VIIRS/MODIS Workshop Hawaii: Practical Aspects of VIIRS Data and Images

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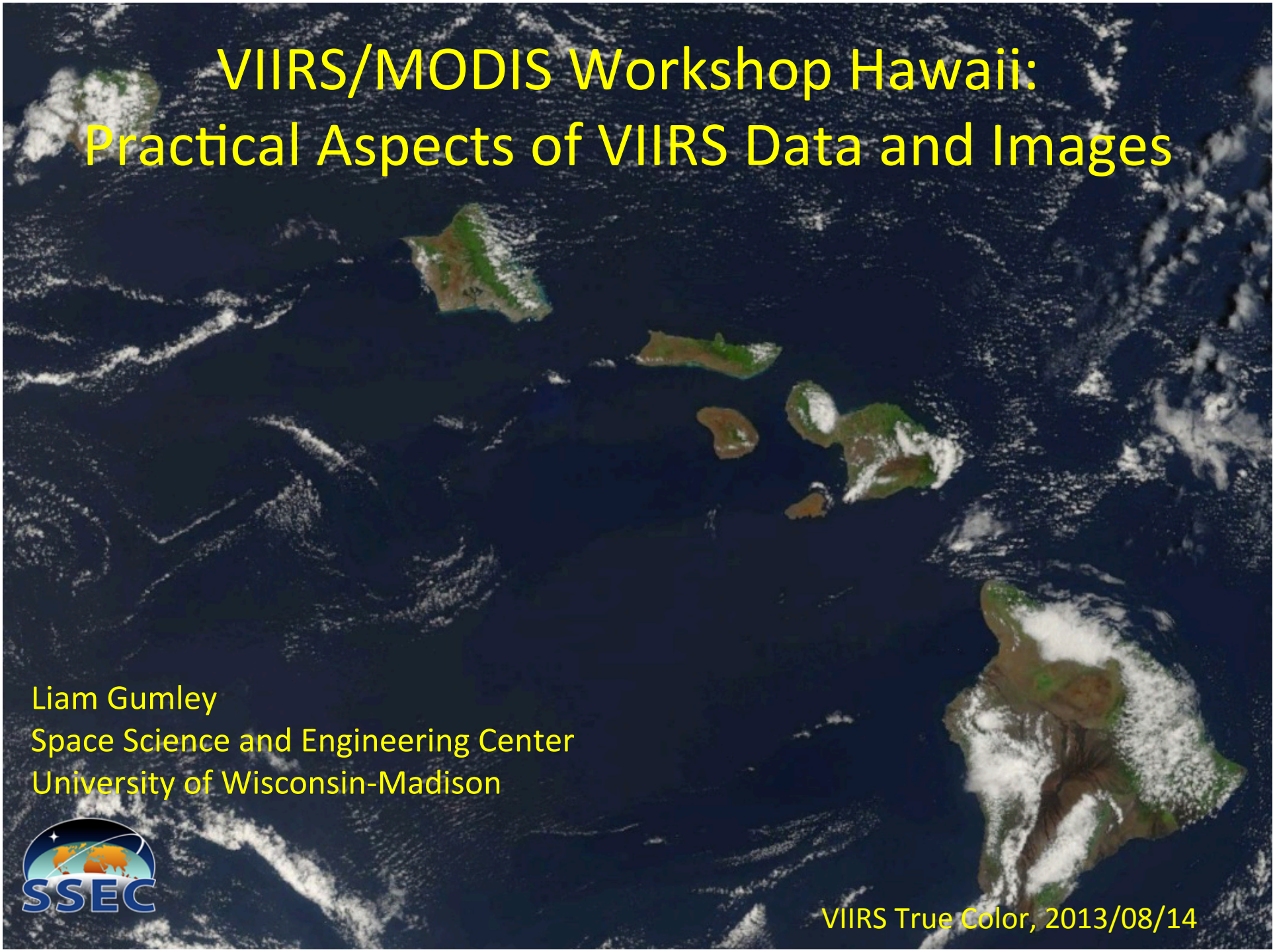


VIIRS True Color, 2013/08/14

About Suomi NPP

Launched into a polar sun-synchronous orbit on Oct 28, 2011.

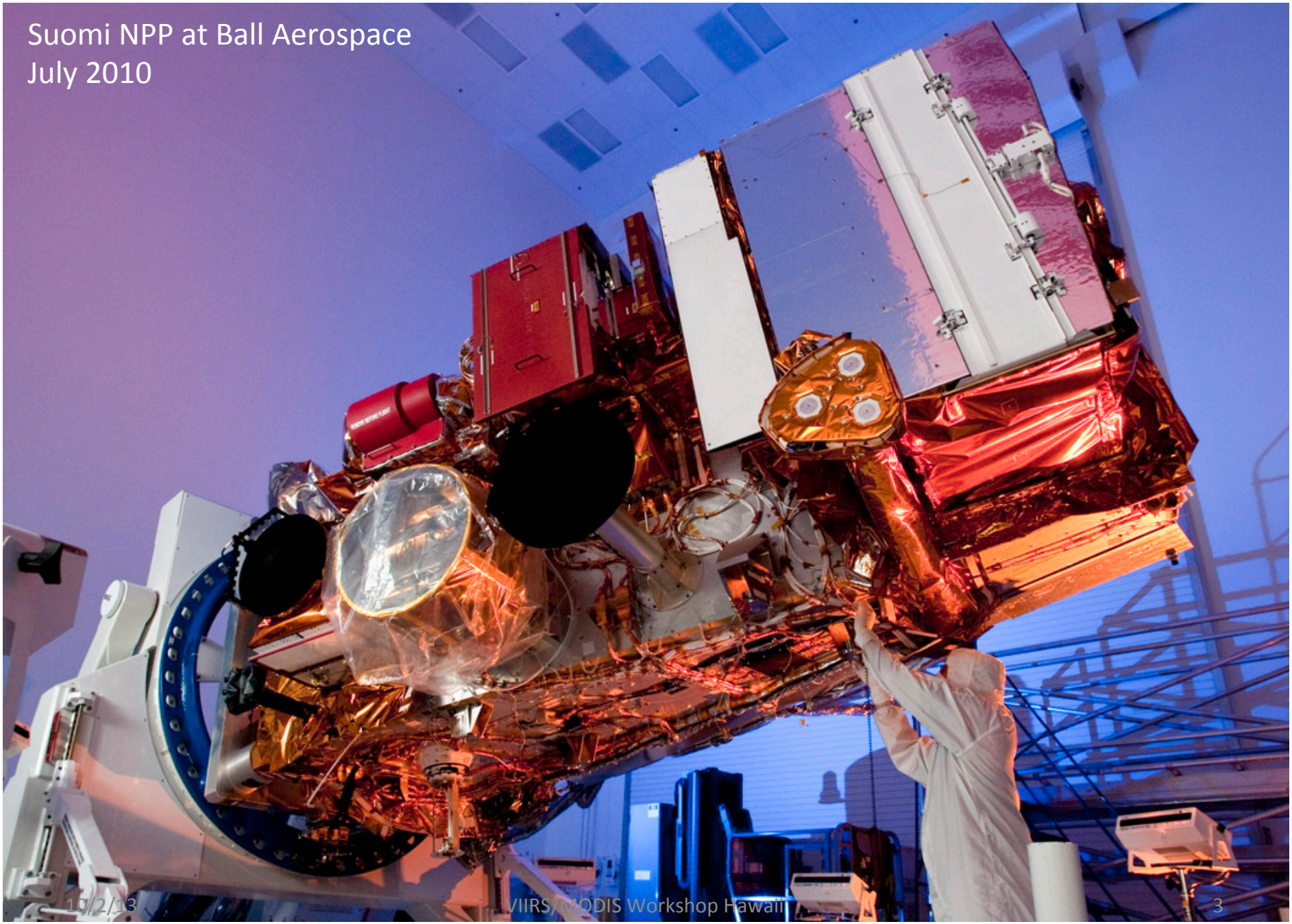
Developed by NASA and industry; operated by NOAA.

Spacecraft and sensors were developed by industry.

Science algorithms were also developed by industry.

Question: Can the science products (e.g., global cloudiness) continue the ***Climate Data Record*** established by previous NASA and NOAA satellites?

Climate Data Record = "A time series of measurements of sufficient length, consistency, and continuity to determine climate variability. and change."


Suomi NPP at Ball Aerospace
July 2010

Suomi NPP Sensor Suite

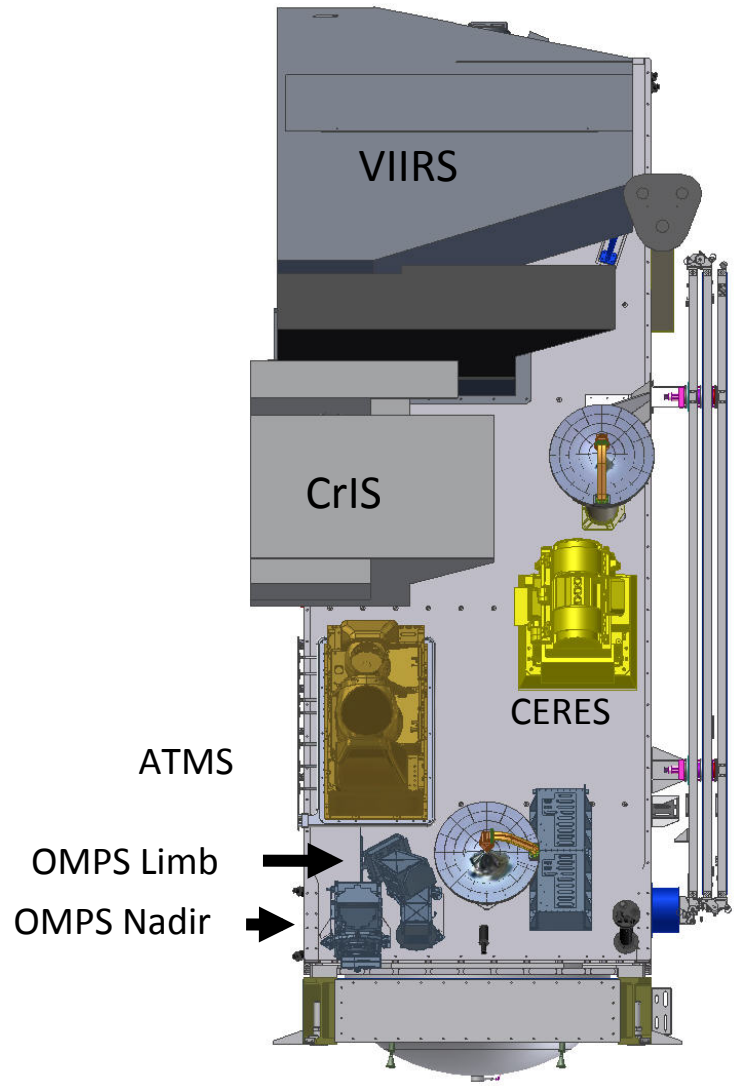
VIIRS – Medium Resolution Visible & Infra-red Imager

CrIS – Fourier Transform Spectrometer for IR Temperature and Moisture sounding

ATMS – Microwave sounding radiometer

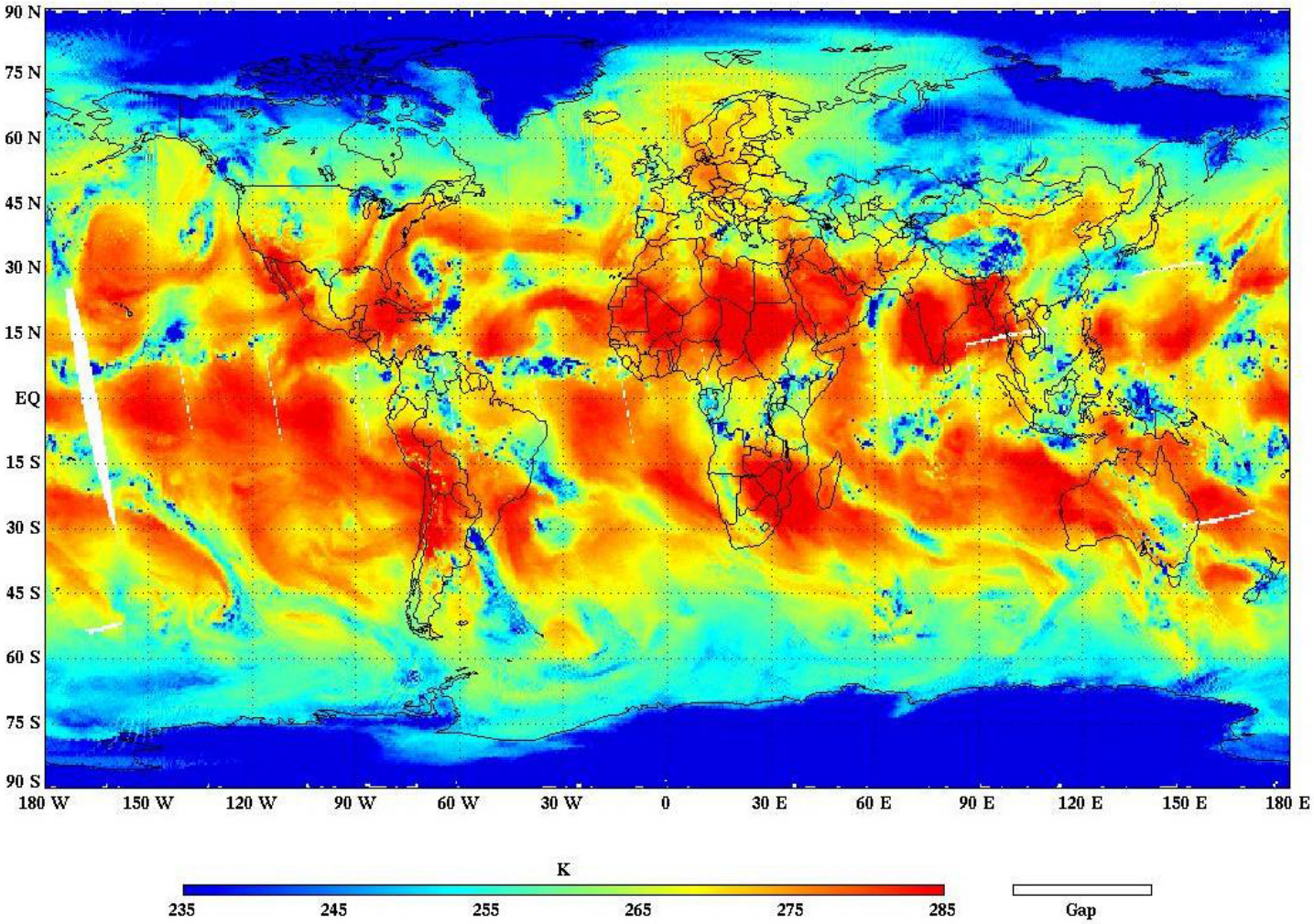
OMPS – Total Ozone Mapping and Ozone Profile measurements

CERES - Earth Radiation Budget



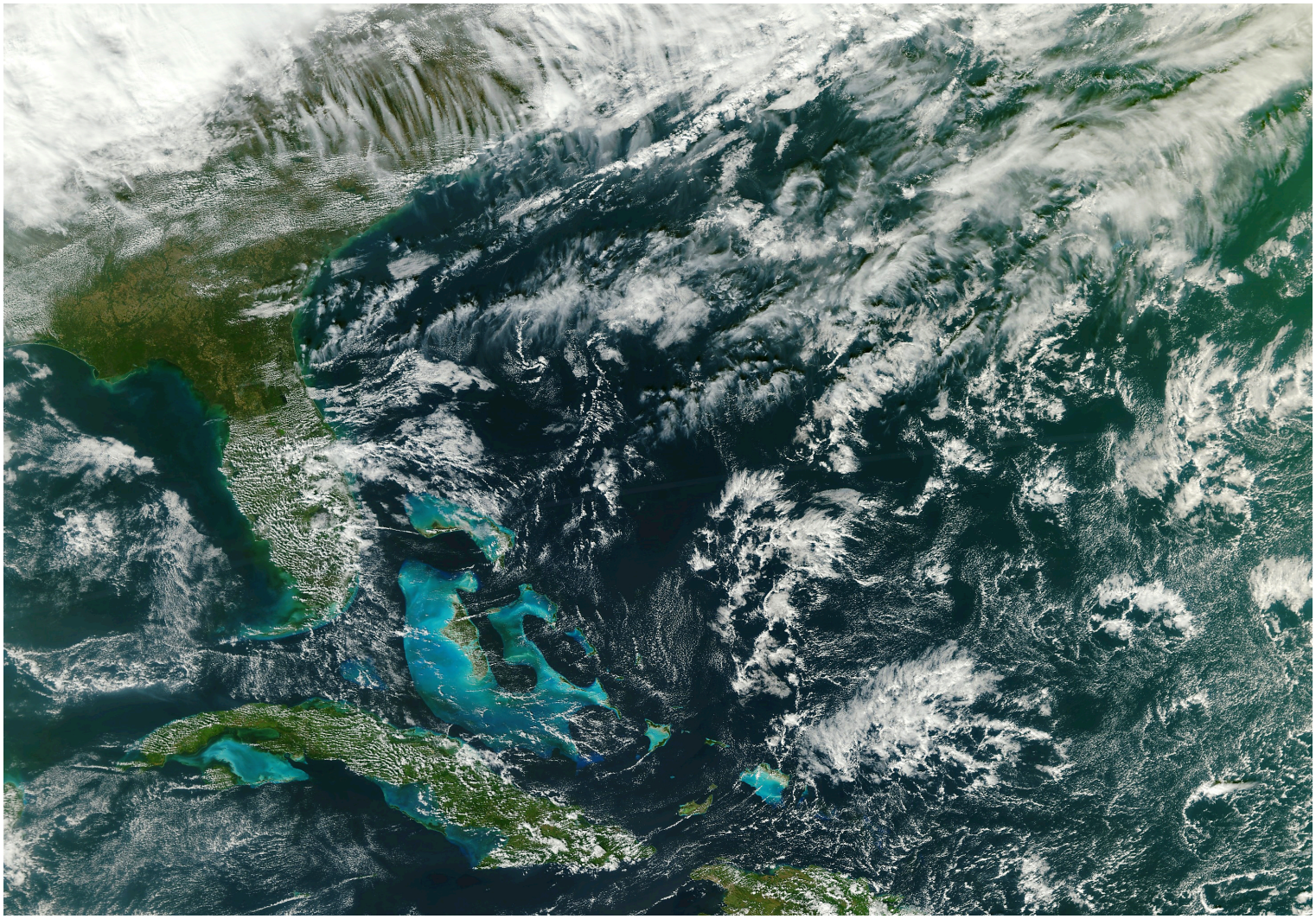
Suomi NPP Launch 2011/10/28

ATMS First Light image



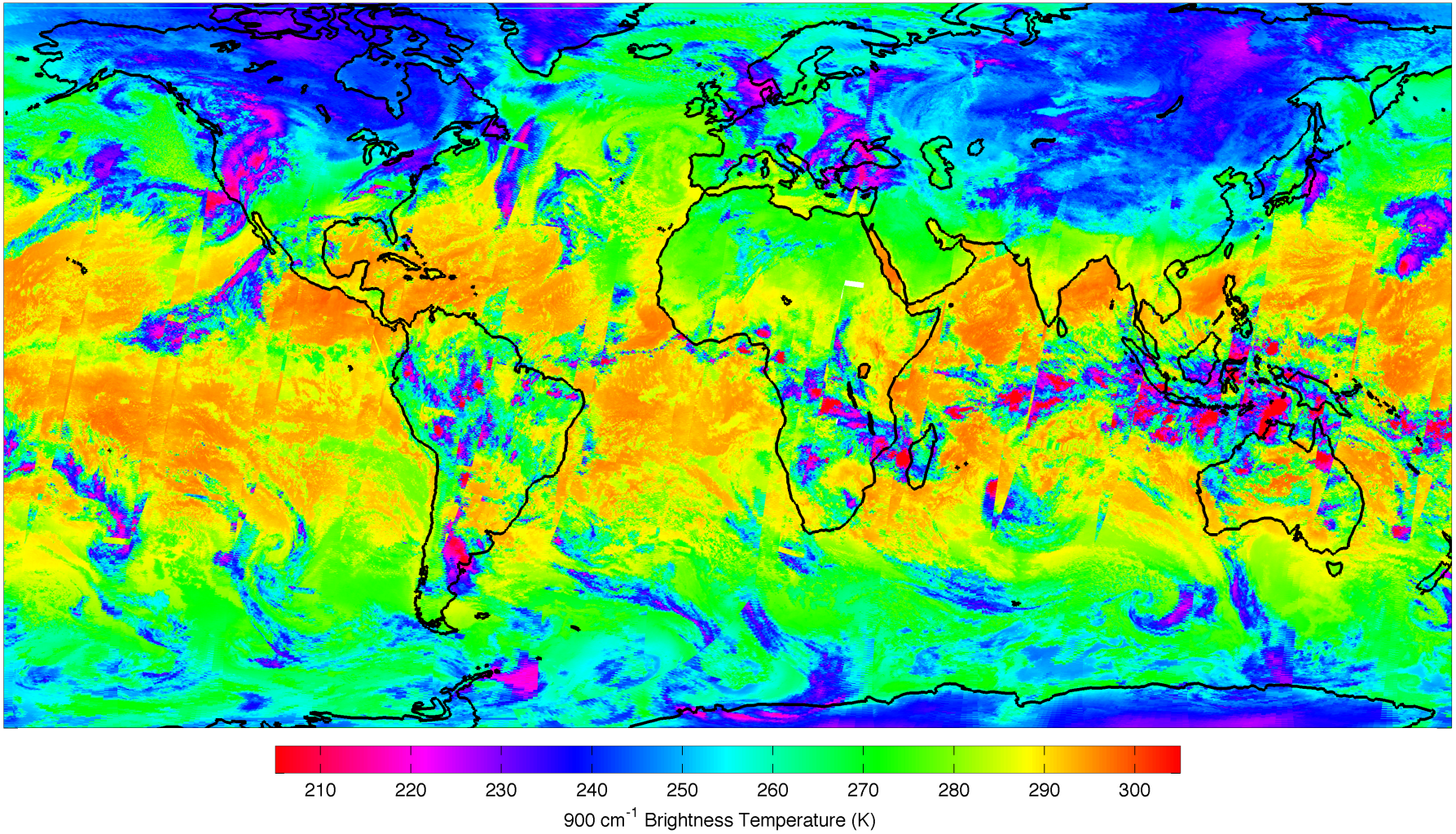
Suomi NPP ATMS channel 18 antenna temperature, 8 November 2011

VIIRS First Light Image



Suomi NPP VIIRS M-band True Color, 21 November 2011

CrIS First Light Image



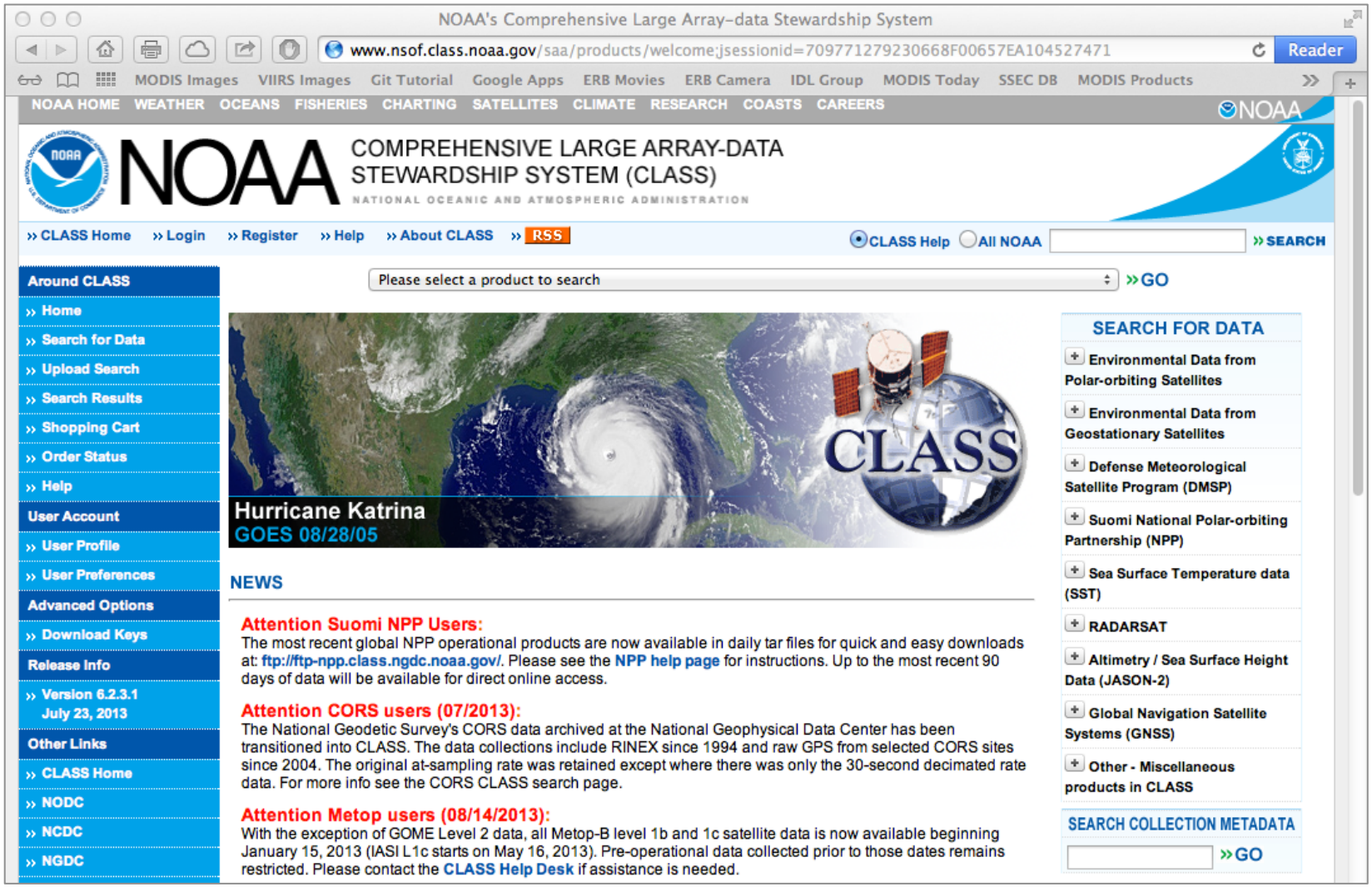
Suomi NPP CrIS thermal infrared, 21/23/25 January 2012

What is new about VIIRS?

- VIIRS native resolution is 375 and 750 meters (vs. 250 and 1000 meters for MODIS).
- VIIRS has 22 spectral bands while MODIS has 36 spectral bands.
- VIIRS has a thermal infrared band at 375 meter resolution.
- VIIRS has a Day/Night visible band.
- VIIRS has near constant FOV size across the scan.
- Redundant "bow-tie" pixels on VIIRS are not transmitted to the ground ("bowtie deletion").

Where To Obtain VIIRS Data

Suomi NPP Data Archive: NOAA CLASS

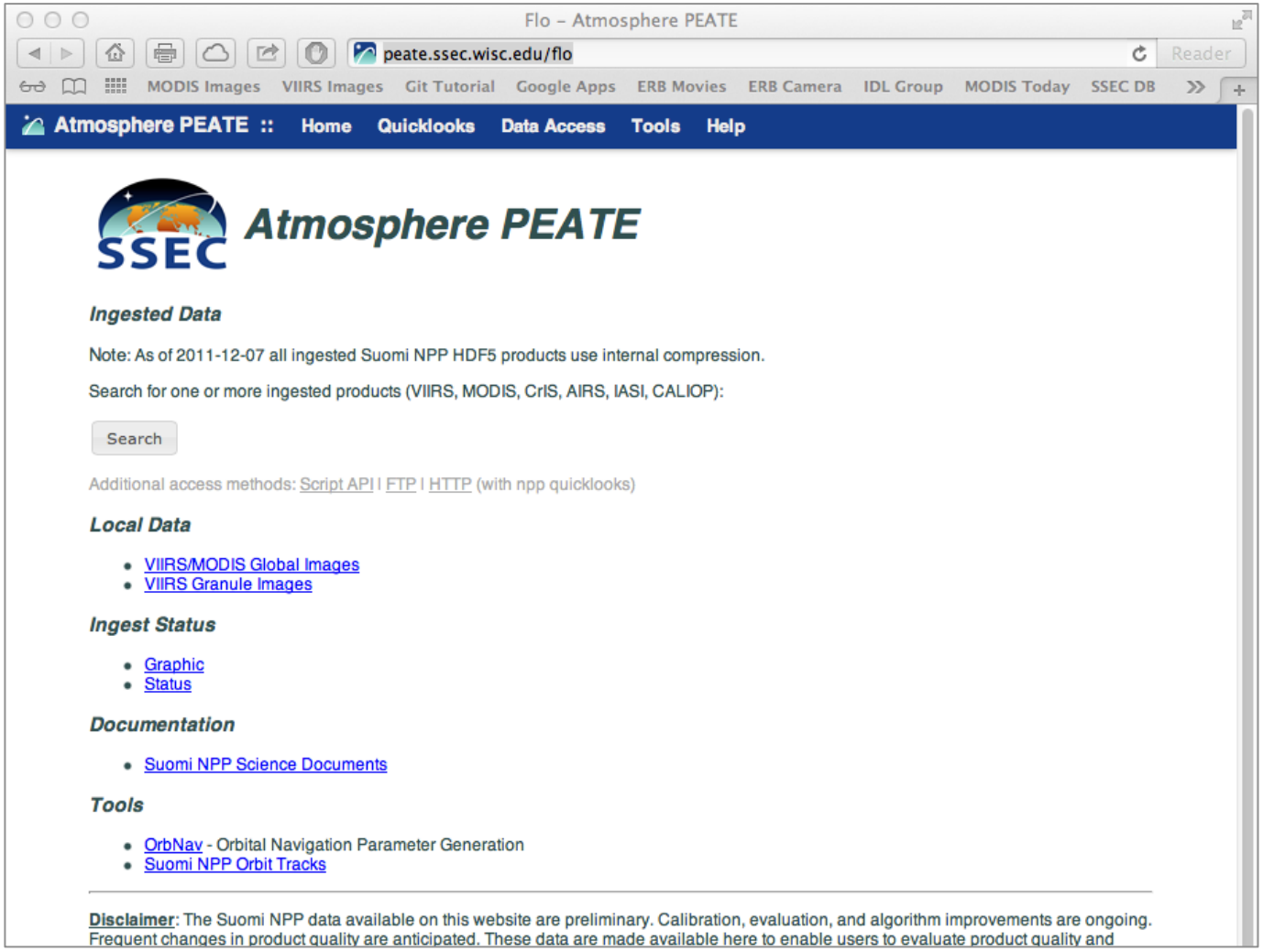


http://www.class.noaa.gov/

Notes about NOAA CLASS

- CLASS is the official archive for NPP and JPSS data.
- Ad-hoc orders are supported.
- Subscription orders are supported.
- A detailed tutorial on ordering Suomi NPP data is available.
- NASA Atmosphere PEATE at UW/SSEC also provides VIIRS SDRs.

Atmosphere PEATE Website



http://peate.ssec.wisc.edu/

Advantages of Atmosphere PEATE

- Easy searching by date/time/region
- Can search for collocated VIIRS and MODIS data from Terra or Aqua
- Downloader scripts for the Linux/Mac command line
- Quicklook images for every granule VIIRS SDR granule
- Daily global mosaic images

VIIRS Scanner Characteristics

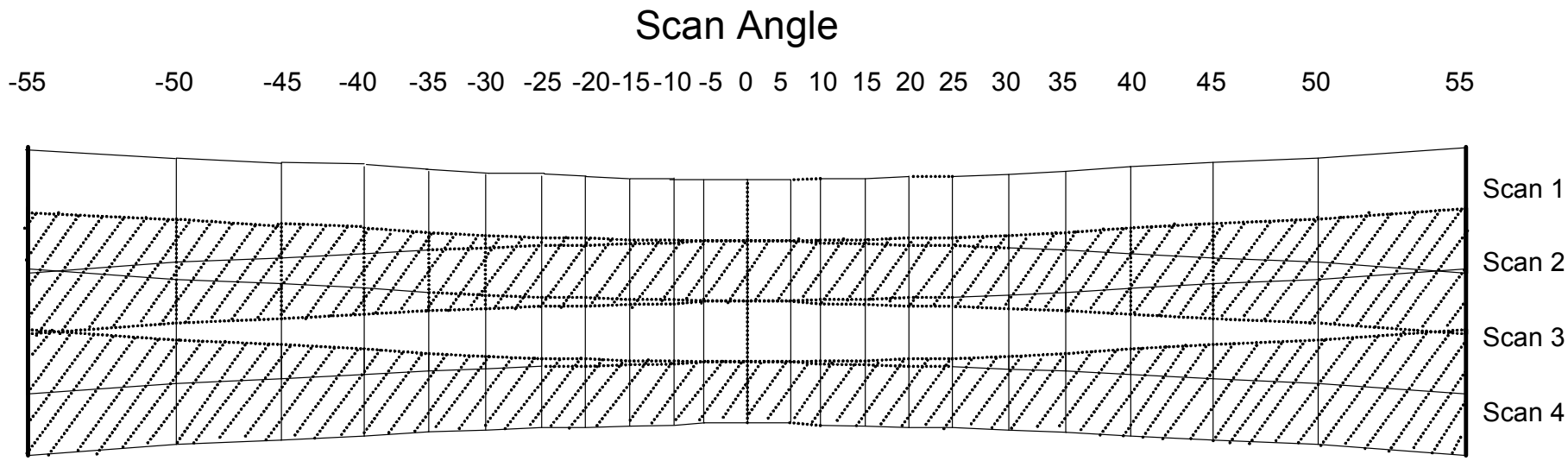
VIIRS Spectral Bands

		Band No.	Wave-length (μm)	Horiz Sample Interval (km Downtrack x Crosstrack)		Driving EDRs	Radi-ance Range	Ltyp or Ttyp	Signal to Noise Ratio (dimensionless) or NE$^{\Delta}$T (Kelvins)		
				Nadir	End of Scan				Required	Predicted	Margin
VIS/NIR FPA	Silicon PIN Diodes	M1	0.412	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols	Low High	44.9 155	352 316	441 807	25% 155%
		M2	0.445	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols	Low High	40 146	380 409	524 926	38% 126%
		M3	0.488	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols	Low High	32 123	416 414	542 730	30% 76%
		M4	0.555	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols	Low High	21 90	362 315	455 638	26% 102%
		I1	0.640	0.371 x 0.387	0.80 x 0.789	Imagery	Single	22	119	146	23%
		M5	0.672	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols	Low High	10 68	242 360	298 522	23% 45%
		M6	0.746	0.742 x 0.776	1.60 x 1.58	Atmospheric Corr'n	Single	9.6	199	239	20%
		I2	0.865	0.371 x 0.387	0.80 x 0.789	NDVI	Single	25	150	225	50%
		M7	0.865	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols	Low High	6.4 33.4	215 340	388 494	81% 45%
CCD		DNB	0.7	0.742 x 0.742	0.742 x 0.742	Imagery	Var.	6.70E-05	6	5.7	-5%
S/MWIR	PV HgCdTe (HCT)	M8	1.24	0.742 x 0.776	1.60 x 1.58	Cloud Particle Size	Single	5.4	74	98	32%
		M9	1.378	0.742 x 0.776	1.60 x 1.58	Cirrus/Cloud Cover	Single	6	83	155	88%
		I3	1.61	0.371 x 0.387	0.80 x 0.789	Binary Snow Map	Single	7.3	6.0	97	1523%
		M10	1.61	0.742 x 0.776	1.60 x 1.58	Snow Fraction	Single	7.3	342	439	28%
		M11	2.25	0.742 x 0.776	1.60 x 1.58	Clouds	Single	0.12	10	17	66%
		I4	3.74	0.371 x 0.387	0.80 x 0.789	Imagery Clouds	Single	270 K	2.500	0.486	415%
		M12	3.70	0.742 x 0.776	1.60 x 1.58	SST	Single	270 K	0.396	0.218	82%
		M13	4.05	0.742 x 0.259	1.60 x 1.58	SST Fires	Low High	300 K 380 K	0.107 0.423	0.063 0.334	69% 27%
LWIR	PV HCT	M14	8.55	0.742 x 0.776	1.60 x 1.58	Cloud Top Properties	Single	270 K	0.091	0.075	22%
		M15	10.763	0.742 x 0.776	1.60 x 1.58	SST	Single	300 K	0.070	0.038	85%
		I5	11.450	0.371 x 0.387	0.80 x 0.789	Cloud Imagery	Single	210 K	1.500	0.789	90%
		M16	12.013	0.742 x 0.776	1.60 x 1.58	SST	Single	300 K	0.072	0.051	42%

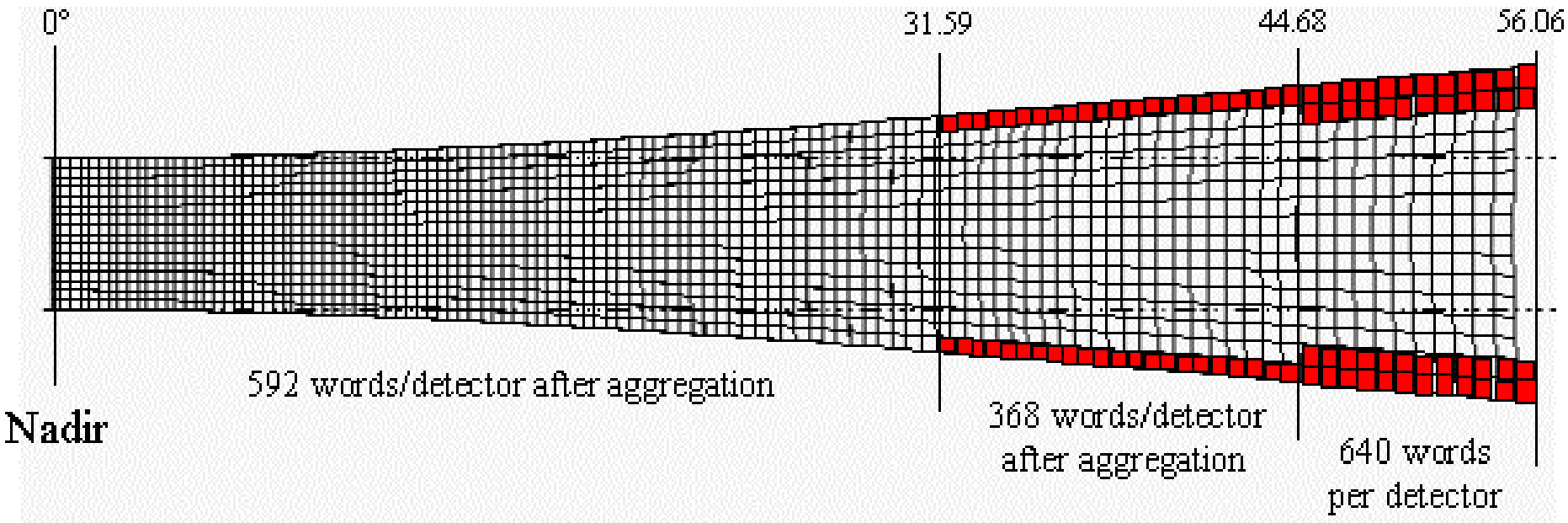
VIIRS Scan Details

- 16 detectors along track (M-bands)
- 32 detectors along track (I-bands)
- Swath width 3000 km
- Granule size 85.7 sec
- Usually 48 scans per granule (sometimes 47)
- Calibrated TOA reflectance is calculated using the terrain corrected solar zenith angle.

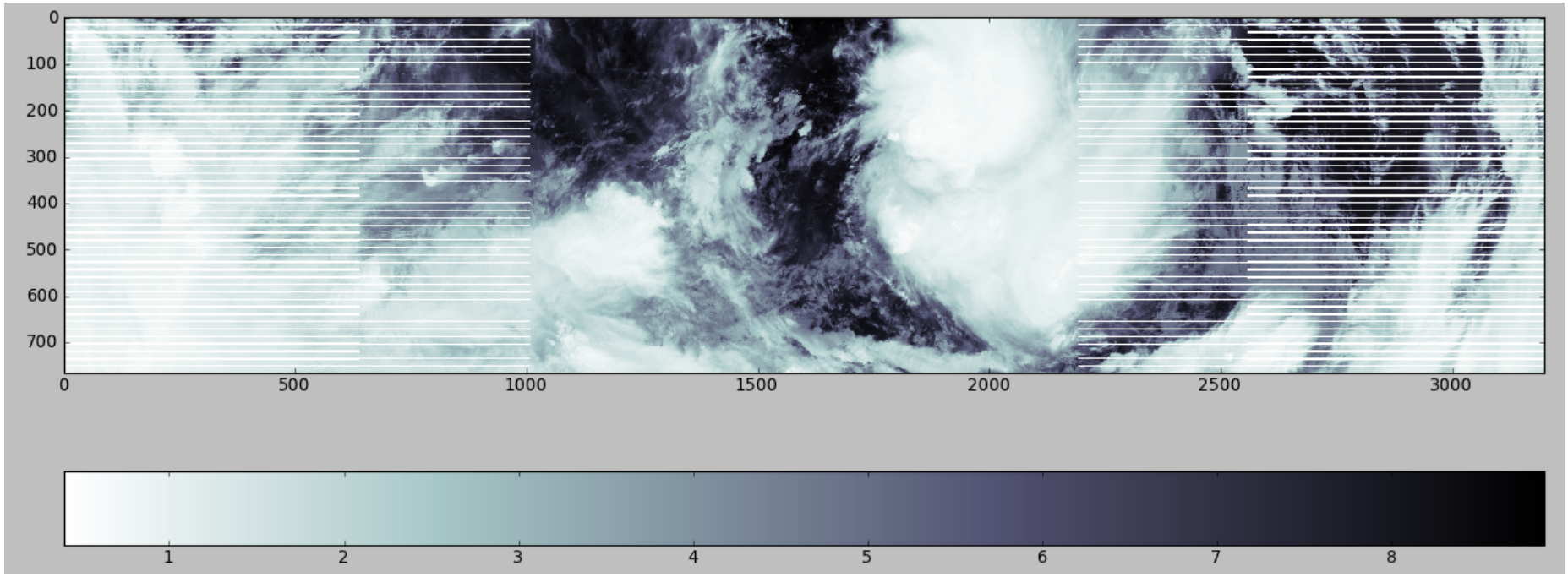
VIIRS Scan Overlap



VIIRS Bowtie Deletion Zones

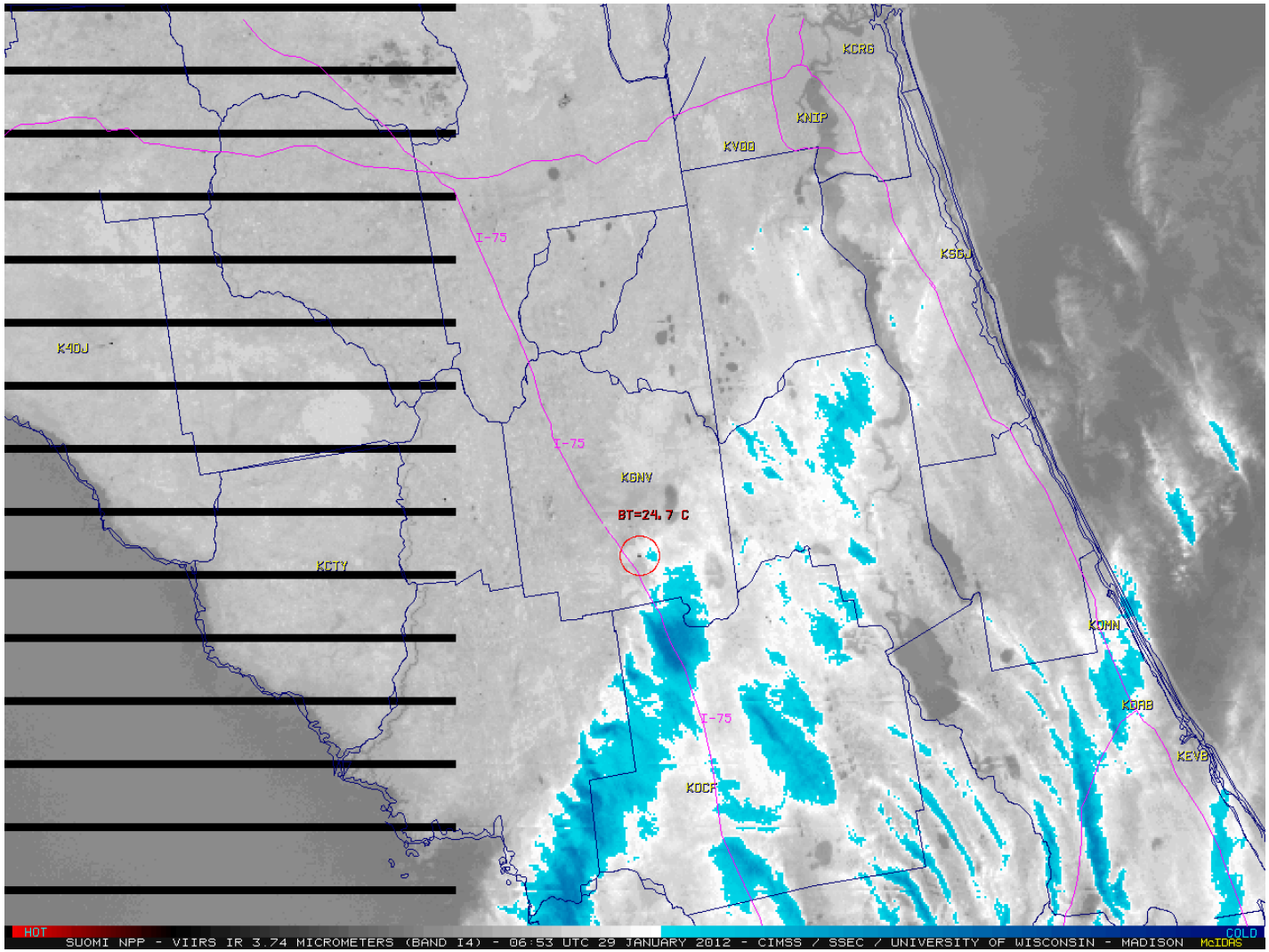


Visualization of a VIIRS M-band SDR granule (Python)



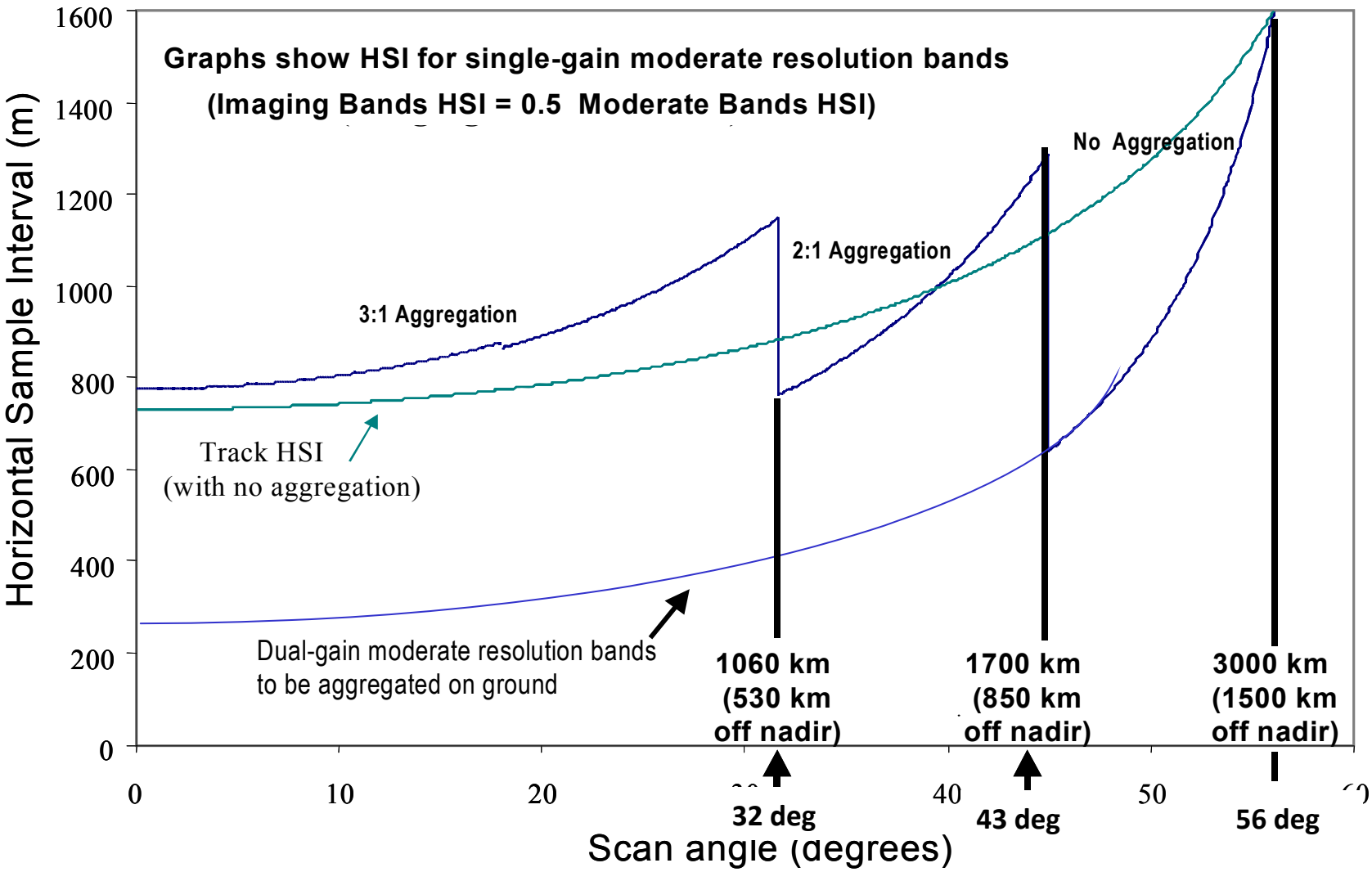
Dimensions are 3200x768 pixels
Note bowtie deletion zones
Fill value in these zones is 65533

Another example of bowtie deletion



McIDAS-X, served by VIIRS SDR ADDE

VIIRS aggregation zones
(to maintain near constant FOV size)



VIIRS Calibration

- For thermal emissive (infrared) bands, a full aperture black body (BB) with accurately-known emissivity and temperature, and deep space, are viewed on every scan.
- For reflected solar (visible, near-infrared) bands, a full aperture solar diffuser (SD) providing precisely-attenuated sunlight in the visible region of the spectrum is viewed on every scan.
- Since the diffusing surface of the SD may degrade slightly over time on orbit, the sensor also includes a Solar Diffuser Stability Monitor (SDSM) to detect changes in the SD reflected radiance.
- SD and SDSM data are valid during a one minute window each orbit that occurs near the Earth's south pole when the sun illuminates the respective input ports.

Anatomy of a VIIRS File Name

GITCO_npp_d20120207_t0456502_e0458143_b01444_c20120207112240904333_noaa_ops.h5

GITCO	= product name (5 characters; GITCO = VIIRS I-band geolocation)
npp	= platform name (3 characters)
d20120207	= date of observation (yyyymmdd)
t0456502	= start time of granule (hhmmsss)
e0458143	= end time of granule (hhmmsss)
b01444	= orbit number
c20120207112240904333	= file creation date and time
noaa	= originator of the file (4 characters; noaa = NOAA/NESDIS/IDPS)
ops	= domain description (3 characters; ops = operational)

The file naming convention is described in detail in JPSS CDFCB External Volume 1: Overview, available at

http://npp.gsfc.nasa.gov/science/documents.html

VIIRS Detailed Information

For detailed information on VIIRS sensor data formats, scanning geometry, bowtie deletion, detector aggregation, etc., see

"NPOESS Common Data Format Control Book - External Volume VII – Part I – NPOESS Downlink Data Formats D34862-07-01 Rev C" from

http://npp.gsfc.nasa.gov/science/documents.html

VIIRS M-band SDR Contents

Name	Description	Data Type	Bands	Aggregate Dimensions (N = Number of Granules)	Granule Dimensions	Units
Radiance	Calibrated Top of Atmosphere (TOA) Radiance for each VIIRS pixel	32-bit floating point	M3-M5, M7, M13	[N*768, 3200]	[768,3200]	W/(m^2 sr μm)
		unsigned 16-bit integer	M1, M2, M6, M8-M12, M14-M16			
Reflectance	Calibrated TOA Reflectance for each VIIRS pixel	unsigned 16-bit integer	M1 – M11	[N*768, 3200]	[768,3200]	unitless
BrightnessTemperature	Calibrated TOA Brightness Temperature for each VIIRS pixel	32-bit floating point	M13	[N*768, 3200]	[768,3200]	kelvin
		unsigned 16-bit integer	M12, M14 – M16			

VIIRS M-band SDR Invalid Values

- For 16-bit unsigned integer values:

  65528 to 65535 are invalid values

- For 32-bit floating point values:

  -999.3 to -999.9 are invalid values

- For example, Bowtie Deleted Pixels have values of 65533 (uint) or -999.7 (float)

VIIRS M-band Geolocation Contents

Name	Description	Data Type	Aggregate Dimensions	Granule Dimensions	Units
StartTime	Starting Time of each scan in IET (1/1/1958)	64-bit integer	[N*48]	[48]	microsecond
MidTime	Mid-Time of each scan in IET (1/1/1958)	64-bit integer	[N*48]	[48]	microsecond
Latitude	Latitude of each pixel (positive North)	32-bit floating point	[N*768, 3200]	[768, 3200]	degree
Longitude	Longitude of each pixel (positive East)	32-bit floating point	[N*768, 3200]	[768, 3200]	degree
SolarZenithAngle	Zenith angle of sun at each pixel position	32-bit floating point	[N*768, 3200]	[768, 3200]	degree
SolarAzimuthAngle	Azimuth angle of sun (measured clockwise positive from North) at each pixel position	32-bit floating point	[N*768, 3200]	[768, 3200]	degree
SatelliteZenithAngle	Zenith angle to Satellite at each pixel position	32-bit floating point	[N*768, 3200]	[768, 3200]	degree
SatelliteAzimuthAngle	Azimuth angle (measured clockwise positive from North) to Satellite at each pixel position	32-bit floating point	[N*768, 3200]	[768, 3200]	degree

VIIRS Geolocation Invalid Values

- For 32-bit floating point values:

  -999.3 to -999.9 are invalid values

- IET base time is 1958-01-01 00:00:00Z

VIIRS Product Types

VIIRS Products

MISSION AREAS

- Atmosphere
- Climate
- Land
- Ocean
- Space Env.
- RDR/SDR Only

- Albedo (Surface)
- Cloud Base Height
- Cloud Cover/Layers
- Cloud Effective Part Size
- Cloud Optical Thickness
- Cloud Top Height
- Cloud Top Pressure
- Cloud Top Temperature
- Land Surface Temp 1
- Surface Type
- Ocean Color/Chlorophyll 2
- Suspended Matter
- Vegetation Index
- Aerosol Optical Thickness
- Aerosol Particle Size
- Ice Surface Temperature 3
- Imagery 3
- Sea Ice Characterization 3
- Snow Cover/Depth 3
- Sea Surface Temperature 3

VIIRS Product Types

Raw Data Record (RDR) = MODIS Level 0

Sensor Data Record (SDR) = MODIS Level 1B

Intermediate Product (IP) = MODIS Level 2

Environmental Data Record (EDR) = MODIS Level 2

Climate Data Record (CDR) = MODIS Level 3

Product format is ***HDF5***; described in CDFCB volumes available at

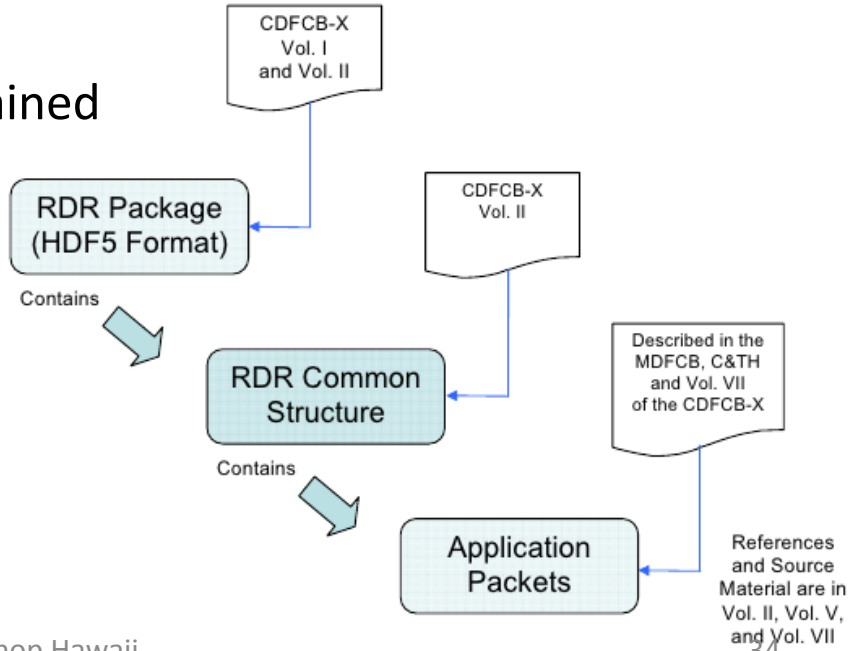
http://npp.gsfc.nasa.gov/science/documents.html

How many VIIRS SDR files per day?

- 16 M-bands, 5 I-bands, and 1 day/night band (16+5+1 = 22)
- Geoid and terrain corrected geolocation for M, I, and DNB (2x3 = 6)
- 85.7 sec per granule
- (86400 sec/day) / (85.7 sec/granule) = 1008 granules per day
- VIIRS SDR: (1008 granules/day) x (28 files/granule) = **28224 files/day**
- MODIS L1B: 288 granules/day x 4 files/granule = **1152 files/day**

Raw Data Record (RDR)

- The RDR is an accumulation of binary data generated by sensors on board the NPP spacecraft and assembled into groups called application packets (APs).
- The ground software collects one or more groups of related APs together into granules which are then assembled into common RDR structures and combined with metadata to create the delivered HDF5 file.
- Similar to MODIS Level 0
- CDFCB-X documents at right can be obtained from...



Sensor Data Record (SDR)

- The SDR is an accumulation of binary data generated by sensors on board the NPP spacecraft and assembled into groups called application packets (APs).

- Processing an RDR into an SDR involves unpacking and decommutating the Application Packet (AP) data, as necessary, applying calibration (radiometric, geometric, engineering), and finally geo-locating, as needed, using ephemeris and attitude information and earth model information.

- An SDR contains the following:
  - Calibrated sensor data
  - Geolocation data (where applicable)
  - Quality flags
  - Metadata at the granule and aggregation level

- Product names GMODO, GMTCO, GIMGO, GITCO, SVM[01-16], SVI[01-05]

Intermediate Product (IP)

- IPs are defined as a data subset or retrieval by-product that is required within another primary data product's generation sequence or is used as an input to secondary processing or analysis.
- Generally are pixel-level products like the SDRs (750m resolution).
- Certain IPs (Cloud Mask, Quarterly Surface Type) are packaged and delivered to the end-user, and are used to create further IPs (Cloud Optical Properties, Cloud Top Parameters, Aerosol etc...).
- Other IPs (Quarterly Surface Type/Land Water Mask [QSTLWM IP] are generated during the creation of IPs and EDRs but are not delivered.
- Atmosphere Product Names:
  - IICMO (Cloud Mask)
  - IVAOT (Aerosol Optical Thickness)
  - IVCOP (Cloud Optical Properties [COT, EPS])
  - IVCTP (Cloud Top Parameters [CTP, CTT, CTH])

Environmental Data Records (EDR)

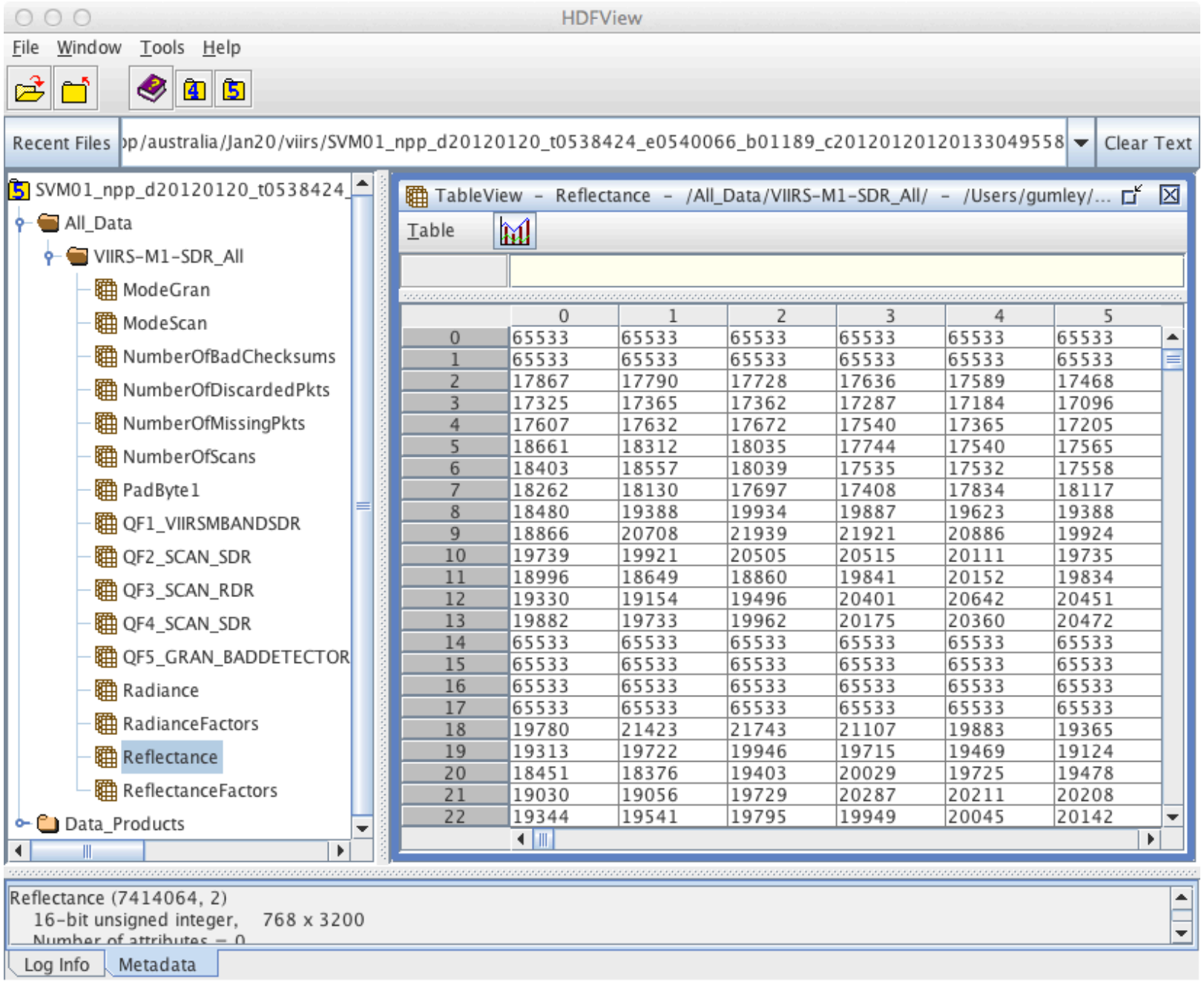
- Environmental Data Records (EDRs) are data records containing environmental parameters or imagery generated by the IDPS system as products deliverable to the user.
- An EDR contains the following:
  - EDR specific data
  - Appropriate geolocation values
  - Quality Flags
  - Metadata represented as Attributes in the HDF5 file that are provided at the granule and aggregation level
- Atmosphere Product names VAOOO (AOT), VCEPO (EPS), VCOTO (COT), VCTPO (CTP), VCTTO(CTT), VCTHO (CTH)...

Software to Read VIIRS Data

HDF5 Software

- http://www.hdfgroup.org/HDF5/
- Software library (API) for C, Fortran, Java
- Command line utilities (e.g., h5dump) for Windows, Mac, Linux
- HDFView interactive viewer

- IDL, Matlab, and Python all have well developed HDF5 APIs
- ENVI and other commercial software does not support VIIRS (yet)



	0	1	2	3	4	5
0	65533	65533	65533	65533	65533	65533
1	65533	65533	65533	65533	65533	65533
2	17867	17790	17728	17636	17589	17468
3	17325	17365	17362	17287	17184	17096
4	17607	17632	17672	17540	17365	17205
5	18661	18312	18035	17744	17540	17565
6	18403	18557	18039	17535	17532	17558
7	18262	18130	17697	17408	17834	18117
8	18480	19388	19934	19887	19623	19388
9	18866	20708	21939	21921	20886	19924
10	19739	19921	20505	20515	20111	19735
11	18996	18649	18860	19841	20152	19834
12	19330	19154	19496	20401	20642	20451
13	19882	19733	19962	20175	20360	20472
14	65533	65533	65533	65533	65533	65533
15	65533	65533	65533	65533	65533	65533
16	65533	65533	65533	65533	65533	65533
17	65533	65533	65533	65533	65533	65533
18	19780	21423	21743	21107	19883	19365
19	19313	19722	19946	19715	19469	19124
20	18451	18376	19403	20029	19725	19478
21	19030	19056	19729	20287	20211	20208
22	19344	19541	19795	19949	20045	20142

Interrogation of VIIRS files using h5dump

- VIIIRS RDR, SDR, EDR, CDR and IP files are in HDF5 format
- HDF5 format is hierarchical in nature, and HDF5 data structure shares a similarity with a UNIX file system. We can dump the basic file structure using "h5dump -n "...

```
h5dump -n SVM16_npp_d20120120_t0534262_e0535504_b01189_c20120120120117709679_noaa_ops.h5

HDF5 "SVM16_npp_d20120120_t0534262_e0535504_b01189_c20120120120117709679_noaa_ops.h5" {
FILE_CONTENTS {
 group      /
 group      /All_Data
 group      /All_Data/VIIRS-M16-SDR_All
 dataset    /All_Data/VIIRS-M16-SDR_All/BrightnessTemperature
 dataset    /All_Data/VIIRS-M16-SDR_All/BrightnessTemperatureFactors
 dataset    /All_Data/VIIRS-M16-SDR_All/ModeGran
 dataset    /All_Data/VIIRS-M16-SDR_All/ModeScan
 dataset    /All_Data/VIIRS-M16-SDR_All/NumberOfBadChecksums
 dataset    /All_Data/VIIRS-M16-SDR_All/NumberOfDiscardedPkts
 dataset    /All_Data/VIIRS-M16-SDR_All/NumberOfMissingPkts
 dataset    /All_Data/VIIRS-M16-SDR_All/NumberOfScans
 dataset    /All_Data/VIIRS-M16-SDR_All/PadByte1
 dataset    /All_Data/VIIRS-M16-SDR_All/QF1_VIIRSMBANDSDR
 dataset    /All_Data/VIIRS-M16-SDR_All/QF2_SCAN_SDR
 dataset    /All_Data/VIIRS-M16-SDR_All/QF3_SCAN_RDR
 dataset    /All_Data/VIIRS-M16-SDR_All/QF4_SCAN_SDR
 dataset    /All_Data/VIIRS-M16-SDR_All/QF5_GRAN_BADDETECTOR
 dataset    /All_Data/VIIRS-M16-SDR_All/Radiance
 dataset    /All_Data/VIIRS-M16-SDR_All/RadianceFactors
 group      /Data_Products
 group      /Data_Products/VIIRS-M16-SDR
 dataset    /Data_Products/VIIRS-M16-SDR/VIIRS-M16-SDR_Aggr
 dataset    /Data_Products/VIIRS-M16-SDR/VIIRS-M16-SDR_Gran_0
 }
}
```

Interrogation of VIIRS SDR files using h5dump

To examine the details about a particular dataset, say the M16 radiance...

```
h5dump -H -d  /All_Data/VIIRS-M16-SDR_All/Radiance
        SVM16_npp_d20120120_t0534262_e0535504_b01189_c20120120120117709679_noaa_ops.h5

HDF5 "SVM16_npp_d20120120_t0534262_e0535504_b01189_c20120120120117709679_noaa_ops.h5" {
DATASET "/All_Data/VIIRS-M16-SDR_All/Radiance" {
DATATYPE  H5T_STD_U16BE
DATASPACE  SIMPLE { ( 768, 3200 ) / ( 768, 3200 ) }
}
}
```

Examining the data values in the radiance dataset...

```
h5dump -d  /All_Data/VIIRS-M16-SDR_All/Radiance
        SVM16_npp_d20120120_t0534262_e0535504_b01189_c20120120120117709679_noaa_ops.h5

HDF5 "SVM16_npp_d20120120_t0534262_e0535504_b01189_c20120120120117709679_noaa_ops.h5" {
DATASET "/All_Data/VIIRS-M16-SDR_All/Radiance" {
DATATYPE  H5T_STD_U16BE
DATASPACE  SIMPLE { ( 768, 3200 ) / ( 768, 3200 ) }
DATA {
(0,0): 65533, 65533, 65533, 65533, 65533, 65533, 65533, 65533, 65533,
(0,9): 65533, 65533, 65533, 65533, 65533, 65533, 65533, 65533, 65533,
(0,18): 65533, 65533, 65533, 65533, 65533, 65533, 65533, 65533, 65533,
(0,27): 65533, 65533, 65533, 65533, 65533, 65533, 65533, 65533, 65533,
(0,36): 65533, 65533, 65533, 65533, 65533, 65533, 65533, 65533, 65533
...
...
```

IDL code to read VIIRS SDR M15

```
;- Open the file
file = 'SVM15_npp_d20120120_t0528446_e0530088_b01189_c20120120115158805940_noaa_ops.h5'
file_id = h5f_open(file)

;- Read the data array
data_id = h5d_open(file_id, '/All_Data/VIIRS-M15-SDR_All/BrightnessTemperature')
data = h5d_read(data_id)
h5d_close, data_id

;- Read the scale factors
data_id = h5d_open(file_id, '/All_Data/VIIRS-M15-SDR_All/BrightnessTemperatureFactors')
factors = h5d_read(data_id)
h5d_close, data_id

;- Apply the scale factors
data = data * factors[0] + factors[1]

;- Close the file
h5f_close, file_id
```

Reprojection/Remapping Software

- MS2GT from NSIDC
  - http://cires.colorado.edu/~tharan/ms2gt/
- Developed for MODIS, but low level routines (ll2cr and fornav) are sensor agnostic
- For 6 concatenated M-band SDR granules:

```
$ ll2cr -v -f   3200   288    16 lat.dat lon.dat remap.gpd image_proj
$ fornav 1 -v -t u2 –f 65533 -F 0 -D 40 3200 28 16 \
  image_proj_cols_03200_00288_00000_16.img \
  image_proj_rows_03200_00288_00000_16.img \
  image.dat 2772  3559 image_proj.dat
```

Defining the projected grid

where lat.dat, lon.dat contain 32-bit floating point lat/lons and imag.dat contains 16-bit unsigned integers (all 3200x4608 values).

Grid Parameter Definition (GPD file) remap.gpd contains:

Map Projection: Cylindrical Equidistant

Map Reference Latitude: 36.50000

Map Reference Longitude: -77.82500

Grid Map Units per Cell: 0.750

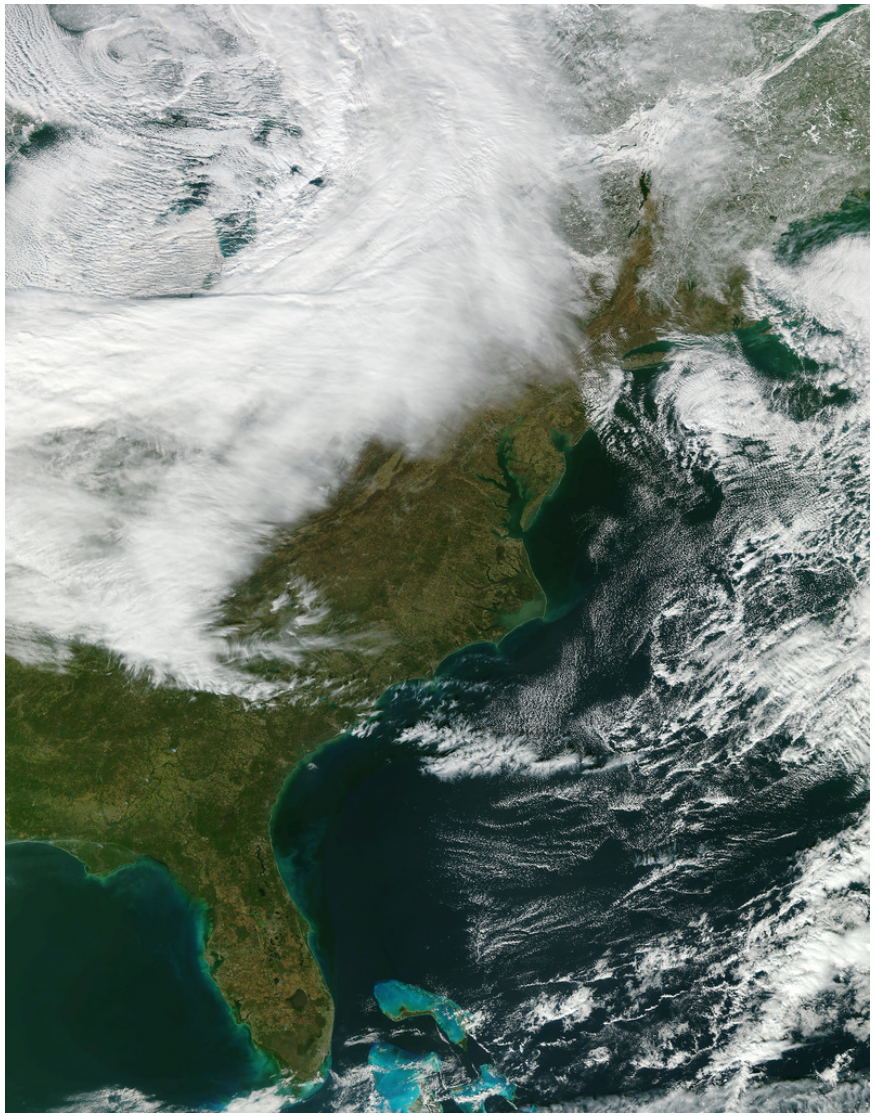
Grid Width: 2772.0

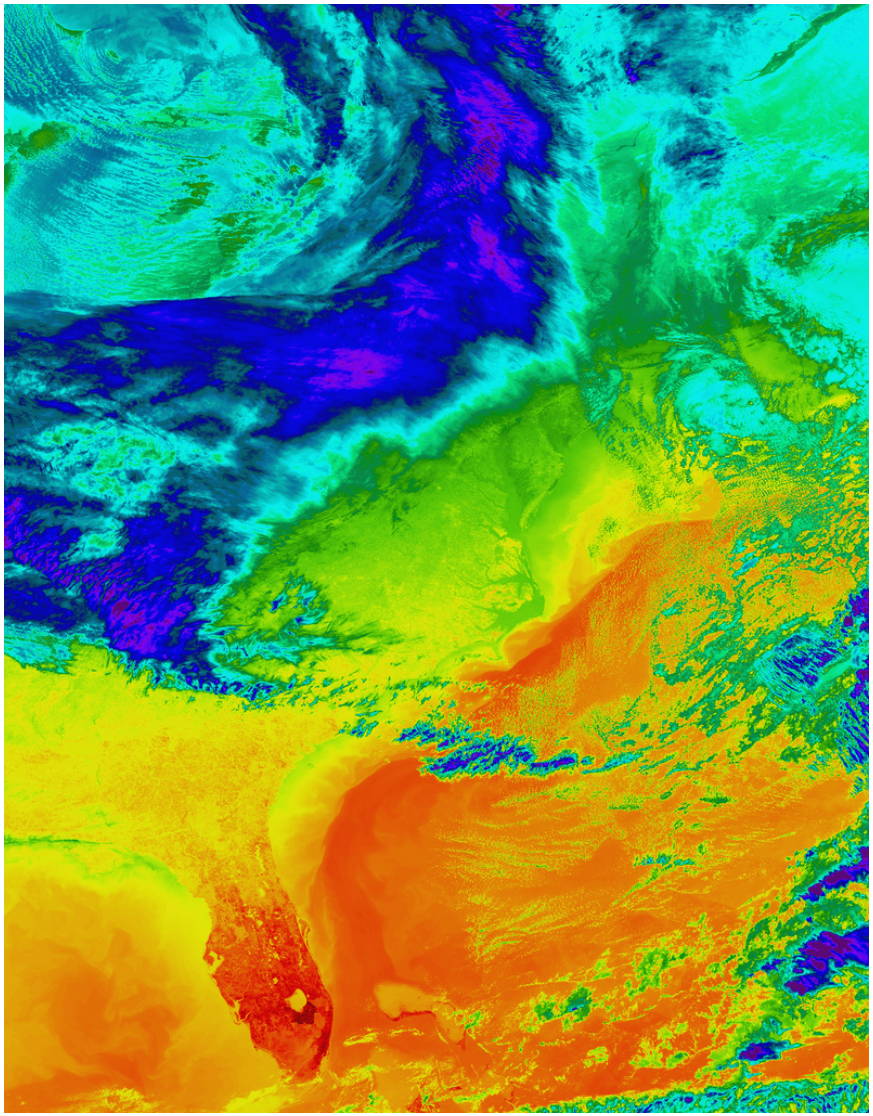
Grid Height: 3559.0

Grid Map Origin Column: 1385.5

Grid Map Origin Row: 1779.0

Image Examples





Suomi NPP Direct Broadcast

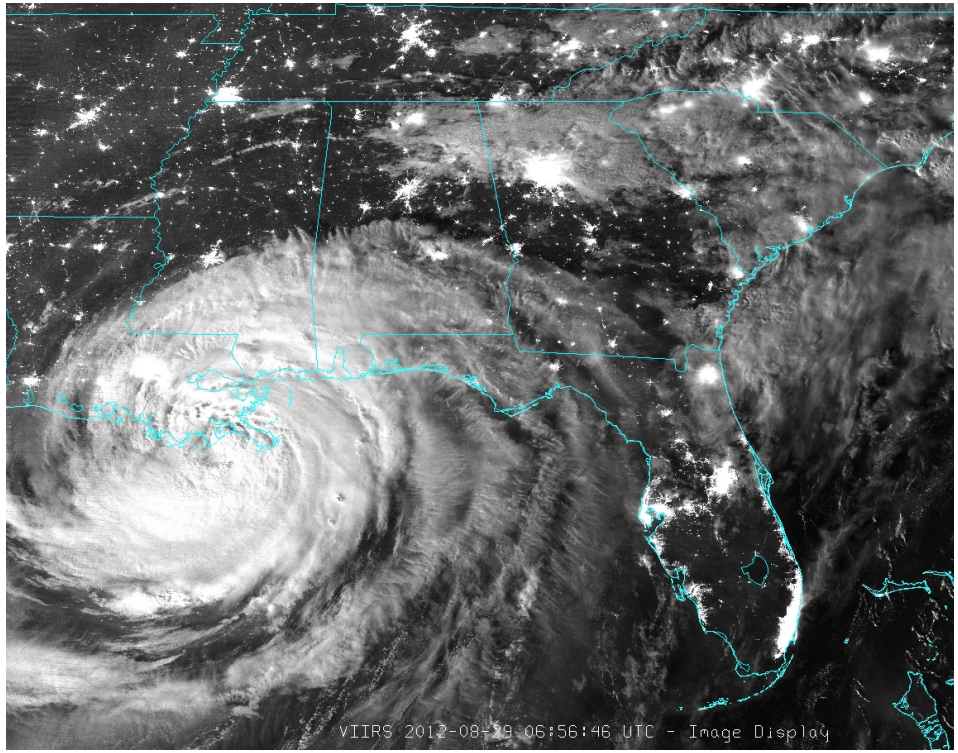
SNPP Direct Broadcast Status

- SNPP transmits VIIRS, CrIS, and ATMS data real-time via X-band direct broadcast.
- 7812 MHz, 13 Mbps.
- No encryption, licenses, or fees.
- Downlink format is described in CDFCB External Volume VII at http://npp.gsfc.nasa.gov/science/documents.html
- Software for real-time DB processing is available from SSEC and NASA.

2.4-meter X/L-band Antenna Hardware Installation at HCC on 8 August 2012

The Community Satellite Processing Package (CSPP) for real-time data received by direct broadcast from Suomi NPP, POES, Metop, and FY-3.

VIIRS Day/Night Band, Hurricane Isaac, 2012/08/29



Liam E. Gumley

Space Science and Engineering Center

University of Wisconsin-Madison

Suomi NPP Sensor Suite

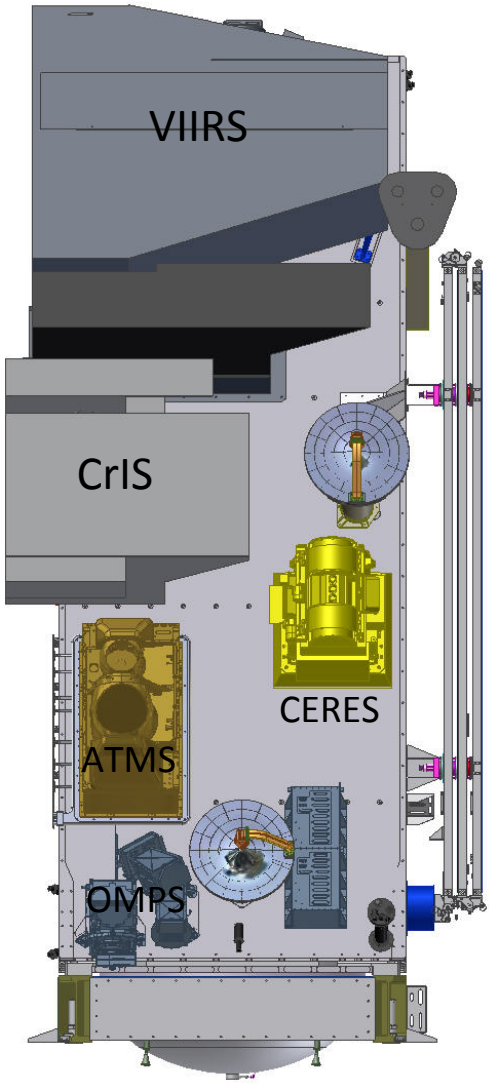
VIIRS – Medium Resolution Visible & Infra-red Imager

CrIS – Fourier Transform Spectrometer for IR Temperature and Moisture sounding

ATMS – Microwave sounding radiometer

OMPS – Total Ozone Mapping and Ozone Profile measurements

CERES - Earth Radiation Budget



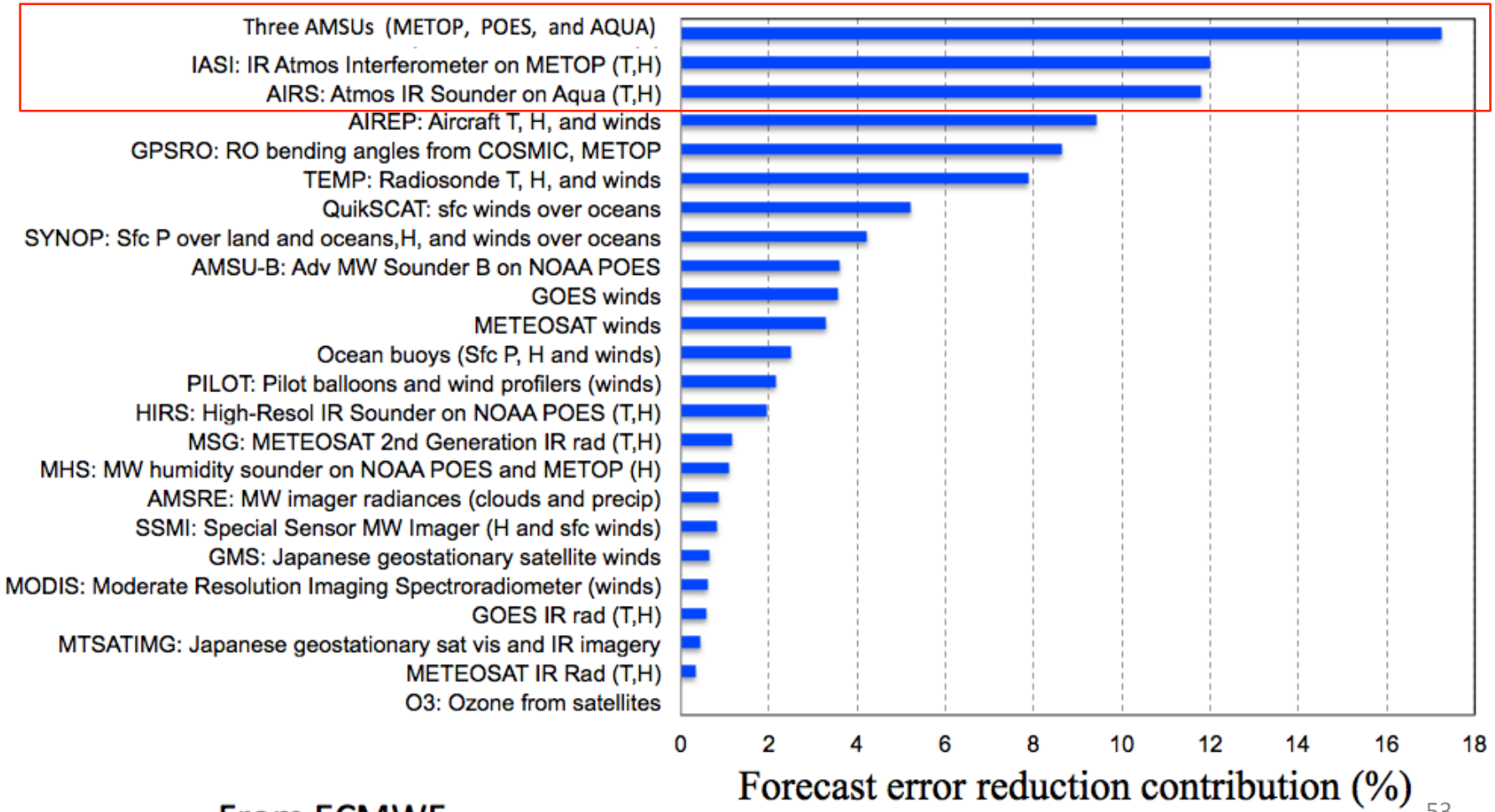
Real-Time Applications

- Numerical Weather Prediction: Infrared and Microwave Sounder Data
- Wildfire Detection for Disaster Management: Thermal Infrared Imager Data (e.g, GA Sentinel)
- Sea Ice Detection for Ship Navigation: Day/ Night Band Imager Data
- Volcanic Ash Detection: Thermal Infrared Imager

Timeliness of the Data is Key

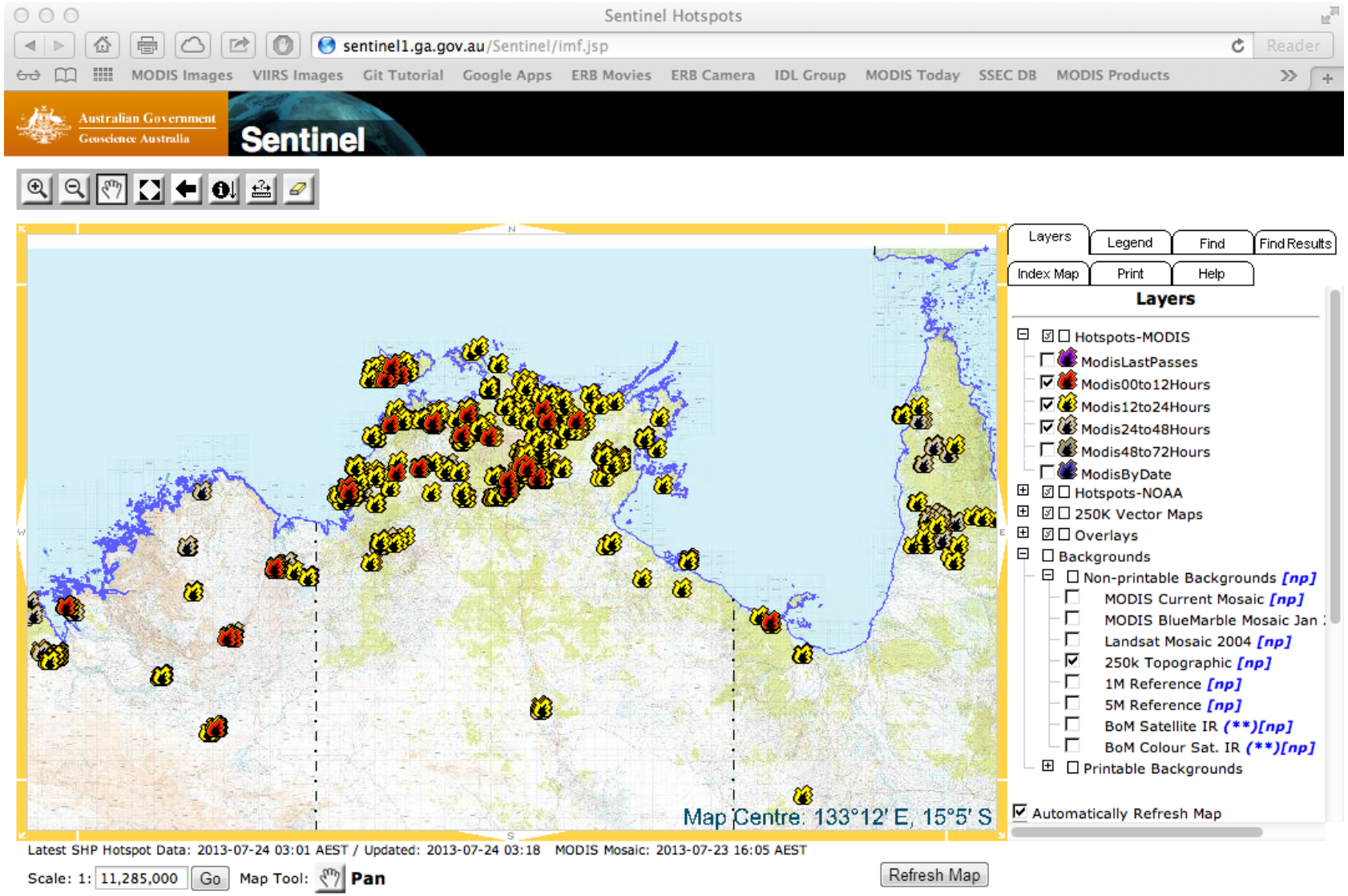
NWP Forecast Error Reduction

Infrared and Microwave Sounder data from polar orbiting satellites have the largest impact on improving NWP forecast skill



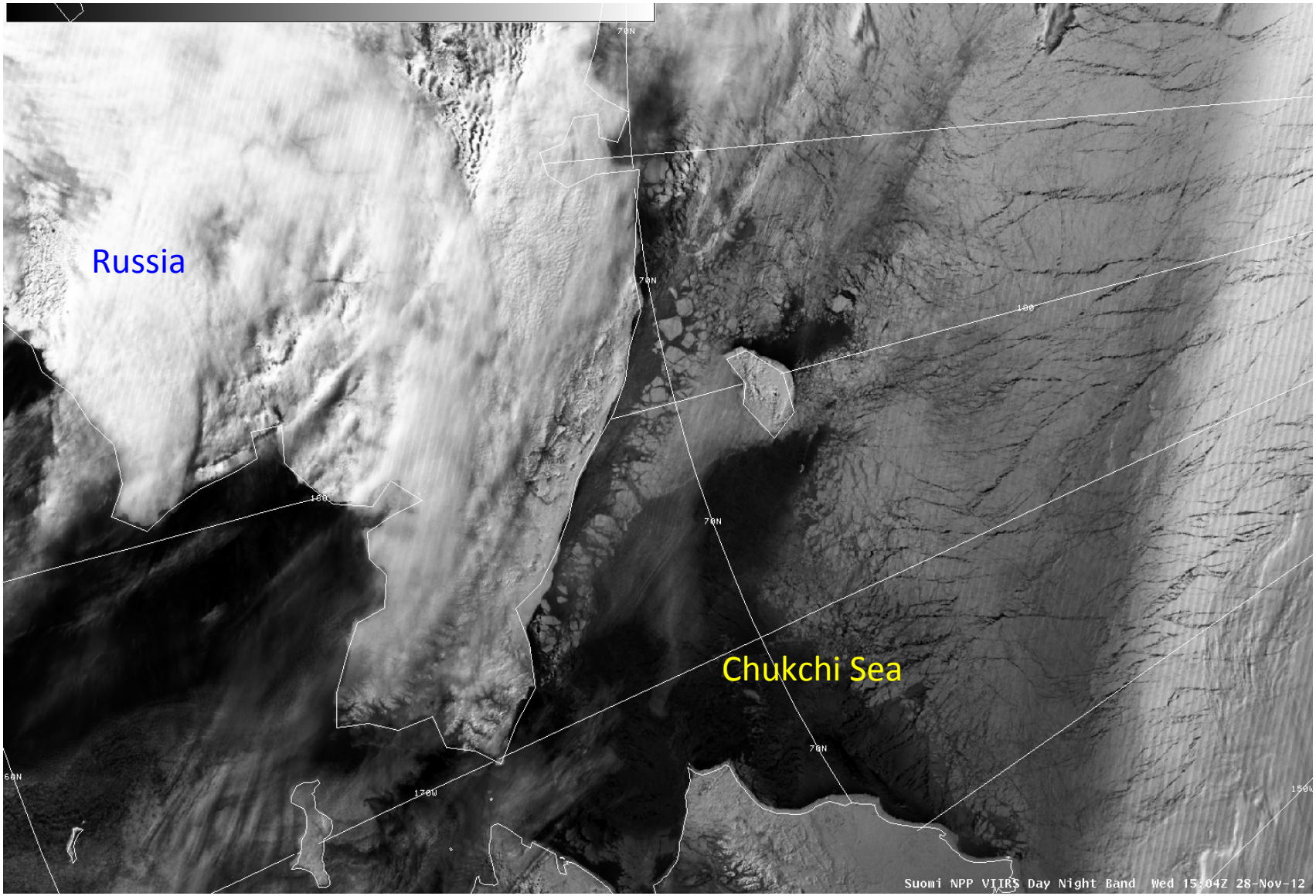
From ECMWF

Wildfire Detection



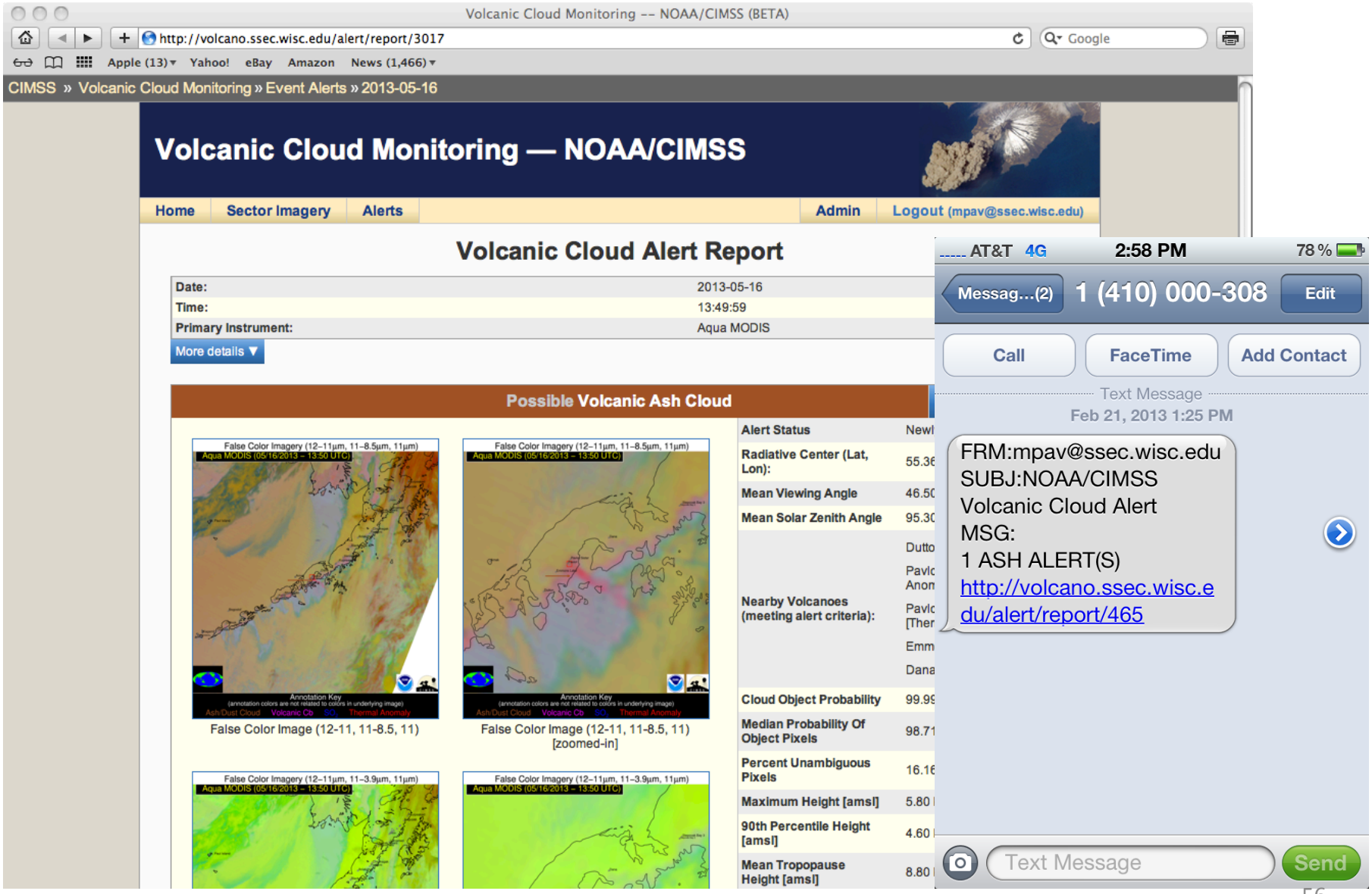
Sentinel Hotspot Detections Derived from MODIS Infrared Imagery

Sea Ice Mapping for Navigation



VIIRS Day/Night Band as seen by NWS Anchorage Ice Desk

Volcanic Ash Alert System



MODIS and VIIRS Infrared Imagery are used to Detect Volcanic Ash

Receiving Real-Time Data

Hardware Required:

- Tracking antenna with 2.4-3.0 meter reflector
- LNA, Downconverter, Demodulator

X-band: *Terra, Aqua, SNPP, FY-3*
L-band: *POES, Metop, Meteor-M*

Output product is raw bitstream from demodulator.

2.4-m X/L-band Antenna
NWS Honolulu

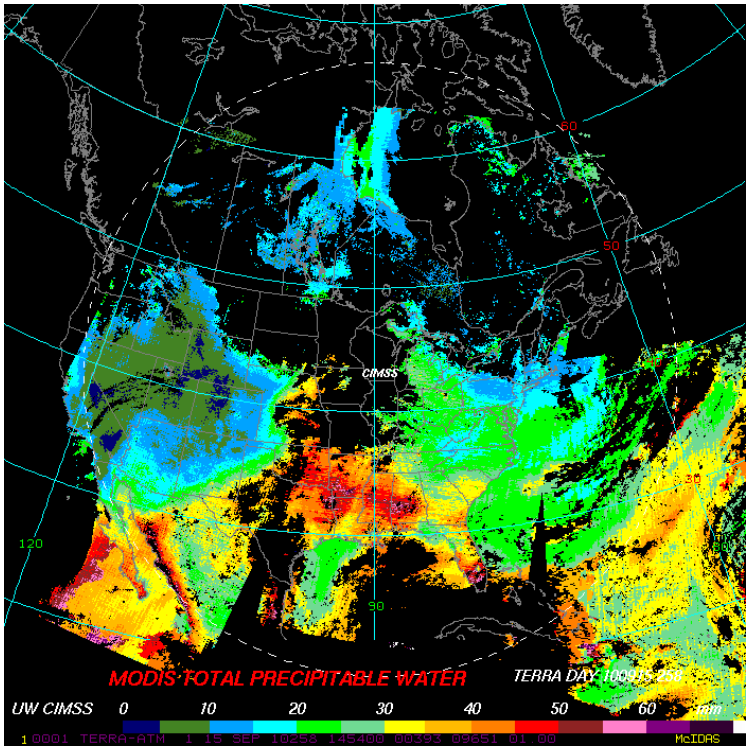
Worldwide X-band Sites

Direct Broadcast Software from SSEC

International ATOVS Processing Package (IAPP) heritage goes back to 1985. IAPP supports NOAA 15-19.

International MODIS/AIRS Processing Package (IMAPP) has been available since 2000 (funded by NASA). IMAPP supports Terra and Aqua.

Community Satellite Processing Package (CSPP) first released in 2012 (funded by JPSS).



IMAPP MODIS TPW

Community Satellite Processing Package

- CSPP supports *Suomi NPP, Terra, Aqua, POES, and Metop*, and will provide support for *FY-3 and Meteor-M*.
- For Suomi NPP, supported sensors include *VIIRS, CrIS, ATMS* (SDRs and a subset of EDRs).
- For POES and Metop, supported sensors include *AVHRR AMSU, and IASI* (Level 2 only; Level 1 processing is provided by Met Office).
- For FY-3, supported sensors will include *VIIR and MERSI* (Level 2 only; Level 1 processing is provided by NSMC).
- Future support for *Meteor-M* is planned in cooperation with Roshydromet.

CSPP Products for Suomi NPP

- VIIRS, CrIS, and ATMS sensor observations and geolocation
- VIIRS Cloud Mask, Active Fires, Aerosol Optical Thickness, Sea Surface Temperature
- CrIS Temperature and Moisture profiles
- VIIRS imagery (AWIPS, GeoTIFF, True Color)

Distribution format is executable code and data (ready to run); source code is available from SSEC.
Supported platform is Red Hat Enterprise Linux 5 (64-bit).
All algorithms are based on ADL versions; the same code that runs in NESDIS operations.

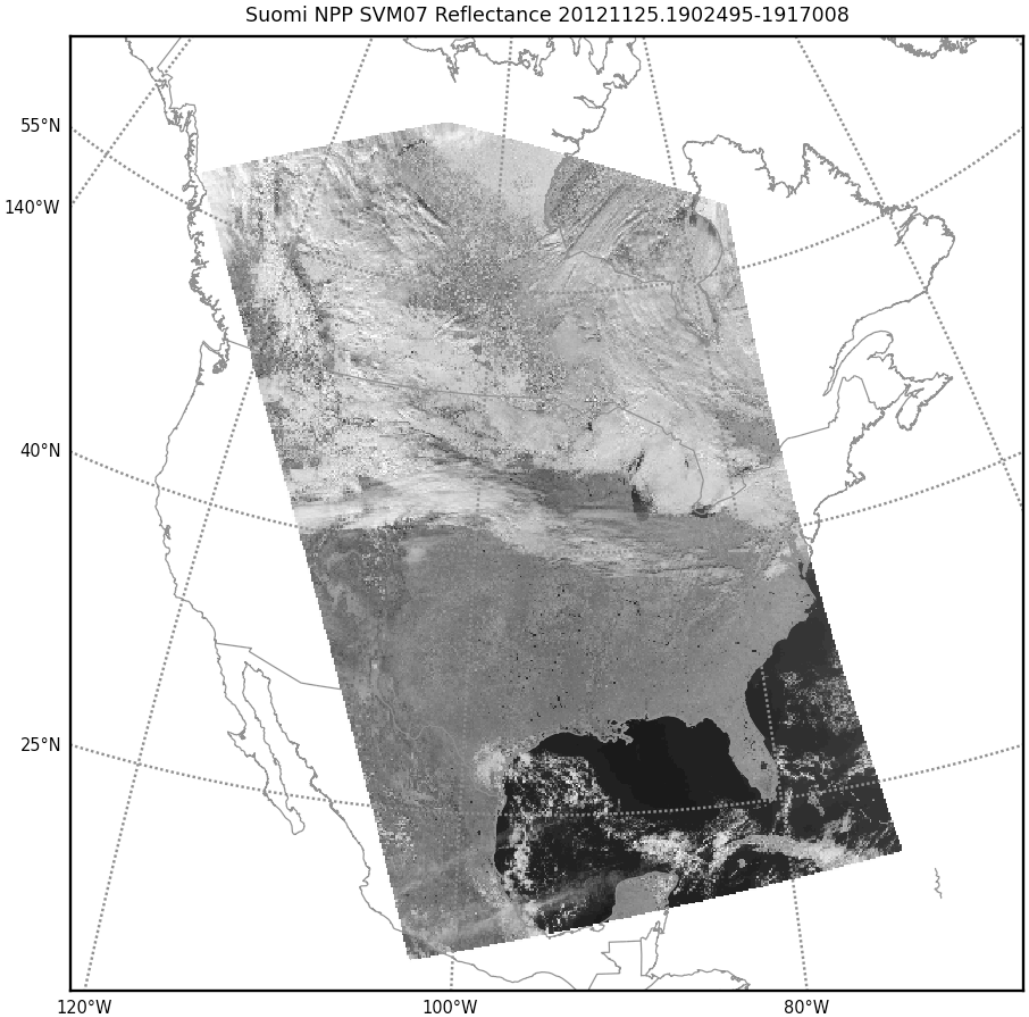
CSPP value added for Suomi NPP

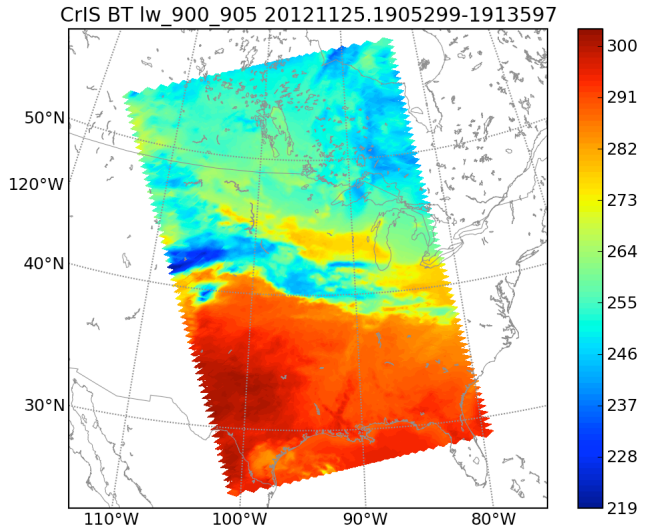
- Multi-core acceleration is available for VIIRS SDR.
- Optional HDF5 internal compression, Granule aggregation, and Mapped Quicklook images.
- Ancillary data are ingested and processed automatically.
- Compiler flags are selected to provide optimized execution speed.
- Details of run-time configuration (e.g., XML files) are transparent.
- Command line scripts require the name of the directory containing the input files, and nothing else.
- Independent algorithms, e.g., CrIS DR retrievals.

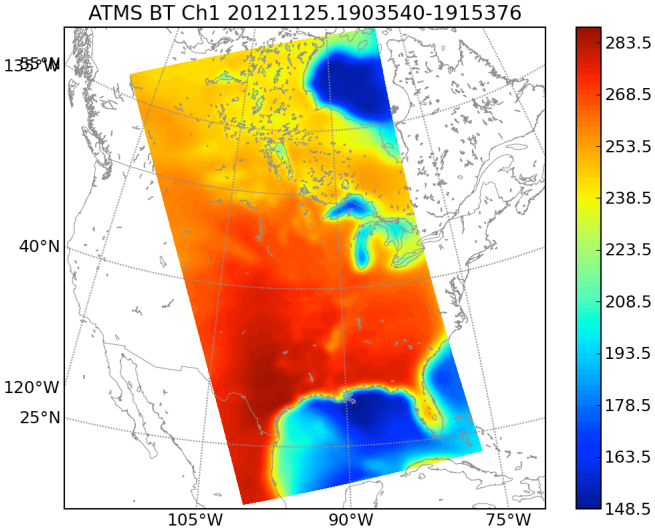
CSPP Users

- **EUMETSAT for EARS-NPP EUMETCast distribution**
- **UK Met Office**
- **Météo-France**
- **CSIR South Africa**
- **Swedish Met Service**
- **DWD – German Met Service**
- **Australia Bureau of Meteorology**
- **Taiwan Central Weather Bureau**
- **Belarus National Academy of Science**
- **Indonesia Government Space Agency (LAPAN)**
- **German Aerospace Center**
- **CONABIO Mexico**
- **EURAC Remote Sensing Institute Italy**
- **China National Satellite Meteorological Center**
- **Brazil INPE**
- **Danish Meteorological Institute**
- **Japanese Meteorological Agency**
- **Norwegian Meteorological Institute**
- **Swedish Met Institute**
- **Kazakhstan Space Investigation Institute**
- **UK Plymouth Marine Lab**
- **Naval Research Lab**
- **Vendors SeaSpace, ScanEx, SpaceTec and others.**
- **In addition, CSPP DB products are being used in the US NWS in HI, Alaska and CONUS**

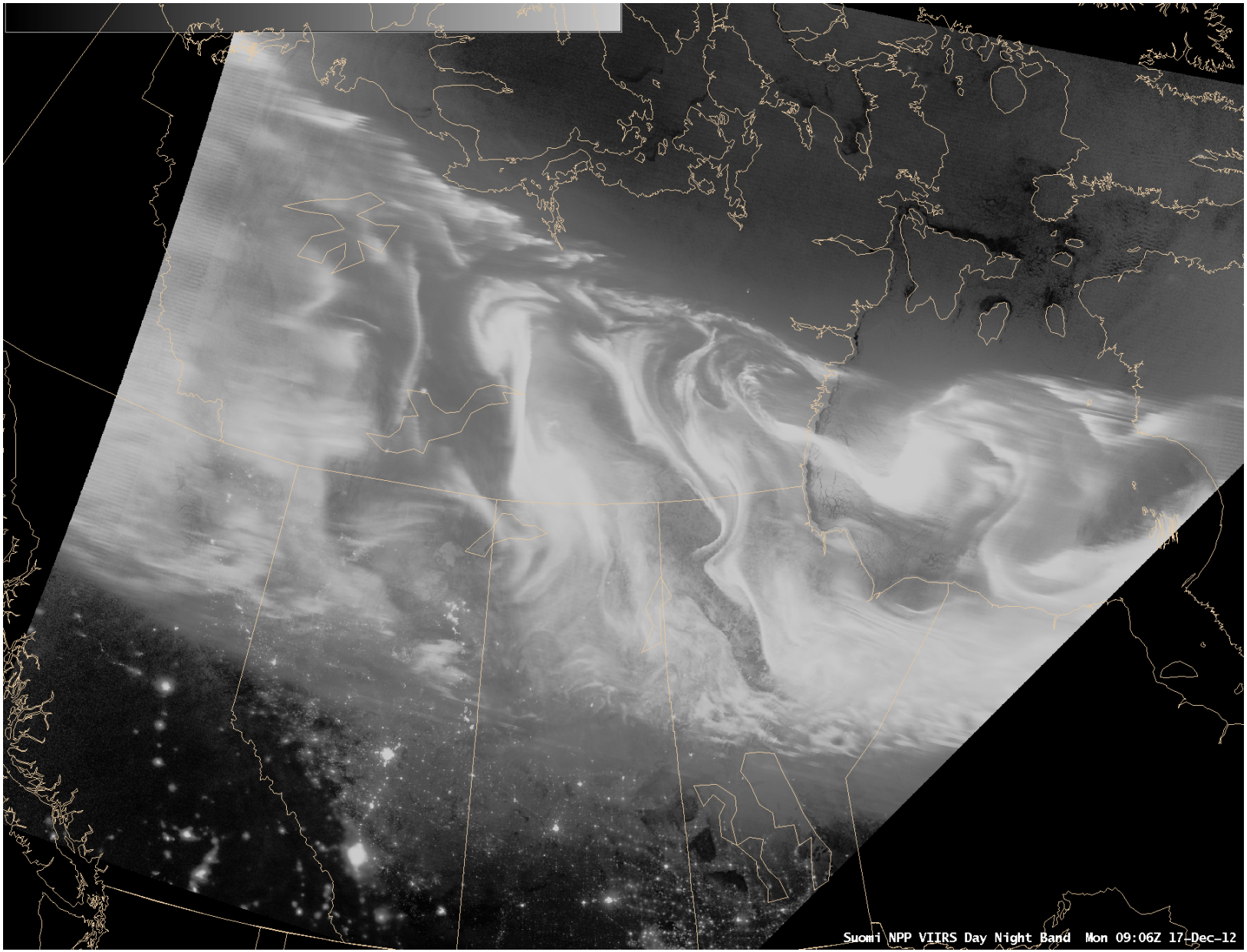
CSPP Quicklook Images



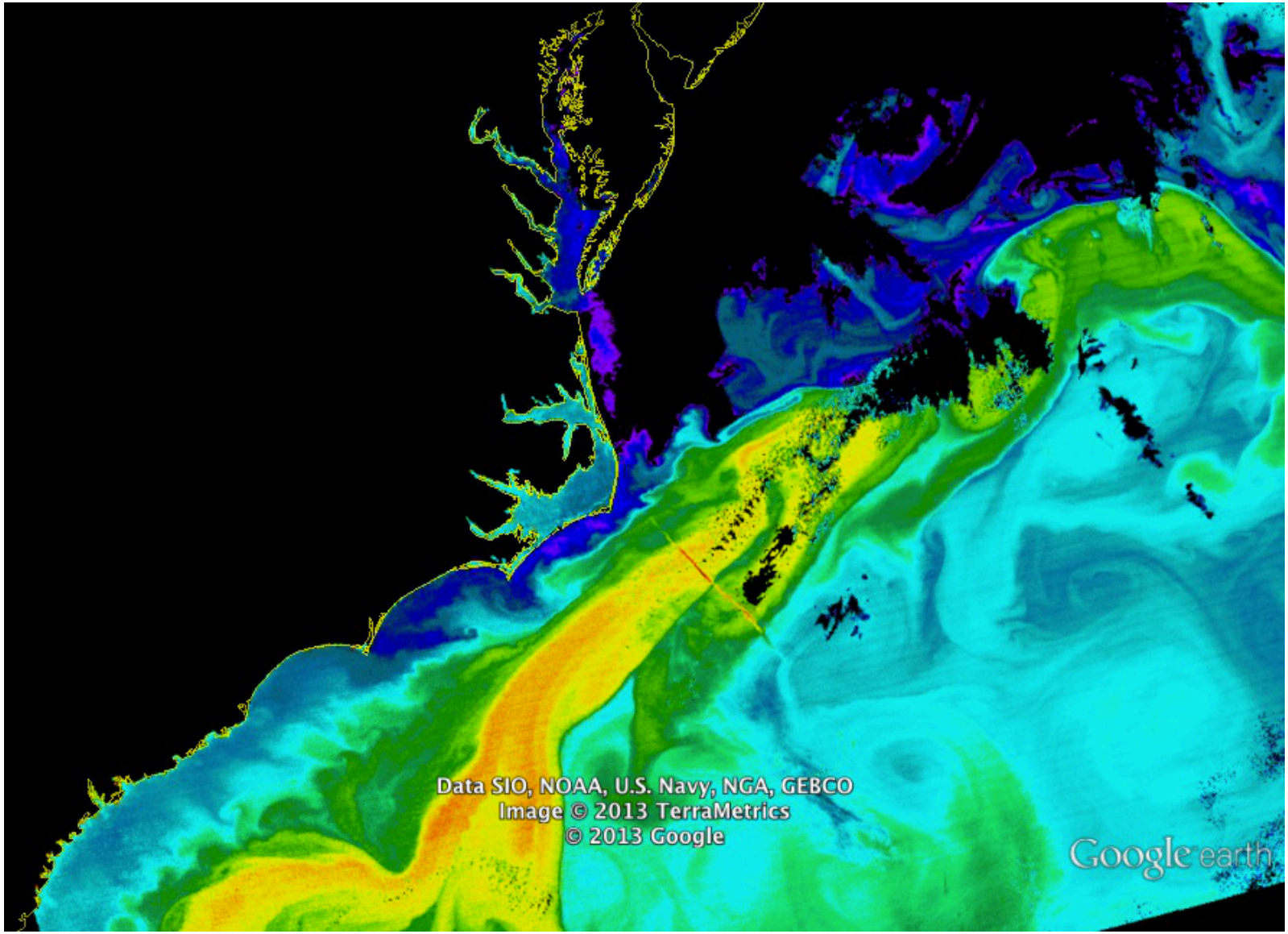




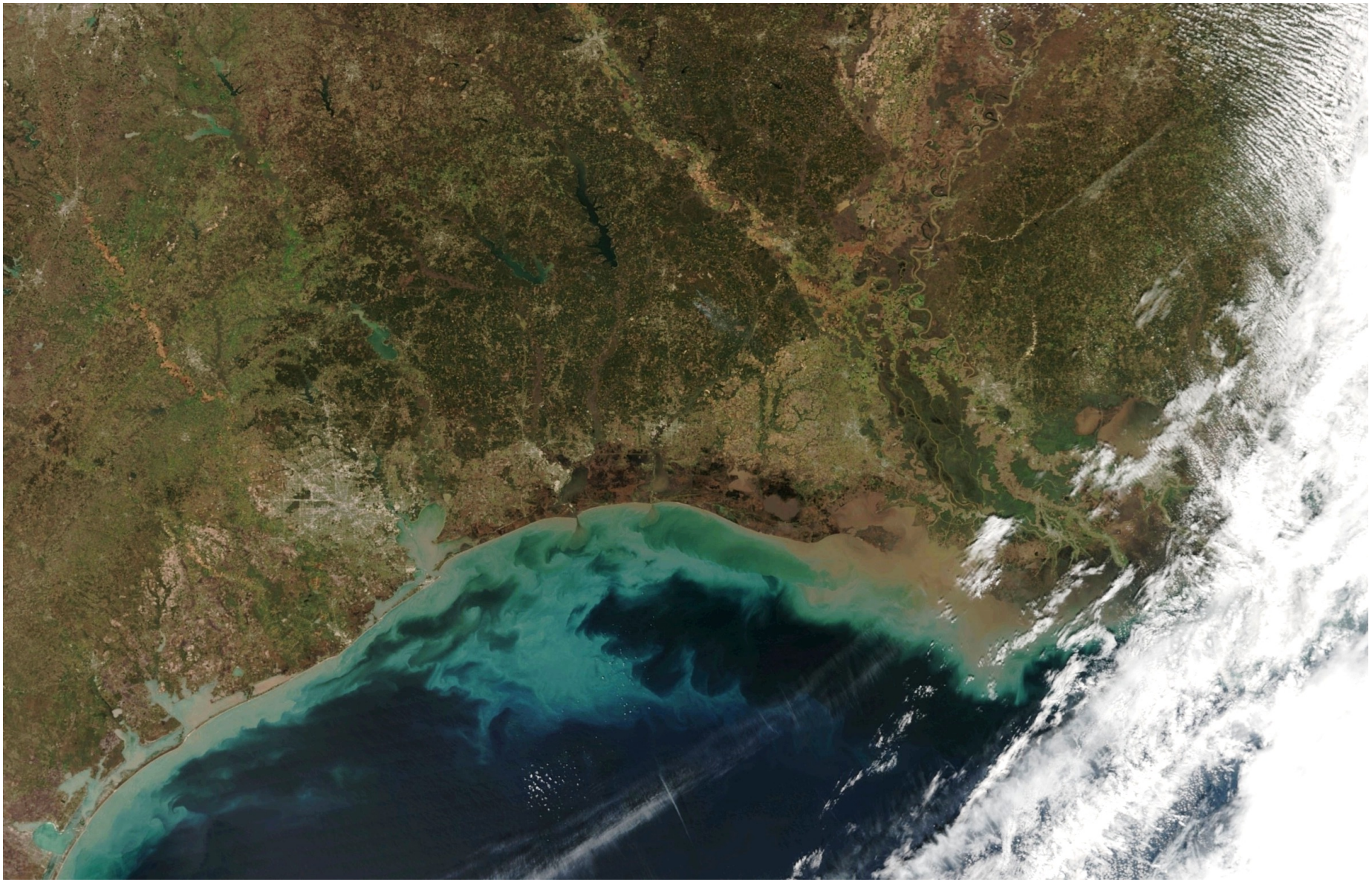
CSPP Product: VIIRS DNB and IR



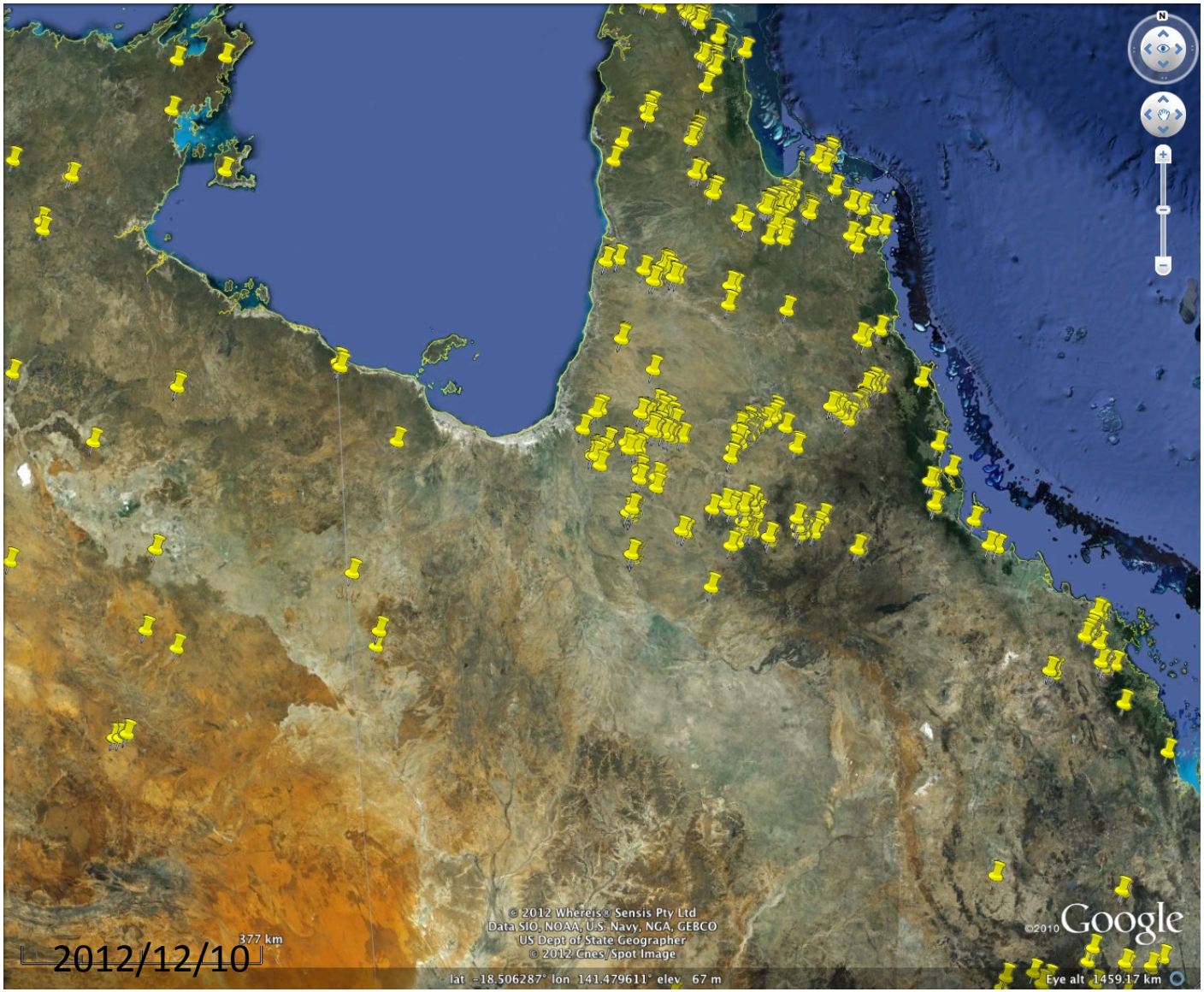
CSPP Product: VIIRS SST



CSPP Product: VIIRS True Color



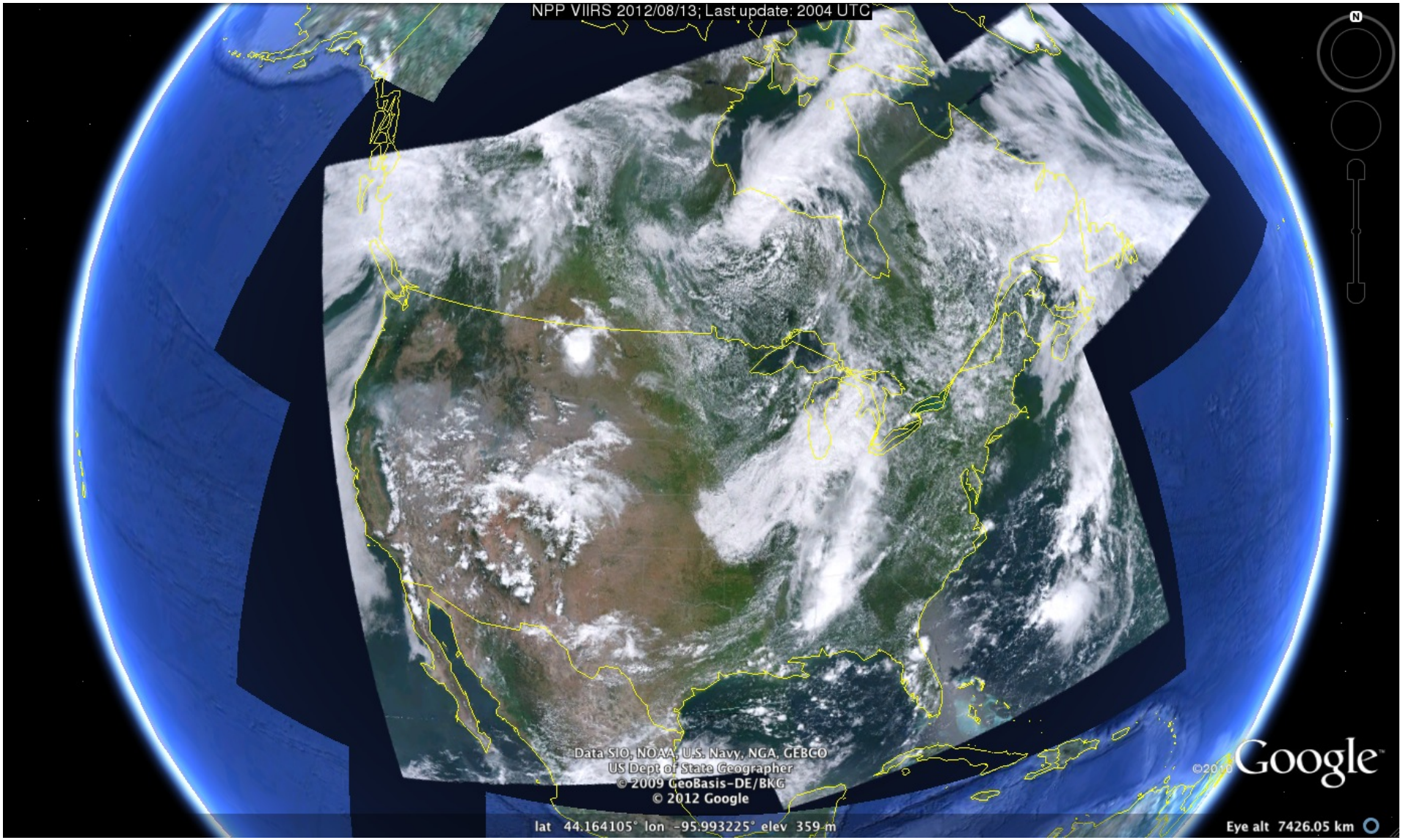
CSPP Product: VIIRS Active Fires



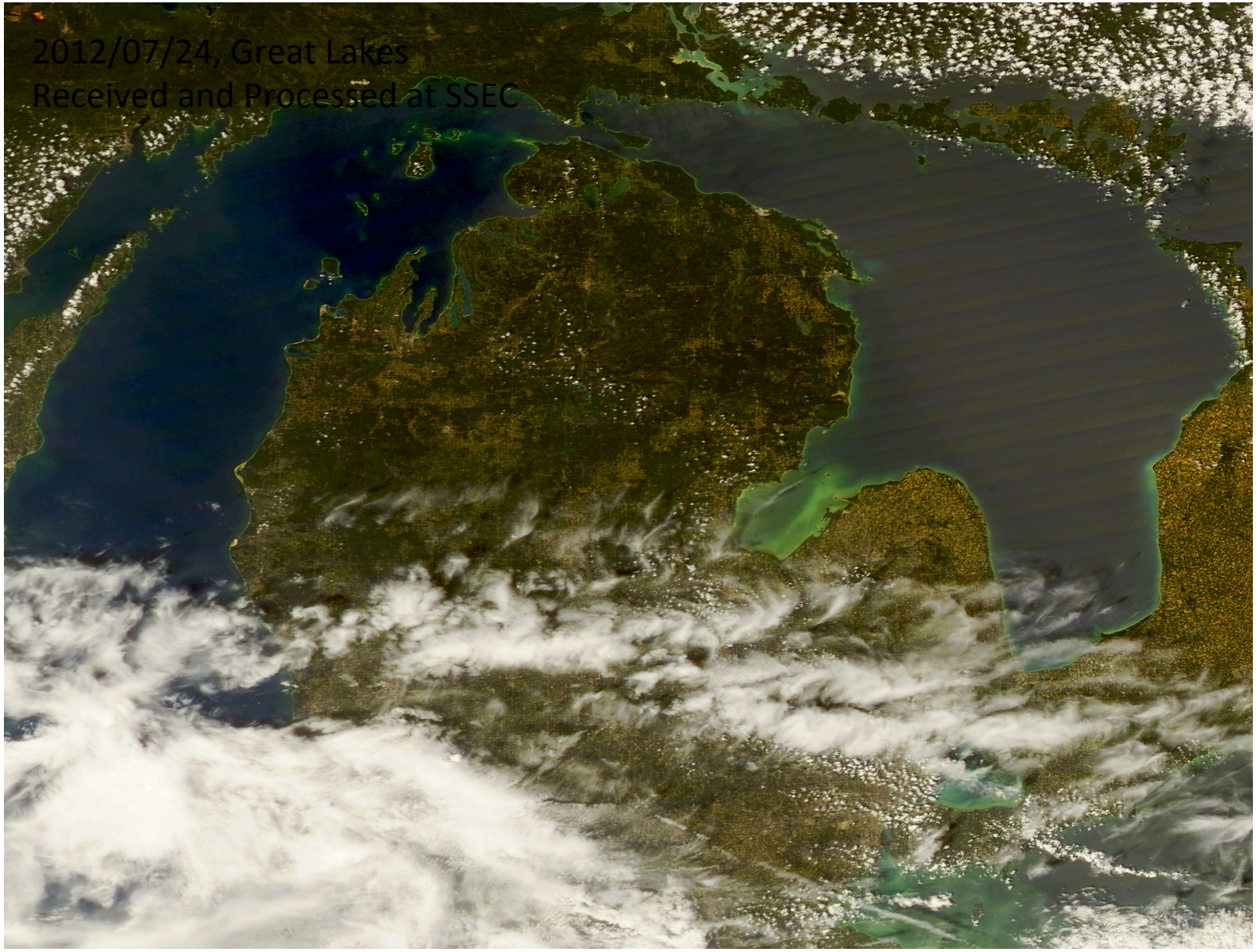
Upcoming CSPP Products

- VIIRS Surface Reflectance, Vegetation Index, and Land Surface Temperature.
- VIIRS, MODIS, and MERSI True Color Imagery in GeoTIFF, JPEG, and KML format.
- Microwave Integrated Retrieval System (MiRS): *ATMS, AMSU rain, ice/snow, precipitation products.*
- Clouds from AVHRR Extended (CLAVR-x): *VIIRS, MODIS, and AVHRR cloud, aerosol products.*

SNPP VIIRS True Color Imagery in KML



FY3-B MERSI True Color



AVHRR Cloud Top Temperature