Introduction to MISR Data Analysis and Tools

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Exploring and Using MISR Data
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SOM Background

Figure A-3 Sample Partial MISR Swath in SOM vs. Distorted Geographic Lat/Lon

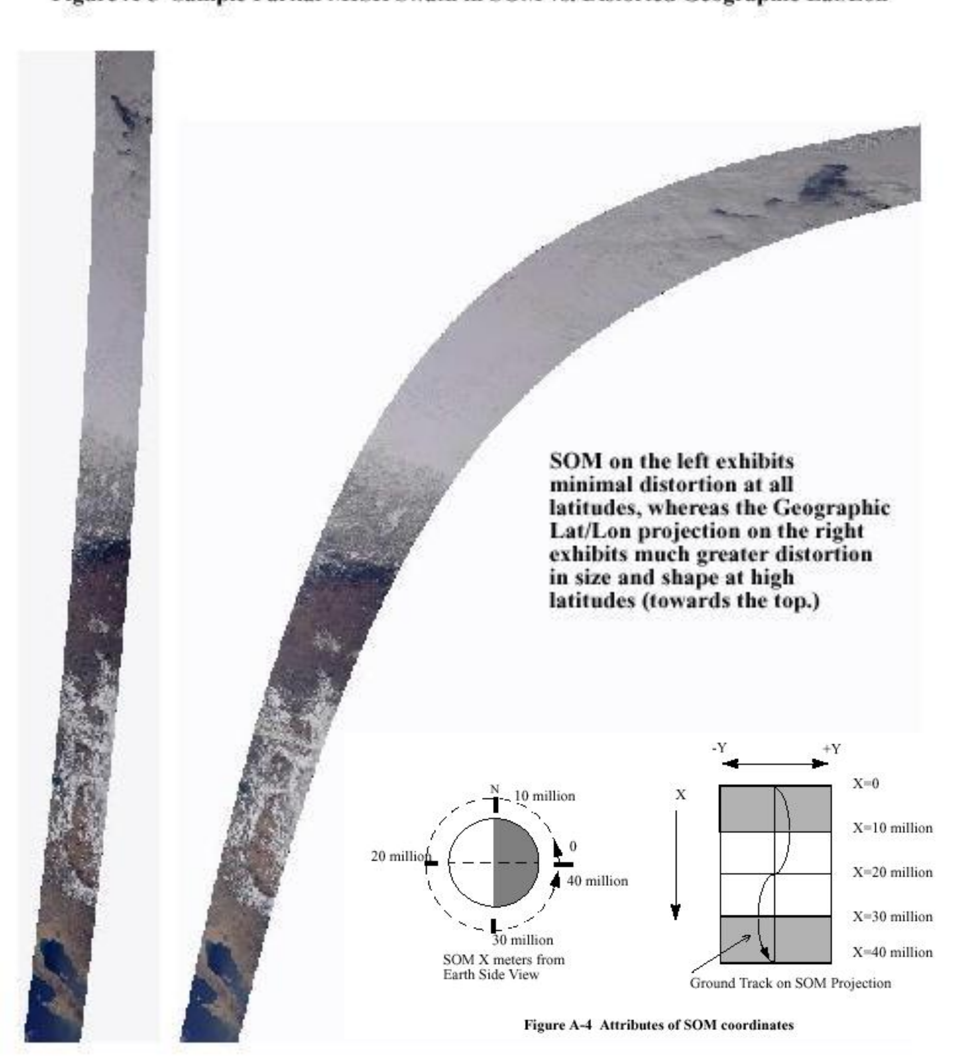


Figure A-4 Attributes of SOM coordinates

The Space Oblique Mercator (SOM) map projection was developed to support LandSat which covers the same large geographic extent as MISR.

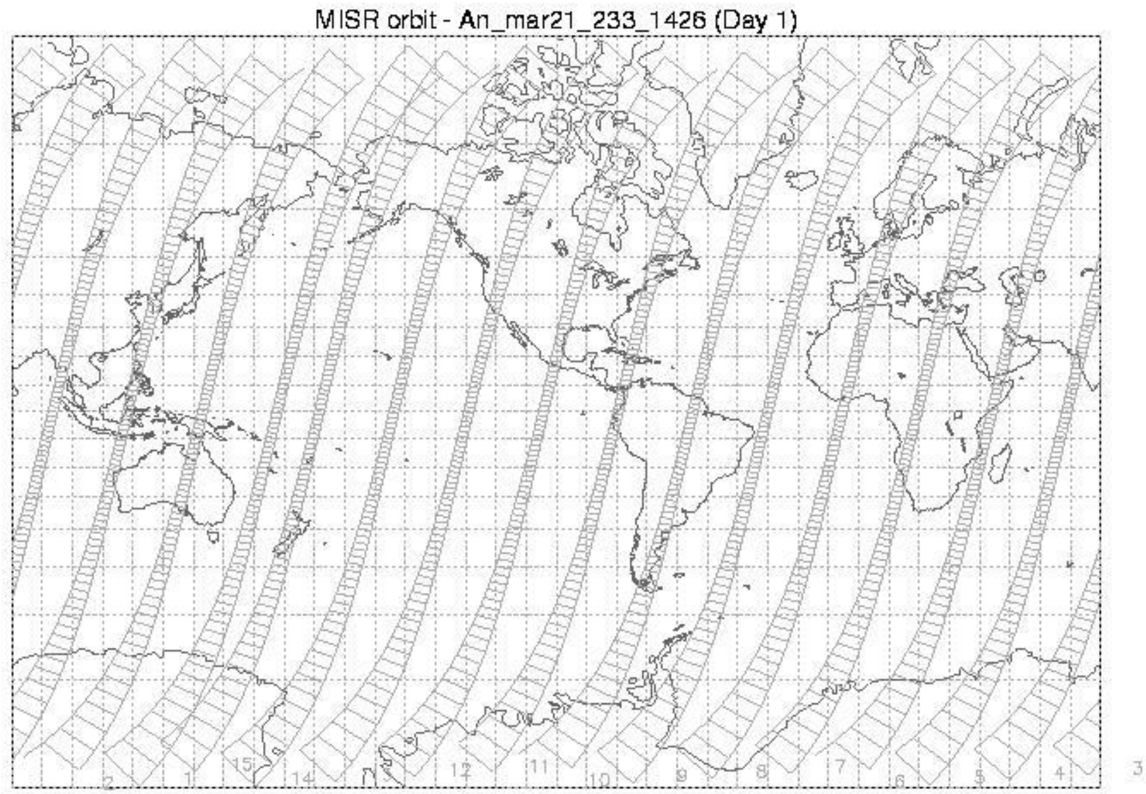
SOM was designed to minimize the shape distortion and scale errors throughout the length of the MISR swath near the satellite ground track.

SOM X is in the direction of the Spacecraft ground track and SOM Y is perpendicular X

SOM Background

- **Terra follows a pattern of orbits which repeats after 233 unique orbits**
- **Each of the 233 possible orbits is called a path**
- **SOM defines a separate projection for each of these paths**
- **For MISR, a path begins at a particular longitude as the satellite crosses the ascending node.**
- **This path implies a specific longitude of ascending node, which implies a specific SOM projection applicable to that path**

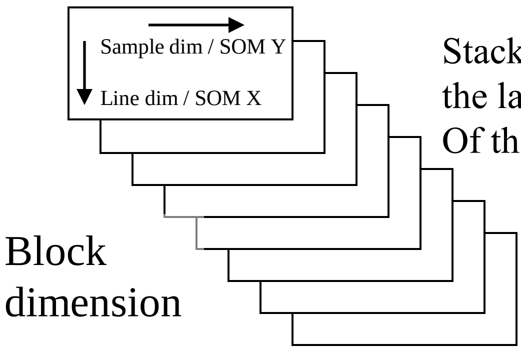
MISR Orbital Paths/Blocks



MISR HDF-EOS “Stacked Block” File vs. Aligned File

Standard Product Files are “Stacked-Block”

Red Channel Grid SDS (180 Stacked Blocks)



Stacked blocks are due to the large geographic extent Of the MISR swath

-SOM coordinates of top-block corners part of Grid metadata.

-Projection and orbital parameters part of Grid Metadata

-Offsets of each block from the one above is part of Stacked-block grid extension metadata.

Conventional Product Files & Browse Product Files are Aligned

MISR HDF-EOS "Stacked Block" Background

HDF-EOS routines do NOT assemble the blocks. That is left for the user.

180 blocks are defined for every MISR Product to make block index in absolute.

However, roughly 142 blocks have data for any given orbit. The extra blocks are to allow for seasonal variation.

We are working on a Conventional Grid Product Specification that will not use stacked blocks, although we will preserve them for Standard Processing.

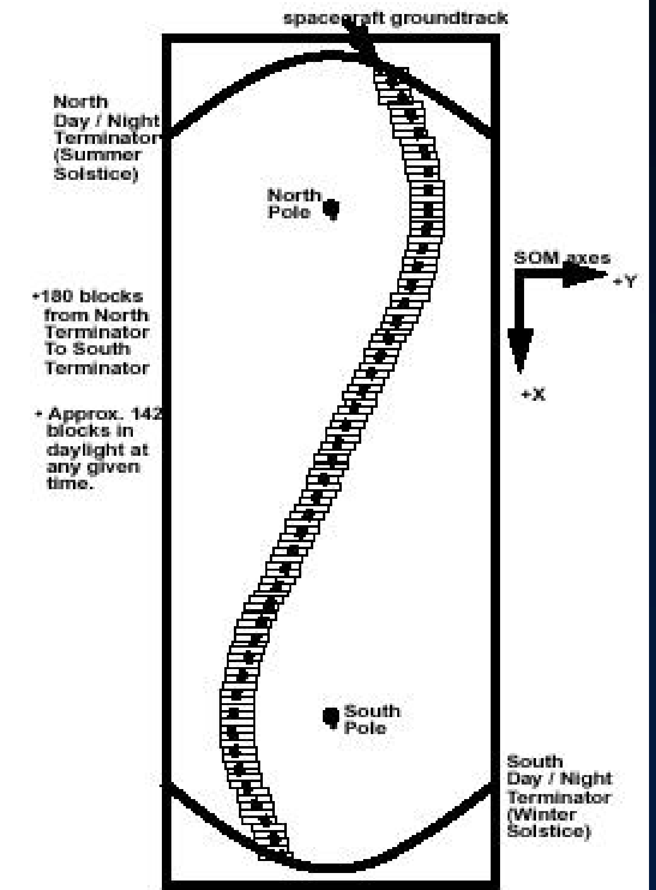


Diagram representing the 180 block series covering a MISR path.

Where does this pixel belong with the MISR HDF-EOS "Stacked Block" Scheme?

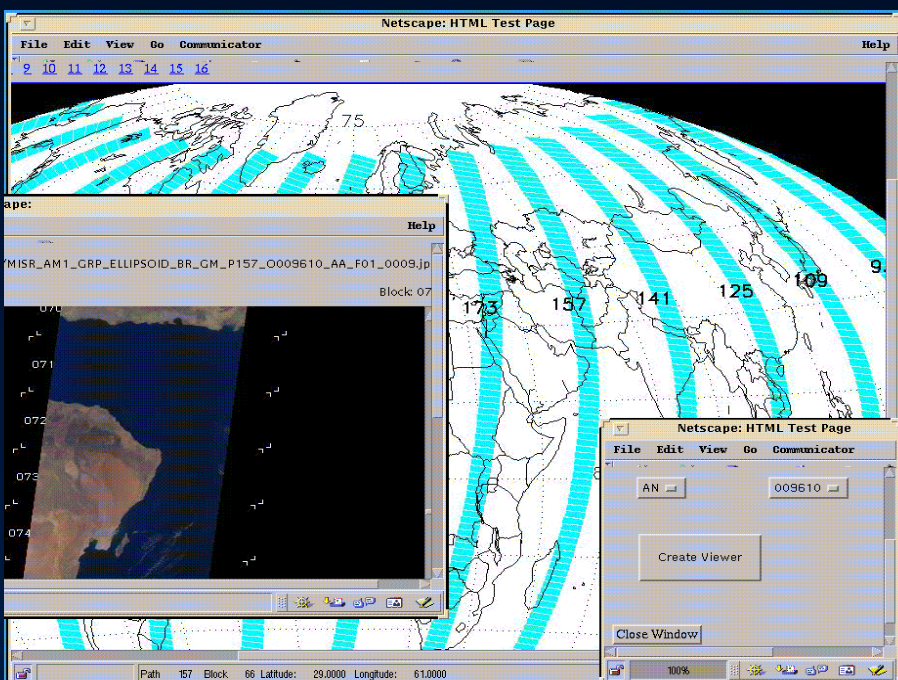
- Inside the HDF-EOS "stacked block grid" = (block, line, sample)
- Convert (block, line, sample) <-> SOM (x,y)
  - Requires several metadata values and some arithmetic.
- Convert SOM (x,y) <-> Lat/Lon
  - Requires use of GCTP map projection coordinate conversion library in HDF-EOS distribution.
- Units: Integral block, fractional line/sample; meters x/y; decimal degrees Lat/Lon.
- This process is described in the MISR Data Product Specification, Appendix A.
- Or simply look up the Lat/Lon of the corresponding block, line, sample in the Ancillary Geographic Product (AGP) datasets (1.1km).

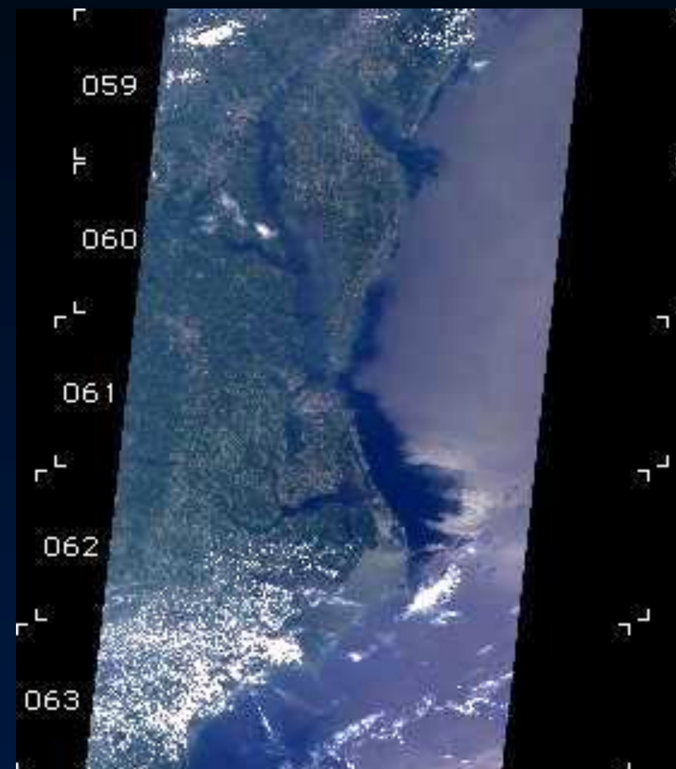
MISR L1B2 Browse Product

JPEG format true-color imagery, all 9 cameras, 2.2 km sampling

Color, multi-angle browse products and on-line interactive viewer available at

http://eosweb.larc.nasa.gov/MISRBR/





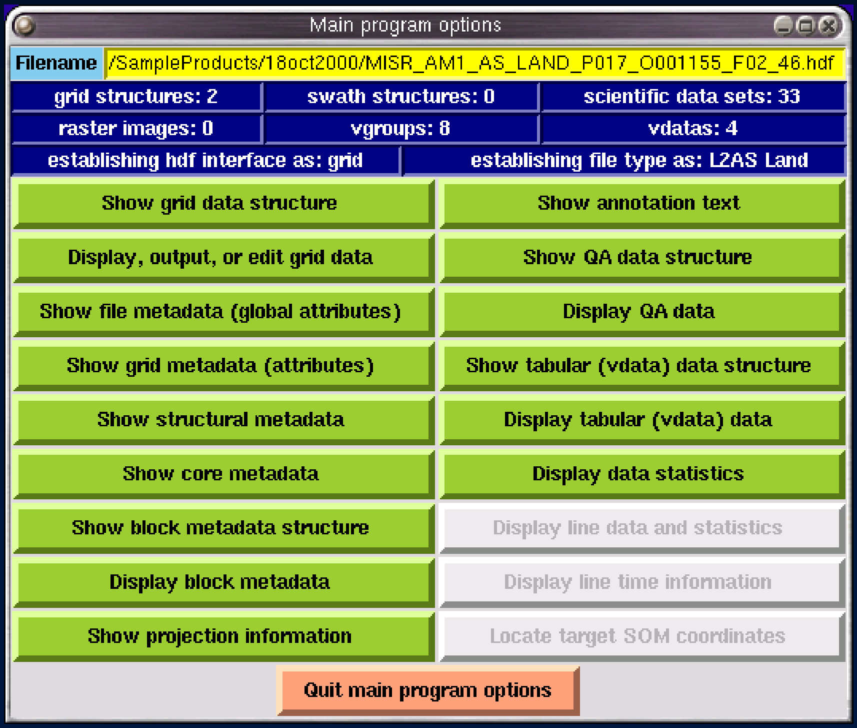
Actual browse resolution

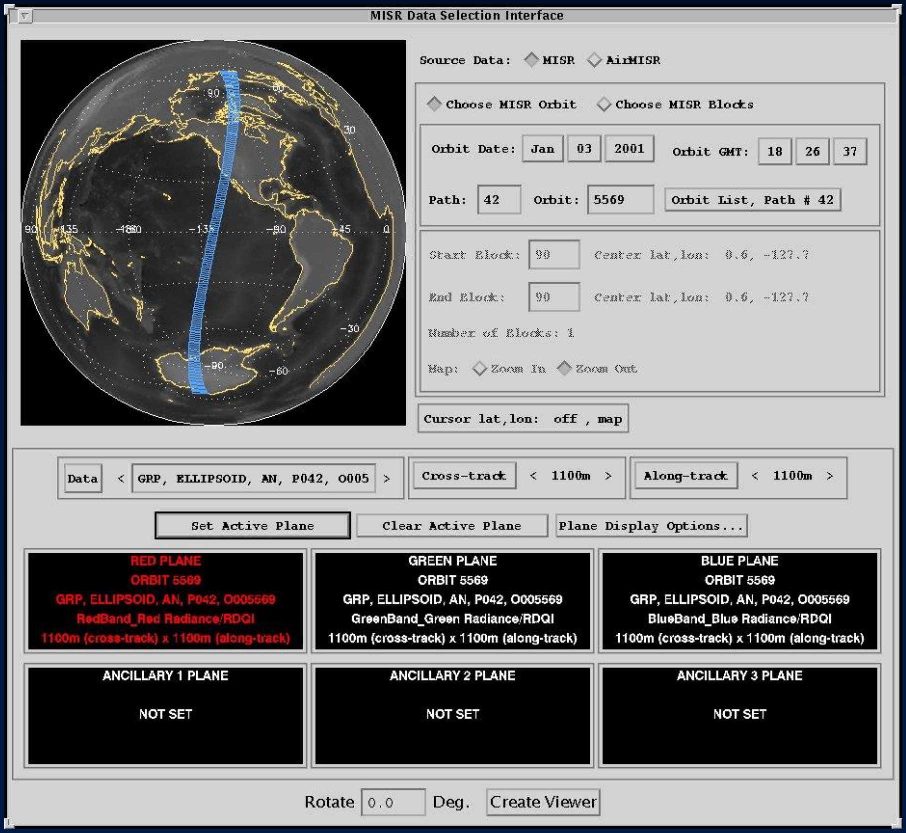
Actual browse extent

MISR Developed Data Visualization and Analysis Tools

For the “Stacked Block” Products

http://eosweb.larc.nasa.gov/HBDOCS/hdf_data_manipulation.html





Hdfscan
For the “Stacked Block” Products

- Very useful during the debugging process
- Displays all HDF-EOS Attributes, SDS’s, Vdata’s easily
- Allows minor editing of the HDF-EOS file
- Performs some statistics on the data
- Does not assemble MISR blocks
- Written in Fortran 90 and Tcl/tk
- Only available on SGI Irix and Sun Solaris

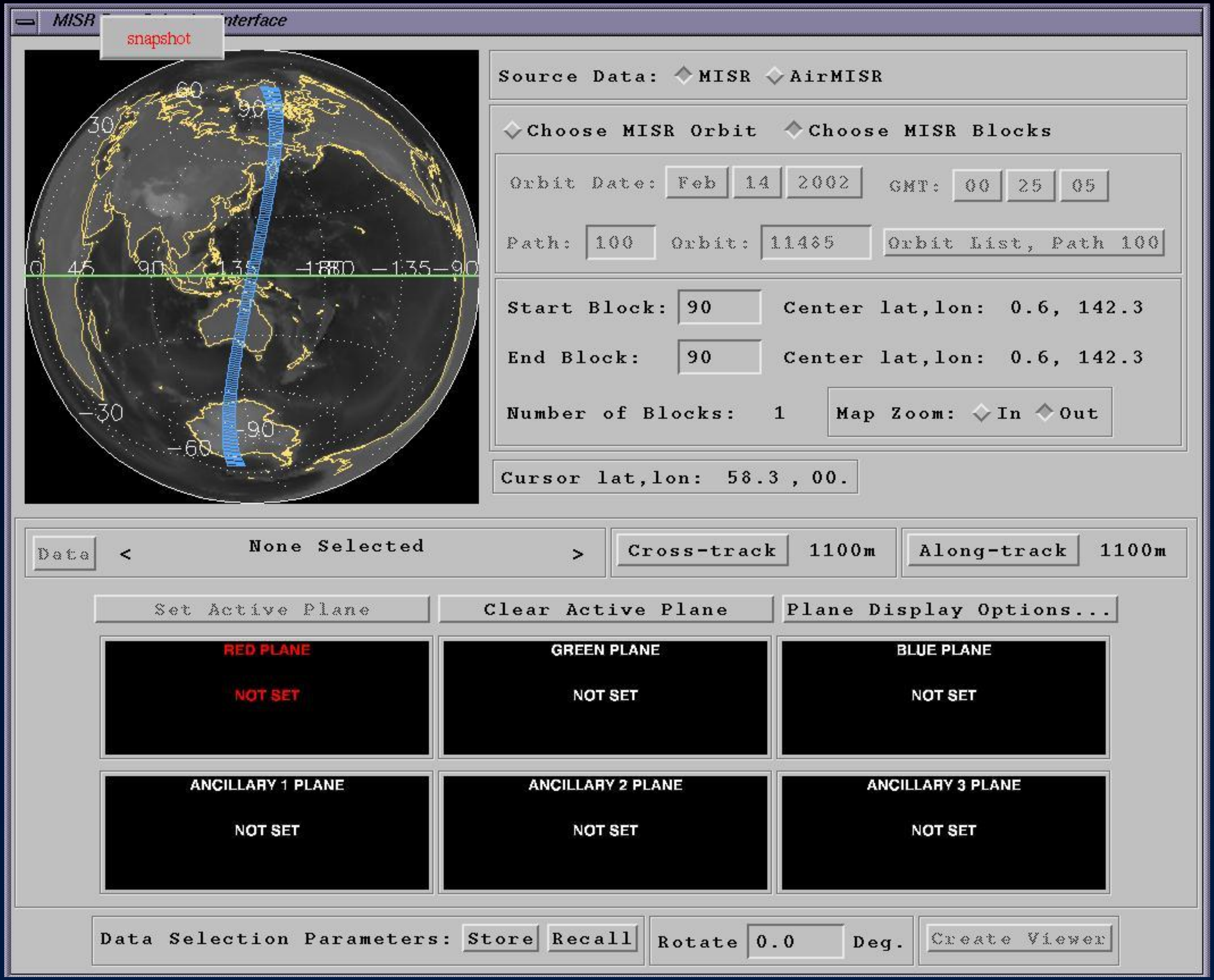
Hdfscan - Locate Path/Block Display using AGP

MISRView
For the “Stacked Block” Products

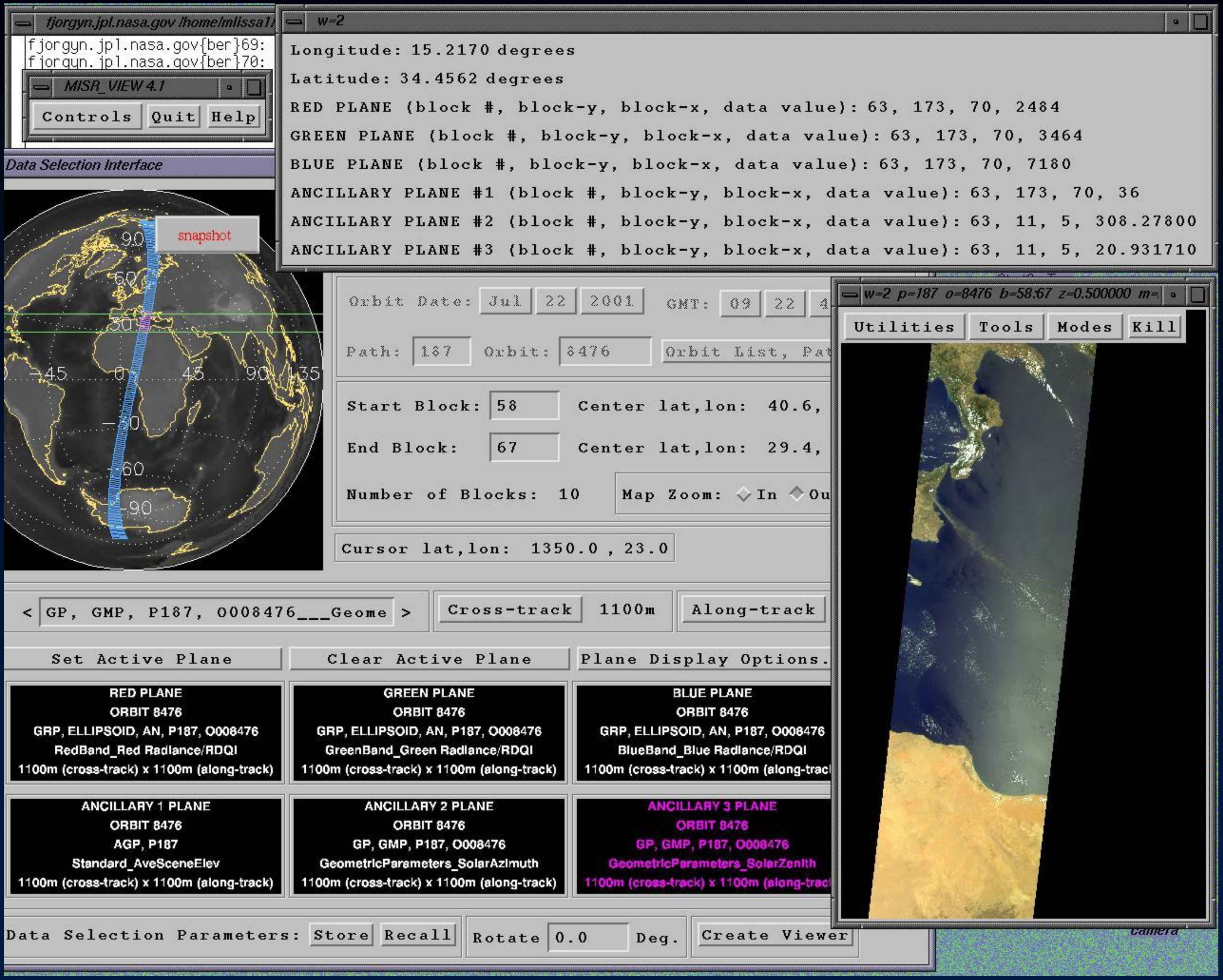
- Maps path/orbit to time and date
- Assembles MISR blocks
- Reports Lat/Lon using the AGP
- Displays true color MISR imagery
- Can reproject MISR imagery
- Requires IDL or IDL VM

- Perspective tool
- Band slider tool
- Scroll tool
- Vector overlay tool
- Reprojection tool
- Color / Contrast tools

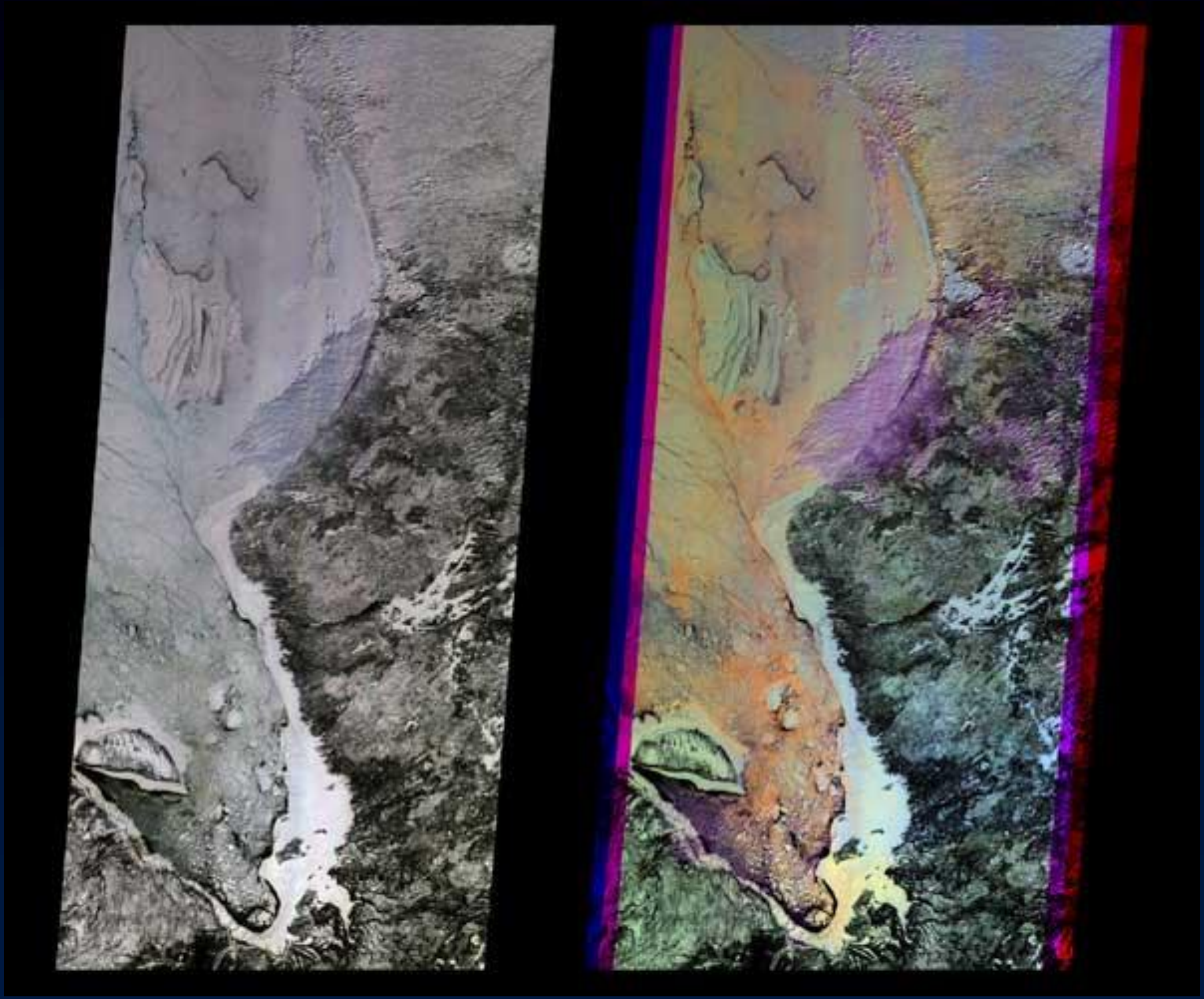
MISRView – Main Menu



MISRView – L1B2 imagery

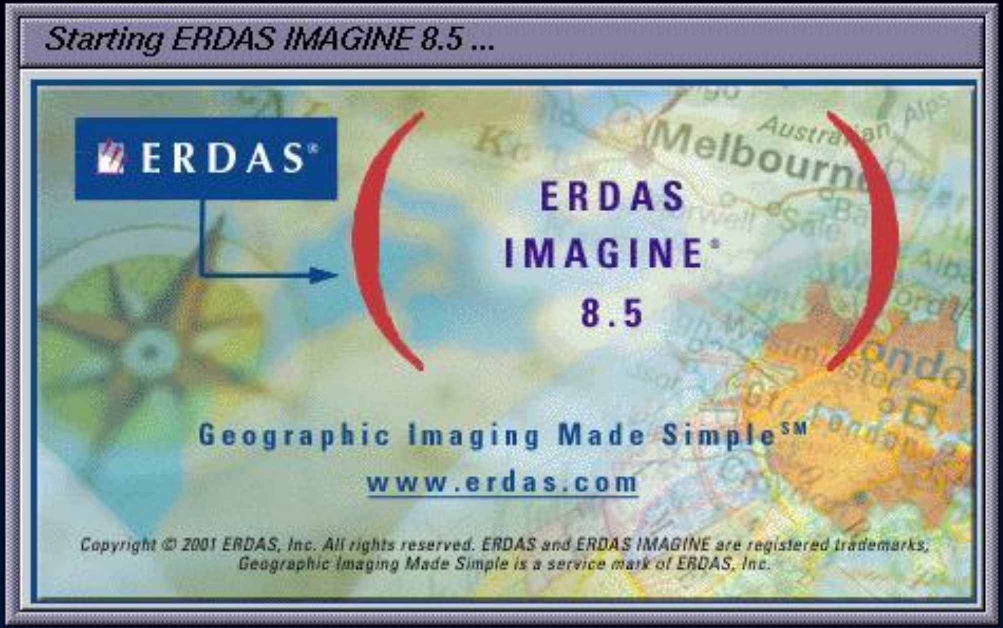


MISRView – MISR Vision (R-Ba, G-An, B-Bf)



ERDAS Imagine

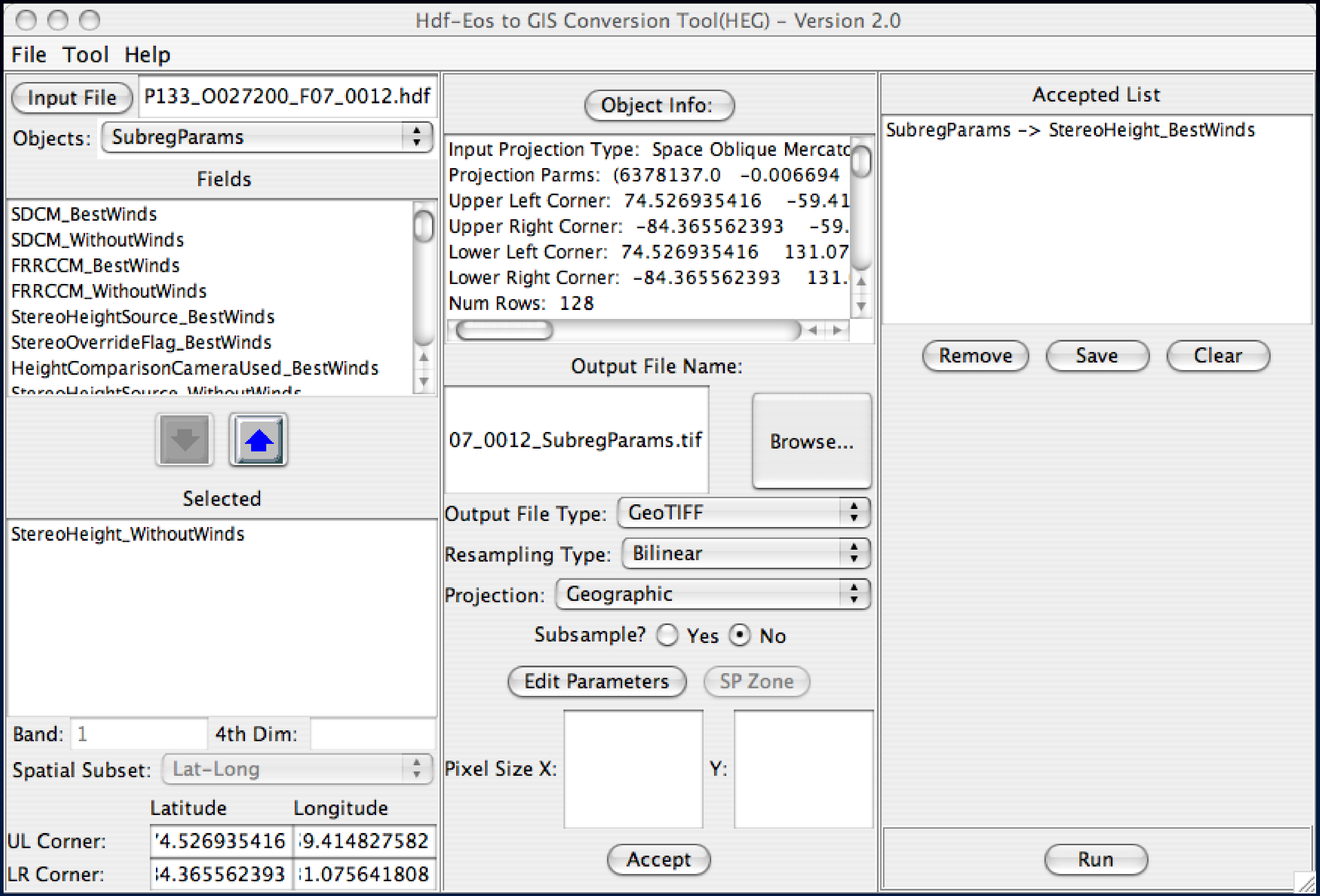
For the “Stacked Block” Products



- Used to assist in validating the geo-calibration of MISR data. We wrote custom import routines to convert MISR HDF-EOS “Stacked Block” files into Imagine files preserving geo-location via stored metadata and projection parameters.
- Unfortunately, these are not generally available and are only for SGI Irix.
- An alternative involves using - **HDF-EOS to GIS converter (HEG)** to convert to geotiff and then import the geotiff file into Imagine.
- http://eosweb.larc.nasa.gov/PRODOCS/misr/tools/geotiff_tool.html

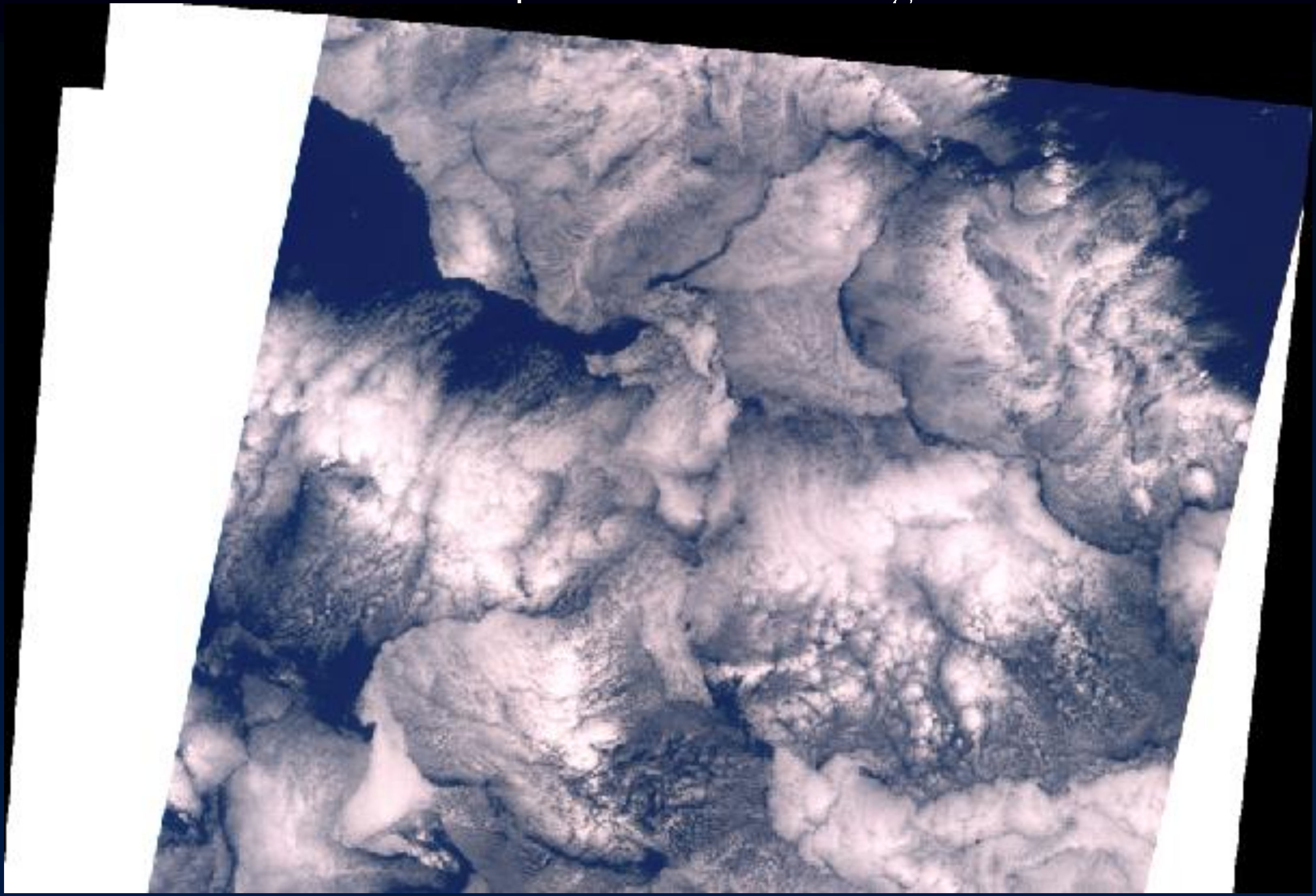
Hdf-Eos to GIS Conversion (HEG)

For the "Stacked Block" Products

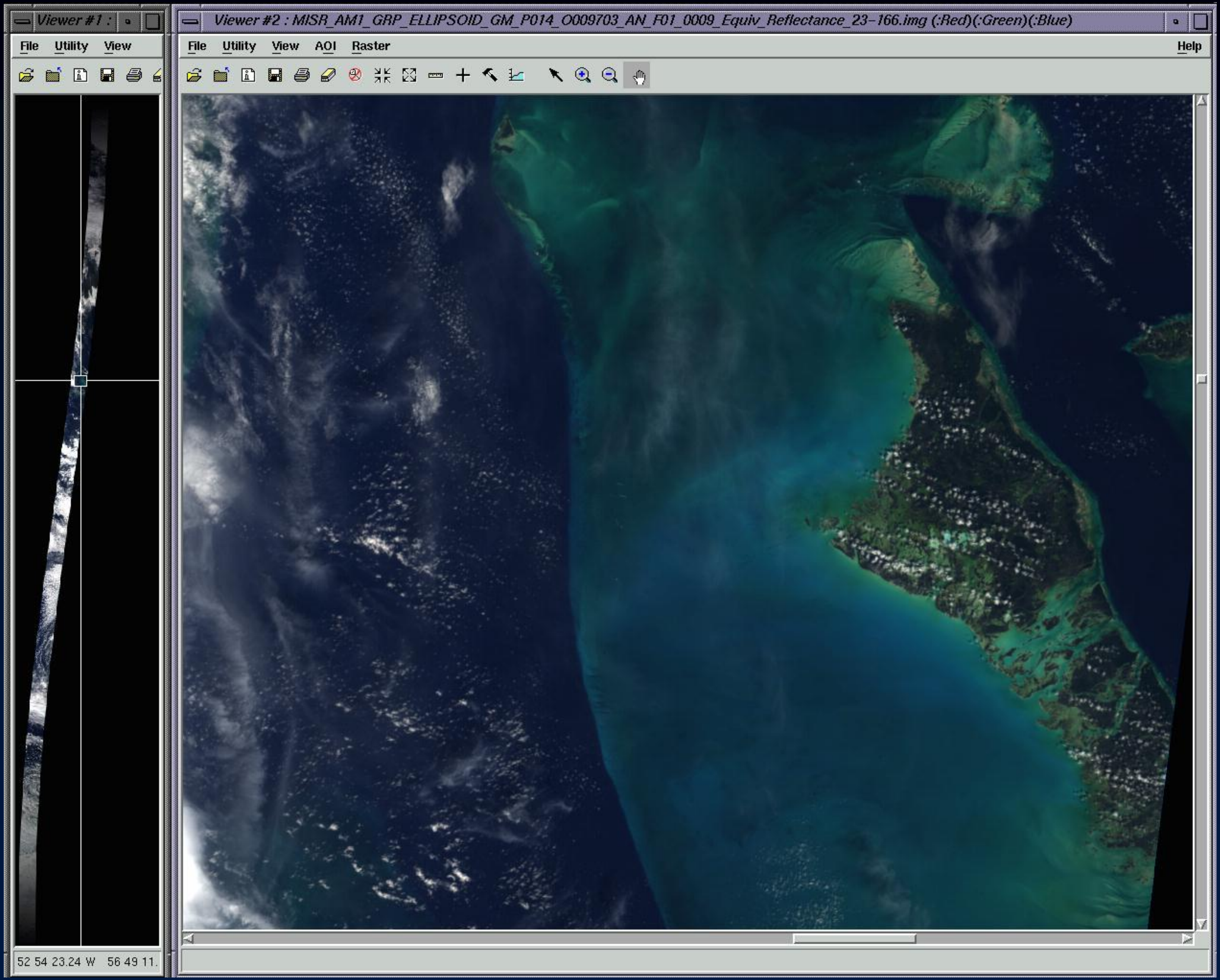


HEG Geographic Lat/Lon Projected GeoTiff

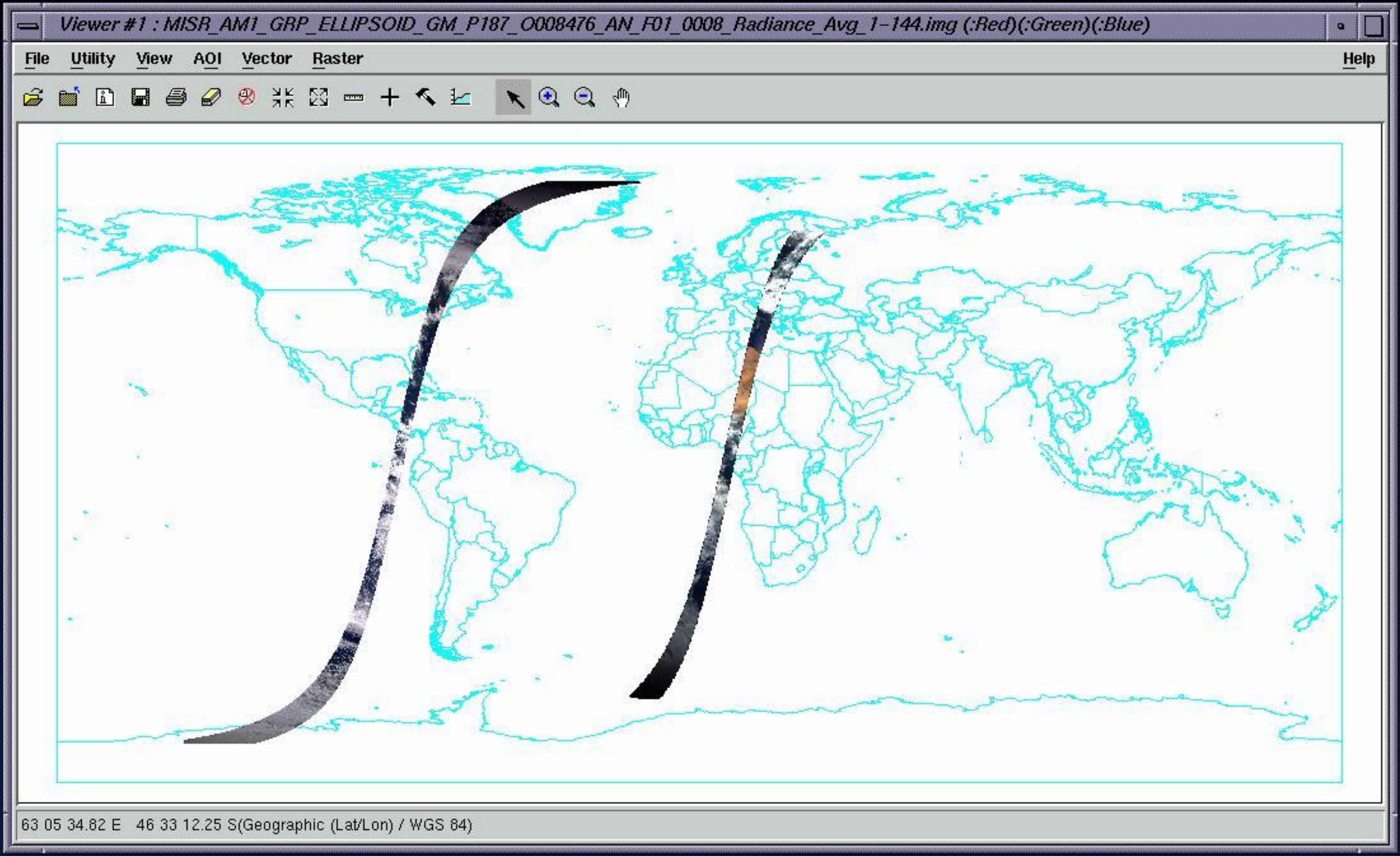
Next Import into ERDAS Imagine



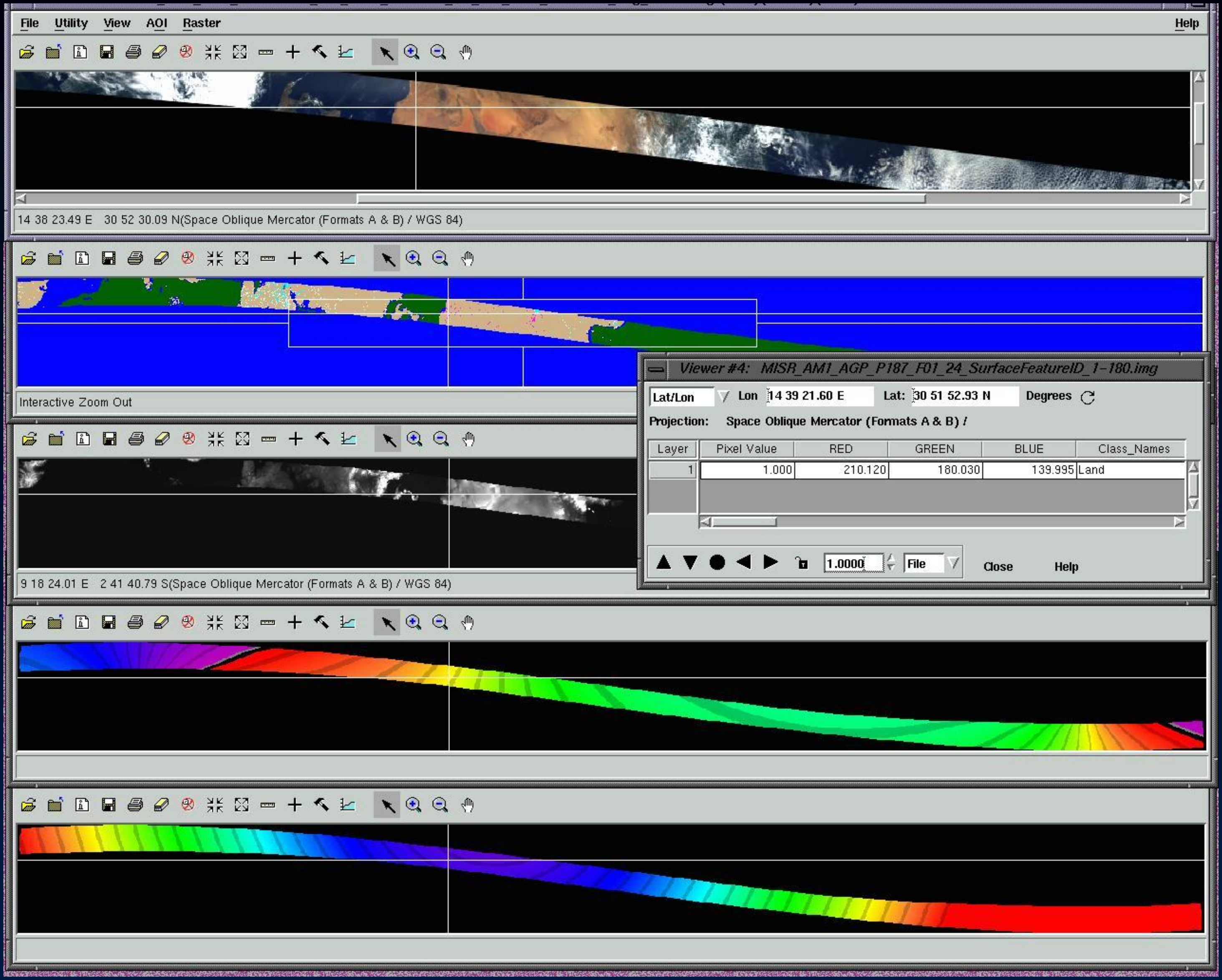
ERDAS Imagine – Full Swath/Full Res. Geo-linked



ERDAS Imagine – Raster/Vector Overlay



ERDAS Imagine – GIS Data Analysis

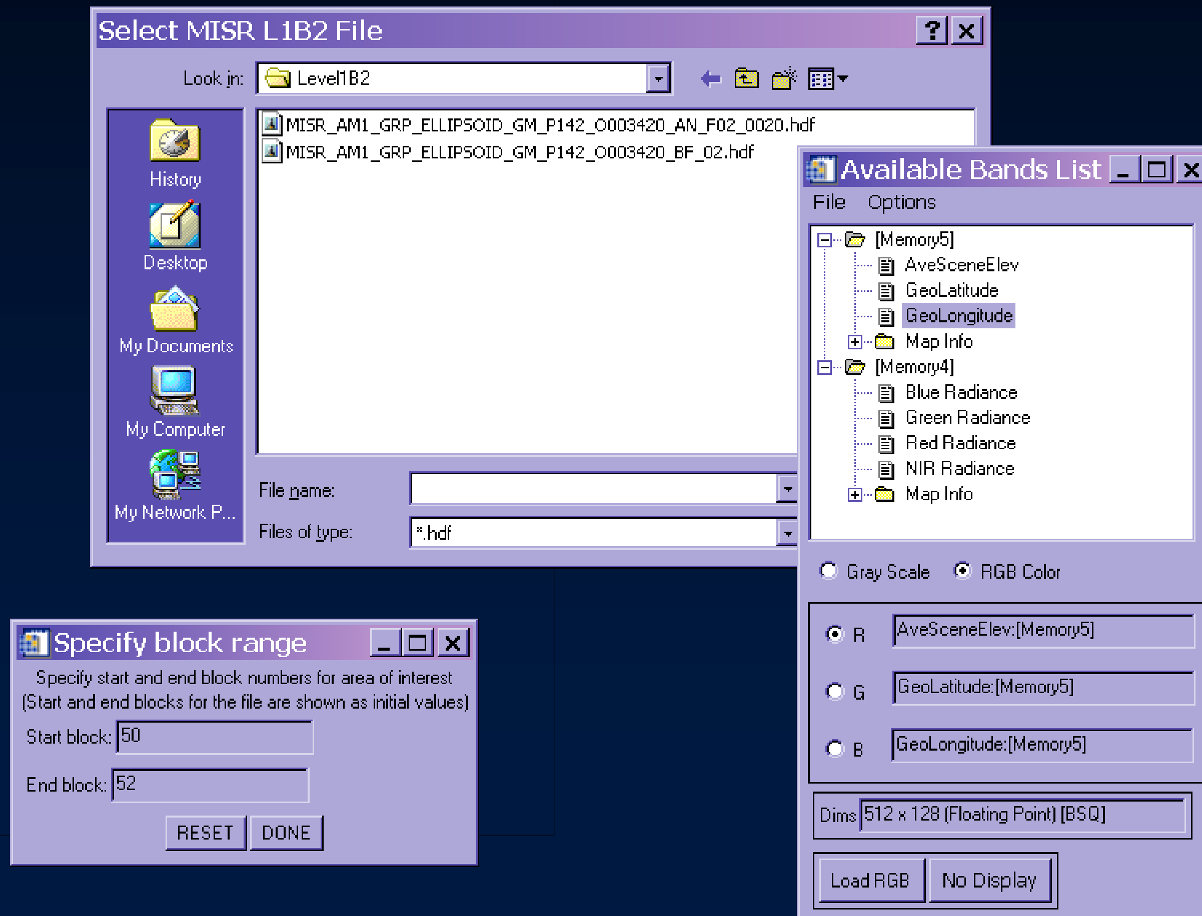


RSI ENVI using MISR ENVI Tool Plug-in

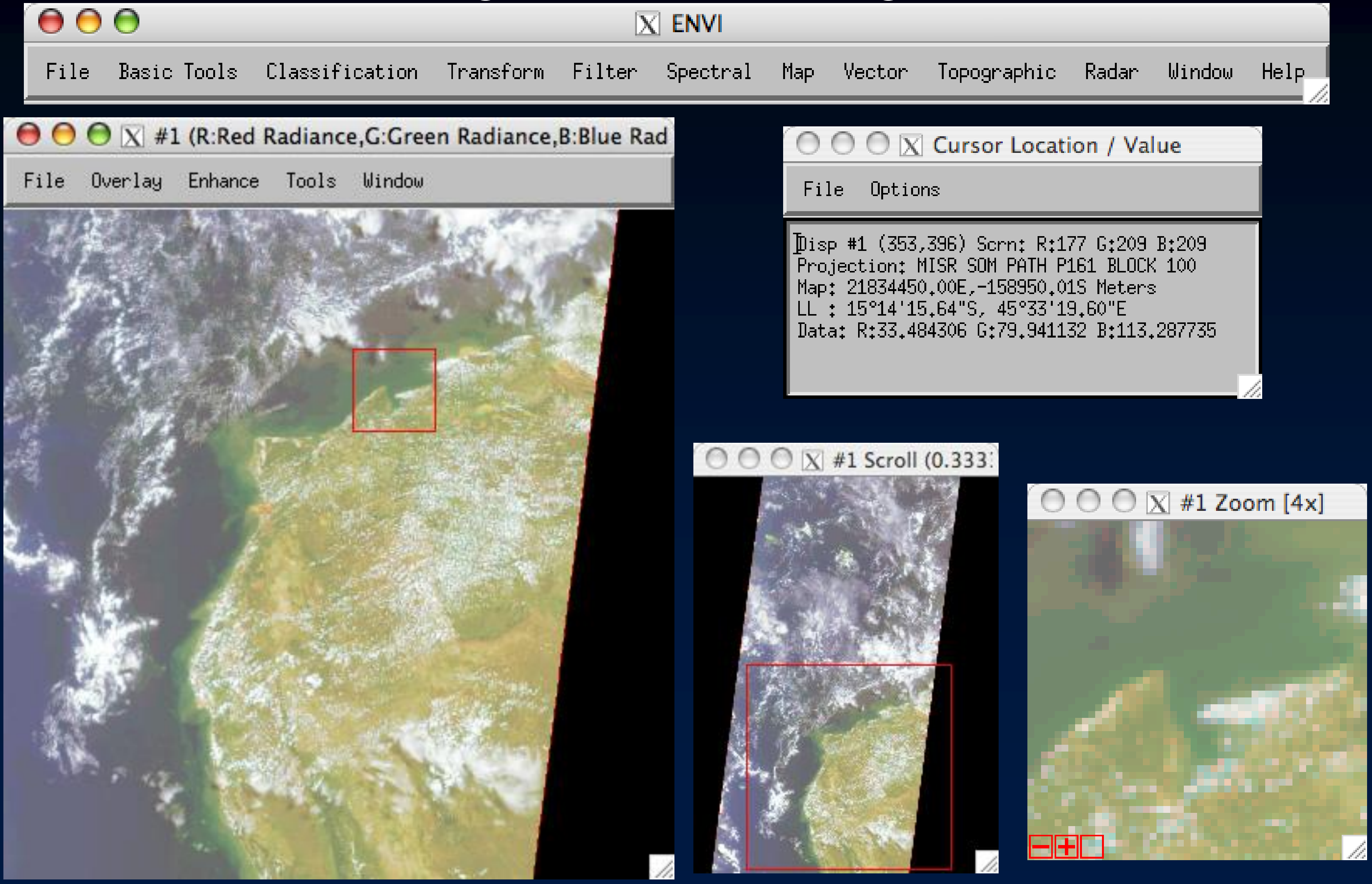
For the “Stacked Block” Products

Geolocates and Visualizes MISR TOA Radiance, Terrain and Ellipsoid Projected Products only

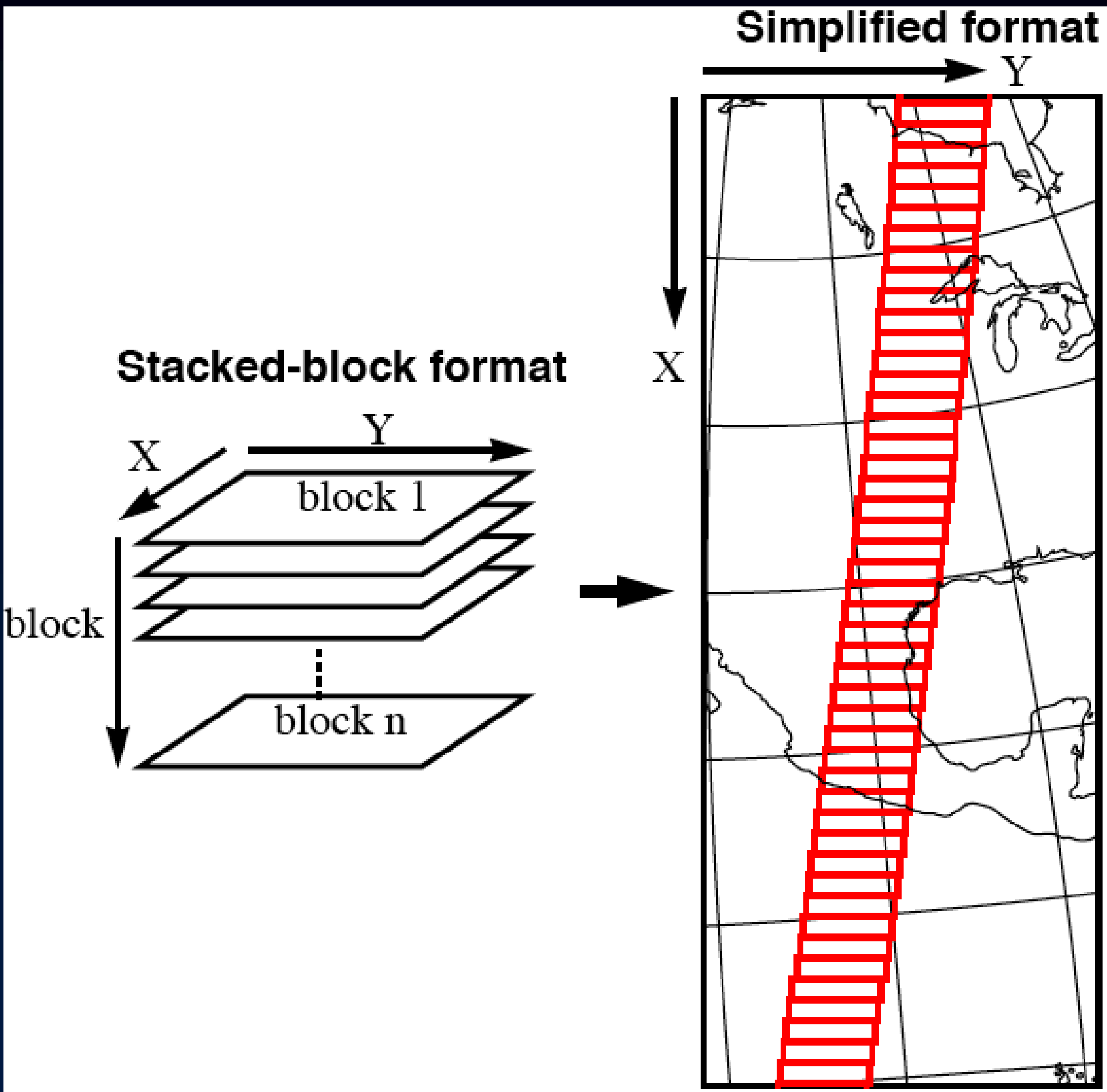
http://eosweb.larc.nasa.gov/PRODOCS/misr/tools/envi_tool.html



MISR "Stacked Block" L1B2 Radiances loaded into ENVI using the MISR Tool Plug-in



What is the "New" Conventional Grid Product?



- Eliminates stacked-blocks.
- Files are still HDF-EOS.
- Same SOM map projection.
- Same spatial resolutions, grid names, field names, and meta-data.
- Approximately same file sizes.
- Most data is gridded identically to original input file => no resampling => identical data numbers.
- Only exception is 35.2 and 70.4 km grids, which require resampling.
- Better tool support.

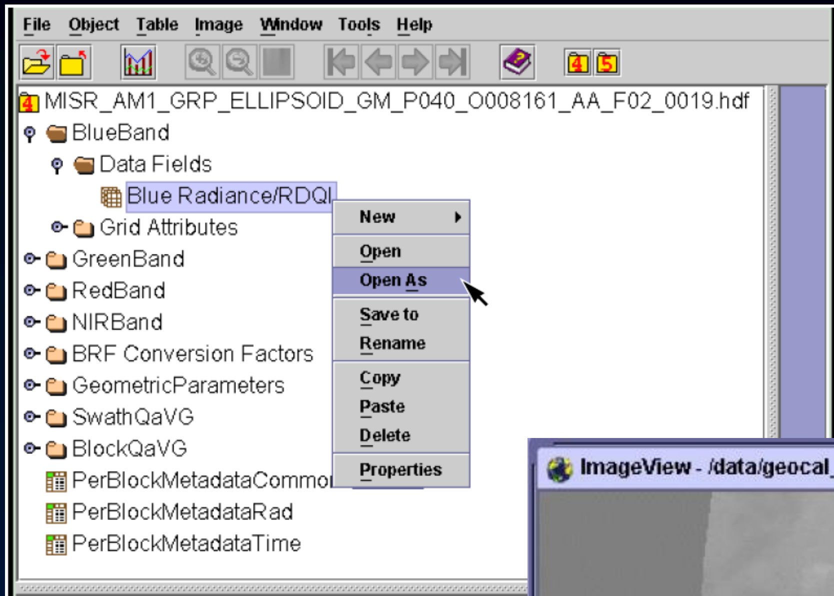
Tools To View Or Not To View the Conventional Grid Products

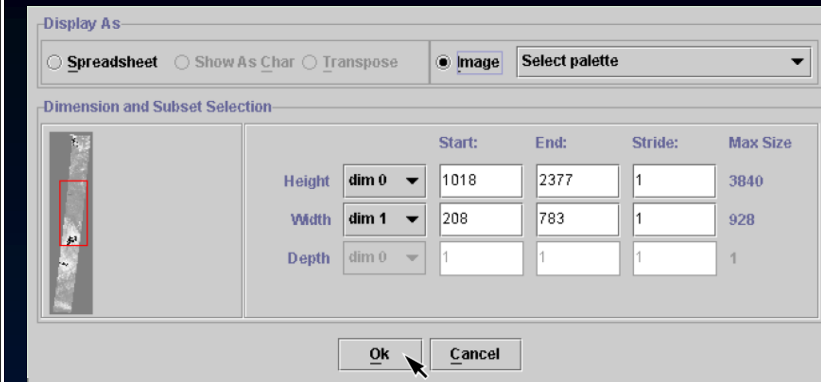
- HDFView version 2.2 (free HDF browser, java based, NCSA)
  - Reads generic HDF files.
  - Displays stacked-blocks one block at a time.
  - Displays conventional grid products easily, as well as Level 3 products
  - No geolocation support.
- ENVI verison 4.0 (commercial GIS, IDL-based)
  - Imports HDF, but not the HDF-EOS geolocation info.
  - Geolocation parameters can be set manually.
  - ENVI SOM projection agrees with MISR SOM.
  - Does not import HDF fields with more than 3 dimensions.
- IDL version 6.0 (commercial Interactive Data Language)
  - HDF_READ() function.
  - Most flexible, yet involves coding in IDL.

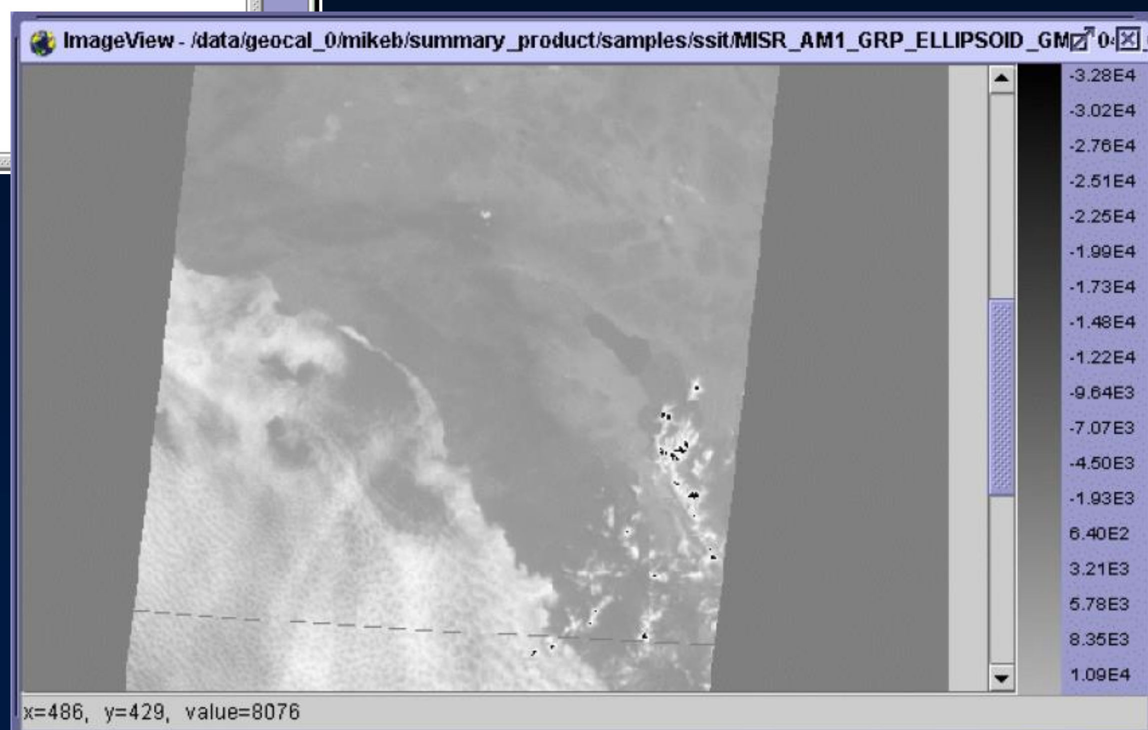
- MISRView (version 5.0)
  - Only supports stacked-block files.
- HDFScan (version 3.5.3)
  - Displays metadata with no problems.
  - Does not display Conventional Grid data. Expects “SOMBlockDim” Dim.
- ERDAS Imagine (version 8.7)
  - Does not support generic HDF or HDF-EOS import.
  - Does support geotiff (see HEG tool).

HDFView 2.2 - L1B2 Imagery

For the "Conventional Grid" Products



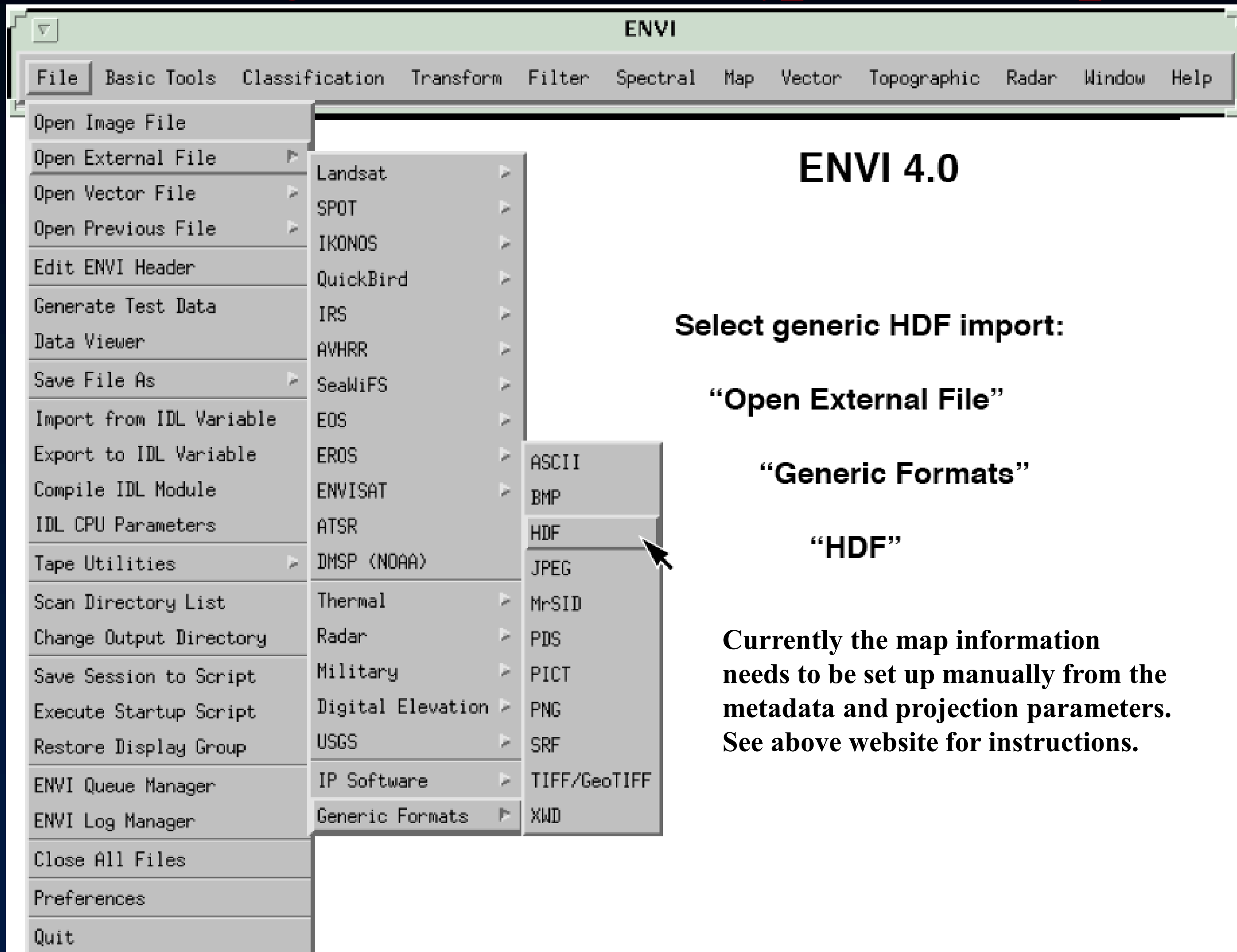




ENVI 4.0 - Generic HDF Import

For the "Conventional Grid" Products

http://eosweb.larc.nasa.gov/PRODOCS/misr/Quality_Summaries/envi_instructions.html



Select generic HDF import:

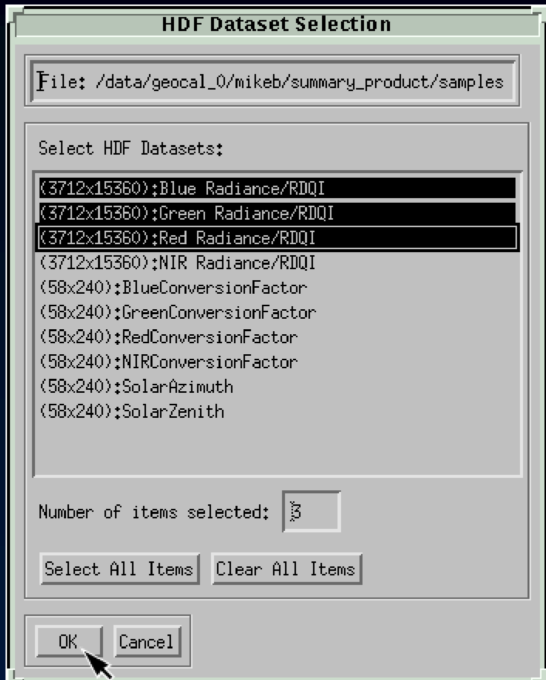
"Open External File"

"Generic Formats"

"HDF"

Currently the map information needs to be set up manually from the metadata and projection parameters. See above website for instructions.

ENVI 4.0 - Selecting Grids and Fields



Select HDF file (not shown)

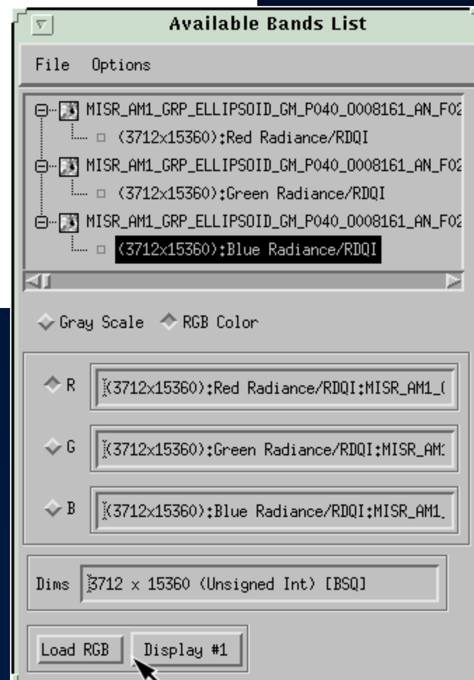
Ellipsoid AN camera

Select HDF datasets to import

Blue Radiance/RDQI

Green Radiance/RDQI

Red Radiance/RDQI



Select datasets to display

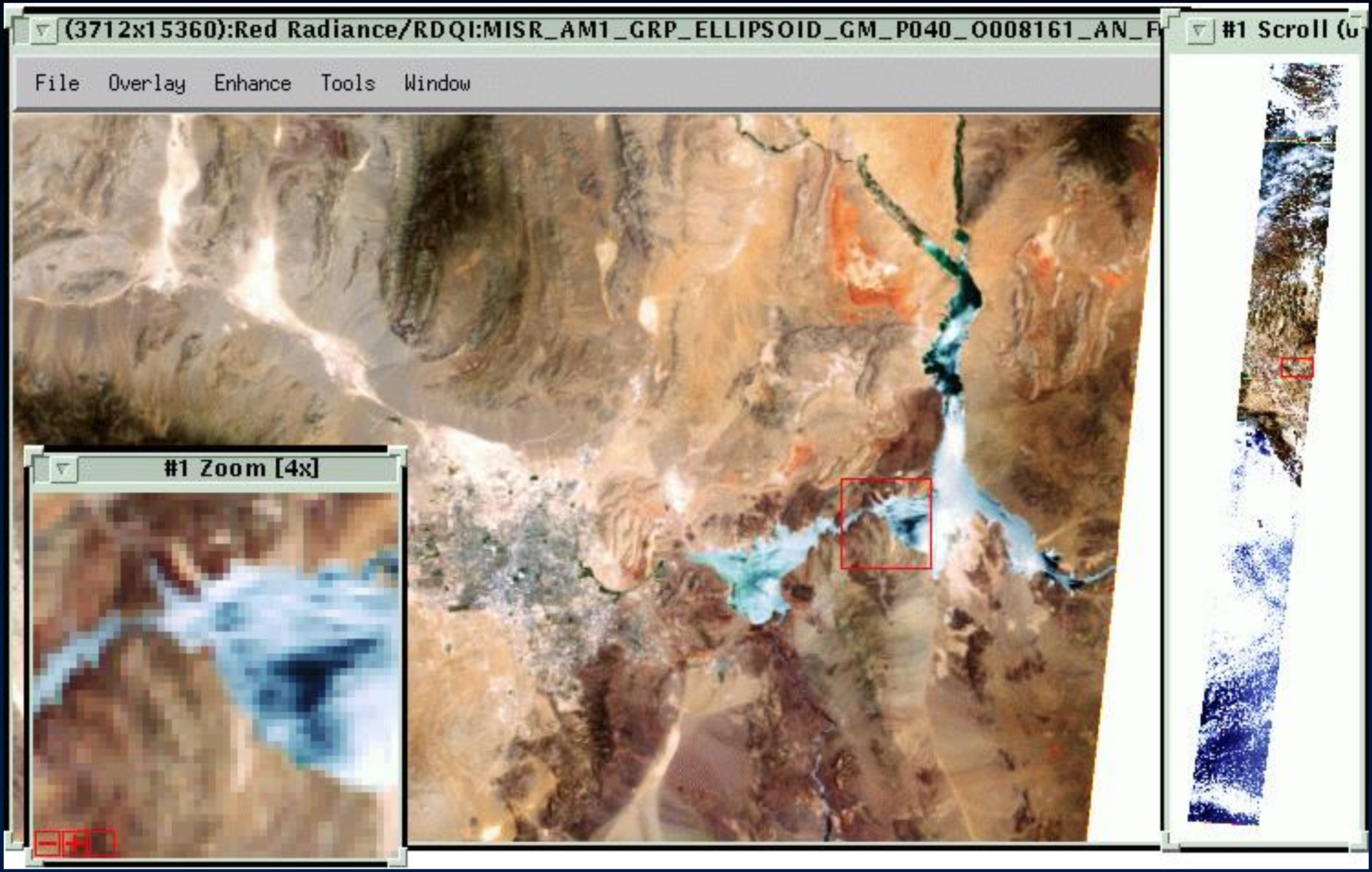
RGB color planes:

Red Radiance/RDQI

Green Radiance/RDQI

Blue Radiance/RDQI

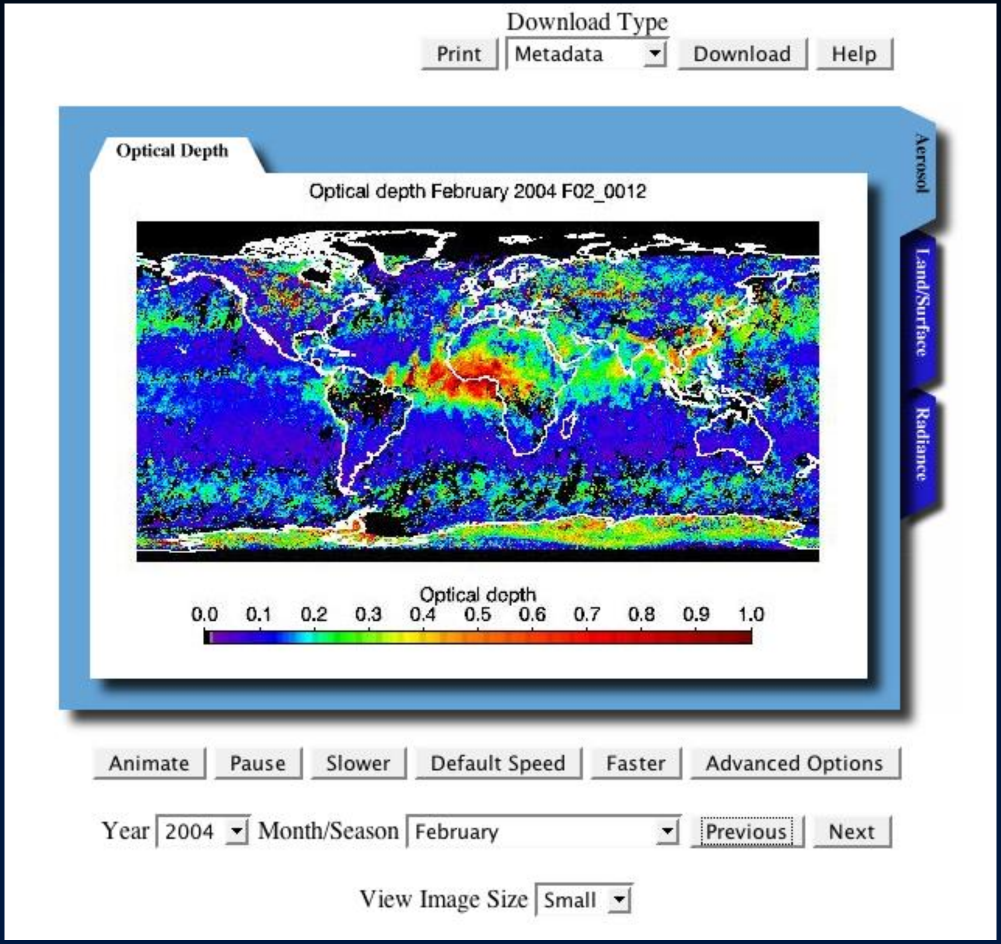
MISR L1B2 Imagery in the ENVI Viewer



MISR Level 3 Overview Web Page

- http://eosweb.larc.nasa.gov/PRODOCS/misr/level3/overview.html

- Can view jpegs of all available Level 3 data.
- Can view by product and by month or season.
- Can view animation through a year’s worth of data.
- Can directly download Level 3 HDF files.



MISR Level 3 Data File Format

- Level 3 data files
  - In standard HDF-EOS grid format.
  - Not in more complicated stack block grid used by Level 1 and Level 2.
  - Can be read by any tool that knows HDF-EOS (i.e, IDL).
  - To simply view data, use Level 3 web page - no need to work with HDF-EOS file.
  - Level 3 HDF-EOS data files can be downloaded directly from the overview web page.

Other Tools to access MISR data

http://eosweb.larc.nasa.gov/PRODOCS/misr/tools/misr_tools.html

ATMOSPHERIC SCIENCES DATA CENTER

Tools for MISR

- ENVI Tool - geolocates and visualizes MISR TOA radiance, Terrain and Ellipsoid projected products
- misr_view - visualizes MISR TOA radiances, aerosol, surface, and cloud data products
- misr_time - calculates the block center times for MISR Level 1B2 files
- hdfscan - visualizes MISR data products
- MISR HDF-to-Binary Converter and Radiance/BRF Calculation Tools
- HDF-EOS to GeoTIFF (HEG) Converter Tool
- HDF Data Manipulation Software
- HDF-EOS Tools and Information Center

MISR Access Data Table | ASDC Home Page | Questions/Help

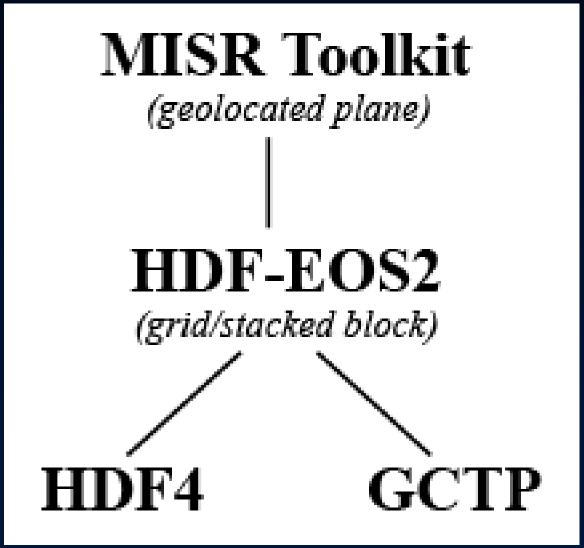
MISR Toolkit Application Programming Interface (API)

- **The MISR Toolkit API will provide simplified MISR data access and geolocation functionality utilizing the GCTP metadata, instead of an ancillary data set lookup**

- **Abstract MISR "stacked block HDF-EOS grid" to a geolocated SOM projected plane with blocks assembled and fields unpacked and unscaled**

- **Will read MISR L1B2, L2 and conventional products**

- **There are no other tools available that simultaneously make use of the GCTP geolocation metadata and are aware of the MISR "stacked block" format**



- **Implemented using standard C, with wrappers for languages such as C++, Java, Python, Fortran, and IDL and will support variety of hardware architectures**

MISR Toolkit API Concept

1) Select a geographic region of interest
2) Read a geolocated SOM plane from any number of MISR product files using the selected region. The region will be "snapped" to the geolocated SOM plane determine by the path number of the product
3) Adjacent paths are actually separate SOM projections, so a map reprojection may need to be performed
4) Query the coordinates of the SOM plane, mapping between plane line/sample, SOM x/y and Latitude/Longitude

MISR Toolkit API Components

1.1) Region Selection

MtkSetRegionByUlcLrc()
MtkSetRegionByLatLonExtentMeters()
MtkSetRegionByLatLonExtentDegrees()
MtkSetRegionByLatLonExtentPixels()
MtkSetRegionByPathBlockRange()

1.2) Reading a Geolocated SOM plane

MtkReadData()
MtkReadRaw()

1.3) SOM Plane Coordinate Query

MtkLSToLatLon()
MtkLatLonToLS()
MtkLSToSomXY()
MtkSomXYToLS()

1.4) Map Reprojection

TBD

2.1) Orbit/Path Query

MtkLatLonToPathList()
MtkRegionToPathList()
MtkTimeToOrbitPath()
MtkTimeRangeToOrbitList()
MtkPathToOrbitList()
MtkOrbitToPath()

2.2) File/Grid/Field Query

MtkMakeFilename()
MtkFindFileList()
MtkFileToGridList()
MtkFileGridToFieldList()

2.3) Coordinated Conversion

MtkPathToProjParam()
MtkLatLonToBls()
MtkBlsToLatLon()
MtkSomXYToBls()
MtkBlsToSomXY()
MtkLatLonToSomXY()
MtkSomXYToLatLon()

2.4) Unit Conversion

MtkDmsToDd()
MtkDdToDms()
MtkDdToRad()
MtkRadToDd()
MtkDmsToRad()
MtkRadToDms()

2.5) Memory Management

MtkDataBufferAllocate()
MtkDataBufferFree()

MISR Toolkit API Overview

North America MISR Multi-path Mosaic

Albers Conic Equal Area Projection
Standard Parallels: 29˚ 30´ and 45˚ 30´
Projection Center: 36˚ N and 92˚ W

Image credit: NASA/GSFC/LaRC/JPL, MISR Team
Multi-path mosaic by Jim Knighton of Clear Light Image Products (jknighton@clear-light.com)

North Eastern US MISR Multi-path Mosaic

Albers Conic Equal Area Projection
Standard Parallels: 29˚ 30´ and 45˚ 30´
Projection Center: 36˚ N and 92˚ W

Image credit: NASA/GSFC/LaRC/JPL, MISR Team
Multi-path mosaic by Jim Knighton of Clear Light Image Products (jknighton@clear-light.com)

Eastern Maryland MISR Multi-path Mosaic

Albers Conic Equal Area Projection
Standard Parallels: 29˚ 30´ and 45˚ 30´
Projection Center: 36˚ N and 92˚ W

Image credit: NASA/GSFC/LaRC/JPL, MISR Team
Multi-path mosaic by Jim Knighton of Clear Light Image Products (jknighton@clear-light.com)

Greenbelt MISR Multi-path Mosaic

Albers Conic Equal Area Projection
Standard Parallels: 29˚ 30´ and 45˚ 30´
Projection Center: 36˚ N and 92˚ W

Image credit: NASA/GSFC/LaRC/JPL, MISR Team
Multi-path mosaic by Jim Knighton of Clear Light Image Products (jknighton@clear-light.com)