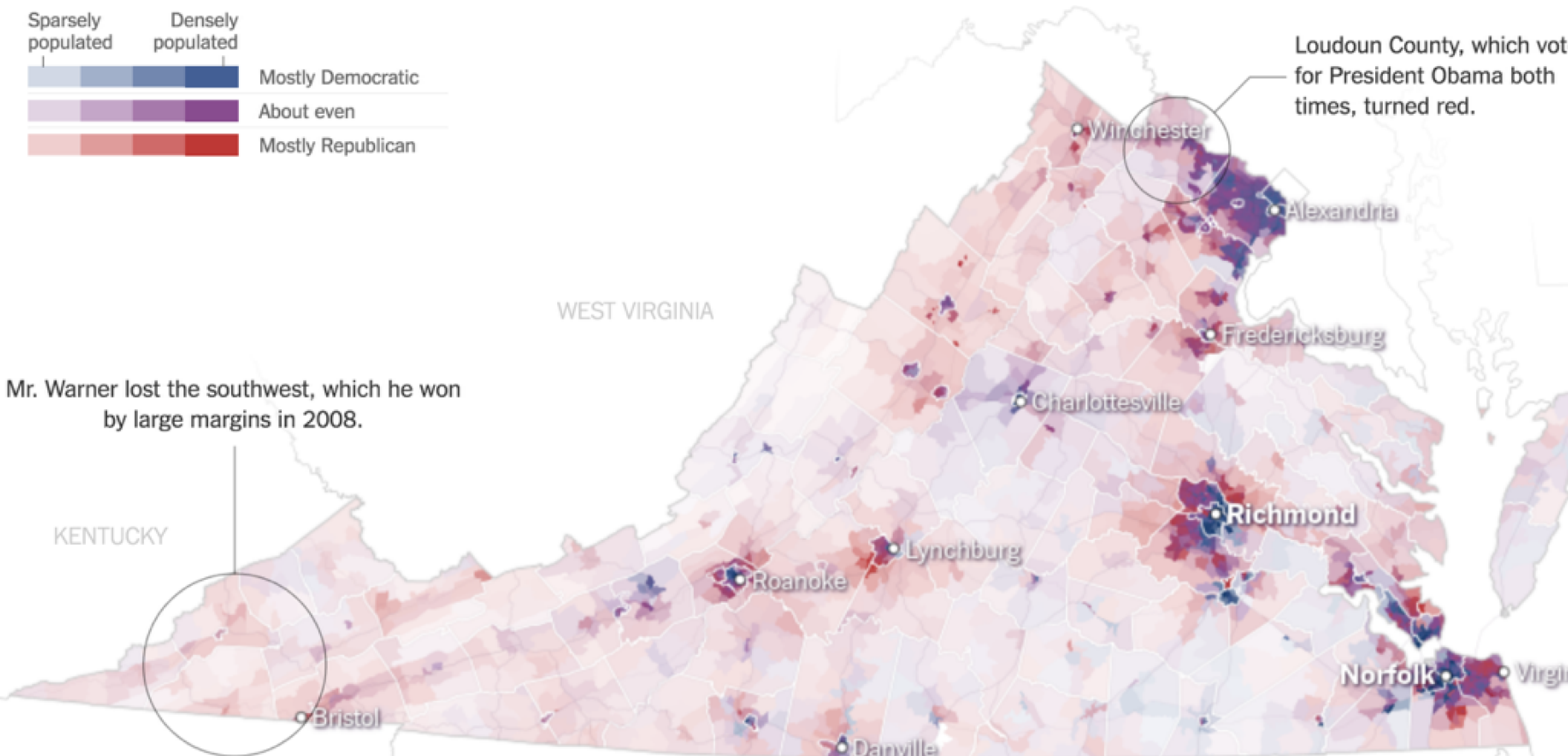
Cartography

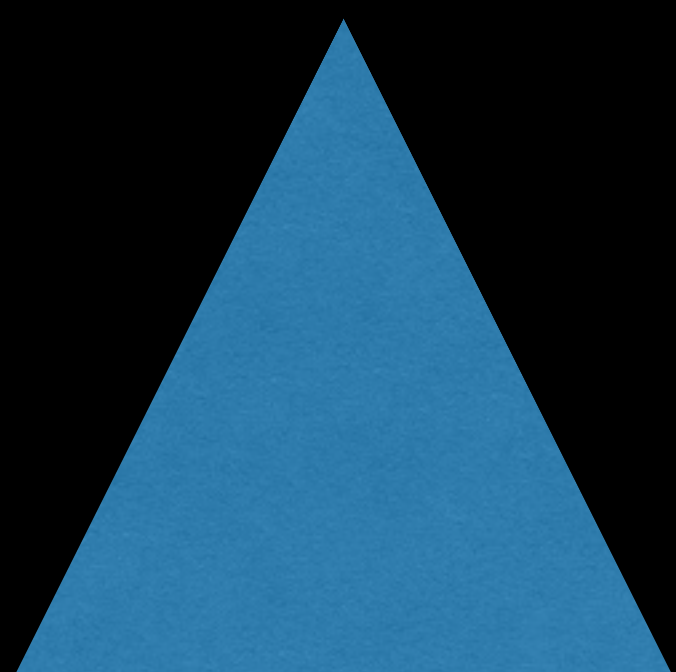
CS444

Why draw a map?



The world is not flat!

What do the internal angles of a triangle sum to?



The world is not flat!

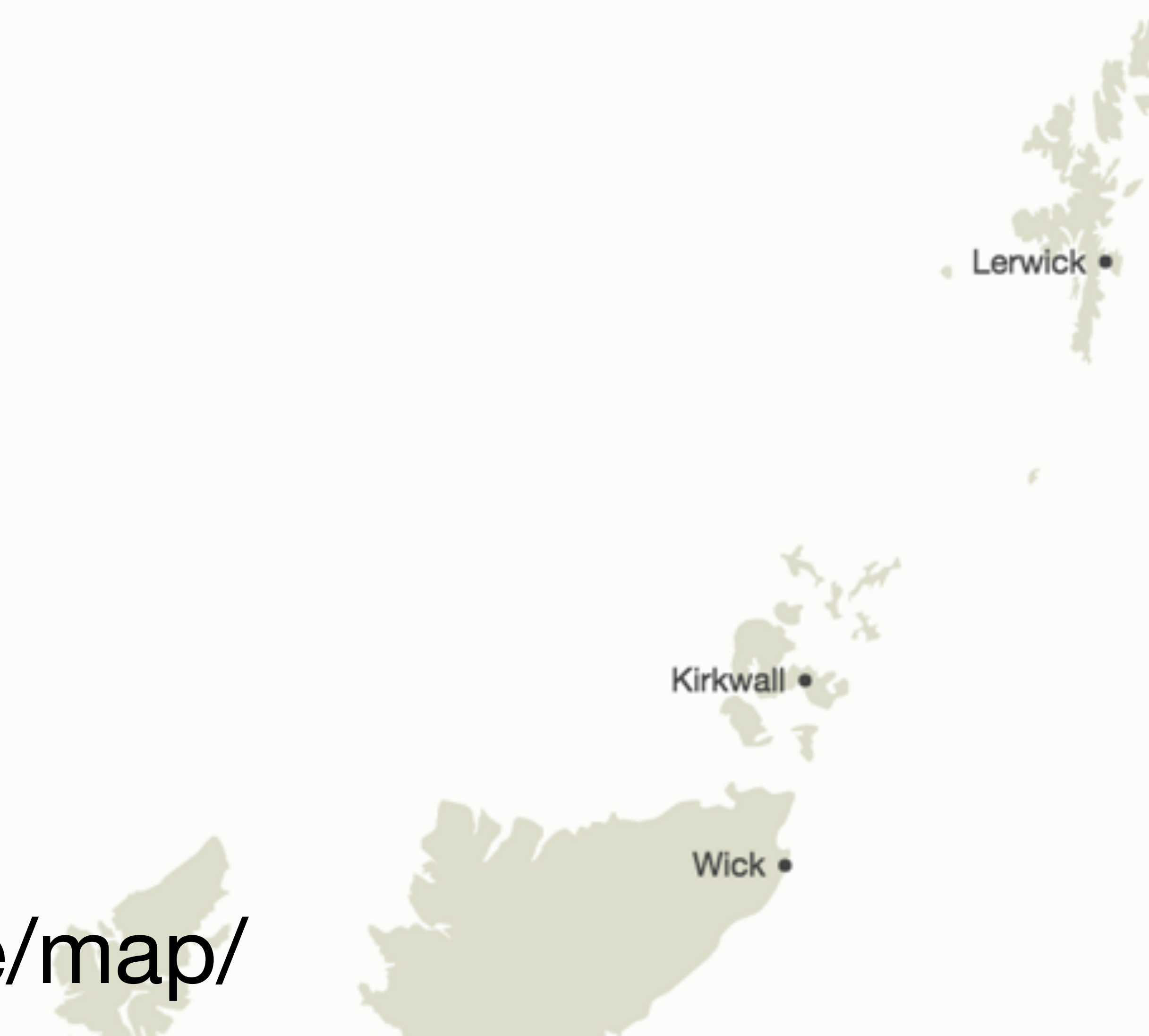
If you walked your way out of Tucson, forever going east, would you be walking in a straight line?

The world is not flat!

Let's Make a Map

In this tutorial, I'll cover how to make a modest map from scratch using D3 and TopoJSON. I'll show you a few places where you can find free geographic data online, and how to convert it into a format that is both efficient and convenient for display. I won't cover thematic mapping, but the map we'll make includes labels for populated places and you can extend this technique to geographic visualizations such as graduated symbol maps and choropleths.

Without further ado, here's the map:



https://bost.ocks.org/mike/map/

Map Projections

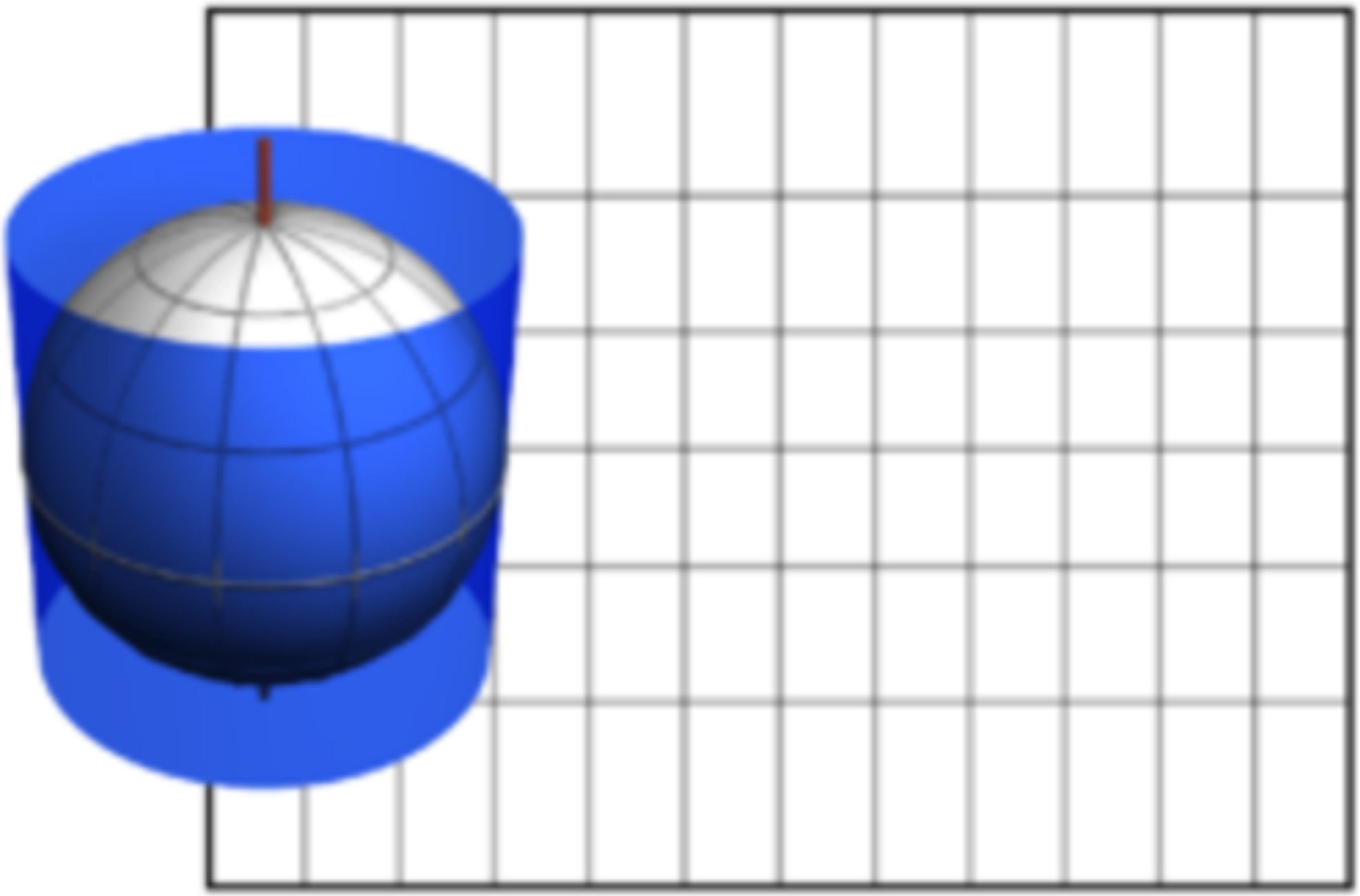
https://www.jasondavies.com/maps/transition/

What properties do we want projections to preserve?

- Shape
- Bearing
- Area
- Distance

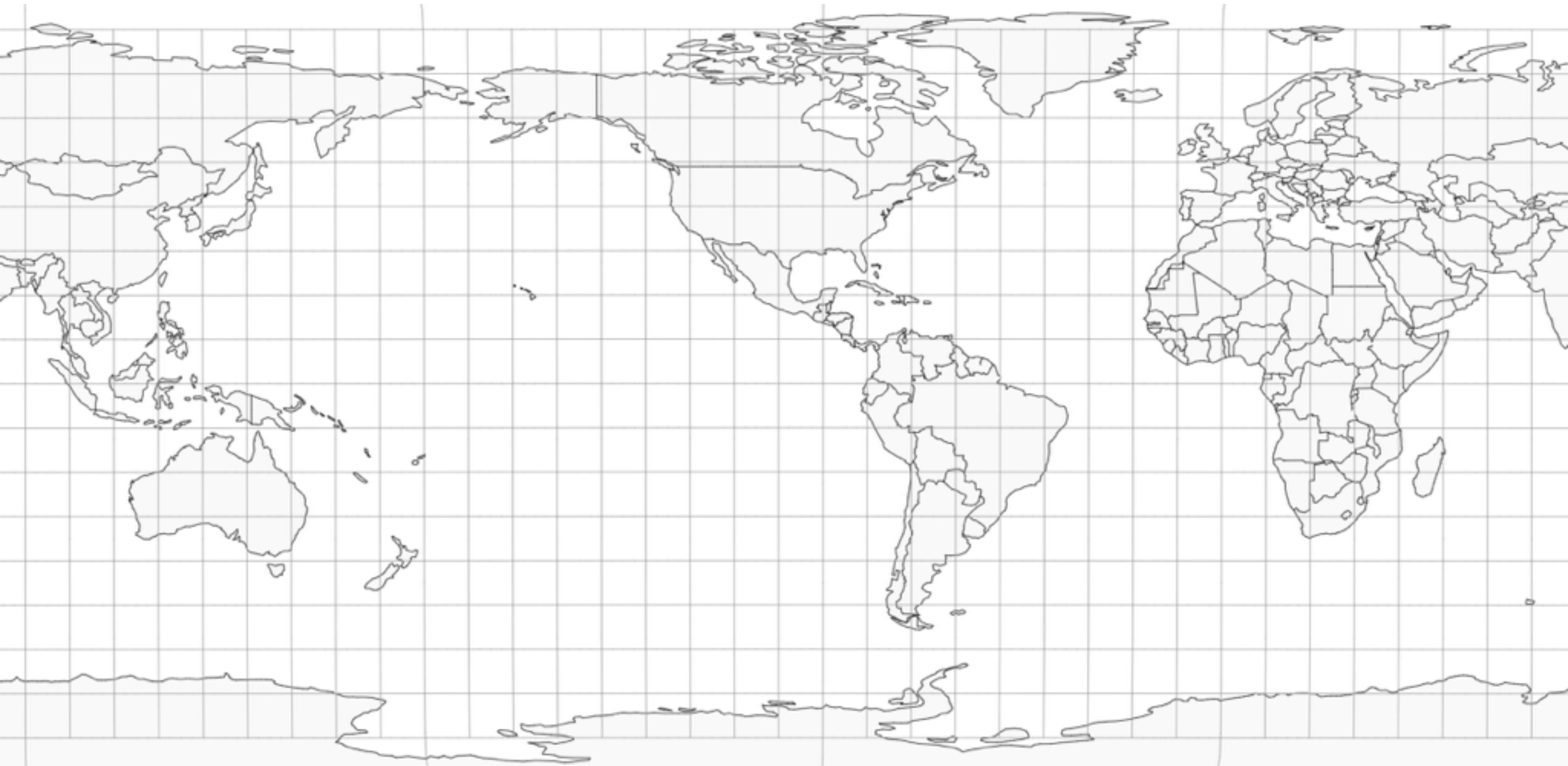
Can we preserve all of these at once?

Cylindrical Projections

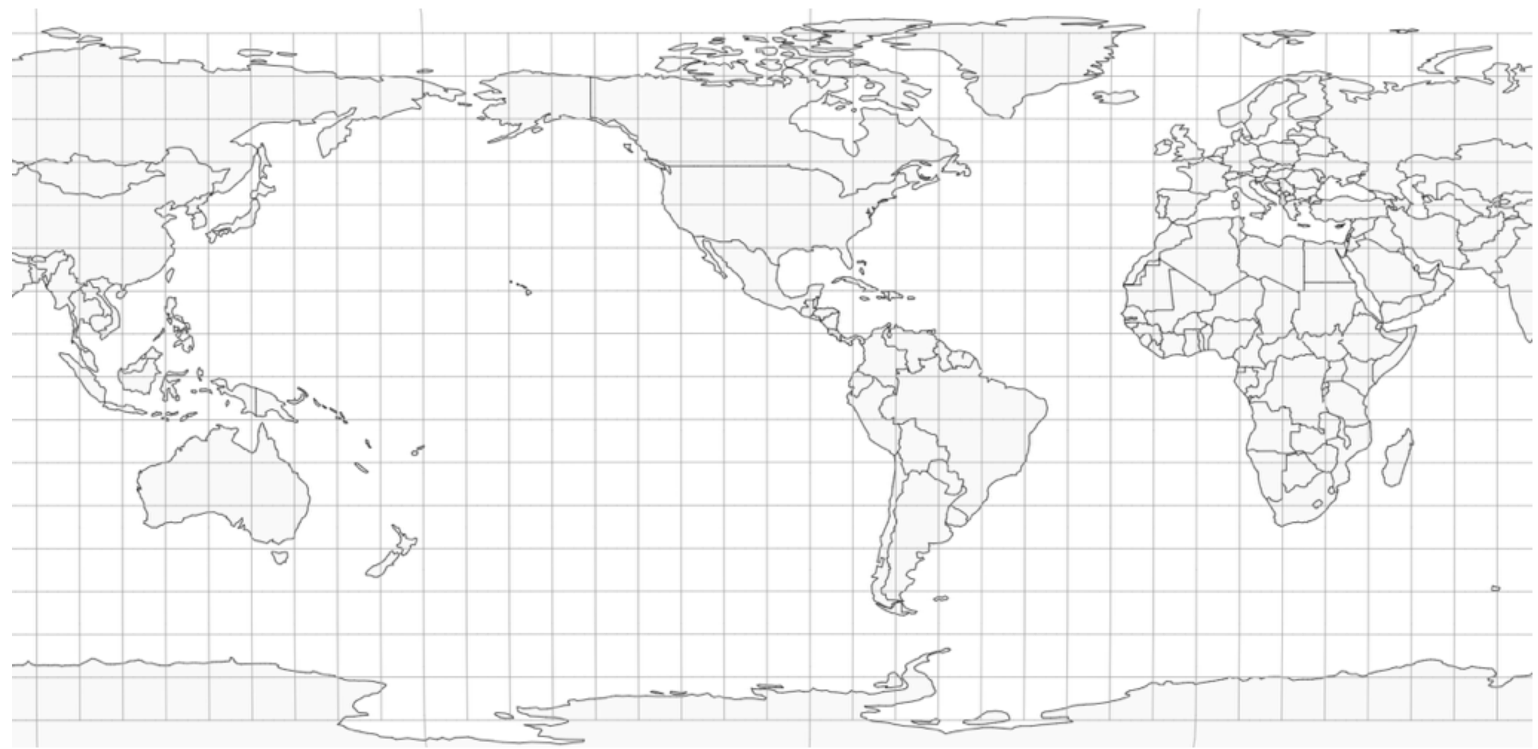


http://www.progonos.com/furuti/MapProj/

Equirectangular Projection



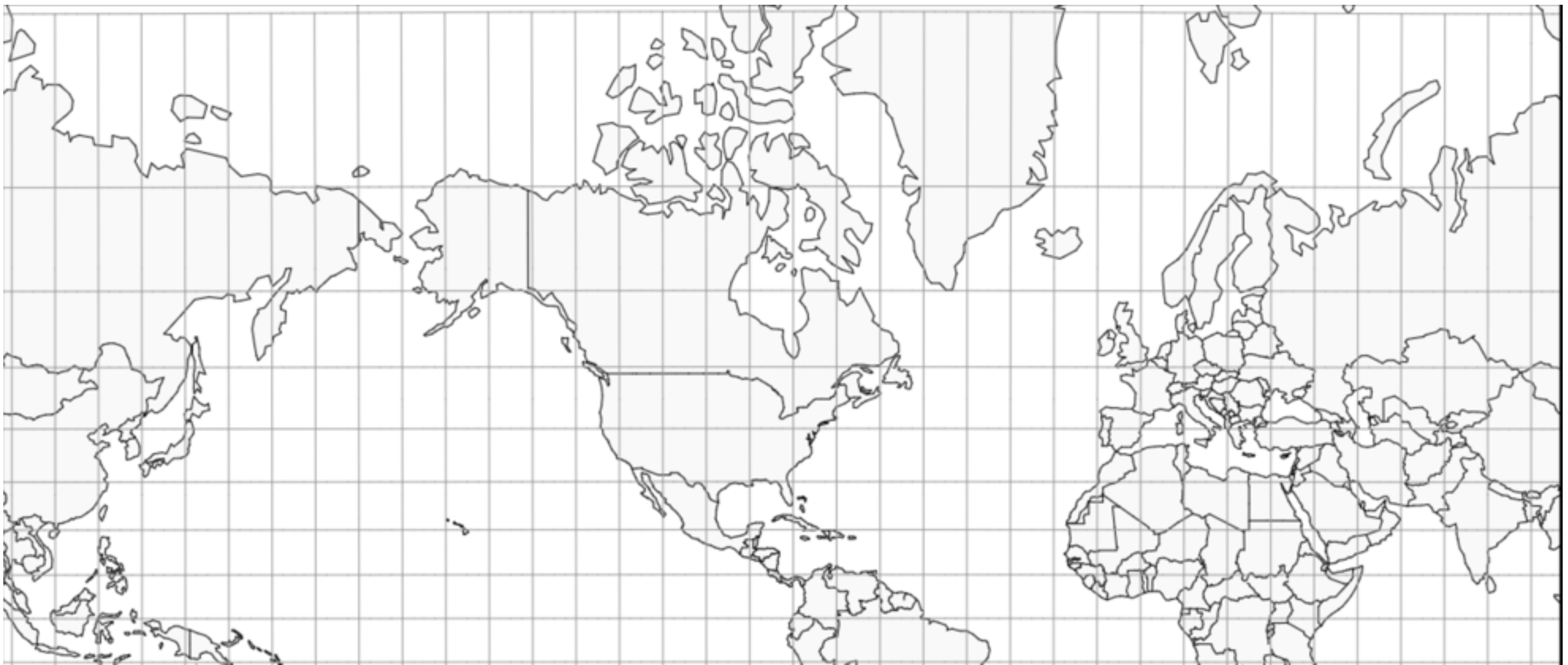
Equirectangular Projection



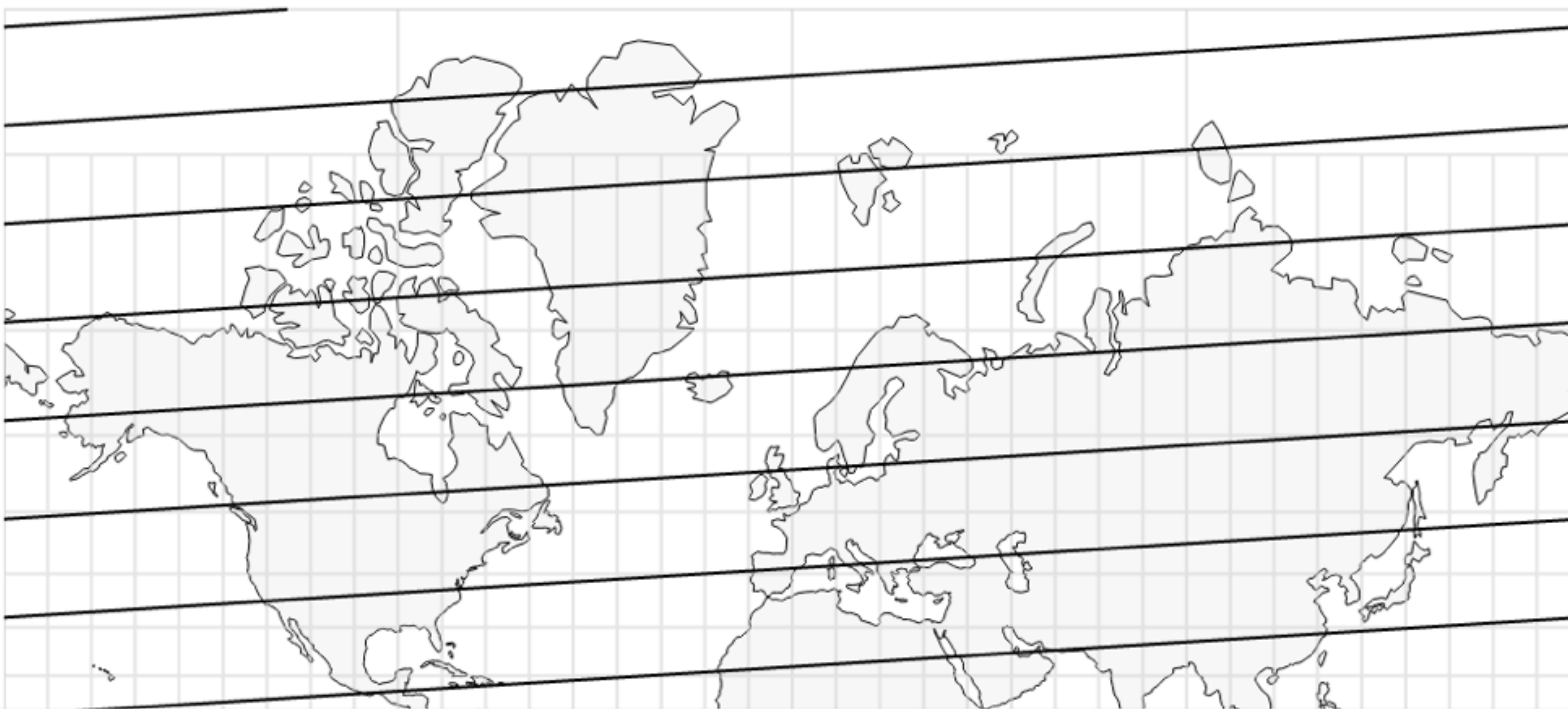
- y = lat
- x = long
- Preserves lat and long

Mercator Projection

- Preserves **local shape**
  - **“conformal”: angles are preserved**



- Bearing: following a compass direction makes a straight line in the Mercator projection



https://www.jasondavies.com/maps/loxodrome/

Sizes?

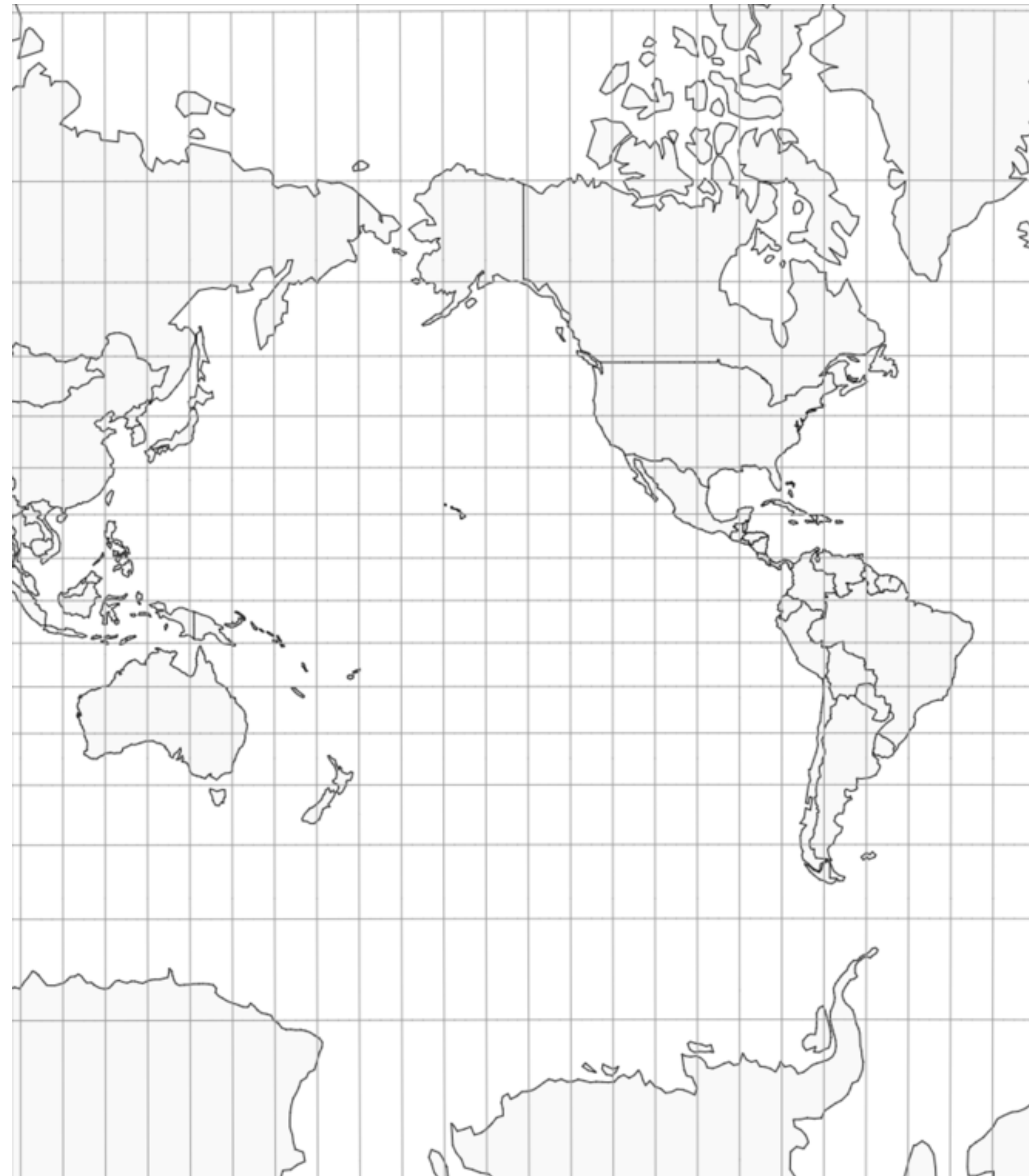
http://thetruesize.com/

Sizes?

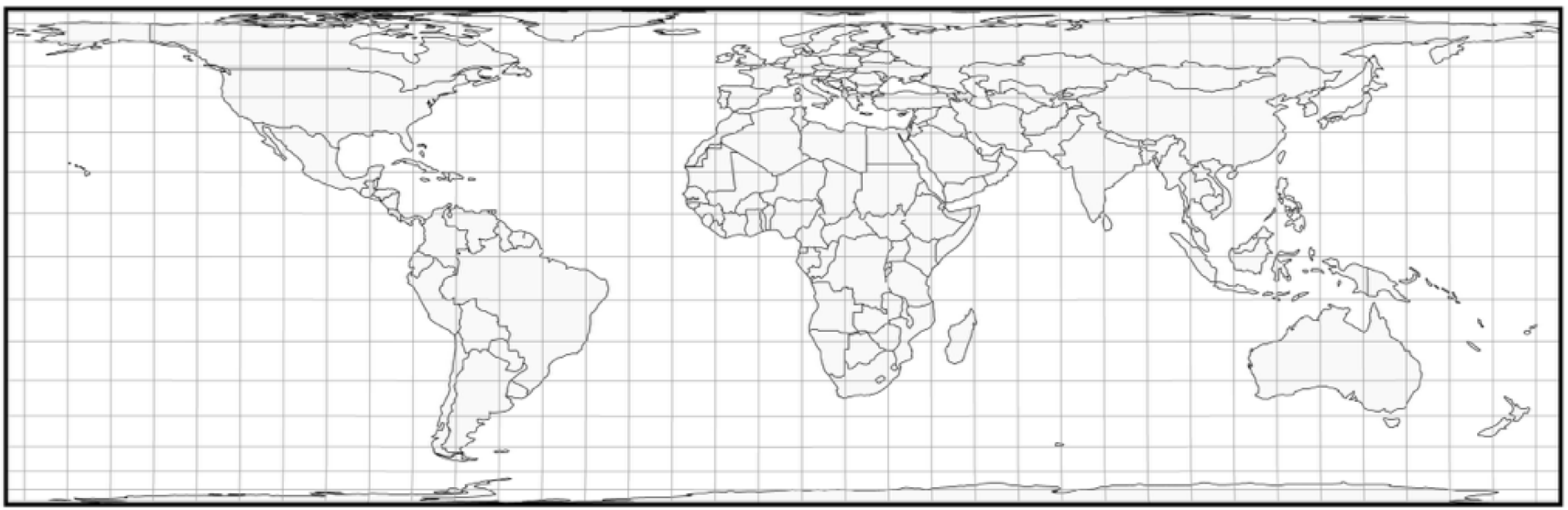

Arctic Ocean
Arctic Ocean
Greenland
Iceland
Finland
Sweden
Norway
Russia
United Kingdom
Poland
Germany
Ukraine
France
Italy
Spain
Kazakhstan
Mongolia
Canada
United States
North Atlantic Ocean
Turkey
China
Japan
South Korea
Iraq
Iran
Afghanistan
Pakistan
Algeria
Libya
Egypt
Saudi Arabia
India
Thailand
Mexico
Mali
Niger
Chad
Sudan
Nigeria
Ethiopia
Venezuela
Colombia
Kenya
DR Congo
Tanzania
Indonesia
Brazil
Peru
Bolivia
Angola
Namibia
Botswana
Madagascar
South Africa
Indian Ocean
Australia
Chile
Argentina
South Pacific Ocean
South Atlantic Ocean

Mercator Projection

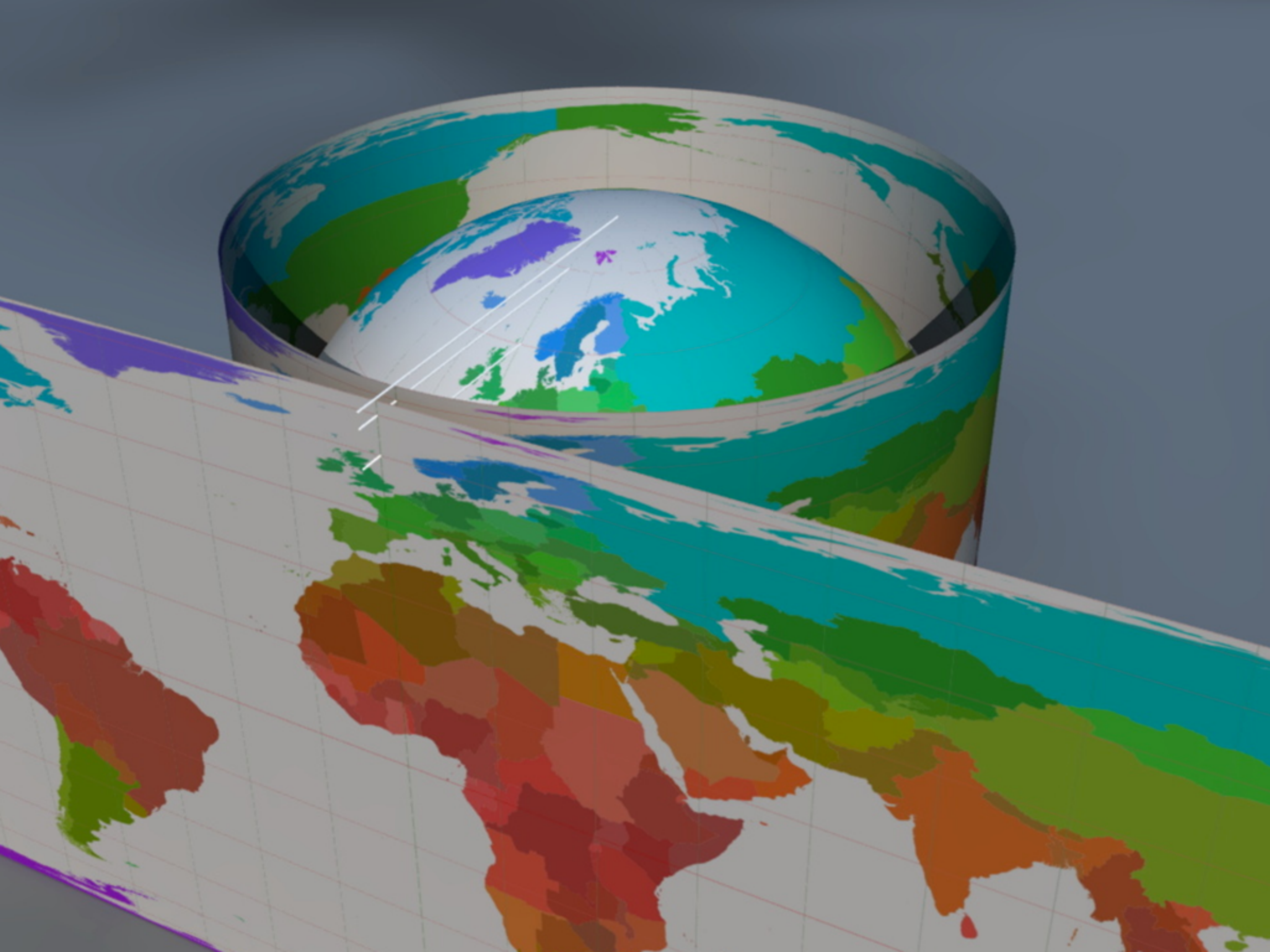
- $y = \log(\tan(45 + lat/2))$
- $x = long$



Lambert's Cylindrical Equal-Area Projection



- $y = \sin(\text{lat})$
- $x = \text{long}$

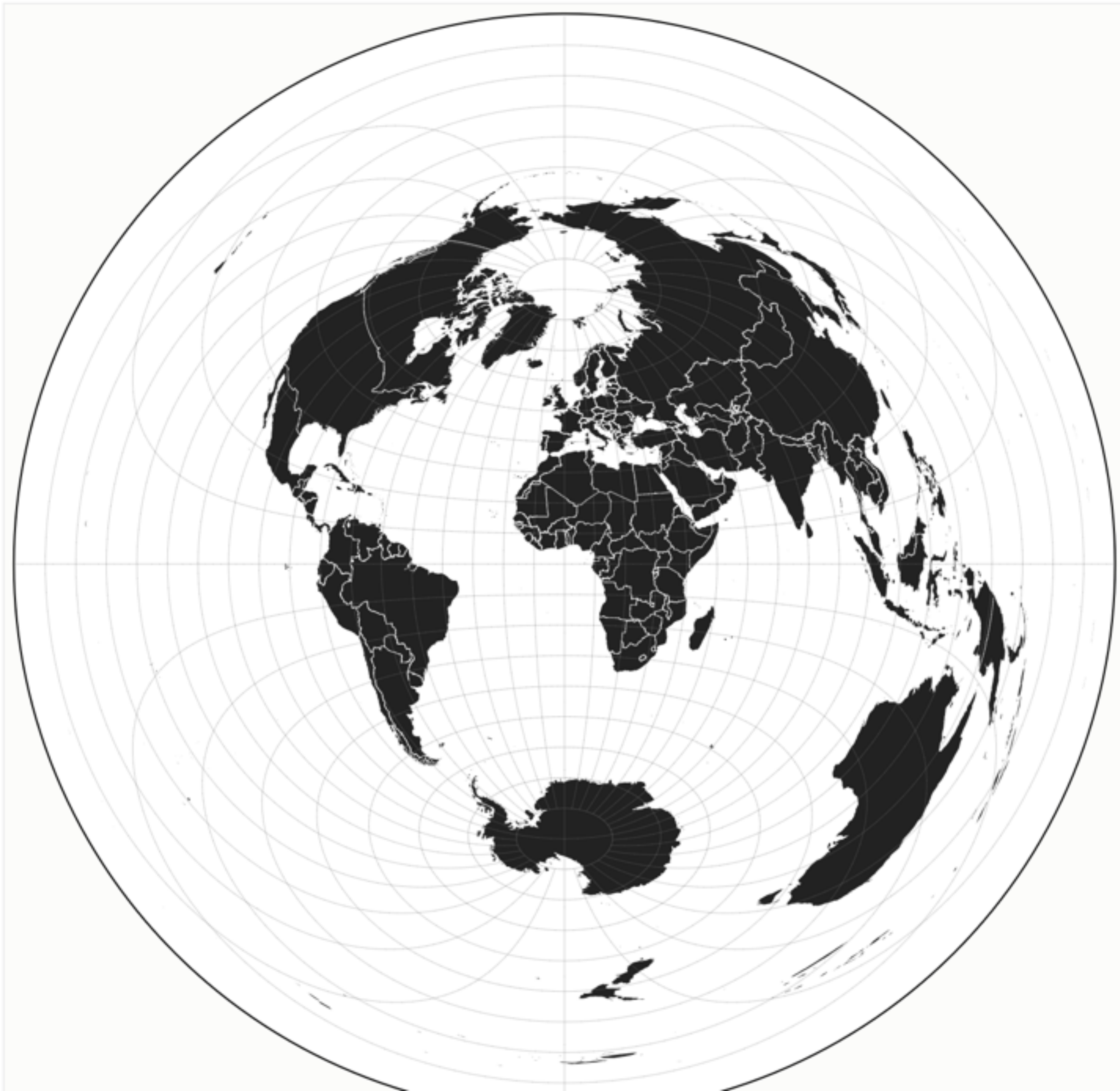


Azimuthal Projections (“Directional” Projections)

Directions from **center point** are preserved

http://bl.ocks.org/mbostock/

Azimuthal Equidistant

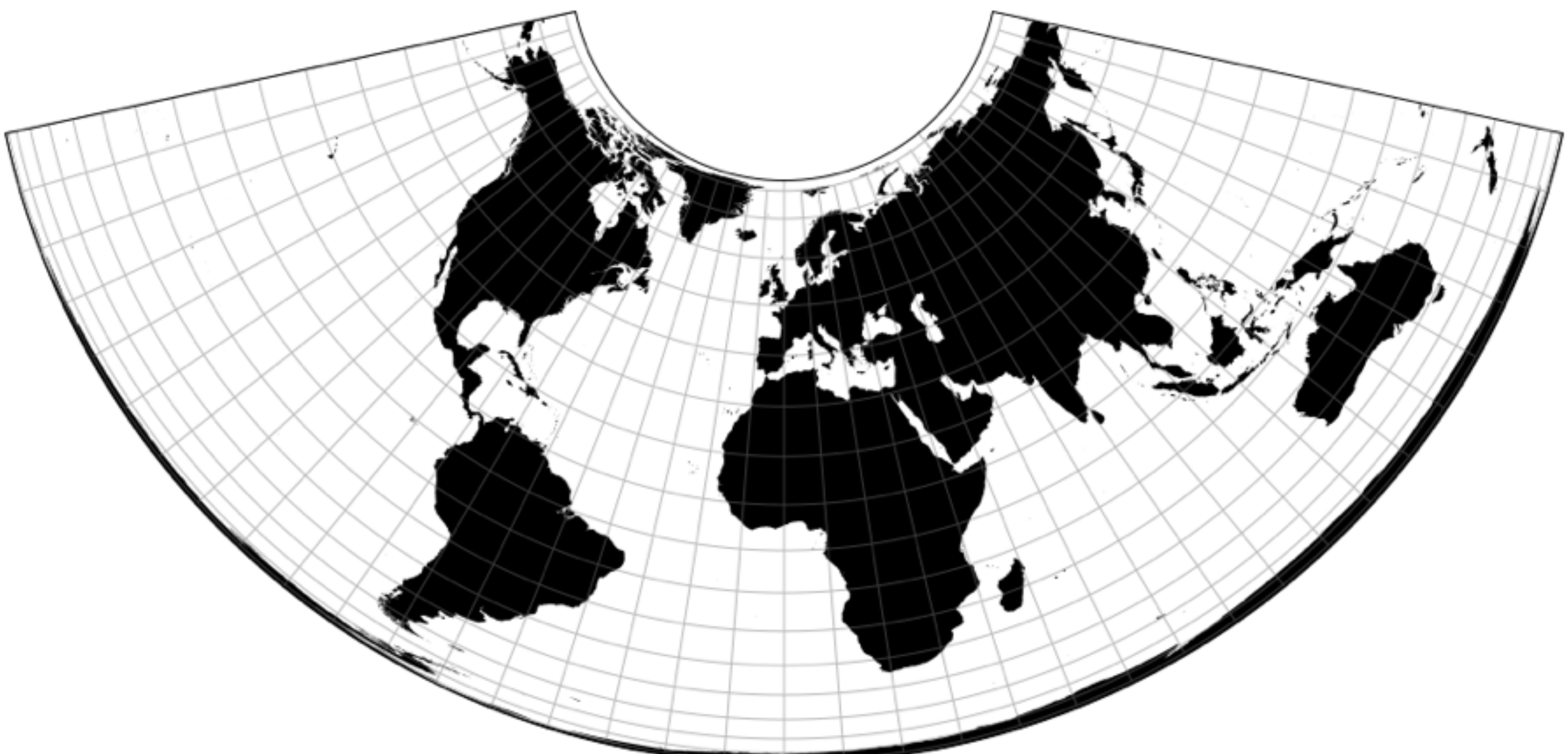


Lambert Azimuthal Equal-Area

Polar Azimuthal Equal-area

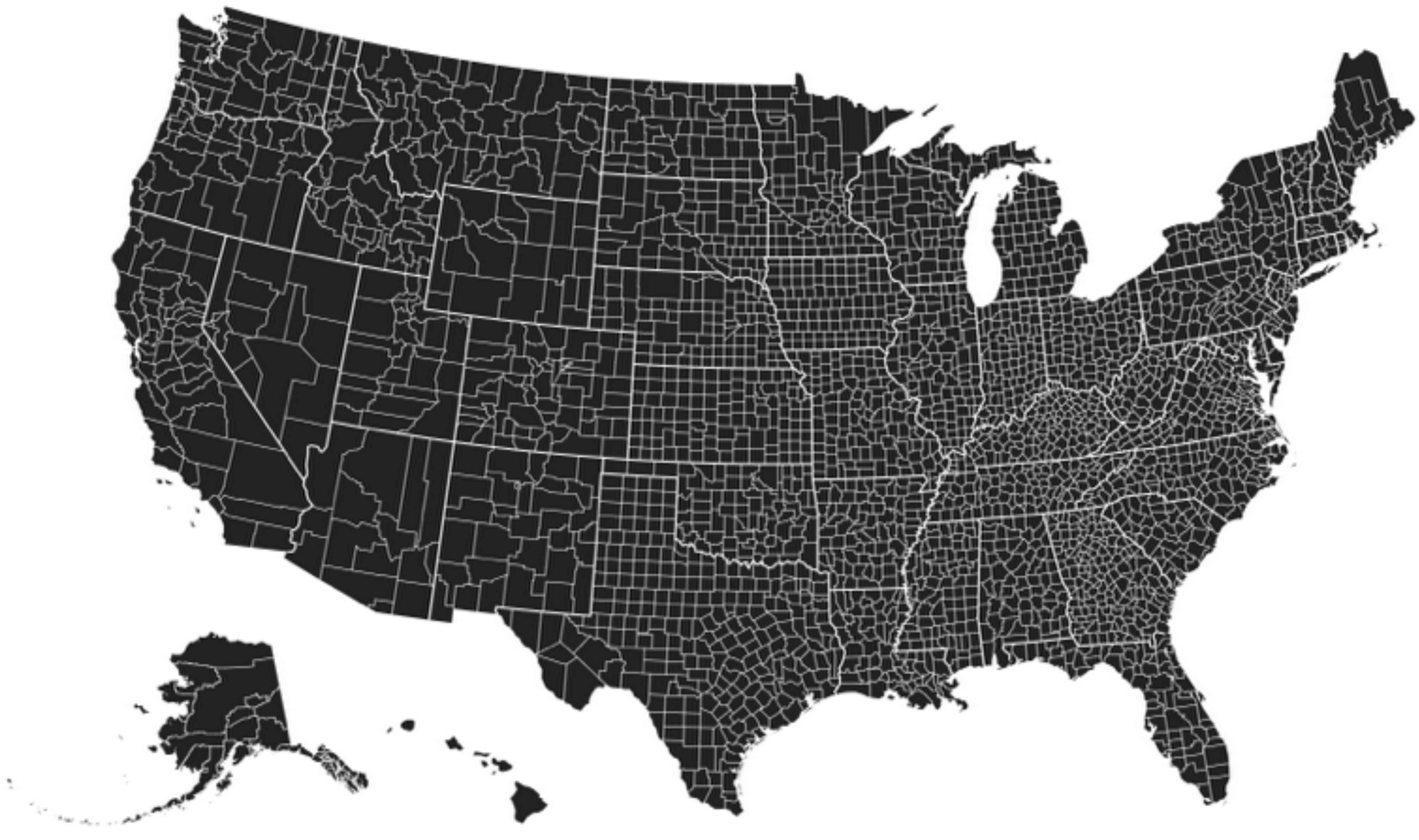
More complex projections

Albers: Conic, equal-area



More complex projections

Composite Albers projection
used by the USGS and Census Bureau



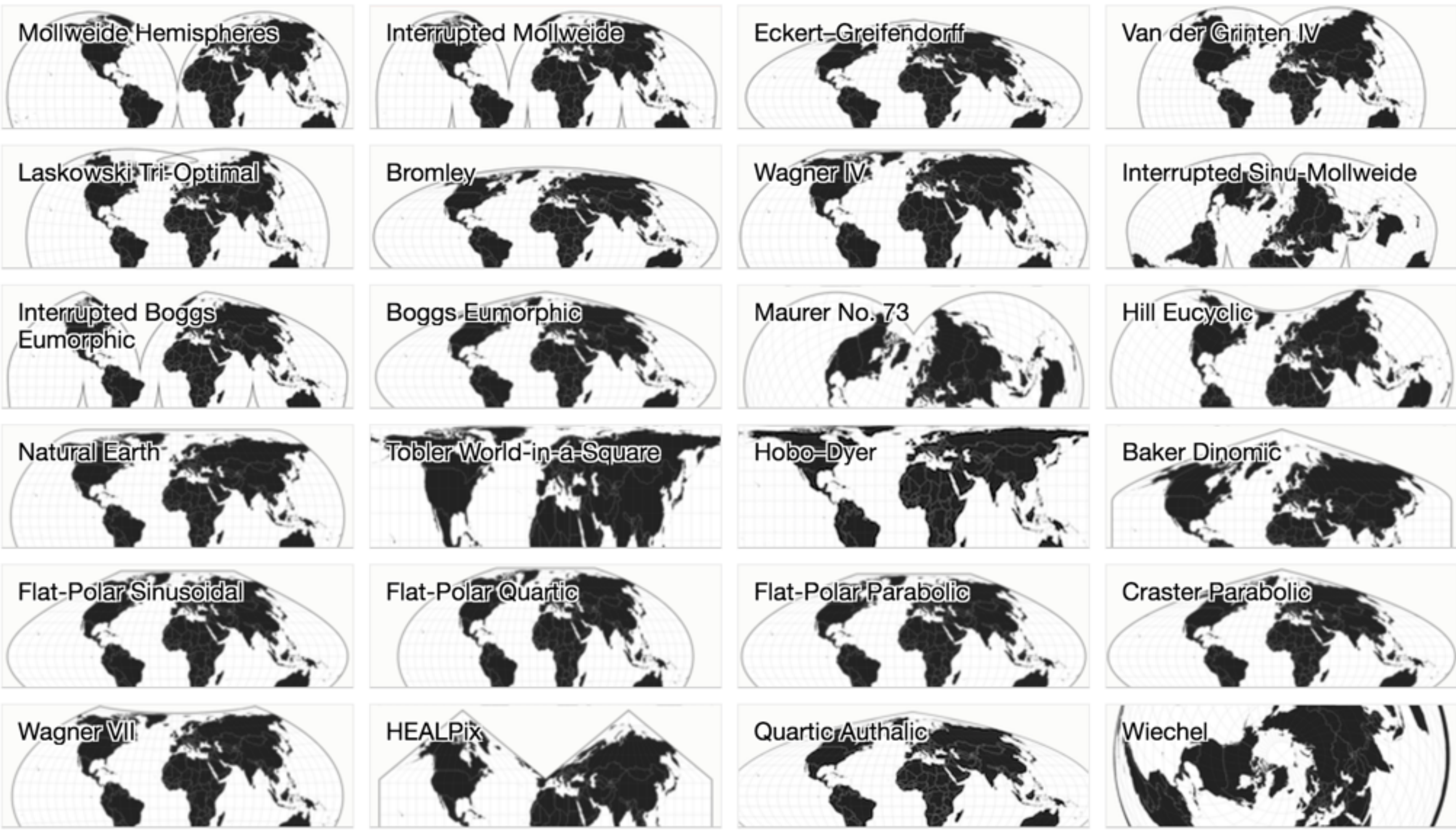
More complex projections

Hammer

More complex projections

Winkel-
Tripel

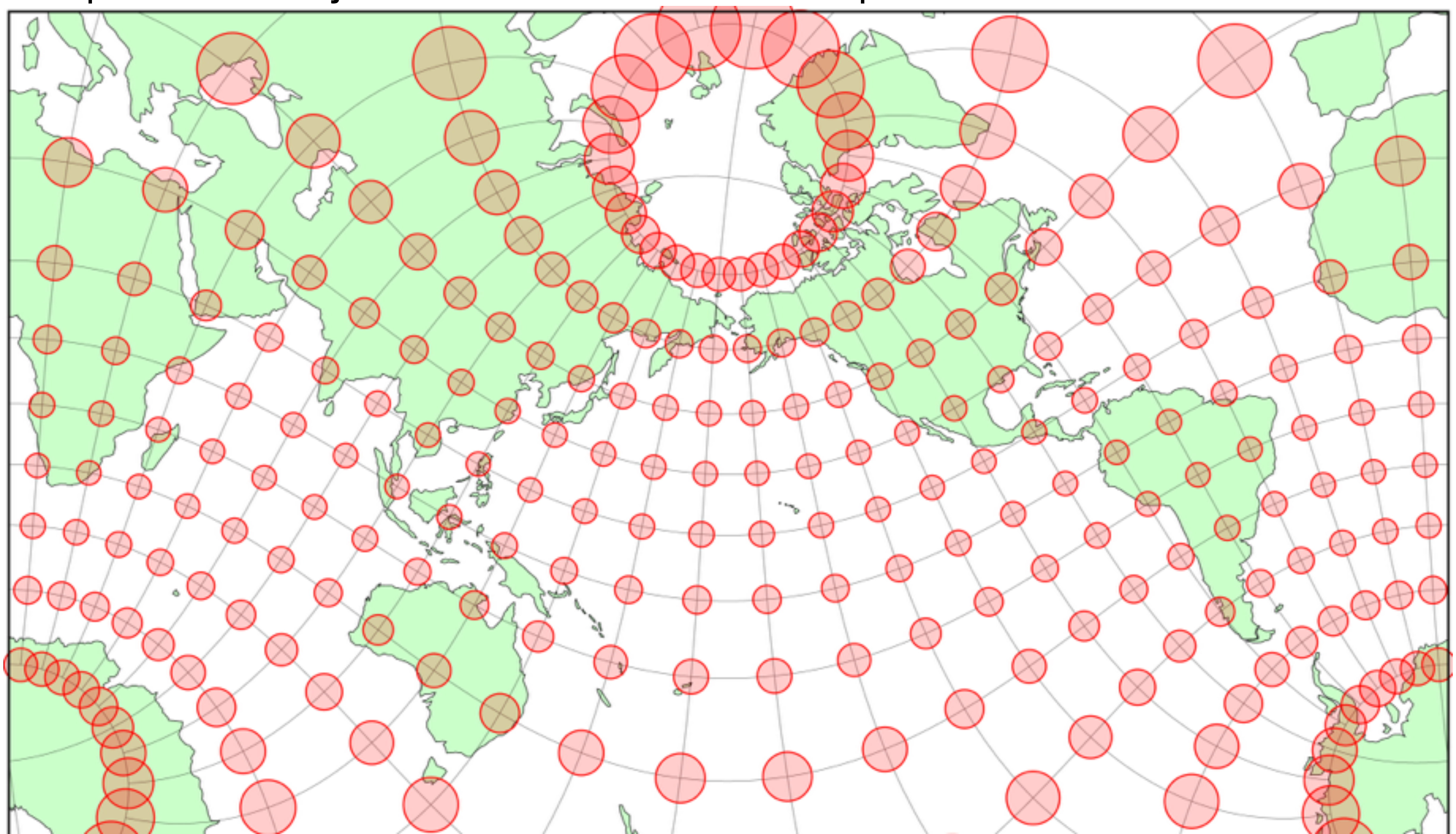
Many, many, many more…



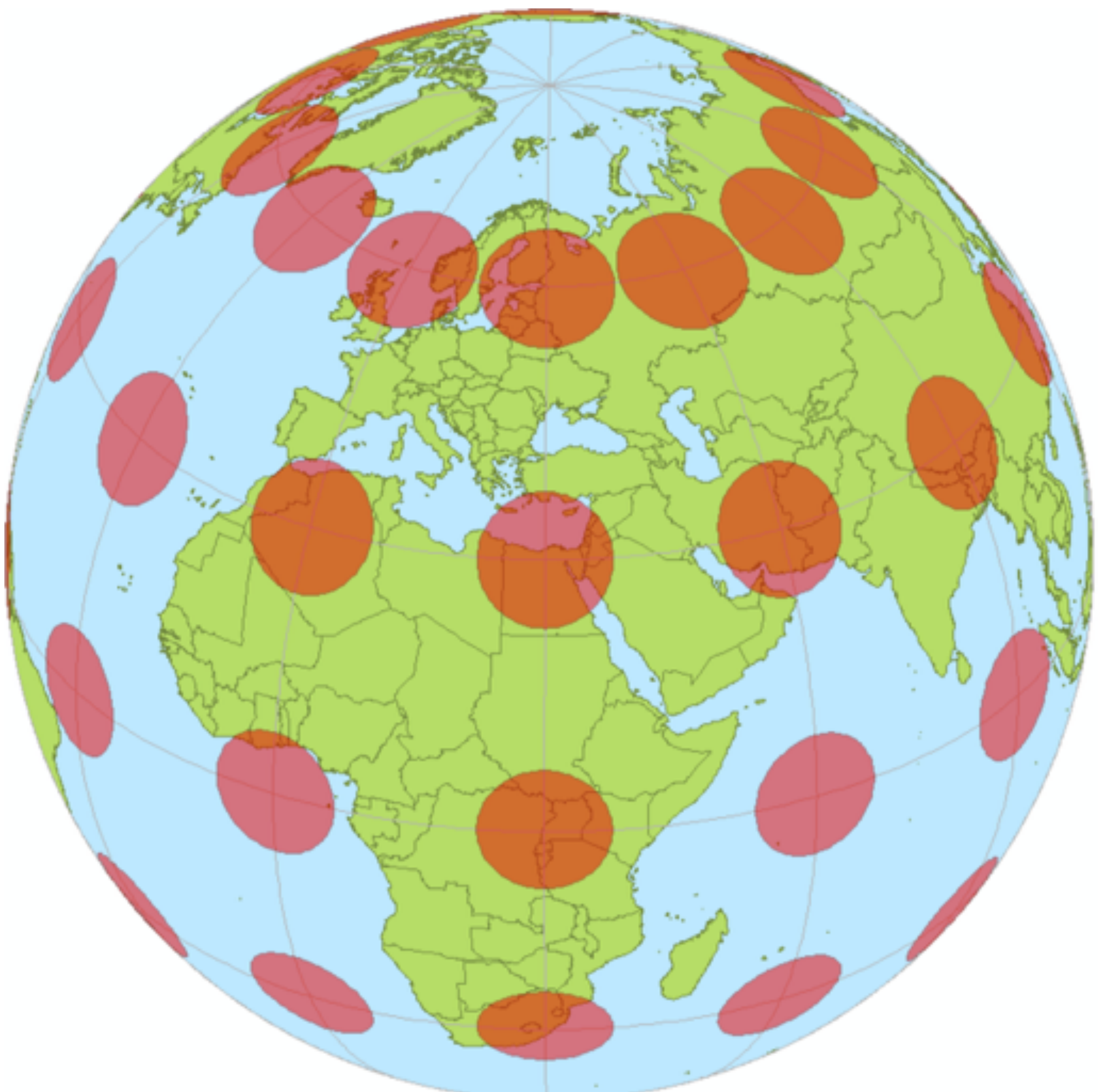
How do we compare projections?

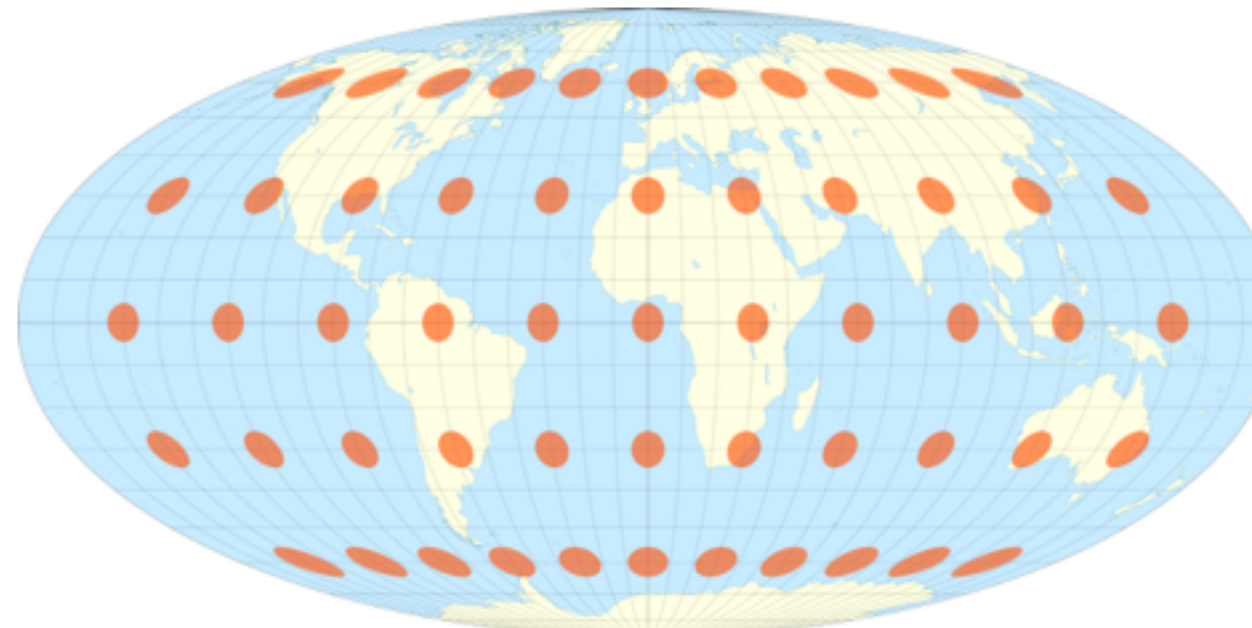
Tissot's Indicatrix

https://www.jasondavies.com/maps/tissot/



Tissot’s Indicatrix





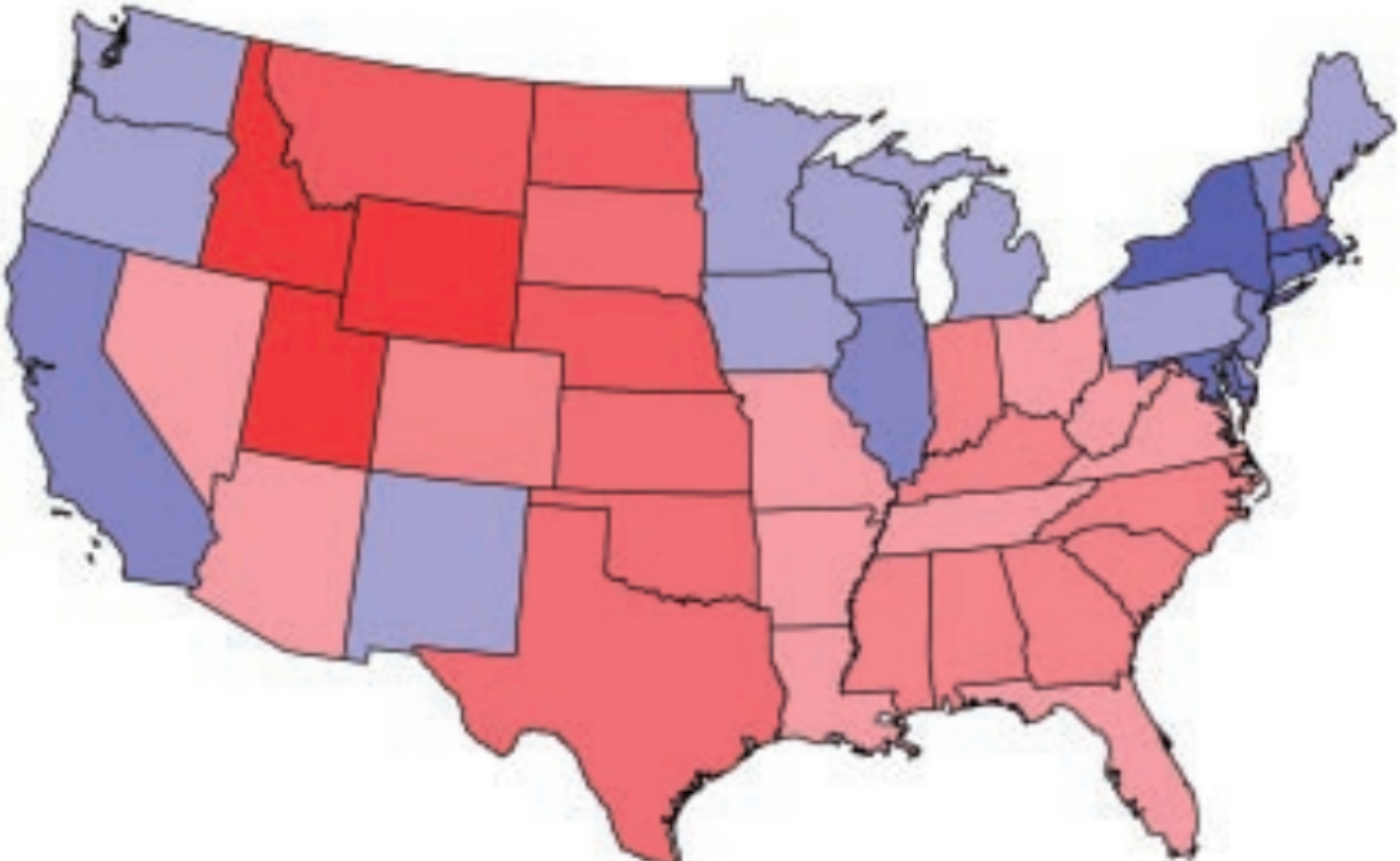
https://en.wikipedia.org/wiki/
Mollweide_projection

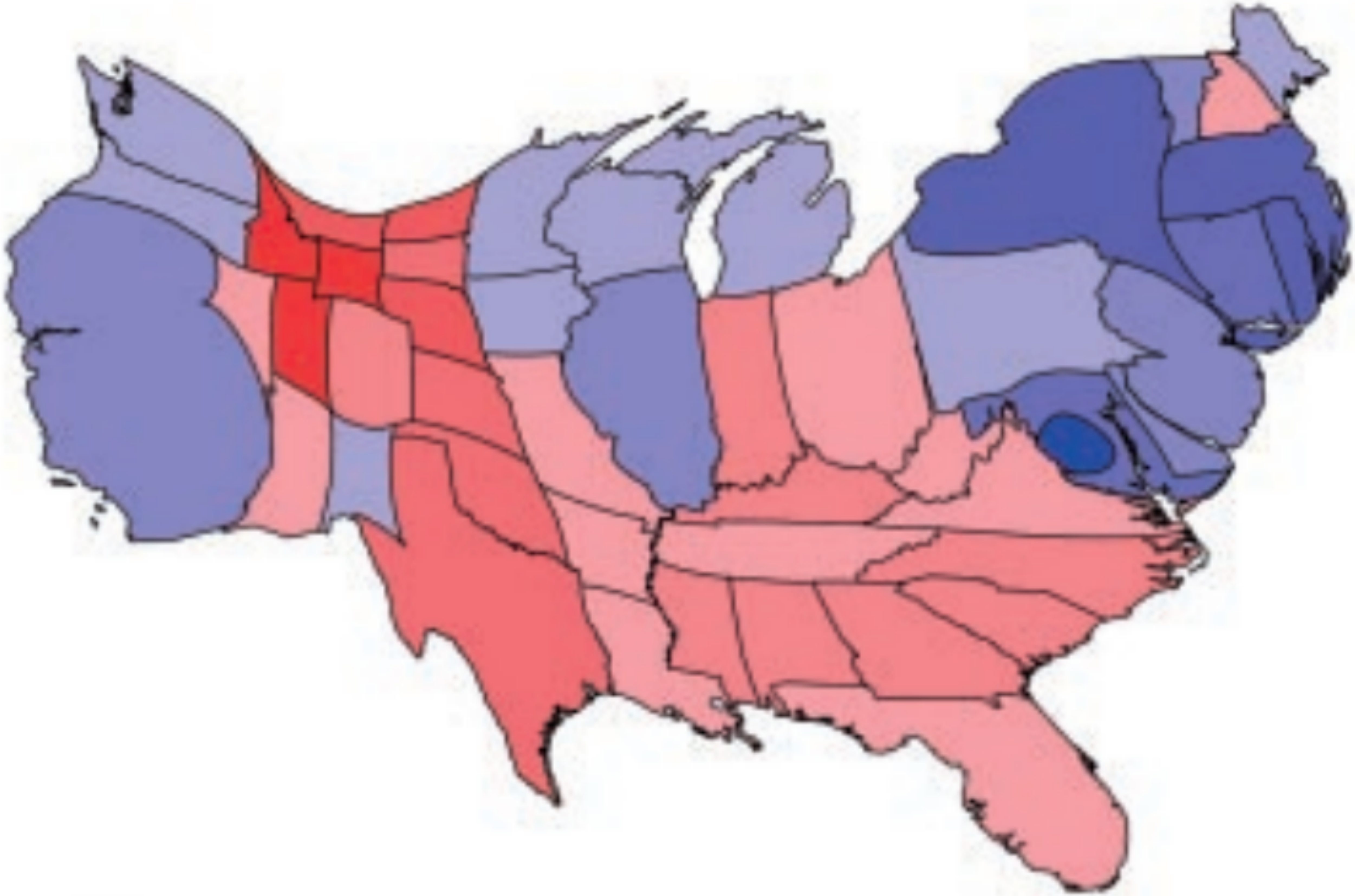
https://en.wikipedia.org/wiki/Tissot%27s_indicatrix

Cartograms

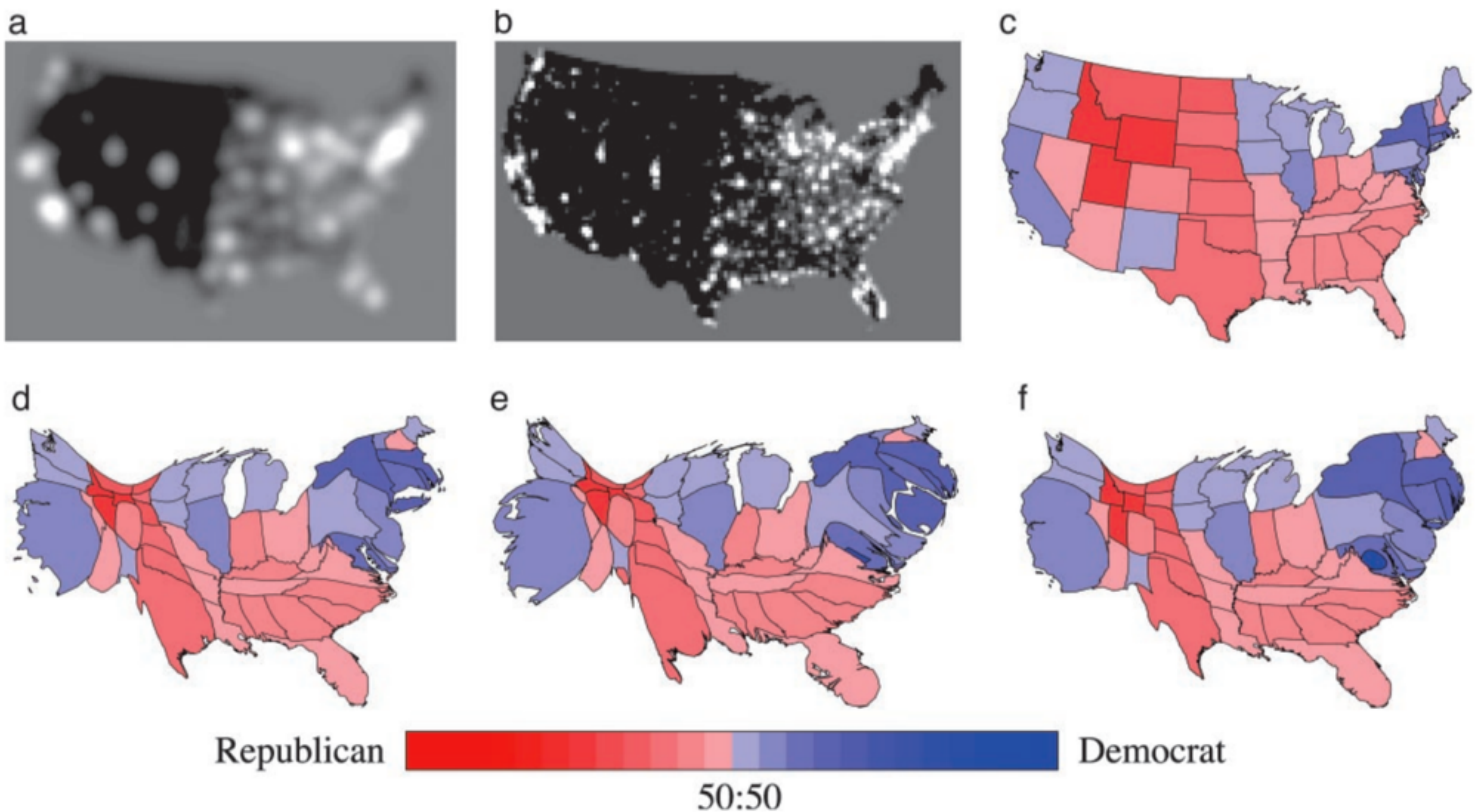
Distort maps explicitly
to use area as channel


NUMBER OF PERSONS 65 YEARS OF AGE AND OVER: 1970
100,000 Persons 65 and over
Source: U.S. Bureau of the Census



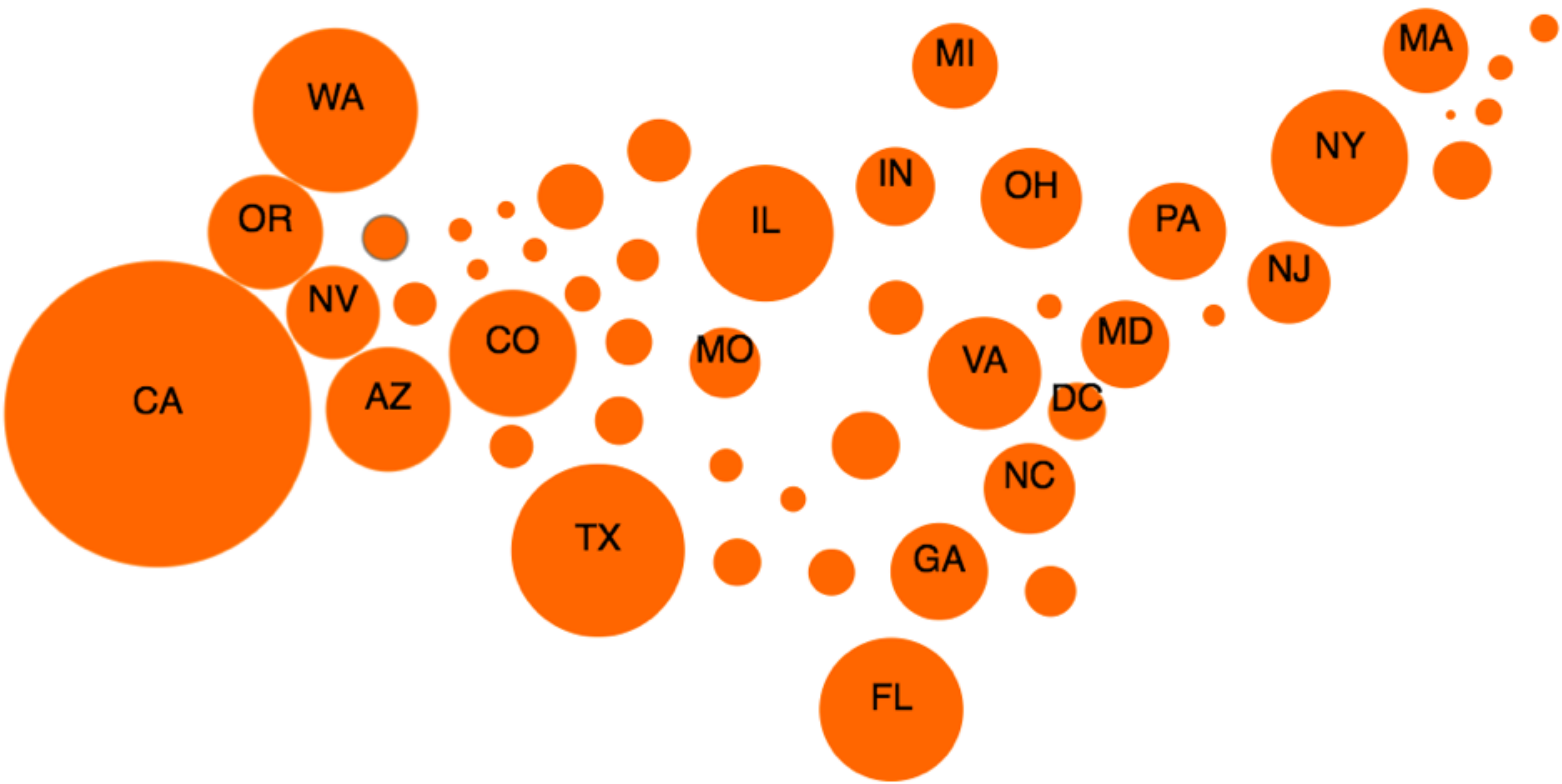


Gastner & Newman: Diffusion-based method for producing density-equalizing maps



http://www.pnas.org/content/101/20/7499.full.pdf

Dorling Cartograms: Turn shapes into Circles



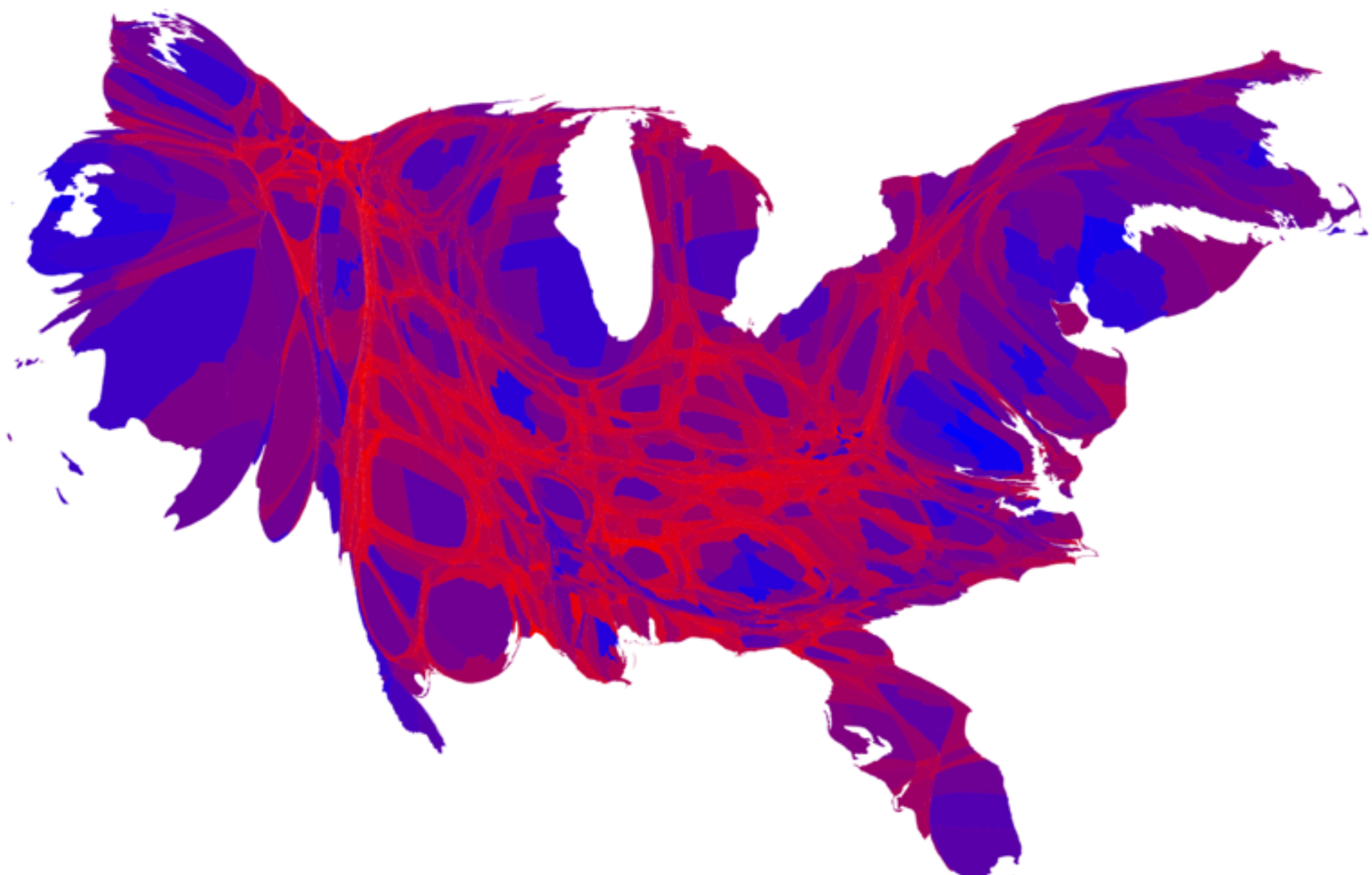
Starbucks per state in the US

Let’s implement Dorling Cartograms

Limitations

- What can we encode with area?
- What do we want to preserve?
    - What happens with extreme distortions?

Limitations



http://www-personal.umich.edu/~mejn/election/2016/

Limitations