



CSPP at 1.5 years: Achievements and Future Plans

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OCONUS Meeting
June 18, 2013



Hurricane Sandy 2012/10/28 06:25 UTC
VIIRS DNB from CSPP direct broadcast



Outline

1. Suomi NPP Reception and Processing at SSEC
2. CSPP Overview and Achievements
3. Future CSPP Additions and Enhancements
4. CSPP Support for GEO Satellites



1. Suomi NPP Reception and Processing at SSEC



SSEC LEO Direct Broadcast

- SeaSpace 4.4 meter X-band antenna receiving Terra and Aqua (operational Aug. 2000).
- Orbital Systems 2.4 meter X/L-band antenna receiving Suomi NPP, Terra, Aqua, NOAA 15-19, Metop-A/B, FY 3A/B, FY-1D (operational Aug. 2011).



6/27/2013



SSEC Suomi NPP DB Coverage



6/27/2013



SSEC LEO DB Scheduling

2.4 meter antenna

1. Suomi NPP
2. Terra, Aqua
3. Metop-B, FY-3B
4. Metop-A, NOAA-18, NOAA-19
5. NOAA-15, NOAA-16

4.4 meter antenna

- Terra and Aqua at equal priority



Suomi NPP Real-Time Processing

- Antenna Server acquires demodulated telemetry (CADU), sends it via network to Processing Server.
- Processing server is Dell R720, Dual hex-core Intel E5-2690 2.90 GHz, 128 GB RAM, 16 TB disk.
- RT-STPS (custom version) receives the CADU and converts to RDR in real time.
- CSPP starts RDR to SDR processing within 10 sec of RDR file completion.
- CSPP products chain invokes AWIPS processing and injection, CrIS retrieval processing, and quicklook creation.
- HDF5 products are sent to SSEC FTP site.



Suomi NPP Real-Time Products

- VIIRS SDR M-bands, I-bands, DNB, and Geolocation (HDF5)
- VIIRS Imagery (AWIPS and GeoTIFF format)
- VIIRS EDRs (Cloud Mask and Active Fires)
- CrIS SDR and Geolocation (HDF5)
- ATMS SDR and Geolocation (HDF5)
- CrIS temperature and moisture retrievals (HDF5)
- All products are available to the public on SSEC FTP site (7 day rolling archive)



VIIRS serial processing timeline

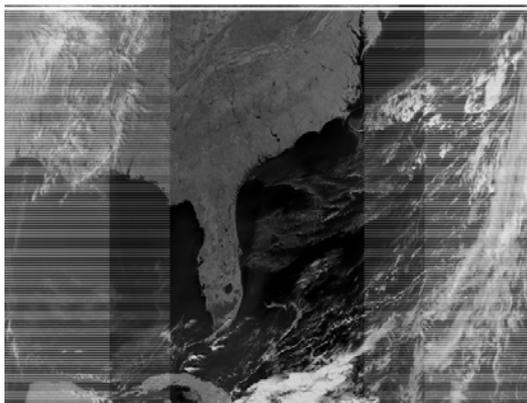
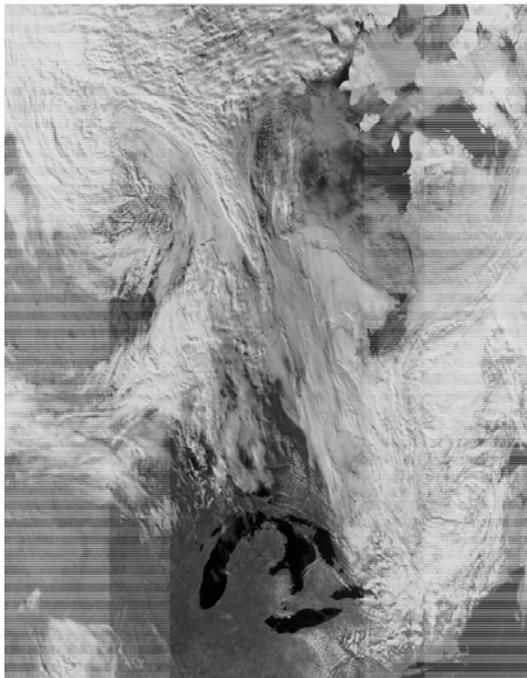
2012/11/26, DB pass from 17:07:02- 17:16:00

17:16:45	RDR done; SDR begins
17:29:45	SDR done; AWIPS begins
17:31:02	AWIPS done; Post-processing begins
17:35:00	Processing done

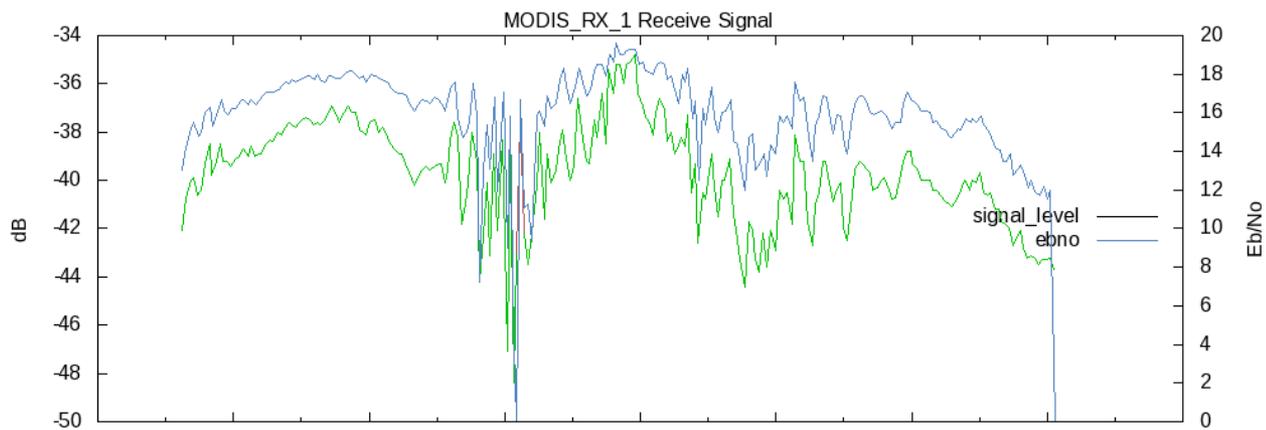
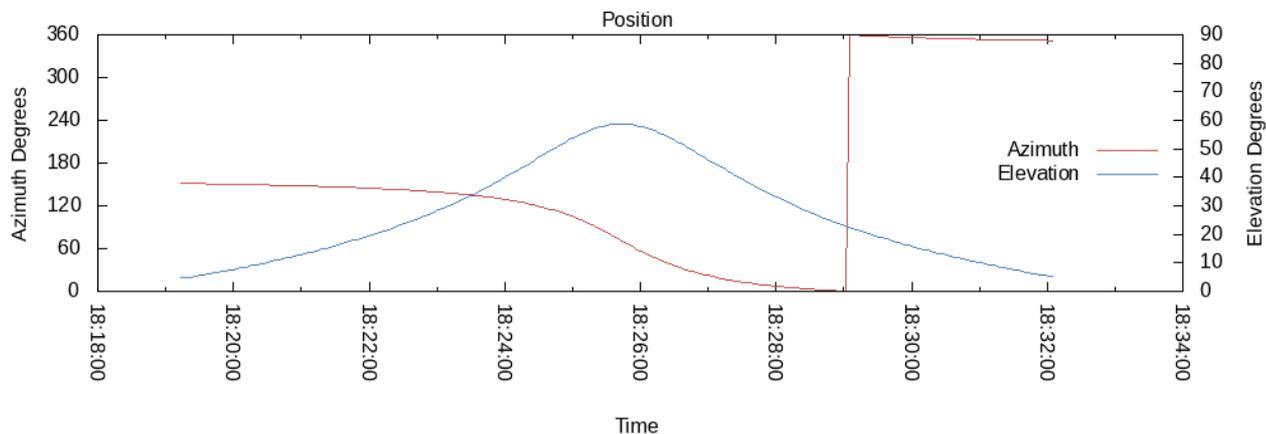
CSPP VIIRS SDR multi-core processing cuts down processing time considerably...



Characterization of HRD Anomaly



Satellite: NPP Start Time: 21-Oct-2012 18:19:13



07/27/2013



HRD Anomaly Analysis

- Collected two months of data (spectrum movies, track plots, raw data)
- Orbital Systems and SSEC have written a report and will be sending it to NASA soon (including assessment of impacts on data quality).
- Ball Aerospace is committed to fixing the problem on JPSS-1 and has a new HRD antenna design.



2. CSPP Overview and Achievements



What is CSPP?

- The Community Satellite Processing Package (CSPP) is a software system for processing direct broadcast data from polar orbiting meteorological satellites.
- Supported satellites include SNPP/JPSS, POES, Metop, Terra, and Aqua.
- Developed and supported by CIMSS/SSEC, UW-Madison.
- Funded by JPSS Project (Mitch Goldberg).



CSPP Goals

CSPP is designed to allow users to

- Create products from their own local DB data,
- Meet their own latency requirements,
- Tailor products to suit local conditions,
- Participate in calibration/validation.

CSPP encourages early use of new satellite sensors (e.g., VIIRS) and products by users outside the operational mainstream.

Suomi NPP Sensor Suite

HRD X-band Direct Broadcast

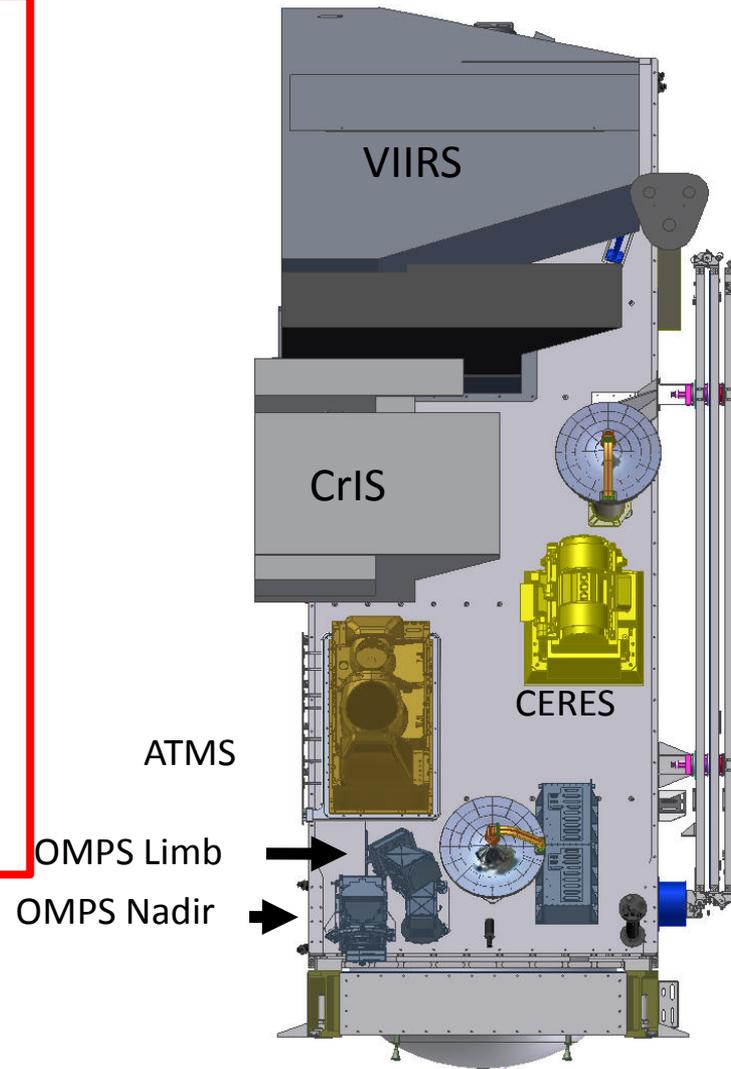
VIIRS – Medium Resolution
Visible & Infra-red Imager

CrIS – Fourier Transform
Spectrometer for IR
Temperature and Moisture
sounding

ATMS – Microwave sounding
radiometer

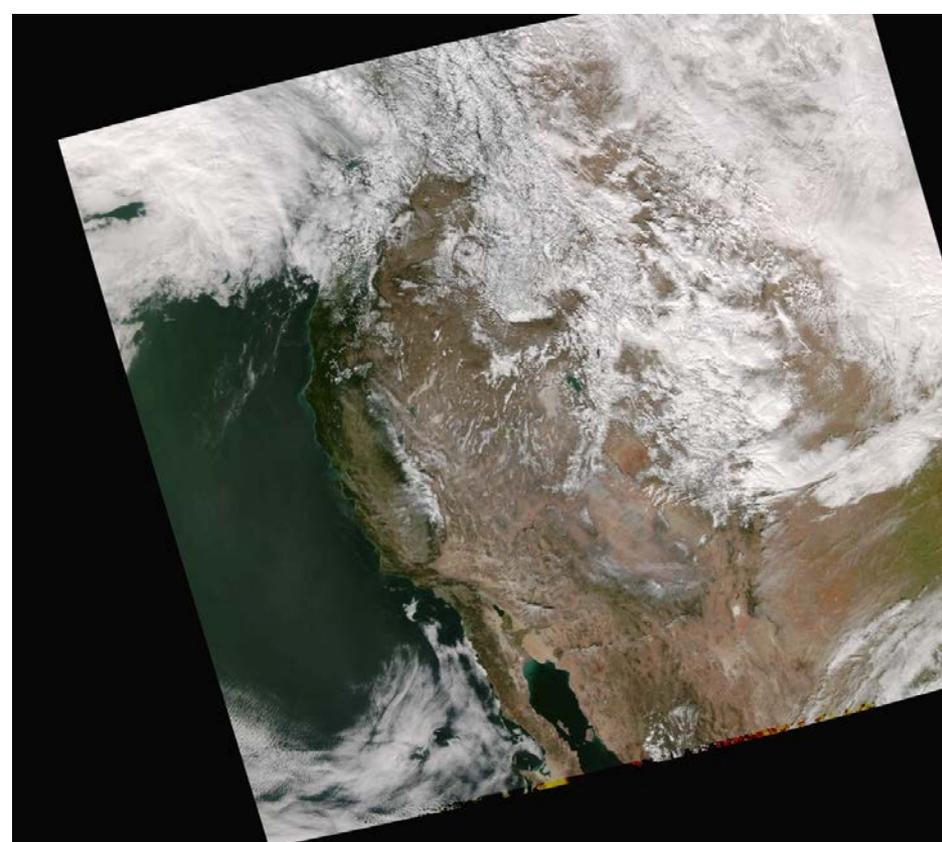
OMPS – Total Ozone Mapping
and Ozone Profile
measurements

CERES - Earth Radiation Budget

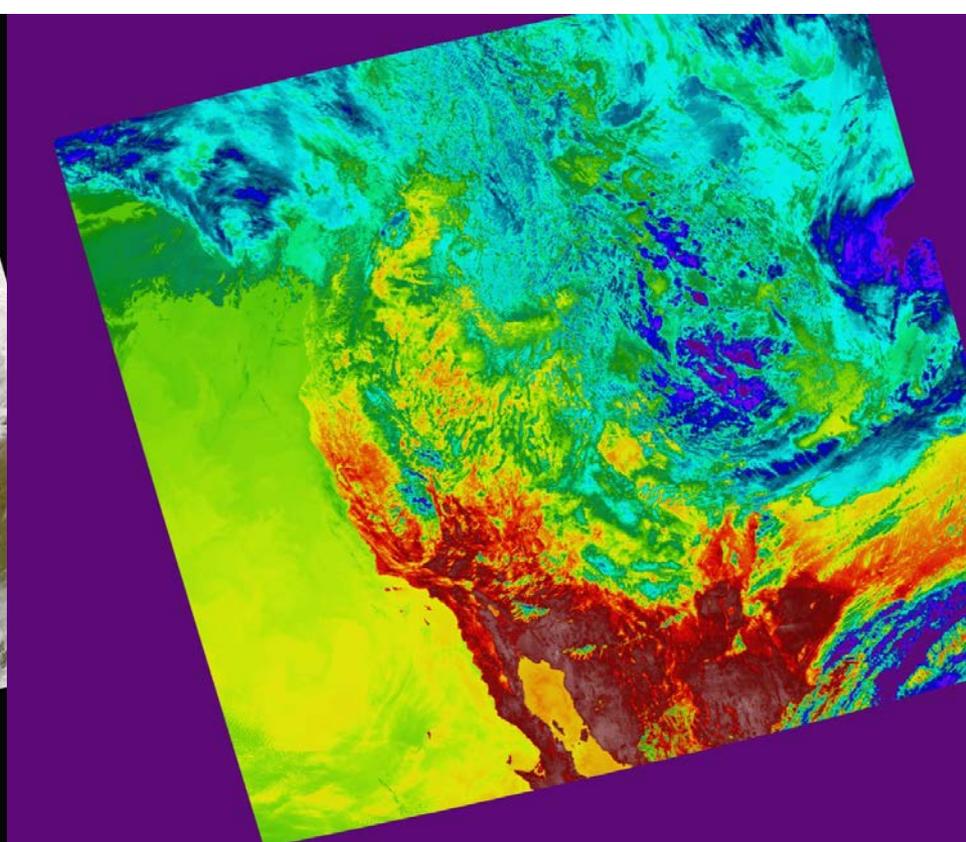




First Suomi NPP DB pass acquired by SSEC 2.4 meter X/L System, 20:30 UTC, 2012/02/23



VIIRS True Color (M5/M4/M3)



VIIRS Infrared (M15)



CSPP for Suomi NPP

- CSPP currently includes software for processing of
 - VIIRS, CrIS, and ATMS SDRs,
 - VIIRS EDRs,
 - CrIS single FOV atmospheric profile retrievals,
 - VIIRS imagery.
- Distribution format is executable code and data (ready to run); source code is available in ADL.
- Supported host platform is Red Hat Enterprise Linux 5 (64-bit); minimum of 16 GB of RAM is required.
- Fast Intel Xeon hardware is recommended for real-time processing.



About CSPP for Suomi NPP

- The CSPP software for NPP is based on the Algorithm Development Library (ADL) developed by Raytheon and the JPSS project (*the same software that runs in IDPS*).
- SSEC has packaged the ADL software to run from the Linux command line in real-time direct broadcast mode. *We have not changed the underlying processing source code, algorithms, or data formats.*
- The output files from the CSPP NPP SDR processing software *are identical in naming, format, and structure to the corresponding files from IDPS.*



Value added features for Suomi NPP

- Alternative algorithms, e.g., CrIS DR retrievals.
- Optional Granule aggregation, HDF5 internal compression, 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.



CSPP Releases to Date

1. Dec 21, 2011: VIIRS, CrIS, and ATMS SDR beta1.
2. Mar 14, 2012: VIIRS and ATMS SDR v1.0.
3. May 02, 2012: VIIRS, CrIS, and ATMS SDR v1.1.
4. May 04, 2012: CrIS UW DR Retrieval v1.0.
5. Oct 04, 2012: VIIRS, CrIS, and ATMS SDR v1.2.
6. Nov 26, 2012: CrIS, AIR, IASI Hyperspectral Retrieval v1.0.
7. Feb 08, 2013: VIIRS, CrIS, and ATMS SDR v1.3.
8. Feb 08, 2013: VIIRS Cloud Mask and Active Fires EDR v1.0.
9. Feb 22, 2013: VIIRS GeoTIFF and AWIPS Reprojected Imagery v1.0.
10. Apr 29, 2013: CrIS, AIR, IASI Hyperspectral Retrieval v1.1.



CSPP - CIMSS

cimss.ssec.wisc.edu/cspp/history.shtml Reader

YouTube TSW MODIS Images VIIRS Images Git Tutorial Google Apps ERB Movies ERB Camera IDL Group MODIS Today

 **Community Satellite Processing Package** 

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CSPP Release History

April 29, 2013 ([CSPP CrIS, AIRS and IASI Dual Regression Retrieval Software Version 1.1](#))

- New version of the multi-instrument hyperspectral retrieval software package that uses Suomi NPP CrIS, Aqua AIRS or MetOP IASI radiances as inputs and produces vertical profiles of temperature, moisture, ozone as well as cloud and surface properties at single field-of-view resolution.

February 22, 2013 ([CSPP VIIRS SDR GeoTIFF and AWIPS Reprojection Software Version 1.0](#))

- First release of software to create reprojected GeoTIFFS and/or AWIPS NetCDF-3 files from Visible Infrared Imaging Radiometer Suite (VIIRS) Science Data Record (SDR) HDF5 files. AWIPS stands for the Advanced Weather Interactive Processing System, the visualization and analysis tool used by the US National Weather Service.

February 8, 2013 ([CSPP Suomi NPP VIIRS Cloud Mask and Active Fires EDR Software Version 1.0](#))

- First release of Visible Infrared Imaging Radiometer Suite (VIIRS) instrument Environmental Data Record (EDR) software that uses VIIRS SDRs as input and produces VIIRS Cloud Mask and Active Fires HDF5 output files. This software is designed to work with the [VIIRS SDR V1.3 algorithms](#).

February 8, 2013 ([CSPP Suomi NPP CrIS, VIIRS and ATMS SDR Software Version 1.3](#))

- New version of the calibration and geolocation Science Data Record (SDR) software for the Visible Infrared Imaging Radiometer Suite (VIIRS), Advanced Technology Microwave Sounder (ATMS), and the Cross-track Infrared Sounder (CrIS) instruments that uses Algorithm Development Library 4.1, and is compatible with the [first CSPP VIIRS EDR release](#). This release replaces existing installations of CSPP SDR (it is not an update).

November 26, 2012 ([CSPP CrIS, AIRS and IASI Dual Regression Retrieval Software Version 1.0](#))

- First release of a core software package that uses input Suomi NPP CrIS, Aqua AIRS or MetOP IASI radiances and retrieves vertical profiles of temperature, moisture, ozone as well as cloud and surface properties at single field-of-view resolution. The dual regression technique was developed at the University of Wisconsin-Madison.

October 4, 2012 ([CSPP Suomi NPP CrIS, VIIRS and ATMS SDR Software Version 1.2](#))

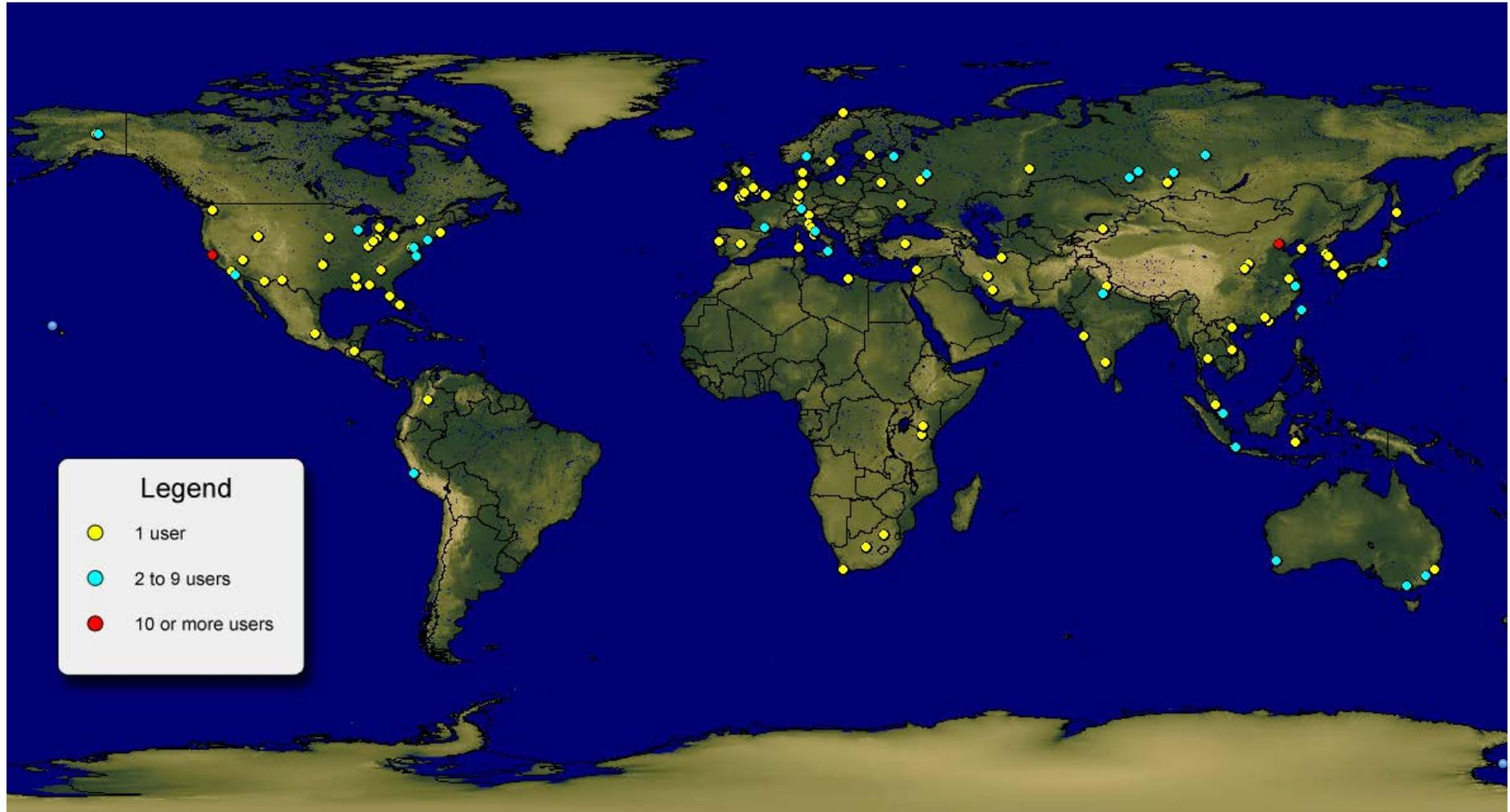
- Update to the calibration and geolocation Science Data Record (SDR) software for the Visible Infrared Imaging Radiometer Suite (VIIRS), Advanced Technology Microwave Sounder (ATMS), and the Cross-track Infrared Sounder (CrIS) instruments. This release includes minor updates to the software, including...

<http://cimss.ssec.wisc.edu/cspp/>



CSPP Users

23 January 2013



More than 250 people have registered to download some part of the CSPP suite of products representing 33 different countries, including all 7 continents.



Who is Using CSPP?

Here is a sample

- 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 Tutorials: Ocean Color

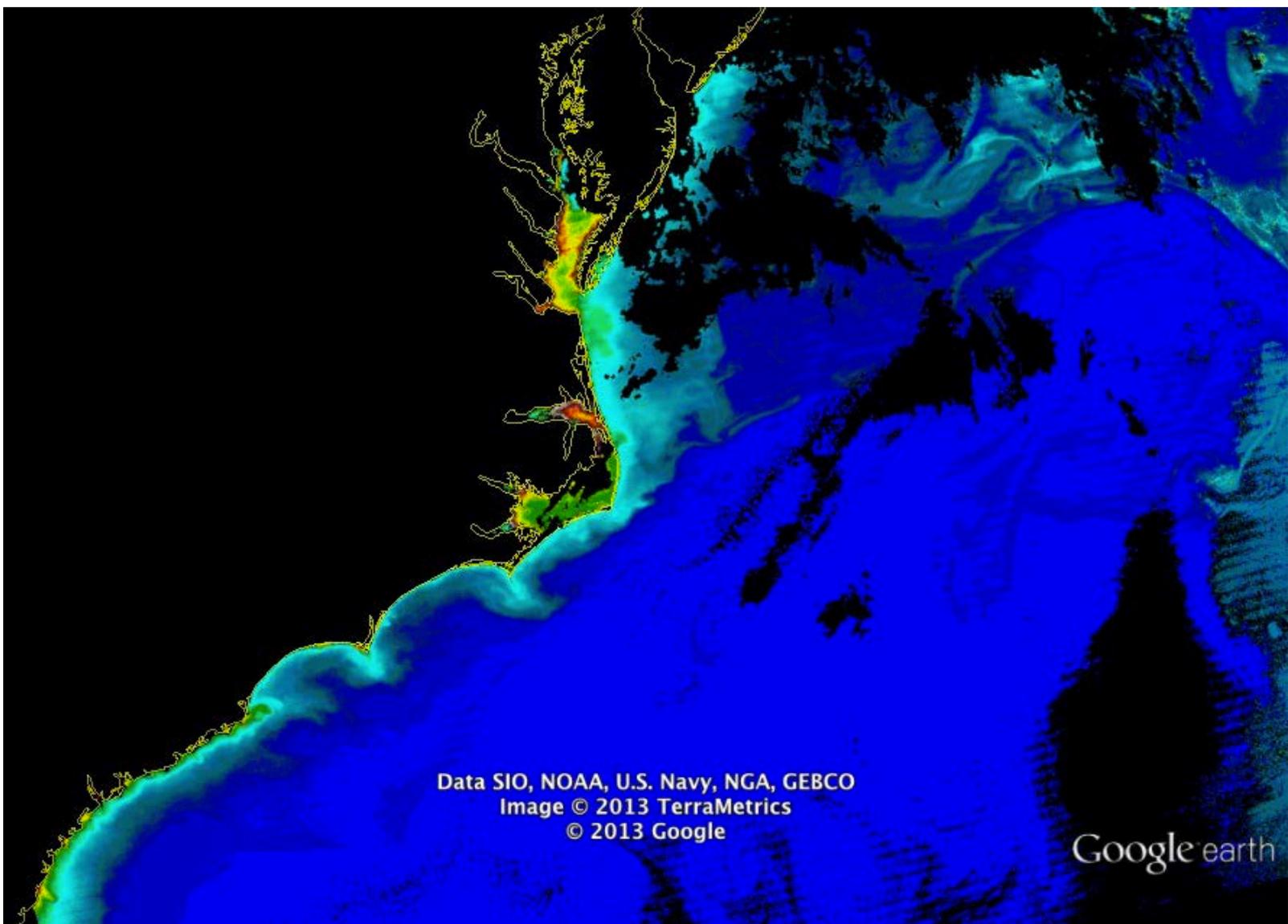
- SeaDAS 7.0 was released on April 23, 2013.
- Supports standard ocean color products for VIIRS (e.g., water leaving radiance, chlorophyll, AOT).
Does not support SST!
- Tested successfully with CSPP VIIRS SDRs.
- Note that standard vis. calibration for VIIRS must be disabled when calling l2gen.

See CSPP Forums entry at

<https://forums.ssec.wisc.edu/viewtopic.php?f=42&t=305>



VIIRS Chlorophyll: Atlantic Ocean 2013/05/15



Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2013 TerraMetrics
© 2013 Google

Google earth



3. Future CSPP Additions and Enhancements



Update 1/7: VIIRS SDR Multi-Processing

- Common request from CSPP users is “Can you speed up VIIRS SDR processing?”.
- We have developed a multiprocessing version of CSPP VIIRS SDR (using Python framework).
- Near-linear speedups of VIIRS SDR processing are achieved when multiple CPU cores are used.
- Activated via command line option (e.g., -p 4); results are identical to serially processed SDRs.
- Memory usage will go up (6GB per core). You will need a fast disk subsystem (we use 4-disk RAID-0).
- This feature will be available in CSPP SDR v1.4 by end of June 2013; now in beta testing.



VIIRS SDR Benchmark

Benchmark of processing speed for a 6 granule sequence of VIIRS direct broadcast data.

Dell R720 Linux system with two Intel Xeon CPU E5-2690 2.90GHz CPUs and 128GB RAM.

Number of Cores Used	Processing Time (min:sec)
1	7:46
2	4:36
4	3:08
6	1:43



Update 2/7: CrIS Full Spectral Resolution

- CrIS will be switching to Full Spectral Resolution (FSR) mode by the end of 2013.
- CSPP CrIS SDR will support a seamless interrupted transition to FSR mode.
- After the switch to FSR, the initial CSPP CrIS SDR product will be identical to current RSR product (FSR is down-sampled to RSR).
- When FSR calibration processing has been verified in IDPS and offline, it will also be available in CSPP SDR. Current plan is to support both modes (FSR and RSR).
- Will be included in CSPP SDR v1.4 to be released by end of June 2013; now in beta testing.

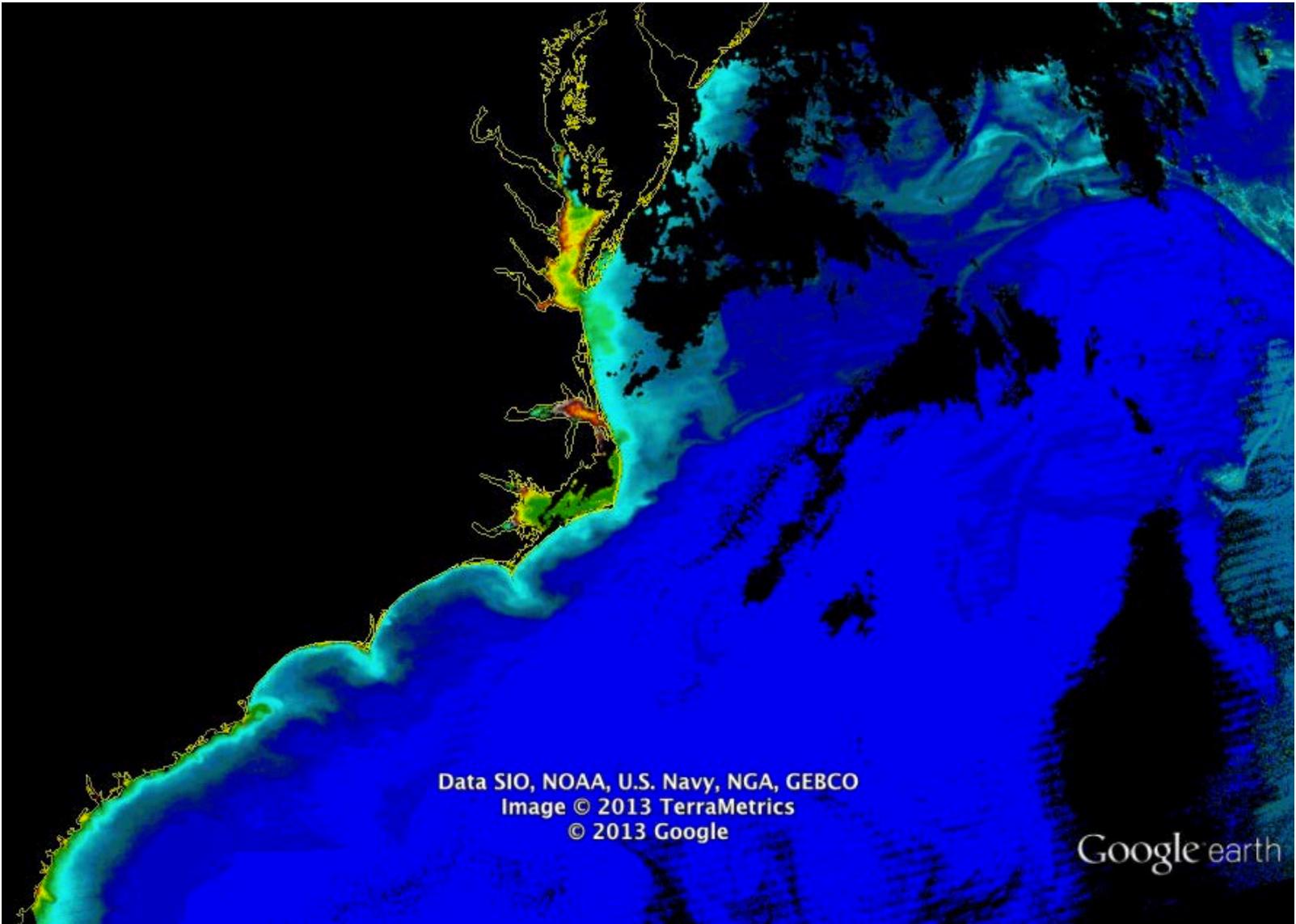


Update 3/7: VIIRS EDR additions

- Have adapted VIIRS Aerosol Optical Thickness (AOT), Sea Surface Temperature (SST), and Imagery EDRs to run in CSPP DB environment.
- Independent real-time ancillary data are ingested and granulated at runtime.
- Algorithms and LUTs are based on ADL versions of current IDPS algorithms.
- Now in community beta testing.

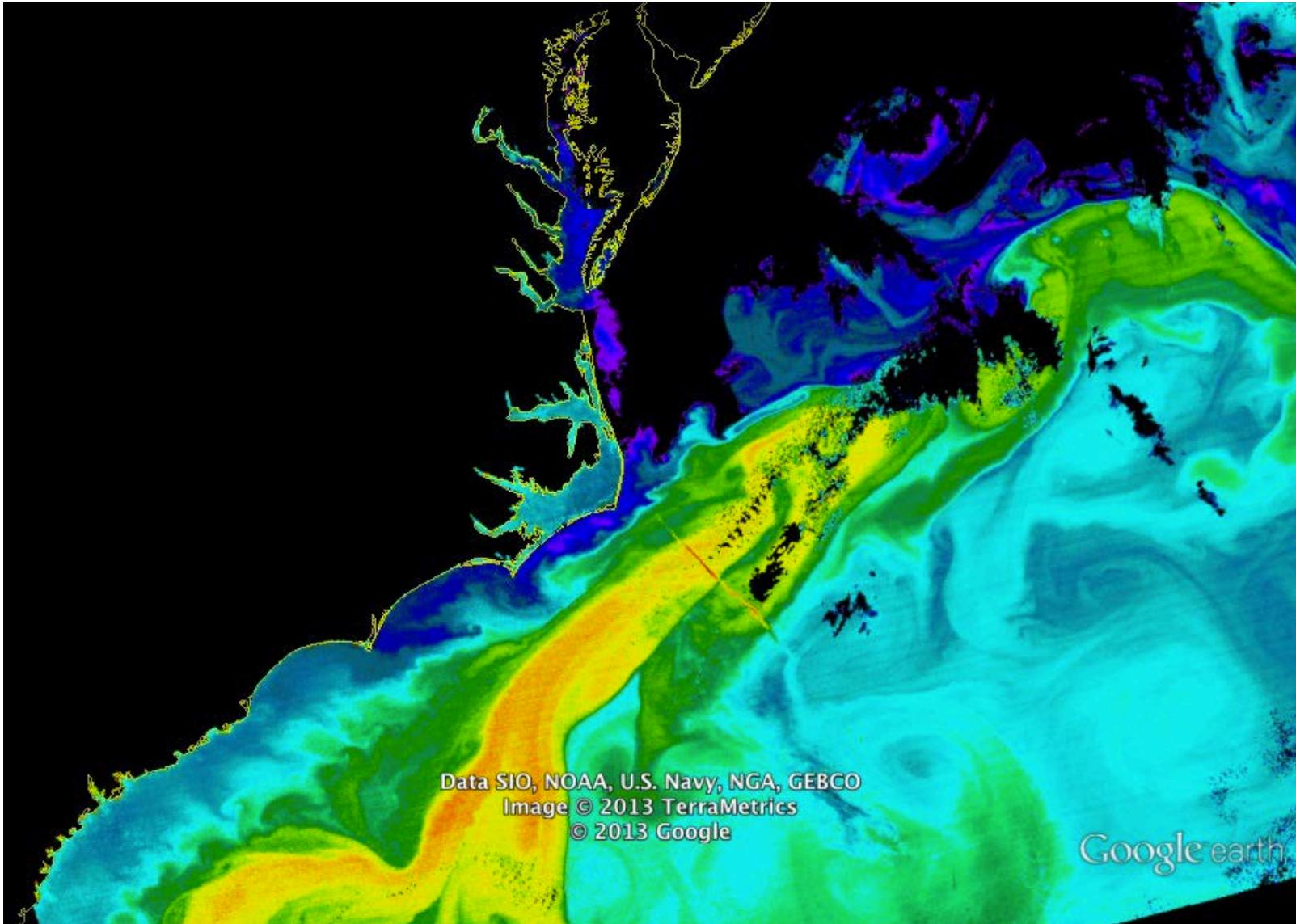


VIIRS Chlorophyll: Atlantic Ocean 2013/05/15





CSPP VIIRS SST: Atlantic Ocean 2013/05/15





Update 4/7: CrIS/IASI/AIRS Retrievals

- CSPP HSRTV retrieval package supports SNPP CrIS, Metop IASI, and Aqua AIRS.
- Have added and tested Metop-B IASI support.
- Have improved detection and handling of AIRS popping channels.
- Released April 29, 2013.

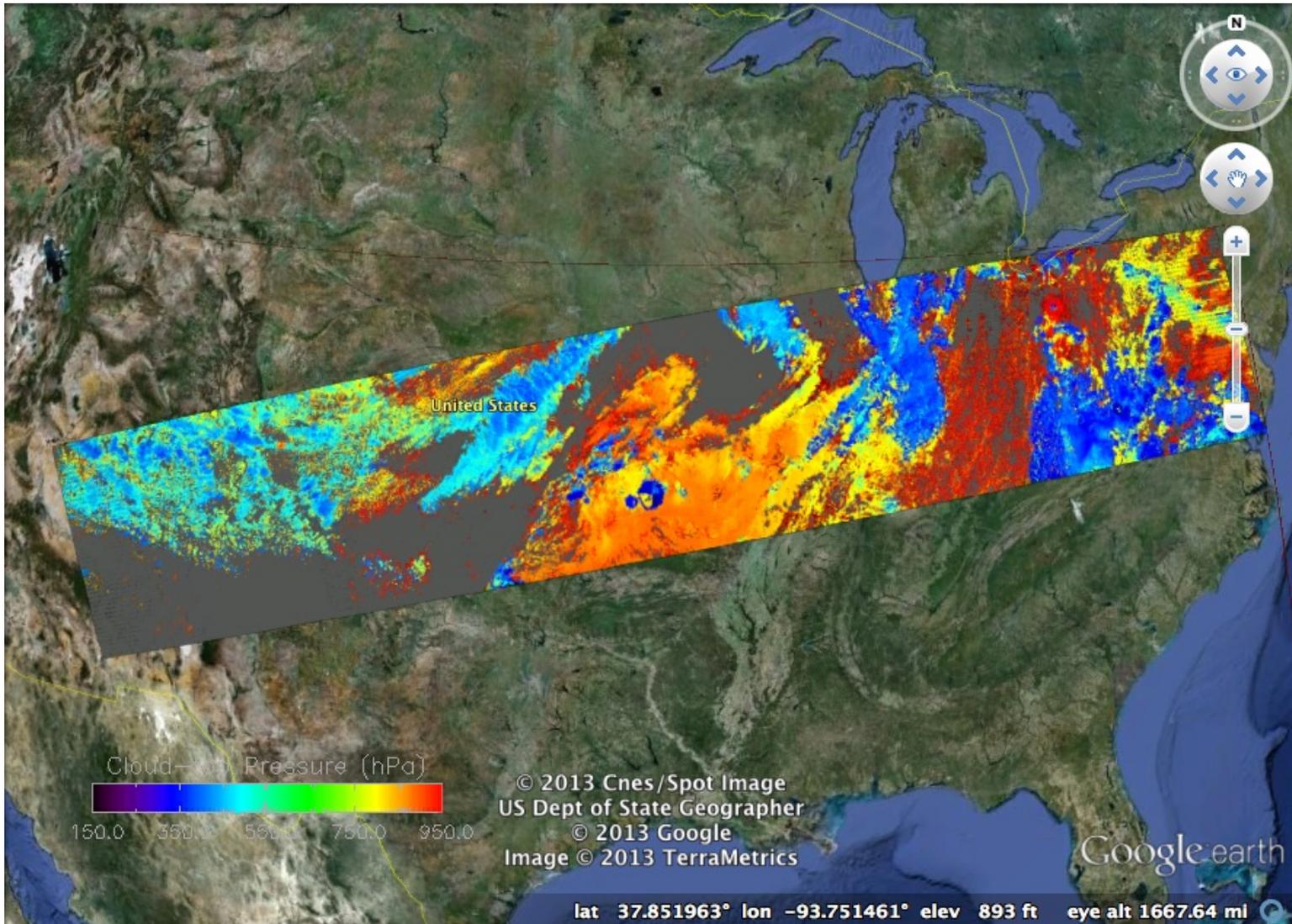


Update 5/7: CLAVR-X

- CLAVR-X creates a suite of Level 2 products including clouds, aerosols, NDVI, and dust.
- SNPP VIIRS, POES and Metop AVHRR (AAPP L1B format), and Terra/Aqua MODIS are supported via common algorithms.
- Will be ready for beta testing by end of June 2013.



CLAVR-X VIIRS Cloud Top Pressure



SSEC DB, 20130520 190938-191102

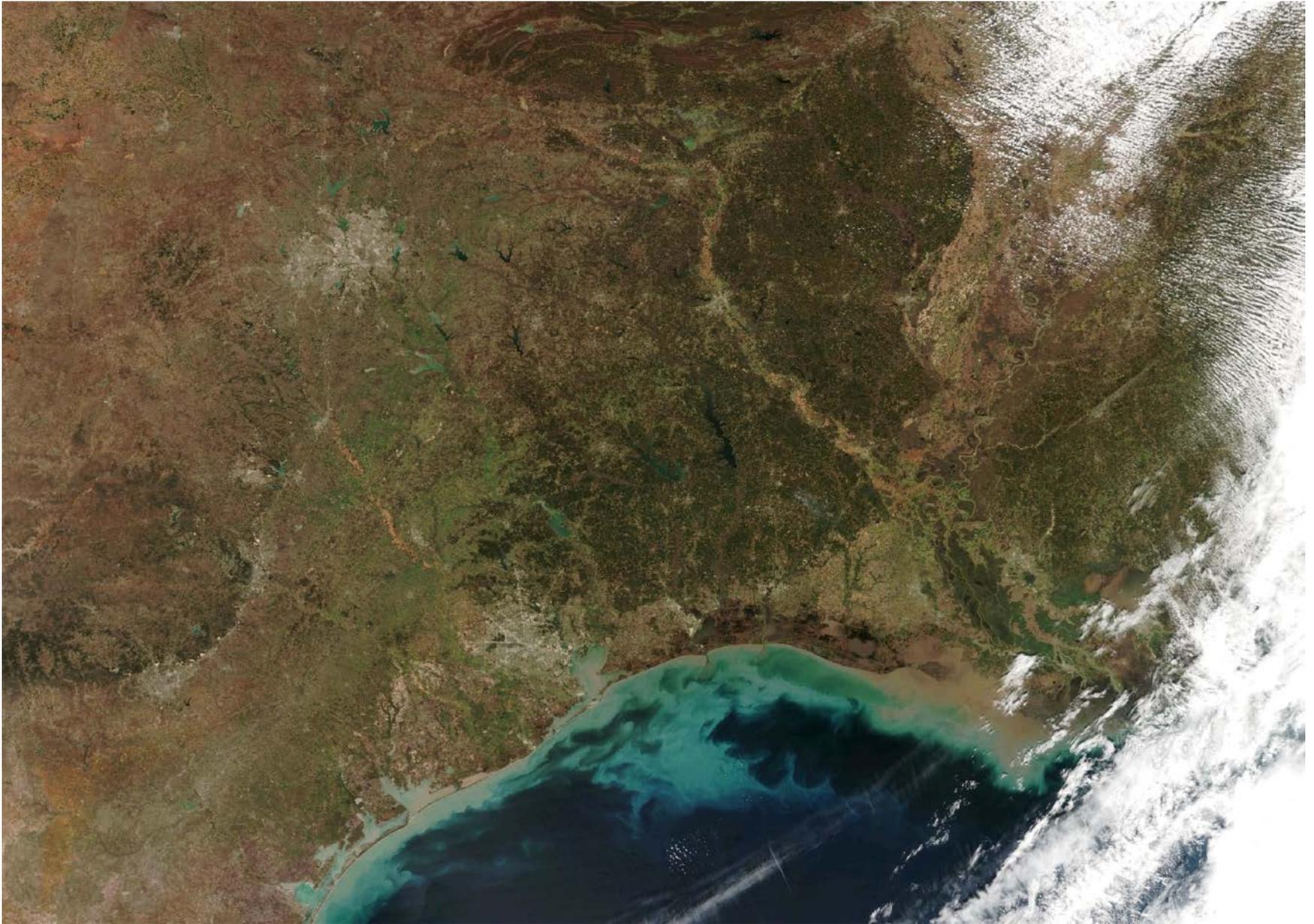


Update 6/7: VIIRS Projected Imagery

- Current POLAR2GRID package supports creation of VIIRS visible, DNB, and infrared imagery at 1.1 km resolution in GeoTIFF and AWIPS formats.
- New version supports multiple visible/near-IR/infrared channels for VIIRS and MODIS at full spatial resolution (375 m for VIIRS).
- Atmospherically corrected true color images will be available for VIIRS and MODIS.
- Will be ready for beta testing by end of June 2013; now in beta testing.



VIIRS True Color GeoTIFF



CSPP for GEO Satellites



Benefits of CSPP Support for GEO

- Provide an early look at products for GOES-R using current imager data.
- Encourage users to upgrade their systems to be ready to receive GOES-R data.
- Enable users outside the NOAA family to make use of GOES-R data from day one.
- Provide a framework for users to adapt their own algorithms for GOES-R.
- Involve the user community in GOES-R calibration and validation.



GEO products in CSPP

- Propose to use GEOCAT, the GOES-R AWG testbed developed at CIMSS/SSEC, as the initial release package to support GEO in CSPP.
- GEOCAT supports GOES 12-15, MTSAT, MSG.
- GEOCAT also supports GOES-R ABI GRB format.
- GEOCAT is self-contained FORTRAN-90 and C code, well tested and documented.



Proposed Initial Approach

- Release GEOCAT under CSPP to support Level 1B and Level 2 products from current GOES.
- Use GVAR as the input format; everyone who receives GOES direct broadcast can create GVAR (in the GOES-R era, format will be GRB).
- Create a subset of GOES-R AWG L2 products.
- Enlist testers in the GOES Direct Readout community to help test the software.



GEOCAT Products for GOES-E/W

Level 1B

- 0.65 um reflectance
- 3.9 um reflectance
- 3.9 um brightness temperature
- 6.7 um brightness temperature
- 11 um brightness temperature
- 13.3 um brightness temperature

Level 2 Cloud Products

- Cloud mask
- Cloud phase/type
- Cloud top height
- Cloud top temperature
- Cloud top pressure

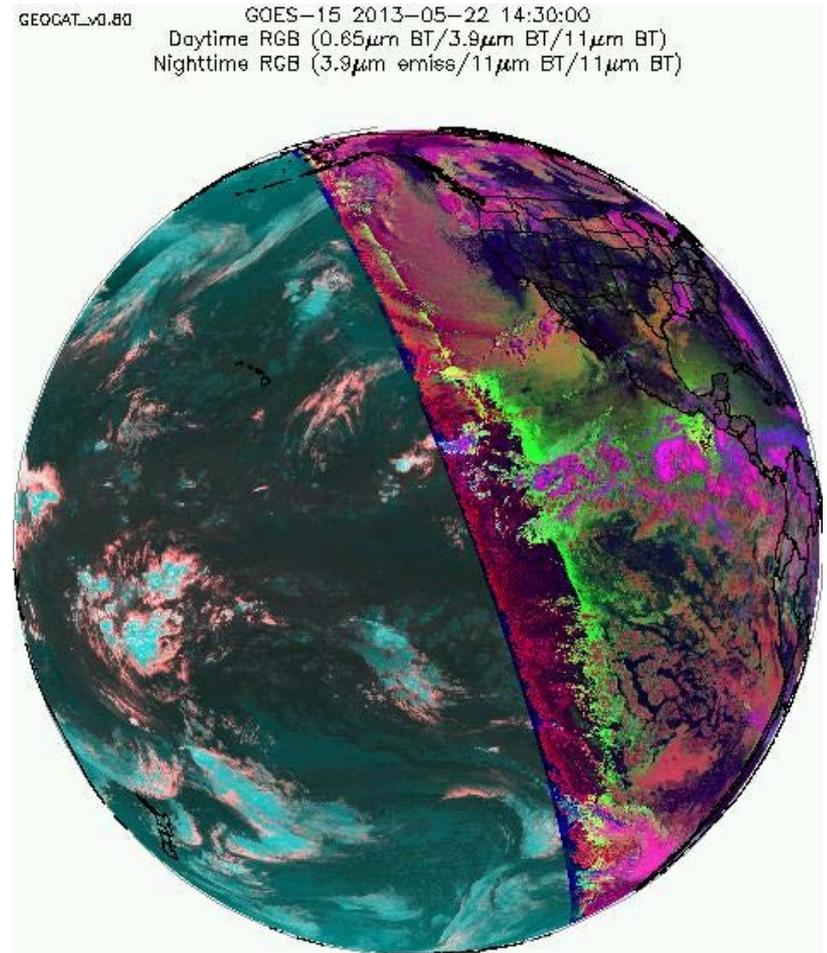
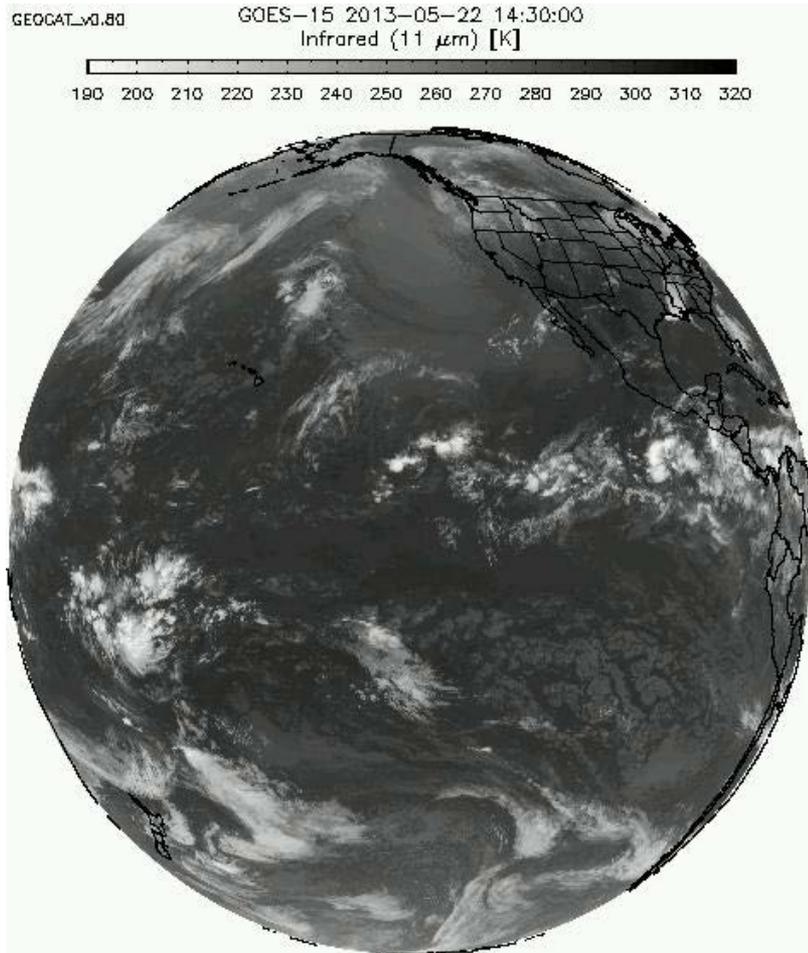
- Cloud 11 um emissivity
- Cloud visible optical depth
- Cloud effective radius
- Cloud liquid water path
- Cloud ice water path

Level 2 Fog / Low-Cloud Products

- Probability of Marginal Visual Flight Rules (MVFR)
- Probability of Instrument Flight Rules (IFR)
- Probability of Low Instrument Flight Rules (LIFR)
- Low cloud geometric thickness

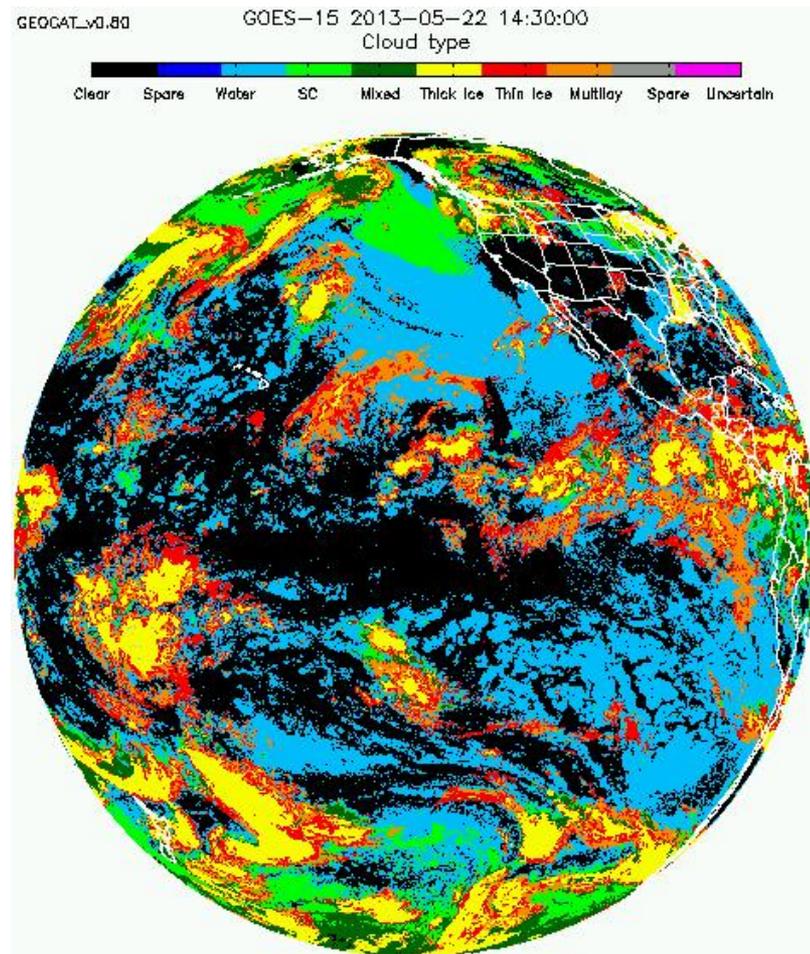
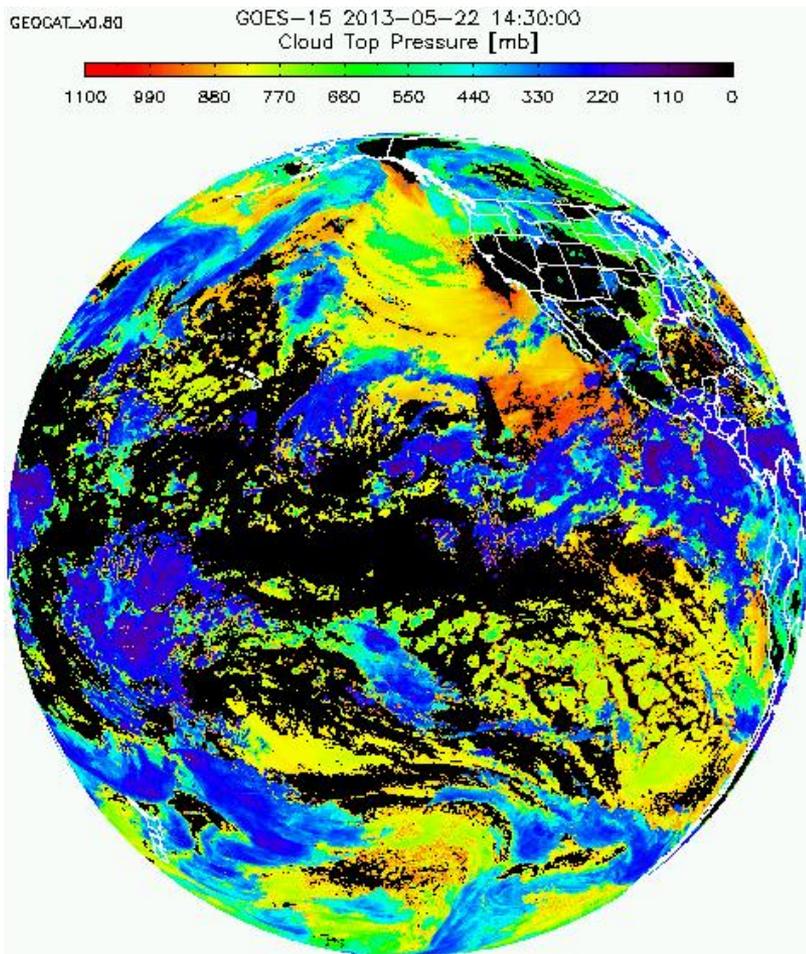


GOES Image Products from GEOCAT





GOES Cloud Products from GEOCAT





CSPP GEO Software Details

- Package would include GEOCAT executable code and scripts for 64-bit Intel Linux systems.
- SSEC/CIMSS would provide GVAR to AREA converter (AREA is input format for GEOCAT).
- Output format is HDF4.
- Ancillary data would be identified and downloaded automatically at runtime.
- Source code can also be made available.



CSPP GEO Summary

- Given sufficient resources, CSPP can support development and distribution of software for creating Level 1 and Level 2 products from GEO direct readout satellite data.
- We propose to start by supporting current GOES by the end of 2013 (subject to funding).
- Support for Meteosat, MTSAT, Himawari, and GOES-R would be added over time.