# VAPOR visualization of WRF-ARW data

A short summary of VAPOR capabilities

1. VAPOR installation
2. Read or convert WRF-ARW output files
3. Apply geo-referenced images to the terrain
4. Calculate 2D and 3D derived variables in Python
5. Volume render 3D variables
6. Display isosurfaces of 3D variables
7. Display color-mapped 2D variables on planes or terrain-mapped.
8. Use wind barbs to show flow direction and speed
9. Display streamlines or path lines in scene
10. Insert contour planes, use them to position flow seeds.
11. Image-based flow shows flow motion in 2D slices
12. Create animated 3D sequences

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# VAPOR Installation

- Available for Linux, Windows, or Mac systems
- Should have a reasonably modern graphics card
  - nVidia, ATI or AMD graphics cards are good; others may not perform all visualizations.
- From the VAPOR website http://www.vapor.ucar.edu: Download appropriate binary installer from the VAPOR download page, follow the installation instructions.
- You will need Administrative privileges on Mac
- Note that on Linux and Mac you need to source vapor-install.csh in your shell before running any VAPOR commands.
- Run the vaporgui application to visualize your data

# Reading or converting WRF-ARW output files

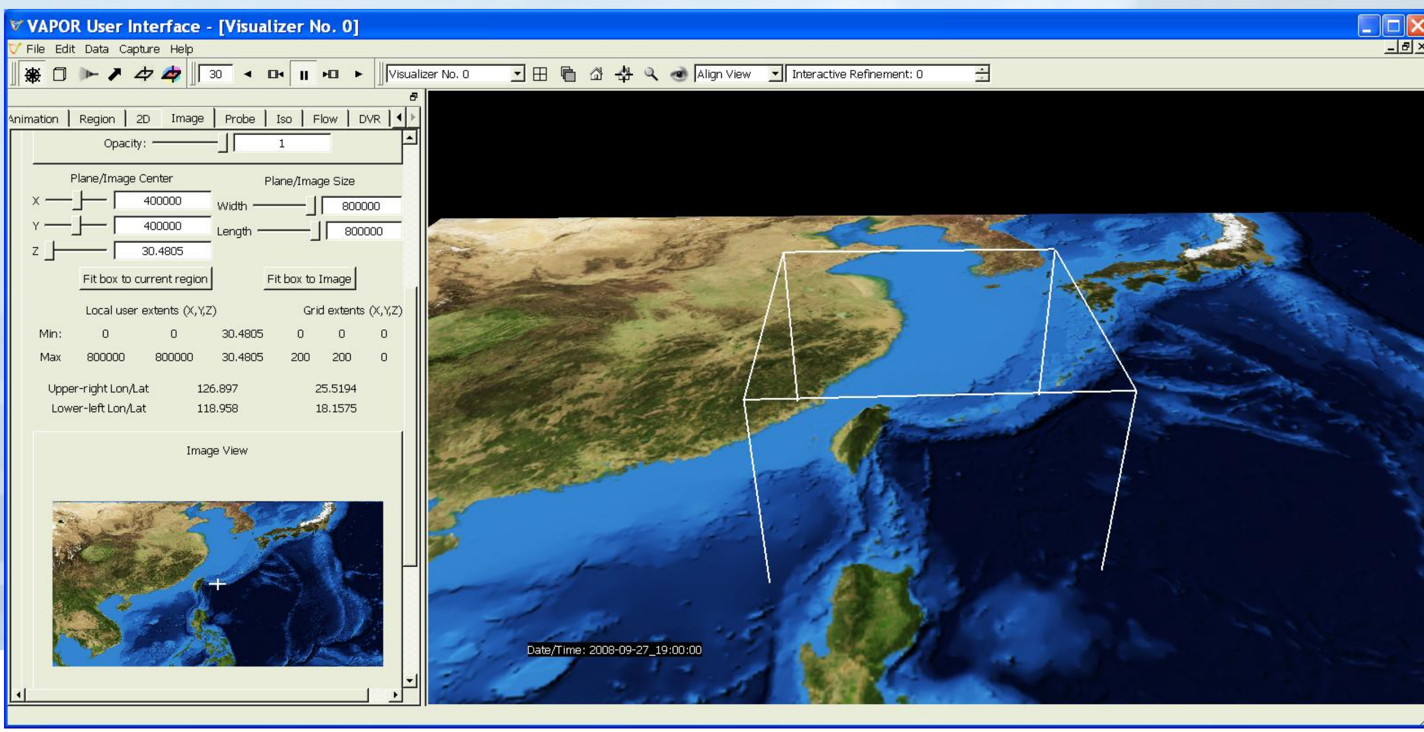
- To directly read WRF output:
  - Run vaporgui
  - All data must be on the same grid, using the same nesting level.
  - Specify "Import WRF-ARW output files" from the Data menu, and select all the wrfout files to visualize
- For interactive visualization of large WRF-ARW datasets, it's best to convert WRF data to the VAPOR data format, using wrfvdfcreate and wrf2vdf utilities.
  - `wrfvdfcreate wrfoutfiles… vdffile.vdf`

    creates a VAPOR metadata file "vdffile.vdf" that describes a set of wrfout files.
  - `wrf2vdf vdffile.vdf wrfoutfiles…`

    converts the specified wrfout files to a vapor data collection
  - From the vaporgui Data menu, load the file "vdffile.vdf" to visualize the converted data

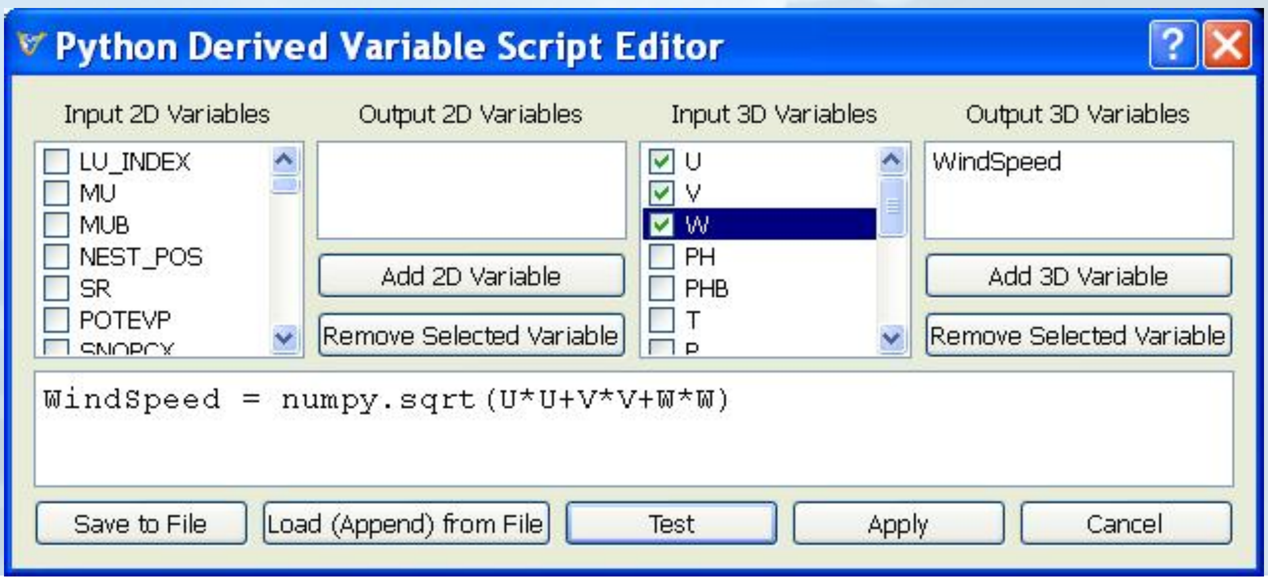
# Apply images to use in the VAPOR scene

- Geo-referenced satellite images can be retrieved from the Web, and VAPOR will insert them at the correct world coordinates.
  - VAPOR provides a shell script "getWMSImage.sh" that can be used to retrieve Web Mapping Service images for a specified longitude/latitude rectangle
- Also, several useful images are installed with vapor; e.g. state or national boundary maps, NASA's Blue Marble image of the earth.
- From the image panel, specify the image file, apply to terrain.



# Create derived variables with Python

- From the Edit menu, “Edit Python program defining a new variable”
- Use Python script editor to define variables as arithmetic expressions of other variables.
- Variables are evaluated and cached as needed for visualization
- Python functions are also provided to derive several useful variables from WRF data; e.g. cloud-top temperature, relative humidity, potential vorticity, sea-level pressure, dewpoint temperature, radar reflectivity, equivalent potential temperature, wind shear, temperature in degrees Kelvin.

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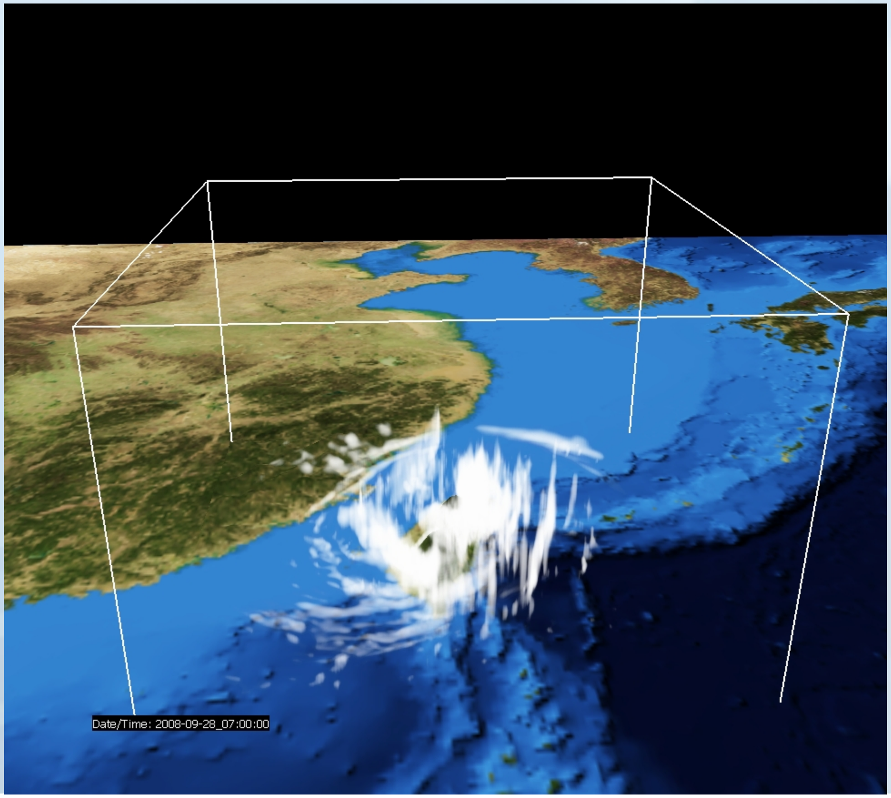
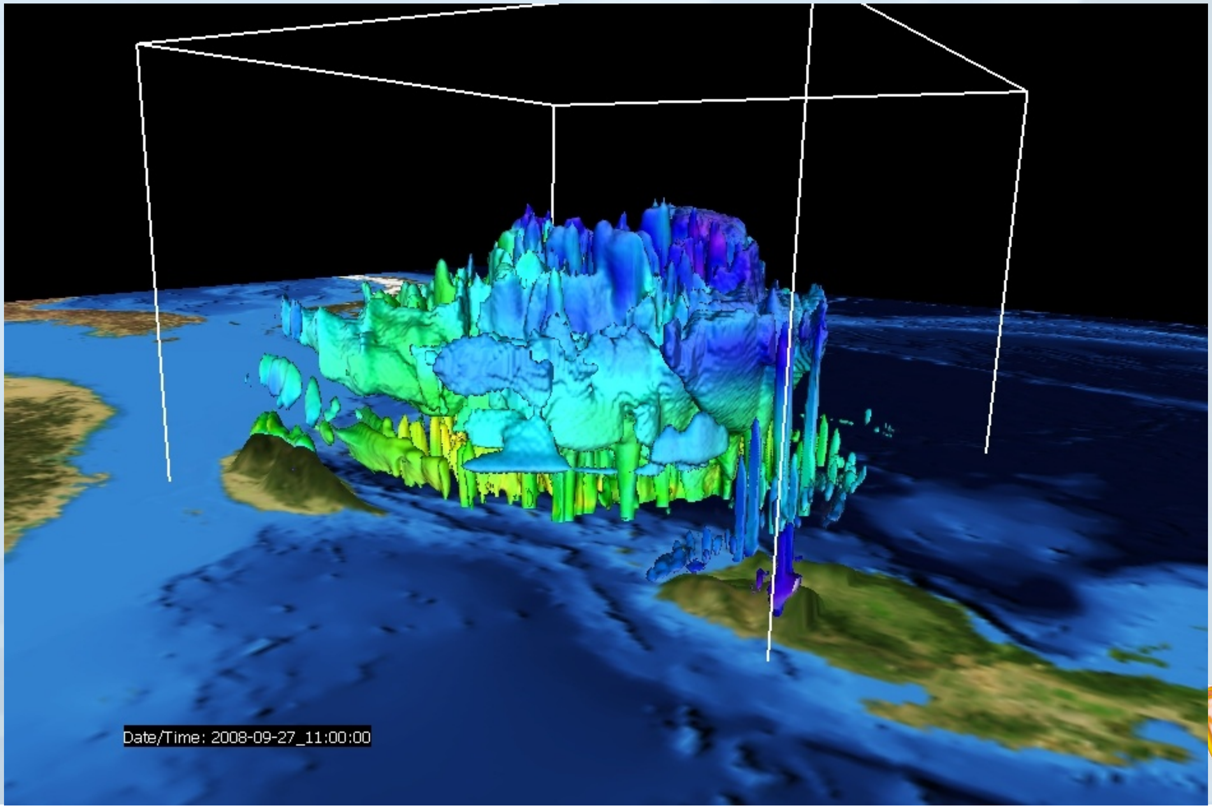
# Volume-render 3D variables to identify important features in the data

- Volume rendering can be used to identify significant 3D features of the WRF data.
- Use a transfer function to control transparency and color:
  - Make the unimportant features transparent, to highlight items of interest
  - Color can be used to distinguish different values of variable



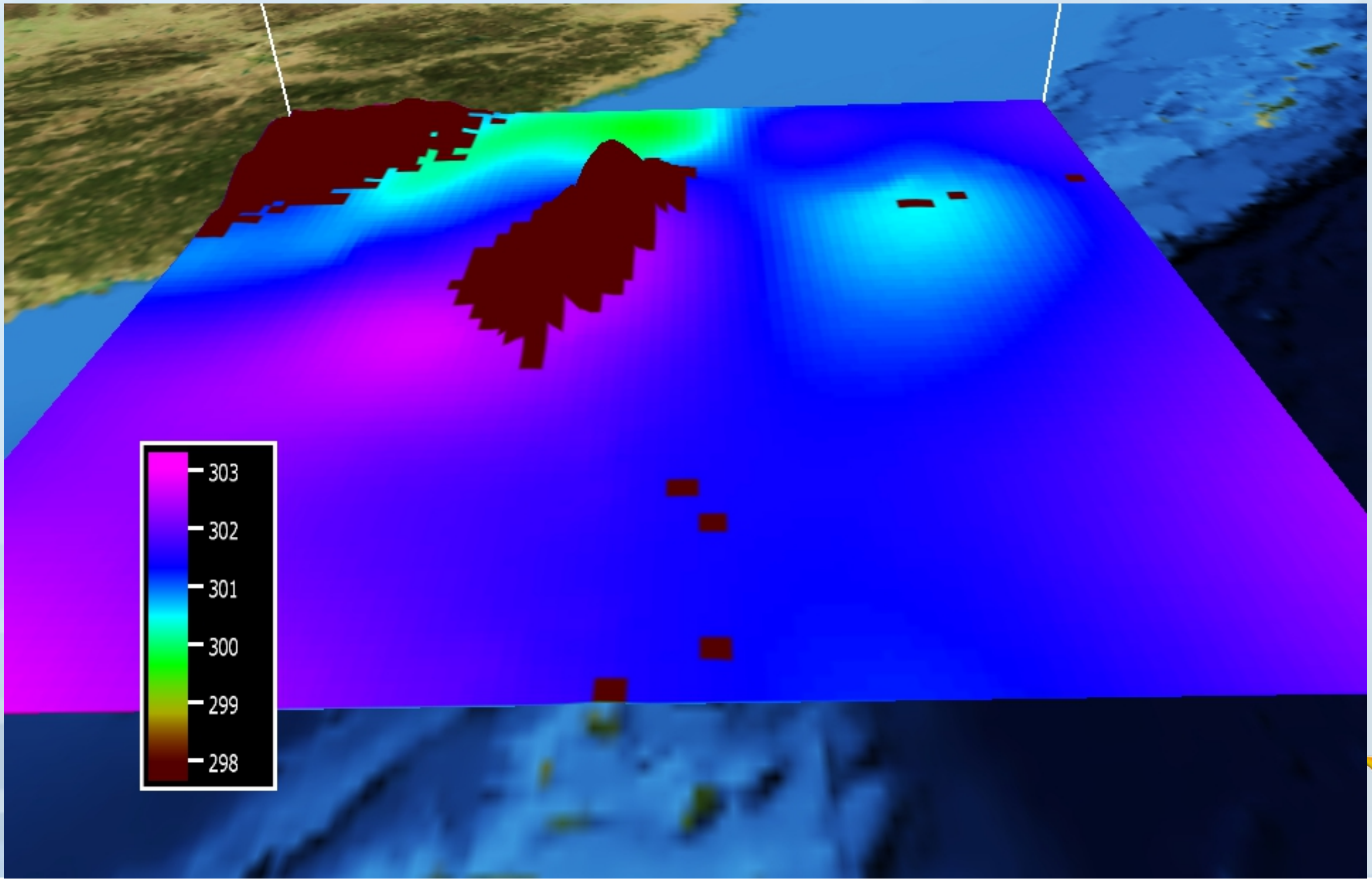
# Isosurfaces indicate the surface where a variable has a specific value

- From the Iso panel, identify the variable
- The isovalue slider controls the isosurface that is drawn
- Optionally use a transfer function to control transparency and color on the surface
  - The color and transparency can be mapped from any variable in the data.



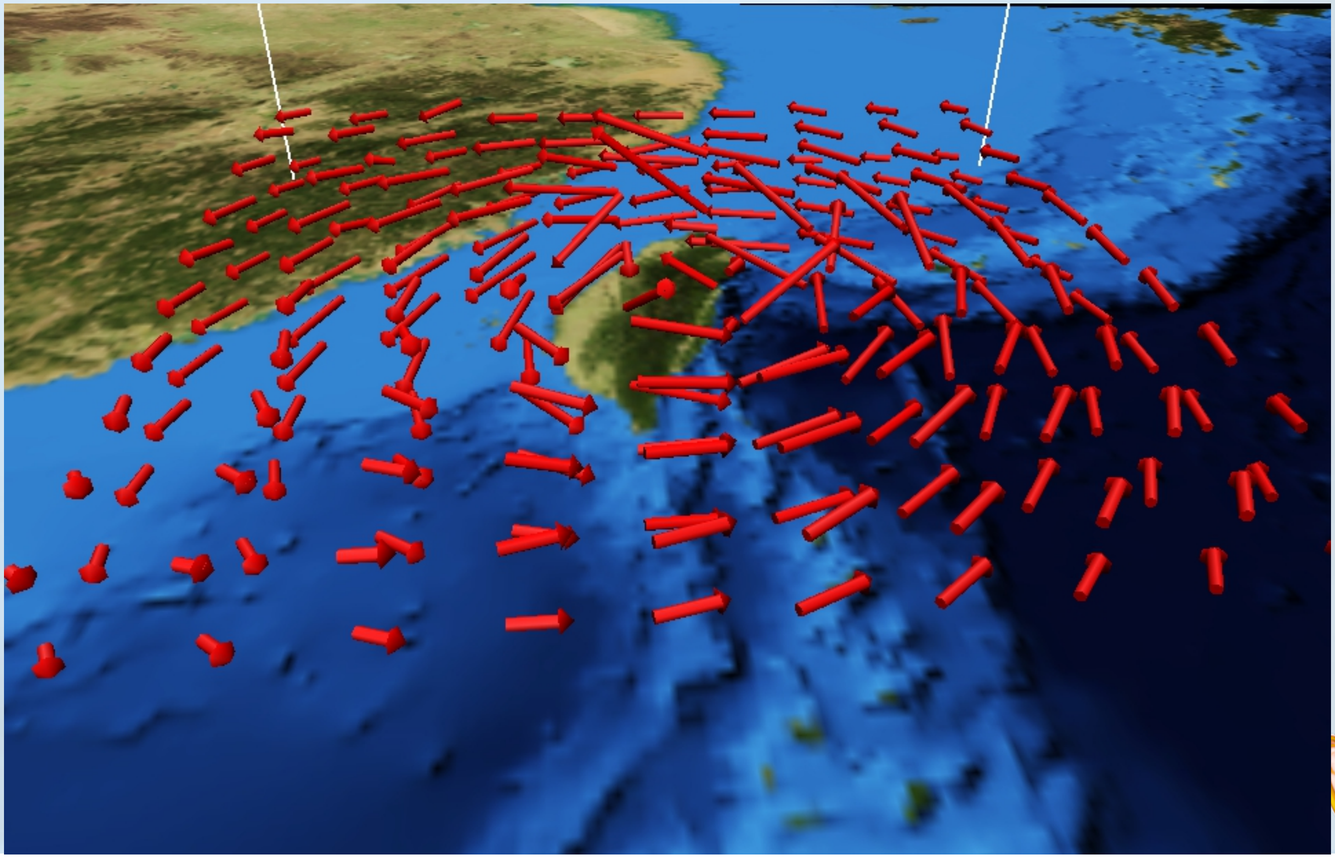
# Two-dimensional variables can be displayed on planar surface or mapped to terrain

- From the 2D panel, identify the variable(s)
- Specify whether the variable is mapped to terrain
- User controls transparency and color of the surface



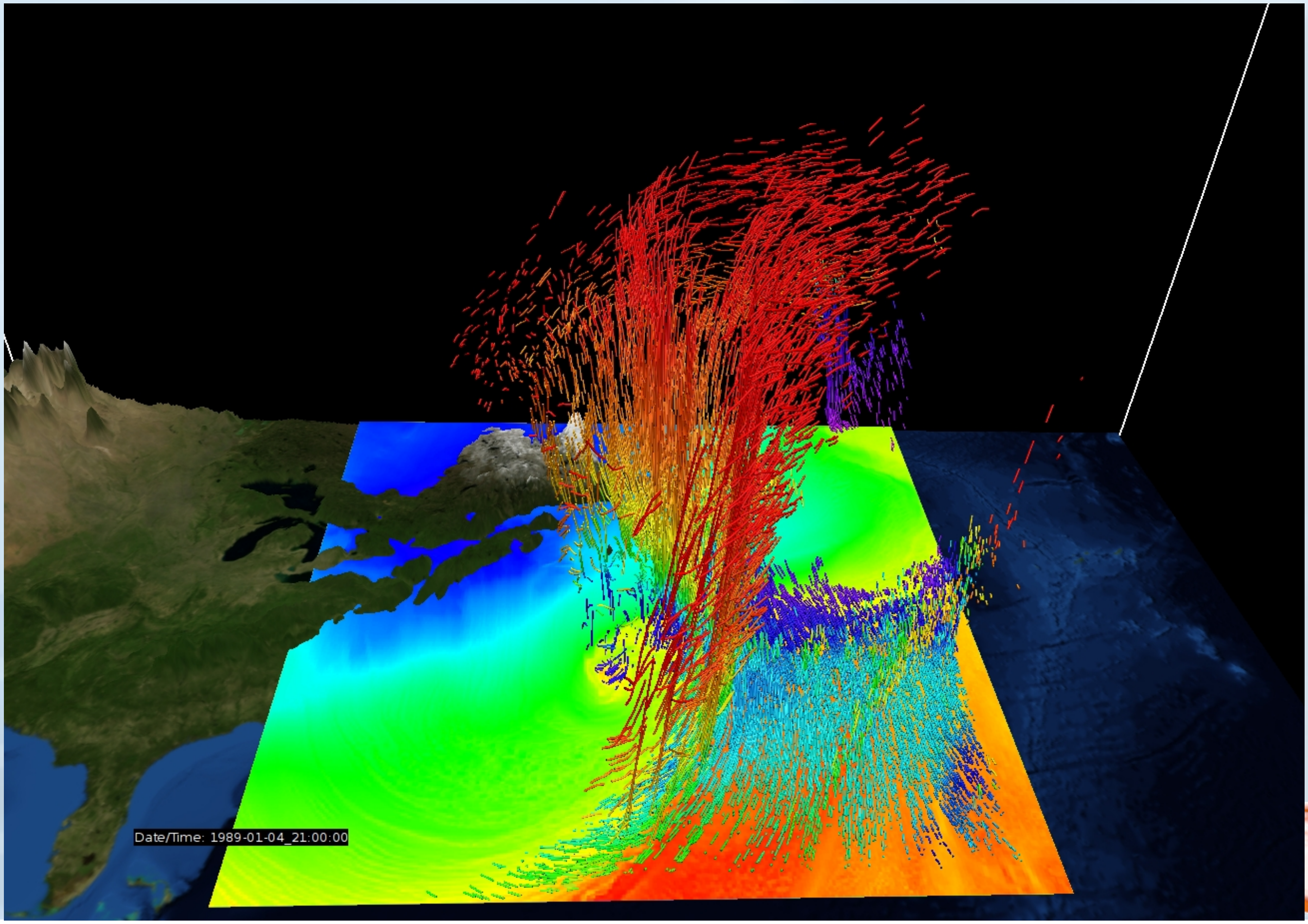
# Wind Barbs

- Specify a grid of seed points in the scene where barbs will appear
  - This grid can be aligned to the WRF data grid
- Specify variables that define X, Y, and Z components of velocity field.
- Grid can be displaced by terrain height.



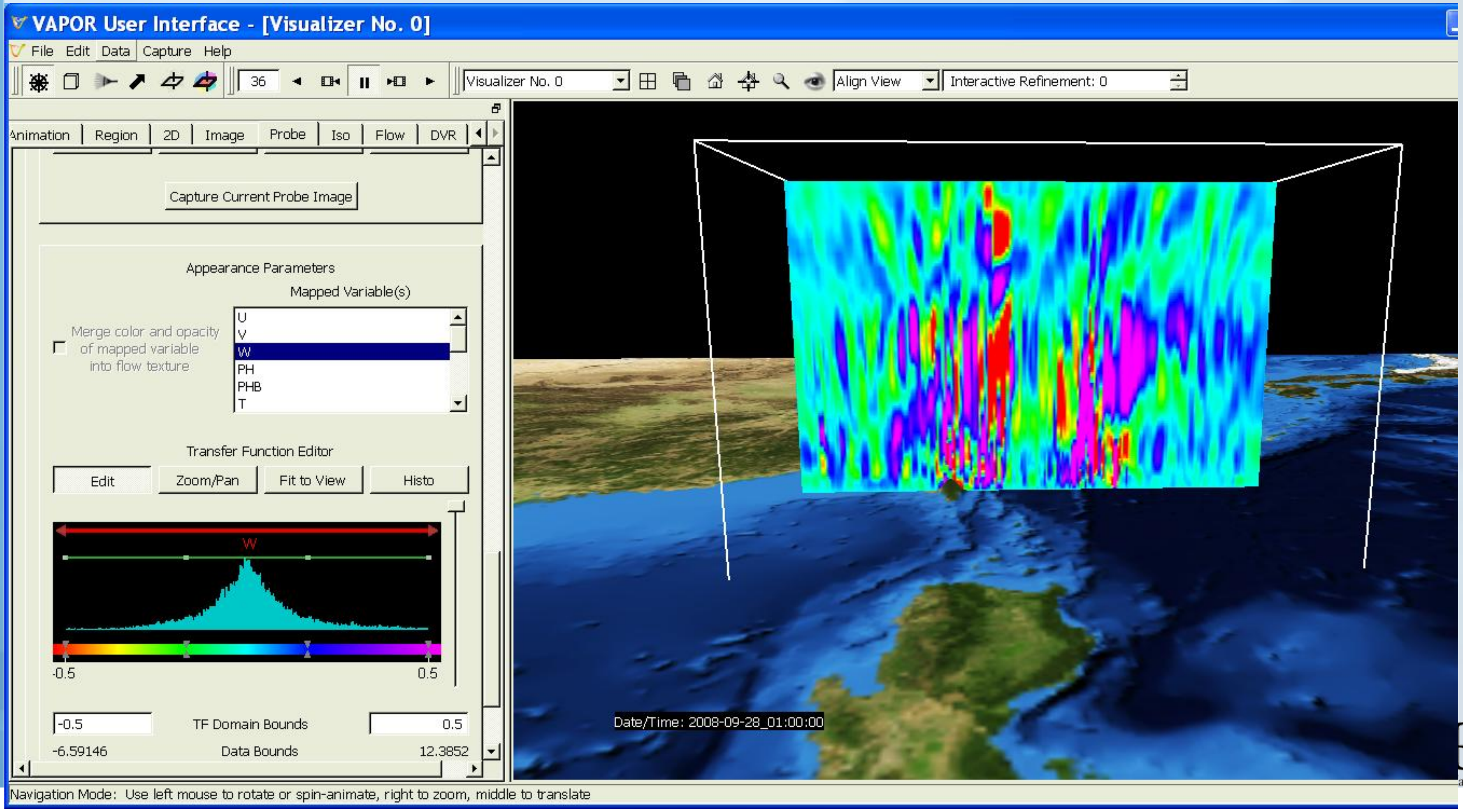
# Streamlines and Path lines

- In the Flow panel, specify flow type and velocity components.
- Streamlines indicate the instantaneous direction of the wind flow.
- Path lines track the movement of massless particles over time.



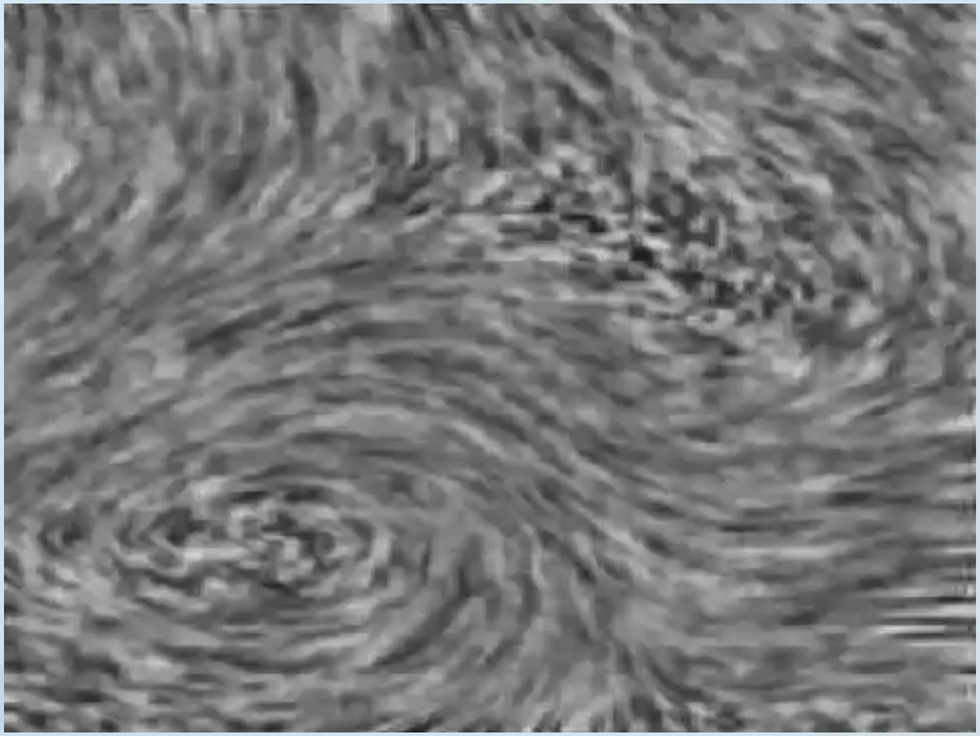
# Contour planes and the Probe

- Use the Probe panel to position rectangle in scene
- Use transfer function to color-map the rectangle
- Probe can also enable interactive specification of flow seeds.



# Image-based flow

- The probe also supports flow images
- Animated images indicate the flow direction in planar section.



# Create animations of your data

- From the Capture menu, begin an image capture sequence as a sequence of jpeg files.
- Then click the VAPOR play button to capture the images
- When completed, from the capture menu, end the sequence.
- Convert your jpeg's to an mpeg using other tools (e.g. Quicktime Pro, ffmpeg)