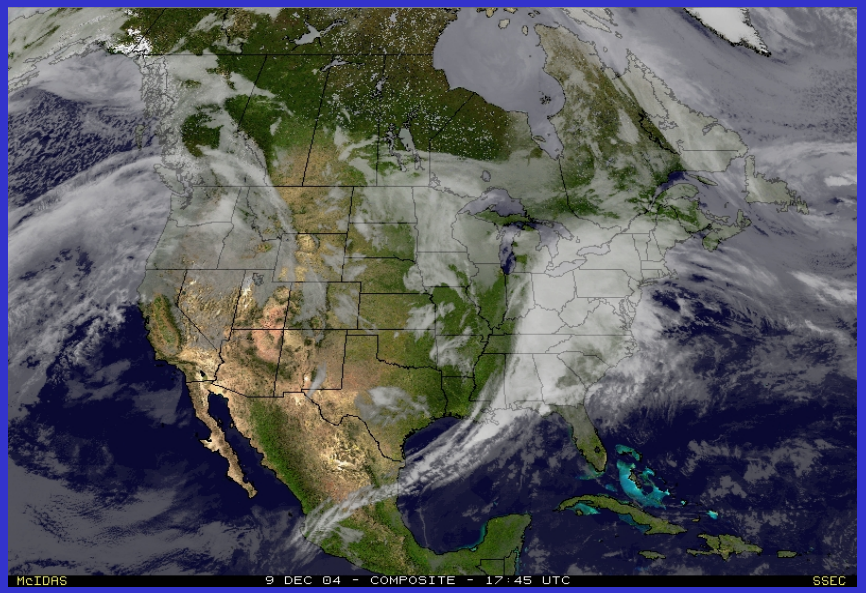
Interactive Processing of Multi- and Hyper-spectral Environmental Satellite Data: The Next Generation of McIDAS

EUMETSAT-AMS Conf. Amsterdam, NL 27 September 2007



Tom Achtor,
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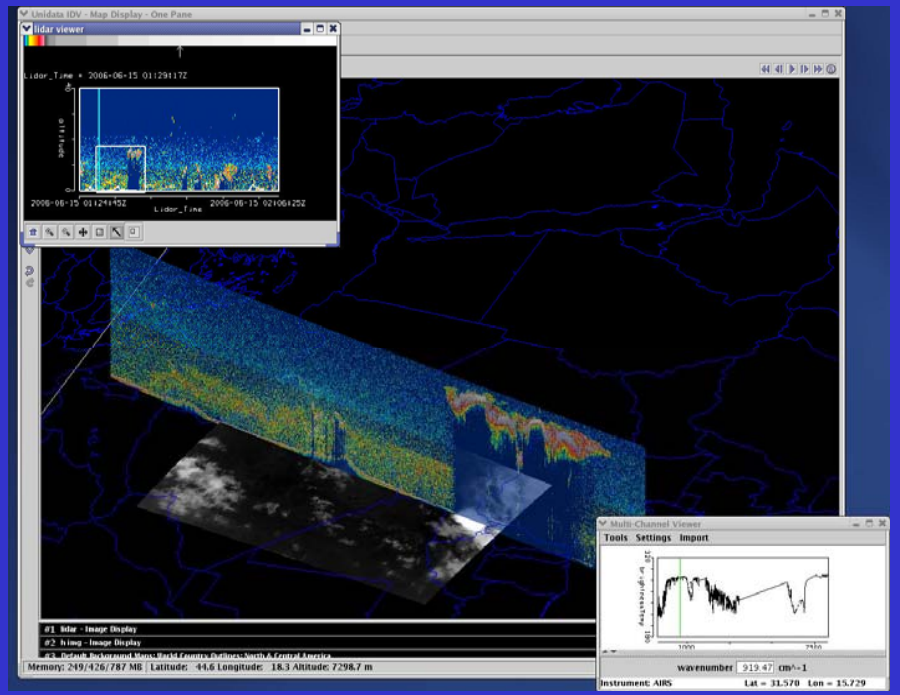
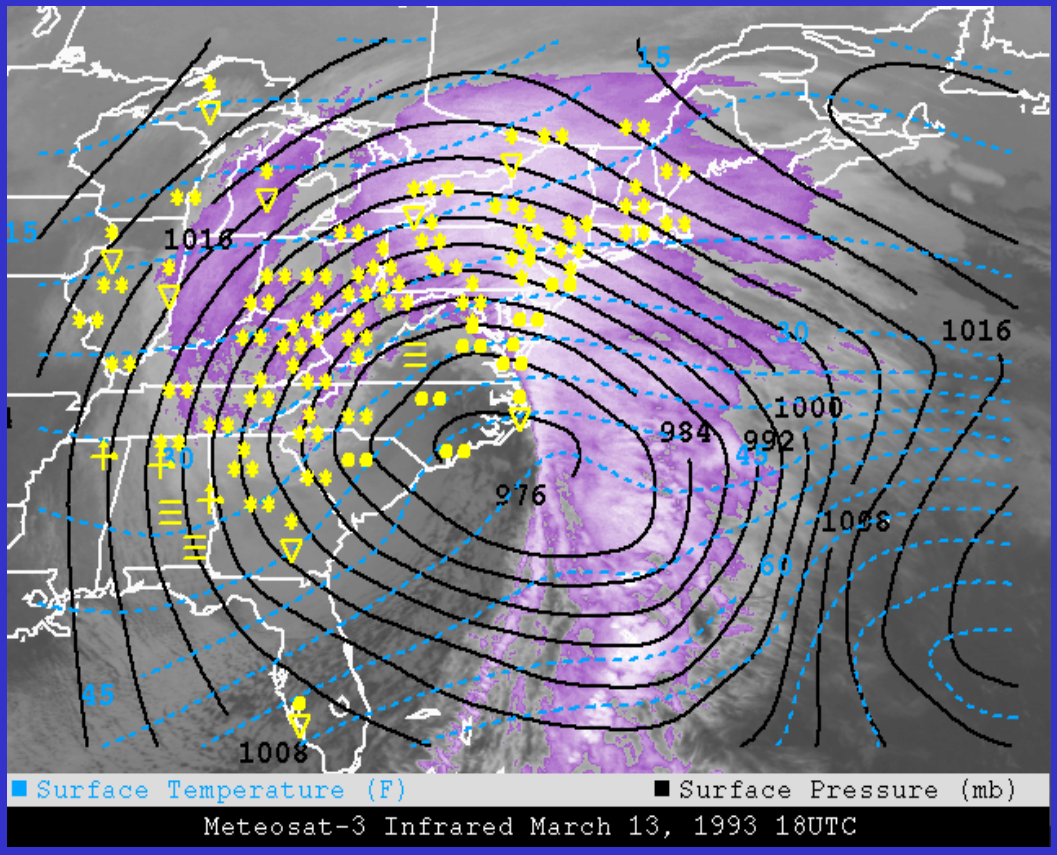
Space Science & Engineering Center (SSEC) at the University of Wisconsin - Madison



What is McIDAS ?
(Man computer Interactive Data Access System)

- Collection of user programs and libraries for visualizing and analyzing geophysical data (focus on environmental satellites)
  - UNIX, PC & Mac capable
- A synergistic tool that integrates numerous data types into one system
- First developed in the early 1970s
- Still in use world-wide at research, operational, educational, and commercial sites



Key McIDAS-X Attributes

- Access to extensive geophysical database
- Core package (MUG supported) plus user-written applications
- Diverse functionality through software (1 million + lines of code)
- Extensive 2-D visualization capabilities
- Satellite and NOAAPORT data ingest

McIDAS-X Functionality

- Digital Image Processing
- GIS Applications
- Weather and Climate Data Analysis and Applications
- Graphical Displays of Data & Information
- Gridded Data Processing and Analysis Tools
- Display & Process Control Utilities
- Interactive and Background Processing

McIDAS-X Users

- NOAA – NESDIS, AWC, SPC, TPC, etc.
- NASA – STS, LaRC, MSFC, JPL
- Unidata – 130 universities, colleges and international educational collaborators
- International – EUMETSAT, Spain, Greece, Mexico, Australia
- Industry –Honeywell, Weathernews, Universal Weather, Meteorlogix, Weather Central, etc.

Why the Change?

- Forthcoming GOES-R & NPOESS operational satellite data cannot be optimally utilized
  - great increase in data rates
  - new tools for working with these large data sets
- McIDAS software (written in Fortran 77 and C) has a 30+ year heritage resulting in limited extensibility potential
- Platform / OS dependence
- New data analysis and visualization concepts are now available (e.g. 4-D)

McIDAS-V Functionality

McIDAS-V will be a collection of software tools, and networked services and data designed to take advantage of a scalable distributed computing environment to meet user needs

- **Full support for McIDAS-X**
- **OpenDap / OpenADDE**
- **Open GIS Consortium**
- **Database archives**
- **Cluster computing**
- **McIDAS-V will be open source and freely available**

What is McIDAS-V

McIDAS-X → VisAD + IDV + HYDRA = McIDAS-V

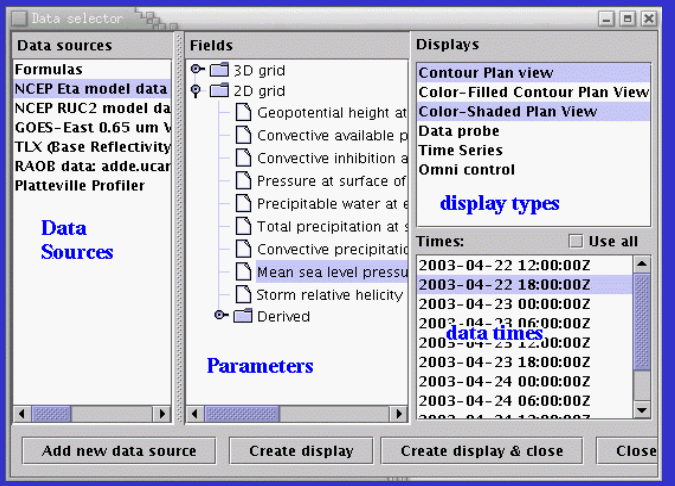
VisAD

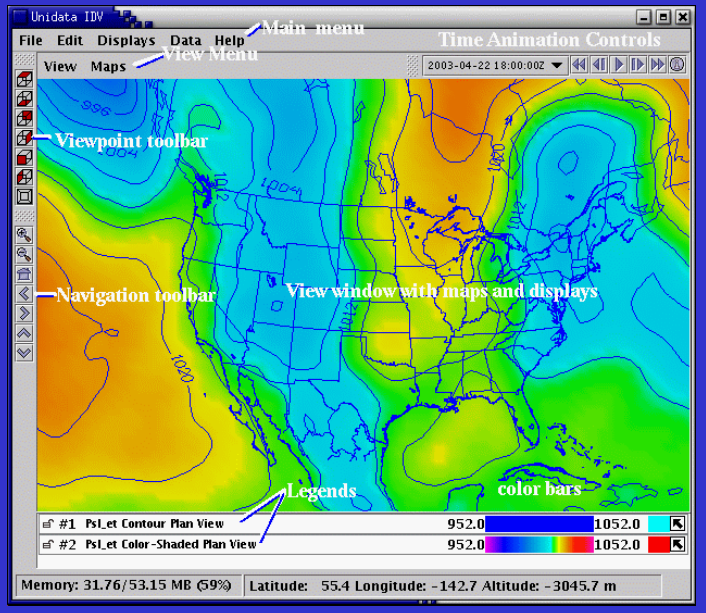
Developer: Bill Hibbard, UW SSEC

- Open-source, Java library for building interactive and collaborative visualization and analysis tools
- <u>Features include:</u>
  - Powerful mathematical data model that embraces virtually any numerical data set
  - General display model that supports 2- and 3-D displays, multiple data views, direct manipulation
  - Adapters for multiple data formats (netCDF, HDF-5, FITS, HDF-EOS, McIDAS, Vis5D, etc.) and access to remote data servers through HTTP, FTP, DODS/OpenDAP, and OpenADDE protocols
  - Metadata can be integrated into each data object

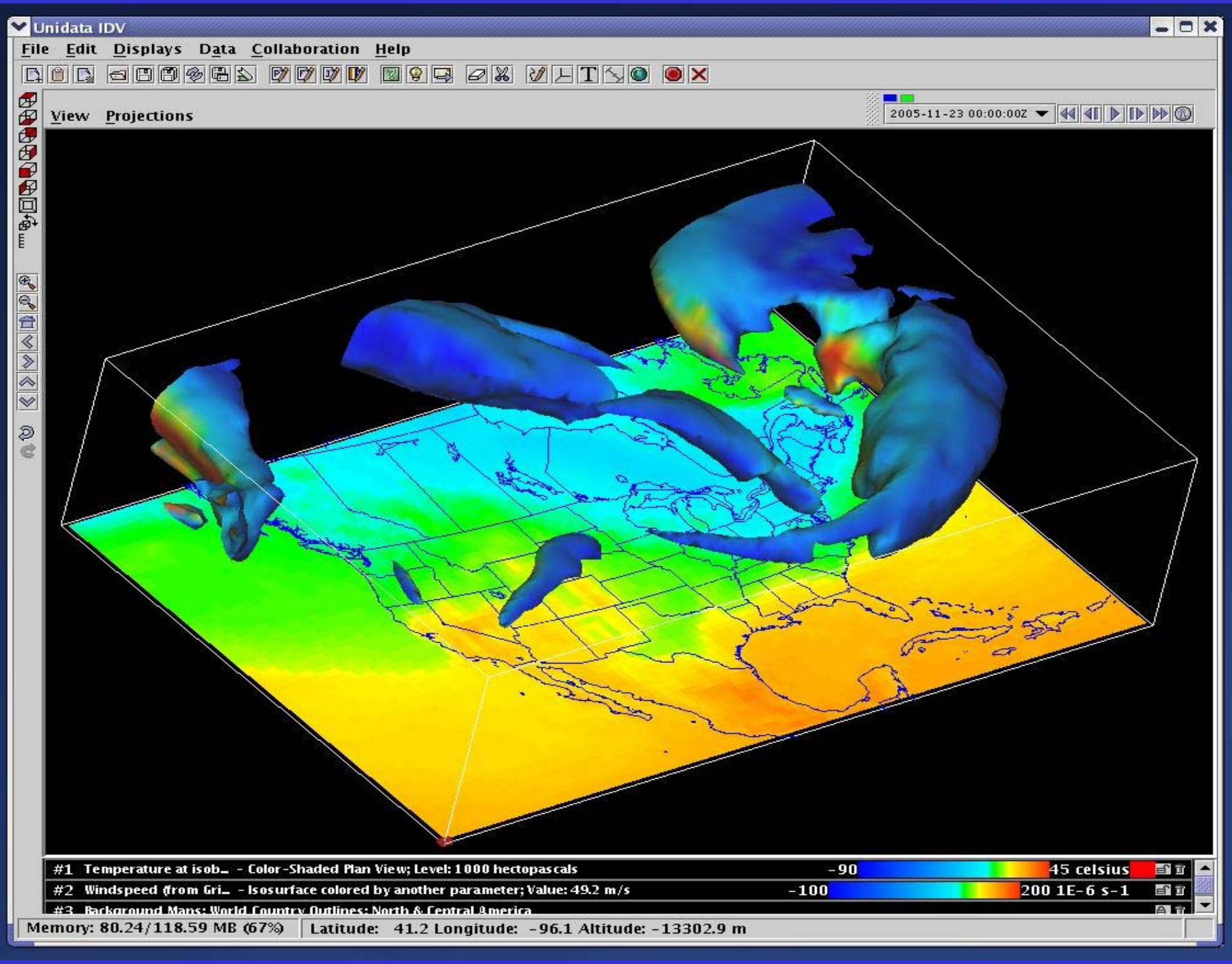
What is the IDV?

- Unidata developed, VisAD-based, scientific analysis and visualization library and toolkit
- Open Source, Java™ framework and reference application
- Provides 2- and 3-D displays of geo-scientific data (plus, of course, animations)
- Stand-alone or networked application





http://www.unidata.ucar.edu/idv


Unidata IDV
File Edit Displays Data Collaboration Help
View Projections
2005-11-23 00:00:00Z
#1 Temperature at isob... - Color-Shaded Plan View; Level: 1000 hectopascals
-90
45 celsius
#2 Windspeed from Gri... - Isosurface colored by another parameter; Value: 49.2 m/s
-100
200 1E-6 s-1
#3 Background Maps: World Country Outlines: North & Central America
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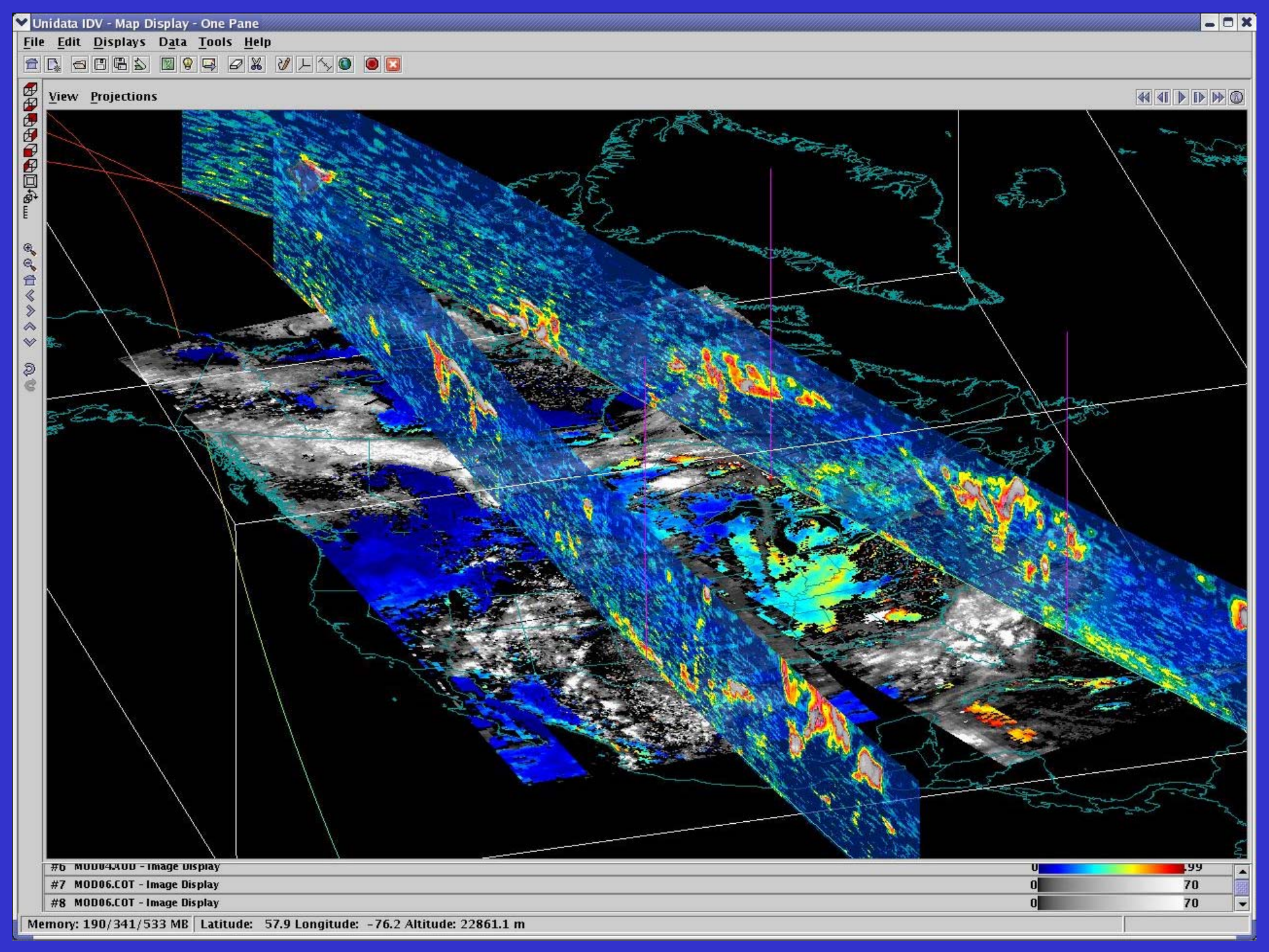
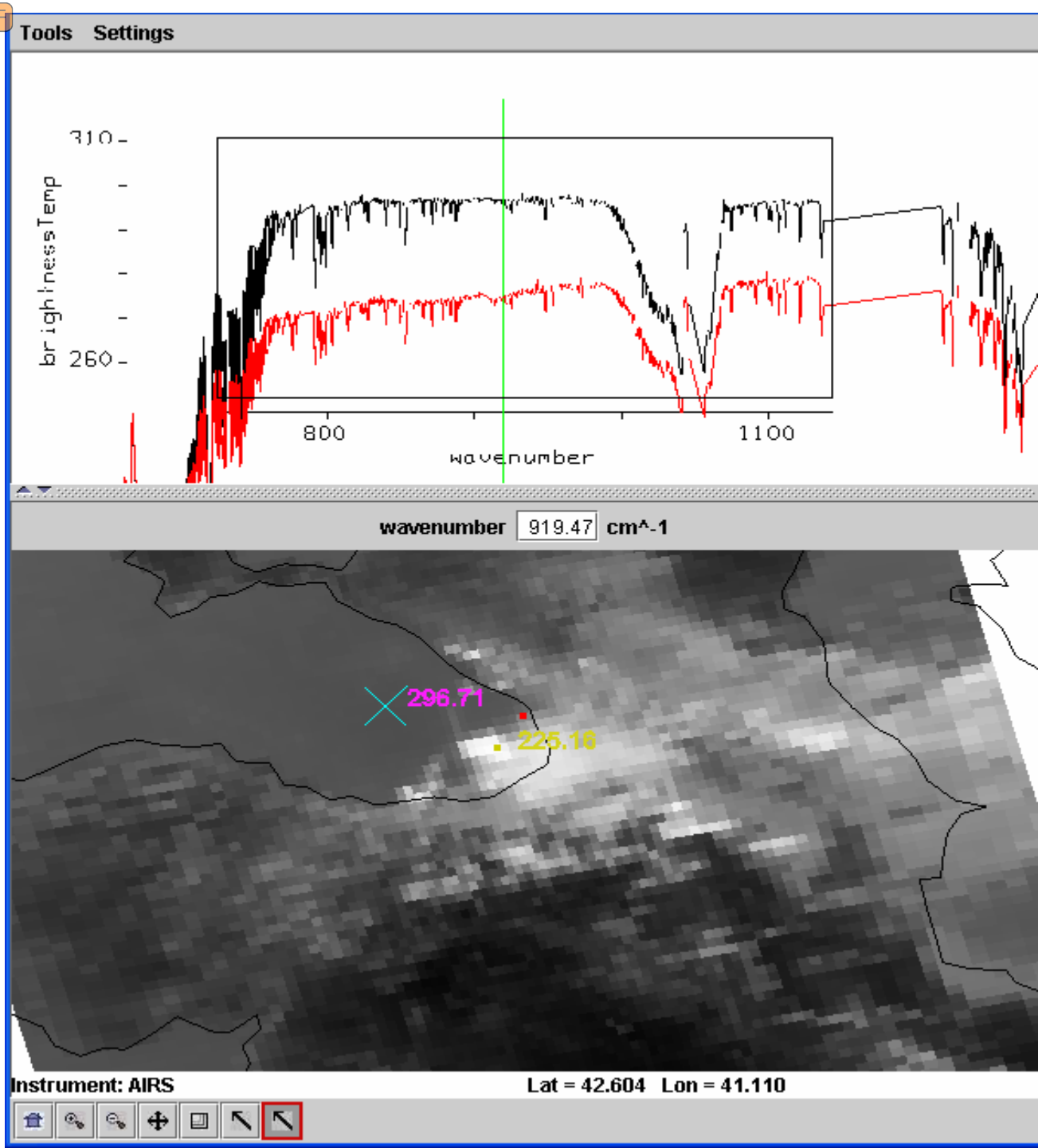
Latitude: 41.2 Longitude: -96.1 Altitude: -13302.9 m

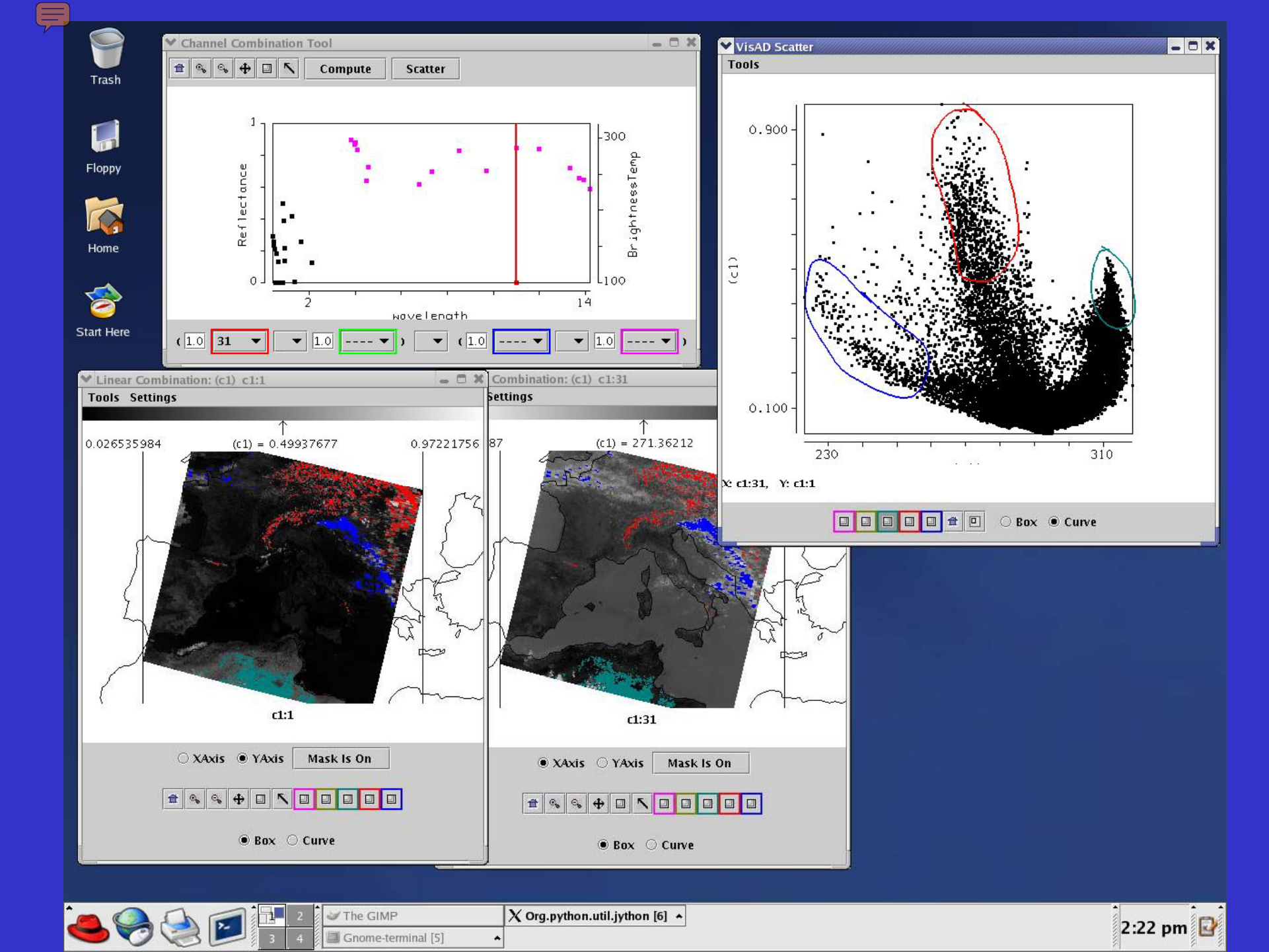

Unidata IDV - Map Display - One Pane
File Edit Displays Data Tools Help
View Projections
#7 MOD06.COT - Image Display
0 70
#8 MOD06.COT - Image Display
0 70
Memory: 190/341/533 MB
Latitude: 57.9 Longitude: -76.2 Altitude: 22861.1 m

HYDRA enables interrogation of multispectral and hyperspectral fields of data

- Individual pixel location and spectral band measurements can be easily displayed
- spectral channels can be combined in linear functions and the resulting images displayed
- false color images can be constructed from multiple channel combinations
- scatter plots of spectral channel combinations can be viewed
- pixels in images can be found in scatter plots and vice versa
- transects of measurements can be displayed
- L2 products; e.g. soundings of temperature and moisture as well as spectra from selected pixels can be compared
- integrated data exploration and analysis between GEO and POLAR observing platforms



AIRS
Cirrus
vs
Clear Sky
Spectra


Trash
Floppy
Home
Start Here
Channel Combination Tool
Compute
Scatter
Reflectance
BrightnessTemp
wavelength
VisAD Scatter
Tools
(c1)
X: c1:31, Y: c1:1
Box
Curve
Linear Combination: (c1) c1:1
Tools Settings
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c1:1
XAxis
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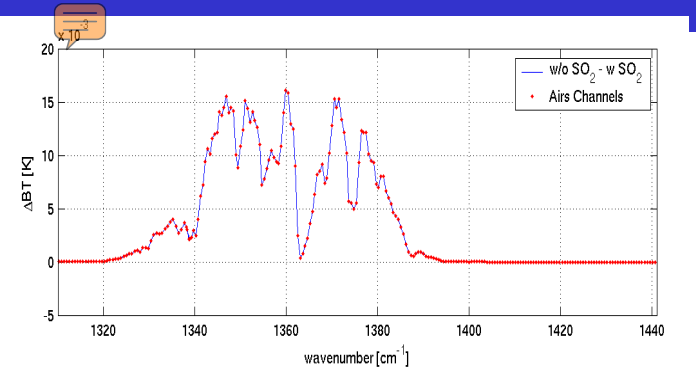
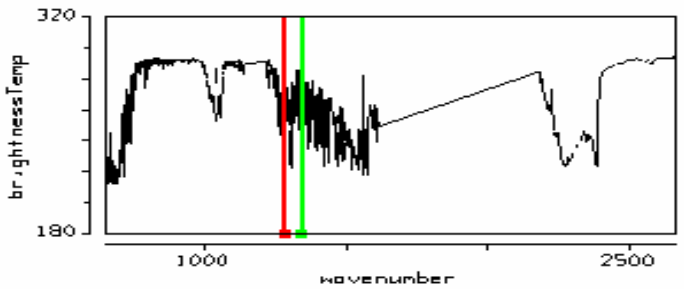
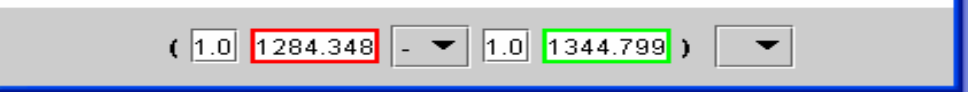
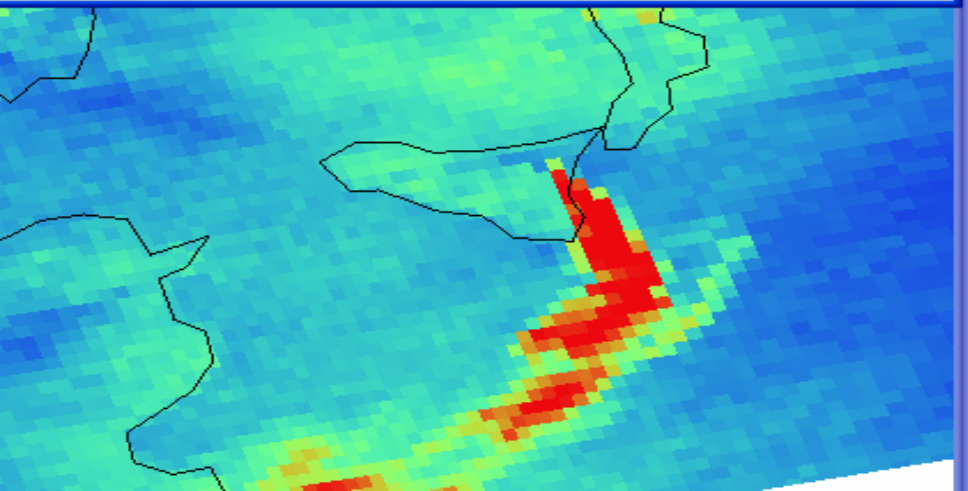


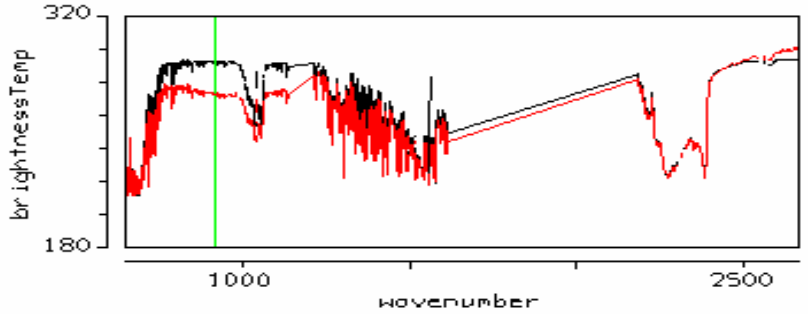
Mt Etna viewed by AIRS 28 Oct 2002

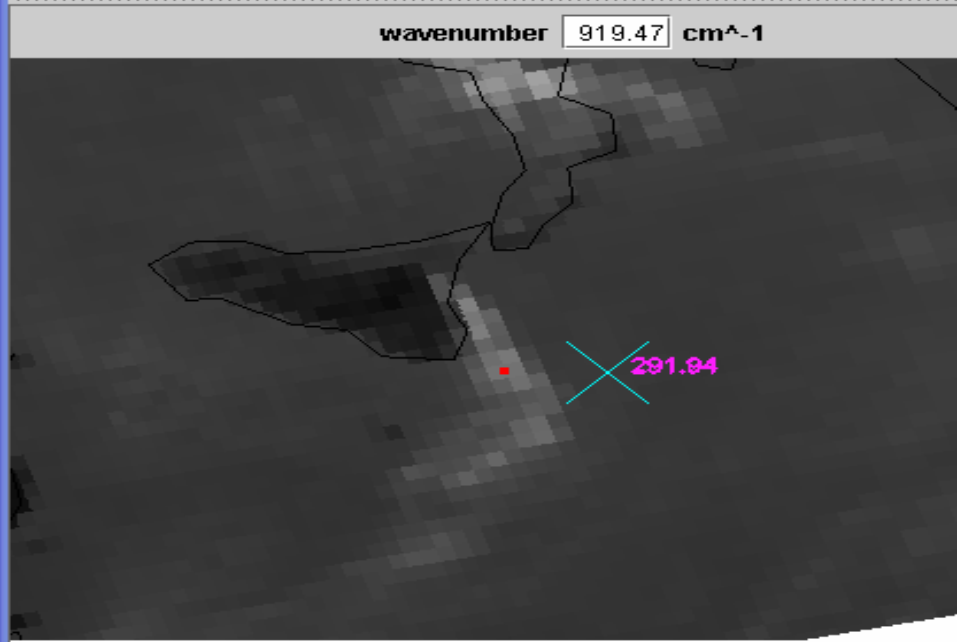
SO2 signal 1284-1345 cm-1





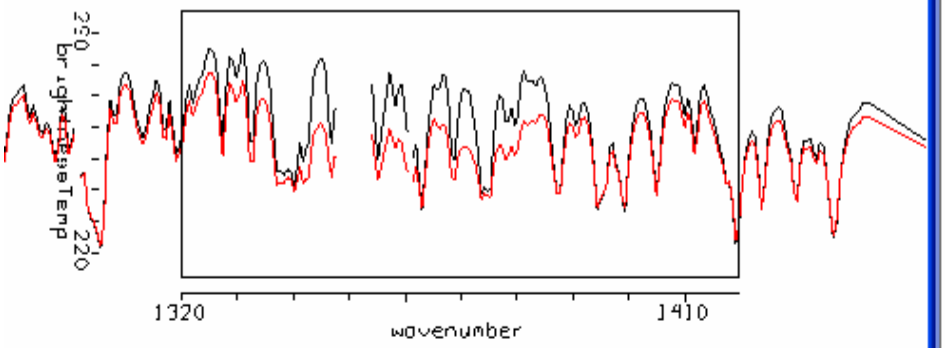


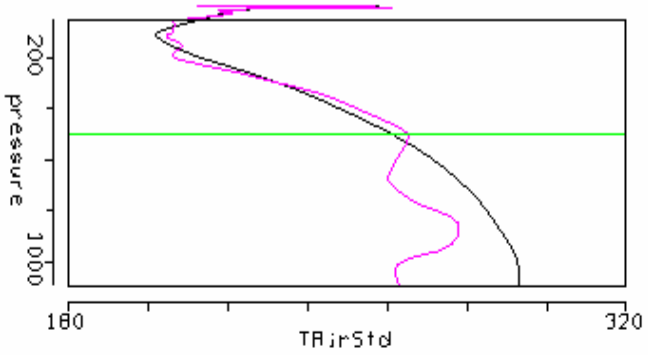


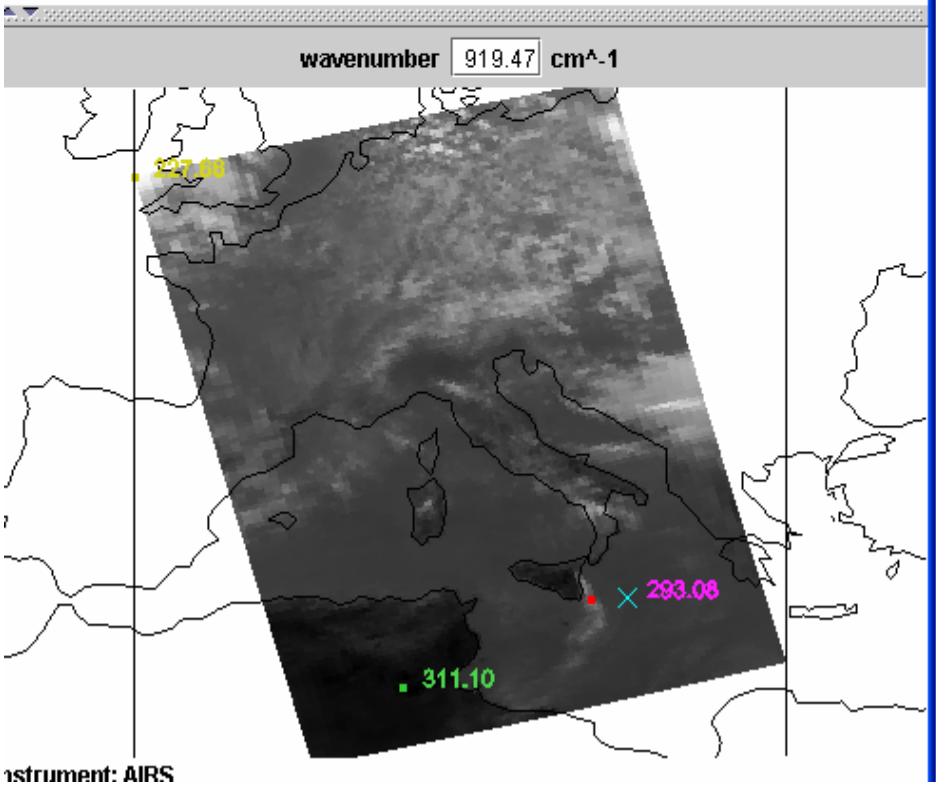


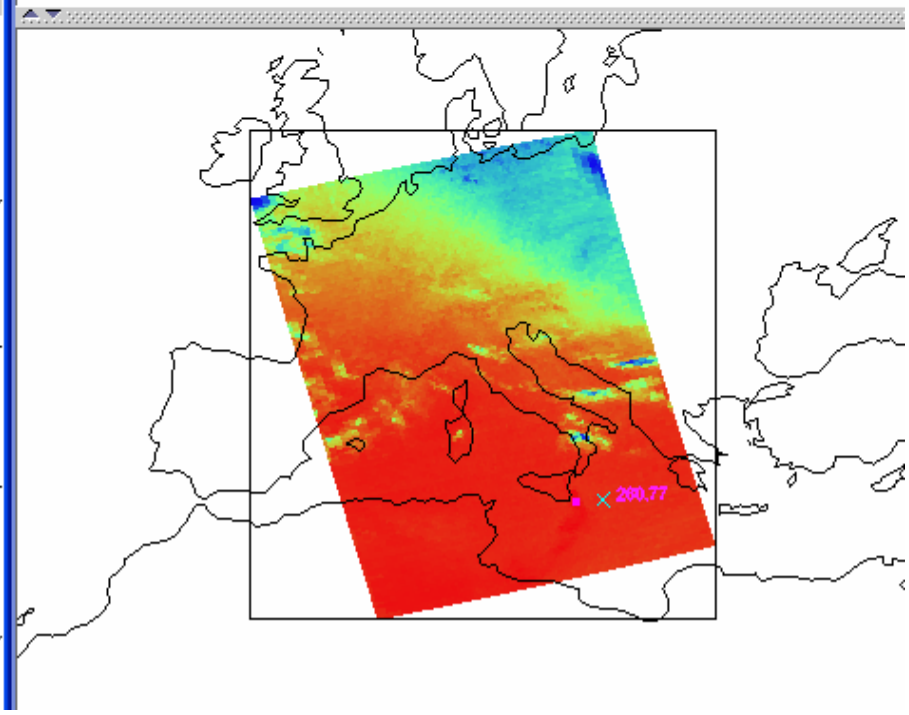
Inferring ash cloud height from AIRS clear sky and in ash soundings

Ash cloud and clear sky spectra

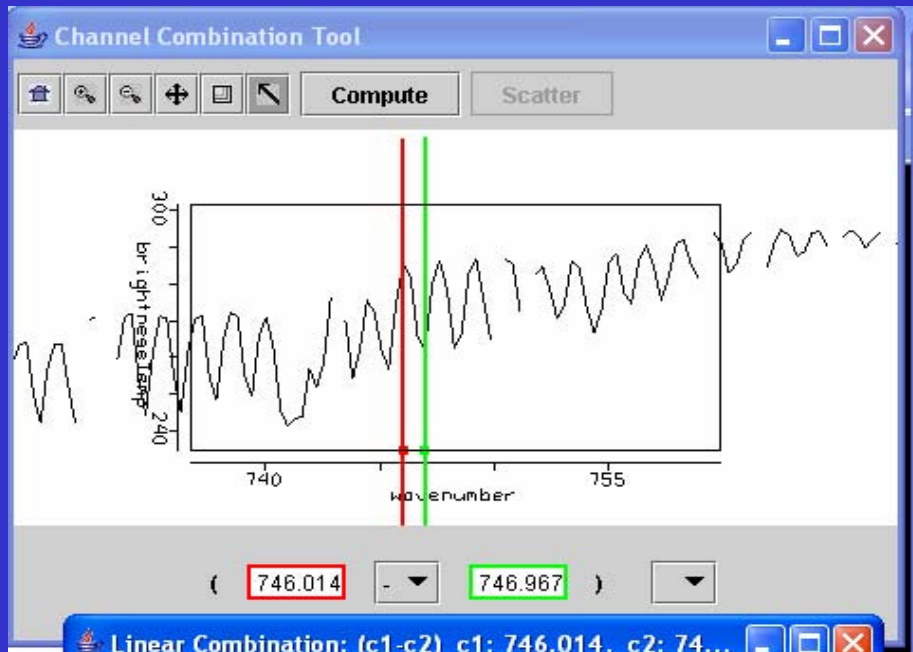


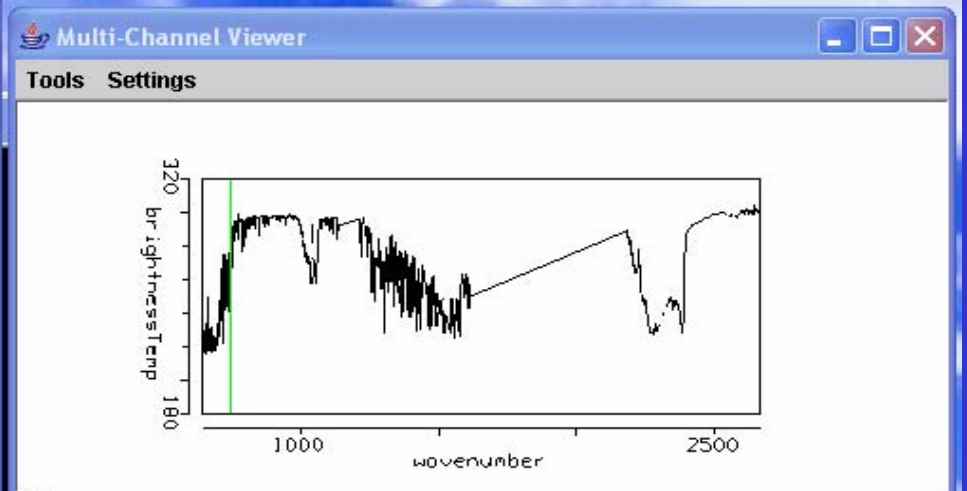


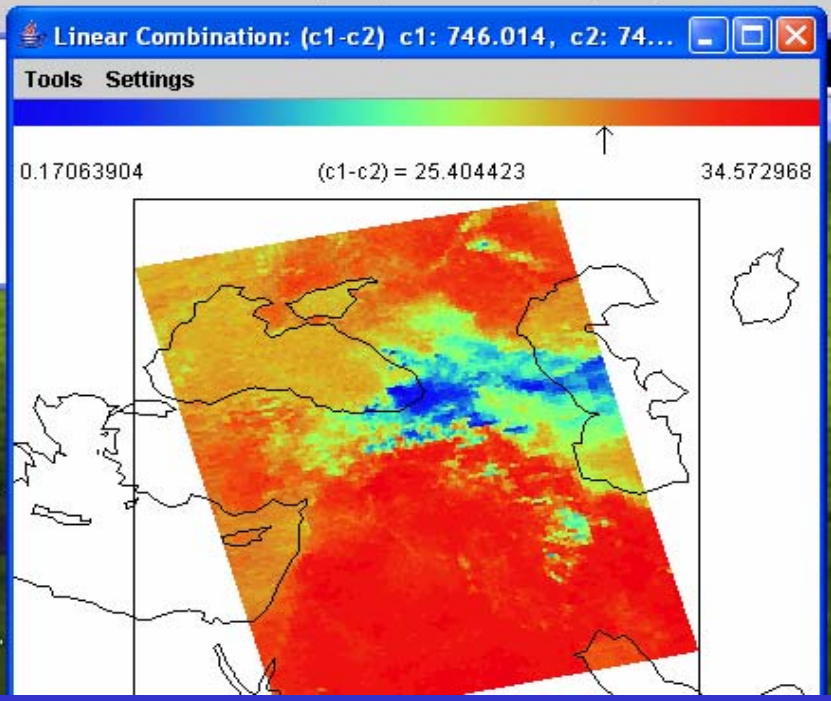


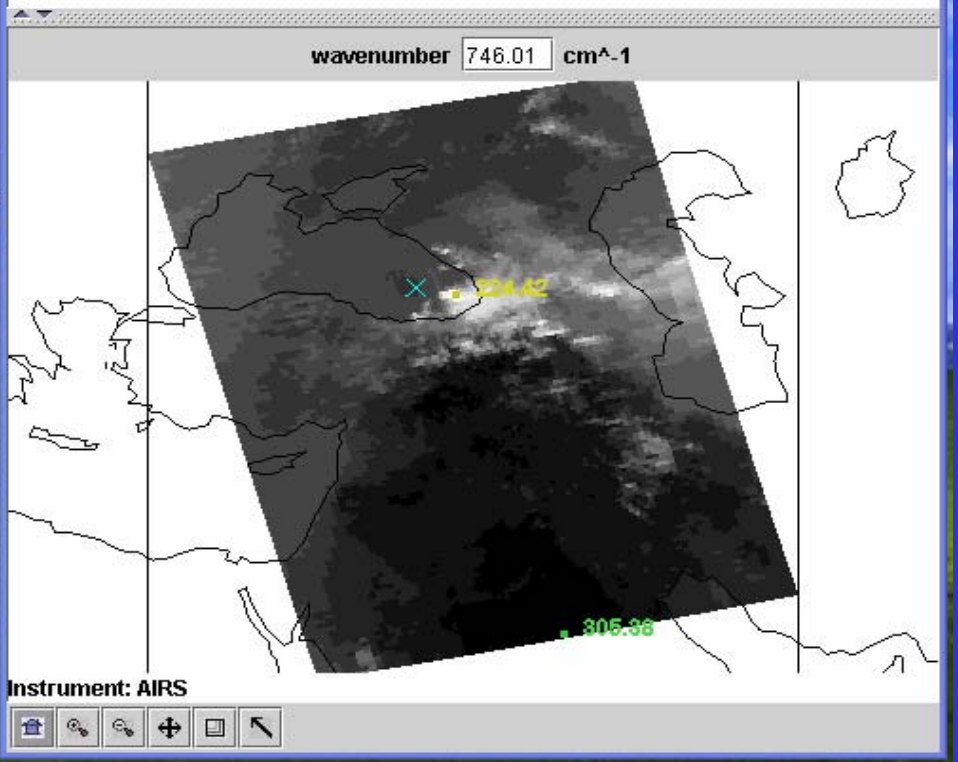


Offline-Online in LW CO2

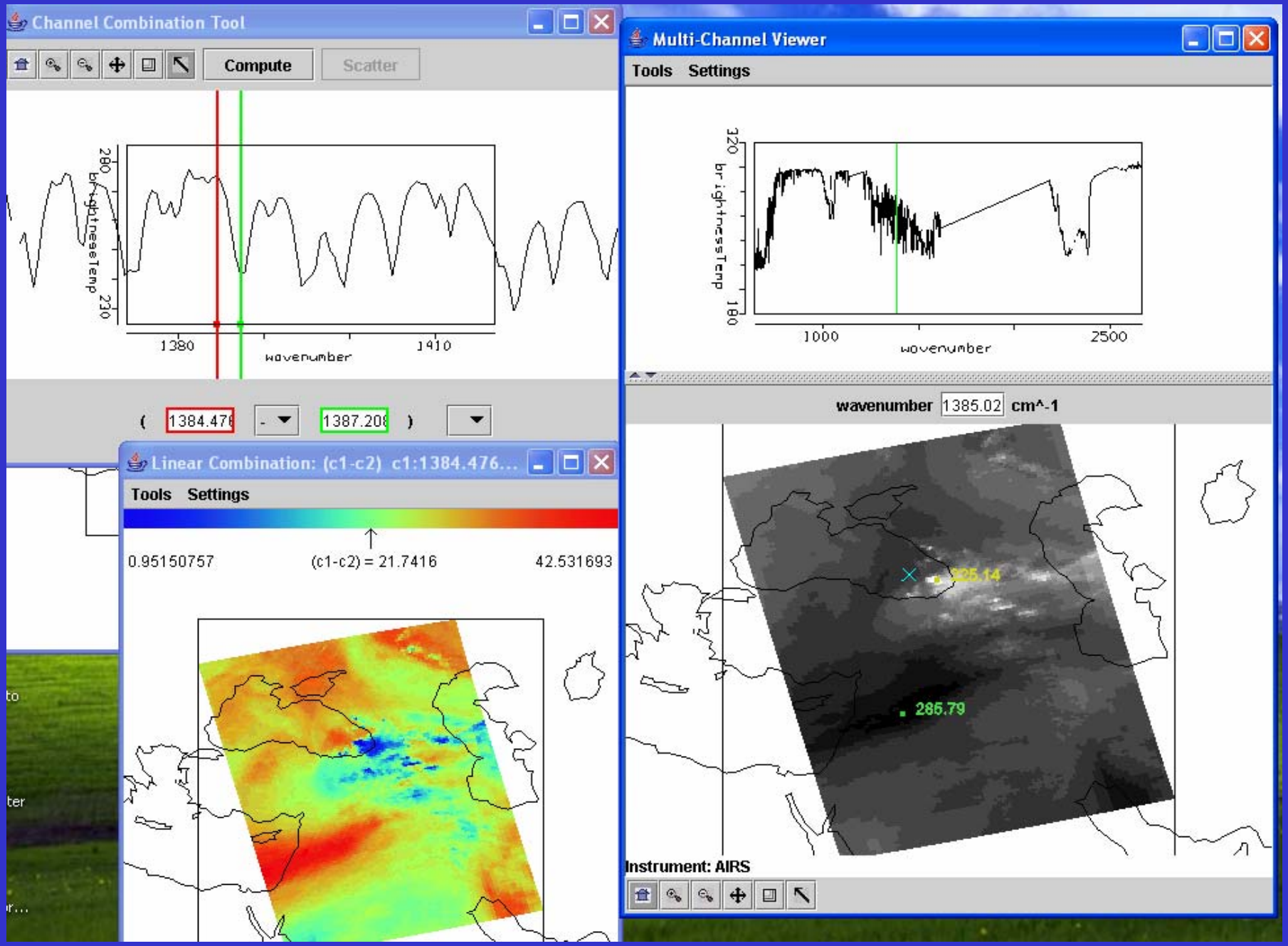








Offline-Online in H2O



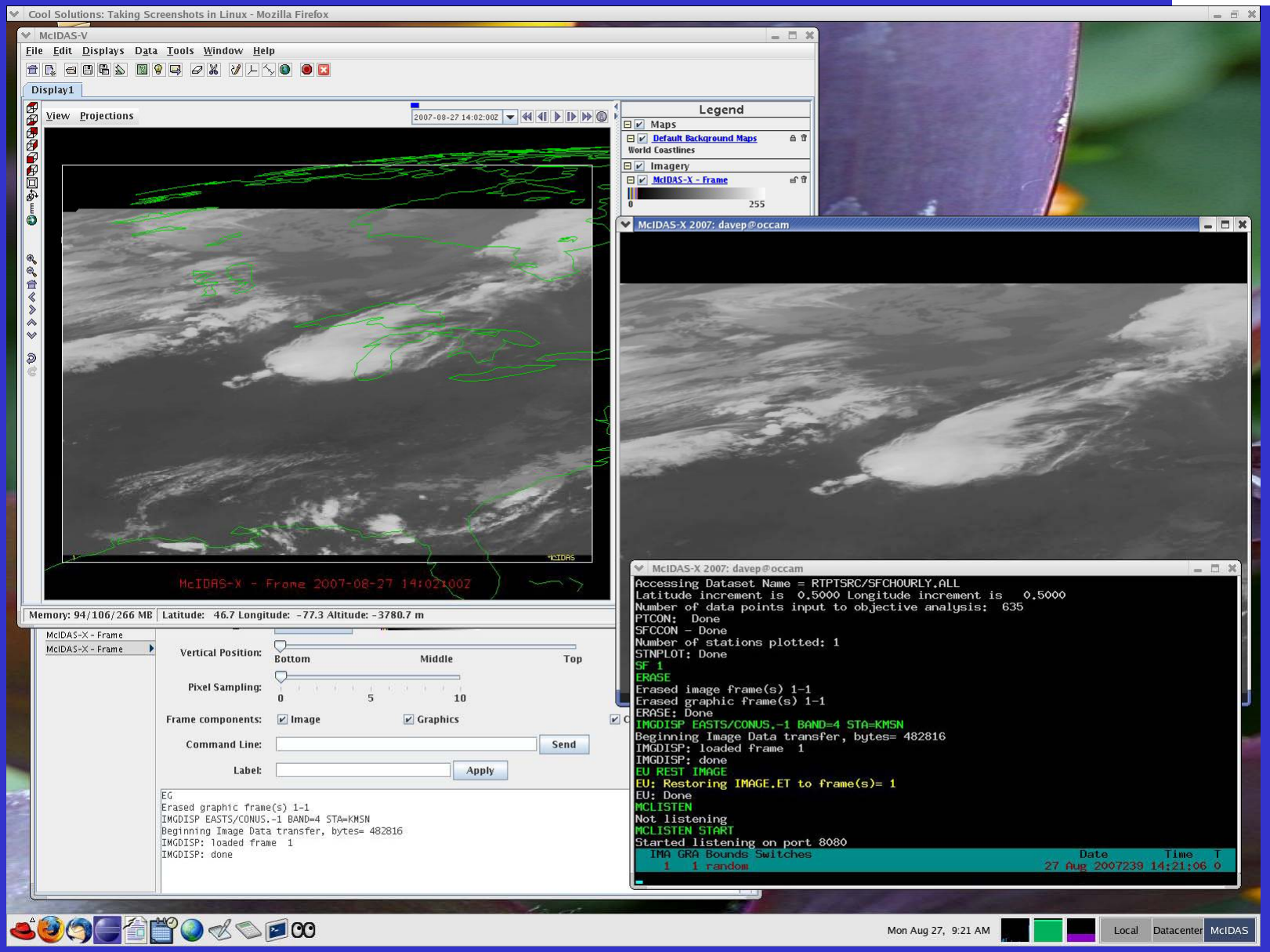
What is McIDAS-V

McIDAS-X → VisAD + IDV + HYDRA = McIDAS-V

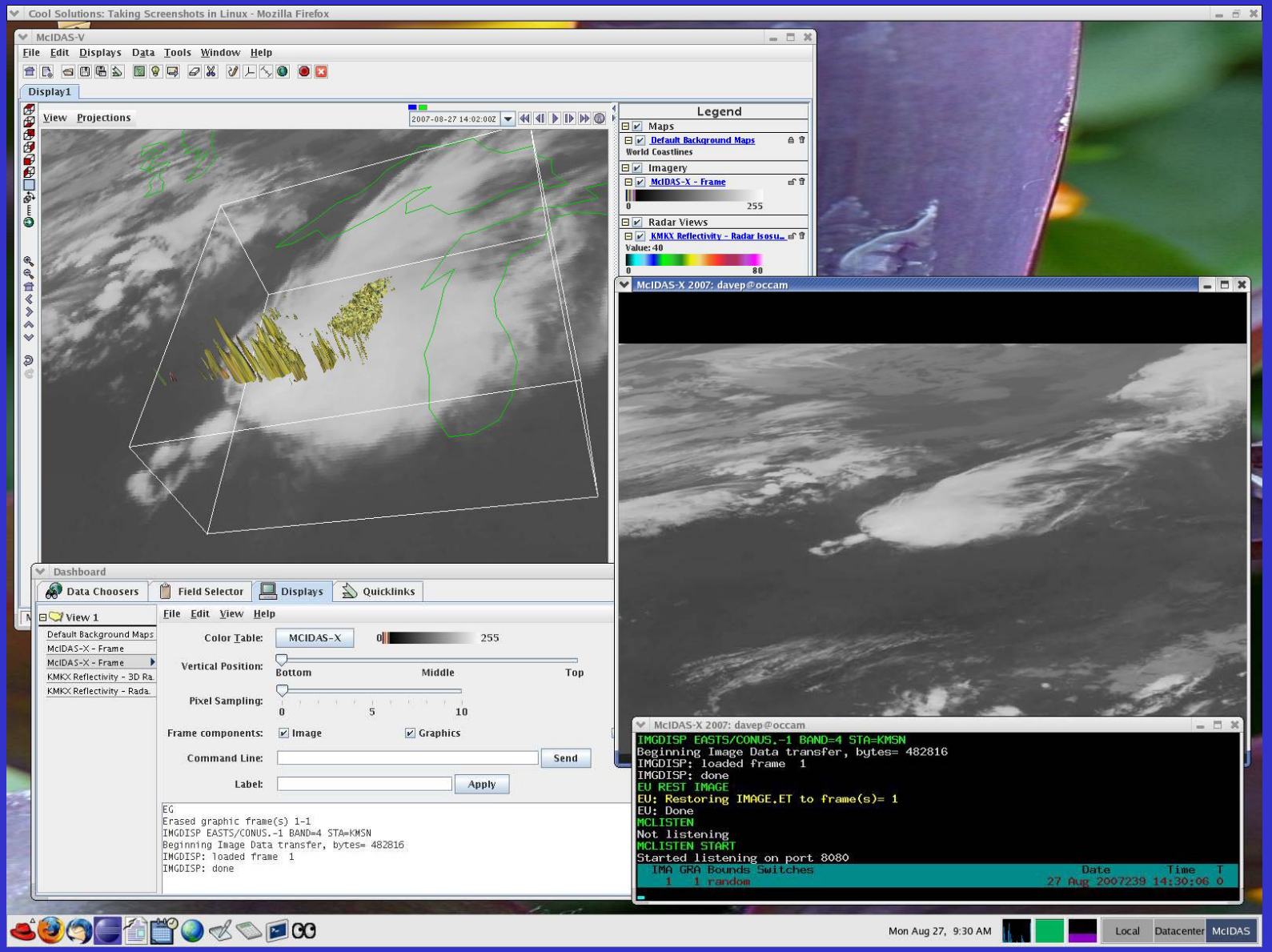
The “X to V” Bridge

- Interacts with a McIDAS-X remote session
- Users provides command line input in a McIDAS-V Data Chooser that sends commands to a server running McIDAS-X
- Runs all McIDAS-X commands, including status, text, imagery and graphics
  - McIDAS-X output displayed in McIDAS-V
- Allows bi-directional interactive communication between McIDAS-V and McIDAS-X

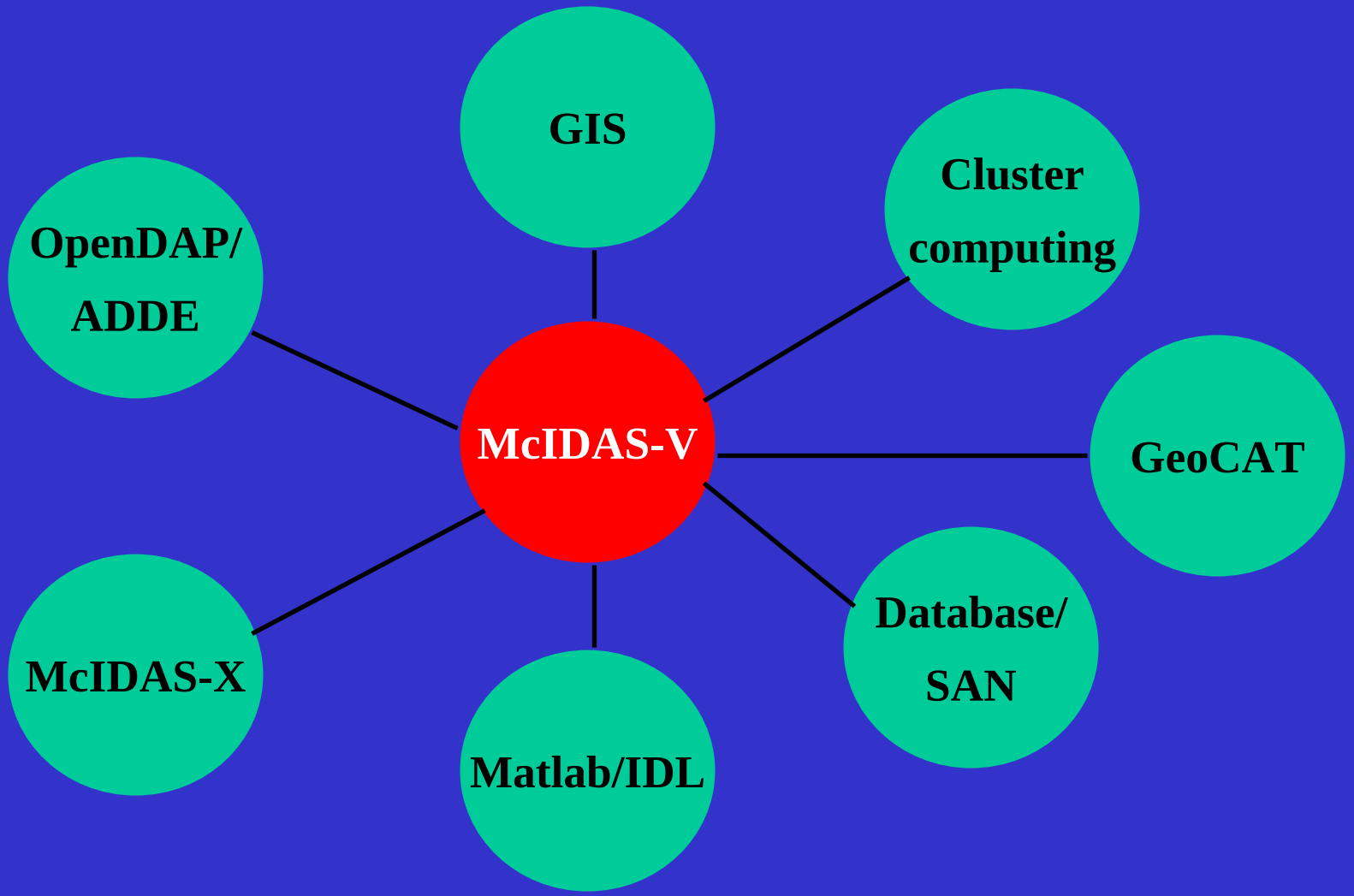
The “X to V” Bridge



The “X to V” Bridge



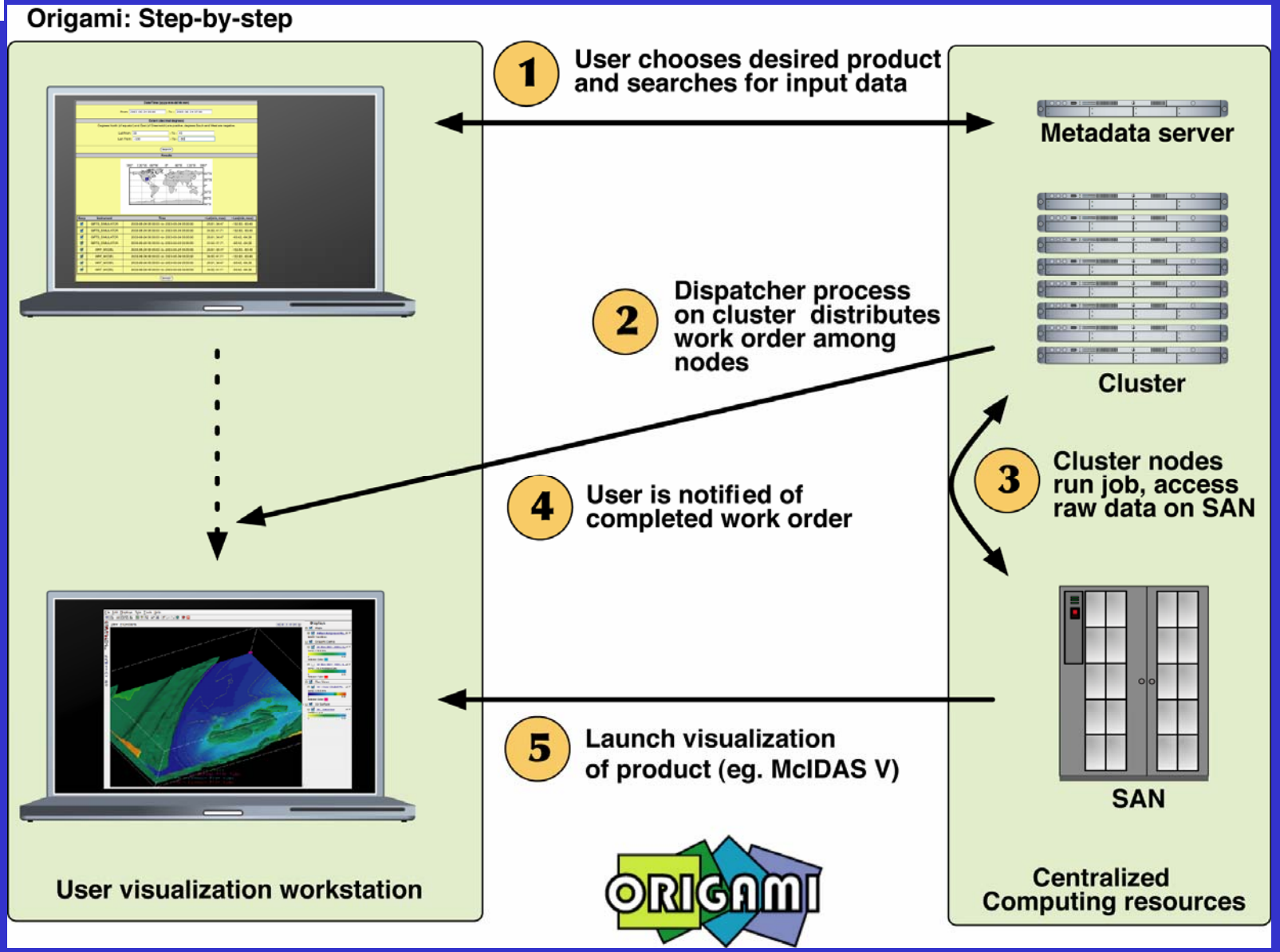
McIDAS-V is a collection of software tools, and networked services and data designed to take advantage of a scalable distributed computing environment to meet user needs

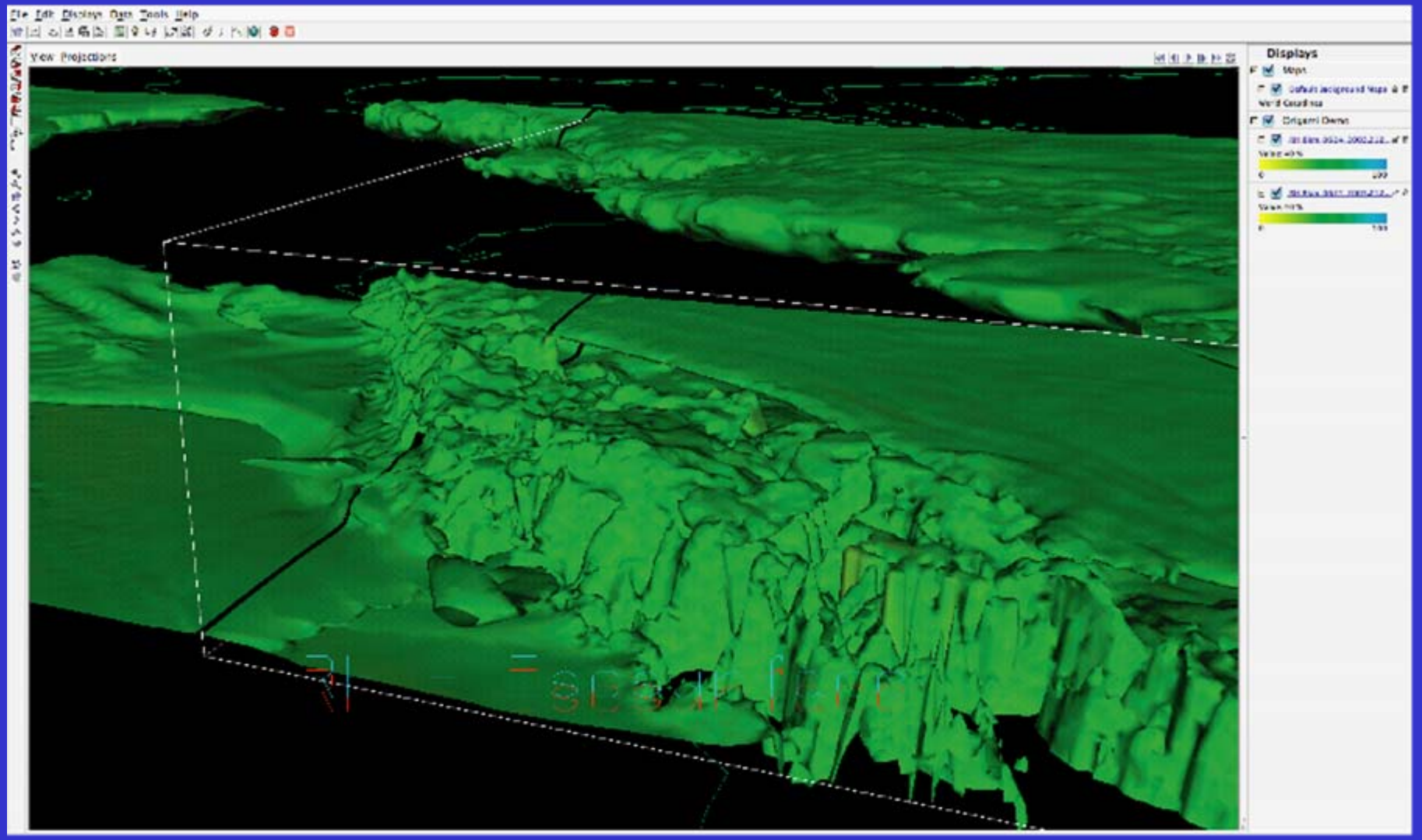


Origami Experiment Goals

- Visualization of meteorological fields from very large simulated model and retrieved data sets
- Remotely query a large database to obtain the required data from a Storage Area Network (SAN) and load into an application (the task)
- Invoke the task on a cluster computer, reading from the database and writing results to a temporary file
- Informing the user where the output data resides (e.g. bring the result into McIDAS-V)

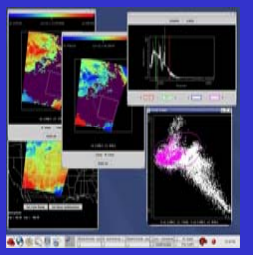
The Origami Experiment





Viewing multiple data blocks (cubes or granules) as part of a single visualization request across a larger geographic area.

McIDAS-V
Transition Plan



- **Built upon the existing capabilities of VisAD/IDV**
- **Incorporate the functionality of the Hyperspectral Data for Research Analysis (HYDRA) toolkit**
- **Allows McIDAS-X heritage code to be usable in the new environment without a need to rewrite**
  - **‘Bridge’ software allows McIDAS-X commands to be submitted from the McIDAS-V display**
- **Provides a new environment for developing algorithms and new visualizations that take advantage of multi and hyper-spectral data from emerging observing systems**

McIDAS-V Future Work

- Complete HYDRA integration
- Complete development of the ‘X to V Bridge’ to provide an evolutionary path for MUG into McIDAS-V (October 2007)
  - Alpha 1.0 release at 10/2007 MUG meeting
- Support the development of applications for the NPP/NPOESS and GOES R science teams (ongoing)
  - Data management and accessibility
  - Broad array of formats and services
  - Advanced analysis and visualization tools

Interactive Processing of Multi- and Hyper-spectral Environmental Satellite Data: The Next Generation of McIDAS

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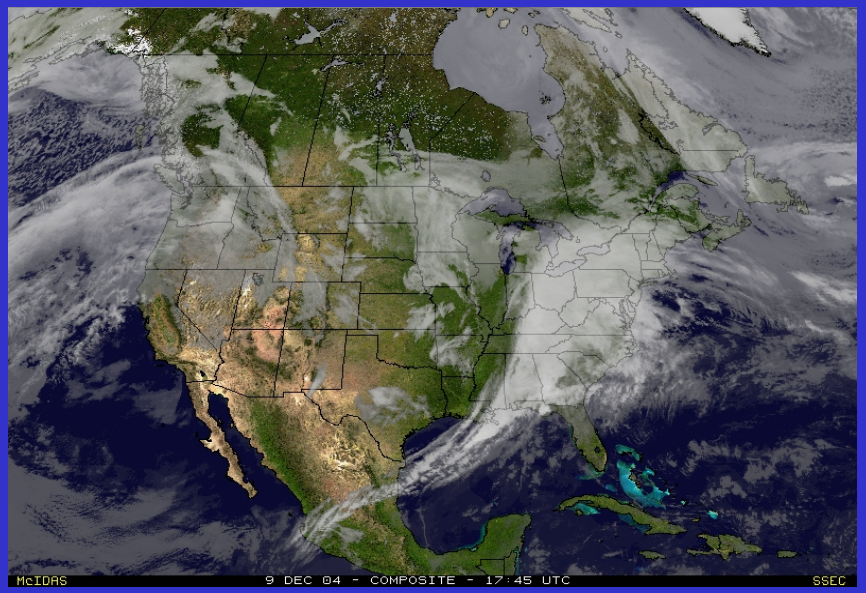

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