CSPP LEO: Status and Recent Enhancements

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What is CSPP LEO?

- The Community Satellite Processing Package (CSPP) is a collection of freely available software for processing data from Low Earth Orbit (LEO) meteorological satellites.

- CSPP LEO supports the creation of calibrated observational data, geophysical derived products, and images from visible, infrared, and microwave sensors.

- CSPP LEO is funded by NOAA JPSS Program Office.
  https://cimss.ssec.wisc.edu/cspp/

Who uses CSPP LEO?

CSPP user database on 2022-06-16 comprises 2996 registrants downloading to 107 countries

○ 1 user
○ 2 to 9 users
● 10 or more users

Features of CSPP LEO
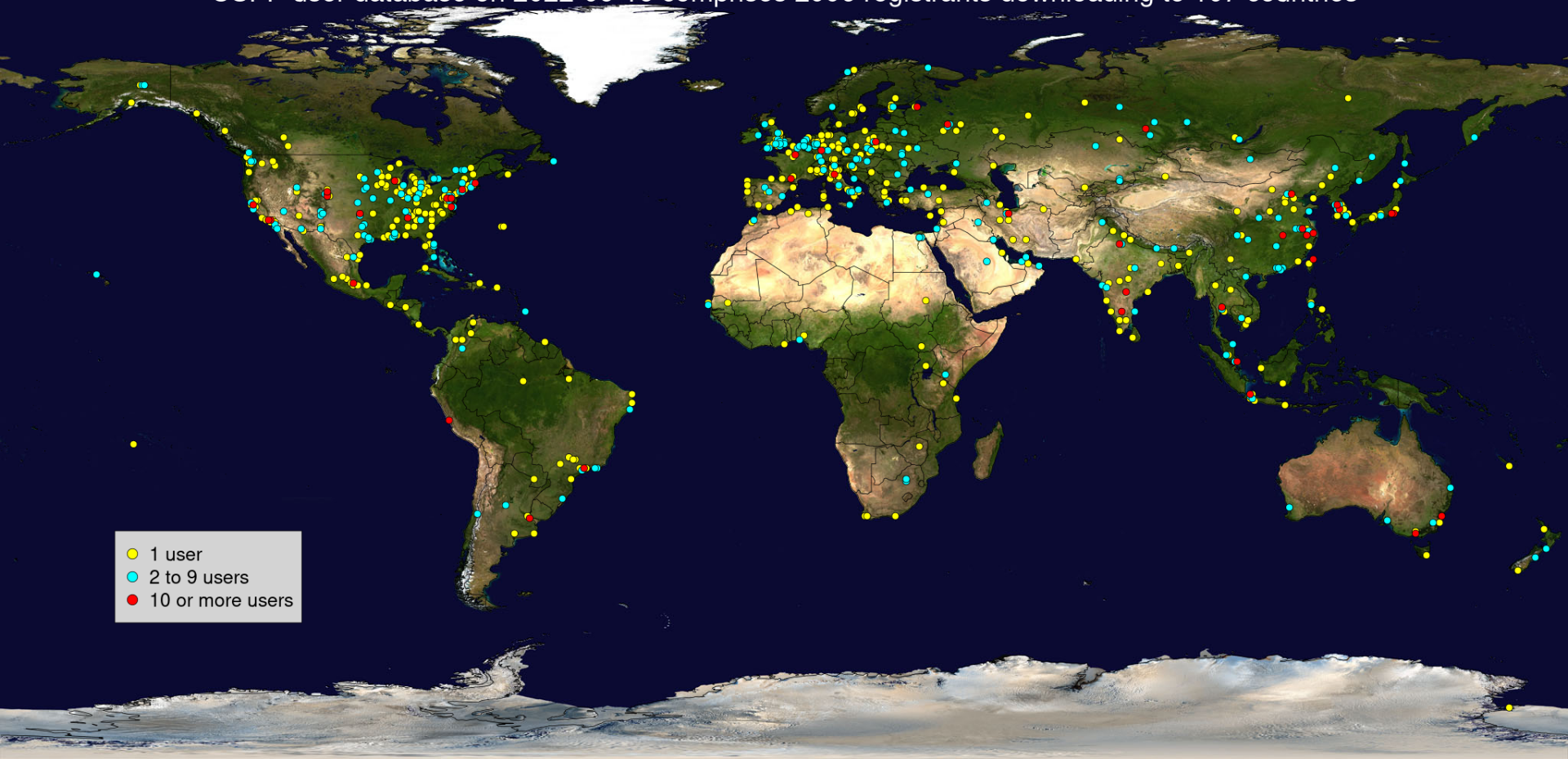
- ***Uses NOAA enterprise algorithms and software (NESDIS STAR)***

- Supports multiple satellites and sensors

- Freely available

- Ready to run on 64-bit Intel Linux

- Easy to install and operate for DB processing

- Prompt and friendly user support

CSPP LEO Satellites and Sensors

- Supported satellites and sensors:

- NOAA-20 and Suomi NPP (VIIRS, CrIS, ATMS today; OMPS coming soon)

- Metop-B/C (IASI, AMSU-A, MHS, HIRS, AVHRR)

- NOAA-18/19 (AMSU-A, MHS, HIRS)

- Terra and Aqua (MODIS, AIRS)

- GCOM-W1 (AMSR-2)

- FY-3D (MERSI-2)

CSPP LEO Products

- Sensor Data Records

  – Calibrated and geolocated VIIRS, CrIS, ATMS, and OMPS

- Imagery

  – Georeferenced single band, RGB, true color, false color in GeoTIFF, JPEG, AWIPS2, KML for many sensors and products…

- Atmosphere

  – Cloud Mask, Cloud Properties, Aerosol Optical Depth, Volcanic Ash Properties, Temperature and Moisture Profiles, Trace Gases, Precipitation, Snowfall, …

- Land

  – Active Fires, Surface reflectance, Land surface temperature, Vegetation indices, Flood detection, Snow properties, …

- Ocean

  – Sea surface temperature (consistent for VIIRS, MODIS, AVHRR)

CSPP Updates since June 2019

Major releases (8), Minor releases (8), and Patches (7) for

- Sensor Data Records (SDR)

- Polar2Grid

- Microwave Integrated Retrieval System (MiRS)

- Hyperspectral Enterprise Algorithm Package (HEAP)

- Advanced Clear Sky Processor for Oceans (ACSPO)

- Clouds from AVHRR Extended (CLAVR-x)

- VIIRS Active Fires

- VIIRS Surface Reflectance and Vegetation Indices

- VIIRS Aerosol, Snow, Cloud, Ice (ASCI)

- GCOM-W1 AMSR-2 Algorithm Software Processor (GAASP)

CSPP LEO Software Packages

CSPP Package	Product Description
Sensor Data Records	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).
VIIRS Surface Reflectance	VIIRS imager surface reflectance, NDVI, and EVI (NOAA algorithm).
HSRTV	Hyperspectral 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).
HEAP	Combined hyperspectral infrared sounder and microwave sounder retrievals of temperature and moisture profiles, cloud cleared radiances, and trace gases (NOAA algorithm).
IAPP	Combined 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).
GAASP	Microwave retrievals of ocean, precipitation, soil, and cryosphere properties (NOAA algorithm).
Sounder Quicklook	Projected 2D maps of temperature and water vapor retrievals, and Skew-T profiles for individual atmospheric profiles.

CSPP LEO Multi-Sensor Support

CSPP Software Package	SNPP, NOAA-20	Metop-B Metop-C	NOAA-18 NOAA-19	Terra	Aqua	GCOM-W1
Sensor Data Records	VIIRS, CrIS, ATMS	Provided by AAPP & OPS-LRS	Provided by AAPP	Provided by SeaDAS	Provided by SeaDAS	
Polar2Grid	VIIRS, CrIS, ATMS	AVHRR, AMSU, MHS	AVHRR, AMSU, MHS	MODIS	MODIS, AIRS	
VIIRS ASCI	VIIRS					
VIIRS Active Fires	VIIRS					
VIIRS Flood Detection	VIIRS					
VIIRS Surface Reflectance	VIIRS					
HSRTV	CrIS	IASI			AIRS	
MIRS	ATMS	AMSU, MHS	AMSU, MHS			
CLAVR-x	VIIRS	AVHRR	AVHRR	MODIS	MODIS	
HEAP	CrIS, ATMS	IASI, AMSU				
IAPP		HIRS, AMSU, MHS	HIRS, AMSU, MHS			
ACSPO	VIIRS	AVHRR	AVHRR	MODIS	MODIS	
GAASP						AMSR-2
Sounder Quicklook	CrIS, ATMS	IASI, AMSU, MHS	AMSU, MHS		AIRS	

How does CSPP LEO get NESDIS software?

1. NESDIS/STAR science team (e.g., Sea Surface Temperature) delivers software to NESDIS Algorithm Scientific Software Integration and System Transition Team (ASSISTT).

2. ASSISTT prepares a Delivery Algorithm Package for deployment in NOAA operational processing stream.

3. ASSISTT also builds and tests the Delivery Algorithm Package on a CSPP LEO server.

4. CSPP LEO team verifies that the DAP build and test is reproducible.

5. CSPP LEO team prepares the CSPP version of the DAP.

Note: CSPP SDR follows a different model (CSPP LEO team starts with the ADL code from OSPO FTS Web Portal).

VIIRS Active Fires: New Feature

The VIIRS I-Band 375 m Active Fire product now includes an array (FP_PersistentAnomalyCategory) consisting of flags that indicate the presence of potential false fire detections.

0 – no persistent anomaly

1 – oil or gas flare

2 – volcano

3 – solar panel (empirically determined, CONUS only)

4 – urban (currently not used)

5 – unclassified (empirically determined)

CSPP SDR support for JPSS-2

- CSPP LEO team has built and tested the latest version of the ADL SDR software that includes support for JPSS-2.

- The format of the CSPP SDR software package will remain the same as it is today. The only change will be separate LUT downloads for each satellite.

- Support has been added for OMPS SDR processing.

- CentOS 7 or higher will be required.

- Public release of CSPP SDR software supporting JPSS-2 will occur after launch (within 3 months).

Containers and CSPP

We have released several CSPP packages where the software is encapsulated in a Singularity container (ACSPO v2.0, HEAP v2.0, MiRS v3.0).

We have developed a workflow for encapsulating CSPP SDR in a Singularity container (but this is not widely available yet).

Singularity is also known as "Apptainer". Compatible with Docker. Runs in rootless mode. Users are the same inside and outside the container.

Benefit to the user: better portability (e.g., run on Ubuntu, Debian, SUSE), fewer system requirements, and smaller disk footprint.

Benefit for the developers: scripted, reproducible, version controlled build process.

CSPP SDR 3.3 native vs. container

- Native installation: 69 GB

- Singularity container installation: 17 GB

- Singularity version is ready to run at time of installation (no initial setup step).

- Software stack is immutable (can't be modified) and is therefore more reliable.

Containerized SDR benchmarks

We ran benchmarks to demonstrate rapid VIIRS, CrIS, and ATMS processing using containerized CSPP SDR on a high performance server (2 x AMD EPYC 24-core CPUs, 384 GB RAM, SSD filesystem).

CSPP SDR v3.2 was packaged in a Singularity container and configured to use 16 cores at runtime.

NOAA-20 HRD dataset from 2021/05/13 18:59 - 19:11 UTC (approximately 720 seconds).

Processing time
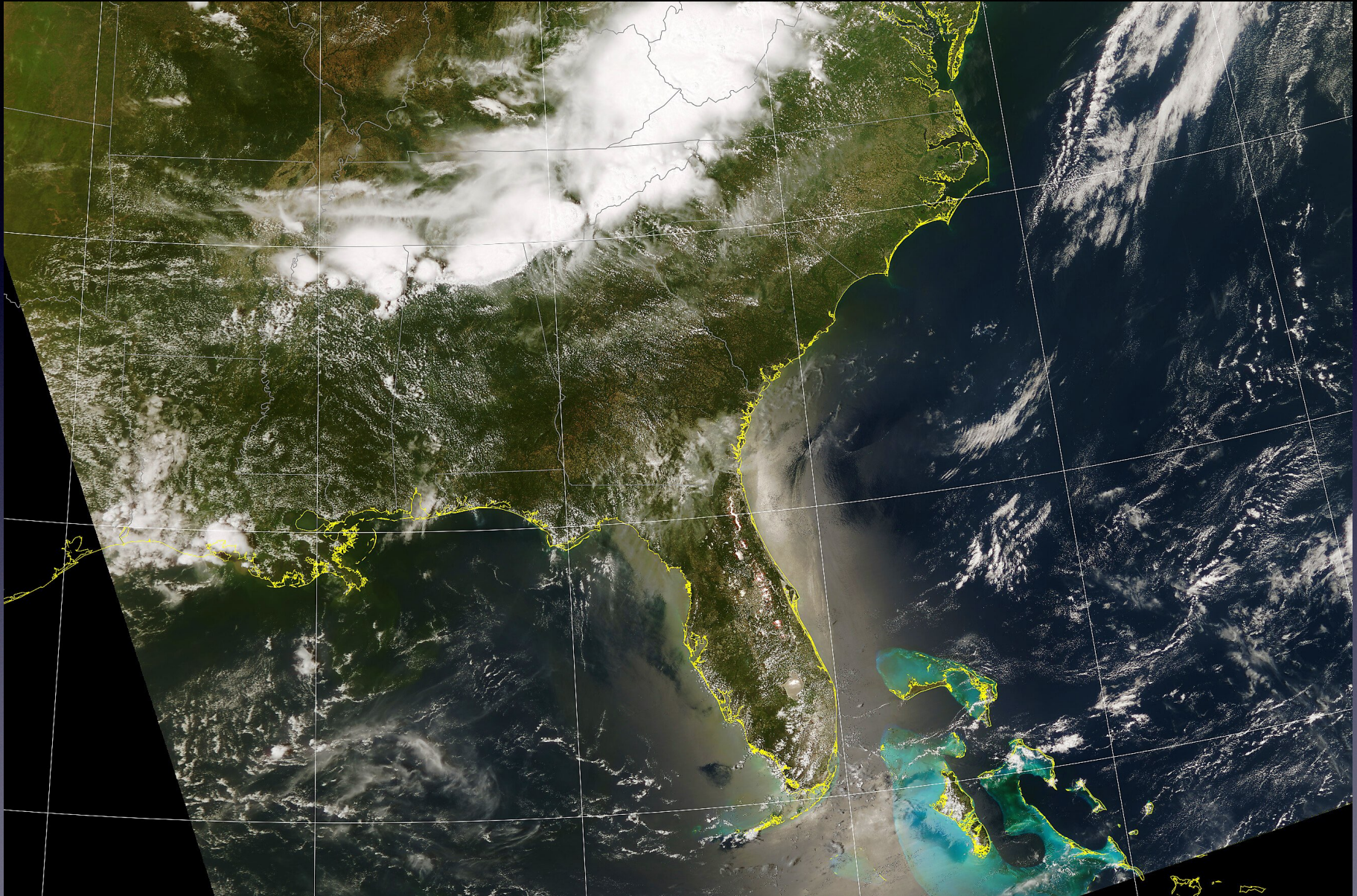
ATMS: 11 seconds

CrIS: 113 seconds
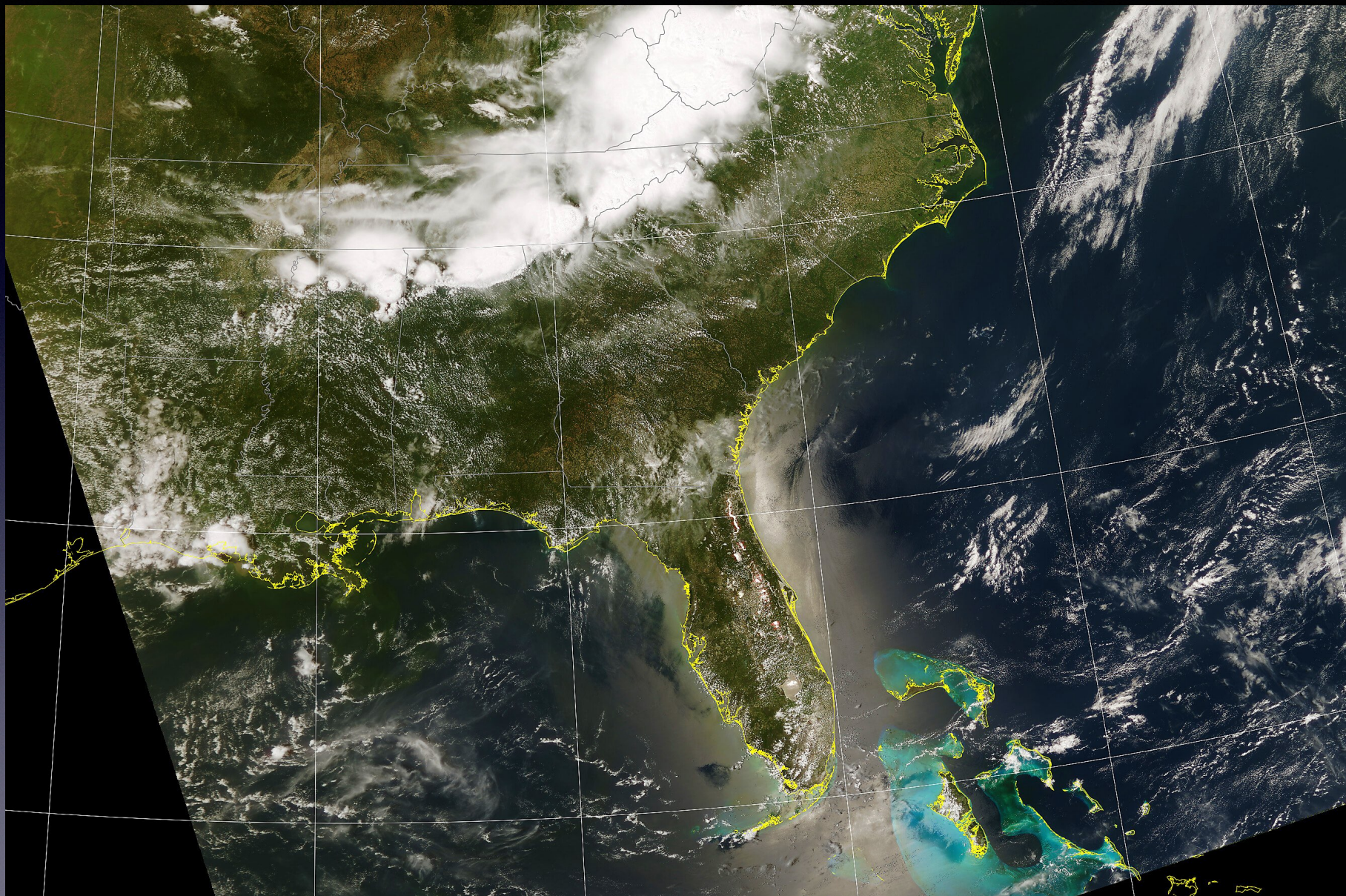
VIIRS: 130 seconds

Operating system support

- Current CSPP packages are built, tested, and supported on CentOS 7.

- CentOS 7 is now in maintenance mode; it will stop receiving updates in June 2024.

- CSPP SDR v4.0 (supporting JPSS-2) will be the last CSPP LEO major software release built on CentOS 7.

- ***Future CSPP LEO major releases will be built, tested, and supported on Rocky Linux 8.***

Recommended server specifications

- Starting in late 2022, there will be 3 satellites in the JPSS orbit plane (SNPP, NOAA-20, NOAA-21). Initial separation could be 25 minutes.

- You will want to avoid processing two passes simultaneously (VIIRS, CrIS, ATMS).

- Recommended server specs are 64 cores (Intel or AMD), 256 GB RAM, SSD for scratch/work space, and Rocky Linux 8.
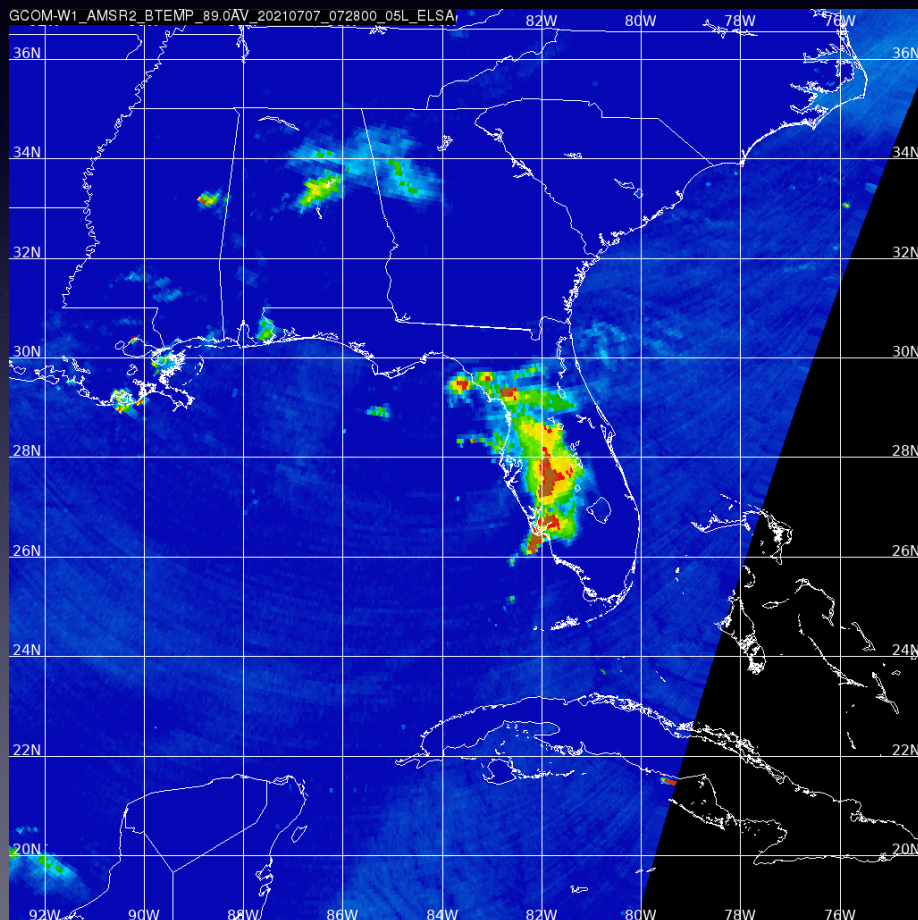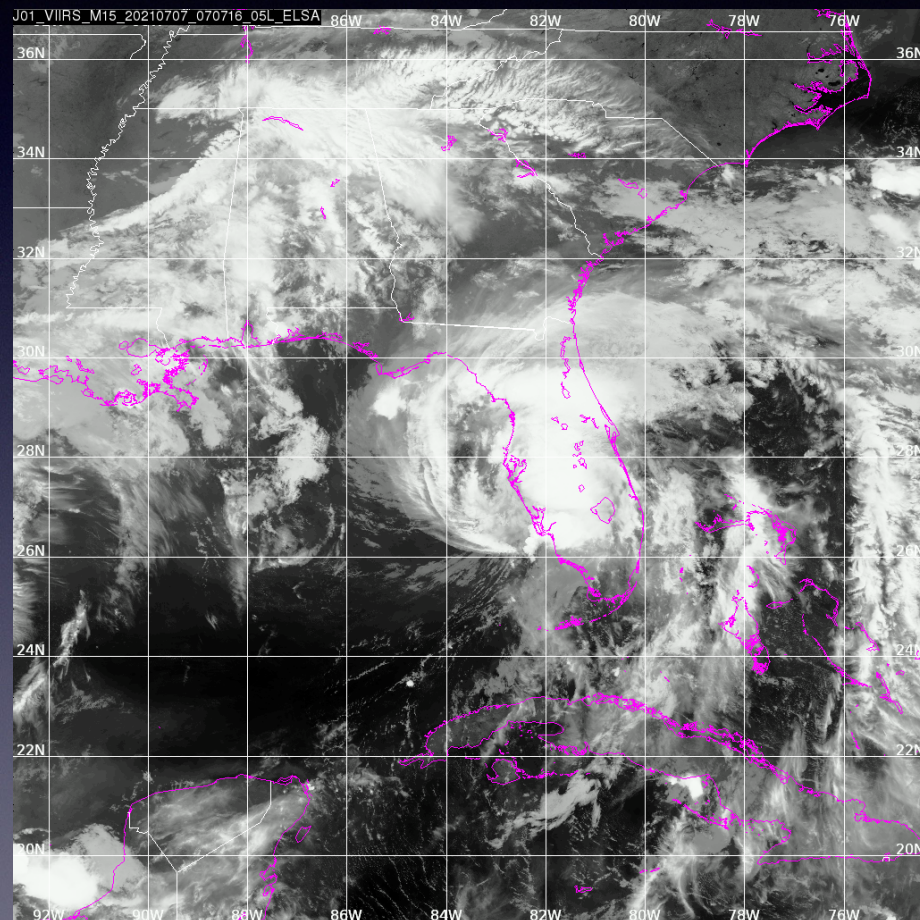
Polar2Grid automatic storm-centered imagery received/processed at AOML Miami
Tropical Storm Elsa 2021/07/07

GCOM-W1 AMSR2 89GHz

NOAA-20 VIIRS INFRARED

Summary

- CSPP LEO continues to support the global DB community with updated software and new products.

- We look forward to supporting JPSS-2 launch and operations.

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

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