



The HDF-EOS5 Tutorial

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What is HDF-EOS ?

- HDF (Hierarchical Data Format) is a disk-based format chosen by NASA as a standard for EOS program
- HDF-EOS is an extension to HDF which standardizes common Earth Sciences data structures
- HDF-EOS2 based on HDF4 is used operationally by EOS TERRA and AQUA instrument teams
- HDF-EOS5, based on HDF5 is newer and will be used by EOS AURA instruments
- Contains Geolocation Information:
 - Structural metadata links Geolocation and science data



HDF-EOS 5 Library

- Provides Grid/Point/Swath/ZA interfaces
- Allows to create/access Grid/Point/Swath/ZA and manipulate their objects (data sets, attributes, etc.)
- Written in C with FORTRAN-77 wrappers
- C-function names prefixed with “HE5_”
- FORTRAN-77 calls have similar naming convention

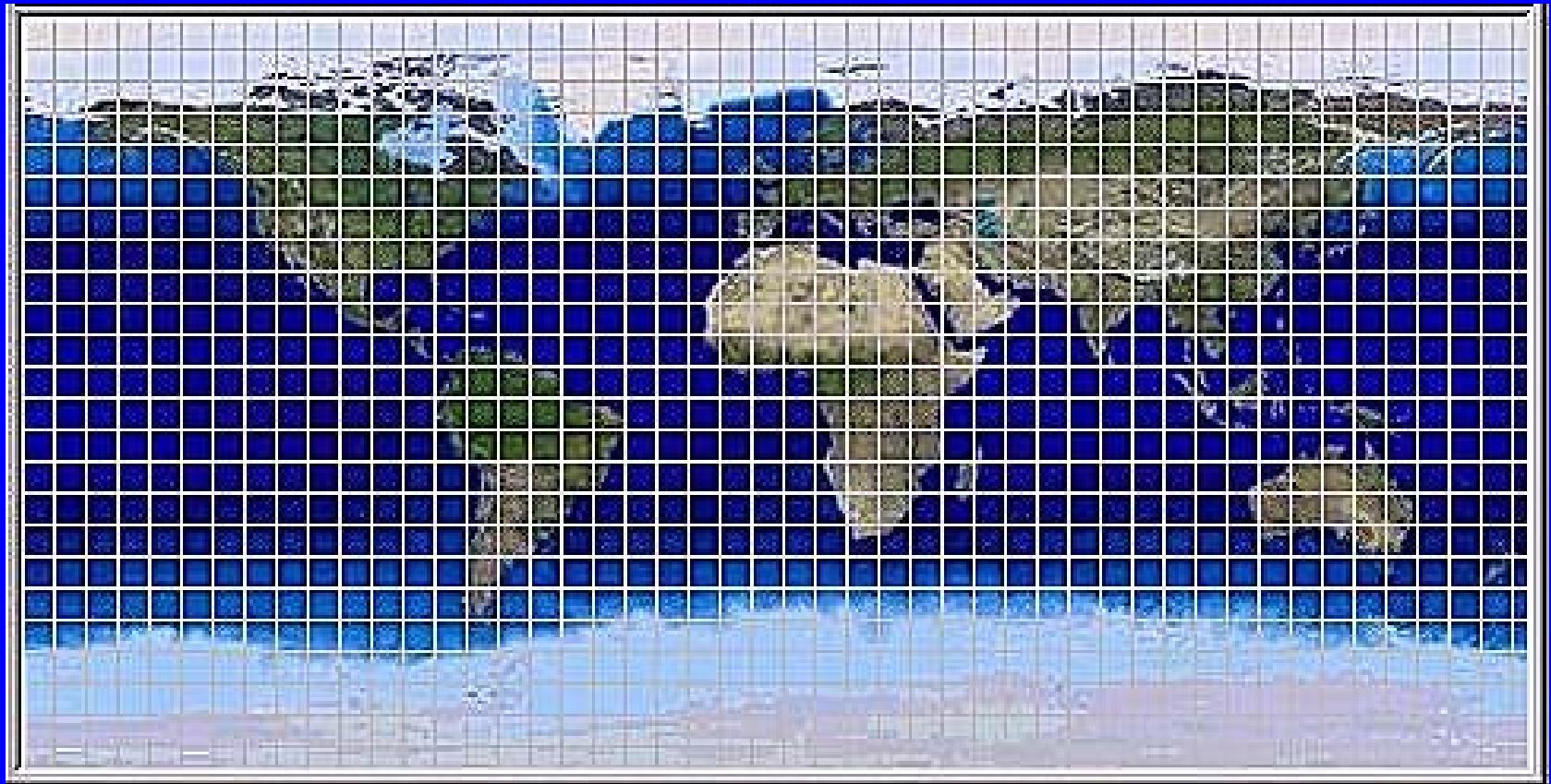


Grid Structure

- Data organized by regular geographic spacing, specified by projection parameters.
- Structure
 - Multidimensional data arrays
 - Geolocation information is given implicitly by projection parameters contained in structural metadata



Grid Data Example



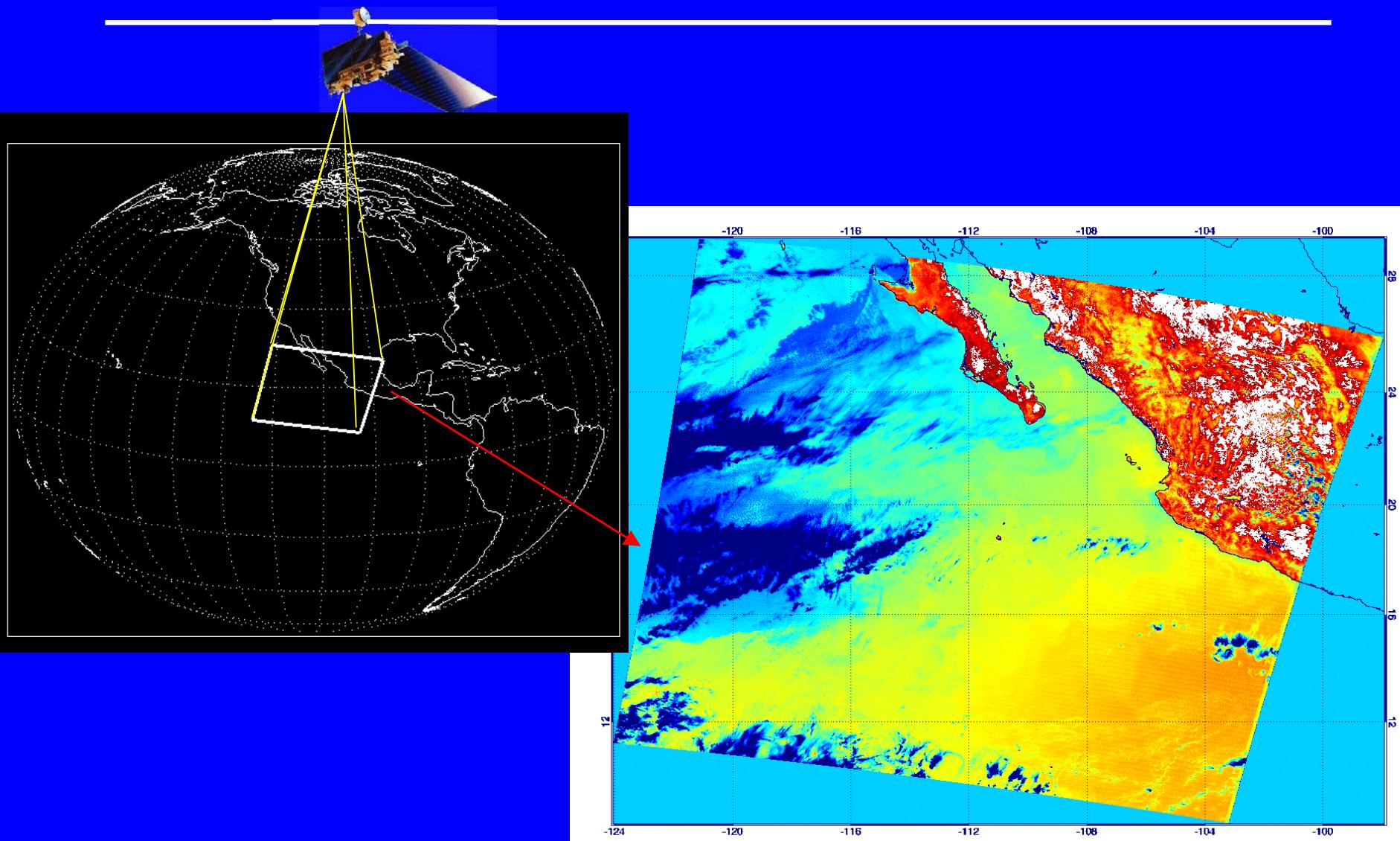


Swath Structure

- Data is organized by time or track parameter
- Data spacing can be irregular
- Structure
 - Geolocation information stored explicitly in Geolocation Field (2-D array)
 - Data stored in multidimensional arrays
 - Time stored in 1-D or 2-D array
 - SM links Geolocation and science data



Swath Data Example

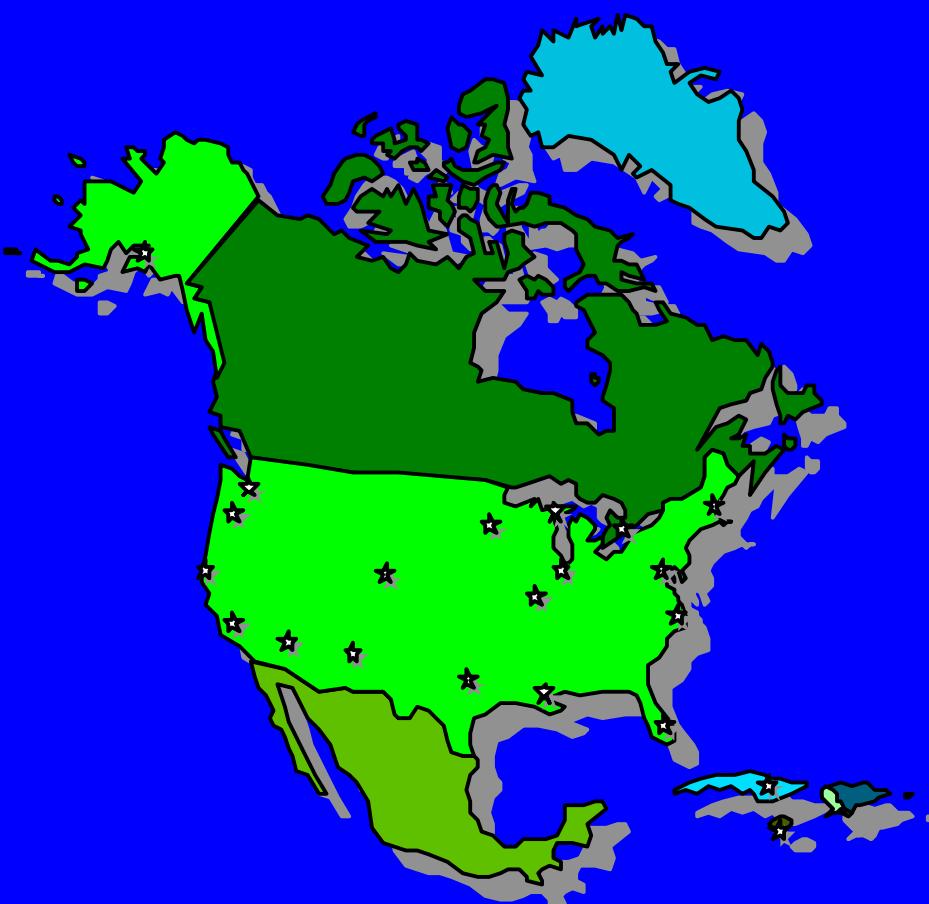




Point Structure

- Data is specified temporally and/or spatially, but with no particular organization
- Structure
 - Tables used to store science data at a particular Lat/Long/Height
 - Up to eight levels of data allowed. Structural metadata specifies relationship between levels.

Point Data Example



Lat	Lon	Temp(C)	Dewpt(C)
61.12	-149.48	15.00	5.00
45.31	-122.41	17.00	5.00
38.50	-77.00	24.00	7.00
38.39	-90.15	27.00	11.00
30.00	-90.05	22.00	7.00
37.45	-122.26	25.00	10.00
18.00	-76.45	27.00	4.00
43.40	-79.23	30.00	14.00
34.03	-118.14	25.00	4.00
32.45	-96.48	32.00	8.00
33.30	-112.00	30.00	10.00
42.15	-71.07	28.00	7.00
35.05	-106.40	30.00	9.00
34.12	-77.56	28.00	9.00
46.32	-87.25	30.00	8.00
47.36	-122.20	32.00	15.00
39.44	-104.59	31.00	16.00
21.25	-78.00	28.00	7.00
44.58	-93.15	32.00	13.00
41.49	-87.37	28.00	9.00
25.45	-80.11	19.00	3.00



Zonal Average (ZA) Structure

- Generalized array structure with no geolocation linkage
- Data can be organized by time or track parameter
- Data spacing can be irregular
- Structure
 - Data stored in multidimensional arrays
 - Time stored in 1-D or 2-D array
 - SM links science data



HDF-EOS Grid Structure

- Usage - Data which is organized by regular geographic spacing, specified by projection parameters.
- Structure
 - Any number of 2-D to 8-D data arrays per structure, one per data type (e.g. temperature)
 - Geolocation information contained in projection formula, coupled by structural metadata.
 - Any number of Grid structures per file allowed.



HDF-EOS Swath Structure

- Usage - Data which is organized by time, monotonic geolocation, track parameter. Spacing can be irregular.
- Structure
 - Geolocation information stored explicitly in Geolocation Field (2-D array)
 - Data stored in 2-D or 3-D arrays
 - Time stored in 1-D or 2-D array, TAI is standard.
 - Geolocation/science data connected by structural metadata



HDF-EOS Point Structure

- Usage - Data which is specified temporally and/or spatially, but with no particular organization.
- Structure
 - Tables (Vdatas) used to store science data at a particular Lat/Long/Height.
 - Up to eight levels of data allowed. Structural metadata specifies relationship between levels.



HDF-EOS ZA Structure

- Usage - Data which is organized by time, track parameter. Spacing can be irregular.
- Structure
 - Data stored in 2-D or 3-D arrays
 - Time stored in 1-D or 2-D array, TAI is standard.
 - Science data connected by structural metadata



Basic HDF-EOS5 Functions

- Access - Open, create, close objects/files
- Definition - Set key parameters of data sets
- Input/Output - Read/Write data
- Inquiry - Return information about data
- Subset - Read data from specified region



File/Object Access

GRID:

- HE5_GDopen/he5_gdopen
- HE5_GDcreate/he5_gdcreate
- HE5_GDattach/he5_gdattach
- HE5_GDdetach/he5_gddetach
- HE5_GDclose/he5_gdclose



File/Object Access

POINT:

- HE5_PTopen/he5_ptopen
- HE5_PTcreate/he5_ptcreate
- HE5_PTattach/he5_ptattach
- HE5_PTdetach/he5_ptdetach
- HE5_PTclose/he5_ptclose



File/Object Access

SWATH:

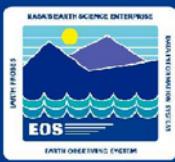
- HE5_SWopen/he5_swopen
- HE5_SWcreate/he5_swcreate
- HE5_SWattach/he5_swattach
- HE5_SWdetach/he5_swdetach
- HE5_SWclose/he5_swclose



File/Object Access

ZA:

- HE5_ZAopen/he5_zaopen
- HE5_ZAcreate/he5_zacreate
- HE5_ZAattach/he5_zaattach
- HE5_ZAdetach/he5_zadetach
- HE5_ZAclose/he5_zaclose



Definition

GRID:

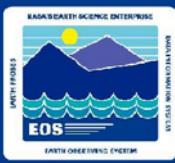
- HE5_GDdefdim/he5_gddefdim
- HE5_GDdefproj/he5_gddefproj
- HE5_GDdeforigin/he5_gddeforigin
- HE5_GDdefpixreg/he5_gd_defpreg



Definition

POINT:

- HE5_PTdeflevel/he5_ptdeflevel
- HE5_PTdeflinkage/he5_ptdeflinkage



Definition

SWATH:

- HE5_SWdefdim/he5_swdefdim
- HE5_SWdefdimmap/he5_swdefmap
- HE5_SWdefidxmap/he5_swdefimap
- HE5_SWdefgeofield/he5_swdefgfld
- HE5_SWdefdatafield/he5_swdefdfld



Definition

ZA:

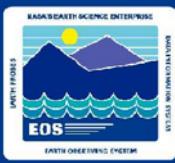
- HE5_ZAdefdim/he5_zadefdim
- HE5_ZAdefine/he5_zadefine
- HE5_ZAdefcomp/he5_zadefcomp
- HE5_ZAdefchunk/he5_zadefchunk



Input/Output

GRID:

- HE5_GDwritefield/he5_gdwrfld
- HE5_GDreadfield/he5_gdrdfld
- HE5_GDwriteattr/he5_gdwrattr
- HE5_GDreadattr/he5_gdrdattr



Input/Output

POINT:

- HE5_PTwritelevel/he5_ptwritelevel
- HE5_PTreadlevel/he5_ptreadlevel
- HE5_PTwriteattr/he5_ptwrattr
- HE5_PTreadattr/he5_ptrdattr



Input/Output

SWATH:

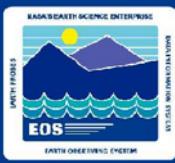
- HE5_SWwritefield/he5_swrfld
- HE5_SWreadfield/he5_swrdfld
- HE5_SWwriteattr/he5_swrrattr
- HE5_SWreadattr/he5_swrdattr



Input/Output

ZA:

- HE5_ZAwrite/he5_zawrite
- HE5_ZAread/he5_zaread
- HE5_ZAwriteattr/he5_zawrattr
- HE5_ZAreadattr/he5_zardattr



Inquiry

GRID:

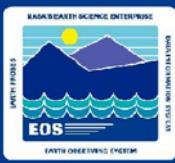
- HE5_GDinqdims/he5_gdinqdims
- HE5_GDdiminfo/he5_gddiminfo
- HE5_GDprojinfo/he5_gdprojinfo
- HE5_GDorigininfo/he5_gdorigininfo
- HE5_GDpixreginfo/he5_gdpreginfo



Inquiry

POINT:

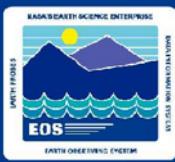
- HE5_PTlevelinfo/he5_ptlevelinfo
- HE5_PTinqattrs/he5_ptinqattrs
- HE5_PTattrinfo/he5_ptattrinfo



Inquiry

SWATH:

- HE5_SWinqdatafields/he5_swinwdflds
- HE5_SWinqgeofields/he5_swinqgflds
- HE5_SWinqattrs/he5_swinqattrs
- HE5_SWattrinfo/he5_swattrinfo



Inquiry

ZA:

- HE5_ZAinquire/he5_zainquire
- HE5_ZAinfo/he5_zainfo
- HE5_ZAinqattrs/he5_zainqattrss
- HE5_ZAattrinfo/he5_zaattrinfo



Programming Model

- **Open** the HDF-EOS5 file
- **Create or Attach** to a specified Grid/Swath/Point/ZA object
- **Define** key object features and/or **perform** necessary **operations** (with the data sets, attributes, etc)
- **Detach** from the Grid/Swath/Point/ZA object
- **Close** the HDF-EOS5 file



HDF-EOS Tools and Utilities

- heconvert - command-line utility to convert HDF-EOS2 objects to HDF-EOS5 objects
- HE5View - X-Motif based tool which displays all parts of the HDF-EOS5 objects
- JEB - Java EOS Browser - Java based tool to display HDF4, HDF-EOS2 and HDF-EOS5 objects