Community Satellite Processing Package for LEO Satellites

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1. CSPP LEO Overview

- The Community Satellite Processing Package (**CSPP**) is a collection of freely available software for processing data from LEO and GEO meteorological satellites. The CSPP LEO project is based at the Space Science and Engineering Center at the University of Wisconsin-Madison and is funded by the NOAA JPSS Program Office.
- CSPP LEO supports the creation of calibrated observational data, geophysical derived products, and mapped images from visible, infrared, and microwave sensors.
- CSPP LEO supports processing of data from these satellites in low earth orbit: **NOAA-20, Suomi NPP, Metop-A/B/C, NOAA-18/19, Terra, Aqua, GCOM-W1, and FY-3B/C/D.**
- Data source is usually Direct Broadcast (DB) from the spacecraft. However, archived data are also supported (e.g., NOAA CLASS, NASA DAAC).
- Recent work on CSPP LEO has focused on adding NOAA-20 and Metop-C support.
- NOAA-20 is now supported by all relevant CSPP software packages.

2. Software Packages and Features

CSPP software features include:
- The executable software is freely available (source code is usually available);
- Packages are pre-compiled and ready to run on **CentOS 6 Linux (x86_64)**;
- Software is easy to install and operate, and well documented;
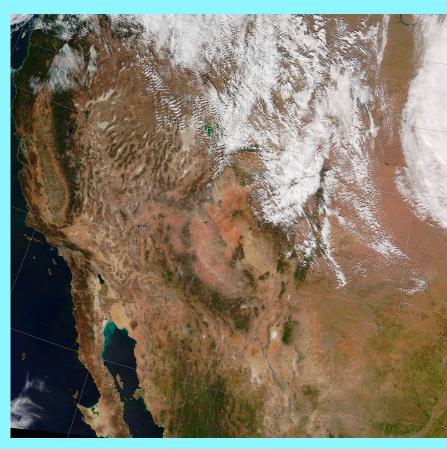- Typical server: 8 x Xeon 2.5 GHz cores, 64 GB RAM, 4 x 2 TB hard drives.

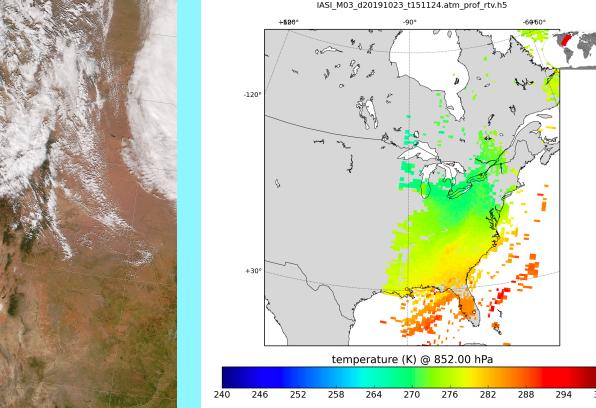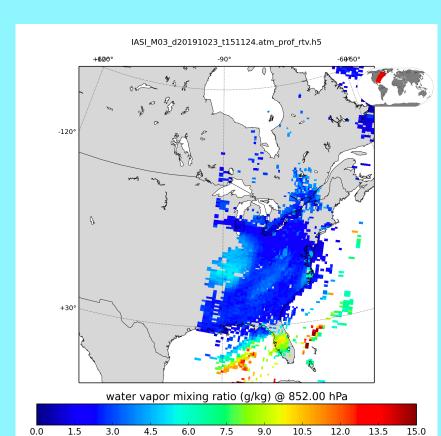| CSPP LEO Package	Product Description
SDR	SNPP and NOAA-20 VIIRS, CrIS, and ATMS geolocated and calibrated earth observations (NOAA algorithm).
Polar2grid	Reprojected imagery (single and multi-band) in GeoTIFF and AWIPS formats.
VIIRS ASCI	VIIRS imager aerosol optical depth, cloud properties, sea ice, and volcanic ash (NOAA algorithm).
VIIRS Active Fires	VIIRS imager wildfire detection (NOAA algorithm).
VIIRS Flood Detection	VIIRS imager flood detection (NOAA algorithm).
HSRTV	Hyper-spectral infrared sounder retrievals of temperature and moisture profiles, cloud properties, total ozone, and surface properties.
MIRS	Microwave sounder retrievals of temperature and moisture profiles; surface properties; snow and ice cover; rain rate; and cloud/rain water paths (NOAA algorithm).
CLAVR-x	Multispectral imager retrievals of cloud properties; aerosol optical depth; surface properties; ocean properties (NOAA algorithm).
NUCAPS and NUCAPS-IASI	Hyper-spectral infrared sounder and microwave sounder retrievals of temperature and moisture profiles, cloud cleared radiances, and trace gases (NOAA algorithm).
IAPP	Infrared sounder and microwave sounder retrievals of temperature and moisture profiles, water vapor, total ozone, and cloud properties.
ACSPO	Multispectral imager retrievals of sea surface temperature (NOAA algorithm).
Sounder Quicklook	2D maps of temperature and water vapor retrievals, and Skew-T plots for individual atmospheric profiles.

3. Supported Satellites and Sensors

CSPP LEO supports processing of imager and sounder data from JPSS, Metop, NOAA, EOS, and FY-3 meteorological satellites. CSPP LEO provides atmosphere, land, and ocean products using common algorithms applied to multiple sensors. For example, SST products are available from VIIRS, MODIS, and AVHRR via a common algorithm developed by NOAA/NESDIS. HSRTV, MIRS, CLAVR-x, IAPP, and ACSPO follow this model.

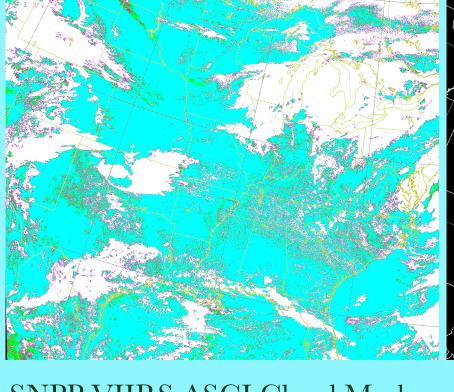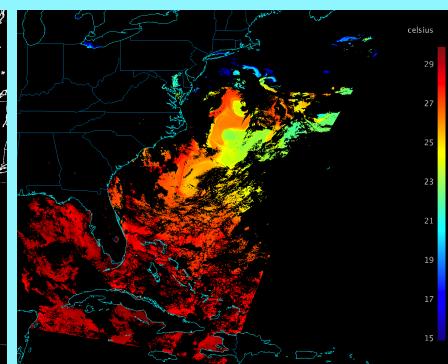| CSPP LEO Package	SNPP, NOAA-20	Metop-A/B/C	NOAA-18/19	Terra/Aqua
SDR	VIIRS, CrIS, ATMS	From AAPP & OPS-LRS	From AAPP	From SeaDAS
Polar2grid	VIIRS, ATMS	AVHRR, AMSU, MHS	AVHRR, AMSU, MHS	MODIS
VIIRS ASCI	VIIRS	N/A	N/A	N/A
VIIRS Active Fires	VIIRS	N/A	N/A	N/A
VIIRS Flood	VIIRS	N/A	N/A	N/A
HSRTV	CrIS	IASI	N/A	AIRS (Aqua only)
MIRS	ATMS	AMSU, MHS	AMSU, MHS	N/A
CLAVR-x	VIIRS	AVHRR	AVHRR	MODIS
NUCAPS	CrIS, ATMS	IASI, AMSU	N/A	N/A
IAPP	N/A	HIRS, AMSU, MHS	HIRS, AMSU, MHS	N/A
ACSPO	VIIRS	AVHRR	AVHRR	MODIS
Sounder Quicklook	CrIS, ATMS	IASI, AMSU, MHS	AMSU, MHS	AIRS (Aqua only)

4. Product Examples

NOAA-20 VIIRS True Color 2019/10/21 20:29 UTC

Metop-C IASI Temperature 2019/10/23 15:11 UTC

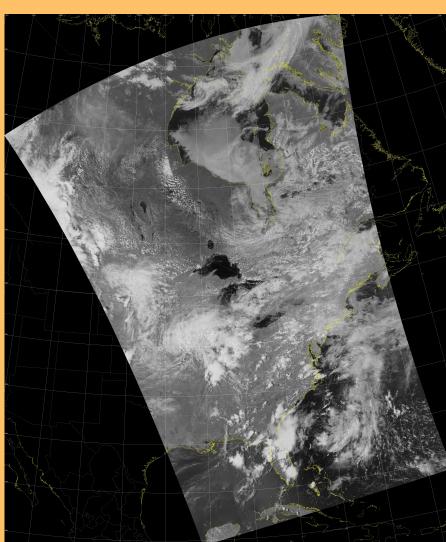Metop-C IASI Water Vapor 2019/10/23 15:11 UTC
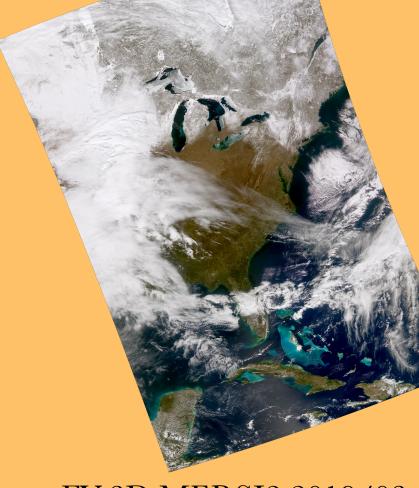
SNPP VIIRS ASCI Cloud Mask 2019/06/01 18:58 UTC

SNPP VIIRS ASCI AOT 2019/06/01 18:58 UTC

NOAA-20 VIIRS SST 2019/06/06

CSPP LEO multi-sensor software packages including HSRTV, MIRS, CLAVR-x, and ACSPO now provide support for new operational satellites including NOAA-20 and Metop-C.
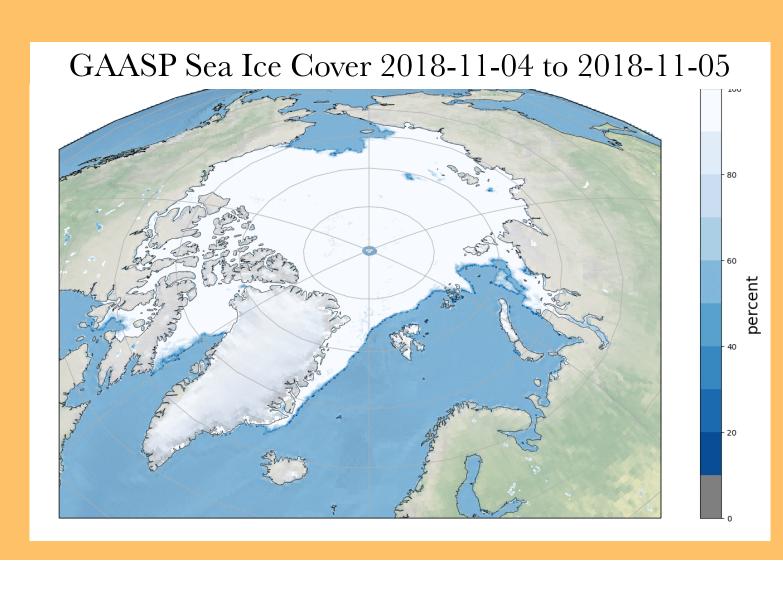
5. FY-3 Imagery and AMSR2 Products

Native support for **FY-3B/C VIRR** and **FY-3D MERSI2** Level 1B data is available in the next release of CSPP **Polar2Grid**. Image types include single bands, true color, and false color with atmosphere correction and sharpening. Overlays include coastlines and gridlines.

FY-3B VIRR 2019/06/19

FY-3D MERSI2 2019/03/12

GAASP Sea Ice Cover 2018-11-04 to 2018-11-05

The **GCOM-W1 AMSR2** Algorithm Software Package (GAASP) developed at NOAA/NESDIS is being adapted for CSPP LEO release. Products include: Precipitation Rate, SST, Sea Surface Winds, TPW, Cloud Liquid Water, Soil Moisture, Surface Type, Snow Cover, Snow Depth, Snow Water Equivalent, and Sea Ice Cover.

6. Future Development

- CSPP **SDR v3.1.2** is the current release of geolocation/calibration software for ATMS, CrIS, VIIRS. An update to v3.1.3 is imminent to support an **ATMS calibration update** (reflector emission and antenna pattern corrections). CSPP **SDR v3.2 release** will occur in December 2019 to support a **CrIS calibration update** (polarization correction).
- Since **CentOS 6** will reach end of life in Nov 2020, all new CSPP software package releases will be built on **CentOS 7** starting in January 2020.
- CSPP **VIIRS Land Surface Properties** (land surface reflectance, NDVI, EVI) will be released by the end of 2019.
- The CSPP team will soon provide documentation on how to create **containerized deployments** of CSPP packages to support continuous integration / continuous deployment workflows.
- The CSPP team will start working on SDR support for **JPSS-2** in 2020.