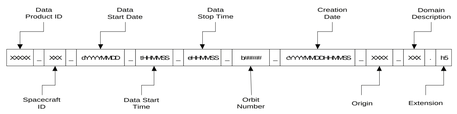
National Polar-orbiting Operational Environmental Satellite System (NPOESS)

Interface Data Processing Segment

NPOESS Data Products

NPOESS Data Products are formatted in HDF5. They are delivered to four weather centrals (NESDIS, AFWA, FNMOC, and NAVO) and the Comprehensive Large Array-data Stewardship System* (CLASS). NPOESS products are classified as Raw Data Records (RDRs), Sensor Data Records (SDRs) / Temperature Data Records (TDRs), Intermediate Products (IPs), Application Related Products (ARPs), and Environmental Data Records (EDRs). NPOESS Product Data Formats are documented in the NPOESS Common Data Format Control Book – External (CDFCB-X).

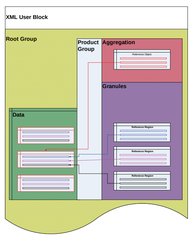
The file name convention is:



GMODO_npp_d20030125_t070307_e070432_b00014_c20071006171144_den_OPS_SEG.h5

NPOESS HDF5 Conceptual Diagram

The XML User Block for NPOESS Data Products provides a 'quick-look' into the metadata of the associated HDF5 file. The User Block size is a multiple of 512 bytes and the format is specified in the Vol V of the CDFCB-X for xDRs, IPs, and ARPs and Vol VI for Ancillary and Auxiliary data. Some of the metadata elements at this level are Mission, Platform, Instrument Names, Number of Data Products, Collection Short Names, Aggregation Information and Timestamps.



NPOESS HDF5 Metadata & QF

The NPOESS HDF5 Metadata is organized hierarchically, from the top down in order to reduce duplication of information and to take advantage of the hierarchical nature of HDF5

- Root Group
- Data Products Group
- Data Product (indicated by the specific product collection shortname)
- Product Aggregation Dataset
- Product Granule Dataset

Quality flags are stored in the HDF5 files as n number(s) of two or three dimensional, 1-byte arrays following the structure of the data product

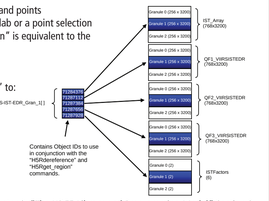
- The number of arrays is dependant on the quality flag definitions, specific to each data product
- Each byte may contain multiple bit-level flags
- Quality flags will be ordered such that each flag is entirely contained within a singlebyte, occasionally resulting in a byte with reserved or meaningless bits
- Byte alignment is the same for every quality flag array
  First bit (left-most) is the LSB

References to Regions

H5S API commands fall into two broad categories:

1. Dataspace Management & Query Functions
   A) These functions operate on the entire dataspace
      Entire dataspace is equivalent to an entire (temporal) aggregated array's dataspace in an NPOESS HDF5 file under the "All_Data" group
   B) Example: H5Sget_simple_extent_npoints
      Returns the number of elements in the entire Array under "All_Data" for HDF5 NPOESS.
      For VIIRS-IST-EDR_Gran_1, the first reference in the array (referencing the IST_Array) would return 768 x 3200 = 2,457,600 points.

2. Dataspace Selection Functions – hyperslabs and points
   A) These functions operate on a hyperslab or a point selection
   B) For NPOESS HDF5 files, the "selection" is equivalent to the granule (hyperslab) for a particular field (array)
   C) The "selection" is the portion of the data array the reference "points" to:

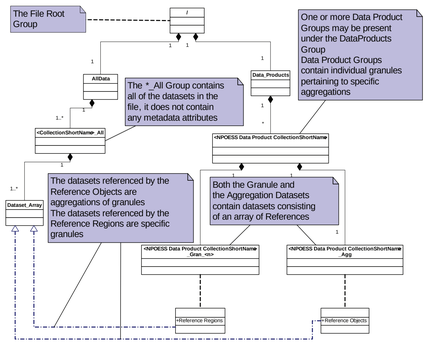


Example: H5Sget_select_npoints
- Determines the number of points in a dataspace selection. For HDF5 NPOESS, this would be the number of points in a granule for a particular field
- For VIIRS-IST-EDR_Gran_1, the first reference in the array (referencing the IST_Array) would return 256 x 3200 = 819,200 points.

Note that the "select" in the API command is short for "selection". It is not a redundant term for "get".

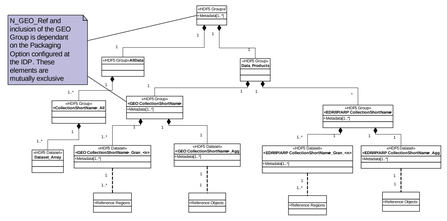
* See the HDF5 User's Guide release 1.6.5, Chapter 2, "The HDF5 Library and Programming Model" Section 2, "Dataspace Function Summaries" - H5S commands

General NPOESS HDF5 File Structure



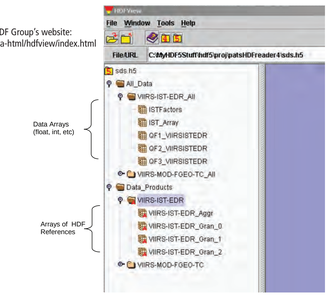
General SDR/TDR/EDR/ARP/IP UML Model

- The General NPOESS HDF5 File Structure is applied to created a model for SDRs, TDRs, EDRs, ARPs, and IPs



Sample HDf5 file in HDFView – VIIRS Ice Surface Temperature (IST) EDR

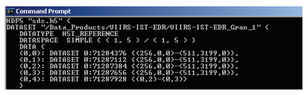
HDFView is available from The HDF Group's website: http://www.hdfgroup.org/hdf-java-html/hdfview/index.html



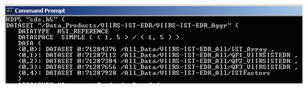
Sample h5dump Screenshot – VIIRS Ice Surface Temperature (IST) EDR

Another way to view the arrays of references (Aggregation and Granule dataset arrays) is with the h5dump utility:

Granule:



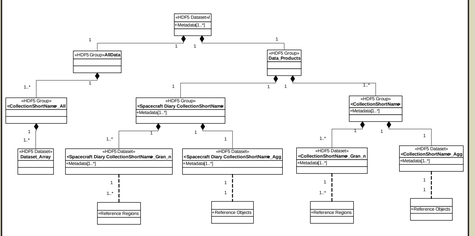
Aggregation:



Note: Currently, the only way to match the object ID in the granule/aggregation datasets is to manually list the aggregation as shown above using h5dump or look up the order in the NPOESS Data Format Control Book - External.
The HDF Group will add the ability to obtain the name of the dataset a reference points to in v1.8 beta.

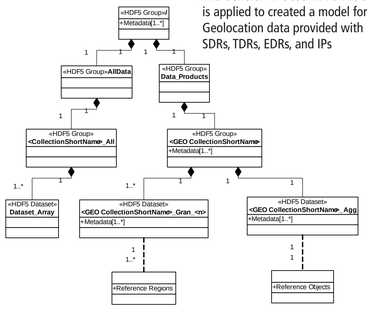
General RDR UML Model

- The General NPOESS HDF5 File Structure is applied to created a model for RDRs



General Geolocation UML Model

- The General NPOESS HDF5 File Structure is applied to created a model for Geolocation data provided with SDRs, TDRs, EDRs, and IPs



Sample Product Profile – VIIRS Ice Surface Temperature (IST) EDR

- The Product Profile describes the NPOESS granule.
  - Provided as raw XML files in IDPS SW drops and in the CDFCB-X, not as part of the HDF5 file
  - Snapshots of the CDFCB-X product profile is shown here, using the respective XSD and DTD for formatting
- For Ice Surface Temperature, the observation data fields in the granule are:
  - IST_Array (Shown below)
  - QF1_VIIRSISTEDR (Shown below)
  - QF2_VIIRSISTEDR
  - QF3_VIIRSISTEDR
  - ISTFactors (Scale & Offset – Shown below)

Fields

Name	Data Size	Field Offset	Dimensions
IST_Array	2bytes	0	

Name	Attribute Name	Granule Boundary	Dynamic	Min Array Size	Max Array Size
inTrack	N_Rows	Yes	No	256	256
crossTrack	N_Columns	No	No	3200	3200

Datum

Description	Datum Offset	Unscaled Valid Range Min	Unscaled Valid Range Max	Measurement Units	Scaled	Scale Factor Name	Data Type	Fill Values	Legend Entries
Ice Surface Temperature	0	213	275	K	Yes	ISTFactors	16-bit unsigned integer		

Fill Values	
Name	Value
NA_UINT16_FILL	65535
MISS_UINT16_FILL	65534
CNBDARO_PT_UINT16_FILL	65533
ONGROUND_PT_UINT16_FILL	65532
ERR_UINT16_FILL	65531
ELNIT_UINT16_FILL	65530
VDNE_UINT16_FILL	65529
SOUB_UINT16_FILL	65528

Legend Entries	
Name	Value

Sample Product Profile – VIIRS Ice Surface Temperature (IST) EDR

- Scale factors are applied to the observation data to get unscaled data.

Fields

Name	Data Size	Field Offset	Dimensions
ISTFactors	4bytes	0	

Name	Attribute Name	Granule Boundary	Dynamic	Min Array Size	Max Array Size
IST scale/offset values		Yes	No	2	2

Datum

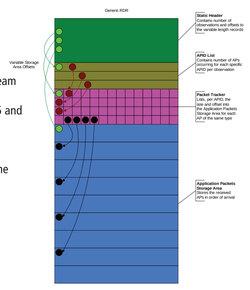
Description	Datum Offset	Unscaled Valid Range Min	Unscaled Valid Range Max	Measurement Units	Scaled	Scale Factor Name	Data Type	Fill Values	Legend Entries
Scale = first array element Offset = second array element				Scale = unitless Offset = K	No		32-bit floating point		

Fill Values	
Name	Value

Legend Entries	
Name	Value

Common RDR Granule Layout

- RDRs are stored in the HDF5 file as a stream of 8-bit unsigned characters (UCHAR). The user extracts the UCHARs from HDF5 and accesses the memory block using the structure shown here.
- The operating system which generated the RDR is AIX 5.2, which uses Big Endian byte ordering. Specific custom code may be needed if the target OS uses a different order.



Sample Product Profile – IST Quality Flag Byte 1

- QFs are packed in HDF5 in an unsigned 8-bit character (UCHAR). The user extracts the packed UCHARs from HDF5 and applies bit masks to extract the bit values.

Fields

Name	Data Size	Field Offset	Dimensions
QF1_VIIRSISTEDR	1byte	0	

Name	Attribute Name	Granule Boundary	Dynamic	Min Array Size	Max Array Size
inTrack	N_Rows	Yes	No	256	256
crossTrack	N_Cols	No	No	3200	3200

Datum

Description	Datum Offset	Unscaled Valid Range Min	Unscaled Valid Range Max	Measurement Units	Scaled	Scale Factor Name	Data Type	Fill Values	Legend Entries
IST Quality	0			unitless	No		(2) bits		
Algorithm	2			unitless	No		(1) bit		
Daylight	3			unitless	No		(1) bit		
Band M15 Brightness Temperature Range	4			unitless	No		(1) bit		
Band M16 Brightness Temperature Range	5			unitless			(1) bit		
Active Fire	6			unitless			(1) bit		
Spare	7			unitless			(1) bit		

Fill Values	
Name	Value

Legend Entries	
Name	Value
High	3
Medium	2
Low	1
No Retrieval	0
Name	Value
2-Band Split Window Baseline Algorithm (12 micrometer)	0
Enhanced	1
Name	Value
Night, (85 Deg. < Solar Zenith Angle)	0
Day, (0 Deg. <= Solar Zenith Angle <= 85 Deg.)	1
Name	Value
Within Range, (190K < BTM15) < 340K)	0
Out Of Range	1
Name	Value
Within Range, (190K < BTM16) < 340K)	0
Out Of Range	1
Name	Value
No Active Fire	0
Active Fire	1
Name	Value

HDF Group

The HDF Group

- Nonprofit group funded by NASA & affiliated with Univ of Illinois
- Funded to support NPP/NPOESS
  - Support to AIX 5.2 OS
  - Enhancements to HDF View and HDFDump for simplified Region dereferencing
  - Modification to support Quality Flag masks

NPOESS HDF5 Files Summary

- The NPOESS Program delivers the official deliverable data products (RDR, SDR/TDR, EDR/ARP/IP) and dynamic ancillary data and auxiliary data in HDF5 Files
- The HDF5 Files have an XML User Block that can be accessed without HDF5 tools - provides a "quick-look" into the metadata before opening the HDF5 file
- Metadata within the HDF5 files are stored as attributes
- There are general UML Models for the NPOESS official delivered data that provide a common framework
- Official deliverable data products are organized by reference objects (aggregated granules) which contain one or more reference regions (individual granules), with some exceptions (e.g., RDR granules are reference objects due to ambiguity aggregating RDR granules)
- Although data may be accessed directly through the All Data group, the Data Products group provides integrated access:
  - Allows the user to access both metadata and data through a common HDF5 group
    - Metadata is accessed directly by reading the Attribute values
    - Datasets may be accessed by dereferencing the object ID stored in the Data Products
    - Group for the aggregation or granule
- NPOESS HDF5 files provide flexibility for a variety of end users

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