#EndTheRainbow

Improving accessibility in data viz

Scottish Government
Riaghaltas na h-Alba
gov.scot

Hi! I'm Liam

Scottish Government
Riaghaltas na h-Alba
gov.scot

- Sea-loving land mammal
- Spatial analysis
- Cartography
- Data visualisation
- Data management
- Metadata (MEDIN)
- Training

@marinemaps | liam.mason@gov.scot

marinescotland

A Plea to #EndTheRainbow

- Campaign started in 2014 by Climate Scientists at University of Reading

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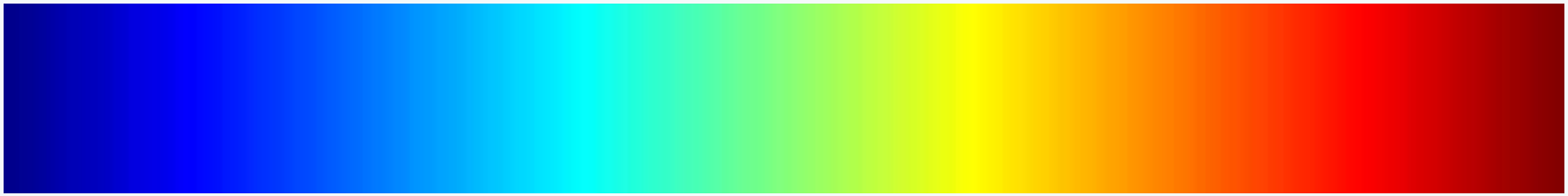
Spectral colour scheme (the “default”, jet…)



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Spectral colour scheme (the [illegible])

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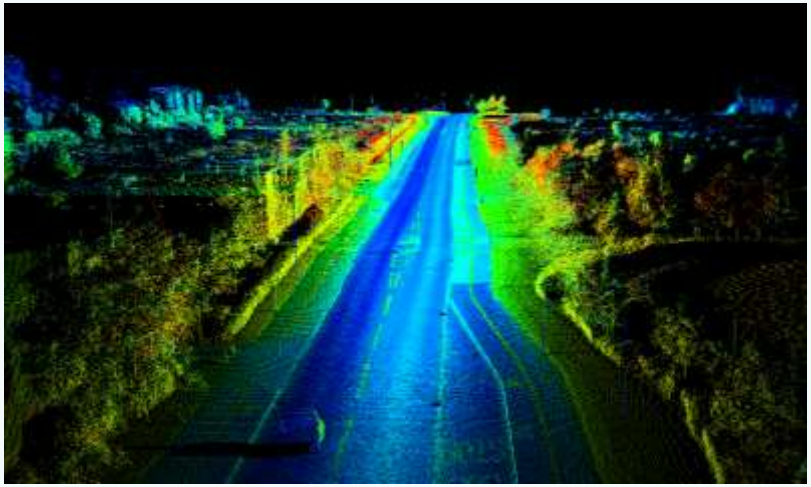

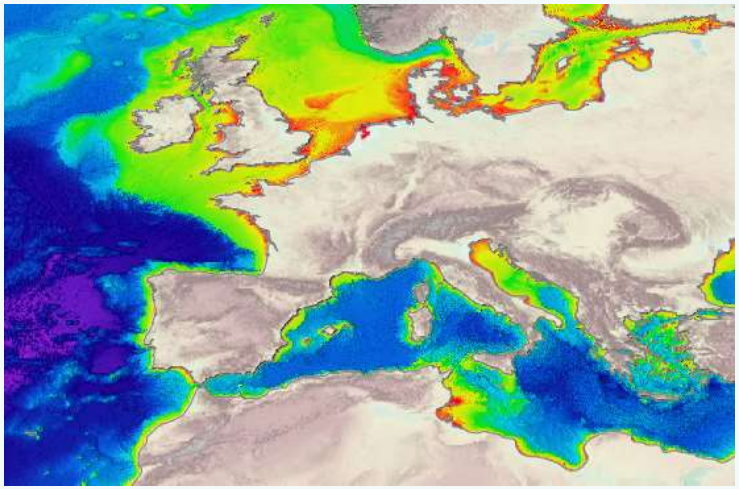

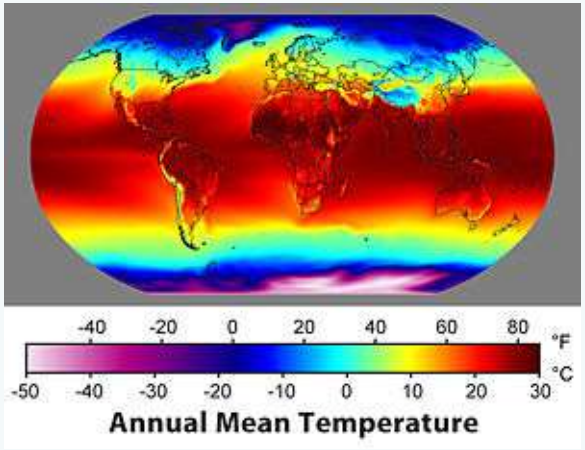

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"Colour scales…often **illegible** to those who are **colour blind**."

Open Letter to Climate Science, University of Reading

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- Colour vision deficiency is **not uncommon**

- Red-green colour weakness affects

1 in 12 Males

1 in 200 Females

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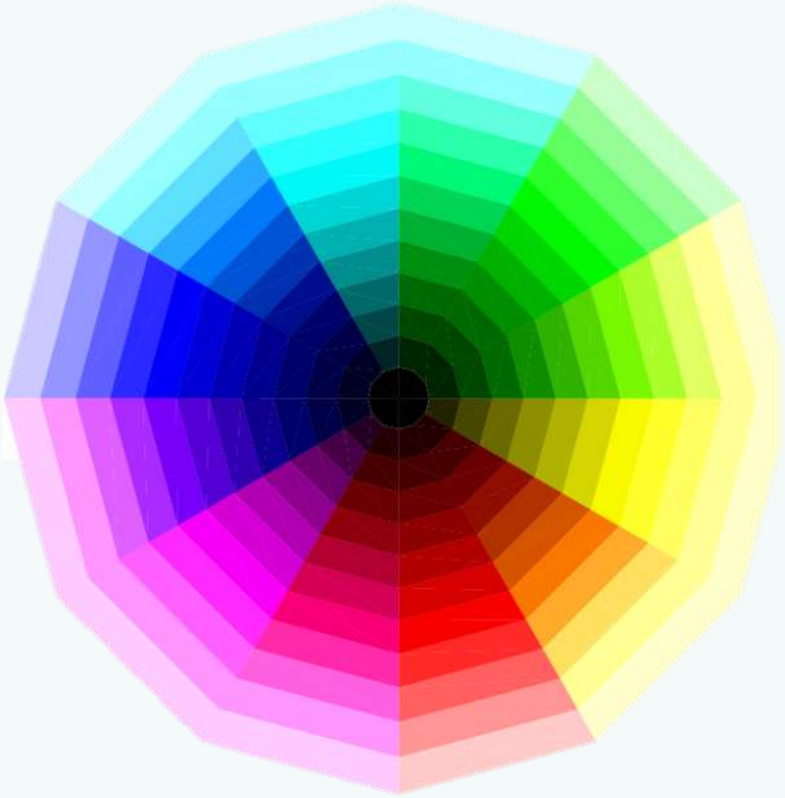

Full spectrum vision

Image from University of Reading Climate Book

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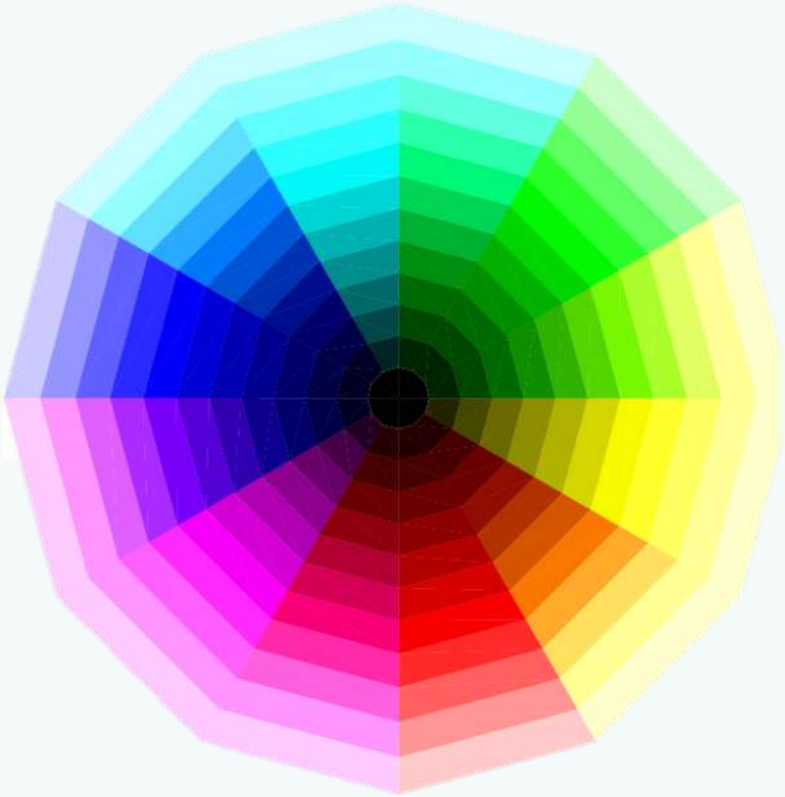
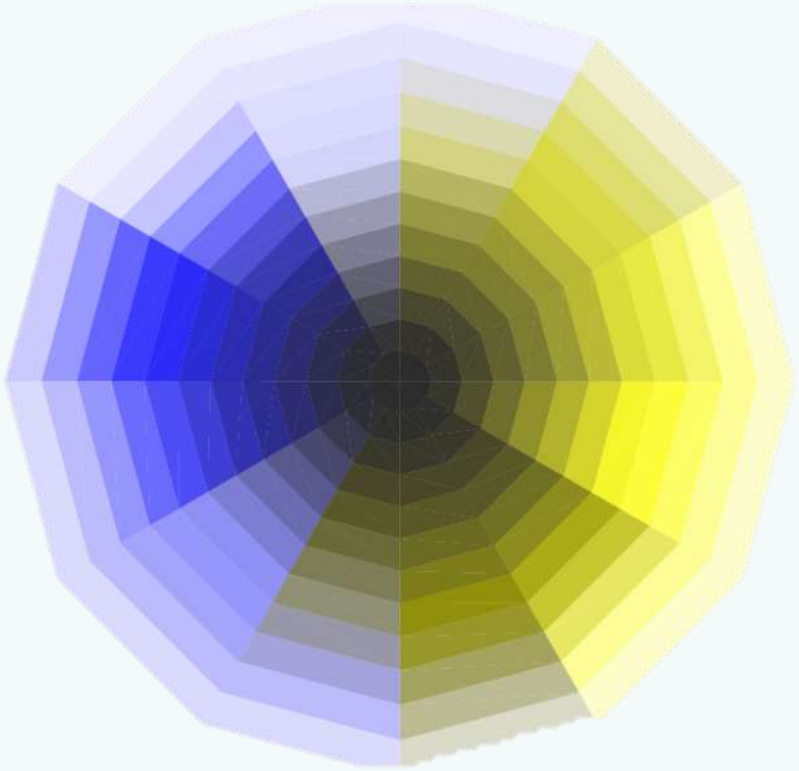


Full spectrum vision



Simulation of severe deuteroanomaly

Images from University of Reading Climate Book

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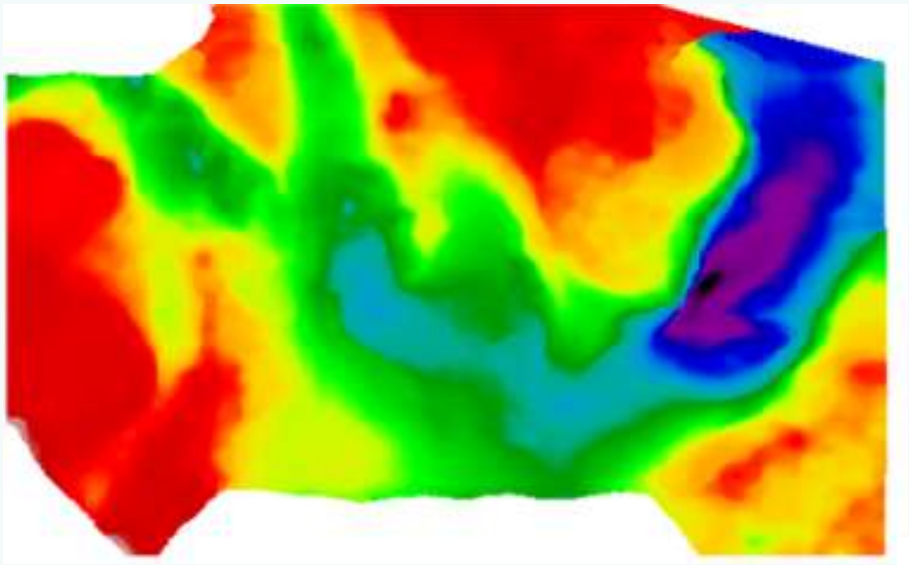
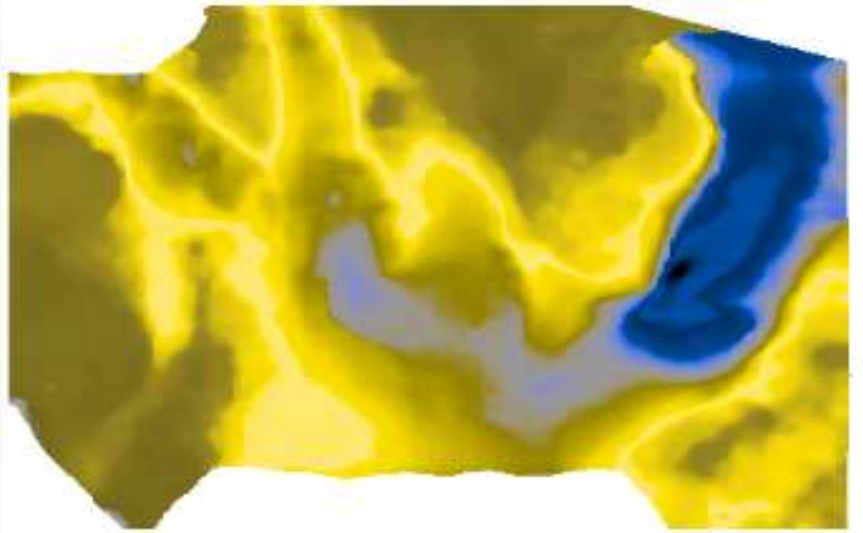


Image(bathymetry, col=rainbow(256)



Images from Agile Scientific

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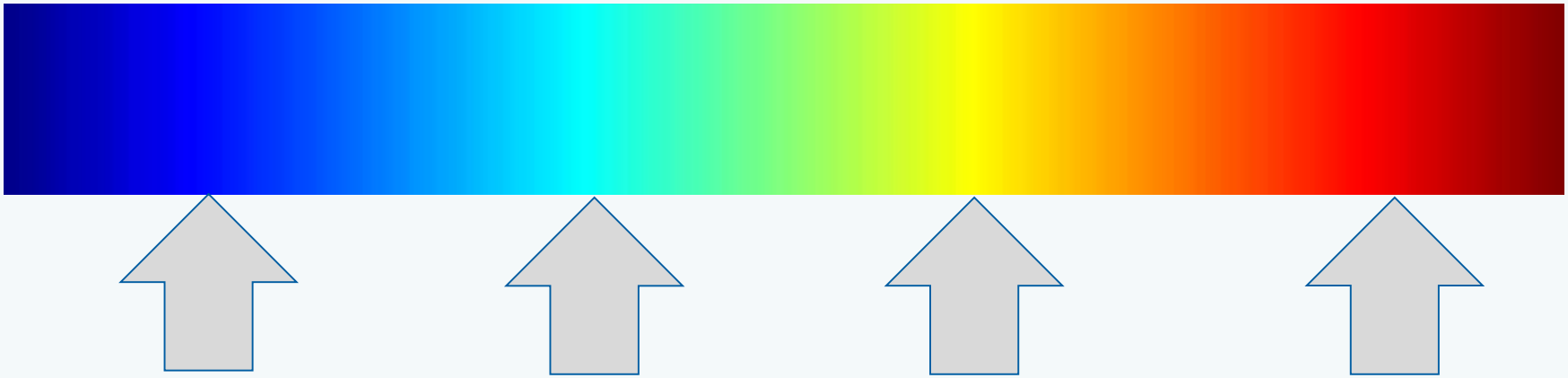
"Colour scales that can **distort**, **mislead** and **confuse**."

Open Letter to Climate Science, University of Reading

#EndTheRainbow #EndRainbow



- #FakeNews #AlternativeFacts
- Are interpretations reflective of data distribution or colour distribution?

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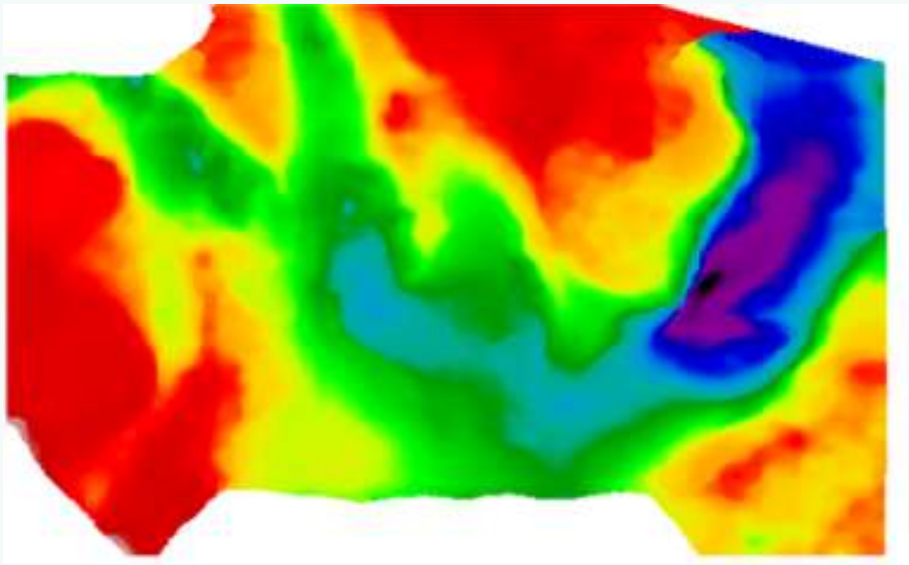
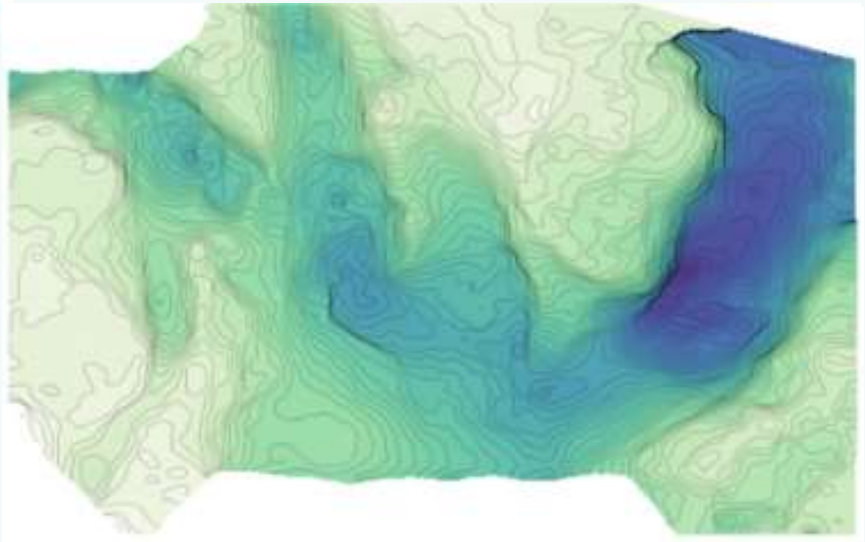


```
Library(RColorBrewer)
cols <- rev(brewer.pal(9,"YlGnBu"))
pal <- colorRampPalette(cols)
Image(bathymetry, col=pal(256))
```



Images from Agile Scientific

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"How do I print in colour again?"

Civil Servant, Victoria Quay

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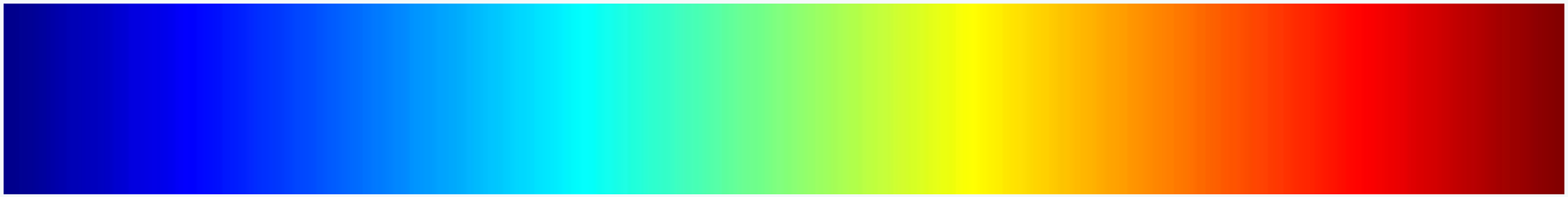
Spectral colour scheme



Printed in greyscale

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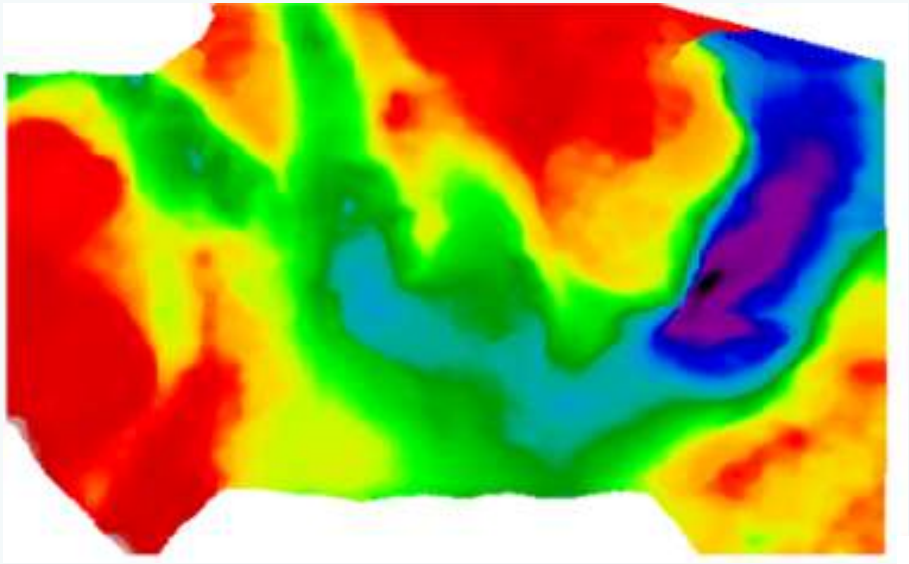
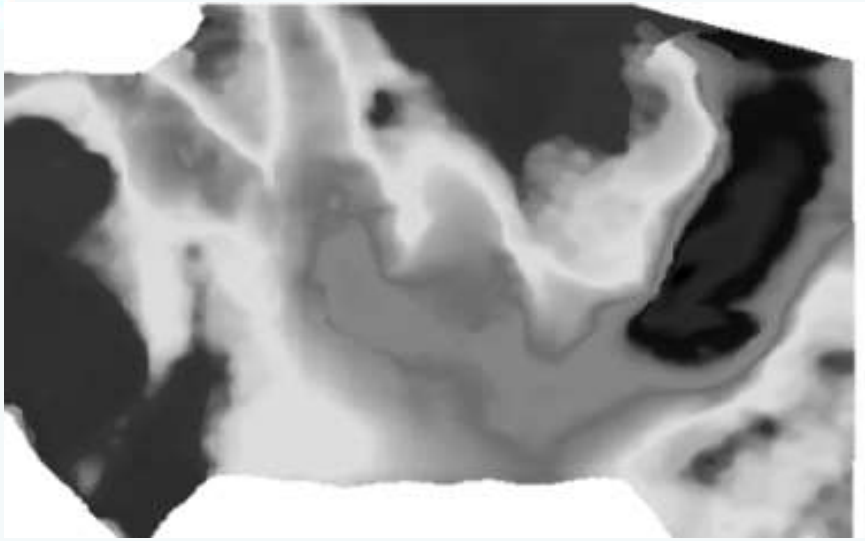




Images from Agile Scientific

#EndTheRainbow #EndRainbow

"We should be equally intolerant to poor use of the **grammar of graphics**"

Open Letter to Climate Science, University of Reading

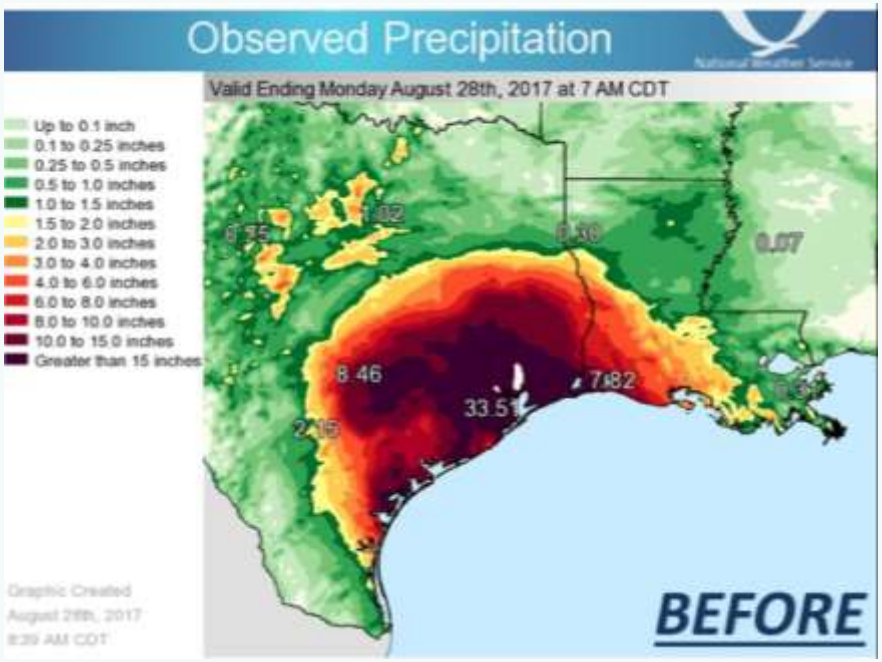
#EndTheRainbow #EndRainbow

"You're on ten on your guitar. Where can you go from there?"

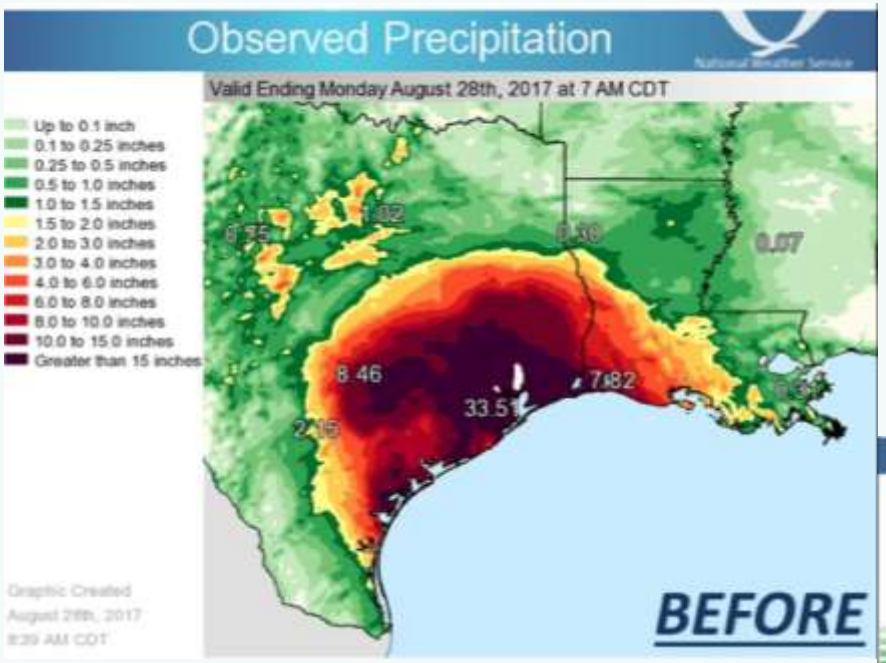
"Put it up to eleven."

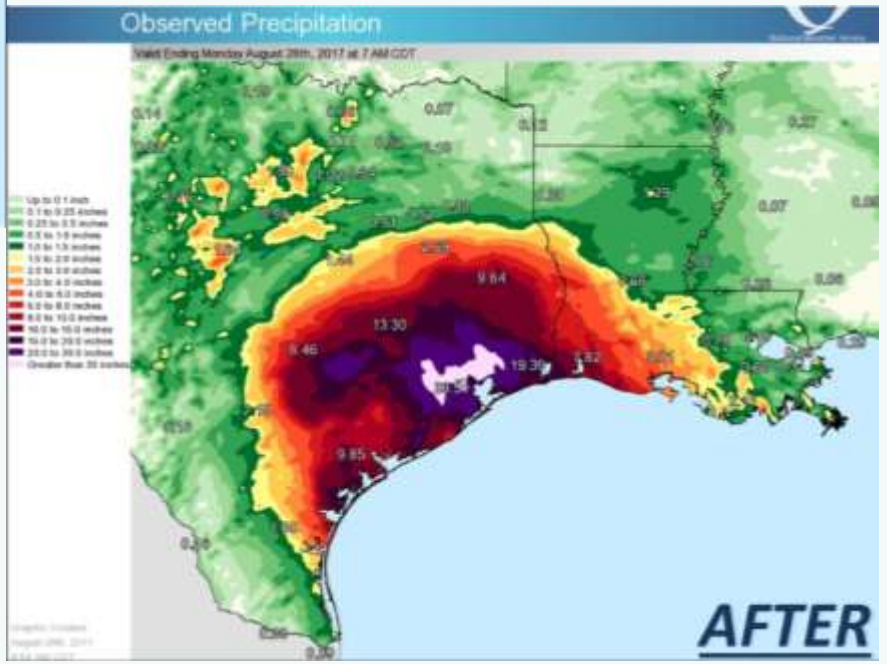
This is Spinal Tap (1984)

#EndTheRainbow #EndRainbow

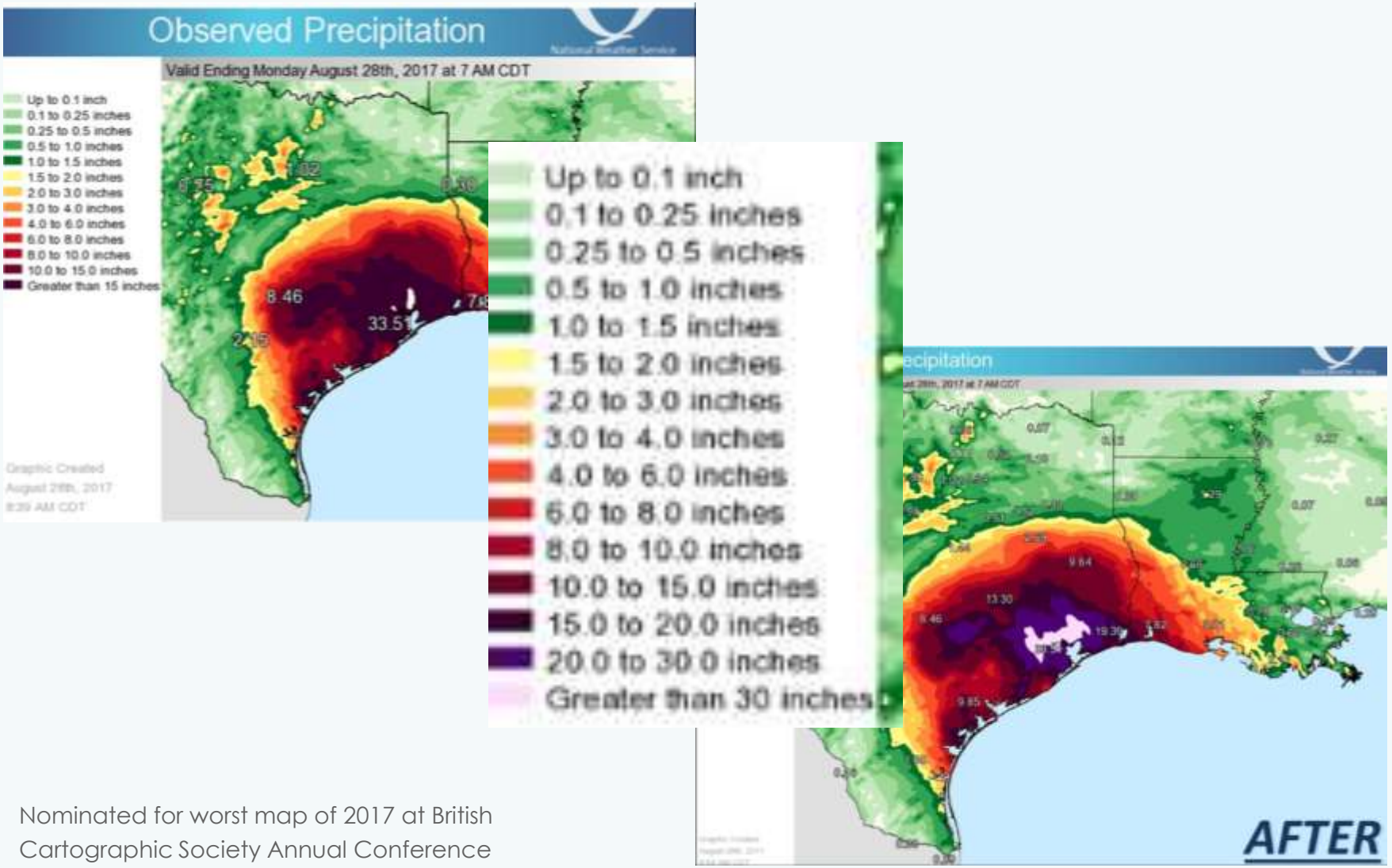


#EndTheRainbow #EndRainbow





#EndTheRainbow #EndRainbow



Nominated for worst map of 2017 at British Cartographic Society Annual Conference

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"People have **expectations** about the meanings of **symbols** and **styles**.

The meaning selected by the designer should be **compatible** with the expectations of the users"

Max Roberts (Tube Map Central)*

* Thanks to Charley Glynn & Paul Naylor at Ordnance Survey for sharing the quote

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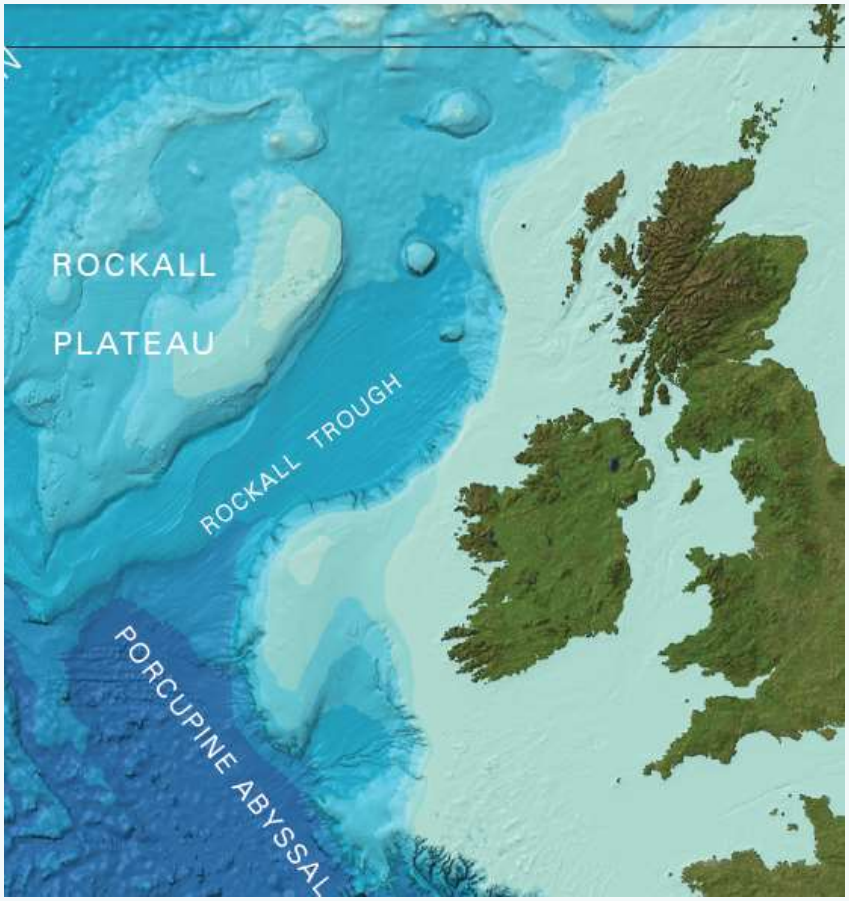
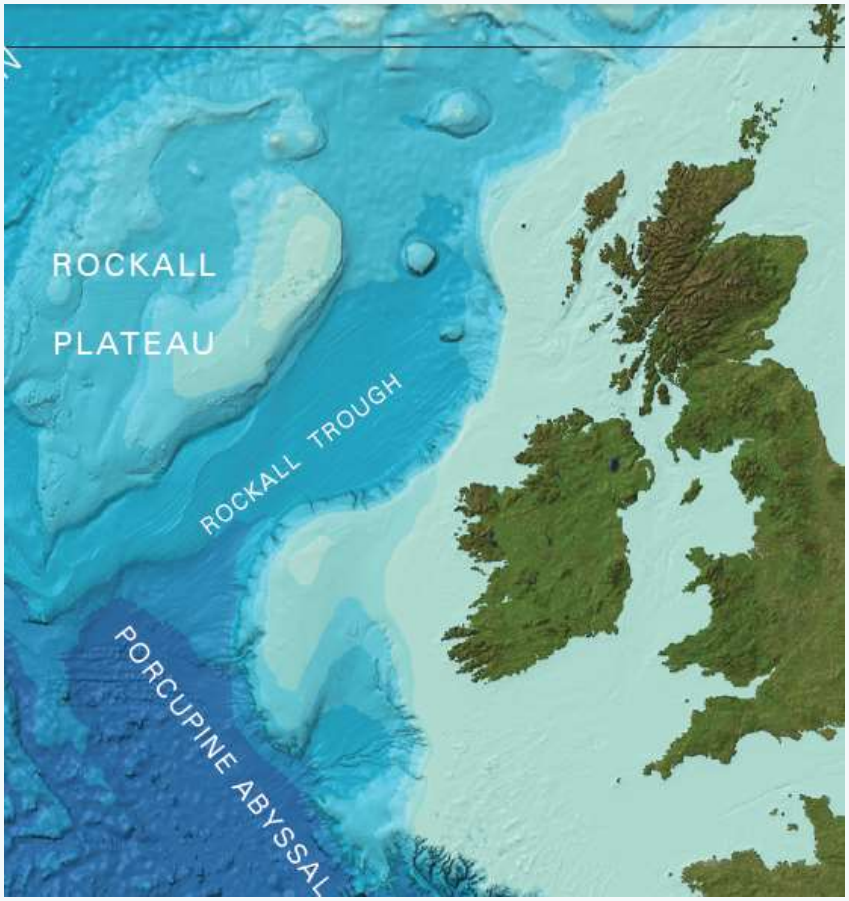
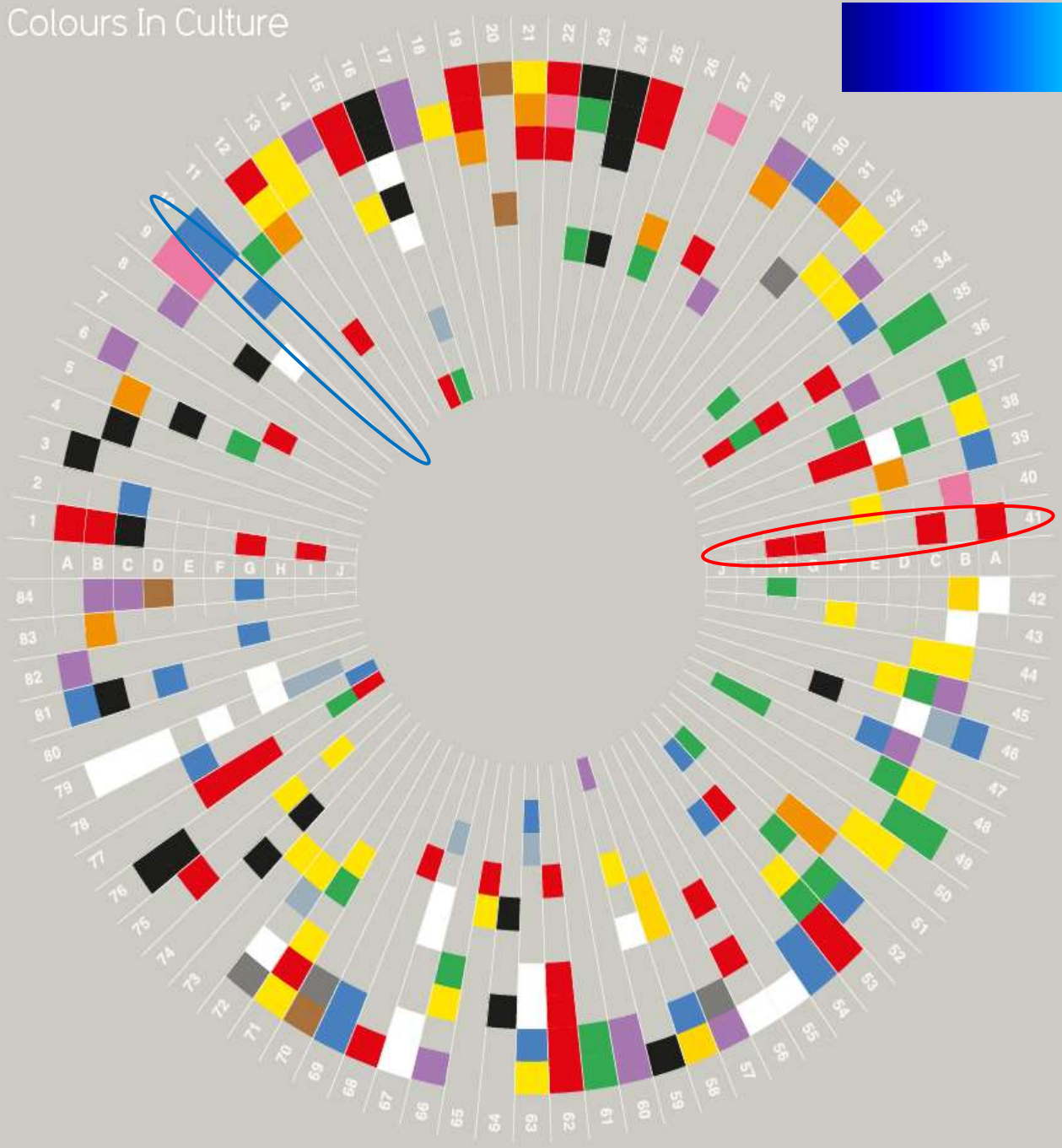


#EndTheRainbow #EndRainbow



Colours In Culture



A Western / American	1 Anger	19 Desire
B Japanese	2 Art / Creativity	20 Earthy
C Hindu	3 Authority	21 Energy
D Native American	4 Bad Luck	22 Erotic
E Chinese	5 Balance	23 Eternity
F Asian	6 Beauty	24 Evil
G Eastern European	7 Calm	25 Excitement
H Muslim	8 Celebration	26 Family
I African	9 Children	27 Femininity
J South American	10 Cold	28 Fertility
	11 Compassion	29 Flamboyance
	12 Courage	30 Freedom
	13 Cowardice	31 Friendly
	14 Cruelty	32 Fun
	15 Danger	33 God
	16 Death	34 Gods
	17 Decadence	35 Good Luck
	18 Deceit	36 Gratitude

37 Growth	55 Luxury	73 Royalty
38 Happiness	56 Marriage	74 Self-cultivation
39 Healing	57 Modesty	75 Strength
40 Healthy	58 Money	76 Style
41 Heat	59 Mourning	77 Success
42 Heaven	60 Mystery	78 Trouble
43 Holiness	61 Nature	79 Truce
44 Illness	62 Passion	80 Trust
45 Insight	63 Peace	81 Unhappiness
46 Intelligence	64 Penance	82 Virtue
47 Intuition	65 Power	83 Warmth
48 Religion	66 Personal power	84 Wisdom
49 Jealousy	67 Purity	
50 Joy	68 Radicalism	
51 Learning	69 Rational	
52 Life	70 Reliable	
53 Love	71 Repels Evil	
54 Loyalty	72 Respect	

Yellow Grey
Gold Silver

source: Pantone, ColorMatters & web sources

#EndTheRainbow #EndRainbow

"We undertake this pledge – **to never again** be an **author** on a paper which uses **a rainbow colour scale.**"

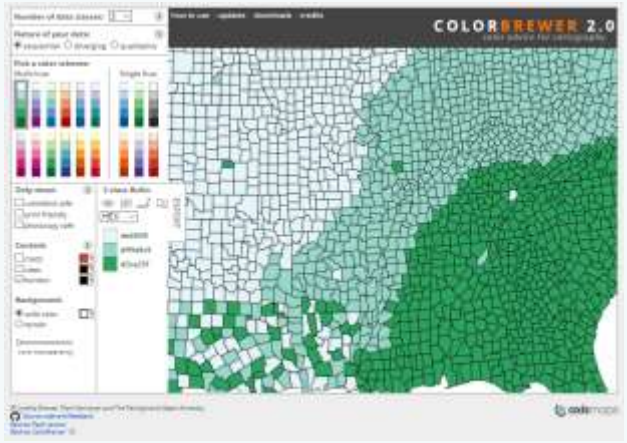
Open Letter to Climate Science, University of Reading

#EndTheRainbow #EndRainbow

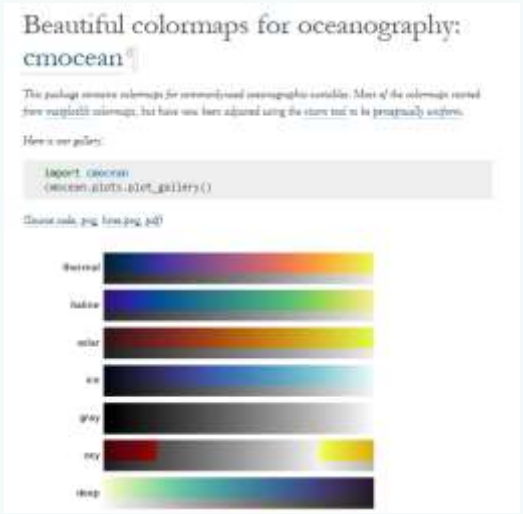
"Gonna make a difference
Gonna make it right"

Michael Jackson, Man in the Mirror (1988)

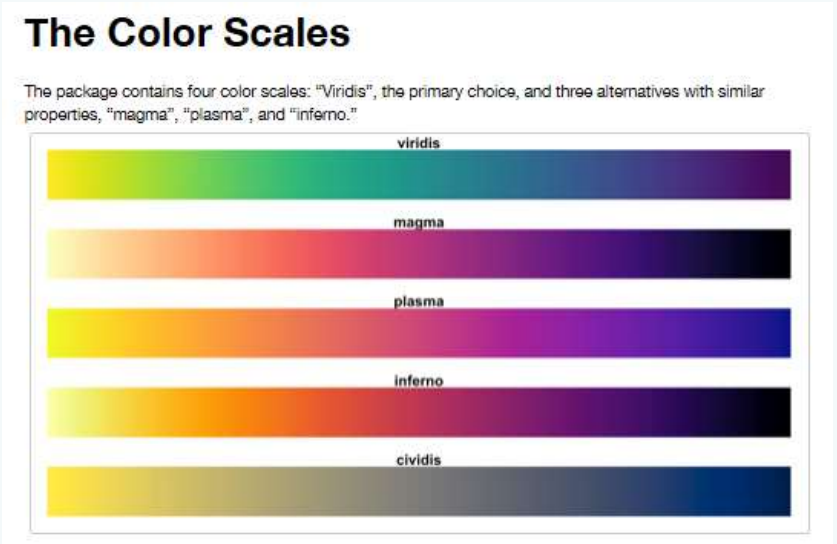
#EndTheRainbow #EndRainbow



Library(RColorBrewer)

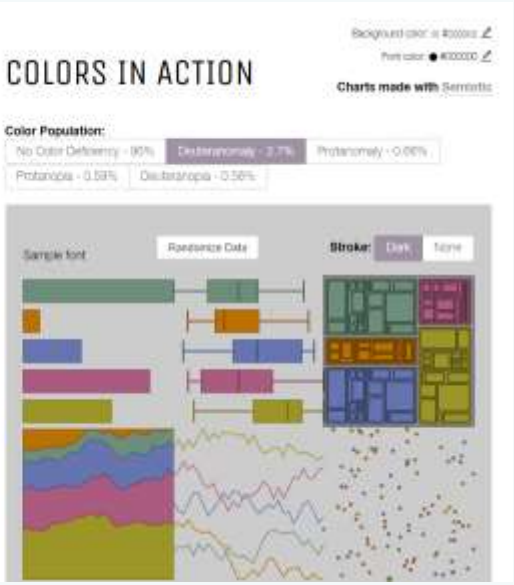


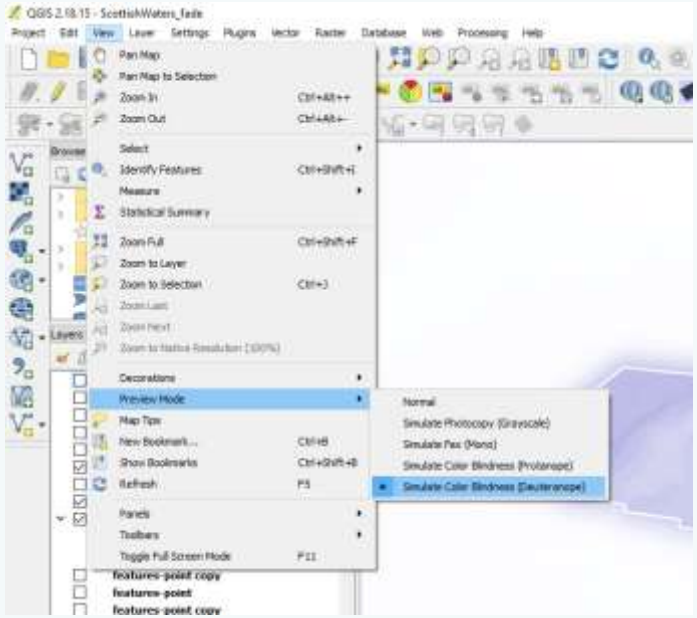
Library(oce)



Library(viridis)

#EndTheRainbow #EndRainbow





cvd_emulator

From colorspace v1.4-0

15th Percentile

Graphical User Interface To Check Images For Color Constraints

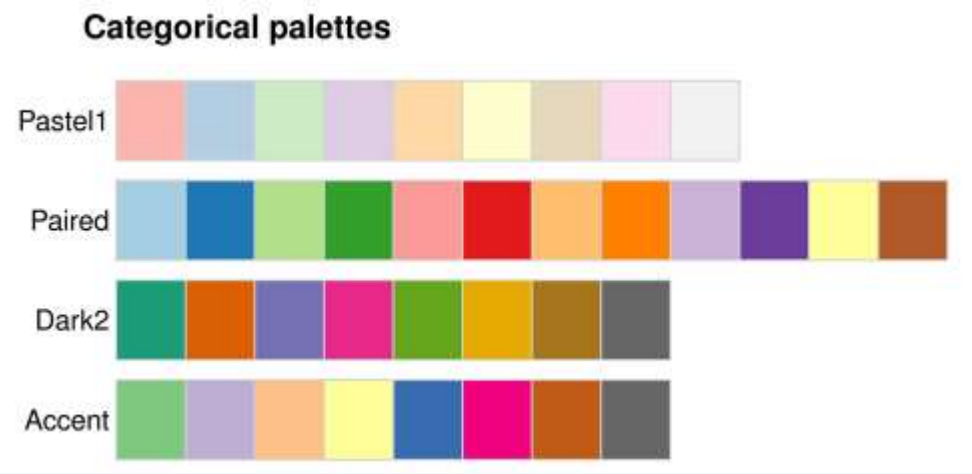
A graphical user interface (GUI) to check an existing jpg/png image for (possible) color constraints. The image will be converted to protanope vision, deuteranope vision, and a desaturated version (monochromatic vision). Allows a rapid check whether the colors used in the image show some constraints with respect to color deficiency or color blindness.

Usage

```
cvd_emulator(file, overwrite = FALSE, shiny.trace = FALSE)
```

#EndTheRainbow #EndRainbow

- If there is **no natural order** to data, do you have to use colour?
- If so, use a **qualitative** scheme

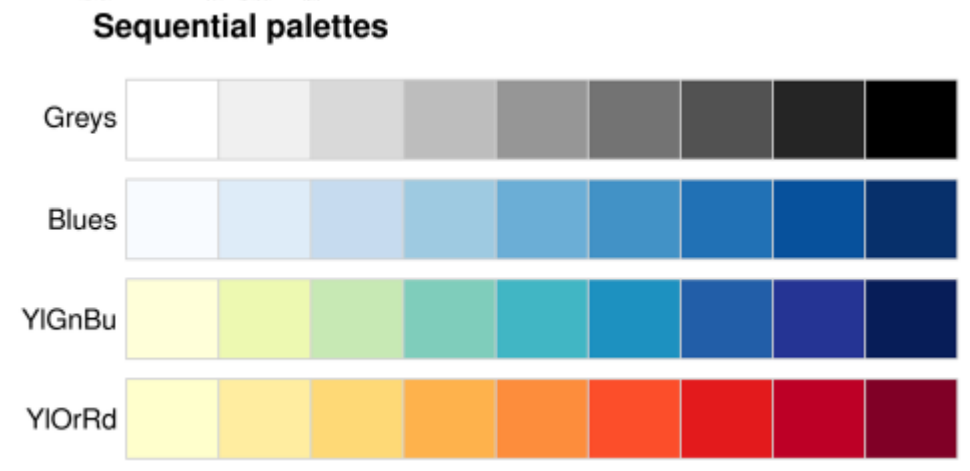


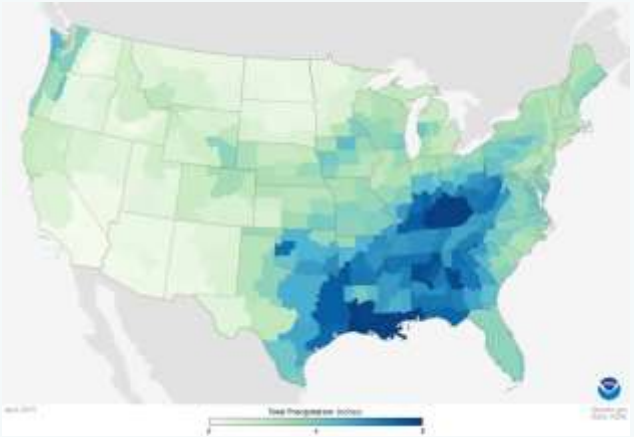
- Sometimes aren't colourblind friendly.

Library(RColorBrewer)
display.brewer.all(n=NULL, type="**qual**", select=NULL, exact.n=TRUE, colorblindFriendly=**TRUE**)

#EndTheRainbow #EndRainbow

- If data is **ordered in one direction**, use a **sequential** scheme

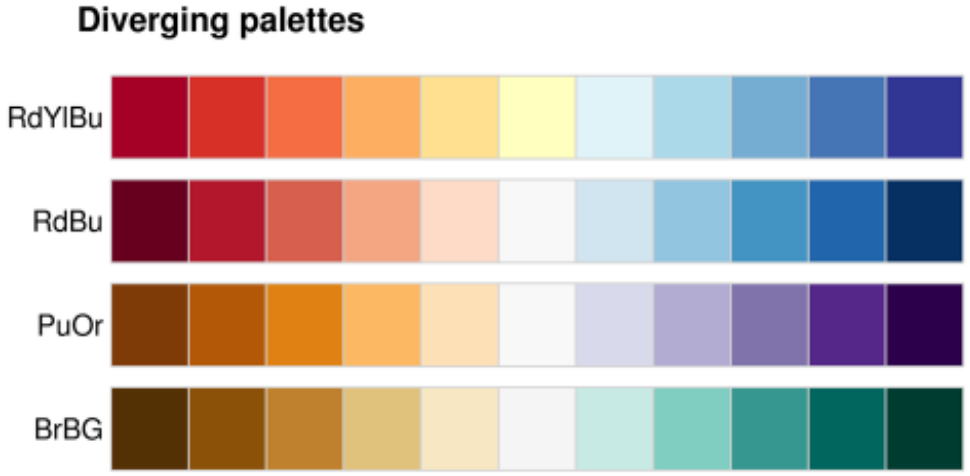


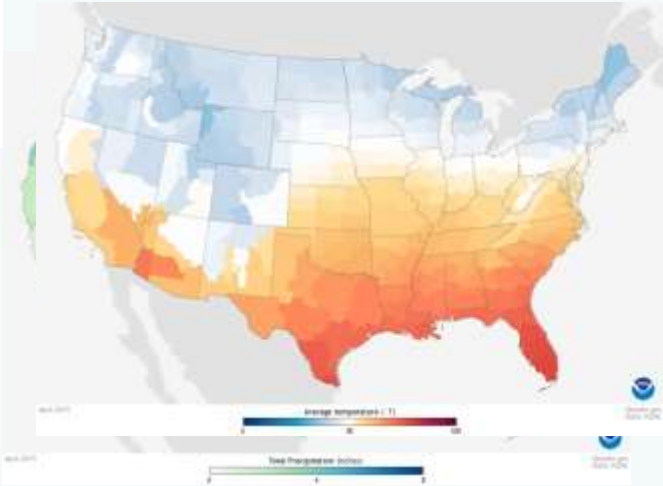


Library(RColorBrewer)
display.brewer.all(n=NULL, type="**seq**", select=NULL, exact.n=TRUE, colorblindFriendly=**TRUE**)

#EndTheRainbow #EndRainbow

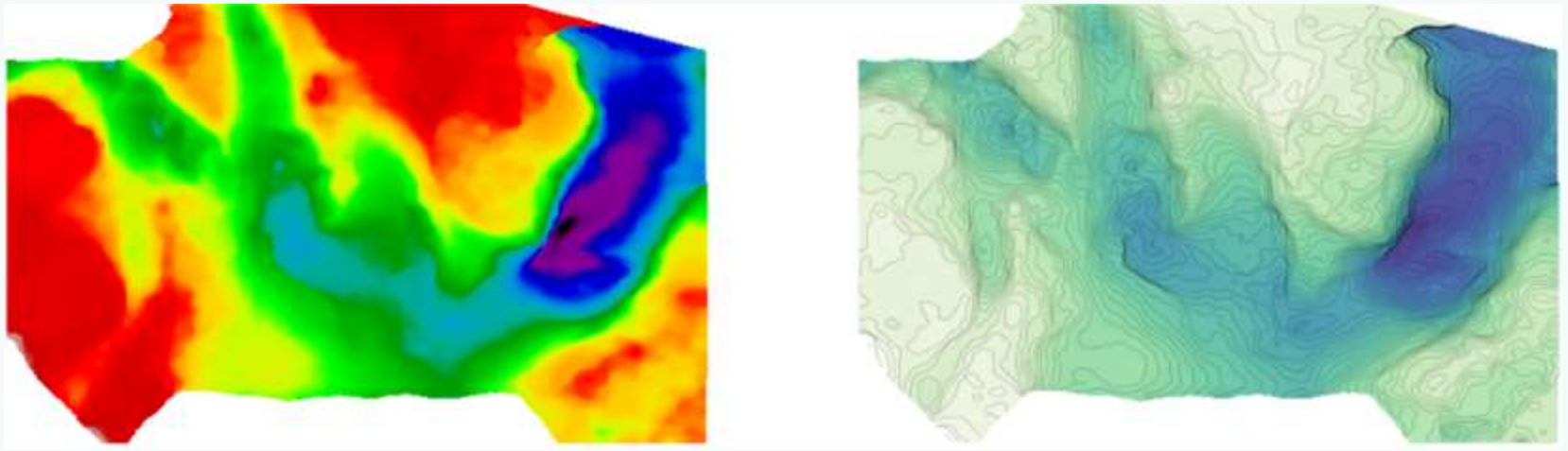
- If data can be divided **above and below a meaningful breakpoint**, use a **diverging** colour scheme





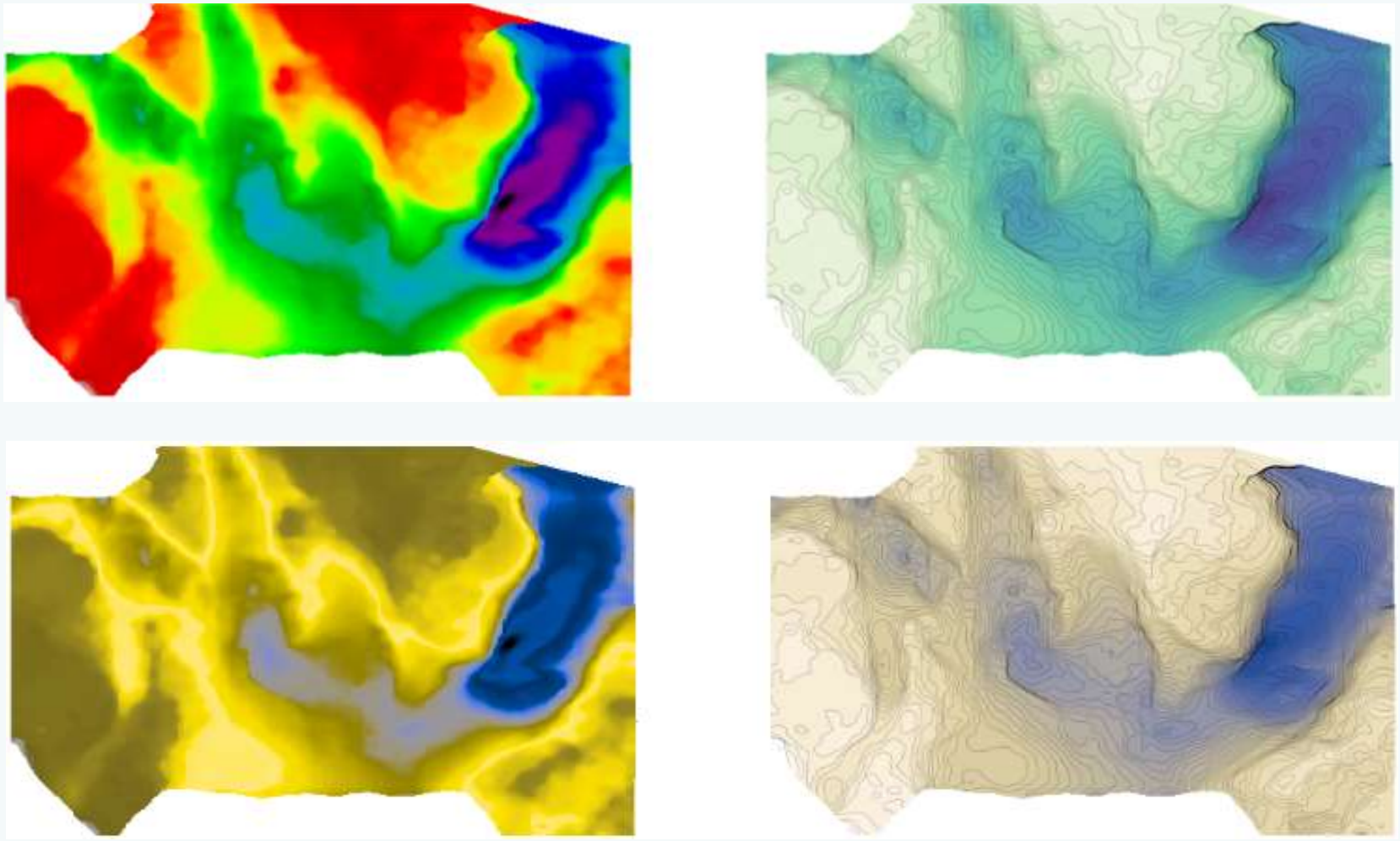
Library(RColorBrewer)
display.brewer.all(n=NULL, type="**div**", select=NULL, exact.n=TRUE, colorblindFriendly=**TRUE**)

#EndTheRainbow #EndRainbow



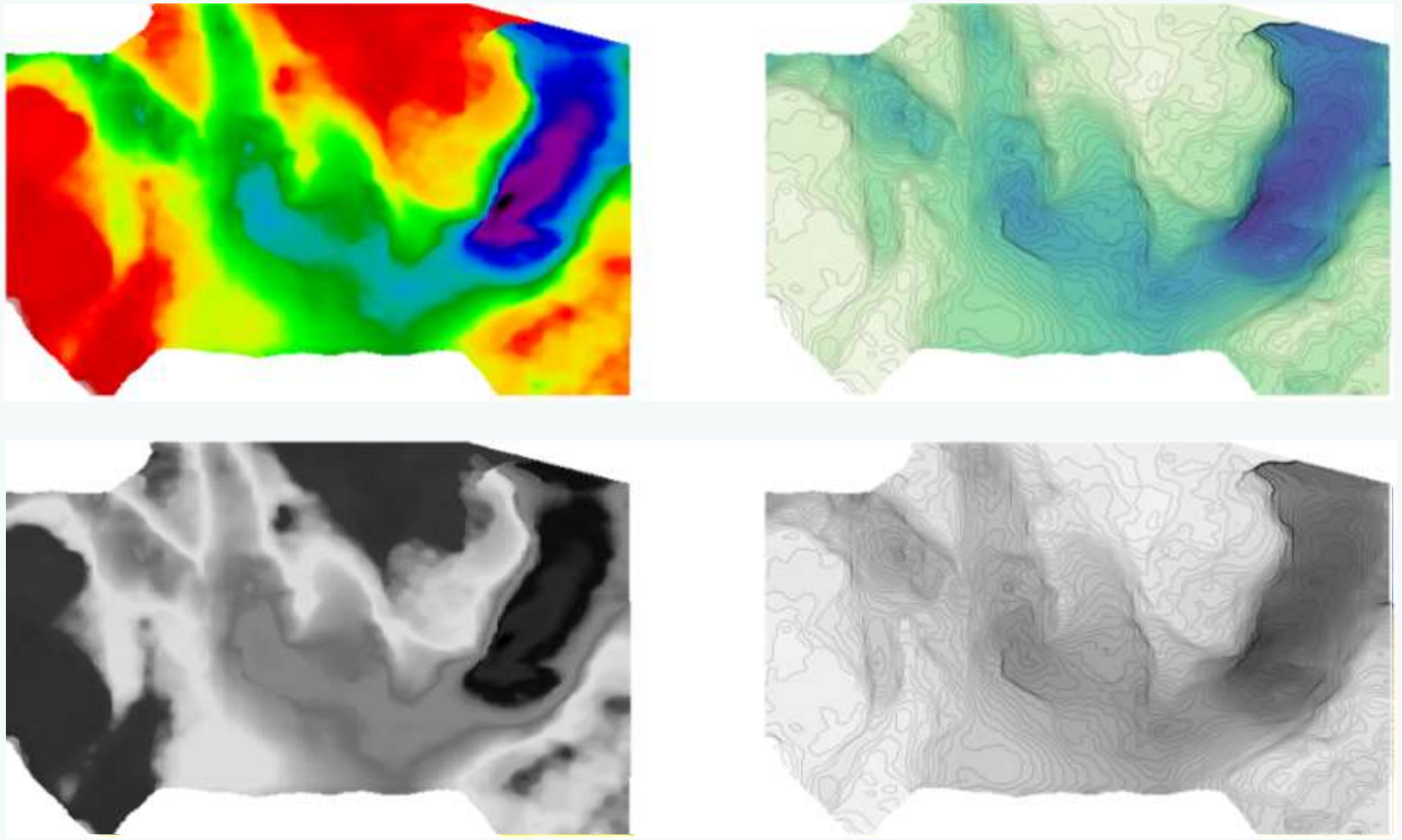
Images from Agile Scientific

#EndTheRainbow #EndRainbow



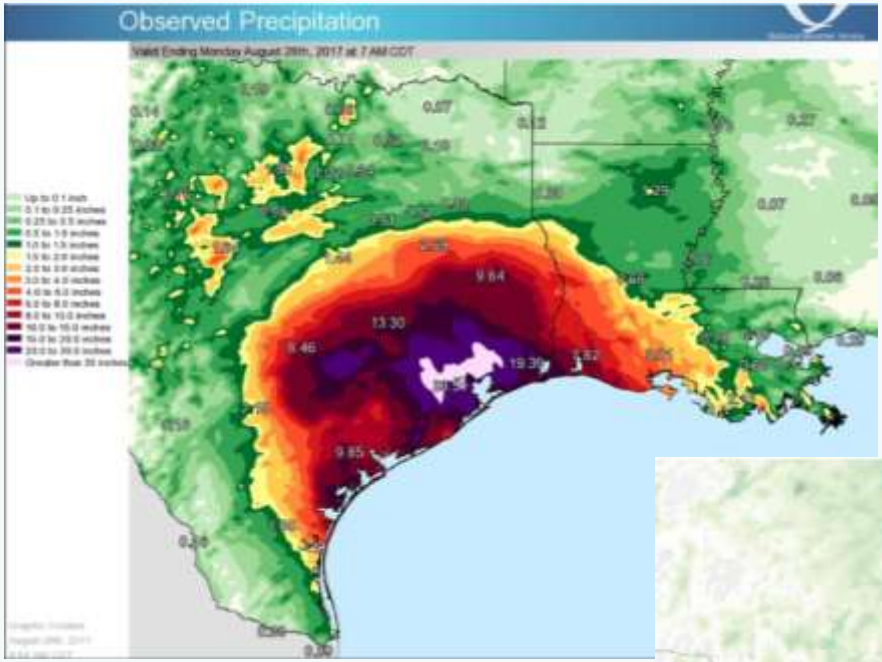
Images from Agile Scientific

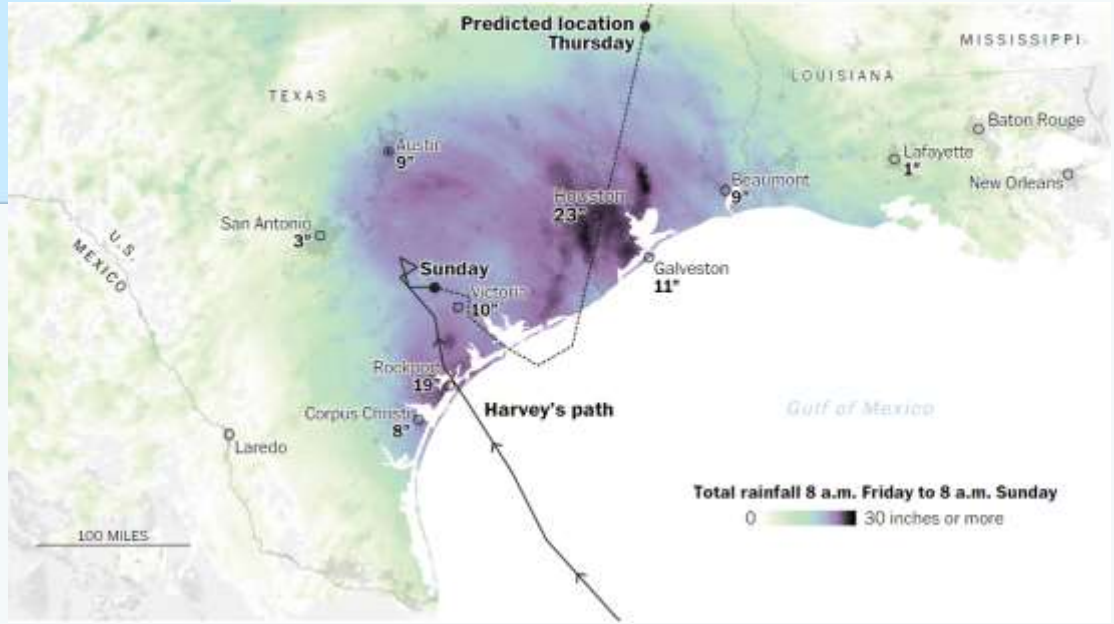
#EndTheRainbow #EndRainbow



Images from Agile Scientific

#EndTheRainbow #EndRainbow





New York Times rendition of same source data (different day)

#EndTheRainbow #EndRainbow

- Don't be afraid to use **greyscale** or **no colour**
- Use **colour-blind friendly palettes** eg
  - Colorbrewer
  - Viridis
- Avoid **red/green** schemes
- Check images using a **colour vision simulator**
- Use alternative **visual encoding**
  - Contours
  - Shapes / Symbols

#EndTheRainbow #EndRainbow

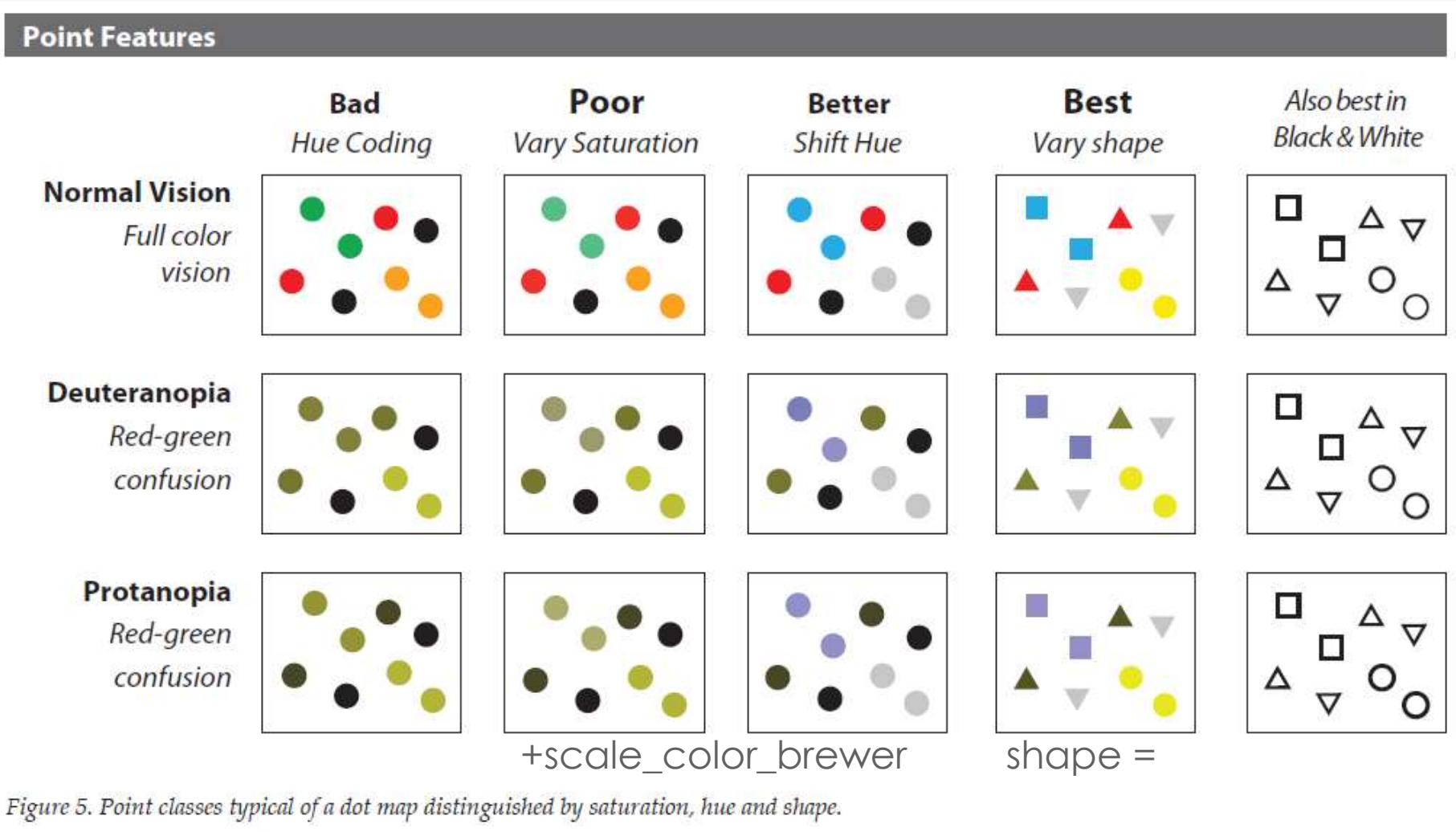


Figure 5. Point classes typical of a dot map distinguished by saturation, hue and shape.

Images from "Color Design for the Color Vision Impaired" (Bernhard Jenny & Nathaniel Vaughn Kelso, 2007)

#EndTheRainbow #EndRainbow

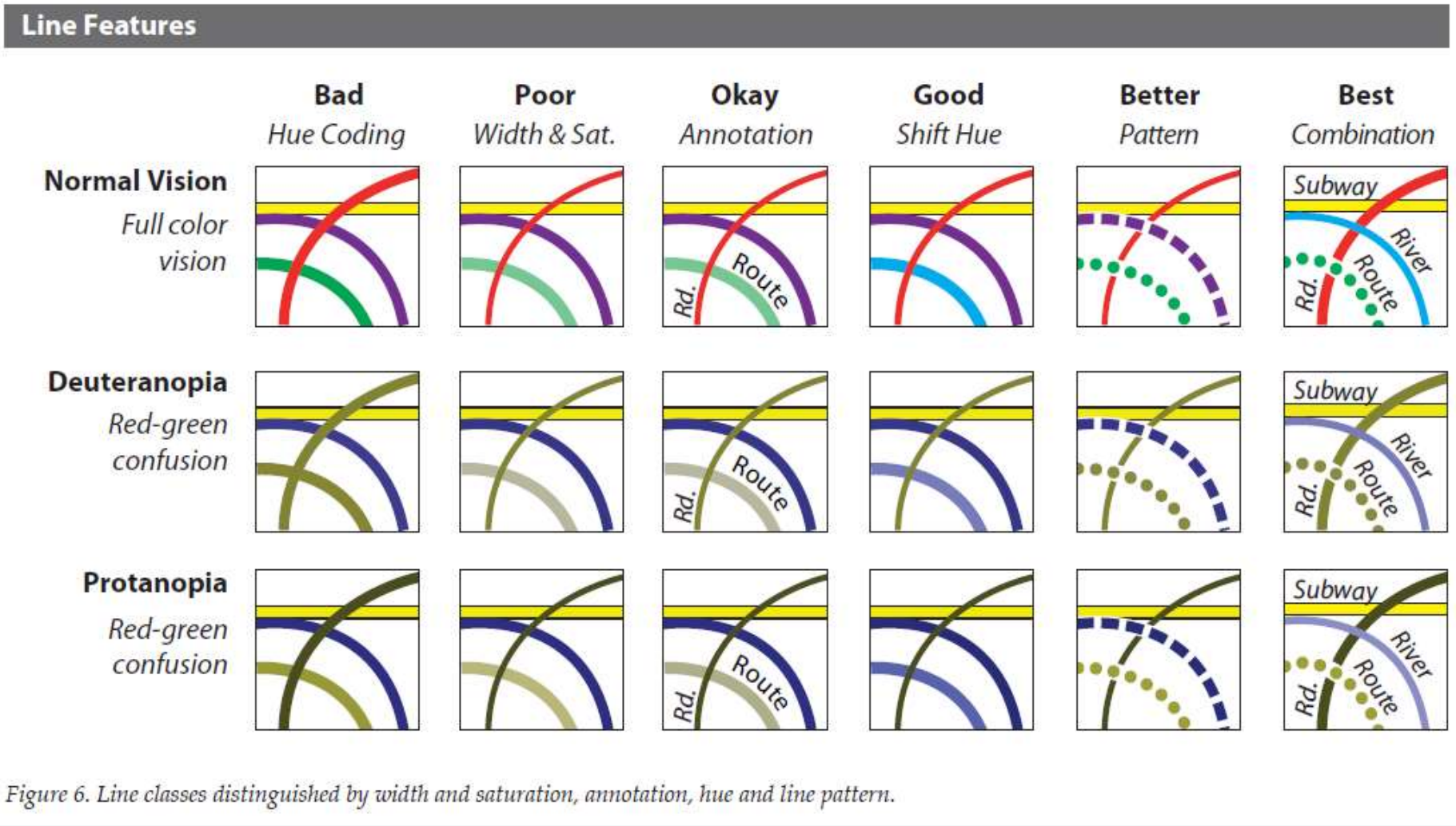


Figure 6. Line classes distinguished by width and saturation, annotation, hue and line pattern.

Images from "Color Design for the Color Vision Impaired" (Bernhard Jenny & Nathaniel Vaughn Kelso, 2007)

Sources and tools

- Climate Lab Book http://www.climate-lab-book.ac.uk/
- Office of National Statistics: Using Colour https://style.ons.gov.uk/category/data-visualisation/using-colours/
- Coblis Colour Blindness Simulator http://www.color-blindness.com/coblis-color-blindness-simulator/
- Viz Palette http://projects.susielu.com/viz-palette
- ColorBrewer http://colorbrewer2.org/
- Ordnance Survey: GeoDataViz Tools https://github.com/OrdnanceSurvey/GeoDataViz-Toolkit

Blogs

- Dark Horse Analytics: Data Looks Better Naked http://www.darkhorseanalytics.com/blog/
- Agile Scientific https://agilescientific.com/blog/
- MapTime Boston: Cartographic Design https://github.com/maptimeBoston/cartographic-design