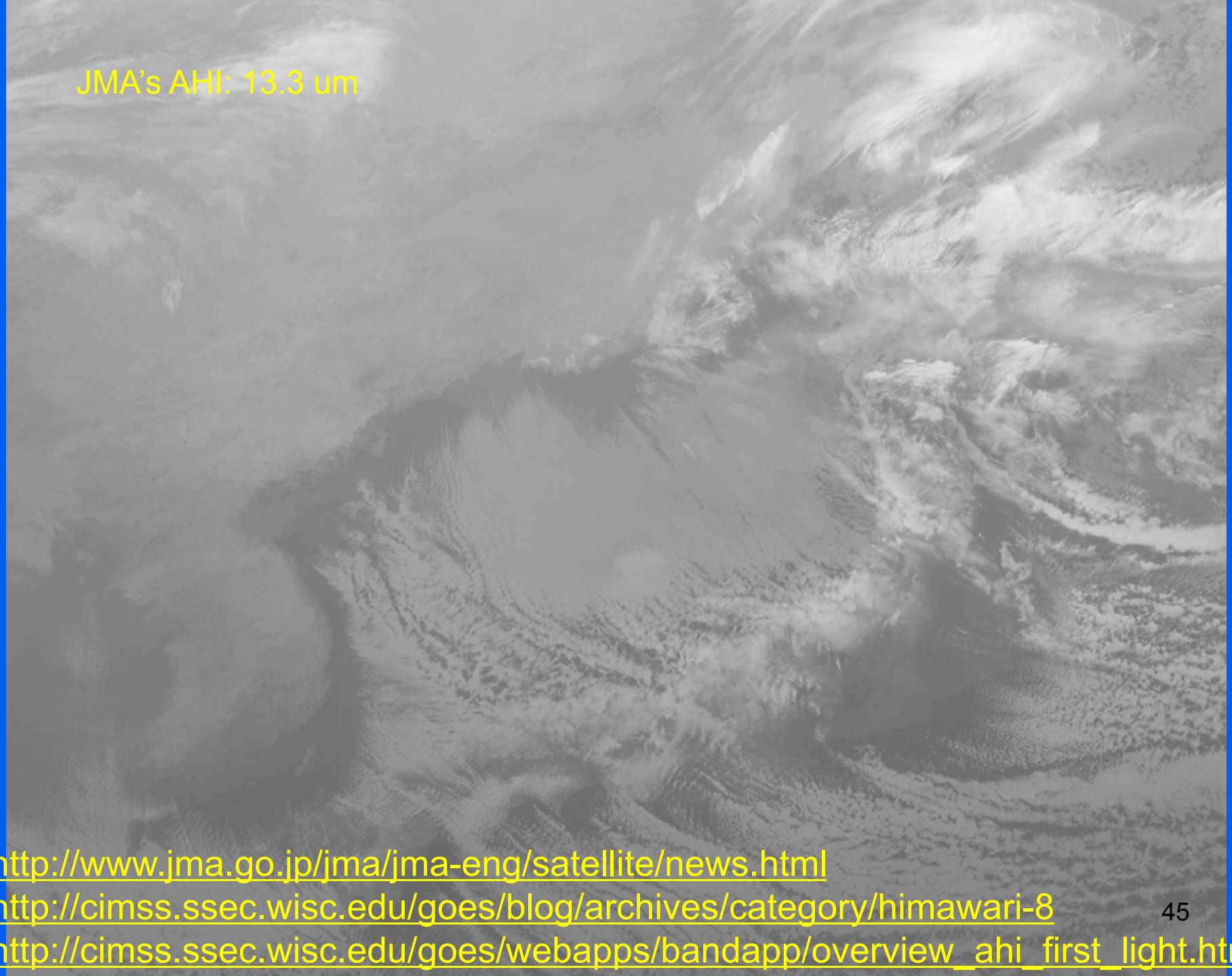

JMA's AHI: 8.6 um


JMA's AHI: 9.6 um


JMA's AHI: 10.4 um


JMA's AHI: 11.2 um


JMA's AHI: 12.4 um



http://www.jma.go.jp/jma/jma-eng/satellite/news.html
http://cimss.ssec.wisc.edu/goes/blog/archives/category/himawari-8
http://cimss.ssec.wisc.edu/goes/webapps/bandapp/overview_ahi_first_light.html

GOES-14 Super Rapid Scan Operations to Prepare for GOES-R (SRSOR)

SRSOR plans for 2015 include May 18-June 12, and August 10-22:

http://cimss.ssec.wisc.edu/goes/srsor2015/GOES-14_SRSOR.html

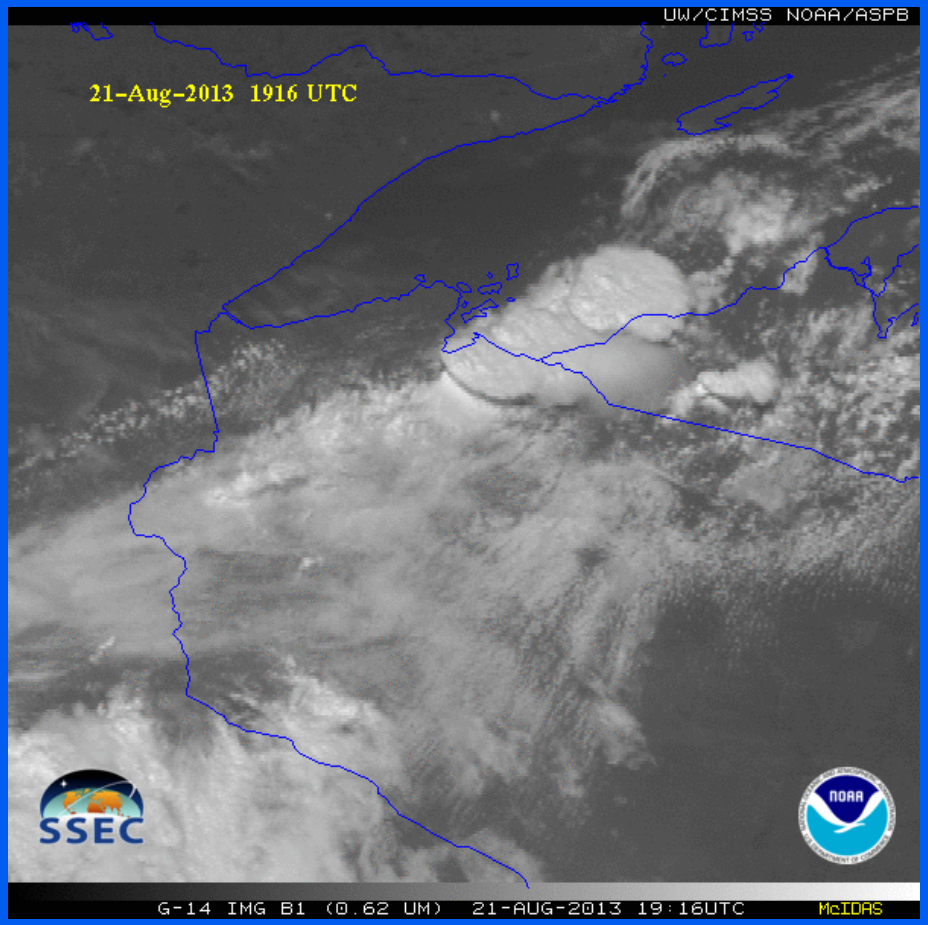
Data during parts of 2012 (Hurricane Sandy, convection), 2013 (CA Rim Fire, convection) and 2014 (Hurricane Marie, convection):

http://cimss.ssec.wisc.edu/goes/srsor/GOES-14_SRSOR.html

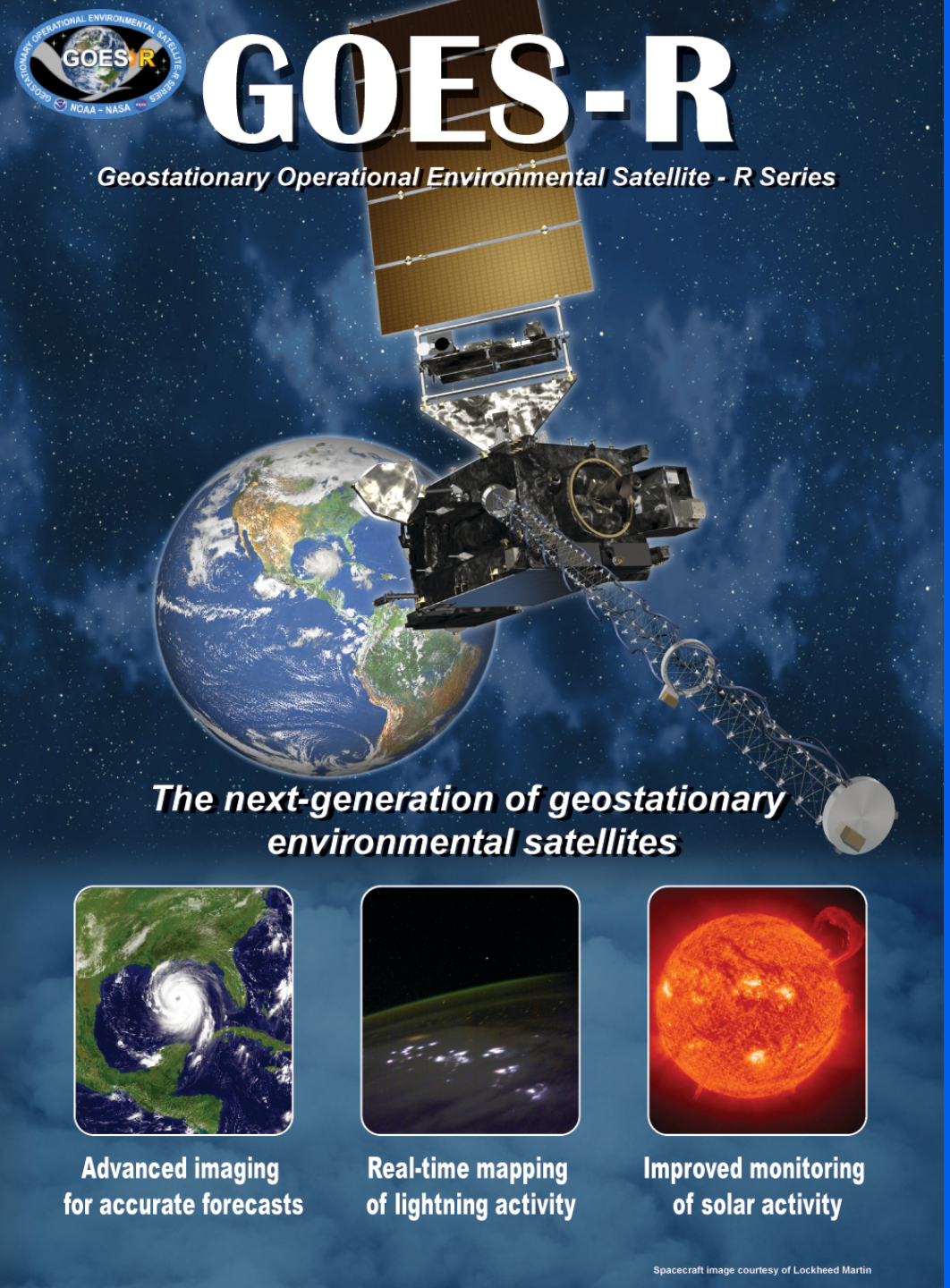
http://cimss.ssec.wisc.edu/goes/srsor2013/GOES-14_SRSOR.html

http://cimss.ssec.wisc.edu/goes/srsor2014/GOES-14_SRSOR.html

GOES-14 provided very unique data and offered a glimpse into the possibilities that will be provided by the ABI on GOES-R in one minute mesoscale imagery



GOES-14 visible image showing rapid convective development



Thank you!

For more information visit
www.goes-r.gov

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