

Don Murray^{1*}, Tom Whittaker², Jeff McWhirter¹, Stuart Wier¹

¹Unidata Program Center, Boulder, Colorado

²University of Wisconsin-Madison, SSEC/CIMSS, Madison, Wisconsin

1. INTRODUCTION

Decision makers are now trying to integrate meteorological data (analysis and model output available in formats like netCDF) with societal data (in typical GIS formats like shapefiles or GeoTIFF). They usually have to find ways to convert the meteorological data into a compatible Geographic Information System (GIS) format so they can be used in their GIS tools (e.g., ArcGIS). However, current GIS tools do not handle the time varying, multidimensional datasets that are often used in meteorological analysis and prediction very well and provide little support for time or spatial animation.

Many scientific display and analysis tools have GIS-like capabilities (overlay, georegistration), but do not have built-in ways to incorporate the typical GIS data formats. Additionally, open standards in the GIS community are providing access to GIS data on remote servers (e.g., Web Coverage Services (WCS)) and few of these tools support network access of data.

There is a need in both communities for a tool that will provide access to environmental and societal data in an integrated environment.

2. IDV OVERVIEW

Unidata's Integrated Data Viewer (IDV) is the first comprehensive application built on a framework being developed at Unidata to meet the analysis and display needs of the geoscience community. The freely available IDV provides features of both standard meteorological display and analysis programs and GIS tools.

Built entirely using the Java language and on top of the VisAD analysis and visualization package (Hibbard, 1998), the IDV reference application provides many of the standard 2-D data displays that atmospheric scientists are used to, as well as 3-D views of the atmosphere. It allows users to interactively slice and probe data to create cross-sections, profiles, animations and

value readouts of multi-dimensional data sets. Using the power of the data model in VisAD, IDV allows users to perform calculations on disparate data sets without having to convert from one format to another. It can display a wide range of meteorological (satellite, radar, surface, upper air, NWP) and other geoscience data concurrently with GIS data (shapefiles, Arc/Info, GeoTIFF).

3. GIS DATA SUPPORTED IN THE IDV

The IDV supports the import, display and analysis of data stored in a few of the common formats used in the GIS community. As the need arises, additional formats will be supported.

3.1 Shapefile

The IDV can display data stored in shapefiles (e.g., AWIPS map files), integrating it with other displays of geoscience data. This allows users to incorporate societal data (e.g., map regions, population centers) with meteorological data.

The IDV can be used to track thunderstorm development and movement through displays of Level II radar data, point observations, and gridded model output. Combining these with societal data such as county and population center outlines allows decision makers to visually determine which areas are to be affected by the storm's path.

3.2 ArcInfo ASCIIGRID

Gridded data stored in Arc/Info ASCIIGRID can easily be imported and displayed in the IDV. A variety of data are stored in this format and the IDV allows the user to display these data in a variety of ways.

For example, Digital Elevation Model (DEM) data stored in this format can be displayed as a 3D topography on which meteorological parameter can be overlain. When combined with 3D radar sweep data, the DEM can be useful in determining the angles at which radar beams are intercepted by the topographic features.

*Corresponding author address: Don Murray,
Unidata/UCAR, PO Box 3000, Boulder, CO 80307;
e-mail dmurray@unidata.ucar.edu

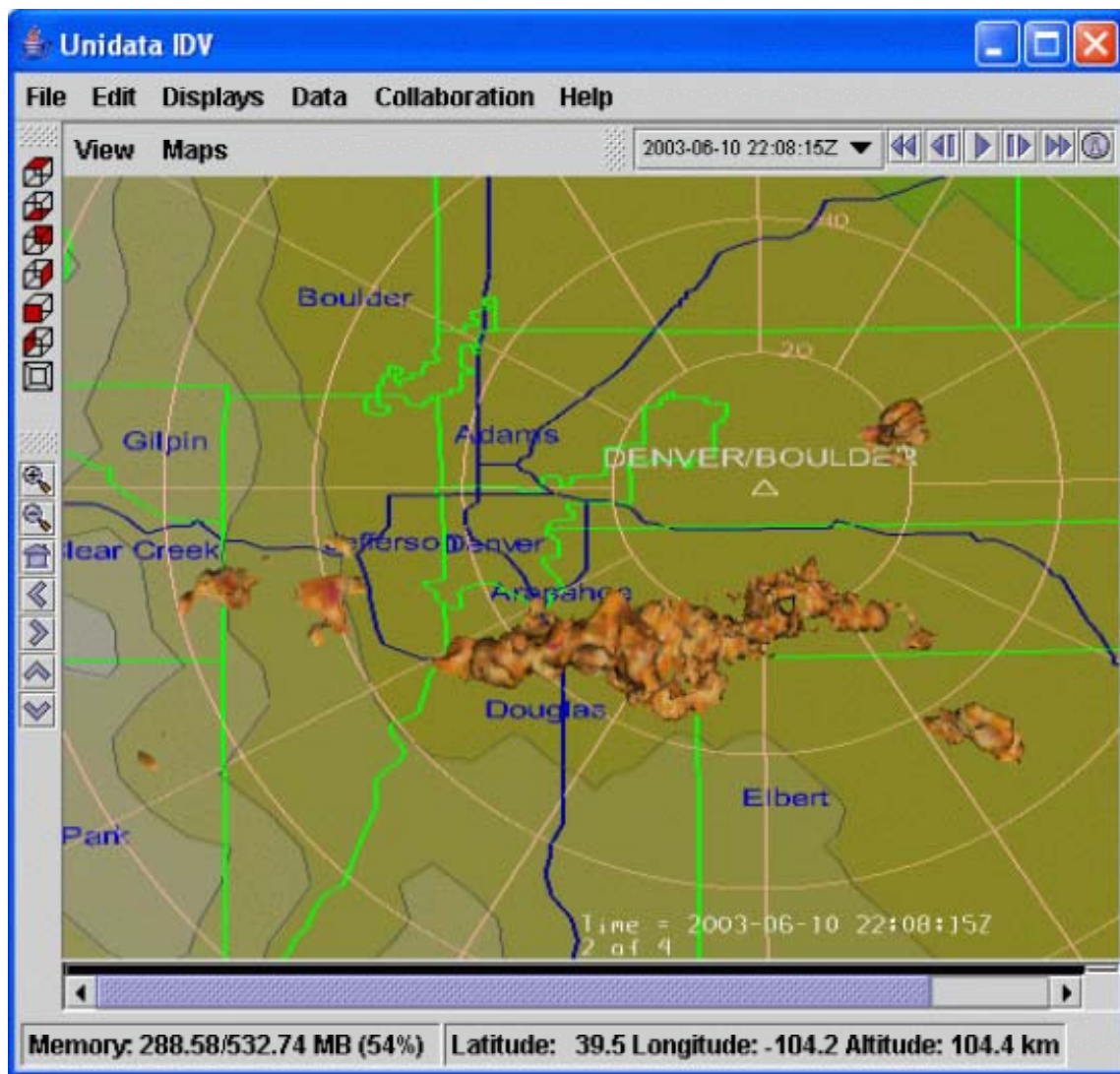


Figure 1: IDV display of 45 dBz isosurface of radar reflectivity from Level II data source, topography from ASCII GRID DEM file, and interstate highways and county outlines/labels from shapefiles.

3.3 GeoTIFF

A third common GIS format that the IDV supports is the GeoTIFF format. The metadata tags in a GeoTIFF specify the geolocation parameters that allow the IDV to correctly register the image in latitude/longitude space. This is useful for incorporating satellite and photographic imagery into complex displays of geoscience data.

4. REMOTE DATA ACCESS

One of the most important features of the IDV is the ability to locate and work with georeferenced datasets located on remote servers. As an increasing number of datasets are made accessible to the geoscience science community (e.g., data from new sensors, local meso-scale

models, higher spatial and temporal resolution data), it is becoming impractical to distribute these datasets in real-time using conventional methods like Unidata's Internet Data Distribution (IDD) system.

Through the framework being developed by the NSDL-funded Thematic Real-time Environmental Distributed Data Services (THREDDS) project (Domenico, 2002), Unidata is creating a network of thematic servers that provide educators and students coherent access to a large collection of distributed data (data web). Using this data web, the IDV provides users with options of selecting entire data sets, or just small subsets of data (spatial and temporal). The integrated nature of the IDV allows users to bring in data from multiple servers through a variety of protocols (e.g. FTP, OPeNDAP, ADDE, HTTP) and combine

them into a single display. It provides a powerful mechanism for using real-time and archived data in a classroom setting.

At the same time, open standards in the GIS community (e.g., OpenGIS Consortium (OGC), ISO) are providing specifications for accessing GIS data from remote servers as well. Work is underway at Unidata to develop a Web Coverage Server (WCS) based on the recently released OGC specification (Caron, 2004). This prototype has been used to serve up grid and image type scientific datasets in GeoTIFF format. The IDV is being adapted to read the data supplied by this and other WCS servers, providing another means of accessing remote GIS formatted data in addition to those listed above.

5. ANALYSIS CAPABILITIES

In recent years, GIS tools have matured to provide analysis capabilities and the IDV supports many of these. Since the IDV uses VisAD's universal data model which supports virtually any numeric data, it is easy for users to perform mathematical calculations between the (essentially 2-D) GIS and the (5-D) geoscience datasets. The IDV allows users to create simple formulas or use the Jython language to perform more complex calculations. The operands used in these formulas can include data from multiple datasets.

Rather than providing a variety of specific data structures like images, grids and tables, the VisAD data model defines a set of classes that can be used to build any hierarchical numerical data structures. Metadata including units, sampling topologies, error estimates and coordinate transformations is incorporated into each data object and is carried along through mathematical operations. The IDV incorporates any metadata available in the dataset or additional metadata supplied by a THREDDS server.

For example, a researcher who wants to calculate the deviation of observed precipitation from monthly climatic normals could use the IDV to find a THREDDS data server that has a dataset of observed monthly average precipitation and web server that has climatic norms of precipitation in ASCII GRID format. She could use the diagnostic capabilities of the IDV to subtract the two datasets. During the process, the precipitation values from the second dataset are resampled to the spatial and temporal locations of the first before they are subtracted. If the two data sets use different units (e.g., in and mm), these are converted before values are subtracted.

The IDV supports a wide variety of data projections including native satellite coordinates. Since the metadata included in the VisAD data objects contains the geolocation information, the IDV can automatically reproject data into any projection. There is no need to redefine a projection for each data object before display. Thus, the researcher in the example above could immediately display the data in a projection different from the native projection of either dataset.

6. SUMMARY

Unidata's IDV is a powerful analysis and visualization tool that allows users to combine meteorological and other geoscience data concurrently with societal data in GIS formats. As the development of the IDV framework continues, new types of data and analysis capabilities will be incorporated.

7. WEB SITES

Unidata Integrated Data Viewer:

my.unidata.ucar.edu/content/software/IDV

VisAD

www.ssec.wisc.edu/~billh/visad.html

8. REFERENCES

- Caron, J. and S. Nativi, 2004: NetCDF to GIS: the Good, the Bad, and the Ugly. *Preprints, 20th Intl Conf. on IIPS for Meteorology, Oceanography and Hydrology*
- Domenico, B., J. Caron, E. Davis, R. Kambic and S. Nativi, 2002: Thematic Real-time Environmental Distributed Data Services (THREDDS): Incorporating Interactive Analysis Tools into NSDL. *J. Digital Information*, **2**(4).
- Hibbard, W., 1998: VisAD: Connecting people to computations and people to people. *Computer Graphics*, **32**(3), 10-12.