

Community Satellite Processing Package (CSPP): LEO and GEO

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2014 GOES-R/JPSS OCONUS Meeting
27 July 2014



What is CSPP?

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

The primary purpose of CSPP is to support users who receive meteorological satellite data via direct broadcast and process it independently to create higher level products and images in real time.

CSPP Software Features

- Ready to install and run on 64-bit Intel Linux (CentOS 6); no compilation required (source code is usually included). Install time < 10 min.
- Supports input data from direct broadcast (primary use case) and from global archives (secondary use case).
- Dynamic ancillary data are downloaded automatically.
- Self-describing output files (e.g., HDF, netCDF).
- Distribution package includes documentation and test data.

CSPP Software Philosophy

CSPP software must:

- Create useful products for the DB community,
- Include up-to-date algorithms,
- Be pre-compiled for 64-bit Linux,
- Be easy to install and operate,
- Include test data for verification,
- Have prompt user support,
- Run efficiently on modest hardware.

CSPP LEO Satellites and Sensors

CSPP includes support for Suomi NPP and JPSS, POES, Metop, Terra, Aqua, and eventually FY-3.

- For Suomi NPP, supported sensors include ***VIIRS, CrIS, ATMS*** (SDRs and a subset of EDRs).
- For POES and Metop, supported sensors include ***AVHRR, IASI, AMSU-A/B, MHS*** (Level 2 products only; Level 1 processing provided by AAPP).
- For Aqua and Terra, supported sensors include ***MODIS, AIRS, and AMSU.***

CSPP LEO Releases (2014/07)

May 16, 2014 (CSPP CLAVR-x VIIRS, MODIS and AVHRR Cloud Retrieval Software Version 1.0)

April 29, 2014 (CSPP CrIS, AIRS and IASI Dual Regression Retrieval Software Version 1.3)

March 21, 2014 (CSPP Suomi NPP Imagery EDR Software Versions 1.1)

March 20, 2014 (CSPP Microwave Integrated Retrieval System (MIRS) Software Version 1.0)

March 19, 2014 (CSPP Suomi NPP HYDRA2 Multispectral Data Analysis Toolkit Version 1.0)

February 14, 2014 (CSPP Suomi NPP VIIRS EDR Software Version 1.2.1)

December 18, 2013 (CSPP Suomi NPP CrIS, VIIRS and ATMS SDR Software Version 1.5)

December 18, 2013 (CSPP Suomi NPP VIIRS EDR Software Version 1.2)

October 18, 2013 (CSPP VIIRS SDR GeoTIFF and AWIPS Reprojection Software Version 1.1)

September 24, 2013 (CSPP CrIS, AIRS and IASI Dual Regression Retrieval Software Version 1.2)

July 8, 2013 (CSPP Suomi NPP CrIS, VIIRS and ATMS SDR

Software Version 1.4)

July 8, 2013 (CSPP Suomi NPP VIIRS EDR Software Version 1.1)

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

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

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

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

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

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

May 4, 2012 (CSPP CrIS UW Retrieval Software Version 1.0)

May 2, 2012 (CSPP Suomi NPP CrIS, VIIRS and ATMS SDR Software Version 1.1)

March 14, 2012 (CSPP Suomi NPP VIIRS and ATMS SDR Software Version 1.0)

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**

Current CSPP LEO Software

1. Suomi NPP CrIS, VIIRS and ATMS SDR (geolocation and calibration)
2. Suomi NPP VIIRS EDR (cloud mask, active fires, surface reflectance, NDVI, SST, aerosol optical thickness)
3. CrIS, IASI, and AIRS Dual Regression Retrieval
4. VIIRS SDR GeoTIFF and AWIPS Reprojected Imagery
5. Microwave Integrated Retrieval System (MIRS)
6. Clouds from AVHRR Extended (CLAVR-x)
7. HYDRA2 Multispectral Data Analysis Toolkit
8. Suomi NPP Imagery EDR (projected imagery for AWIPS)

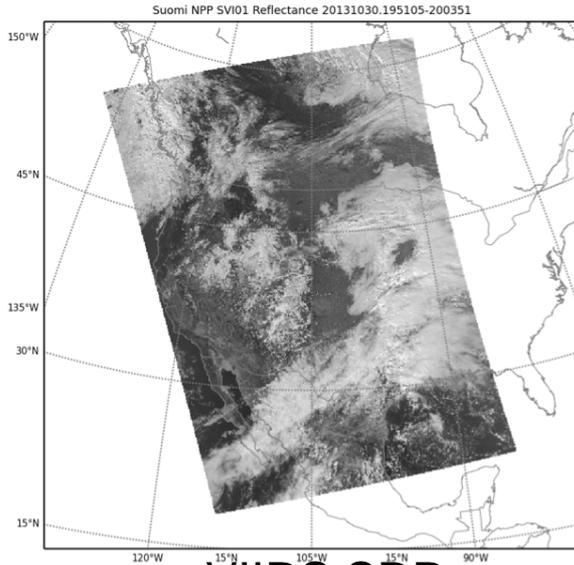
1. VIIRS, CrIS, and ATMS SDR

- Converts RDR files (CCSDS packets) to SDR files (geolocation and calibrated radiances and reflectances)
- Based on operational algorithms and lookup tables (IDPS version Mx7.2)
- CSPP version added features include multi-core processing, automated LUT updates, granule aggregation, HDF5 compression.
- Supports CrIS full spectral resolution data.

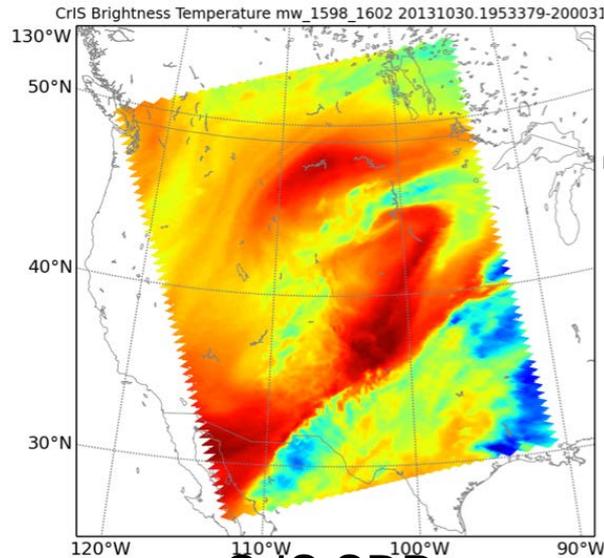
2. VIIRS EDR

- Creates geophysical products from VIIRS radiances and reflectances.
- Based on operational algorithms and lookup tables (IDPS version Mx7.2).
- Products include cloud mask, active fires, surface reflectance, NDVI, SST, AOT.
- CSPP version added features include selectable products, multi-core processing, automated ancillary data download, granule aggregation, HDF5 internal compression.

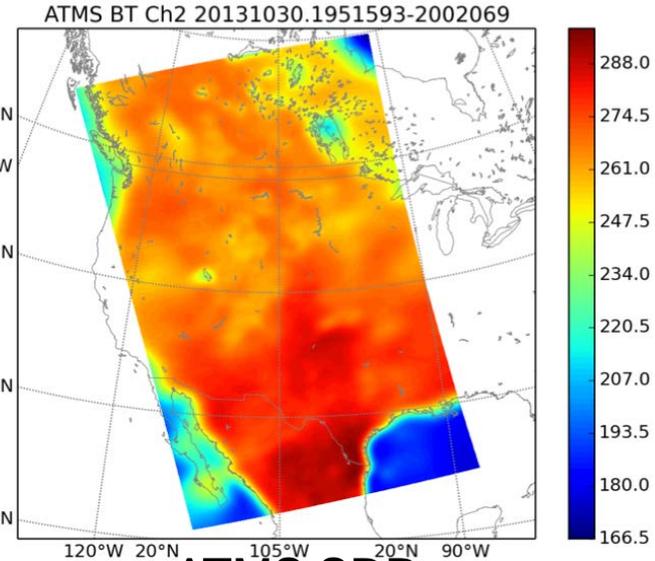
VIIRS EDR Products from SSEC DB



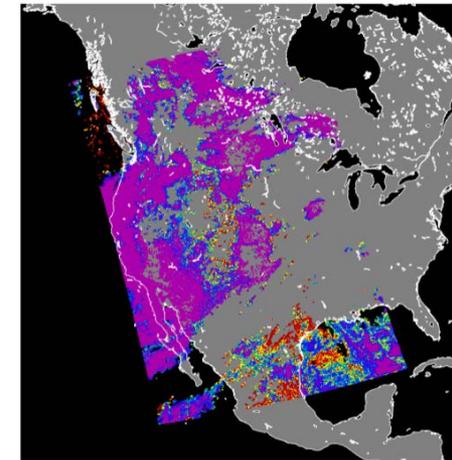
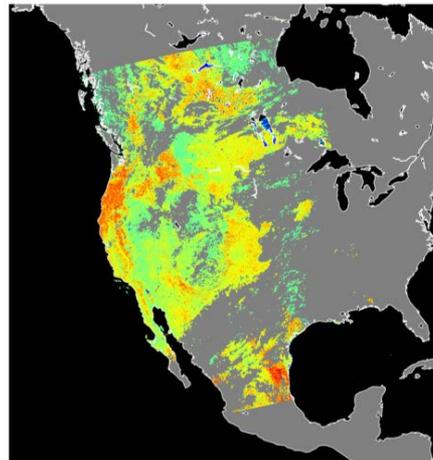
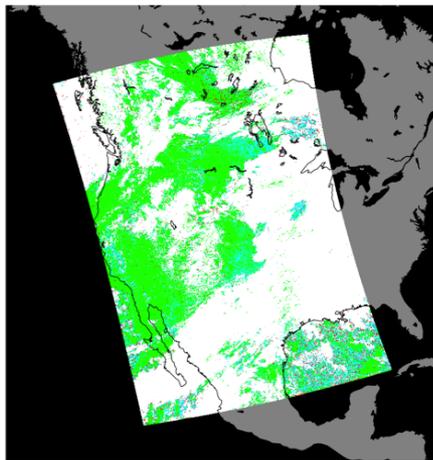
VIIRS SDR



Cris SDR

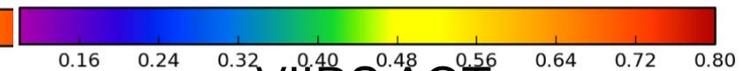
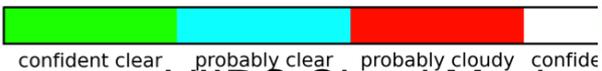


ATMS SDR



Vegetation Index

AOT



VIIRS Cloud Mask

VIIRS NDVI

VIIRS AOT

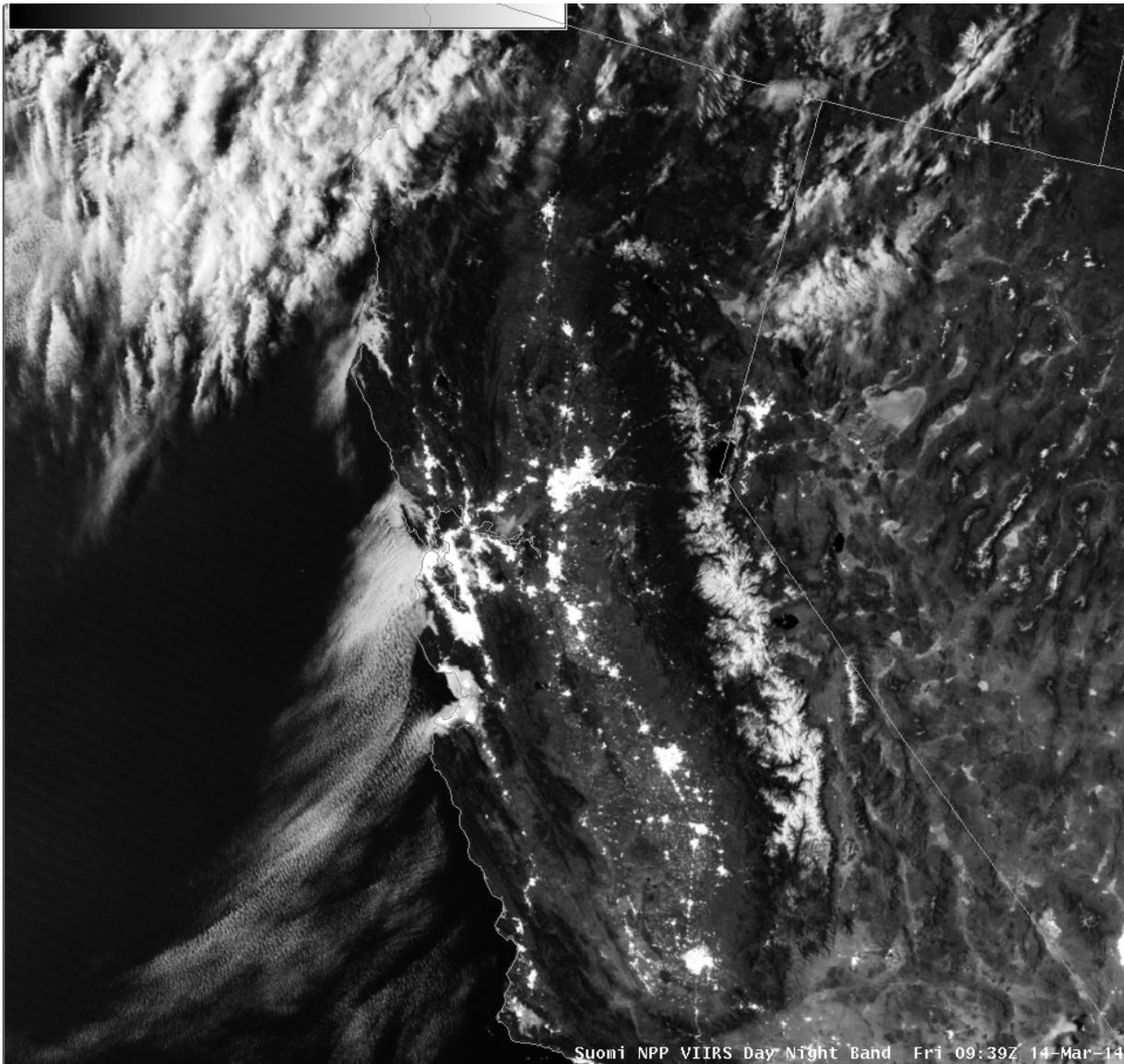
3. Dual Regression Retrievals

- Computes profiles of atmospheric temperature, moisture, and ozone from CrIS SDR; IASI and AIRS Level 1B.
- Computes cloud top products (height, pressure, emissivity) surface parameters.
- Common fast regression algorithm by Bill Smith, Elisabeth Weisz, Nadia Smith.
- Products are created for every FOV, clear and cloudy.

4. VIIRS SDR Projected Imagery

- Creates VIIRS imagery on a user-defined grid and projection.
- Reads multi-granule VIIRS SDRs as input (M-band, I-band, and DNB).
- Saves images in GeoTIFF and AWIPS formats.
- Used operationally at SSEC and GINA to create products for National Weather Service Forecast Offices.

Low Cloud/ Fog Seen by VIIRS DNB at Night



AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE SAN
FRANCISCO BAY AREA
443 AM PDT FRI MAR 14 2014

.DISCUSSION...AS OF 4:10 AM PDT
FRIDAY...THE DRY TAIL END OF A
WEATHER SYSTEM MOVING IN TO THE
PACIFIC NORTHWEST IS APPROACHING
OUR DISTRICT...AND RESULTING IN
ENHANCEMENT OF THE MARINE
LAYER AND **A RETURN OF THE
MARINE STRATUS. LATEST GOES FOG
PRODUCT IMAGERY...AND IN RATHER
SPECTACULAR DETAIL JUST REC'D
SUOMI VIIRS NIGHTTIME HIGH RES
VISUAL IMAGE...SHOW COVERAGE
ALONG MUCH OF THE COAST FROM
PT REYES SOUTH TO THE VICINITY OF
THE MONTEREY PENINSULA...AND A
BROAD SWATH EXTENDING INLAND
ACROSS SAN FRANCISCO AND
THROUGH THE GOLDEN GATE TO THE
EAST BAY.** LATEST BODEGA BAY AND FT
ORD PROFILER DATA INDICATE A
MARINE LAYER DEPTH OF ABOUT 1300
FT. SOME THIN HIGH CLOUDS ARE
ALSO PASSING THROUGH ABOVE.

5. Microwave Integrated Retrieval System

- Retrieves atmospheric profile and surface parameters from ATMS, AMSU-A, and MHS sensor SDR and Level 1B data.
- Development is led by Sid Boukabara at the NOAA NESDIS Center for Satellite Applications and Research (STAR).
- Supports ATMS SDR from CSPP or CLASS, and Metop/NOAA AMSU-A and MHS from AAPP v7.

MIRS Product List

Official Validated Products:

Temperature profile over open water ocean
Humidity profile over open water ocean
Humidity Profile over non-coastal Land
Total Precipitable Water (TPW) over open water ocean
Total Precipitable Water over non-coastal land
Land surface temperature
Surface Emissivity over land and snow
Surface Type Classification
Snow Water Equivalent (SWE)
Sea Ice Concentration (SIC)
Snow Cover Extent (SCE)
Vertically-Integrated Non-precipitating Cloud Liquid Water (CLW) over open water ocean
Vertically-Integrated Graupel Water Path (IWP)
Vertically-Integrated Rain Water Path (RWP)

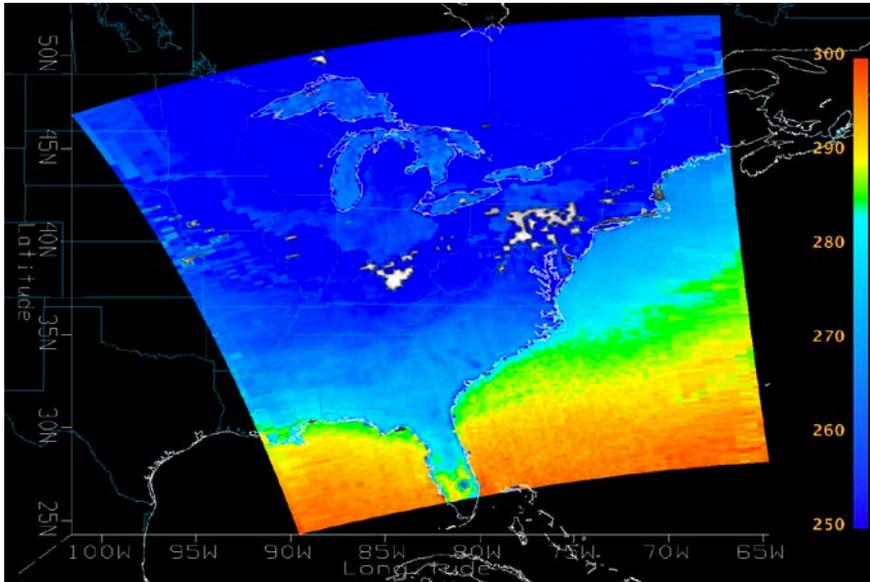
Rainfall Rate (RR) over open water ocean and non-coastal, non-snow-covered land surface types

Experimental Products (not fully validated):

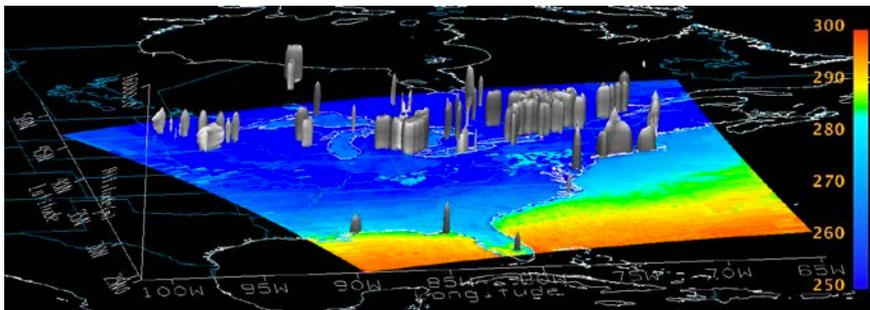
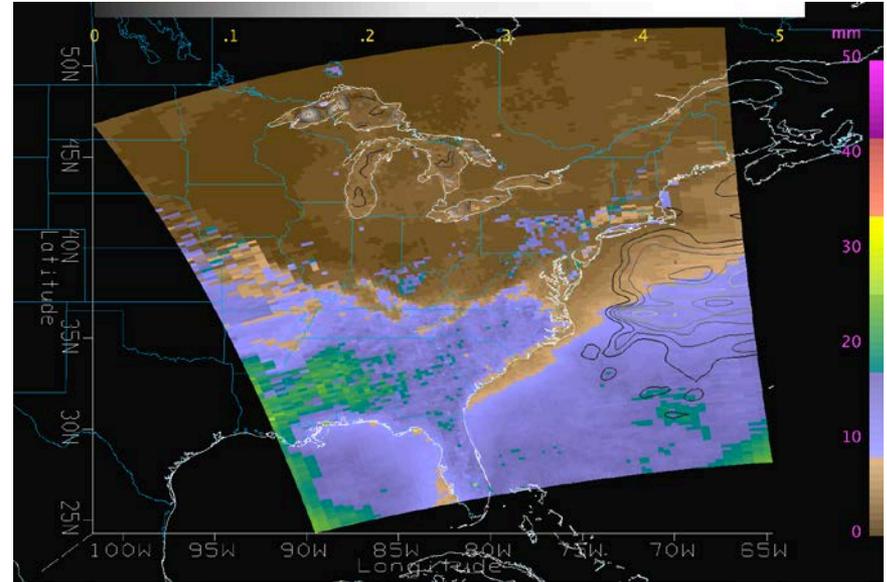
Cloud Liquid Water Profile (CLWP) over ocean
Surface Temperature (skin) extended to snow-covered land surface type
Surface Temperature (skin) extended to open ocean water
Effective grain size of snow (over snow-covered land surface)
Multi-Year (MY) Type Sea Ice Concentration
First-Year (FY) Type Sea Ice Concentration

MIRS Products from ATMS DB

Surface Temperature
with Rain Mass Profile



Total Precipitable Water
with contours of Cloud Liquid Water

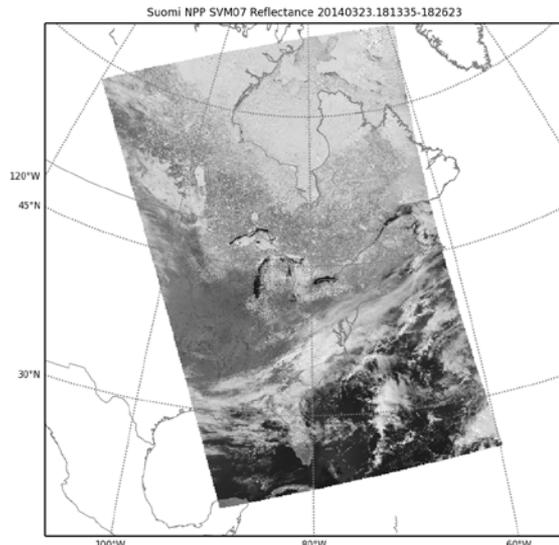


S-NPP/ATMS
2014-01-23 18:19Z

6. Clouds from AVHRR - Extended

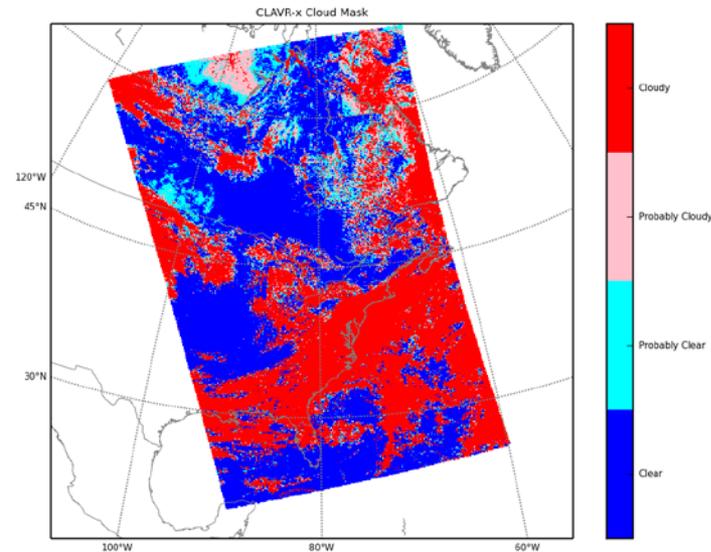
- CLAVR-X derives cloud parameters (cloud top height, pressure, phase, ...) and surface parameters from multispectral imager data.
- Development led by Andy Heidinger.
- Supports VIIRS, MODIS, and AVHRR.
 - VIIRS SDRs from CSPP or IDPS/CLASS,
 - MODIS Level 1B from SeaDAS or MODAPS,
 - AVHRR Level 1B from AAPP v7.
- One algorithm supports multiple sensors.

CLAVR-X products from VIIRS DB

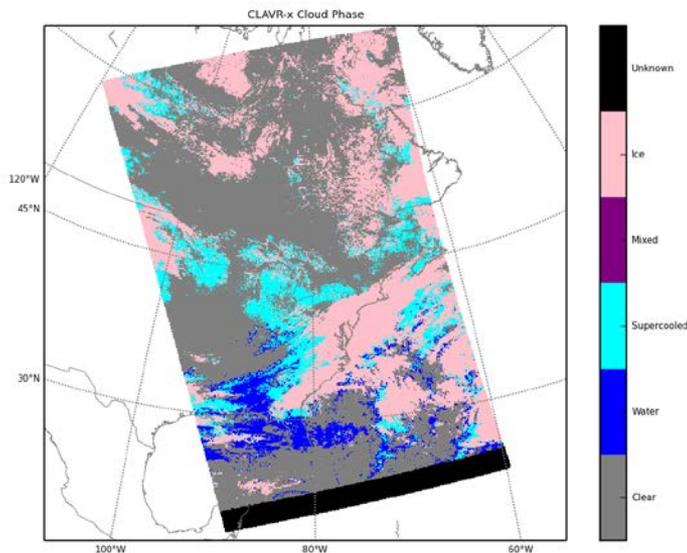


VIIRS SVM07

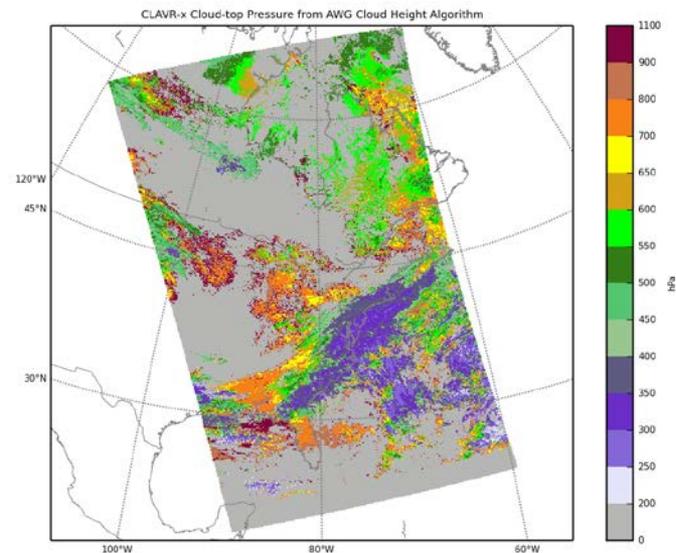
2014/03/23
18:13 UTC



Cloud Mask



Cloud Phase

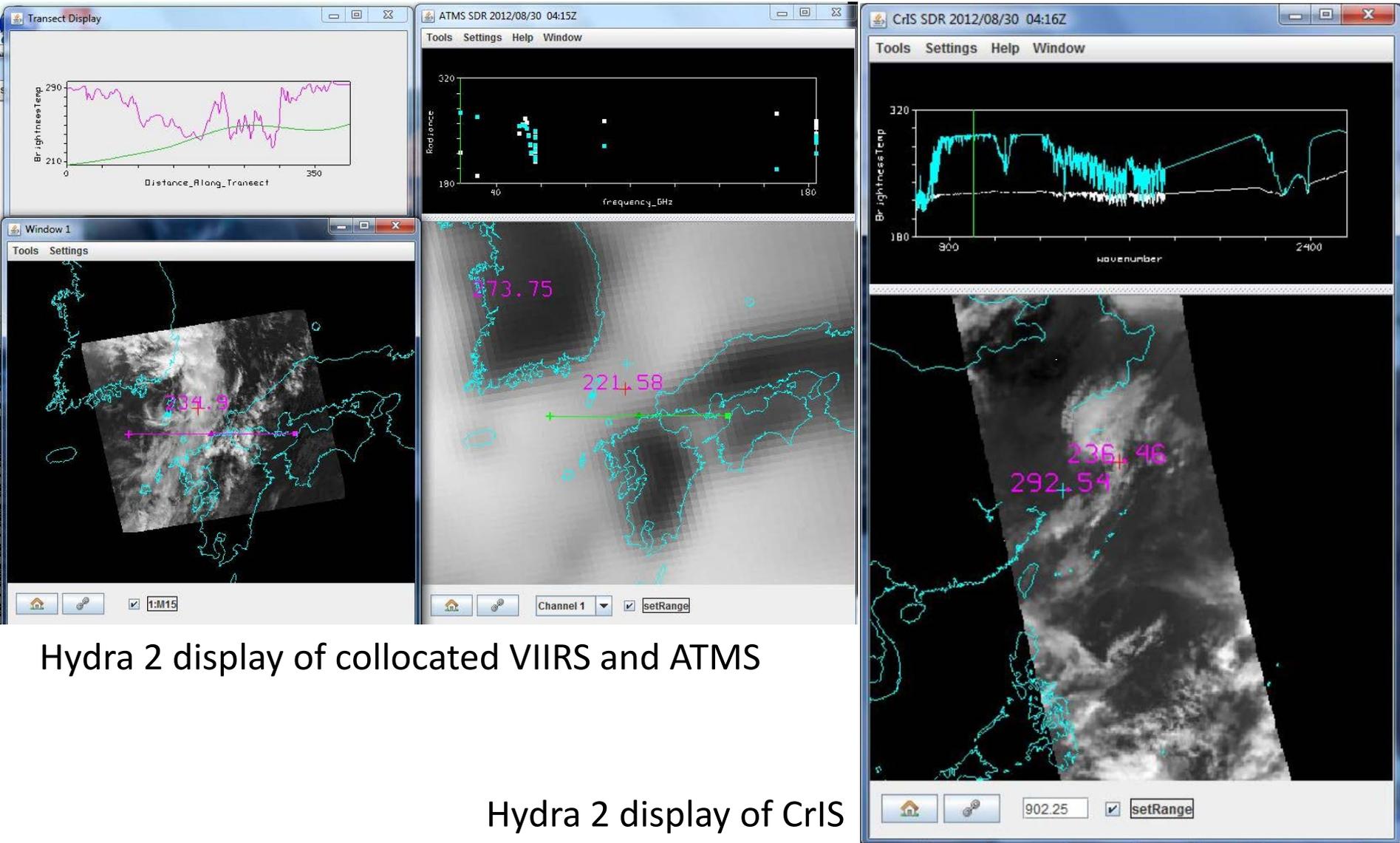


Cloud Top Pressure

7. Hydra2 Multispectral Data Toolkit

- Allows interactive display of Level 1B and Level 2 products from multispectral imagers (VIIRS, MODIS), high spectral resolution sounders (CrIS, IASI, AIRS), and microwave sounders (ATMS, AMSU).
- Designed to be easy to learn and use, especially for students.
- Supported on Windows, OS X, and Linux.

Hydra2 Screenshots (SNPP 2012/08/30 04:16Z)



Hydra 2 display of collocated VIIRS and ATMS

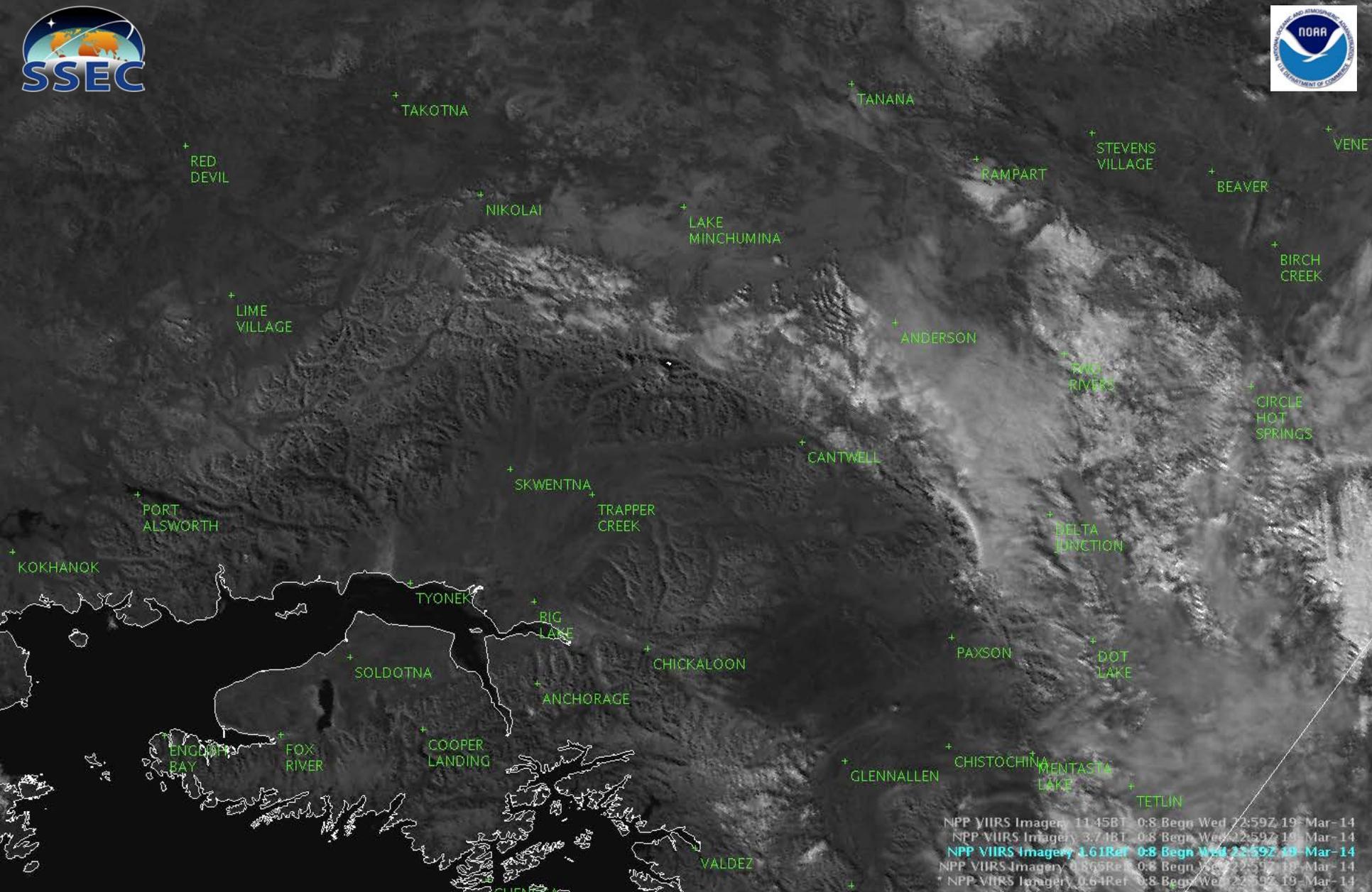
Hydra 2 display of CrIS

8. VIIRS Imagery EDR

- Creates projected VIIRS image data on a Ground Track Mercator grid.
- Product can be directly ingested into NWS AWIPS2.
- Supports I-band resolution (375 meters).
- Provides VIIRS Near Constant Contrast (NCC) product for Day/Night Band.

VIIRS Imagery EDR I-Band 3 in AWIPS-II

Processed using CSPP Software including conversion to NetCDF4 19 March 2014



NPP VIIRS Imagery 1145BT 0:8 Bgn Wed 22:59Z 19-Mar-14
NPP VIIRS Imagery 374BT 0:8 Bgn Wed 22:59Z 19-Mar-14
NPP VIIRS Imagery 161Rd 0:8 Bgn Wed 22:59Z 19-Mar-14
NPP VIIRS Imagery 086Rd 0:8 Bgn Wed 22:59Z 19-Mar-14
NPP VIIRS Imagery 064Ref 0:8 Bgn Wed 22:59Z 19-Mar-14

Coming Soon #1: Mx8.4 SDR and EDR

- CSPP SDR software based on Mx8.4 includes VIIRS autocal LUTs and DNB terrain correction.
- CSPP VIIRS EDR software based on Mx8.4 includes updated science algorithms for all EDRs and adds Land Surface Temperature.
- CSPP VIIRS Imagery EDR includes conversion utilities for AWIPS2.
- Packages are in production at SSEC today and will be released the week of August 4.

Coming Soon #2: NUCAPS

- Creates profiles of temperature, moisture, ozone, and other trace gases; cloud and surface products; and other products from cloud cleared radiances from CrIS/ATMS.
- Development led by Chris Barnet.
- Also supports IASI/AMSU/MHS and AIRS/AMSU.
- Currently in testing on CSPP development systems at SSEC/CIMSS.
- Expect CSPP integration to begin in August, followed by CSPP release in September.

Coming Soon #3: ACSPO

- Derives cloud cleared sea surface temperatures from VIIRS, MODIS, and AVHRR Level 1B imagery.
- Development led by Alex Ignatov.
- Currently in testing on CSPP development systems at SSEC/CIMSS.
- Expect CSPP integration to begin in August, followed by CSPP release in September.

CSPP GEO

- NOAA GOES-R Project is funding the development of a CSPP GEO software package.
- Supported satellites/sensors will include GOES-R ABI (GRB), GOES-N Imager (GVAR), and Himawari-8 AHI (HSF).
- CSPP GEO will create Level 1B products for all sensors on GOES-R (from GRB downlink).
- CSPP GEO will create atmosphere, cloud, and surface products from ABI Level 1B data via the GEOCAT framework.

CSPP GEO for GOES-R

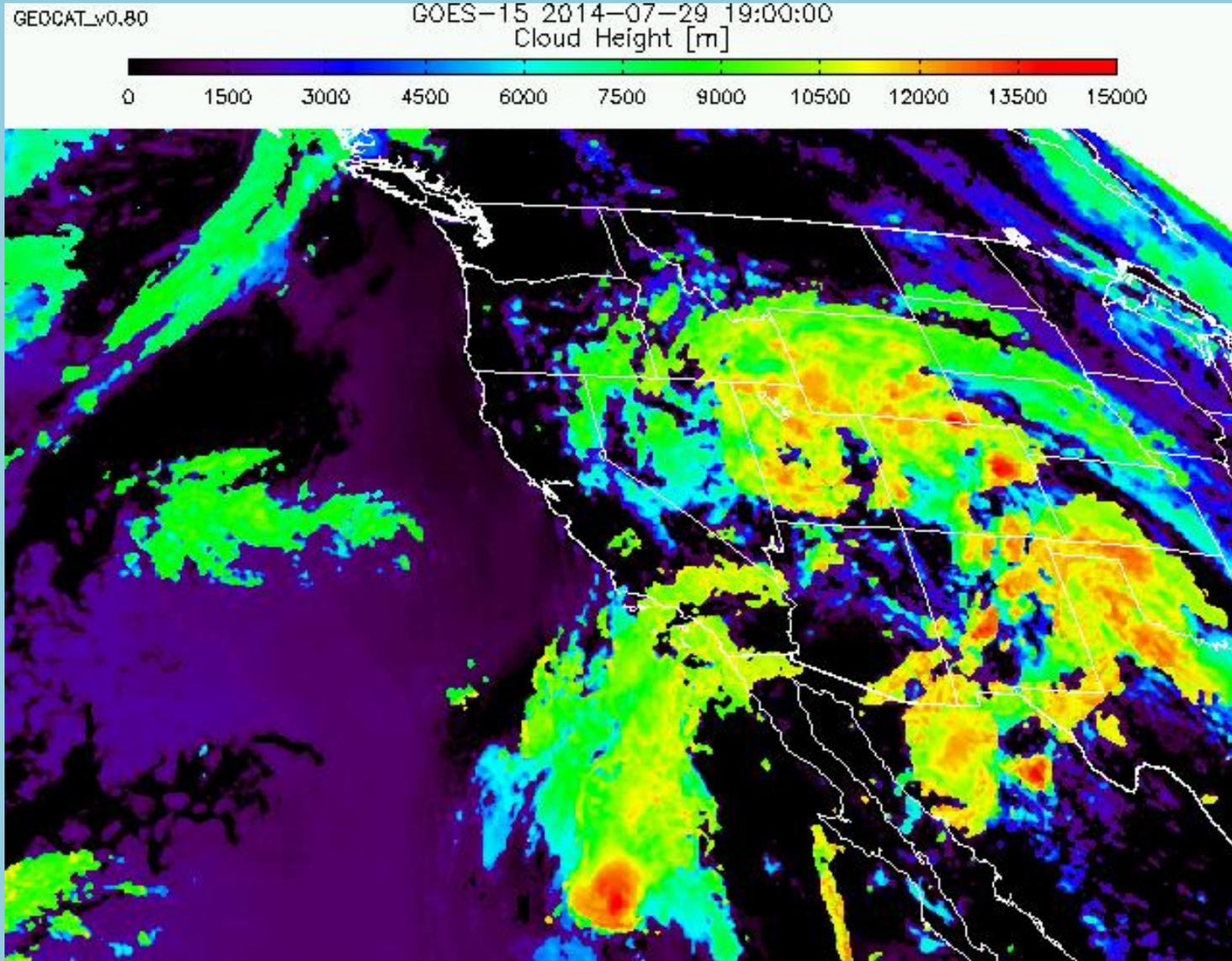
Will support users receiving GOES-R Re-Broadcast (GRB) via their own antenna, feed, LNA, downconverter, and DVB demodulator.

1. CSPP GEO will supply a utility for framing the GRB bitstream to create CCSDS packets.
2. CSPP GEO will provide a utility to construct Level 1B NetCDF files from CCSDS packets for all sensors.
3. CSPP GEO will provide GEOCAT to create Level 2 products from ABI Level 1B data.

GEOCAT

- The Geostationary Cloud Algorithm Testbed (GEOCAT) was developed by the GOES-R AWG Cloud Application Team for testing ABI cloud algorithms using existing sensors including GOES Imager, SEVIRI, MTSAT, and ABI proxy data (led by Mike Pavolonis).
- GEOCAT is designed to provide imager data and supporting ancillary data in a structure where it can be analyzed by multiple common algorithms.

GEOCAT Cloud Top Pressure (GOES-15)



GOES-R ABI Products

Baseline Products

Advanced Baseline Imager (ABI)

Aerosol Detection (Including Smoke and Dust)

Aerosol Optical Depth (AOD)

Clear Sky Masks

Cloud and Moisture Imagery

Cloud Optical Depth

Cloud Particle Size Distribution

Cloud Top Height

Cloud Top Phase

Cloud Top Pressure

Cloud Top Temperature

Derived Motion Winds

Derived Stability Indices

Downward Shortwave Radiation: Surface

Fire/Hot Spot Characterization

Hurricane Intensity Estimation

Land Surface Temperature (Skin)

Legacy Vertical Moisture Profile

Legacy Vertical Temperature Profile

Radiances

Rainfall Rate/QPE

Reflected Shortwave Radiation: TOA

Sea Surface Temperature (Skin)

Snow Cover

Total Precipitable Water

Volcanic Ash: Detection and Height

Future Capabilities

Advanced Baseline Imager (ABI)

Absorbed Shortwave Radiation: Surface

Aerosol Particle Size

Aircraft Icing Threat

Cloud Ice Water Path

Cloud Layers/Heights

Cloud Liquid Water

Cloud Type

Convective Initiation

Currents

Currents: Offshore

Downward Longwave Radiation: Surface

Enhanced "V"/Overshooting Top Detection

Flood/Standing Water

Ice Cover

Low Cloud and Fog

Ozone Total

Probability of Rainfall

Rainfall Potential

Sea and Lake Ice: Age

Sea and Lake Ice: Concentration

Sea and Lake Ice: Motion

Snow Depth (Over Plains)

SO₂ Detection

Surface Albedo

Surface Emissivity

Tropopause Folding Turbulence Prediction

Upward Longwave Radiation: Surface

Upward Longwave Radiation: TOA

Vegetation Fraction: Green

Vegetation Index

Visibility

Underlined products are already integrated in GEOCAT (others can be added)

CSPP GEO for GOES Imager

- GEOCAT already supports GOES Imager via McIDAS area files. However, McIDAS is not freely available.
- CSPP GEO has created a freely available GVAR to area file converter to enable GOES Imager data to be ingested by GEOCAT without needing McIDAS.
- A prototype of the CSPP GEO software for GOES Imager has been tested in the DB community (converter + GEOCAT).

CSPP GEO for Himawari AHI

- CSPP GEO will ingest the Level 1B format for Himawari AHI data (HSF).
- The existing suite of GEOCAT algorithms will be used to create AHI Level 2 products.
- This will provide an important source of ABI-like products for evaluation by users including the NWS.

CSPP GEO: Current Activities

- Have captured data from GRB simulator at SSEC.
- Developing GRB bitstream to CCSDS packet converter.
- Developing CCSDS packet to netCDF L1B converter.
- Developing library for ingesting AHI HSF format.
- Contacting system vendors to learn about plans for GRB reception (CSPP GEO ICD).
- Preparing CSPP GEO for Goes Imager package for public release in 3Q 2014.

Credits

CSPP team at UW/SSEC/CIMSS

Algorithm Developers

JPSS Project

GOES-R Project

DB User Community

Liam.Gumley@ssec.wisc.edu