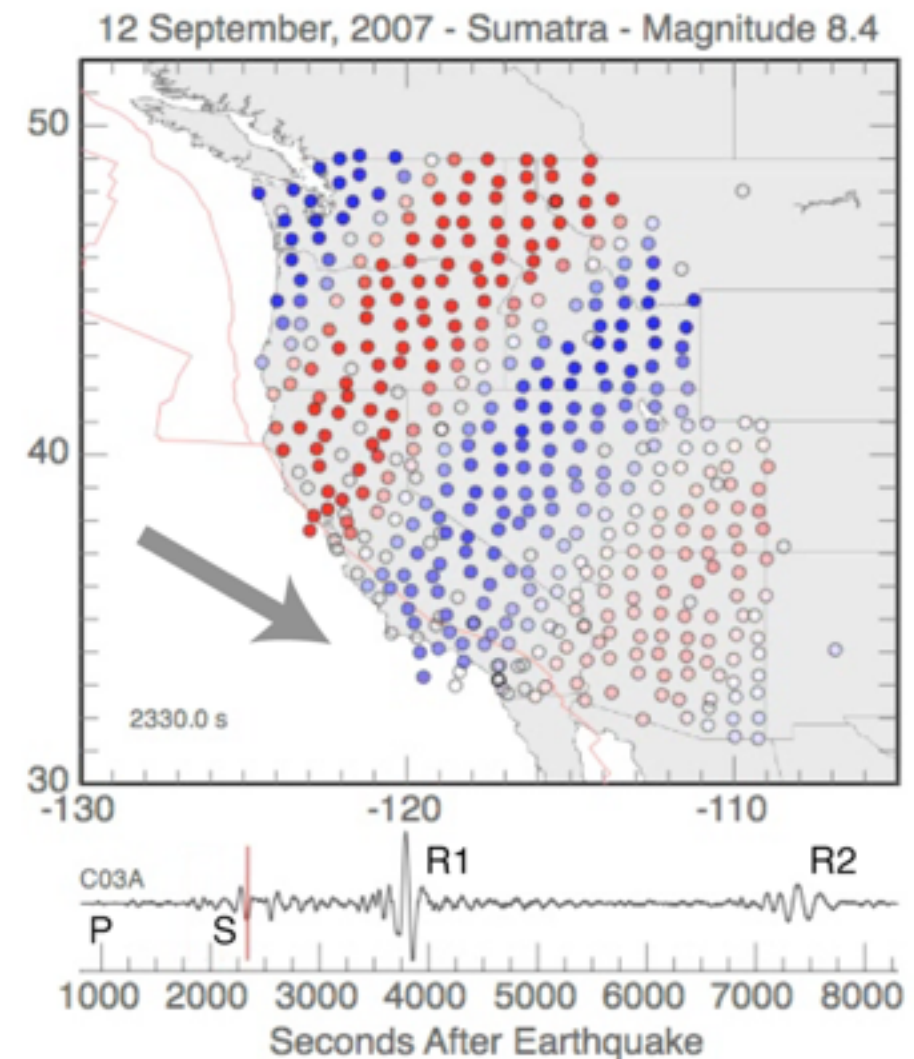


# An Introduction to Scientific Visualization

## EarthScope Data Processing Workshop



# Scientific Visualization

- An Introduction to Data Visualization
- Discussion - Color
- Simple Animations (MATLAB) (2D)
- Ground Motion Videos (Danielle)
- 3D Visualization with Paraview (Gary)

# Scientific Visualization

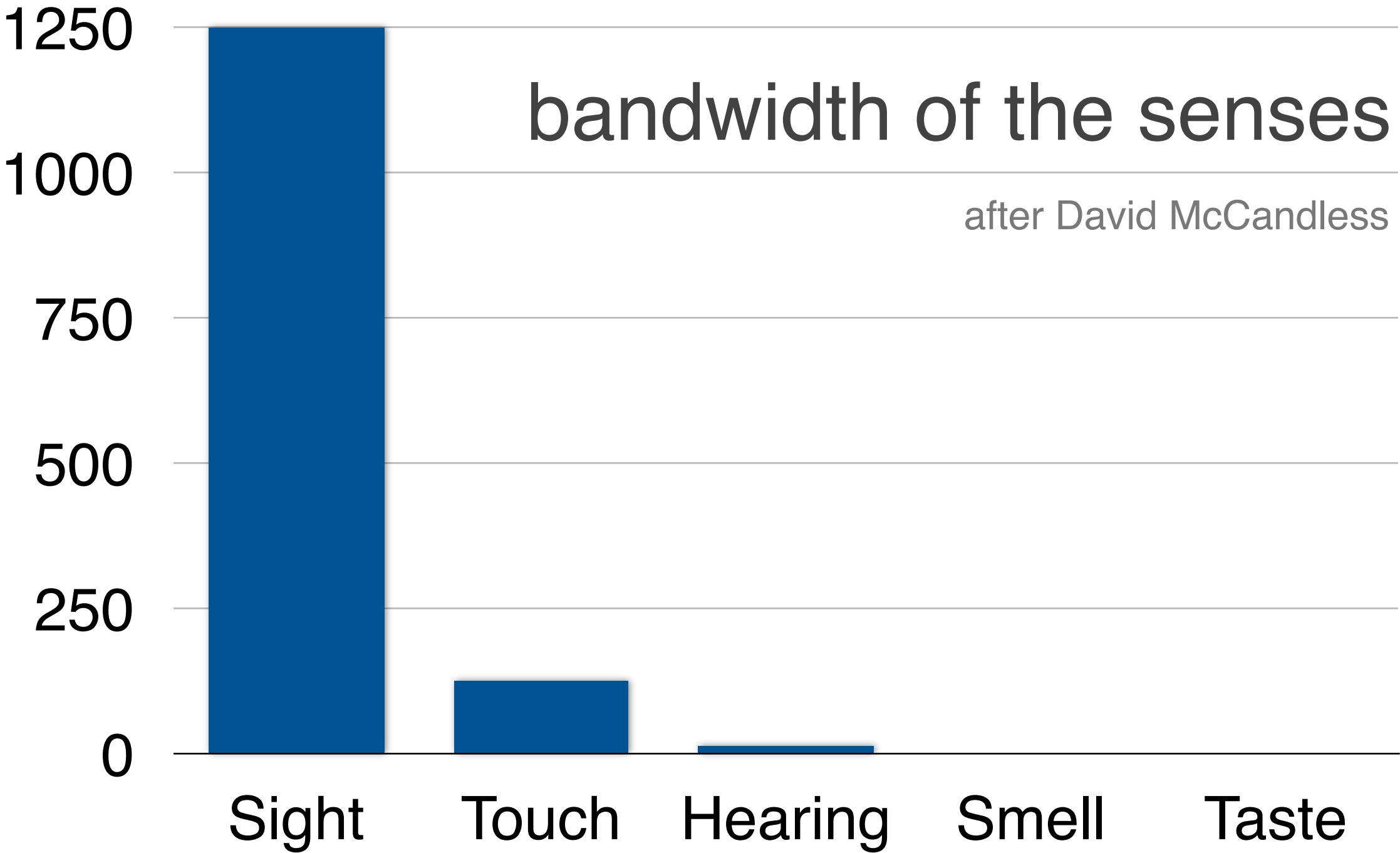
**Exploratory** - you are the audience and you experiment with views of your data to develop insight; to learn the story the data tell.

**Explanatory** - you know the story, you are trying to communicate that story to inform an audience.

# bandwidth of the senses

after David McCandless

Mb/s

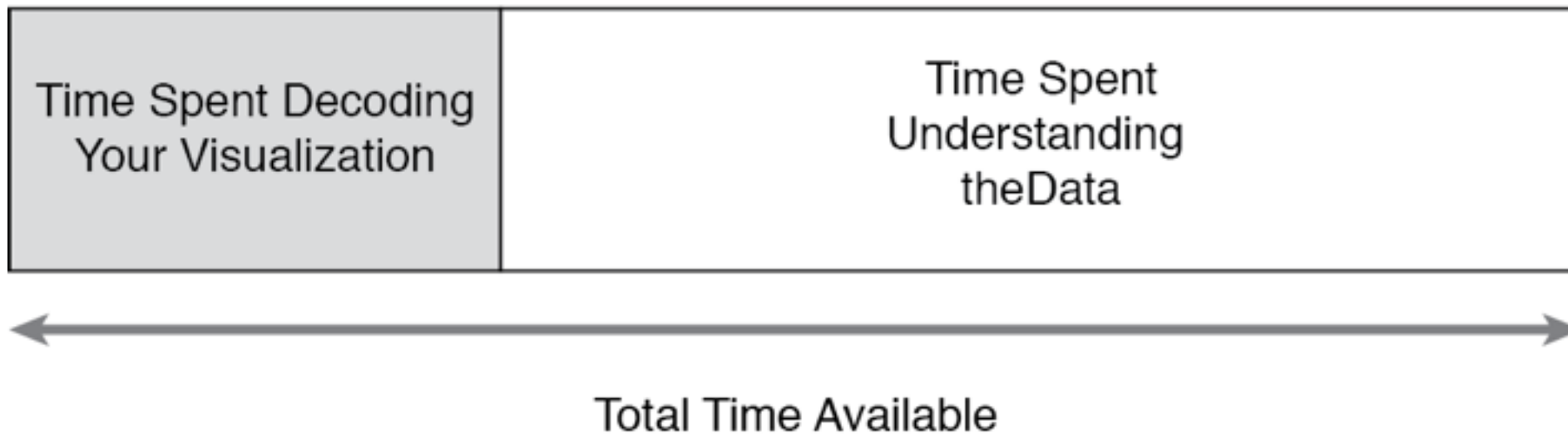
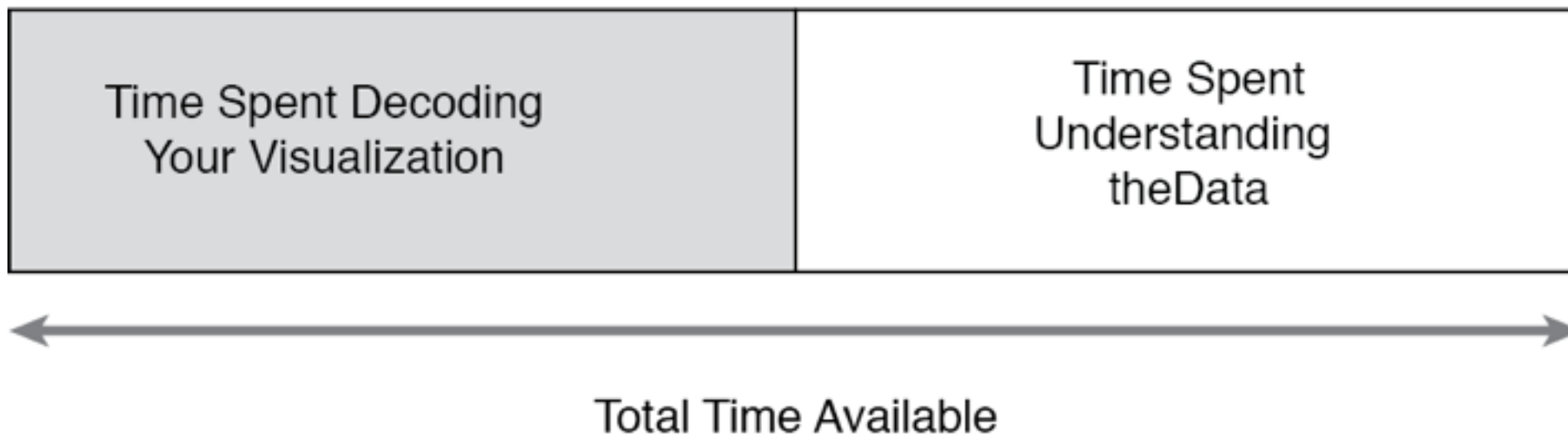
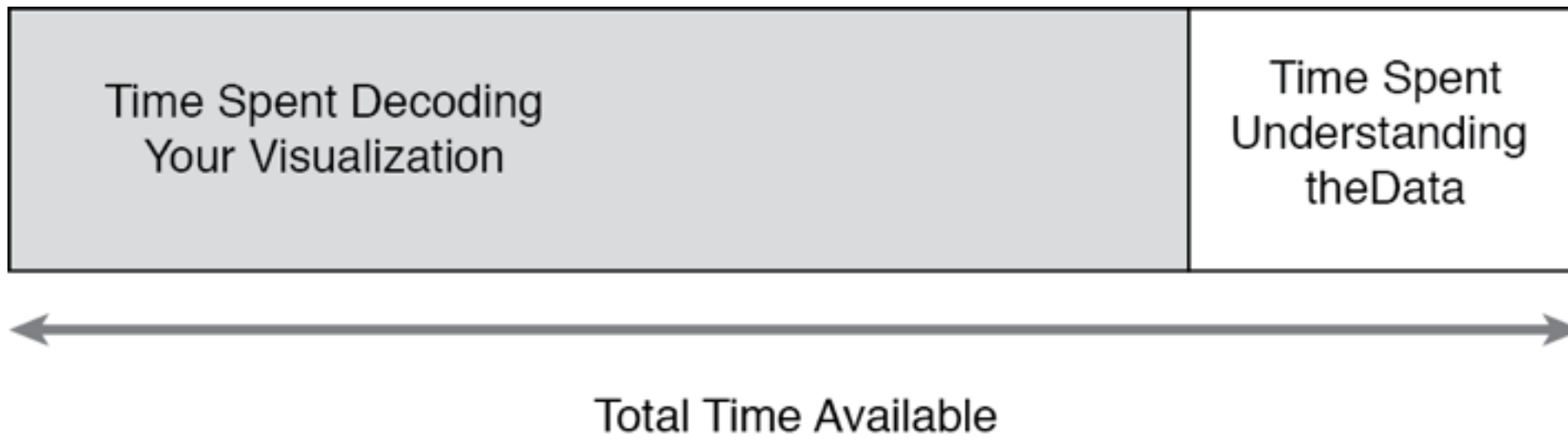


# Scientific Visualization

“the defining challenge of data visualization is projecting higher dimensional data onto a low dimensional canvas”.

M. Driscoll, in Beautiful Visualizations, Chapter 4

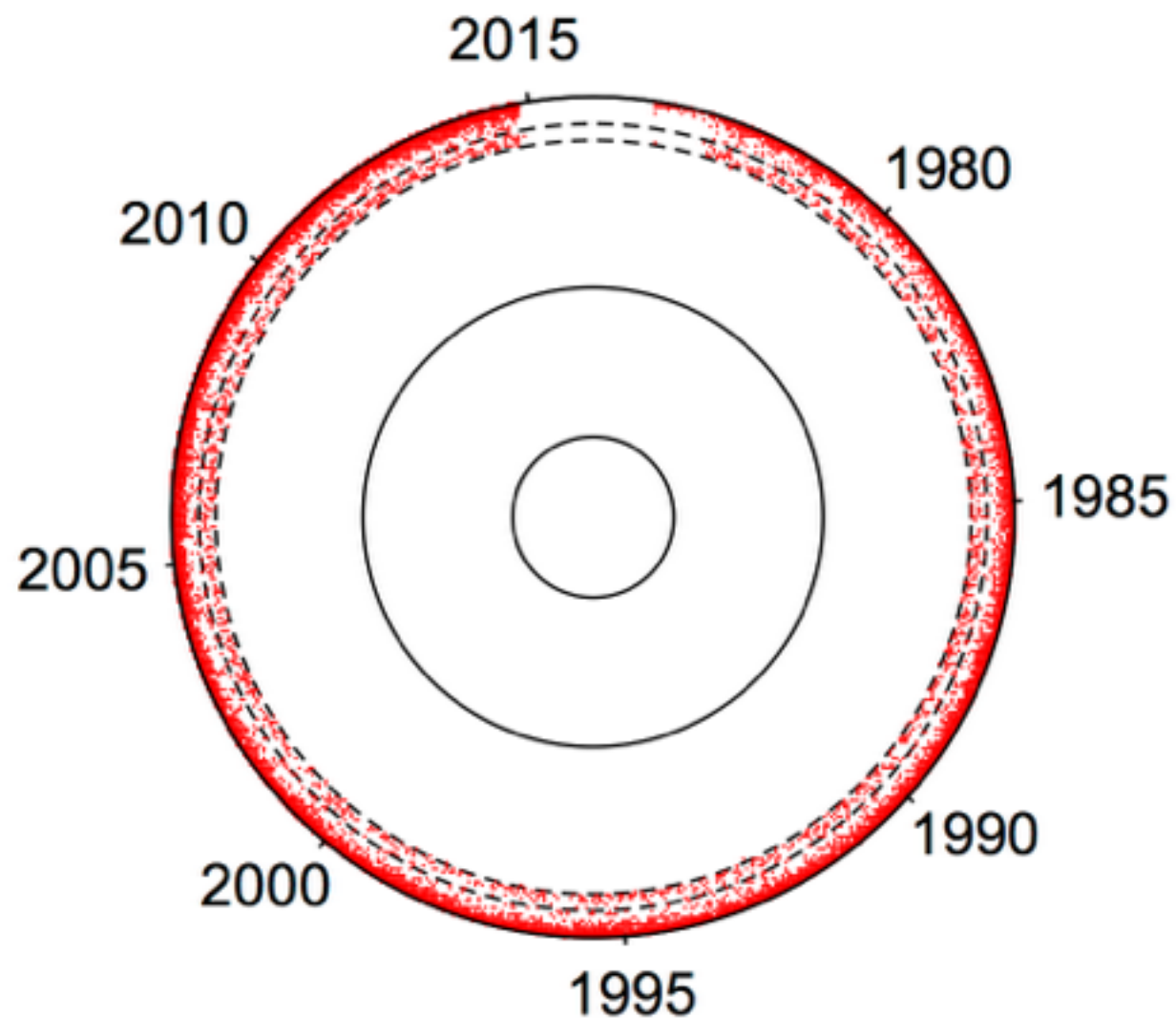
meeting the challenge takes work



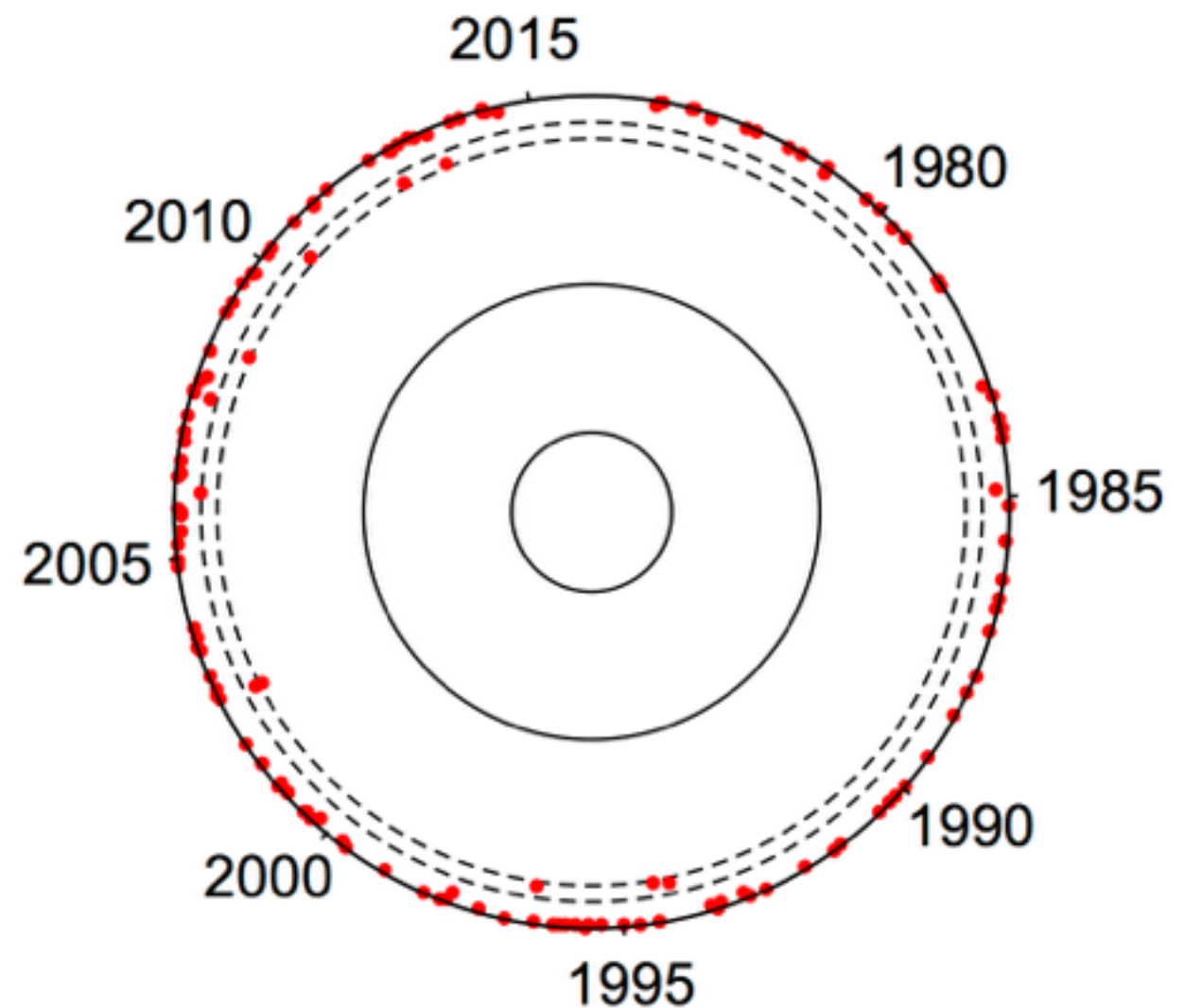
We can't cover  
everything

I will focus on animations, but  
statics displays are important  
too (especially in papers)

All GCMT, 1976–2014



$M_W \geq 7.5$ , 1976–2014



We can't cover  
everything

# Color



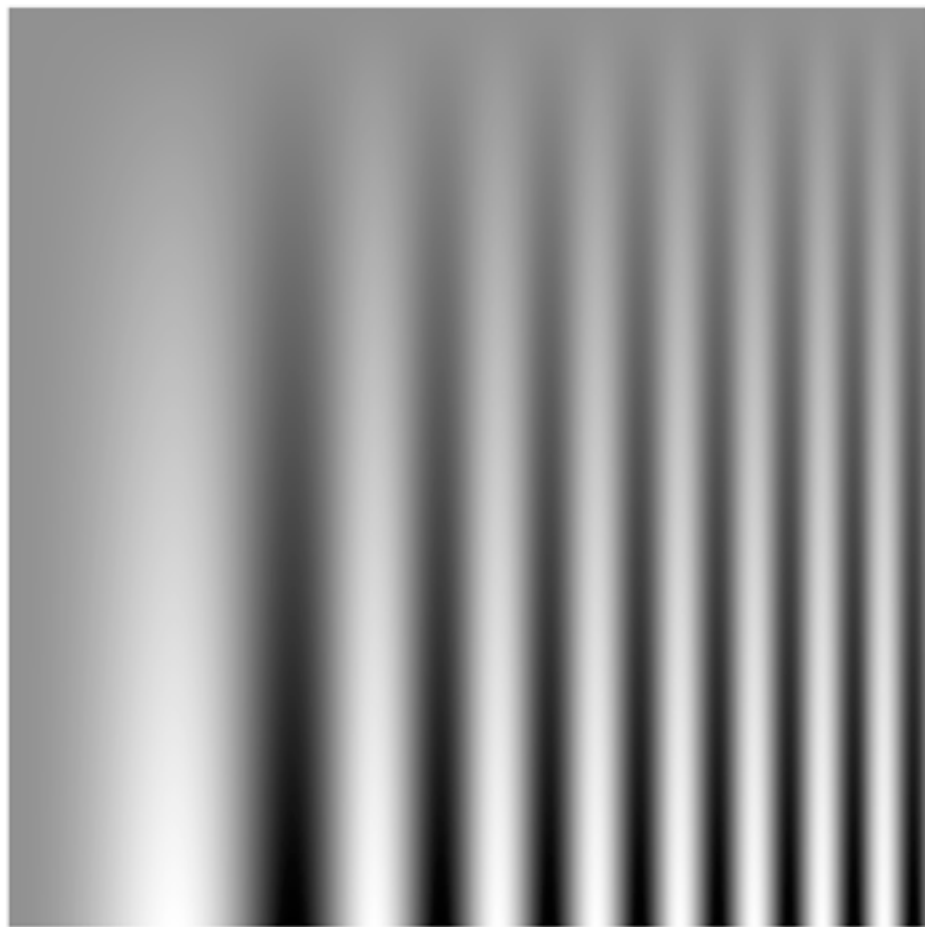
# Scientific Visualization

Cognitive scientists & others have studied the effectiveness of communication for many decades.

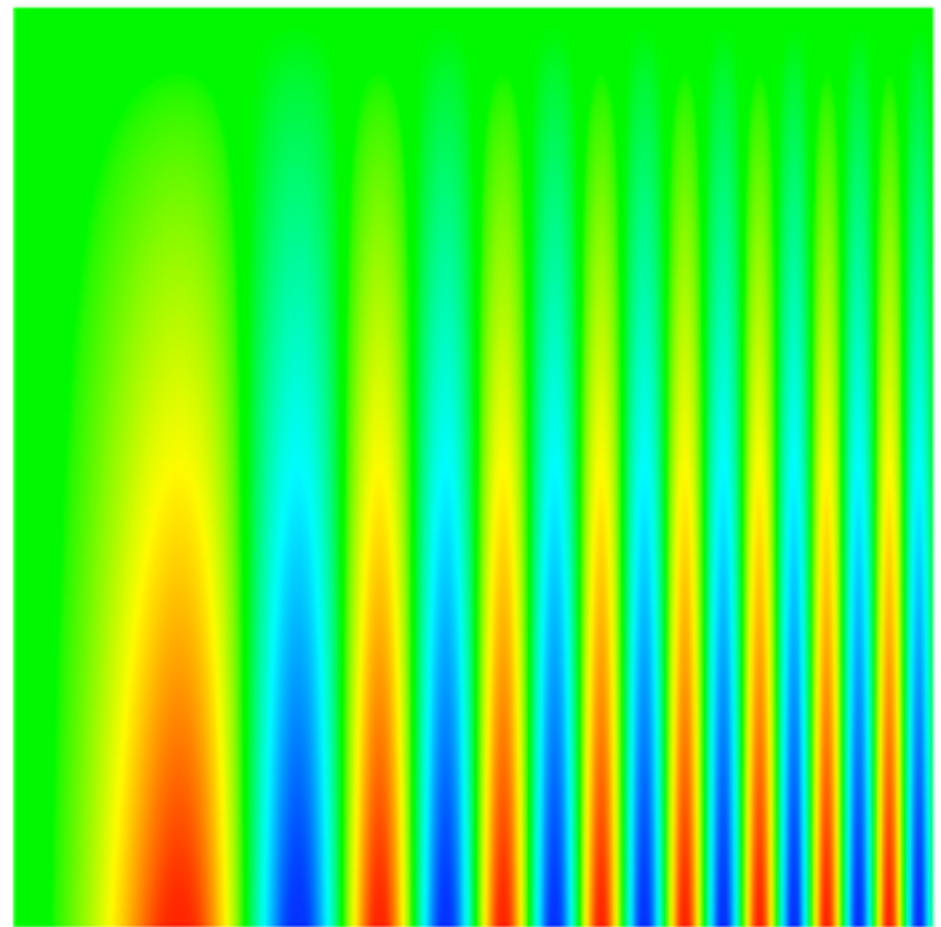
The results are fascinating and important for anyone who wants to communicate information or ideas.

when used correctly, color is a powerful visualization tool; it carries information well.  
but color is almost always misused.

Gray

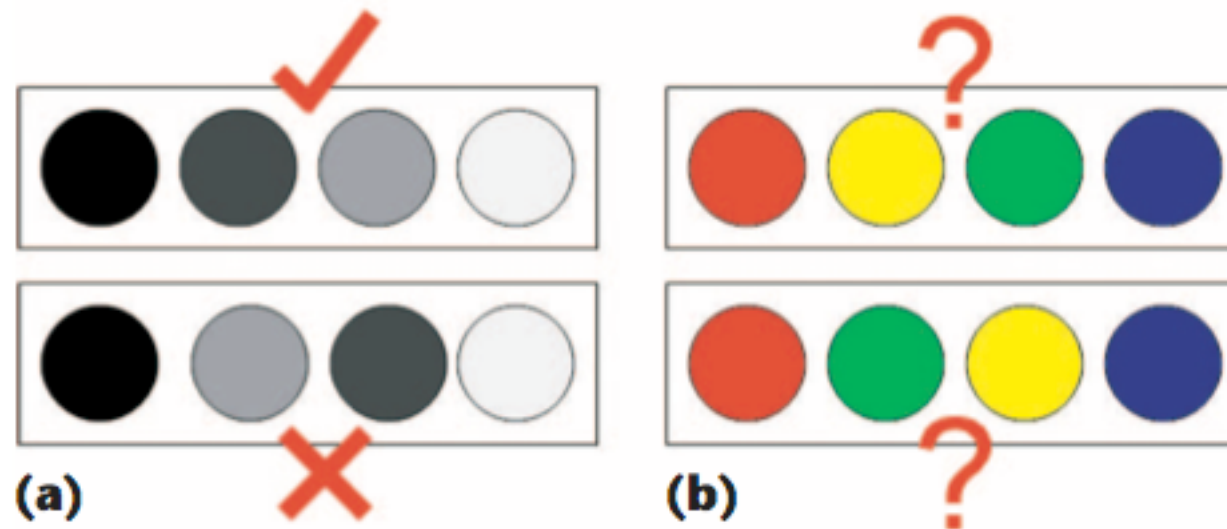


Rainbow



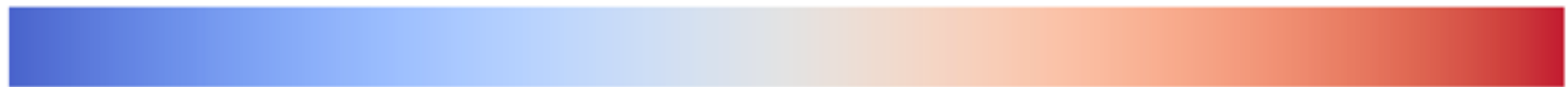
From Borland and Taylor, 2007, IEEE Computer Graphics and Applications

# color has no intrinsic order



From Borland and Taylor, 2007, IEEE Computer Graphics and Applications

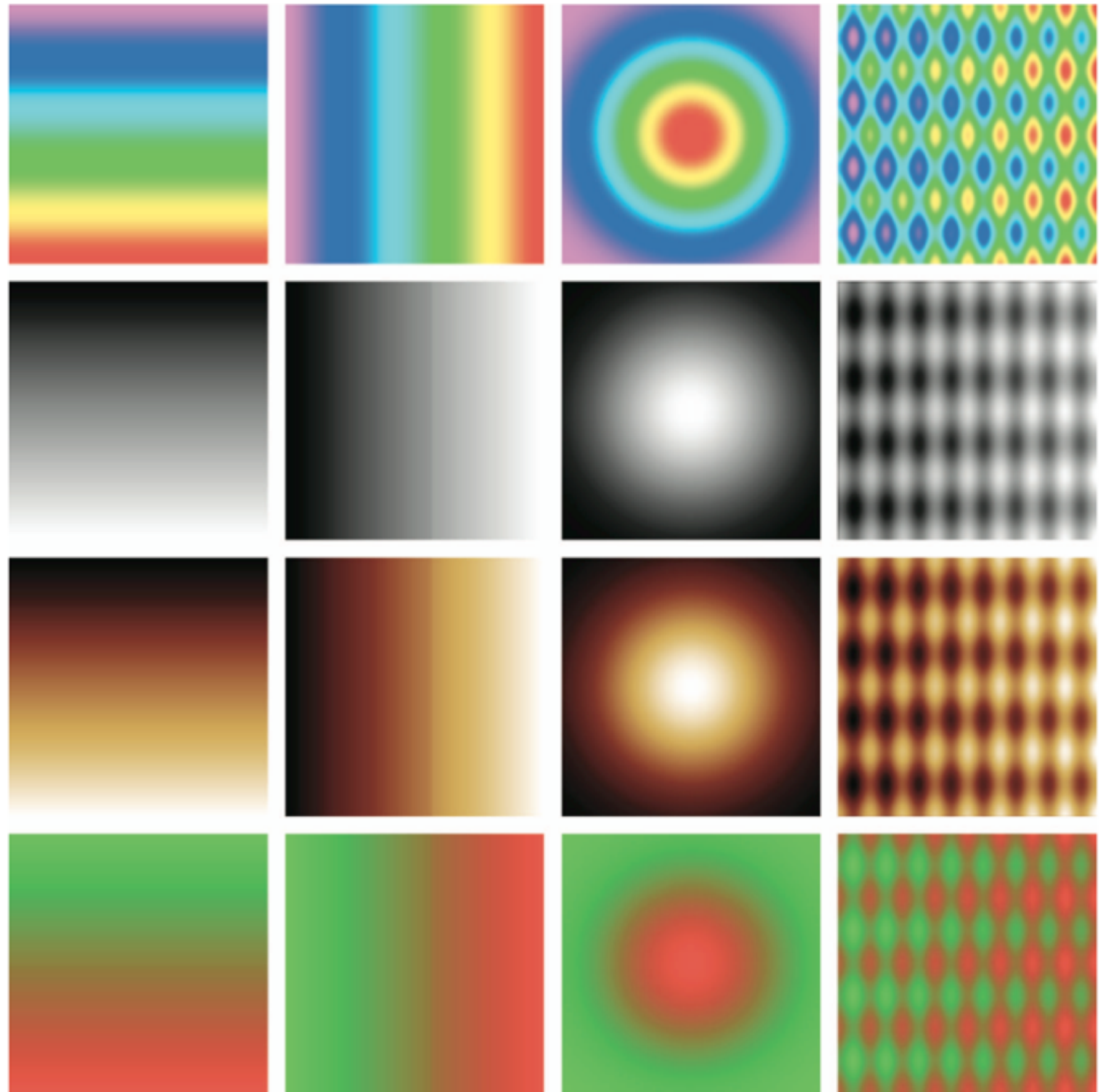
if you want to use color to illuminate quantitatively, you should use colors that vary smoothly with how humans perceive data.



use linear variations in saturation or brightness.

Palette from Kenneth Moreland, Sandia National Laboratory

never use an  
unbanded  
rainbow  
palette



From Borland and Taylor, 2007, IEEE Computer Graphics and Applications

grays are good, but we can really only see about 10 or so shades of gray.



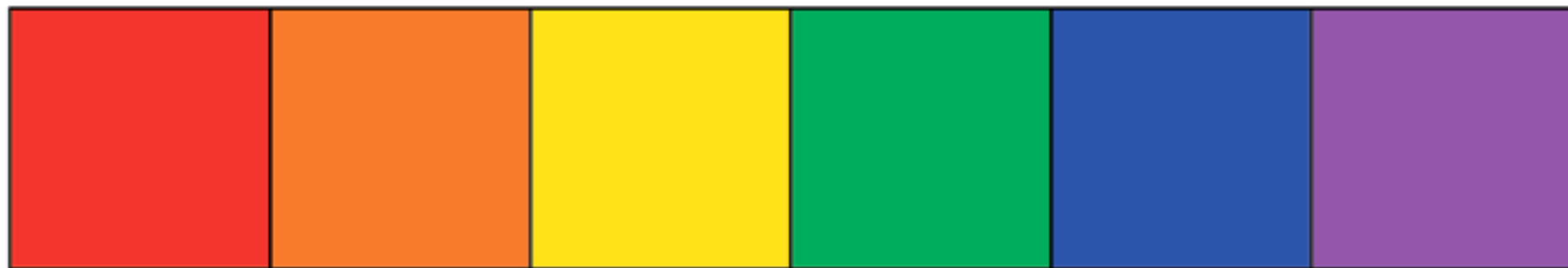
using as many grays as shown above introduces some problems.

we see gray shades comparatively, so  
even though you think you can see  
many shades, you can't.



the solid bar in the middle is a single  
shade of gray.

a simple fix for these issues





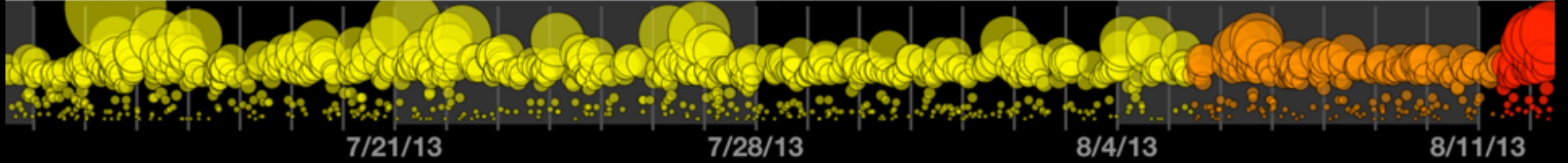
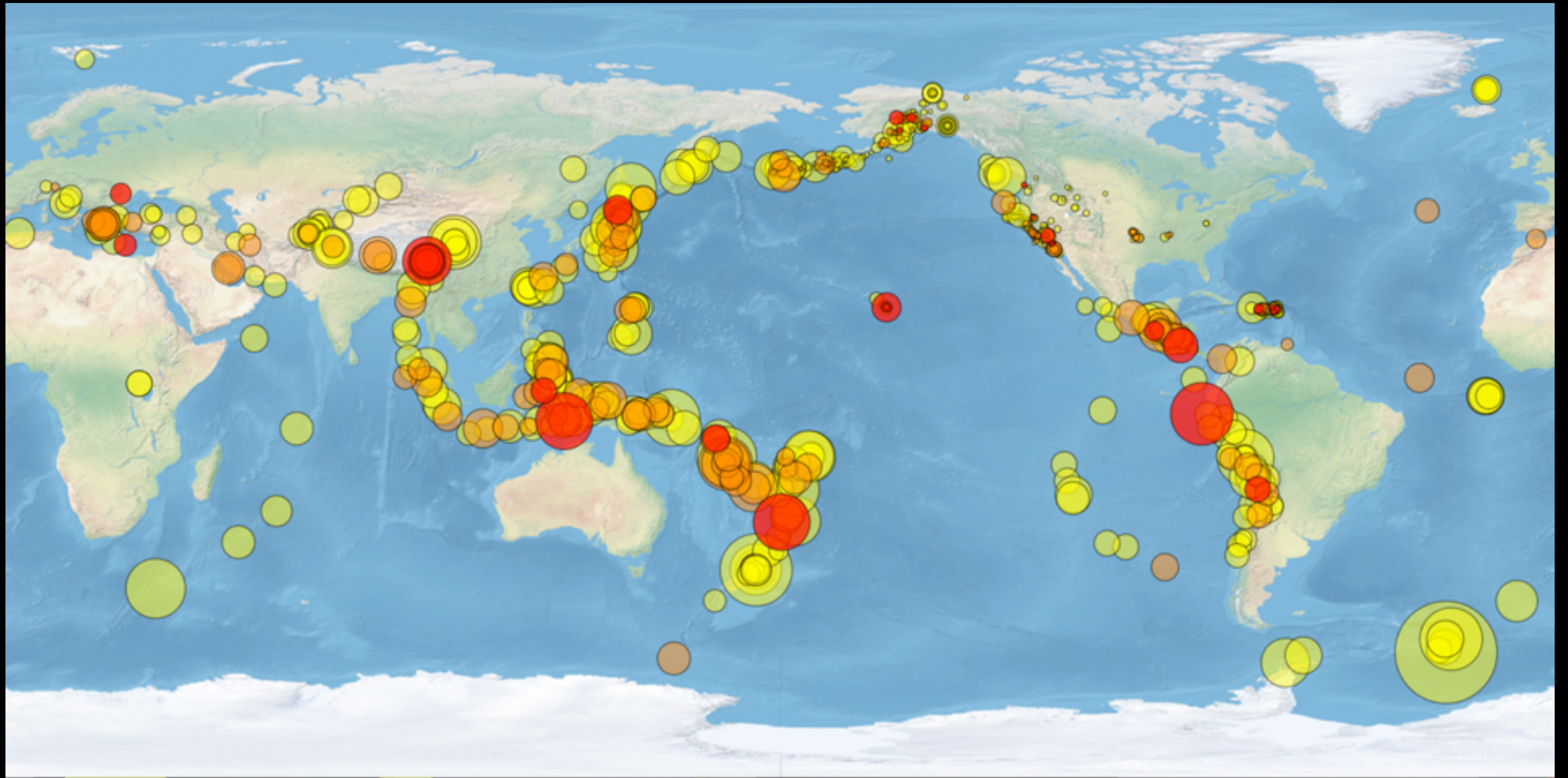
# spatial perceptions of color

warm colors appear to advance from the figure



cool colors appear to recede into the figure.

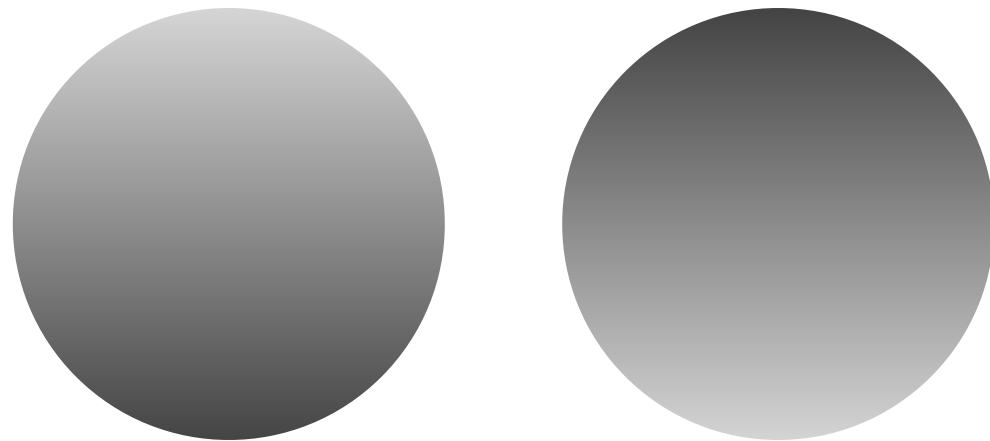




use gradients carefully

lighter colors advance the image

darker colors recess the image



# Color Resources

<https://kuler.adobe.com>

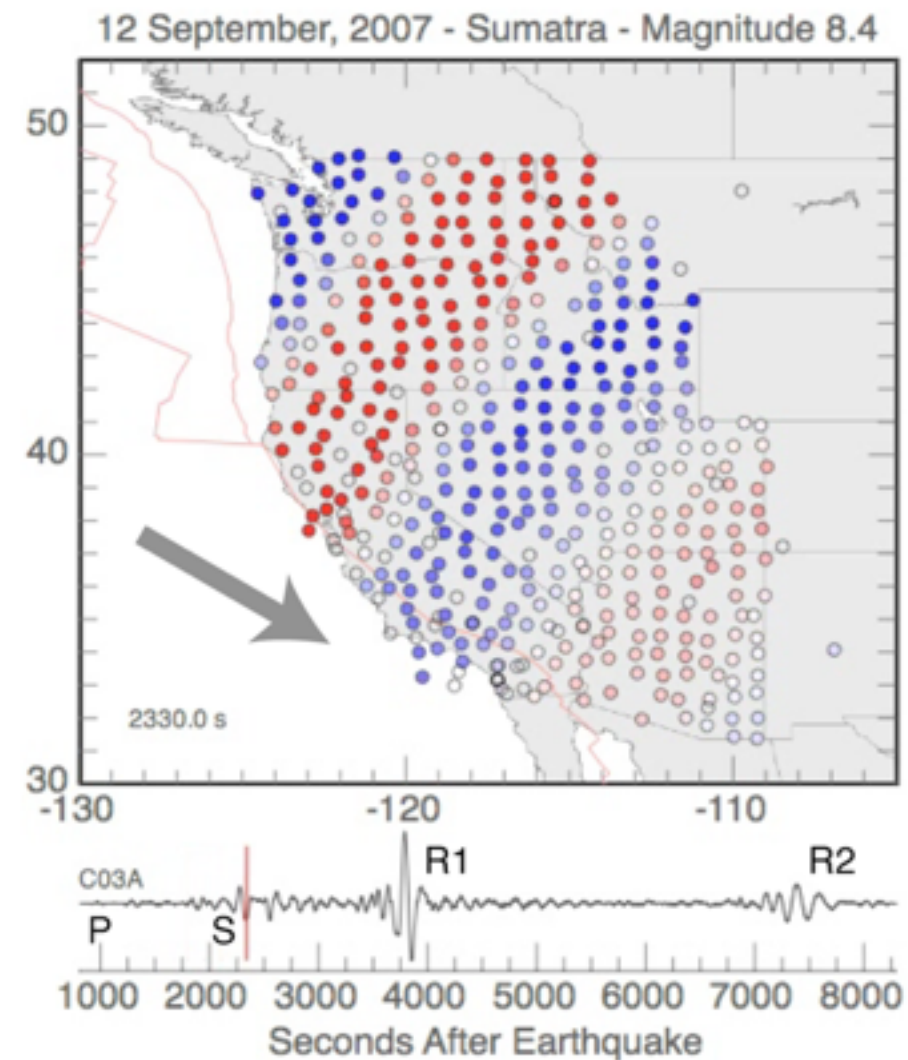


<http://colorbrewer2.org>



# Using Animation to Explore Evolving Data

## EarthScope Data Processing Workshop



# Summary: Animations Can Help With

## Education & Outreach

On all levels (if students control the animation)

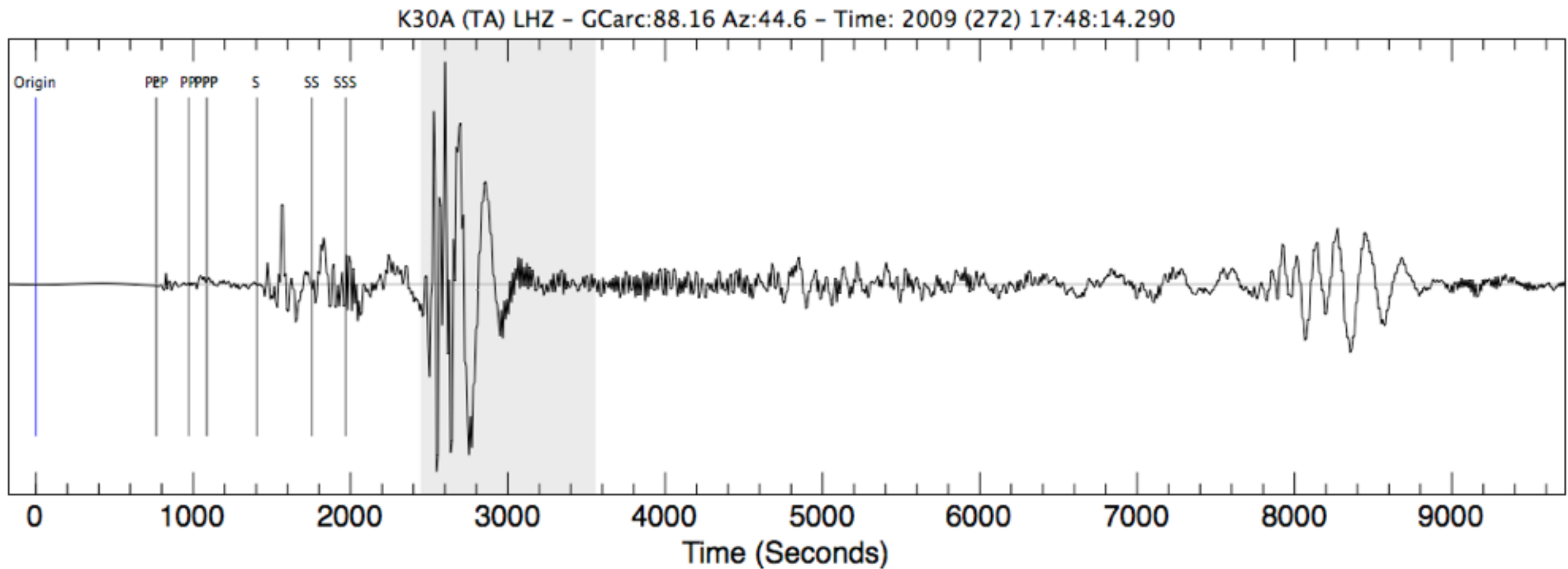
## Research

From illustrating talks to allowing researchers to step through observations or modeling results (e.g. looking through the wavefield to identify interesting time windows of coherent scattered waves, amplitude focussing & wavefront distortion, etc).

Animations are not analysis tools, but help develop intuition & understanding.



# Seismograms



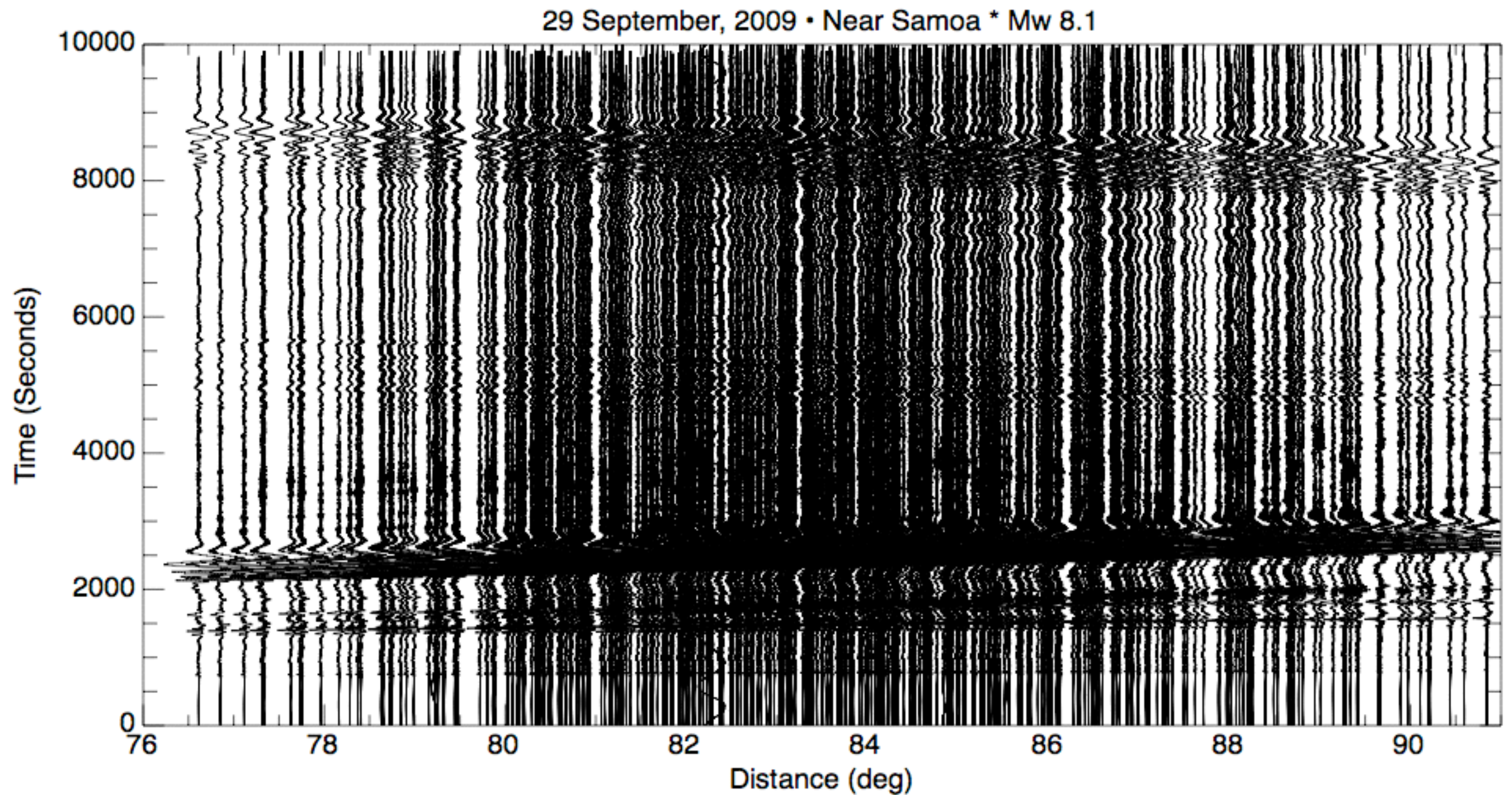
Waveforms from NSF & USGS (IRIS & EarthScope)

[www.nsf.gov](http://www.nsf.gov)

[www.iris.edu](http://www.iris.edu)

[www.earthscope.org](http://www.earthscope.org)

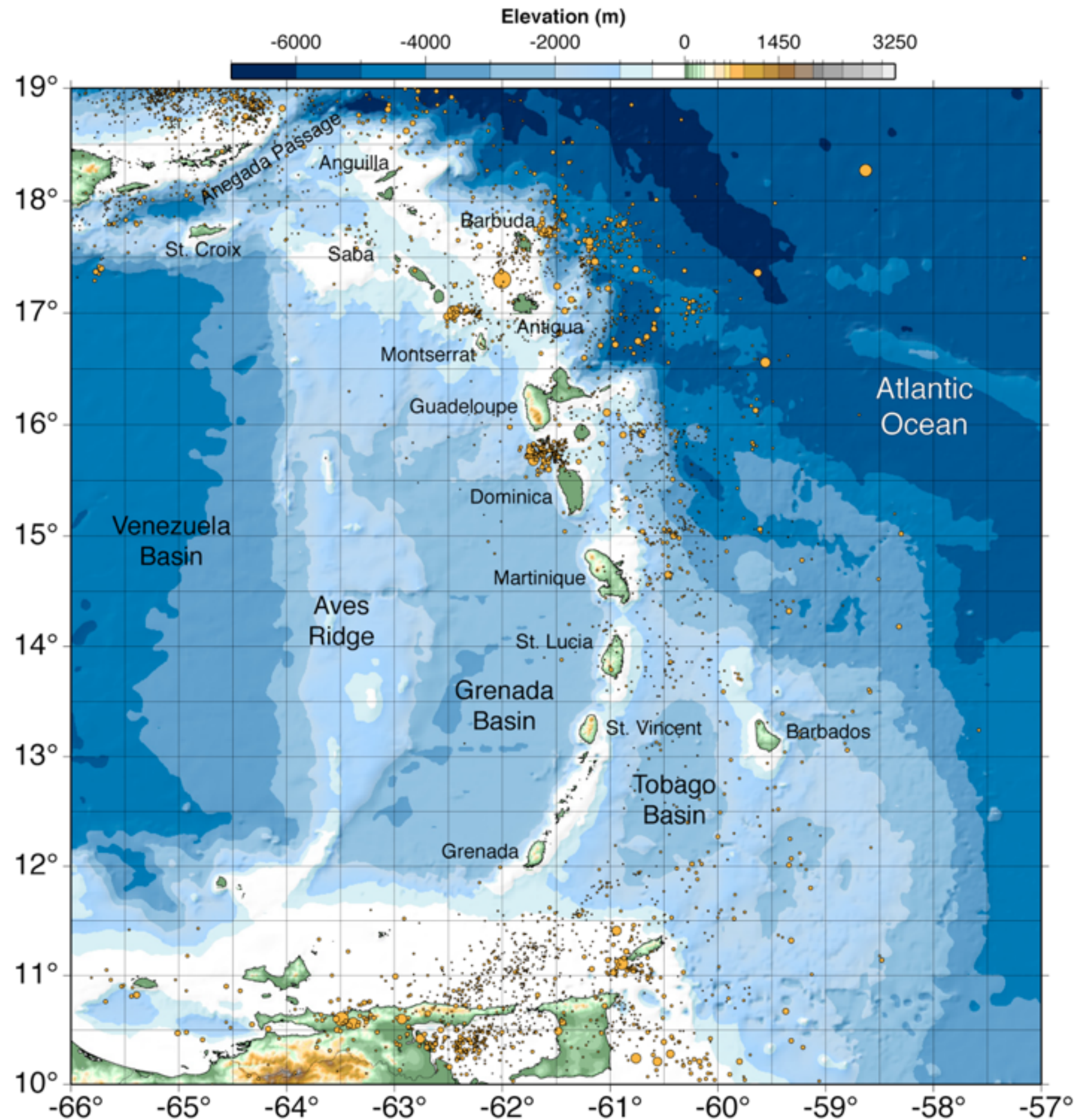
# The Seismic Wavefield

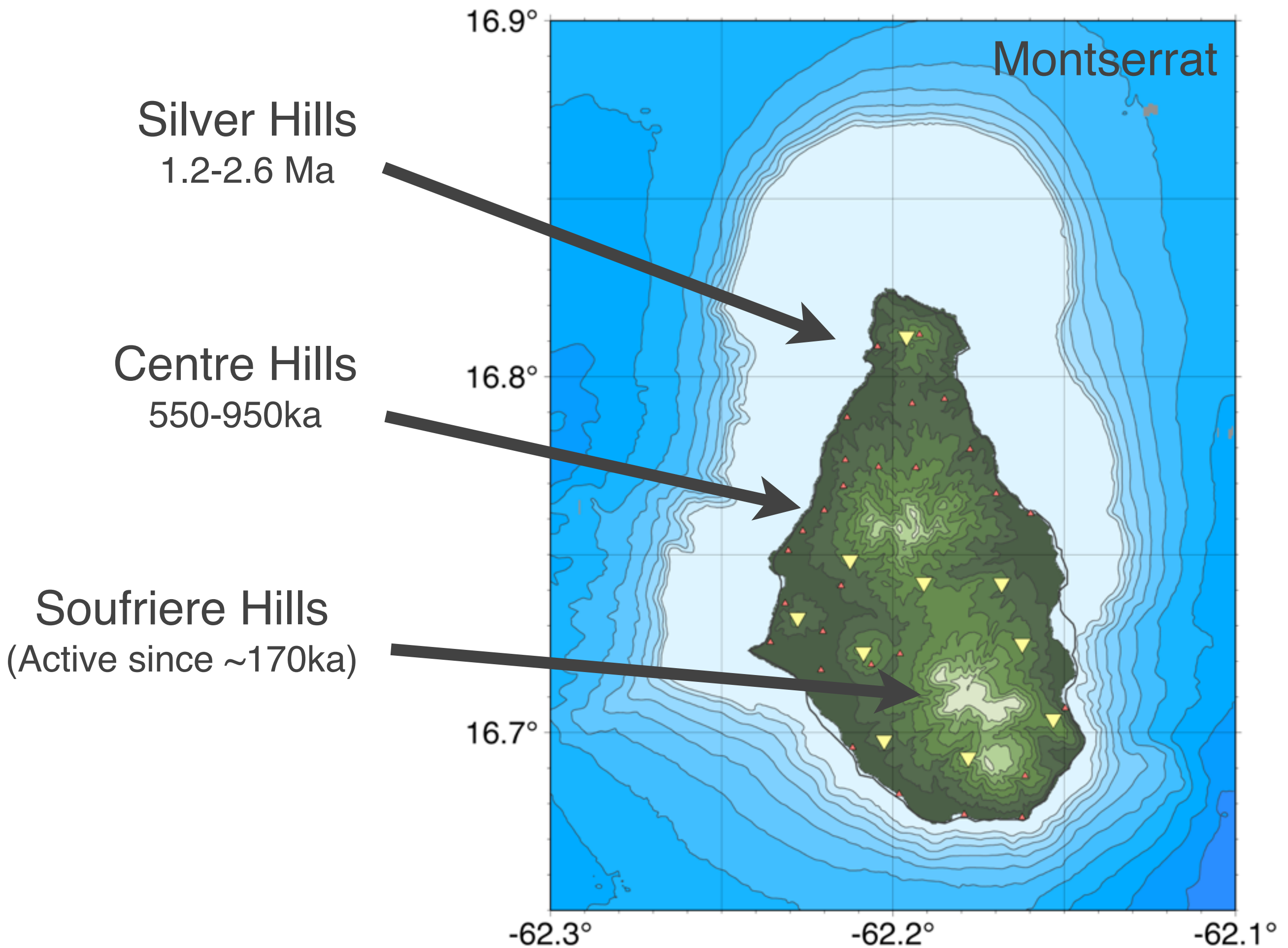


Waveforms from NSF & USGS (IRIS & EarthScope)



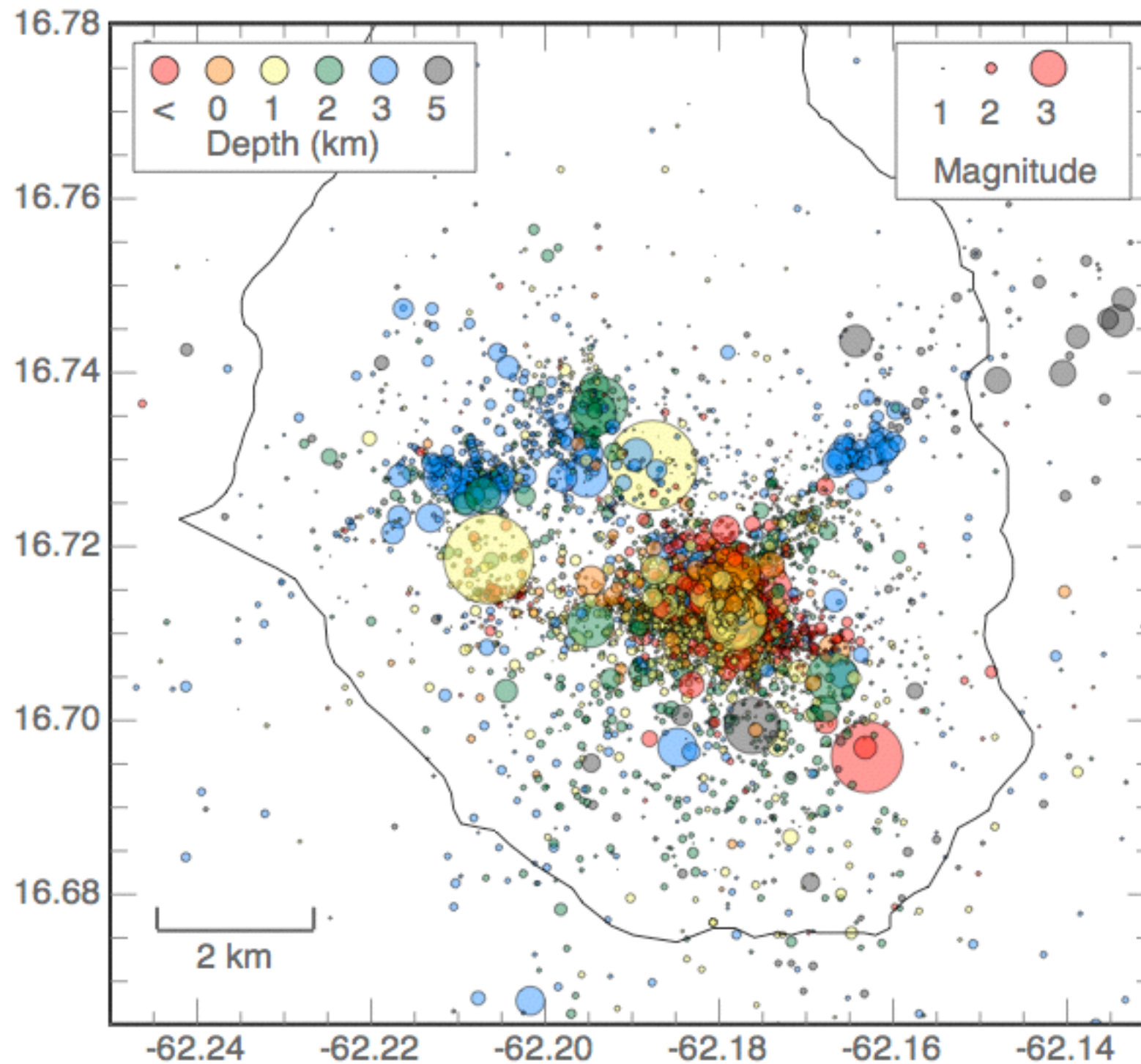
# The Lesser Antilles Island Arc



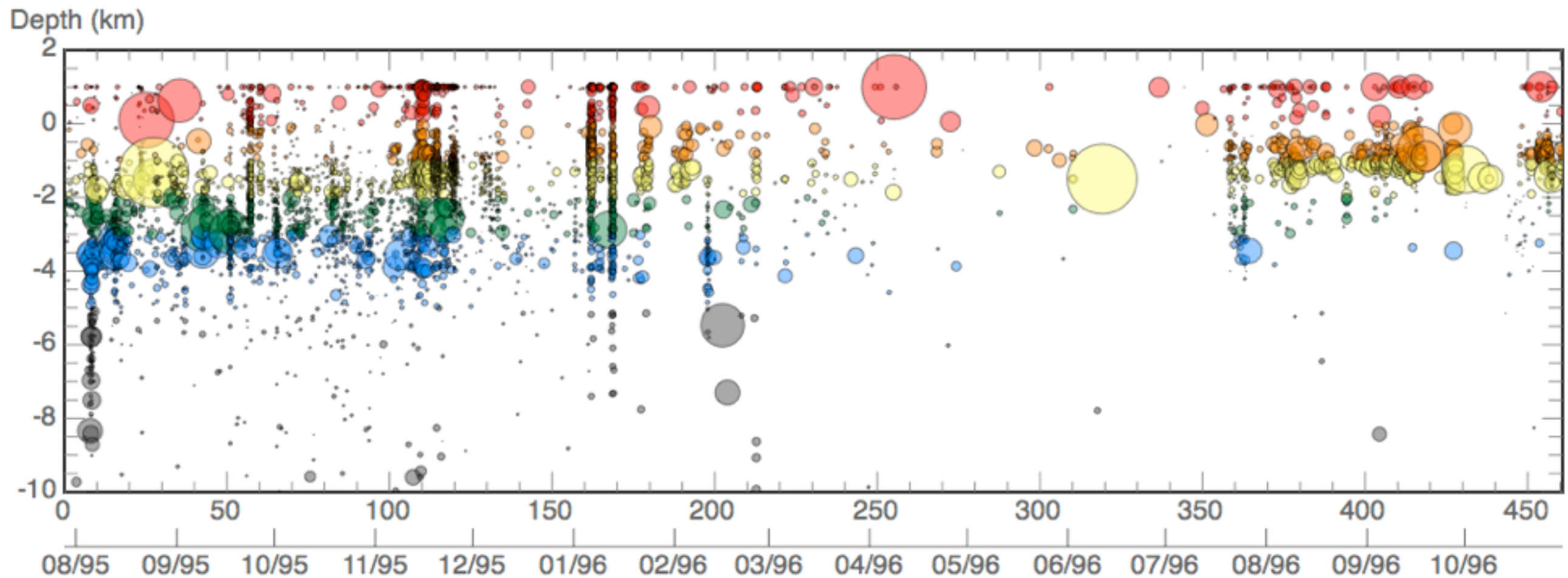
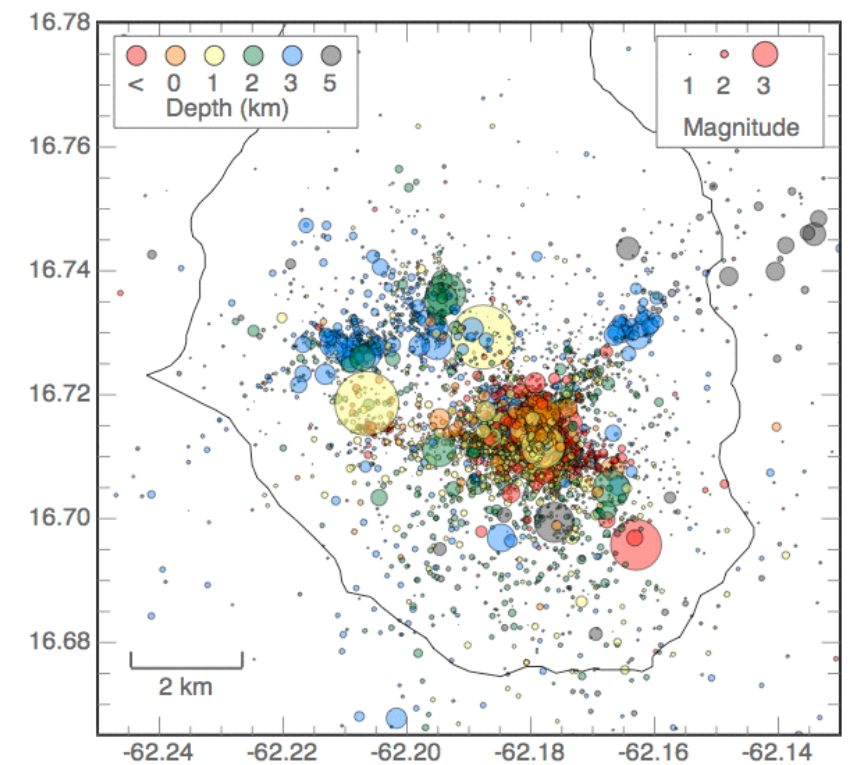




# Montserrat Seismicity - July 1995-Oct 1996



# Montserrat Seismicity July 1995-Oct 1996



# Summary: Animations Can Help With

## Education & Outreach

On all levels (if students control the animation)

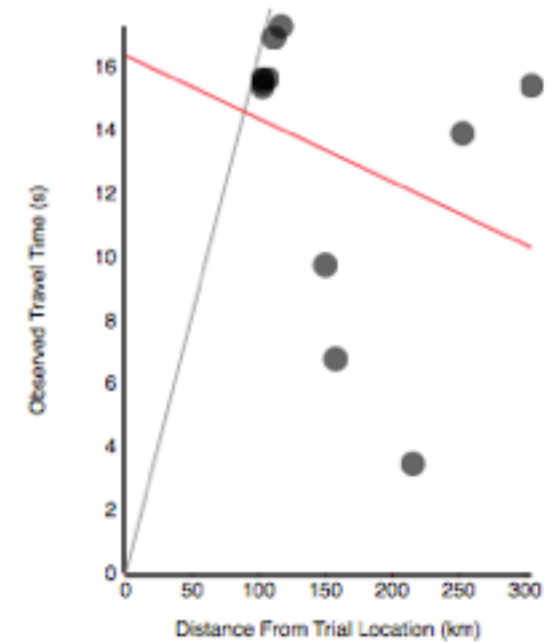
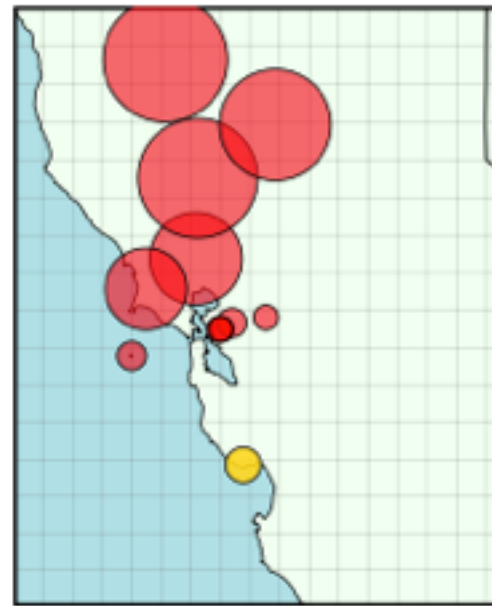
## Research

From illustrating talks to allowing researchers to step through observations or modeling results (e.g. looking through the wavefield to identify interesting time windows of coherent scattered waves, amplitude focussing & wavefront distortion, etc).

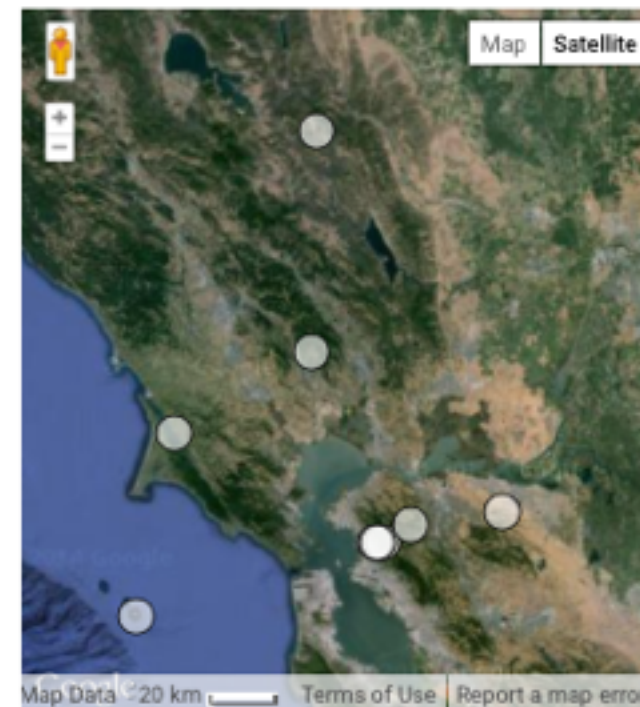
Animations are not analysis tools, but help develop intuition & understanding.

# Using Animation in Education

## EarthScope Data Processing Workshop



36.964N, -122.058E, 0 km / RMS:18.01 s, Mean Misfit: -12.45 s.



# Load

<http://bit.ly/eqloc2014>

The “buttons” toggle the display of different frames in this javascript program.

Load the observations and several views of the data and model are displayed.

Click on the google map to try a location for the event.

so how can you make  
simple animations?

**MATLAB**