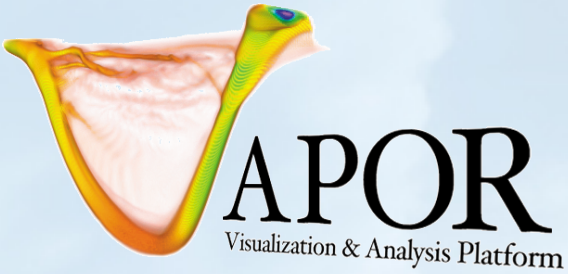
Understanding WRF-ARW Datasets with Interactive 3D Visualization: Supplementary Material



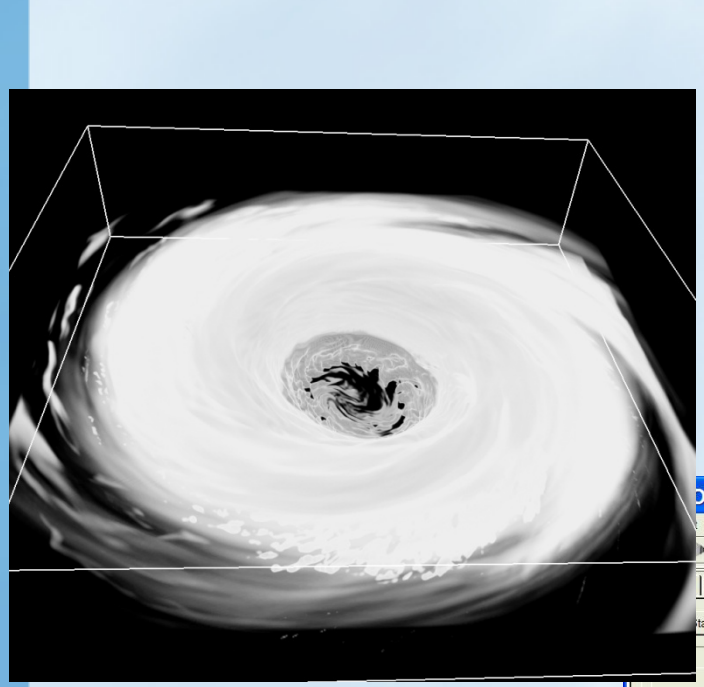
Alan Norton
NCAR/CISL
Mini-Tutorial atWRF Users' Workshop
June 24, 2011

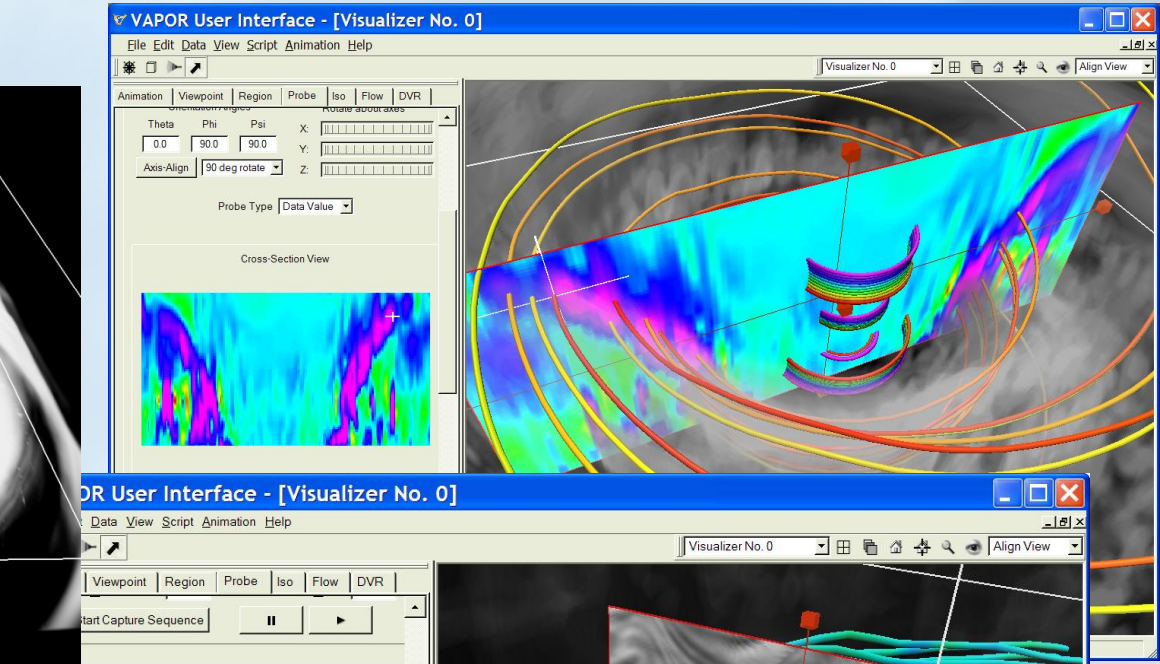
This work is funded in part through a U.S. National Science Foundation, Information Technology Research program grant

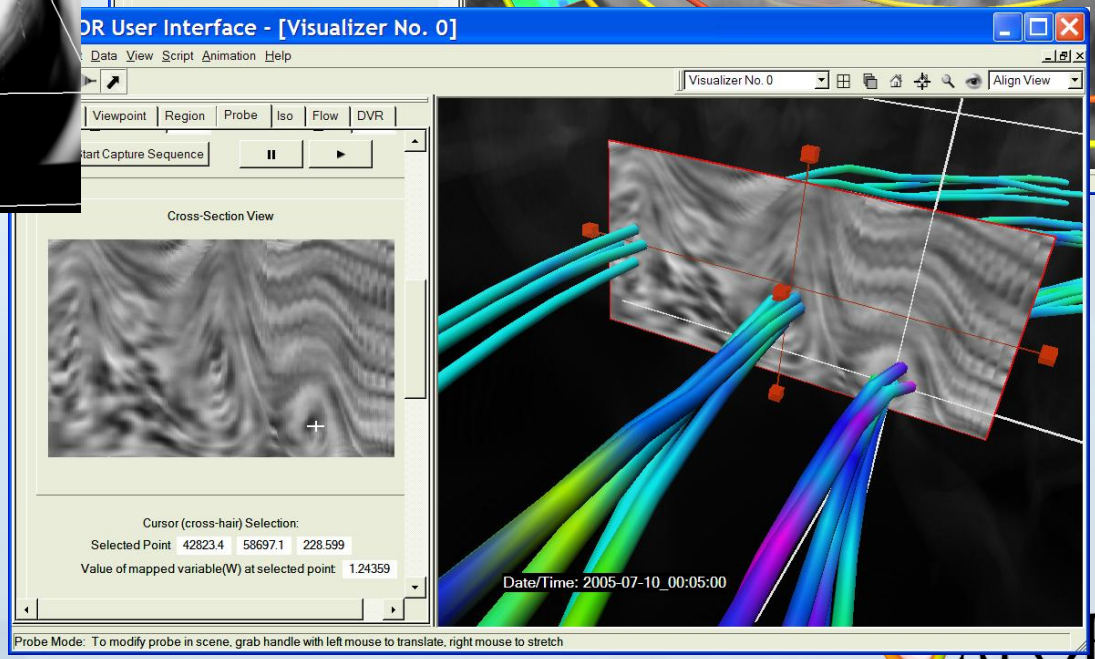
alan@ucar.edu

Visualization of hurricane data

Data provided by Yongsheng Chen, MMM/NCAR







Outline

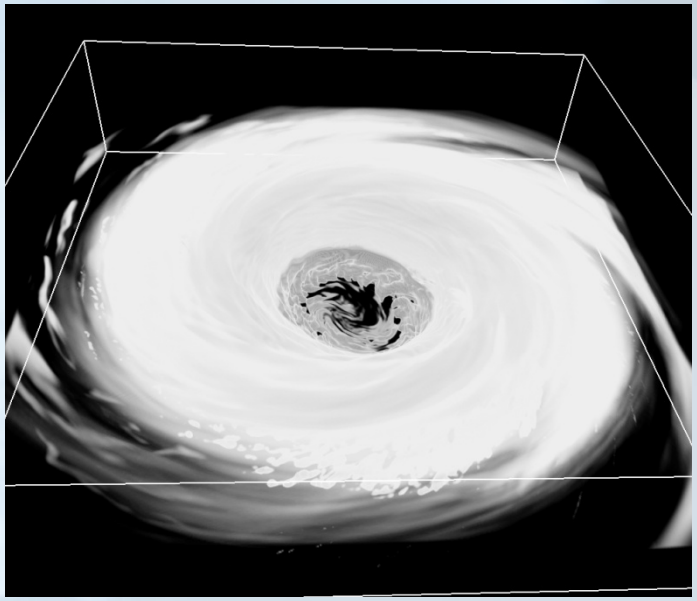
- Hurricane visualization
  - Construct QCLOUD volume visualization to animate hurricane motion
  - Volume rendering of W (vertical wind velocity) to see updrafts near eye of storm
- Understanding hurricane structure
  - Use probe cross section of W to place streamline seed points
  - Use Image based flow visualization to investigate vortices near eye wall

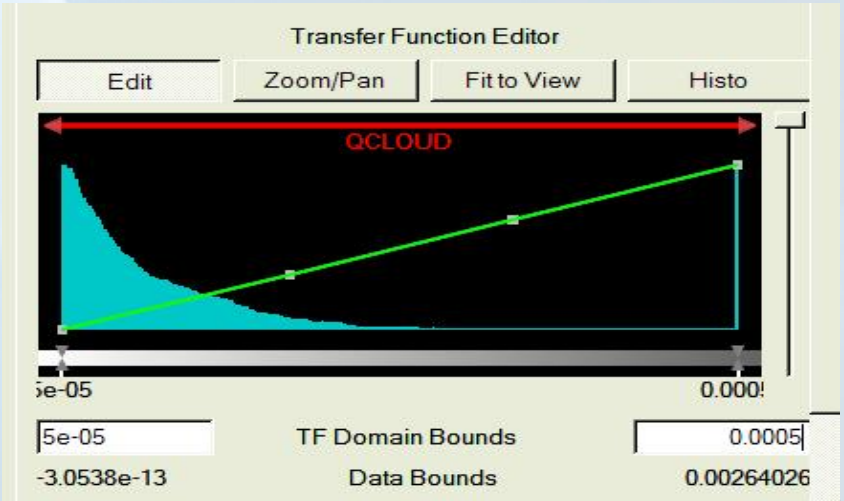
Downloads for this supplement

- Vapor 2.0.2 installer at http://www.vapor.ucar.edu/
- Example datasets at:
  - http://vis.ucar.edu/~alan/wrf2009/data/hurricane.zip
  - http://vis.ucar.edu/~alan/wrf2009/data/hurricane_hires.zip
- The hurricane download has timestep 0 at refinement level 1, other 9 timesteps are refinement level 0
- The hurricane_hires data is just timestep 0, at full resolution, refinement level 2.

Set up for visualizing hurricane data

- Use hurricane dataset (10 timesteps already converted to Vapor)
- Note: This is a large dataset, we limit data access time by controlling refinement level.
- Load hurricane.vdf (into default session)
- Edit Visualizer Features, set vertical stretch factor 5
- In DVR panel set variable QCLOUD (cloud water mixing ratio)
- Check Instance:1 to enable rendering.
- Set largest color control points to grey(100,100,100), remove others
- Adjust transfer function bounds to [5e-5, .0005]
- Animate

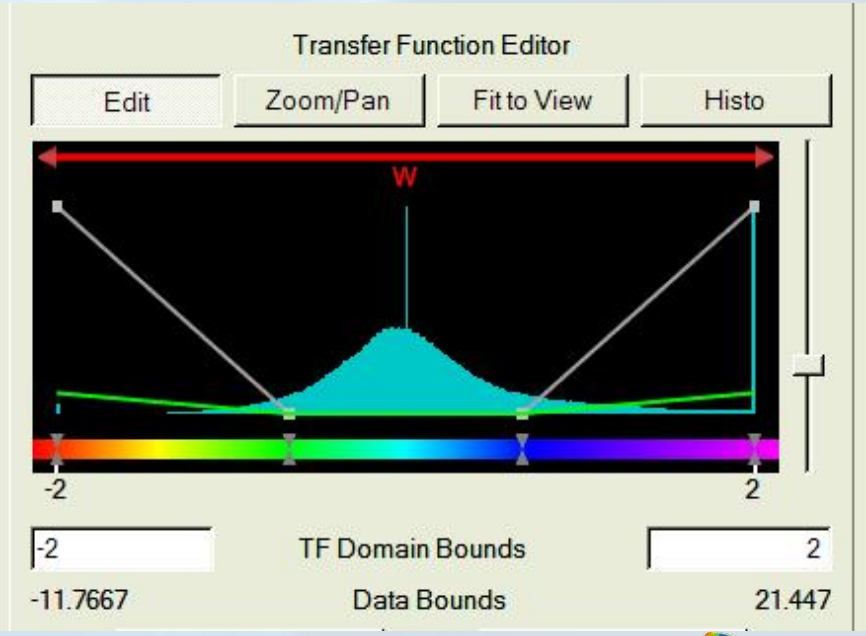




alan@ucar.edu

Examine vertical wind currents

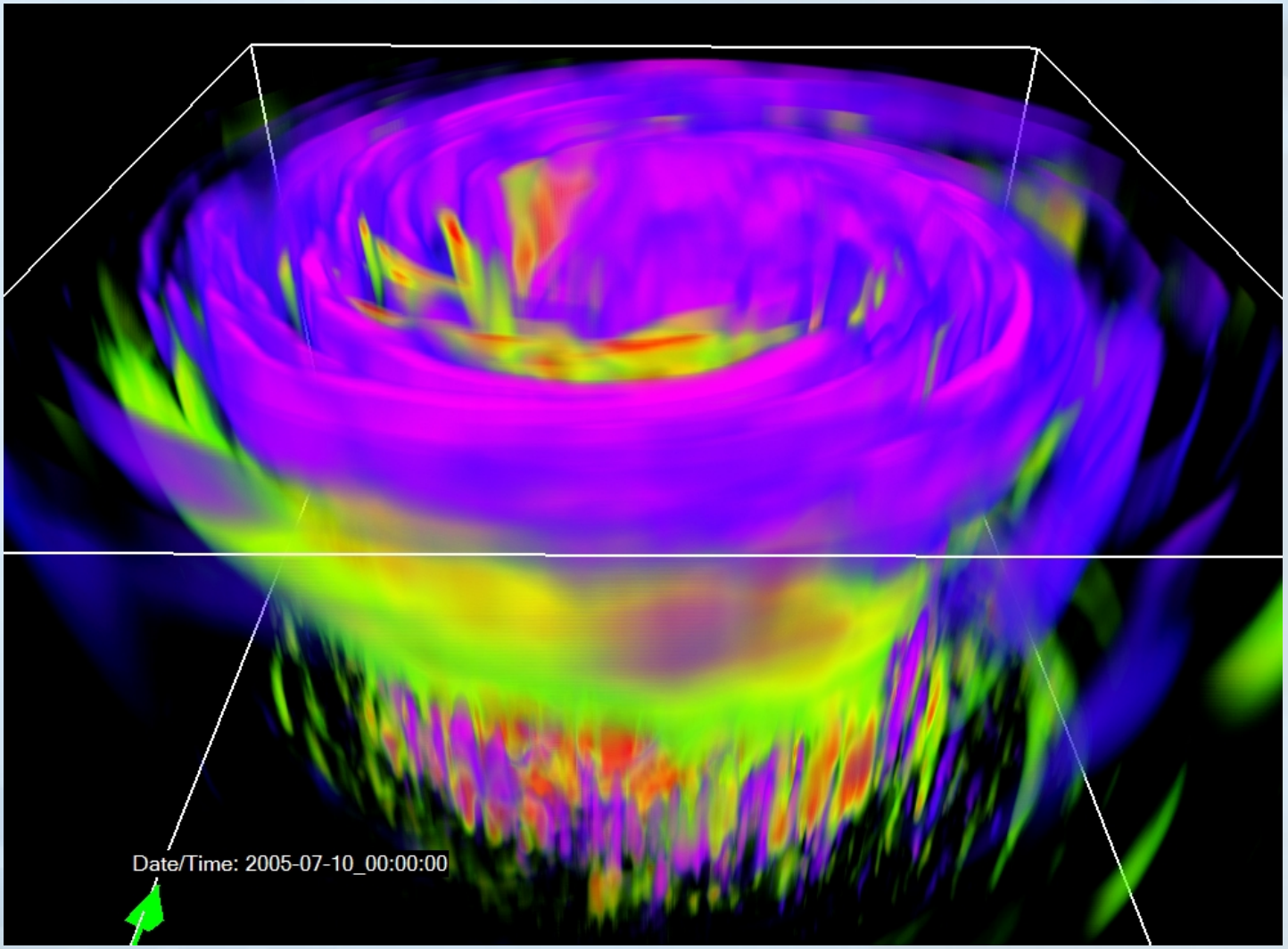
- Return to time step 0
- Change DVR variable to “W” to examine vertical wind currents
- Set transfer function bounds to [-2,2]
- Make transfer function transparent between -1 and 1, opaque at ends (accentuate extremes).
- Lower opacity scale to ~0.1



alan@ucar.edu

Volume rendering of vertical wind currents

NCAR



alan@ucar.edu

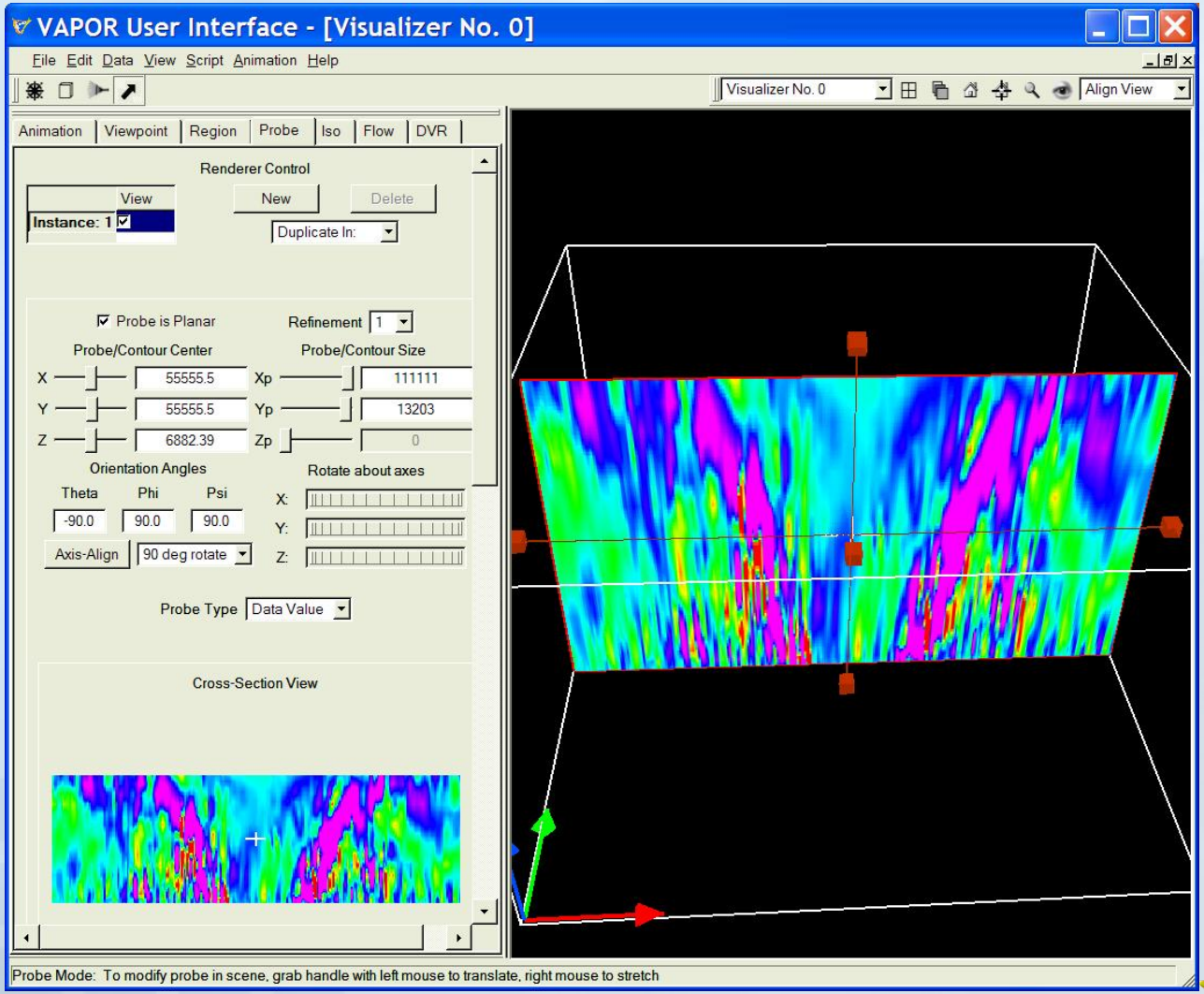
CISL

VAPOR Visualization & Analysis Platform

Use Probe to see cross-section

- Disable DVR
- Click on probe mode (arrow above tabs)
- In probe panel, use “90 degree rotate” in +X direction to make probe vertical
- Move x, y size sliders to maximize probe size
  - Alternatively use right mouse to drag probe extents
- Scroll down to appearance parameters and set probe mapped variable to W
- Set color map interval to [-2,2], fit to view
- Enable probe (check Instance: 1)
- Note how maximal values of W form upward-opening cone

Probe of hurricane cross-section



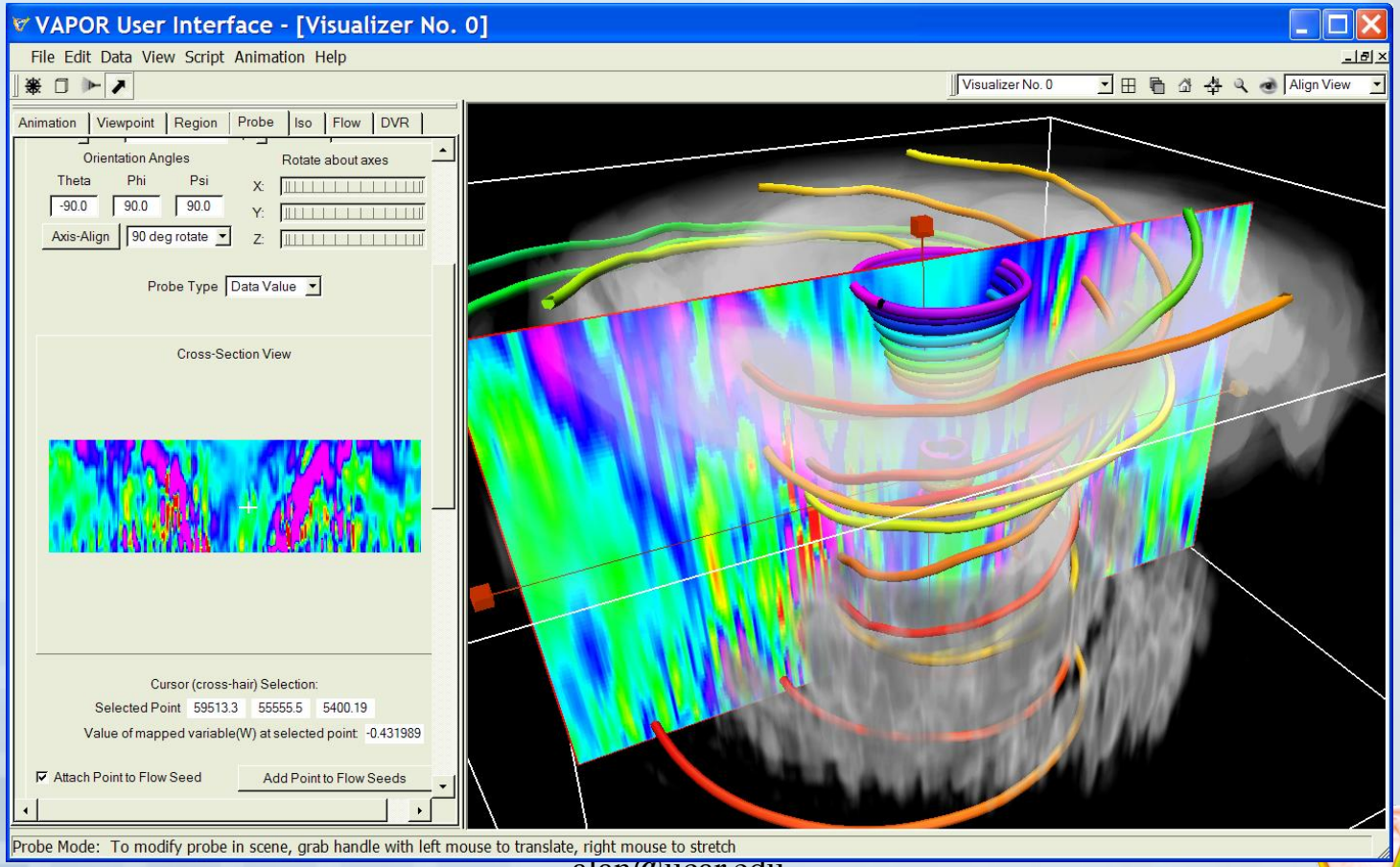
alan@ucar.edu

Seed placement with probe

- On Flow panel, set Flow Seeding to “List of Seeds”
- Set steady integration direction to “forward”
- Make sure U, V, W are steady field variables
- Set smoothness to 100, steady flow length to 5
- Color mapped by Position along Flow
- Enable flow (You should not see a change)
- In probe tab, put probe cursor in updraft cone
- Check “Attach point to flow seed” to see resulting streamline
- Try various cursor positions to see streamlines
- Click “Add point to flow seeds” to add streamlines

Insert flow seeds with probe to see structure

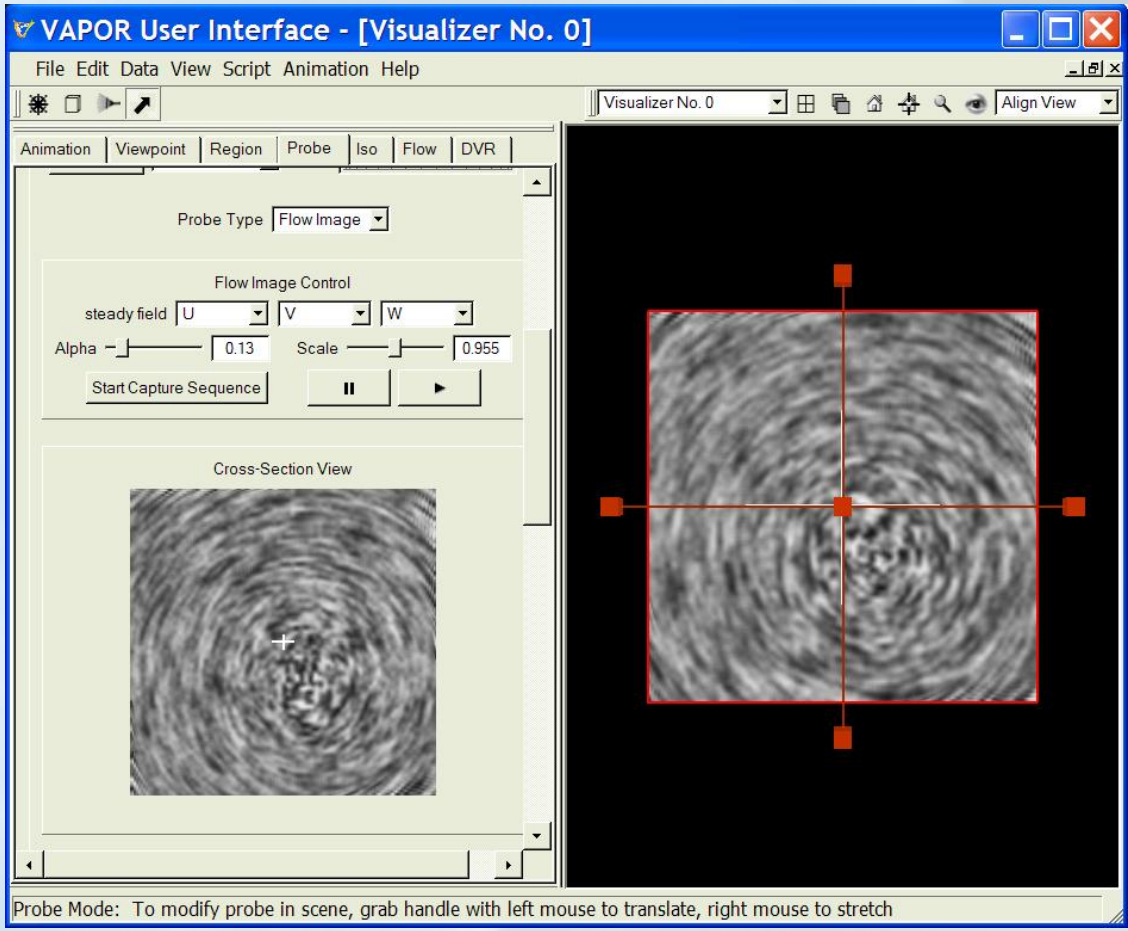
- Low outside streamlines are drawn into hurricane
- Along cone of maximal W, streamlines rotate upward
- In eye, streamlines almost circular, without much vertical motion



alan@ucar.edu

Use Image Based Flow Visualization

- Disable Flow and Probe.
- Click on Probe mode.
- In Renderer Control, create a new probe instance (it will be horizontal, in center of scene)
- Set probe type to “Flow Image”
- Enable probe Instance:2
- Click “play” button to see wind motion in eye of hurricane
- Tweak Alpha and Scale as desired.

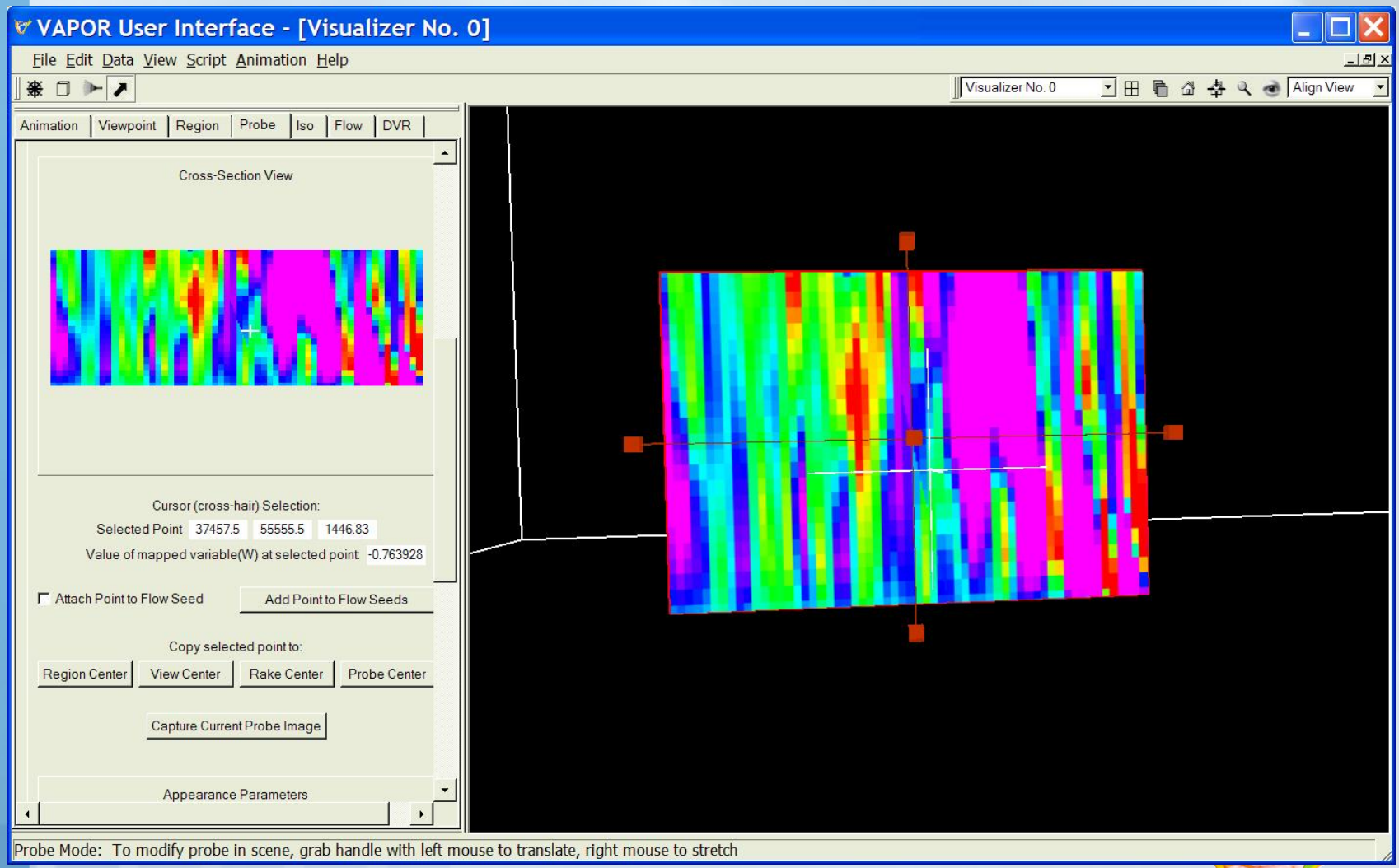


alan@ucar.edu

Use IBFV to investigate Vortices near hurricane eye-wall

- Note: This works better with full resolution dataset (hurricane_hires.vdf)
- un-check probe Instance:2 to disable
- Enable probe Instance:1 (hurricane cross-section of W)
- Set refinement level 1 (or 2 if you have high-res data)
- Shrink the probe to examine small slice near earth surface, where the cone of maximal W reaches the surface
  - Drag handles with right mouse to resize
  - Drag handles with left mouse to move.
- Re-center view by clicking in probe tab on "copy point to view center"

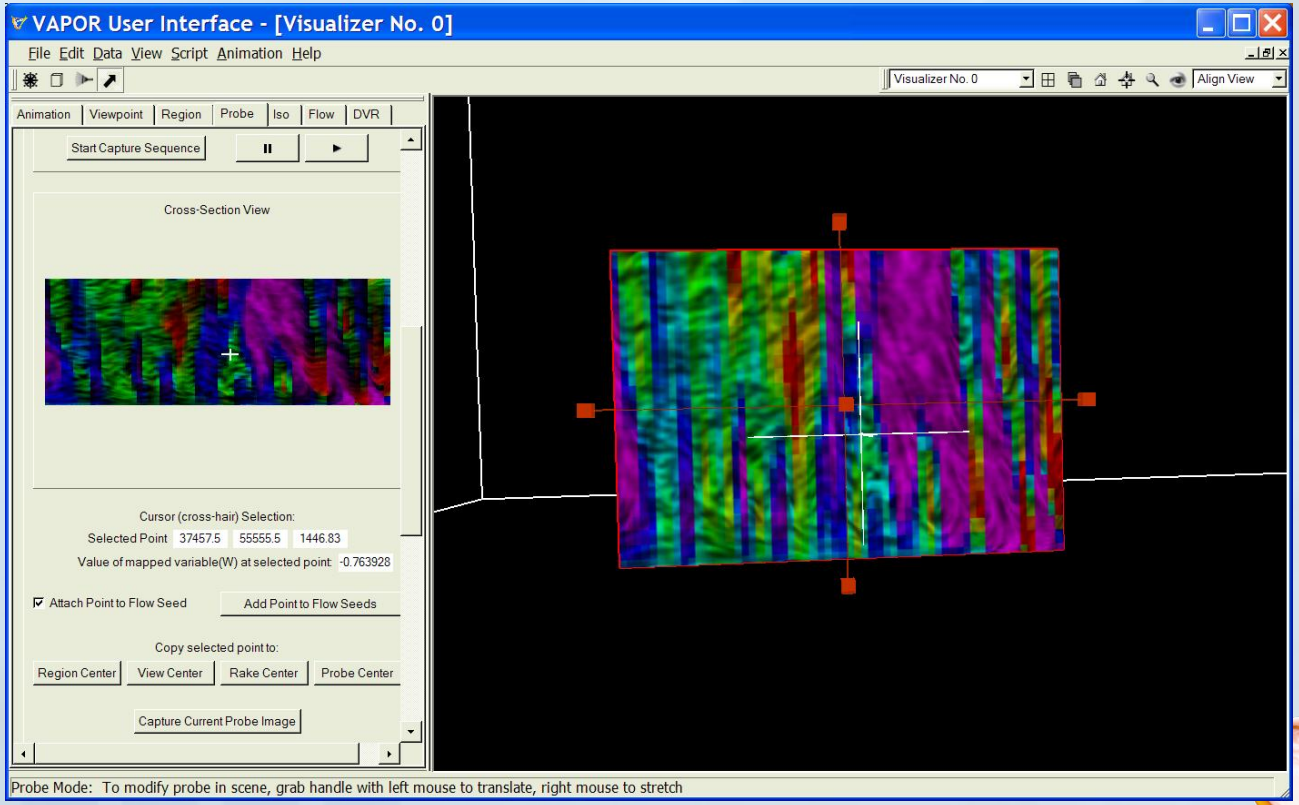
Probe of W at eye wall near earth surface



alan@ucar.edu

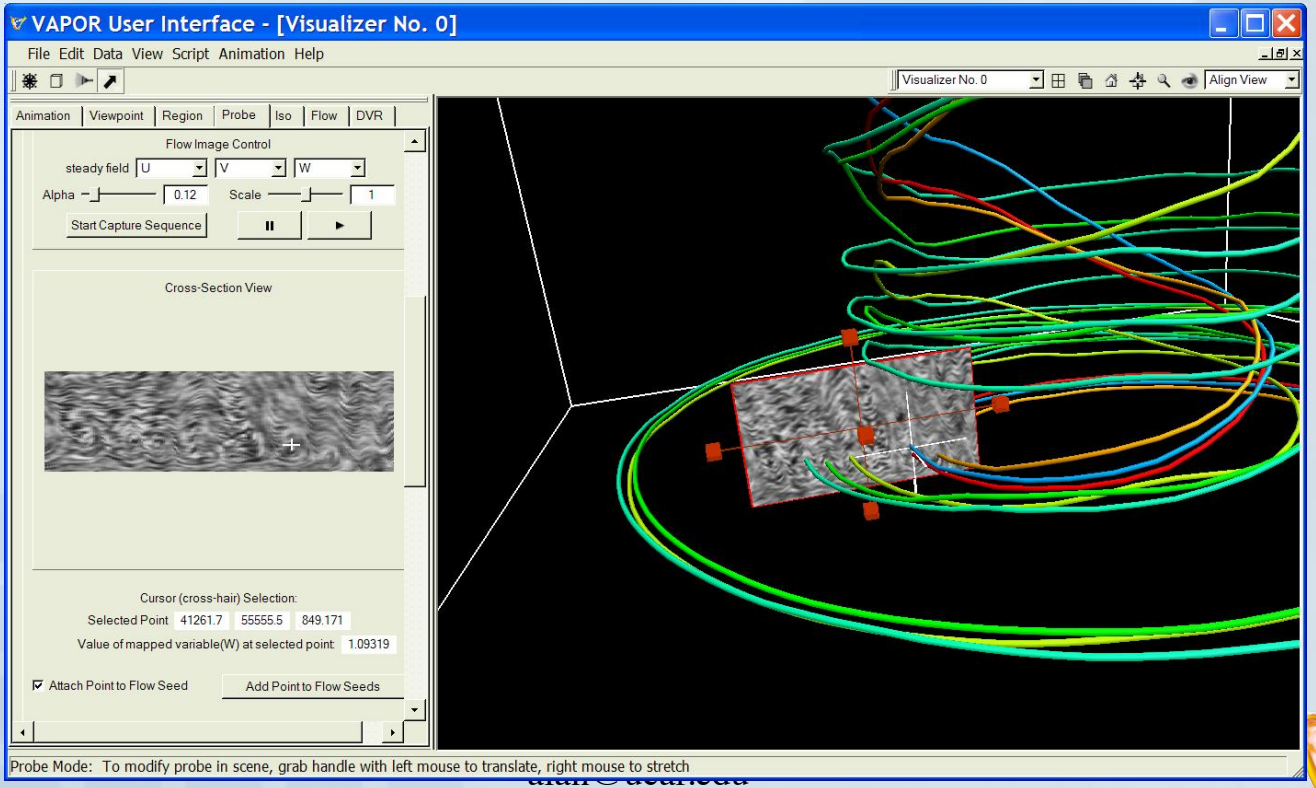
Using IBFV to investigate Vortices near hurricane eye-wall

- Change probe type to “Flow Image”
- Note vortex at outer edge of maximal W cone
- Slide probe outward or inward to see vortices at ground level
- Check “Merge color and opacity of mapped variable…” to see relationship to maximal W cone



Insert flow seeds in Vortices near hurricane eye-wall

- In flow tab, click “edit seed list” and delete all the seeds.
- Color flow by seed index
- Set flow direction “bidirectional”, and check to enable Instance:1
- In Probe tab, check “attach point to flow seed”
- Enable probe
- Insert seeds in and around vortices



Acknowledgements

- Steering Committee
  - Nic Brummell - CU
  - Yuhong Fan - NCAR, HAO
  - Aimé Fournier – NCAR, IMAGe
  - Pablo Mininni, NCAR, IMAGe
  - Aake Nordlund, University of Copenhagen
  - Helene Politano - Observatoire de la Cote d'Azur
  - Yannick Ponty - Observatoire de la Cote d'Azur
  - Annick Pouquet - NCAR, ESSL
  - Mark Rast - CU
  - Duane Rosenberg - NCAR, IMAGe
  - Matthias Rempel - NCAR, HAO
  - Geoff Vasil, CU
- WRF consultation
  - Wei Wang – NCAR, MMM
  - Cindy Bruyere –NCAR, MMM
  - Yongsheng Chen-NCAR,MMM
  - Thara Prabhakaran-U. of Ga.
  - Wei Huang – NCAR, CISL
- Design and development
  - John Clyne – NCAR, CISL
  - Alan Norton – NCAR, CISL
  - Markus Stobbs – NCAR, CISL
  - Kenny Gruchalla – CU
  - Victor Snyder - CSM
- Research Collaborators
  - Kwan-Liu Ma, U.C. Davis
  - Hiroshi Akiba, U.C. Davis
  - Han-Wei Shen, Ohio State
  - Liya Li, Ohio State
- Systems Support
  - Joey Mendoza, NCAR, CISL

alan@ucar.edu