

Good Scientific Visualization Practices + Python

Kristen Thyng

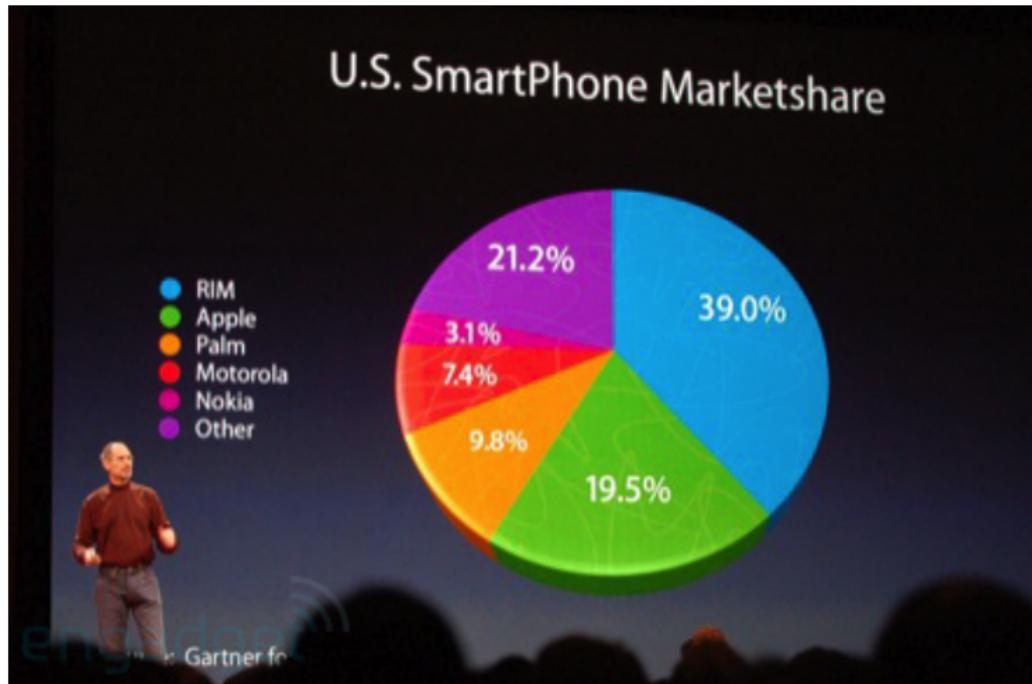
Python in Geosciences

September 19, 2013

Outline

- 1 Overview of Bad Plotting
- 2 Perceptually-based colormaps
- 3 Matplotlib Tools
- 4 Miscellaneous Considerations

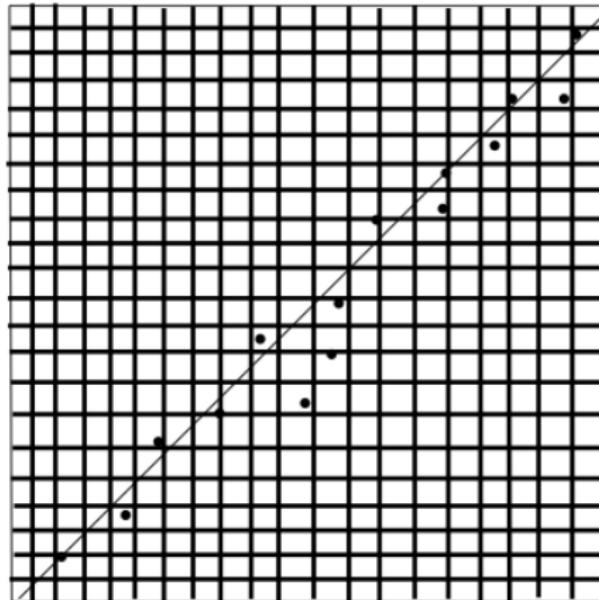
There are lots of bad plots out there



Using 3D when unnecessary

<http://www.engadget.com/2008/01/15/live-from-macworld-2008-steve-jobs-keynote/>

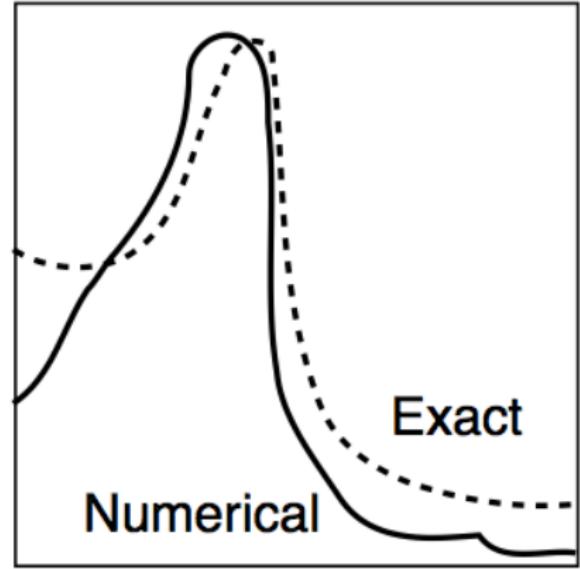
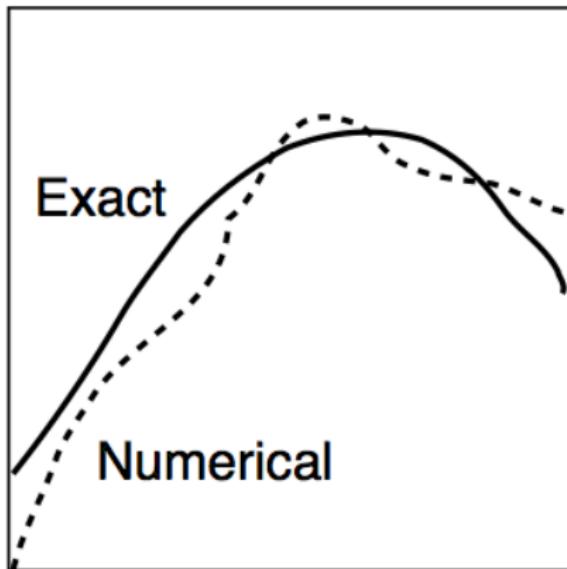
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What is the dominant feature of this plot?

<http://www-personal.umich.edu/~jboyd/sciviz.1.graphbadly.pdf>

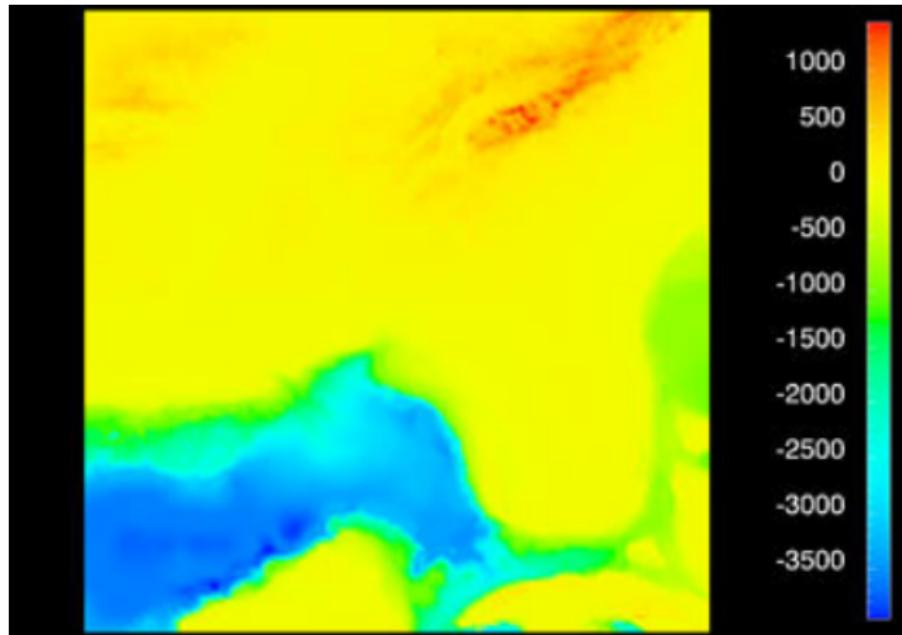
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Inconsistent representations

http://www-personal.umich.edu/~jboyd/sciviz_1_graphbadly.pdf

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Unintuitive representation

<http://www.research.ibm.com/people/l/lloyd/color/color.HTM>

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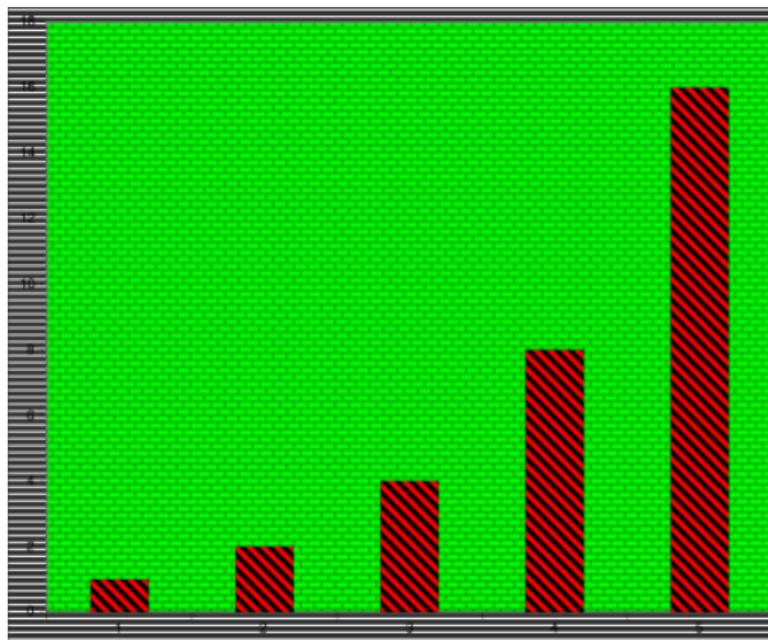


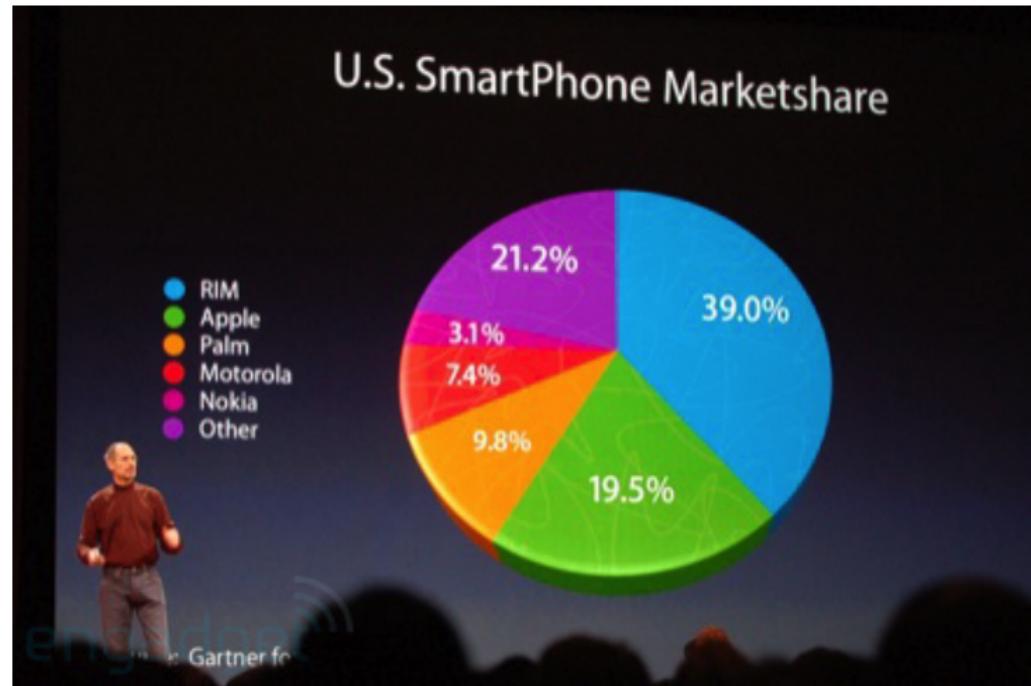
Chart junk

<http://en.wikipedia.org/wiki/File:Chartjunk-example.svg>, Tufte, Edward R. (1983). *The Visual Display of Quantitative Information*. Cheshire, CT: Graphics Press.

Goals in Visualization

- Honestly present the information - no cheating!
- Clear presentation - nothing unnecessary
- Label axes, units, etc, with large lettering
- Intuitive, consistent markers/coloring
- Give context

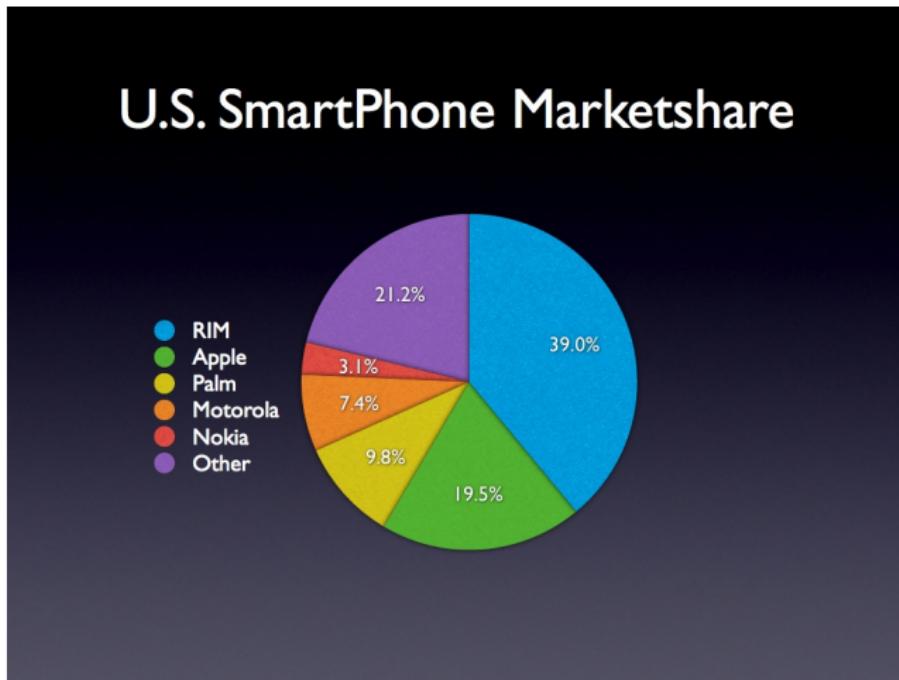
Better plots



Using 3D when unnecessary

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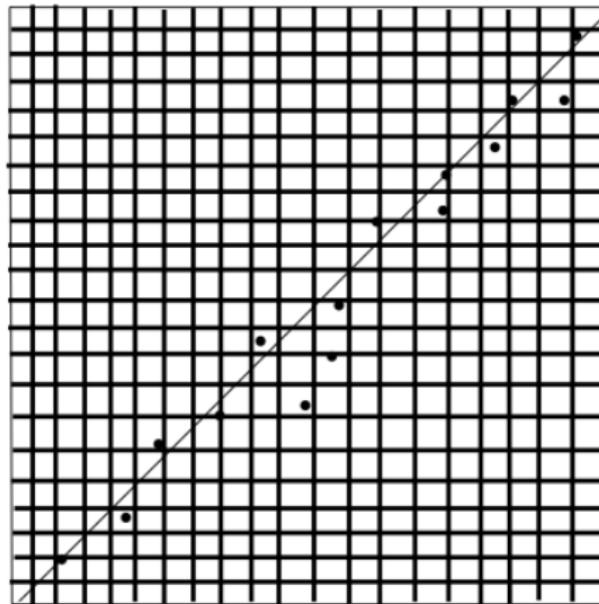
Better plots



Better presentation, though pie charts not great

<http://www.quora.com/Data-Visualization/What-should-everyone-know-about-making-good-charts-and-graphs-to-represent-data>

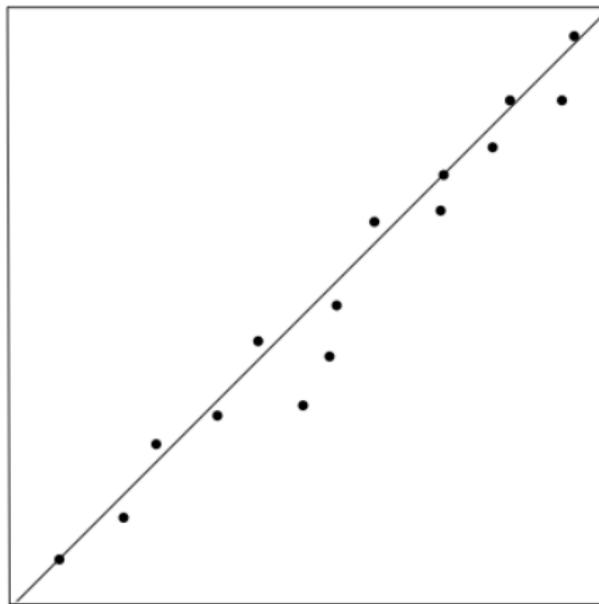
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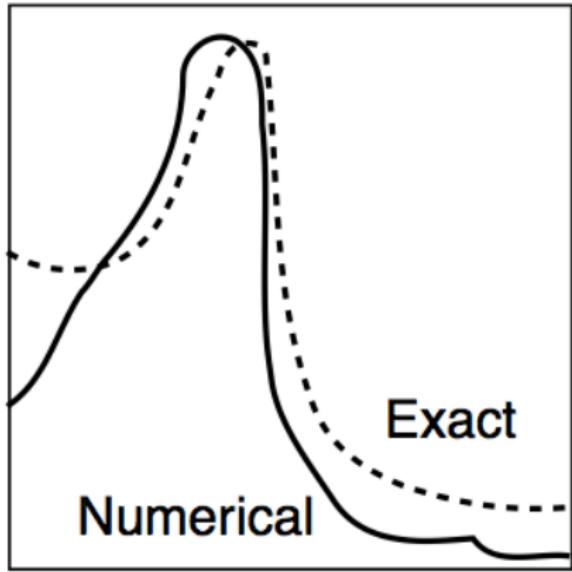
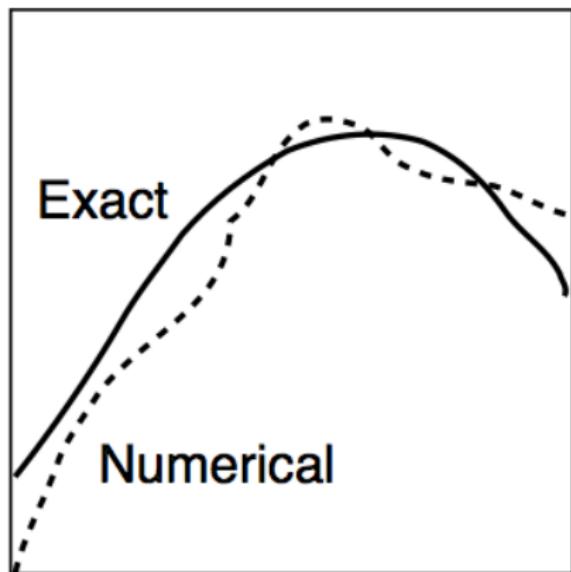
Better plots



Simpler is often better

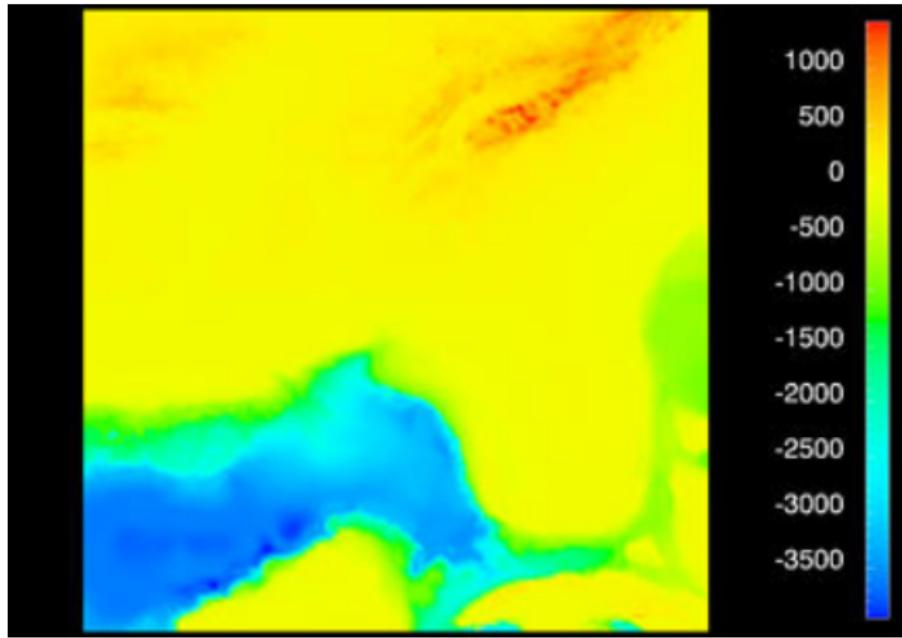
http://www-personal.umich.edu/~jpboyd/sciviz_1_graphbadly.pdf

Better plots



Pick a representation and stick with it
http://www-personal.umich.edu/~jboyd/sciviz.1_graphbadly.pdf

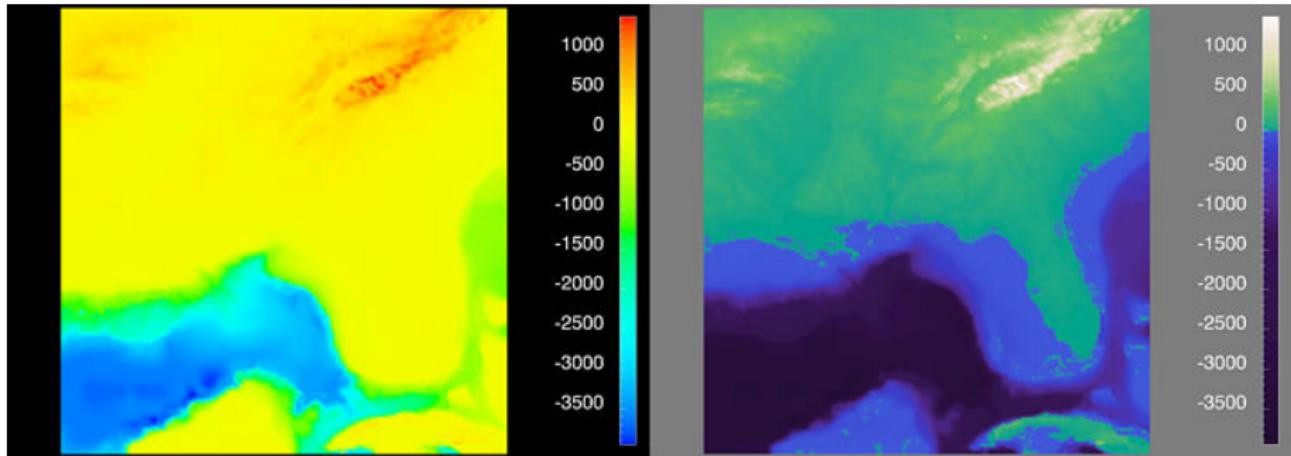
Better plots



Unintuitive representation

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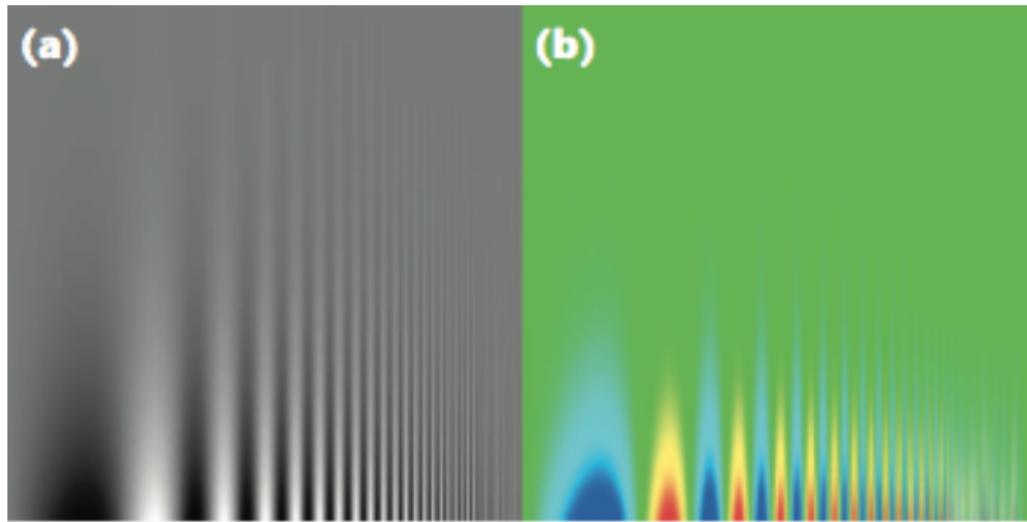
Better plots



Color choices are key

<http://www.research.ibm.com/people/l/lloyd/color/color.HTM>

Better plots



Color choices are key

http://www.sv.vt.edu/~rkriz/Projects/create_color_table/color_07.pdf

Better plots

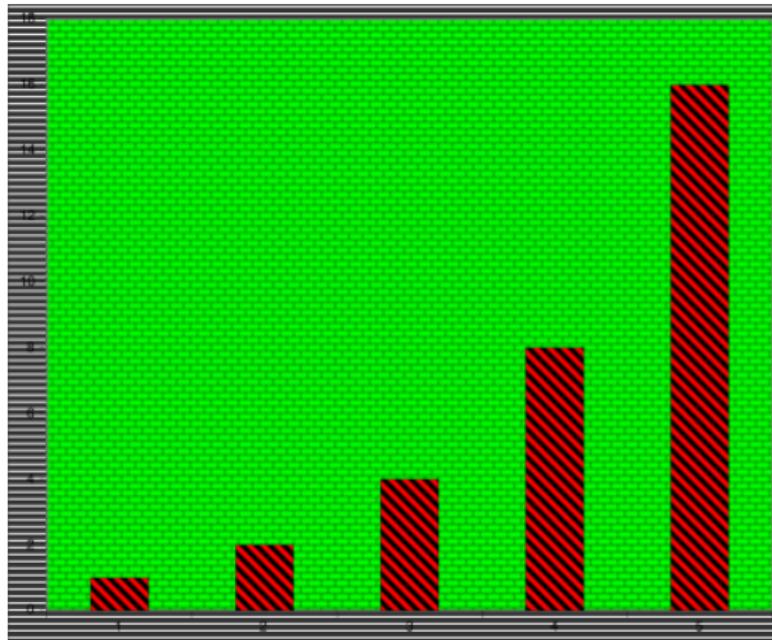


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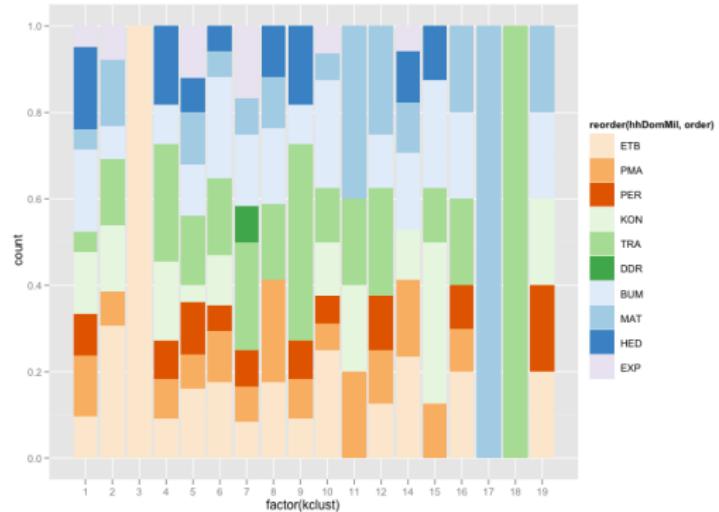
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- 2 Perceptually-based colormaps
- 3 Matplotlib Tools
- 4 Miscellaneous Considerations

Data Types

- Categorical: Representing discrete things, not on continuum
- Interval or sequential: intervals of the data are equal distances
- Ratio or diverging: has critical value (often 0) and ratios of values are equal

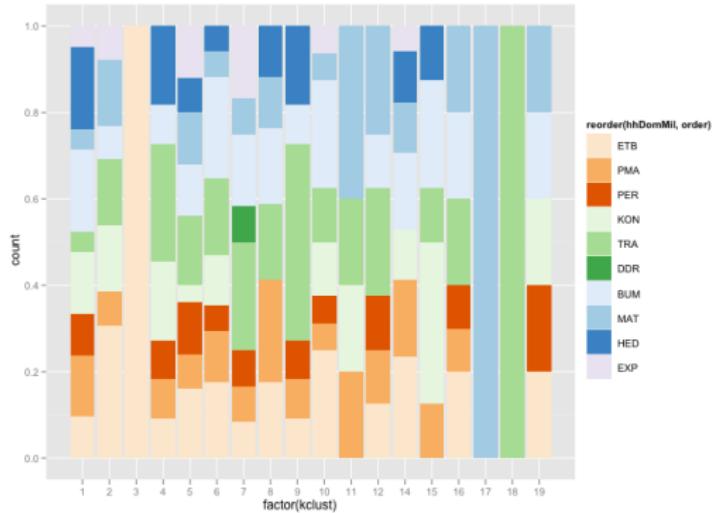


<http://stackoverflow.com/questions/7150453/order-categorical-data-in-a-stacked-bar-plot-with-ggplot2>

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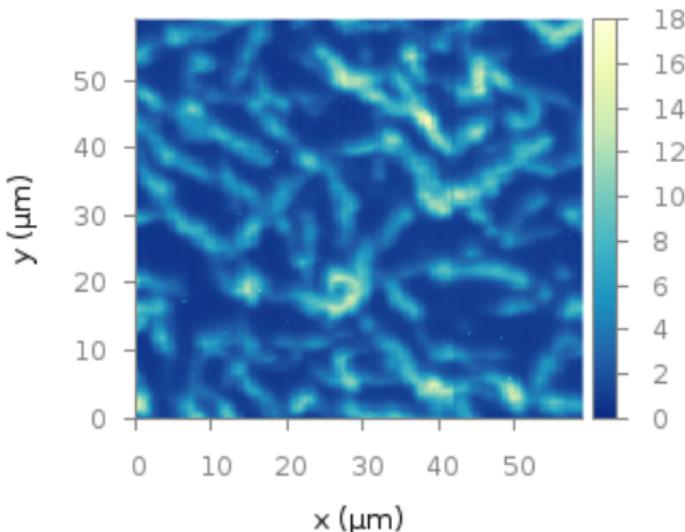


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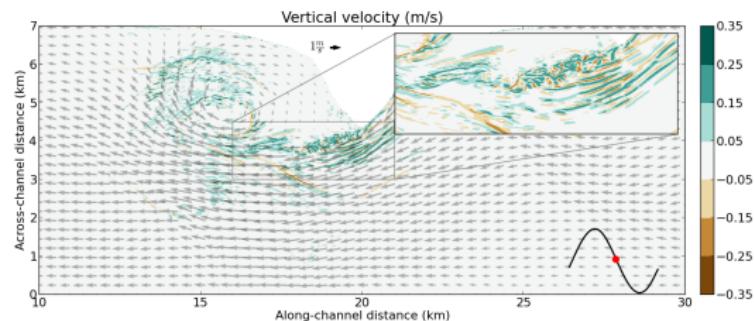


<http://www.gnuplotting.org/tag/colormap/>

<http://www.research.ibm.com/people/l/lloyd/color/color.HTM>

Data Types

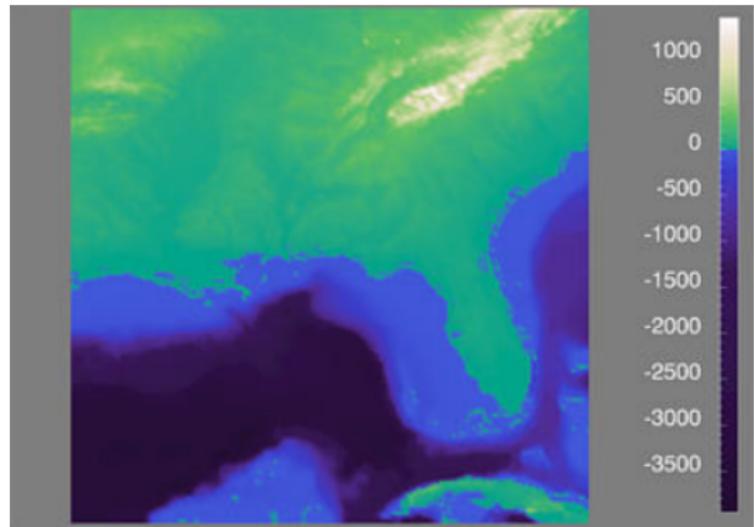
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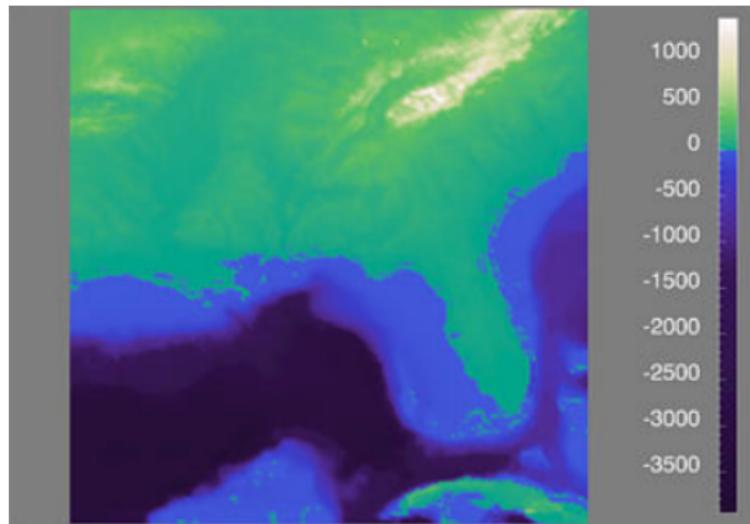


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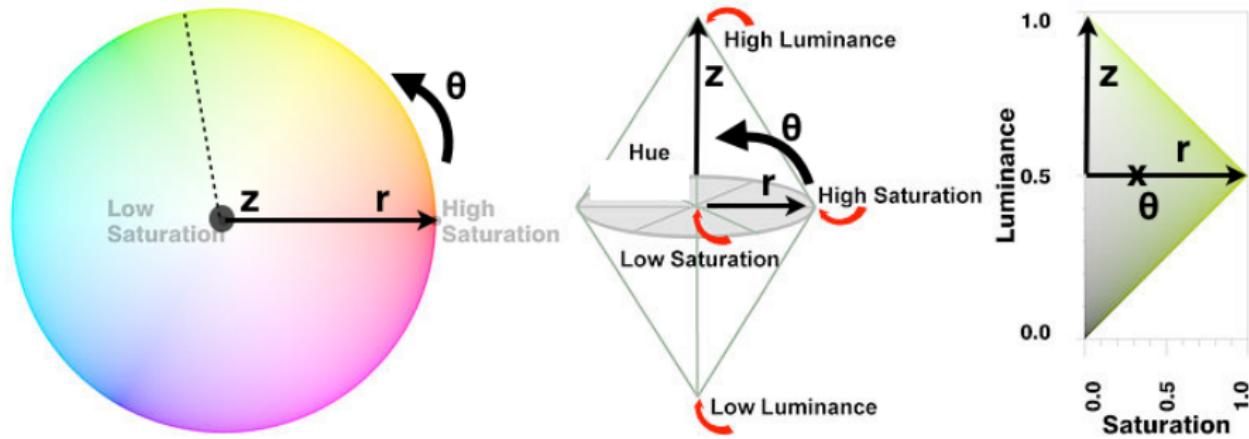
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⇒ Equal steps in data should correspond to equal steps in perception



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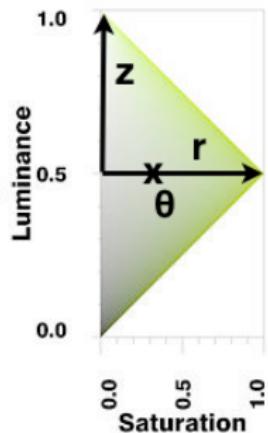
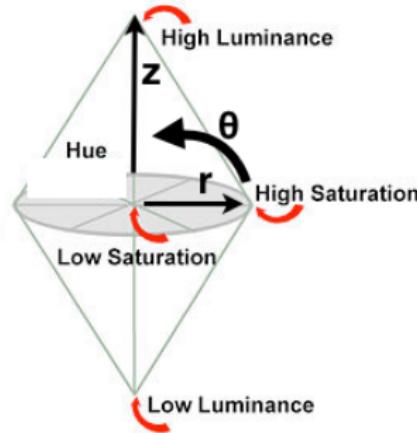
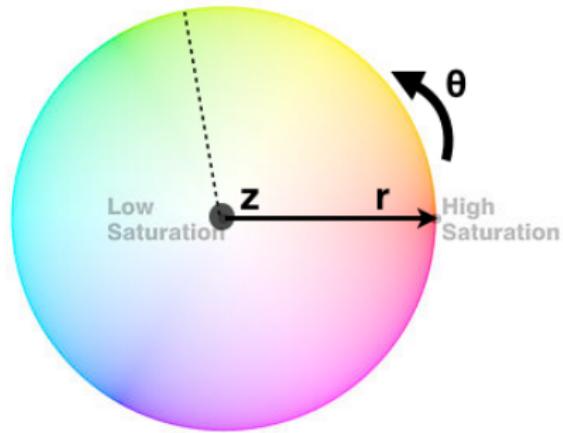
Color is 3D



r : saturation/color intensity, z : luminance/brightness, θ : color hue

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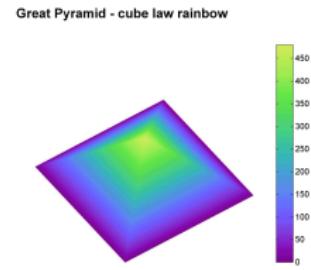
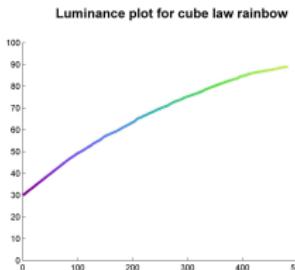
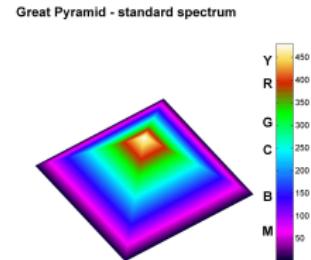
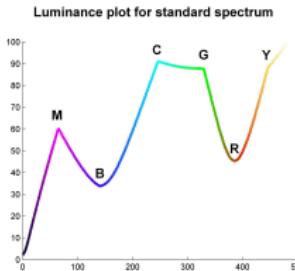
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r : saturation/color intensity, z : luminance/brightness, θ : color hue
 \Rightarrow good for representing continuous variations in data magnitude

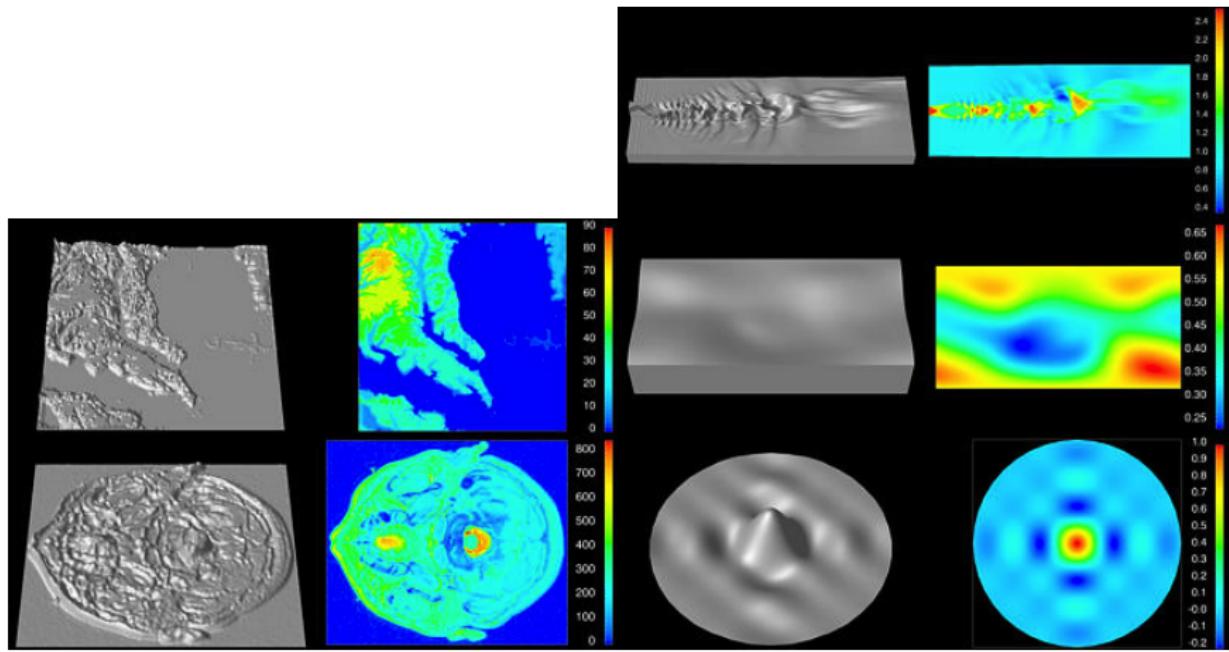
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Jet Luminance



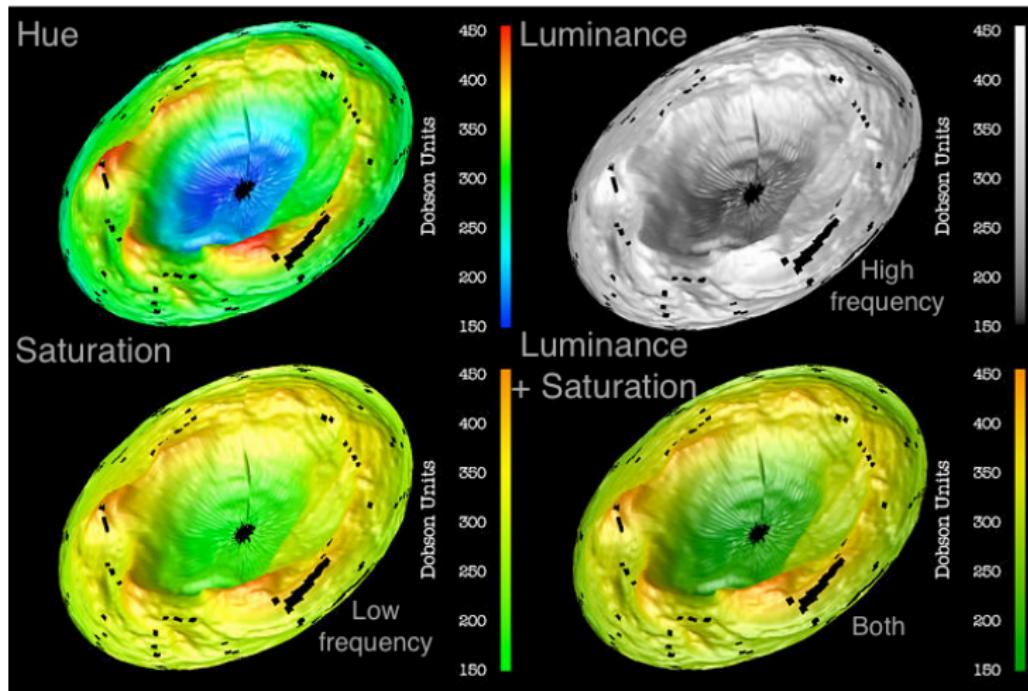
http://www.mathworks.com/matlabcentral/fx_files/28982/16/spectrum_vs_cubicYF.png

Hue-based Colormaps Perceptually Distort Information



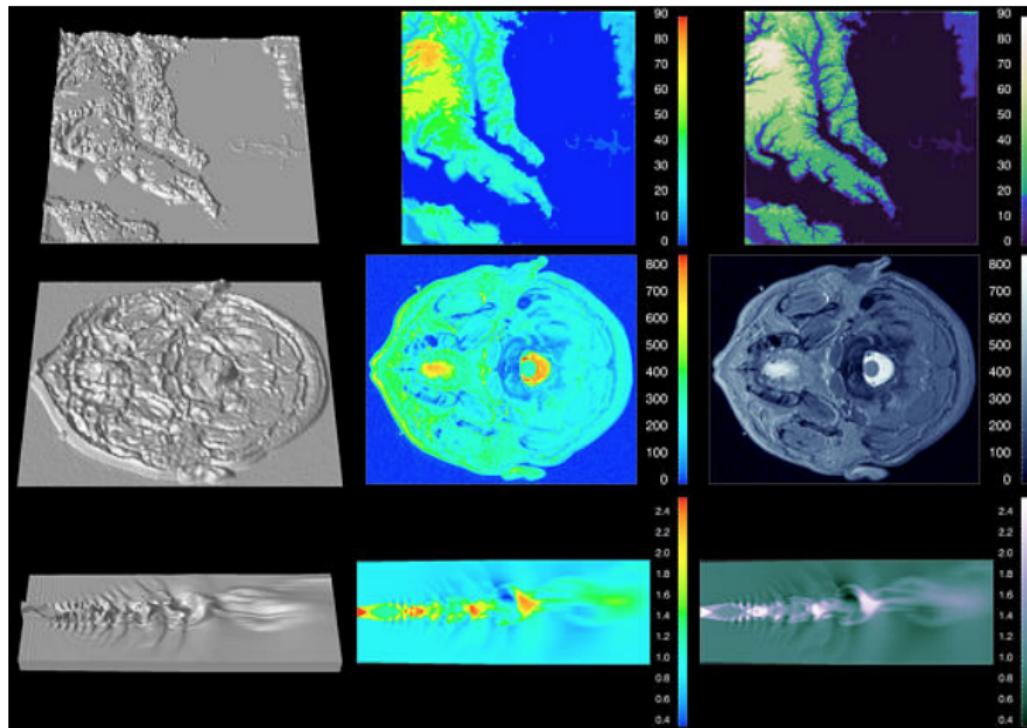
<http://www.research.ibm.com/people/l/lloyd/color/color.HTM>

Luminance and Saturation Colormaps



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Improved Colormapping



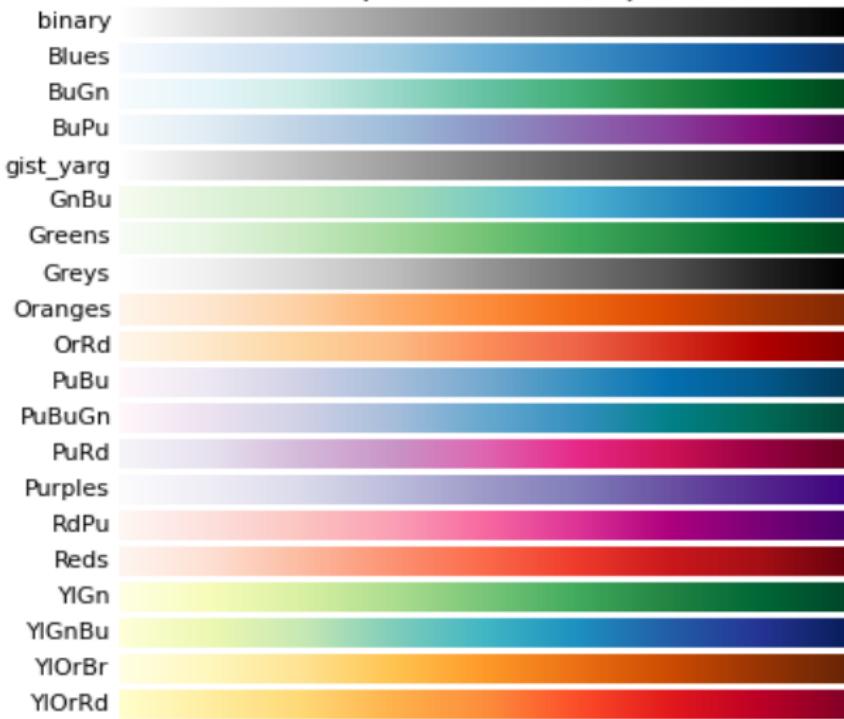
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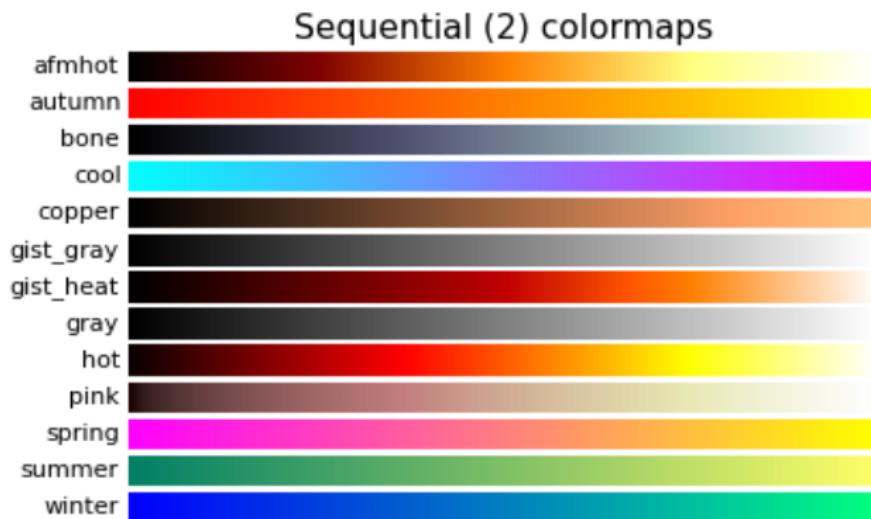
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Types of Colormaps

Sequential colormaps

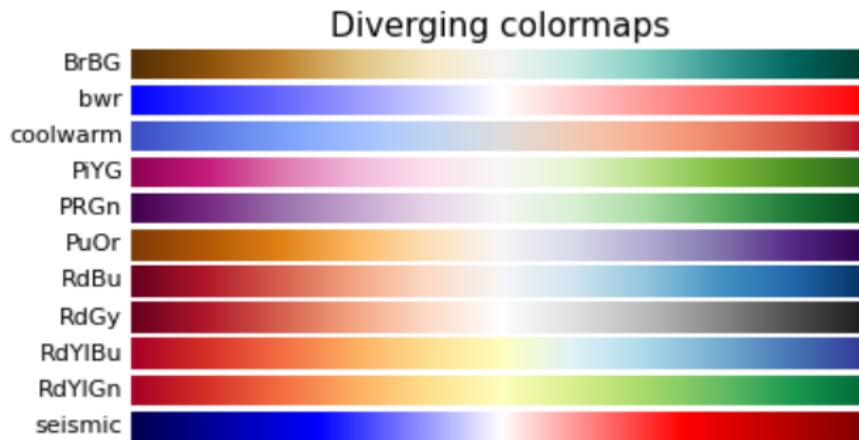


Types of Colormaps



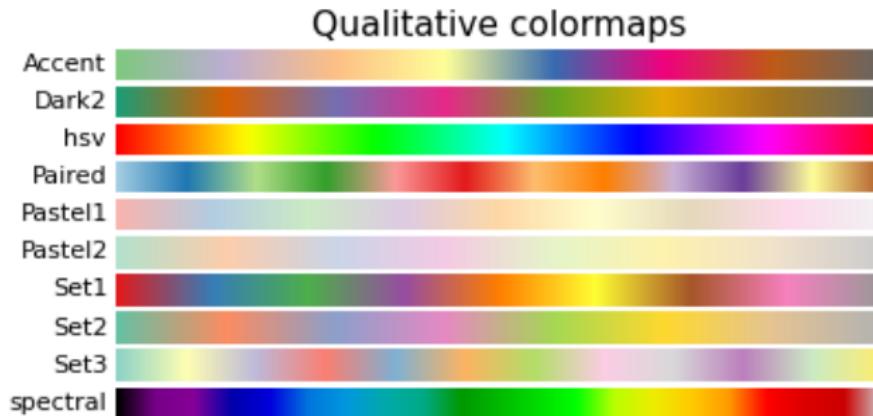
http://matplotlib.org/examples/color/colormaps_reference.html

Types of Colormaps



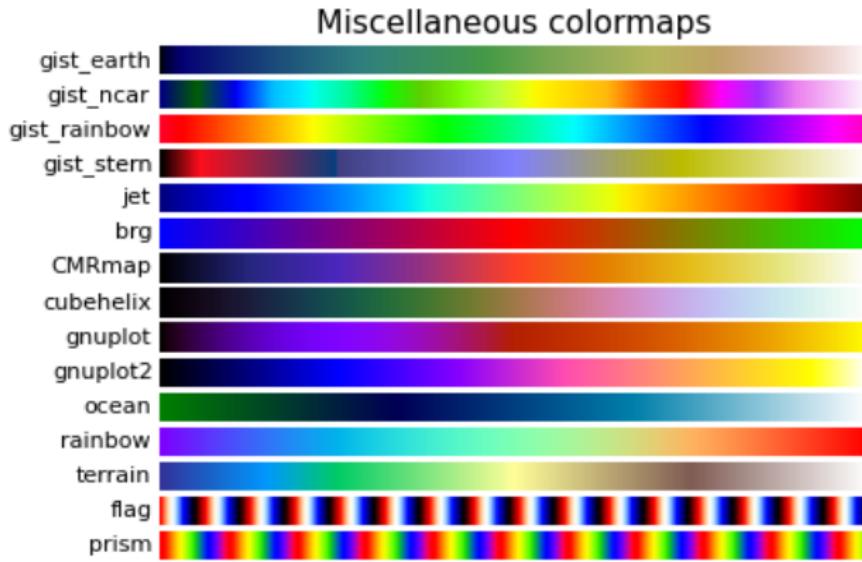
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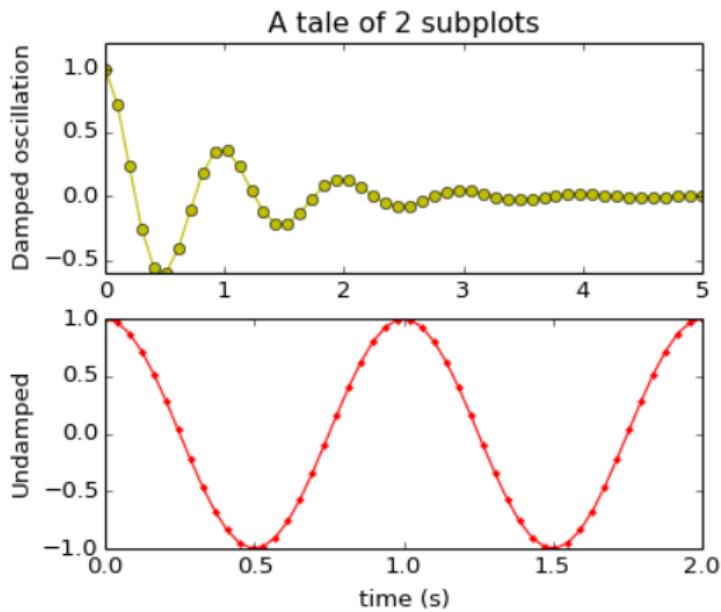
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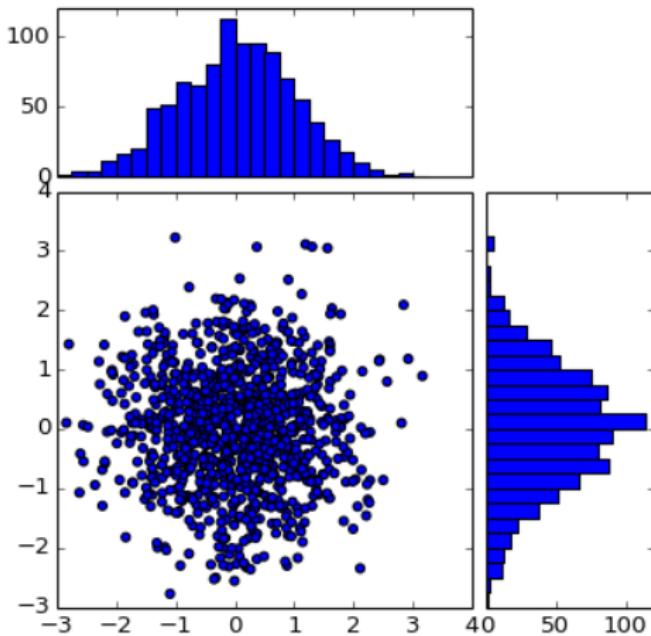
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Subplot

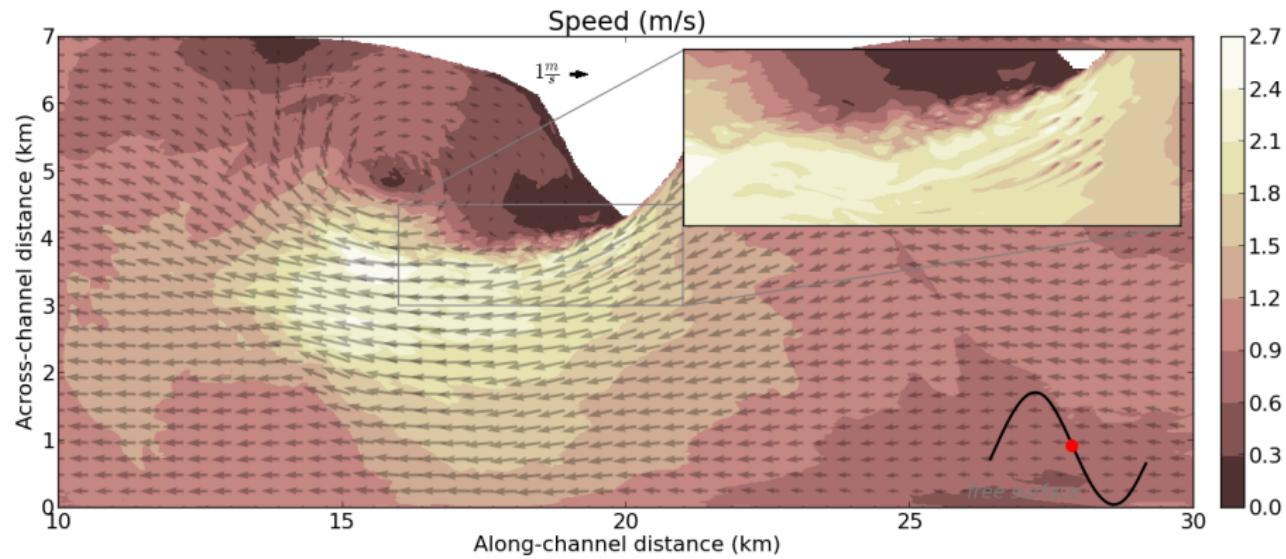


http://matplotlib.org/examples/subplots_axes_and_figures/subplot_demo.html

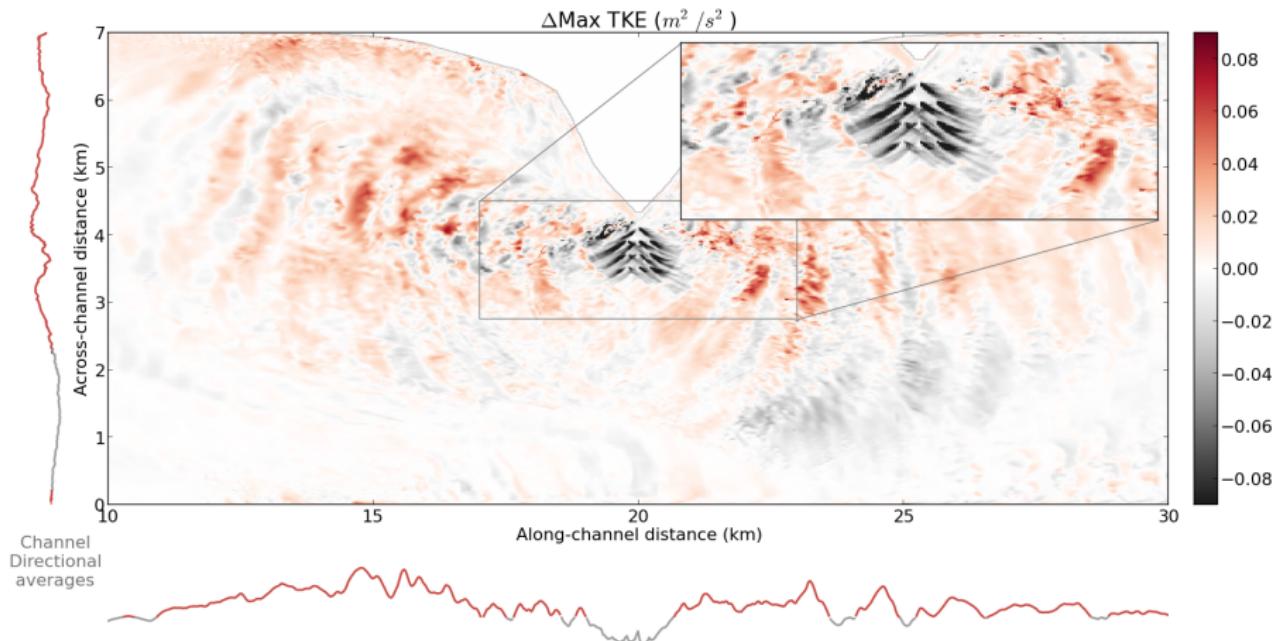
Axes Grid Toolbox



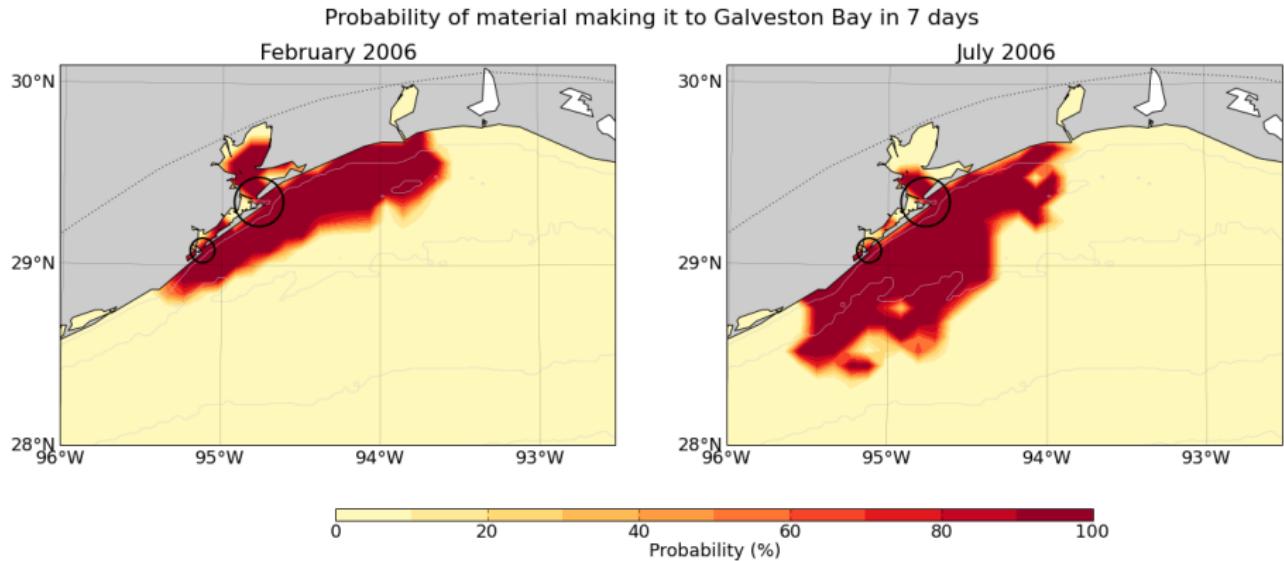
Inset Axes



Overlaid Axes



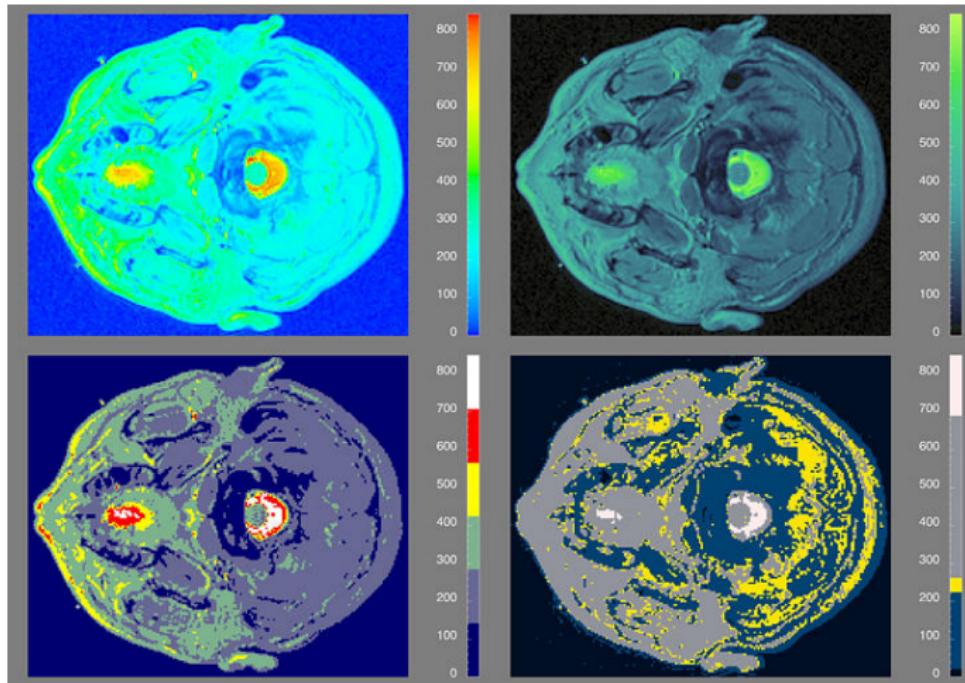
Overlaid Axes: Colorbar Placement



Outline

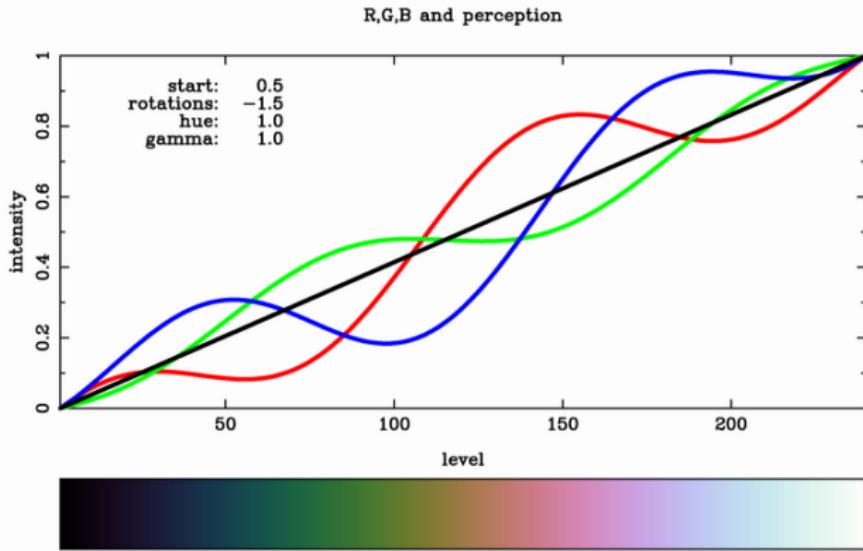
- ➊ Overview of Bad Plotting
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Use Colormaps for Different Purposes



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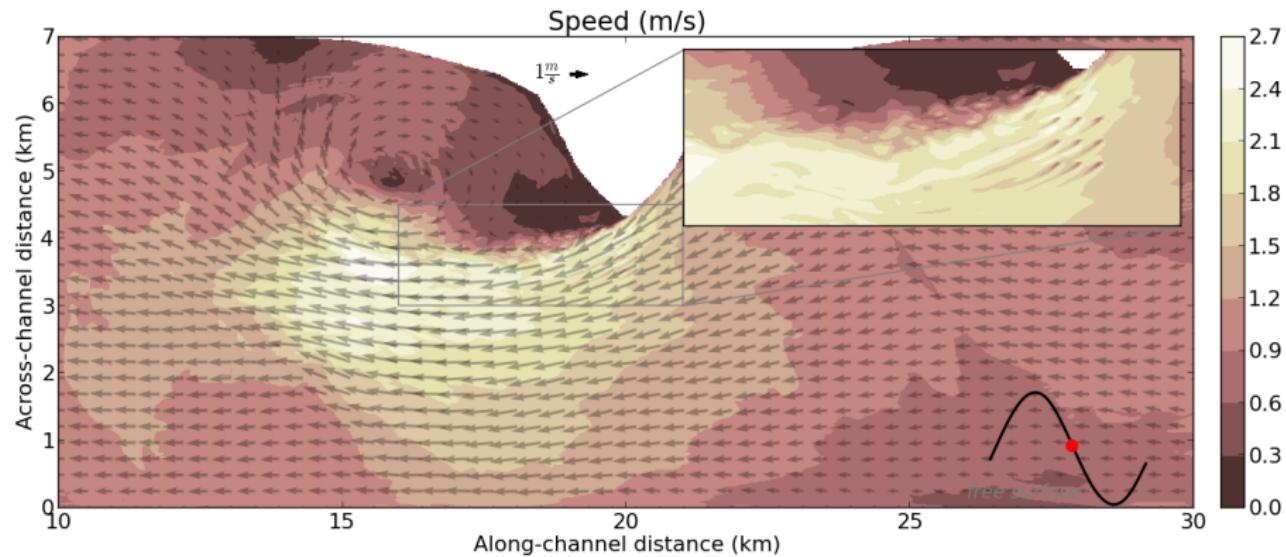
Cube Helix



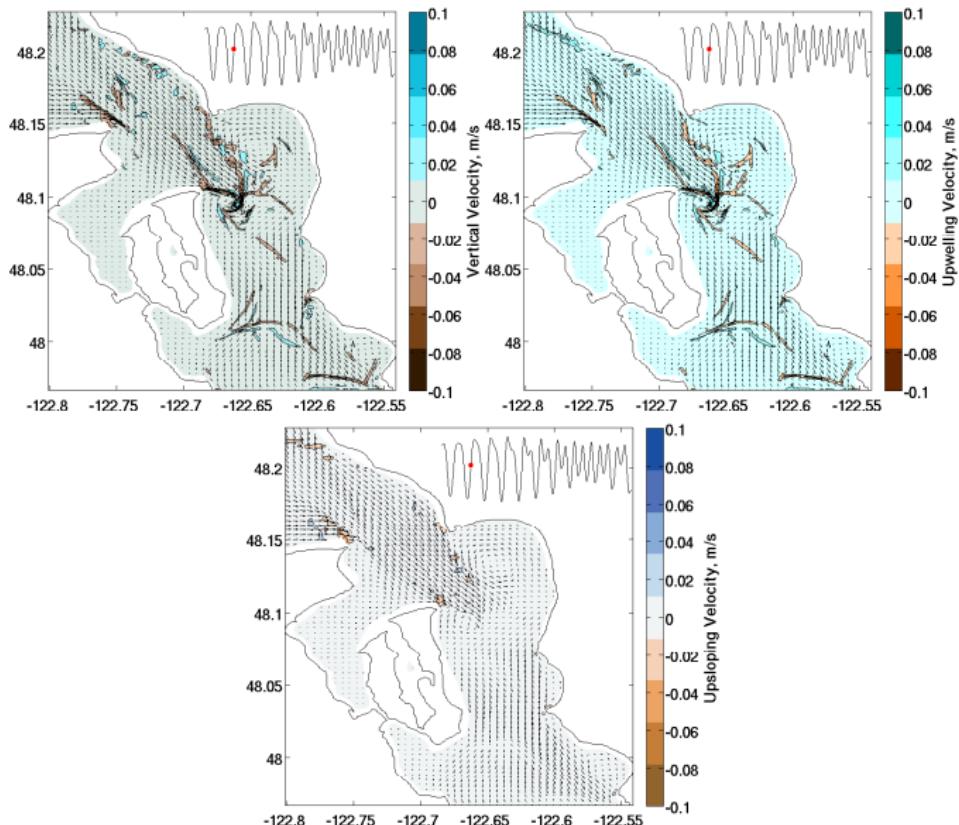
Proper intensity scaling, though do consider application

<http://www.mrao.cam.ac.uk/dag/CUBEHELIX/>

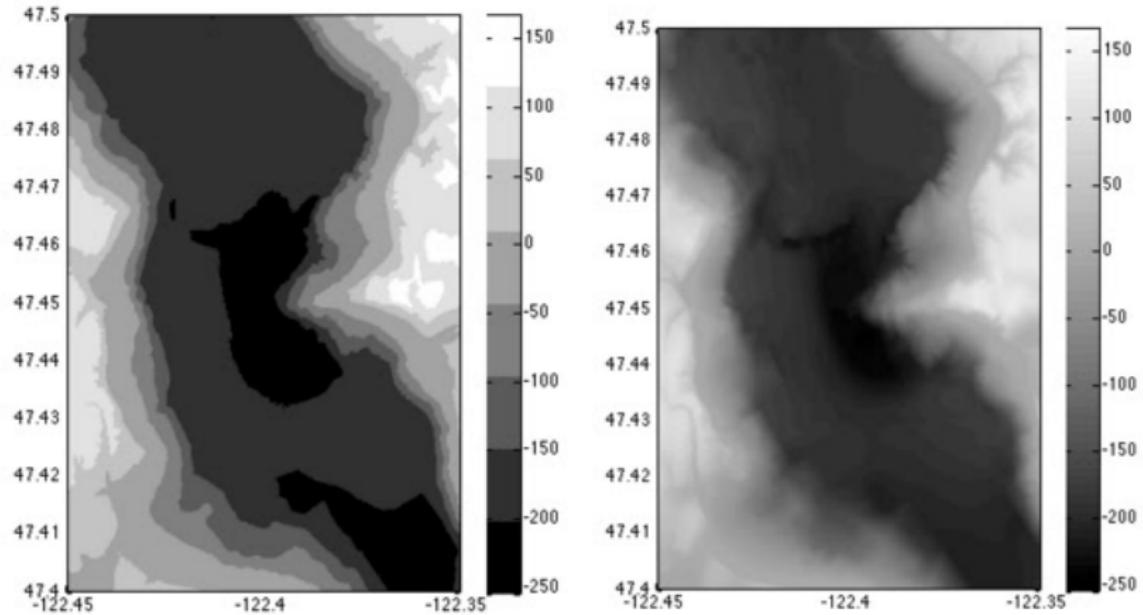
Give Context



Be Consistent

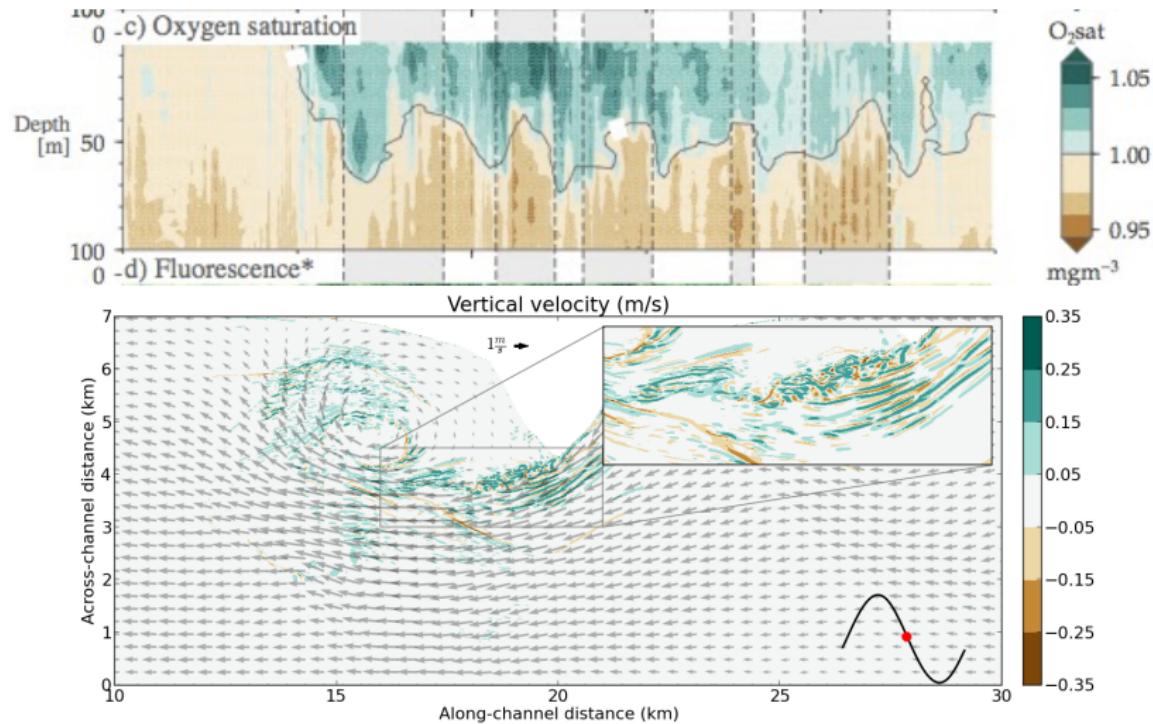


Discrete vs. Continuous Colorbar

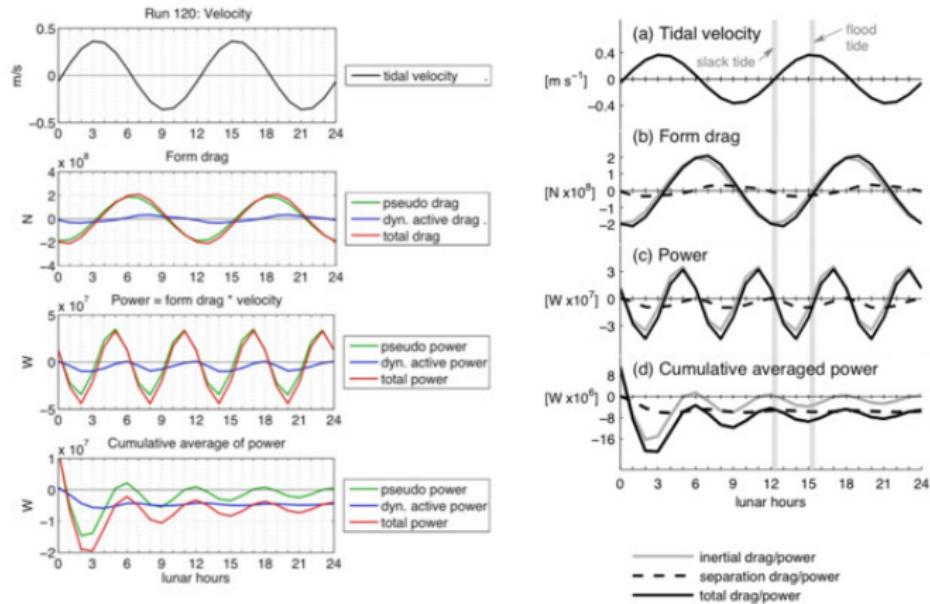


<http://figuredesign.blogspot.com/2012/04/meeting-recap-colors-in-figures.html>

Diverging Colormap: Critical value treatment



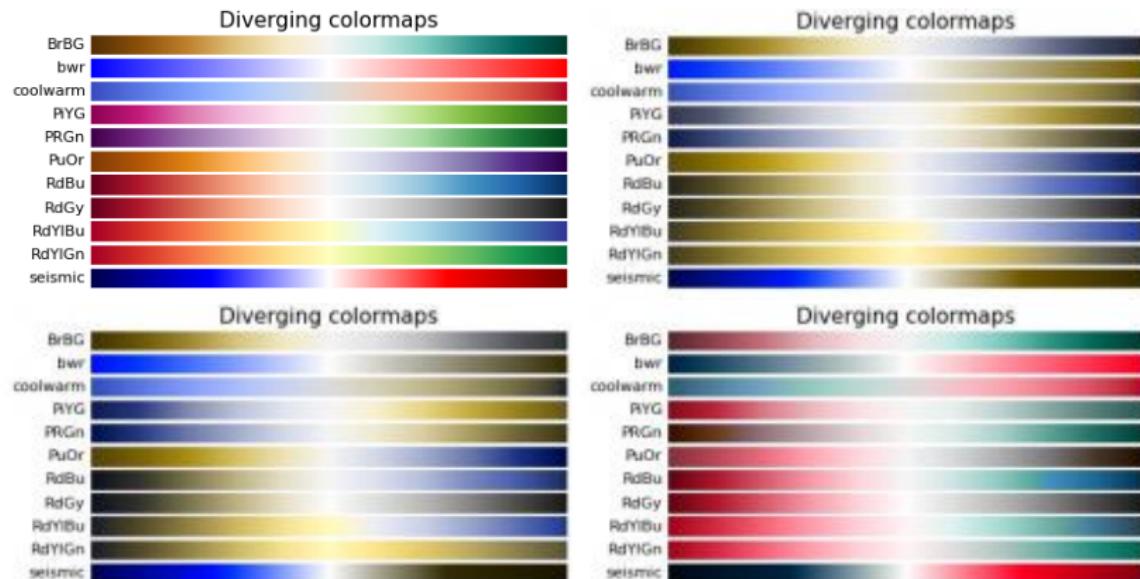
Printing in Black and White from Color



Change the design choices altogether, or be sure the colors will print to different grayscale values

<http://figuredesign.blogspot.com/2012/04/meeting-recap-colors-in-figures.html>

Color Blindness



Problems distinguishing green-yellow-red, and rarely blue-yellow

<http://www.etre.com/tools/colourblindsight/>

Resources

- Edward Tufte's books
- IBM articles:
<http://www.research.ibm.com/people/l/lloydt/color/color.HTM>
- Color Brewer: Color advice for maps: <http://colorbrewer2.org>
- IEEE Computer Society article:
http://www.sv.vt.edu/rkriz/Projects/create_color_table/color_07.pdf
- MatLab colormap function, with lots of references:
<http://www.mathworks.com/matlabcentral/fileexchange/28982-perceptually-improved-colormaps/content/pmkmp.m>
- Cube Helix colormap:
<http://www.mrao.cam.ac.uk/dag/CUBEHELIX/>
- Test plots for sensitivity to color blindness:
<http://www.etre.com/tools/colourblindsight/>
- Matplotlib example gallery: <http://matplotlib.org/gallery.html>
- Useful design blog: <http://figuredesign.blogspot.com>
- Figures writeup:
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