

Easy Access to the VIIRS Science Raw Data Record

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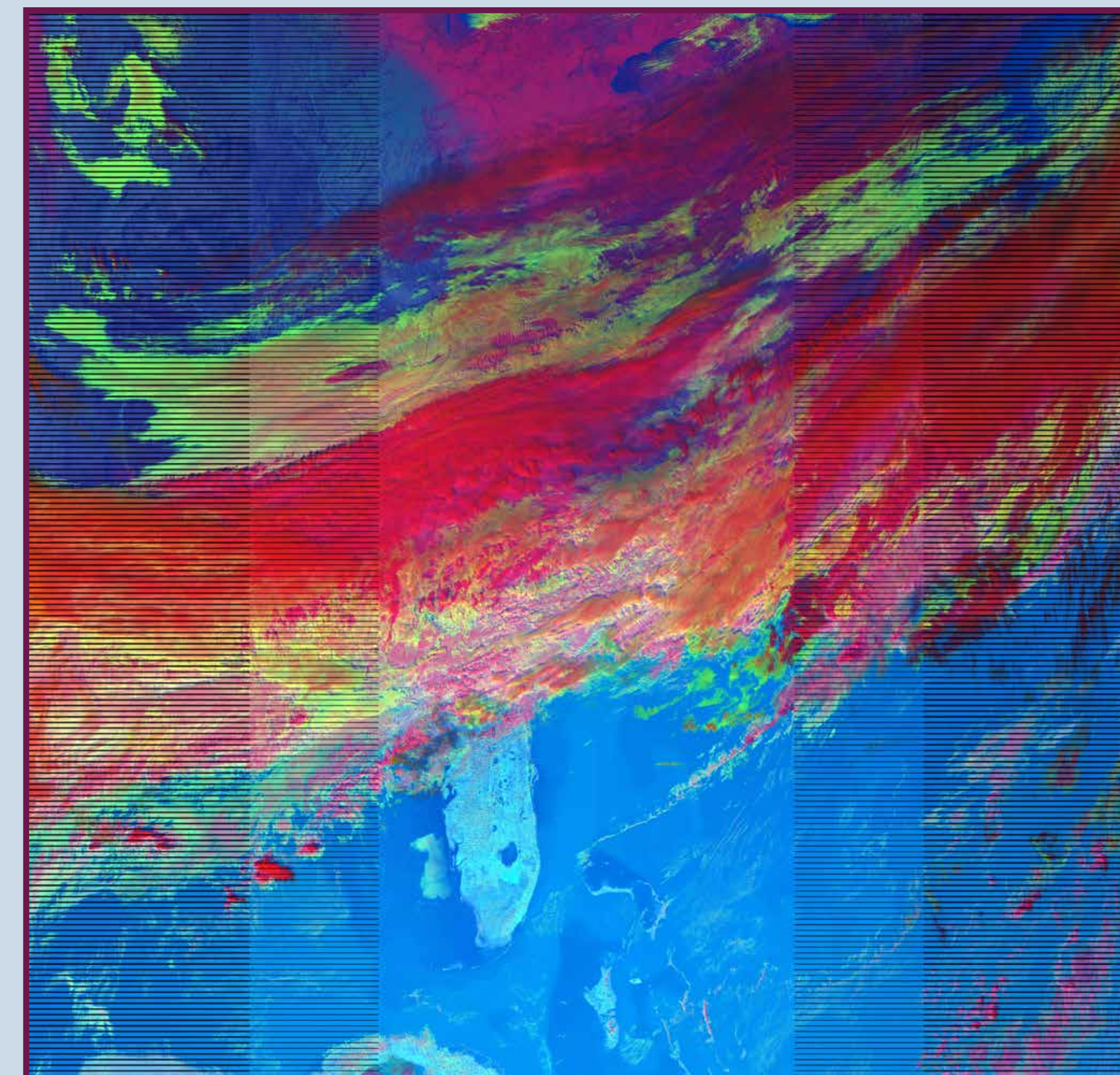
Introduction

The Climate Raw Data Record (C-RDR) Project at NOAA's National Climatic Data Center (NCDC), under the auspices of the Climate Data Record Program (CDRP), is producing a NOAA Level 1b (NASA level 1a) dataset for the VIIRS instrument on the Suomi National Polar-orbiting Partnership (SNPP) satellite. A Level 1b dataset contains "unprocessed data at full resolution, time-referenced, and annotated with ancillary information including data quality indicators, calibration coefficients and georeferencing parameters." [FGDC-STD-012-2002] This dataset is being produced operationally and is being archived and made available for public use.

The NOAA Interface Data Processing Segment (IDPS) produces Raw Data Record (RDR), Sensor Data Record (SDR), and Environmental Data Record (EDR) datasets for the VIIRS instrument. The RDR dataset is processed to NOAA Level 1a (NASA level 0), and it contains time-sequenced and indexed Consultative Committee for Space Data Systems (CCSDS) Space Packets containing the VIIRS engineering and science data. The contents of the CCSDS Space Packets have not been unpacked at this level.

The SDRs contain data that has undergone calibration transformations, some of which are complex, and the engineering data that was used in the operations have not been preserved within the datasets. As a result, those who wish to use different calibration values or algorithms must start from the VIIRS Science RDR, which is complex to use and requires a significant custom code base.

Those who want to do diagnostic studies of the VIIRS instrument have to deal with the same issues as those who wish to produce their own SDRs or EDRs from scratch. The VIIRS C-RDR solves these problems by providing an easy to use source for the raw science and engineering measurements.



False-color image created from the raw band 5, 4, and 2 (used as blue, green, and red, respectively) 375 m resolution pixels extracted from the VIIRS C-RDR file with a start time of 18:24:51 GMT, January 28, 2014.

How Is the VIIRS C-RDR Produced?

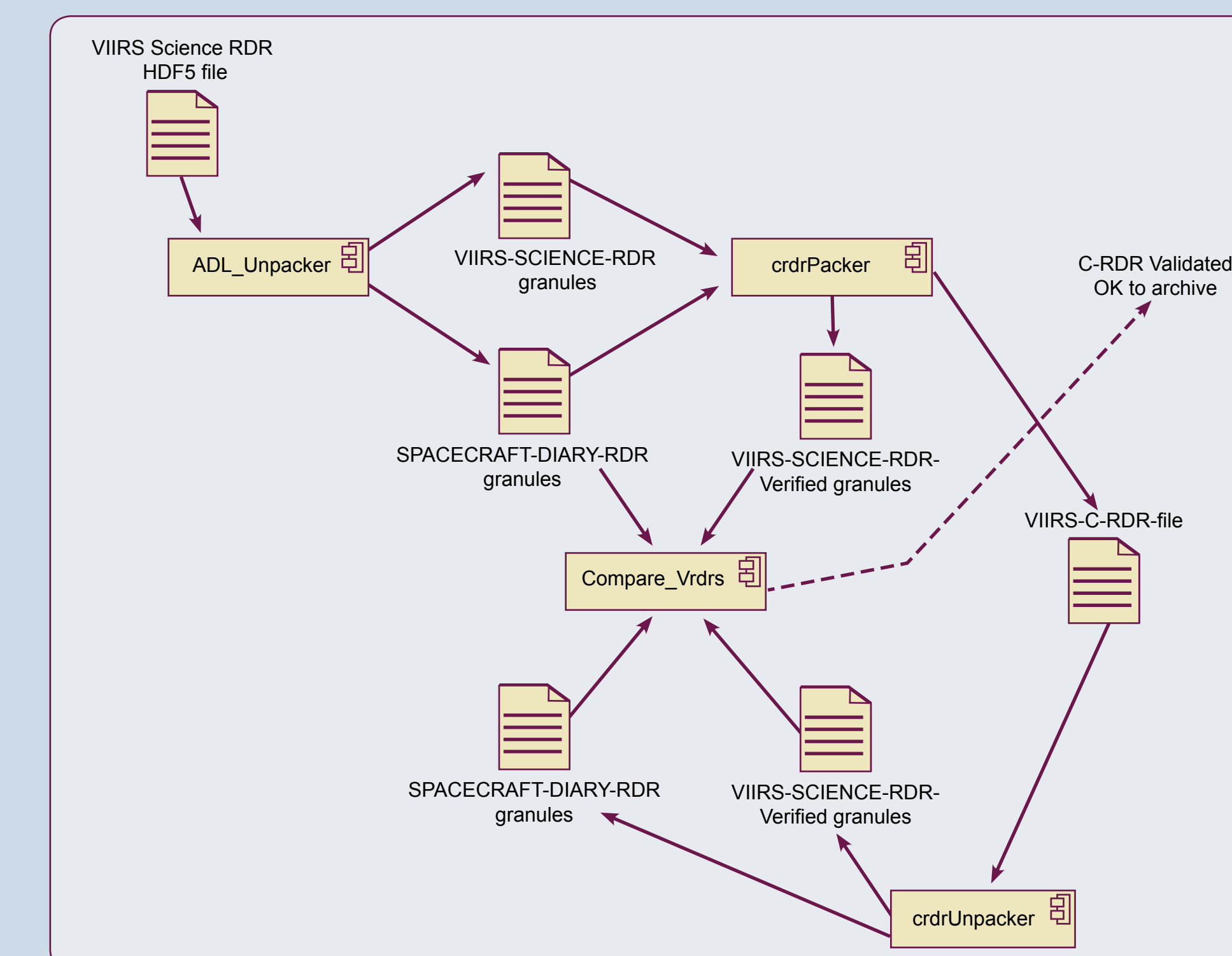
The VIIRS C-RDR is produced by applications developed using the Application Development Library (ADL). ADL provides the data structures and processing framework needed to marshal the VIIRS-SCIENCE-RDR and SPACECRAFT-DIARY-RDR granule inputs. It is generated on a continuous operational basis as files are obtained by subscription from NOAA's Comprehensive Large Array-data Stewardship System (CLASS). The processing includes validation of each VIIRS C-RDR file as part of the workflow.

As each VIIRS Science RDR HDF5 file is obtained from CLASS, it is unpacked into VIIRS-SCIENCE-RDR and SPACECRAFT-DIARY-RDR granule files with accompanying ASCII metadata. The crdrPacker application then reads the granule files, organizes the information into time series arrays, and writes them as variables to a C-RDR file. One VIIRS C-RDR file nominally contains four granules of VIIRS Science RDR data.

The crdrPacker application also produces a set of VIIRS-SCIENCE-RDR-Verified (VRDR) granule files with associated ASCII metadata - one for each VIIRS-SCIENCE-RDR granule. The VRDR granules are the inputs used by all of the IDPS VIIRS SDR algorithms.

The crdrUnpacker application uses the VIIRS C-RDR file just produced to create VRDR and SPACECRAFT-DIARY-RDR granule files with accompanying metadata. The SPACECRAFT-DIARY-RDR granules files and metadata should be identical to those extracted from the VIIRS Science RDR HDF5 file, and the VRDR granule files and metadata should be identical to those produced by the crdrPacker application.

If the VRDR and Spacecraft Diary RDR files are found to match one another, the VIIRS C-RDR file is considered to be validated and is submitted to the archive system for long-term storage and public access.



What Does the VIIRS C-RDR Contain?

The VIIRS C-RDR contains raw, unpacked engineering and science data from VIIRS Science RDR granules, along with satellite position, velocity, attitude, and operation state data from associated Spacecraft Diary RDR granules, stored as time-series variables in Network Common Data Form 4 (netCDF-4) files. The netCDF-4 format is platform-independent, binary, hierarchical, and self-describing. Each variable within a VIIRS C-RDR file is annotated with a description of the measurement it contains, information about the source, and specifications of valid limits and fill values.

The image data, which were differentially encoded and compressed using the RICE algorithm by the VIIRS on-board processing, are decompressed, decoded, and stored as multi-band images in the VIIRS C-RDR files. Each VIIRS C-RDR file also contains 70 elements of file-level metadata conforming to the Climate and Forecast (CF) metadata conventions, the Attribute Convention for Dataset Discovery (ACDD), and the JPSS RDR/SDR metadata standards.

The measurements inside a VIIRS C-RDR file are organized into groups of measurements that share a common type or theme.

VIIRS C-RDR Variable Groups		
Group	Number of Variables	Description
Quality_Measures	4	Per-scan counts of missing packets, bad check-sums, and discarded packets, and the per-scan RDR quality measure.
Engineering_Data	242	All the raw VIIRS engineering measurements with time stamps.
Image_375m	8	The raw earth view and calibration view for the 5 VIIRS imaging-resolution bands, along with time stamps and band control words.
Image_750m_DualGain	10	The raw earth view and calibration view for the 7 VIIRS dual-gain moderate-resolution bands, along with gains, time stamps, and band control words.
Image_750m_SingleGain	8	The raw earth view and calibration view for the 9 VIIRS single-gain moderate-resolution bands, along with time stamps and band control words.
Image_DayNight	12	The raw earth view and calibration view for the VIIRS day/night band, along with time stamps, aggregation mode, active sample counts, and band control words.
Spacecraft_Diary	10	The satellite position, velocity, and attitude vectors, a selection of housekeeping telemetry elements, and accompanying time stamps.
Spacecraft_Diary/ADCS_Hous_keeping_Telemetry	3	Full APID 8 packets, along with the packet sequence counter and fill percentage metadata.
Spacecraft_Diary/Bus_Critical_Telemetry	3	Full APID 0 packets, along with the packet sequence counter and fill percentage metadata.
Spacecraft_Diary/Ephemeris_Attitude_Telemetry	3	Full APID 11 packets, along with the packet sequence counter and fill percentage metadata.

Where Can I Get VIIRS C-RDR Files?

VIIRS C-RDR files can be obtained from the NCDC Hierarchical Data Storage System (HDSS) Access System (HAS). The current holdings start from October 19, 2013, with plans to extend them back to the beginning of VIIRS science mode operation. HAS allows you to search for and order VIIRS C-RDR files based on time. (See the "For more information" section at the end.)

How Do I Read a VIIRS C-RDR File?

Accessing the measurements within a VIIRS C-RDR file is quite straightforward. Since the netCDF-4 format is built on top of the HDF5 format, existing applications that can read either netCDF-4 or HDF5 files can be used to read VIIRS C-RDR files. As an example, IDL and MATLAB both support these formats. The HdfView application produced by the HDF Group can also be used to access and view the contents.

If you are going to write your own application, it takes only a few lines of code to open and read the contents of a variable from a VIIRS C-RDR file. NetCDF-4 and/or HDF5 libraries are available for many languages (C, C++, FORTRAN, Java, and python to name a few). The process is similarly straightforward in other languages.

```
import ucar.nc2.*;
import ucar.ma2.*;

...
// Open the VIIRS C-RDR file.
//
NetcdfFile oDataFile = NetcdfFile.open(sInputFilePath, null);

// Find the calibration view variable for the 750 m dual-gain
// image group. This variable has dimensions of band, calibration
// source, line number, and number of samples.
//
Variable oVar = oDataFile.findVariable("Image_750m_DualGain/calibview");

// Get the dimensions of the variable.
//
int[] anCounts = oVar.getShape();

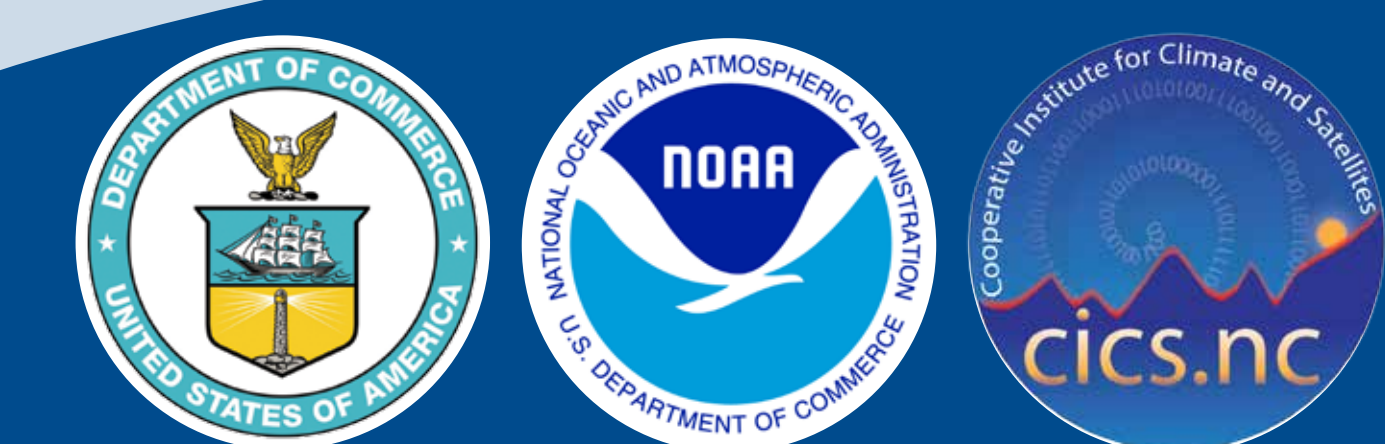
// Create an array of start indices. They all have the value
// index value of zero.
//
int[] anStarts = new int[anCounts.length];

// Read the values from the variable.
//
Array oValues = oVar.read(anStarts, anCounts);
...

```

Info

For More Information
If you would like to know more about the VIIRS C-RDR, you can go to its NCDC product page at:
<http://www.ncdc.noaa.gov/data-access/satellite-data/satellite-data-access-datasets/c-rdr-viirs>
This page provides links to the data access portal, documentation, and a demonstration Java application that can be used to investigate a VIIRS C-RDR file once you download it. You can also go directly to the HAS data access portal at:
http://has.ncdc.noaa.gov/pls/plhas/HAS.FileAppSelect?datasetname=3658_01



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NOAA's National Climatic Data Center Asheville, North Carolina

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