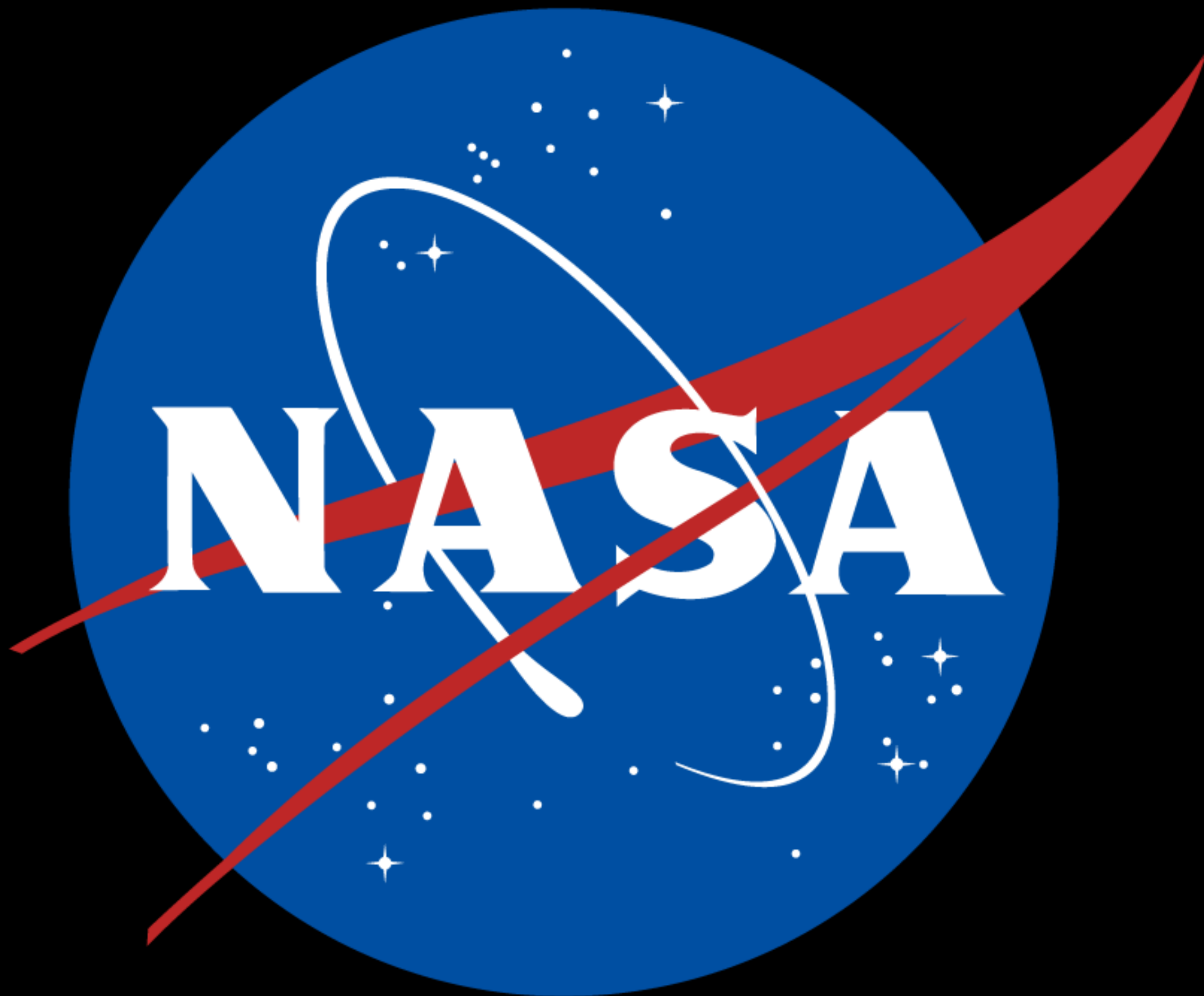


Getting Started With Data Visualization

April 6, 2016

Robert Simmon
Planet Labs
simmon@mac.com
@rsimmon





The logo consists of a large blue circle centered on a black background. Inside the circle, the words "PLANET" and "LABS" are written in white, bold, sans-serif capital letters. "PLANET" is on the top line and "LABS" is on the bottom line, both centered horizontally.

PLANET
LABS



NASA




Lake Simcoe, Ontario





Yazghil Glacier
Pakistan

Planet Labs

An aerial satellite image of Itumbiara, Brazil, showing a river, agricultural fields, and a town. The image is a mosaic of various colors representing different land uses and vegetation. A prominent river flows through the scene, and a town is visible in the center-left. The surrounding area is dominated by agricultural fields in various shades of green, brown, and tan. A large, dark, irregularly shaped area is visible in the upper-middle part of the image, possibly a forest or a large field. The overall scene depicts a rural landscape with significant agricultural activity and a small urban center.

Itumbiara, Brazil
August 8, 2014

Planet Labs/NASA/USGS

Itumbiara, Brazil
August 9, 2014

Planet Labs



Abstraction & Representation



cc Jeanette, flickr



cc Kate Ter Haar, flickr



cc Judy Baxter, flickr

\$9.99/
box

**HEADLEY'S
BIG PEACH**

Chilton County
I-65, EXIT 212

LOCATED UNDER
"ALABAMA'S LARGEST PEACH"

**HEADLEY'S
BIG PEACH**

Chilton County
I-65, EXIT 212

LOCATED UNDER
"ALABAMA'S LARGEST PEACH"

**HEADLEY'S
BIG PEACH**

Chilton County
I-65, EXIT 212

LOCATED UNDER
"ALABAMA'S LARGEST PEACH"

Do Not
Mash on
Peaches

cc Brent Moore, flickr

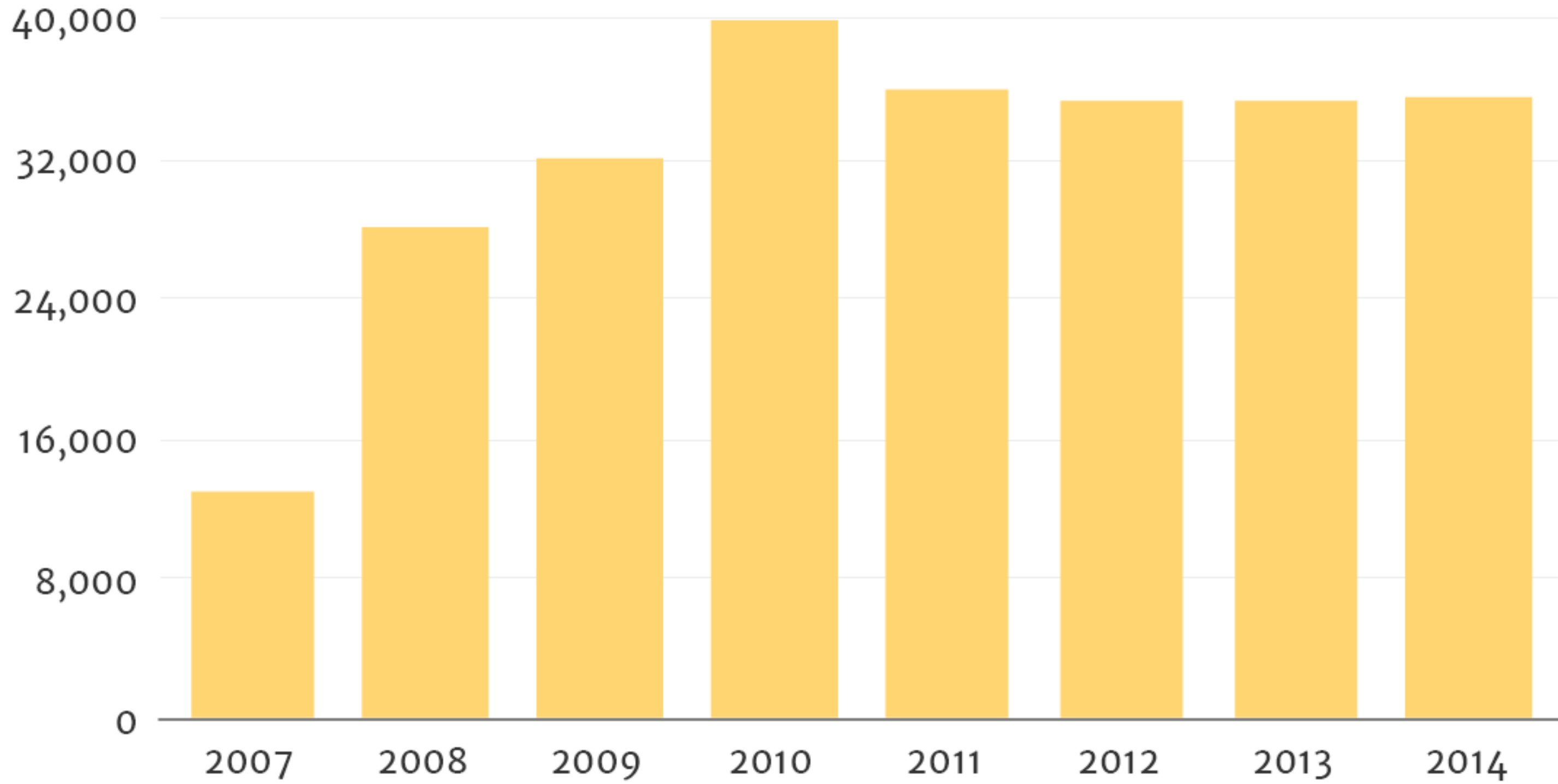
**HEADLEY'S
BIG PEACH**

Georgia Peaches

Year	Production (tons)	Price (\$/ton)
2014	35,500	1,090
2013	35,250	826
2012	35,300	961
2011	36,000	930
2010	40,000	817
2009	32,000	930
2008	28,000	773
2007	13,000	819

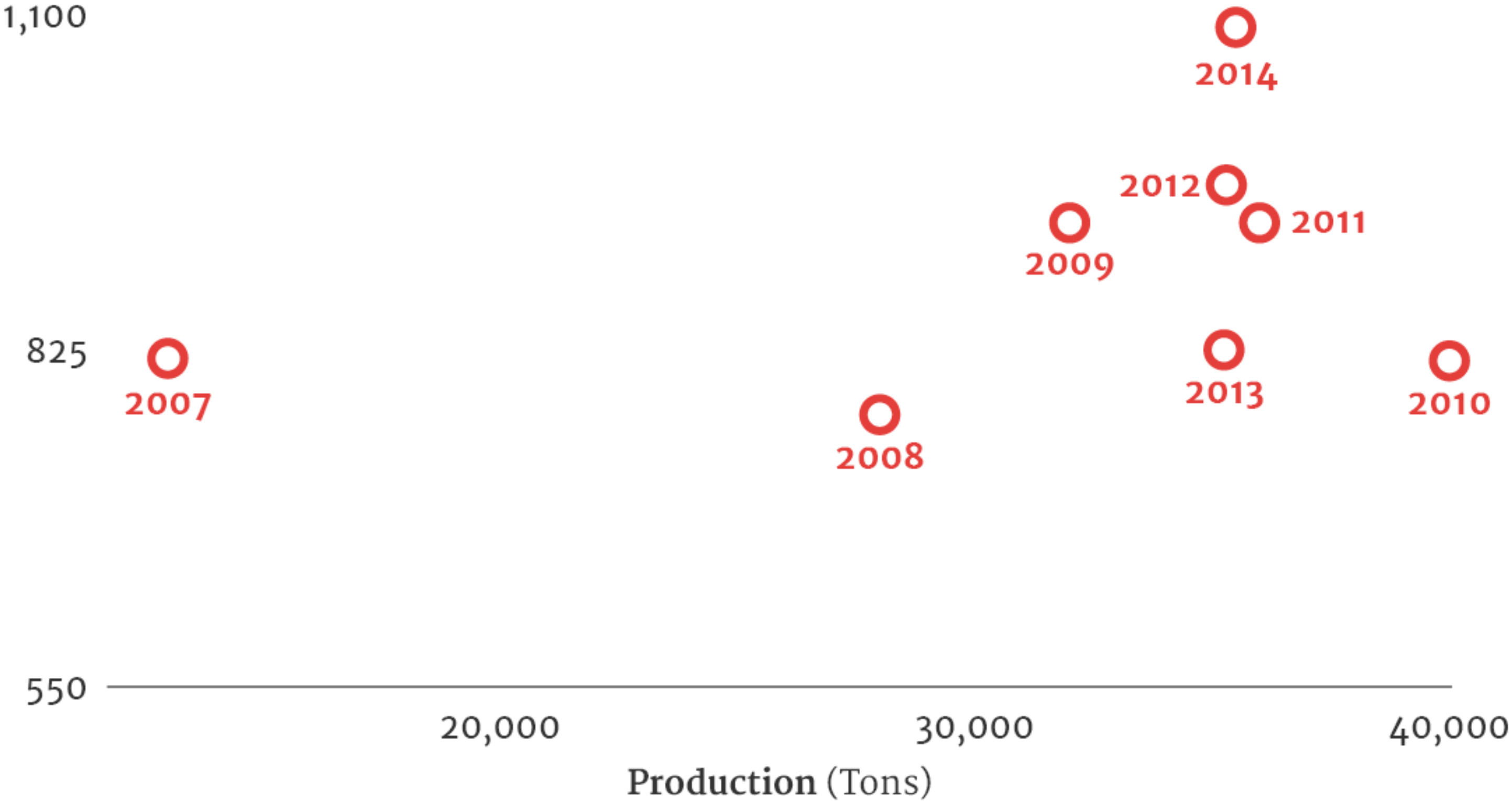
source: USDA

Georgia Peach Production (tons)



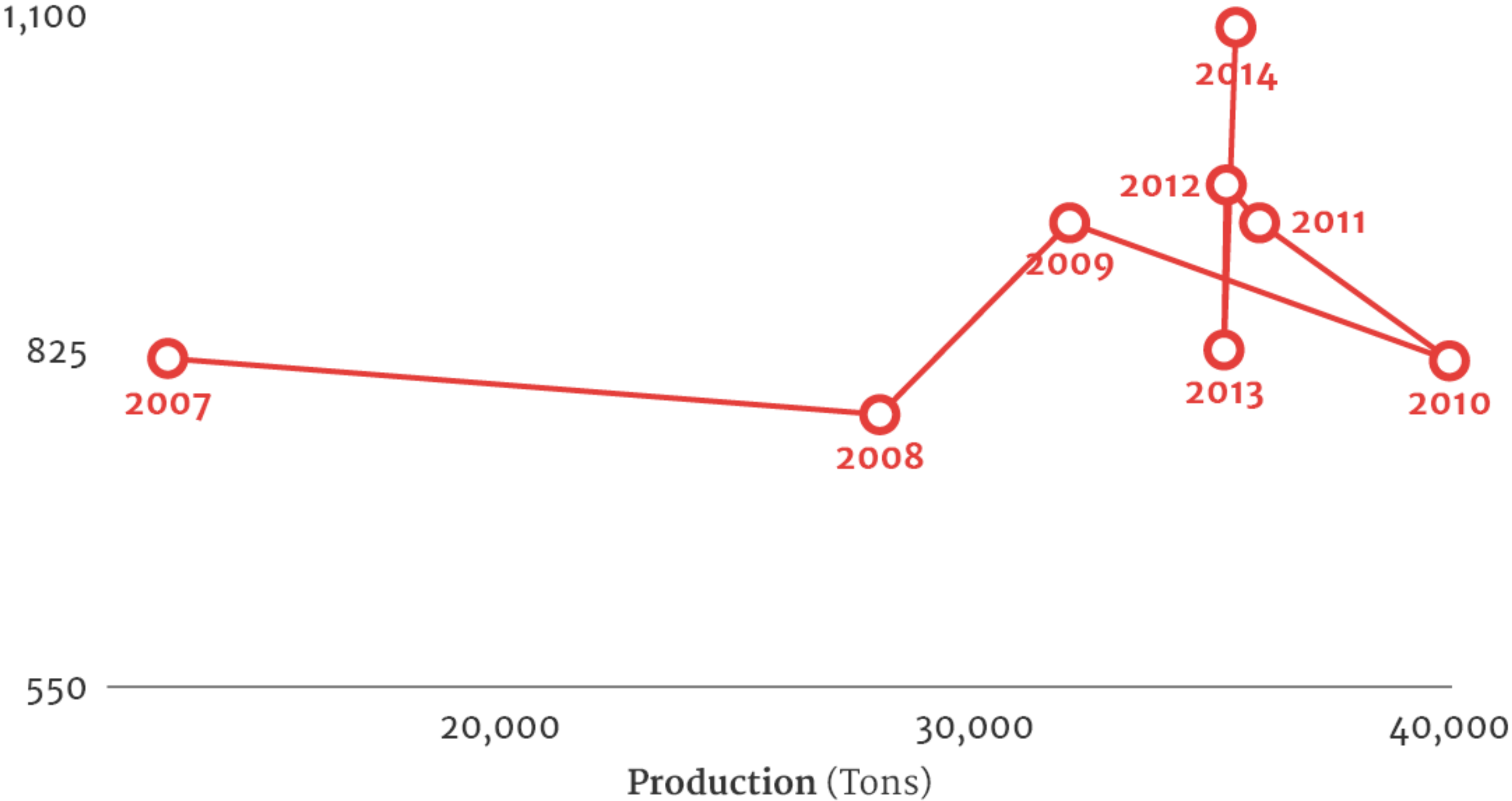
source: USDA

Price (Dollars per Ton) vs. Production



source: USDA

Price (Dollars per Ton) vs. Production



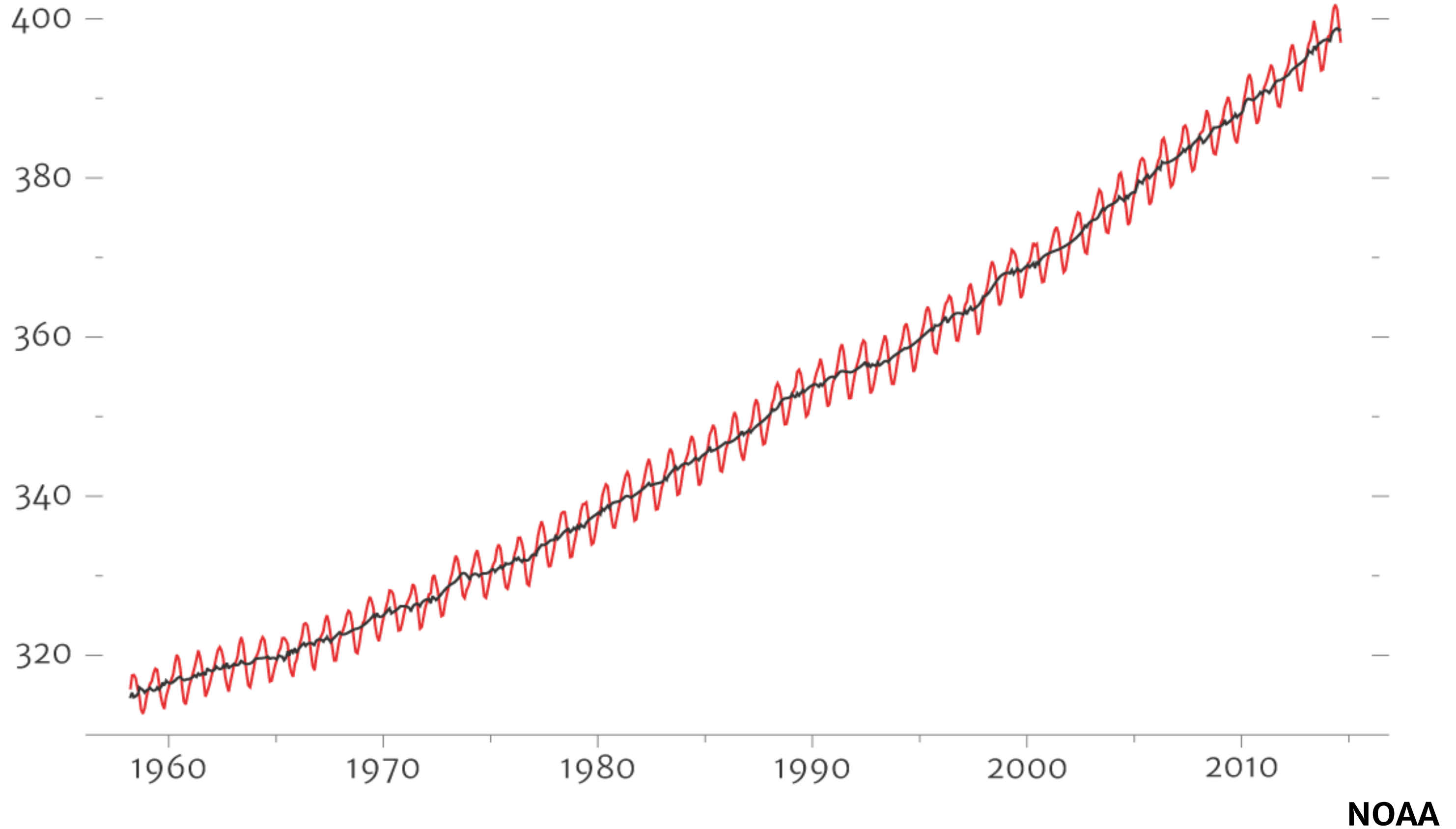
source: USDA

The Power of Visualization

Carbon Dioxide (parts per million)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1958			315.71	317.45	317.50	317.10	315.86	314.93	313.20	312.66	313.33	314.67	1987	348.38	348.70	349.72	351.32	352.14	351.61	349.91	347.84	346.52	346.65	347.96	349.18
1959	315.62	316.38	316.71	317.72	318.29	318.15	316.54	314.80	313.84	313.26	314.80	315.58	1988	350.38	351.68	352.24	353.66	354.18	353.68	352.58	350.66	349.03	349.08	350.15	351.44
1960	316.43	316.97	317.58	319.02	320.03	319.59	318.18	315.91	314.16	313.83	315.00	316.19	1989	352.89	353.24	353.80	355.59	355.89	355.30	353.98	351.53	350.02	350.29	351.44	352.84
1961	316.93	317.70	318.54	319.48	320.58	319.77	318.57	316.79	314.80	315.38	316.10	317.01	1990	353.79	354.88	355.65	356.27	357.29	356.32	354.88	352.89	351.28	351.59	353.05	354.27
1962	317.94	318.56	319.68	320.63	321.01	320.55	319.58	317.40	316.26	315.42	316.69	317.69	1991	354.87	355.68	357.06	358.51	359.09	358.10	356.12	353.89	352.30	352.32	353.79	355.07
1963	318.74	319.08	319.86	321.39	322.25	321.47	319.74	317.77	316.21	315.99	317.12	318.31	1992	356.17	356.93	357.82	359.00	359.55	359.32	356.85	354.91	352.93	353.31	354.27	355.53
1964	319.57	320.07	320.73	321.77	322.25	321.89	320.44	318.70	316.70	316.79	317.79	318.71	1993	356.86	357.27	358.36	359.27	360.19	359.52	357.42	355.46	354.10	354.12	355.40	356.84
1965	319.44	320.44	320.89	322.13	322.16	321.87	321.39	318.81	317.81	317.30	318.87	319.42	1994	358.22	358.98	359.91	361.32	361.68	360.80	359.39	357.42	355.63	356.09	357.56	358.87
1966	320.62	321.59	322.39	323.87	324.01	323.75	322.39	320.37	318.64	318.10	319.79	321.08	1995	359.87	360.79	361.77	363.23	363.77	363.22	361.70	359.11	358.11	357.97	359.40	360.61
1967	322.07	322.50	323.04	324.42	325.00	324.09	322.55	320.92	319.31	319.31	320.72	321.96	1996	362.04	363.17	364.17	364.51	365.16	364.93	363.53	361.38	359.60	359.54	360.84	362.18
1968	322.57	323.15	323.89	325.02	325.57	325.36	324.14	322.03	320.41	320.25	321.31	322.84	1997	363.04	364.09	364.47	366.25	366.69	365.59	364.34	362.20	360.31	360.71	362.44	364.33
1969	324.00	324.42	325.64	326.66	327.34	326.76	325.88	323.67	322.38	321.78	322.85	324.11	1998	365.18	365.98	367.13	368.61	369.49	368.95	367.74	365.79	364.01	364.35	365.52	367.08
1970	325.03	325.99	326.87	328.13	328.07	327.66	326.35	324.69	323.10	323.16	323.98	325.13	1999	368.12	368.98	369.60	370.96	370.77	370.33	369.28	366.86	364.94	365.35	366.68	368.04
1971	326.17	326.68	327.18	327.78	328.92	328.57	327.34	325.46	323.36	323.57	324.80	326.01	2000	369.25	369.50	370.56	371.82	371.51	371.71	369.85	368.20	366.91	366.99	368.33	369.67
1972	326.77	327.63	327.75	329.72	330.07	329.09	328.05	326.32	324.93	325.06	326.50	327.55	2001	370.52	371.49	372.53	373.37	373.82	373.18	371.57	369.63	368.16	368.42	369.69	371.18
1973	328.54	329.56	330.30	331.50	332.48	332.07	330.87	329.31	327.51	327.18	328.16	328.64	2002	372.45	373.14	373.93	375.00	375.65	375.50	374.00	371.83	370.66	370.51	372.20	373.71
1974	329.35	330.71	331.48	332.65	333.19	332.12	330.99	329.17	327.41	327.21	328.34	329.50	2003	374.87	375.62	376.48	377.74	378.50	378.18	376.72	374.31	373.20	373.10	374.64	375.93
1975	330.68	331.41	331.85	333.29	333.91	333.40	331.74	329.88	328.57	328.36	329.33	330.59	2004	377.00	377.87	378.73	380.41	380.63	379.56	377.61	376.15	374.11	374.44	375.93	377.45
1976	331.66	332.75	333.46	334.78	334.78	334.06	332.95	330.64	328.96	328.77	330.18	331.65	2005	378.47	379.76	381.14	382.20	382.47	382.20	380.78	378.73	376.66	376.98	378.29	379.92
1977	332.69	333.23	334.97	336.03	336.82	336.10	334.79	332.53	331.19	331.21	332.35	333.47	2006	381.35	382.16	382.66	384.73	384.98	384.09	382.38	380.45	378.92	379.16	380.18	381.79
1978	335.10	335.26	336.61	337.77	338.01	337.98	336.48	334.37	332.33	332.41	333.76	334.83	2007	382.93	383.81	384.56	386.40	386.58	386.05	384.49	382.00	380.90	381.14	382.42	383.89
1979	336.21	336.65	338.13	338.94	339.00	339.20	337.60	335.56	333.93	334.12	335.26	336.78	2008	385.44	385.73	385.97	387.16	388.50	387.88	386.42	384.15	383.09	382.99	384.13	385.56
1980	337.80	338.28	340.04	340.86	341.47	341.26	339.34	337.45	336.10	336.05	337.21	338.29	2009	386.94	387.42	388.77	389.44	390.19	389.45	387.78	385.92	384.79	384.39	386.00	387.31
1981	339.36	340.51	341.57	342.56	343.01	342.49	340.68	338.49	336.92	337.12	338.59	339.90	2010	388.50	389.94	391.09	392.52	393.04	392.15	390.22	388.26	386.83	387.20	388.65	389.73
1982	340.92	341.69	342.85	343.92	344.67	343.78	342.23	340.11	338.32	338.39	339.48	340.88	2011	391.25	391.82	392.49	393.34	394.21	393.72	392.42	390.19	389.04	388.96	390.24	391.83
1983	341.64	342.87	343.59	345.25	345.96	345.52	344.15	342.25	340.17	340.30	341.53	343.07	2012	393.12	393.60	394.45	396.18	396.78	395.83	394.30	392.41	391.06	391.01	392.81	394.28
1984	344.05	344.77	345.46	346.77	347.55	346.98	345.55	343.20	341.35	341.68	343.06	344.54	2013	395.54	396.80	397.31	398.35	399.76	398.58	397.20	395.15	393.51	393.66	395.11	396.81
1985	345.25	346.06	347.66	348.20	348.92	348.40	346.66	344.85	343.20	343.08	344.40	345.82	2014	397.80	397.91	399.58	401.29	401.78	401.15	399.00	397.01				
1986	346.54	347.13	348.05	349.77	350.53	349.90	348.11	346.09	345.01	344.47	345.86	347.15													

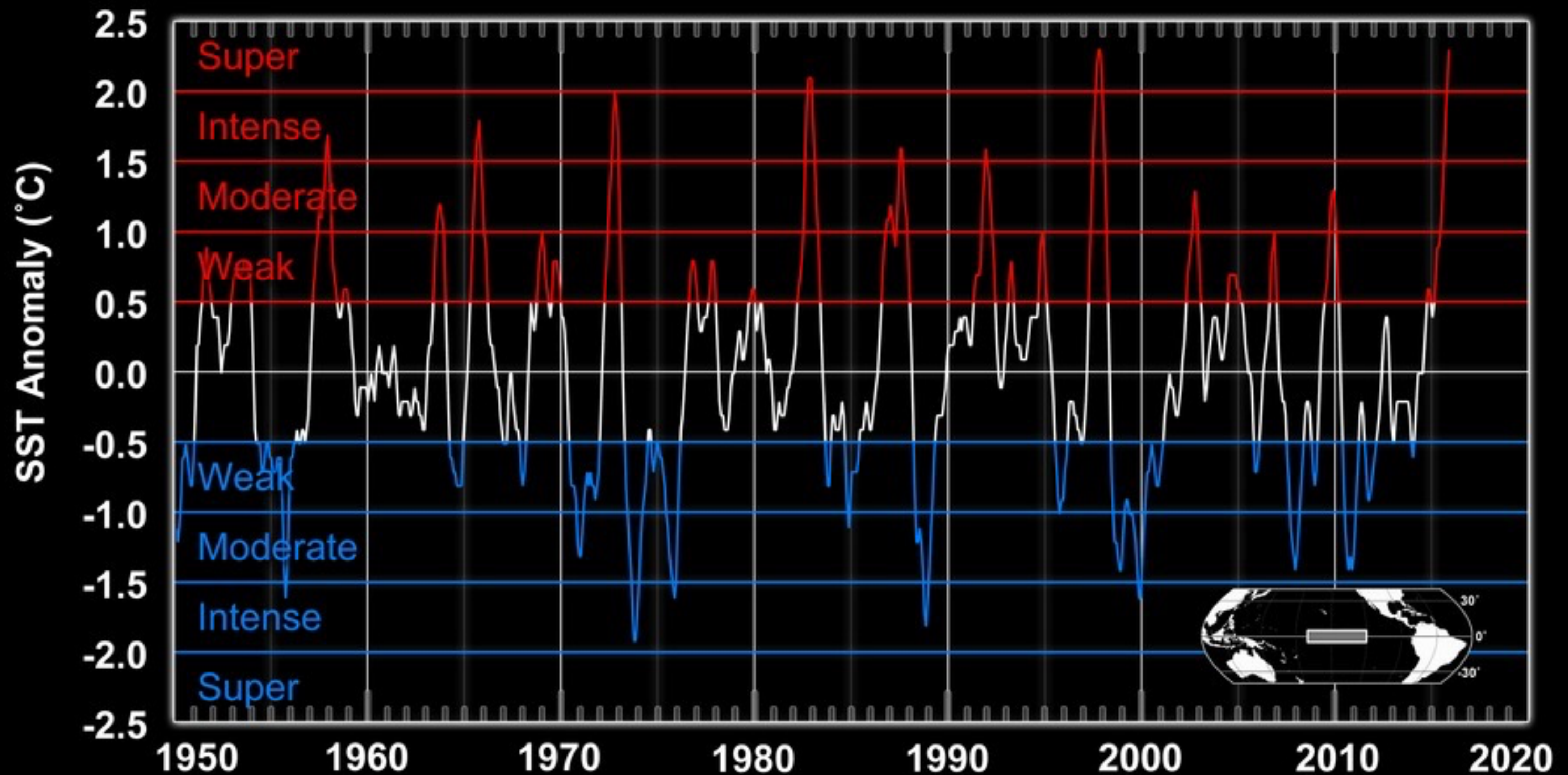
Carbon Dioxide (parts per million)



Case Study: Design

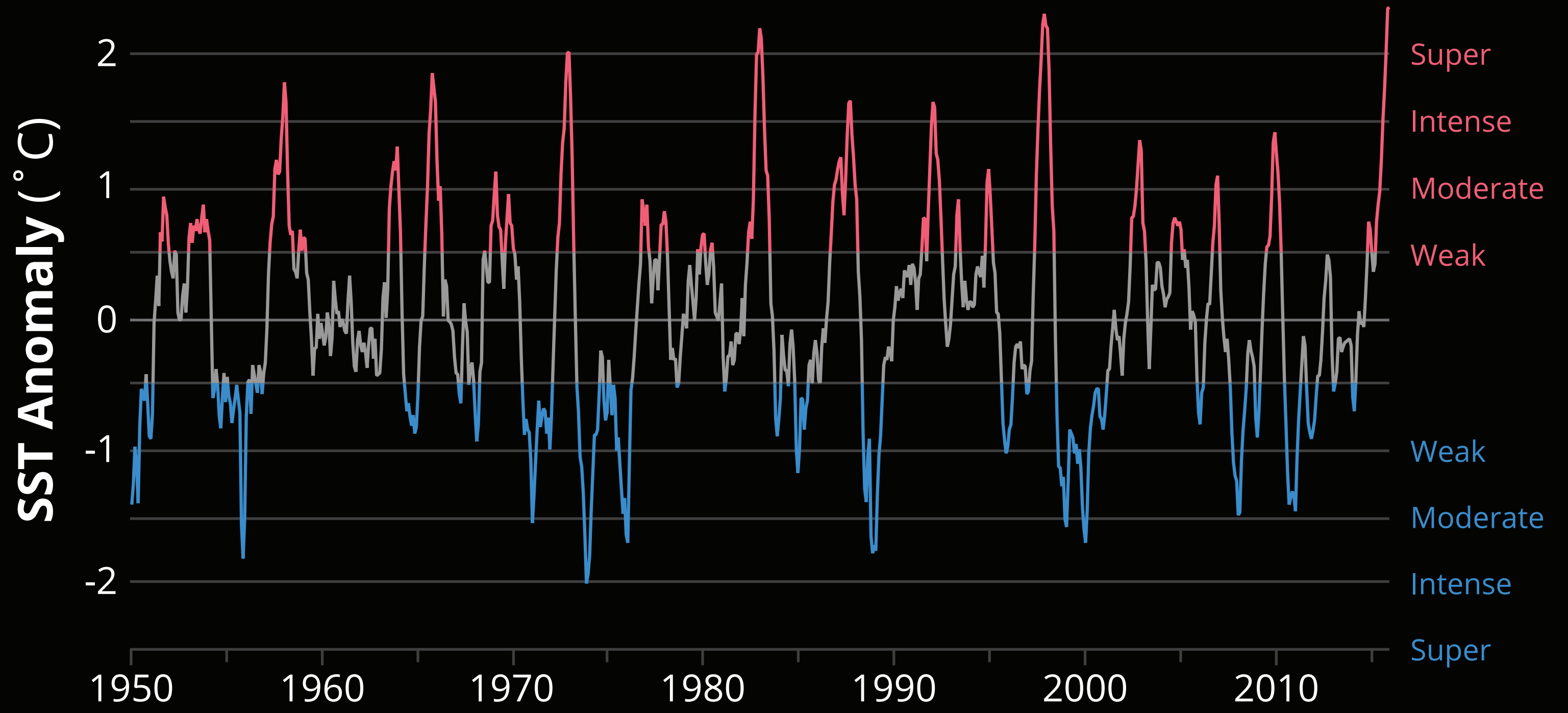
NOAA Sea Surface Temperature Anomaly (°C)

for Oceanic Nino Index Region 3.4 (5°S - 5°N, 170°W - 120°W)



NOAA Sea Surface Temperature Anomaly (°C)

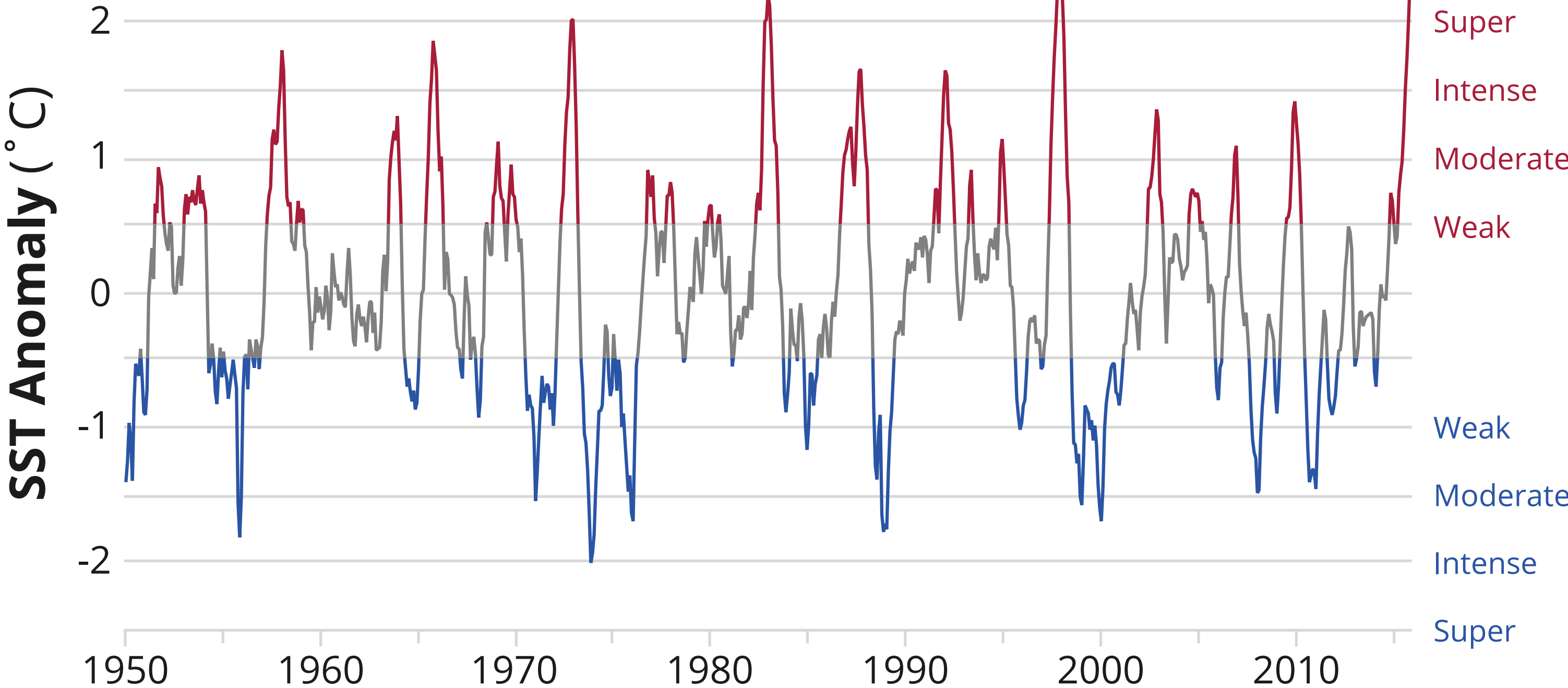
for Oceanic Niño Region 3.4 (5°S–5°N, 170°W–120°W)



source: www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_change.shtml

NOAA Sea Surface Temperature Anomaly (° C)

for Oceanic Niño Region 3.4 (5 ° S–5 ° N, 170 ° W–120 ° W)



source: www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_change.shtml

Robert Simmon/NOAA

Color

Theory
Applications
Tools

Color has an objective reality, but the colors we see are tricks of the imagination, and there is no perfectly objective view of color.

James Gleick on Radiolab



red



green



blue

how computers calculate color



lightness



hue

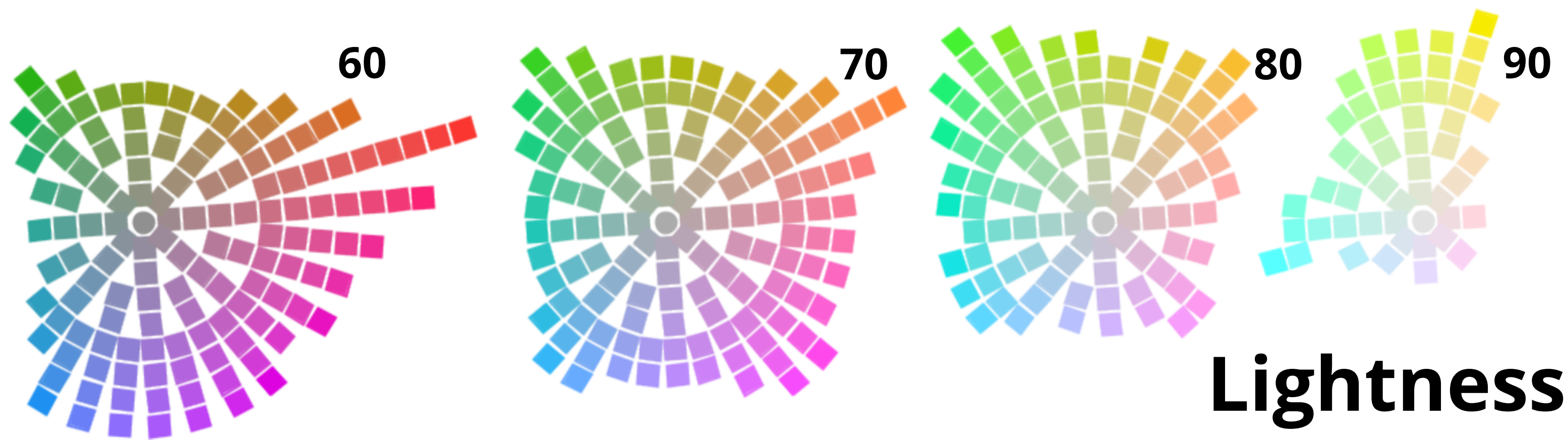
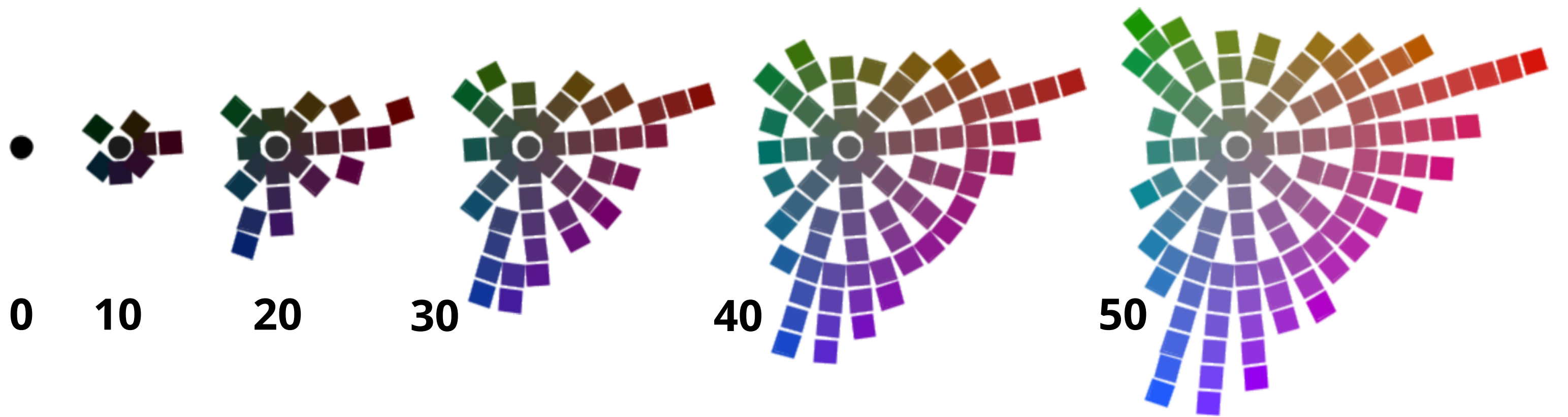


saturation

how we perceive color

CIE L*C*h

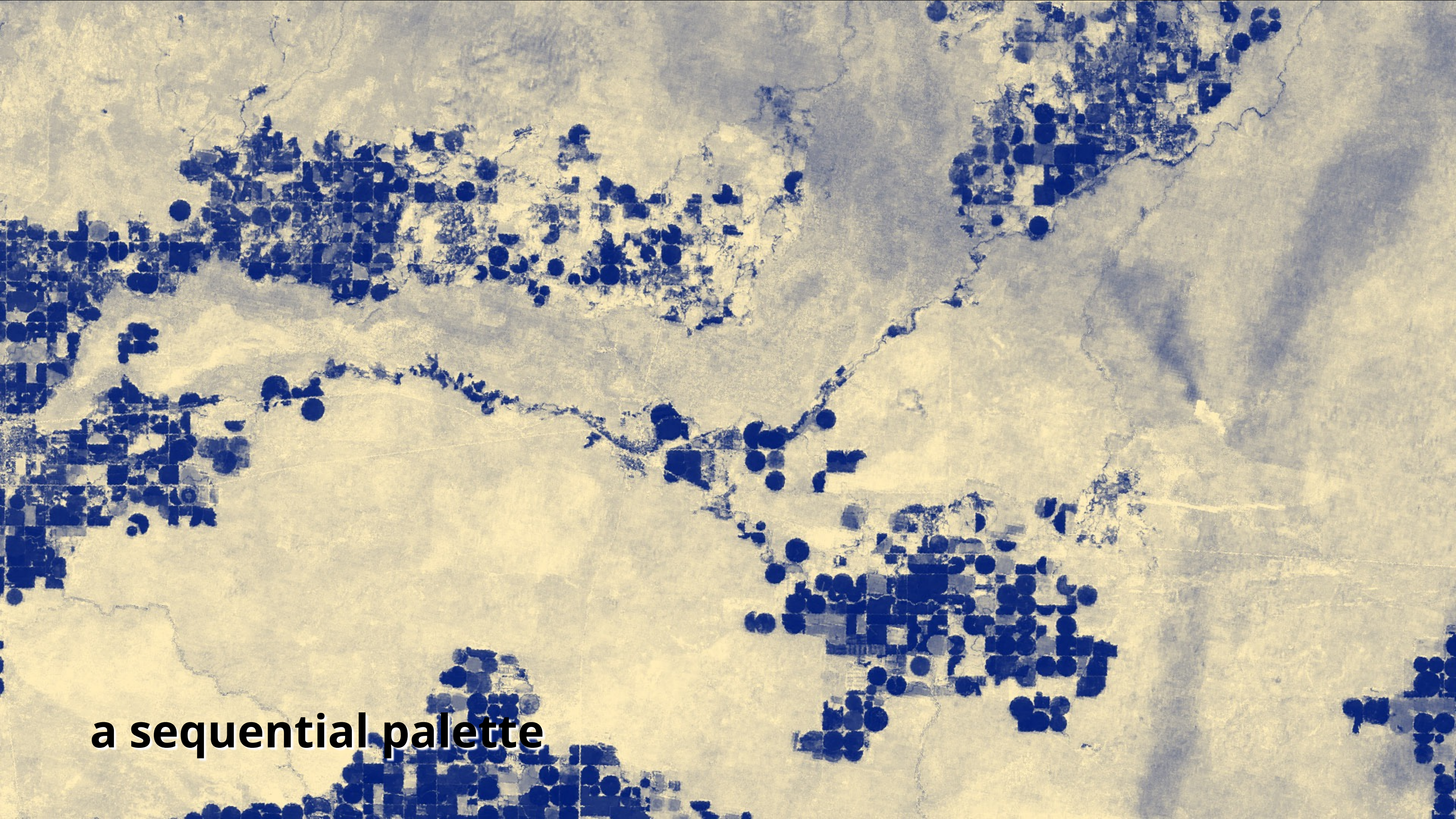
lightness, chroma (saturation), hue



Lightness

Applications

sequential, divergent, and qualitative maps

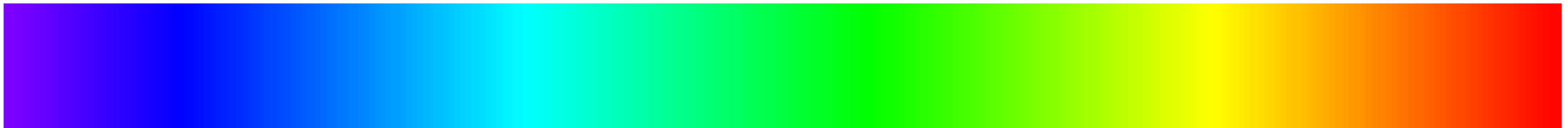


a sequential palette

grayscale

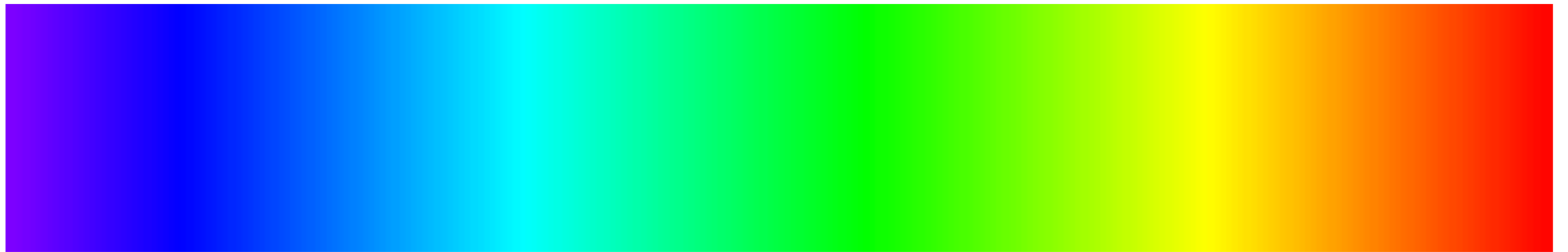


rainbow





simultaneous contrast

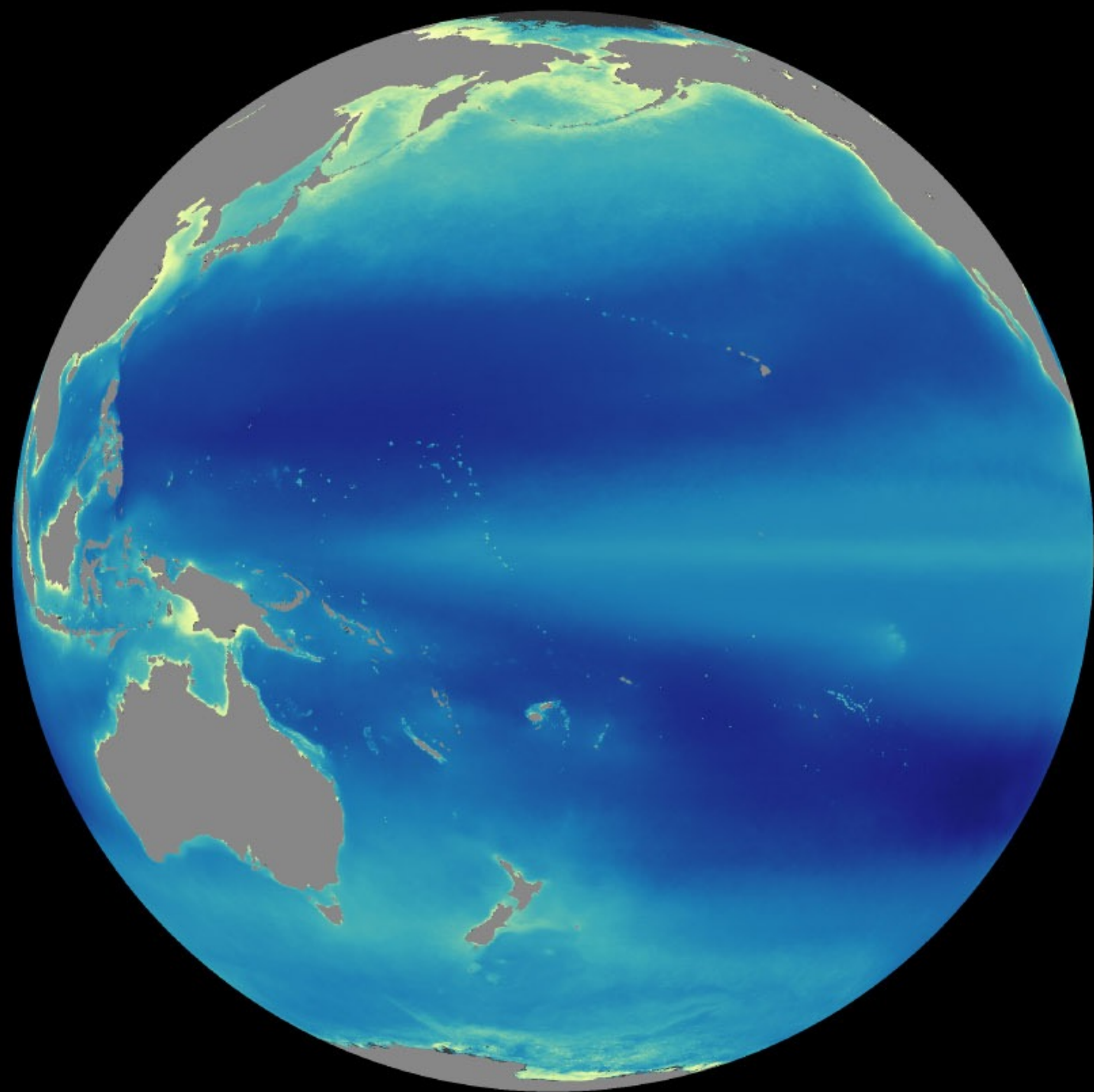
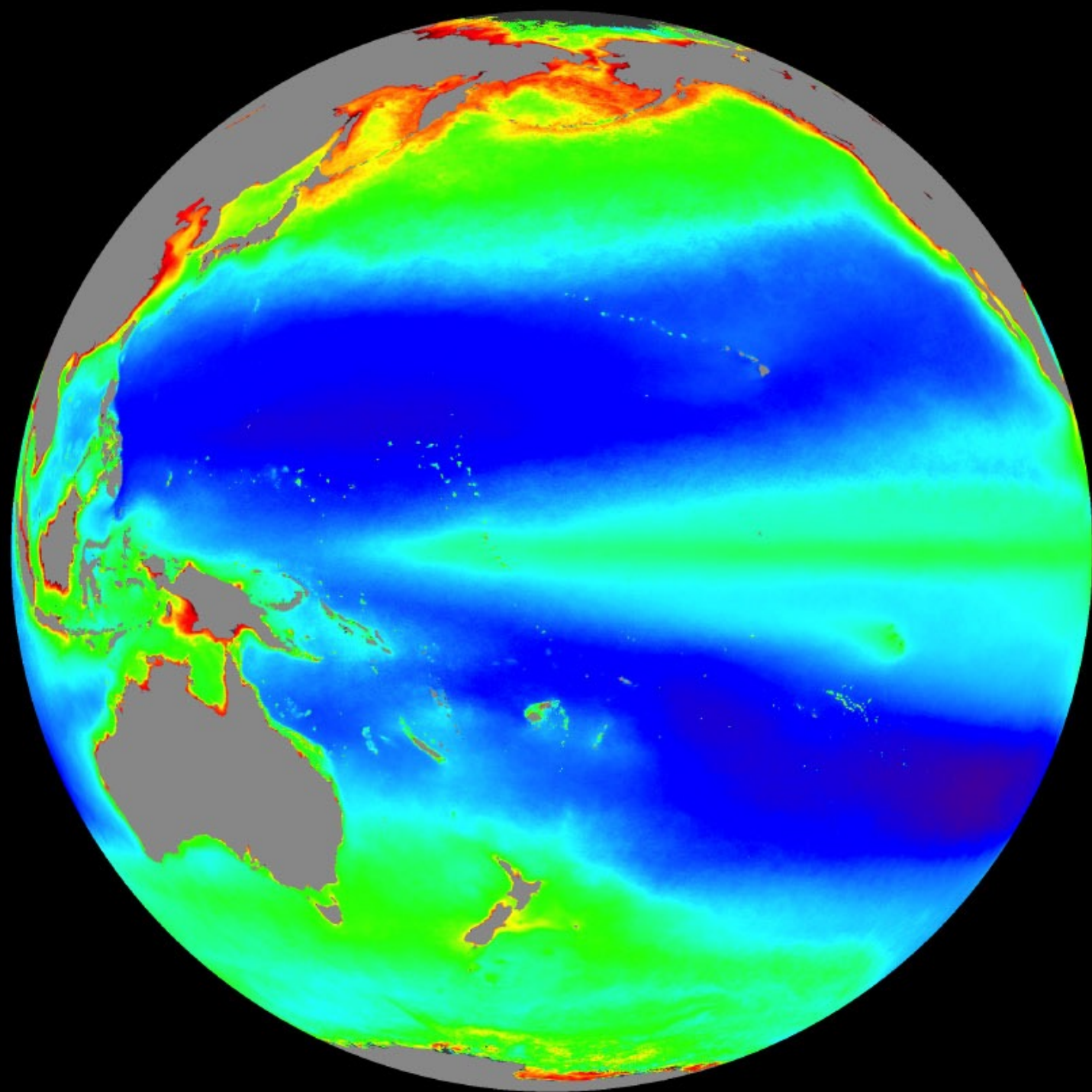


rainbow palette

“Perfect” Palettes



“a kind of spiral in color space that cycles through a variety of hues while continuously increasing in lightness” —Colin Ware

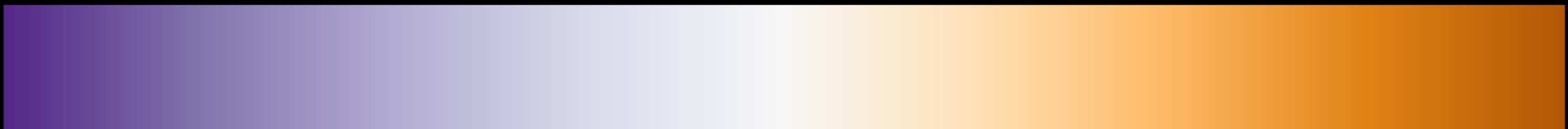


perceptually linear lightness, saturation, and hue shift (L^*c^*h)

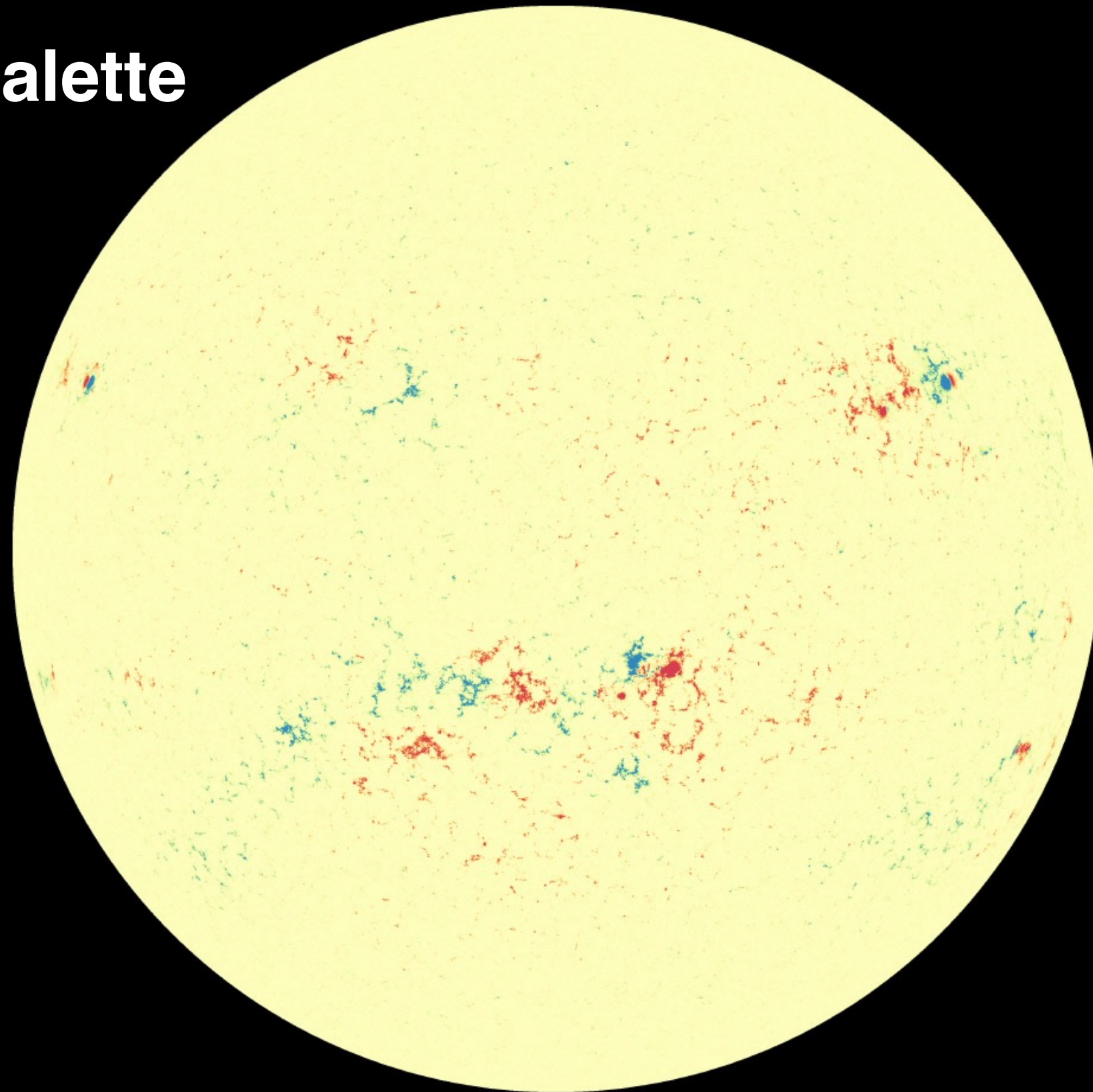


nonlinear shift (HSB)

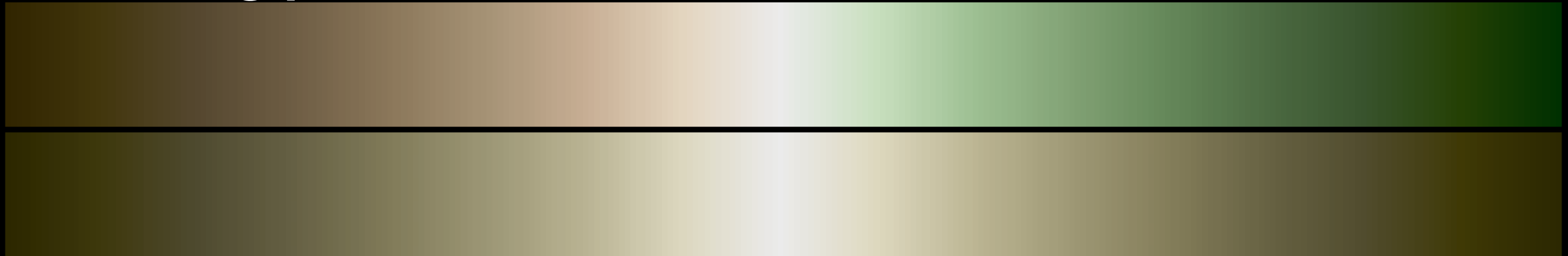




a divergent palette



confusing palette



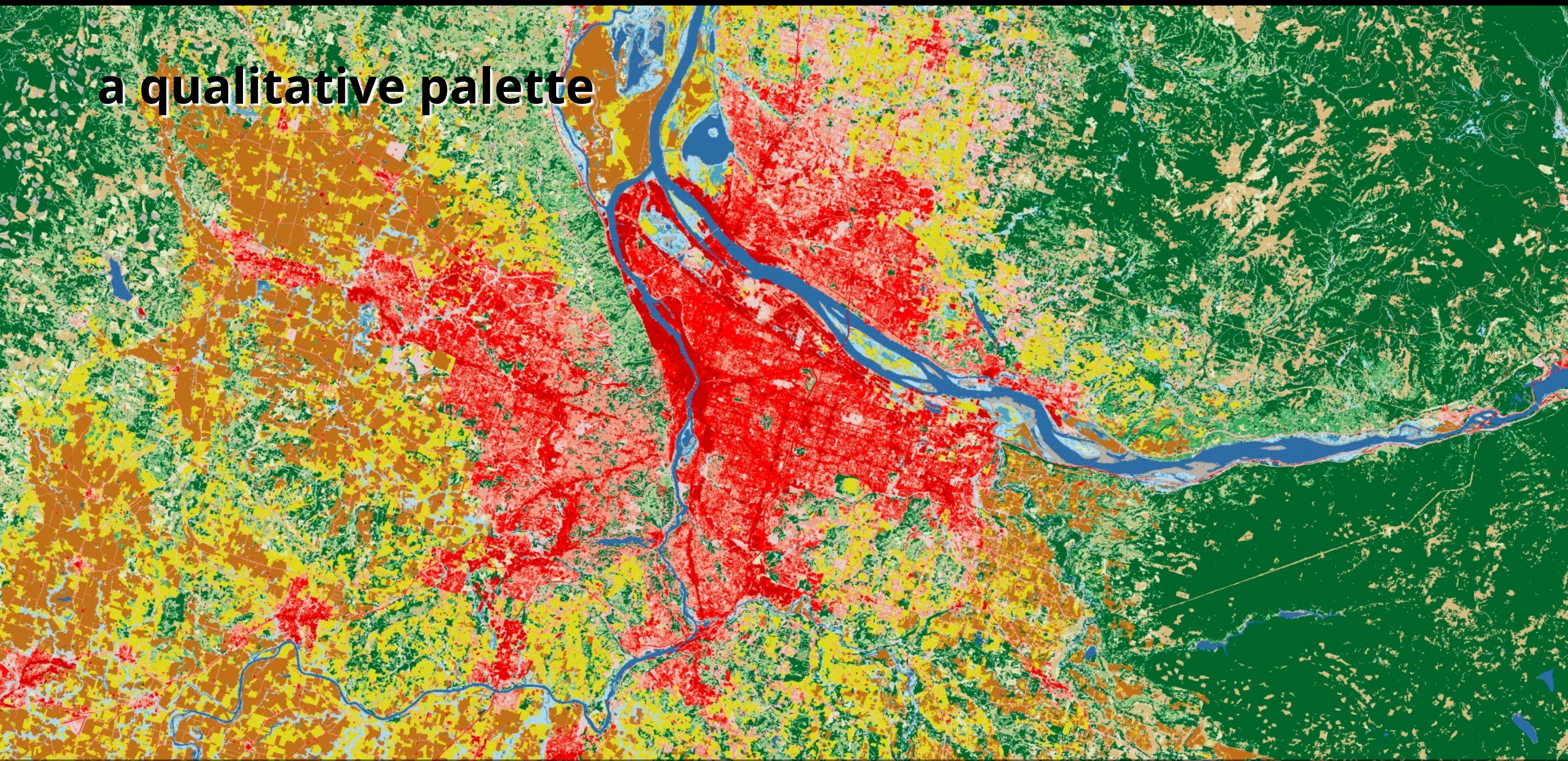
color blind safe palette



two 12-class qualitative palettes



a qualitative palette



visual hierarchy



Tools

Color Brewer, NASA Color Tool, chroma.js

Color Brewer: colorbrewer2.org

The screenshot shows the Color Brewer 2.0 web application interface. The browser address bar displays colorbrewer2.org. The page title is "Color Brewer: Color Advice for Maps". The main navigation bar includes links for "how to use", "updates", and "credits". The "COLORBREWER 2.0" logo is prominently displayed, with the tagline "color advice for cartography".

The interface is divided into several sections:

- number of data classes on your map:** A dropdown menu is set to "3".
- the nature of your data:** A dropdown menu is set to "sequential".
- pick a color scheme: BuGn:** A grid of color schemes is shown, with the "BuGn" scheme selected. Below the grid, there are options for "multihue" and "single hue".
- (optional) only show schemes that are:** Checkboxes for "colorblind safe", "print friendly", and "photocopy-able".
- pick a color system:** A color selection tool is shown with the RGB system selected. The selected colors are 229, 245, 249 (lightest), 153, 216, 201 (middle), and 44, 162, 95 (darkest).
- adjust map context:** Checkboxes for "roads", "cities", and "borders". The "borders" checkbox is checked.
- select a background:** Radio buttons for "solid color" (selected) and "terrain".
- color transparency:** A slider control.

The main map area displays a map of the United States with a color scheme applied to the states. The colors range from light green to dark green. A "SCORE CARD" is visible on the right side of the map. At the bottom of the map area, there is a button labeled "EXPORT YOUR COLORS >>".

At the bottom of the page, the copyright information reads: "© Cynthia Brewer, Mark Harrower and The Pennsylvania State University". There is also a "Support" link and the "axm" logo.

NASA Color Tool:

colorusage.arc.nasa.gov/ColorTool.php

The screenshot displays the NASA Color Tool interface, titled "Interactive Design Tool". At the top, there is a "Sample area" with a grid of 30 color swatches (5 rows by 6 columns). Each swatch is labeled with its background RGB values. Below the grid are controls for "Symbols" (set to "Decimal text"), "Font Size" (set to 13), and a mode selector for "Color" (selected) and "Grayscale".

The bottom section is divided into two main panels:

- Choose by Hue:** Features a color wheel with a hue slider set to 5 degrees. Below it is a "Lightness/Chroma Choices" grid where the vertical axis is L* (0-100) and the horizontal axis is C* (0-156). A "Background L*" value of 65 is set.
- Hue/Chroma Choices:** A radial grid of color swatches. Below it is a "Choose by Lightness" section with a horizontal axis for L* values (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100). A "Foreground history" and "Background history" table is located above this section.

Sample	Background: R	Background: G	Background: B
1	240	220	224
2	225	186	194
3	209	152	164
4	192	119	135
5	174	84	106
6	156	44	78

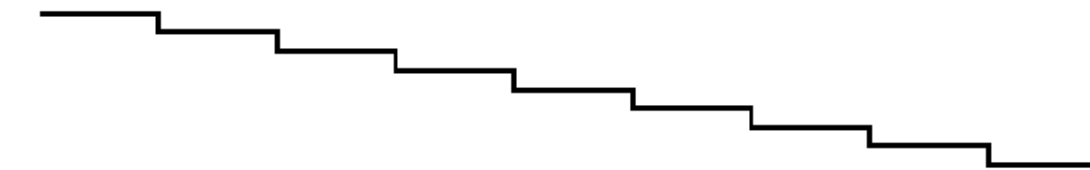
chroma.js: <https://vis4.net/labs/multihue/>

Chroma.js Color Scale Helper

This [chroma.js](#)-powered tool is here to help us [mastering multi-hued, multi-stops color scales](#).

Enter [named colors](#) or hex codes: Step count

Bezier interpolation Correct lightness gradient



```
['#ffffe0', '#ffe0a9', '#ffbe84', '#ff986d', '#f47361', '#e35056', '#cb2f44', '#ae112a', '#8b0000']
```

Created by [Gregor Aisch](#) for the sake of better use of colors in maps and datavis. [Edit in JSFiddle!](#)

Gregor Aisch



jet



parula (Matlab)



viridis (matplotlib)

<https://www.youtube.com/watch?v=xAoljeRJ3IU>



Export Options

R py m GrADS RAW

Examples

METEOROLOGY

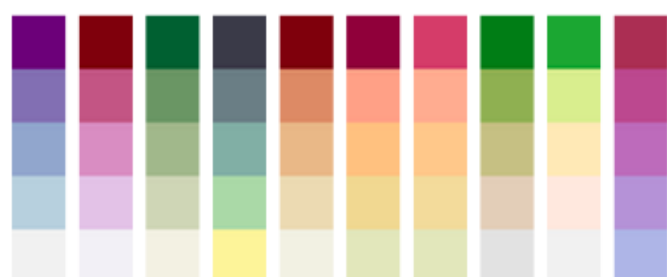
- Austria
- Equiv. Pot.
- Temperature
- Geopot. Temperature
- Topography
- Chlorophyll

COLORSPACE

- Map
- Lineplot
- Scatterplot
- Perspective
- Pieplot
- Mosaicplot
- Barplot
- Spline
- Heatmap

Color Settings

Type Sequential multiple hue



H1 250

H2 0

C1 50

C2 50

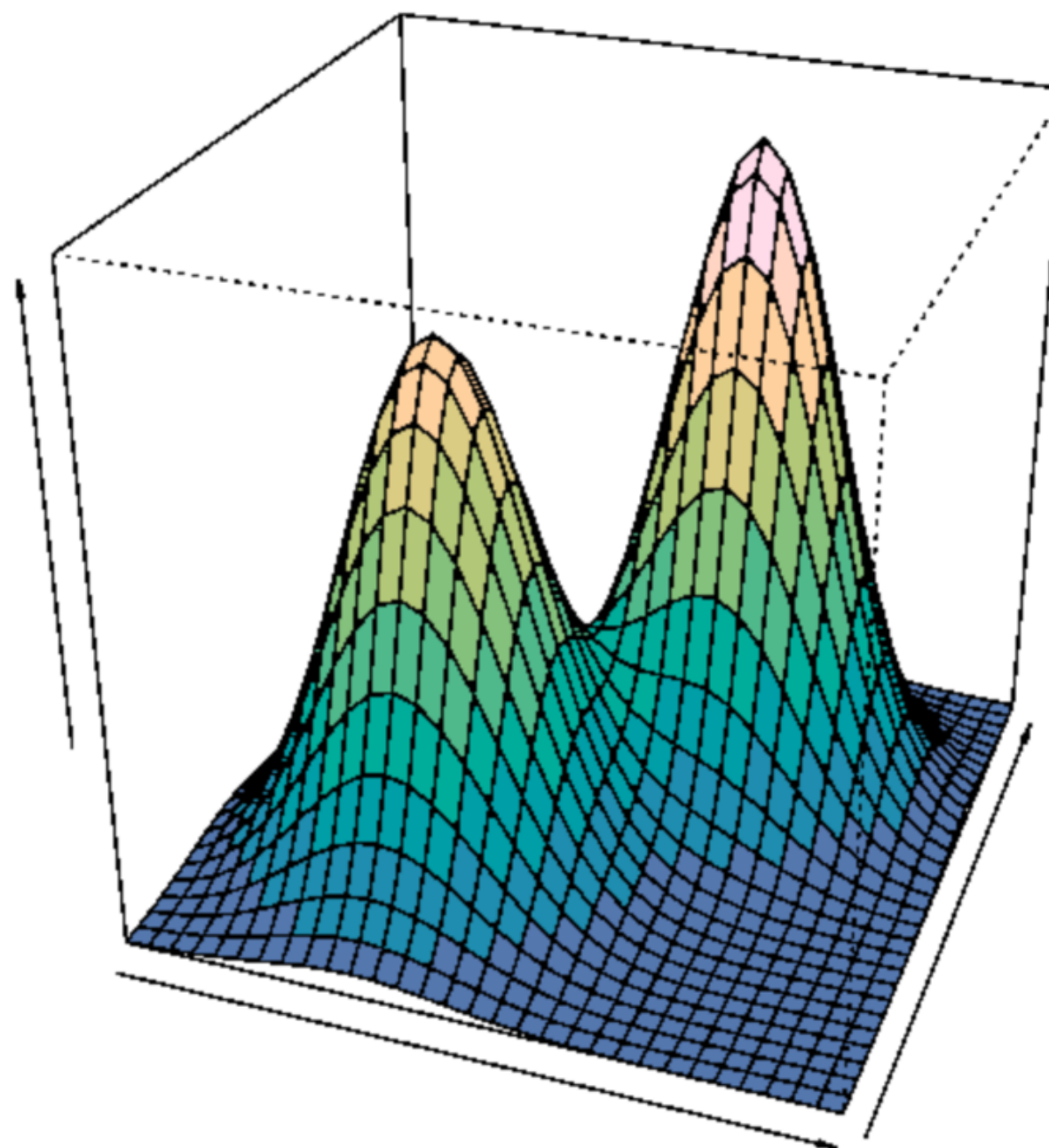
L1 50

L2 95

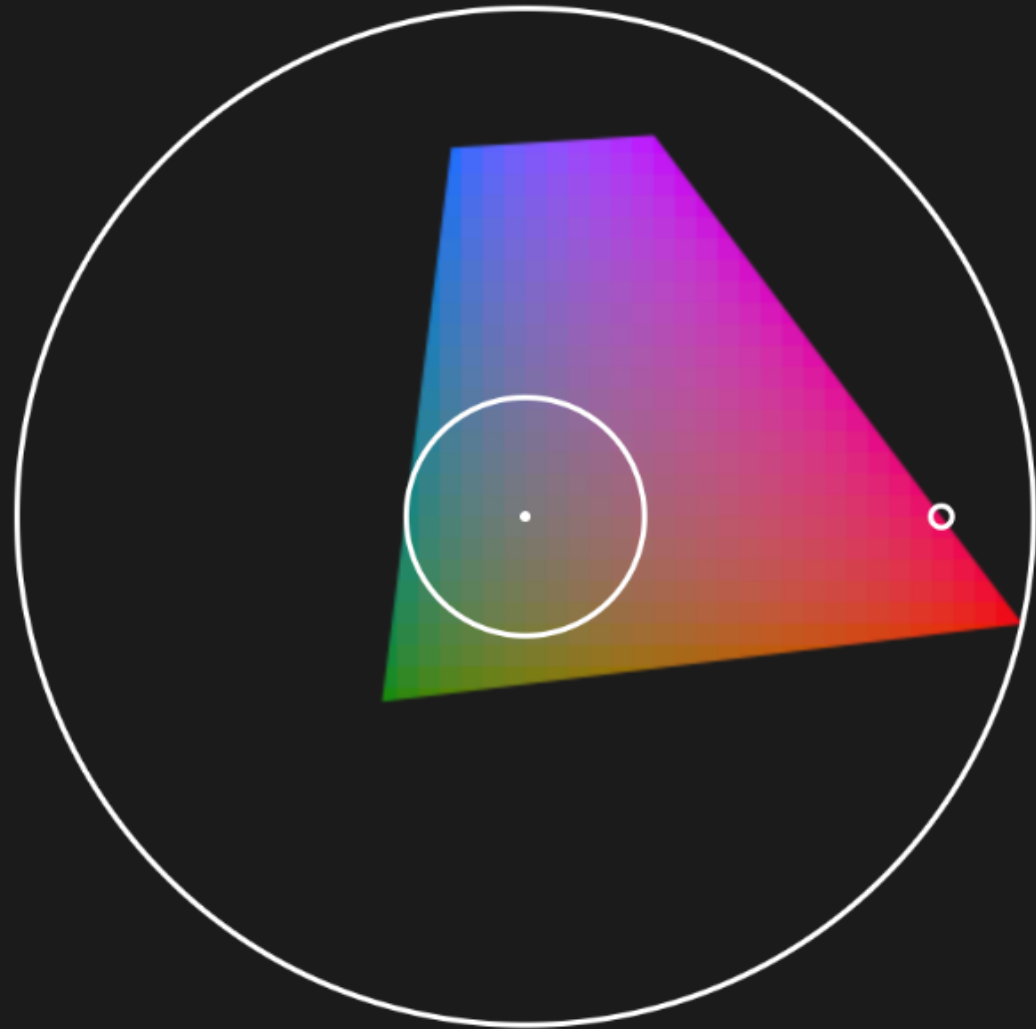
P1 1

P2 1

N 11






hclwizard.org



HUSL is a **human-friendly** alternative to HSL.

To the left you can see **CIE LUV**, a color space designed for perceptual uniformity based on human experiments. When accessed by polar coordinates, it becomes functionally similar to HSL with a single problem: its chroma component doesn't fit into a specific range.

HUSL extends CIE LUV with a new saturation component that allows you to span all the available chroma as a neat percentage.

H		<input type="text" value="0.0"/>	
S		<input type="text" value="100.0"/>	
L		<input type="text" value="50.0"/>	
			<input type="text" value="#ea0064"/>

Selected Resources

Colin Ware. *Information Visualization: Perception for Design*

Edward Tufte. *Envisioning Information*

Cynthia Brewer. *ColorBrewer* colorbrewer2.org

Bruce MacEvoy. *Color Theory* www.handprint.com/HP/WCL/wcolor.html

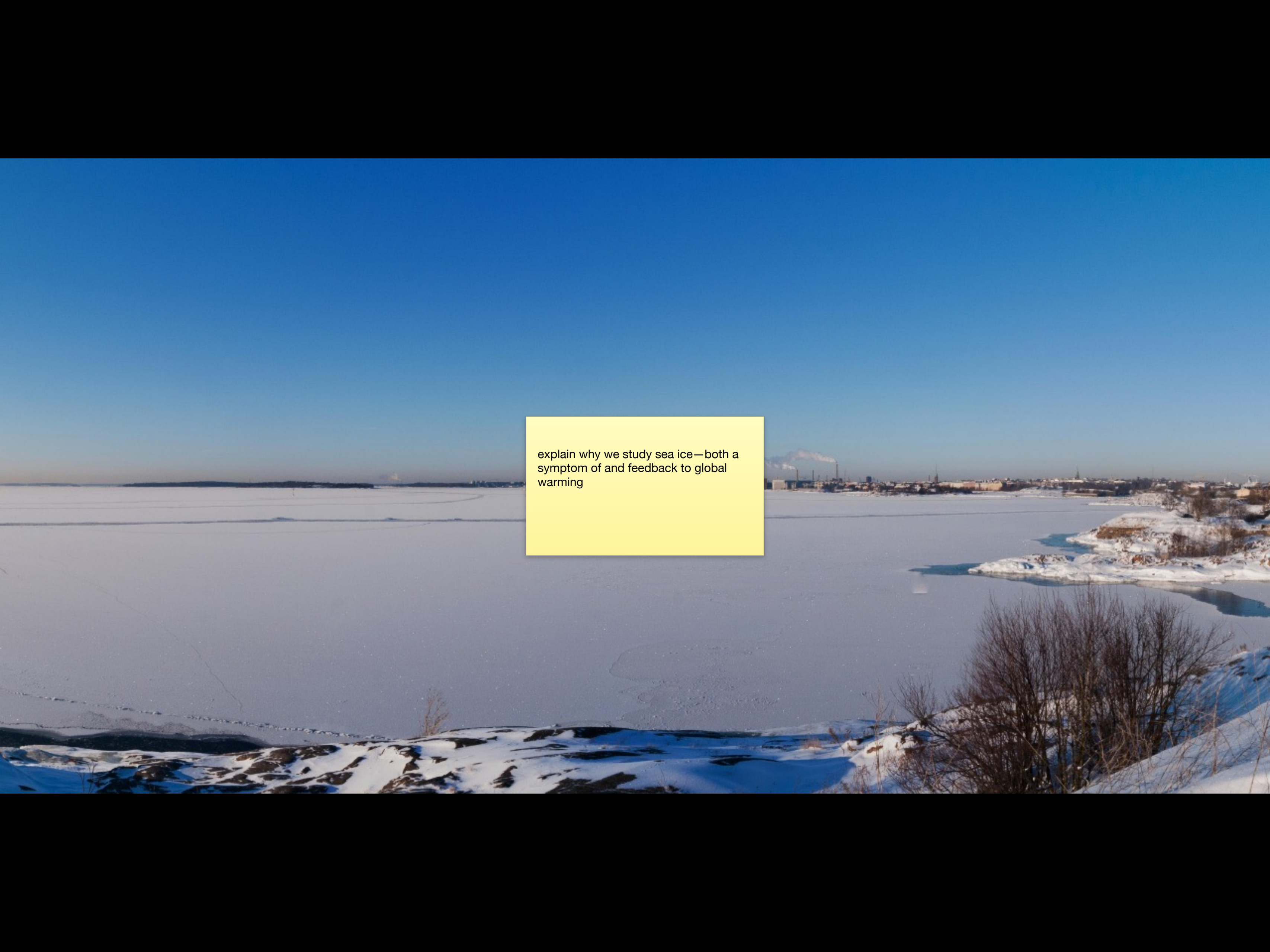
Maureen Stone. *A Field Guide to Digital Color*

Bernice Rogowitz and Lloyd Treinish. *How NOT to Lie with Visualization*

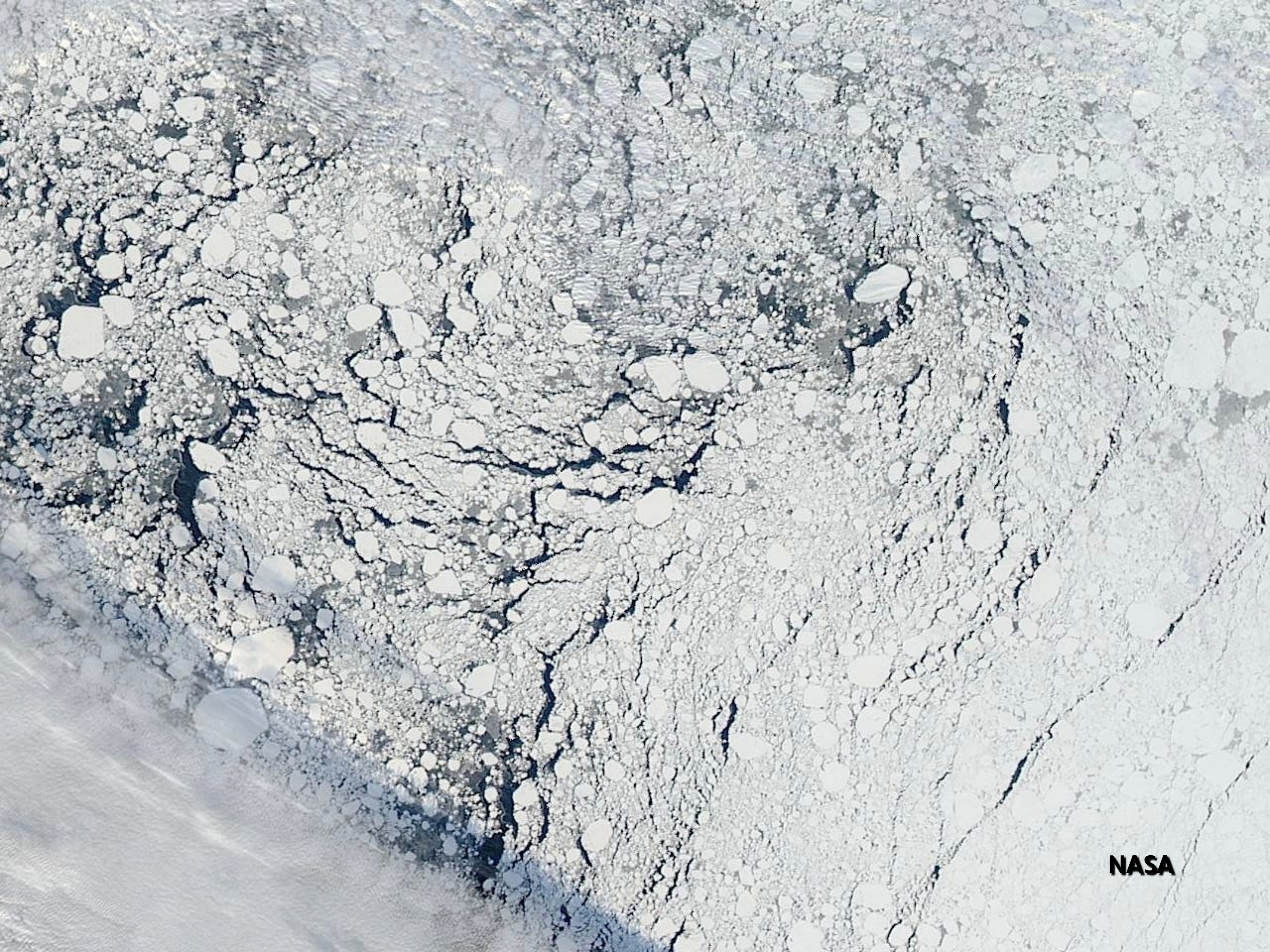
Robert Simmon *Subtleties of Color*

earthobservatory.nasa.gov/blogs/elegantfigures/2013/08/05/subtleties-of-color-part-1-of-6/

Case Study: Sea Ice



explain why we study sea ice—both a symptom of and feedback to global warming

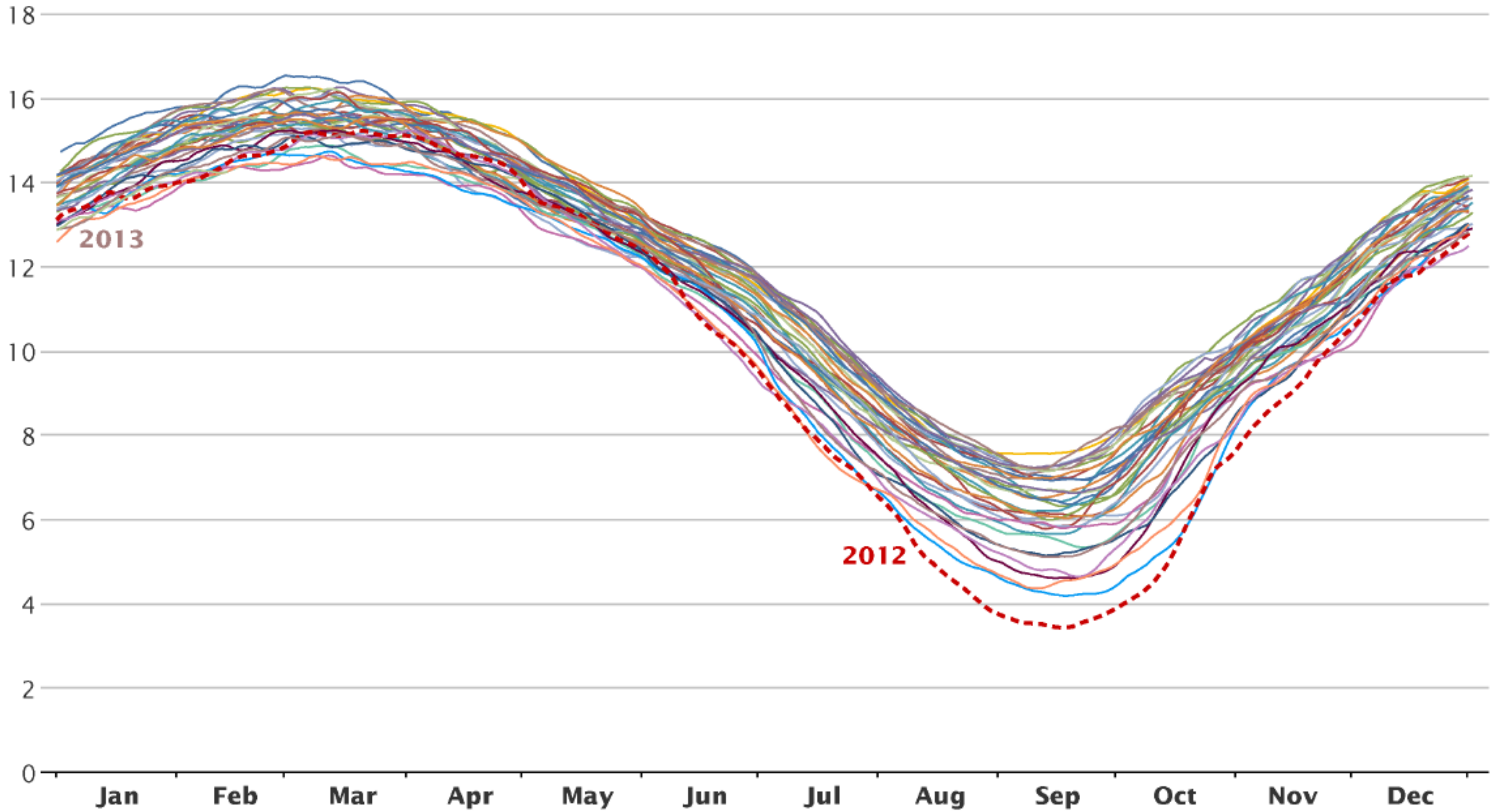


NASA

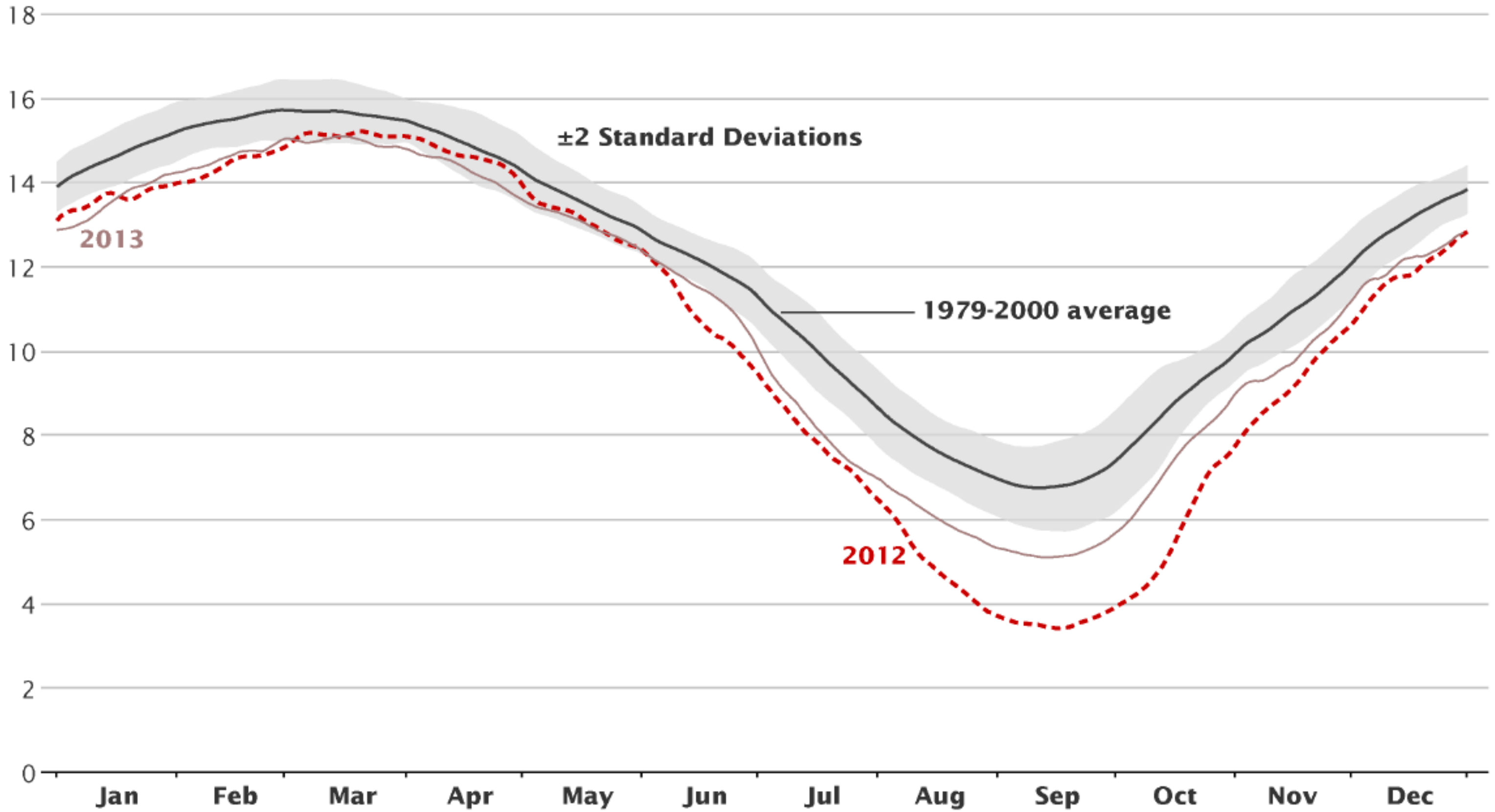
Mar 21, 2014



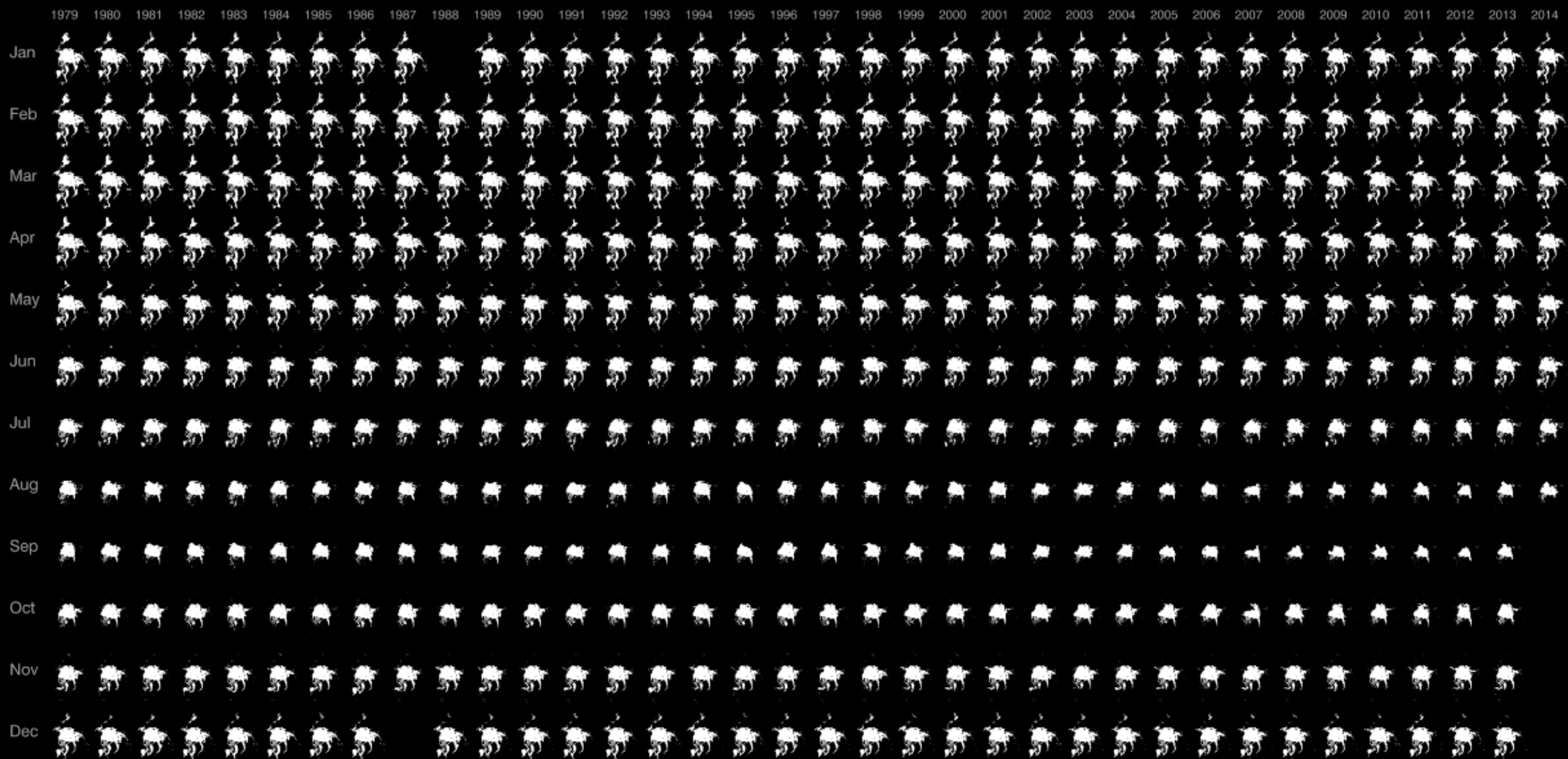
Arctic Sea Ice Extent (millions of square kilometers)
Area of Ocean with at Least 15% Sea Ice



Arctic Sea Ice Extent (millions of square kilometers)
Area of Ocean with at Least 15% Sea Ice



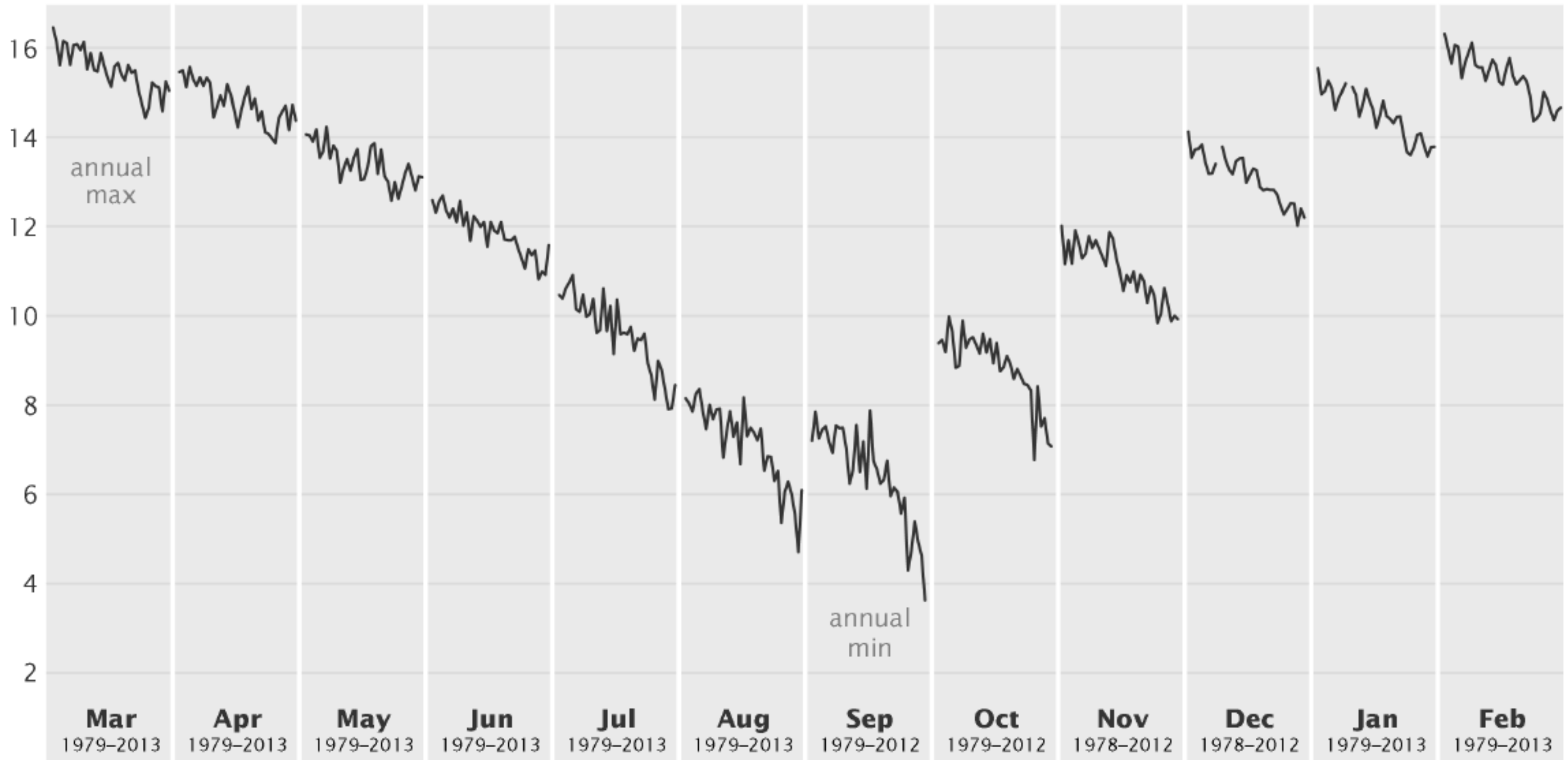
Small Multiples



Based on available images from NSDC

Cycle Plot

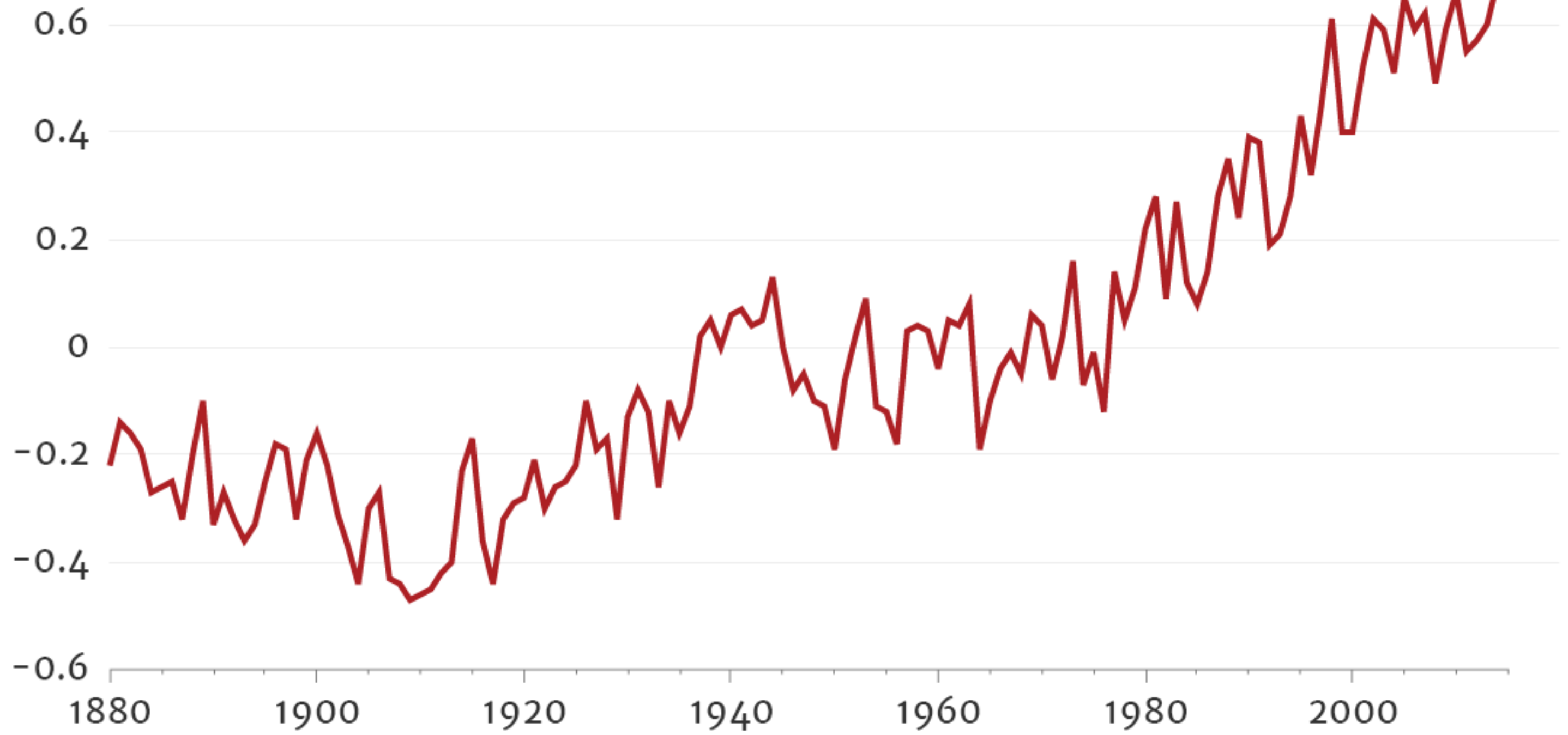
Monthly Mean Arctic Sea Ice Extent November 1978–August 2013 (millions of square kilometers)



Case Study: Global Temperature

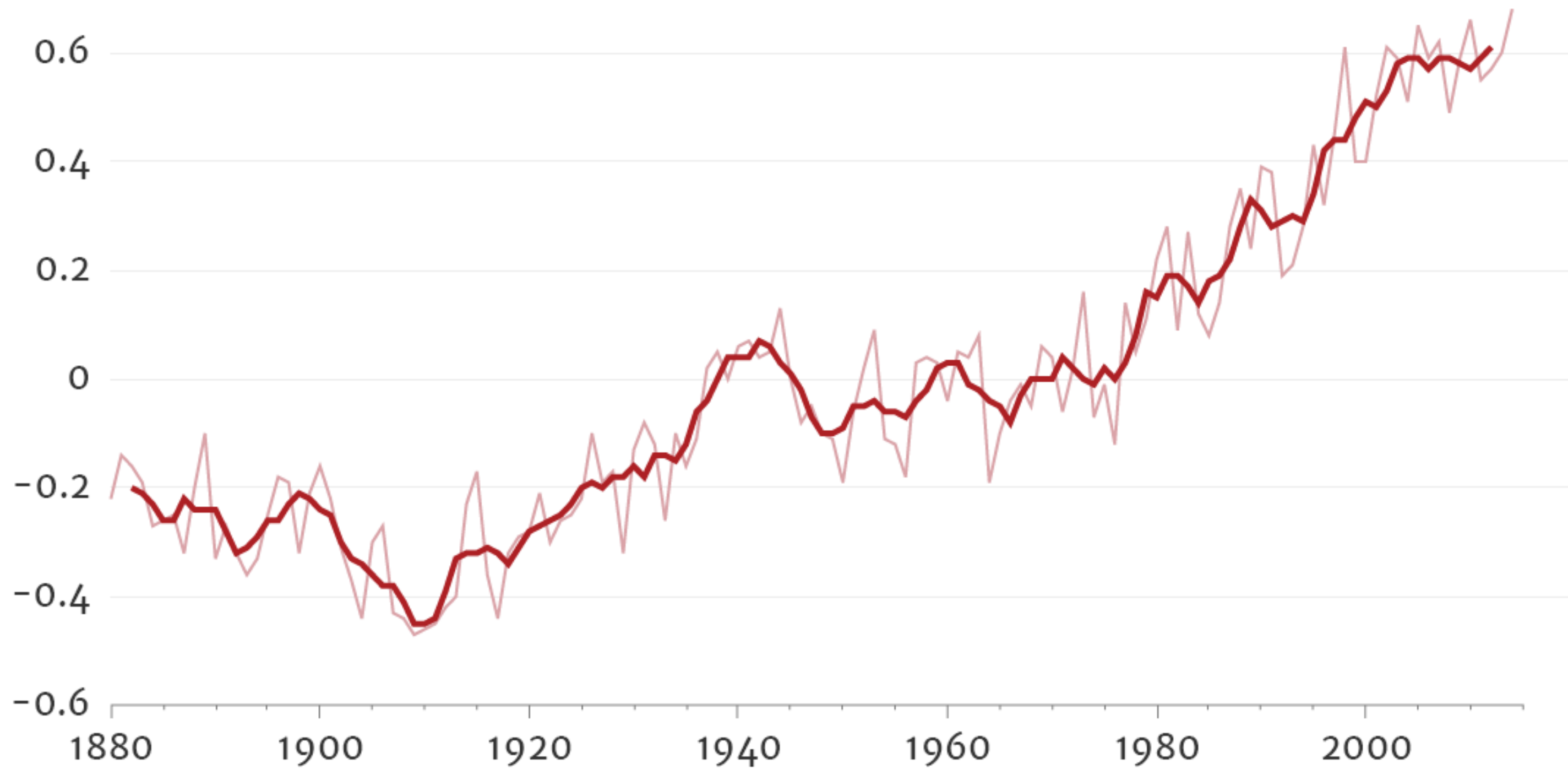
Global Temperature (°C)

Annual Difference from 1951–1980 Average



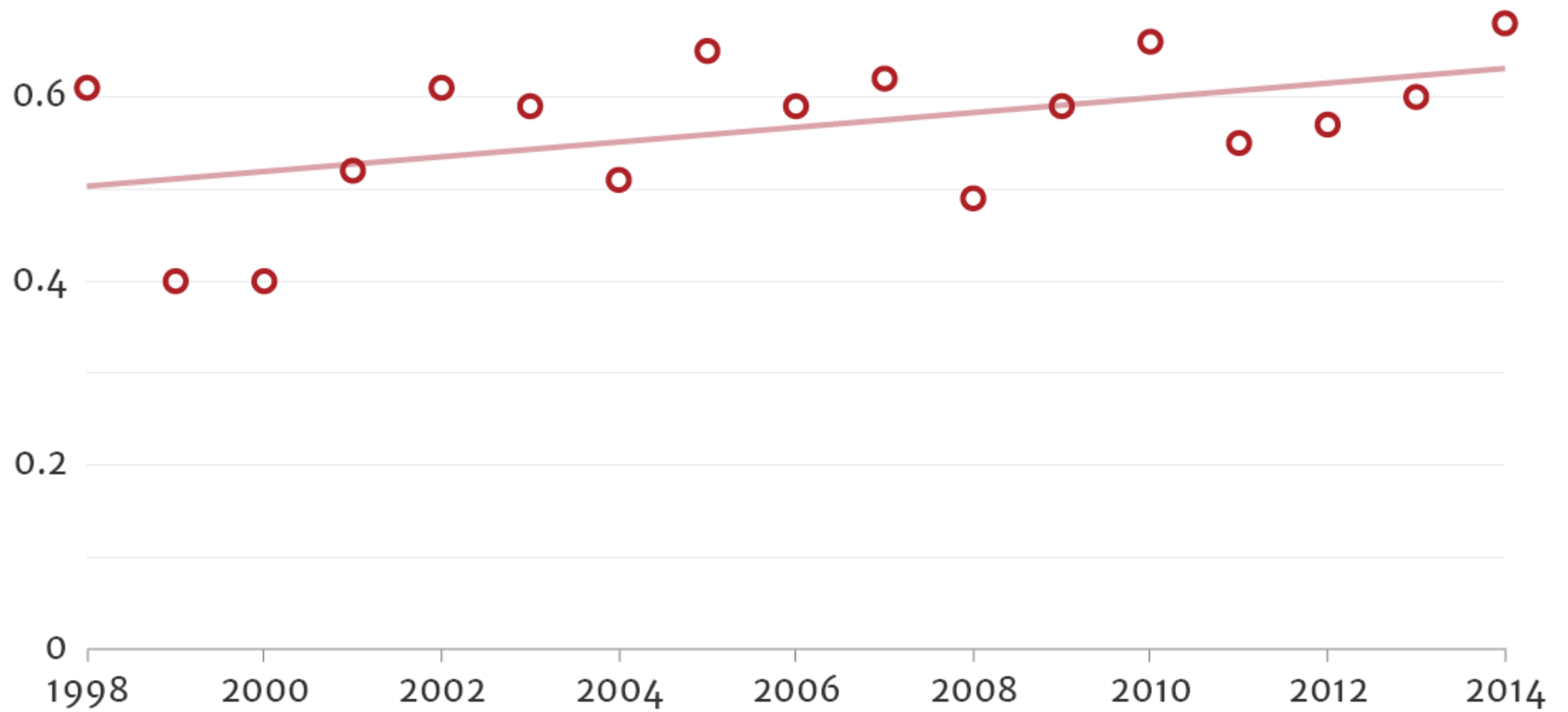
Global Temperature (°C)

5-Year Average



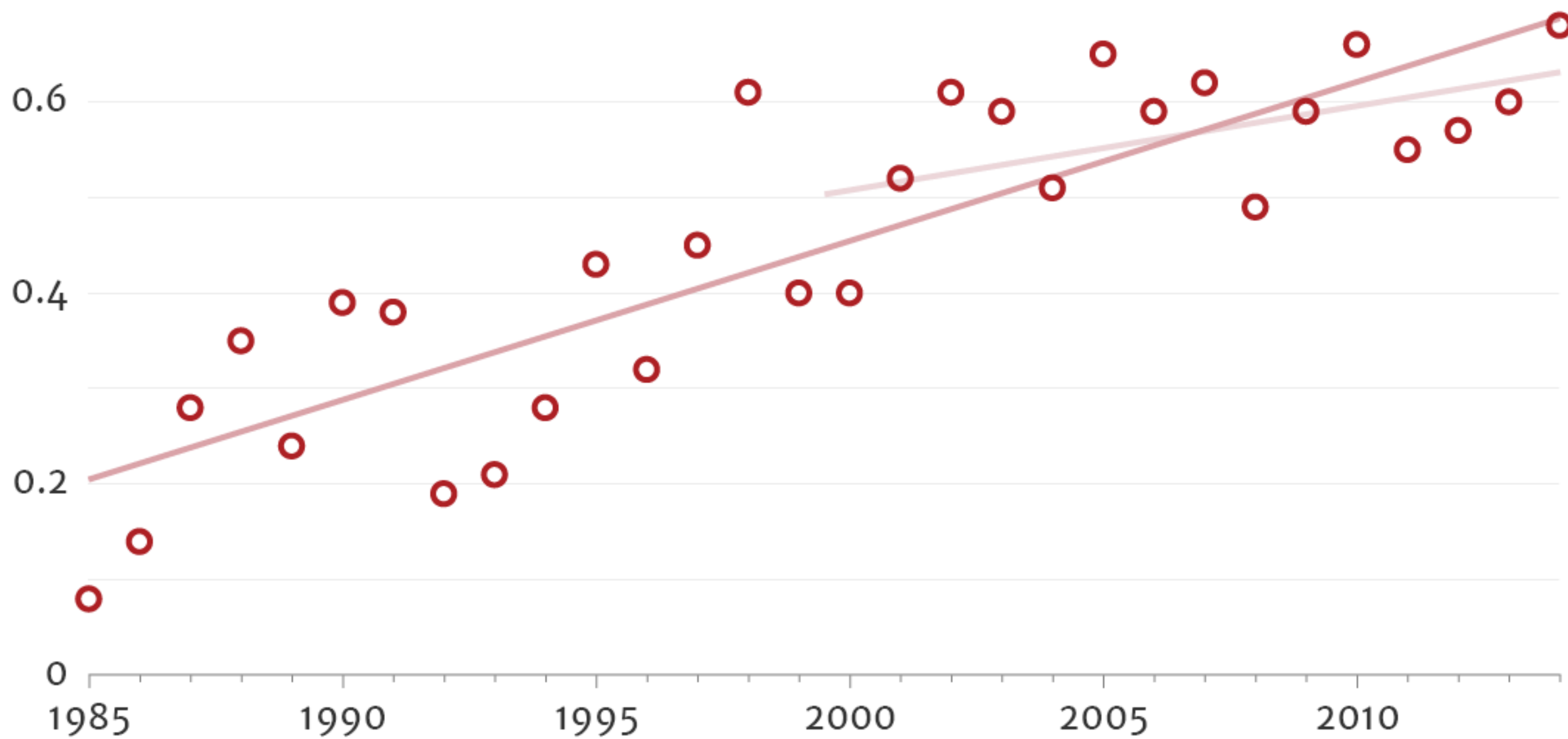
Global Temperature (°C)

15-Year Trend

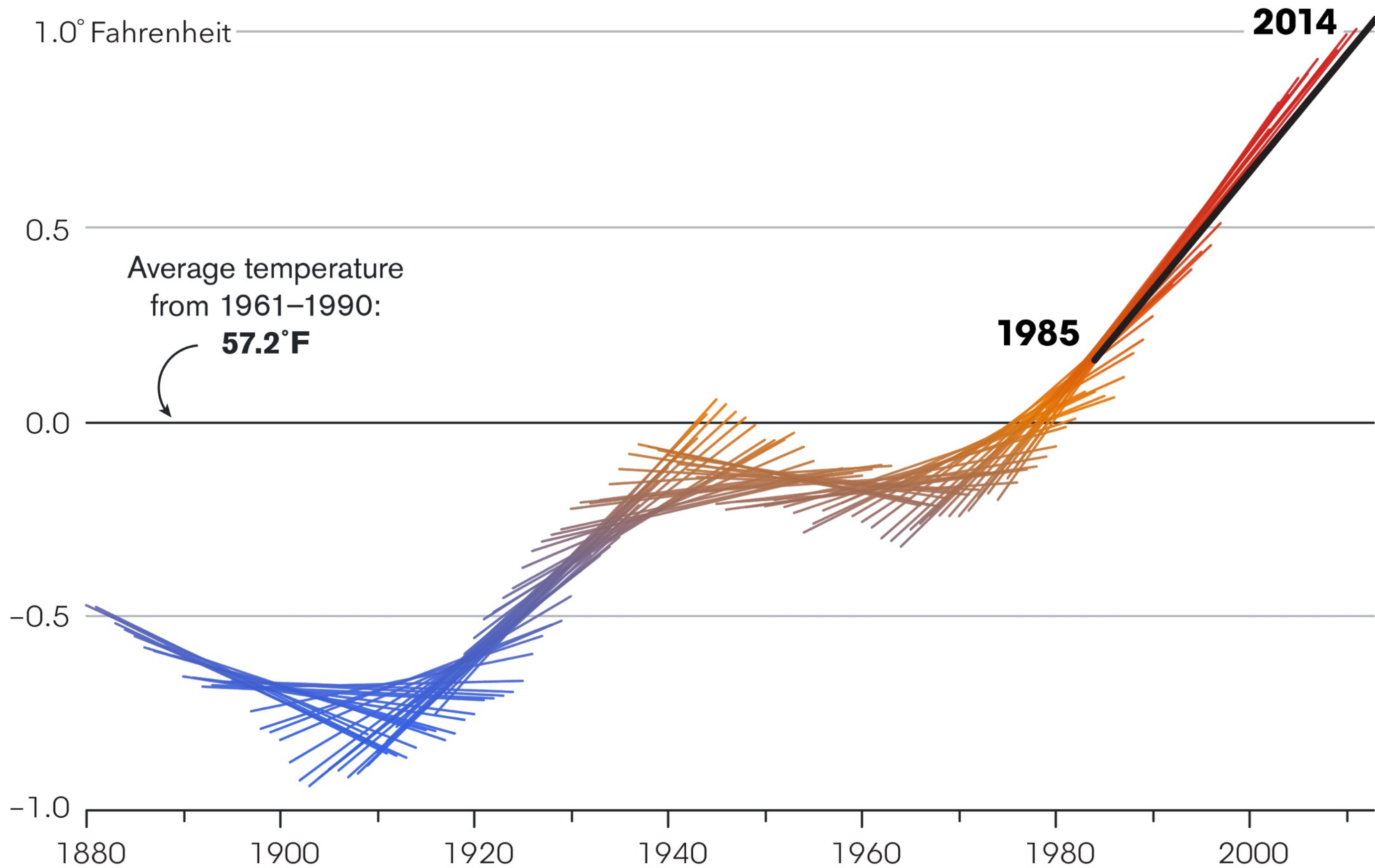


Global Temperature (°C)

30-Year Trend



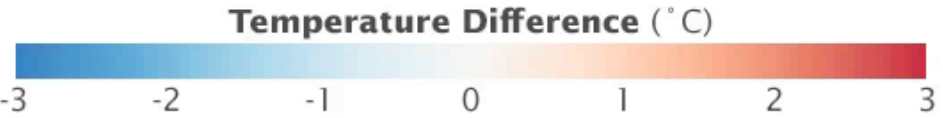
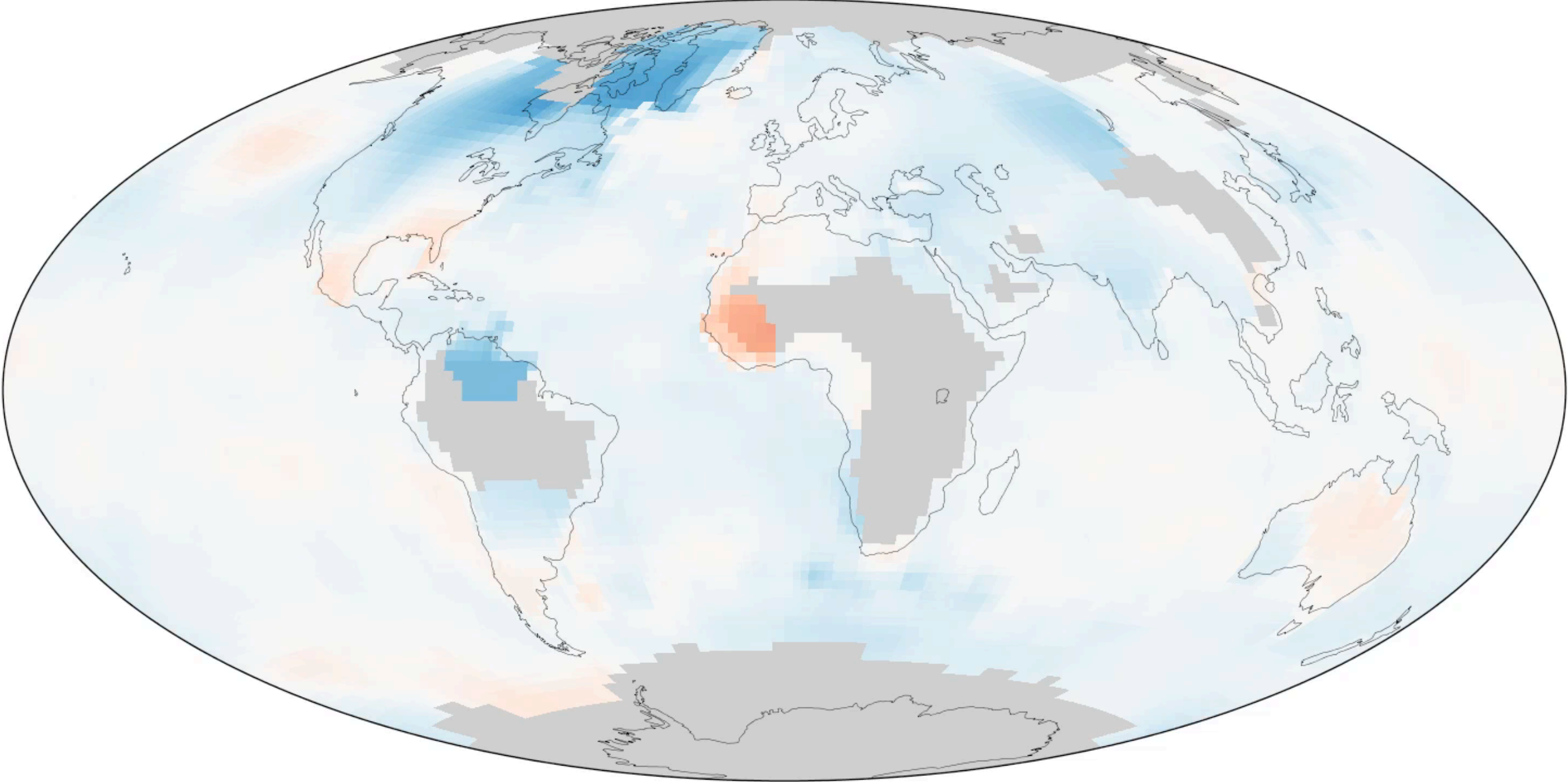
Change in Global Average Air Temperature Over 30-Year Periods

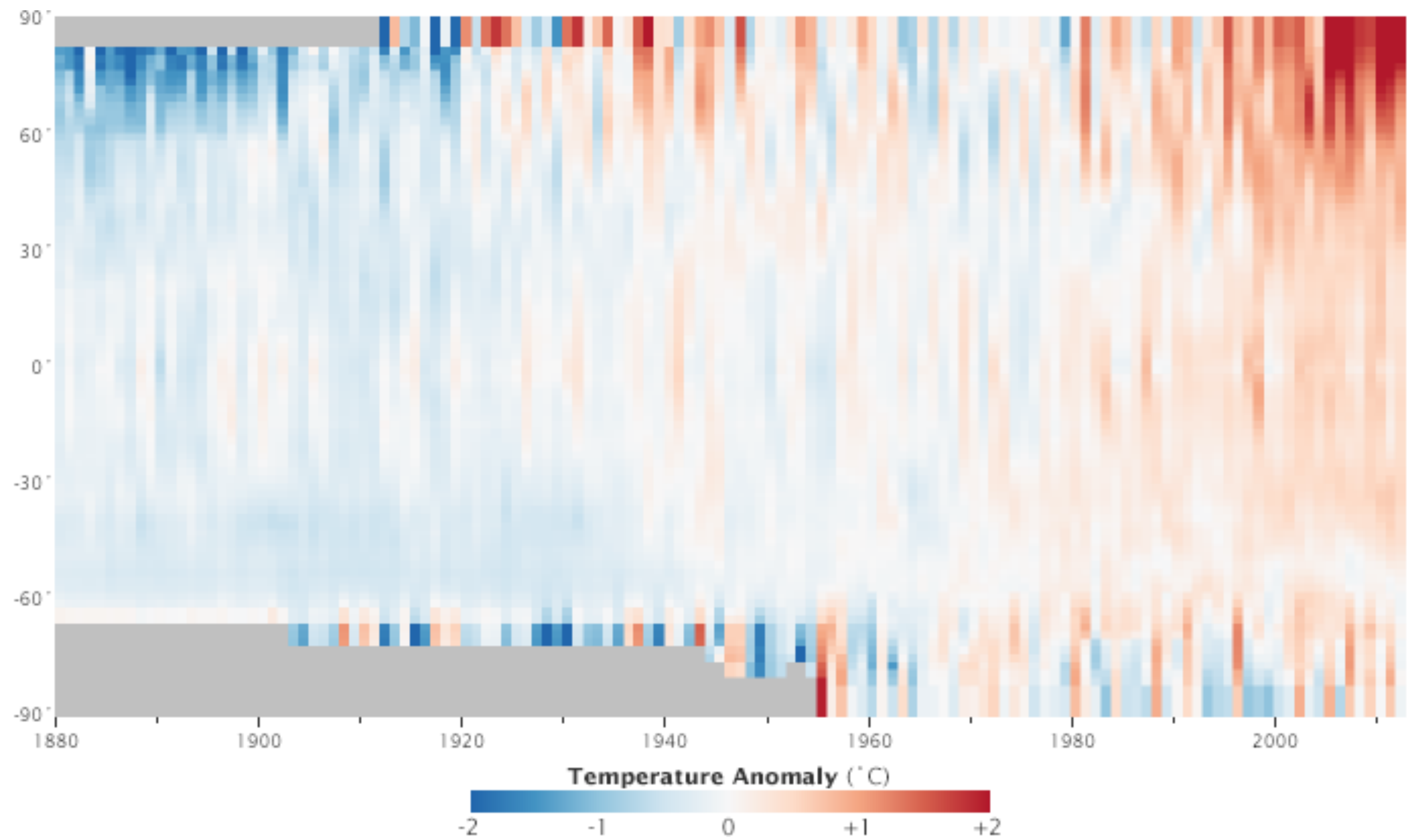


Note: Changes are measured against the planet's average temperature over the 30 years from 1961-1990, the time period the UN uses as a climate benchmark.
Sources: United Nations' World Meteorological Organization, NASA-GISS

Global Temperature

Difference from 1951–1980 Average





Inspirations

Cynthia Brewer *Color Brewer*

Robert Bringhurst *The Elements of Typographic Style*

Alberto Cairo *The Functional Art*

William Cleveland *The Elements of Graphing Data*

Philip B. Meggs *History of Graphic Design*

Donald Norman *The Design of Everyday Things*

Edward Tufte *Visual Display of Quantitative Information*

Colin Ware *Information Visualization: Perception for Design*

Contact

simmon@planet.com
@rsimmon

planet.com

thumbsupviz.com

earthobservatory.nasa.gov/blogs/elegantfigures