

Visualization of spatiotemporally varying geophysical data with applications for the web

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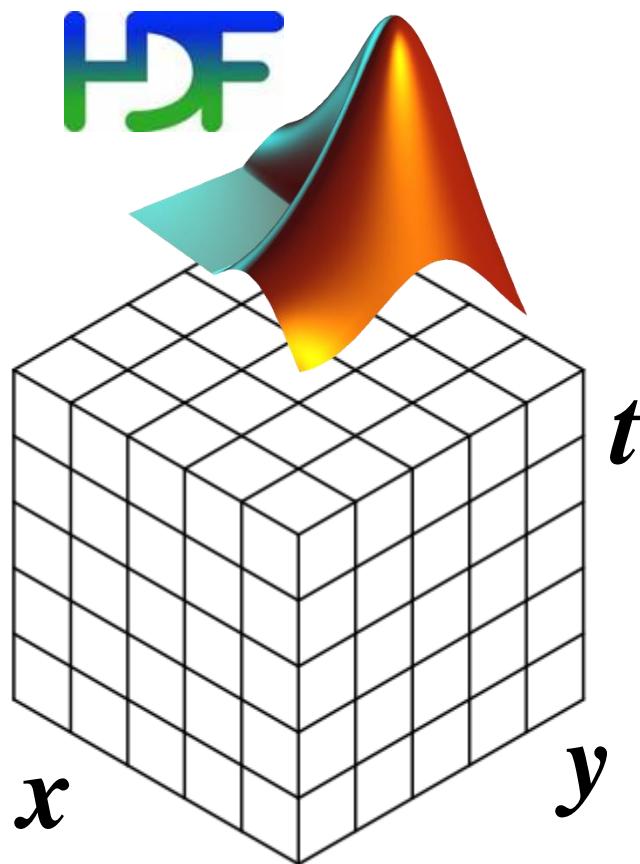
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Ann Arbor, MI

Archive date:
November 5, 2014

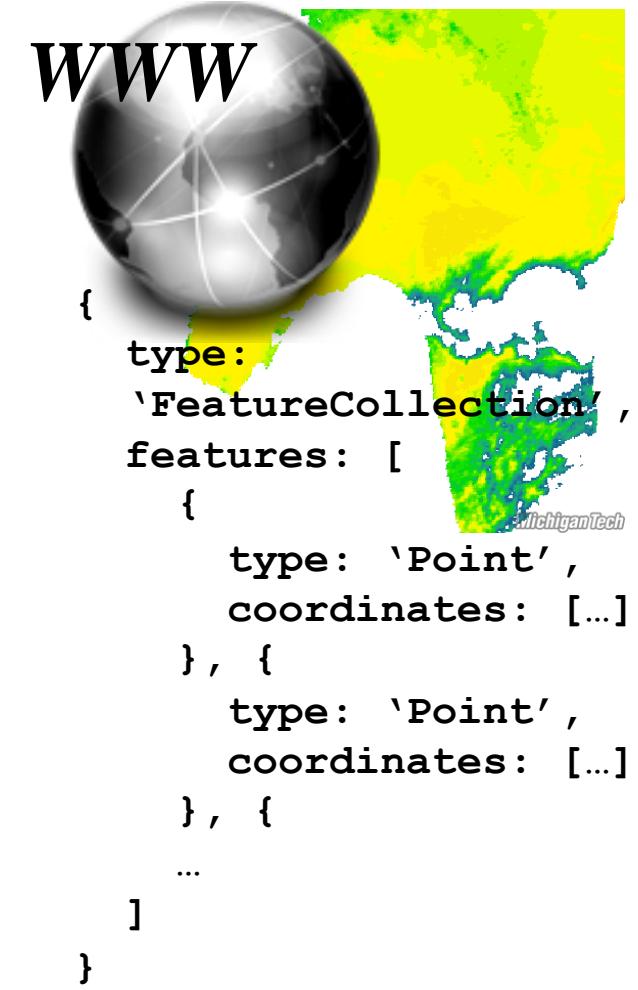
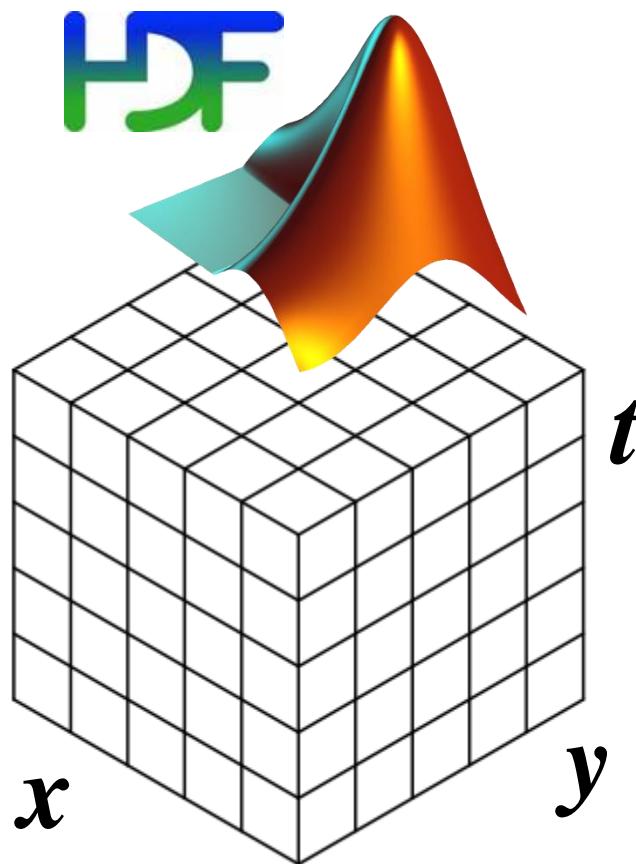


Sci Data Challenge for the Web

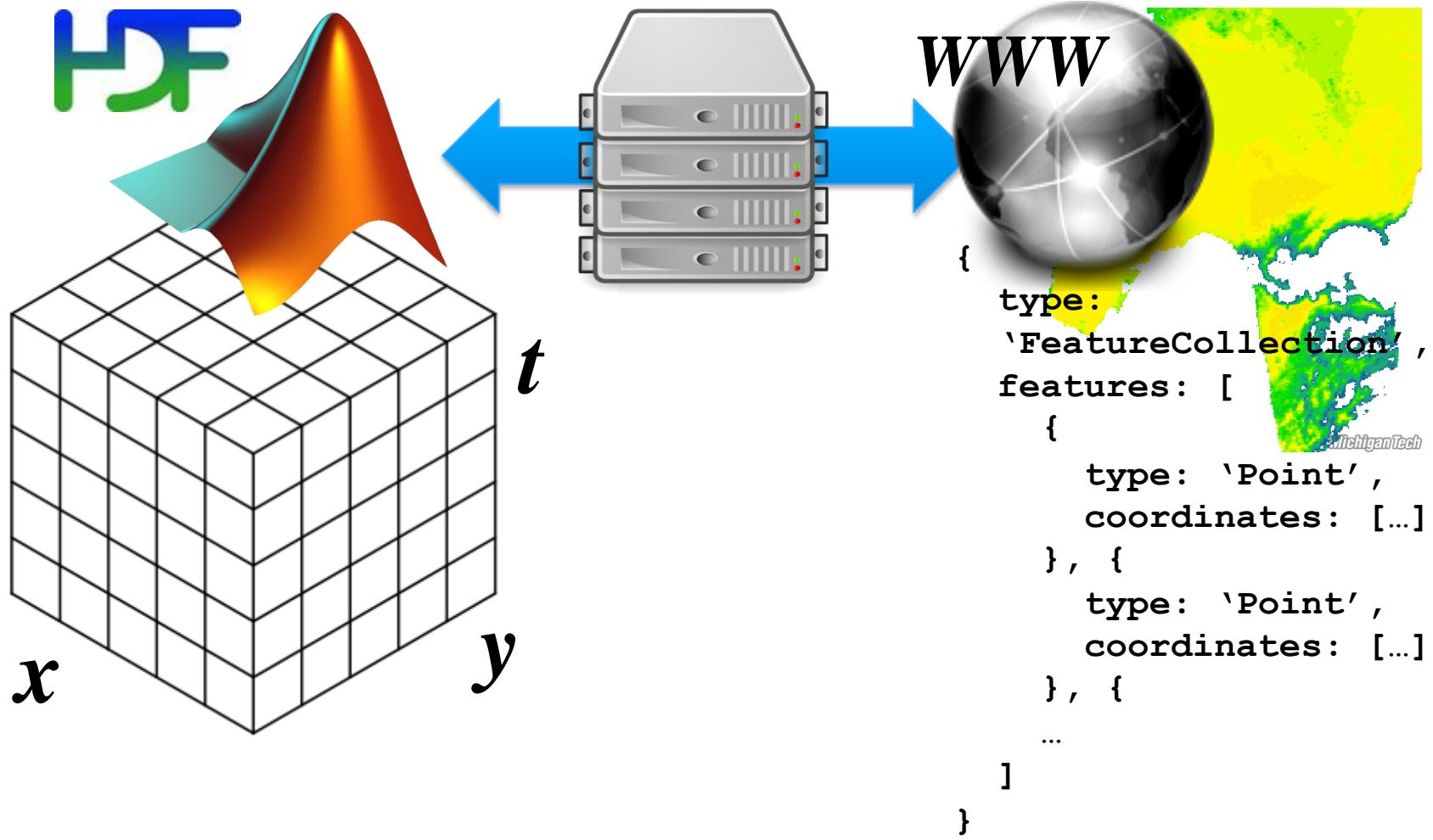




Sci Data Challenge for the Web



Sci Data Challenge for the Web



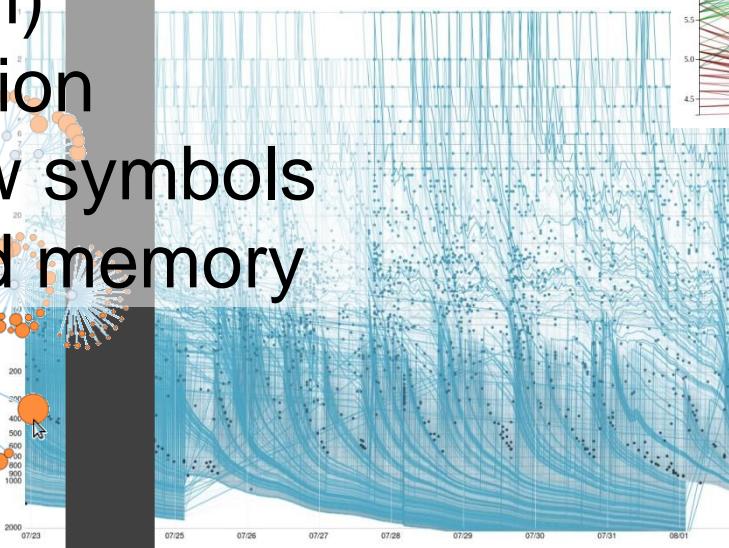
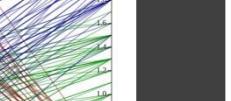
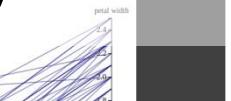
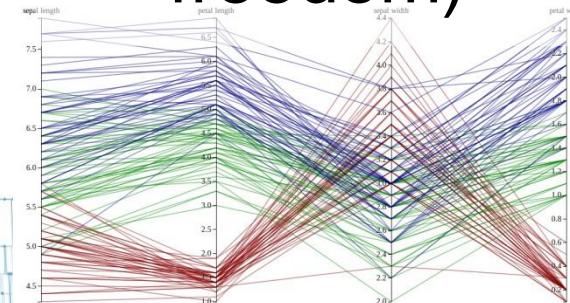
Challenges of Big-*m*, Big-*n* Data

Increasing dimensionality (Big *n*) →

↓ Increasing resolution (Big *m*)

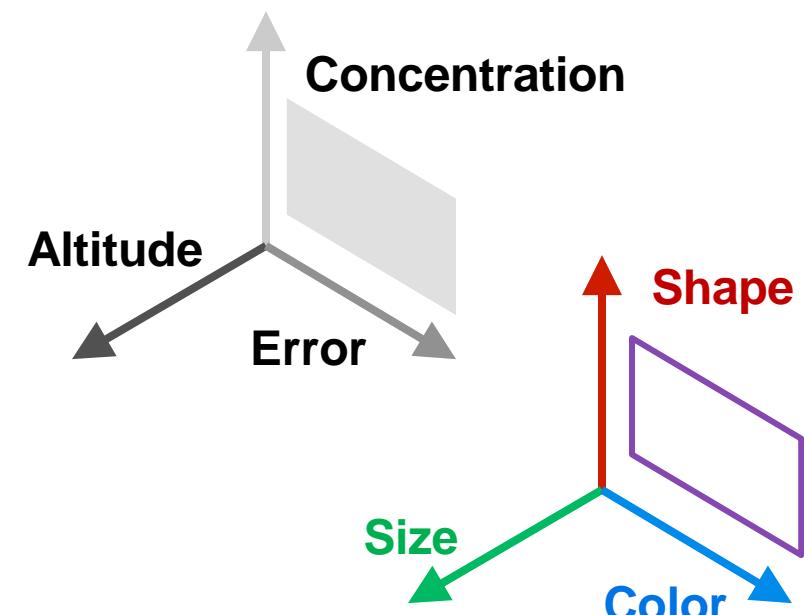
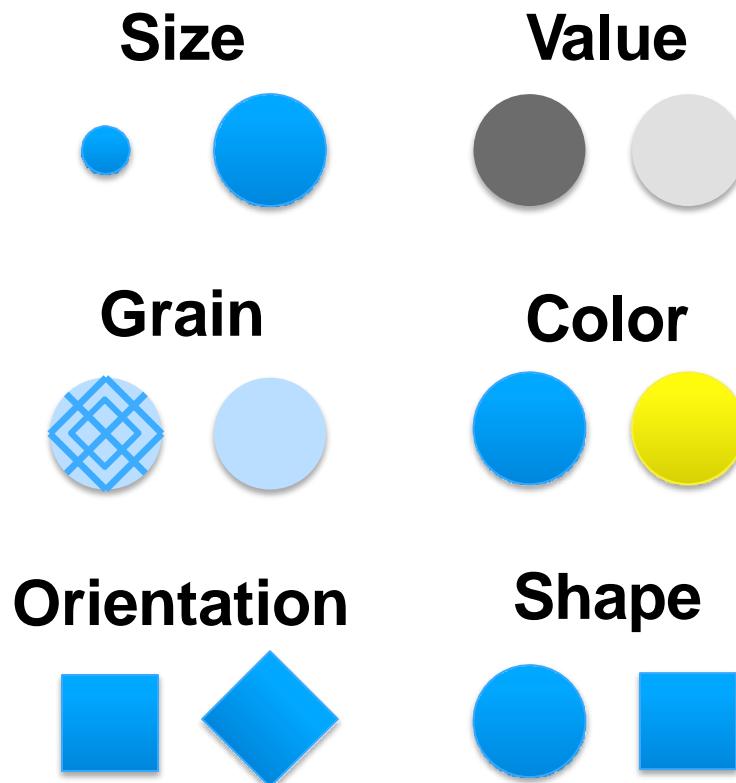
— Too few sense cues (degrees of freedom)

- Limited (screen) resolution
- Too few symbols
- Limited memory



Degrees of Freedom

Bertin's **eight visual variables** (Bertin, 1983),
including Cartesian coordinates

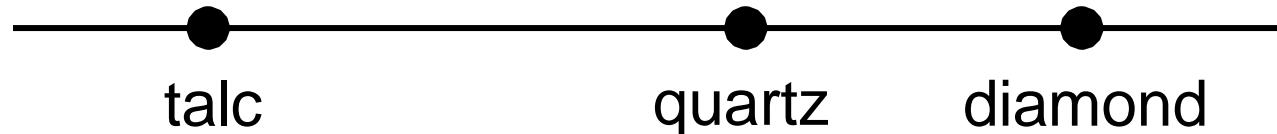


Measurement Scales (Stevens, 1946)

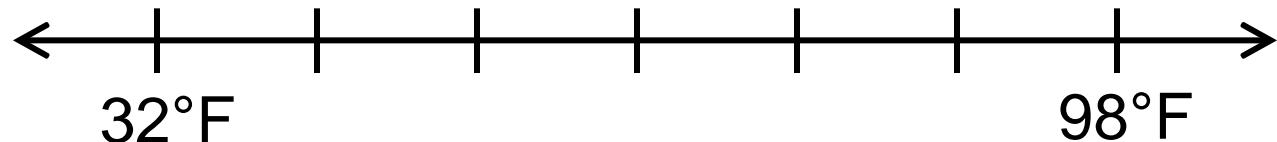
Nominal



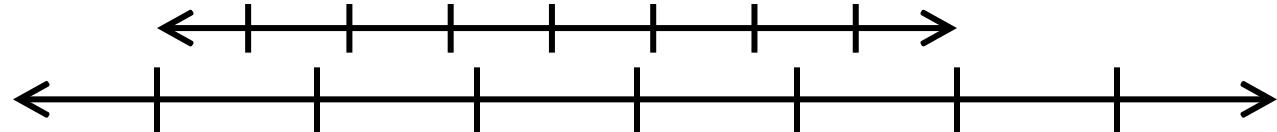
Ordinal



Interval

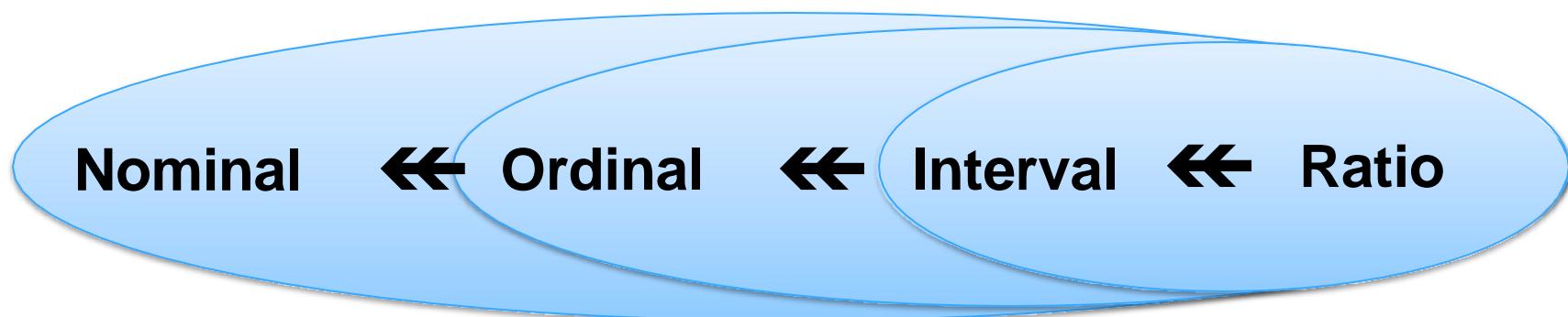


Ratio



Measurement Scales (Stevens, 1946)

	Used for Testing...	Permitted Statistics
Nominal	<i>Equality?</i>	<i>Count, mode</i>
Ordinal	<i>Greater or less?</i>	<i>Median, percentiles</i>
Interval	<i>Equality of intervals?</i>	<i>Mean, std. deviation</i>
Ratio	<i>Equality of ratios?</i>	<i>Coefficient of variation</i>





Focus on Color

Size



Value



Grain



Color



Orientation



Shape

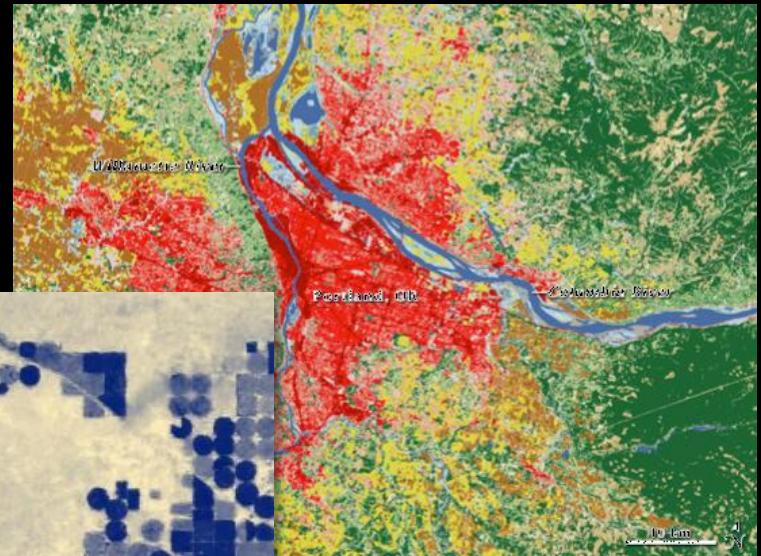


Spatial Visualization Approaches

Ordered Scales



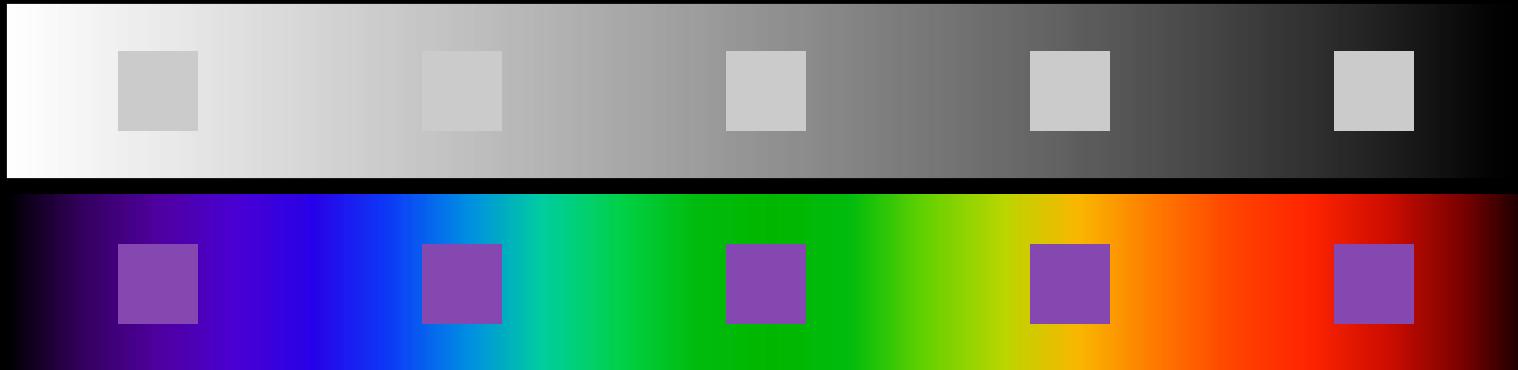
Nominal or
Unordered Scales



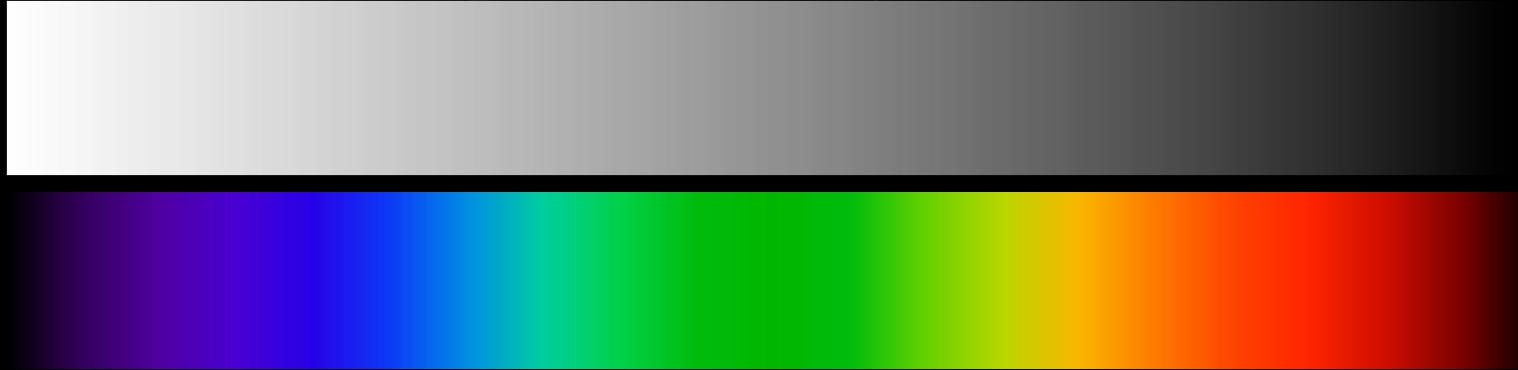
Fine or
Coarse-Scale
Patterns



Simultaneous Contrast (Ware 1988)



(Lack of) Perceptual Linearity



Uncategorized

Why rainbow colors aren't the best option for data visualizations



by [Anna Li](#)

Published Oct. 3, 2013 8:33 am

Updated Oct. 3, 2013 9:03 am

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Data visualizations are beautiful, exciting ways to tell stories. But you have to

Why rainbow colors aren't the best option for data visualizations



by [Anna Li](#)

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Data visualizations are beauti

How The Rainbow Color Map Misleads

JULY 7, 2013 BY ROBERT KOSARA — 24 COMMENTS

Colors are perhaps the visual property that people most often misuse in visualization without being aware of it. Variations of the rainbow colormap are very popular, and at the same time the most problematic and misleading.

The rainbow color map is based on the colors in the light spectrum, and is sometimes done correctly, sometimes the colors are in the wrong order. Quick, name the colors in the rainbow in order! See, that's part of the problem. Even if they were used consistently, nobody would know the right sequence anyway. Here is an image to jog your memory, courtesy of Wikipedia.

Dear NASA: No More Rainbow Color Scales, Please

by [Drew Skau](#) |  2 years ago

FILED UNDER: DESIGN

Dear NASA,

The visualization community has noticed your [insistence on using rainbow color scales](#) for representing continuous data. This is a plea to you (and anyone else doing the same thing) to stop.

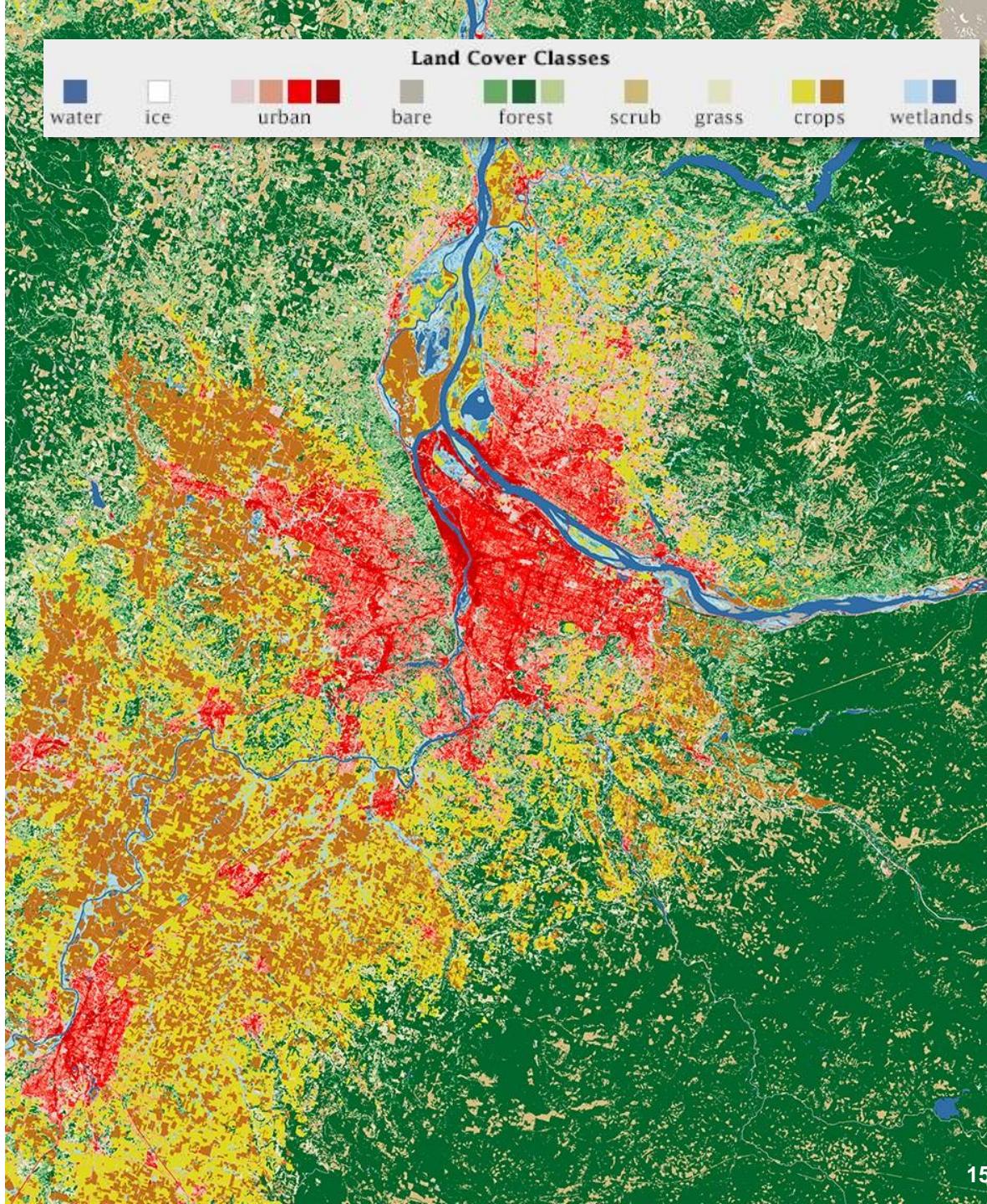
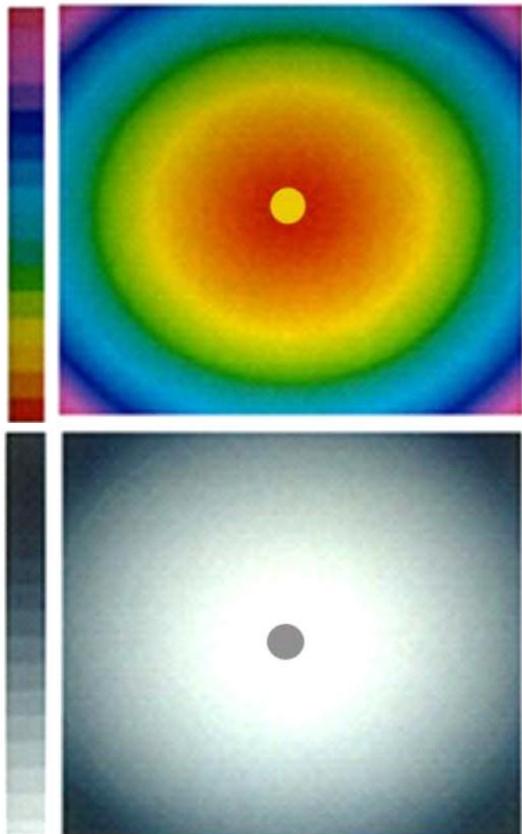
On the surface, the logic behind using a rainbow color scale makes sense: the more colors there are, the easier you would expect it to be to see detail in a huge range of data. However, when perceptual issues are taken into account, rainbow color schemes are one of the worst ways to represent continuous data. There are five main reasons for that:

1. **Colorblind people cannot use them.**

The image below shows simulated views of what someone with Protanopia would see for two different color scales. Clearly, the diverging color scale is better for Protanopes because there

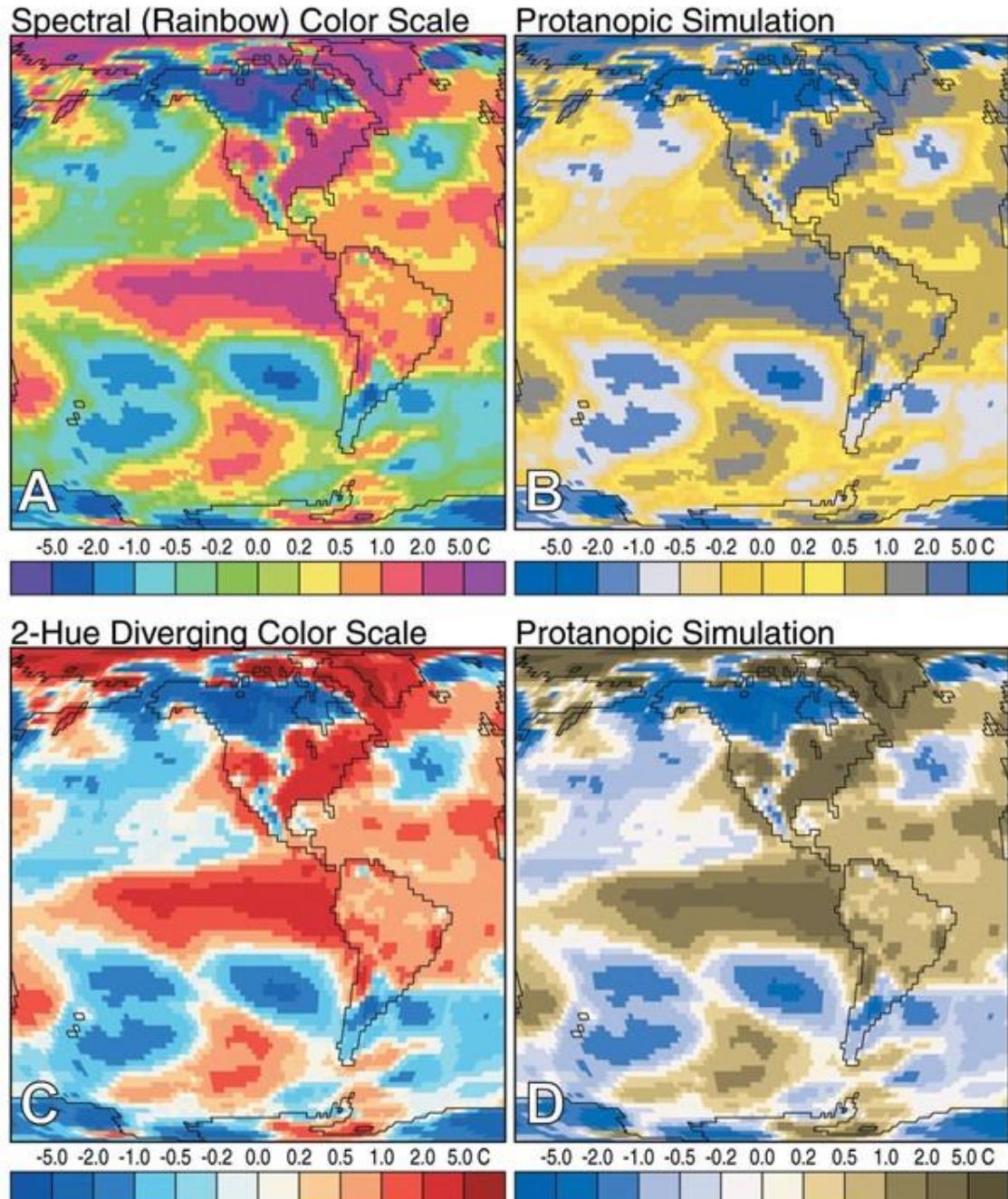
Unordered Color Scales

(Ware 1988)



Ordered Color Scales

- Step changes in brightness, contrast (Ware, 1988)
- Peak in brightness, trough in saturation (Spence et al. 1999)
- Both fine and coarse scales (Rogowitz and Treinish, 1995)



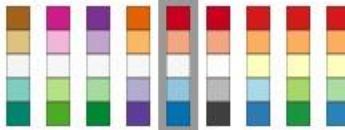


Choosing Colors: ColorBrewer2.org

Number of data classes: 5 i

Nature of your data: i
 sequential diverging qualitative

Pick a color scheme:



Only show: i
 colorblind safe
 print friendly
 photocopy safe

Context: i
 roads
 cities
 borders

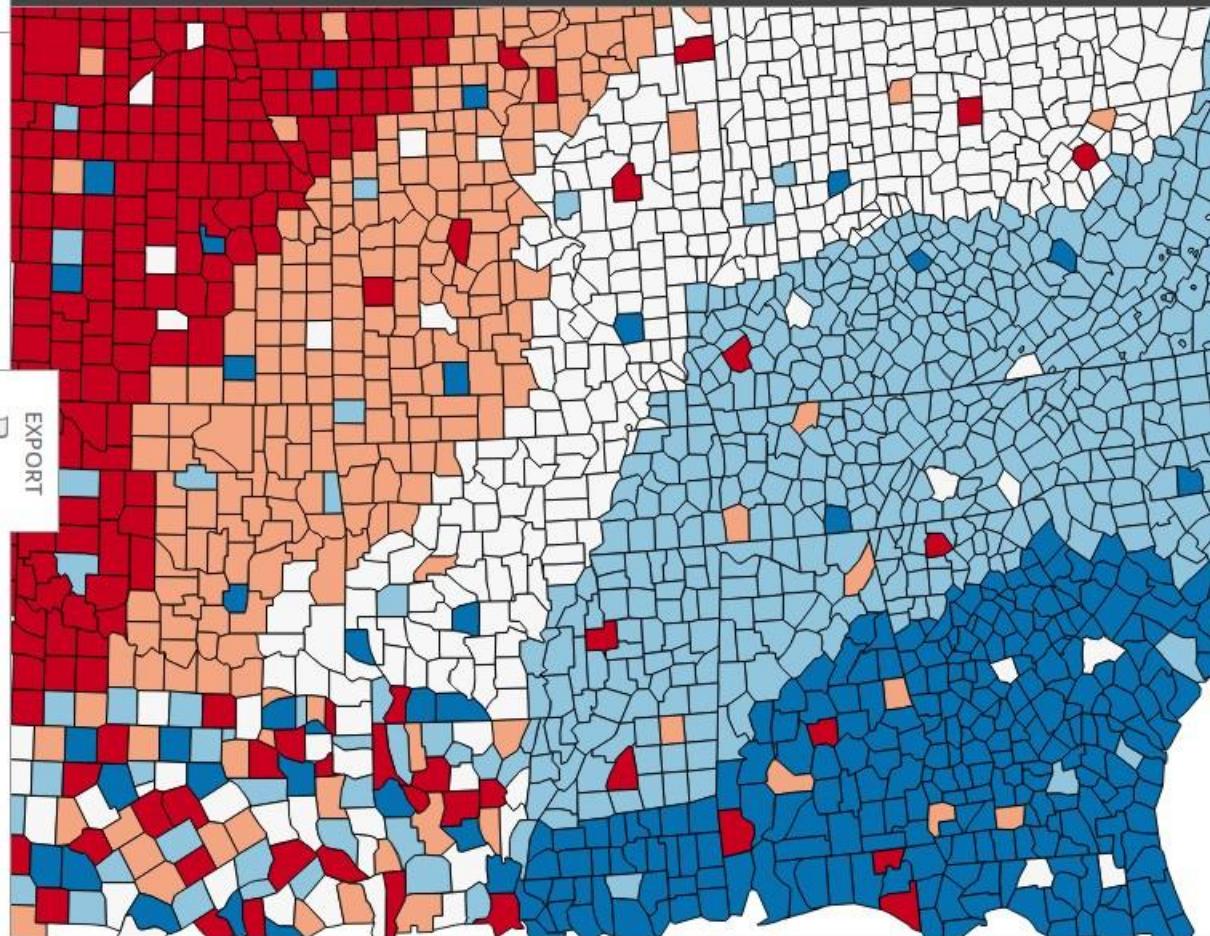
Background: i
 solid color terrain

color transparency

how to use | updates | downloads | credits

COLORBREWER 2.0
color advice for cartography

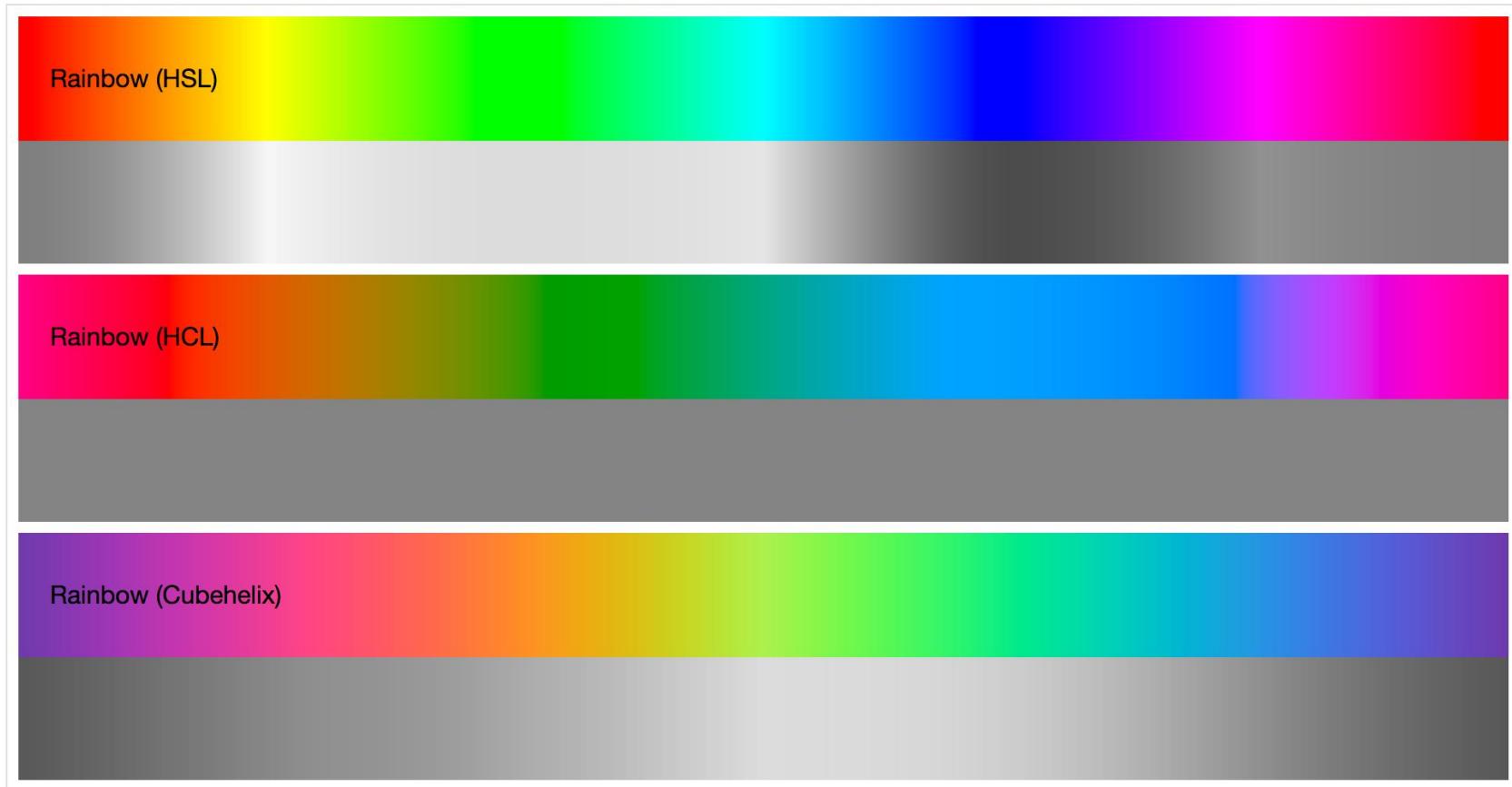
5-class RdBu



EXPORT

Color Class	Hex Code
Red	#ca0020
Orange	#f4a582
Yellow	#f7f7f7
Green	#92c5de
Blue	#0571b0

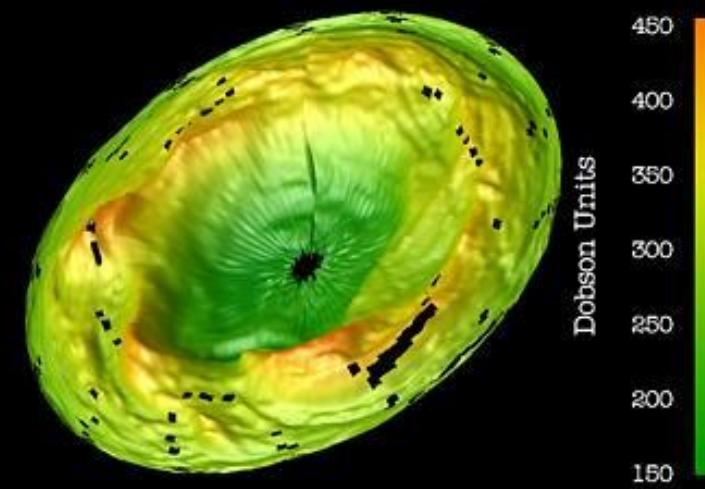
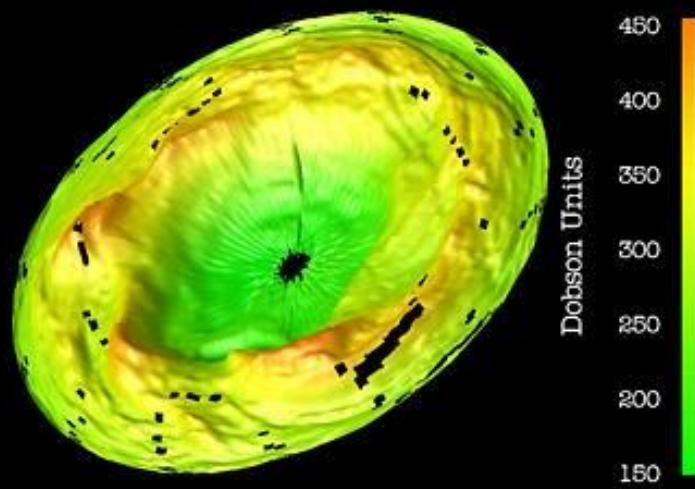
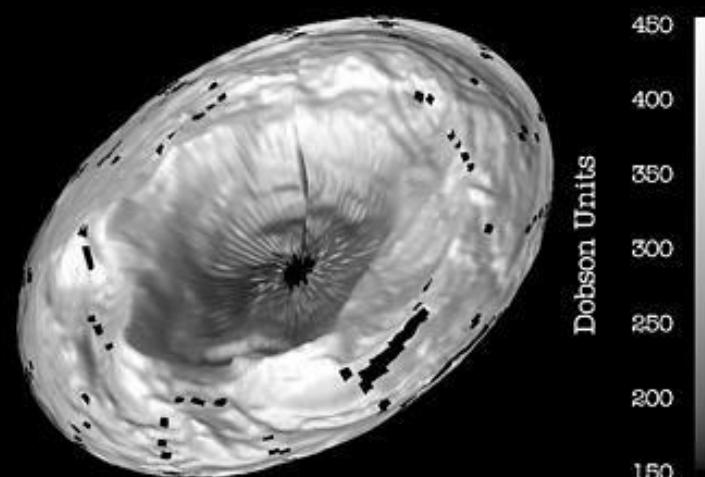
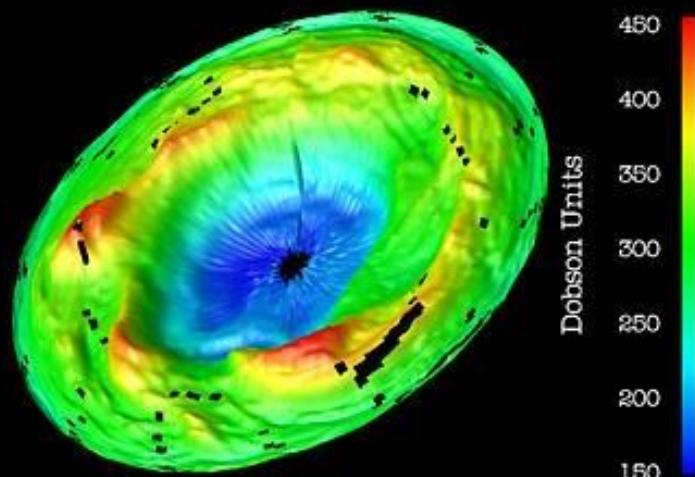
A Less-Angry Rainbow



Experimenting with a rainbow color scale that is cyclical but has better perceptual properties. The HCL rainbow has roughly-constant luminance, but is ugly. The cubehelix rainbow, inspired by Matteo Niccoli's [perceptual rainbow](#) but extended to 360°, varies in brightness but is prettier.

[Open in a new window.](#)

Fine or Coarse Spatial Scales



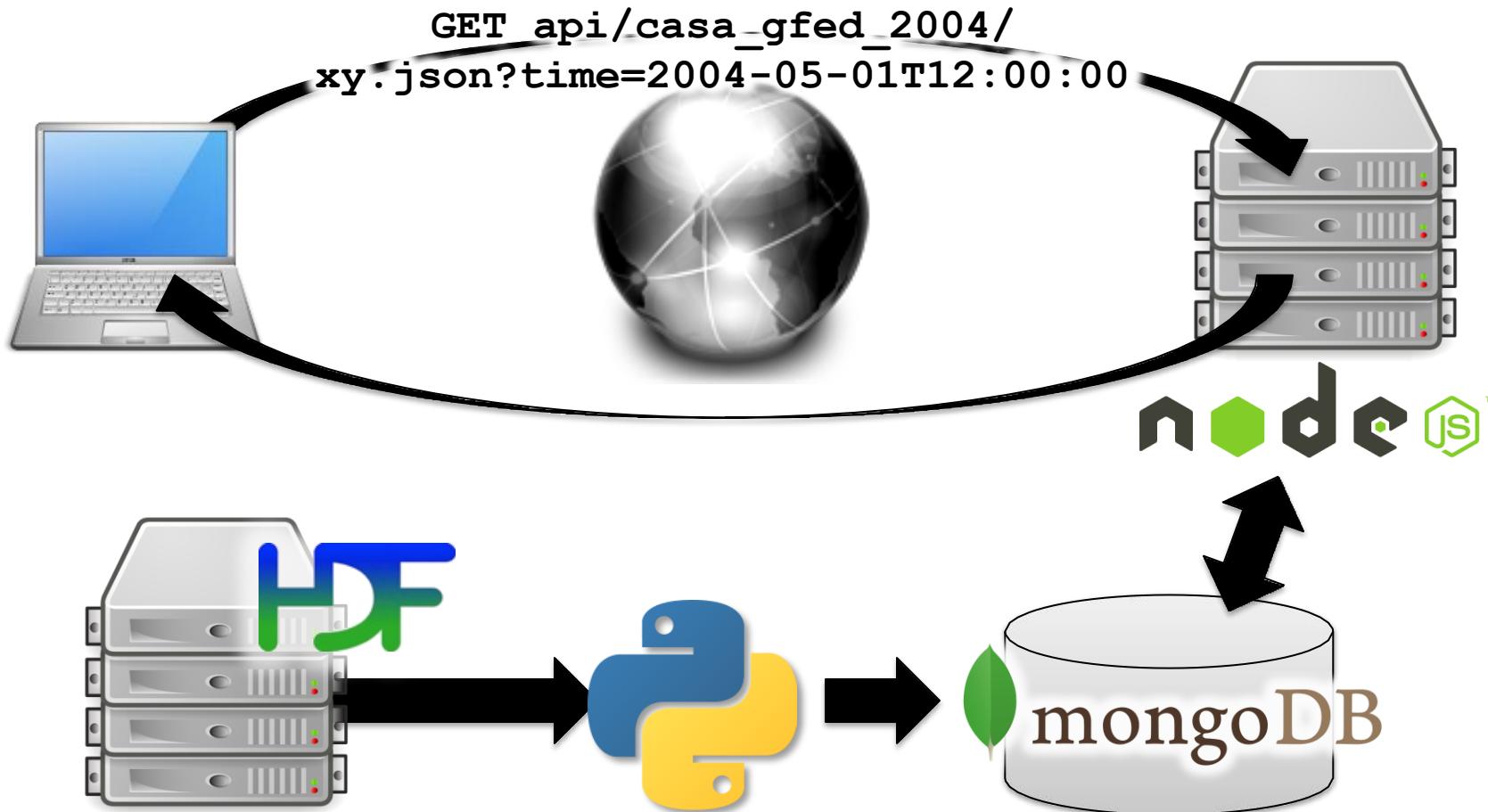
Courtesy of: Rogowitz and Treinish (1995) and NASA GSFC

Pre-Investigation Questions

- What kind of analysis do you need to perform (e.g. Ordering your data? Comparing measurements? Find the “average” behavior?)
- Does quantity Y vary [linearly logarithmically, exponentially] with quantity X?
- Is the mean/ median or zero meaningful? Do you need to include it within your scale?
- What are outliers in your data? How will you identify; how will you represent them?



Software Architecture





The Carbon Data Web API

Request a map of (C flux, XCO₂, etc...) at a given time:

xy.json?time=2004-05-01T03:00:00

Request map of net C aggregated over a range of time:

**xy.json?start=2004-01-01&end=2004-01-31
&aggregate=net**

Request a time series of C at or near a given point:

t.json?coords=POINT (-50.5+69.5)

Request an aggregated time series; Net daily C across the North American continent:

**t.json?roi=continent&aggregate=net
&interval=daily**



The Carbon Data Web API

Request time series of mean daily C at certain model point:

**t.json?geom=POINT (-50.5 69.5) &aggregate=mean
&interval=daily**

Request uncertainty data as a map; The covariances with respect to a certain point in the model:

**uncertainty.json?time=2004-05
&covarianceAt=POINT (-50.5 69.5)**

Request uncertainty data as a time series; The covariance between two points in the model over a month:

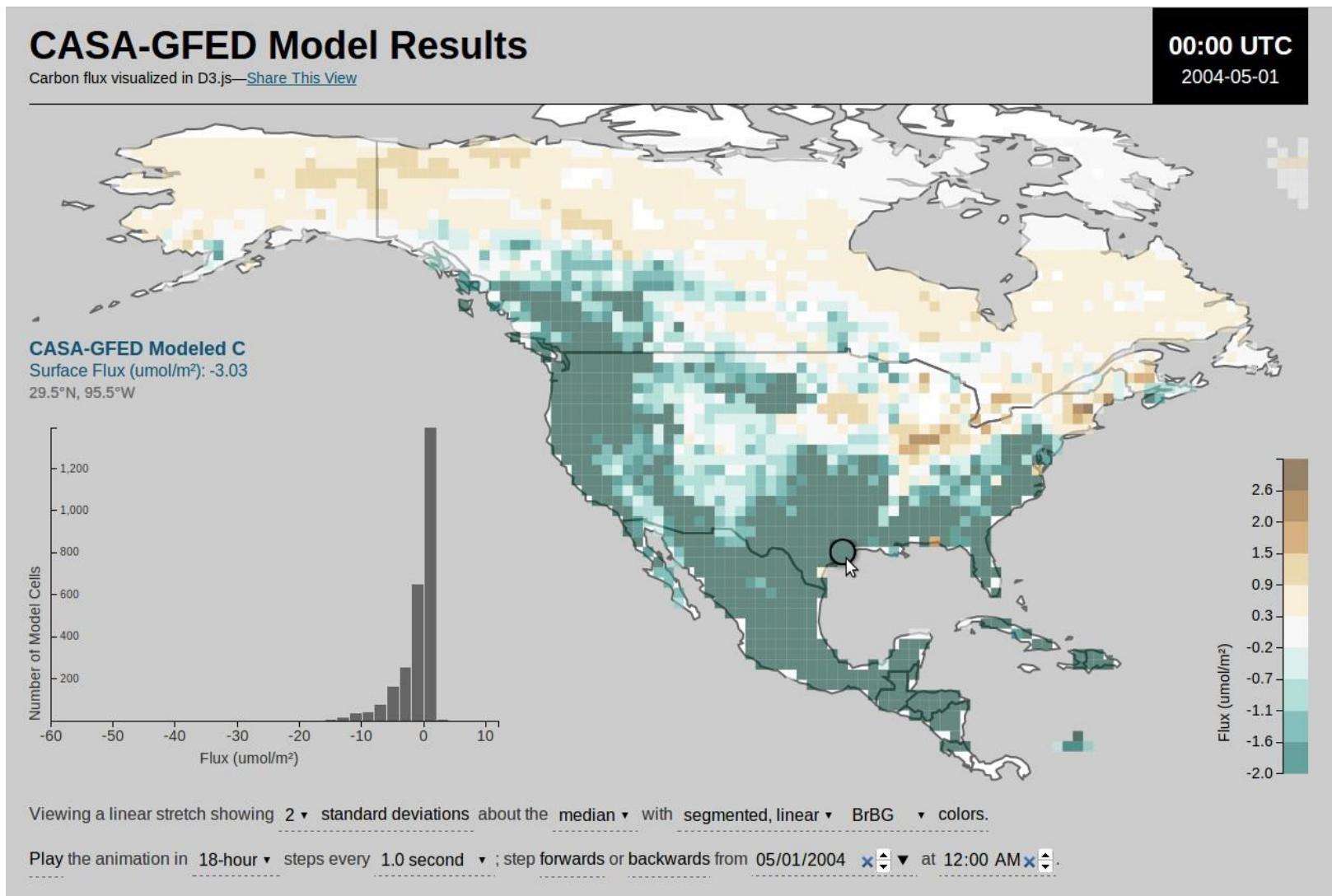
**uncertainty.json?start=2004-05&end=2004-06
&source=POINT (-50.5 69.5)
&target=POINT (-45.5 69.5)**

- 1) <http://spatial.mtri.org/flux/map.html>
- 2) <http://spatial.mtri.org/flux/us-states-breathing.html>
- 3) [ftp://ftp.mtri.org/pub/
2014_01_Endsley_OCO-2_Pasadena_Example.kmz](ftp://ftp.mtri.org/pub/2014_01_Endsley_OCO-2_Pasadena_Example.kmz)
- 4) <http://spatial.mtri.org/flux/xco2.html>

DEMOS



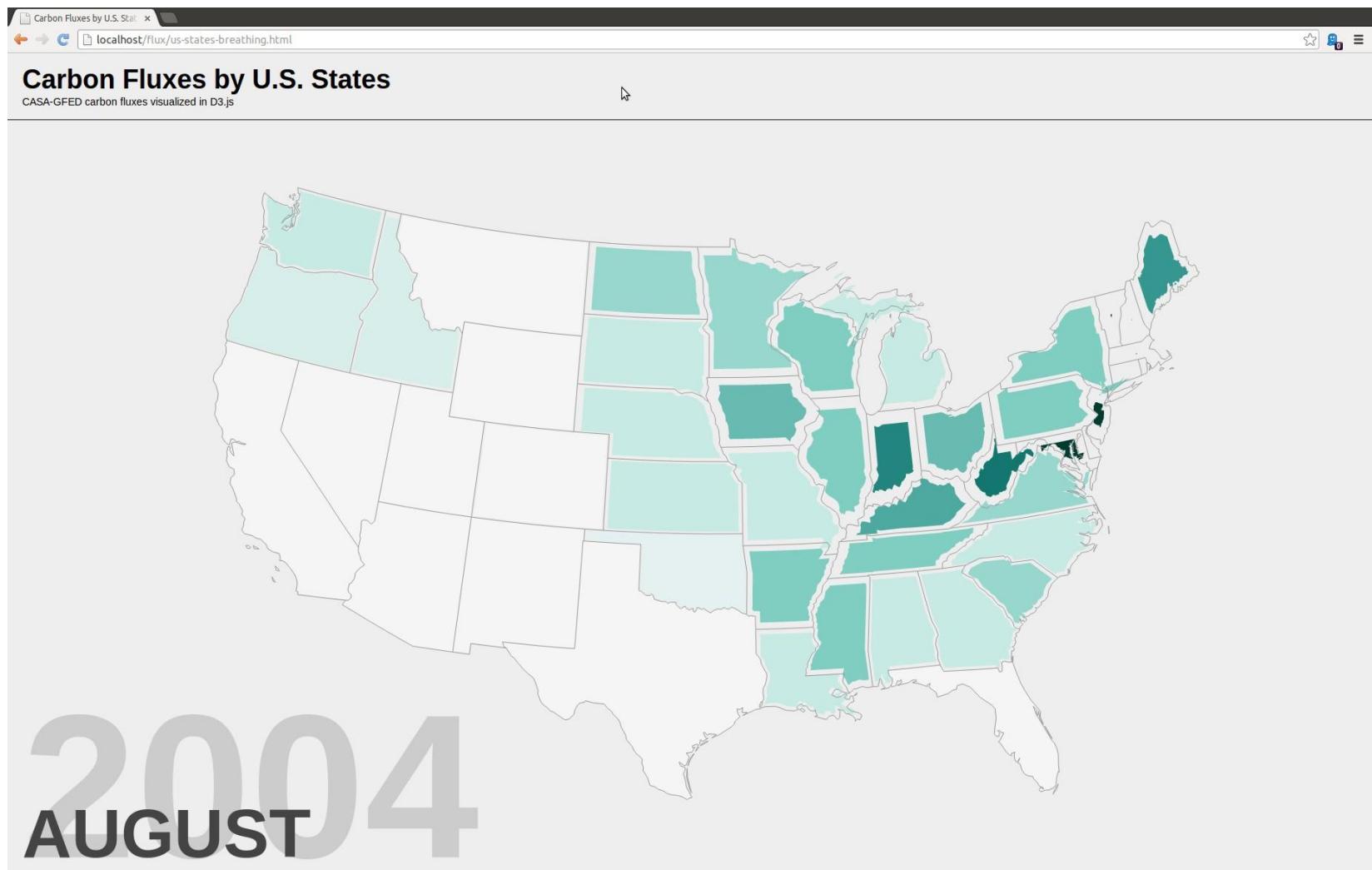
Web-Based GIS for C Flux





MichiganTech
Research Institute

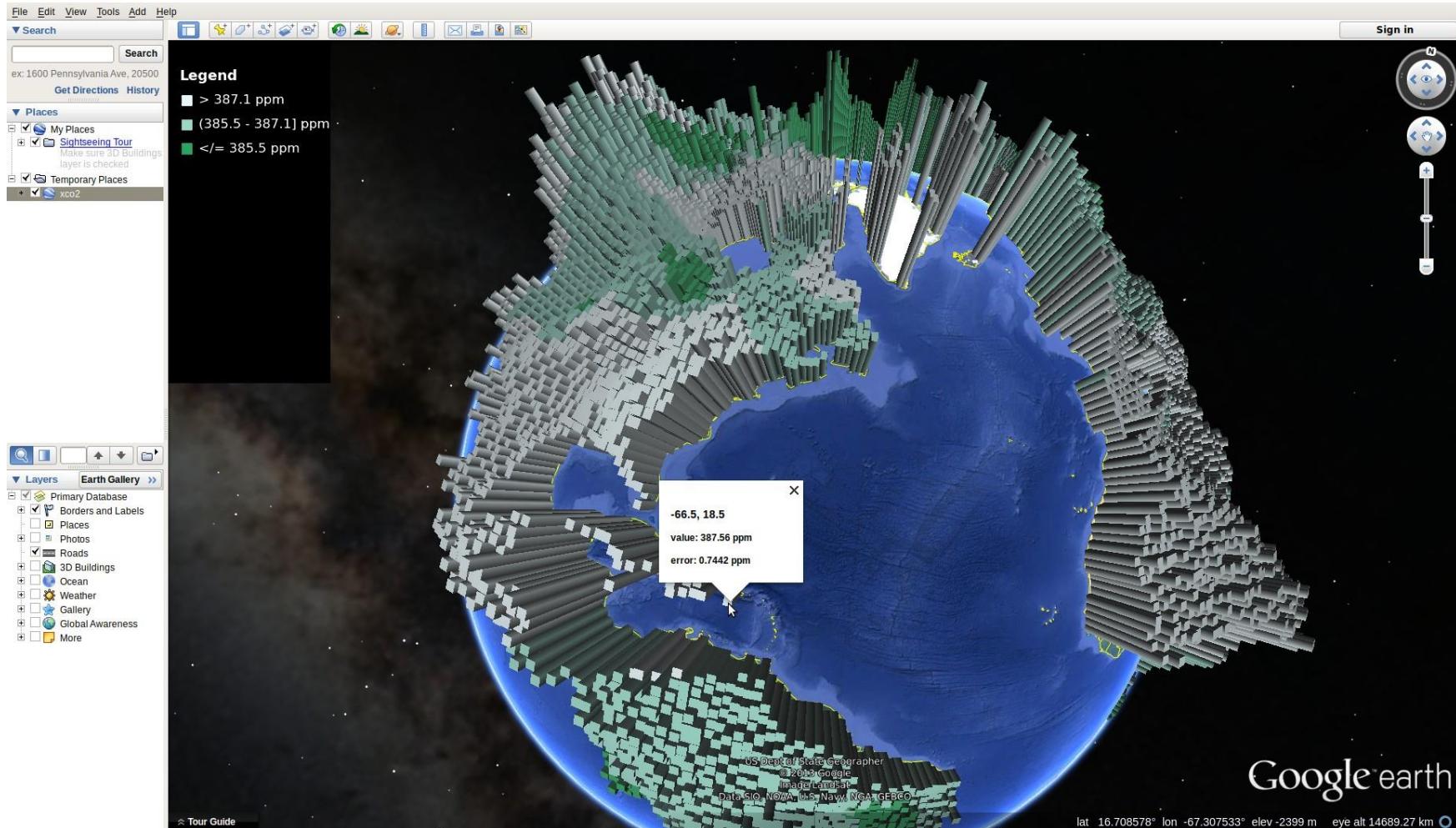
Aggregate C Flux Time Series





MichiganTech
Research Institute

KML and Google Earth

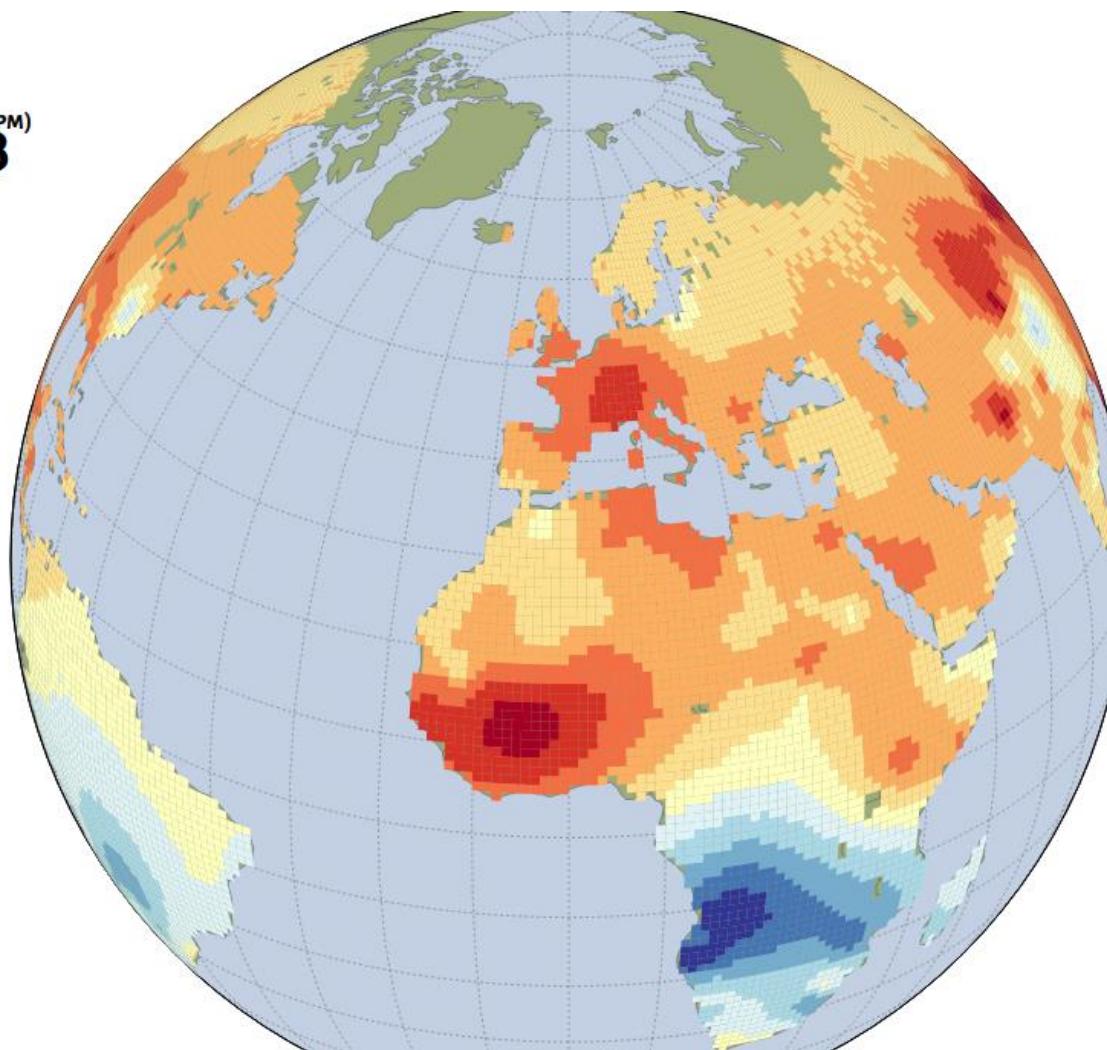


Google earth



Virtual Globe in a Web Browser

XCO₂ CONCENTRATION (PPM)
395.16688



Next Steps: 3D in the Browser

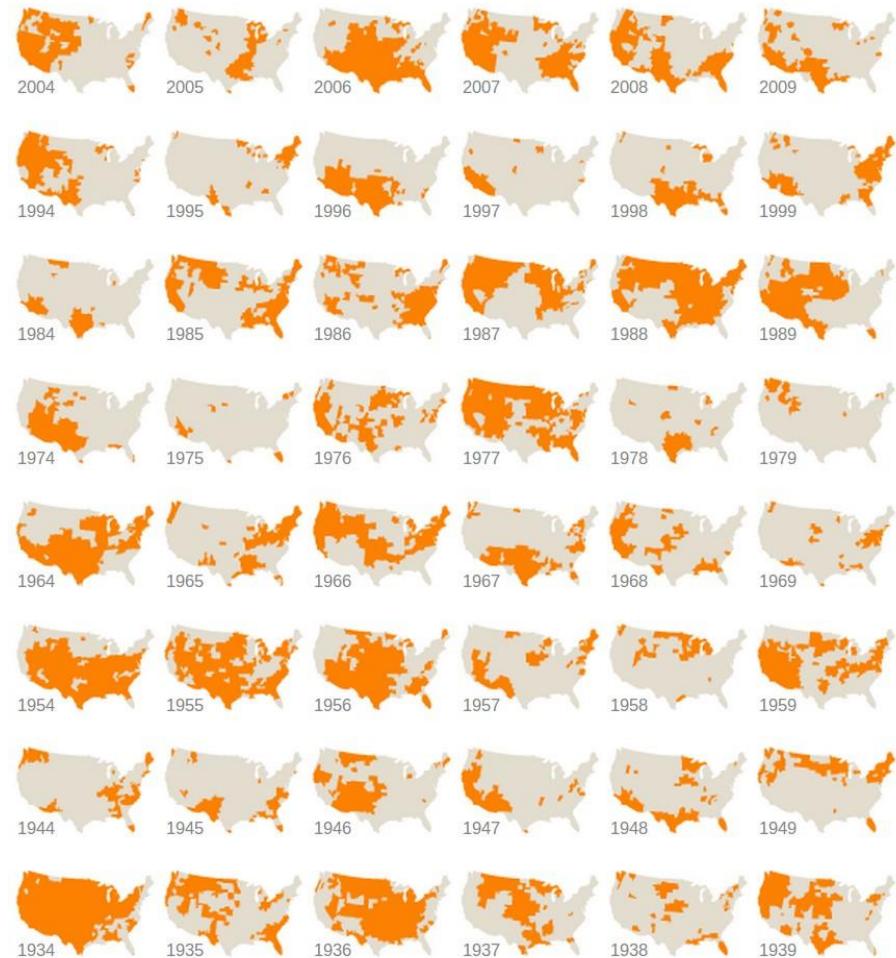
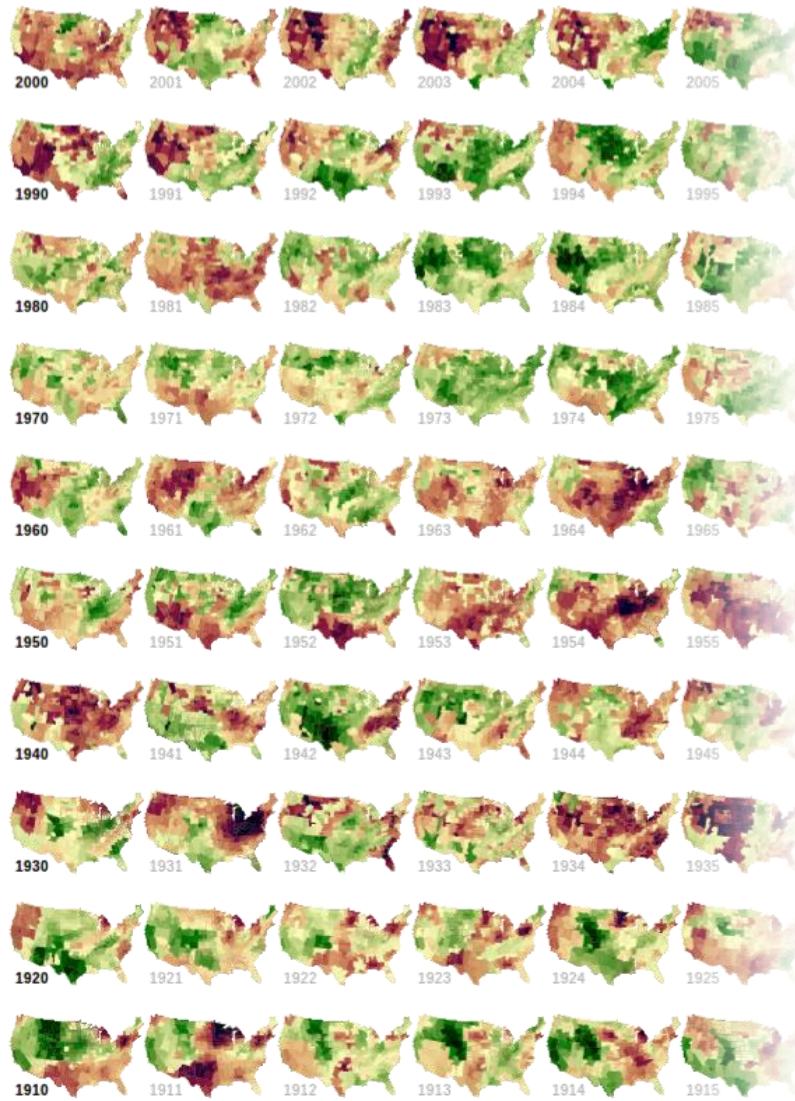
World Population

1990 1995 2000



[Google Data Arts Team](#)

Next Steps: Multiplots



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