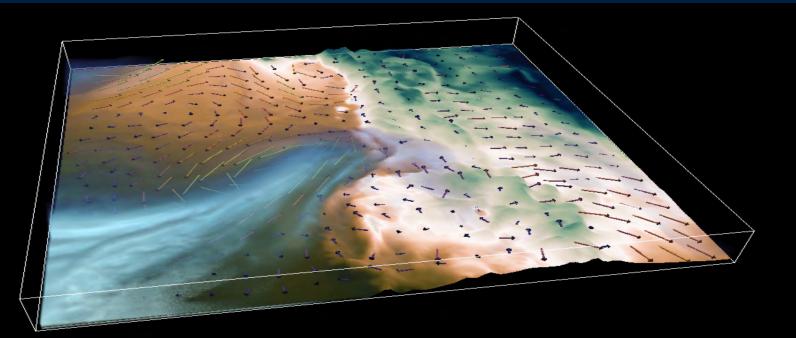


INTERACTIVE VISUALIZATION OF WRF DATA WITH VAPOR 3.9

VAPOR: Data Exploration Tool Designed for Earth System Science MARCH 11, 2024



OVERVIEW

INTRO: VAPOR SOFTWARE

- what is VAPOR?
- what makes it different from other visualization tools?
- examples

HANDS-ON WORKSHOP

- importing data
- twoddata with elevation projection
- wind barbs
- volume rendering



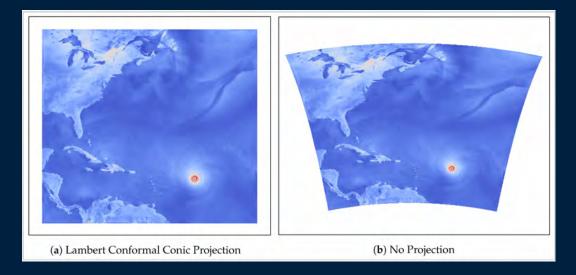


INTRO: VAPOR SOFTWARE



INTRODUCTION: WHAT IS VAPOR?

- Stand-alone visualization package designed specifically for Earth Systems
 Science (ESS) developed by NCAR
- Focus:
 - Interactive data exploration
- Main Challenges:
 - Large 3D numerical data
 - ESS-specific datasets/geo-referencing





INTRODUCTION: WHAT MAKES IT SPECIAL?

- How is it different from other tools?
 - Vislt, ParaView interactive, but general-purpose, computationally demanding
 - support distributed memory, parallel rendering often performed on a cluster
 - NCL, Python (MetPy, CDAT) ESS specific, but not interactive, 2D focus
 - challenging for data exploration

• VAPOR = fills the gap

- allows interactive data exploration on commodity hardware
- addresses issues specific to ESS
 - georeferencing
 - vertical coordinate systems, common grids (staggered, eta levels)
 - missing data
 - common ESS file formats (NetCDF, MPAS, WRF)

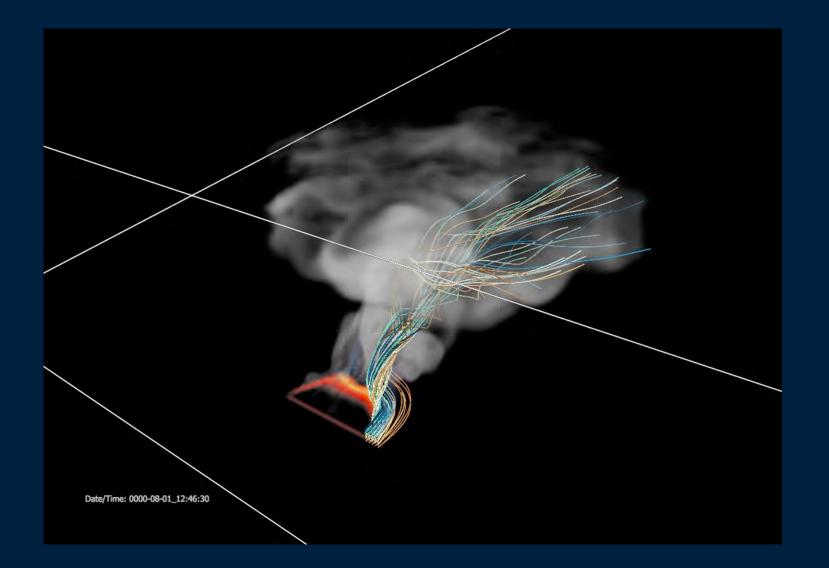


VAPOR DATA COLLECTION (VDC)

- What makes VAPOR fast?
 - progressive data access
 - multi-resolution
 - eg. GoogleMaps data hierarchy
 - lossy compression
 - order data based on its "information content" and use only the important bits
 - eg. JPEG, streaming
 - both possible using discrete wavelet transform
 - transform data into frequency space and store coefficients only (VDC format)
 - combine both controls above into a single fidelity control
 - THIS IS OPTIONAL!

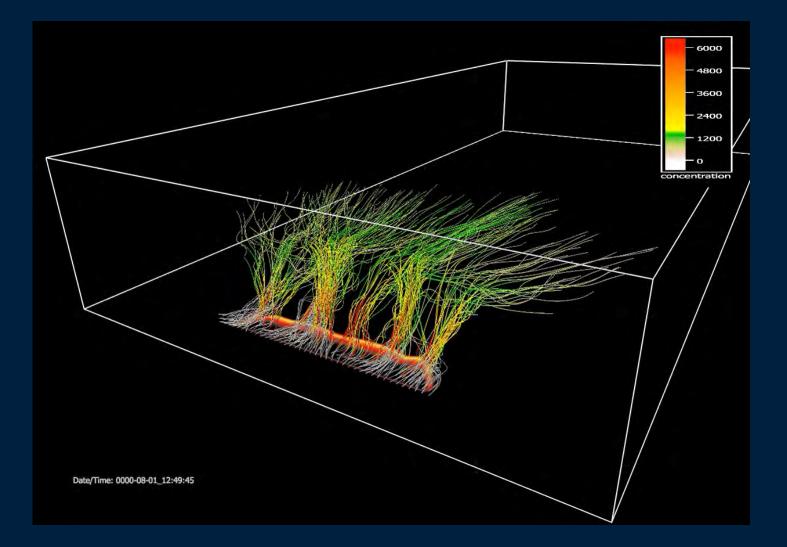


EXAMPLES: WILDFIRE SMOKE AND TURBULENCE



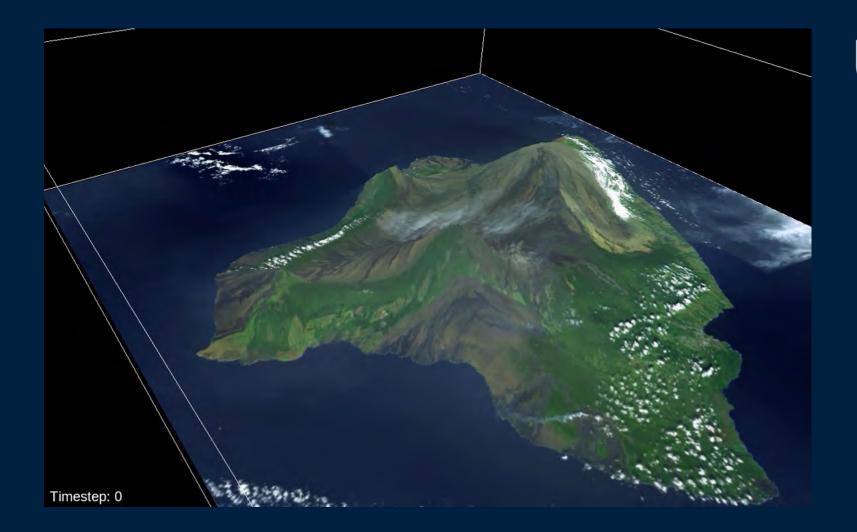


EXAMPLES: WILDFIRE SMOKE AND TURBULENCE

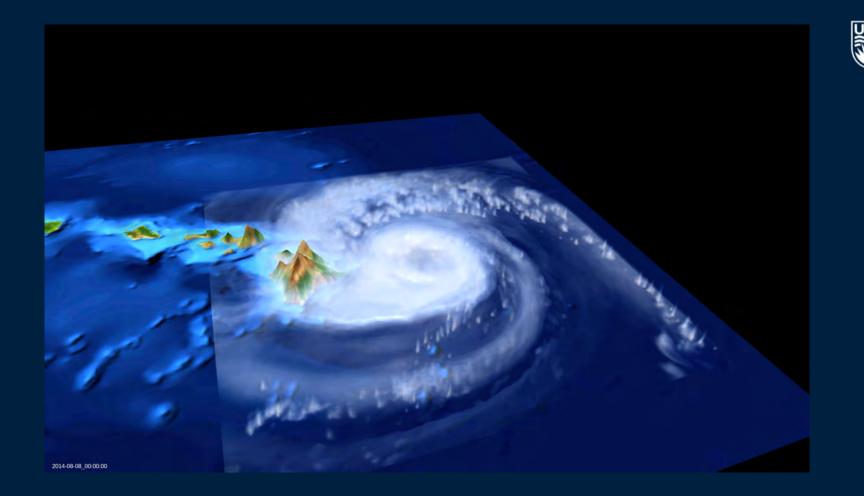




EXAMPLES: VOG DISPERSION



EXAMPLES: HURRICANE ISELLE





HANDS-ON WORKSHOP

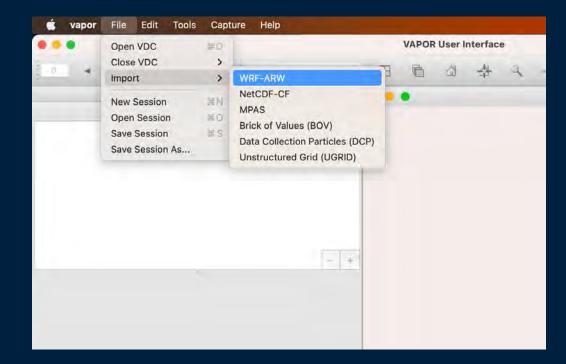


HANDS-ON WORKSHOP: IMPORTING DATA

- VAPOR is able to directly import:
 - NetCDF files that follow the CF Convention (NetCDF-CF)
 - WRF-ARW
 - MPAS



• VDC allows user to control fidelity





HANDS-ON WORKSHOP: CREATING A RENDER

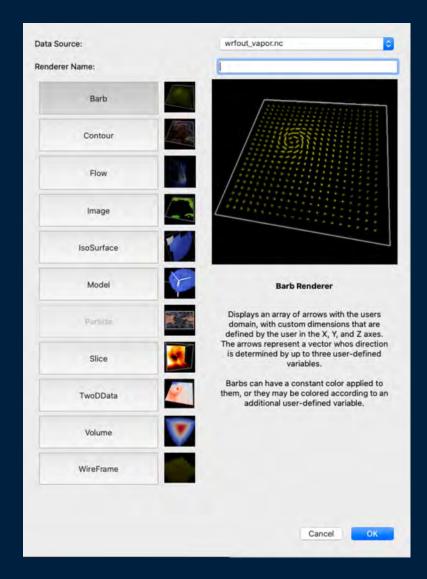
• VAPOR's main utility = RENDERERS

• We WILL NOT:

•Perform basic visualization (slicing, contouring etc.)

• We WILL:

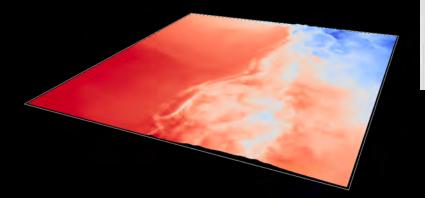
•Focus on data exploration

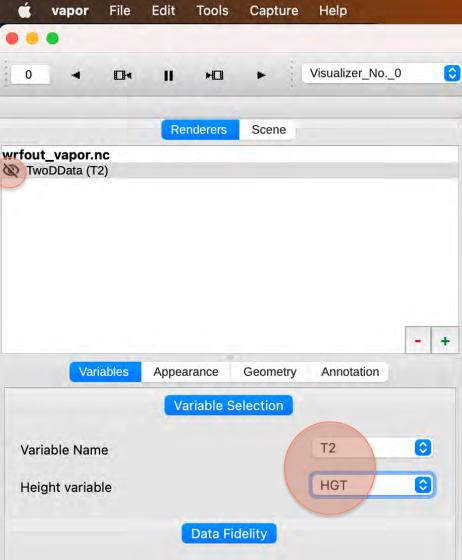




HANDS-ON WORKSHOP: SURFACE DATA

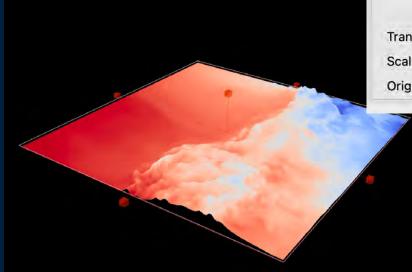
- Create New Renderer
- Select TwoDData
- Variable Name T2
- Height Variable HGT
- Enable viewing





HANDS-ON WORKSHOP: SURFACE DATA

- Click Geometry
- Set **Scale** to **4** for the vertical (z)

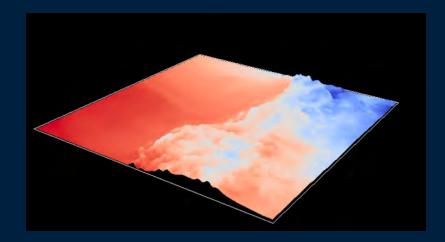


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HANDS-ON WORKSHOP: COMMON DISPLAY CONTROLS

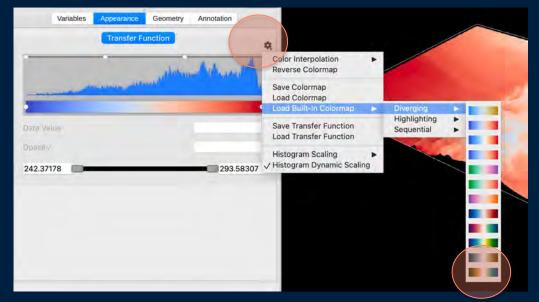
- Click Appearance
- Explore Transfer Function
- Are default colormap setting appropriate?
 - Colors should diverge at 0C for temperature

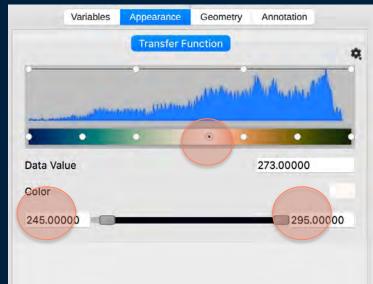




HANDS-ON WORKSHOP: COMMON DISPLAY CONTROLS

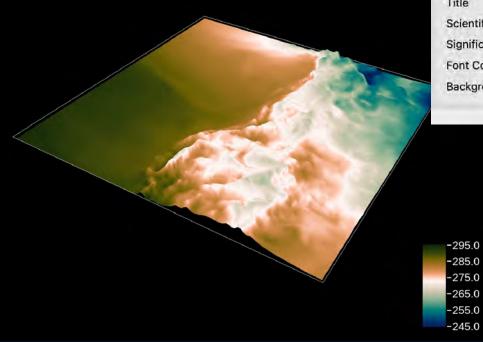
- Let's select a different colormap and adjust it for our purpose
- Click Settings Load Built-in
 Colormap Diverging select the last one
- Click Settings again and select Reverse Colormap
- Adjust range: set values to go from 245 to 295
- Click on the middle Control Point and set its value to 273

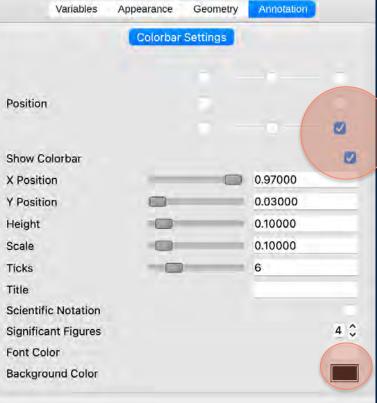




HANDS-ON WORKSHOP: COMMON DISPLAY CONTROLS

- Annotate your plot
 - Select Annotations
 - Click Show Colorbar
 - Adjust range, position, appearance







HANDS-ON WORKSHOP: TIME CONTROL

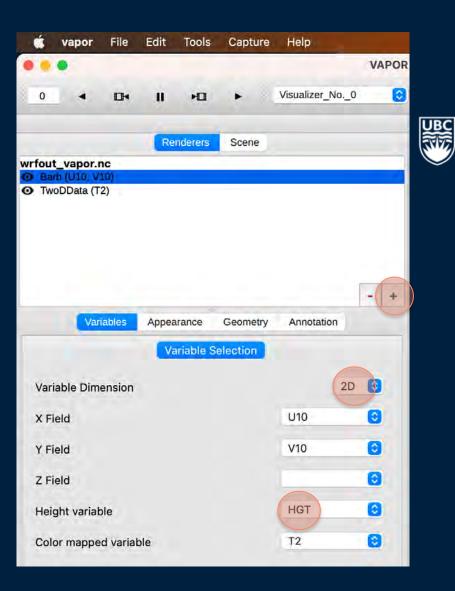
- Now lets enjoy what we've made so far
 - In top menu click Play button



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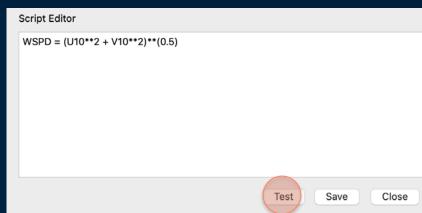
HANDS-ON WORKSHOP: BARB RENDERER

- Create New Renderer
- Select Barb
- Set Variable Dimension to 2D
- Set Height Variable to HGT
- Enable viewing



HANDS-ON WORKSHOP: PYTHON VARIABLE EDITOR

- In Tools select Python Variables
- Click New to create a new script get_wspd
- Select U10 and V10 as Input Variables
- Create new output variable WSPD
- Write Python code in Script Editor:
 WSPD = (U10**2 + V10**2)**(0.5)
- Click Test Save Close



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HANDS-ON WORKSHOP: BARB RENDERER

- Under Variables
 - change Color mapped variable to WSPD
- Under Geometry
 - Set Scale (Z) to 4
 - Set Origin (Z) to 0
- Under Appearance
 - Change colormap to Sequential Thermal (second last option)
 - Change range max to 10
 - Set X Barbs to 20
 - Set Y Barbs to 20
 - Set Thickness Scale to 0.6
 - Unclick Use Constant Color

	Var	iables Appeara	nce	Geometry	An	notation
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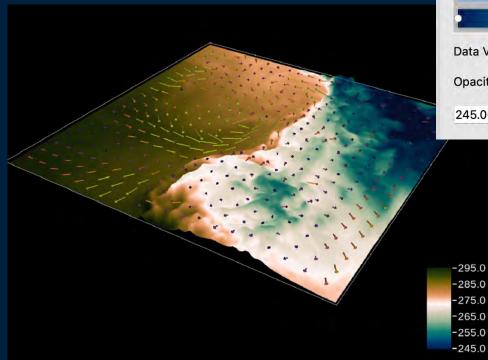




HANDS-ON WORKSHOP: ADJUSTING OPACITY

 Change Renderer to TwoDData and under Appearance set the opacity of first and last points to 0.5

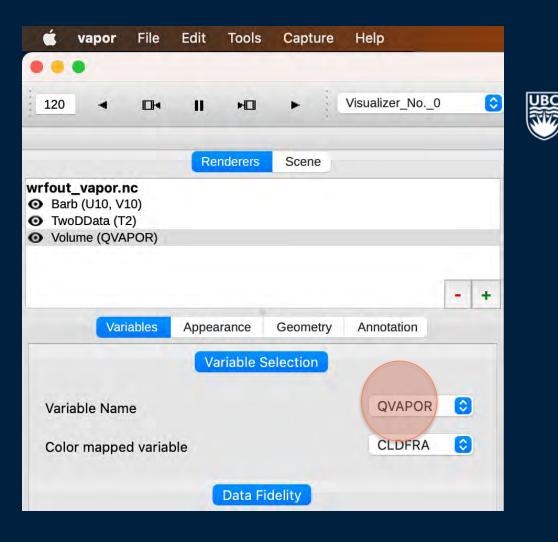
• Play



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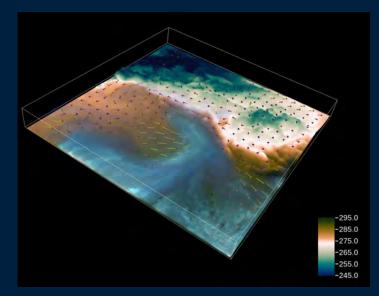
HANDS-ON WORKSHOP: VOLUME RENDERING

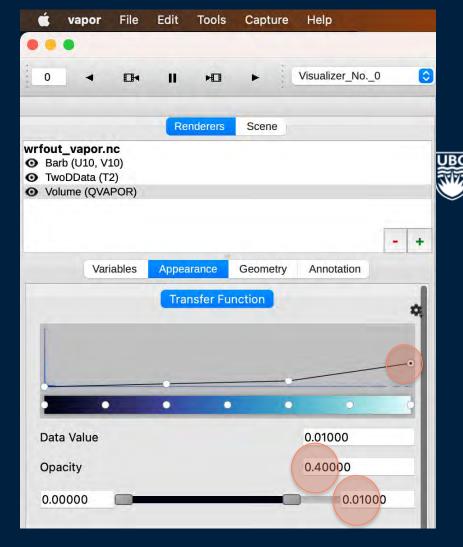
- Create New Renderer
- Select Volume
- Set Variable Name to QVAPOR
- Enable viewing



HANDS-ON WORKSHOP: VOLUME RENDERING

- Under Geometry
 - Set Scale (z) to 4
- Under Appearance
 - Change colormap to Sequential Ice
 - Set data range from 0 to 0.01
 - Set Opacity points to 0, 0.05, 0.1, 0.4
 - Experiment with Lighting Parameters





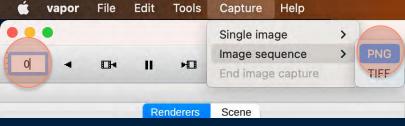
HANDS-ON WORKSHOP: EXPORTING YOUR WORK

- Set frame number to 0
- From Capture Image Sequence select PNG
- Select save location and click Play
- From Capture select End image capture
- Animate your frames using program of choice, for example:

convert *.png vapordemo.gif

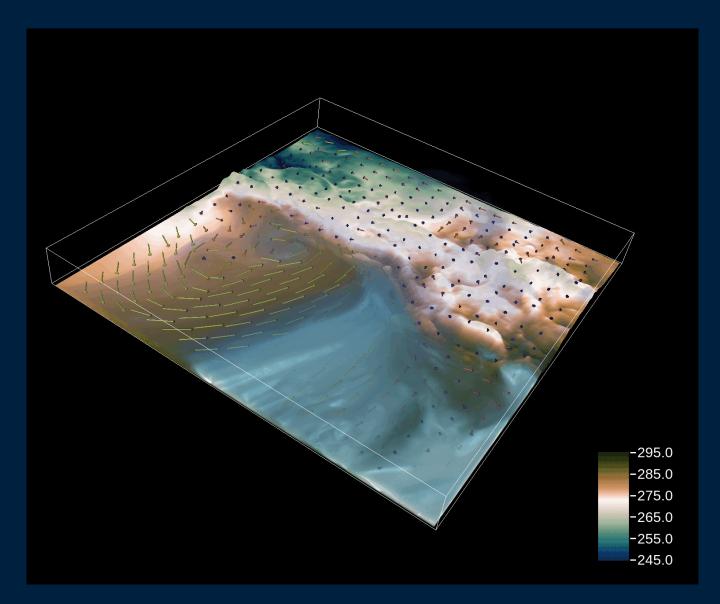
OR

ffmpeg -framerate 15 –I demo%04d.png -vf scale=-2:836 -pix_fmt yuv420p demo.mp4





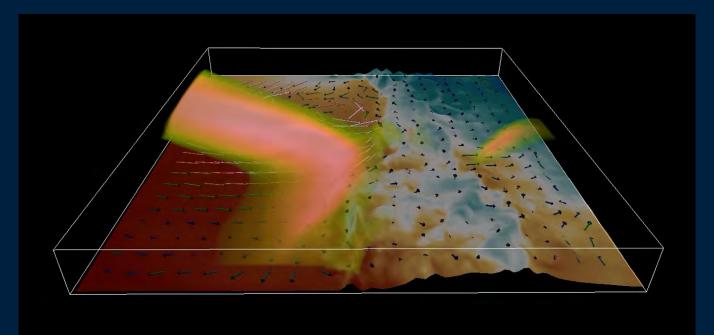
ENJOY





A [HOMEWORK?] CHALLENGE:

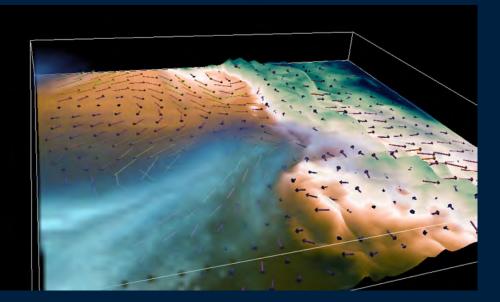
- Try to visualize the jet in three dimensions
- Hints:
 - Create a volume renderer of 3D wind fields and play around with ranges, opacity and colormaps
 - Alternatively, test out an Isosurface rendere





HANDS-ON WORKSHOP: SUMMARY

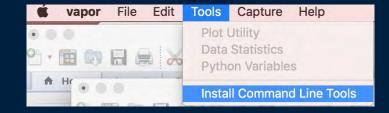
- What we [hopefully] learned:
 - Importing data into VAPOR
 - Using Renderers:
 - TwoDData
 - Barbs
 - Volume
 - Creating new Python Variables
 - Using Display Controls
 - Working with colormaps
 - Working with data and opacity ranges
 - Exporting your work





APPENDIX: CONVERTING DATA TO VDC

- Install Command Line Tools
- Log out/in



- Open a new terminal window and navigate to your data folder
- Run the following commands:

wrfvdccreate wrfout_vapor.nc wrfout_vapor.vdc

wrf2vdc wrfout_vapor.nc wrfout_vapor.vdc

• File – Open VDC

