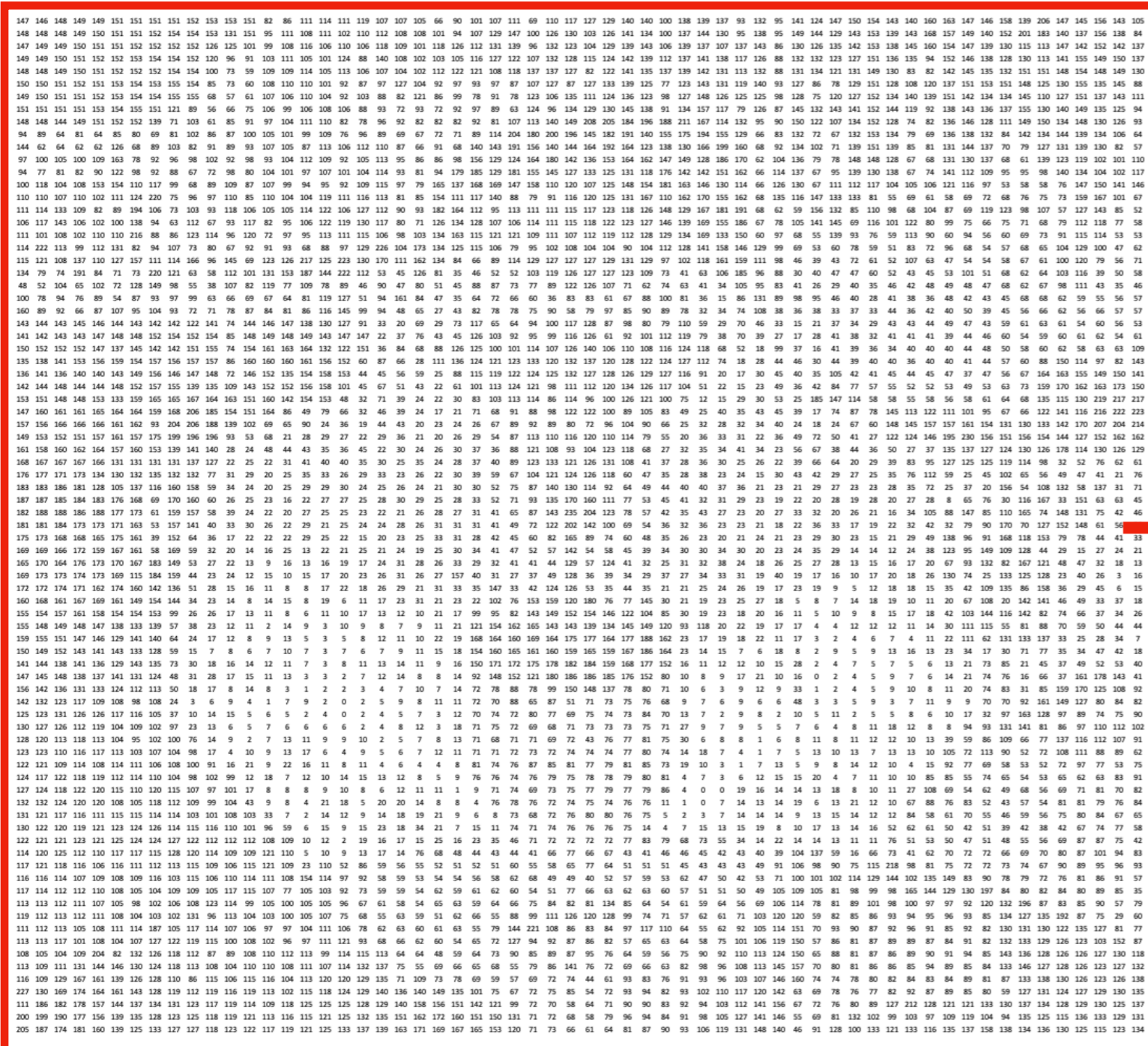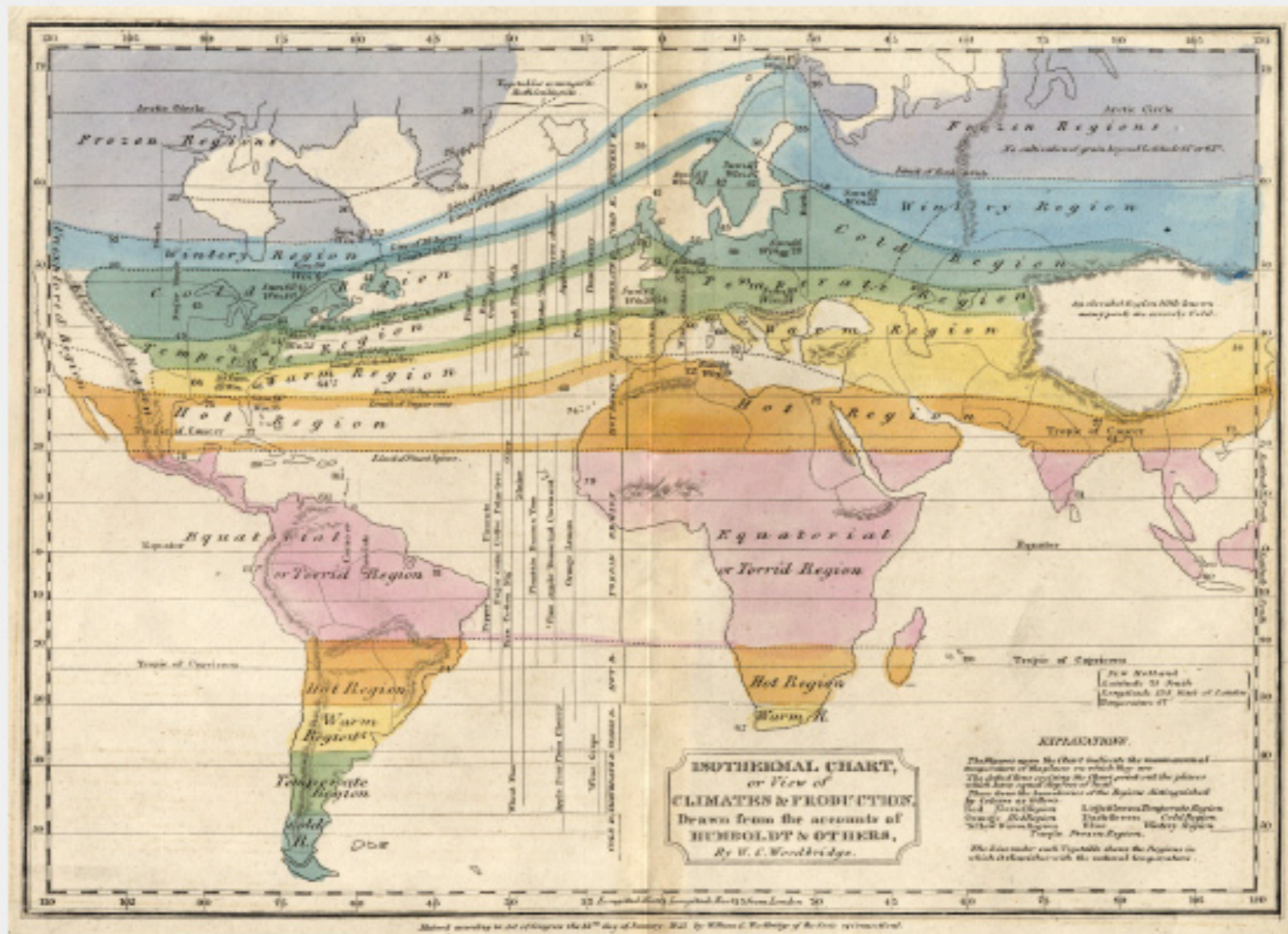# COLORS

in scientific communication

Baptiste Lafoux — May 2022

Vassily Kandinsky, 1913 - *Color Study, Squares with Concentric Circles*

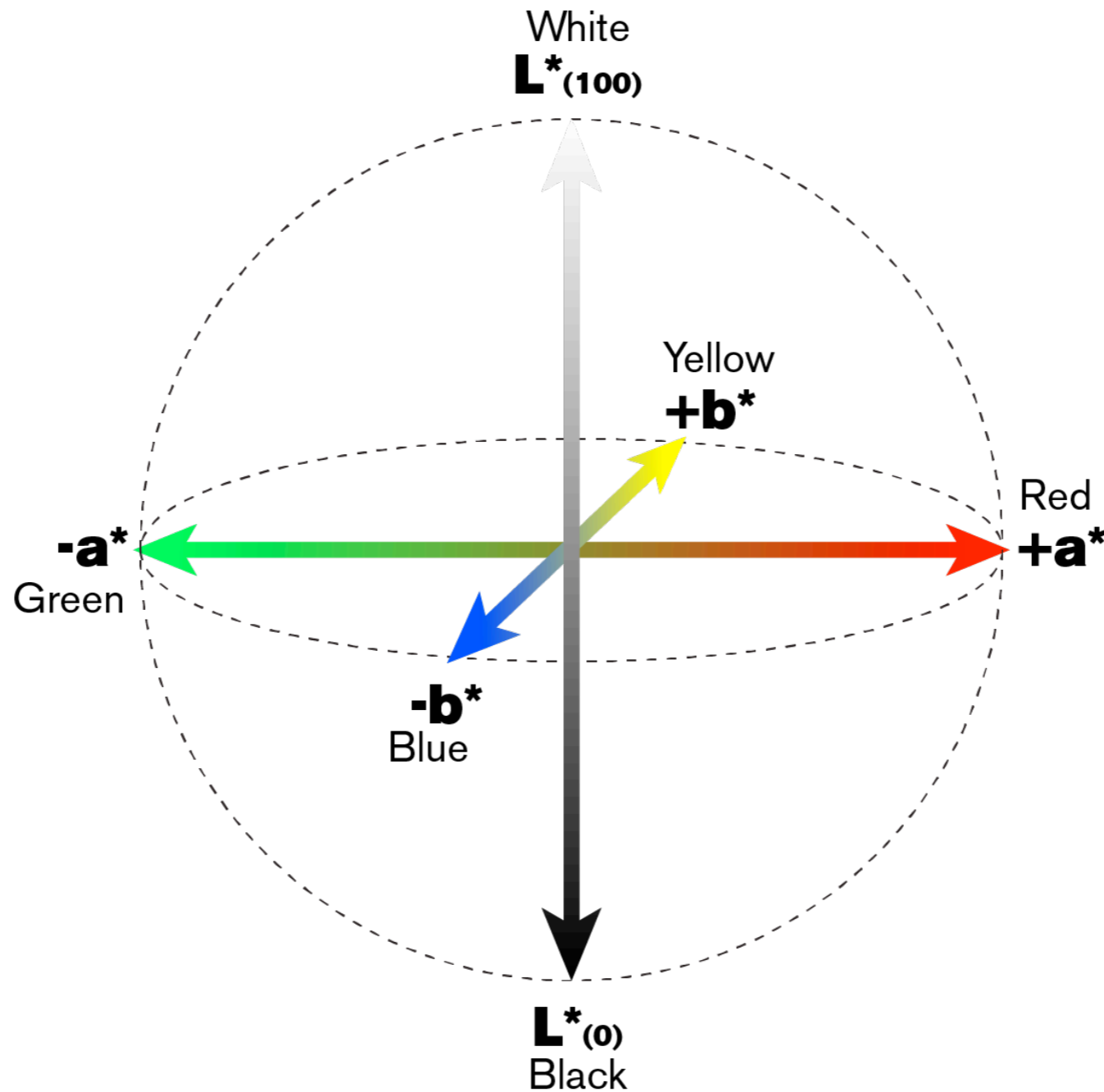# Why are color(maps) useful ?

We've being using colormaps for a long time
Sometimes poorly

1823 map [W. C. Woodbridge] → early example of a (bad) use of colors to represent numbers

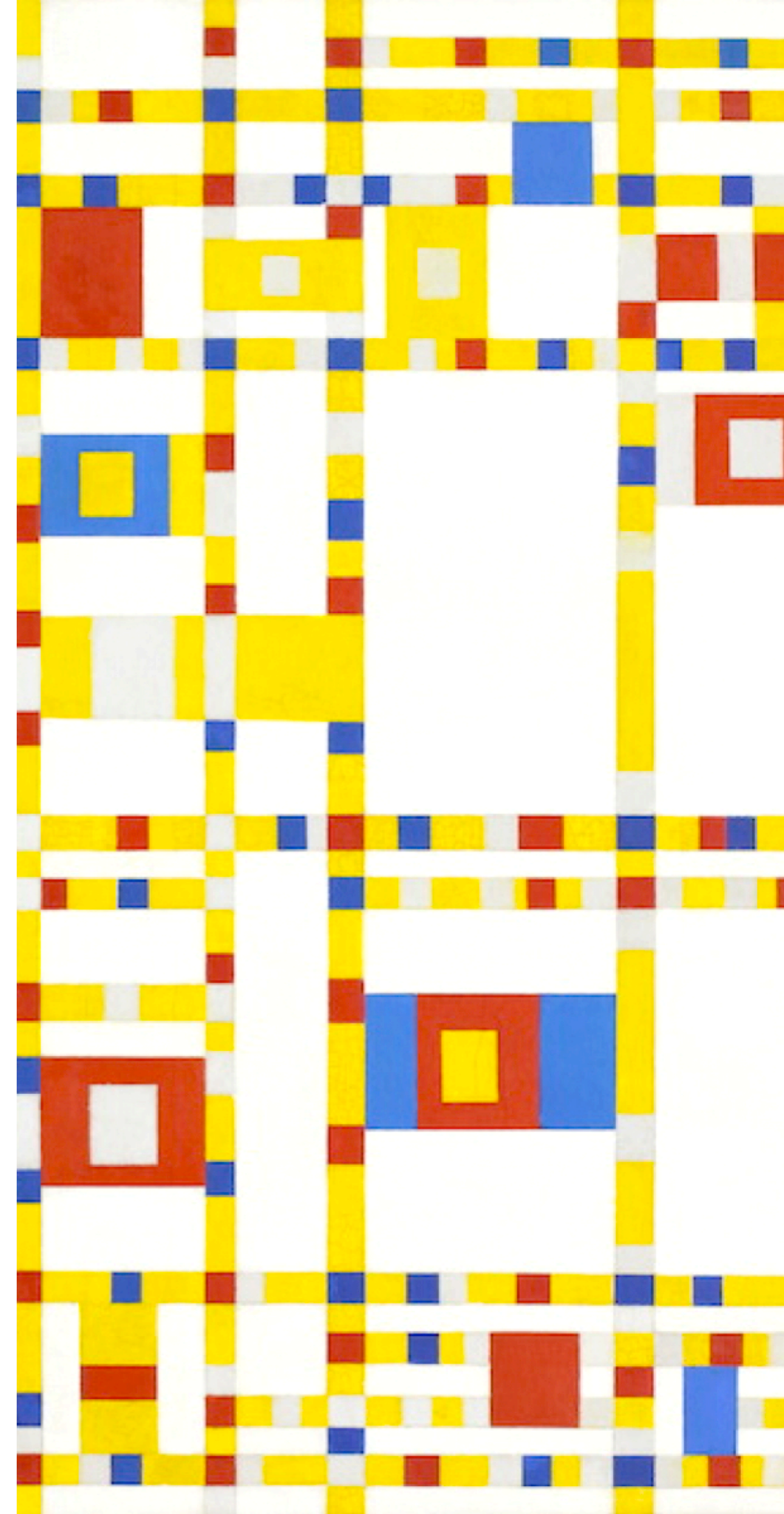# Color representation
The CIELAB or HSL color spaces

Overview

- The terrible **jet** colormap

- How to chose wisely a better colormap

- Ressources

To be continued

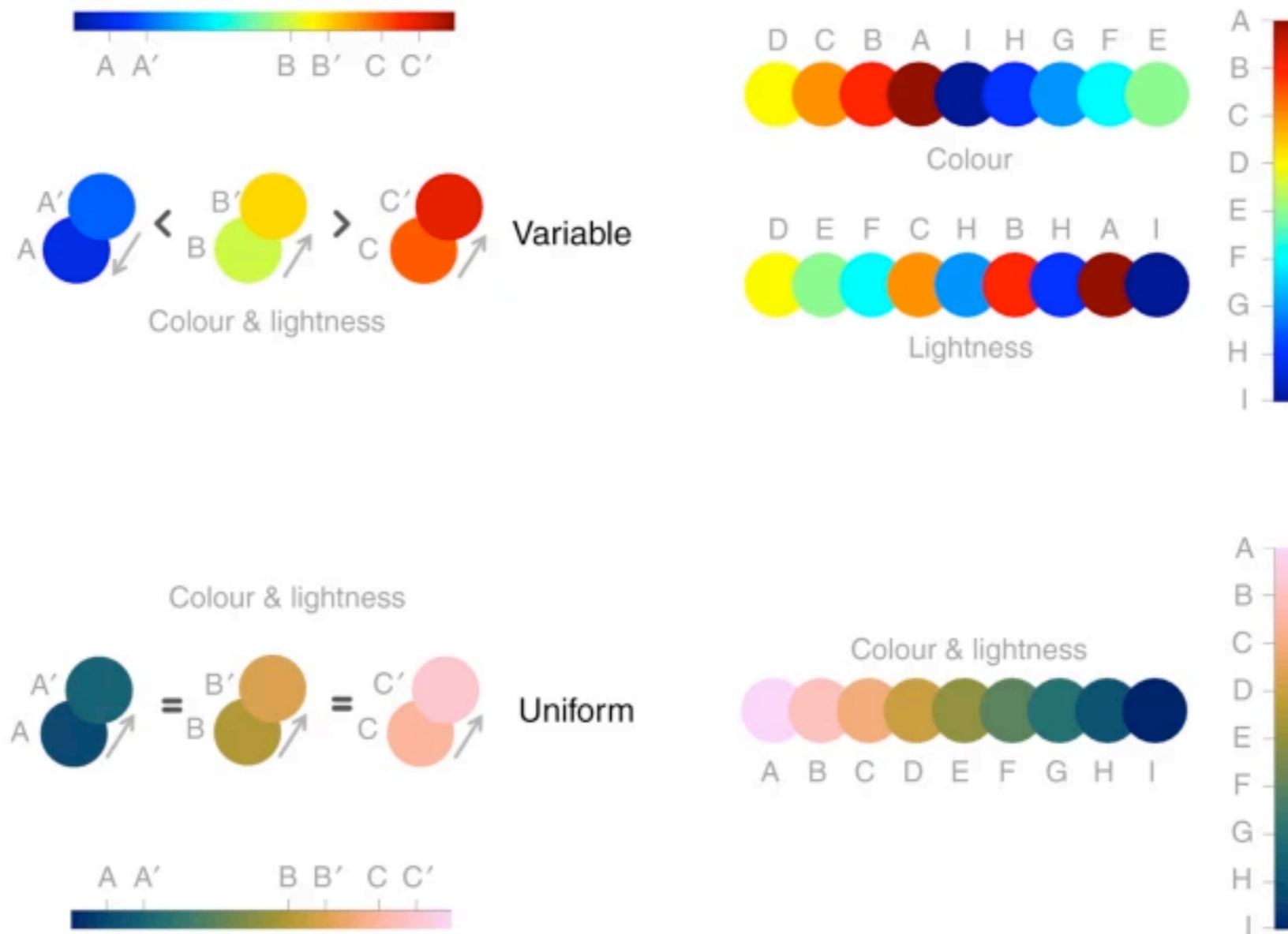- Be colorblind friendly

- Maybe **grey** is a good option ?

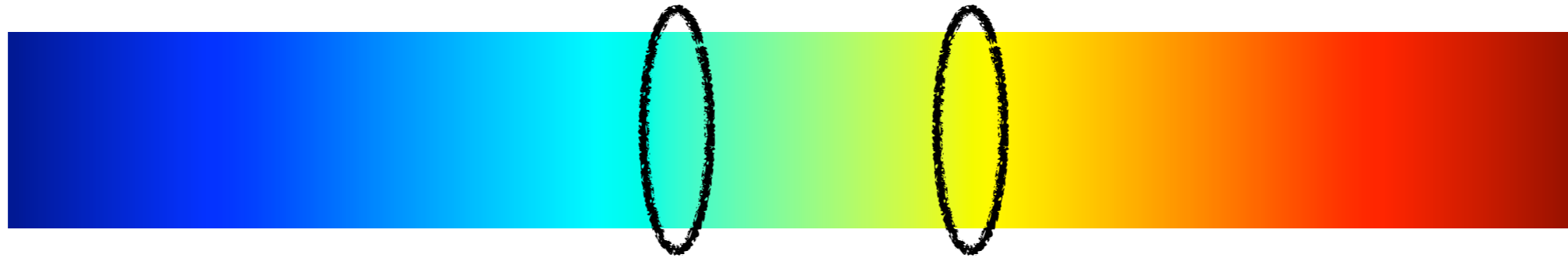# Why you should not use `jet`

Never

Ever. Stop that.

Perceptually uniform colormaps

Crameri et al. (2020). Nature communications

equal steps in data are perceived as **equal steps in the color space**

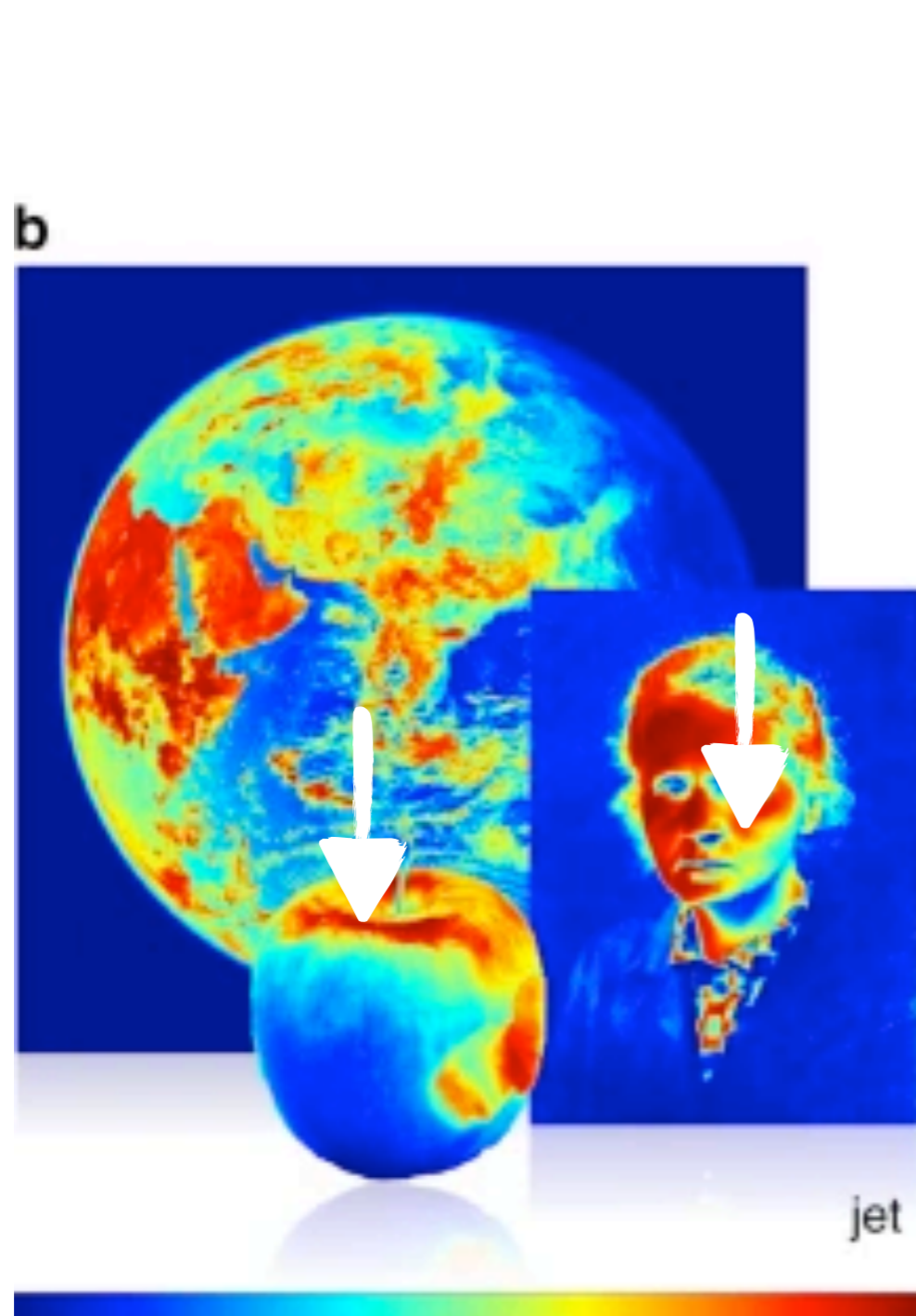# `jet` (aka the rainbow) is deeply *flawed*

- Jet is **not** *perceptually uniform*

Why is that an issue ?

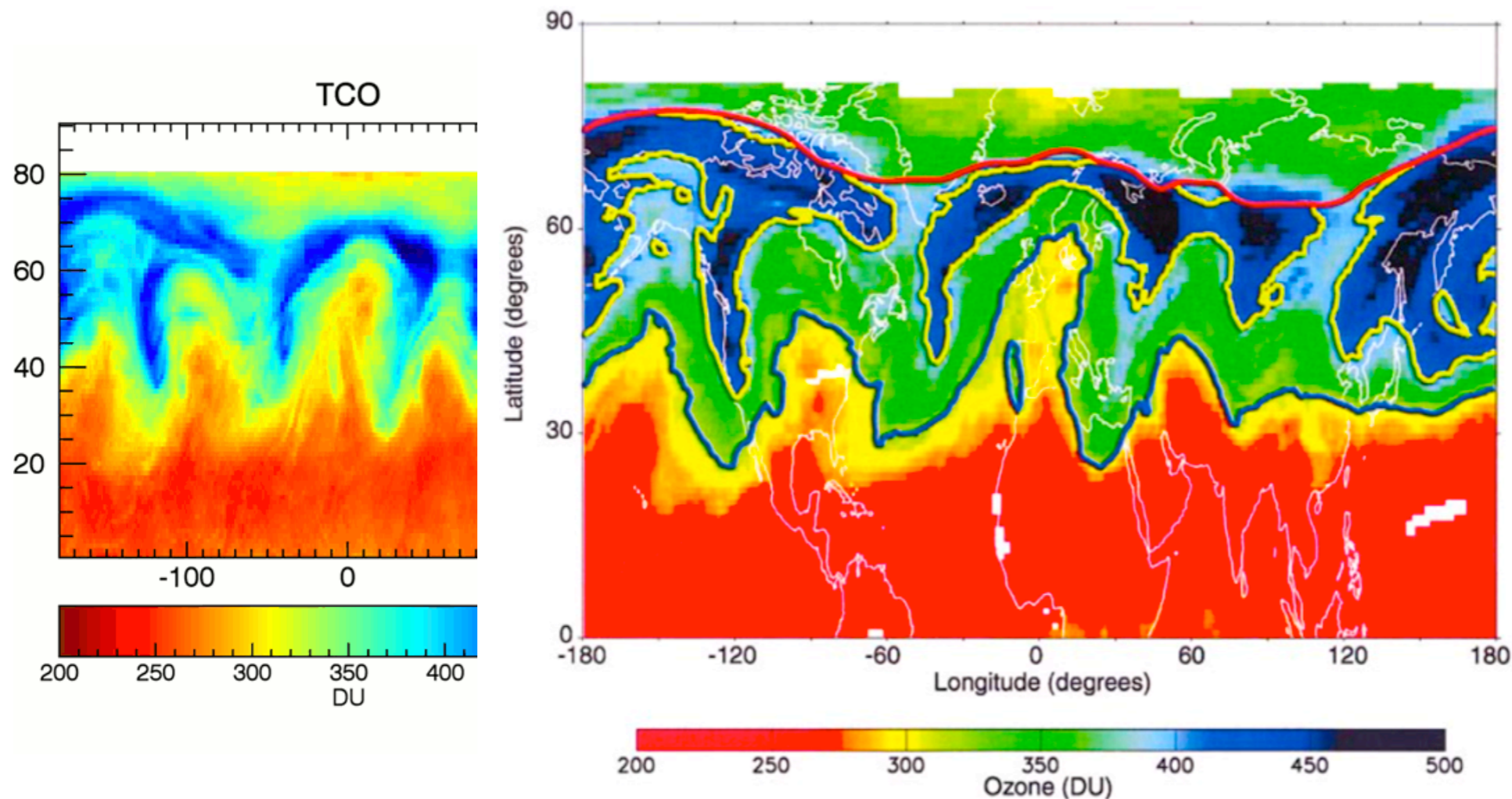jet **creates crazy gradients where there should be none**

(also it's ugly)

Crameri et al. (2020). Nature communications

`jet` **can thus be misleading**
An example

Hudson et al. *Atmos. Chem. Phys.*, 2006 → 152 citations
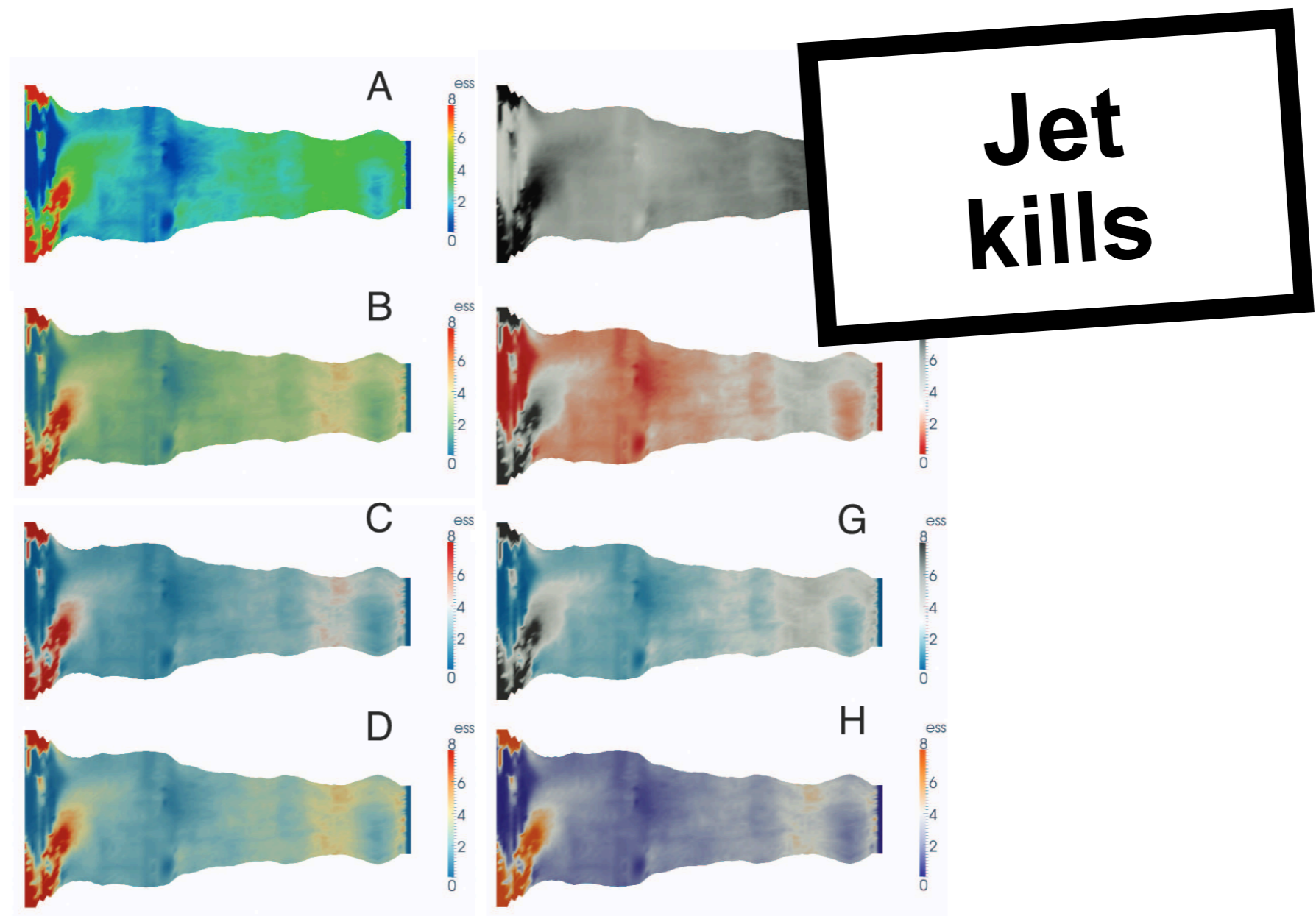
They identified a « front in the spatial ozone field »

TCO : Total Column Ozone — DU : Dobson unit
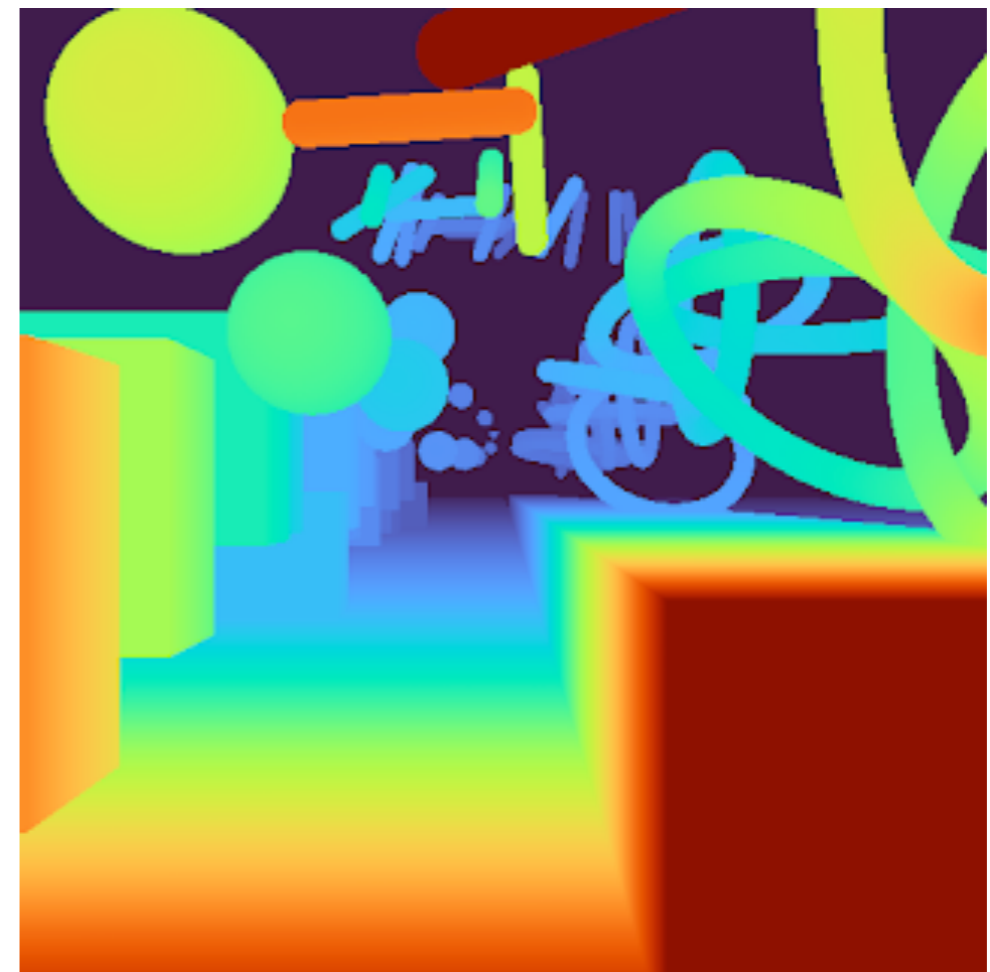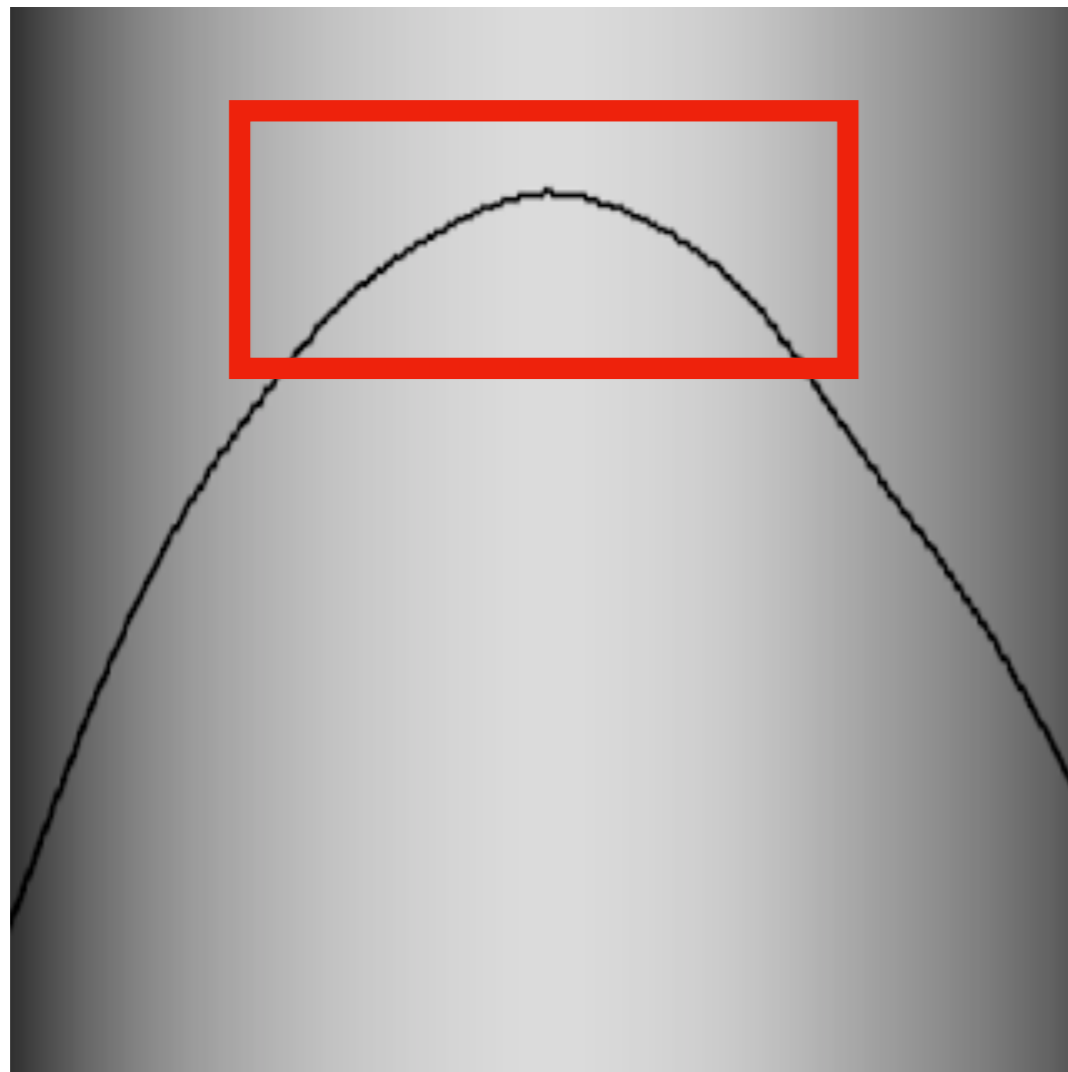
`jet` **is even bad for your health !**

M. Borkin et al., IEEE Visualization and Computer Graphics, 2011

Caronoray arteries imagery
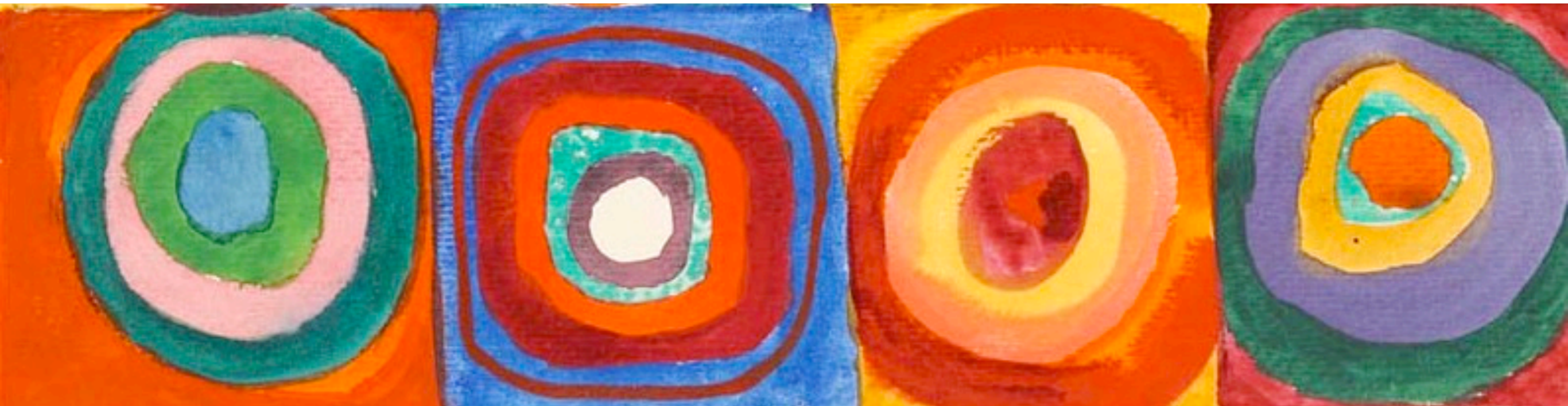Significantly slower diagnosis + more errors with jet

A (partial) solution

turbo **colormap —if you *really* want to use the rainbow**

(still ugly and problematic)

How to chose
a colormap ?

Disclaimer
Reference/inspiration article

Crameri, F., Shephard, G. E., & Heron, P. J. (2020). The misuse of colour in science communication. *Nature communications*

STEP 1— categorize your dataset

A dataset can be

- **Sequential** [energy, norm of anything]

- **Multisequential** [terrain elevation (water + ground)]

- **Diverging** [curl, velocity, temperature, elevation]

- **Cyclic** [angle, phase]

- **Categorical** [votes, anything unordered]

STEP 2— Variations/noise ?
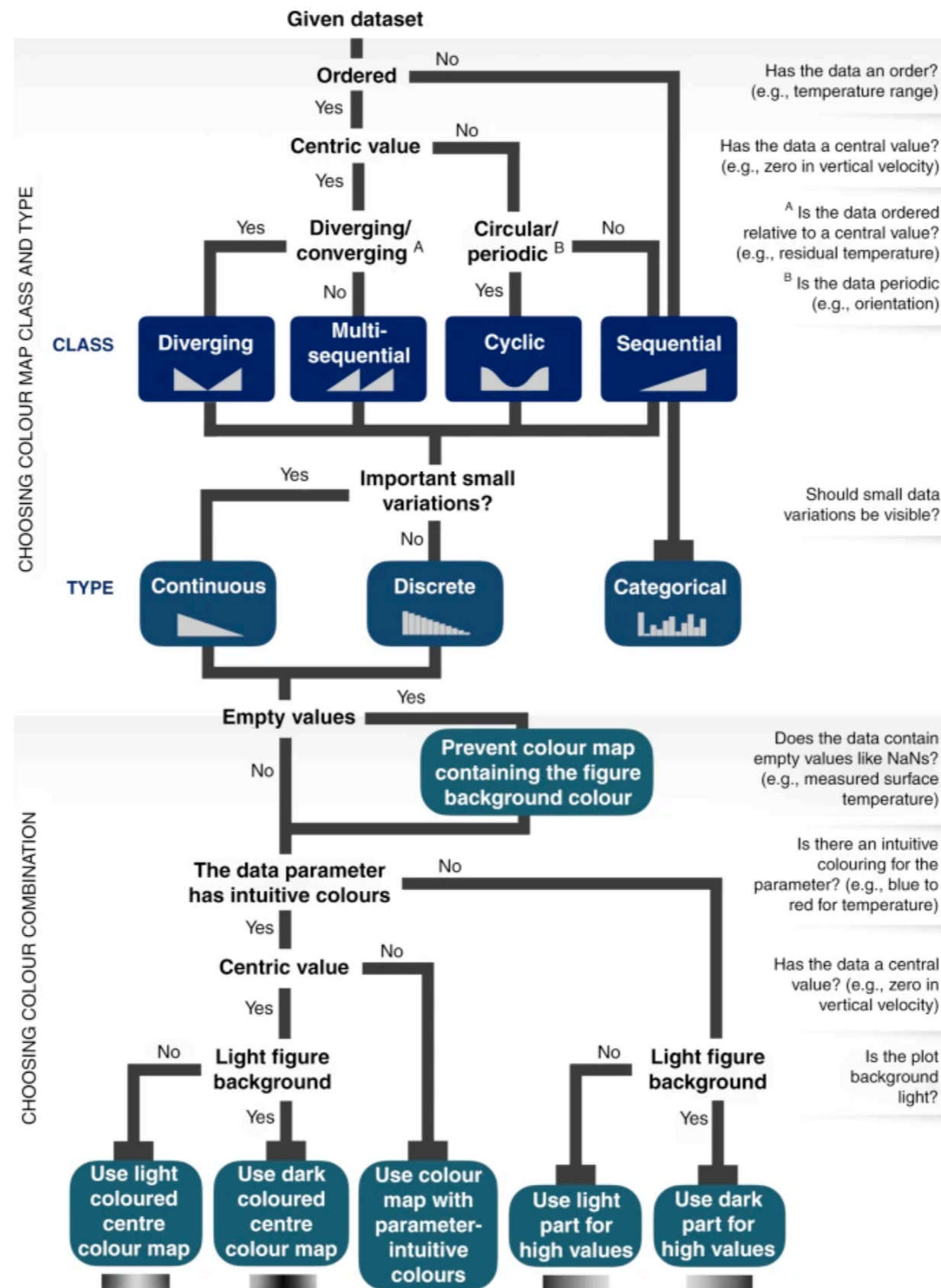
If there is a lot of small variations — **continuous**

otherwise — **discrete**

STEP 3— other attention points

- **If NaNs** : avoid a colormap containing same color as the background

- Use **intuitive colors** (*e.g* red → blue for T°, blue for water and brown for ground, etc…)

- Consider the **background color** :

  - if bg is **dark** : high values are light
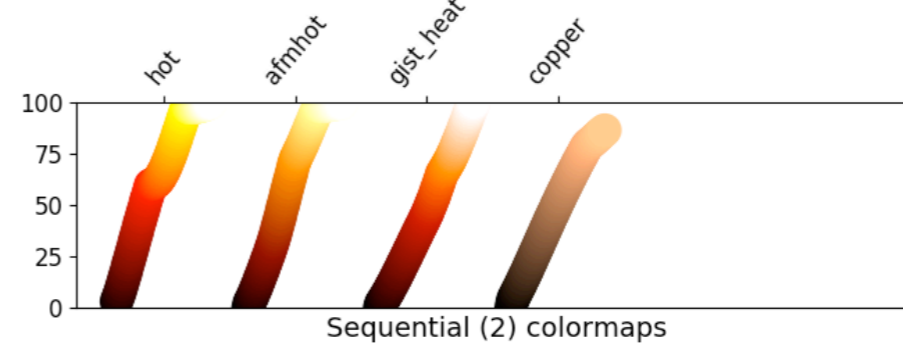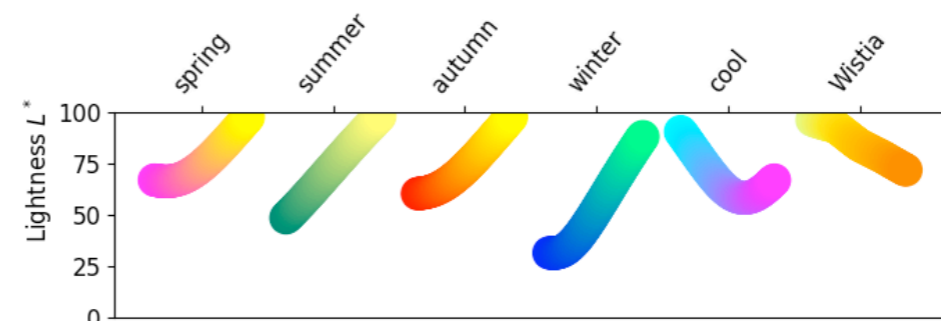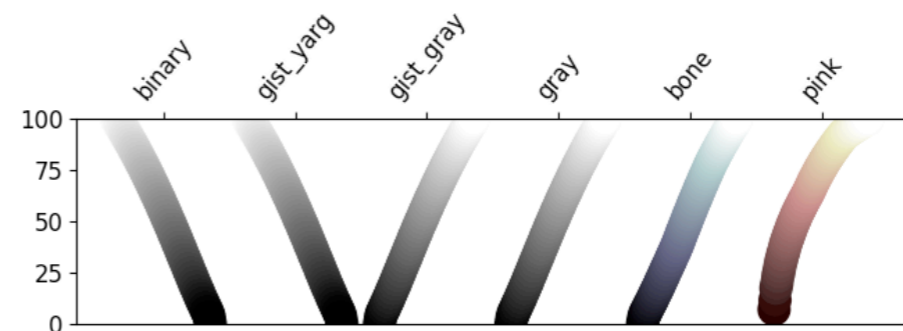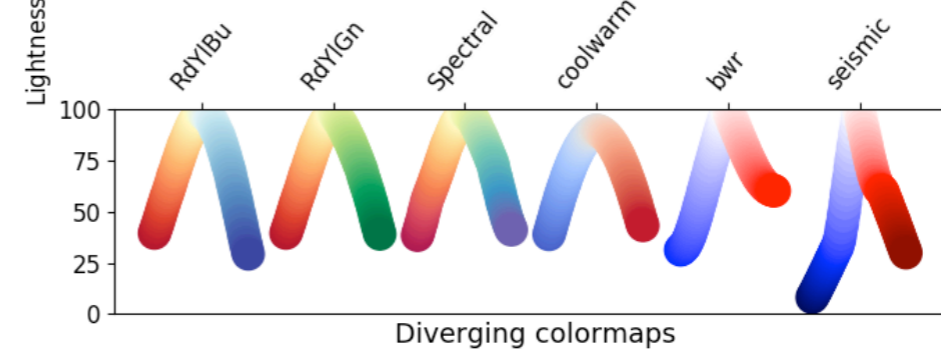
  - if bg is light : high values are **dark**

A summary

Some ressources
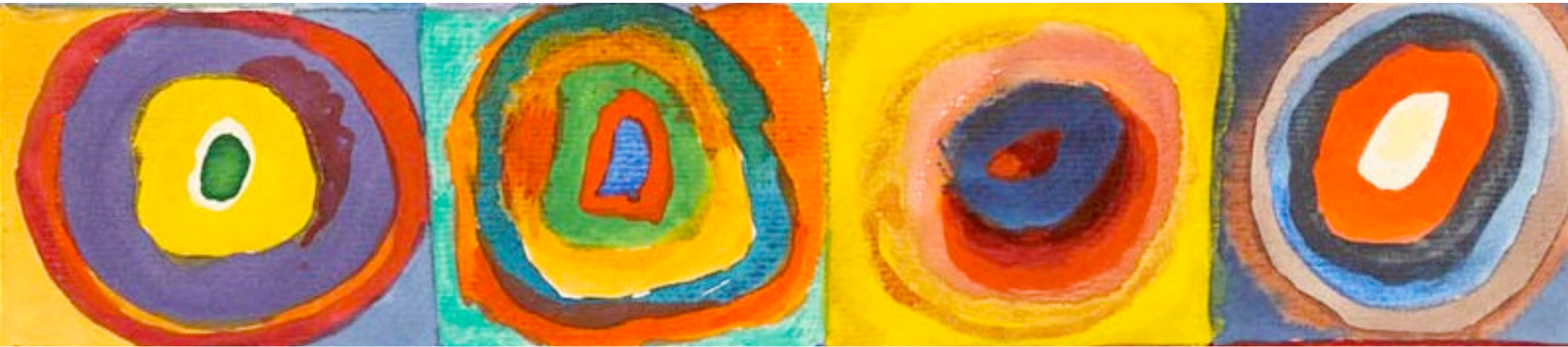
Matplotlib colormaps
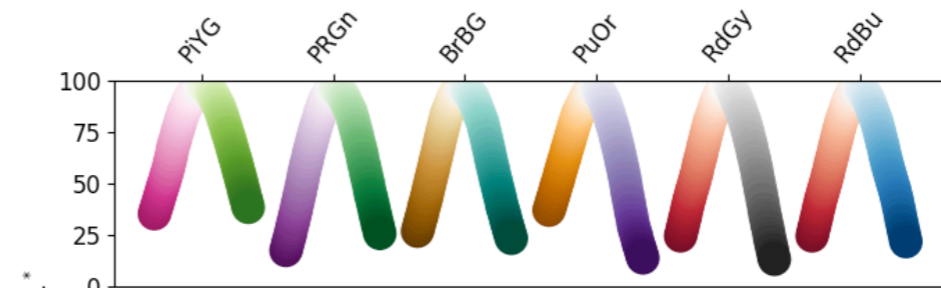
→ **already quite good !**

Ressources

cmocean 1/2

https://matplotlib.org/cmocean/

- Exists for Python, Matlab, R, etc…

FESOM
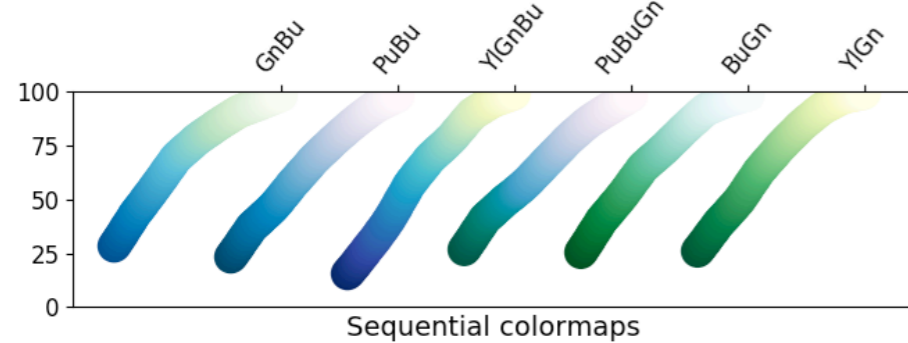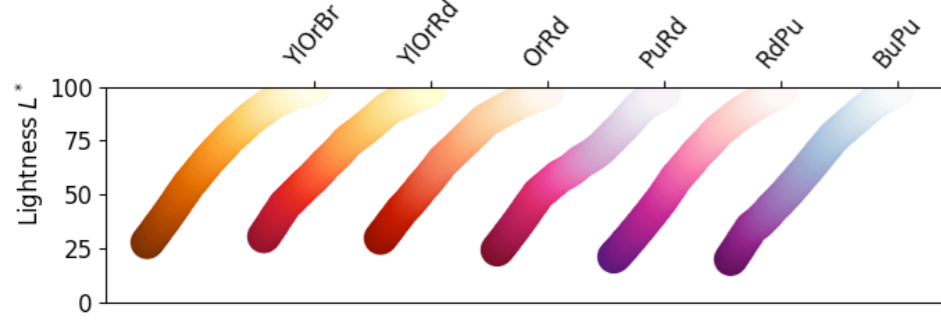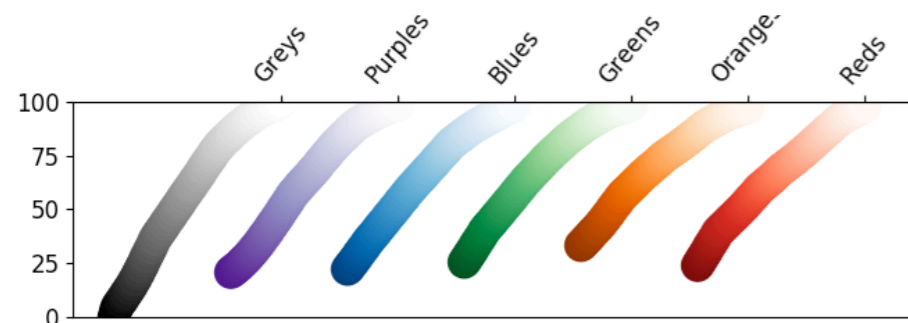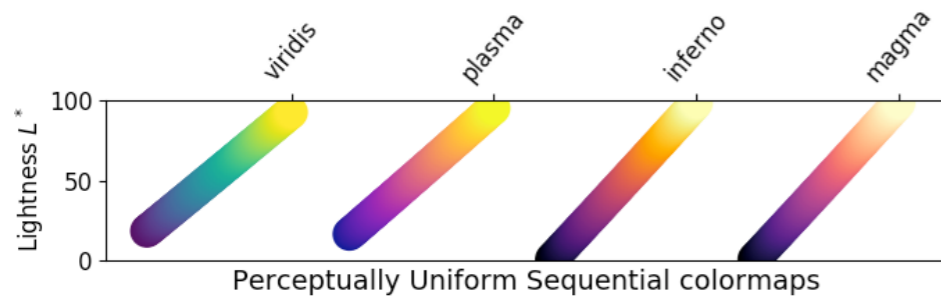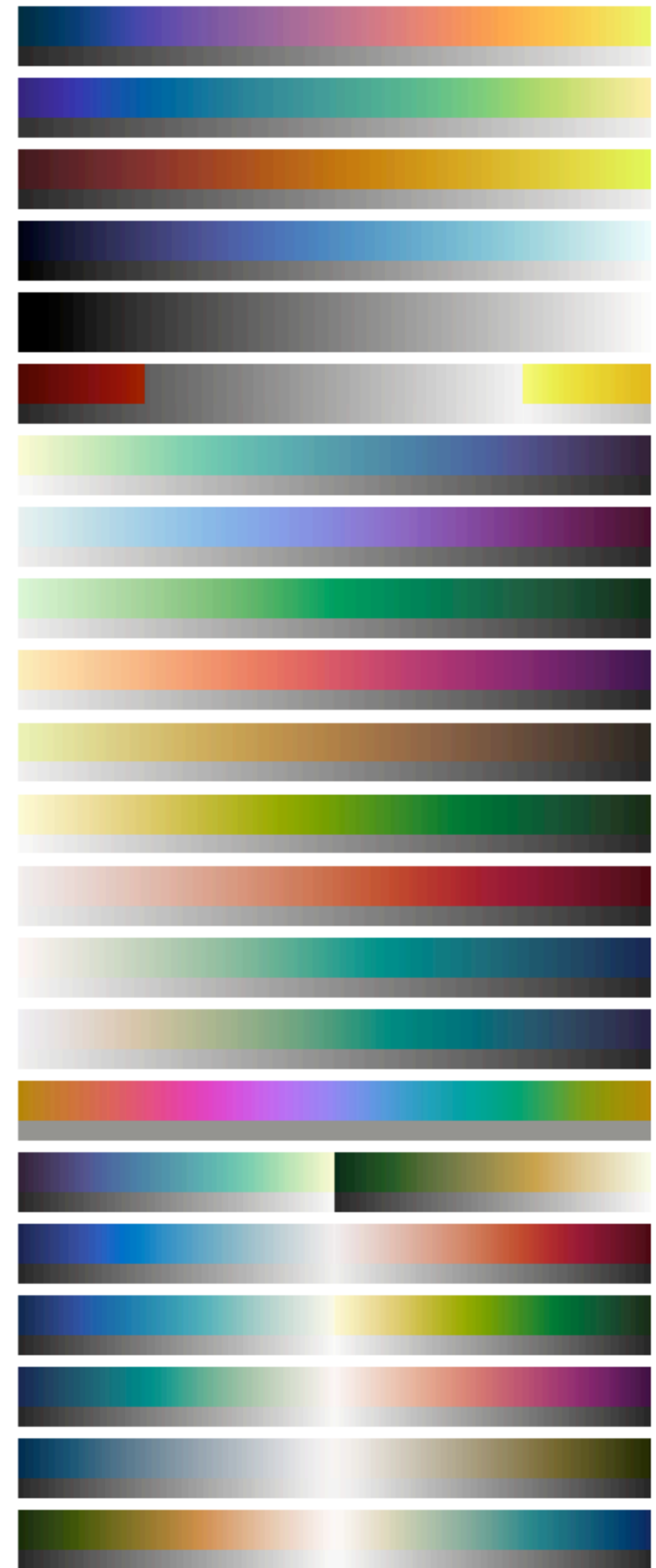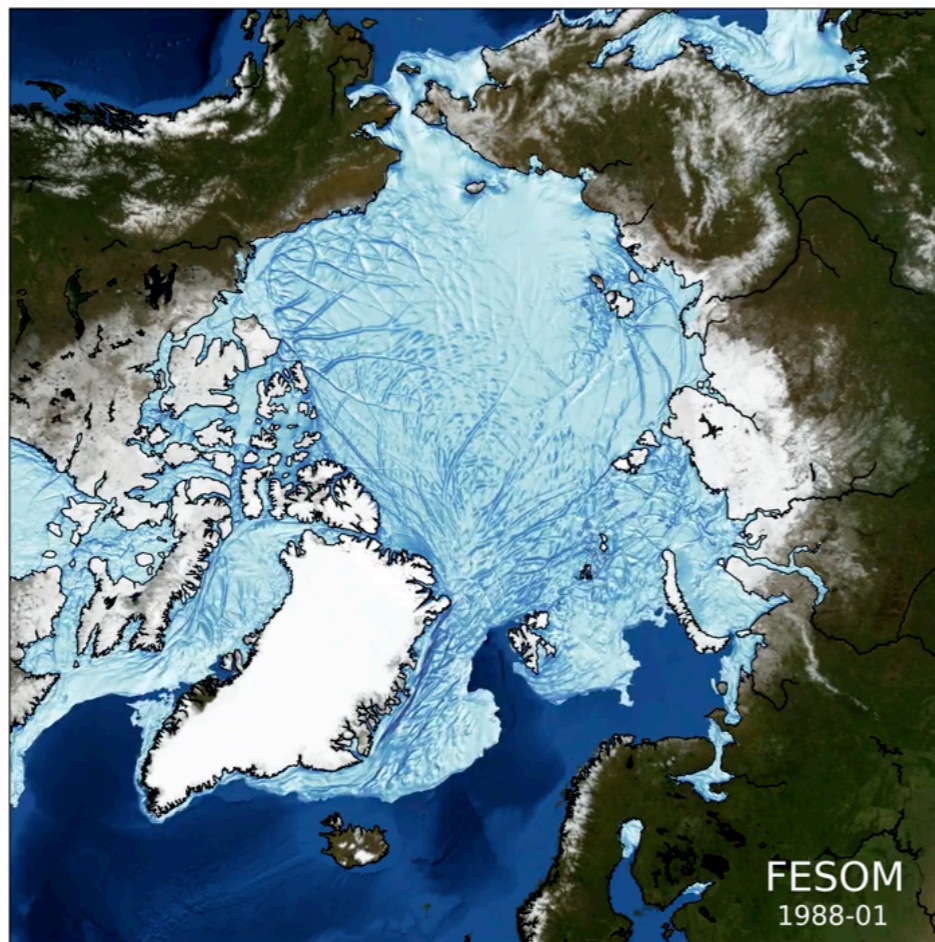1988-01

Ressources

cmocean 2/2

Lightness for each colormap
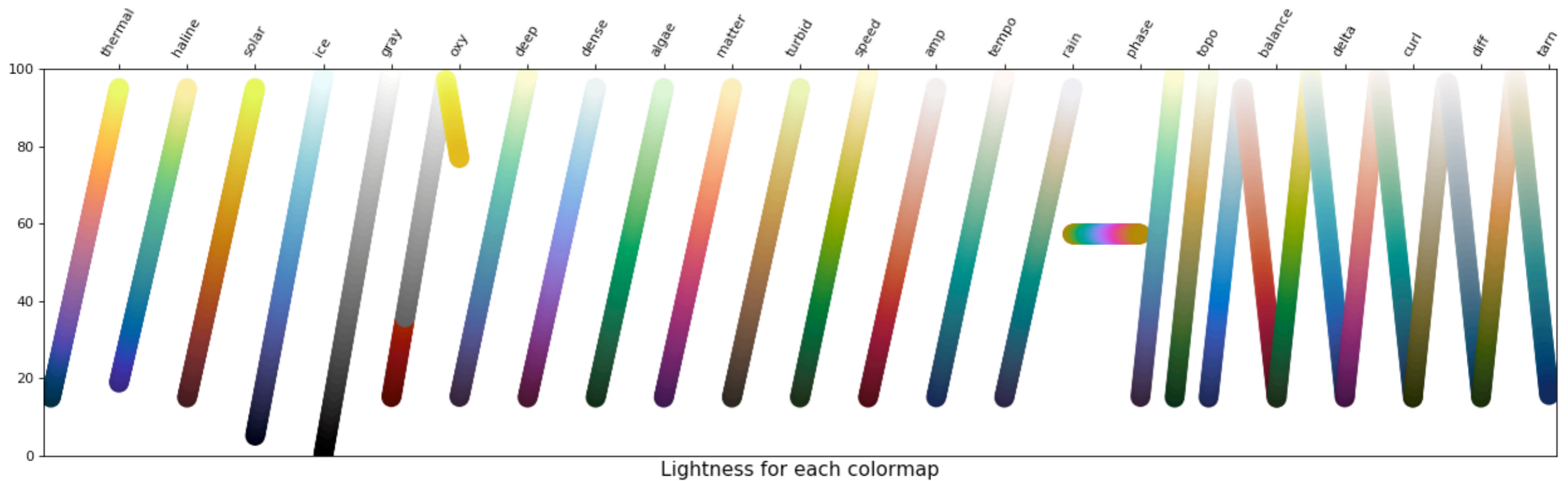
Beautiful (all perceptually uniform) colormaps

Ressource
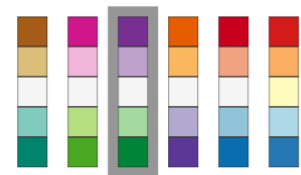
Colorbrewer

http://colorbrewer2.org/
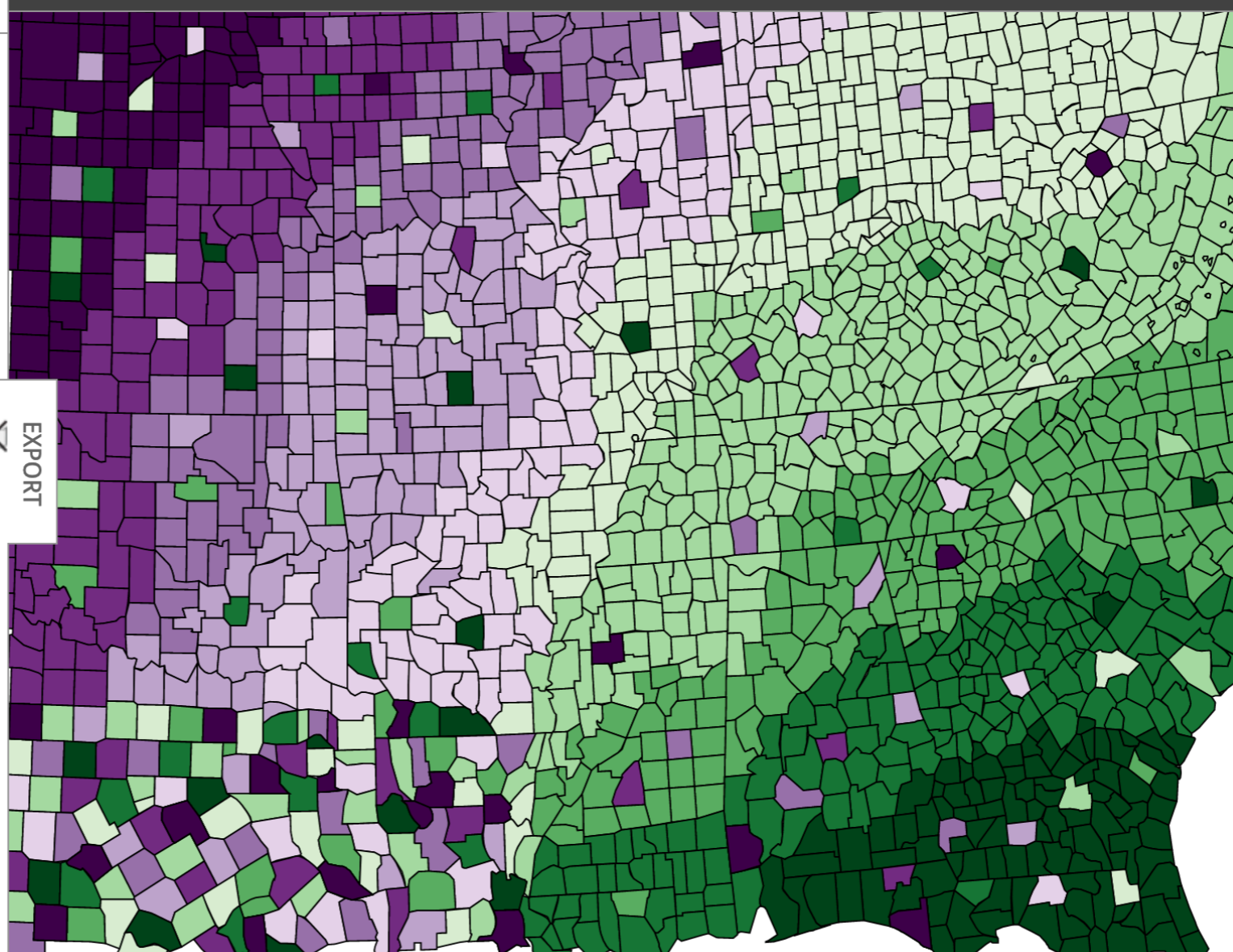
Ressource

Palettable (*One to rule them all*)

https://jiffyclub.github.io/palettable

```
pip install palettable
```

One library for all of the above !

- palettable.cartocolors.diverging
- palettable.cartocolors.qualitative
- palettable.cartocolors.sequential
- palettable.cmocean.diverging
- palettable.cmocean.sequential
- palettable.colorbrewer.diverging
- palettable.colorbrewer.qualitative
- palettable.colorbrewer.sequential
- palettable.lightbartlein.diverging
- palettable.lightbartlein.sequential
- palettable.matplotlib
- palettable.mycarta
- palettable.scientific.diverging
- palettable.scientific.sequential
- palettable.tableau
- palettable.wesanderson

```python
from palettable.cmocean.diverging import balance
ax.imshow(data, cmap=balance.mpl_colormap)
```

Wes Anderson palettes

- Also on Palettable (`palettable.wesanderson`)

- All Wes Anderson Palettes are **qualitatives** (for **categorical data**)

from **The French Dispatch**

from **The Darjeeling Limited**

from **Moonrise Kingdom**

Metbrewer

METropolitain Museum collection

```python
import met_palettes
colors = met_brew(name="VanGogh1", n=123, brew_type="continuous")
```


Derain

Greek

Isfahan2

Hokusai1

Conclusion

Colors are *important*.

Color misuse can be :

- **misleading**

- **excluding** for certain people with illness (avoid cmaps with green **AND** red)

- **ugly**

Proper usage of color can :

- **improve** your **scientific message**

- **generate interest** for your work

- make you/others **feel good**

Care about it !
It is neither a loss of time, nor a neutral choice

Thanks !

Paul Klee, 1927 - *Flora on Sand*

Diverse links on the subject

Rob Simmon (NASA observatory) *Subtleties of Color* — https://earthobservatory.nasa.gov/blogs/elegantfigures/2013/08/05/subtleties-of-color-part-1-of-6/

https://matplotlib.org/cmocean/

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

https://betterfigures.org/2015/06/23/picking-a-colour-scale-for-scientific-graphics/