Installation Instructions for the Community Satellite Processing Package (CSPP) VIIRS Cryosphere Environmental Data Record (EDR) Products BETA Version 1.0

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Section 1: Introduction

1.1 Overview

This document provides instructions for installing and operating the Community Satellite Processing Package (CSPP) release of the NOAA/NESDIS/STAR JPSS CRYOshpere Enterprise Environmental Data Record (EDR) software. This software is used for creating VIIRS Cryosphere Products (Ice Age, Ice Thickness, Ice Concentration and Ice Surface Temperature) from daytime and nighttime direct broadcast NOAA-21, NOAA-20 and Suomi-NPP Sensor Data Record (SDR) and Atmosphere EDR inputs. NOAA archived files can also be used as input.

The VIIRS EDR software package includes binary executable files, supporting static data files, and input and output files for verifying a successful local installation. This CSPP release (VIIRS CRYO Version 1.0) offers NOAA VIIRS EDR Software for retrieving VIIRS Versions 3.2, 3.3 Ice Products, adapted and tested for real-time direct broadcast environments. It supersedes the Cryosphere Products previously created as part of the CSPP ASCI package.

The JPSS program worked with the CSPP team to integrate the JPSS processing framework enterprise algorithms into standalone executables. These can be executed through simple CSPP bash shell and Python scripts. The output files are identical in naming, format (NetCDF), and structure to the corresponding NOAA archived files. For algorithm and product descriptions for NOAA JPSS EDRs, visit:

https://www.star.nesdis.noaa.gov/jpss/Docs.php#S647549

The VIIRS CRYOsphere EDR software is distributed through the CSPP website at:

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

You can also download software, test data, and documentation from this site. For questions or comments about CSPP, please use the ‘Contact Us’ form on the website.

1.2 CSPP Cryosphere Software Features

This software replaces the Cryosphere Products created in previous CSPP VIIRS ASCI releases. It has been preceded by the CSPP VIIRS ATMOSphere EDR software and will be followed by CSPP VIIRS Land EDR software releases.

The CSPP software includes the following features:

- **Simple Execution**: Easily run through the main bash shell script, `cspp_cryo.sh`.
- **Multi-Core Processing**: Supported via the `-p` option for faster performance.
- **Compatibility**: Designed to work with VIIRS SDRs created by CSPP SDR v4.1 and higher, and CSPP ATMOS version 1.0 products. Ensure your versions are up-to-date before running CSPP VIIRS CRYO v1.0 software.

1.3 System Requirements

System requirements for the CSPP VIIRS CRYO EDR software are as follows:

- Intel or AMD CPU with 64-bit instruction support,
- 16 GB RAM,
- Rocky Linux 8.10 the software has also been tested on Rocky Linux release 9.4,
- 5 GB disk space (minimum),
- Internet connection (for downloading dynamic ancillary data).

Linux terminal commands included in these instructions assume the bash shell is used.

1.4 Disclaimer

Original scripts and automation included as part of this package are distributed under the GNU GENERAL PUBLIC LICENSE agreement version 3. Binary executable files included as part of this software package are copyrighted and licensed by their respective organizations, and distributed consistent with their licensing terms.

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1.5 Input Data Requirements

1.5.1 VIIRS Sensor Data Records (SDRs)

VIIRS NOAA-21, NOAA-20 or Suomi-NPP SDR files in standard JPSS HDF5 format are required as input to the CSPP VIIRS CRYO EDR processing software. The CSPP VIIRS CRYO software can ingest SDR files in HDF5 format from direct broadcast systems, either aggregated or unaggregated, as well as the NOAA Open Data Dissemination (NODD) access points on Amazon Web Services or Google Cloud, or the NOAA CLASS archive.

The following VIIRS M-bands (SVM*) are required by the CRYOsphere software, as well as the M-band terrain corrected geolocation files (GMTCO*) Sensor Data Record (SDR) files.

VIIRS M-Band HDF5 files - SVM01, SVM03, SVM05, SVM07, SVM10, SVM15, SVM16
VIIRS M-Band Terrain Corrected Geolocation HDF5 files – GMTCO*.h5

with naming conventions:

```
<prod>_<sat>_dYYYYMMDD_tHHmmSSS_eHHmmSSS_bXXXXX_cYYYYMMDDHHmmSSSSSSS_<*>.h5
```

Where:

`prod` is the product name: (for example `SVM01 or GMTCO`)
`sat is the satellite name:` `npp, j01, j02`
`dYYYYMMDD` is the observation date of the first scan of data
`tHHmmSSS` is the observation time of the first scan of data
`bXXXXX` `XXXXX` is the orbit number of the first scan of data
`cYYYYMMDDHHmmSSSSSSS` is the creation date and time of the file in microseconds.

All times are in Universal Time Coordinated (UTC)

1.5.2 VIIRS Atmosphere EDR Products

CSPP CRYO also requires two VIIRS Atmosphere EDR products as input. These are created using the CSPP VIIRS ATMOS software which can be acquired through the CSPP distribution website:

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

These products must match the satellite, date and time for each input SDR granule.

The required inputs are listed in Table 1.

Table 1: CSPP VIIRS CRYOsphere Required Atmosphere EDR Product Files

CSPP ASCI EDR Product	File Name Pattern
VIIRS Cloud Mask	JRR-CloudMask_v3r2_*.nc
VIIRS Cloud Height	JRR-CloudHeight_v3r2_*.nc

with naming conventions:

```
<prod>_<version>_<sat>_sYYYYMMDDHHmmSSS_eYYYYMMDDHHmmSSS_cYYYYMMDDHHmmSSS.nc
```

Where:

`prod` is the product name: `(JRR-CloudMask or JRR-CloudHeight)`
`version is the NOAA software version number`
`sat is the satellite name: npp, j01 or n21`
`sYYYYMMDDHHmmSSS` is the observation date and time of the first scan of data
`eYYYYMMDDHHmmSSS` is the observation date time of the last scan of data
`cYYYYMMDDHHmmSSSSSSSS` is the creation date and time of the file.

All times are in Universal Time Coordinated (UTC)

All required VIIRS ATMOS EDR files must be located in a single directory, which is then provided to the software as an argument. Both SDR and EDR files should be located in the same directory.

Section 2: Installation of the CSPP VIIRS CRYOsphere (CRYO) EDR Software

2.1 Overview

This software package contains the CSPP VIIRS CRYO Version 1.0 Software for creating VIIRS Ice Environmental Data Record (EDR) products from input NOAA-21, NOAA-20 and S-NPP direct broadcast or archived VIIRS Sensor Data Records (SDRs) and VIIRS Atmosphere EDRs.

2.2 Installation

Download the following files from the CSPP website: https://cimss.ssec.wisc.edu/cspp/

```
CSPP_VIIRS_CRYOS_V1.0_BETA.tar.gz
CSPP_VIIRS_CRYO_V1.0_STATIC_BETA.tar.gz
```

Next, unpack the tarfiles. Make a CSPP directory and install the software as follows (a new directory named `CSPP_CRYO_1_0` will be created):

```
mkdir CSPP
```

```
cd CSPP
tar xf ../CSPP_VIIRS_CRYO_V1.0_BETA.tar.gz
tar xf ../CSPP_VIIRS_CRYO_V1.0_STATIC_BETA.tar.gz
```

Set the `CSPP_VIIRS_CRYO_HOME` environment variable to the name of the directory where CSPP CRYO software was installed ($HOME in the example below):

```
export CSPP_VIIRS_CRYO_HOME=$HOME/CSPP/CSPP_CRYO_1_0
```

CSPP VIIRS CRYO is now ready to use. Execute the main driver script now with no arguments:

```
${CSPP_VIIRS_CRYO_HOME}/bin/viirs_cryo.sh
```

If the installation has been successful to this point, you will be presented with CSPP VIIRS CRYO command line switches and options.

To execute commands without including the preceding directory path, or if executing through a script in its own background environment, then set the path to include the /bin directory:

```
export PATH=$PATH:$CSPP_VIIRS_CRYO_HOME/bin
```

To verify your installation, download the test data tar file:

```
CSPP_VIIRS_CRYO_V1.0_TEST_DATA.tar.gz
```

The test data should be unpacked in a directory separate from the CSPP CRYO installation, e.g.,

```
cd $HOME
tar xf CSPP_VIIRS_CRYO_V1.0_TEST_DATA.tar.gz
```

This will create a `viirs_cryo_test_data` directory containing input and output files for verification of a successful installation.

Section 3: VIIRS CRYOsphere EDR Software

This section describes how to create the VIIRS Cryosphere products using the CSPP VIIRS CRYO software.

3.1 Executing the CSPP VIIRS CRYOsphere Run Script

The principal script is `CSPP_CRYO_1_0/bin/viirs_cryo.sh`, which operates by default in the current directory. The only required argument is the full path and directory containing all required input data, as described in Section 1.5. All required inputs must be located or linked into the same directory. The algorithm is implemented for all illuminations (both daytime and nighttime).

When the driver script is invoked, it de-aggregates the input SDRs if necessary, creates temporary working directories for each granule, ensures all required inputs are provided, generates soft links and intermediate files, and then creates the final NetCDF product file(s). The temporary directories and intermediate files are removed upon completion by default.

An example execution is:

```
viirs_cryo.sh /data/sdr/viirs
```

Executing this command will result in the creation of all of the CSPP VIIRS CRYO EDR products from all input VIIRS SDR and required ATMOS EDR files found in the `/data/sdr/viirs` directory, with the processing taking place in the current directory. The output products are at VIIRS M-Band spatial resolution (750 m).

There are are a number of options available to the CSPP VIIRS CRYO EDR run script,

`${CSPP_VIIRS_CRYO_HOME}/bin/viirs_cryo.sh`

For a complete list of execution options, type `viirs_cryo.sh -h`

```
Create VIIRS Cryosphere products.

Usage: viirs-cryo [OPTIONS] <inputs>...

Arguments:
  <inputs>...  Directories containing VIIRS SDR and EDR input files.
Options:
     -W, --work <PATH>    Directory in which all activity occurs, defaults to
                           current directory.
     -v[vv]               Sets the level of verbosity.
     -d                   Always retain intermediate files.
     -p <processors>      Specify the number of processors to use.
     -h, --help           Print help.
     -V, --version        Print version.
```

The output products along with key parameters per product file are listed below. All products will be made with each execution. All products are created for all inputs, even if the output granules only contain arrays of Fill Values.

Table 2: CSPP CRYOsphere Output Key Parameters and Output File Prefixes

Key VIIRS Products	Internal Array Names	Output Filename Prefix (*.nc)
Ice Age, Ice Thickness	IceAge, IceThickness	JRR-IceAge
Ice Concentration, Ice Surface Temperature	IceConc, IceSrfTemp	JRR-IceConcentration

The number of output NetCDF files will match the number of input SDR granules one-to-one. The output product files will always be un-aggregated individual granule product files, even if the input SDRs are aggregated.

Examples Executions:

```
viirs_cryo.sh -p 4 ../viirs_sdr/data

viirs_cryo.sh -p 2 -W /data2/viirs/working /data/my_data/input

viirs_cryo.sh -vv -d -p 8 -W /scratch/temp /input/viirs_edr
```

3.2 Running the VIIRS CRYOsphere Test Case

To confirm a successful CSPP VIIRS CRYO local installation, unpack the test data as described in Section 2.2. and then execute the commands below.

```
cd viirs_cryo_test_data
mkdir work
cd work
${CSPP_VIIRS_CRYO_HOME}/bin/viirs_cryo.sh -p 4 ../input
```

In this test, we are executing the CSPP VIIRS CRYO EDR algorithms on the input test 10 granule direct broadcast NOAA-21 overpass acquired on 24 February 2025, beginning at 17:11 UTC. The test data consists of daytime granules. The output files for a local test run are shown below. Note that there will be a different creation date/time section of the filename for your own local execution.

JRR-IceAge_v3r2_n21_s202502241711139_e202502241712386_c202504211957370.nc
JRR-IceAge_v3r2_n21_s202502241712398_e202502241714027_c202504211957371.nc
JRR-IceAge_v3r2_n21_s202502241714039_e202502241715286_c202504211957371.nc
JRR-IceAge_v3r2_n21_s202502241715298_e202502241716545_c202504211957370.nc
JRR-IceAge_v3r2_n21_s202502241716558_e202502241718186_c202504211957461.nc
JRR-IceAge_v3r2_n21_s202502241718199_e202502241719445_c202504211957465.nc
JRR-IceAge_v3r2_n21_s202502241719458_e202502241721104_c202504211957467.nc
JRR-IceAge_v3r2_n21_s202502241721117_e202502241722346_c202504211957491.nc

JRR-IceAge_v3r2_n21_s202502241722358_e202502241724005_c202504211957550.nc
JRR-IceAge_v3r2_n21_s202502241724017_e202502241725264_c202504211957564.nc

JRR-IceConcentration_v3r3_n21_s202502241711139_e202502241712386_c202504211957370.nc
JRR-IceConcentration_v3r3_n21_s202502241712398_e202502241714027_c202504211957371.nc
JRR-IceConcentration_v3r3_n21_s202502241714039_e202502241715286_c202504211957371.nc
JRR-IceConcentration_v3r3_n21_s202502241715298_e202502241716545_c202504211957370.nc
JRR-IceConcentration_v3r3_n21_s202502241716558_e202502241718186_c202504211957461.nc
JRR-IceConcentration_v3r3_n21_s202502241718199_e202502241719445_c202504211957465.nc
JRR-IceConcentration_v3r3_n21_s202502241719458_e202502241721104_c202504211957467.nc
JRR-IceConcentration_v3r3_n21_s202502241721117_e202502241722346_c202504211957491.nc
JRR-IceConcentration_v3r3_n21_s202502241722358_e202502241724005_c202504211957550.nc
JRR-IceConcentration_v3r3_n21_s202502241724017_e202502241725264_c202504211957564.nc

The products are Ice Age, which also includes an Ice Thickness array, and Ice Concentration, which also includes an Ice Surface Temperature Array. For each input SDR granule, one file of each product is created. If the VIIRS CRYO EDR processing script runs normally, it will return a status code equal to zero. If the VIIRS CRYO EDR processing script encounters a fatal error, it will return a non-zero status code. Using 4 cores, the software should complete processing in less than 1 minute on modern computers.

To verify your output files against the benchmark output files, execute the following commands:

```
cd ..
./viirs_cryo_compare.bash noaa_edr/ work/
```

This script compares the contents of key parameters in the Cryosphere EDR files for all granules. The number of differences found will be printed. There should be few, if any differences.