# Recommended Practices in WRF Visualization

***Scott Pearse***
*Software Engineer, NCAR/CISL*

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# Overview

**Tools**

**Color**

**Map Projections**

**Vapor Demo**

# Overview

**Tools**

**That are free**
**That you can run**
**That you can can build**

**Color**

**Map Projections**

**Vapor Demo**

# Overview

**Tools**

**That are free**
**That you can run**
**That you can can build**

**Color**

**Color maps** 
**General guidelines**

**Map Projections**

**Vapor Demo**

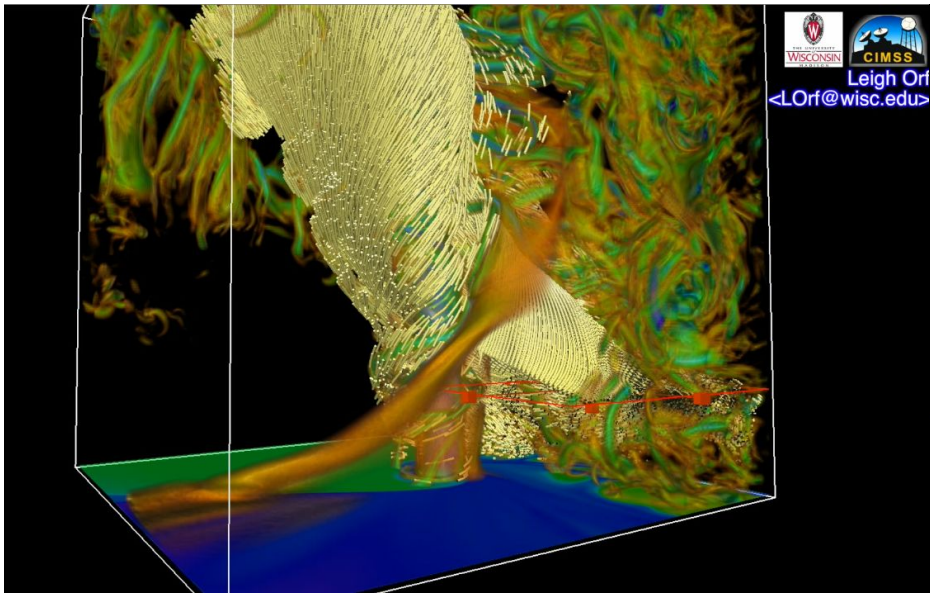
**Vapor 2**

Vapor 3

ParaView

VISIT

Blender




- Native support for WRF
- Interactive data model (VDC)
- Very feature rich

**Vapor 2**

Vapor 3

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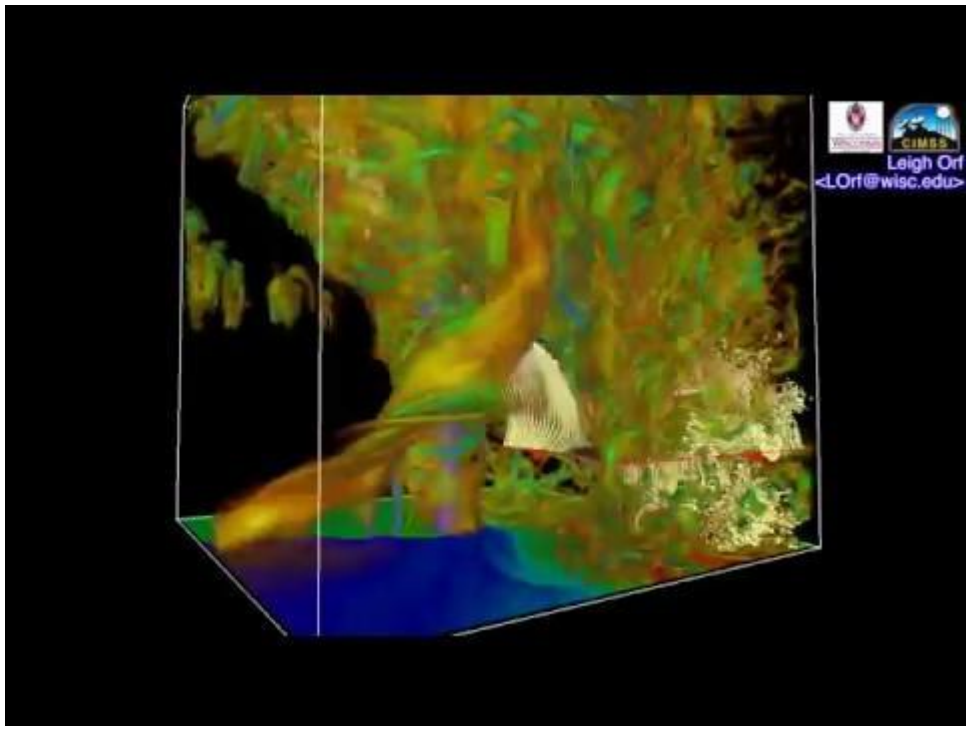

**Tools** Color Map Projections Vapor Demo

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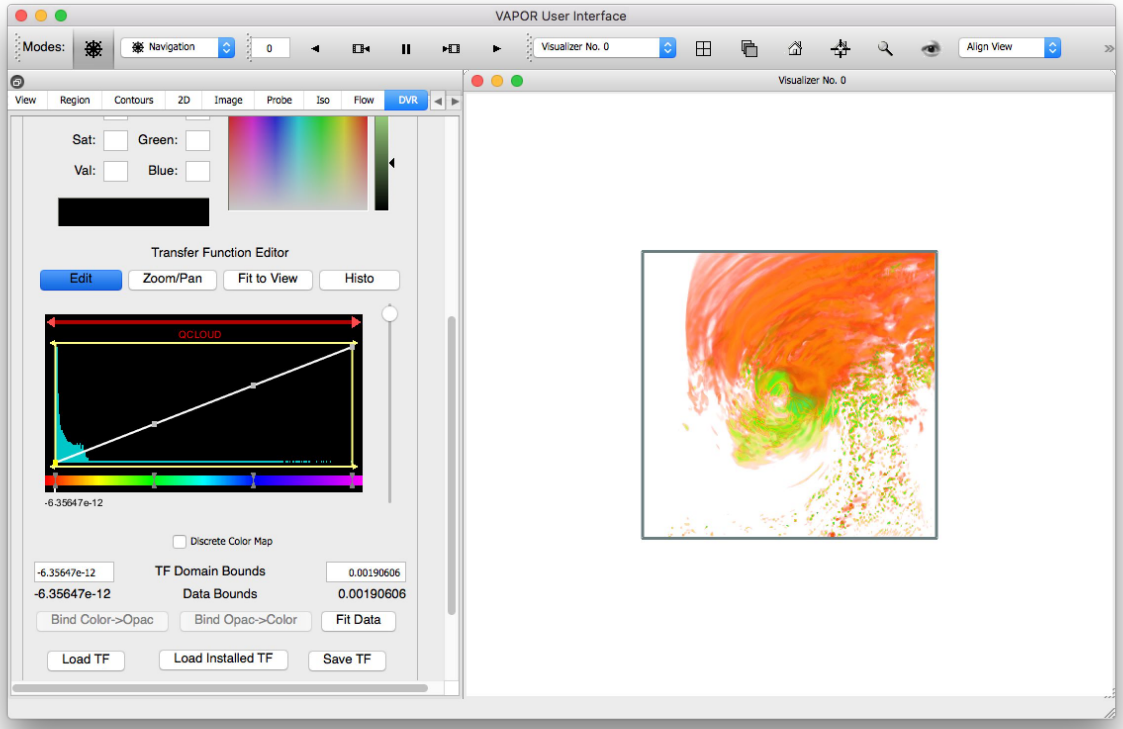


Difficult User Interface

**Vapor 2**

Vapor 3

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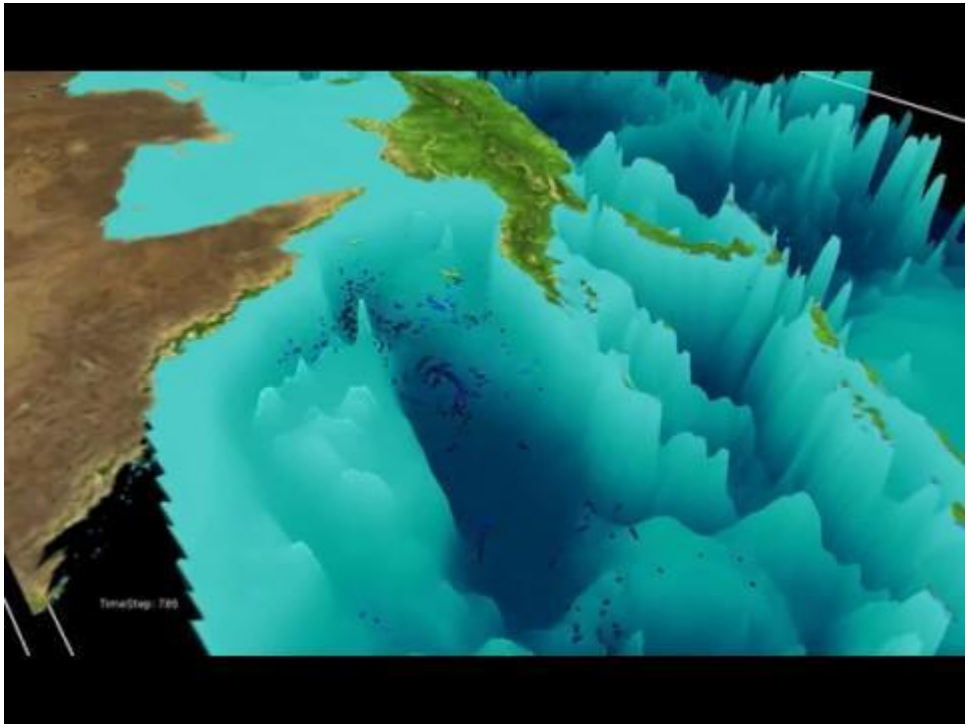

Reinterpolated Grid :(

**Tools** Color Map Projections Vapor Demo

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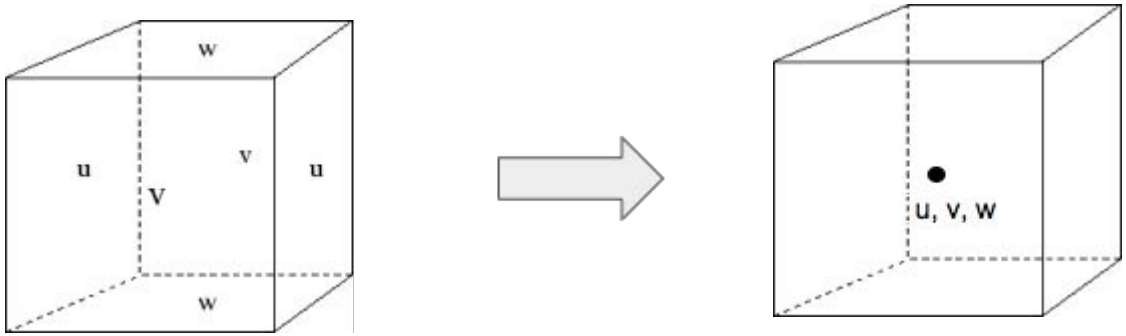
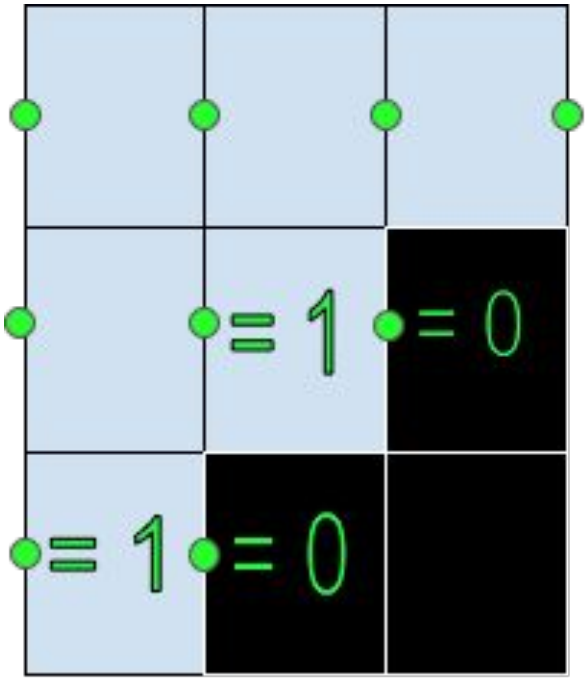
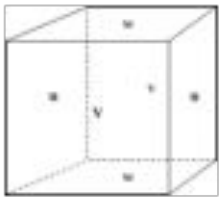
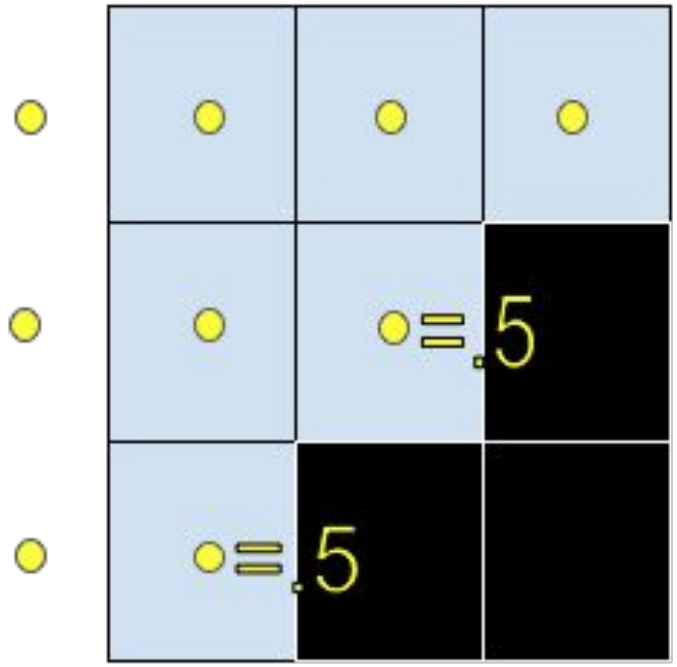



Reinterpolated Grid :(




model output for U






Interpolation onto single grid

u is now non-zero
at the boundary!

Vapor 2

**Vapor 3**

ParaView

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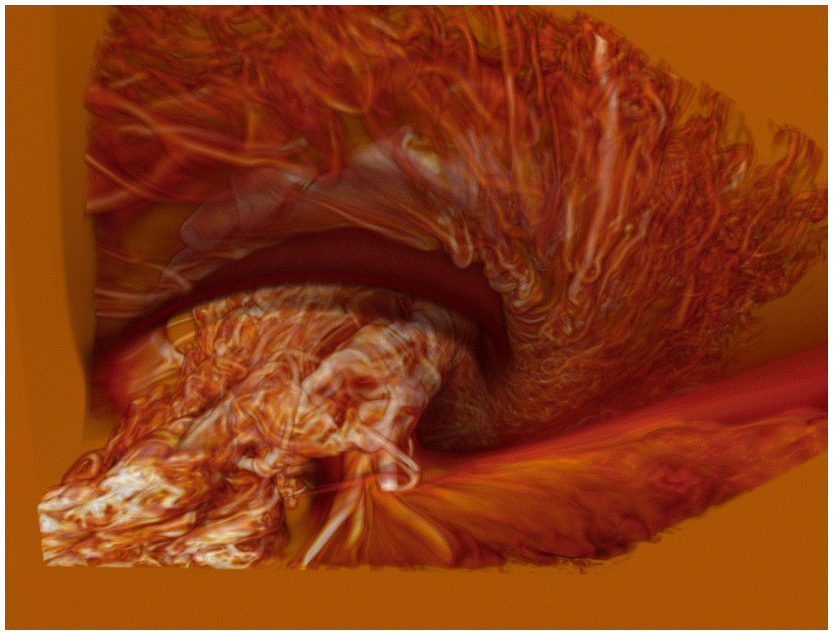
Blender



- Caters to WRF and MPAS
- Intuitive UI
- Interactive
  - Data model (VDC)
  - Ray caster

**Tools** Color Map Projections Vapor Demo

Vapor 2

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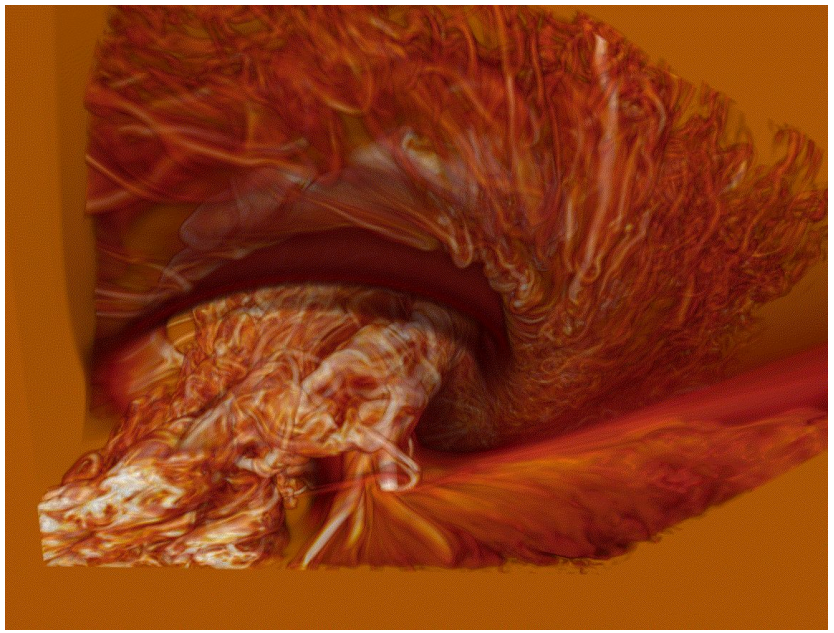


To contribute:

- www.github.com/NCAR/VAPOR
- Clone the repository
- Make a branch, and submit a PR

**Tools** Color Map Projections Vapor Demo

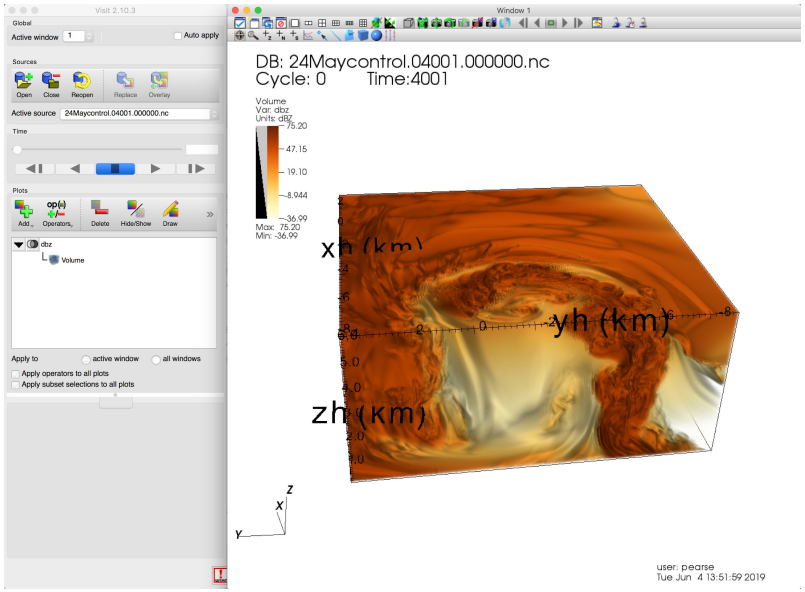
Vapor 2

Vapor 3

**VISIT**

ParaView

Blender




- Support many grids and data formats
- Parallel rendering
- Distributed rendering
- Many volume rendering methods

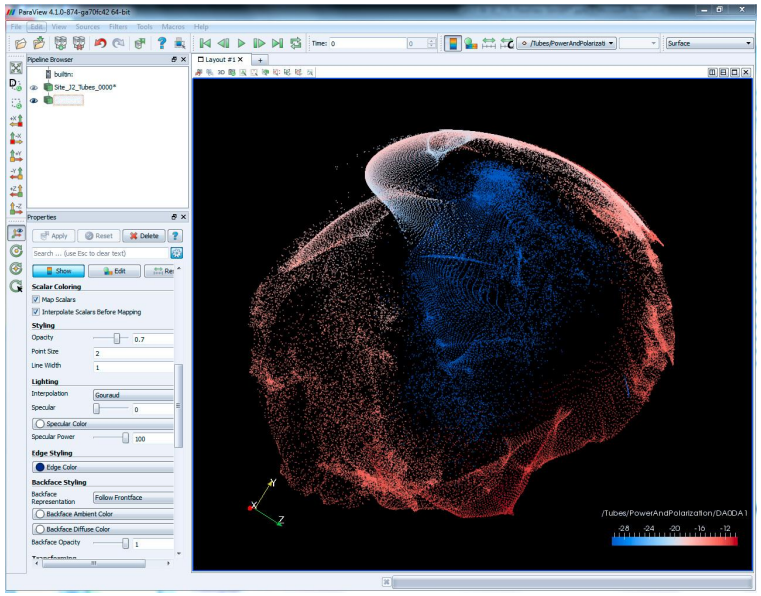
Vapor 2

Vapor 3

VISIT

**ParaView**

Blender



- NVIDIA Index Volume Rendering
- Ospray
- Parallel rendering engine
- In-situ visualization

Vapor 2

Vapor 3

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**ParaView**

Blender

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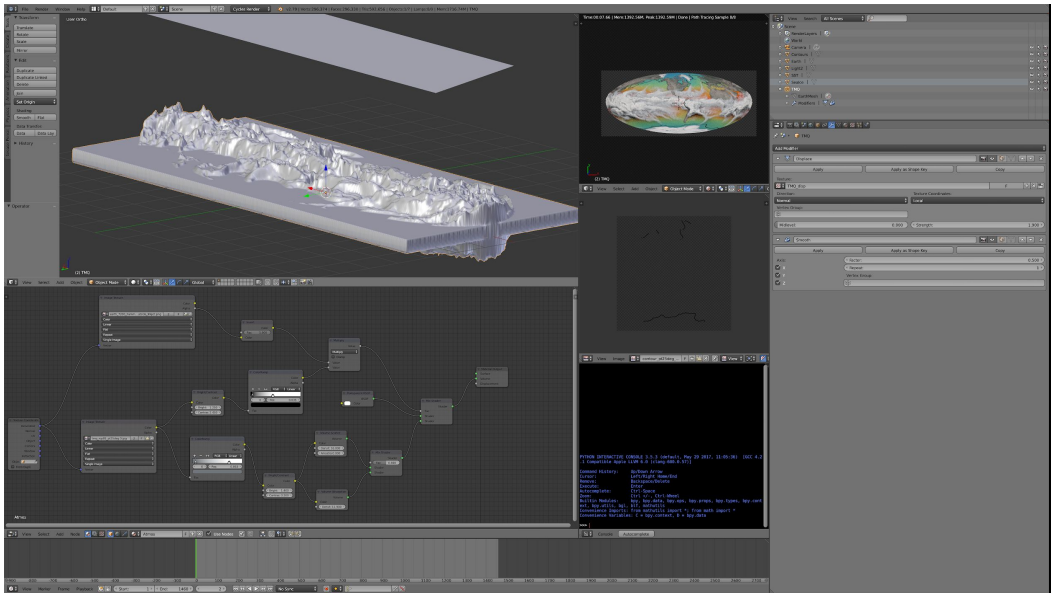
Vapor 3

VISIT

ParaView

**Blender**



| Pros | Cons |
|---|---|
| Rich feature set<br>Cinematic quality renderings<br>OpenVDB Volume Rendering | Gargantuan UI<br>Very steep learning curve<br>No native support for NetCDF |

Vapor 2

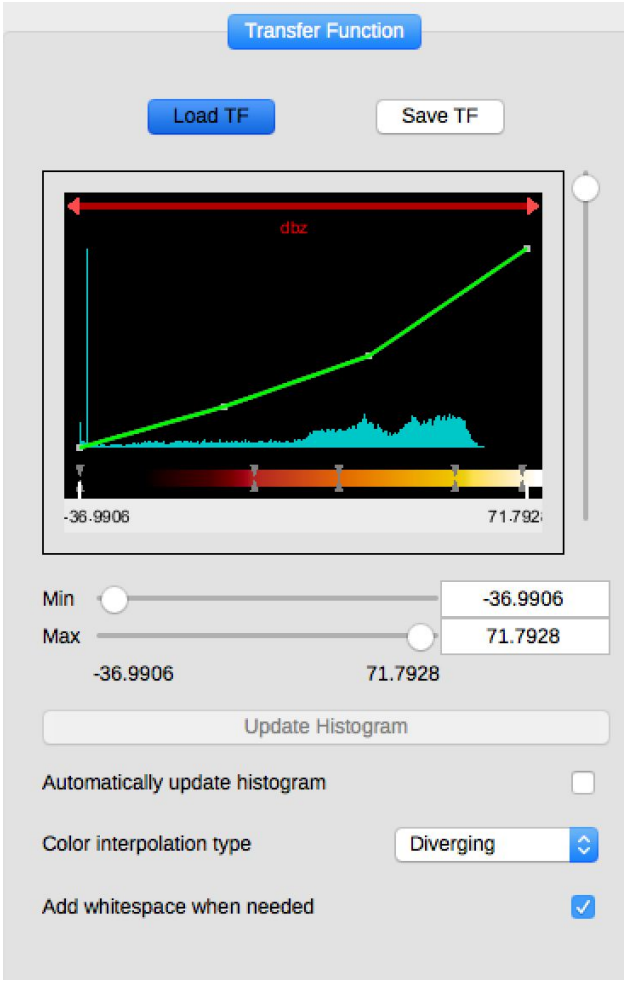
Vapor 3

VISIT

ParaView

**Blender**

Warren Washington
Tyler Prize winning CESM simulation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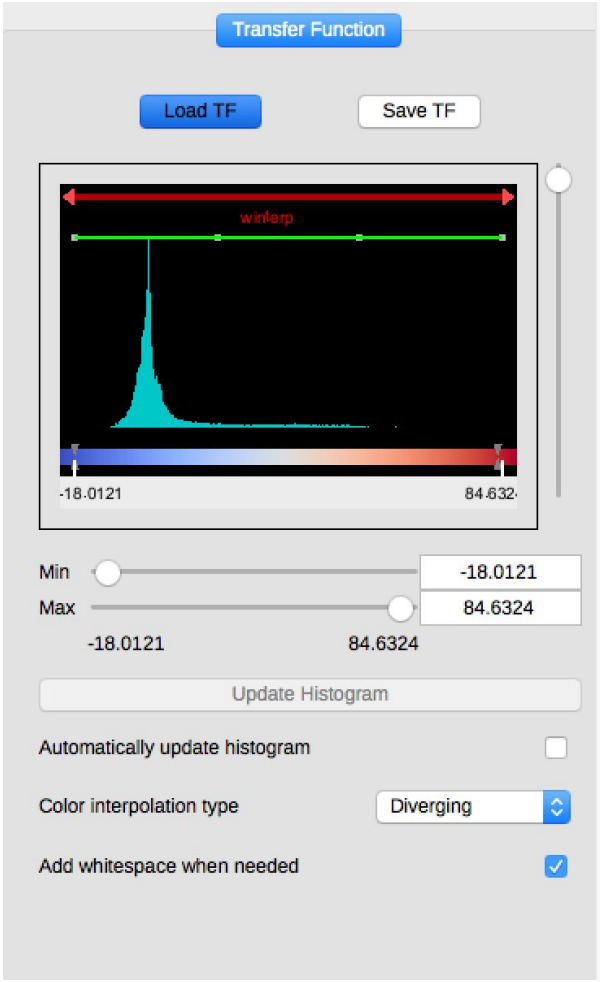
Update Histogram
Automatically update histogram
Color interpolation type
Diverging
Add whitespace when needed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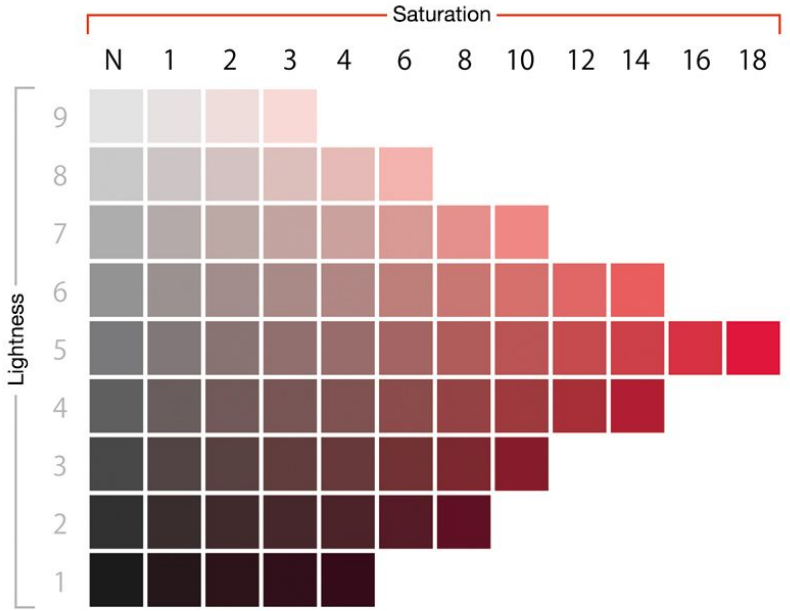
84.6324
Update Histogram
Automatically update histogram
Color interpolation type
Diverging
Add whitespace when needed

| | | |
|---|---|---|
| Hue | = | Color |
| Saturation | = | Intensity of Color/Hue |
| Value<br>Lightness<br>Brightness<br>Tone | = | Intensity of light |



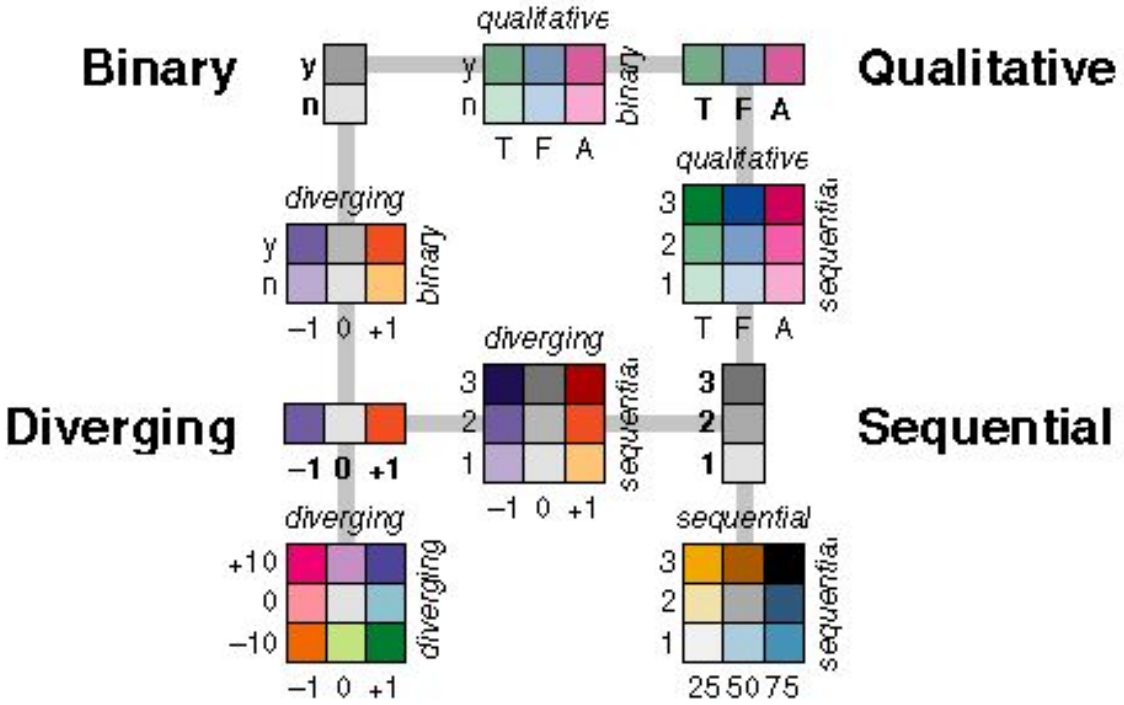

*Munsell chart*

Cynthia Brewer:
Professor of geography at Penn State


Design consultant for:

- -US Census Bureau
- -National Cancer Institute
- -National Center for Health Statistics
- -National Park Service

http://colorbrewer2.org/


Binary
Qualitative
Diverging
Sequential
qualitative
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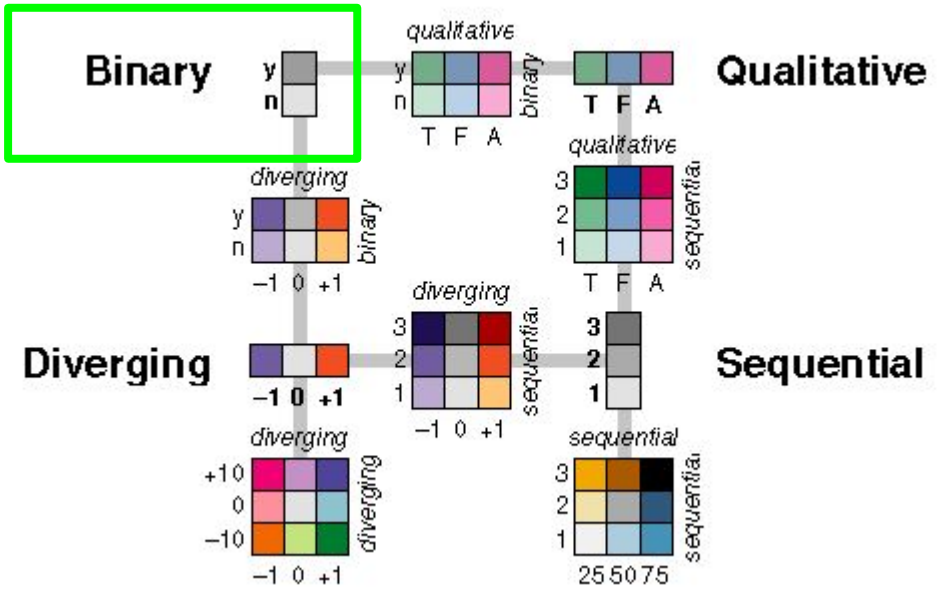
25 50 75

**Binary schemes** show differences that are divided into two categories.

The difference between the two categories may be a lightness step.



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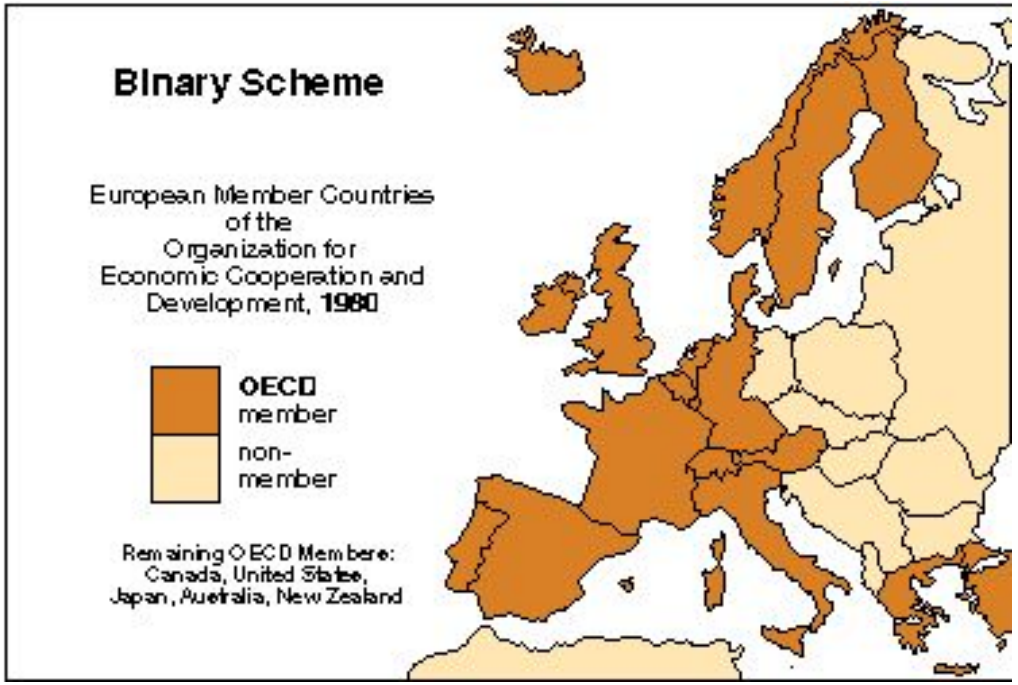
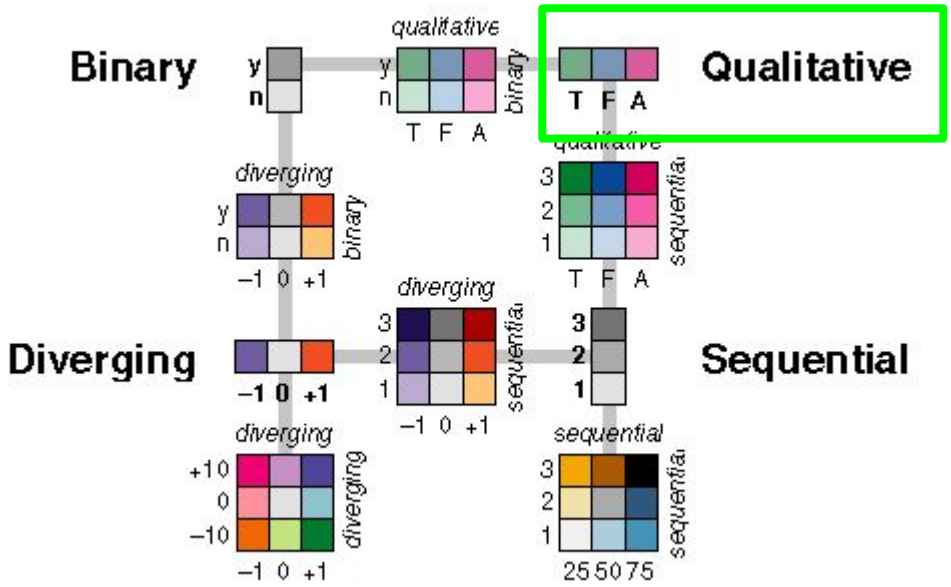


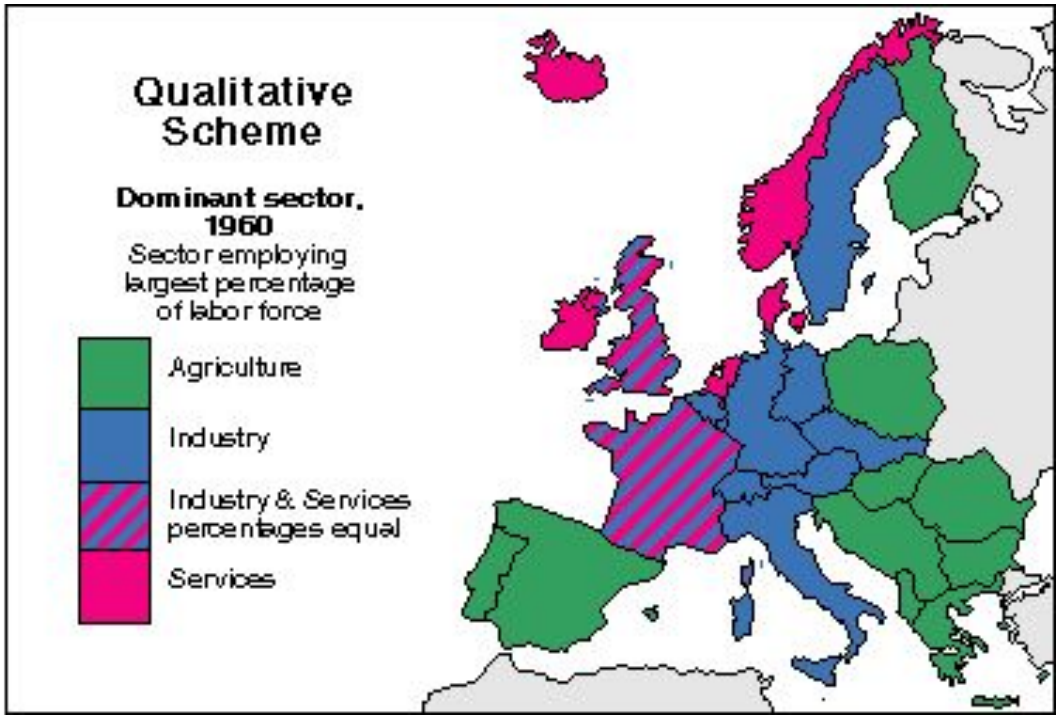
**Qualitative** schemes use differences in hue to represent in kind.

The lightness of the hues used for qualitative categories should be similar but not equal.



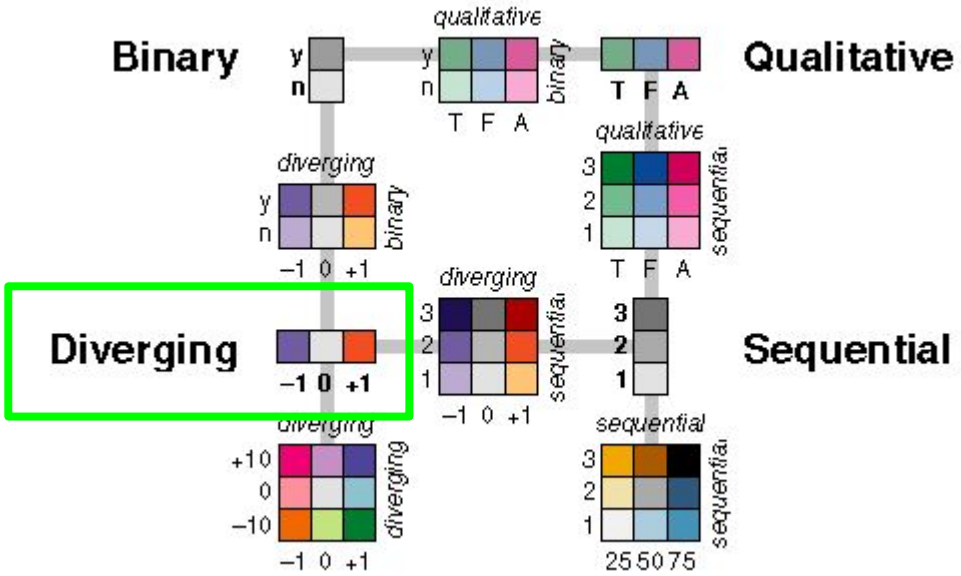
**Qualitative:**
Assign the lightest, darkest, and most saturated hues in the scheme to categories that warrant emphasis on the map.

Data about land use are well represented by a qualitative color scheme.

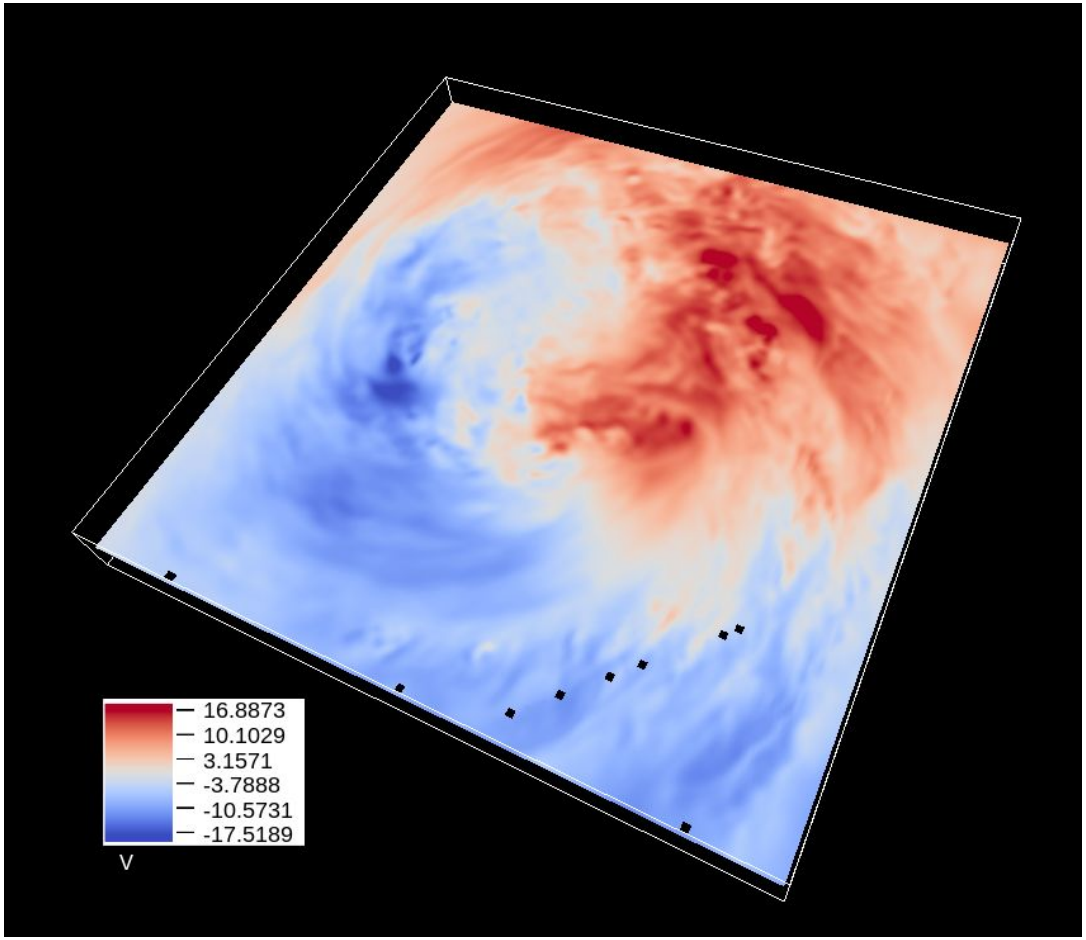


**Diverging** schemes emphasize the data's change outward from a critical midpoint.

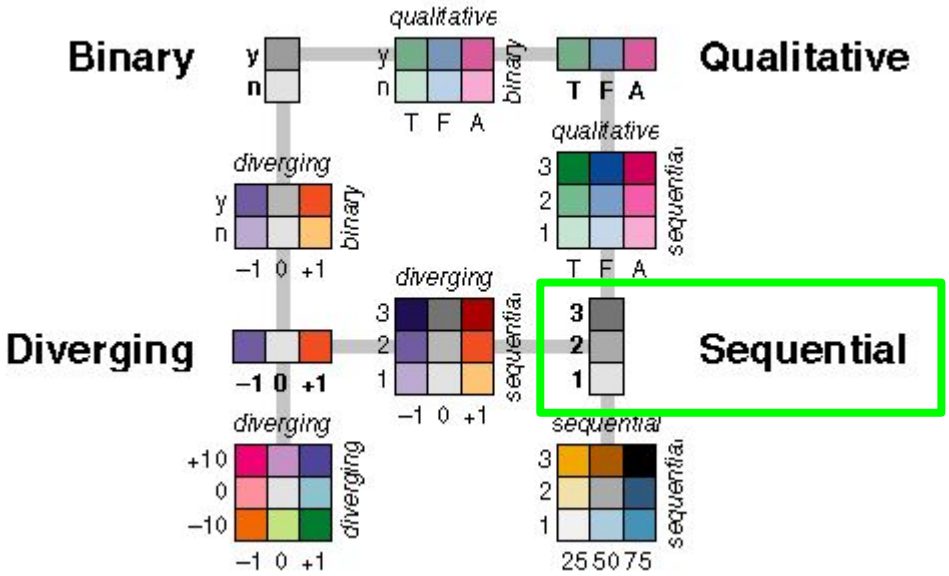
These are based on two different hues that meet at the lightly colored midpoint.



Wind velocity and vectors in general almost always need to be mapped with diverging schemes.



Sequential data classes are logically arranged from high to low, and this stepped sequence of categories should be represented by sequential lightness steps.



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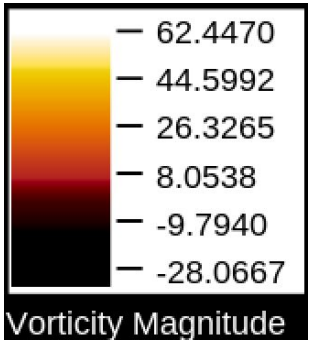


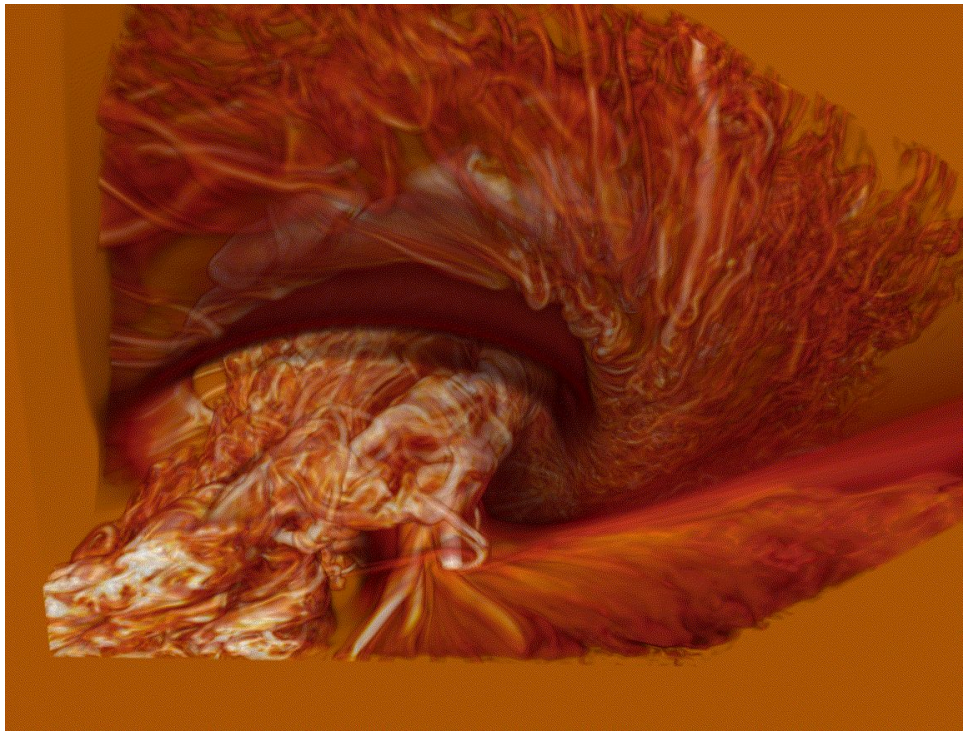

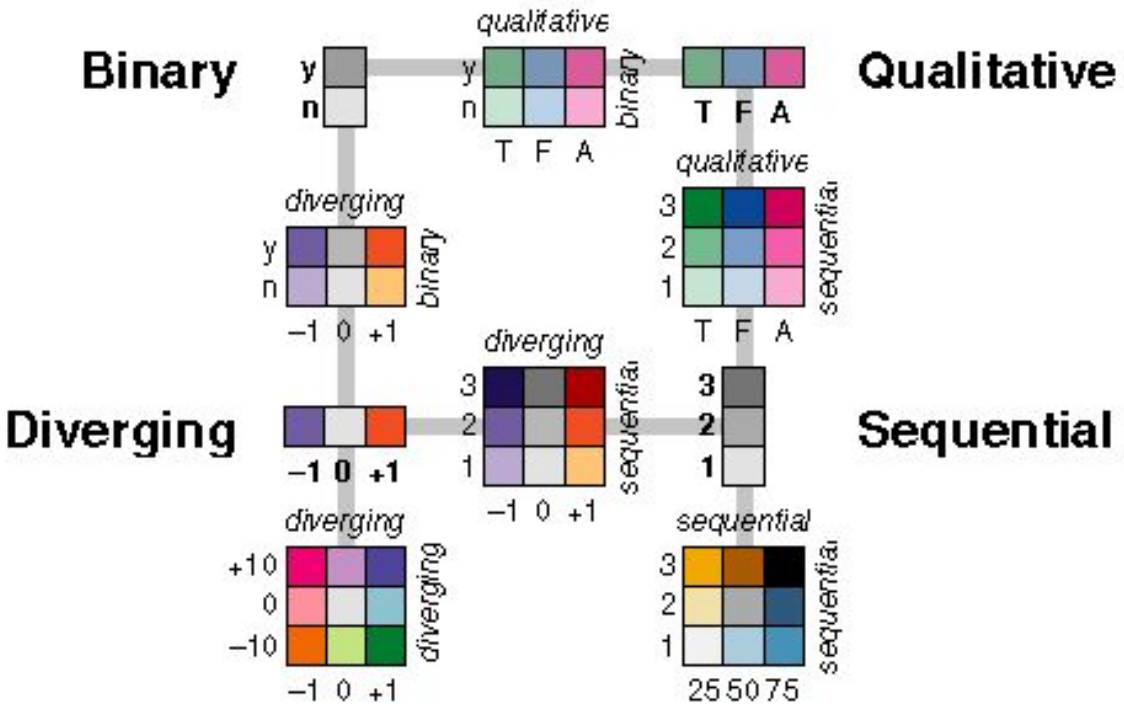


http://colorbrewer2.org/

**Rainbow Color Map is Bad**

Problem 1) The rainbow colors do not follow any natural perceived ordering.

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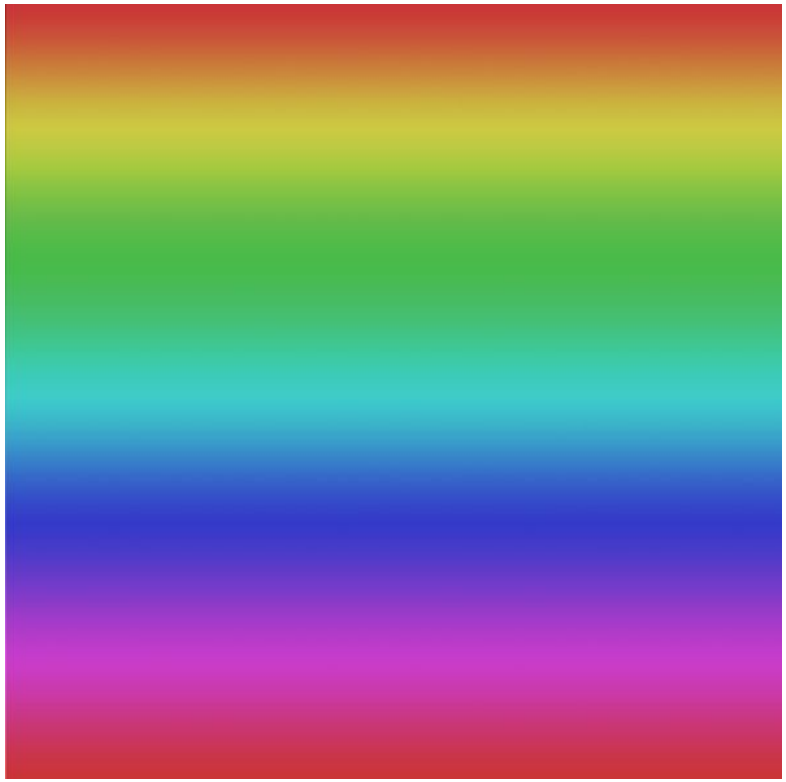
**Rainbow Color Map is Bad**

Problem 2) The perceptual changes in the rainbow colors are not uniform.

The colors appear to change much faster in the yellow region than the green region.



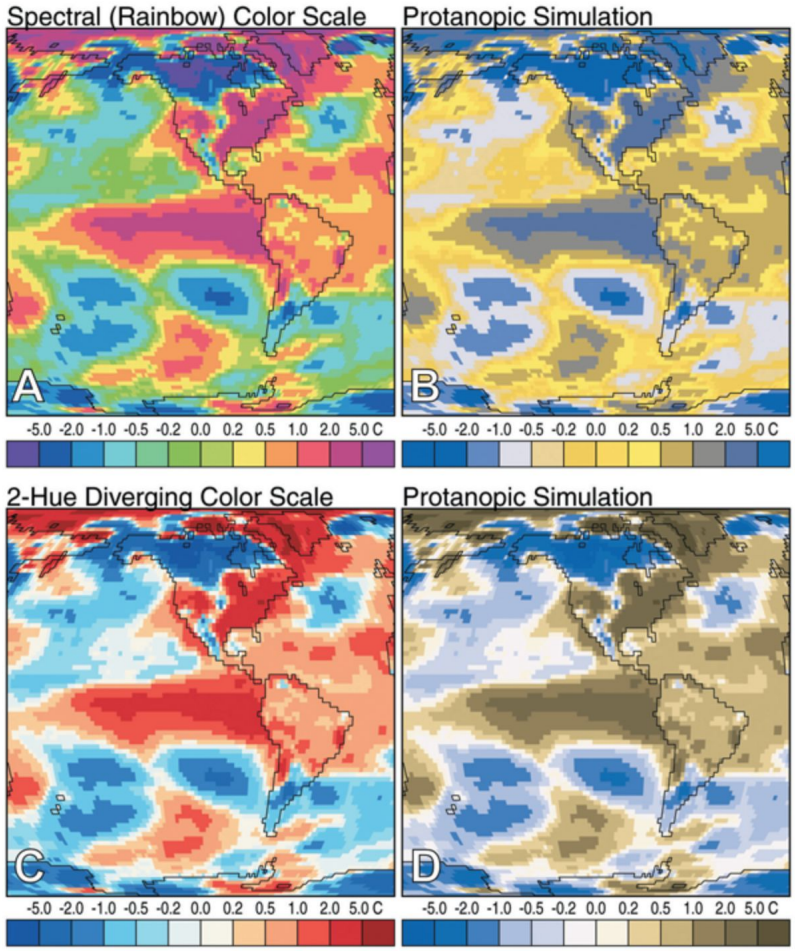
Mach Banding

**Rainbow Color Map is Bad**

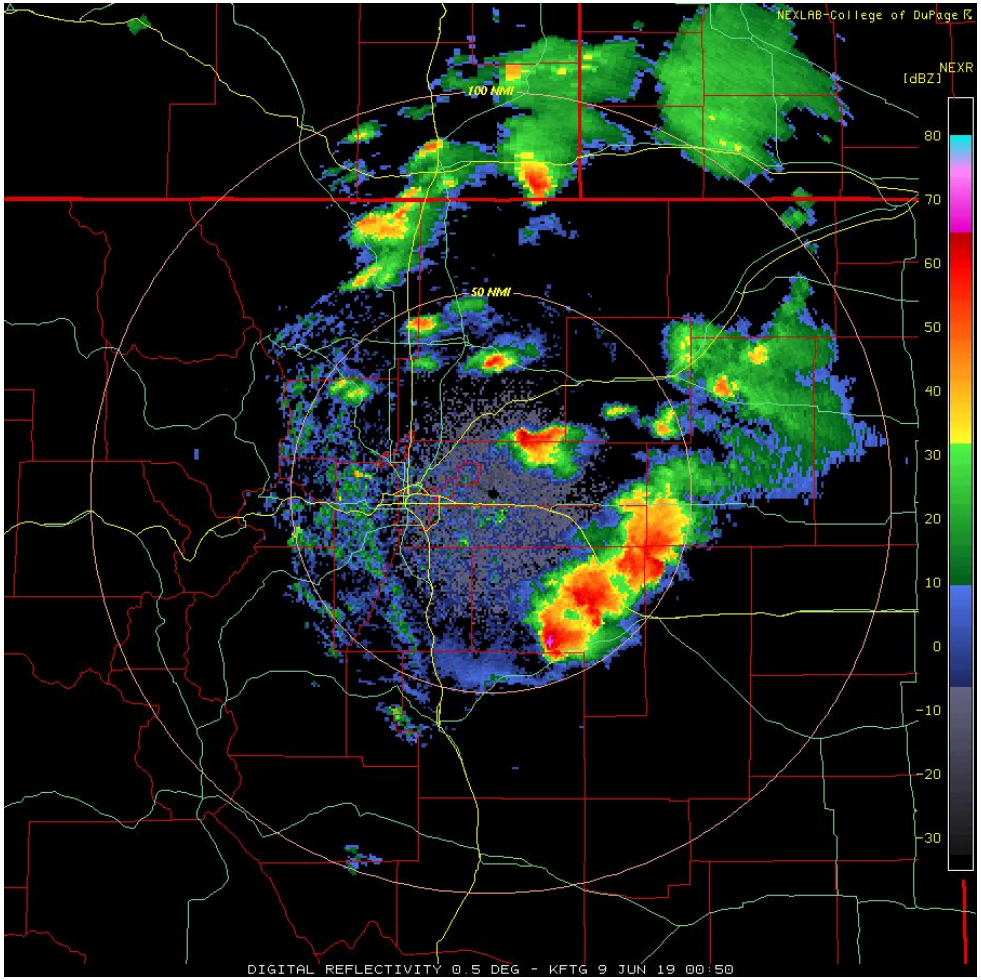
Problem 3) It is sensitive to deficiencies in vision.

Roughly 5% of the population has deficiencies in distinguishing these colors (usually between green and red).

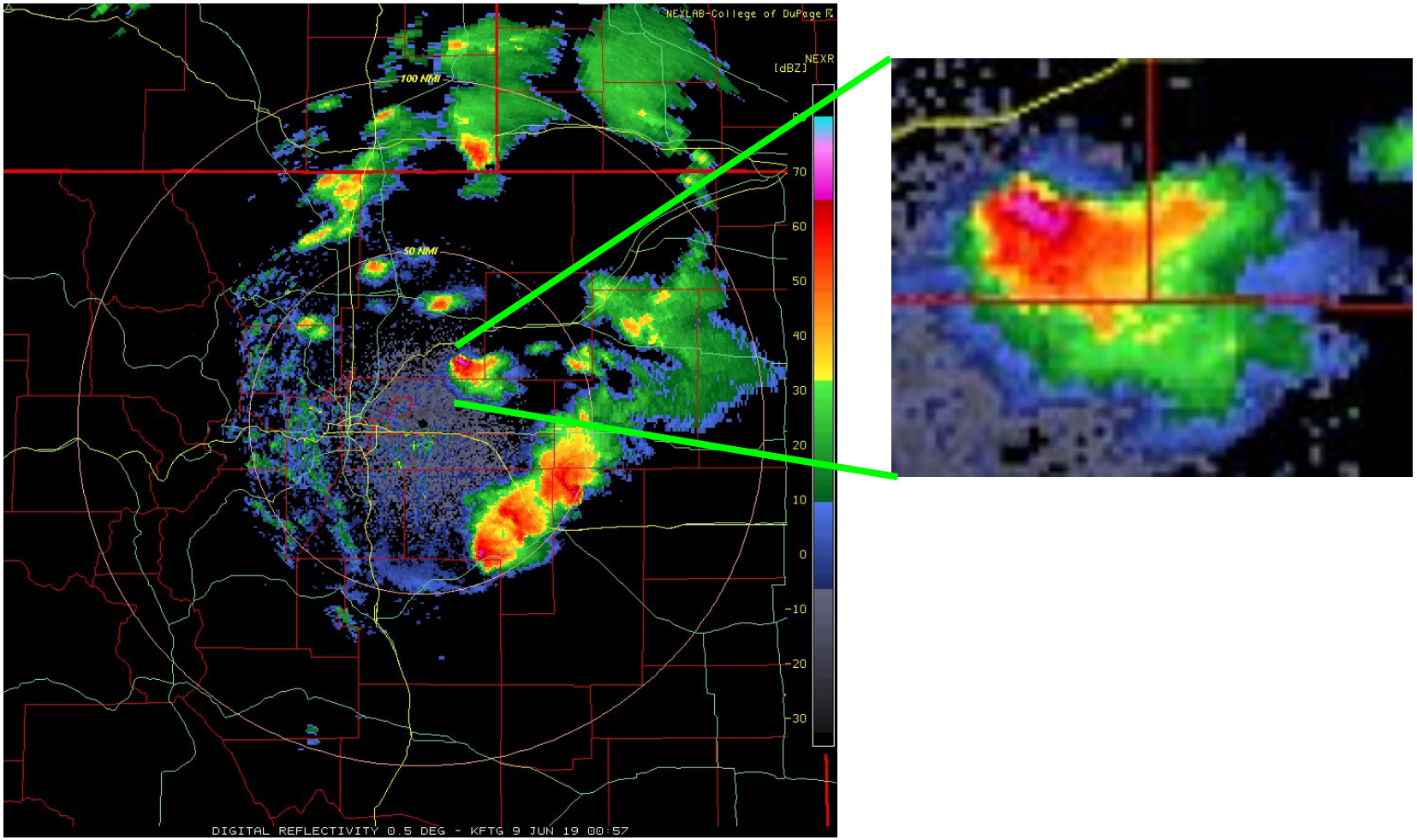
These viewers will misinterpret much of the color map



Tools **Color** Map Projections Vapor Demo




https://weather.cod.edu/satrad/nexrad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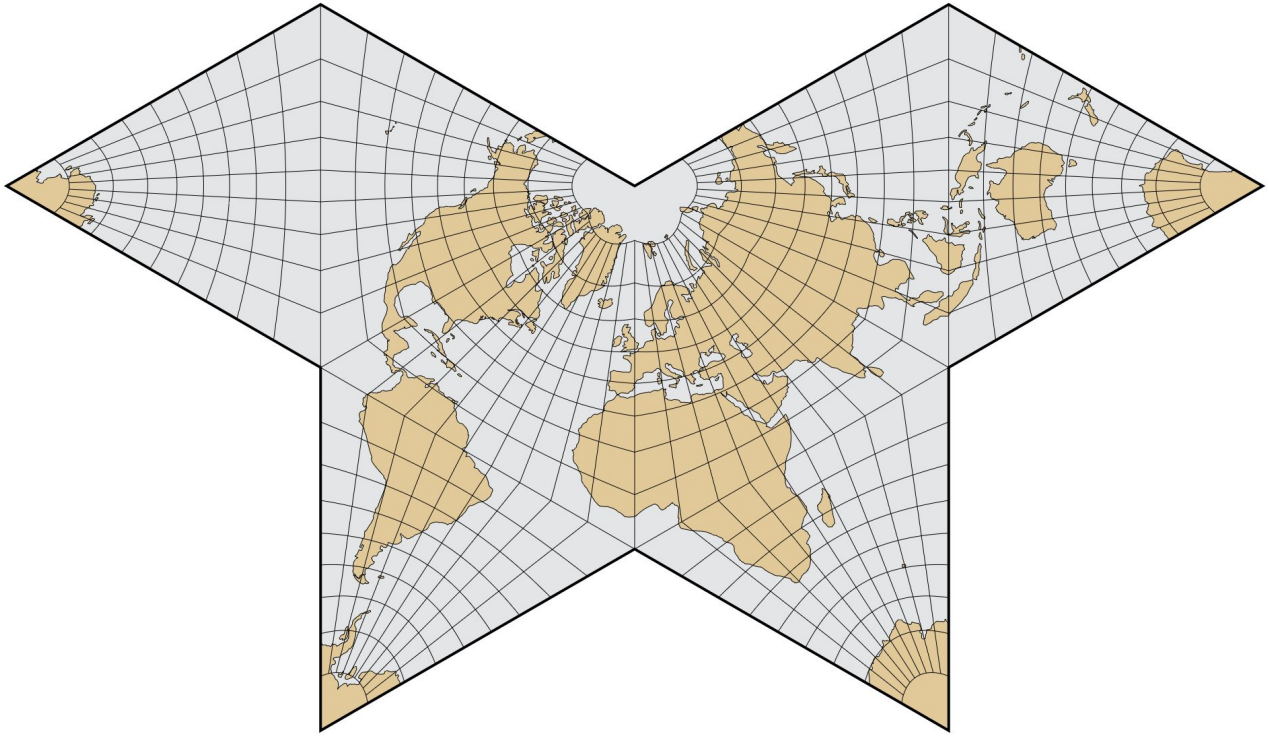
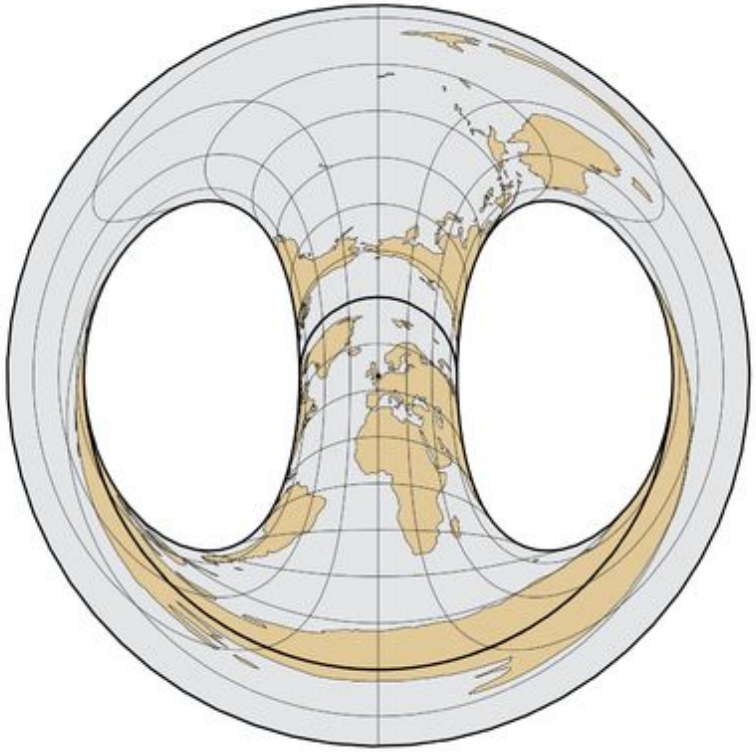


Gnomonic Butterfly
Great Circle segments are straight lines



Hammer Retroazimuthal

Vapor 2

Vapor 3

VISIT

ParaView

**Blender**

**If reprojecting your model data:**

The input data should *also* be transformed in a spherical coordinate system before being used by WRF.[1]

Reprojection can be done with:

- Vapor
- Python: Qhull library
- NCO: ncks operator

[1] Monaghan et al. 2012: Overlapping Interests: The Impact of Geographic Coordinate Assumptions on Limited-Area Atmospheric Model Simulation.