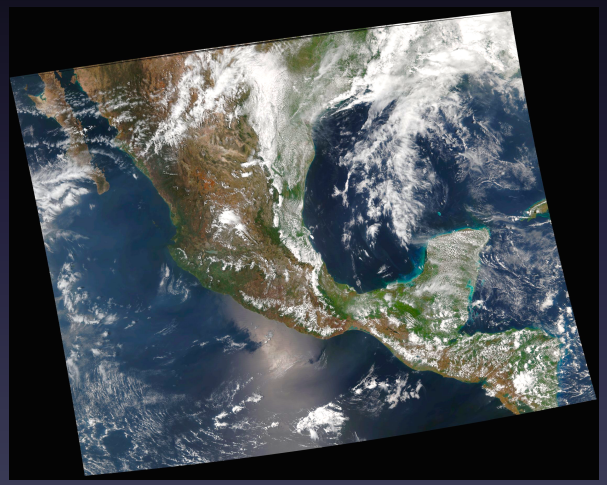
Community Satellite Processing Package (CSPP) Polar-Orbiting Satellite Software and Products

Liam Gumley, Allen Huang, Kathy Strabala, Scott Mindock, Ray Garcia, Graeme Martin, Geoff Cureton, Elisabeth Weisz, Nadia Smith, Nick Bearson, James Davies, Jessica Braun.
CIMSS/SSEC, University of Wisconsin-Madison.



CSPP/IMAPP Users' Group Meeting
EUMETSAT, Darmstadt Germany, 2015/04/15

What is CSPP?

CSPP (Community Satellite Processing Package) is a collection of software systems for processing data from meteorological satellites.

The primary goal of CSPP is to support users who

- Receive satellite data via direct broadcast;
- Create Level 1B and higher level products and images in real time.

Funding is supplied by JPSS and NOAA.

CSPP Software Philosophy

The CSPP software

Creates useful products for the DB community,

Includes up-to-date algorithms,

Is pre-compiled for 64-bit Intel Linux (CentOS),

Is easy to install and operate,

Includes test data for verification,

Runs efficiently on modest hardware,

Has prompt user support.

CSPP by the numbers

Satellites supported: 7

Software packages: 10

Sensors supported: 25

Releases and updates: 29

Registered users: 913

Individual downloads: > 5000

CSPP Satellite/Sensor/Product Matrix

Satellite	Multispectral Imager	Infrared Sounder	Microwave Sounder
Suomi NPP	**VIIRS** *SDRs (Level 1B), Images, Visualization, Clouds, Aerosols, Land, Ocean*	**CrIS** *SDRs (Level 1B) Atmospheric Profiles, Clouds, Visualization*	**ATMS** *SDRs (Level 1B), Atmospheric Profiles, Precipitation, Visualization*
Metop-A/B	**AVHRR** *Clouds, Aerosols, Land Surface, SST, Visualization*	**IASI, HIRS** *Atmospheric Profiles, Clouds, Visualization*	**AMSU, MHS** *Atmospheric Profiles, Precipitation*
NOAA-18/19	**AVHRR** *Clouds, Aerosols, Land Surface, SST, Visualization*	**HIRS** *Atmospheric Profiles*	**AMSU, MHS** *Atmospheric Profiles, Precipitation*
Terra	**MODIS** *Images, Visualization*	*N/A*	*N/A*
Aqua	**MODIS** *Images, Visualization*	**AIRS** *Atmospheric Profiles, Clouds, Visualization*	**AMSU** *Atmospheric Profiles, Precipitation, Visualization*

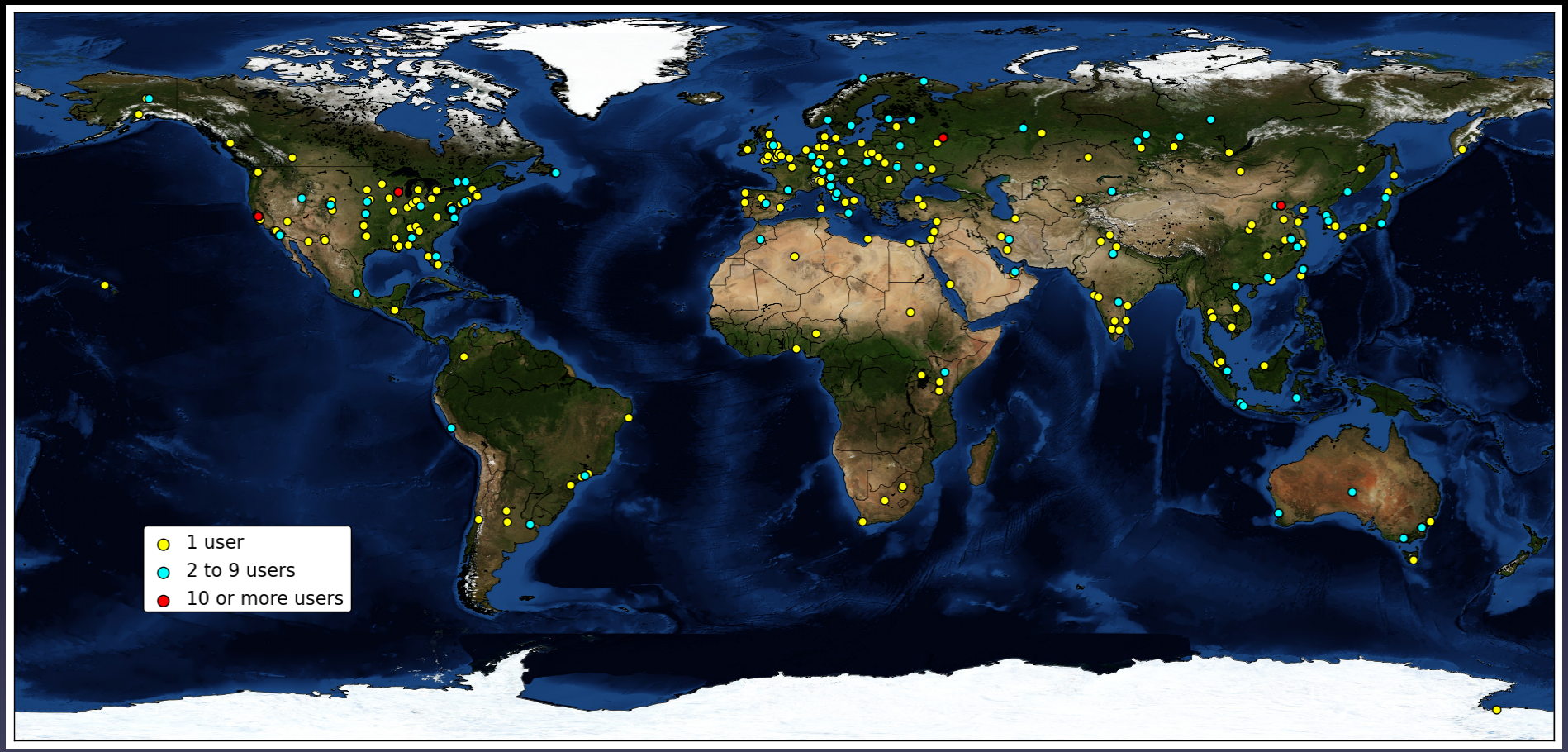
CSPP Software (Apr 2015)

CSPP Software	Product Description
1. SDR	VIIRS, CrIS, and ATMS geolocated and calibrated earth observations.
2. VIIRS EDR	VIIRS imager cloud mask, active fires, surface reflectance, vegetation indices, sea surface temperature, land surface temperature, and aerosol optical depth.
3. HSRTV	Hyperspectral infrared sounder retrievals of temperature and moisture profiles, cloud properties, total ozone, and surface properties.
4. Polar2grid	Reprojected imagery (single and multi-band) in GeoTIFF and AWIPS formats.
5. Hydra	Interactive visualization and interrogation of multispectral imagery and hyper spectral soundings.
6. MIRS	Microwave sounder retrievals of temperature and moisture profiles; surface properties; snow and ice cover; rain rate; and cloud/rain water paths.
7. CLAVR-x	Multispectral imager retrievals of cloud properties; aerosol optical depth; surface properties; ocean properties.
8. NUCAPS	Combined hyperspectral infrared sounder and microwave sounder retrievals of temperature and moisture profiles, cloud cleared radiances, and trace gases.
9. IAPP	Combined infrared sounder and microwave sounder retrievals of temperature and moisture profiles, water vapor, total ozone, and cloud properties.
10. ACSPO	Multispectral imager retrievals of sea surface temperature.

CSPP Software/Satellite/Sensor Matrix

CSPP Software	Suomi NPP	Metop-A/B	NOAA-18/19	Terra	Aqua
1. SDR	VIIRS, CrIS, ATMS	Provided by AAPP	Provided by AAPP	Provided by SeaDAS	Provided by SeaDAS
2. VIIRS EDR	VIIRS	N/A	N/A	N/A	N/A
3. HSRTV	CrIS	IASI	N/A	N/A	AIRS
4. Polar2Grid	VIIRS, CrIS, IASI	Future version	Future version	MODIS	MODIS, AIRS
5. Hydra	VIIRS, CrIS, ATMS	AVHRR, IASI	AVHRR	MODIS	MODIS, AIRS
6. MIRS	ATMS	AMSU, MHS	AMSU, MHS	N/A	N/A
7. CLAVR-x	VIIRS	AVHRR	AVHRR	MODIS	MODIS
8. NUCAPS	CrIS, ATMS	Future version	N/A	N/A	Future version
9. IAPP	N/A	HIRS, AMSU, MHS	HIRS, AMSU, MHS	N/A	N/A
10. ACSPO	VIIRS	AVHRR	AVHRR	MODIS	MODIS

CSPP Registered User Locations



February, 2015

1. CSPP SDR

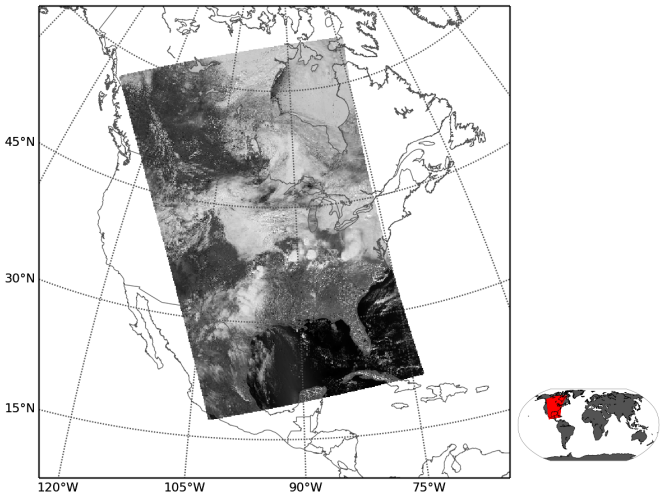
CSPP SDR (Sensor Data Record) creates calibrated and geolocated earth observation products (Level 1B).

Heritage	Developed by Raytheon and released as part of Algorithm Development Library (ADL). Source code is available in ADL.
Satellites/Sensors	SNPP (VIIRS, CrIS, ATMS).
Products	**VIIRS**: M-band, I-band, and Day/Night Band SDR calibrated sensor data and geolocation files in HDF5 format. **CrIS**: Calibrated spectra and geolocation in HDF5 format. **ATMS**: Calibrated antenna temperatures and geolocation in HDF5 format.
Features	• Multi-core support for faster processing. • Optional product aggregation and compression. • Automated download and installation of calibration LUTs. • Quicklook images

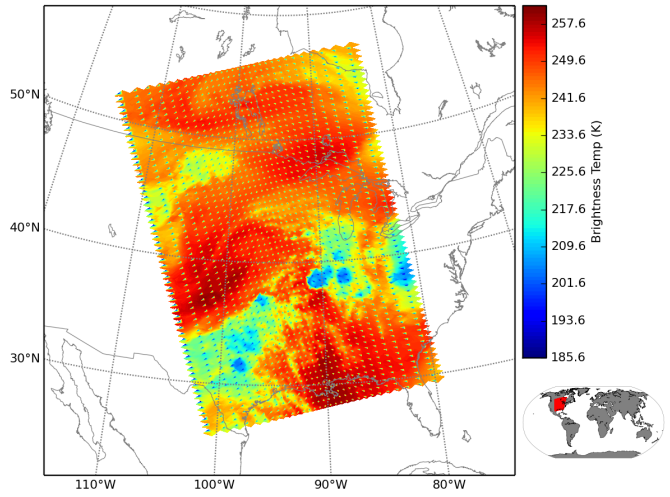
SDR Examples

SNPP 2015/04/08 19:10 UTC

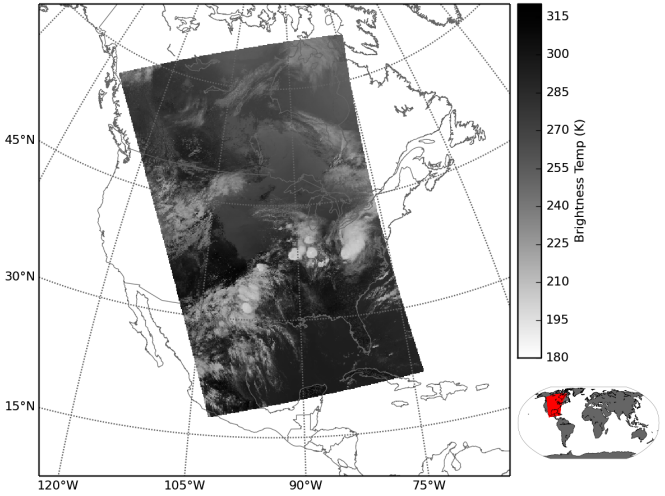
VIIRS M7



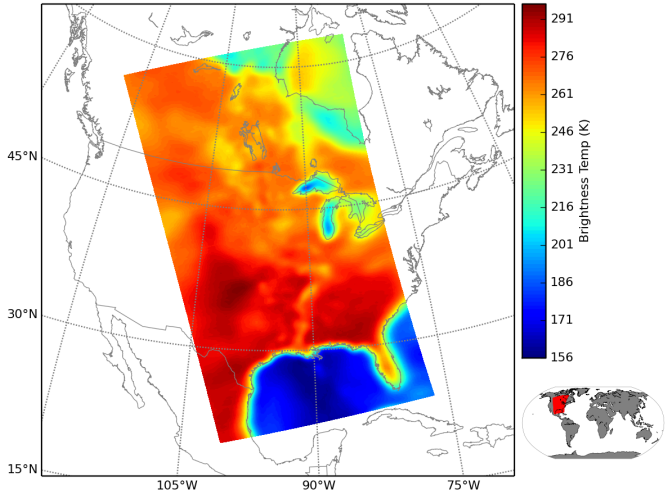
CrIS MW



VIIRS M15



ATMS Ch 2



2. CSPP EDR

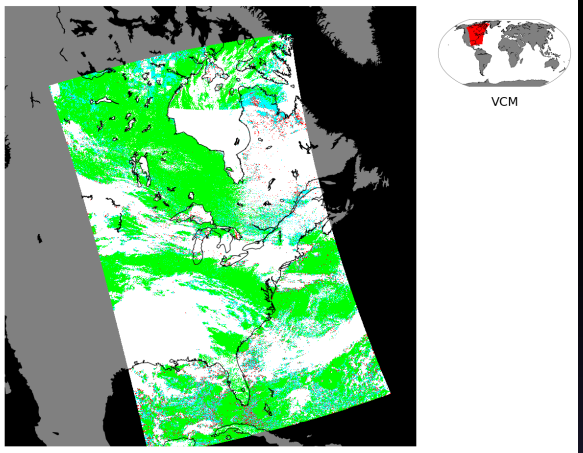
CSPP EDR (Environmental Data Record) creates atmosphere, land, and ocean products.

Heritage	Developed by Raytheon and released as part of Algorithm Development Library (ADL). Source code is available in ADL.
Satellites/Sensors	Suomi NPP VIIRS.
Products	Cloud Mask, Active Fires, Aerosol Optical Thickness, Suspended Matter, Sea Surface Temperature, Surface Reflectance, Normalized Difference Vegetation Index, Enhanced Vegetation Index, Surface Type, Land Surface Temperature, and Imagery in HDF5 format.
Features	• Multi-core support for faster processing. • Optional product aggregation and compression. • Automated download and preparation of ancillary data. • Quicklook images.

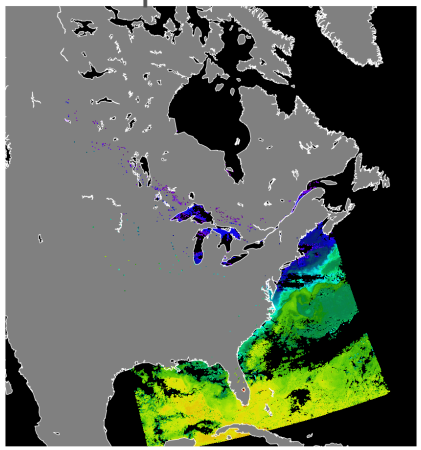
EDR Examples

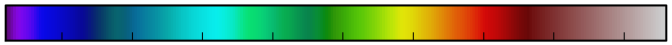
SNPP 2015/04/05 18:26 UTC

Cloud Mask

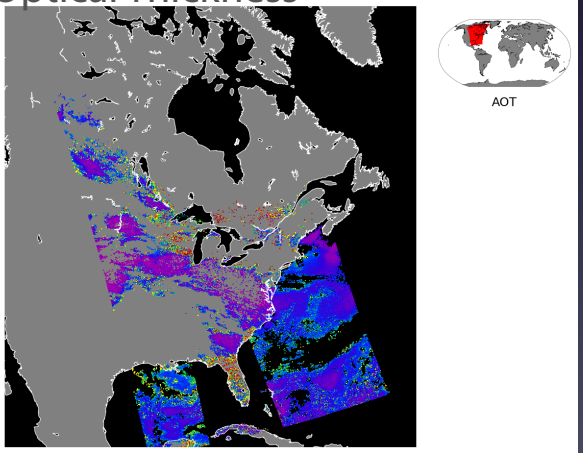


Sea Surface Temperature

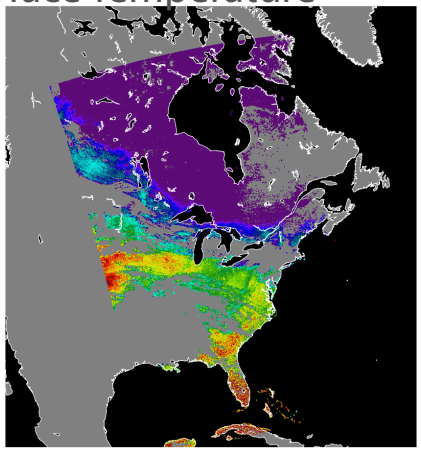


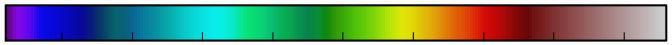


Aerosol Optical Thickness



Land Surface Temperature





3. HSRTV

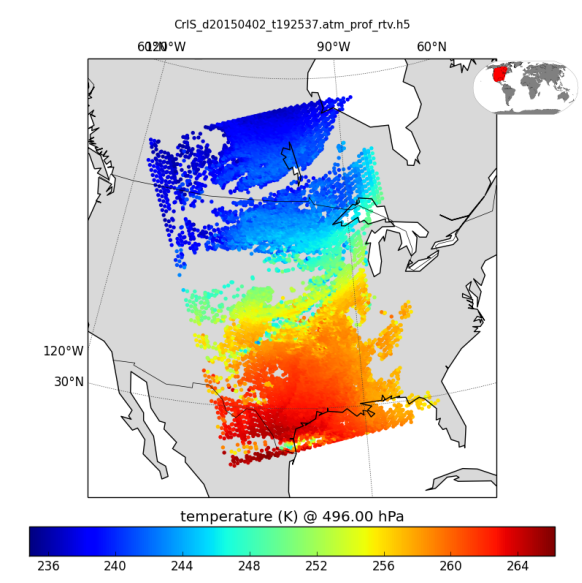
HSRTV (High Spectral Resolution Retrieval) creates temperature, moisture, and trace gas profiles, and cloud products.

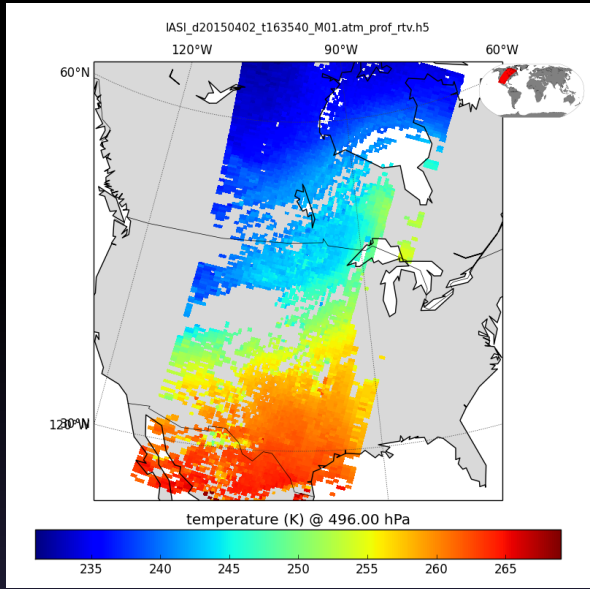
Heritage	Developed at CIMSS/SSEC by Bill Smith, Elisabeth Weisz, and Nadia Smith.
Satellites/Sensors	Suomi NPP CrIS; Metop-A/B IASI; Aqua AIRS.
Products	Temperature, moisture, and ozone at 101 pressure levels; surface skin temperature and emissivity; total column water vapor and ozone; CO_2 amount; cloud mask; cloud top pressure and temperature; and cloud optical thickness in HDF5 format
Features	• Common multi-sensor algorithm. • Single field of view retrievals. • Fast regression algorithm.

HSRTV Examples

SNPP 2015/04/02 19:25 UTC
Metop-B 2015/04/02 16:35 UTC

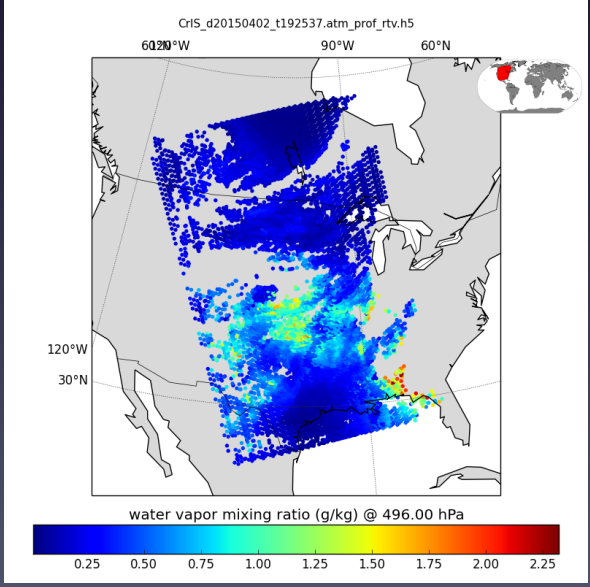
CrIS Temperature 500 hPa

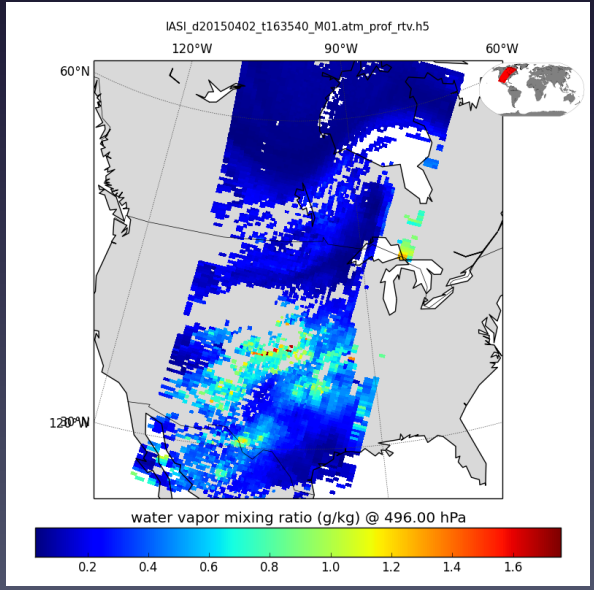




IASI Temperature 500 hPa

CrIS Mixing ratio 500 hPa





IASI Mixing ratio 500 hPa

4. Polar2grid

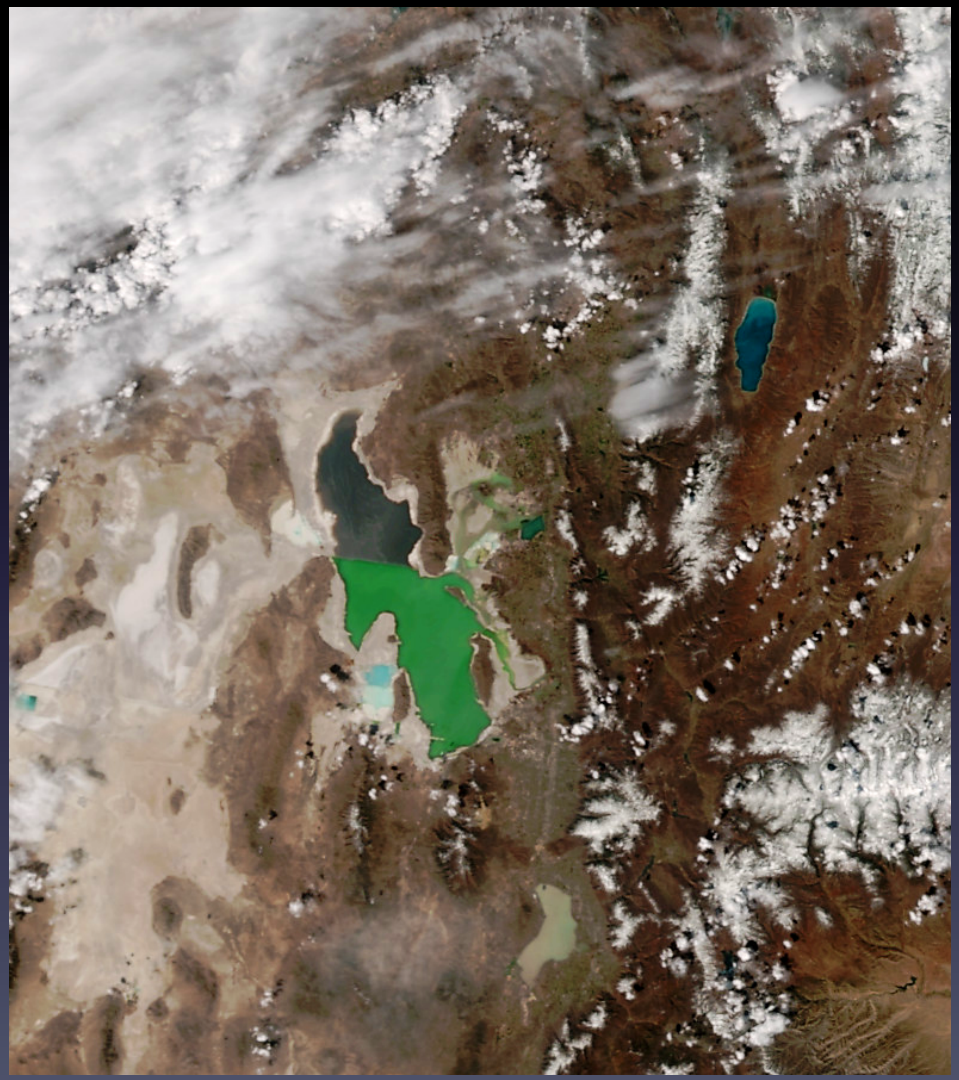
Polar2grid creates reprojected imagery for single bands (grayscale) and band composites (RGB).

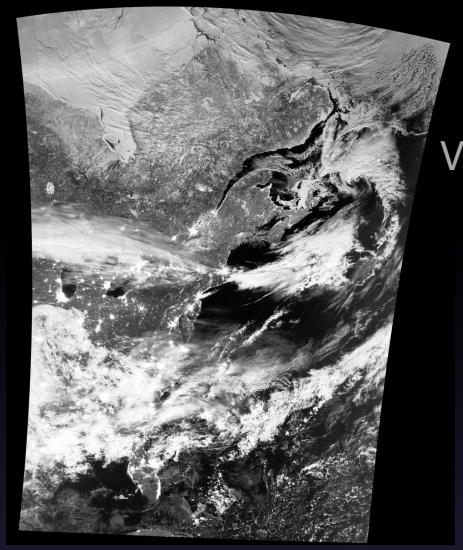
Heritage	Developed at CIMSS/SSEC by Dave Hoese.
Satellites/Sensors	Suomi NPP VIIRS; Terra/Aqua MODIS.
Products	Single band and multi-band images in GeoTIFF and netCDF formats (for AWIPS).
Features	• Atmospherically corrected true color images. • Automatic adaptive enhancement for VIIRS Day/Night band. • User defined projection grids are supported. • Multiple input granules are composited on one output image.

Polar2grid Examples

SNPP 2015/04/06 06:44 UTC
SNPP 2015/04/06 20:07 UTC

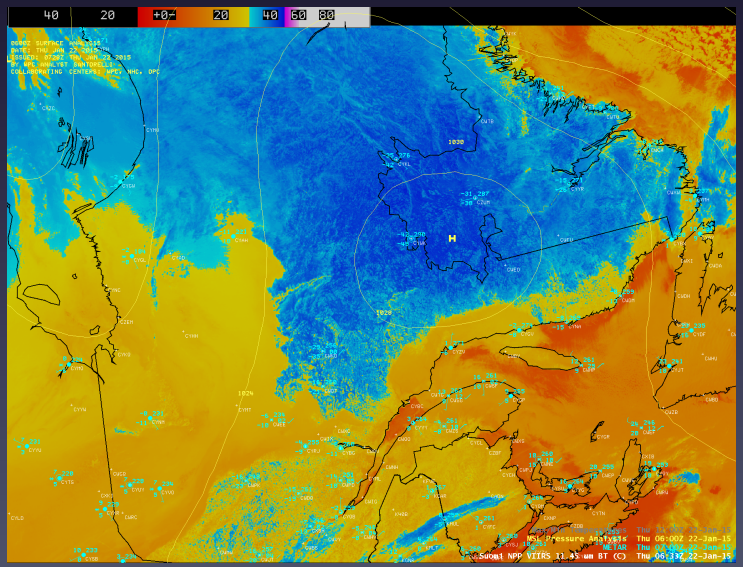
VIIRS True Color





VIIRS DNB

VIIRS M15 in AWIPS2



5. Hydra

Hydra is an interactive GUI application for exploring multispectral satellite data.

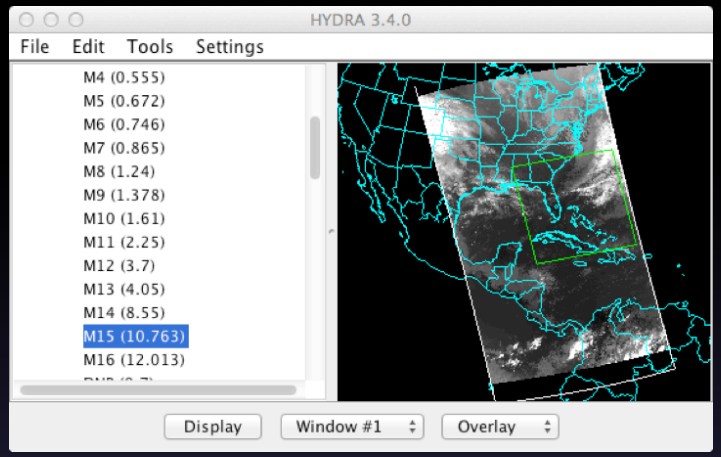
Heritage	Developed at CIMSS/SSEC by Tom Rink.
Satellites/Sensors	Suomi NPP VIIRS, CrIS, ATMS; Metop-A/B IASI; Terra/Aqua MODIS; Aqua AIRS.
Products	Images in JPEG and KML format.
Features	• Supports Windows, OS X, and Linux platforms. • Simple to install and use for training/classroom environments. • Multi-sensor comparisons (e.g., MODIS/VIIRS) are supported. • User-defined band combinations, scatter plots, and transects.

Hydra Examples

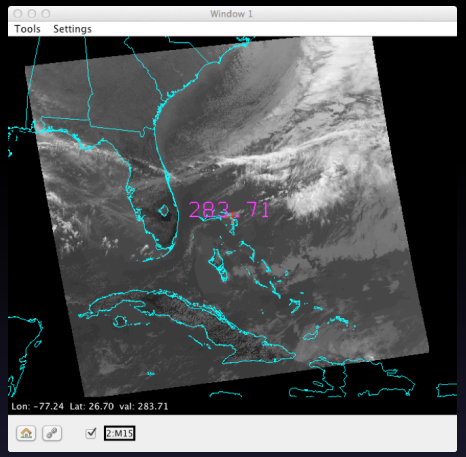
SNPP 2015/01/30 18:40 UTC
Terra 2014/06/19 06:05 UTC

SSEC

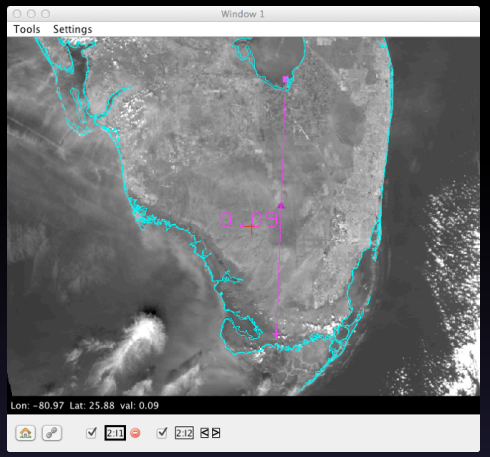
VIIRS Data Selector



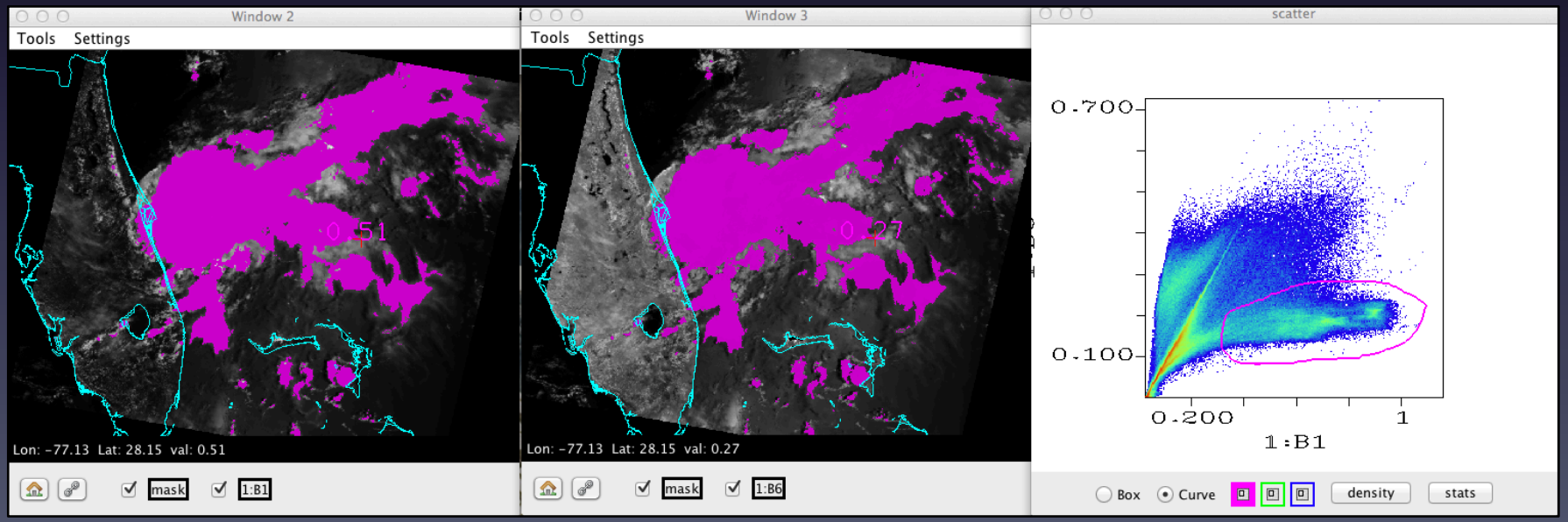
VIIRS M15 Image Window



VIIRS I1 Image Window



MODIS Band 6 vs. Band 1 Scatter Plot



6. MIRS

MIRS (Microwave Integrated Retrieval System) creates atmospheric profile, precipitation, and surface products from microwave sounder data.

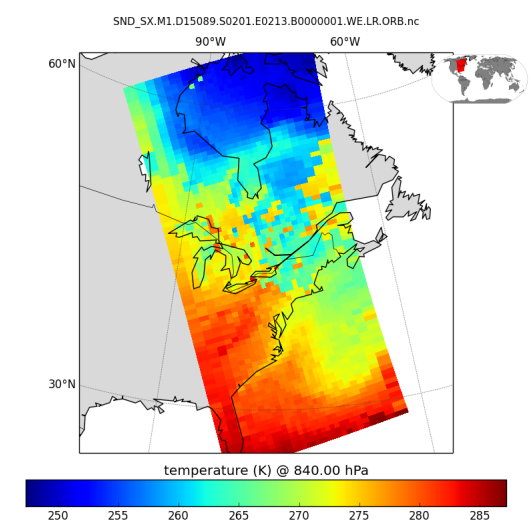
Heritage	Developed at NOAA/NESDIS by Sid Boukabara, Chris Grassotti, et al.
Satellites/Sensors	Suomi NPP ATMS; Metop-A/B AMSU, MHS; NOAA-18/19 AMSU, MHS.
Products	Temperature and moisture profiles, total precipitable water, surface skin temperature and emissivity, rain rate, cloud liquid water, rain water path, ice water path, liquid water path, sea ice concentration, snow water equivalent, and snow cover.
Features	• Multi-sensor common algorithm. • Physics-based retrieval. • Retrieves land and ocean products in all sky conditions. • Extensively validated and documented.

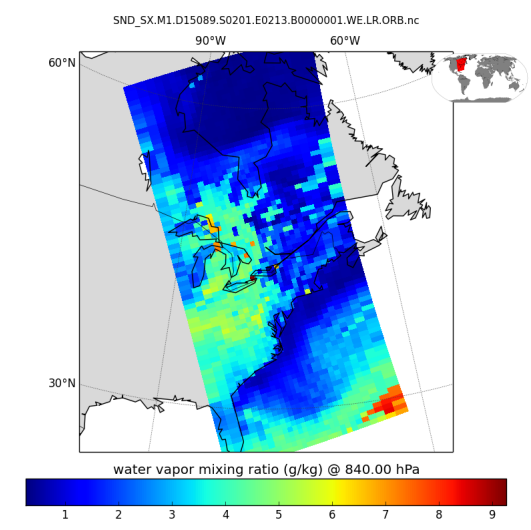
MIRS Examples

Metop-B 2015/03/30 02:01 UTC
SNPP 2015/03/18 11:03 UTC

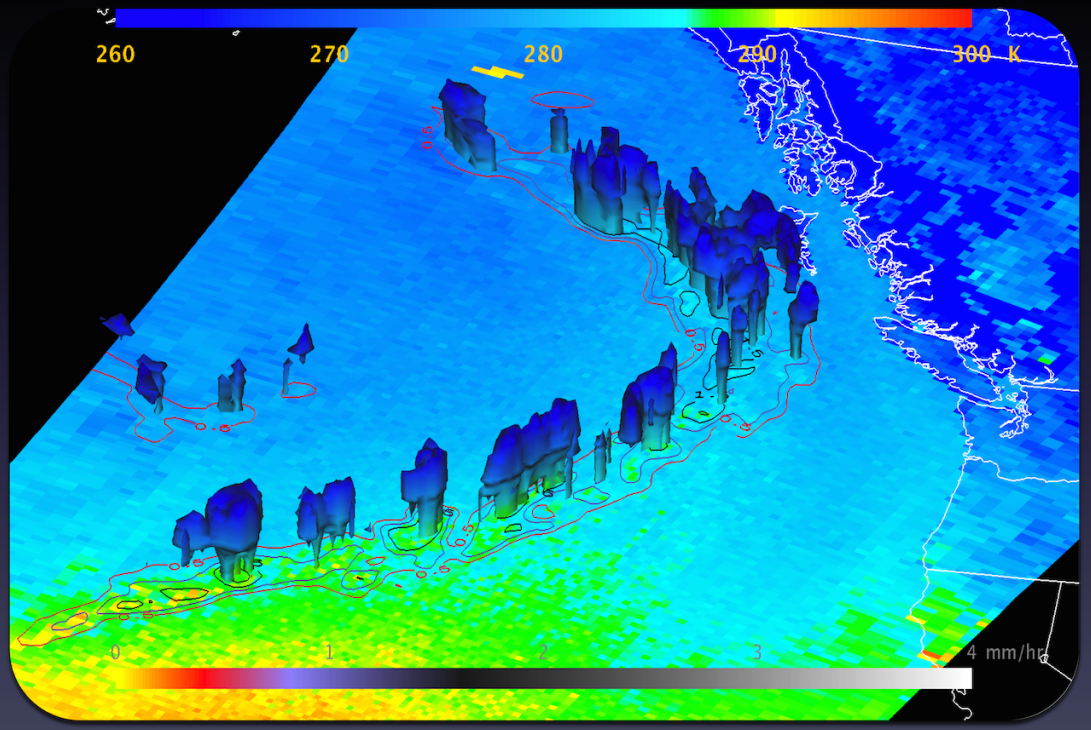
SSEC

Metop-B AMSU/MHS 840 hPa
temperature and water vapor





SNPP ATMS Surface Skin Temperature with Rain Rate
contours and isosurface of Rain Mass Profile



7. CLAVR-x

CLAVR-x (Clouds from AVHRR Extended) creates quantitative cloud, aerosol, and surface products from imager data.

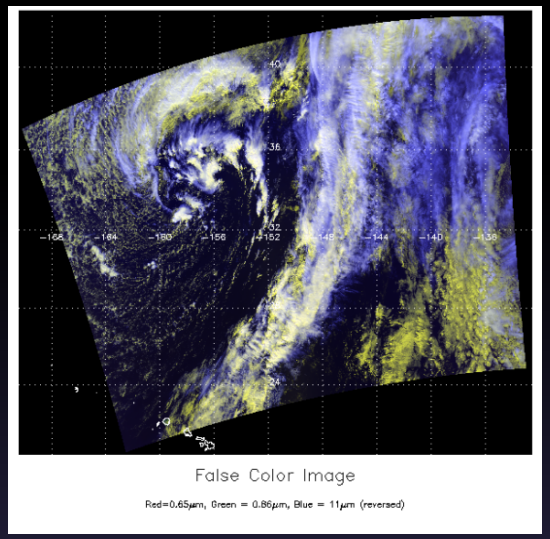
Heritage	Developed at NOAA/NESDIS/STAR and CIMSS/SSEC by Andy Heidinger, Andi Walther, Denis Botambekov, et al.
Satellites/Sensors	Suomi NPP VIIRS; Terra/Aqua MODIS; Metop-A/B AVHRR; NOAA-18/19 AVHRR.
Products	Cloud mask, type, fraction, and phase; cloud top height, pressure, temperature, and emissivity; cloud optical depth and effective radius; aerosol optical thickness; normalized difference vegetation index; sea surface temperature; all in HDF4 format.
Features	• Multi-sensor common algorithm. • Product files include cloud and surface products, calibrated observations, and many ancillary data fields (user controlled). • CLAVR-x is the official NOAA cloud product for JPSS.

CLAVR-x Examples

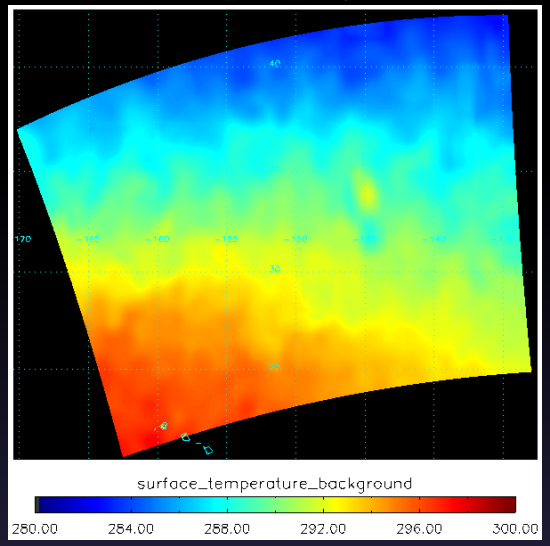
SNPP 2013/03/10 23:00 UTC

SSEC

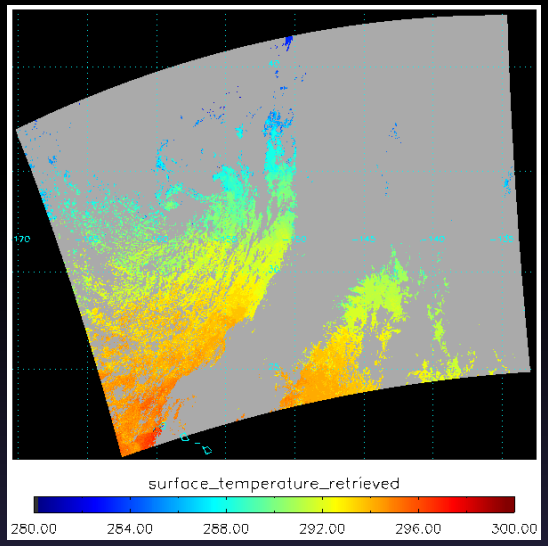
VIIRS False Color



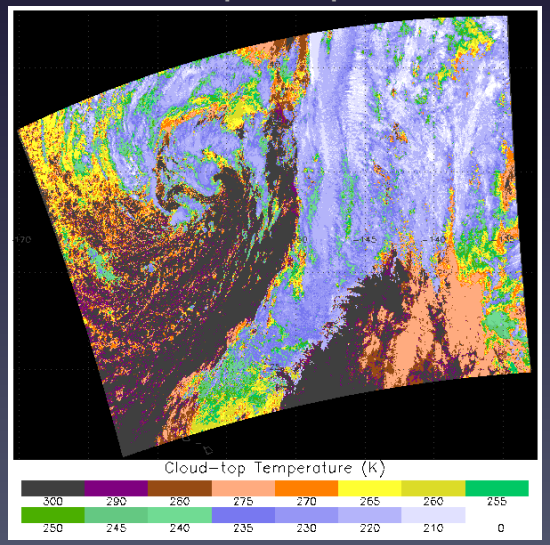
SST Ancillary Data



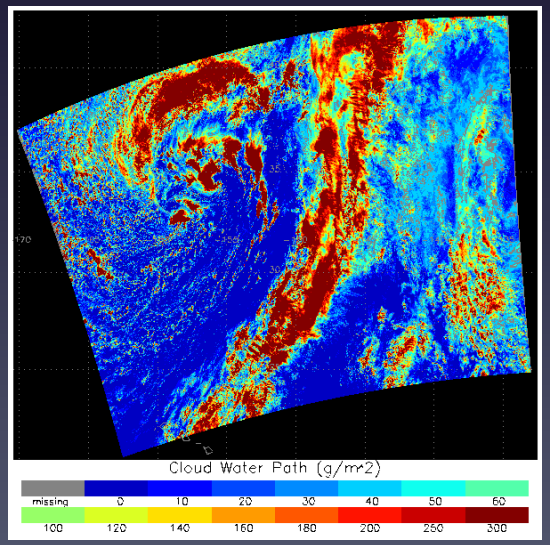
Cloud Masked SST



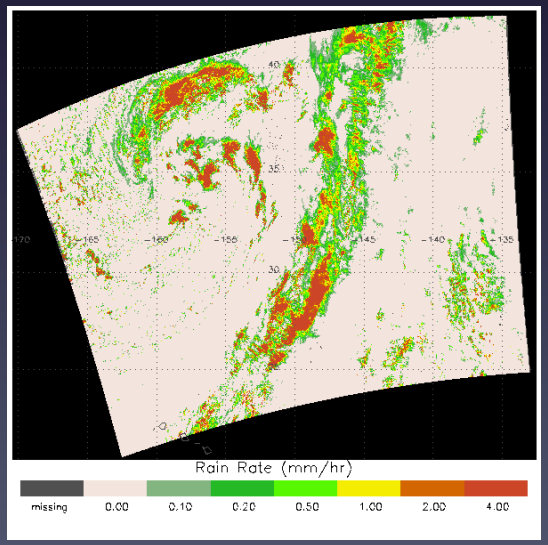
Cloud Top Temperature



Cloud Water Path



Rain Rate



8. NUCAPS

NUCAPS (NOAA Unique CrIS/ATMS Processing System) retrieves atmospheric temperature, moisture, and trace gases from combined infrared and microwave observations.

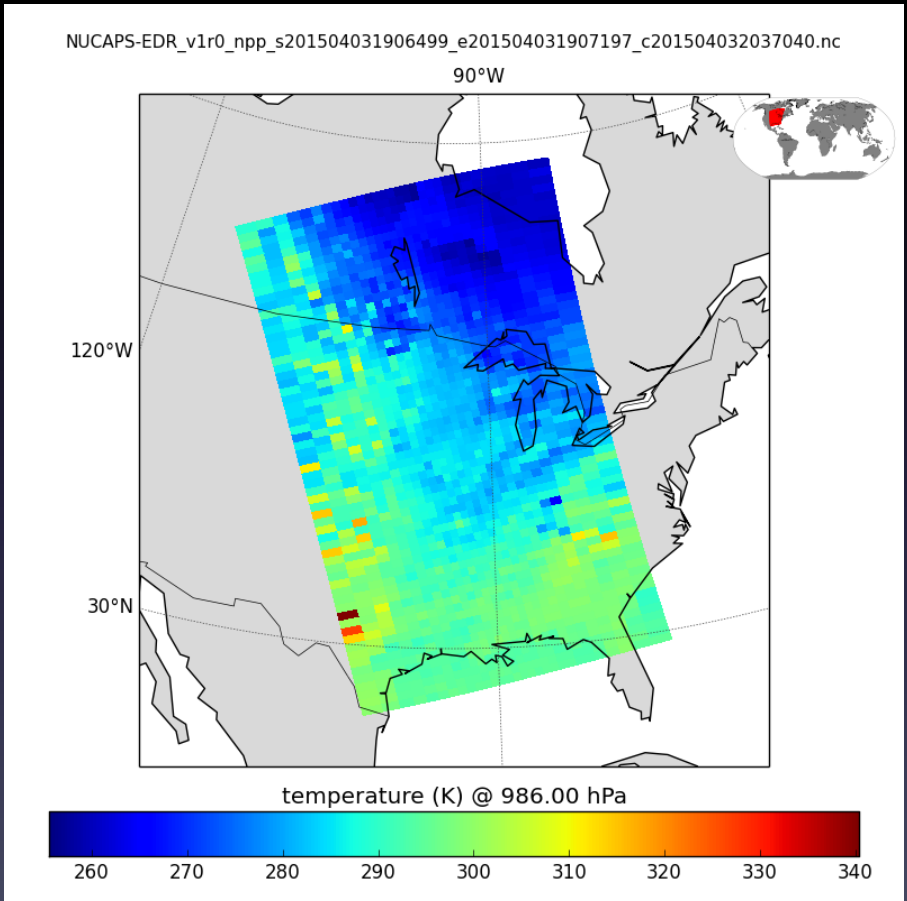
Heritage	Developed at NOAA/NESDIS/STAR by Chris Barnet, Antonia Gambacorta, Walter Wolf, Mark Liu et al.
Satellites/Sensors	Suomi NPP CrIS/ATMS
Products	Temperature, water vapor, and ozone profiles; trace gas profiles including ozone, carbon monoxide, methane, carbon dioxide, nitrous oxide, sulphur dioxide; infrared and microwave surface emissivity; cloud cleared radiances.
Features	• Multi-sensor common physical retrieval algorithm. • Future versions will support Metop-A/B IASI/AMSU/MHS and Aqua AIRS/AMSU. • NUCAPS is the official NOAA sounding product for JPSS.

NUCAPS Examples

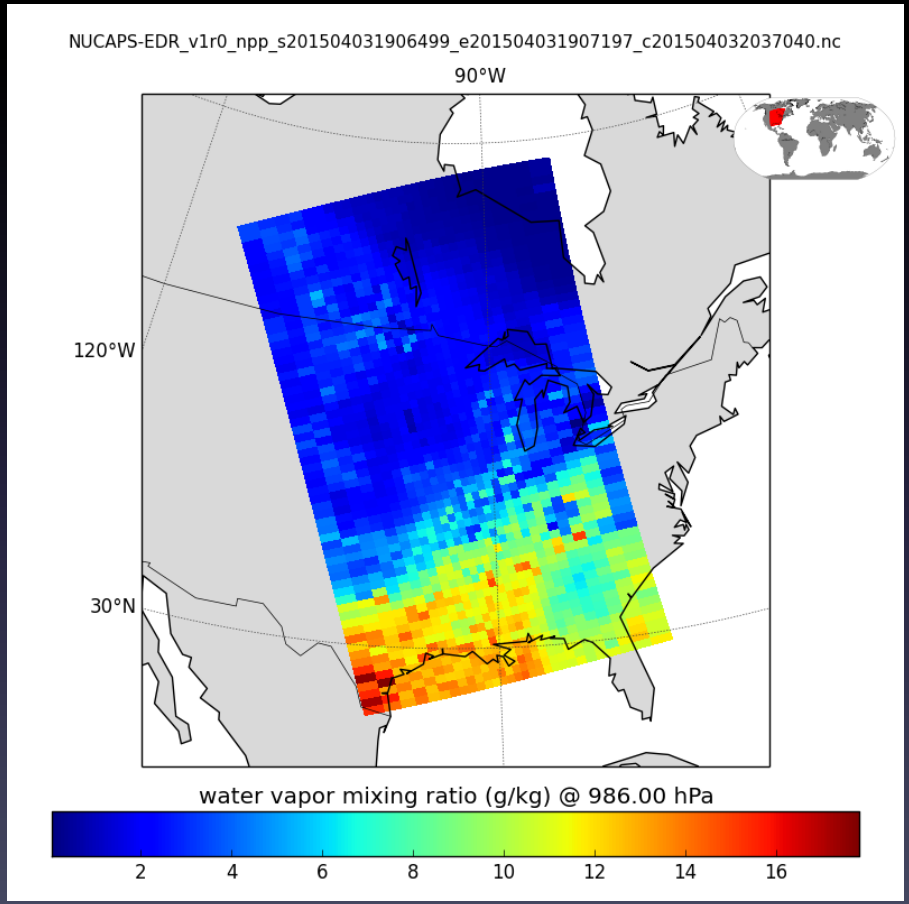
SNPP 2015/04/03 19:07 UTC

SSEC

Temperature



Water Vapor Mixing Ratio



9. IAPP

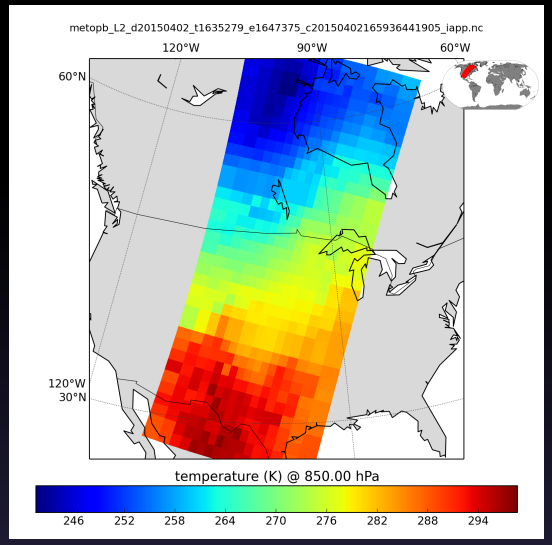
IAPP (International ATOVS Processing Package) retrieves atmospheric temperature and moisture, total ozone, and cloud top properties from ATOVS sounder data.

Heritage	Developed at CIMSS/SSEC by Hal Woolf, Jun Li, Chia Moeller, Tom Achtor et al.
Satellites/Sensors	NOAA-18/19 HIRS/AMSU/MHS; Metop-A/B HIRS/AMSU/MHS.
Products	Temperature and water vapor profiles; total column water vapor and ozone; cloud fraction; cloud top pressure and temperature; surface skin temperature and microwave emissivity.
Features	• Fast regression first guess; iterative nonlinear physical retrieval. • Also supports NOAA-15/16 (non operational).

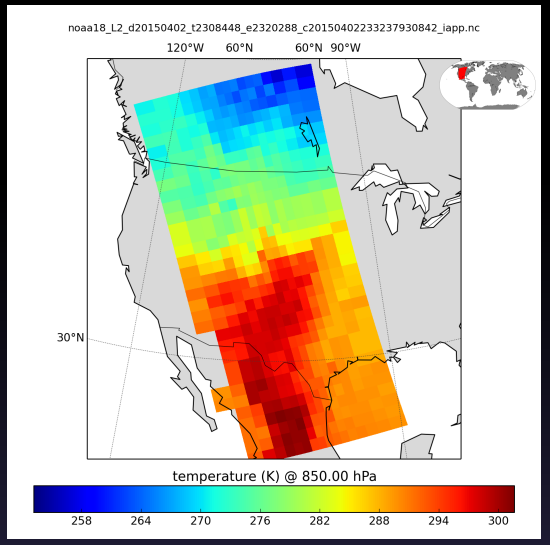
IAPP Examples

Metop-B 2015/04/02 16:35 UTC
NOAA-18 2015/04/02 23:08 UTC

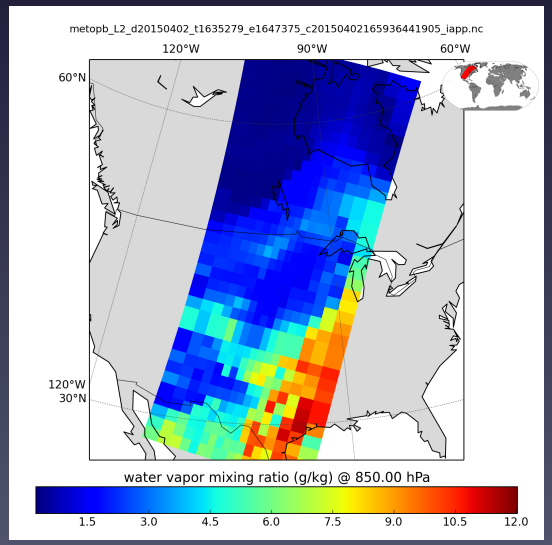
Metop-B Temperature at 850 hPa



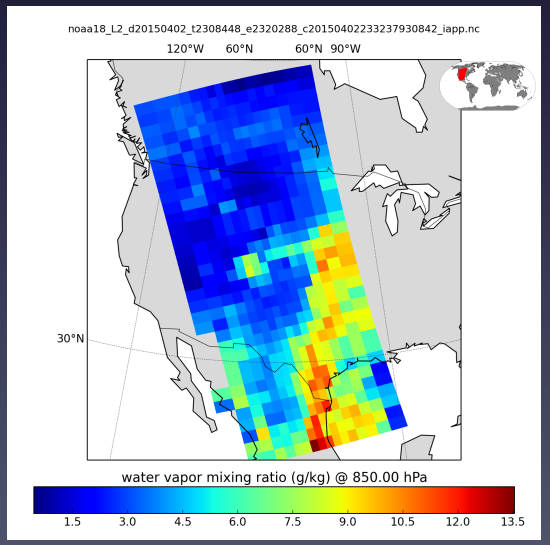
NOAA-18 Temperature at 850 hPa



Metop-B Water Vapor at 850 hPa



NOAA-18 Water Vapor at 850 hPa



10. ACSPO

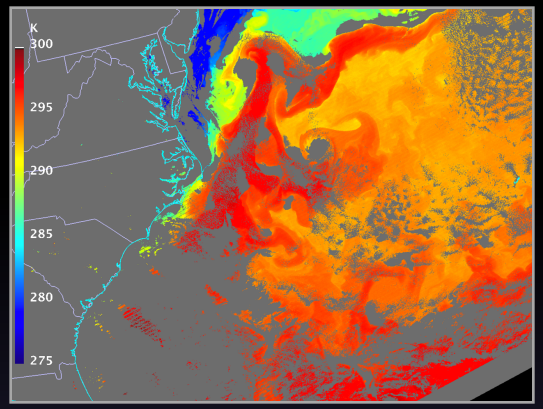
ACSPO (Advanced Clear-Sky Processor for Oceans) retrieves sea surface temperature from multispectral imager observations.

Heritage	Developed at NOAA/NESDIS/STAR by Alex Ignatov, John Sapper, John Stroup, and Yury Kihai.
Satellites/Sensors	Suomi NPP VIIRS; NOAA-18/19 AVHRR; Metop-A/B AVHRR; Terra/Aqua MODIS.
Products	Sea surface temperature, aerosol optical thickness; and clear-sky radiances.
Features	• Multi-sensor common algorithm. • ACSPO is the official JPSS algorithm for SST.

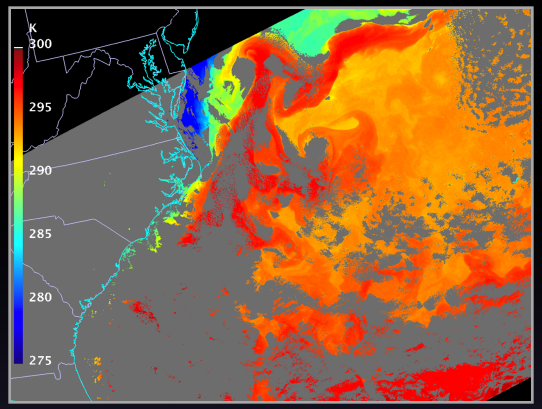
ACSPO Examples

2015/04/02

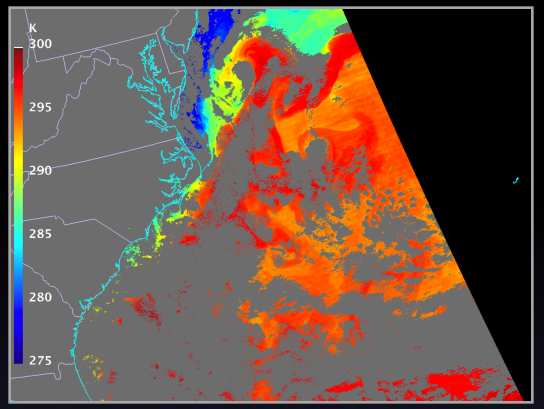
VIIRS SST 17:44 UTC



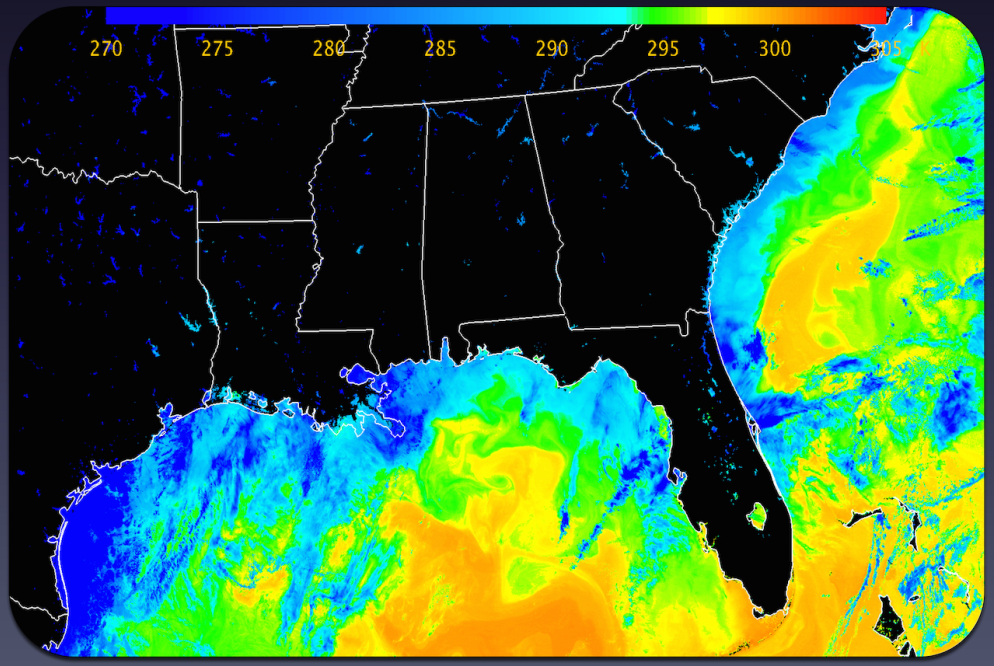
AVHRR SST 18:31 UTC



MODIS SST 18:35 UTC



VIIRS SST 2015/03/18 07:40 UTC



Future additions: CrIS FSR

CrIS switched to full spectral resolution mode on 2014/12/04. Current CSPP SDR software reduces the resolution.

Prototype software for calibration at full spectral resolution has been developed at NOAA/NESDIS/STAR by CrIS SDR team:

- Running operationally at CIMSS/SSEC on DB data since January 2015.
- Software package is available on request for beta testing.
- CSPP version of CrIS full spectral SDR is expected by end of 2015.
- Current version will still be available (reduced resolution).

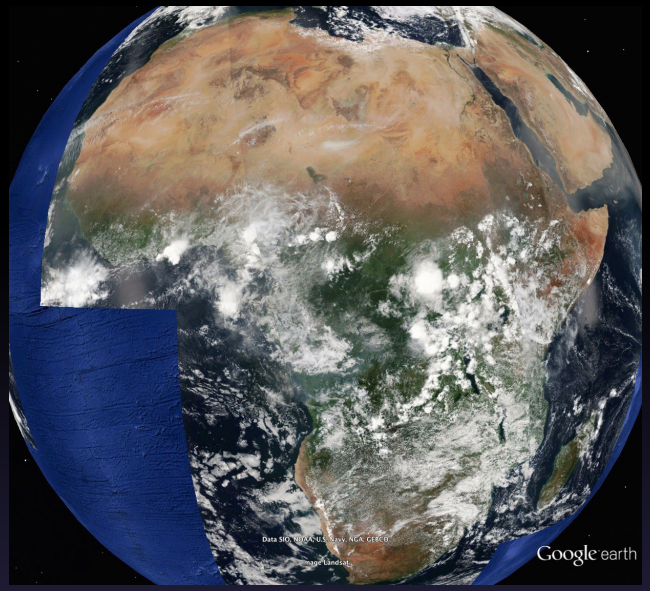
Future additions: MIPS

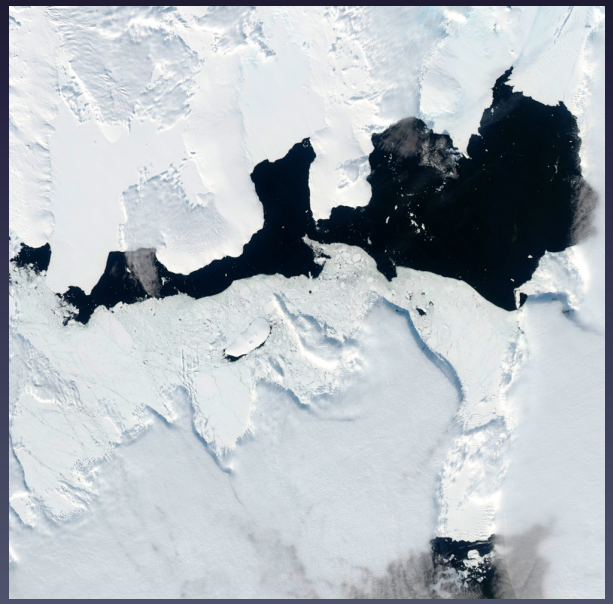
The Multispectral Image Processing System (MIPS) is designed to create high-quality true color and false color composited images in GeoTIFF, JPEG, and KML format.

- Supports SNPP VIIRS, Terra/Aqua MODIS, and FY-3 MERSI.
- Allows composites to be created for a DB region, polar regions, or the entire globe.

MIPS Examples

SNPP VIIRS 2015/04/09





CSPP Summary

- CSPP continues to support the polar orbiting satellite DB community with a wide range of software and products supporting Suomi NPP, Metop, NOAA, and EOS satellites.
- CSPP GEO now supports geostationary satellites.
- We look forward to JPSS-1 in early 2017.

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