Overview of IVĒ

IVĒ, the Interactive Visualization Environment, has been optimized for the precision analysis and visualization of arbitrary sub-volumes of large four-dimensional datasets. Both scalar fields (e.g., temperature, pressure, ...) and vector fields (e.g., velocities, fluxes ...) are supported. The particular strengths of IVĒ lie in its:

- Ability to plot data on general curvilinear grids
- Intuitive graphical interface
- Precision plotting and quantitative analysis capabilities
- Sophisticated 2D and 1D analysis capabilities
- Extensibility via subprograms supplied by the user at run time
- Extensive html-based online help and documentation

3D plotting capabilities will be available in the near future. Our initial focus has been to create a quick easy way to display one- and two-dimensional subsets of the complete data set, because 2D (and even 1D) images are crucial elements in scientific publications and scholarly communication.

Further details about each of the features in the preceding list is provided below.

Ability to plot data on general curvilinear grids: Since four-dimensional data cannot be directly displayed on a flat computer screen, it is necessary to reduce the dimensionality of the data before it is displayed. Lower-dimensional subsets of the data are achieved either by fixing one or more coordinates (data slicing) or by averaging over a specified range of one or more coordinates. Data slicing and averaging may be done with respect to a fixed physical coordinate even if the data is stored in a curvilinear coordinate system. For example, data stored in a terrain following coordinate may be displayed on a horizontal plane of fixed elevation, as illustrated in Fig. 1. The subvolume to be displayed is selected via a widget interface (visible in Fig. 2), or by using the mouse to zoom or to select a cross-section of the data already being displayed.

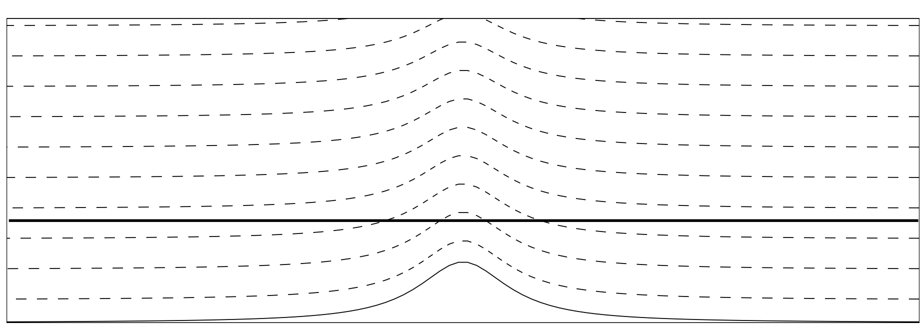

Figure 1. Fig. 1: Horizontal slice (along the heavy solid line) through data on a boundary-following curvilinear mesh (dashed lines).

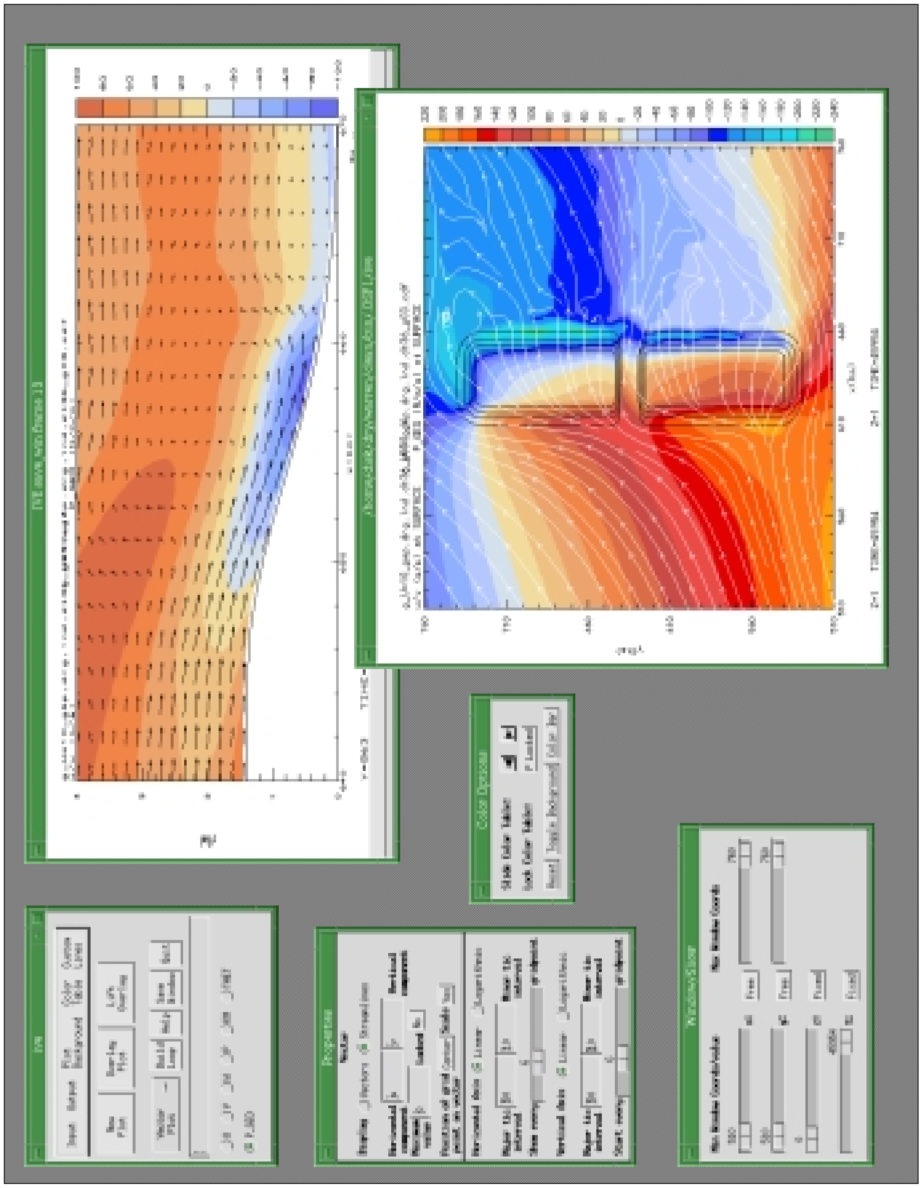

Figure 2. Fig. 2: Screen display during the analysis of flow through a gap in a ridge illustrating some of the widget and plotting capabilities available in IVE. A close up of perturbation pressure and velocity vectors is shown in the window in the upper right (assuming the computer screen is oriented so that the text on the screen reads right to left), the lower right shows perturbation pressure, streamlines along the surface, and topographic contours. The main IVE control widget is in the upper left; the data slicer widget is in the lower left. The widget in the middle left changes depending on the nature of the plot being generated; as shown, it gives options for displaying a 2D slice through a vector field. Color fill properties may be manipulated and accessed using the small widget in the center.

Easy and intuitive graphical interface: The IV$\bar{\text{E}}$ widget interface is intelligent in that the widgets automatically change to reflect the range of choices available at each point in the analysis. This reduces screen clutter and focuses the user on those specific options that are currently relevant. For example, different widgets containing options appropriate for 1D or 2D displays appear depending on whether the currently specified subdomain is one- or two-dimensional and whether the field is to be displayed as a vector or as a scalar. IV$\bar{\text{E}}$ remembers previous choices and offers them as defaults when they are appropriate later on in the session. For example, if the contour interval in a two-dimensional plot of the pressure field is set to 5 mb, this becomes the new default and is remembered the next time a 2D plot of pressure is created no matter what other fields may have be plotted or other types of plots may have been generated in the interim. Multiple fields can easily be overlaid; conversely overlays can easily be lifted off and replaced with another field or the same field can be overlayed once again using different contour intervals, colors, or line styles. The loop widget can be used to easily loop the current image (perhaps containing several overlaid fields) with respect to any fixed coordinate. For example, a 2D plot in an x-y plane might be defined by fixing z and t; the resulting x-y image can then be looped with respect to either the z or t coordinate.

Precision plotting and quantitative analysis capabilities: IV$\bar{\text{E}}$ displays data on a curvilinear mesh without unnecessary interpolation. For example, if data to be displayed as a contour plot lies in a true physical-space plane but is arranged on curvilinear coordinates within that plane, IV$\bar{\text{E}}$ uses the curvilinear coordinate transformation to correctly display each contour. This procedure avoids the loss in precision that would be encountered if curvilinear data was first interpolated to a regular rectangular array and then contoured. Staggered grid structures may be specified, and data fields with different staggering will be correctly displayed with respect to each other. IV$\bar{\text{E}}$ allows complete control of contour values and data ranges. IV$\bar{\text{E}}$ has a command-line facility for the computation of new fields from those fields initially contained in the data set.

Sophisticated 2D and 1D analysis capabilities: IV$\bar{\text{E}}$ is capable of creating and easily animating most types of 1D and 2D images relevant to the display of four dimensional data describing fluid flows including: line plots and contour plots of scalar fields, vector and streamline plots of vector fields, and fluid-parcel trajectories. Arbitrary numbers of fields may be overlaid or lifted off the underlying plot. Details such as colors, fill-patterns, line widths, line styles, contour intervals and axes labels can be easily manipulated.

Extensibility via subprograms supplied by the user at run time: Arbitrarily complex curvilinear coordinates may be accommodated through user-supplied subprograms that convert between physical space coordinates and the array indices for gridded data on a curvilinear mesh. Arbitrarily complex derived field computations may also be performed via user supplied subprograms. These subprograms are compiled separately from the main IV$\bar{\text{E}}$ package.

Extensive html-based online help and documentation: IV$\bar{\text{E}}$ help and documentation are available at *www.atmos.washington.edu/ive/* in html format, cross-indexed by hot links.