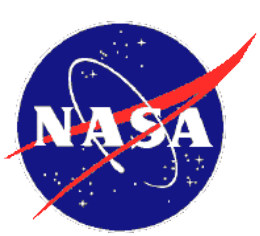
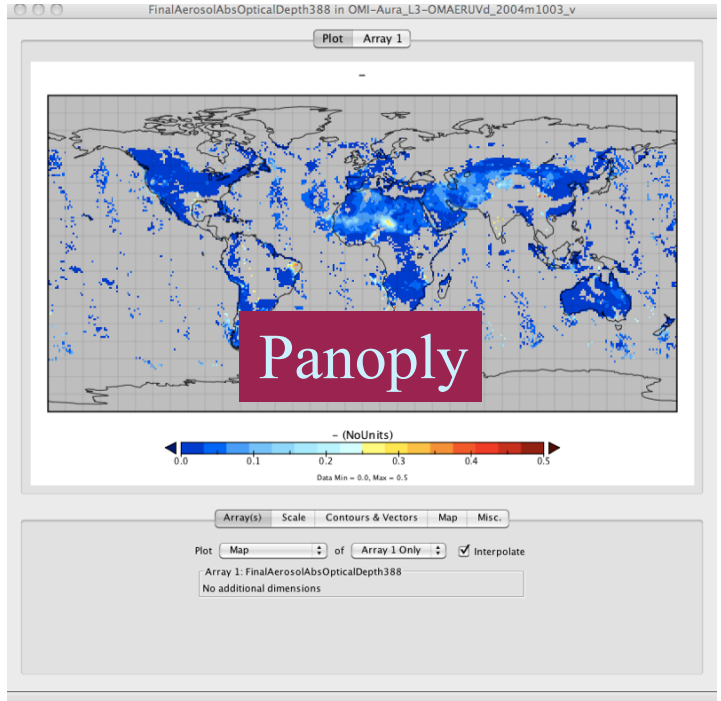
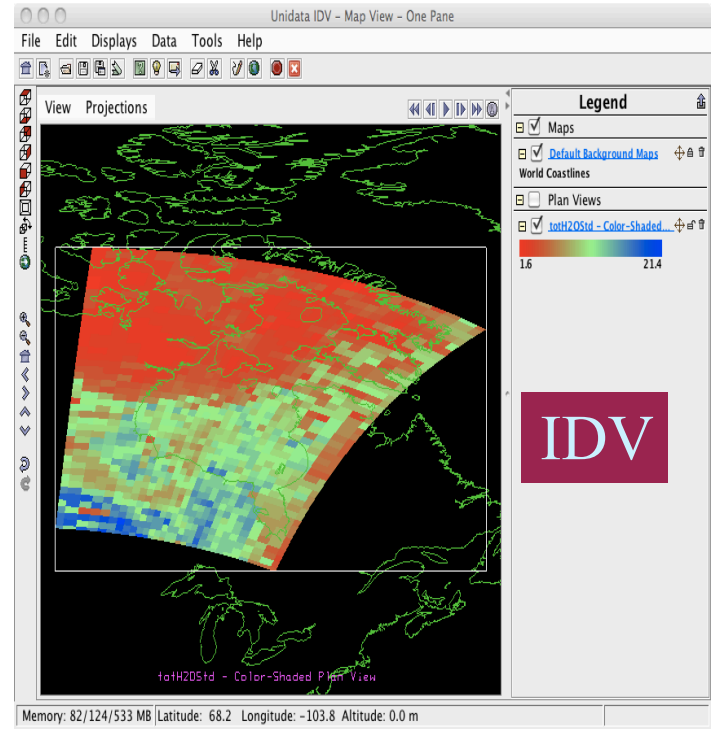


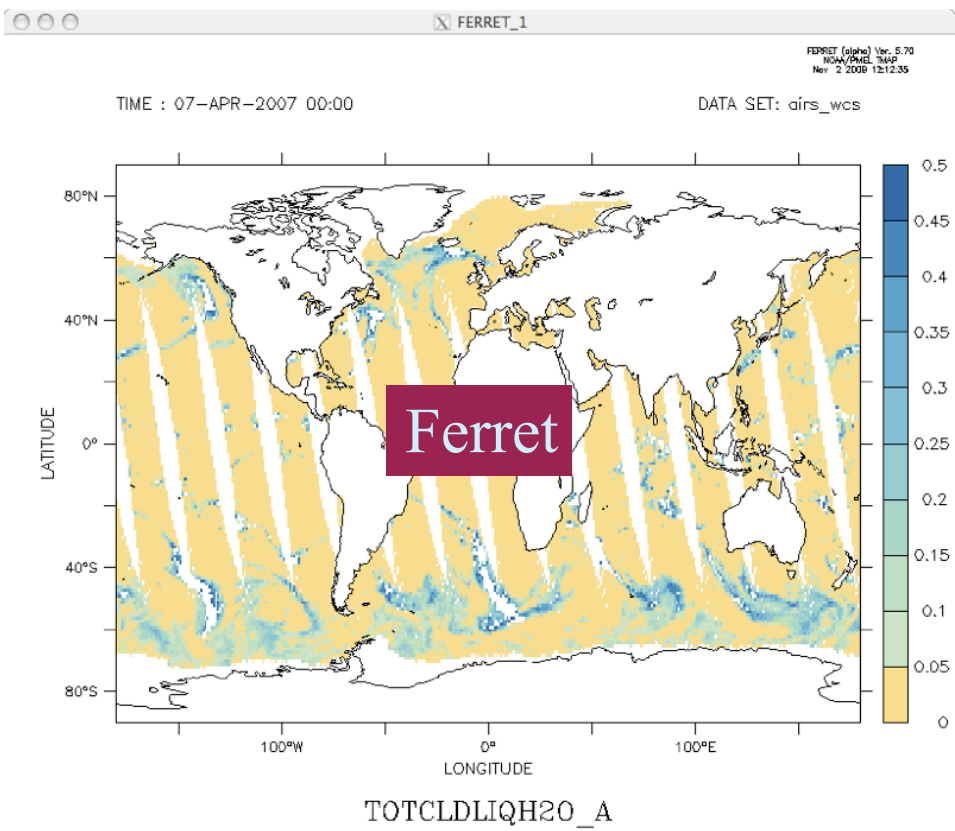
PRACTICAL METHODS FOR MAKING HDF DATA USABLE IN NETCDF-BASED TOOLS

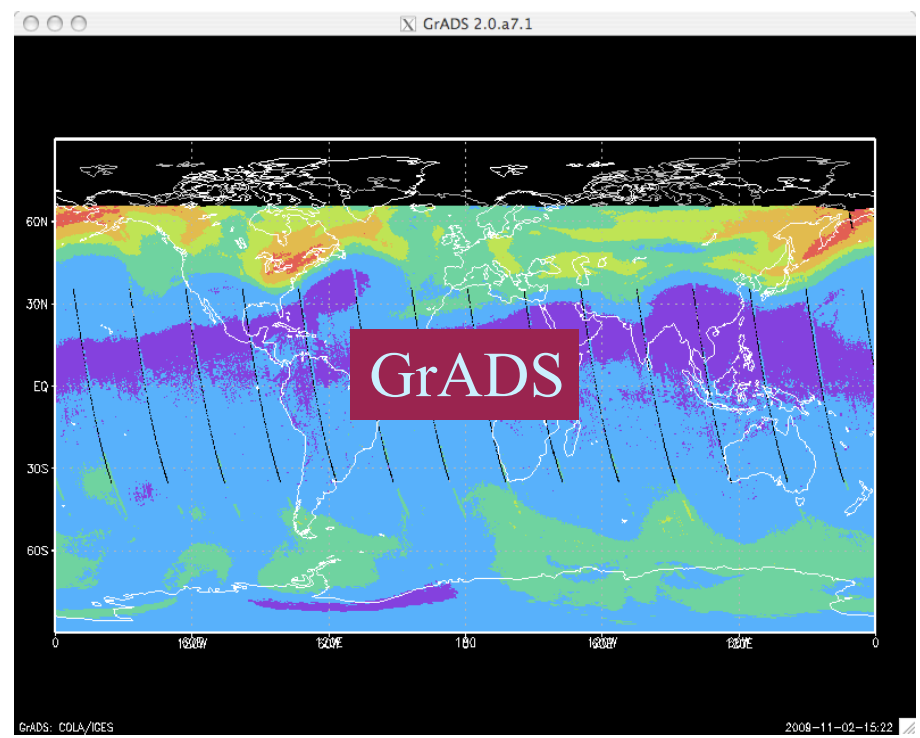
Chris Lynnes and Fan Fang

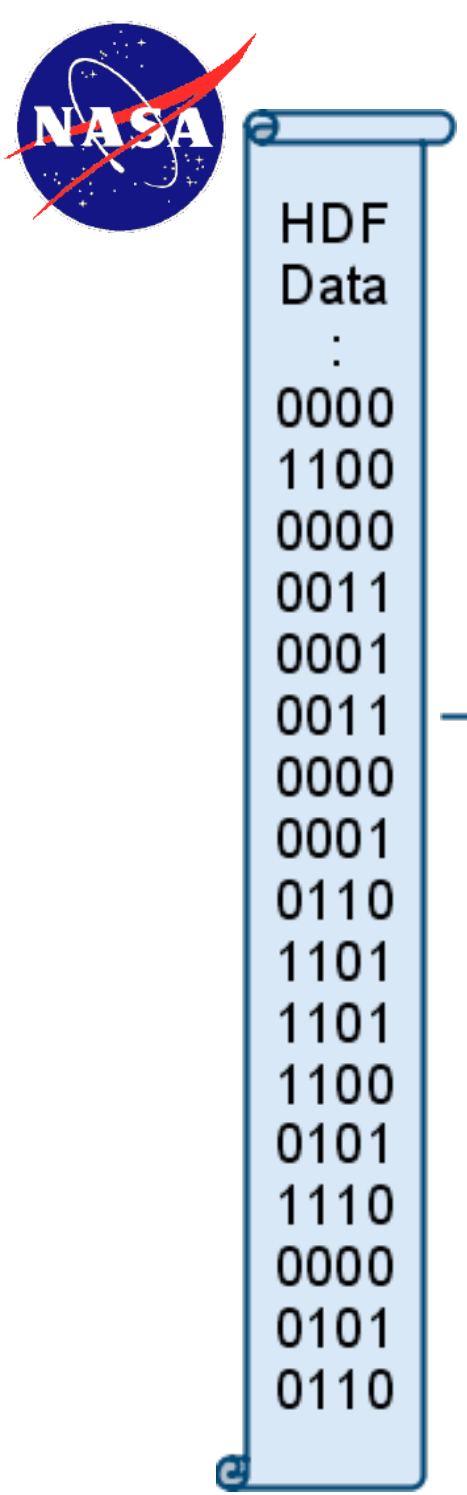
Goddard Earth Sciences
Data and Information Services Center


FinalAerosolAbsOpticalDepth388 in OMI-Aura_L3-OMAERUVd_2004m1003_v
Plot
Array 1
- (NoUnits)
0.0
0.1
0.2
0.3
0.4
0.5
Data Min = 0.0, Max = 0.5
Array(s)
Scale
Contours & Vectors
Map
Misc.
Plot
Map
of
Array 1 Only
Interpolate
Array 1: FinalAerosolAbsOpticalDepth388
No additional dimensions
Panoply


Unidata IDV - Map View - One Pane
File
Edit
Displays
Data
Tools
Help
View
Projections
Legend
Maps
Default Background Maps
World Coastlines
Plan Views
totH2OStd - Color-Shaded...
1.6
21.4
totH2OStd - Color-Shaded Plan View
Memory: 82/124/533 MB
Latitude: 68.2
Longitude: -103.8
Altitude: 0.0 m
IDV

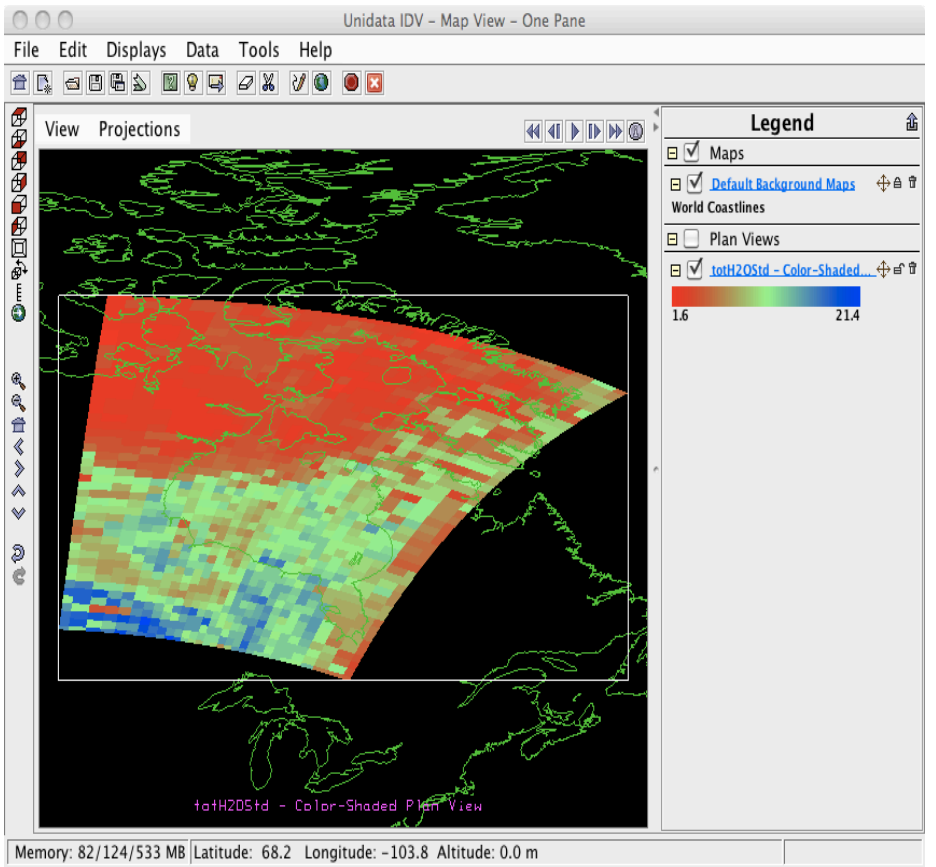

FERRET_1
FERRET (alpha) Ver. 5.70
NOAA/PMEL TMAP
Nov 2 2009 12:12:35
TIME : 07-APR-2007 00:00
DATA SET: airs_wcs
80°N
40°N
0°
40°S
80°S
LATITUDE
100°W
0°
100°E
LONGITUDE
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Ferret
TOTCLDLIQH2O_A


GrADS 2.0.a7.1
60N
30N
EQ
30S
60S
0
180W
120W
180
120E
0
GrADS: COLA/IGES
2009-11-02-15:22
GrADS



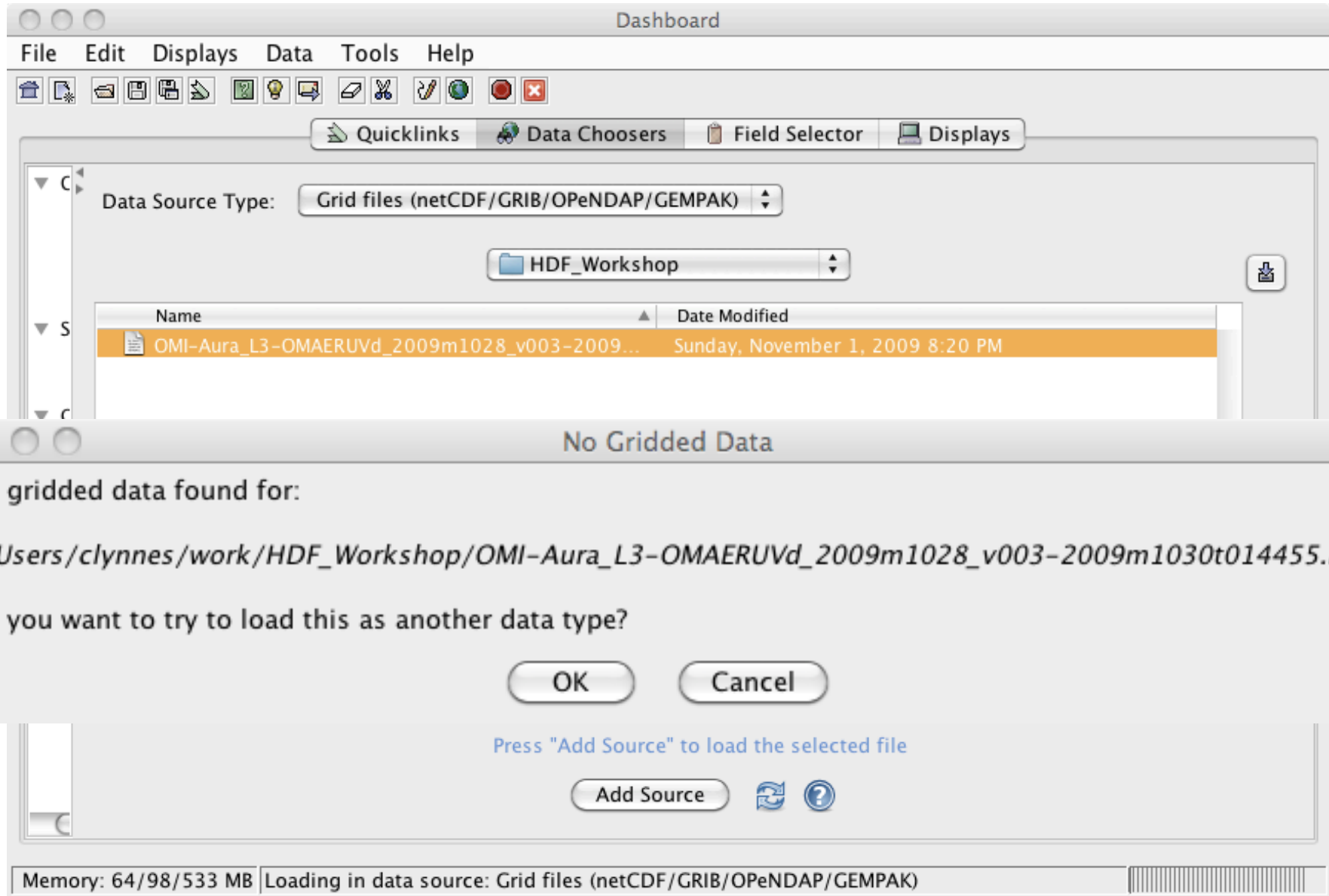
"And then a miracle occurs..."

Unidata IDV

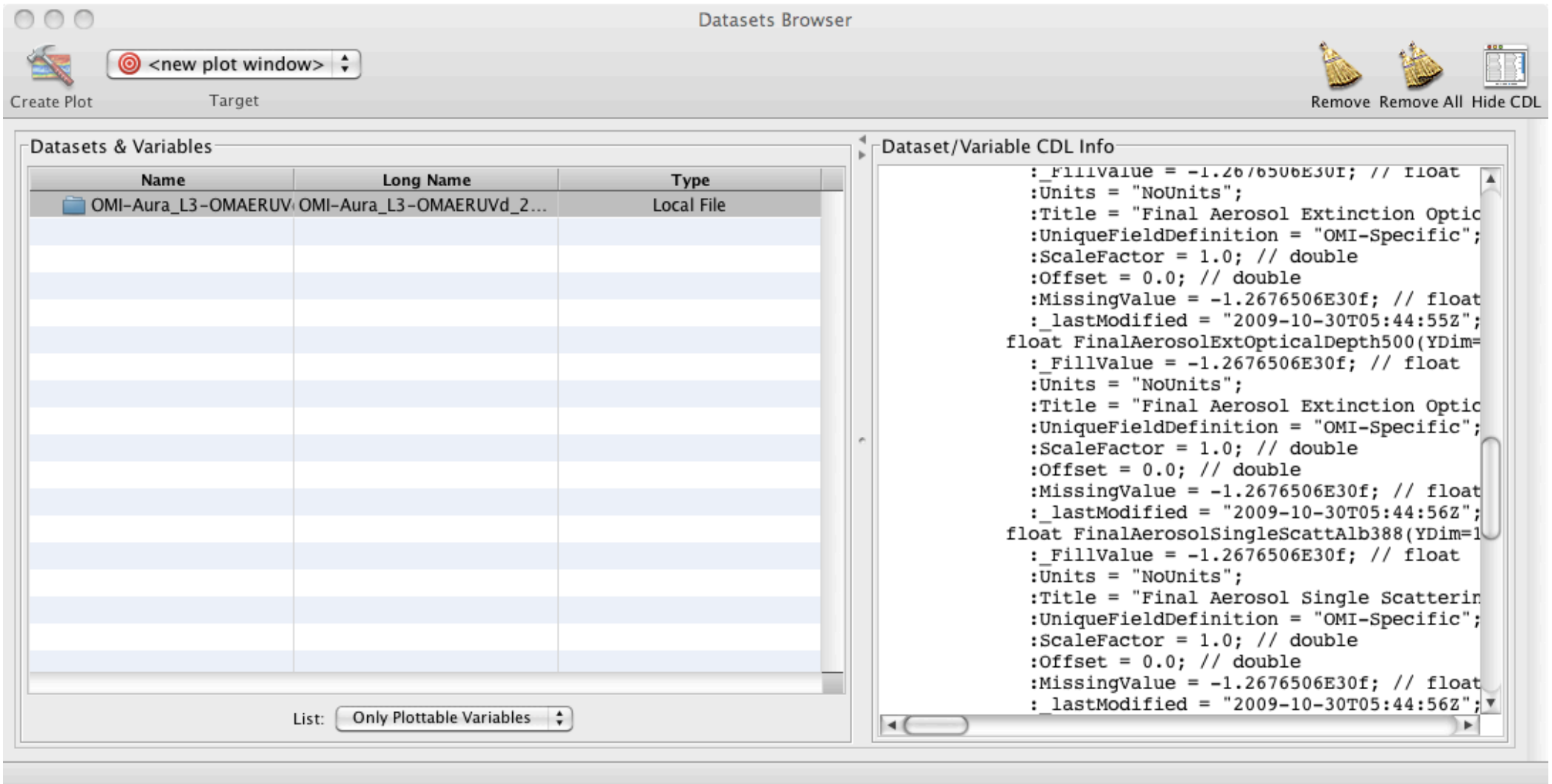


IDV with HDF-EOS5 “self-describing format”

IDV with HDF-EOS5 “self-describing format”



Panoply w/HDF5



Ferret and GrADS with HDF-EOS5

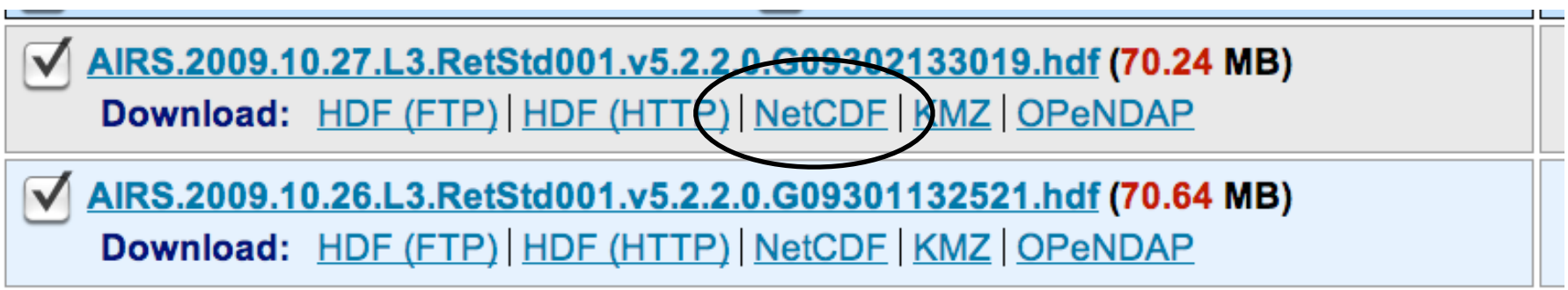
```
yes? set data OMI-Aura_L3-OMAERUVd_2004m1001_v003-2009m0714t093948.he5

 **TMAP ERR: Error in namelist record
             Error in: FORMAT_RECORD; or file not descriptor file
             Data set: ./OMI-Aura_L3-OMAERUVd_2004m1001_v003-2009m0714
t093948.he5
yes? quit
```

```
ga-> sdfopen OMI-Aura_L3-OMAERUVd_2004m1001_v003-2009m0714t093948.he5
Scanning self-describing file:  OMI-Aura_L3-OMAERUVd_2004m1001_v003-20
09m0714t093948.he5
gaopnc error: nc_open failed to open file OMI-Aura_L3-OMAERUVd_2004m10
01_v003-2009m0714t093948.he5
read_metadata: gaopnc failed
gadsdf: Couldn't ingest SDF metadata.
ga->
```

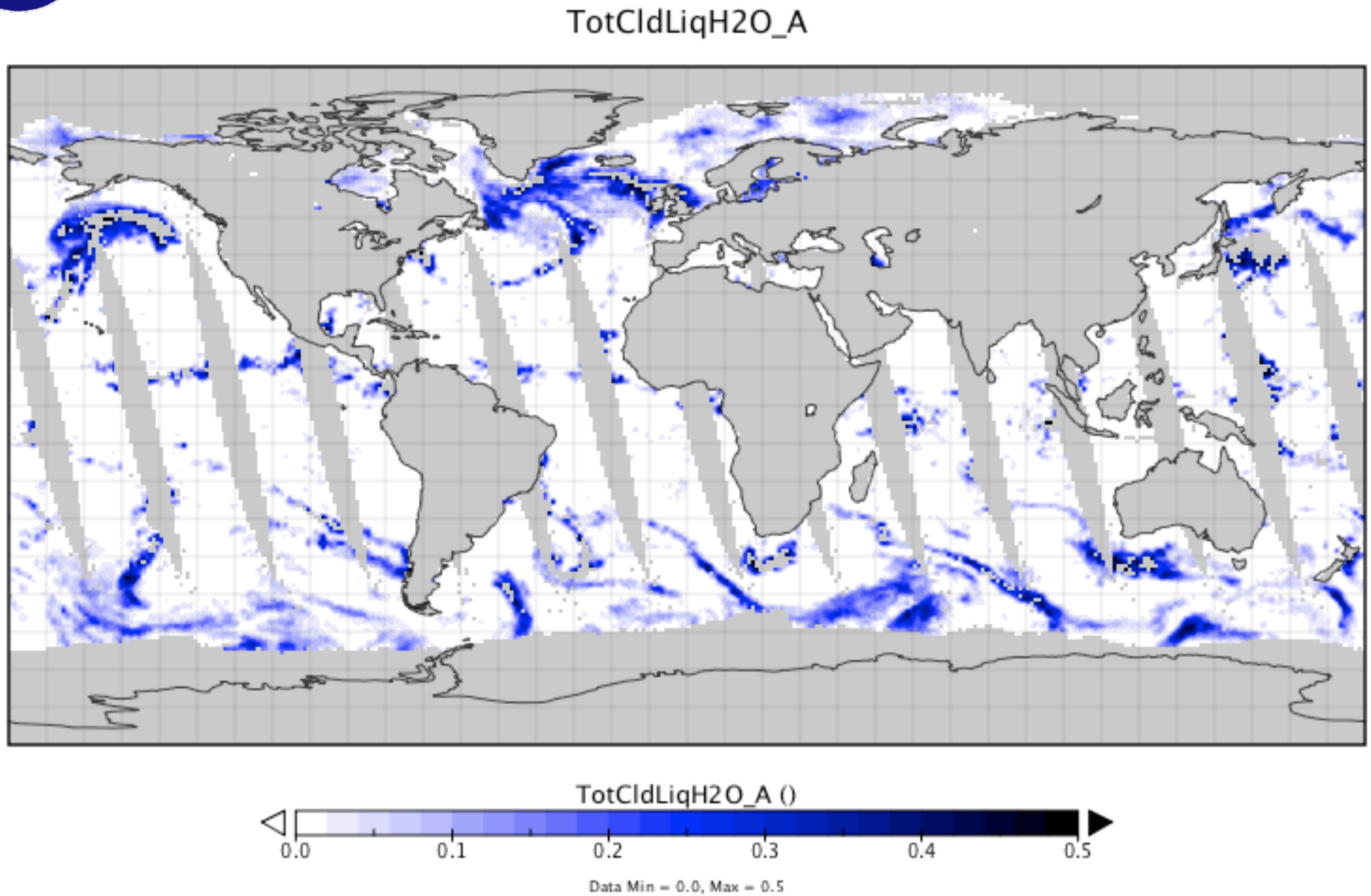
*Can be opened if user defines dimensions and uses **xdfopen**

Solution #1: Convert to netCDF

- On-the-fly conversion to netCDF-3
- Custom C++ code
- Acquiring the URL executes the conversion and downloads the file

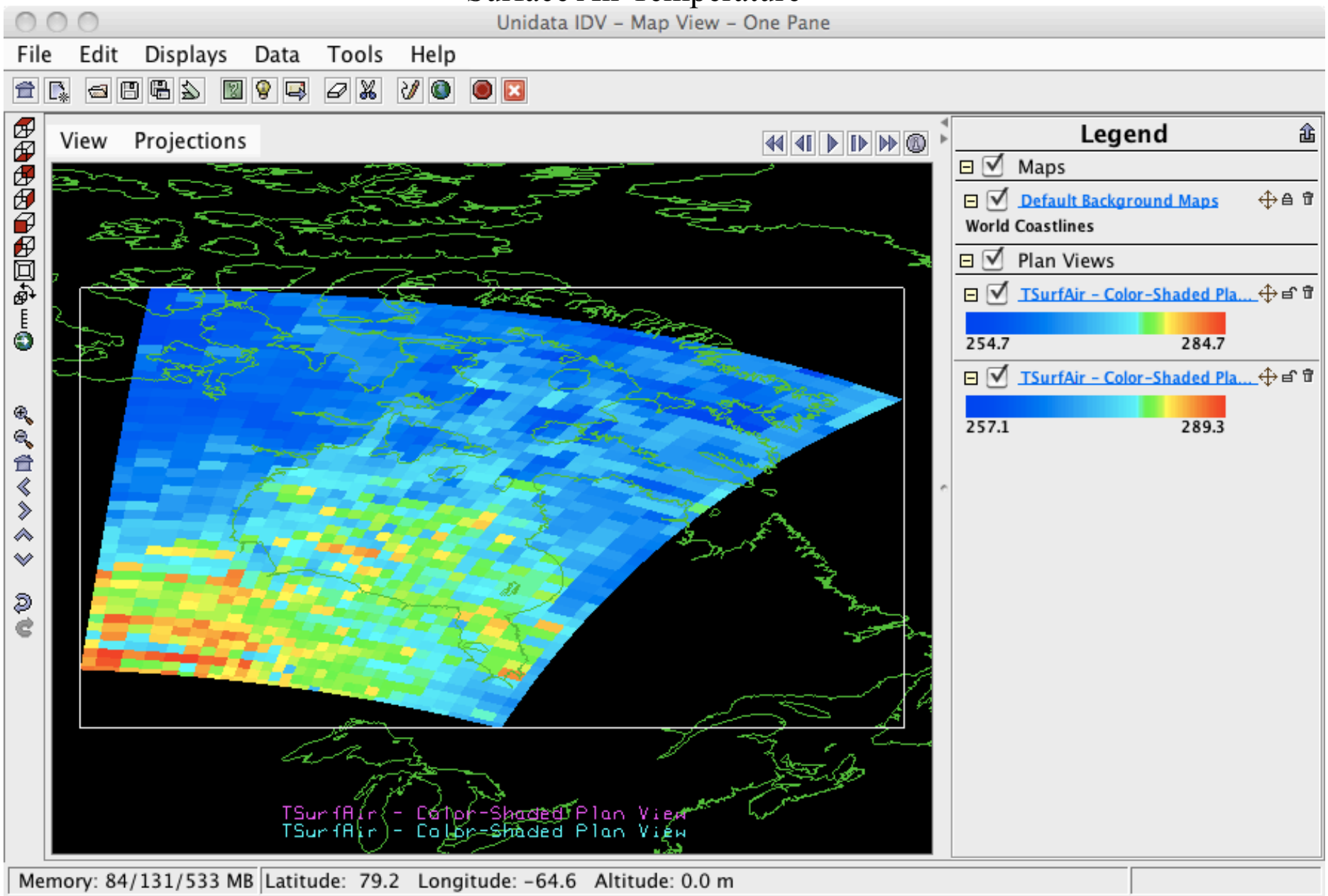


Panoply w/converted AIRS L3



IDV w/Converted AIRS L2

Surface Air Temperature

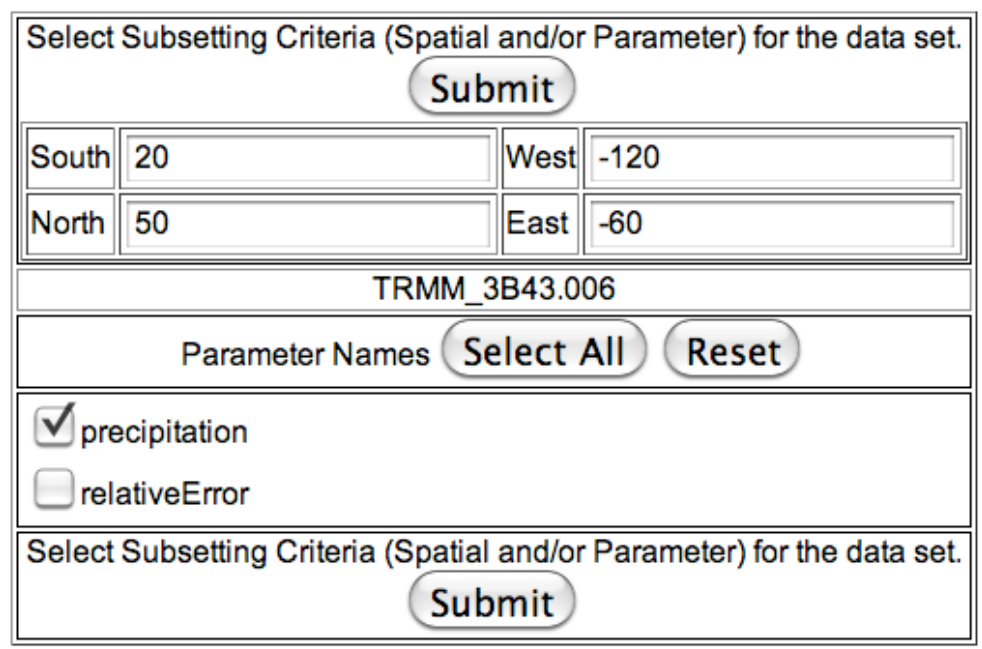


But...

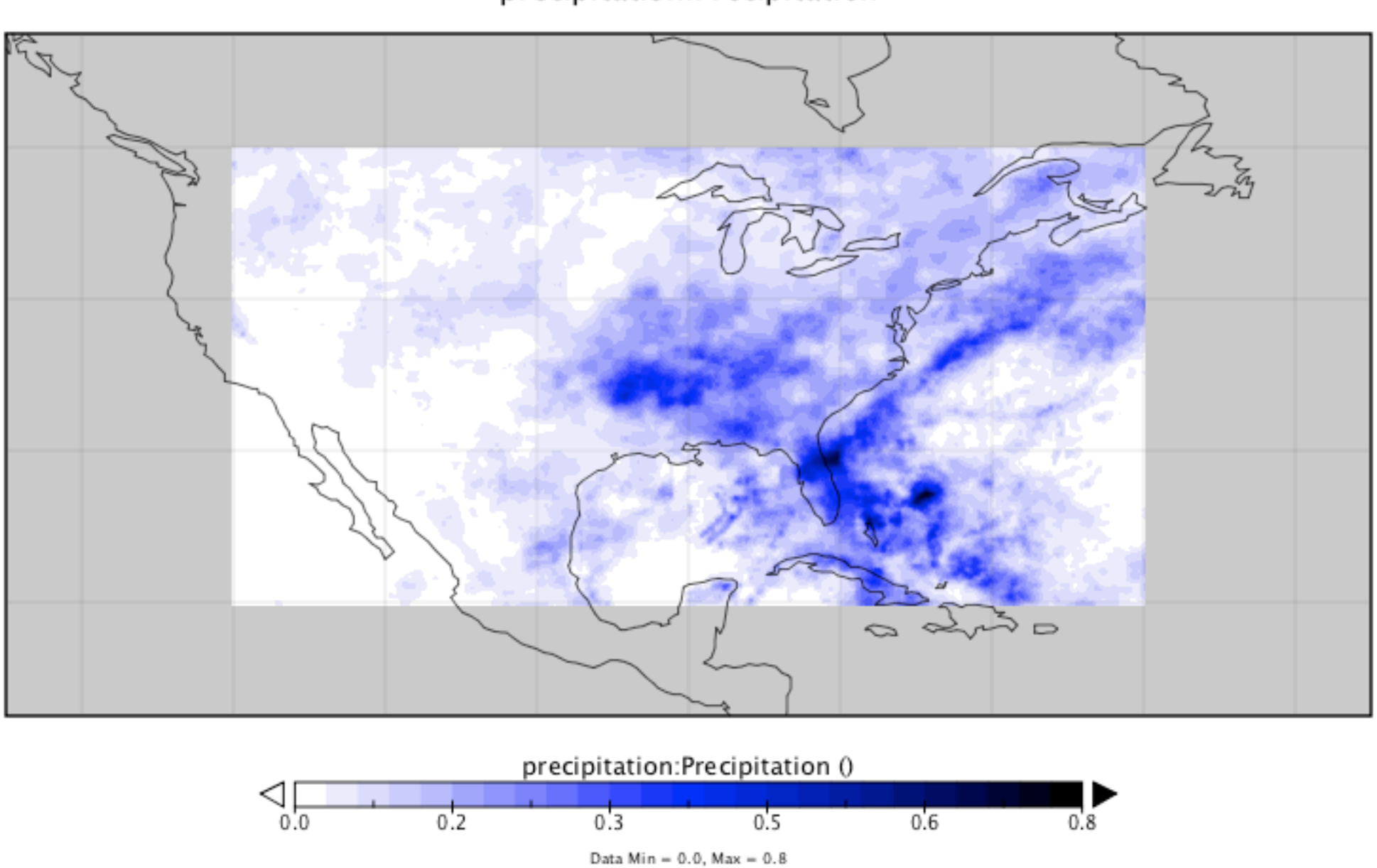
- Custom C++ code is expensive to maintain
- Z dimension scale values are hard to find in AIRS data
  - vdatas w/non-standard names
  - external documents
  - therefore: hard-coded in C++ class
  - *if only we could attach standard Z dimscales to the SDS*
- New class for each dataset

Solution #2: Lats4D Conversion

- Essentially a GrADS script from Arlindo DaSilva, NASA/GSFC/GMAO
- Same on-the-fly mechanism as NetCDF converter
- If you can read it into GrADS, you can convert it (usually)
  - Dimensions can be defined in GrADS control file
  - Limited to L3 and L4 gridded products
  - Handles both HDF-EOS and HDF
- Also supports subsetting



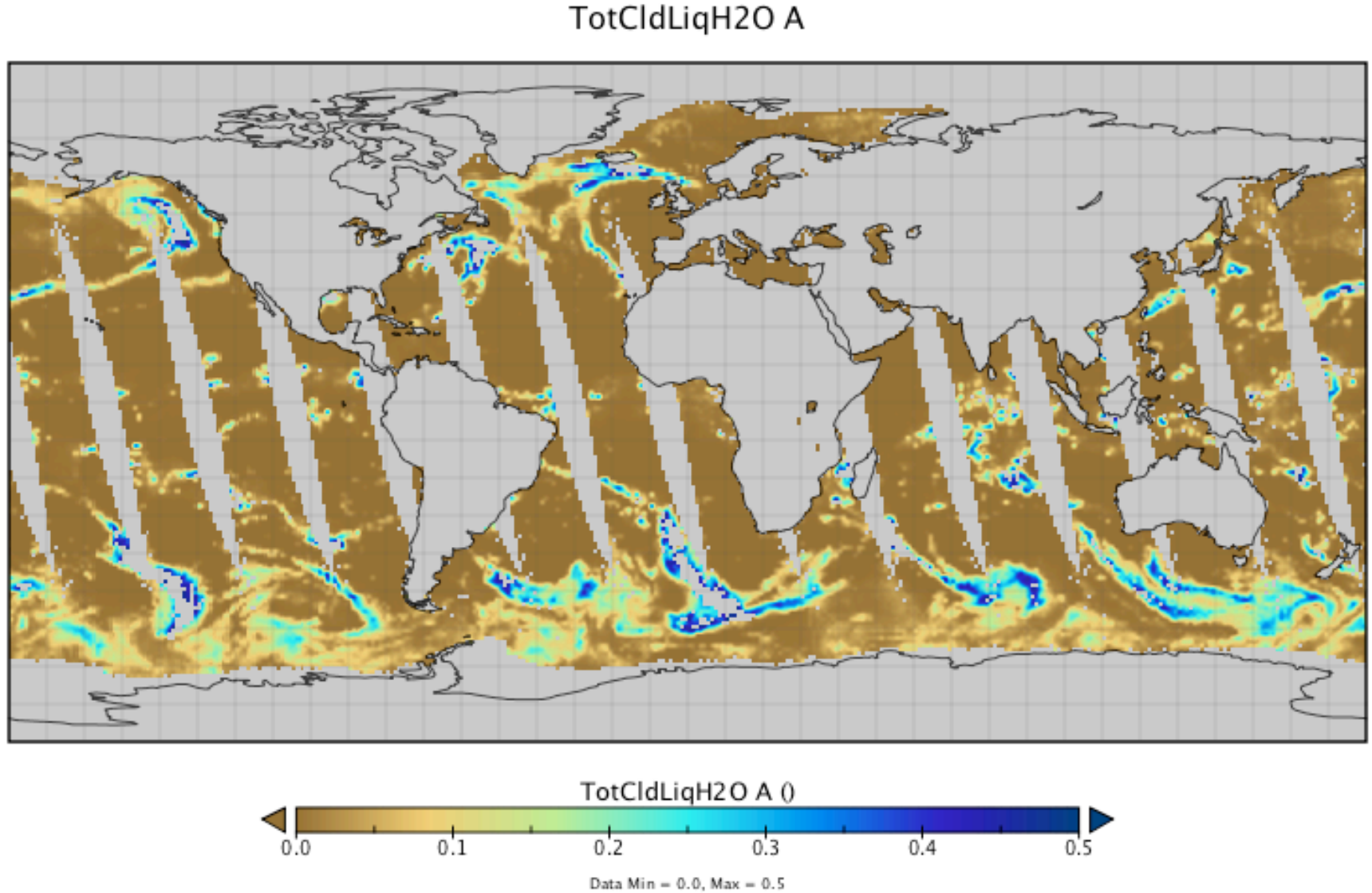
TRMM Monthly (May 2009) in Panoply Lats4D Conversion + Subset



Solution #3: OGC Web Coverage Service

- OGC WCS with netCDF/CF-1 profile
  - Supports subsetting
  - But: "prefers" interpolation to user's resolution
  - Requests are difficult for users to submit
  - Works better for machine-to-machine interfaces
    - DataFed
    - DLR
  - Using GMU-developed WCS Server

AIRS L3 via WCS in Panoply



wget -O airs_wcs.nc 'http://acdisc.sci.gsfc.nasa.gov/daac-bin/wcsAIRSL3?VERSION=1.0.0&SERVICE=WCS
&REQUEST=getCoverage&FORMAT=NetCDF&COVERAGE=AIRX3STD:ascending:TotCldLiqH2O_A
&BBOX=-179.5,-89.5,179.5,89.5&TIME=2007-04-07/2007-04-07/P1D&CRS=CRS:84&RESX=1.0&RESY=1.0'

Solution #4: OPeNDAP

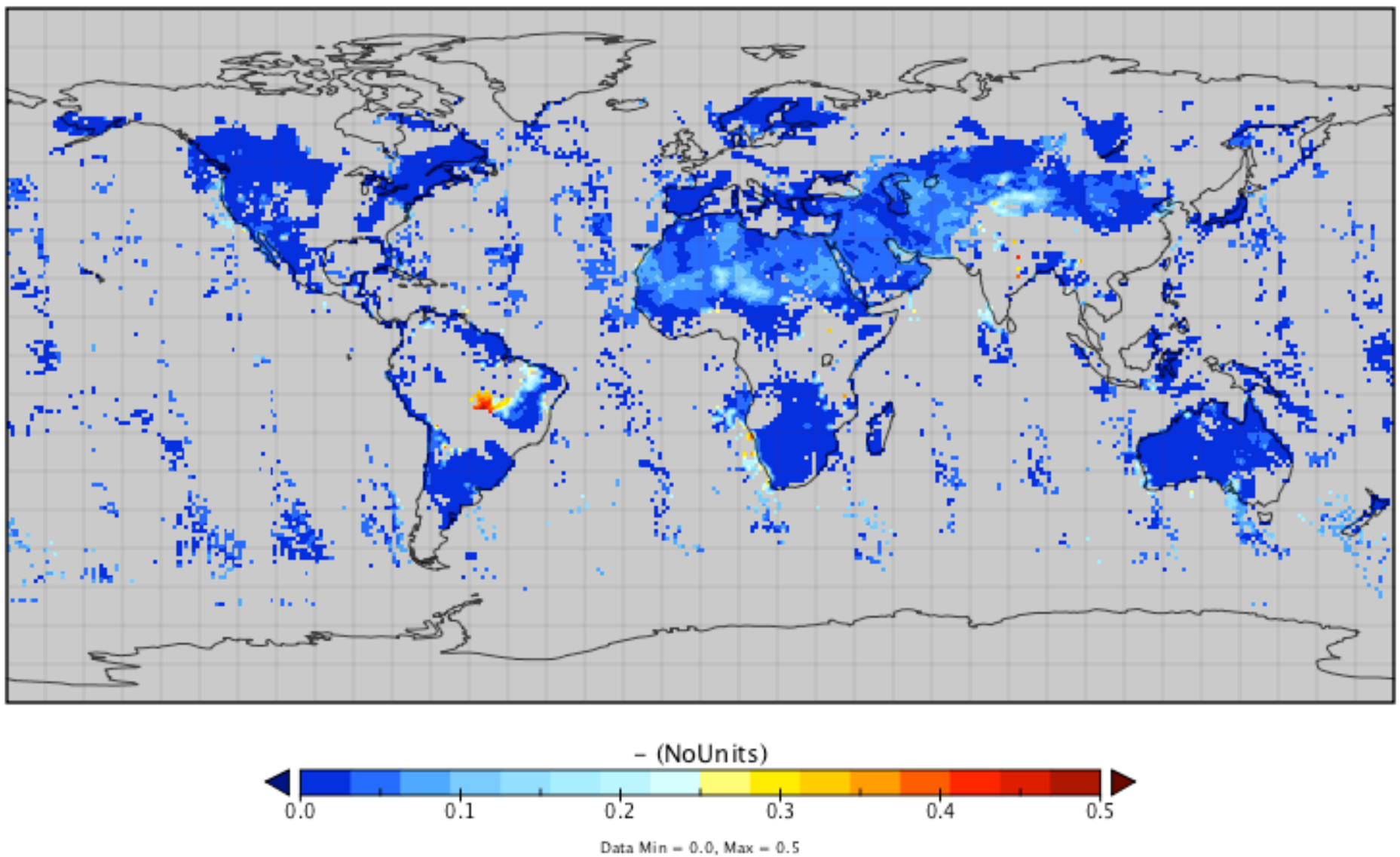
- HDF handlers
  - Released HDF5 version supports L3 grid
  - New HDF4 and HDF5 version supports
    - HDF4
    - L2 swath

OPeNDAP Usability Results

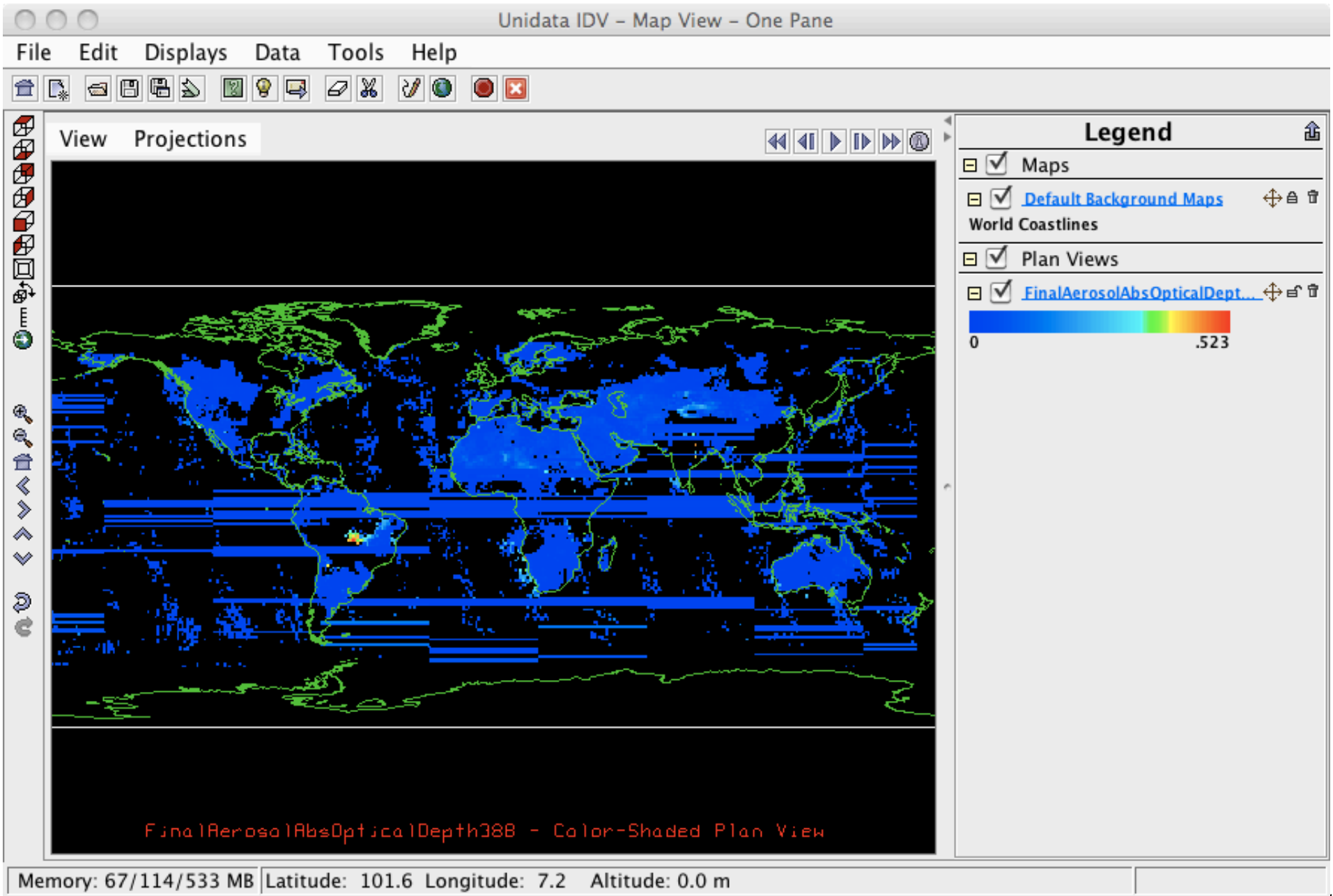
	IDV	Panoply	Ferret	GrADS	Comments
AIRS L3	✓	✓	✓	✓	exc. AIRX3C2M
MODIS L3	✓	✓		✓	latest version only
OMI L3	✓	✓	✓	✓	
TOMS L3	✓	✓	✓	✓	
AIRS L2	✓	✓	✓	x	
HIRDLS L2				x	
MLS L2				x	
MODIS L2	✓	✓	✓	x	so far: MOD04, MOD07
OMI L2	✓		✓	x	exc. OMIBRO, OMHCO, OMOCLO, OMUVB

OMI L3 NearUV AAOD via OPeNDAP in Panoply

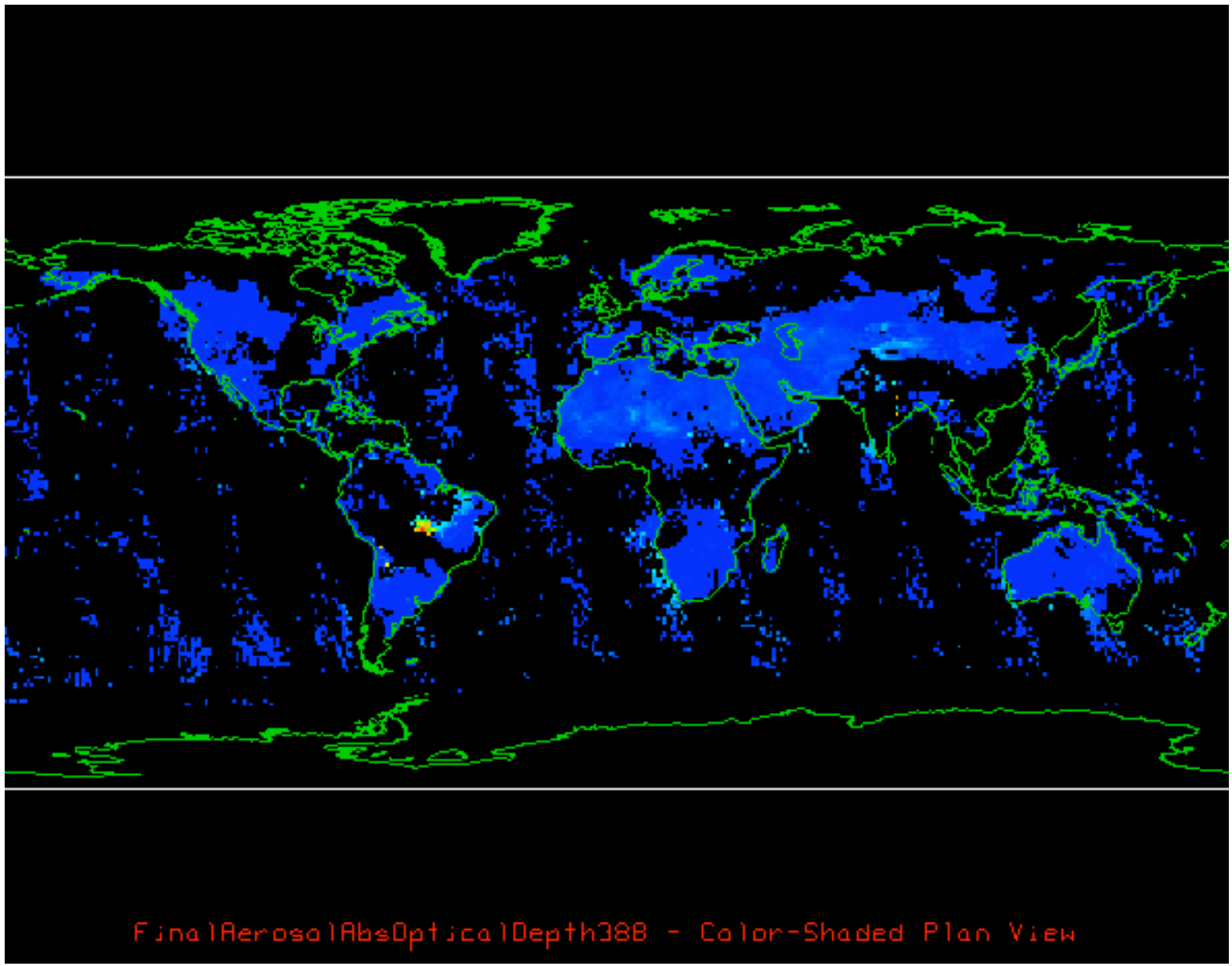
–



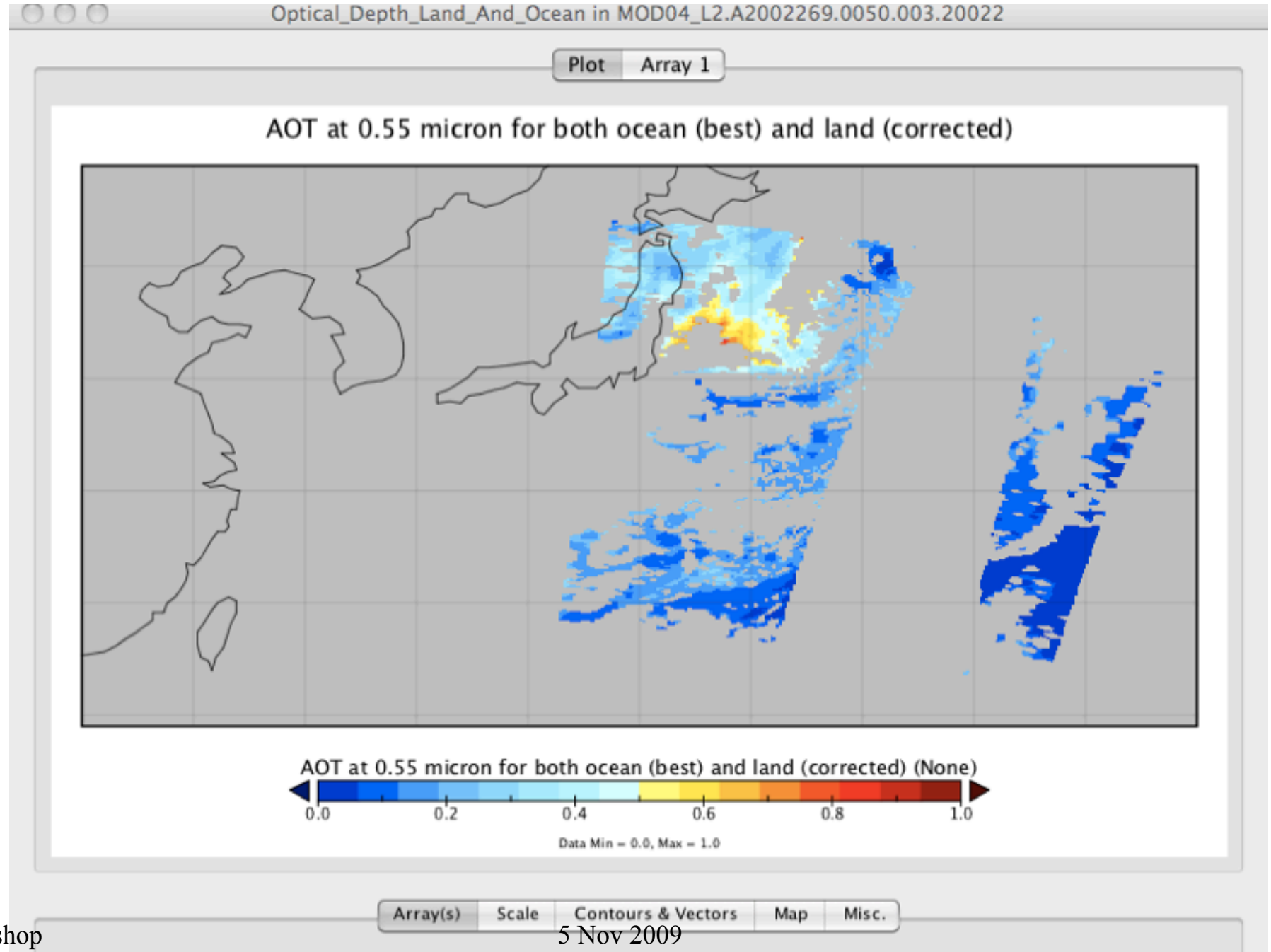
(but watch out for fast rendering in IDV)



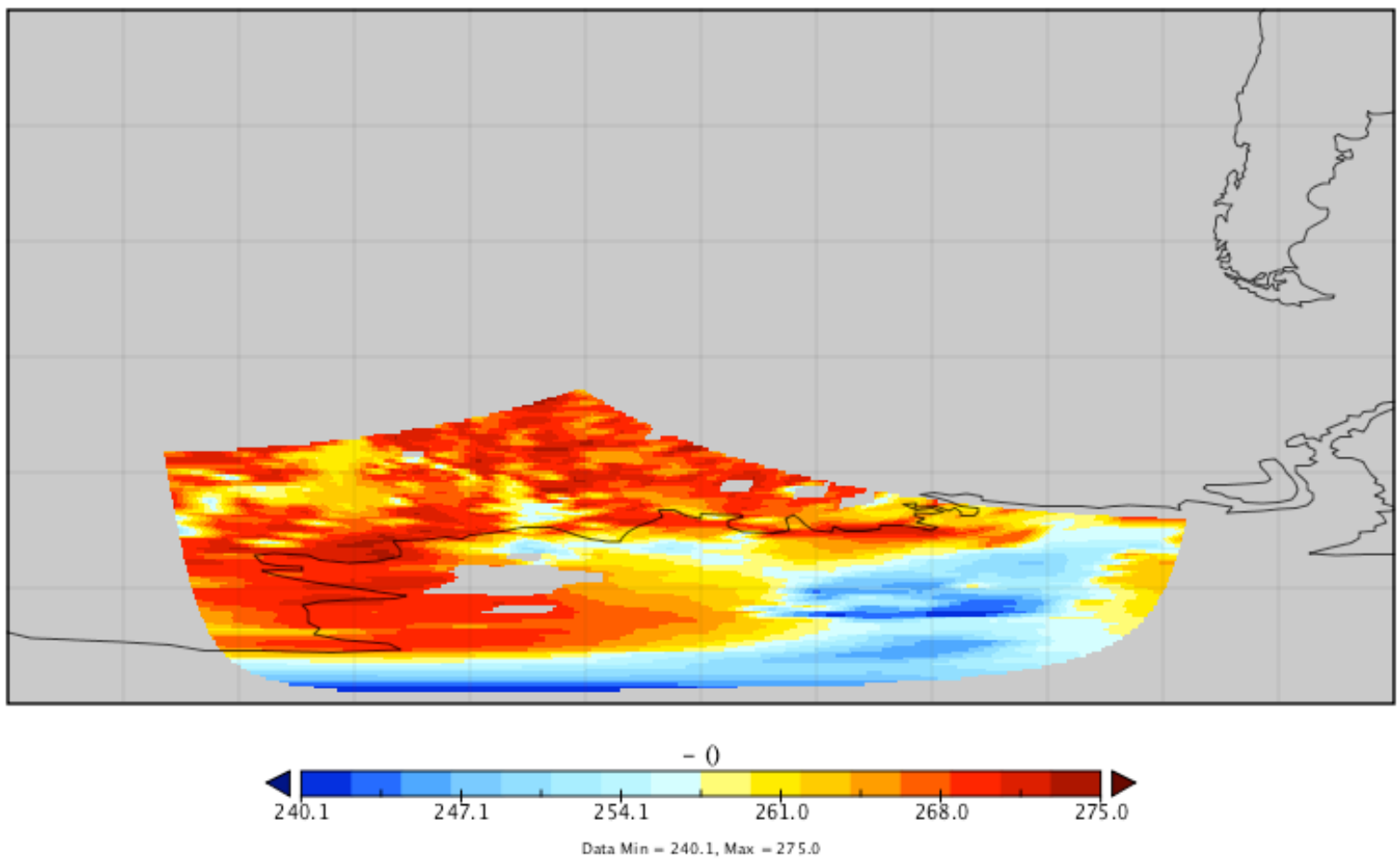
IDV w/fast rendering off



Panoply w/MODIS L2 via new OPeNDAP HDF4 handler



Panoply w/AIRS L2 via new OPeNDAP HDF4 Handler

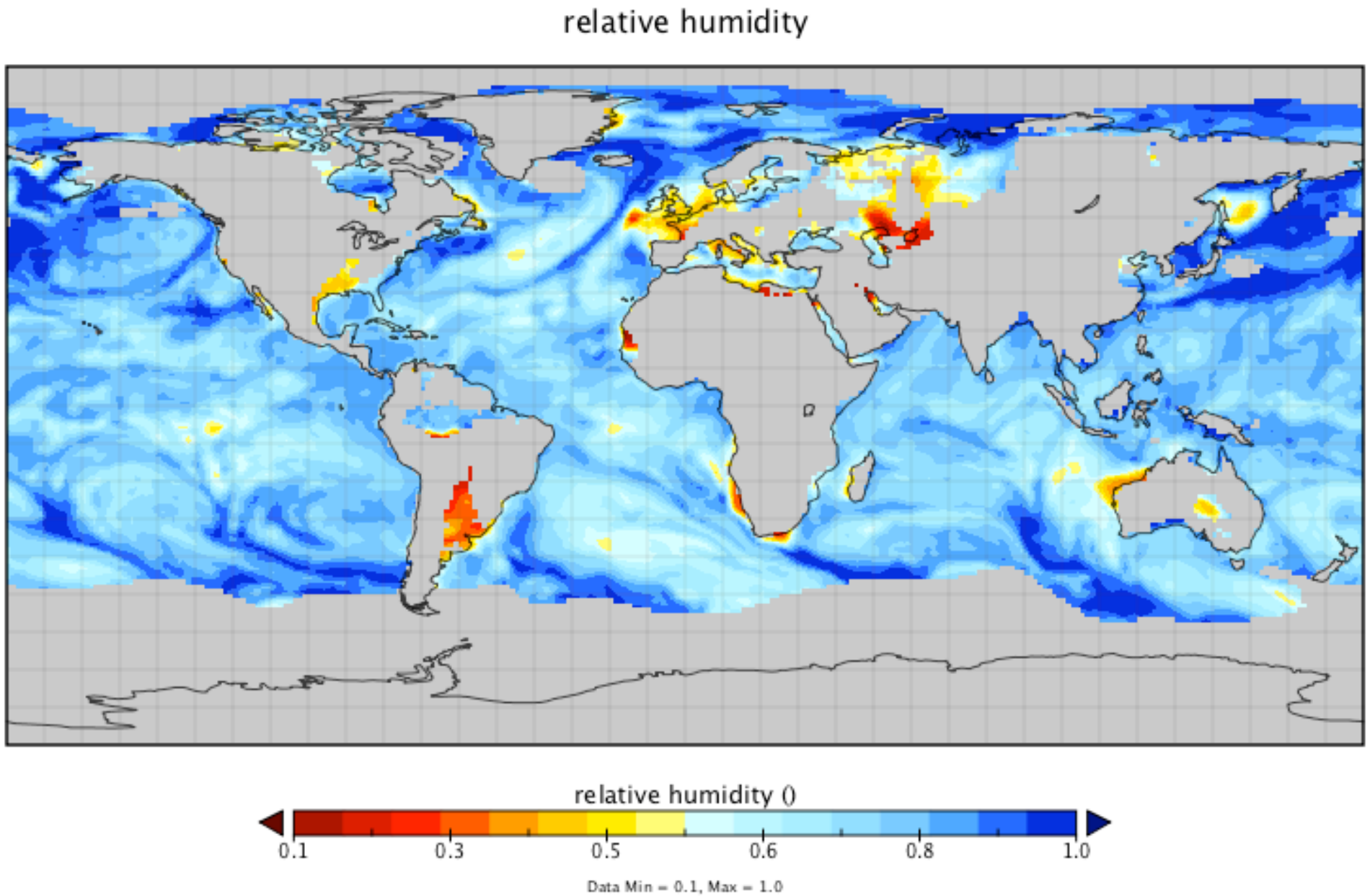


- Cool..but who projected the data and how?

Solution #5: GrADS Data Server

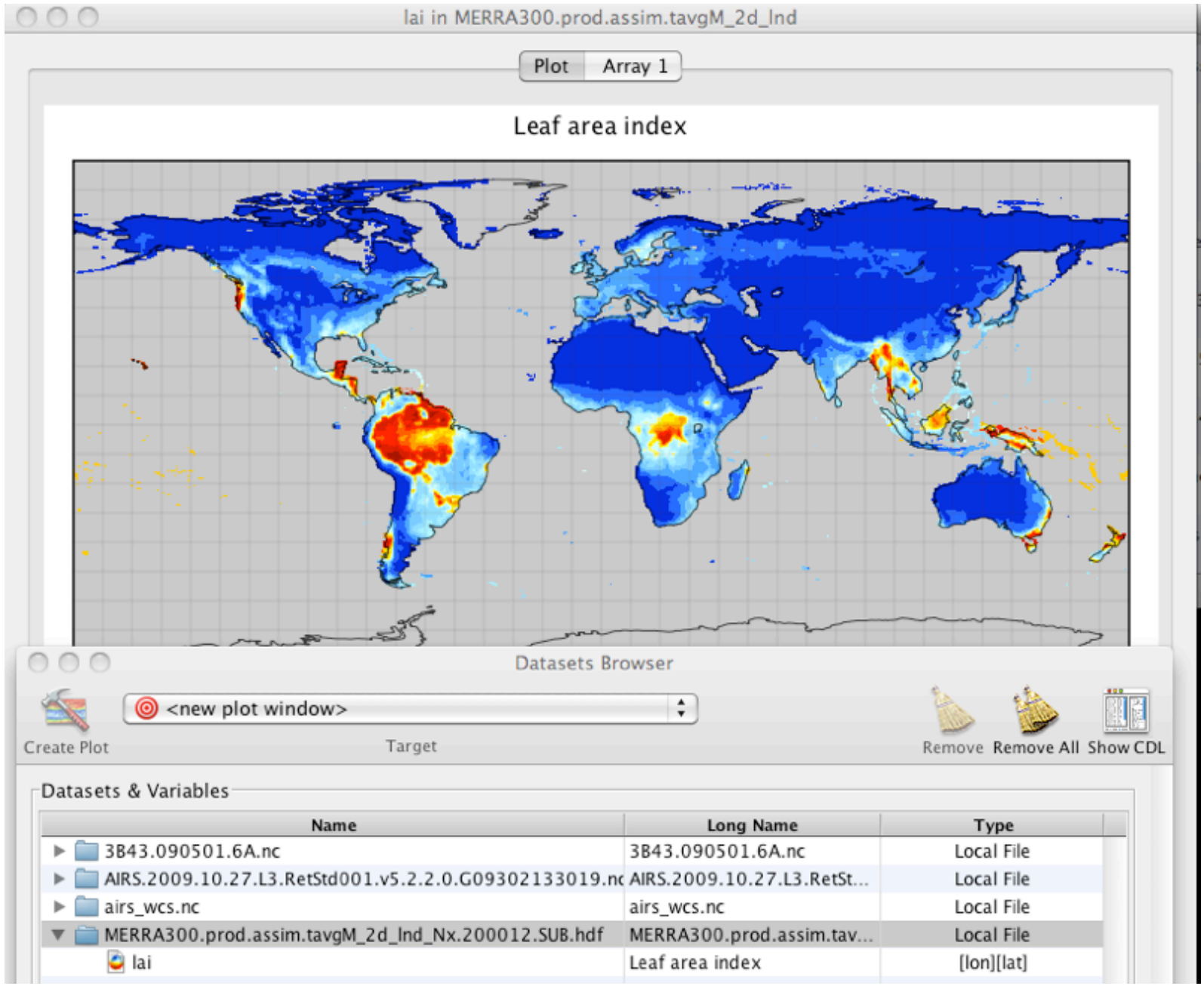
- DAP protocol, but data read by GrADS
  - Sort of like an OPeNDAP with a GrADS handler
  - If you can read it in in GrADS...
- Includes time aggregation
  - (Not *always* a good thing)

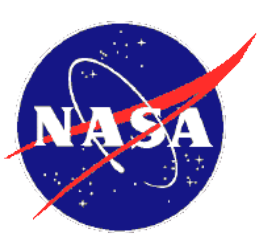
MERRA via GDS in Panoply



Solution #6?: netcdf library

MERRA ***HDF*** Subset from Lats4D in Panoply

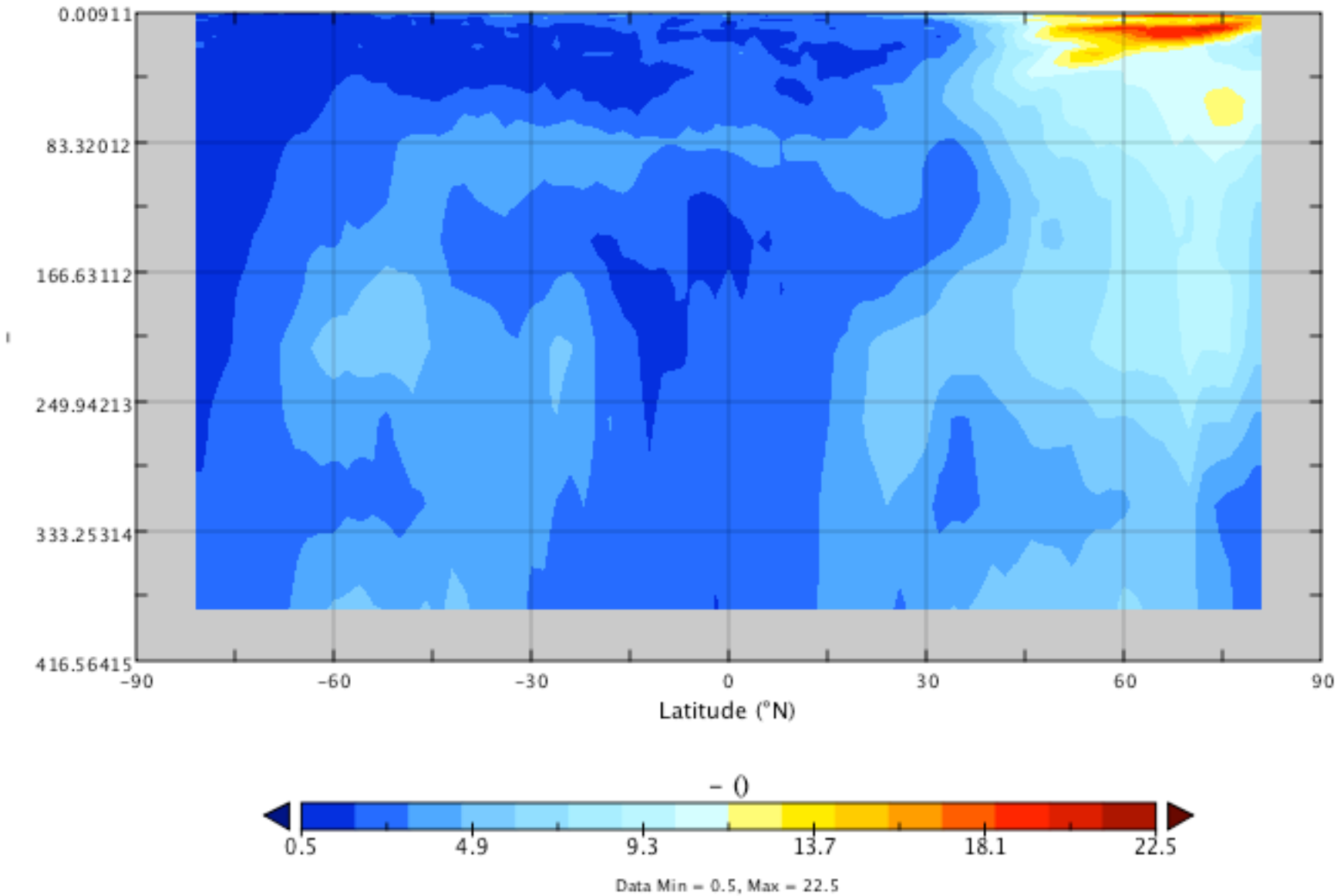


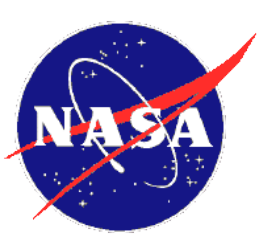


netcdf libraries

- netcdf-java library can read some HDF files
  - But not HDF-EOS...
    - Tried adding lat/long dimscales to an HDF-EOS2 grid, to no avail
  - Except for an MLS L3 HDF-EOS5
    - (not a standard product)

Panoply, using netcdf-java w/ MLS L3, HDF-EOS5



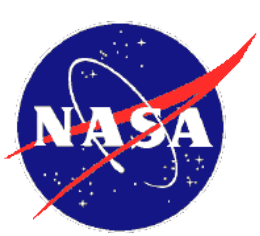


Can we make netcdf libraries read HDF-EOS?

- Might require joint effort between UCAR, THG and tool developers to develop and debug...
- OR, solution might emerge from HDF-EOS5 / netCDF-4 Augmentation effort
- ...BUT
  - could make a *lot* of conversions unnecessary
  - would make data usage much easier for users

Trade Space

	Pros	Cons
Custom C++ Conversion	L2 swath + L3/L4 grid Fast	Costly Data size expansion
Lats4D Conversion	Easy to add HDF + HDF-EOS	L3/L4 grid only Slow
WCS	Subsetting	Interpolation Costly
OPeNDAP	L2 swath + L3/L4 grid Efficient Inexpensive	Reprojects L2 swath
GrADS Data Server	HDF + HDF-EOS	L3/L4 only Slow
netcdf library	**Enables many tools** **Obsoletes conversion**	**HDF-EOS**



Future of HDF-netCDF Tool Interoperability: Key Challenges

- Level 1b data (calibrated radiance)
  - How should we fit the channel/wavelength dimension into CF1?
- Level 2 in native swath coordinates
- netCDF library direct access to HDF-EOS
- Non-self-describing implementations of HDF
  - e.g., NPP