Current GOES constellation in the Pacific: status and plans

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CIMSS/SSEC, Madison, WI

GOES-R O-CONUS PG meeting
29-July-2010

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

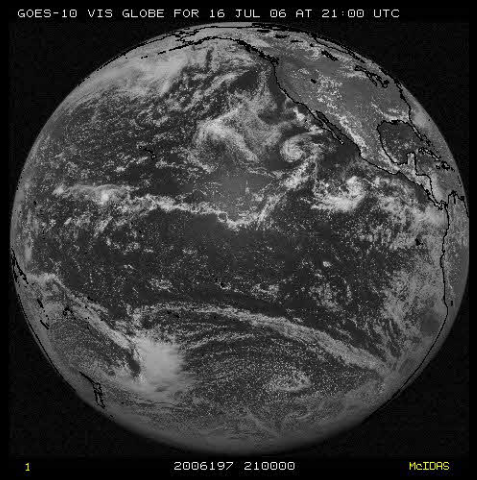
Outline

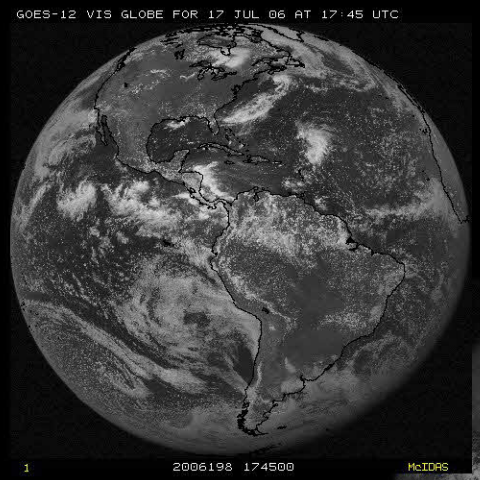
- Introduction
- Imager and sounder images
- Improved imager band 6 (13.3 um) spatial resolution
- Preliminary inter-calibration results
- Improved INR and Operation thru eclipse
- Initial products (imager and sounder)
- Web links

NOAA Operational: Geostationary (mid-2010)

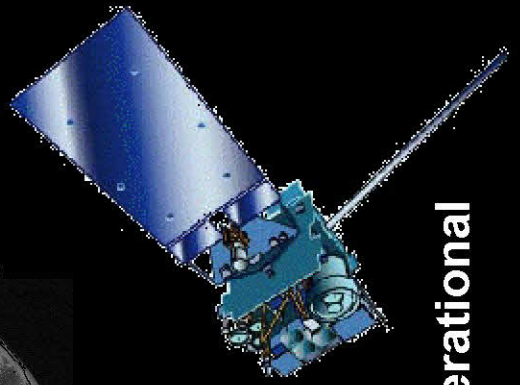
Operational

GOES-11
(135W)



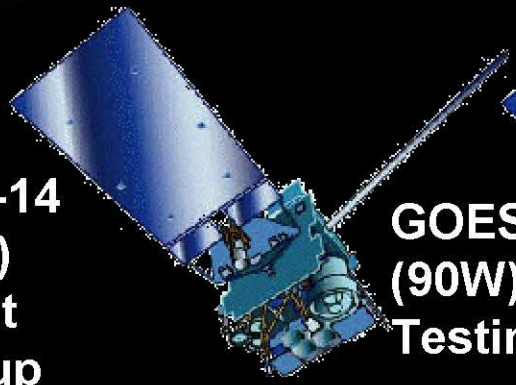


GOES-13
(75W)

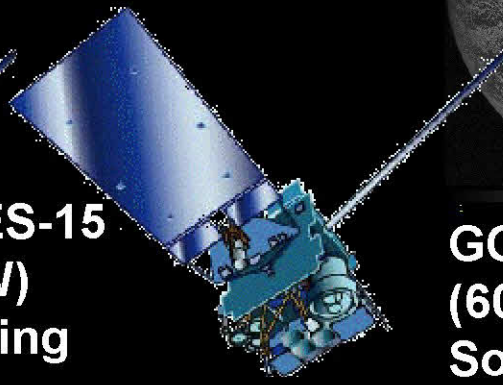


Operational

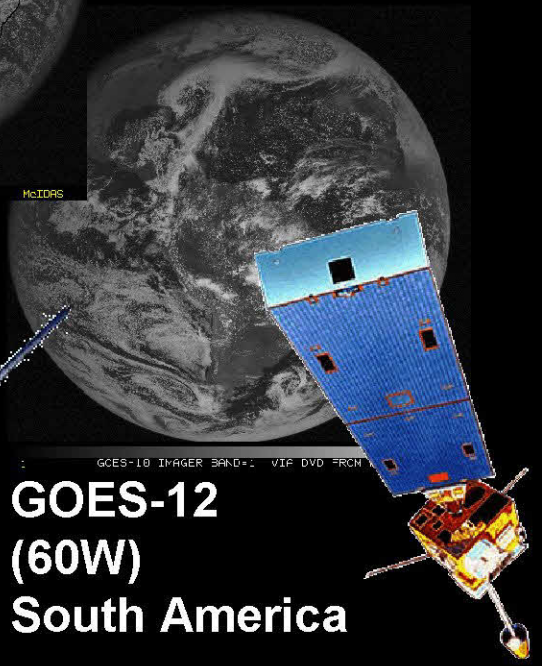
Very healthy GOES constellation.



GOES-14
(105W)
In-orbit
Back-up



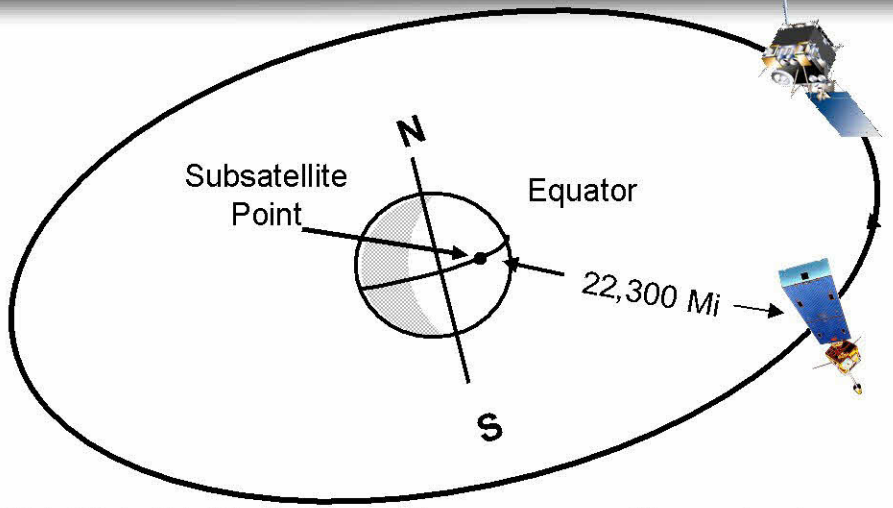
GOES-15
(90W)
Testing



GOES-12
(60W)
South America

GOES Constellation

Primary Requirement: Continuity of Capability



Two operational satellites and on-orbit spare

GOES I-M (8-12) series operational since 1994

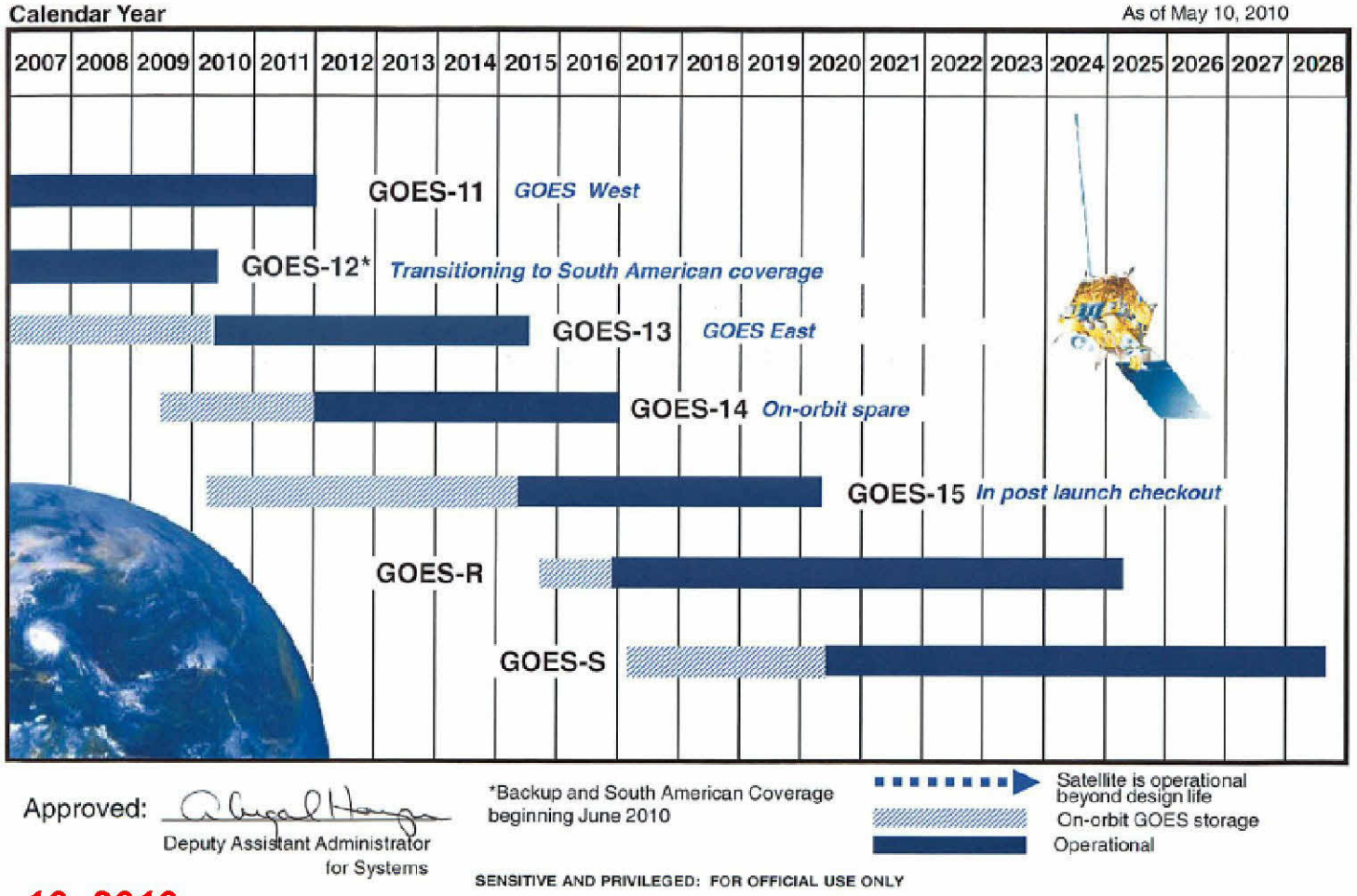
- GOES-10 was at 60º W in support of South America December 2, 2006 – December 1, 2009
- GOES-11 operational as GOES West at 135° W - June 21, 2006
- GOES-12 providing South America coverage, with drift stop May 17, 2010

GOES N/O/P (13/14/15) operational beginning 2010

- GOES-13 launched May 24, 2006. Currently the GOES-East operational satellite since April 14, 2010
- GOES-14 launched June 27, 2009, at 105º W and finished Post Launch Testing Dec 2009.
  - ***Note new GVAR format for GOES-14 and GOES-P***
  - ***Currently earth (sun) pointing to provide critical XRS space weather data to SWPC (imager/sounder are off)***
- GOES-15 launched March 4, 2010, currently in PLT at 90°W

Operational GOES Updates

Continuity of GOES Operational Satellite Program

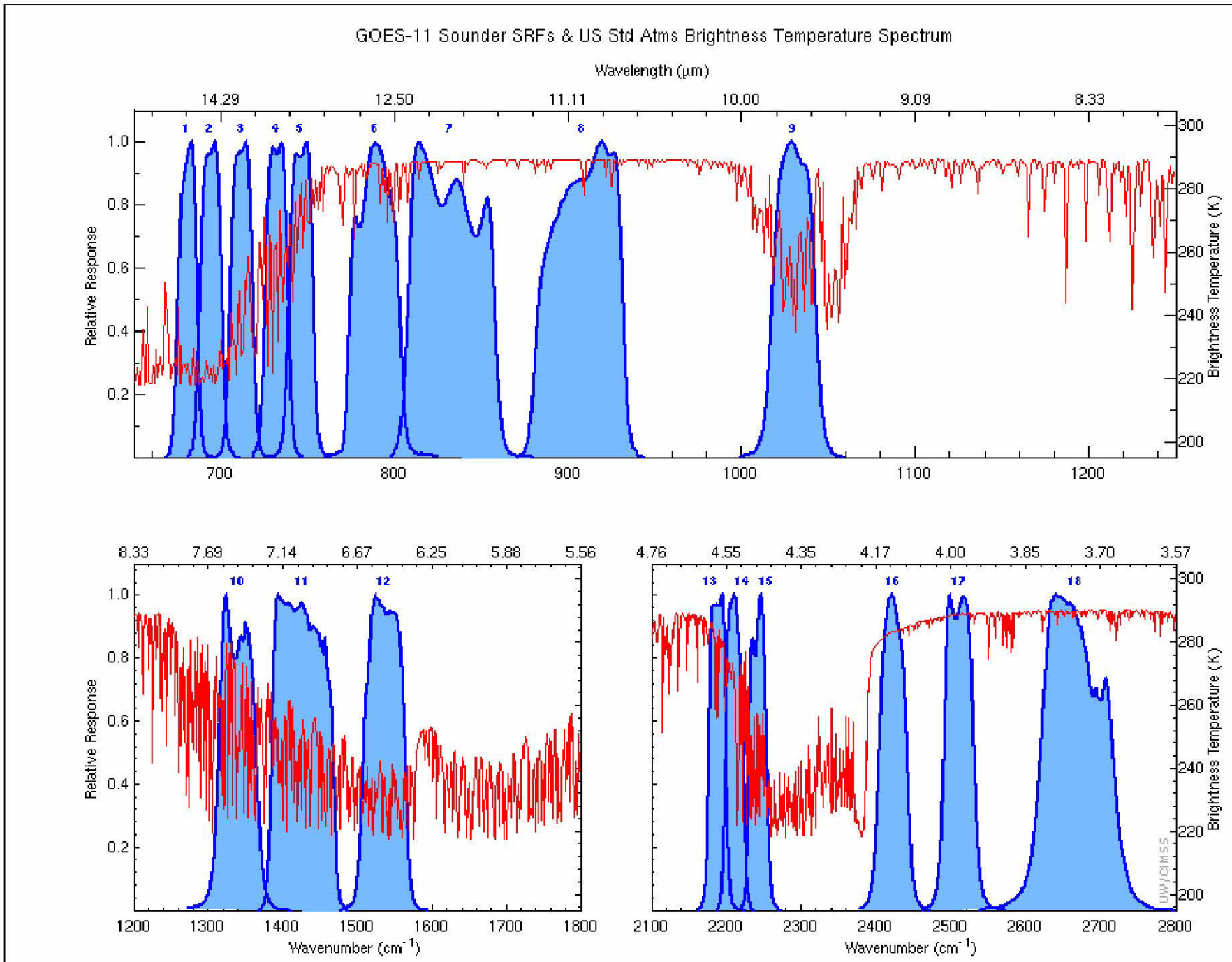


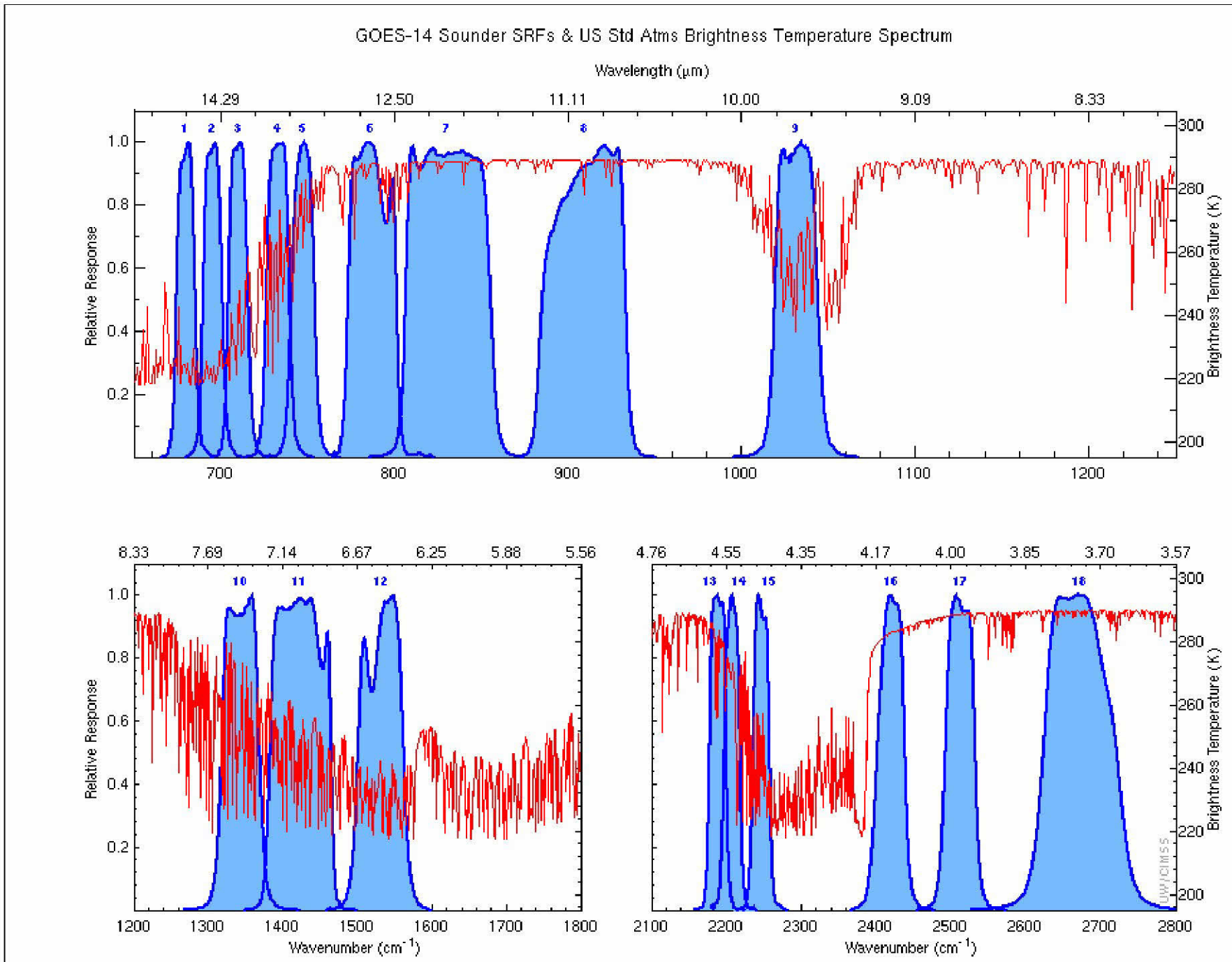
As of May 10, 2010

http://www.nesdis.noaa.gov/FlyoutSchedules.html

GOES-11 to GOES-14

- New spacecraft
- Less noisy data
- Spectrally modified imager band 3 (‘water vapor’)
- Improved imager band 6 (13.3 um) spatial resolution
- Modified GVAR format
- No 12 um band on Imager
- Improved INR and Operation thru eclipse


GOES-11 Sounder SRFs & US Std Atms Brightness Temperature Spectrum
Wavelength (μm)
14.29
12.50
11.11
10.00
9.09
8.33
1
2
3
4
5
6
7
8
9
Relative Response
Brightness Temperature (K)
700
800
900
1000
1100
1200
8.33
7.69
7.14
6.67
6.25
5.88
5.56
10
11
12
1200
1300
1400
1500
1600
1700
1800
Wavenumber (cm-1)
4.76
4.55
4.35
4.17
4.00
3.85
3.70
3.57
13
14
15
16
17
18
2100
2200
2300
2400
2500
2600
2700
2800
Wavenumber (cm-1)
UW/CIMSS


GOES-14 Sounder SRFs & US Std Atms Brightness Temperature Spectrum
Wavelength (μm)
14.29
12.50
11.11
10.00
9.09
8.33
1
2
3
4
5
6
7
8
9
Relative Response
Brightness Temperature (K)
700
800
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1000
1100
1200
8.33
7.69
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5.56
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Wavenumber (cm-1)
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4.55
4.35
4.17
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3.85
3.70
3.57
13
14
15
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2200
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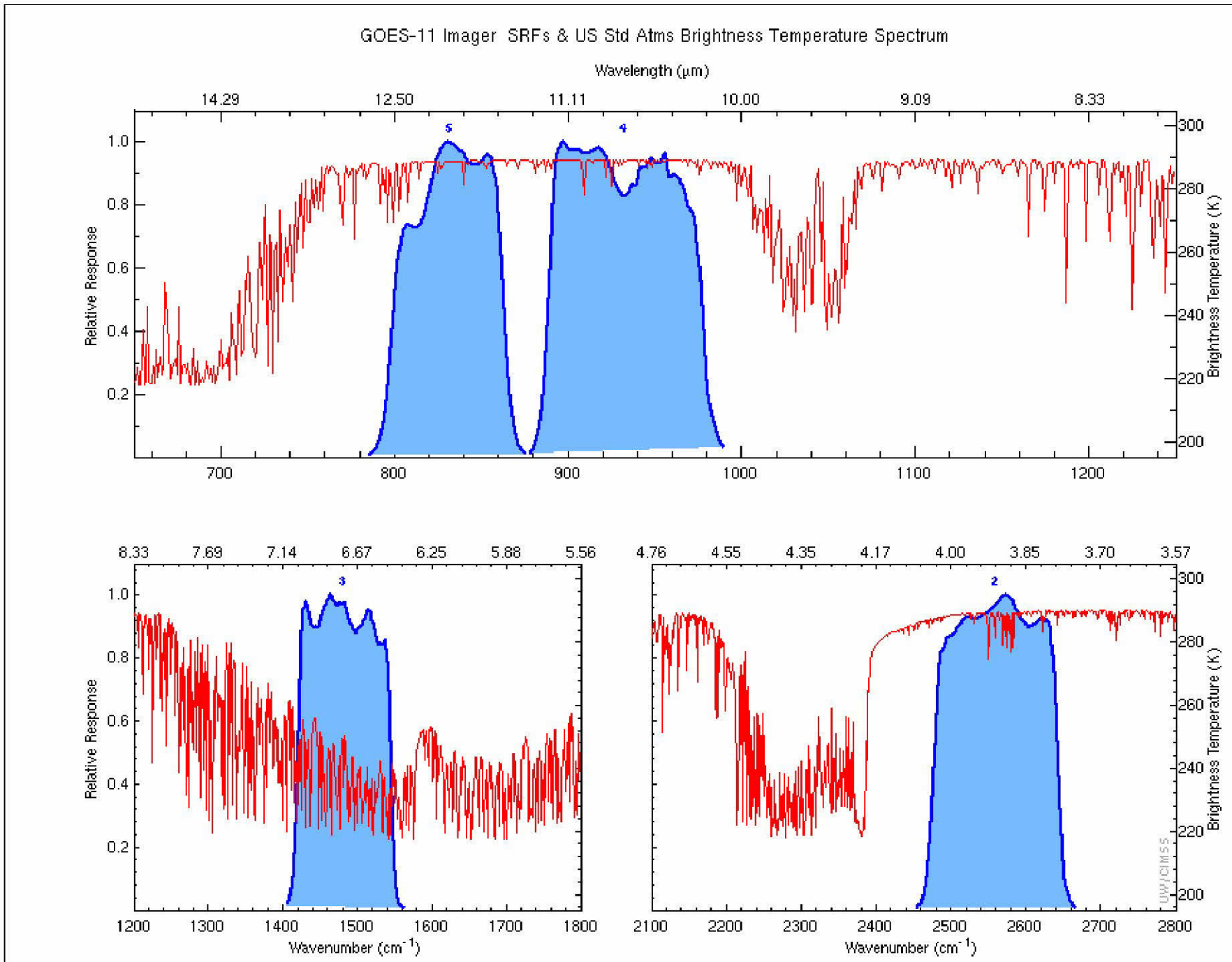
2800
Wavenumber (cm-1)
UWICIMSS


GOES-11 Imager SRFs & US Std Atms Brightness Temperature Spectrum
Wavelength (μm)
14.29
12.50
11.11
10.00
9.09
8.33
5
4
Relative Response
Brightness Temperature (K)
700
800
900
1000
1100
1200
8.33
7.69
7.14
6.67
6.25
5.88
5.56
3
4.76
4.55
4.35
4.17
4.00
3.85
3.70
3.57
2
1200
1300
1400
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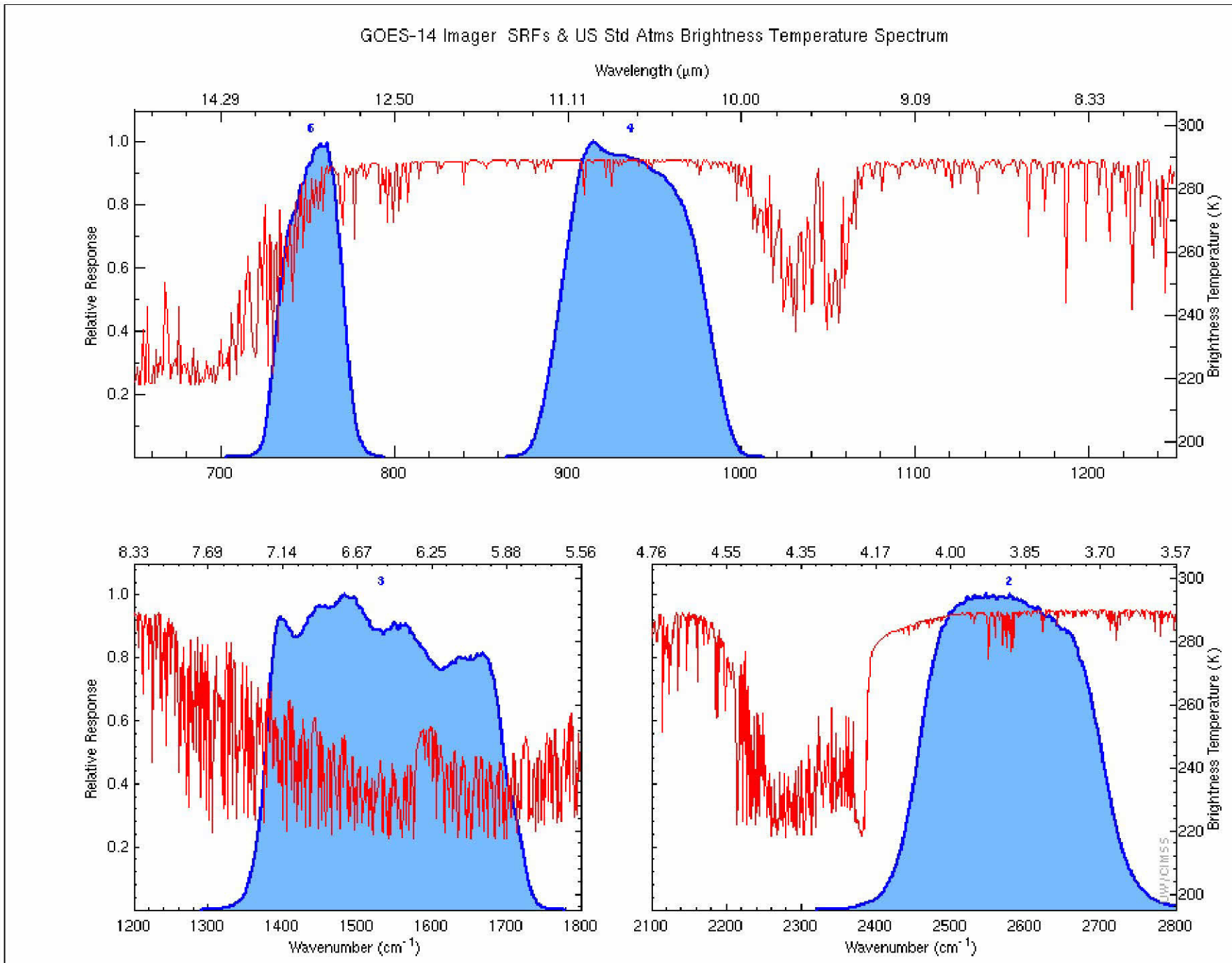
1800
2100
2200
2300
2400
2500
2600
2700
2800
Wavenumber (cm-1)
UWICIMSS


GOES-14 Imager SRFs & US Std Atms Brightness Temperature Spectrum
Wavelength (μm)
14.29
12.50
11.11
10.00
9.09
8.33
6
4
Relative Response
Brightness Temperature (K)
700
800
900
1000
1100
1200
8.33
7.69
7.14
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Wavenumber (cm-1)
4.76
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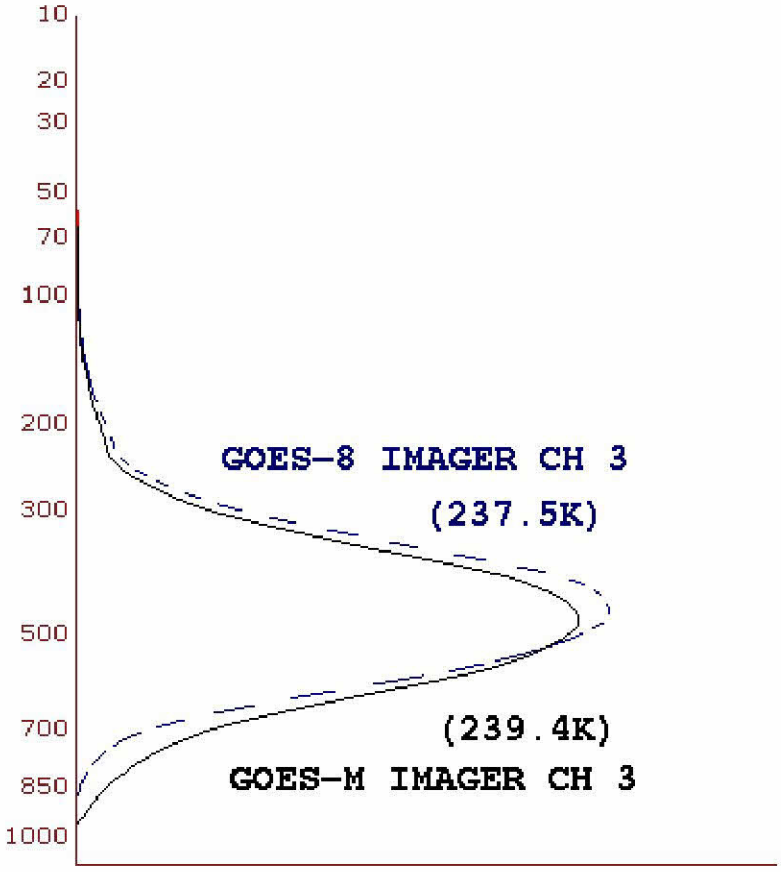
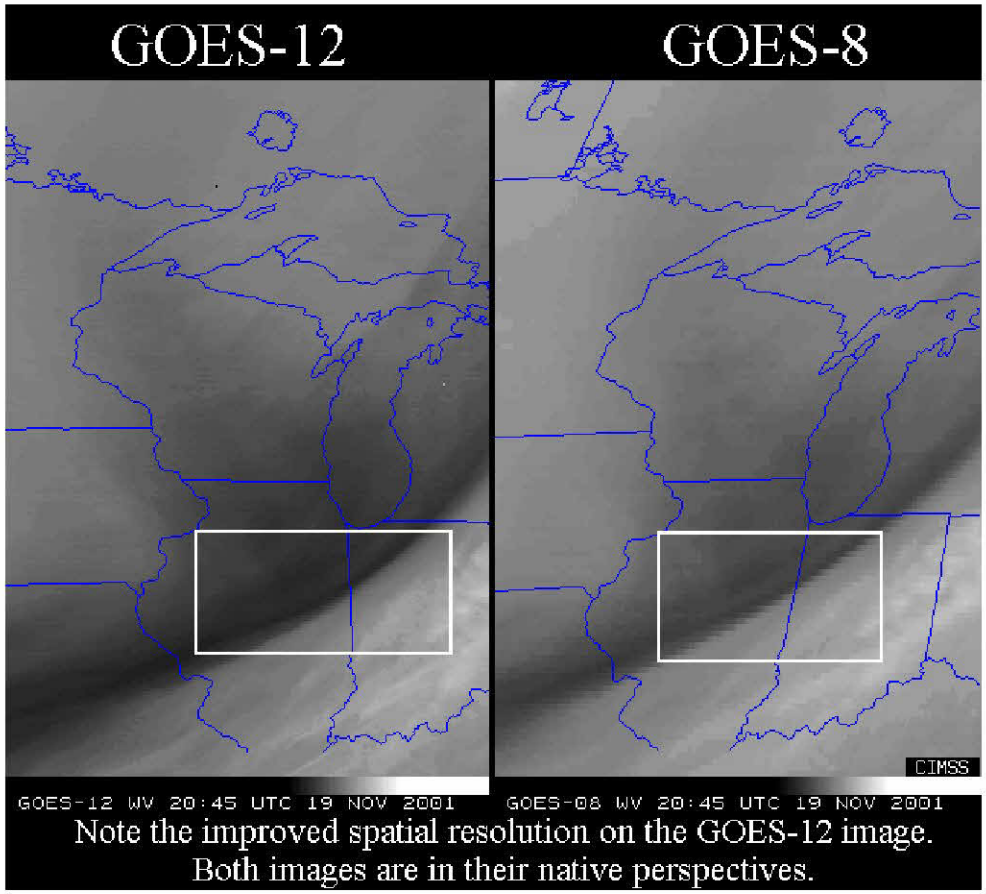
4.17
4.00
3.85
3.70
3.57
2
2100
2200
2300
2400
2500
2600
2700
2800
Wavenumber (cm-1)
UWICIMSS

Water vapor band





GOES-14 Imager and Sounder

a preliminary look

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Don Hillger and Tim Schmit co-lead the NOAA Science Test

STAR Center for Satellite Applications and Research

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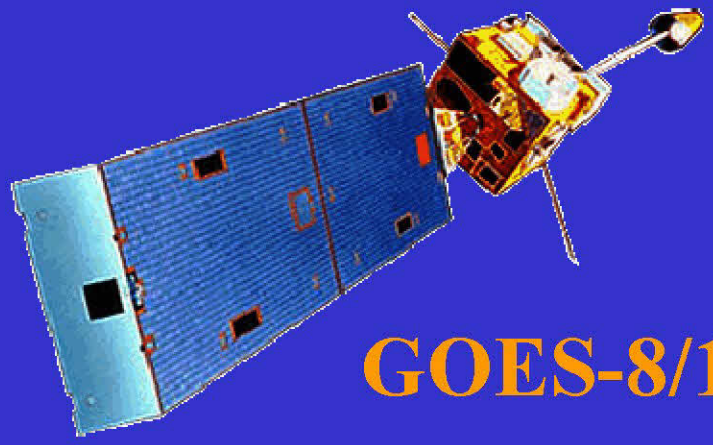
GOES-14

GOES-13/14/P have similar instruments to GOES-8-12, but on a different spacecraft bus.

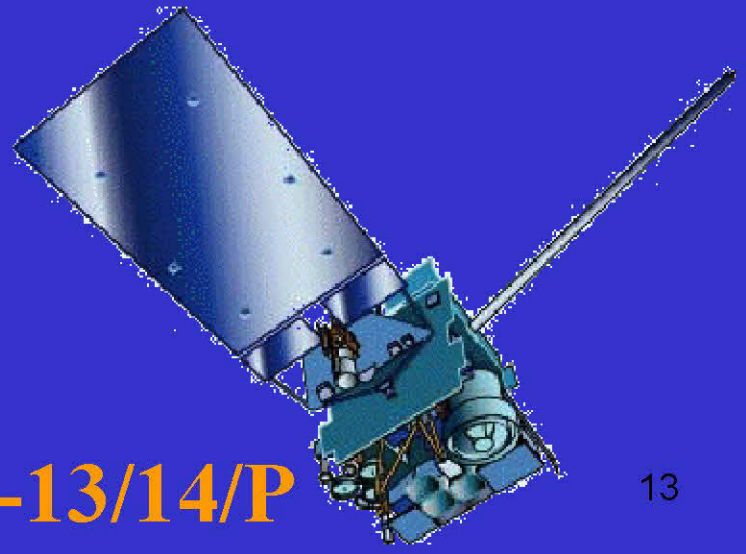
Spring and fall eclipse outages will be avoided by larger onboard batteries.

Improved navigation

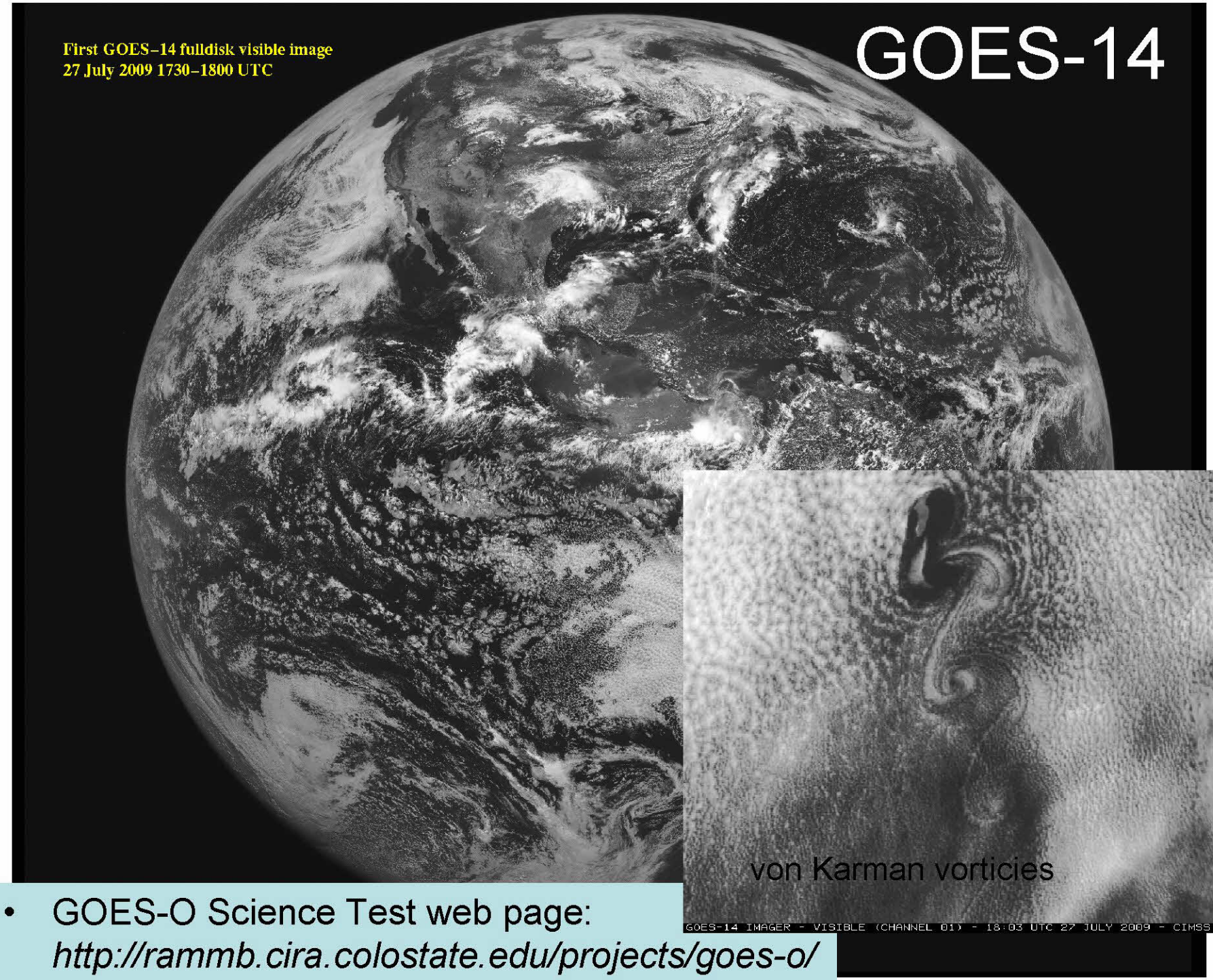
Improved radiometrics



GOES-8/12



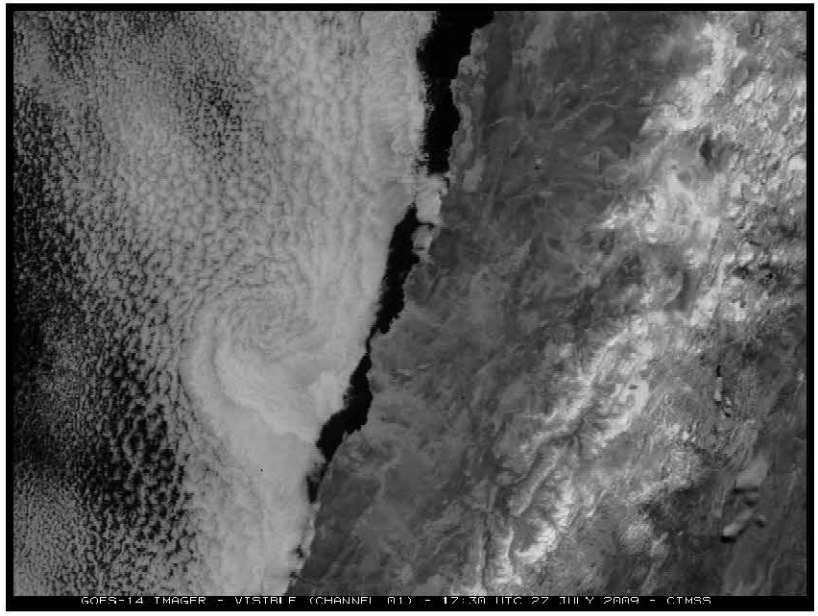
GOES-13/14/P

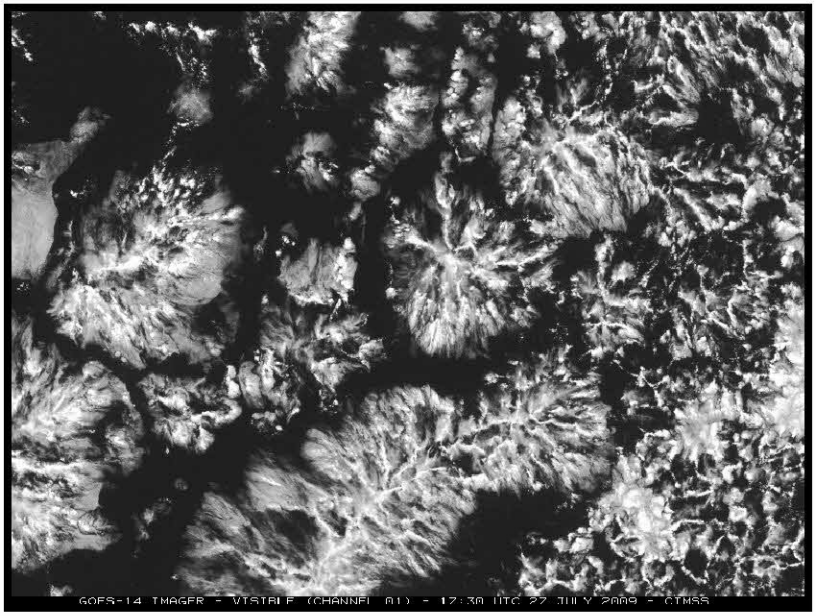


- GOES-O Science Test web page:
  http://rammb.cira.colostate.edu/projects/goes-o/

sediment plume

vortex in the marine layer clouds , snow

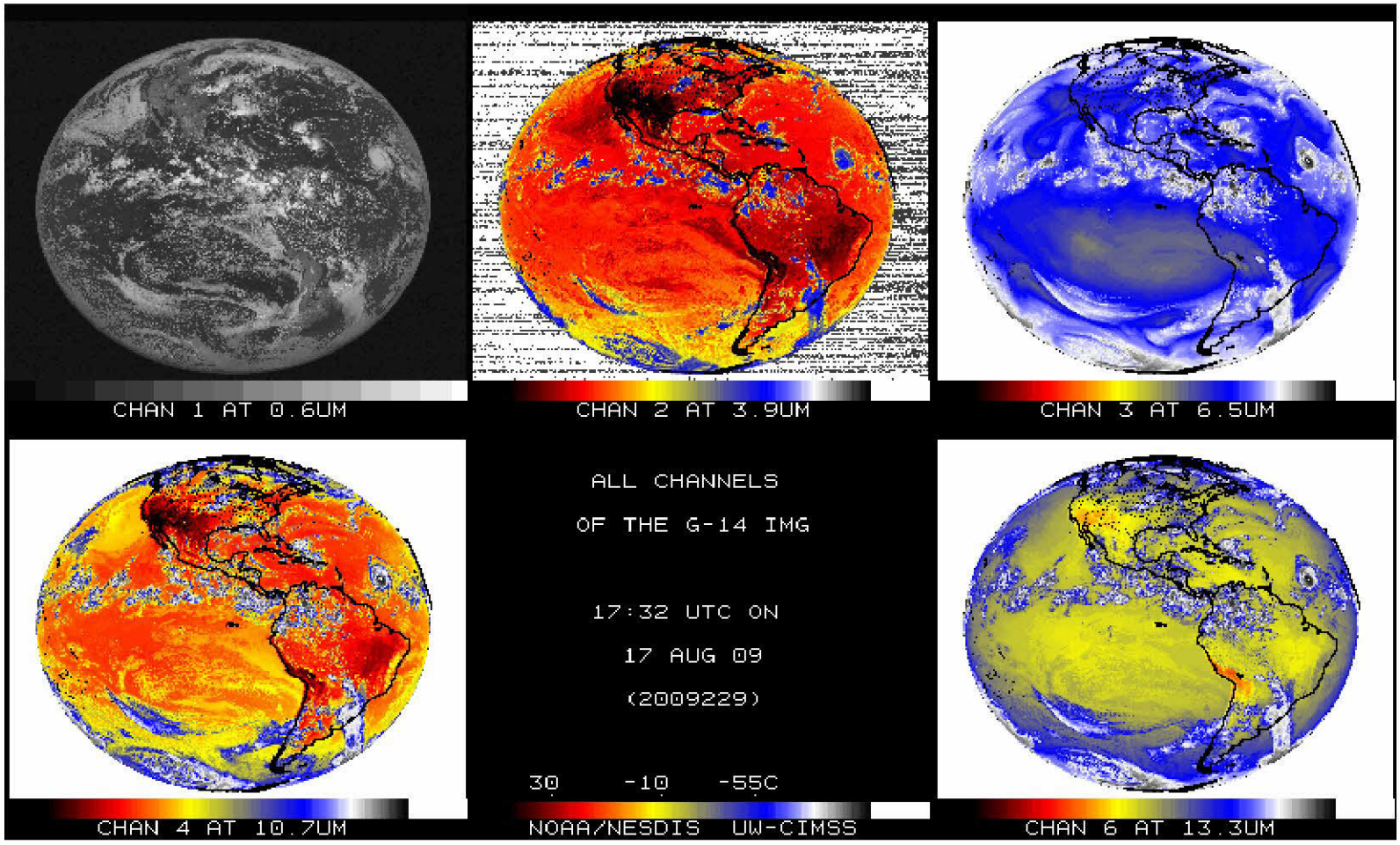




actinoform clouds

Amazon suppressing the formation of cumulus

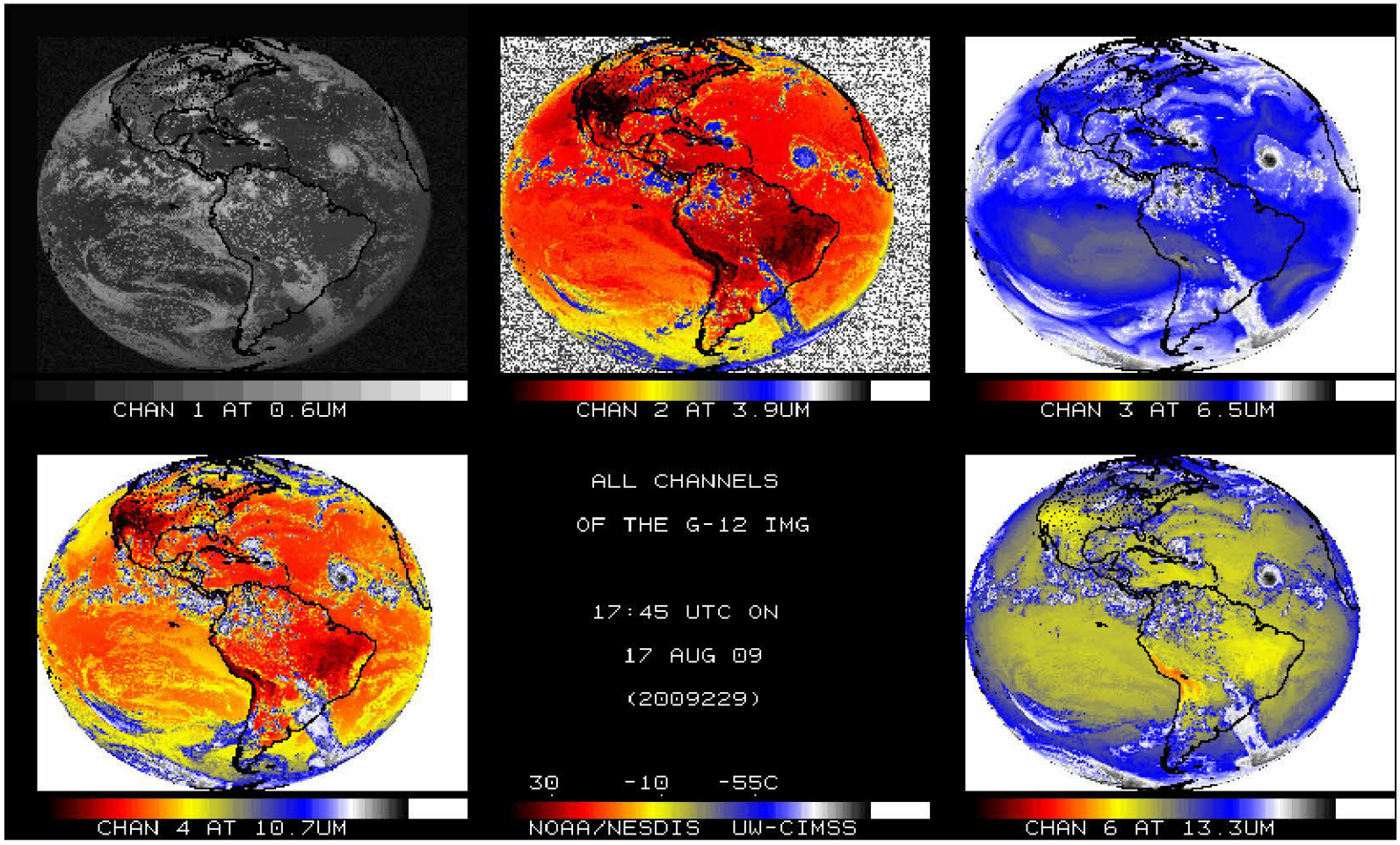
First GOES-14 Images
(sub-sampled)



Note the 'brighter' GOES-14 visible image

From NOAA ASPB

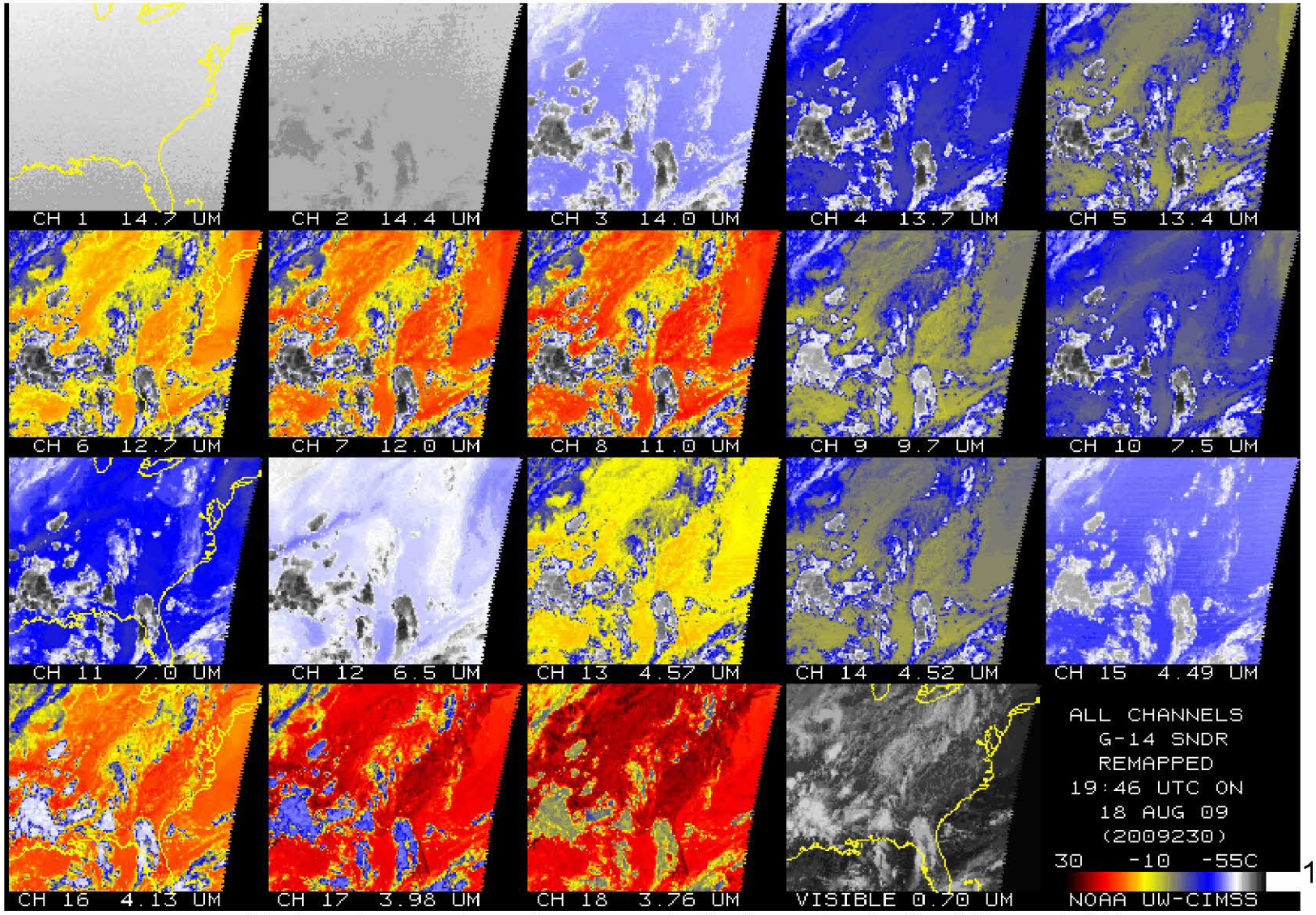
GOES-12 (for comparison)



Note the sub-satellite points are different

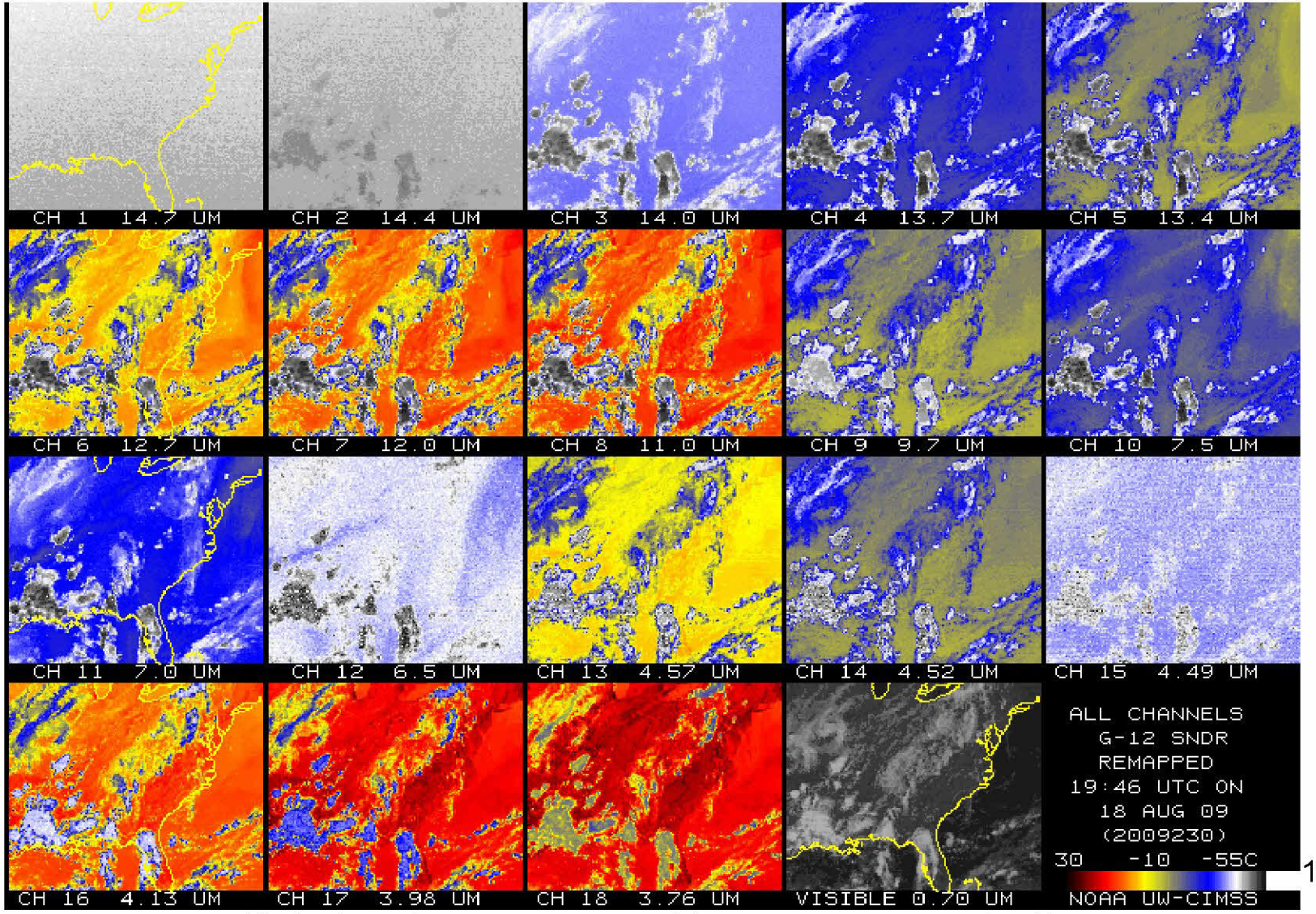
From NOAA ASPB

GOES-14 Sounder!



Note clean signal, especially bands 1, 2, 12 and 15.

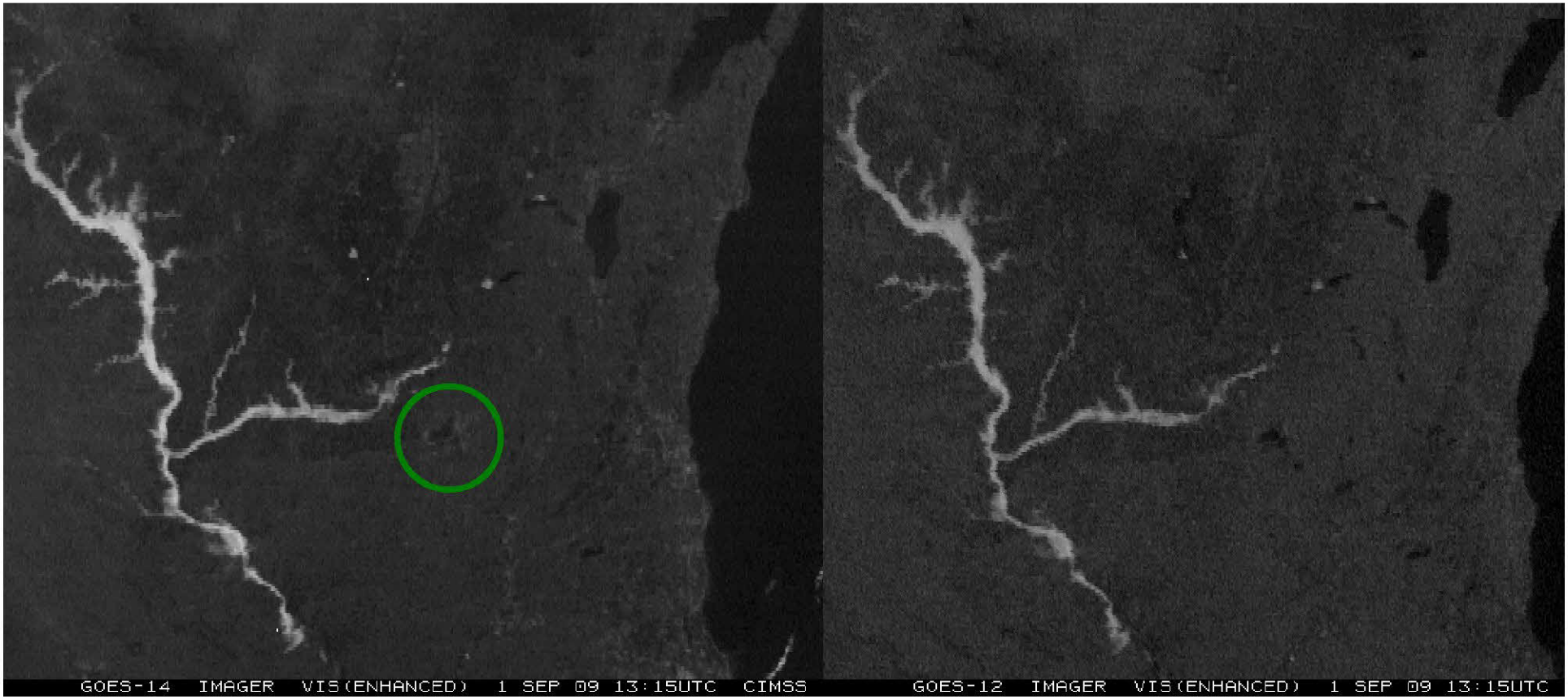
GOES-12 Sounder



Data has been remapped to a common projection.

River Fog

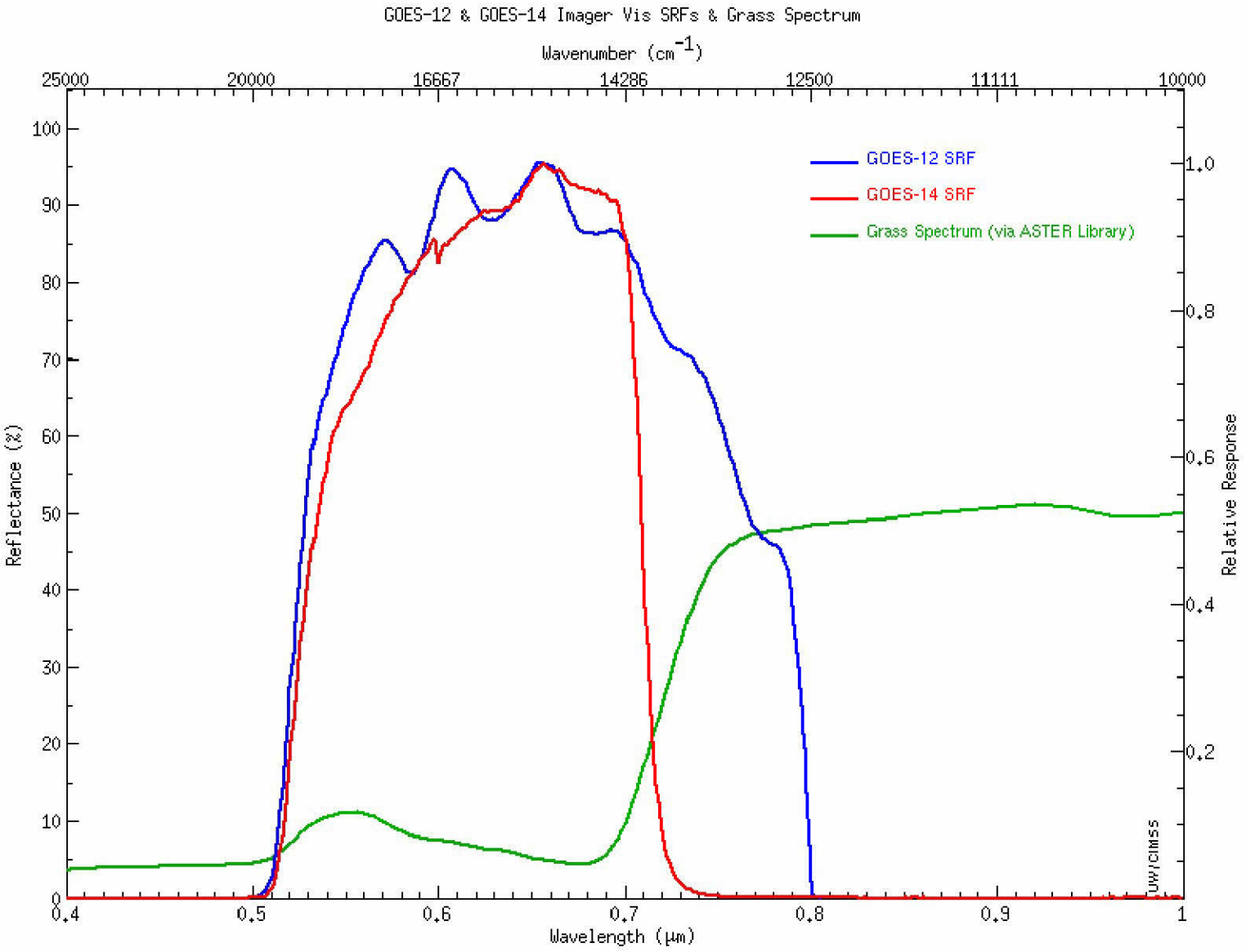
GOES-14 GOES-12



The fog is a bit brighter and a appears more extensive in the GOES-14 image.

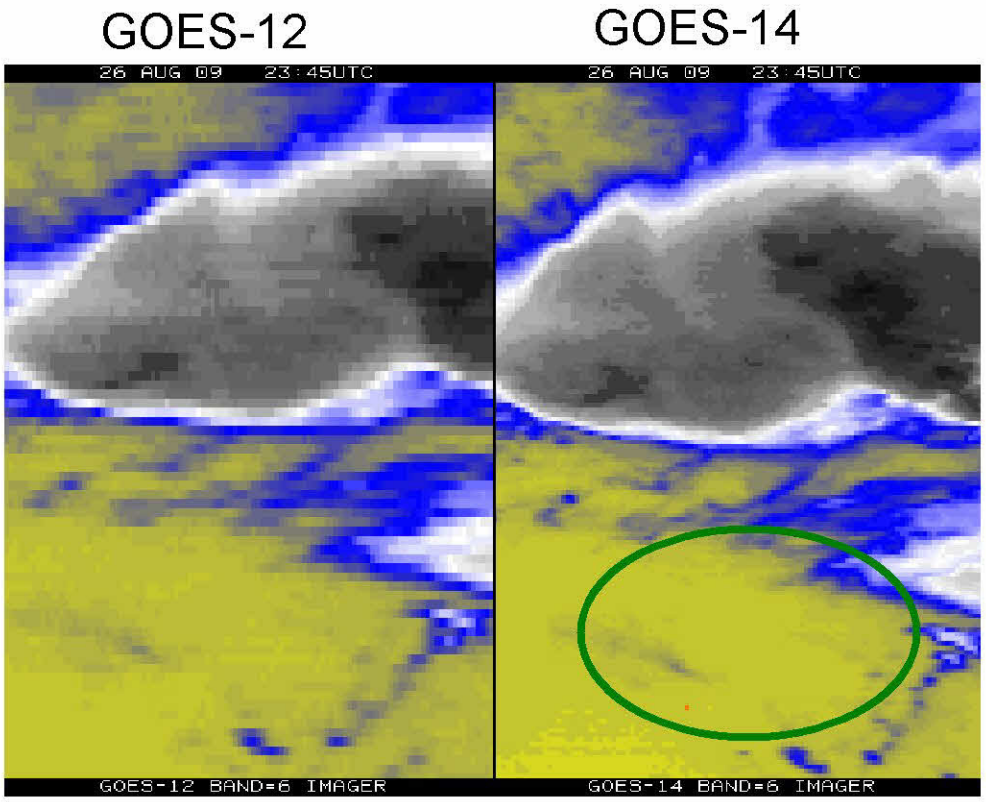
GOES-14 is able to discern urban centers more readily than GOES-12.

Imager SRF


GOES-12 & GOES-14 Imager Vis SRFs & Grass Spectrum
Wavenumber (cm-1)
25000
20000
16667
14286
12500
11111
10000
GOES-12 SRF
GOES-14 SRF
Grass Spectrum (via ASTER Library)
Reflectance (%)
Relative Response
Wavelength (μm)
0.4
0.5
0.6
0.7
0.8
0.9
1
UW/CIMSS

Improved spatial resolution of GOES-14 Imager band 6

- The improved spatial resolution of the Geostationary Operational Environmental Satellites (GOES)-14 imager band 6 has been verified. This band, centered at 13.3 um, has a number of uses, the main being cloud height determination.
- Important diagnostic work was under-taken. After an issue was raised dealing with the data stream of imager band 6, the suggested fix was implemented at the ground station. Many groups, both within NOAA/NESDIS, the Cooperative Institutes, NASA and others, quickly worked together to fix this issue.



The 13.3 um band 6 of the GOES-12 (left panel) has an 8 km IGFOV (Instantaneous Geometric Field of View); while the same band on the GOES-14 (right panel) has a 4 km IGFOV. Note the finer resolution of the cloud edges and the 'cleaner' image.

The improved spatial resolution of the GOES-14 imager band 6 (over GOES-12/13 imagers) has been verified with initial on-orbit data.

(Courtesy of T. Schmit)

Sponsor: OSD G-PSDI Program

Methodology: GEO – IASI Intercal

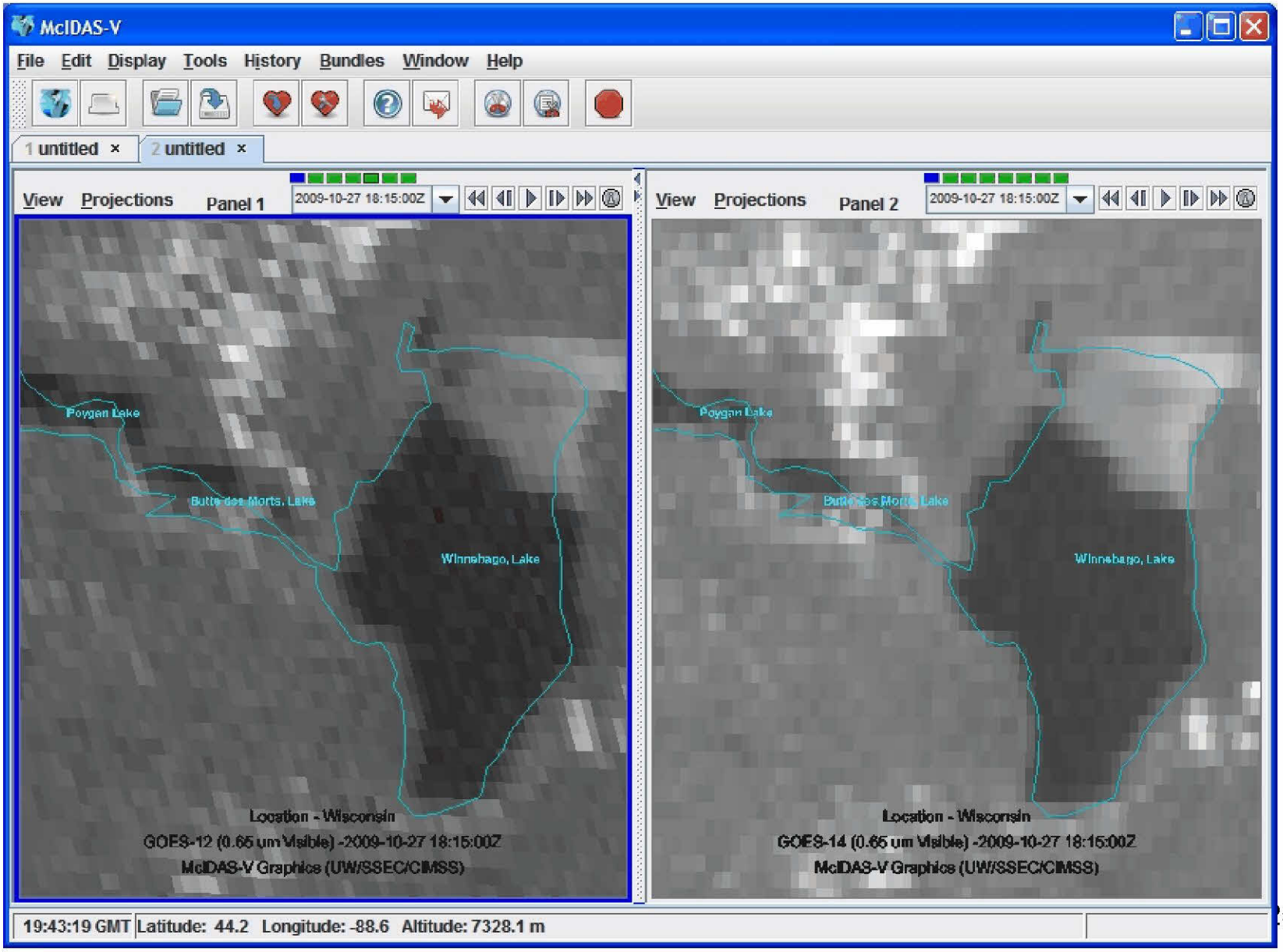
- Collocation in time and space.
  - Within 30 minutes at geostationary subpoint (GSNO – Geostationary Simultaneous Nadir Observation)
  - Low Satellite View Angles (< 14)
- Spatial smoothing
  - 100km "running average" mitigates the negative effects of poor spatial and temporal collocation, poor navigation, and spatial resolution differences.
  - Average radiances, not temperatures.
  - Compare a common area around the GEO sub-point, not "pixel to pixel" comparisons
- "Convolve" high spectral resolution Radiance spectra with GEO Spectral Response Function.
  - Compare mean scene brightness temperatures (converted from mean scene radiances).

$$L_i = \frac{\int_{v_1}^{v_2} R(v) S_i(v)\, dv}{\int_{v_1}^{v_2} S_i(v)\, dv}$$

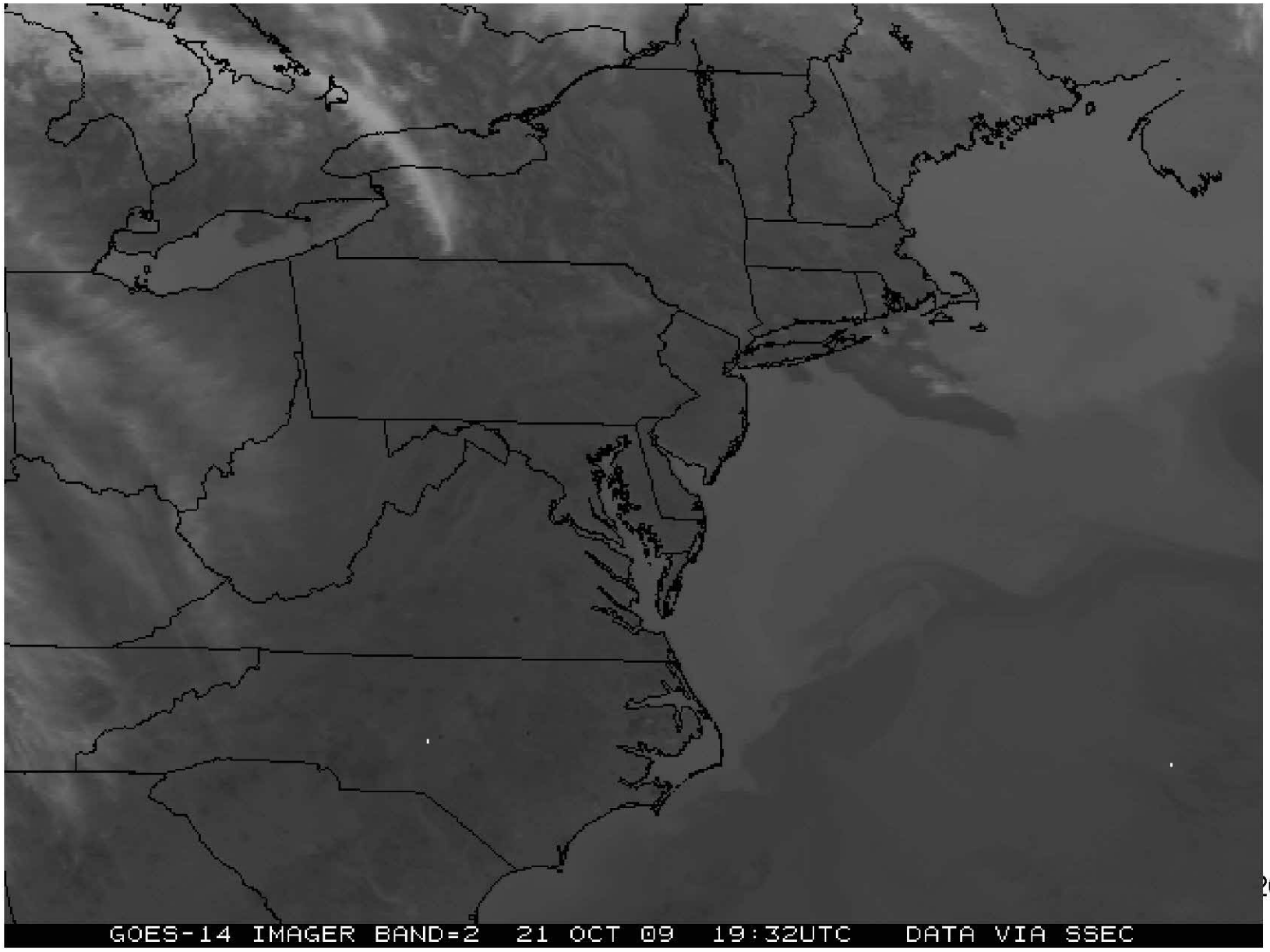
Preliminary intercalibration results with GOES-14 Imager using IASI

- Mean temperature differences with IASI (for 12 cases) are:
  - -0.4 K for the Shortwave Window band (5 night cases)
  - +0.8 K for the Water Vapor band
  - +0.1 K for the IR Window band
  - -0.6 K for the CO_2 Absorption band
  - The CO_2 band SRF may be updated before the science test takes place.
  - Some of these results may include cases where navigation was not optimal.
  - Similar results from Dr. Wu (not shown)

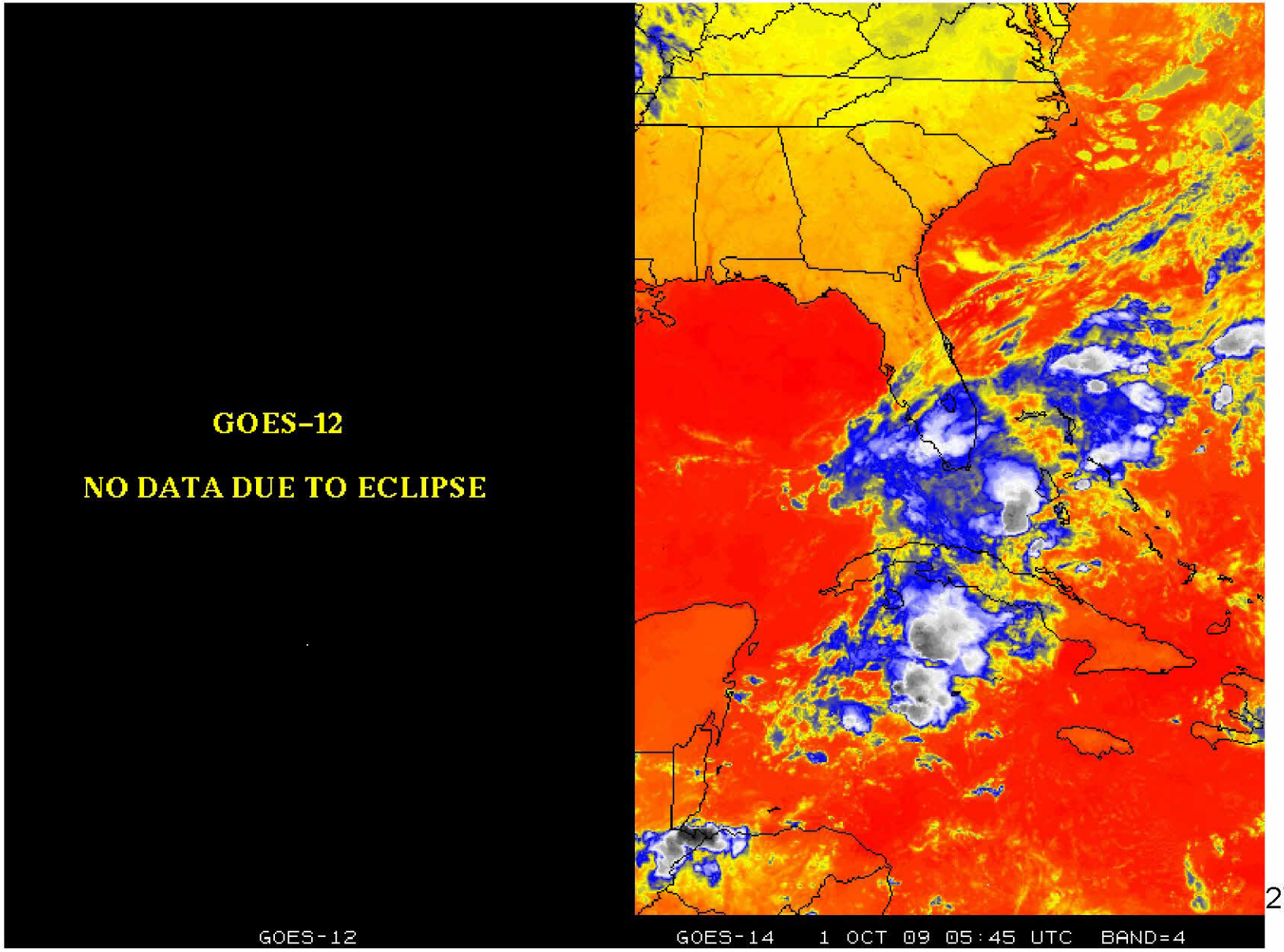
Improved INR



Great navigation just after satellite yaw-flip

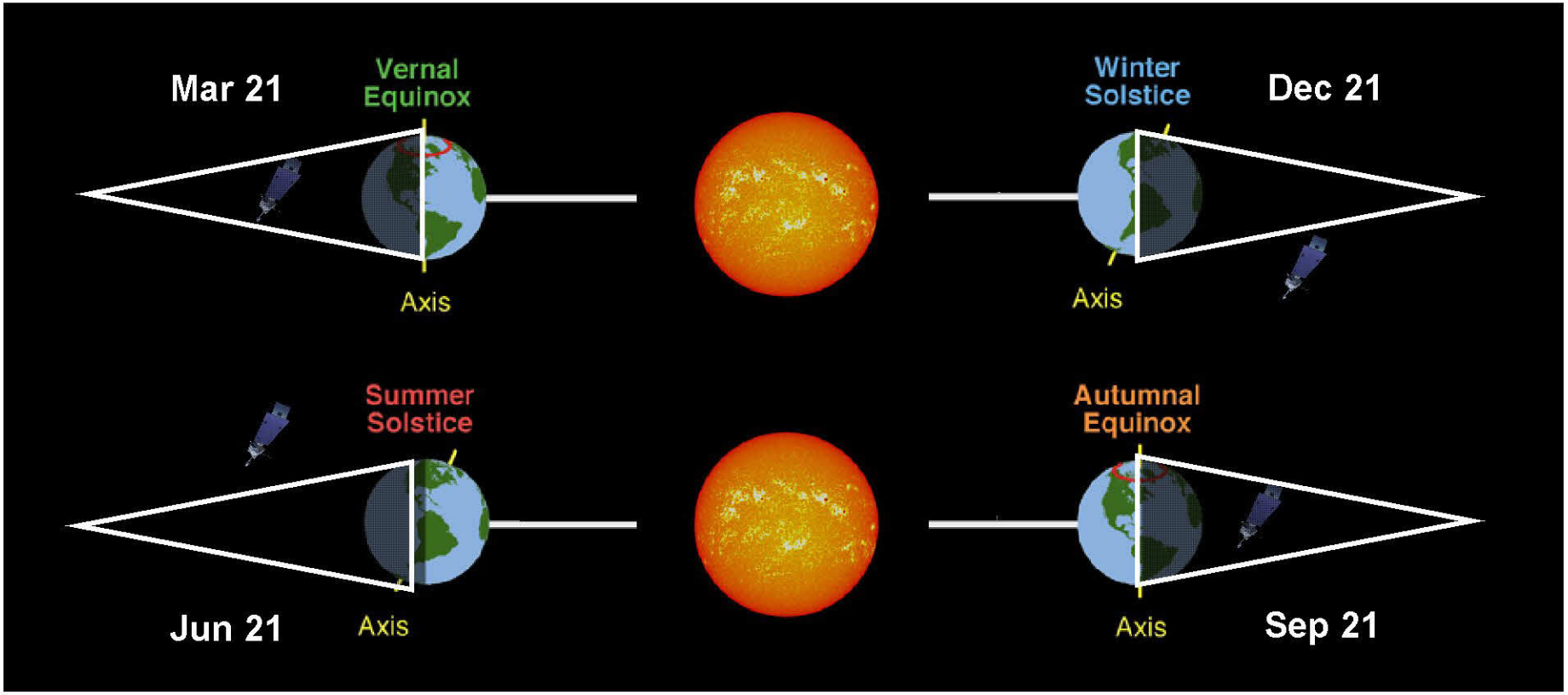


Operation through Eclipse



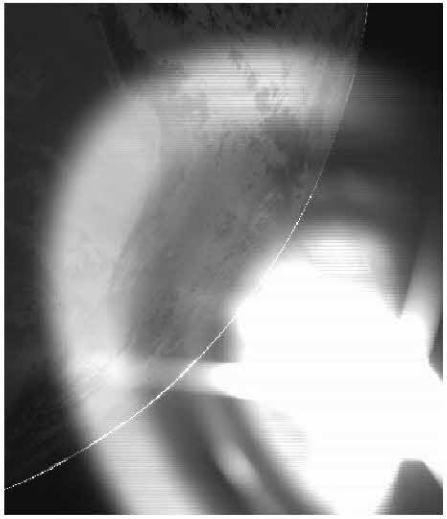
Eclipse Periods

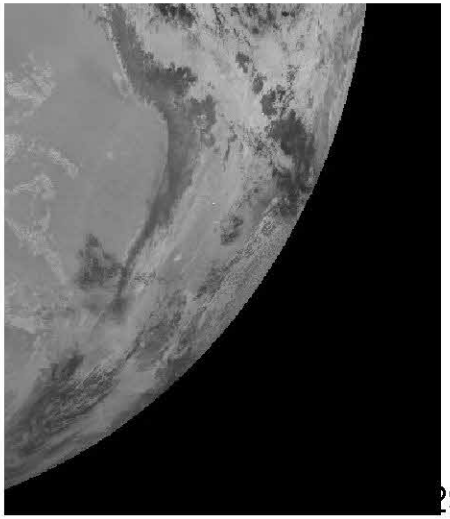
- GOES solar panels are blocked from sunlight up to 72 minutes/day
  - Insufficient power for instruments (GOES I/M series)
  - Can not image during daily eclipse (GOES I/M series) or Keep Out Zone (KOZ) (GOESI/M series) periods
- Midwest thunderstorm occur during Vernal Equinox
- Hurricane season occurs during Autumnal Equinox period



GOES-13 Schedules and Eclipse

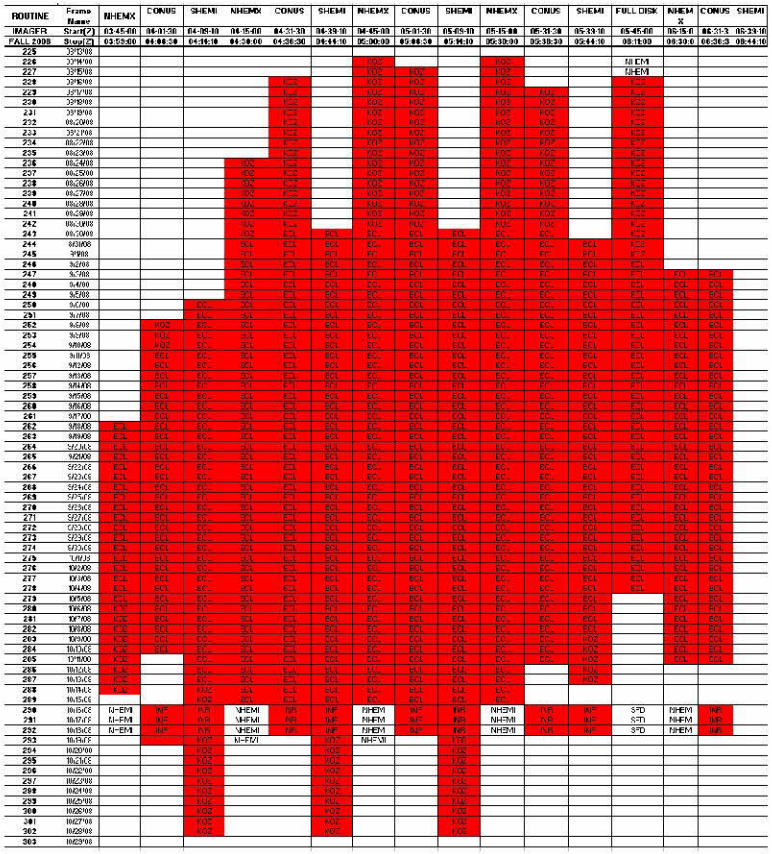
- GOES-13 operates with a slightly modified schedule:
  - GOES-East housekeeping moved from 1834Z to 1534Z
- Eclipse and "Stray Light Zone" (SLZ) Ops:
  - GOES-13 currently performing Partial Frame scans (imager) when the Sun is within 6 degrees.
  - NOAA/NASA and ITT working on an algorithm that would "clean" stray light from imagery:
    - Currently testing products such as Fire, CSBT, and other products that depend on band 2





Differences in Imager cancellations: GOES-12 and GOES-13

KOZ plus Eclipse cancellations (GOES-12 @ 75°W, KOZ @ 6° Sun)



Actual Spring 2010 cancellations on GOES-13 for KOZ only, including partial frame scans (in green)

IMAGER	Start(Z)	04:01:30	04:09:10	04:15:00	04:31:30	04:39:10	04:45:00	05:01:30	05:09:10	05:15:00	05:31:30	05:39:10	05:45:00	06:15:00	06:31:30
SPRING 2010	Stop(Z)	04:06:30	04:14:10	04:29:15	04:36:30	04:43:43	04:59:15	05:06:30	05:13:43	05:29:15	05:36:30	05:43:43	06:11:11	06:29:15	06:36:30
90	03/31/10				ECL		NHEMI	SLZ		PECL SLZ	CONUS-S	SHEMI-N	FDISK-S	NHEMX-S	
91	04/01/10				ECL		NHEMI	SLZ		PECL SLZ	CONUS-S	SHEMI-N	FDISK-S	NHEMX-S	
92	04/02/10				ECL		NHEMI	SLZ		PECL SLZ	CONUS-S	SHEMI-N	FDISK-S	NHEMX-S	
93	04/03/10				ECL		ECL	SLZ		PECL SLZ	CONUS-S	SHEMI-N	FDISK-S	NHEMX-S	
94	04/04/10				ECL		ECL	SLZ		PECL SLZ	ECL	ECL	ECL	SLZ	
95	04/05/10				ECL		ECL	SLZ		ECL	ECL	ECL	PECL	SLZ	
96	04/06/10				ECL		ECL	SLZ	PECL	ECL	ECL	ECL	PECL	SLZ	
97	04/07/10				ECL		ECL	SLZ	PECL	ECL	ECL	ECL	PECL	SLZ	
98	04/08/10				ECL		ECL	SLZ	PECL	ECL	ECL	ECL	PECL	SLZ	
99	04/09/10				ECL		ECL	SLZ	PECL	ECL	ECL	ECL	PECL	SLZ	
100	04/10/10				ECL		SLZ	SLZ	PECL	ECL	ECL	ECL	PECL	SLZ	
101	04/11/10				ECL		SLZ	SLZ	PECL	ECL	ECL	ECL	PECL SLZ	SLZ	
102	04/12/10				ECL		SLZ	SLZ		ECL	ECL	PECL	SLZ	SLZ	
103	04/13/10				ECL		SLZ	SLZ		PECL SLZ	PECL SLZ		SLZ	NHEMX-S	
104	04/14/10						SLZ	SLZ		SLZ	SLZ		SLZ	NHEMX-S	
105	04/15/10				CONUS-S		SLZ	SLZ		SLZ	SLZ		SLZ	NHEMX-S	
106	04/16/10				CONUS-S		SLZ	SLZ		SLZ	SLZ		SLZ	NHEMX-S	
107	04/17/10				CONUS-S		NHEMX-S	CONUS-S		NHEMX-S	CONUS-S		NHEMX-S		
108	04/18/10				CONUS-S		NHEMX-S	CONUS-S		NHEMX-S	CONUS-S		NHEMX-S		
109	04/19/10				CONUS-S		NHEMX-S	CONUS-S		NHEMX-S	CONUS-S		NHEMX-S		
110	04/20/10				CONUS-S		NHEMX-S	CONUS-S		NHEMX-S	CONUS-S		NHEMX-S		
111	04/21/10				CONUS-S		NHEMX-S	CONUS-S		NHEMX-S	CONUS-S		NHEMX-S		
112	04/22/10				CONUS-S		NHEMX-S	CONUS-S		NHEMX-S	CONUS-S		NHEMX-S		
113	04/23/10				CONUS-S		NHEMX-S	CONUS-S		NHEMX-S	CONUS-S		NHEMX-S		
114	04/24/10				CONUS-S		NHEMX-S	CONUS-S		NHEMX-S	CONUS-S		NHEMX-S		
115	04/25/10				CONUS-S		NHEMX-S	CONUS-S		NHEMX-S			NHEMX-S		
116	04/26/10				CONUS-S		NHEMX-S	CONUS-S		NHEMX-S			NHEMX-S		
117	04/27/10				CONUS-S		NHEMX-S	CONUS-S		NHEMX-S			NHEMX-S		
118	04/28/10						NHEMX-S			NHEMX-S			NHEMX-S		
119	04/29/10												NHEMX-S		
120	04/30/10														

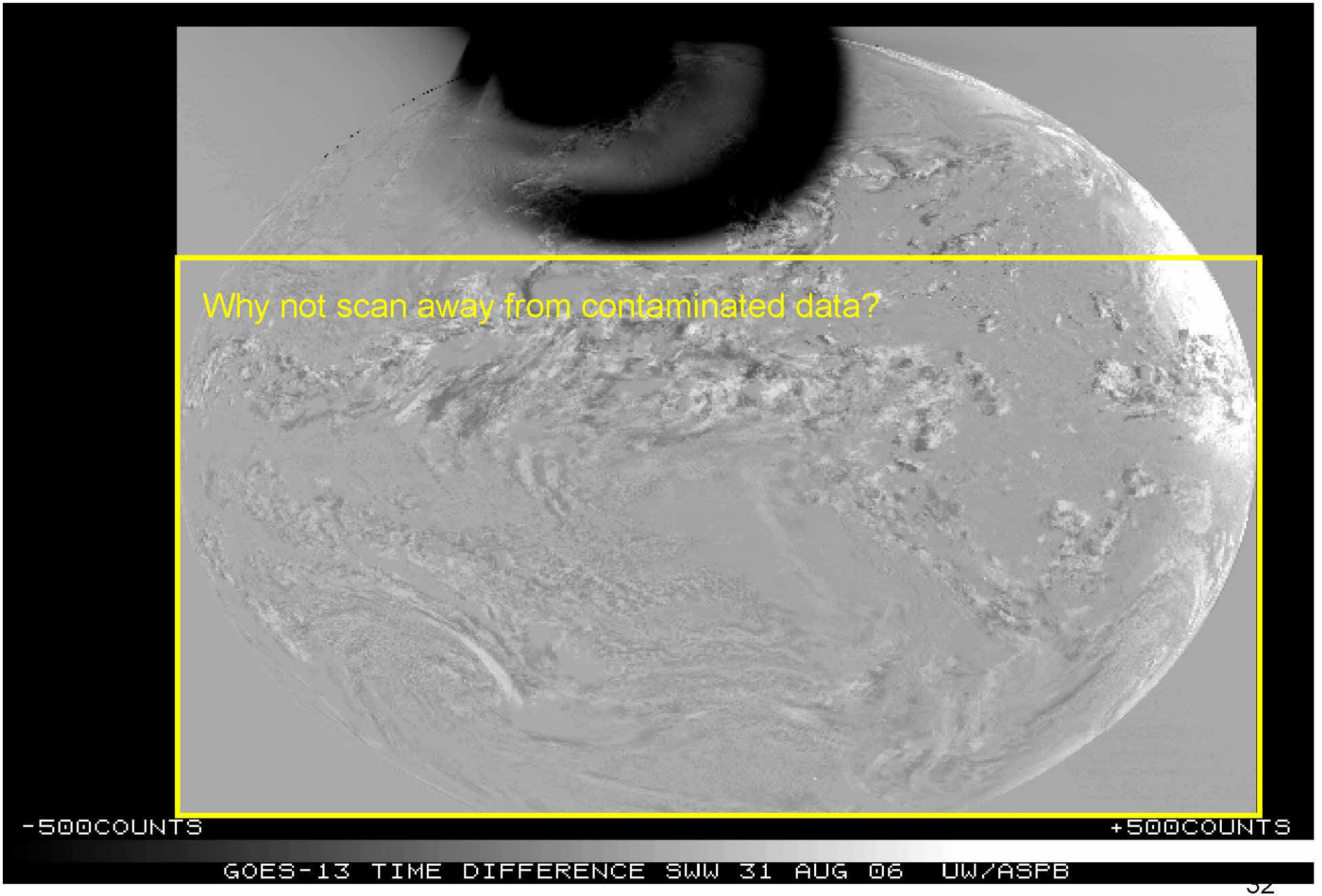
Differences in Sounder cancellations: GOES-12 and GOES-13

KOZ plus Eclipse cancellations (GOES-12 @ 75°W, KOZ @ 6° Sun)

SOUNDER FALL 2000	Frame Name Start(Z)	03:20:00	03:46:10	04:20:00	04:46:10	05:20:00	05:46:10	06:20:00	06:46:10
	Stop(Z)	03:45:00	04:19:00	04:45:00	05:19:00	05:45:00	06:19:00	06:45:00	07:19:00
230	08/18/08				KOZ				
231	08/19/08				KOZ				
232	08/20/08				KOZ				
233	08/21/08				KOZ				
234	08/22/08				KOZ				
235	08/23/08				KOZ				
236	08/24/08				KOZ				
237	08/25/08				KOZ				
238	08/26/08				KOZ				
239	08/27/08				KOZ				
240	08/28/08				KOZ				
241	08/29/08				KOZ				
242	08/30/08				KOZ				
243	08/30/00			ECL	ECL	ECL			
244	08/31/00			ECL	ECL	ECL			
245	9/1/00			ECL	ECL	ECL			
246	9/2/00			ECL	ECL	ECL	ECL		
247	9/3/08			ECL	ECL	ECL	ECL	ECL	
248	9/4/08			ECL	ECL	ECL	ECL	ECL	
249	9/5/08			ECL	ECL	ECL	ECL	ECL	
250	9/6/08		ECL	ECL	ECL	ECL	ECL	ECL	
251	9/7/08		ECL	ECL	ECL	ECL	ECL	ECL	
252	9/8/08		ECL	ECL	ECL	ECL	ECL	ECL	
253	9/9/08		ECL	ECL	ECL	ECL	ECL	ECL	
254	9/10/08		ECL	ECL	ECL	ECL	ECL	ECL	
255	9/11/08		ECL	ECL	ECL	ECL	ECL	ECL	
256	9/12/08		ECL	ECL	ECL	ECL	ECL	ECL	
257	9/13/08		ECL	ECL	ECL	ECL	ECL	ECL	
258	9/14/08		ECL	ECL	ECL	ECL	ECL	ECL	
259	9/15/08		ECL	ECL	ECL	ECL	ECL	ECL	
260	9/16/00		ECL	ECL	ECL	ECL	ECL	ECL	
261	9/17/08		ECL	ECL	ECL	ECL	ECL	ECL	
262	9/18/00		ECL	ECL	ECL	ECL	ECL	ECL	
263	9/19/08		ECL	ECL	ECL	ECL	ECL	ECL	
264	9/20/08		ECL	ECL	ECL	ECL	ECL	ECL	
265	9/21/08		ECL	ECL	ECL	ECL	ECL	ECL	
266	9/22/08		ECL	ECL	ECL	ECL	ECL	ECL	
267	9/23/08		ECL	ECL	ECL	ECL	ECL	ECL	
268	9/24/08		ECL	ECL	ECL	ECL	ECL	ECL	
269	9/25/08		ECL	ECL	ECL	ECL	ECL	ECL	
270	9/26/08		ECL	ECL	ECL	ECL	ECL	ECL	
271	9/27/08		ECL	ECL	ECL	ECL	ECL	ECL	
272	9/28/08		ECL	ECL	ECL	ECL	ECL	ECL	
273	9/29/08		ECL	ECL	ECL	ECL	ECL	ECL	
274	9/30/08		ECL	ECL	ECL	ECL	ECL	ECL	
275	10/1/08		ECL	ECL	ECL	ECL	ECL	ECL	
276	10/2/08		ECL	ECL	ECL	ECL	ECL	ECL	
277	10/3/08		ECL	ECL	ECL	ECL	ECL	ECL	
278	10/4/08		ECL	ECL	ECL	ECL		ECL	
279	10/5/08		ECL	ECL	ECL	ECL		ECL	
280	10/6/08		ECL	ECL	ECL	ECL		ECL	
281	10/7/08		ECL	ECL	ECL	ECL		ECL	
282	10/8/08		ECL	ECL	ECL	ECL		ECL	
283	10/9/08		ECL	ECL	ECL	ECL		ECL	
284	10/10/00		ECL	ECL	ECL	ECL		ECL	
285	10/11/00		ECL	ECL	ECL	ECL		ECL	
286	10/12/00		ECL	ECL	ECL	ECL			
287	10/13/00		ECL	ECL	ECL	ECL			
288	10/14/08			ECL	ECL	ECL			
289	10/15/08			ECL	ECL				
290	10/16/08			INR		INR		INR	
291	10/17/08			INR		INR		INR	
292	10/18/08			INR		INR		INR	

Actual Spring 2010 cancellations on GOES-13 for KOZ only

GOES-E SOUNDER SPRING 2010	Frame Name Start(Z)	MEX/HUR1 03:20:00	DNUS/ASO 3:46:10	MEX/HUR1 4:20:00	DNUS/ASO 4:46:10	MEX/HUR1 5:20:00	DNUS/ASO 5:46:10	MEX/HUR1 6:20:00	DNUS/ASO 6:46:10	NATLANT 8:20:00
	Stop(Z)	03:41:06	4:15:38	4:41:06	5:15:38	5:41:06	6:15:38	6:41:06	7:15:38	8:41:06
90	03/31/10				ECL	PECL SLZ	ECL	PECL		ECL
91	04/01/10				ECL	ECL	ECL	PECL		ECL
92	04/02/10				ECL	ECL	ECL			ECL
93	04/03/10				ECL	ECL	ECL			ECL
94	04/04/10				ECL	ECL	PECL SLZ			ECL
95	04/05/10				ECL	ECL	PECL SLZ			ECL
96	04/06/10				ECL	ECL	PECL SLZ			ECL
97	04/07/10				ECL	ECL	PECL SLZ			ECL
98	04/08/10				ECL	ECL	PECL SLZ			ECL
99	04/09/10				ECL	ECL	PECL SLZ			ECL
100	04/10/10			GMEX lim	PECL SLZ	ECL	PECL KOZ			ECL
101	04/11/10			GMEX lim	PECL SLZ	ECL	SLZ			ECL
102	04/12/10			GMEX lim	PECL SLZ	ECL	SLZ			ECL
103	04/13/10			GMEX lim	SLZ	ECL	SLZ			ECL
104	04/14/10				SLZ	SLZ	SLZ			
105	04/15/10				SLZ	SLZ	SLZ			
106	04/16/10				SLZ	SLZ	SLZ			
107	04/17/10				SLZ					
108	04/18/10				SLZ					
109	04/19/10				SLZ					
110	04/20/10				SLZ					
111	04/21/10				SLZ					
112	04/22/10				SLZ					
113	04/23/10				SLZ					
114	04/24/10				SLZ					
115	04/25/10				SLZ					
116	04/26/10									
117	04/27/10									
118	04/28/10									

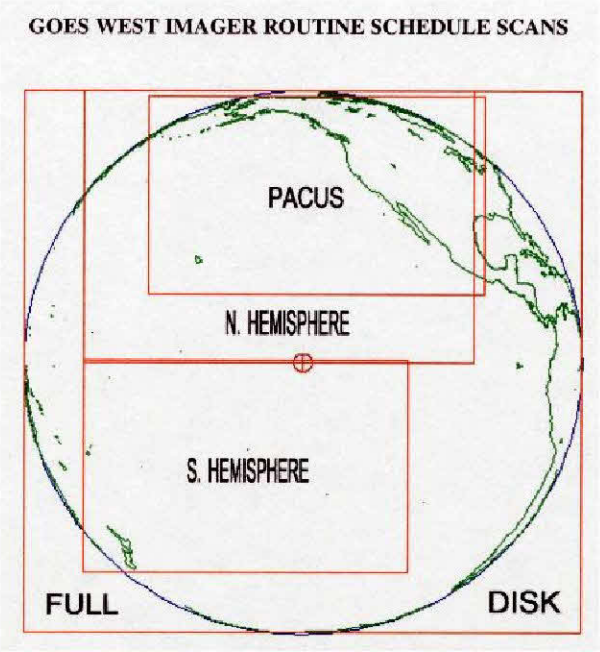

Why not scan away from contaminated data?
-500COUNTS
+500COUNTS
GOES-13 TIME DIFFERENCE SWW 31 AUG 06 UW/ASPB

GOES N/O/P SLZ Summary

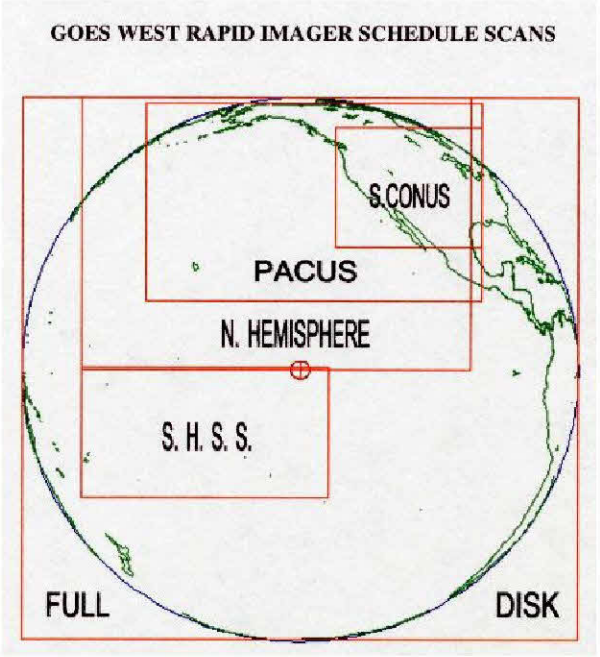
- In summary, current probable path:
  - Correct the frames when sun < 6 degrees and > 3 degrees
  - Cancel or create partial frames when sun < 3 degrees.
    - Still saves 75% of the "Keep Out Zone" frames from I-M series.
- Comments or suggestions?

GOES-West Schedules

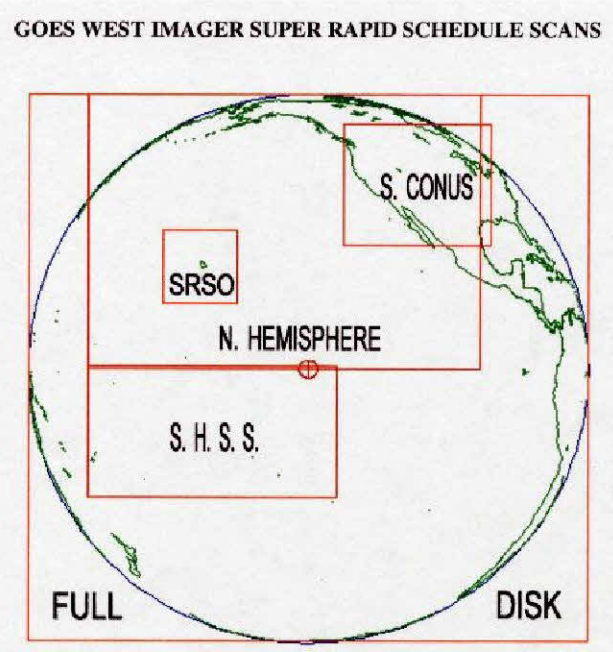
Routine



RSO



SRSO

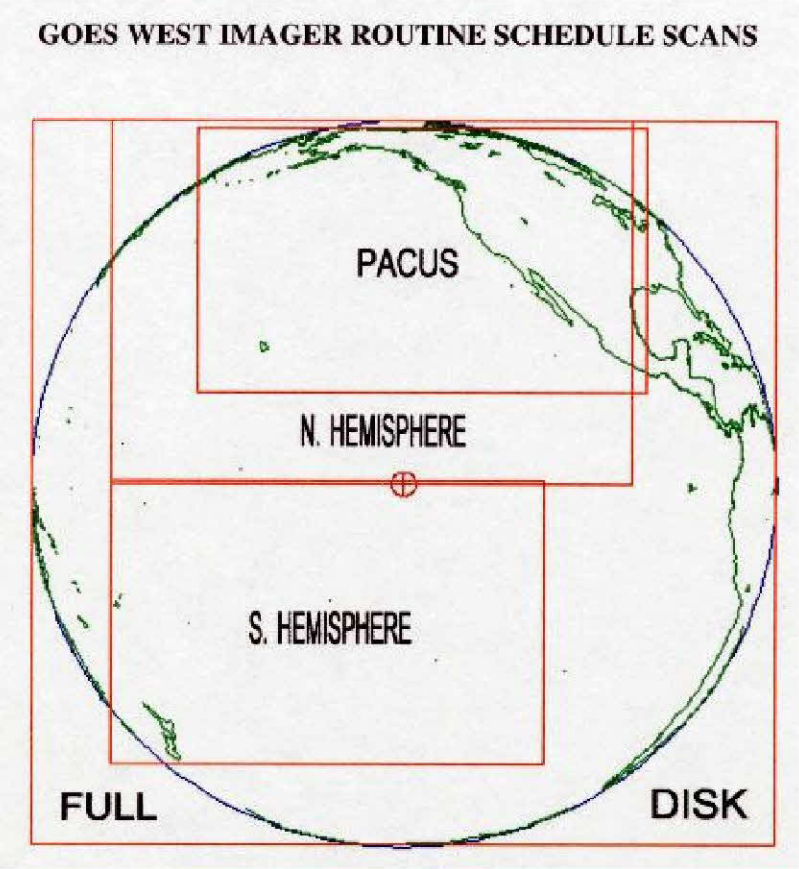


Note - SRSO sector here is an example
Sectors are called by center point
latitude /longitude

http://www.ssd.noaa.gov/PS/SATS/GOES/WEST/sched.html

Routine Operations

GOES West Imager Routine Scan Operations



UTC Time / Sector / Time of Sector (schedule repeats every 3 hours)

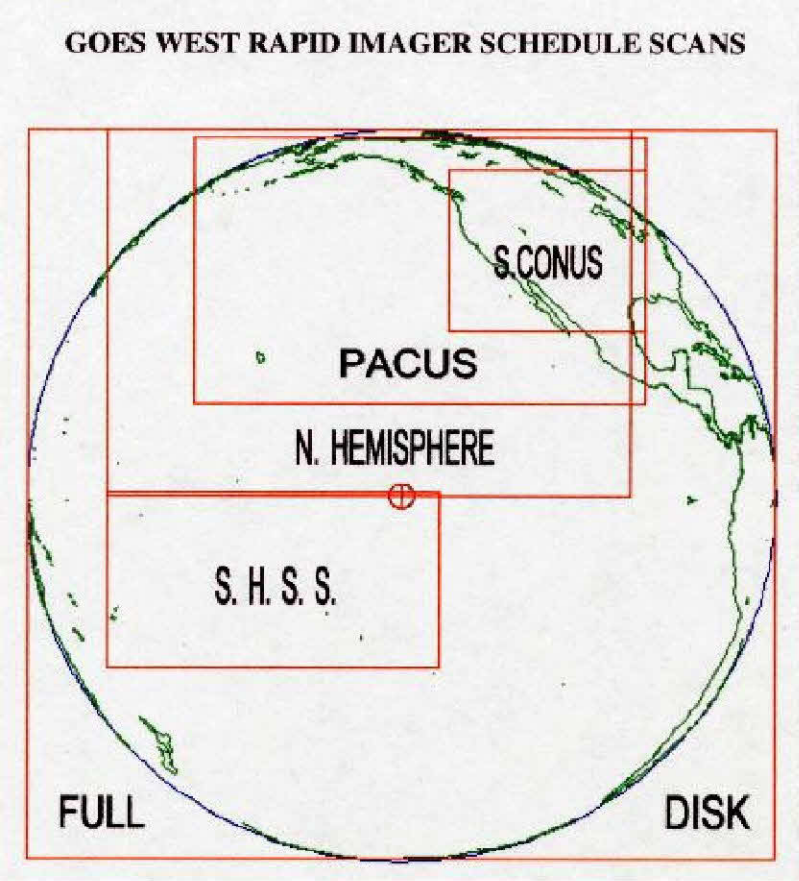
03:00:00.0 FULL DISK 26:06
03:30:00.0 WEST NORTHERN HEMISPHERE 10:15
04:00:00.0 WEST NORTHERN HEMISPHERE 10:15
04:15:00.0 PACIFIC U.S. (PACUS) 6:35
04:21:55.0 WEST SOUTHERN HEMISPHERE 7:00
04:30:00.0 WEST NORTHERN HEMISPHERE 10:15
04:45:00.0 PACIFIC U.S. (PACUS) 6:35
04:51:55.0 WEST SOUTHERN HEMISPHERE 7:00
05:00:00.0 WEST NORTHERN HEMISPHERE 10:15
05:15:00.0 PACIFIC U.S. (PACUS) 6:35
05:21:55.0 WEST SOUTHERN HEMISPHERE 7:00
05:30:00.0 WEST NORTHERN HEMISPHERE 10:15
05:45:00.0 PACIFIC U.S. (PACUS) 6:35
05:51:55.0 WEST SOUTHERN HEMISPHERE 7:00
06:00:00.0 FULL DISK 26:06
02:45:00.0 FULL DISK 26:06

Nominal - 4 PACUS Views per Hour

This image and more found at
http://www.ssd.noaa.gov/PS/SATS/GOES/WEST/sched.html

Rapid Scan Operations

GOES West Imager Rapid Scan Operations



UTC Time / Sector / Time of Sector (schedule repeats every 3 hours)

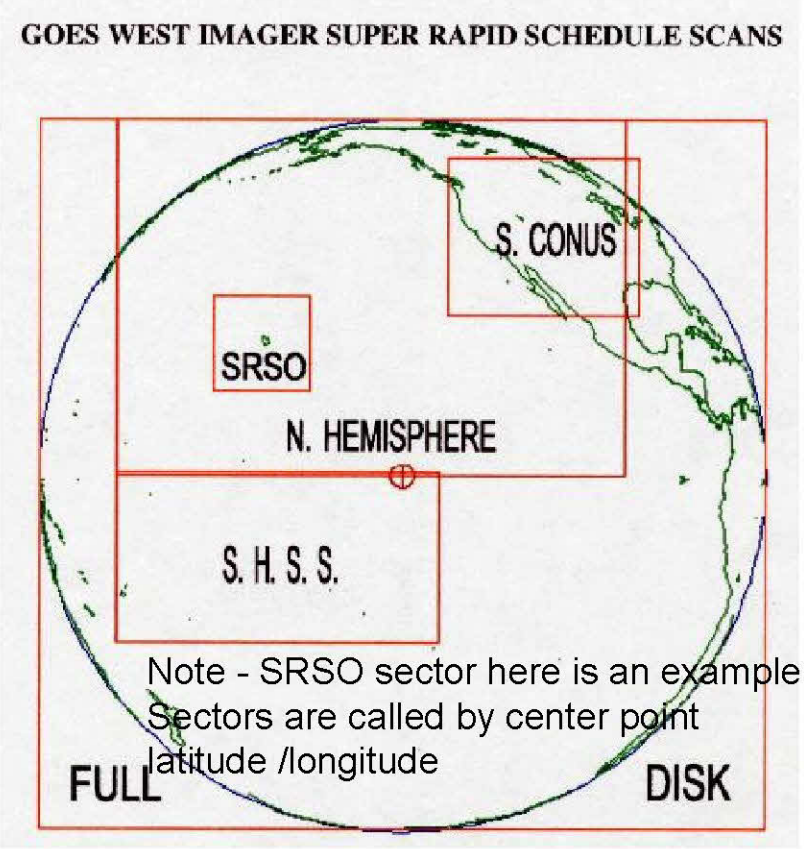
03:00:00.0 FULL DISK 26:06
03:30:00.0 NORTHERN HEMISPHERE 10:15
03:40:30.0 CONTINENTAL US (SUB-CONUS) 2:18
04:00:00.0 NORTHERN HEMISPHERE 10:15
04:10:30.0 CONTINENTAL US (SUB-CONUS) 2:18
04:16:00.0 PACIFIC U.S. (PACUS) 6:35
04:22:50.0 CONTINENTAL US (SUB-CONUS) 2:18
04:25:20.0 SOUTHERN HEMISPHERE S.S. 3:34
04:30:00.0 NORTHERN HEMISPHERE 10:15
04:40:30.0 CONTINENTAL US (SUB-CONUS) 2:18
04:46:00.0 PACIFIC U.S. (PACUS) 6:35
04:52:50.0 CONTINENTAL US (SUB-CONUS) 2:18
05:00:00.0 NORTHERN HEMISPHERE 10:15
05:10:30.0 CONTINENTAL US (SUB-CONUS) 2:18
05:16:00.0 PACIFIC U.S. (PACUS) 6:35
05:22:50.0 CONTINENTAL US (SUB-CONUS) 2:18
05:25:20.0 SOUTHERN HEMISPHERE S.S. 3:34
05:30:00.0 NORTHERN HEMISPHERE 10:15
05:40:30.0 CONTINENTAL US (SUB-CONUS) 2:18
05:46:00.0 PACIFIC U.S. (PACUS) 6:35
05:52:50.0 CONTINENTAL US (SUB-CONUS) 2:18
06:00:00.0 FULL DISK 26:06

Nominal - 8 Sub CONUS Views per Hour

This image and more found at
http://www.ssd.noaa.gov/PS/SATS/GOES/WEST/sched.html

Super Rapid Scan Operations

GOES West Imager Super Rapid Scan Operations



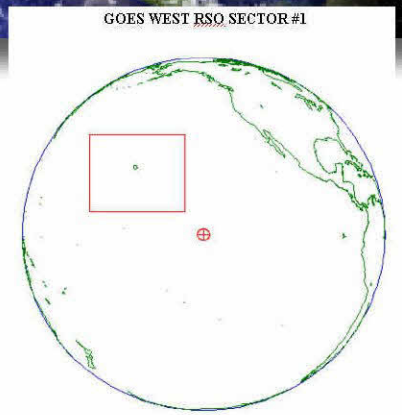
UTC Time / Sector / Time of Sector (schedule repeats every 3 hours) – Note – SRSO Sectors of 2:00, 4:00 or 6:00 minutes, are 2, 4, or 6 individual 1 minute sectors resectively

03:00:00.0 FULL DISK 26:06
03:30:00.0 NORTHERN HEMISPHERE 10:15
03:40:30.0 SRSO SECTOR 2:00
04:00:00.0 NORTHERN HEMISPHERE 10:15
04:10:30.0 SRSO SECTOR 4:00
04:15:00.0 CONTINENTAL US (SUB-CONUS) 2:18
04:18:00.0 SRSO SECTOR 8:00
04:30:00.0 NORTHERN HEMISPHERE 10:15
04:40:30.0 S. HEMI SS 3:36
04:45:00.0 CONTINENTAL US (SUB-CONUS) 2:18
04:48:00.0 SRSO SECTOR 6:00
05:00:00.0 NORTHERN HEMISPHERE 10:15
05:10:30.0 SRSO SECTOR 4:00
05:15:00.0 CONTINENTAL US (SUB-CONUS) 2:18
05:18:00.0 SRSO SECTOR 8:00
05:30:00.0 NORTHERN HEMISPHERE 10:15
05:40:30.0 S. HEMI SS 3:36
05:45:00.0 CONTINENTAL US (SUB-CONUS) 2:18
05:48:00.0 SRSO SECTOR 6:00
06:00:00.0 FULL DISK 26:06

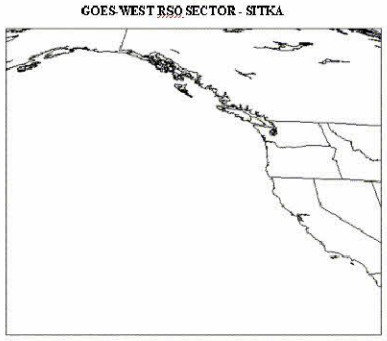
This image and more found at
http://www.ssd.noaa.gov/PS/SATS/GOES/WEST/sched.html

Nominal - 4 Sub CONUS Views per Hour

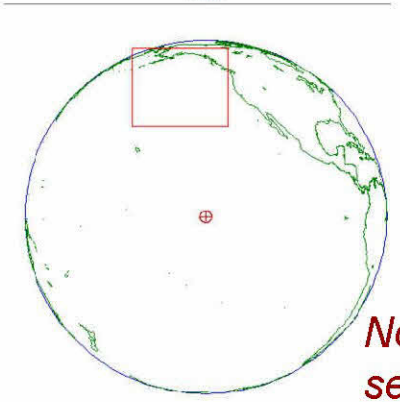
Other GOES-West Rapid Scan Sectors



Hawaii



Sitka



Alaska or TPARC

Other RSO (Hawaii, Alaska, Sitka) - ~7.5 minute repeat (HH:11, HH:23, HH:41, HH:53, others carved from PACUS or NHEM (8 per hour) Takes the place of the additional SubCONUS sectors in the regular RSO schedule

PACUS – 15 minute repeat (HH:16 and HH:46, other 2 carved from NHEM)

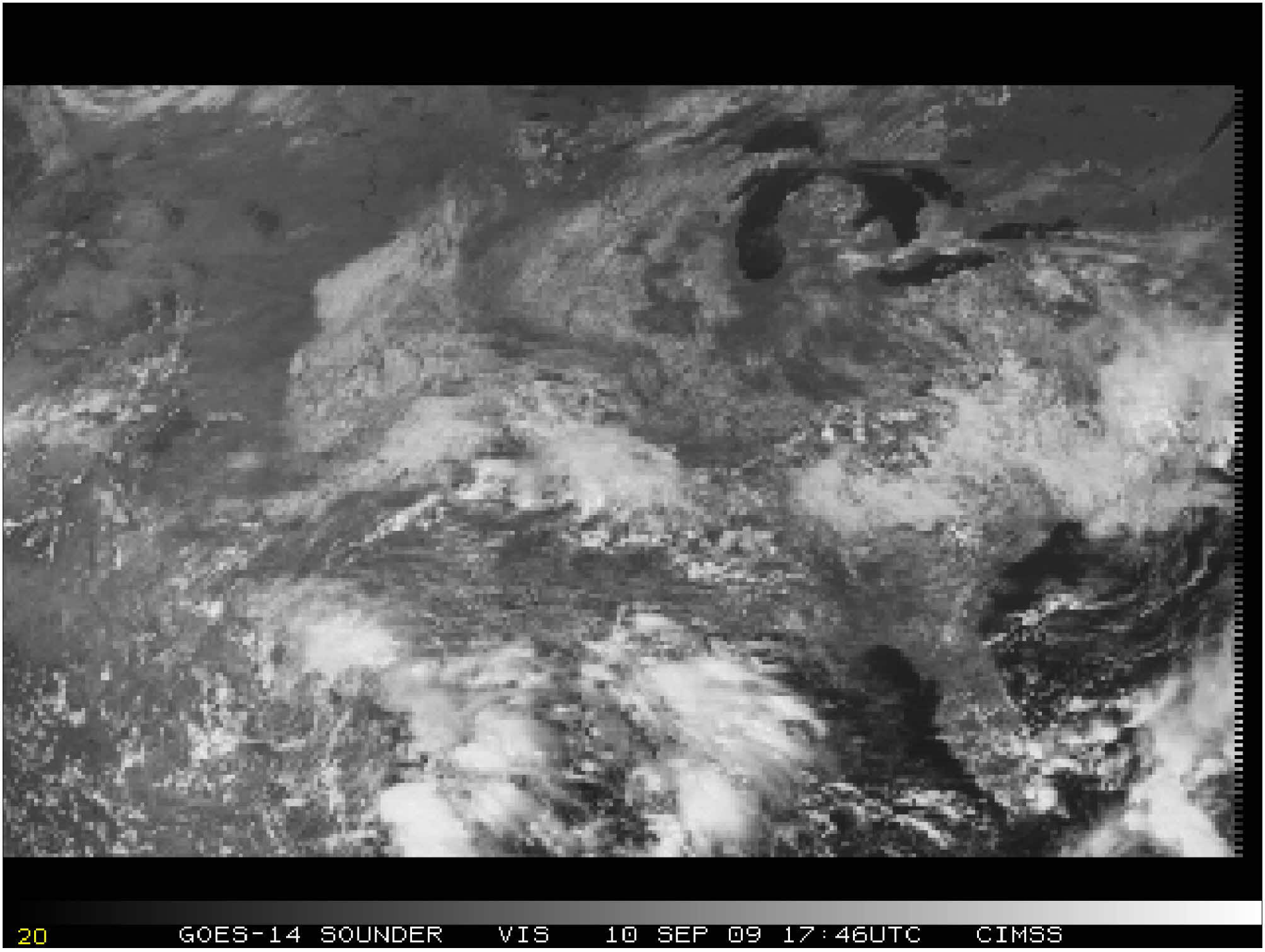
NHEM – 30 minute repeat (HH:00 and HH:30)

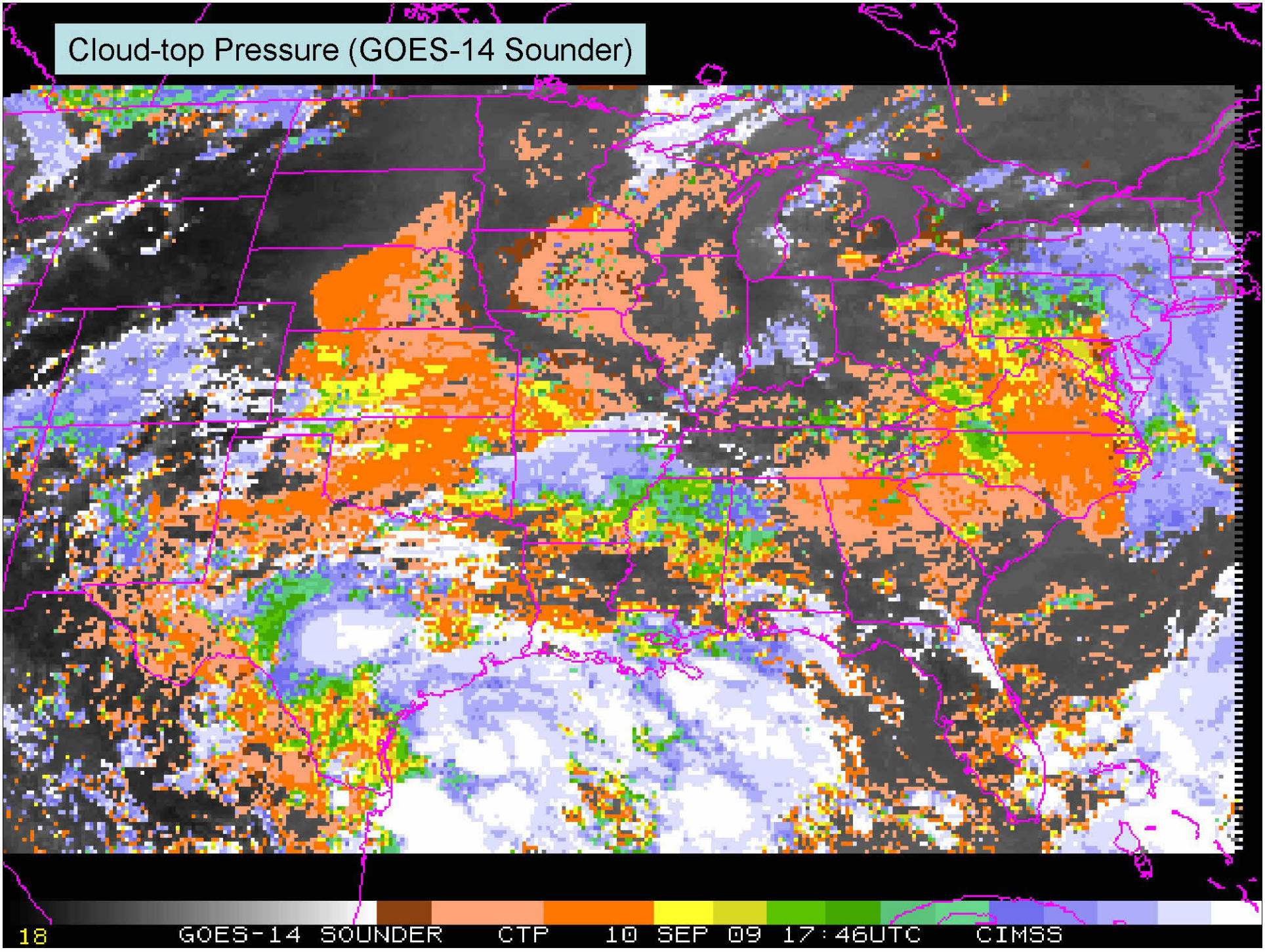
SHEM - 60 Minute repeat (HH:25)

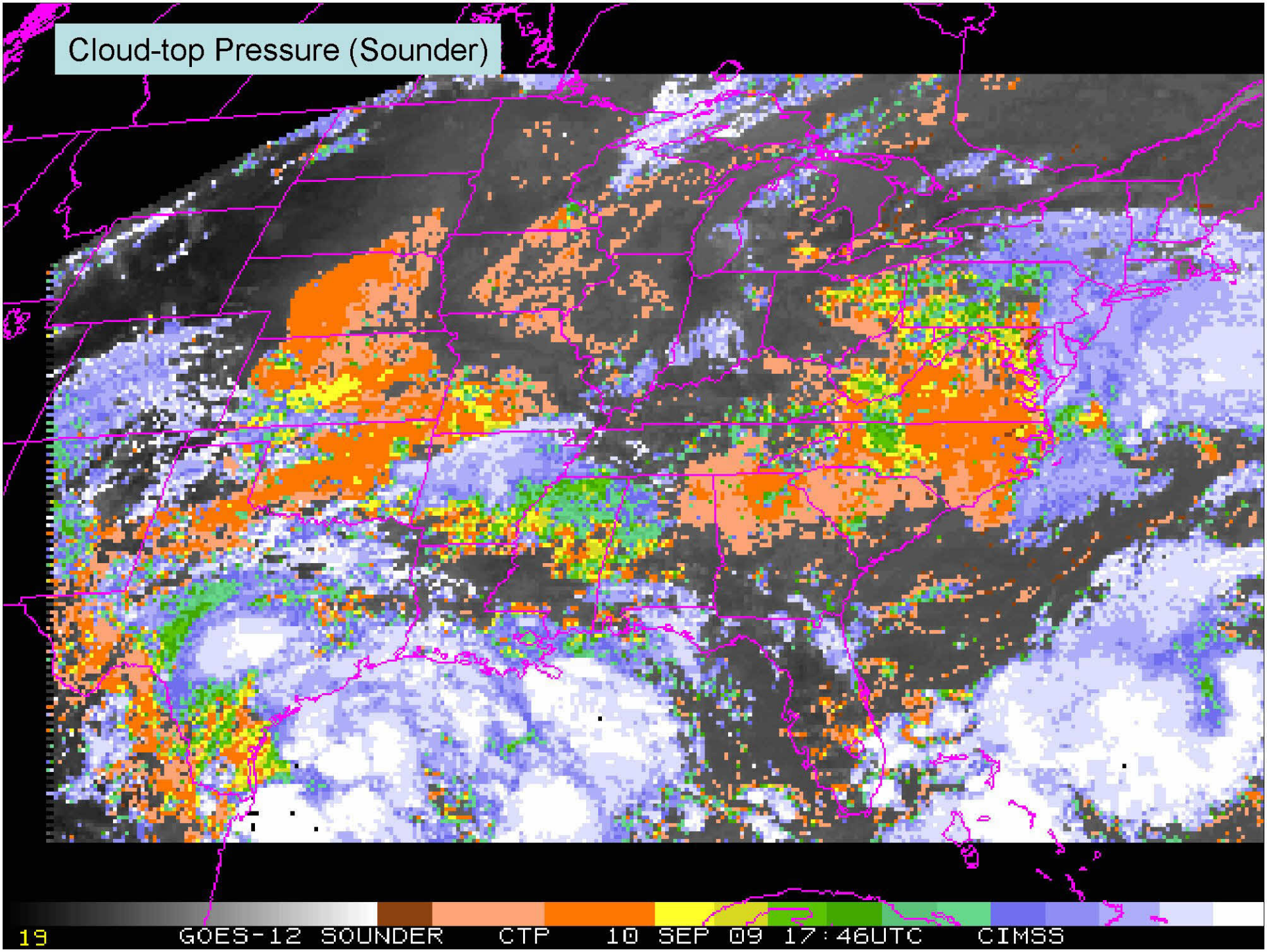
FULL Disk – 3 hour repeat (00:00, 03:00, 06:00 etc…)

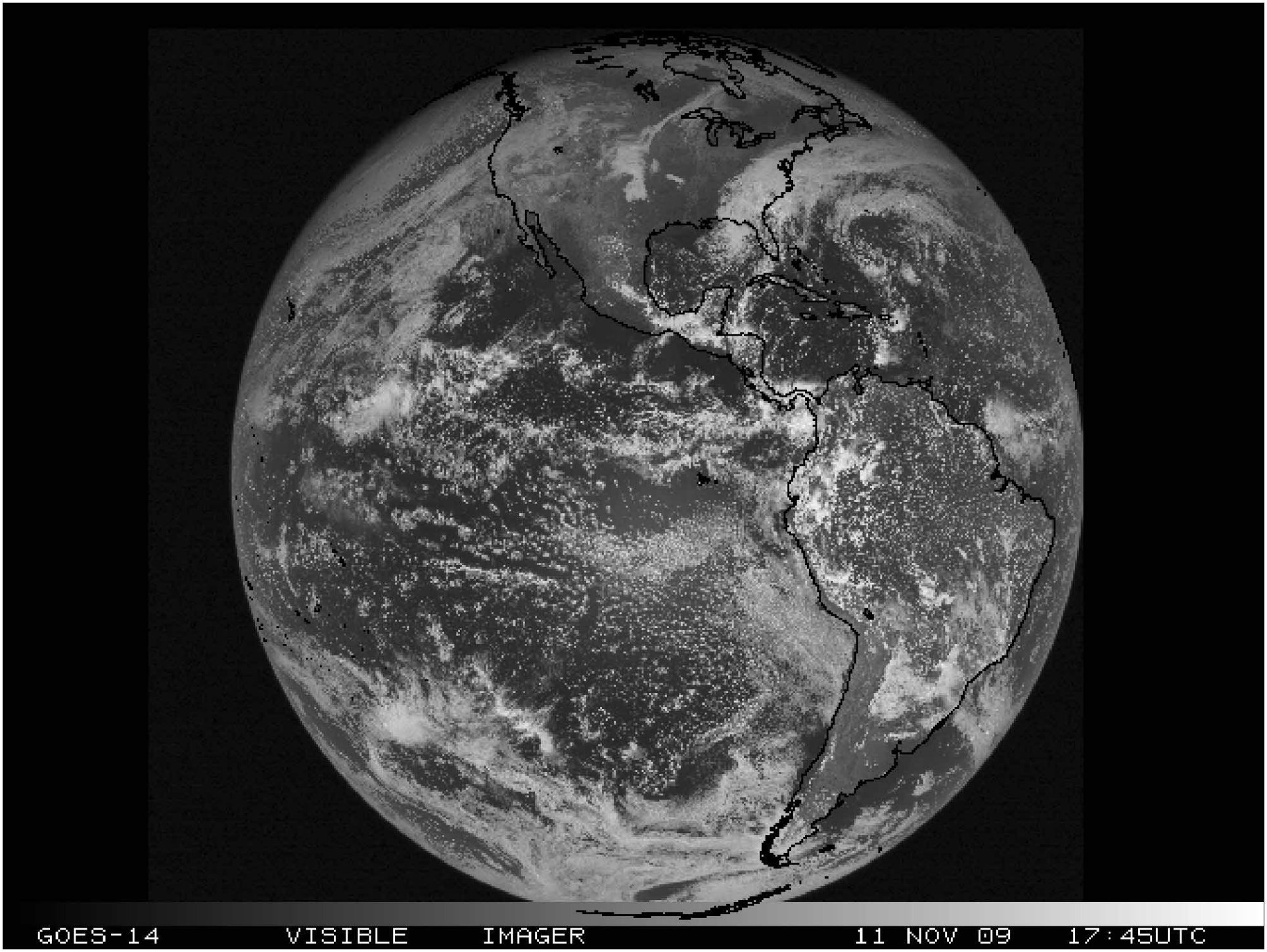
Nominal - 4 Sub CONUS Views per Hour

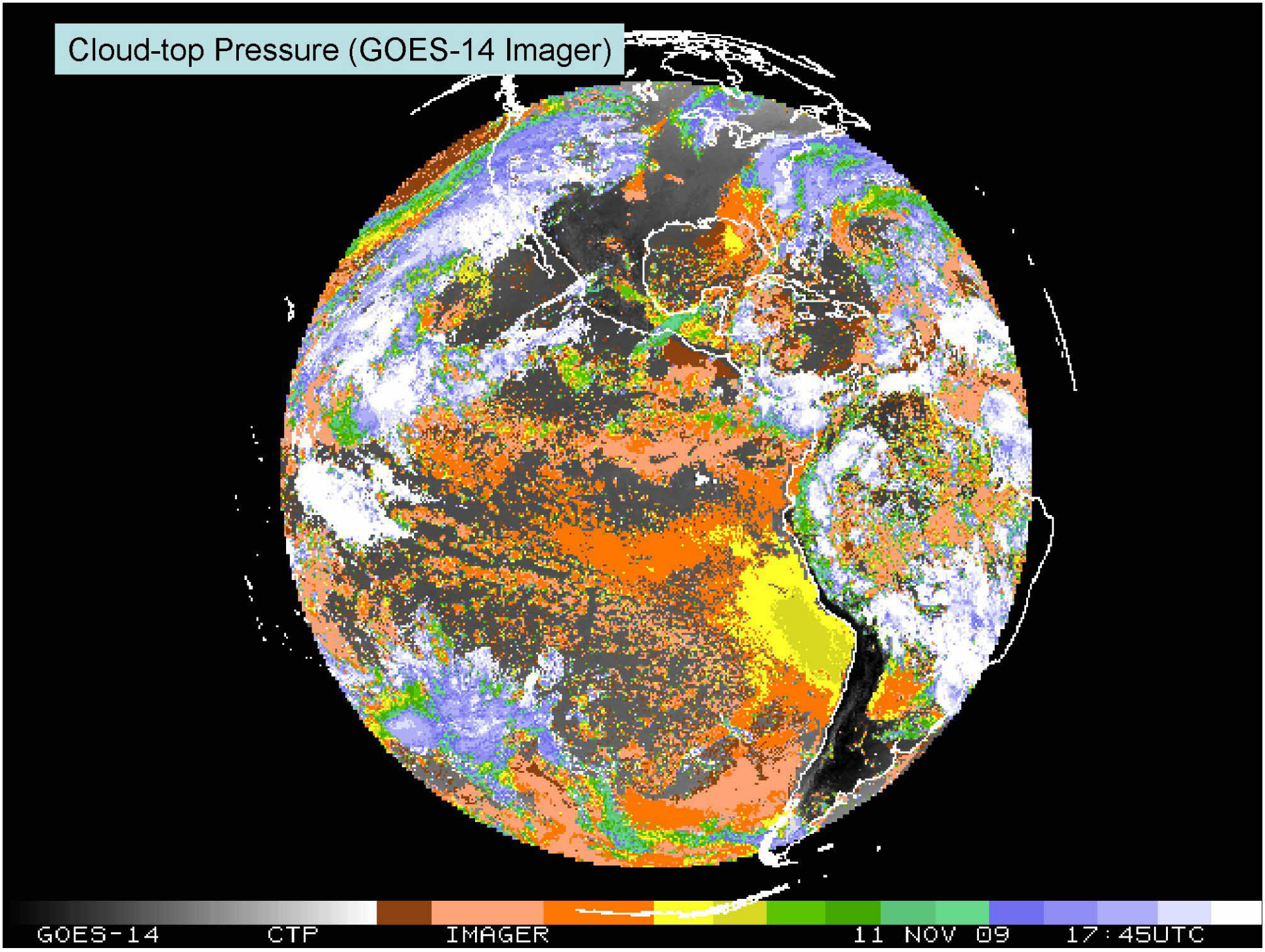
Note – Plans are in work for additional GOES-East alternate Rapid Scan sector to support Hurricane research and operations summer 2010

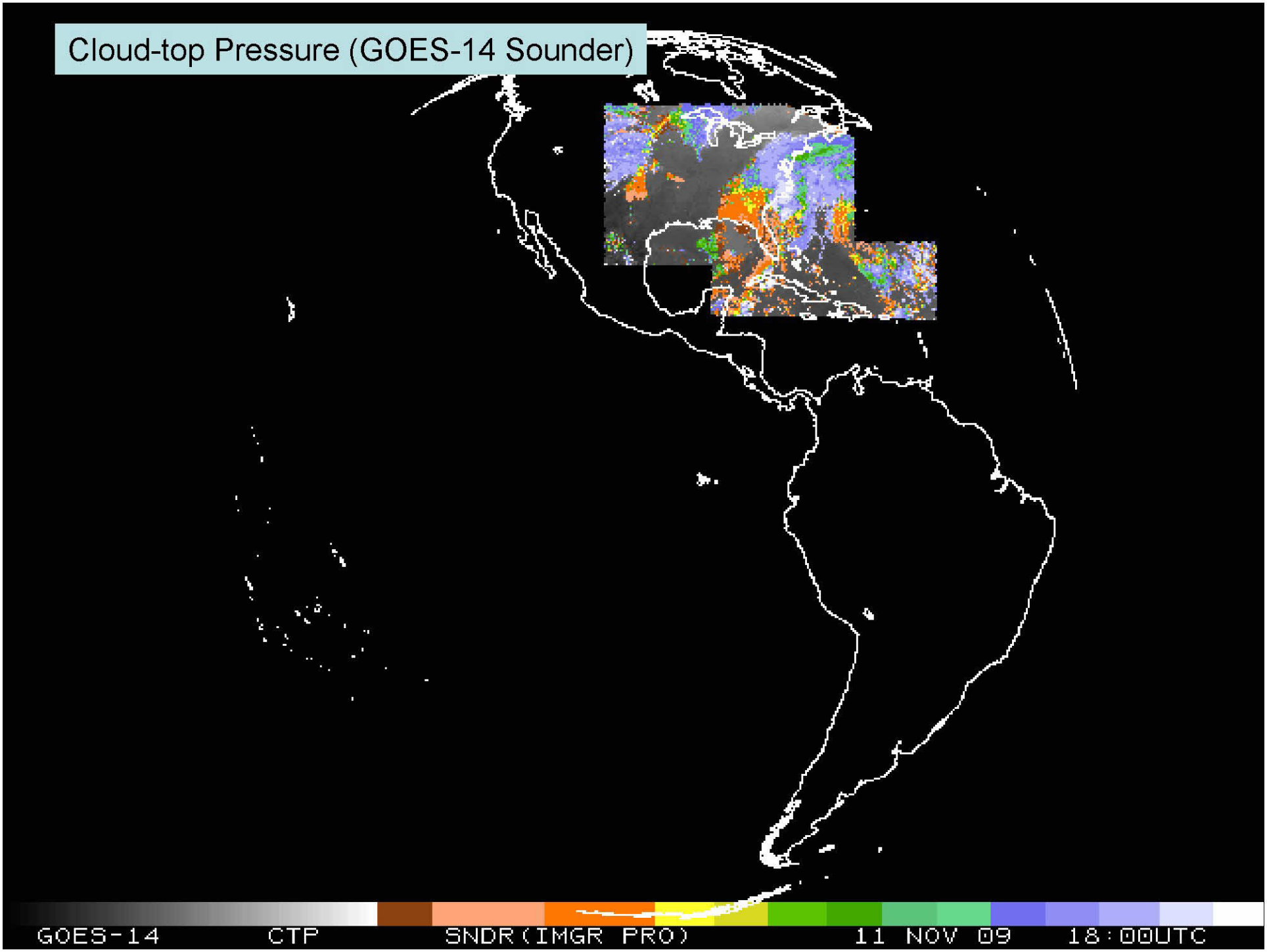

20
GOES-14 SOUNDER VIS 10 SEP 09 17:46UTC CIMSS

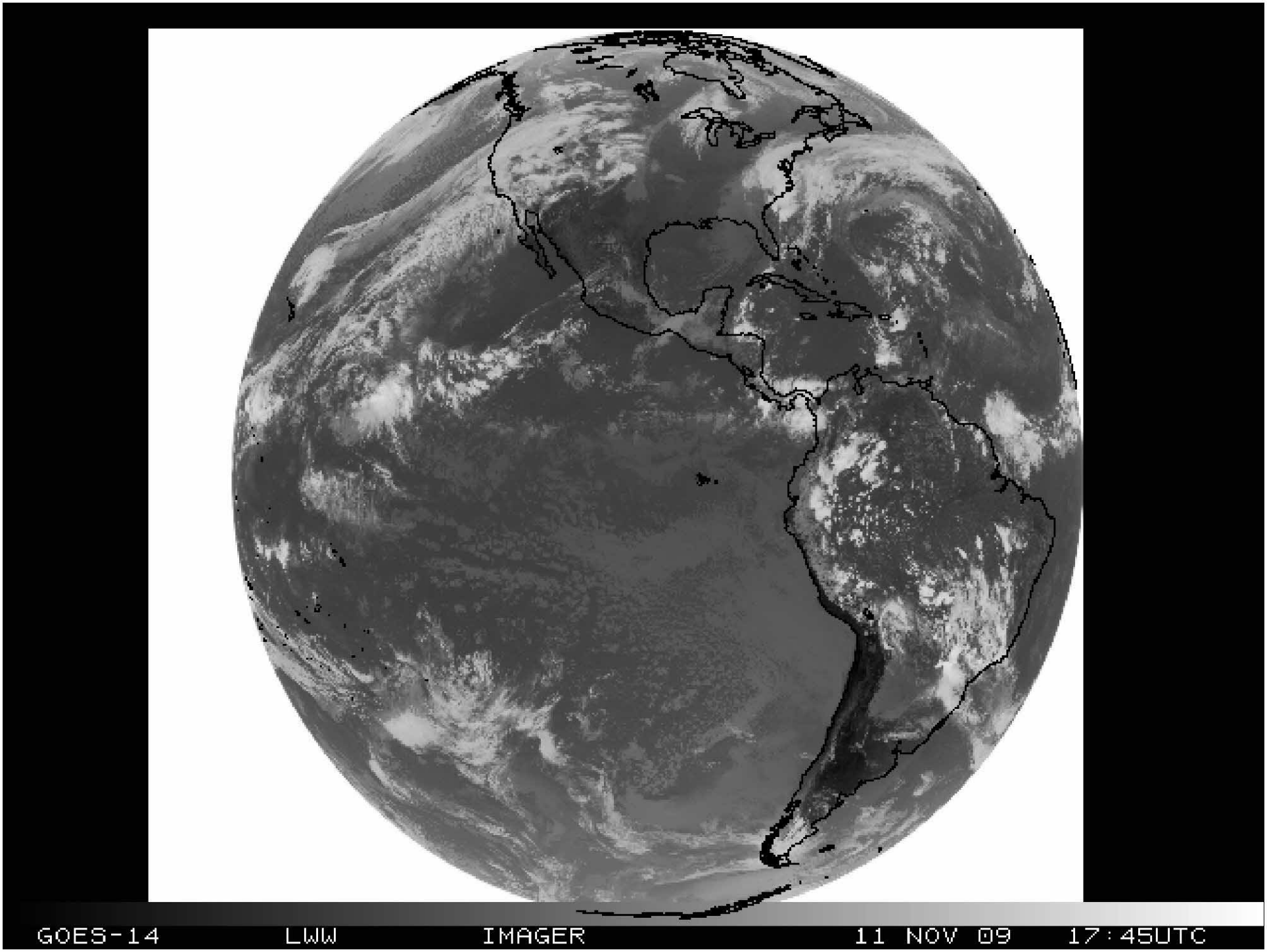

Cloud-top Pressure (GOES-14 Sounder)
18 GOES-14 SOUNDER CTP 10 SEP 09 17:46UTC CIMSS

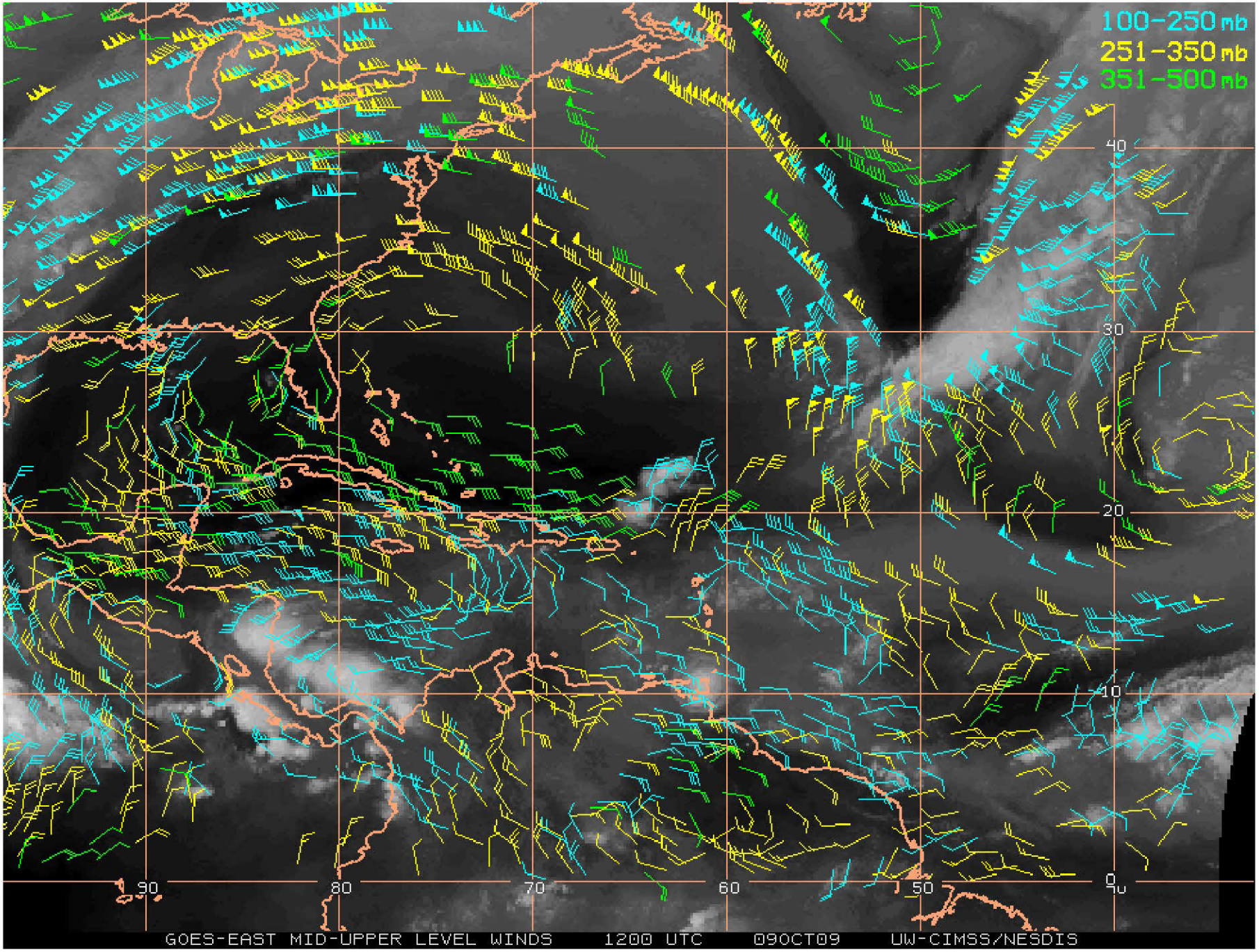

Cloud-top Pressure (Sounder)
19 GOES-12 SOUNDER CTP 10 SEP 09 17:46UTC CIMSS


GOES-14 VISIBLE IMAGER 11 NOV 09 17:45UTC


Cloud-top Pressure (GOES-14 Imager)
GOES-14 CTP IMAGER 11 NOV 09 17:45UTC

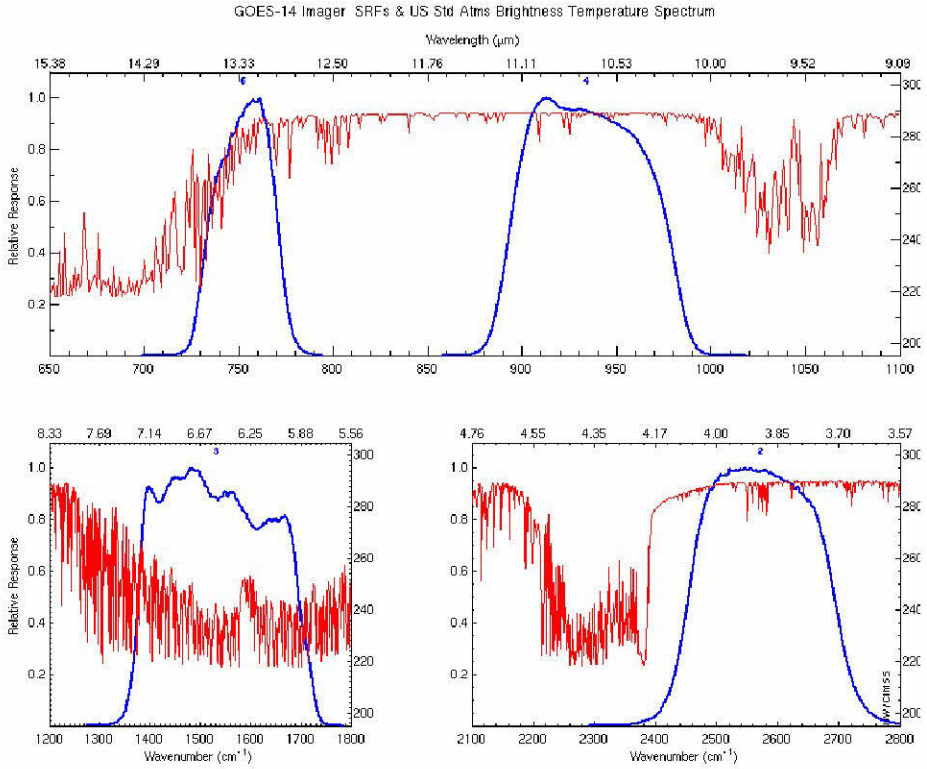

Cloud-top Pressure (GOES-14 Sounder)
GOES-14 CTP SNDR(IMGR PRO) 11 NOV 09 18:00UTC

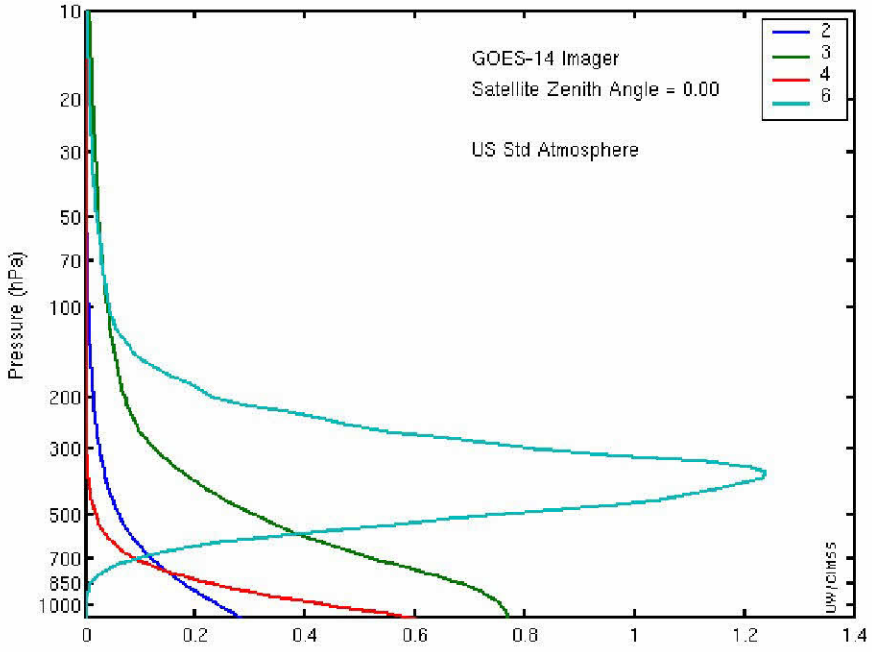

GOES-14 LWW IMAGER 11 NOV 09 17:45UTC


100-250 mb
251-350 mb
351-500 mb
40
30
20
10
0
90
80
70
60
50
GOES-EAST MID-UPPER LEVEL WINDS 1200 UTC 09OCT09 UW-CIMSS/NESDIS

SRF

- There will be updated imager and sounder GOES-14 spectral response functions (SRF) released (Rev F.). Check OSO page.



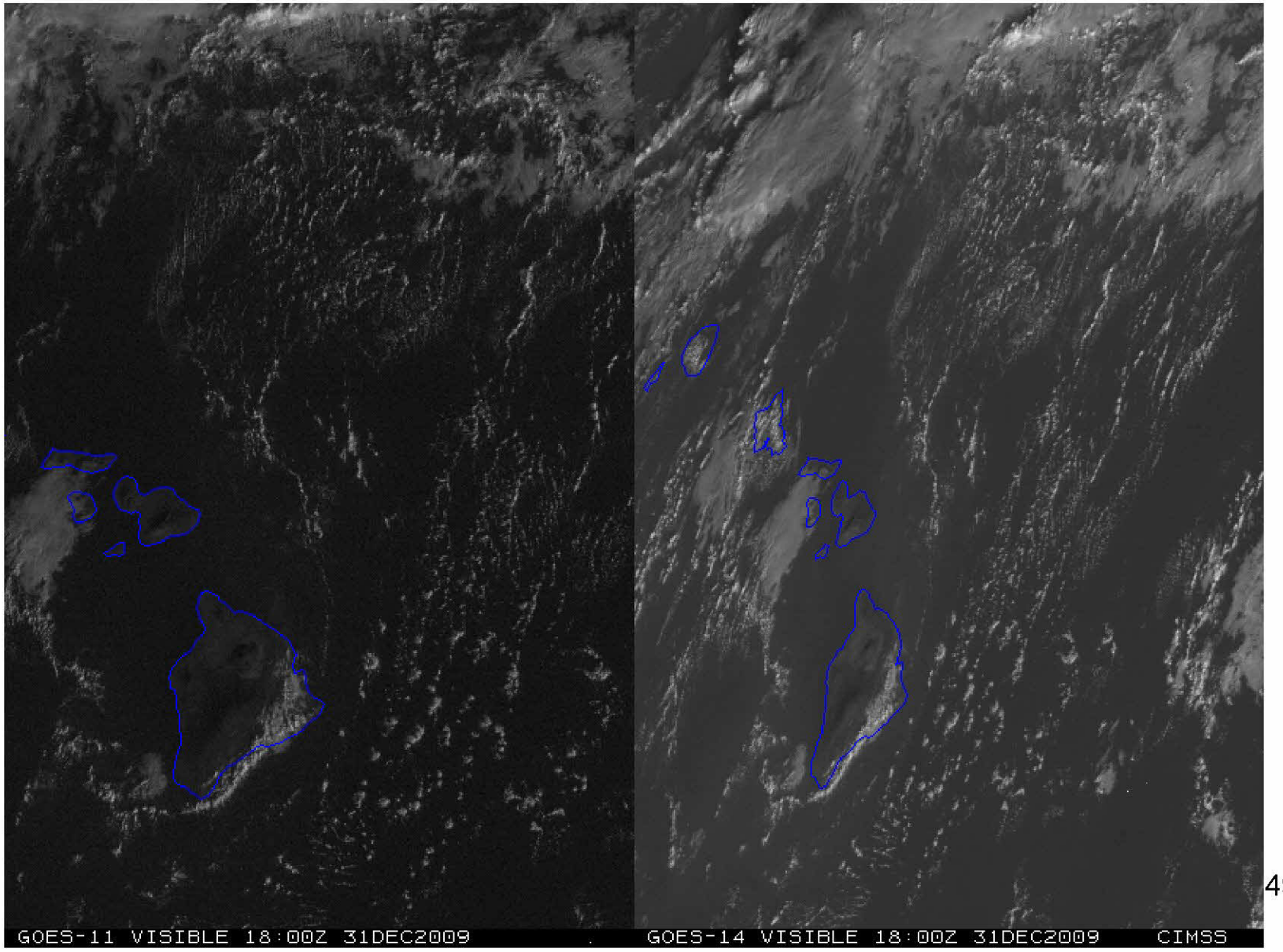


Hawaiian "vog" plume

- McIDAS images of GOES-11 and GOES-14 visible channel data revealed a large hazy plume streaming northeastward from the Hawaiian Islands on 31 December 2009 – 01 January 2010. The primary source of this plume was emissions from the Kilauea volcano on "The Big Island" of Hawaii — the resulting "vog" (volcanic smog) is air pollution that forms when sulfur dioxide and other gases/particles emitted by an erupting volcano react with oxygen and moisture in the presence of sunlight.

- The GOES-11 vs GOES-14 visible image comparison helps to highlight two important points:
  - (1) due to a more favorable "forward scattering" geometry with GOES-14 positioned at 105º West longitude, the extent of the "vog" plume shows up with greater clarity on GOES-14 images later in the day compared to GOES-11 (positioned at 135º West longitude), and
  - (2) the performance of the GOES visible channel detectors degrades over time, so the much older GOES-11 (launched in 2000) visible imagery appears significantly darker (the enhancement of the images is the same). GOES-14 (launched in 2009) was emulating GOES-West during the final 48 days of its NOAA Science Test.

Hawaiian “vog” plume



GOES-14 Science Test
December 2009

Don Hillger, Deb Molenar, Dan Lindsey, John Knaff

NOAA/NESDIS/Satellite Applications and Research

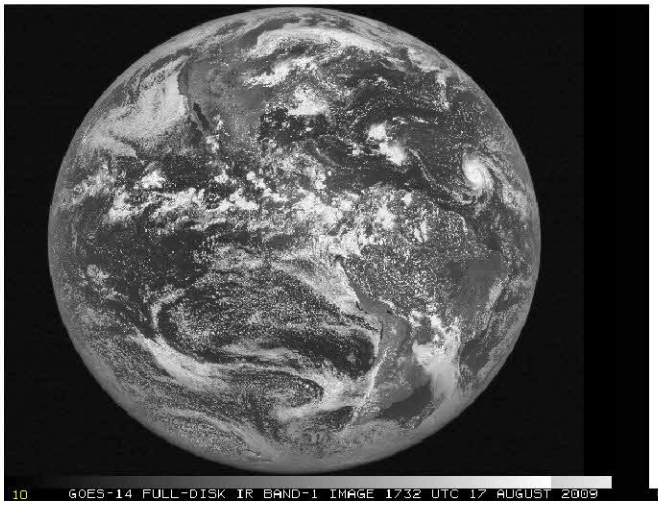
Regional And Mesoscale Meteorology Branch (RAMMB)

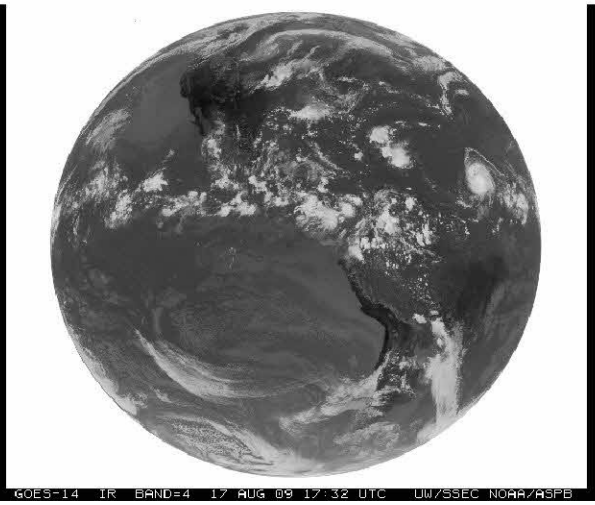
Dave Watson, Mike Hiatt, Dale Reinke, etc.

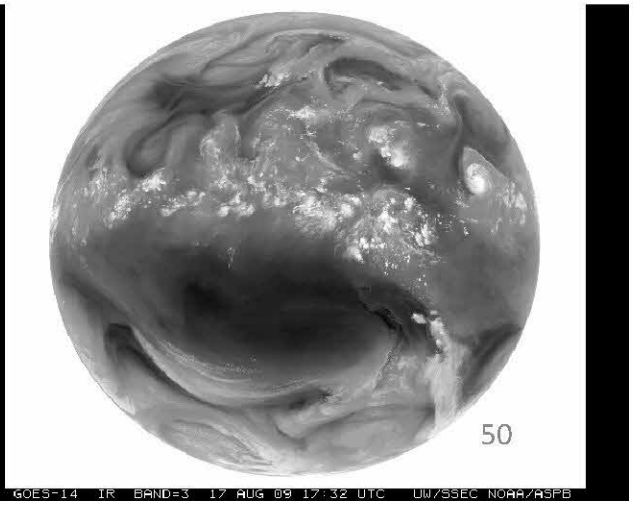
CIRA, Colorado State University

Fort Collins CO

Don Hillger and Tim Schmit co-lead the NOAA Science Test







GOES-13 Science Test – December 2006

NOAA Technical Report NESDIS 125

The GOES-13 Science Test:
Imager and Sounder Radiance and Product Validations

Washington, D.C.
September 2007

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service

for Earth. It doesn't sound like much, but he found that just a 3% reduction in total sunlight after the eruption coincided with a 20% drop in peak power output at the largest collective of solar power plants in the world, Solar Electric Generating Stations in California.

Fortunately, the flat photovoltaic solar cells and the solar panels used to heat water, commonly visible on homeowners' roofs, can use both direct and diffuse sunlight. The curved mirrors and other devices used to concentrate sunlight at solar plants to generate lots of electricity for low cost, however, would be adversely affected.

"The sensitivity of concentrating solar systems to stratospheric particles may seem surprising," Murphy says. "But because these systems use only direct sunlight, increasing stratospheric particles has a disproportionately large effect on them." (SOURCE: NOAA)

OBSERVING SYSTEMS

THE GOES-13 SCIENCE TEST
A Synopsis

BY DONALD W. HILLGER AND TIMOTHY J. SCHMIT

The *GOES-13* science test, which took place during December of 2006, was an opportunity for NOAA and other scientists to preview the capabilities of the latest U.S. geostationary operational satellite. Such science tests are a vital aspect of the checkout of each Geostationary Operational Environmental Satellite (GOES), and have been formalized as a part of post-launch testing for at least the last four GOES satellites. Results of the science test confirmed three major improvements expected from *GOES-13*: less loss of imagery during satellite eclipse periods, improved navigation, and lower instrument noise. There was also the discovery of a cold bias for one of the imager bands, an issue that continues to be investigated.

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SCIENCE TEST BASICS. NOAA scientists are regularly involved in the checkout of GOES Imager and Sounder instruments. These science tests are part of the post-launch testing (PLT) administered by NASA for each satellite.

In the case of *GOES-13*, the PLT started shortly after launch of this GOES-N series satellite on 24 May 2005. After the end of the engineering tests, which take up most of the available PLT period, the science test started on 7 December and continued for 3 weeks. During that time, NOAA scientists were able to select among various predetermined operating modes for the satellite instruments, the 5-band imager, and the 19-band sounder. Others investigated the solar/space instrumentations. After those 3 weeks, *GOES-13* continued to transmit data until it was put into storage mode on 5 January 2007.

Goals of the science test included:

1) the investigation and quantification of *GOES-13* data, by comparison to previous GOES, as well as other satellites;
2) the generation of imager and sounder products from the *GOES-13* data stream, and their comparison to similar products created from previous GOES;
3) investigation of the impact of changes due to the new spacecraft bus that began with *GOES-13*; and,

Previous GOES Science Tests

GOES-11

Daniels, J.M., T.J. Schmit, and D.W. Hillger, 2001: GOES-11 Imager and Sounder Radiance and Product Validations for the GOES-11 Science Test, *NOAA Tech. Rep. NESDIS 103*, (August), 49 pp.

GOES-12

Hillger, D.W., T.J. Schmit, and J.M. Daniels, 2003: Imager and Sounder Radiance and Product Validation for the GOES-12 Science Test. *NOAA Tech. Rep., NESDIS 115*, (September), 70 pp.

GOES-13

Hillger, D.W., and T.J. Schmit, 2007: The GOES-13 Science Test, *NOAA Tech. Rep., NESDIS 125*, (September), 88 pp.

Hillger, D.W., and T.J. Schmit, 2009: The GOES-13 Science Test: A Synopsis. *Bull. Amer. Meteor. Soc.*, 90(5), (May), 6-11.

Acknowledgements

The GOES Science Tests occur at the end of long Post Launch Test (PLT) periods for each satellite and are possible because of the cooperation of NASA and NOAA/OSD and OSO personnel, who in particular prepare the satellite schedules and enable the daily changes that are requested by the science team. Thanks as well to all who contribute to the analysis of the data collected during the Science Tests.

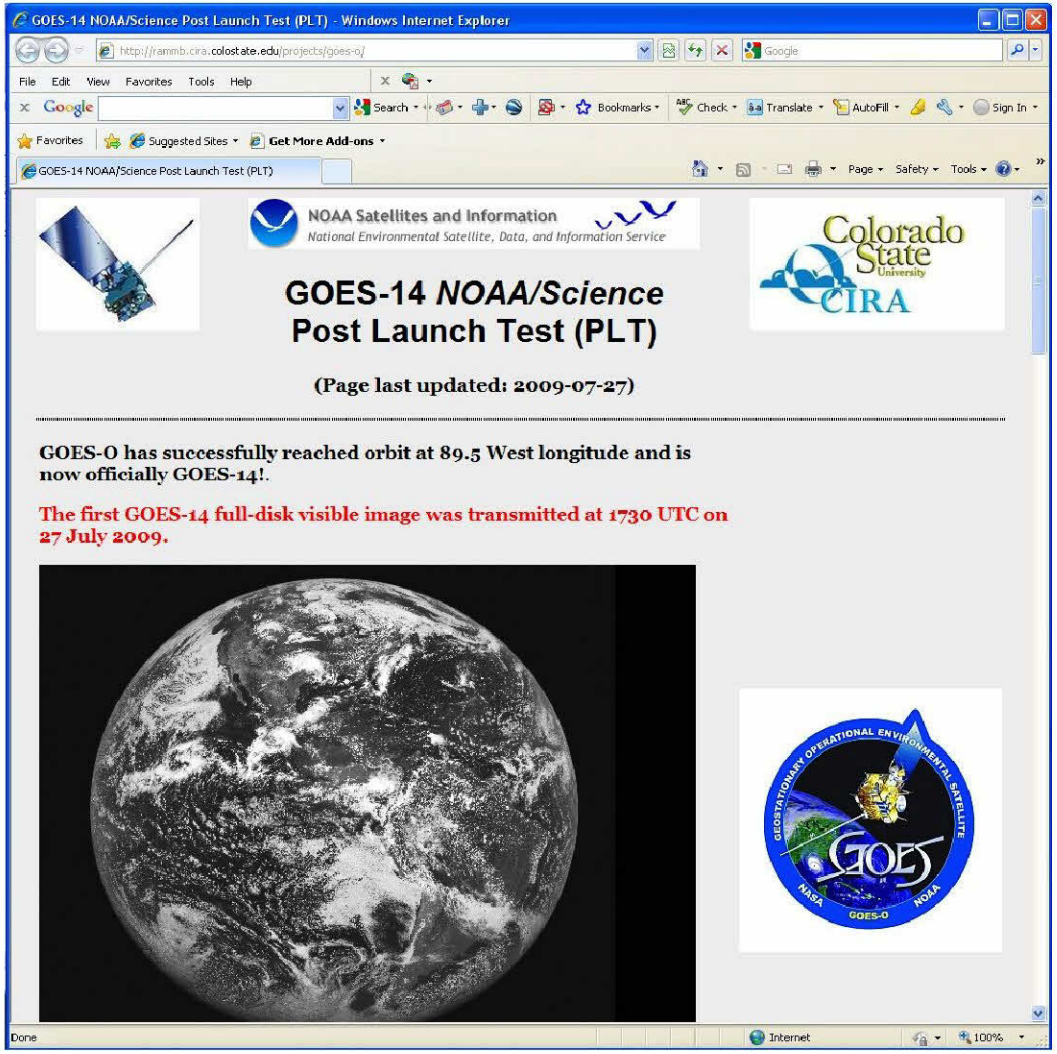
GOES Science Test Goals

For all GOES check-outs, the goals of the Science Test include the following:

1) **To assess the quality of the GOES radiance data**. This is accomplished by comparison to other satellite measurements or by calculating the signal-to-noise ratio compared to specifications, as well as assess the striping in the imagery due to multiple detectors.
2) **To generate products from the GOES data stream and compare to those produced from other satellites.** These included several Imager and Sounder products currently used in operations.
3) **Rapid-scan imagery of interesting weather cases** are collected with temporal resolutions as fine as every 30 seconds, a capability of rapid-scan imagery from GOES-R that is not implemented operationally on current GOES.

GOES-14 NOAA/Science Test Website

GOES-14 Tech memo current under review



http://rammb.cira.colostate.edu/projects/goes-o/

GOES-O Test Schedules

Test Schedule	Imager	Sounder	Purpose
C5RTN	Emulation of **GOES-East routine** operations	Emulation of **GOES-East routine** operations	Radiance and product comparisons
C4RTN	Emulation of **GOES-West routine** operations	Emulation of **GOES-West routine** operations	Radiance and product comparisons
C1CON	Continuous **5-minute CONUS** sector	26-minute **CONUS** sector every 30 minutes	Test navigation, ABI-like (temporal) CONUS scans
C2SRSO	Continuous **1-minute rapid-scan** (with center point specified for storm analysis)	26-minute sector every 30 minutes (with center point same as Imager)	Test navigation, ABI-like (temporal) mesoscale scans
C3SRSO	Continuous **30-second rapid-scan** (with center point over either Huntsville AL, Normal OK, or Washington DC areas) **three locations only**	26-minute sector every 30 minutes (with center same as Imager)	To coordinate with lightning mapping arrays in Huntsville AL, Norman OK, or Washington DC
C6FD	Continuous **30-minute Full Disk** (including off-earth limb/space view measurements)	Alternating **east and west limb/space views** every hour	Noise, detector-to-detector striping, fires, etc.
C7MOON	Capture **moon** off edge of earth (when possible)	Emulation of **GOES-East routine** operations	Test ABI lunar calibration concepts
C8	**Emulation of 2 km ABI** through spatial over-sampling (continuous 19 minutes for same sector per specific line-shifted scan strategy)	Emulation of **GOES-East routine** operations	ABI-like higher-resolution product development

GOES-14 Science Test Preliminary Results

- **First official GOES-14 images** were collected from Imager (visible and IR) and Sounder
- **Improved (4 km) resolution of 13.3 µm band** required changes to GVAR format.
- Several issues with implementing the **new GVAR format** were discovered and are being rectified, both at the front end, and at GVAR receiving sites.
  - **Paired detectors** on the higher-resolution 13.3 µm band were **inadvertently swapped**. Now fixed.
  - Image navigation issues have been addressed (**McIDAS server software was upgraded.**)

GOES-14
Imager and Sounder

http://rammb.cira.colostate.edu/projects/goes-o/

http://www.star.nesdis.noaa.gov/star/GOES-14FirstImage.php

http://www.ssec.wisc.edu/media/spotlight/goes14/ir.html

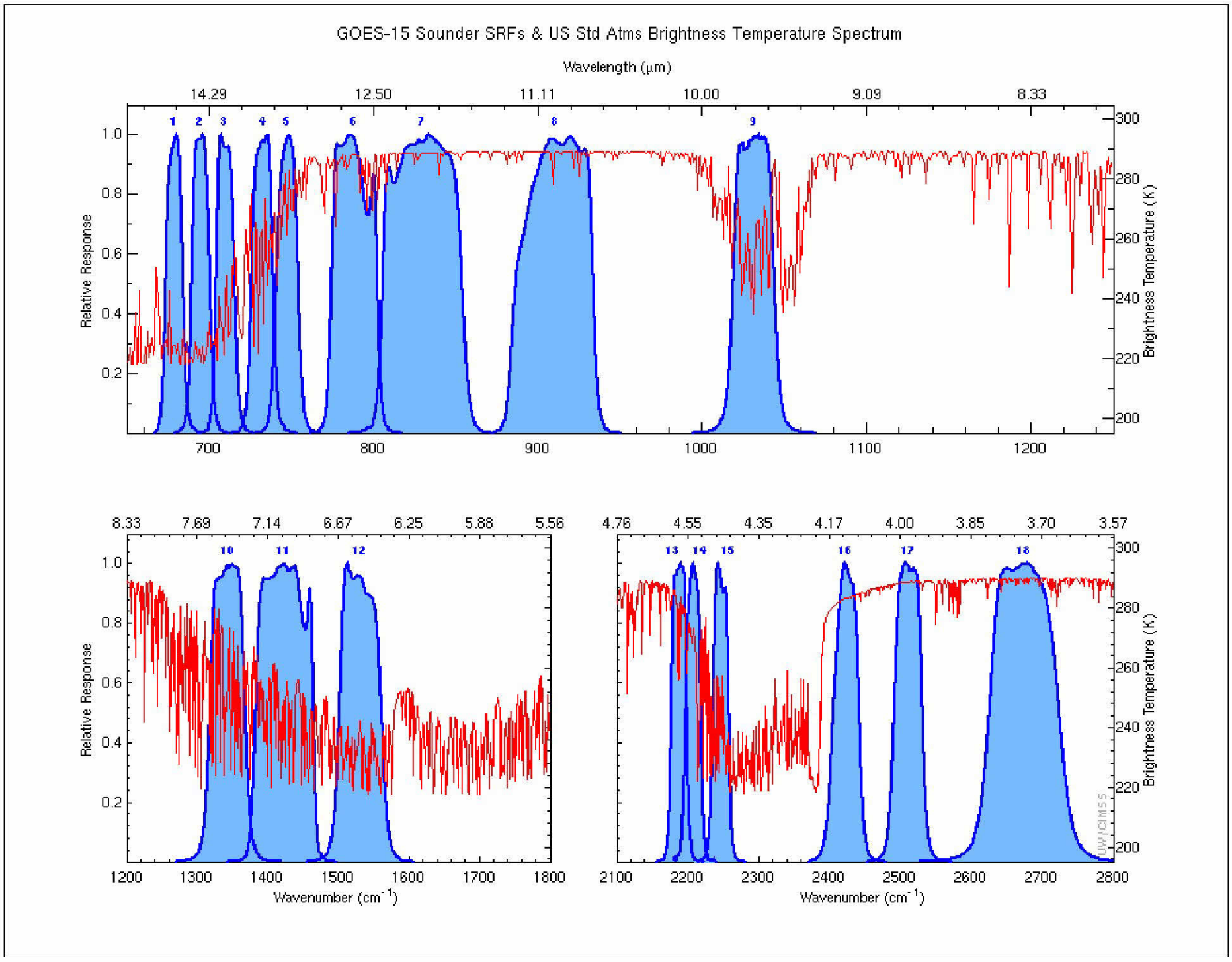
http://cimss.ssec.wisc.edu/goes/blog/archives/3054

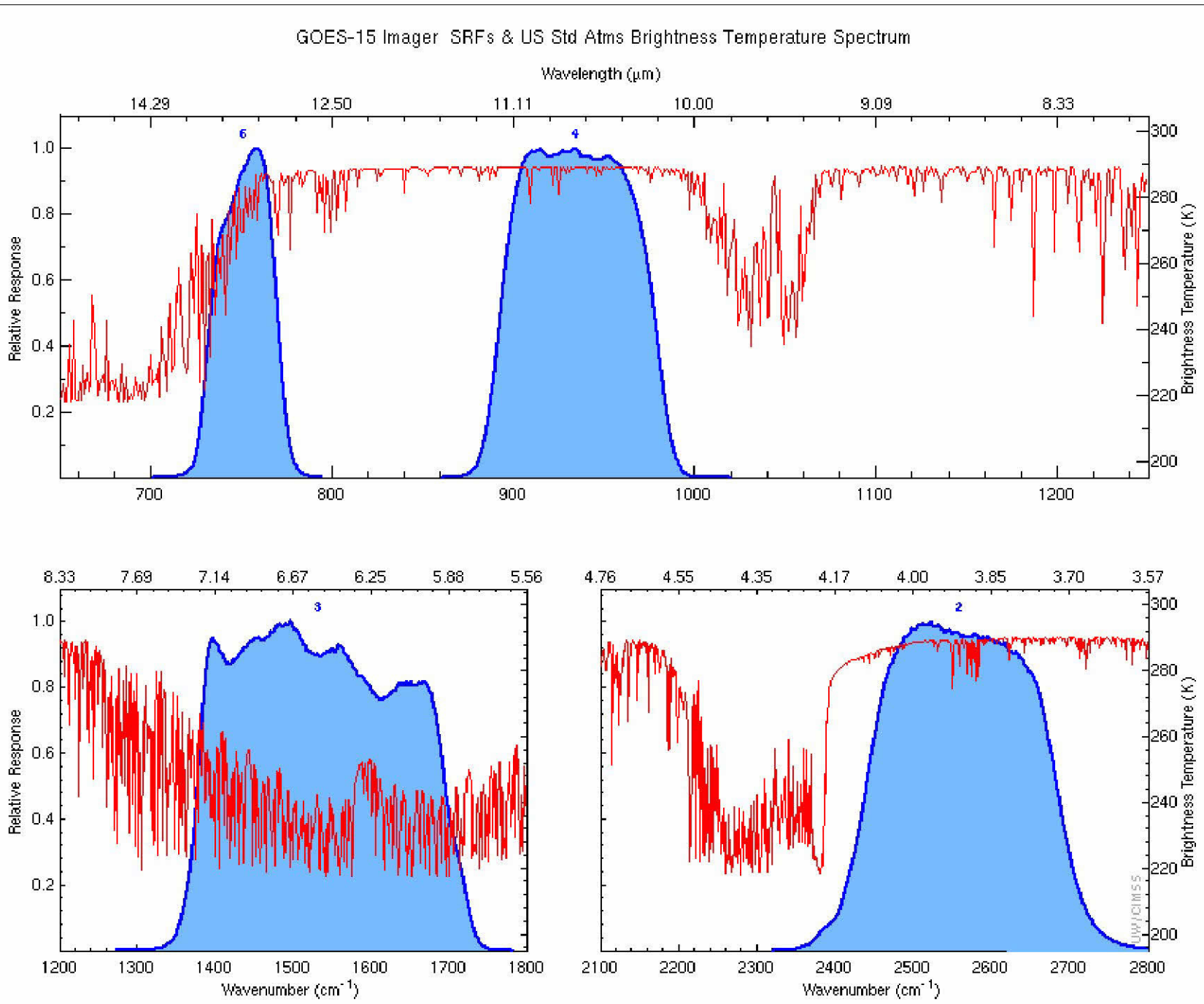
http://www.ssec.wisc.edu/data/geo/index.php?satellite=goes14&file=jpg

http://cimss.ssec.wisc.edu/goes/rt/sounder-dpi.php

STAR Center for Satellite Applications and Research

formerly ORA — Office of Research and Applications

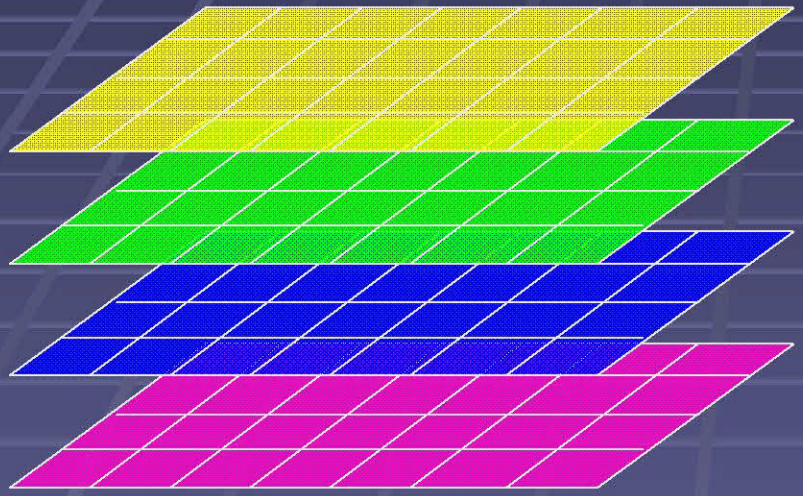

GOES-15 Sounder SRFs & US Std Atms Brightness Temperature Spectrum
Wavelength (μm)
14.29
12.50
11.11
10.00
9.09
8.33
1
2
3
4
5
6
7
8
9
Relative Response
Brightness Temperature (K)
700
800
900
1000
1100
1200
8.33
7.69
7.14
6.67
6.25
5.88
5.56
10
11
12
1200
1300
1400
1500
1600
1700
1800
Wavenumber (cm-1)
4.76
4.55
4.35
4.17
4.00
3.85
3.70
3.57
13
14
15
16
17
18
2100
2200
2300
2400
2500
2600
2700
2800
Wavenumber (cm-1)
UW/CIMSS


GOES-15 Imager SRFs & US Std Atms Brightness Temperature Spectrum
Wavelength (μm)
14.29
12.50
11.11
10.00
9.09
8.33
6
4
Relative Response
Brightness Temperature (K)
700
800
900
1000
1100
1200
8.33
7.69
7.14
6.67
6.25
5.88
5.56
3
Wavenumber (cm-1)
1200
1300
1400
1500
1600
1700
1800
4.76
4.55
4.35
4.17
4.00
3.85
3.70
3.57
2
2100
2200
2300
2400
2500
2600
2700
2800
UW/CIMSS

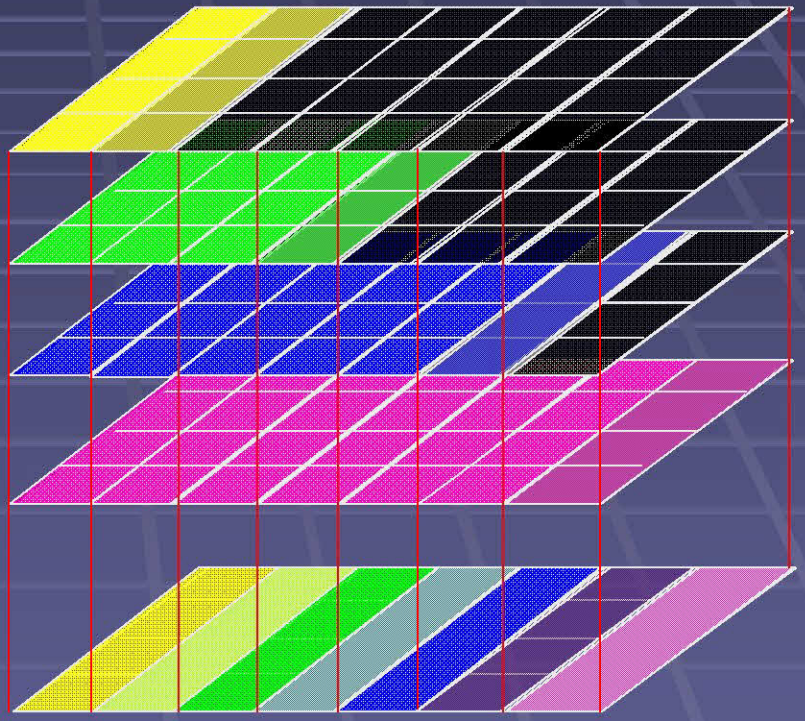
2. GeoColor Blended Imagery

(Multi-Sensor, Synthesis/Composite)

Layers of Information



Spatial Opacity Rules



Blending is accomplished both in the vertical and horizontal dimensions

"*N-dimensional blending*" allows for simultaneous display of multiple GOES-R AWG products, day & night, with dynamic transparency factors defined at the pixel level.