# Four AVS Modules: READ_NETCDF, TOPO2IRREG, Z_SLICER, WIDE_ARROW

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ABSTRACT

This report describes four software modules for the Application Visualization System (AVS). The modules were written to facilitate visualization of an ocean circulation and sediment transport model. However, they are general enough to be used for a variety of applications.

## INTRODUCTION

An ocean circulation and sediment transport model for Massachusetts Bay produces large data sets of three-dimensional variables such as currents, salinity, temperature, turbulence, momentum fluxes and dispersion coefficients. These are computed for a spatial grid which is curvilinear in the X and Y directions and rectilinear in Z. The Application Visualization System (AVS) software environment developed by AVS Inc. provides a means to visualize this data for interpretation.

This ocean circulation model posed some unique visualization requirements. We found it necessary to write some of our own modules. The four modules described here, initially written to satisfy our needs, were made as general as possible so that they might be useful to the community at large.

One of the modules described here requires the use of the netCDF interface, a public-domain, hardware-independent mechanism for accessing data in a self-describing binary format (UCAR, 1991). The data for the ocean circulation model is stored in netCDF files. Retrieval of data from netCDF files requires a special AVS module to read the data into AVS. An initial version of the module "read_netcdf" (Wright, 1992) was specific to this ocean circulation model. The version described here is much more general in scope and should be useful to a wide audience.

The module "topo2irreg" converts two-dimensional topographic data stored in an AVS 2-coordinate field to an AVS 3-coordinate irregular field, using the data variable as the vertical coordinate. This enables us to display bathymetry or topography in 3-D, through the use of the AVS field_to_mesh module.

The module "Z_slicer" extracts a 2-D field at a specified Z-level from a 3-D field with stretched vertical coordinates. The 3-D field must have the same X,Y coordinates at each vertical index. This module allows us to extract information at a specified depth or elevation from atmospheric and oceanic circulation models which employ stretched ("sigma") coordinates in the vertical dimension.

The module "wide_arrow" was written to display a one-dimensional, 2-component vector field as a wide arrow in the X-Y plane to indicate the direction and magnitude of the vector. This allows us to display wind direction and velocity for our oceanic circulation model.

The C source code and Makefile for generating the executable program for each module is available via anonymous ftp from the International AVS Center (IAC) at the North Carolina Supercomputing Center (avs.ncsc.org). The descriptions of the modules included in this report are also available from the IAC. They are the on-line help files and are named the module name followed by the .txt extension.

## REFERENCES

1. Unidata Program Center, 1991, NetCDF User's Guide: An Interface for Data Access, University Corporation for Atmospheric Research, Boulder, CO.

2. Wright, E.L., 1992, An Example of Interfacing AVS and NetCDF: U.S. Geological Survey Open-File Report 92-332.

NAME

read netcdf - read a netCDF file that follows certain conventions

SUMMARY

Name read netcdf

Version 2.0

Author Evelyn Wright (ew@orpheus.er.usgs.gov)

Type data input

Input none

Output field scalar float {uniform or rectilinear}

Parameters

| Name | Type | Default | Min | Max |
|---|---|---|---|---|
| Read netCDF File | browser | *.cdf | | |
| Data Variables | string | | | |
| Var0 | boolean | off | | |
| Var1 | boolean | off | | |
| Var2 | boolean | off | | |
| Var3 | boolean | off | | |
| Var4 | boolean | off | | |
| Var5 | boolean | off | | |
| Var6 | boolean | off | | |
| Var7 | boolean | off | | |
| Dimensions | string | | | |
| Dim0 | boolean | off | | |
| Dim1 | boolean | off | | |
| Dim2 | boolean | off | | |
| Dim3 | boolean | off | | |
| Dim4 | boolean | off | | |
| Dim5 | boolean | off | | |
| Dim6 | boolean | off | | |
| Dim7 | boolean | off | | |
| Activate Dimension Selections | string | | | |
| OK | boolean | off | | |
| Enable Reader | boolean | off | | |
| Hyperslab Selections | string | | | |
| Min0 | integer | 0 | INT_UNBOUND | INT_UNBOUND |
| Max0 | integer | 0 | INT_UNBOUND | INT_UNBOUND |
| Min1 | integer | 0 | INT_UNBOUND | INT_UNBOUND |
| Max1 | integer | 0 | INT_UNBOUND | INT_UNBOUND |
| Min2 | integer | 0 | INT_UNBOUND | INT_UNBOUND |
| Max2 | integer | 0 | INT_UNBOUND | INT_UNBOUND |
| Min3 | integer | 0 | INT_UNBOUND | INT_UNBOUND |
| Max3 | integer | 0 | INT_UNBOUND | INT_UNBOUND |
| Single Record Selections | string | | | |
| Record0 | integer | 0 | INT_UNBOUND | INT_UNBOUND |
| Record1 | integer | 0 | INT_UNBOUND | INT_UNBOUND |
| Record2 | integer | 0 | INT_UNBOUND | INT_UNBOUND |
| Record3 | integer | 0 | INT_UNBOUND | INT_UNBOUND |
| Save Settings | boolean | off | | |

DESCRIPTION

This module reads data from netCDF files into uniform or rectilinear AVS fields. The data variables must be of dimension 8 or less. Variables that are one-dimensional and have the same name as a dimension name are assumed to be coordinate variables. Coordinate variables, if present, define the coordinate values along each axis of the data space. A maximum of 8 data variables that are NOT coordinate variables may be present.

The variables may be short, long, float, or double. They may have a scale factor and an offset stored as float attributes scale_factor and add_offset.

The number of dimensions in the AVS output field is determined by the number of dimensions selected by the user; the maximum is 4. The output field will have the same number of coordinates as dimensions.

If 1-D coordinate variables are present, the coordinate data for each user-selected dimension is read automatically; the AVS output field will be rectilinear. If no coordinate variables are present, the AVS output field will be uniform.

This module allows the user to select a hyperslab of data to be read.

OUTPUT

The output data is a scalar float field that is uniform or rectilinear and has 1, 2, 3, or 4 dimensions (and the same number of coordinates).

PARAMETERS

Read netCDF File

This is a file browser that displays filenames with the .cdf extension. The user selects the desired netCDF file.

Data Variables

This is the title for the next group of parameters.

Var0
Var1
Var2
Var3
Var4
Var5
Var6
Var7

These boolean parameters display the names of the data variables found in the user-selected netCDF file. Only variables that are NOT coordinate variables are displayed. The user selects the desired variable to be read.

Dimensions

This is the title for the next group of parameters.

Dim0
Dim1
Dim2
Dim3
Dim4
Dim5
Dim6
Dim7

These boolean parameters display the names of the dimensions of the user-selected data variable. The user selects 1, 2, 3, or 4 of these dimensions. The number of selections determines the number of dimensions of the AVS output field.

Activate Dimension Selections
: This is the title for the next parameter.

OK
: This boolean parameter is selected by the user to indicate completion of user-selection of the desired dimensions.

Enable Reader
: This boolean parameter is selected by the user to indicate completion of user-selection of the desired hyperslab of data and to activate reading the selected data from the netCDF file.

Hyperslab Selections
: This is the title for the next group of parameters.

Min0
Max0
Min1
Max1
Min2
Max2
Min3
Max3
: These integer type-in parameters display the name and the currently selected minimum and maximum index value of each user-selected dimension. The values determine the hyperslab of data to be read.

Single Record Selections
: This is the title for the next group of parameters.

Record0
Record1
Record2
Record3
: These integer type-in parameters display the name and the currently selected index value of each dimension NOT user-selected. The values determine the hyperslab of data to be read.

Save Settings
: This boolean parameter is selected by the user to enable saving the current dimension and hyperslab settings. This is useful when the user wishes to save and later restore the current AVS network.

## USAGE

Begin by selecting a netCDF file name (only files with the extension .cdf are displayed by the file browser). The names of the data variables that are NOT coordinate variables are displayed on boolean buttons. Selections are made by clicking on them using the left mouse button.

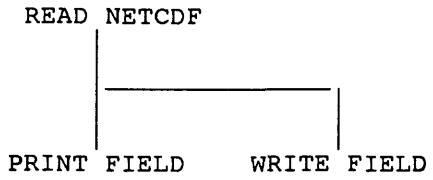
Selecting the desired variable displays the dimension names for that variable on boolean buttons. Up to 4 dimensions may be selected. The number of dimensions selected will be the number of dimensions of the AVS output field. Click on the OK button to display the hyperslab selections. If you change the dimension selections, click on the OK button again. This causes the hyperslab portion of the menu to be re-initialized.

Two type-in integer parameters are displayed for each dimension selected. They are the minimum and maximum index values of the data to be read for that dimension. Also displayed are single index values of the data to be read for each dimension NOT selected. The user may modify these values. When the hyperslab of data is selected, click on Enable Reader.

Select the Save Settings button to preserve the current dimension and hyperslab selections before saving the current AVS network. This allows all current "read netcdf" settings to be reinstated. Otherwise, only the file and variable name selections will be reinstated.

EXAMPLE AVS NETWORK

The following network converts netCDF data into an AVS field, displays the contents of the new field, and also writes the new AVS field to disk.




ACKNOWLEDGEMENTS

This module uses some of the ideas and code of a similar module written by Tim Scheitlin.

SEE ALSO

Unidata Program Center, 1991, NetCDF User's Guide: An Interface for Data Access, University Corporation for Atmospheric Research, Boulder, CO.

NAME

Topo2irreg - converts a 2D scalar float 2-coordinate field typically containing topography into a 3-coordinate irregular field

SUMMARY

| | |
|---|---|
| Name | Topo2irreg |
| Author | Evelyn Wright (ew@orpheus.er.usgs.gov) |
| Type | filter |
| Input | field 2D scalar float 2-coordinate |
| Output | field 2D scalar float 3-coordinate irregular |

| Parameter | Name | Type | Default | Min | Max |
|---|---|---|---|---|---|
| | Vertical Scale Factor | float | 1.0 | FLOAT_UNBOUND | FLOAT_UNBOUND |

DESCRIPTION

This module converts a 2D scalar float 2-coordinate field to an irregular 3-D field by adding Z coordinates. The Z coordinates are the data values of the input field (typically topography) multiplied by the value of the vertical scale factor parameter. The input field may be uniform, rectilinear, or irregular.

The output field has the same data values and X and Y coordinates as the input field.

APPLICATION

This module is useful for displaying 2-D bathymetry or topography in 3-D with or without an image draped over it.

INPUT

The input data must be a 2D 2-coordinate field with scalar float data values.

OUTPUT

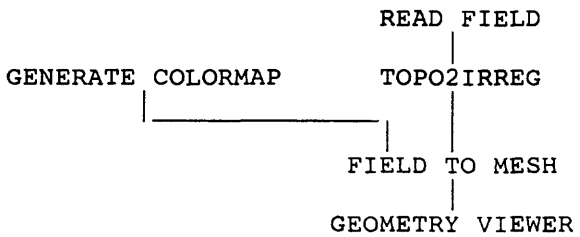
The output data is a 2D 3-coordinate irregular field with the same scalar float data values as the input field. The third coordinate is generated by multiplying the scalar float data value by the vertical scale factor.

PARAMETER

Vertical scale factor

This is the multiplicative factor for scaling the data values for use as Z coordinates (i.e., vertical exaggeration)..

EXAMPLE AVS NETWORK



NAME

Z_slicer - interpolates a 2D Z-slice from a 3D irregular field with stretched ("sigma") vertical coordinates

SUMMARY

| | |
|---|---|
| Name | Z_slicer |
| Author | Evelyn Wright (ew@orpheus.er.usgs.gov) |
| Type | filter |
| Input | field 3D float 3-coordinate irregular |
| Output | field 2D float 3-coordinate irregular |

| Parameter | Name | Type | Default | Min | Max |
|---|---|---|---|---|---|
| Z | Value | float | -10.0 | FLOAT_UNBOUND | FLOAT_UNBOUND |

DESCRIPTION

Z_slicer interpolates a 2D irregular field at a specified Z value from a 3D irregular field with stretched ("sigma") vertical coordinates. This is a common need in 3D atmospheric and oceanic models, where irregular fields have fixed X,Y locations for each vertical index, but Z values vary with the thickness of the fluid layer.

Z_slicer accepts either scalar or vector data. The module assumes that the Z coordinates corresponding to each (X,Y) coordinate pair are in either increasing or decreasing numerical order.

Z_slicer is similar to arbitrary slicer, but Z_slicer interpolates data for a specific Z coordinate and outputs a field instead of geometry.

APPLICATION

This module is useful for working with multi-valued oceanographic or meteorological data that corresponds to an irregular X-Y grid.

INPUT

The input data must be a 3D float 3-coordinate irregular field with scalar or vector data values. It is assumed there are multiple Z coordinates for each (X,Y) coordinate pair.

OUTPUT

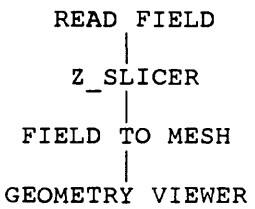
The output data is a 2D float 3-coordinate irregular field with interpolated scalar or vector data values. The X and Y coordinates are the same as for the input field. The Z coordinates are the user-specified Z Value.

PARAMETER

Z Value

Specifies the Z coordinate value for which data values will be interpolated.

EXAMPLE AVS NETWORK



NAME

Wide Arrow - create geometry to display a 1D, 2-vector field as a wide arrow in the X-Y plane

SUMMARY

| | |
|---|---|
| Name | Wide Arrow |
| Author | Evelyn Wright, U.S. Geological Survey<br>ew@orpheus.er.usgs.gov |
| Type | mapper |
| Input | field 1D 2-vector float 3-coordinate irregular |
| Output | geometry |

| Parameter | Name | Type | Default | Min | Max |
|---|---|---|---|---|---|
| | Scale Factor | float | 1.0 | FLOAT_UNBOUND | FLOAT_UNBOUND |

DESCRIPTION

This module reads a 1D 3-coordinate irregular field containing a single floating-point 2-element vector specifying X and Y velocity components at the specified (X,Y,Z) coordinate.

Wide Arrow creates the geometry to display a wide arrow indicating the vector direction at the specified (X,Y,Z) coordinate. The length of the arrow is proportional to the vector magnitude. The Scale Factor parameter allows the user to scale the data to produce an arrow of the desired length.

APPLICATION

This module is useful for displaying wind direction and velocity.

INPUT

The input data must be a 1D 2-vector float 3-coordinate irregular field. The vector components are assumed to be in the X and Y directions.

OUTPUT

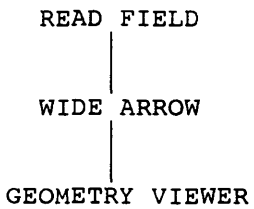
The output data is an AVS polytriangle geometry object.

PARAMETER

Scale Factor

This is the multiplicative factor for scaling the data values to produce an arrow of the desired length.

EXAMPLE AVS NETWORK




ACKNOWLEDGEMENTS

This module is partially derived from code written by Albert Fischer.