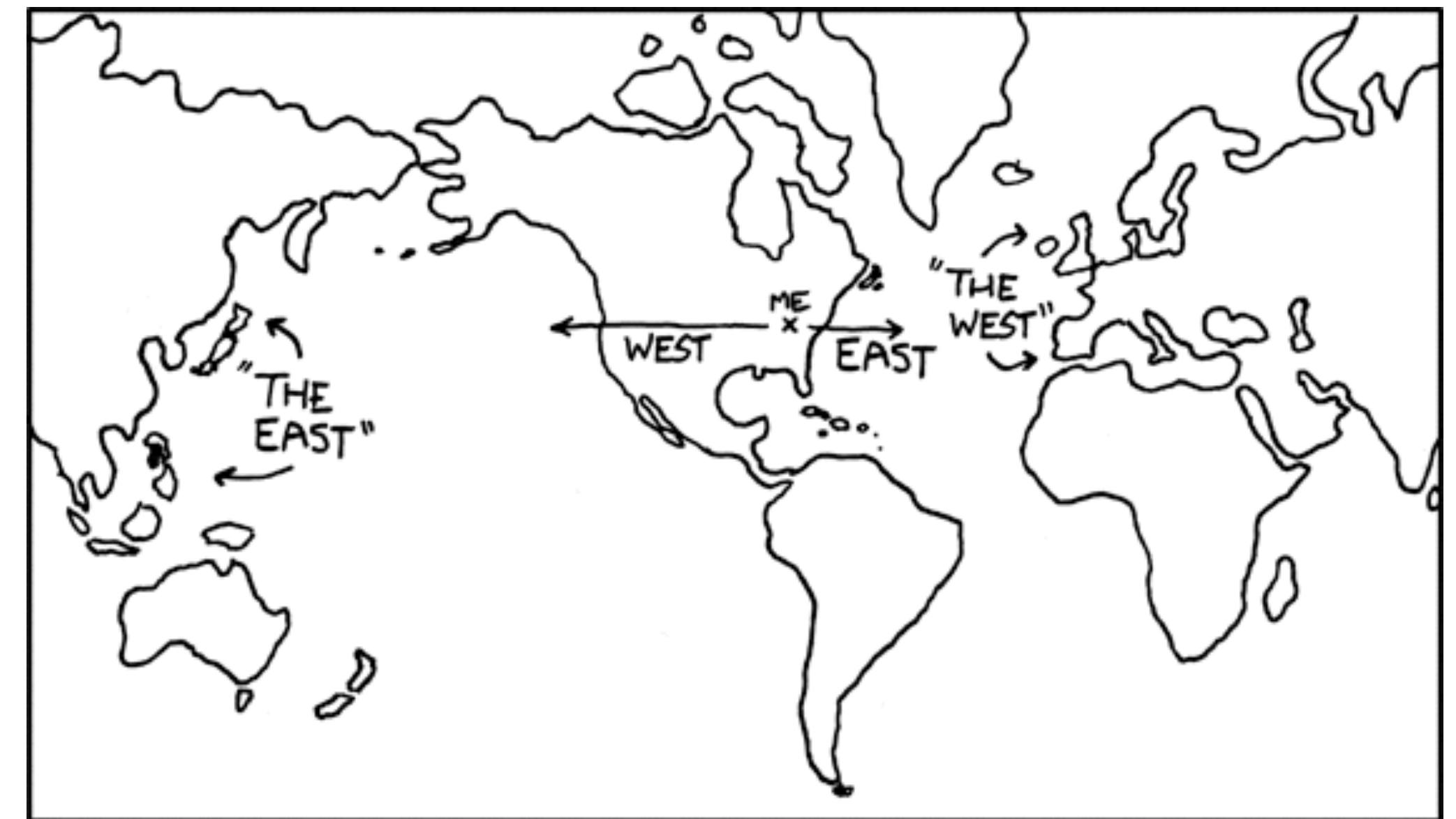


CS-5630 / CS-6630 Visualization

Maps

Alexander Lex
alex@sci.utah.edu



THIS ALWAYS BUGGED ME.

[xkcd]

Principles

Special type of Spatial Data

Use maps when spatial relationships are paramount

Map Tasks:

- Find Location / Feature (county, country, city, street)

- Find Route

- Identify attribute associated with location (elevation, land/water, GDP)

- Compare attributes between Locations/Features

Map Projections

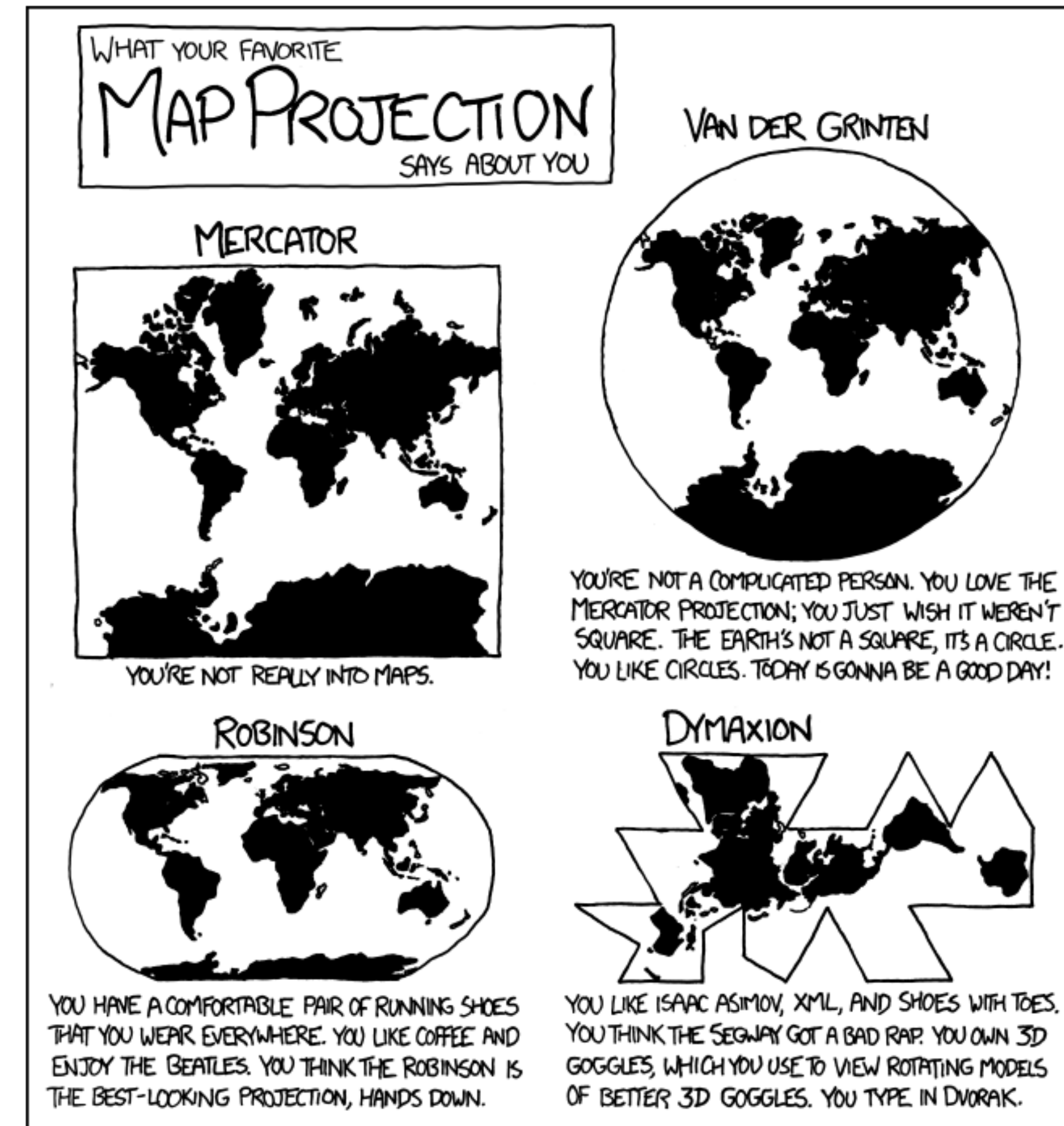
Why projections?

Earth is a (flattened) Sphere

Need to project or “unfold” the hull of the sphere to fit onto paper/screens

Relevant attributes:

Area, Shape, Direction,
Bearing, Distance, Scale



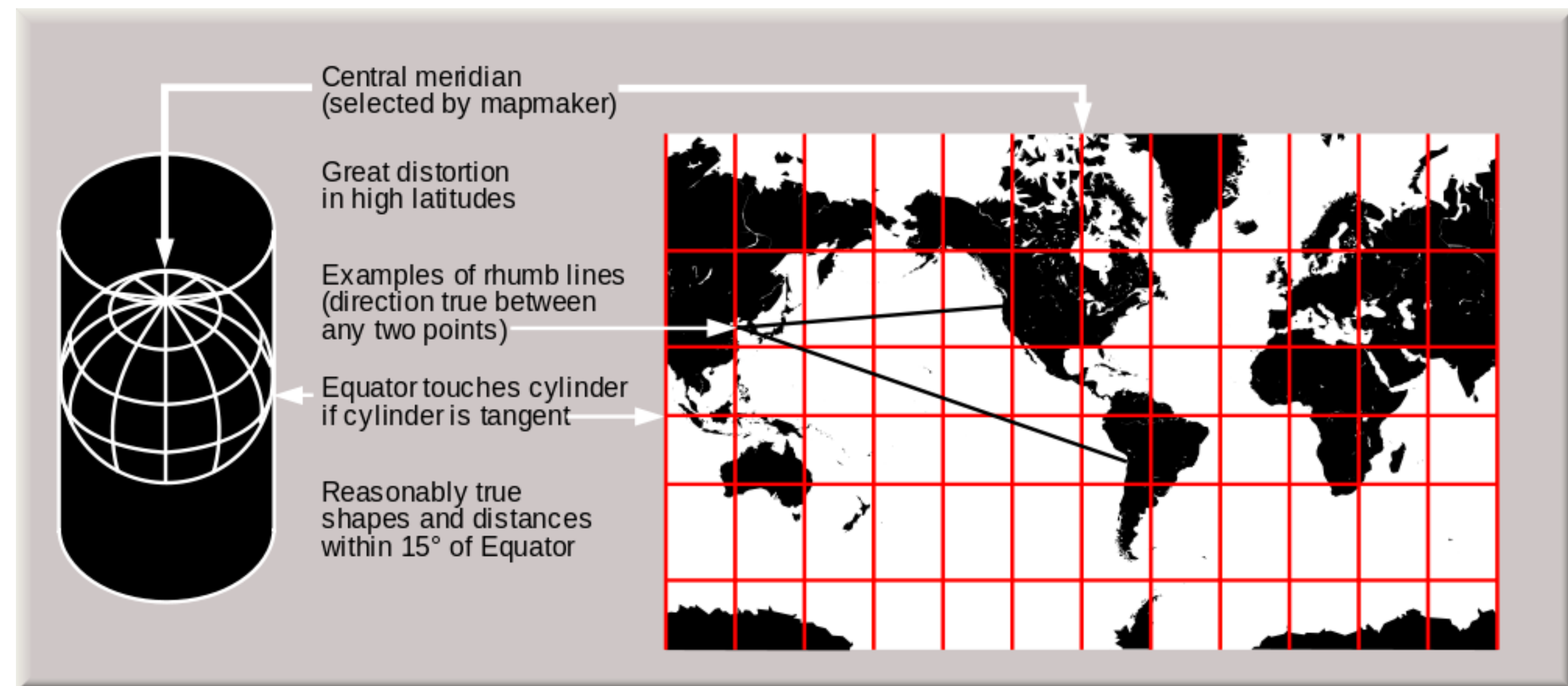
Mercator Projection

Gerardus Mercator, 1569

Projection onto a cylinder wrapped around the globe
conformal map projection; that is, angles are preserved.

All lines of constant bearing
are straight lines.

Constant bearing means
constant compass heading -
developed for sailors

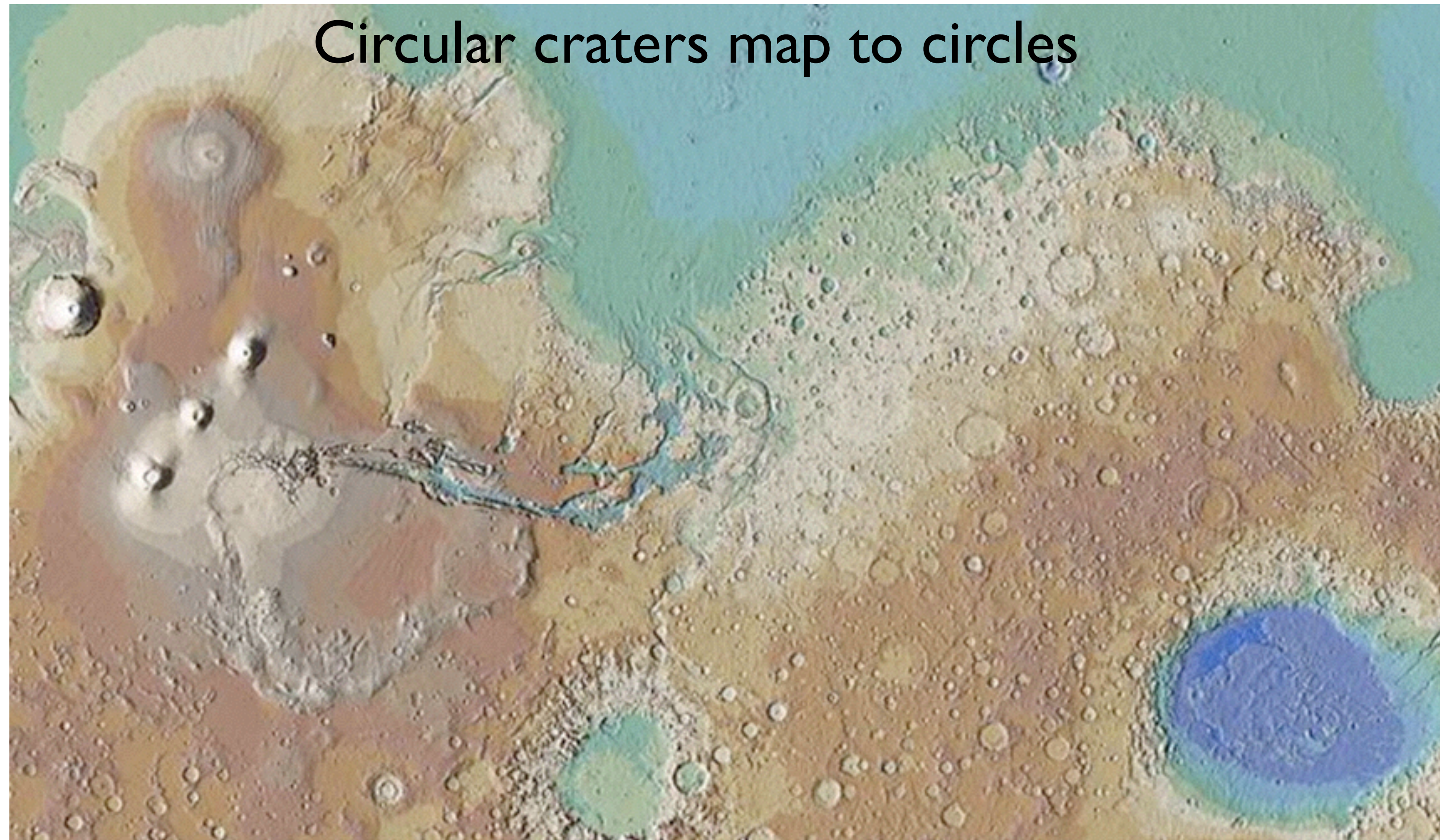


Mercator Projection



D3 / M.
Bostock

Mercator Projection of Mars



Why Mercator is Problematic

Traditional map, used to teach geography

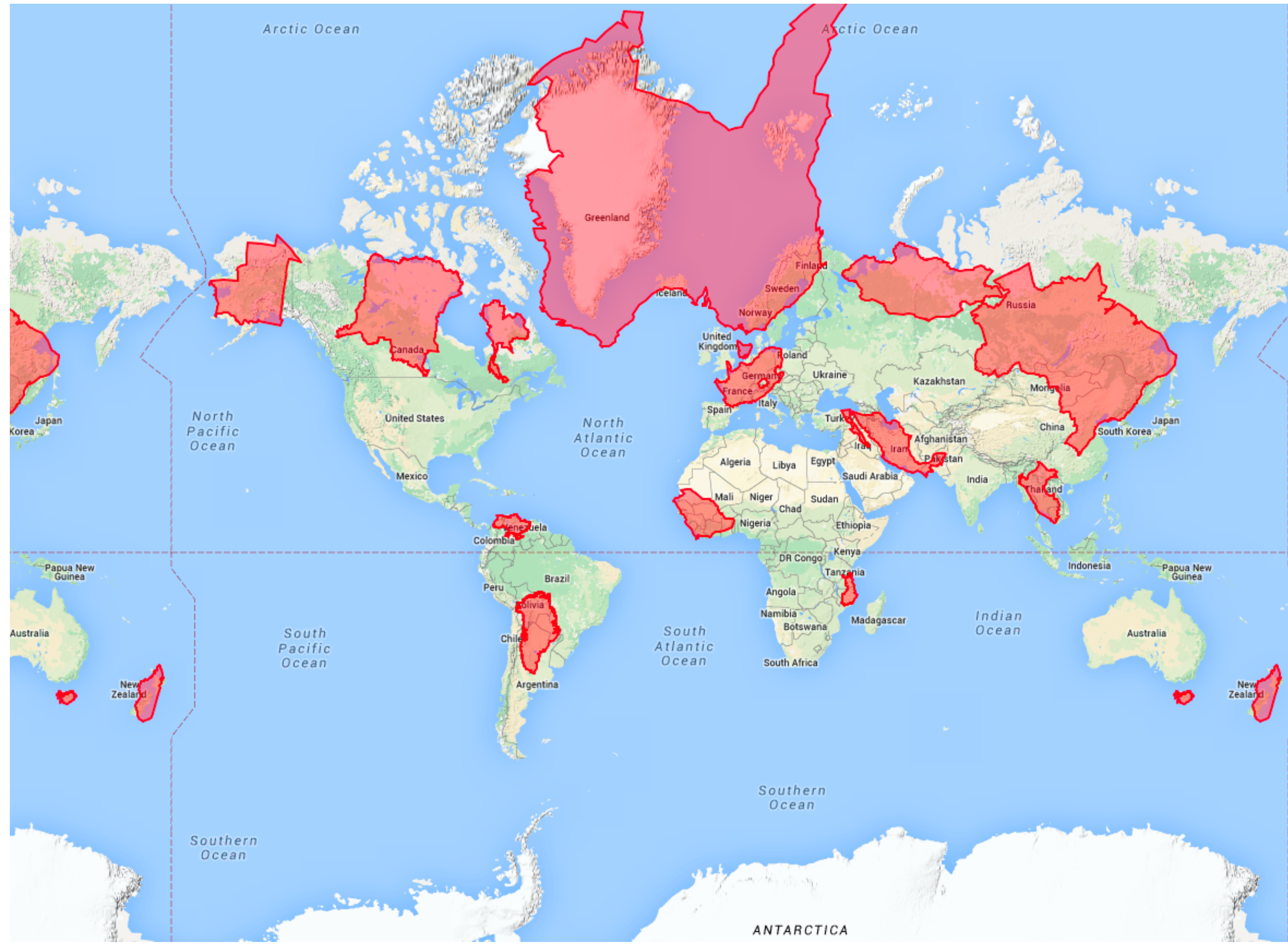
Massive distortion of area distant from equator

“unfair to the Global South, making places that are mostly trees, snow, and better-off white people look huge, and the places where most of the world’s population lives look puny”

Mercator Projection

Mercator works really great if you're, say, Ferdinand Magellan looking for a compass bearing that will take you around Cape Horn, because all of the latitude and longitude lines and angles in between lay out nice and straight on the map like we experience them in real life. It also works well if you're Google and you want a map image that you can neatly slice up into little squares that your server sends to a customer's browser. North is always up, your hometown doesn't look squished or slanted when you zoom in to it, and everybody's happy.

Mercartor Puzzle

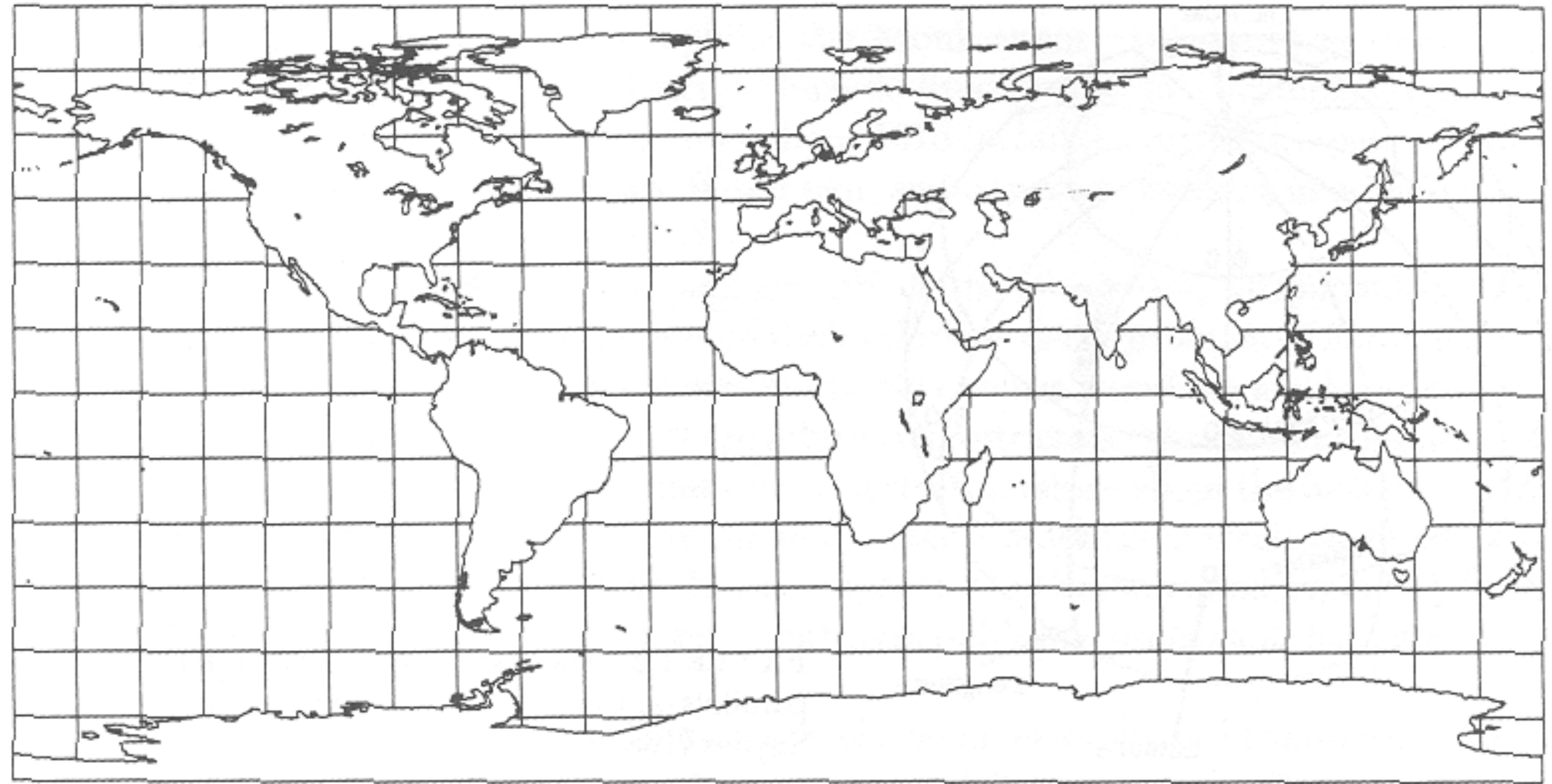


Latitude-Longitude

Does not preserve angles

Does not preserve areas

Things are squashed
at the top and bottom



Snyder, "Flattening the Earth"
Based on slide from Hanrahan

Azimuthal Projections

Radical Cartography

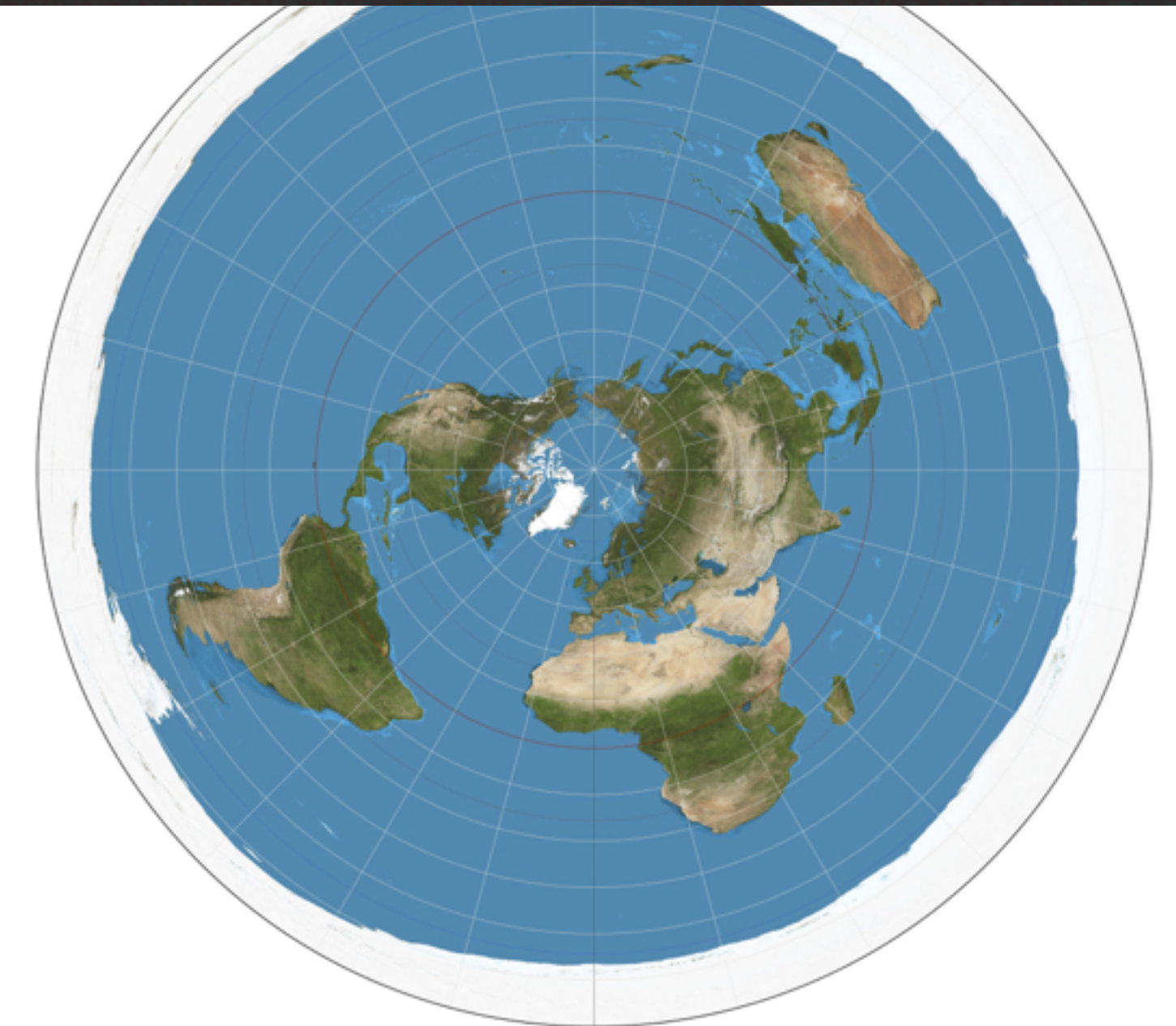
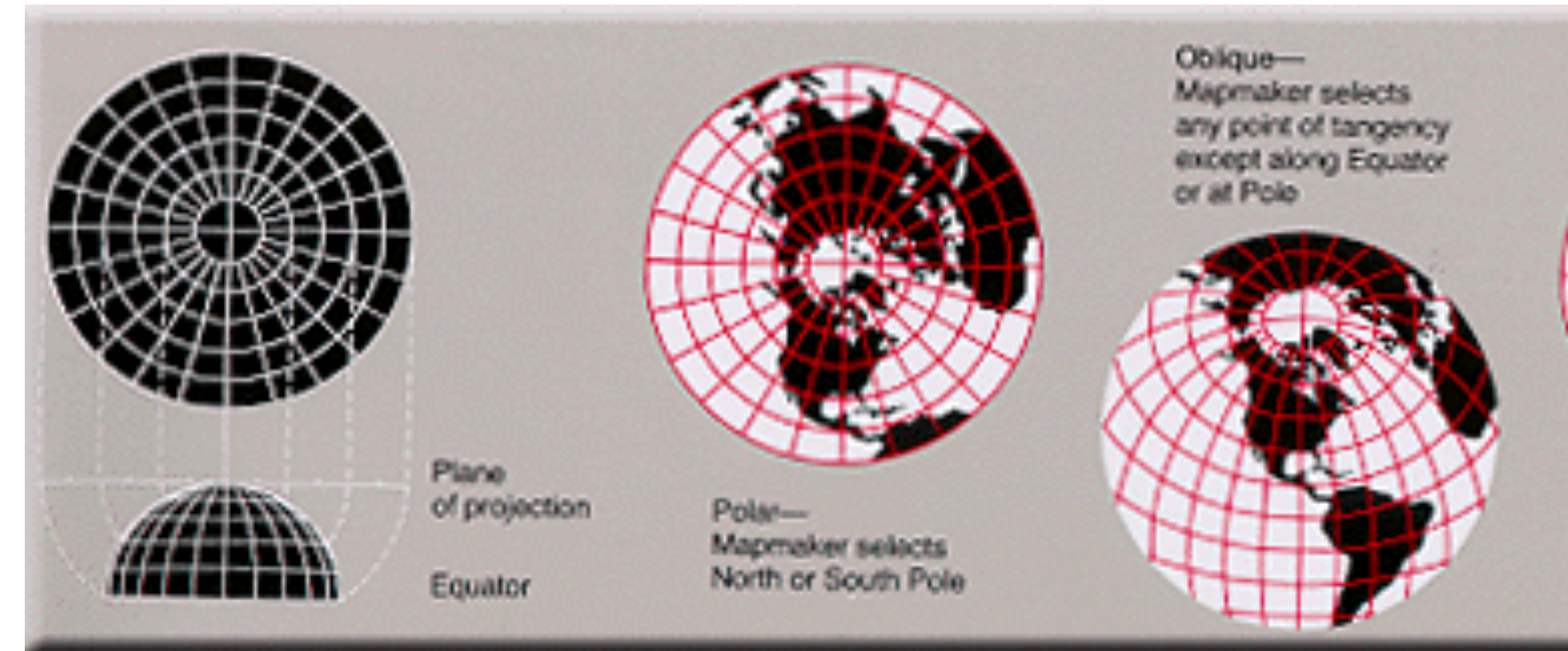
Projection onto a plane tangent to the Earth

angles are correct around the center point

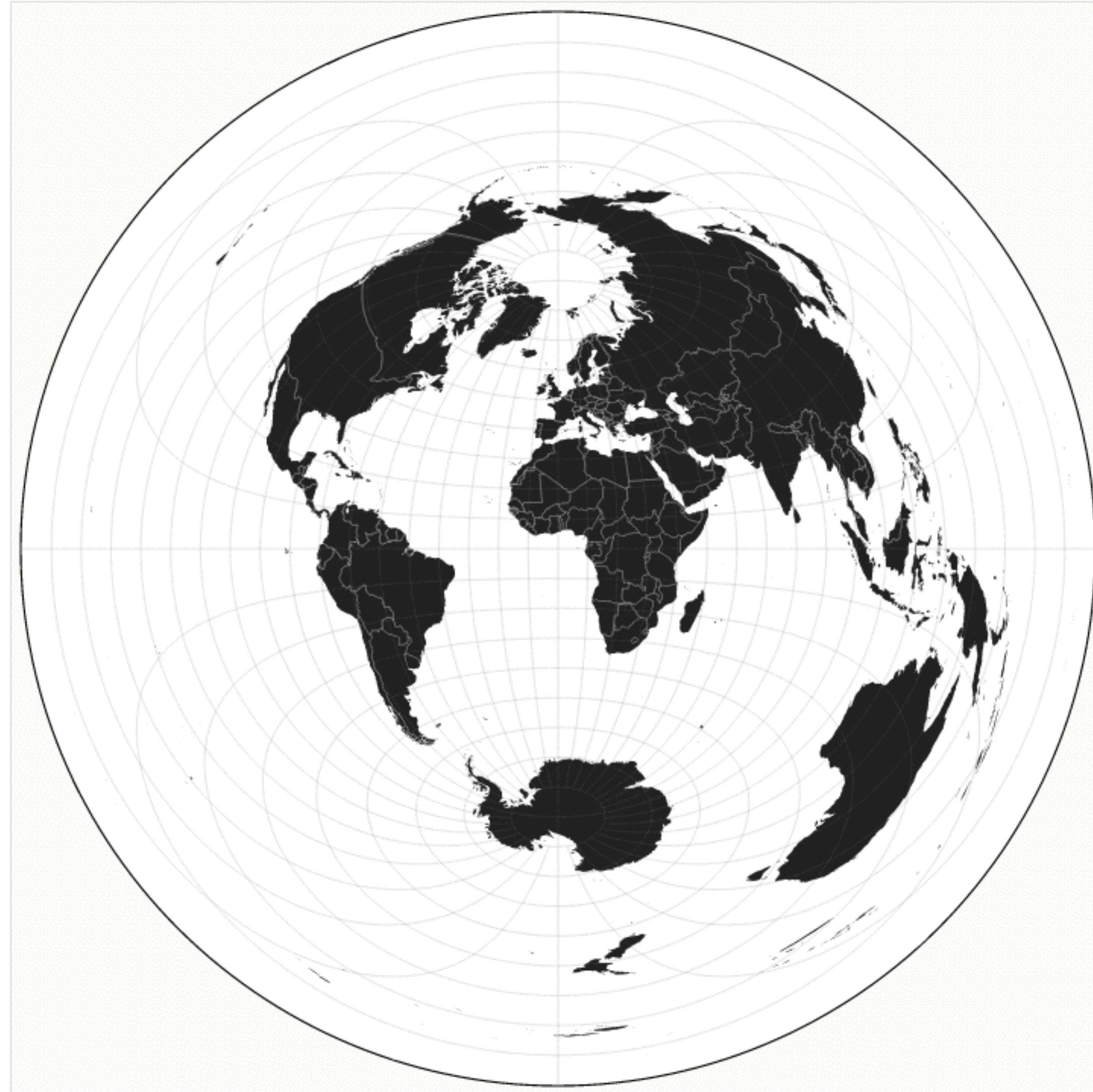
Great circles through the center are straight lines

Radii correspond to true distances

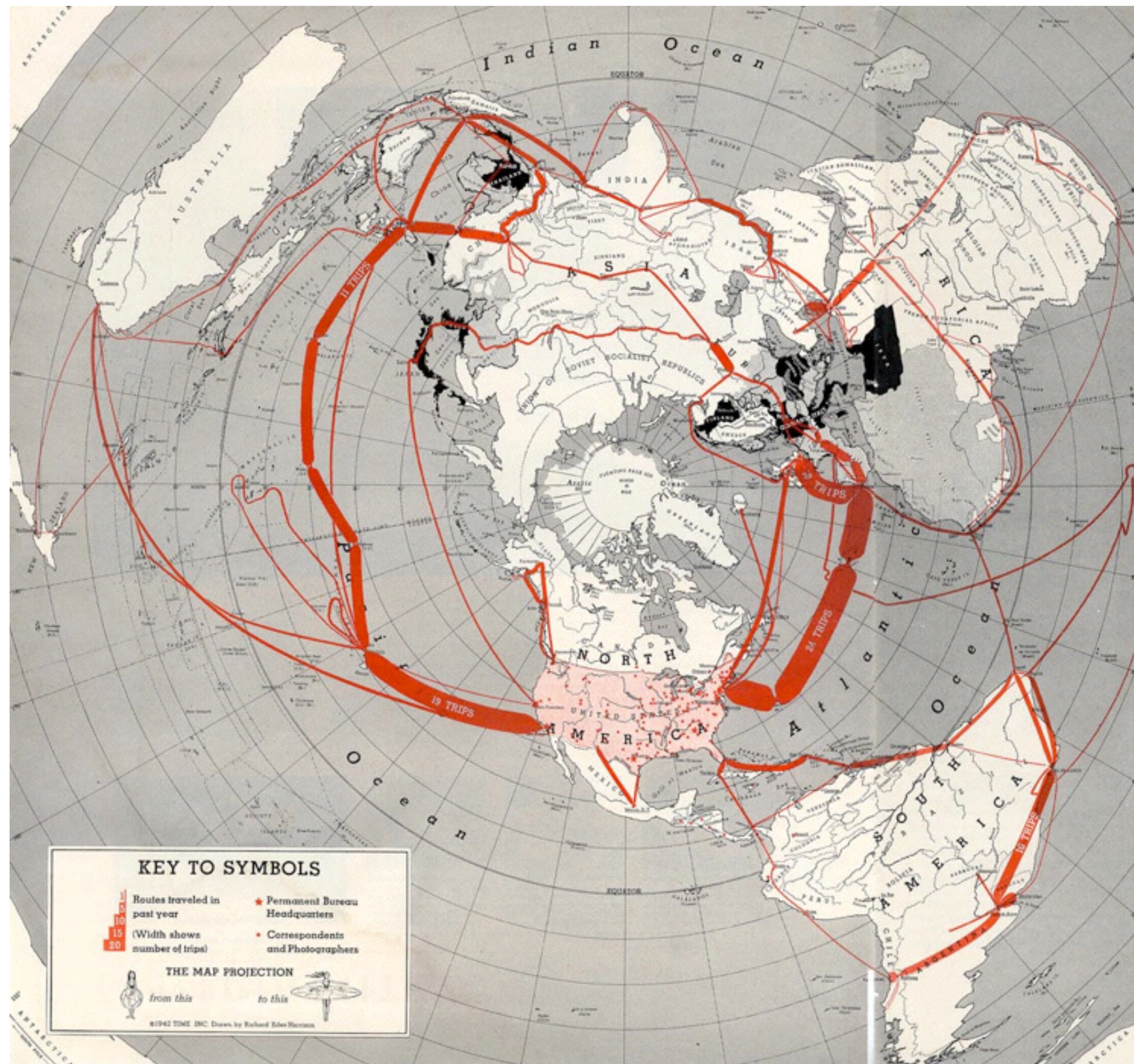
Sometimes see this in airline magazine centered around the hub



Azimuthal Equidistant



D3 / M.
Bostock



ON ASSIGNMENT

In Reykjavik and Rio, New Delhi and Khartoum, Calcutta, Capetown, Sydney and Suva, as you read this—in every troubled news-corner of the globe—are one or more of the 300 special correspondents who work for TIME, LIFE and FORTUNE. In the past twelve months alone, their assignments carried them the 1,505,000 miles you see plotted on this map.

Some of these people are reporters, some photographers, some researchers. Two were on an American cruiser off Hawaii when the Japs blasted Pearl Harbor. Two more were in Manila on December 7, now are interned by the Japanese in ancient Santo Tomas University. Still another managed to make Corregidor from the mainland, filed almost daily dispatches all through January and February, last reported that he had finally reached Australia in safety, joined three other TIME — LIFE — FORTUNE correspondents there. Two of these men had made the trip to Australia in a troop ship with an AEF convoy; the third had arrived on a grimy freighter, he its only passenger, high explosives its only cargo.

But this is not a map of adventure. Rather it is an attempt to visualize a hard-working, world-wide research organization—the News and Picture Bureaus of TIME, LIFE and FORTUNE.

The real significance of the map grows out of the hundreds of fact-finding assignments it represents—the millions of words filed—the stories documented with photos, the weeks and months of observation and analysis it plots.

Eighty thousand of the 1,505,000 miles of travel plotted on the map, for example, were covered by Correspondent Allan Michie. The dispatches he filed from Cairo, Tehran, Simla, Singapore, Batavia and Manila were the basis of news stories in the columns of TIME. Documented with pictures taken by a Picture Bureau photographer in the Middle East, several of his pieces ran in LIFE. Back in New York, he assembled the threads of his experiences and first-hand knowledge on the broad pattern of world strategy into the story of *The Coming Battle for Asia* that appeared in FORTUNE for March.

This same mechanism functions similarly as Walter Graebner, head of the London office, returns to New York to report on the European situation for TIME and LIFE and write the story of *British Politics and the War* for the April FORTUNE—as Sherry Mangan heads back from Buenos Aires via Santiago, Lima and Panama — as correspondents file their dispatches from Ireland, Alaska, India and Bataan . . .

These and three hundred other men like them are a part of the world-wide news and picture organization which is constantly serving your editors, with spot news, with background information, with well-documented research.

TIME—LIFE—FORTUNE

Winkel Tripel Projection

Modified azimuthal map projection

averaged to cylindrical projection

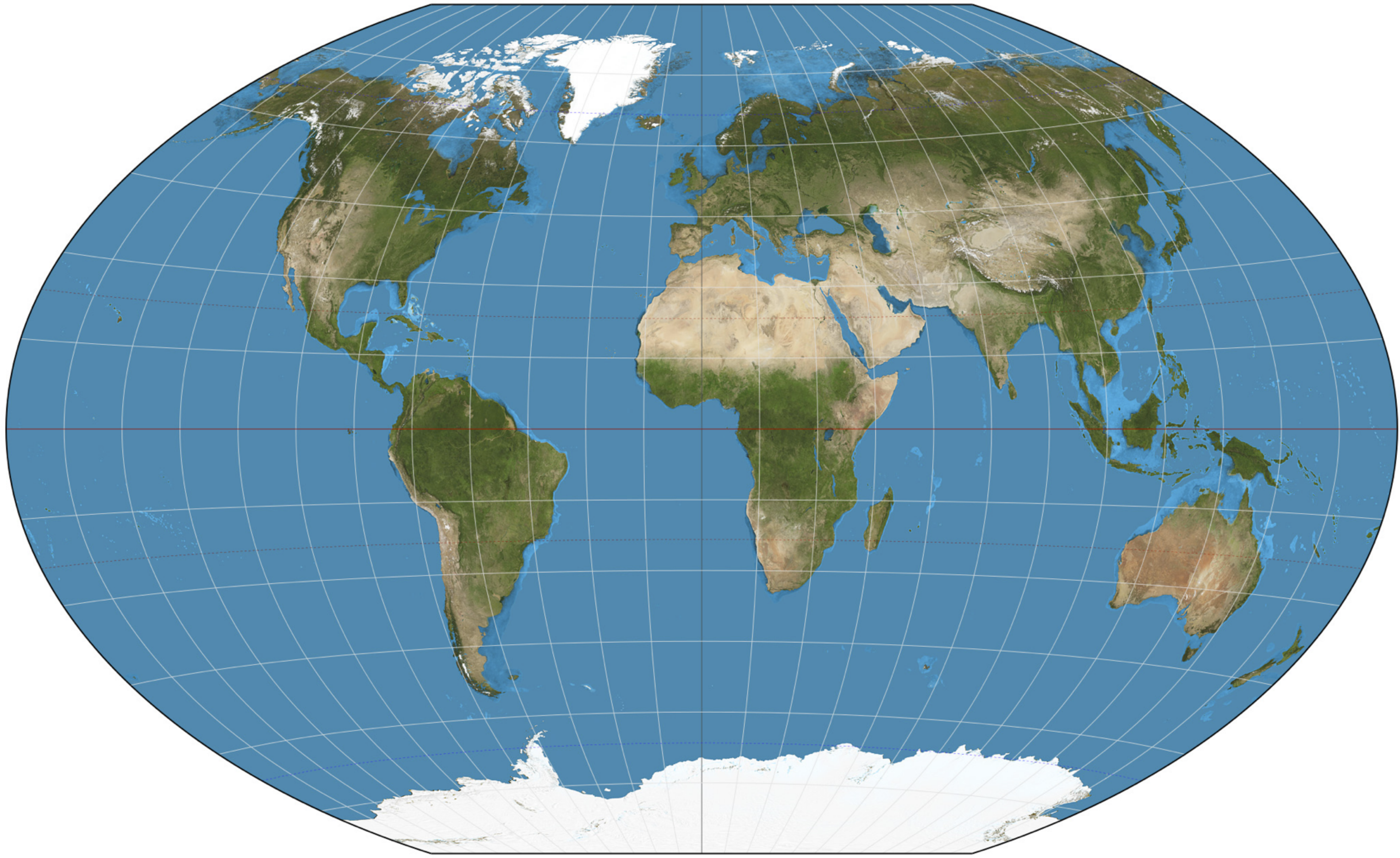
Minimizing three kinds of distortion:

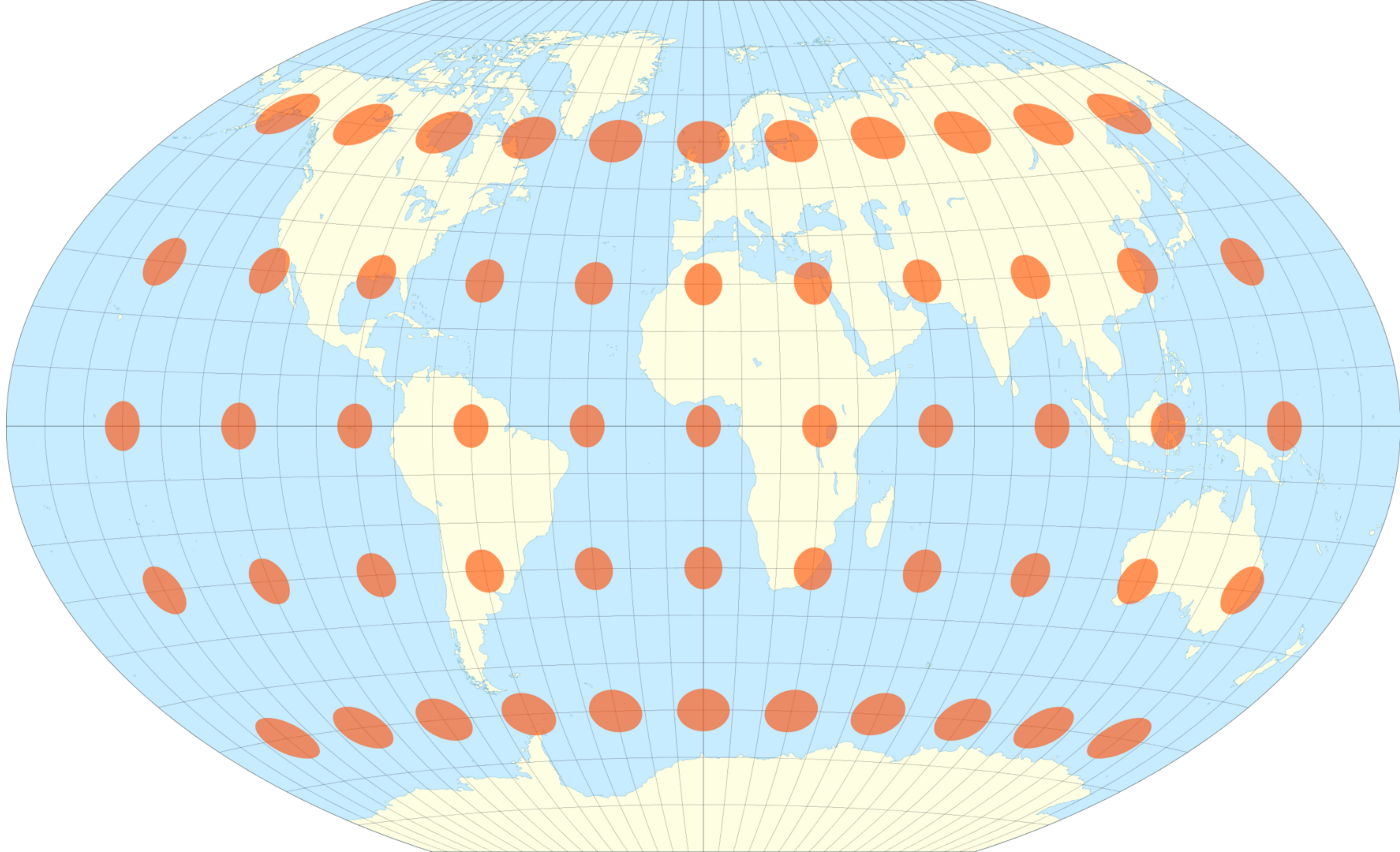
- area

- direction

- distance

Considered good projection for world maps, endorsed by
National Geographic Society, used in Textbooks

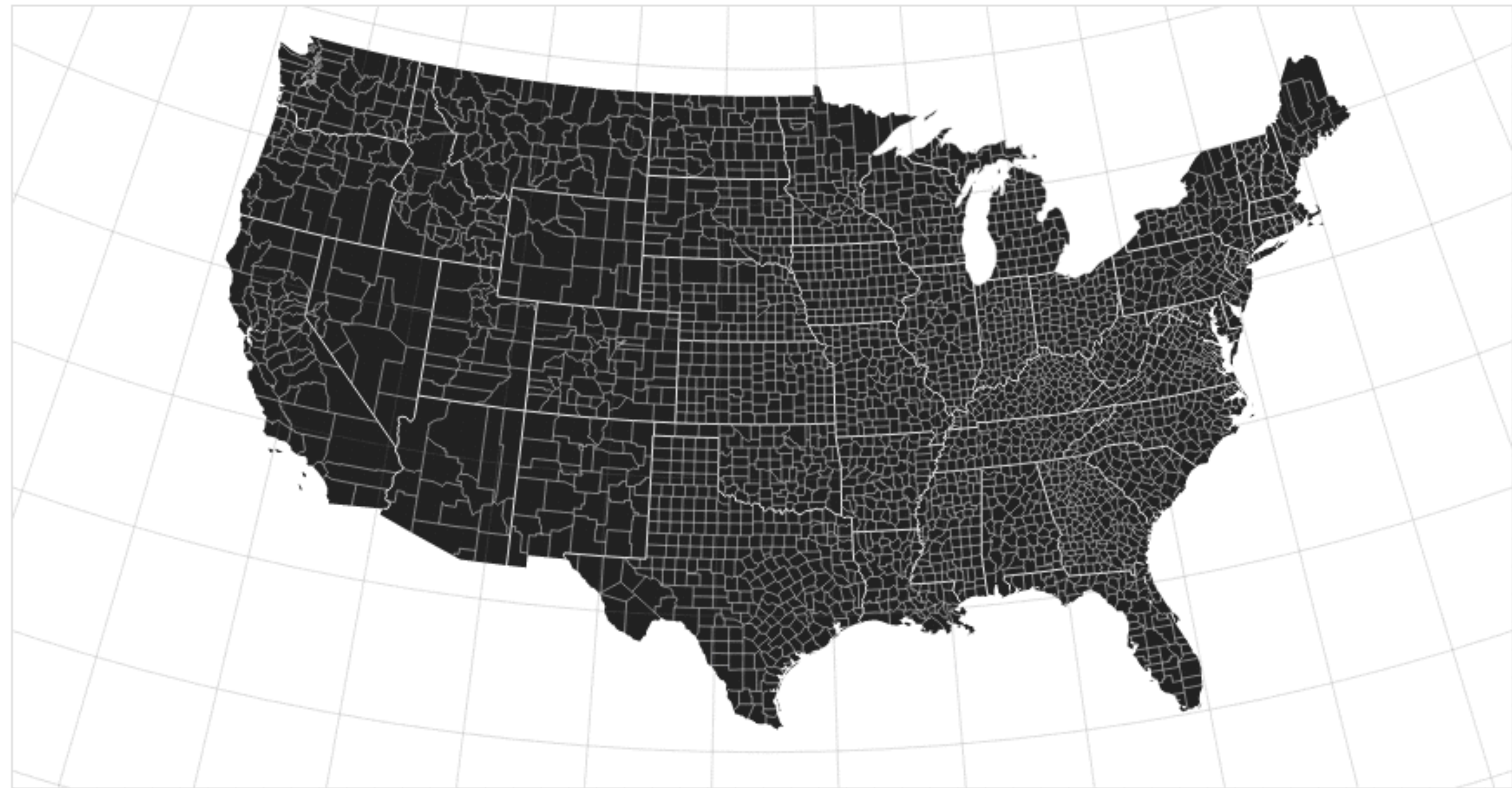


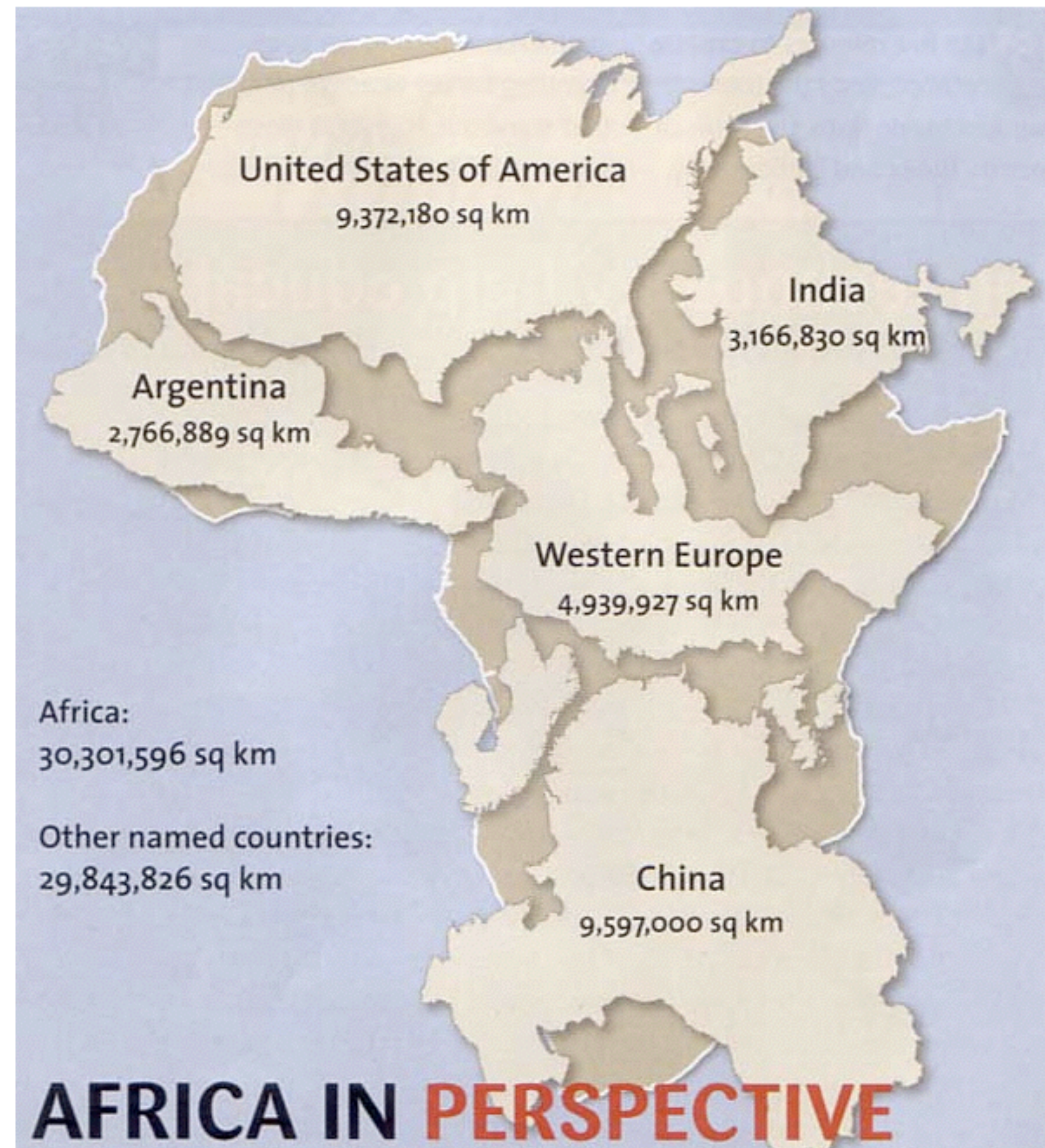


Albers Equal-Area

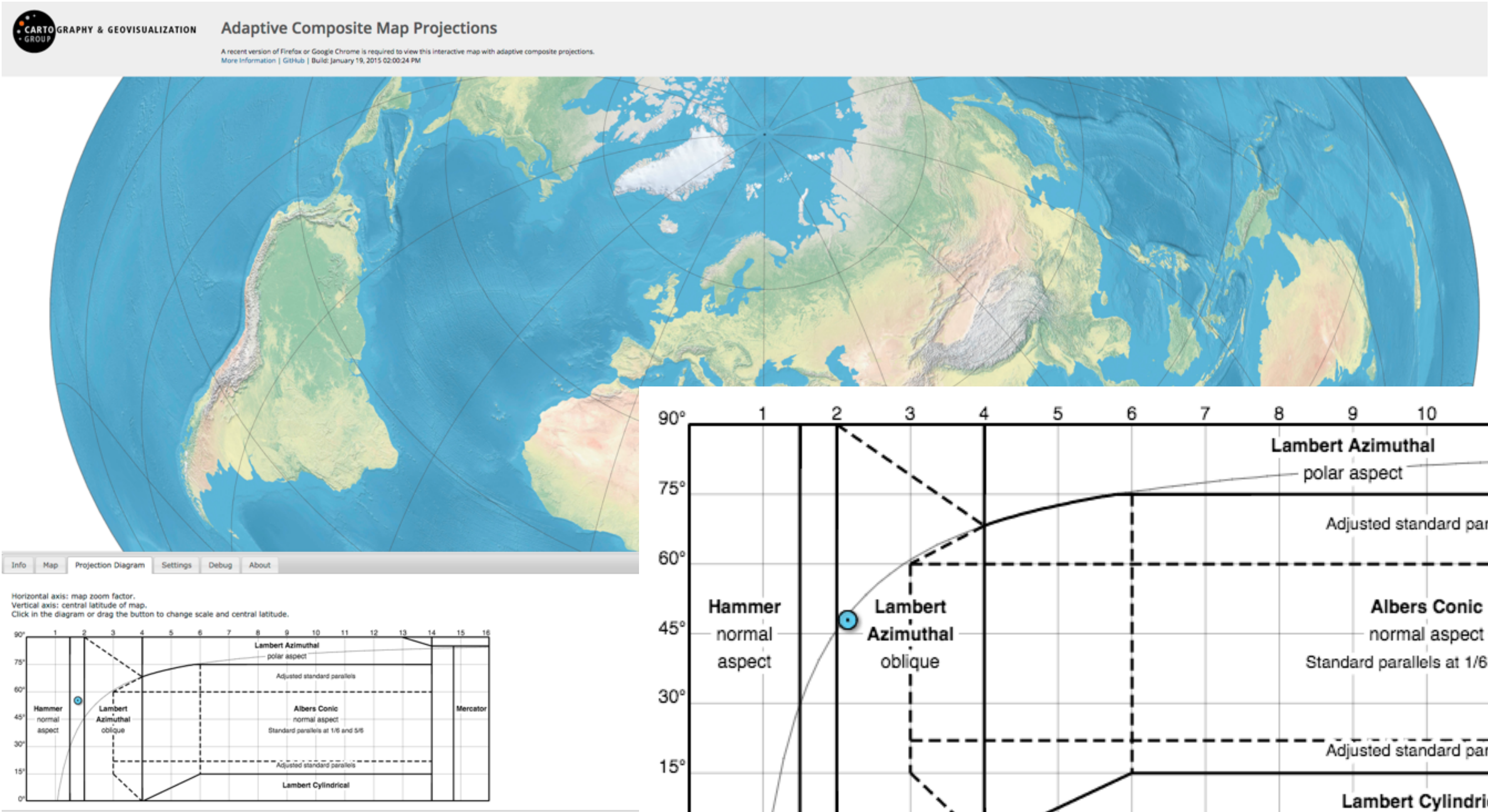
Shows areas correctly

Distorts distances and
shapes





Composite Projections



Bernhard Jenny

Projections in D3

Many projections
included:

<https://github.com/mbostock/d3/wiki/Geo-Projections>

<https://github.com/d3/d3-geo-projection/>



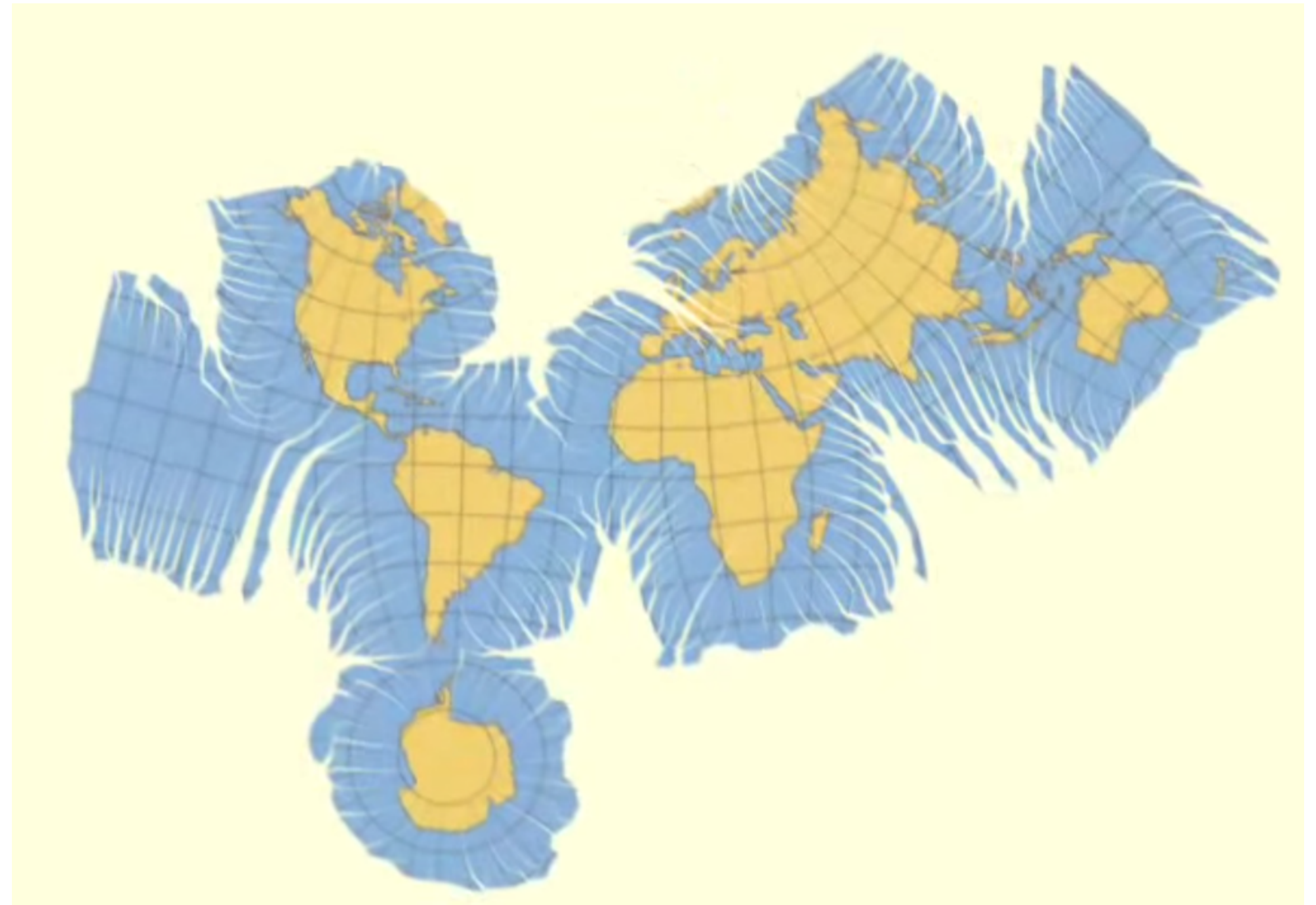
Extended Geographic Projections



Unfolding The Earth

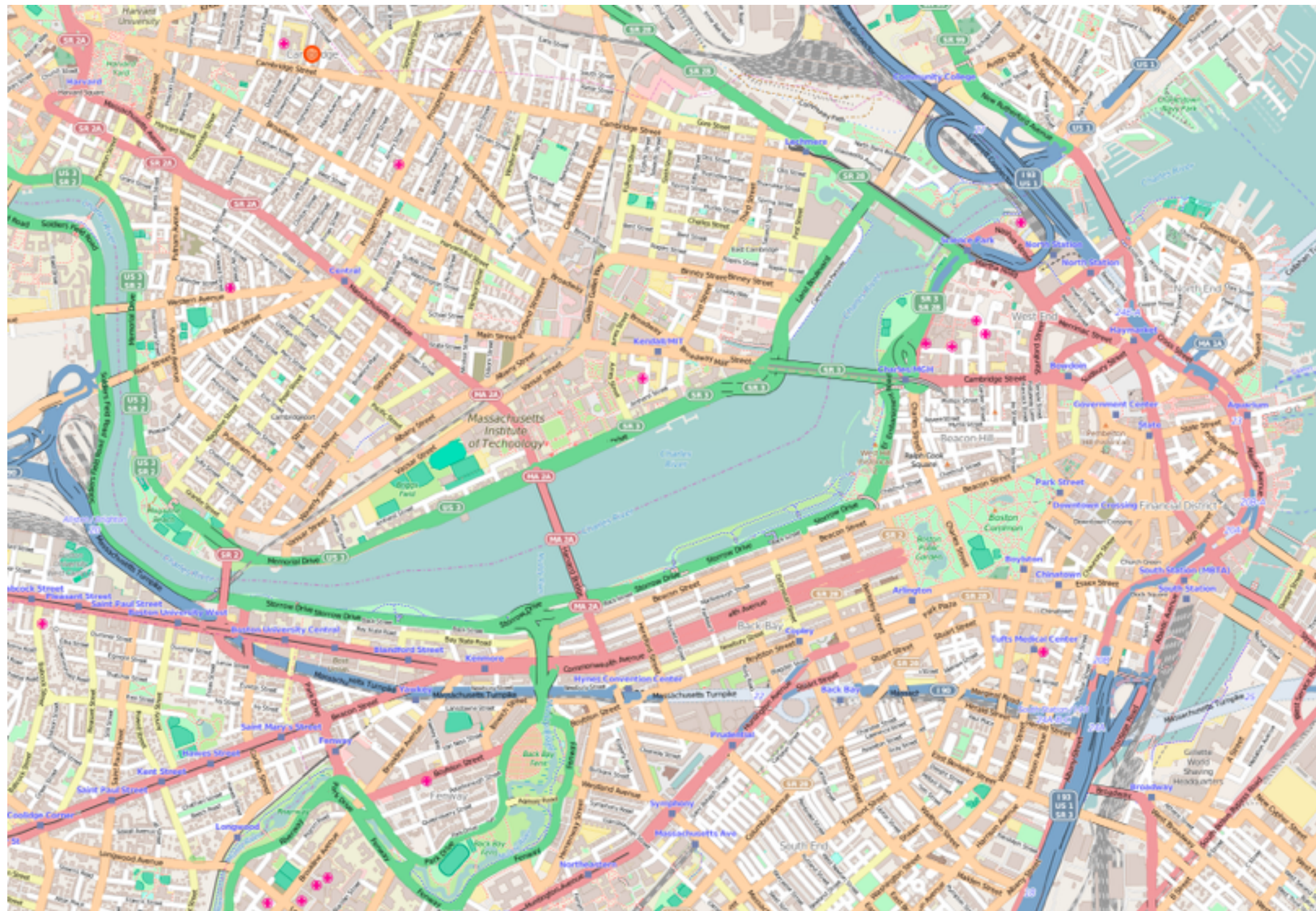
Idea: use small patches
flatten them out
Jarke van Wijk

[http://www.win.tue.nl/~vanwijk/
myriahedral/](http://www.win.tue.nl/~vanwijk/myriahedral/)

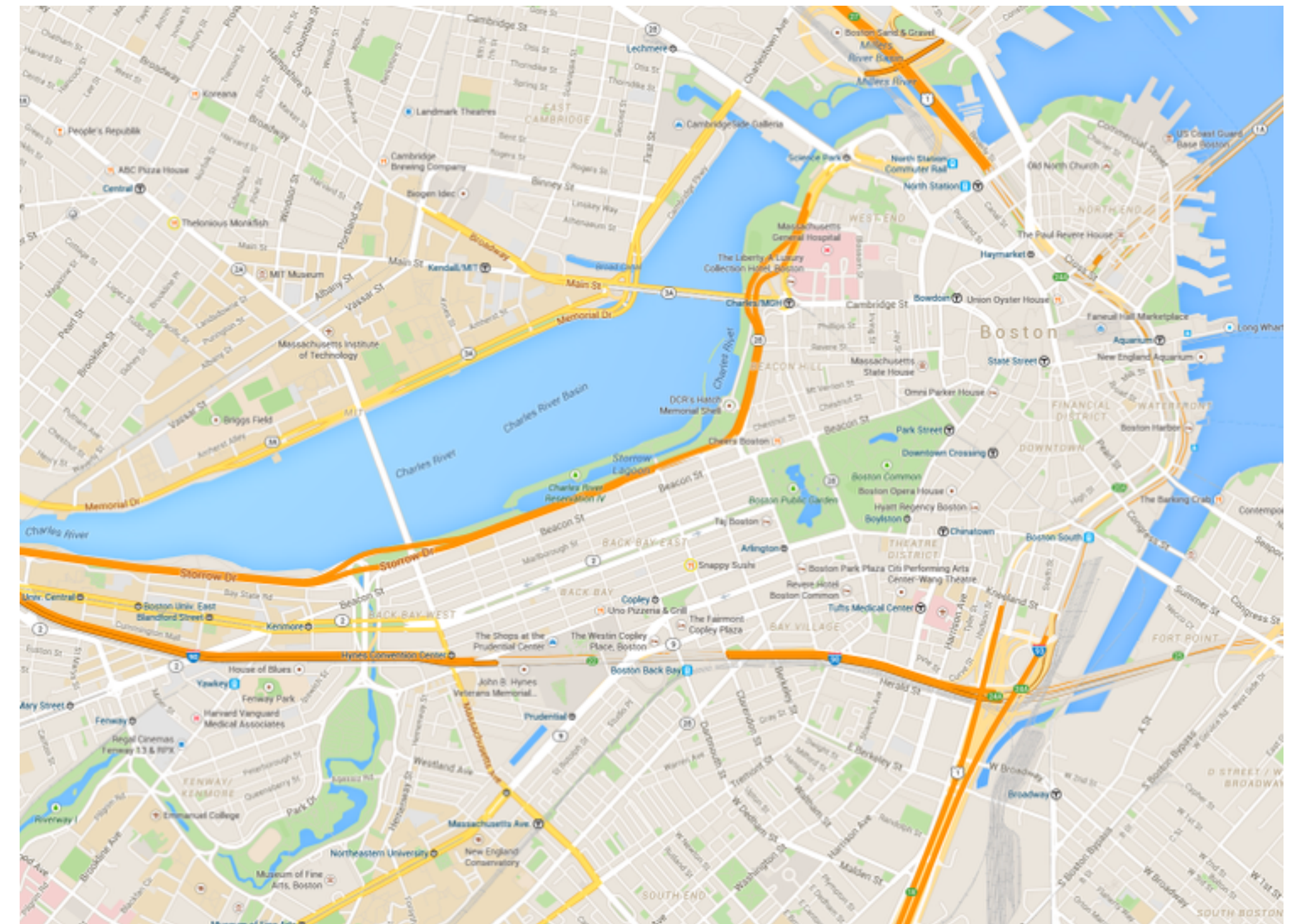


Map Software / Navigation

Mapping Software

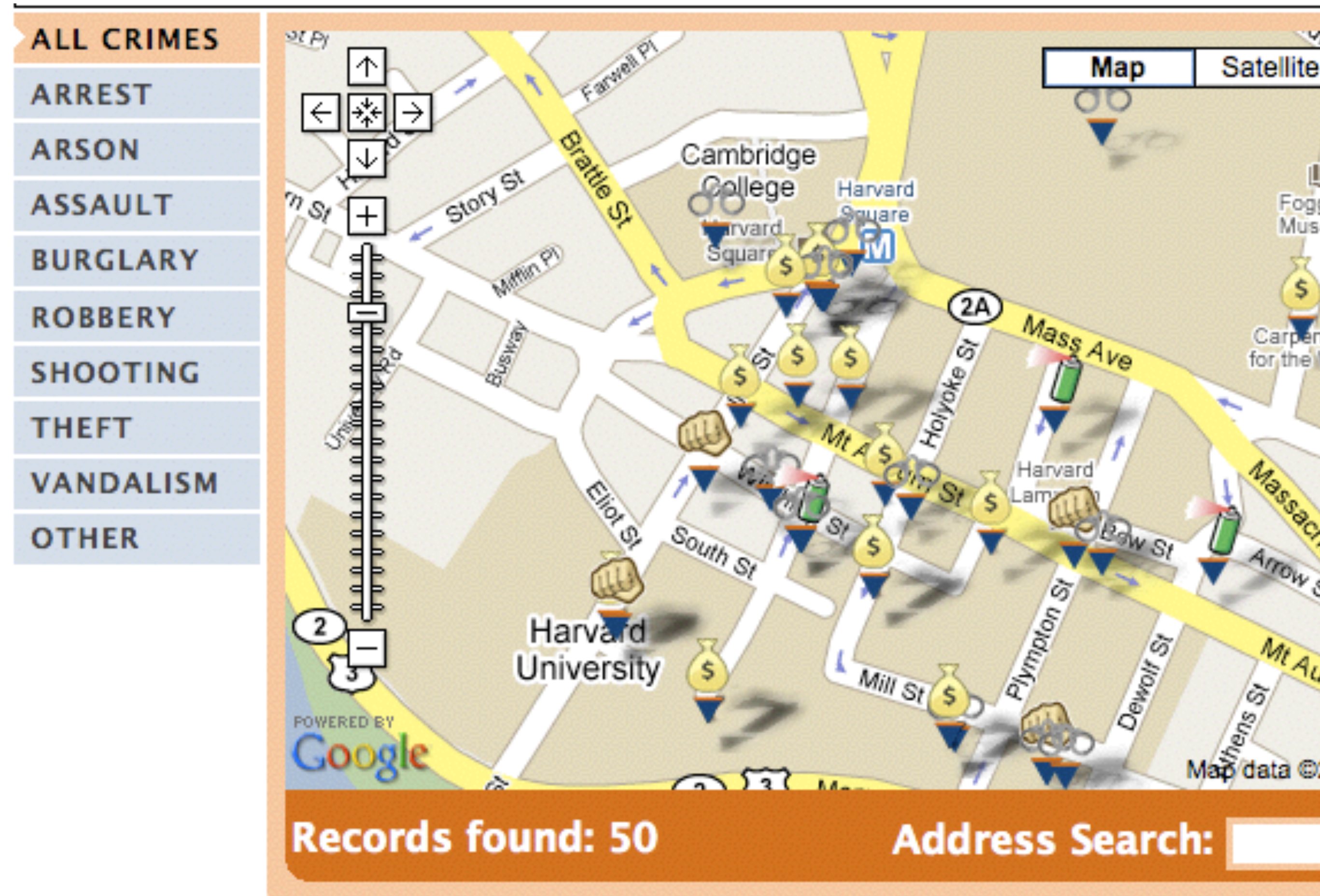


Open StreetMap



Google Maps

Mashups



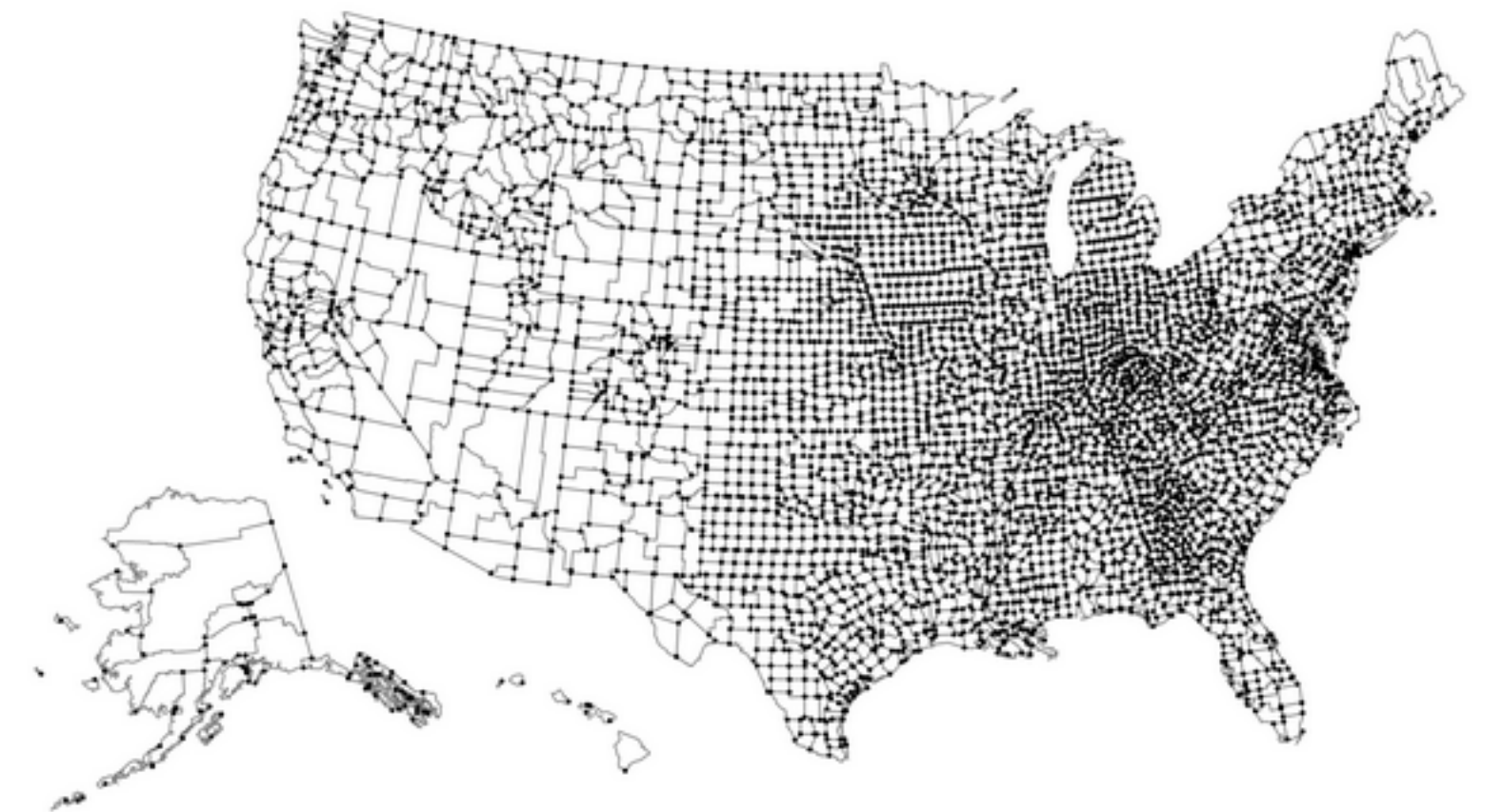
D3 Maps

1) get TopoJSON / GeoJSON file

<https://github.com/mbostock/topojson/wiki>

2) Map Values to Geolocations
contained in JSON file

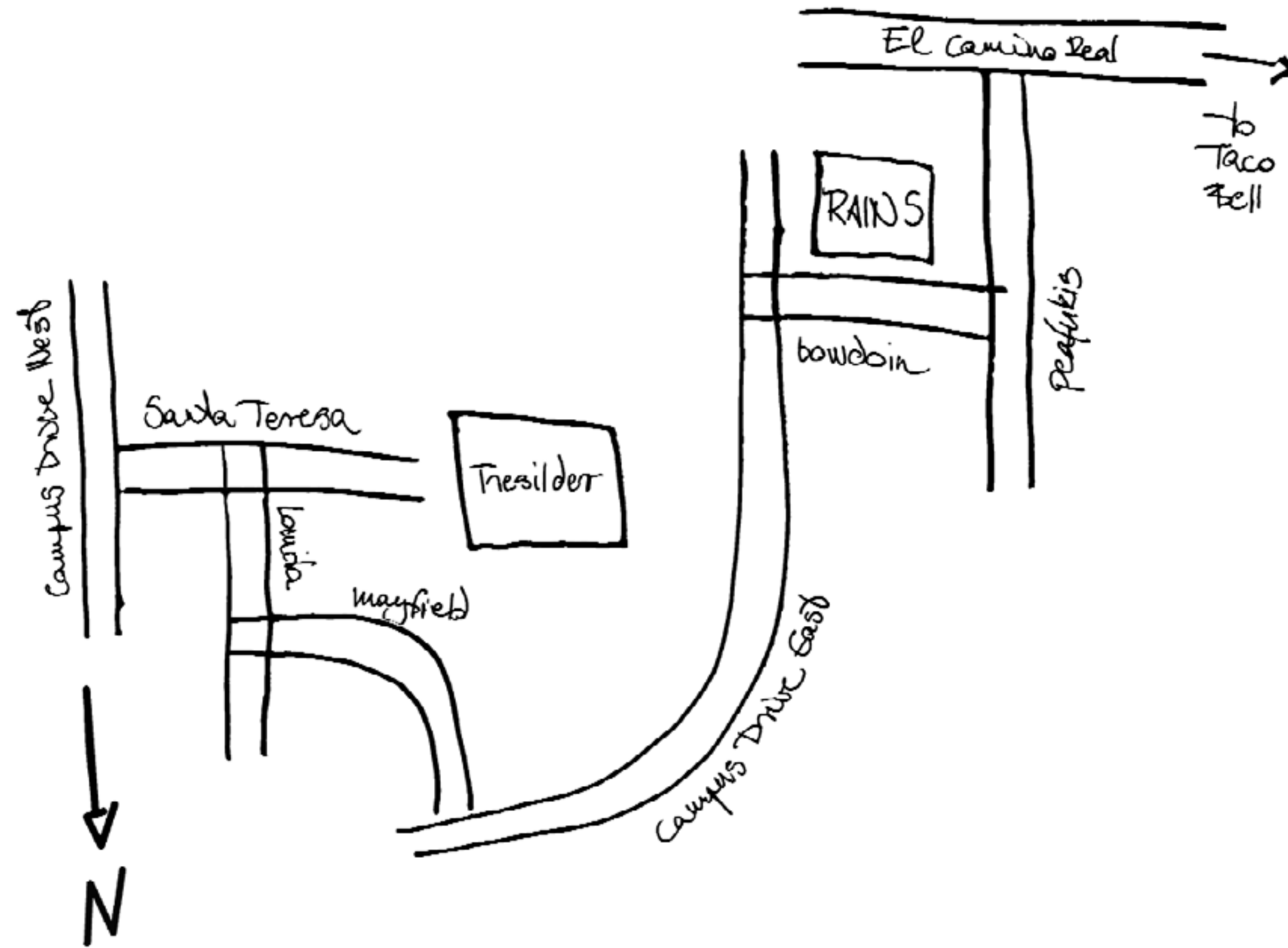
3) Map Values to Channel



Abstract

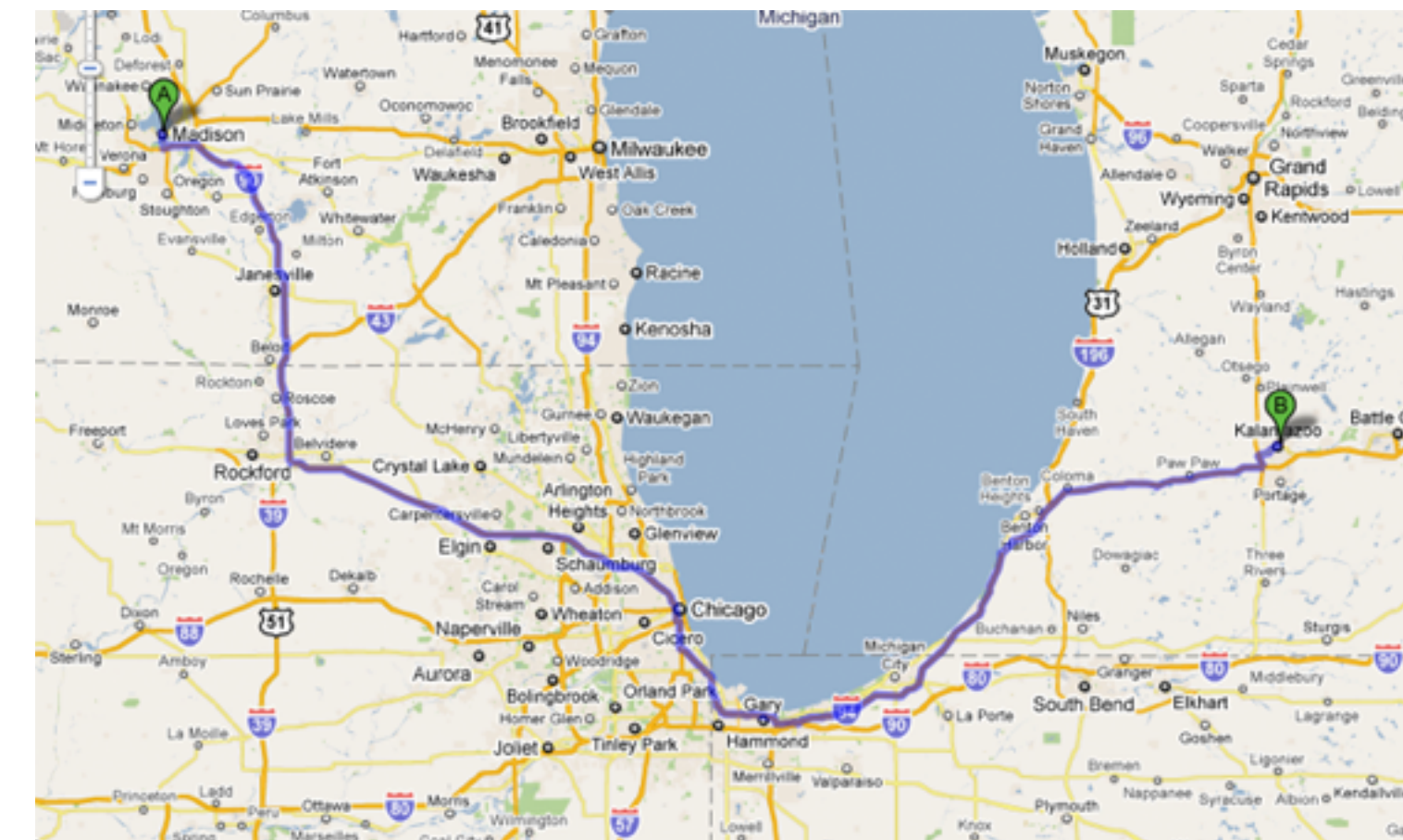
The map displays a route starting from John Harvard's O (marked with a blue dot) and ending at Work (marked with a red dot). The route is highlighted in blue and includes a yellow loop around Cambridge Common Park. Key locations along the route include Harvard Square Station, Harvard University, and various museums and libraries. A legend indicates a 10 min bus ride every 5 min and a 9 min bus ride every 7 min. A walking distance of 10 min (0.5 mile) is also marked.

Landmarks & Paths



LineDrive, 2001

- Straighten wiggly lines
- Turn directions to right angles
- Expand regions with turns
- Contract long straight roads
- Label carefully to avoid clutter
- Maintain overall orientation



Microsoft®

msn Maps & Directions



Home

Maps

Directions

Help

Map Size



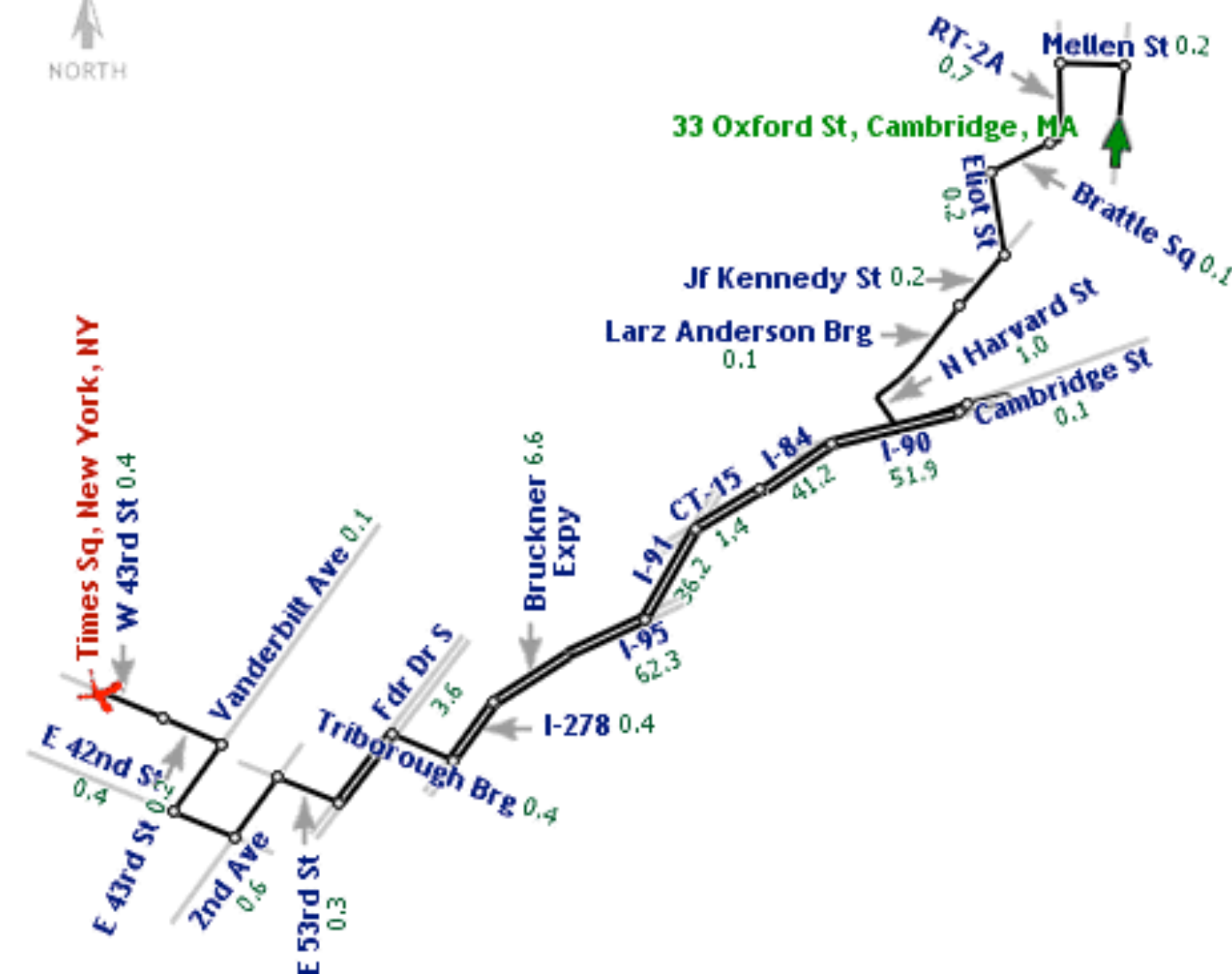
Print



E-mail



NORTH



Start: 33 Oxford St, Cambridge, MA 02138

End: Times Sq, New York, NY 10036

Total Distance: 211.2 Miles

Estimated Total Time: 3 hours, 29 minutes

Directions

Miles

Route

- Turn-by-Turn Directions
- Reverse Directions
- Change Start
- Change End
- Get New Directions

Local Resources

- [Traffic Maps](#)
- City Guide
- Yellow Pages
- Weather

advertisement

Microsoft®

Choropleth Maps

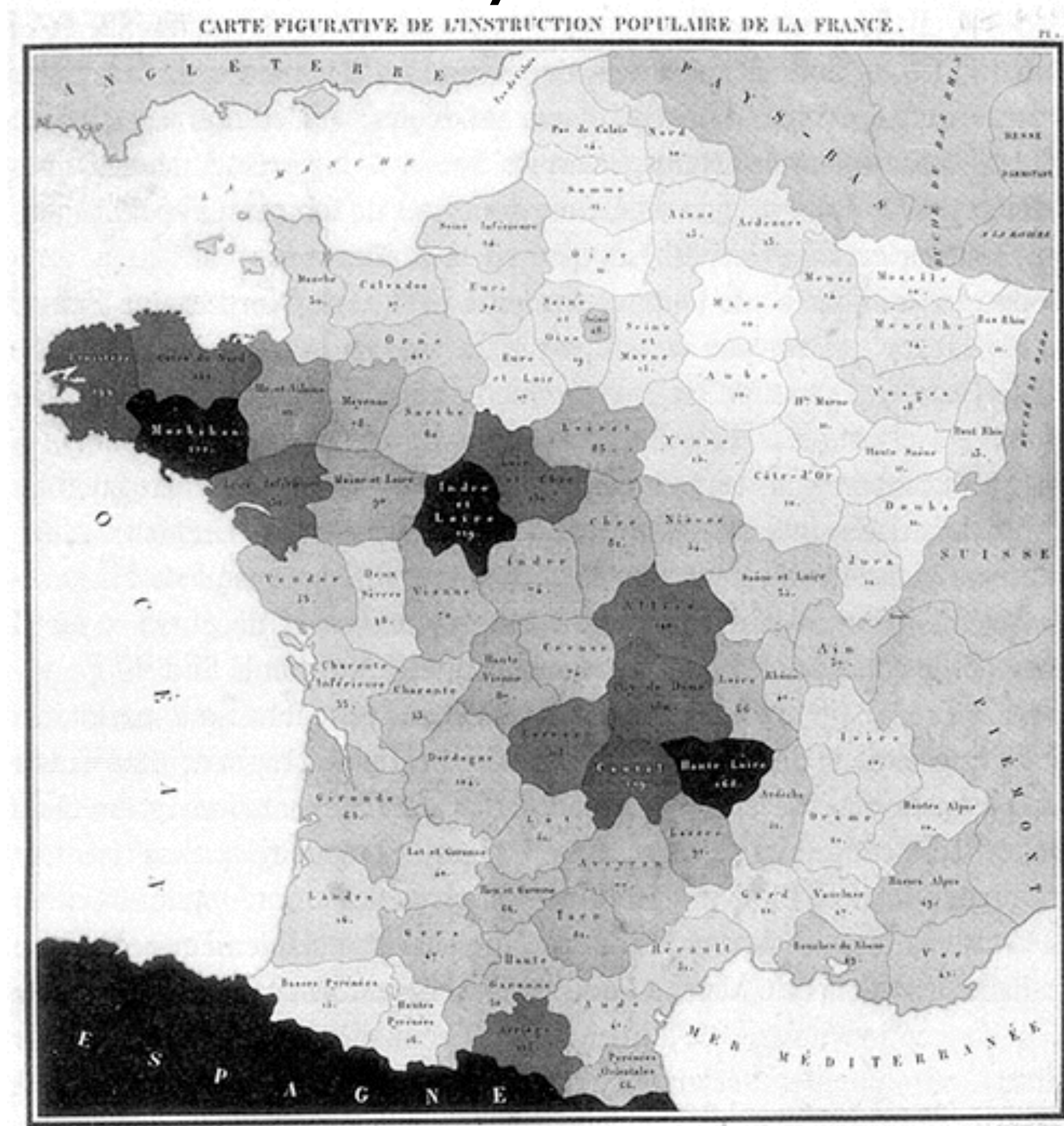
Principle

Area are shaded or patterned in proportion to measurement

Each spatial unit is filled with a uniform color or pattern

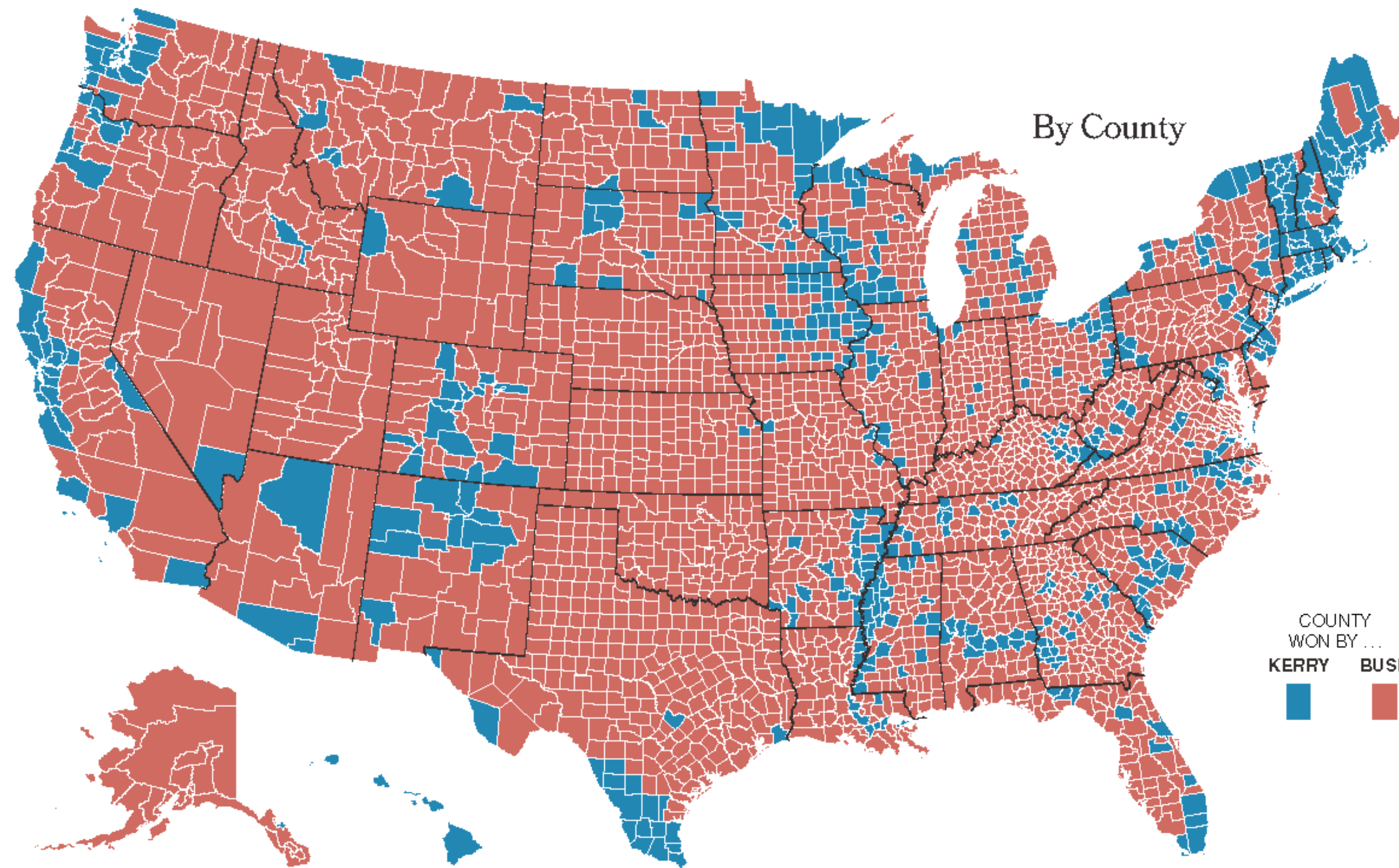
Early Choropleth Map

Illiteracy in France



Charles Dupin, 1826

Kerry vs. Bush, 2004

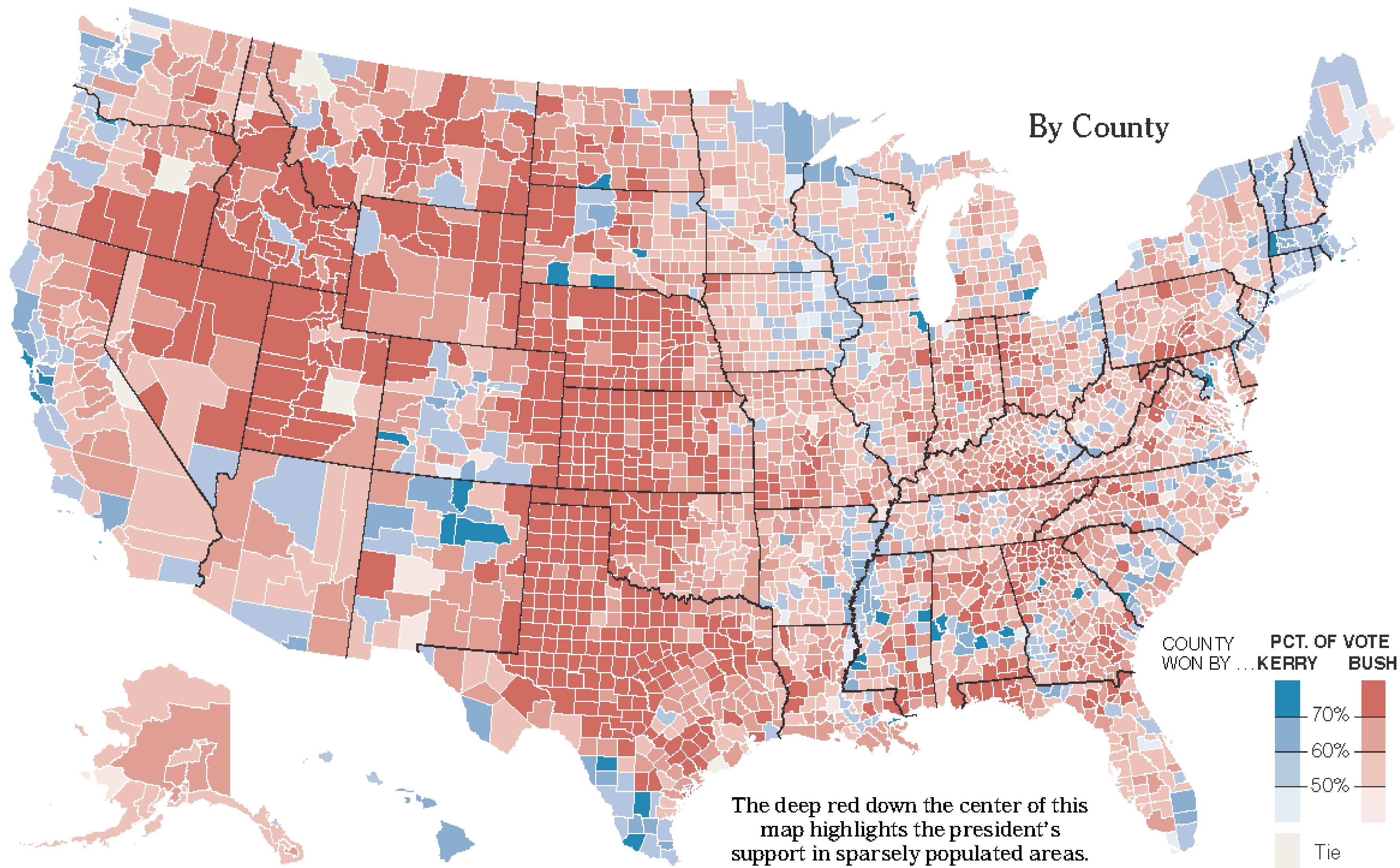


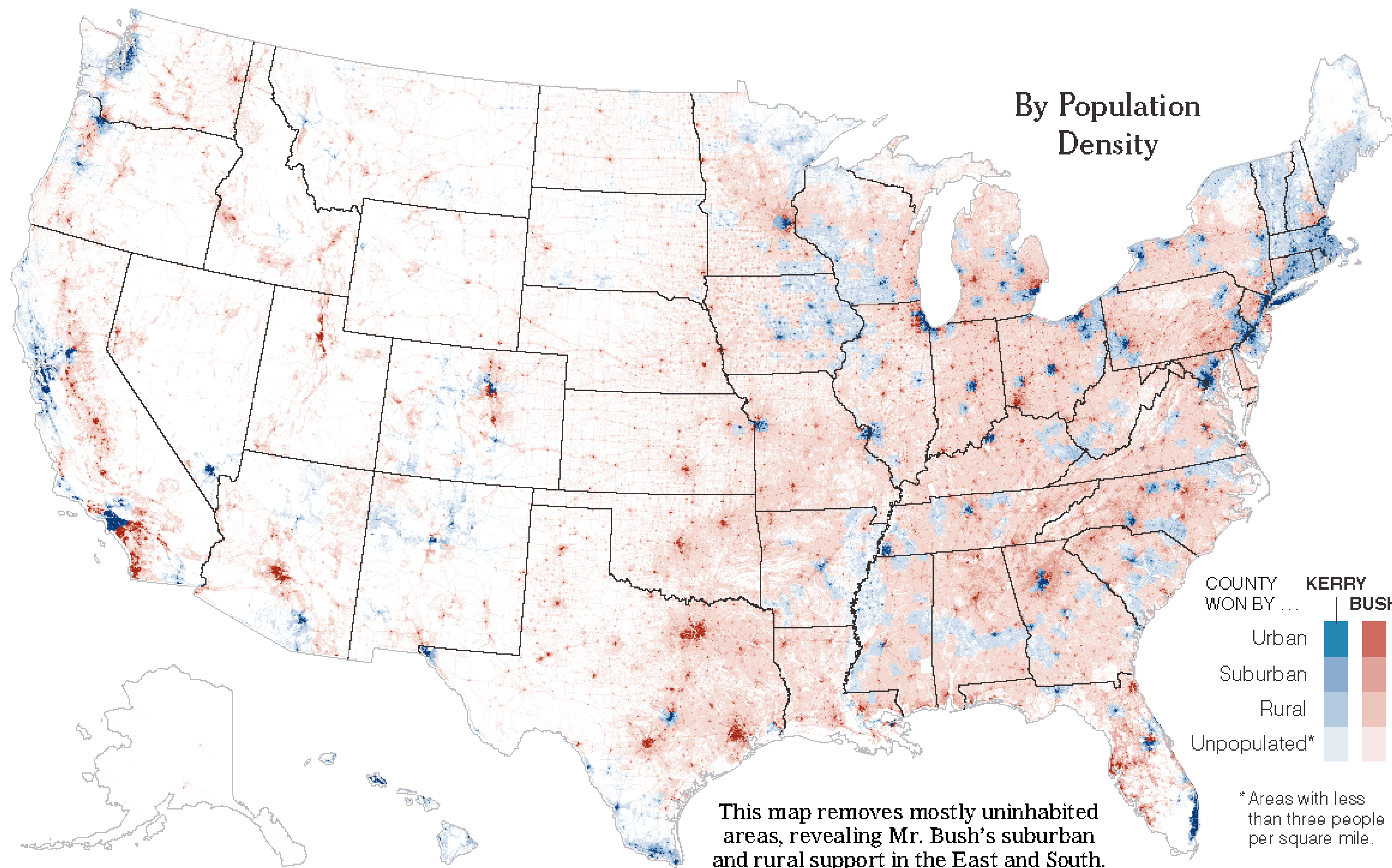
2004 Popular Vote



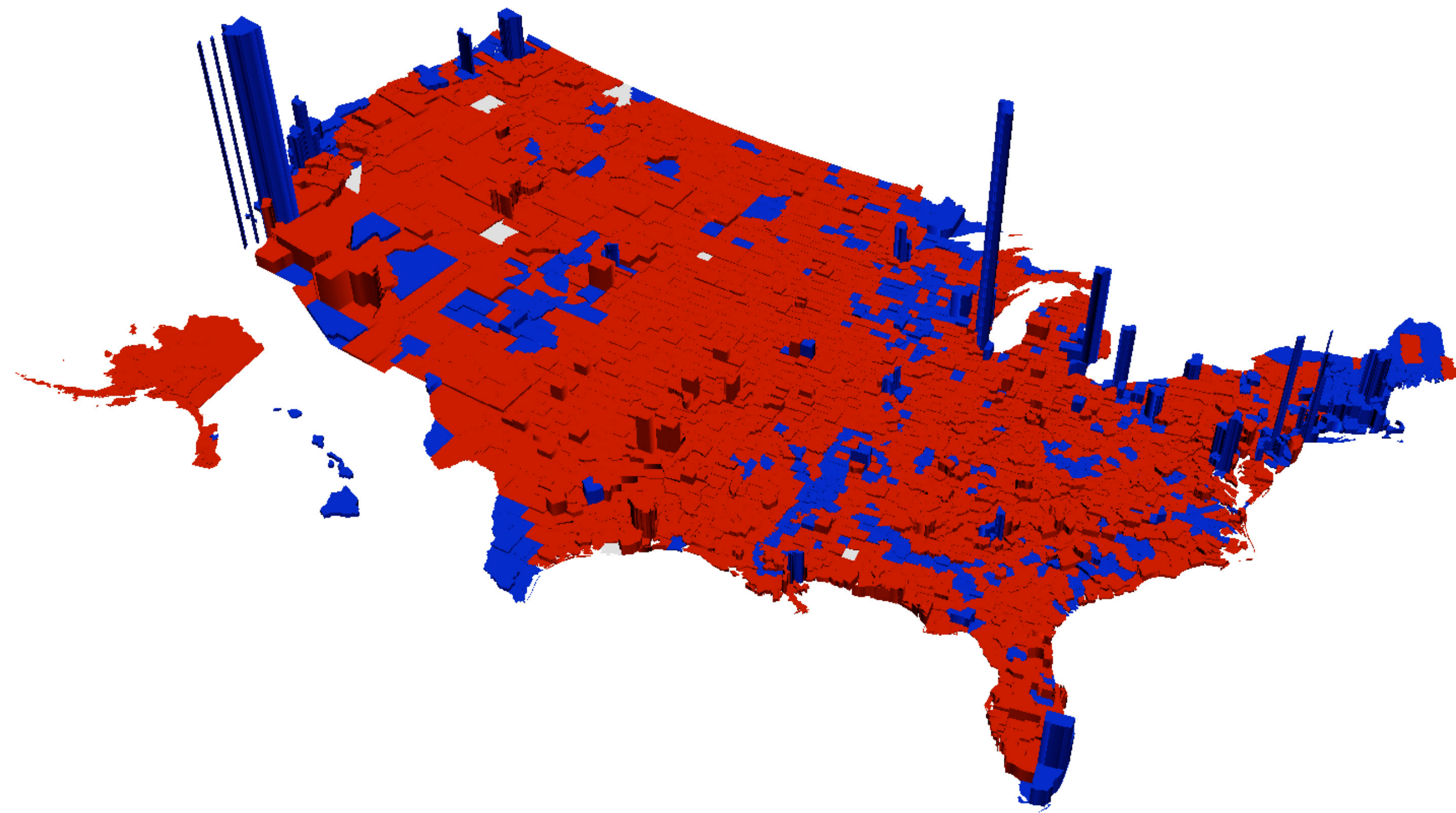
Amount of red and blue shown on map







In 3D!



A.A. Mäkijärvi proudly presents:

The Magnificent BEARS of the Glorious Nation of FINLAND

Approximately before & after the year 2010

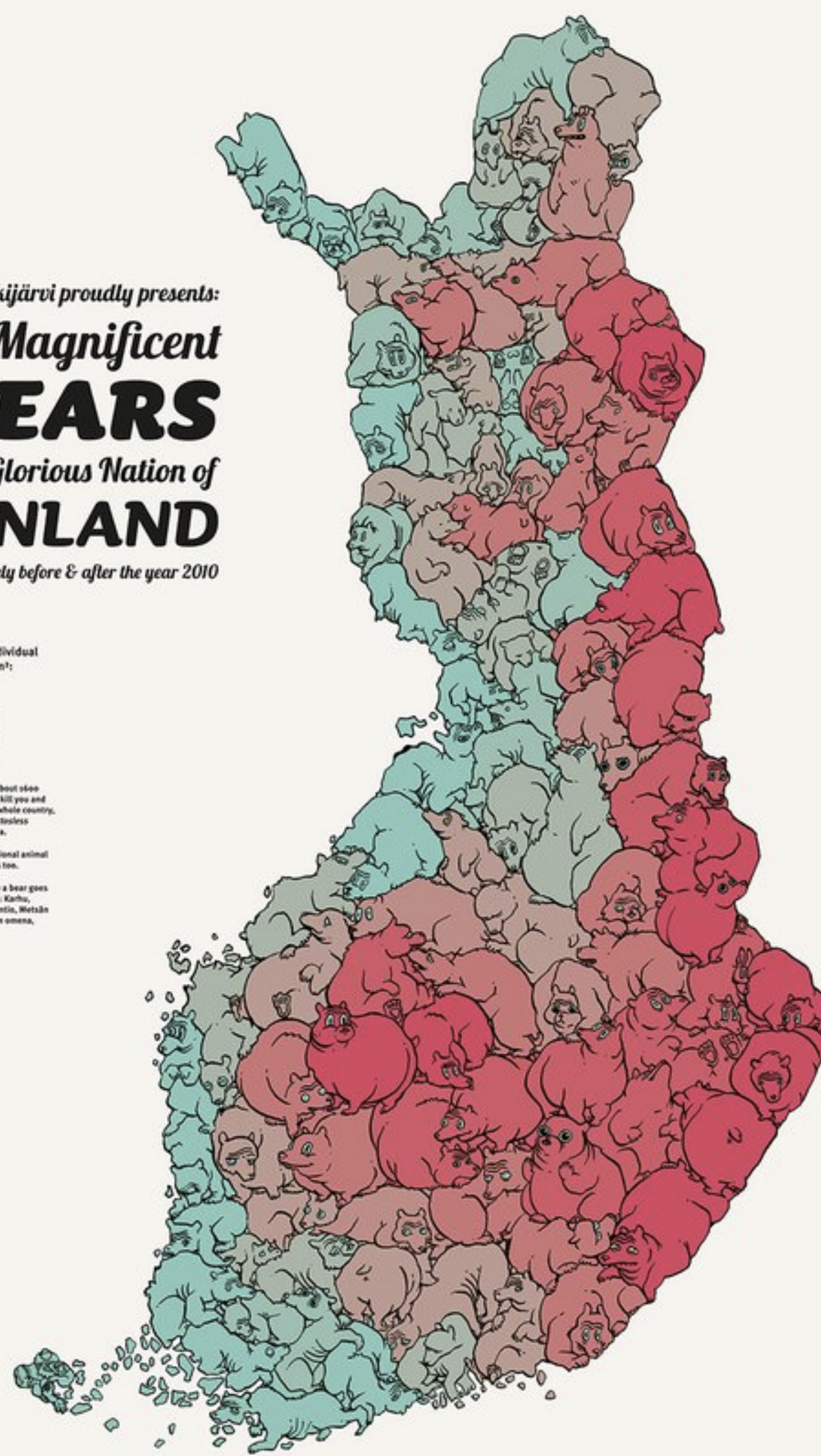
The amount of individual
bears per 1000 km²:

- 0 - 2,0
- 2,1 - 4,0
- 4,1 - 6,0
- 6,1 - ∞

Which means there is about 1000
grateful bears ready to kill you and
your loved ones in the whole country,
excluding the Gross endlessless
province of Ahvenanmaa.

Fun fact! Bear is the national animal
of Finland. And Russia's too.

In the Finnish language a bear goes
by the following names: Karhu,
Metsäkämme, Ötös, Korkin, Metsän
kuningas, Nalle, Metsän omene,
Ötö and Nallukka.

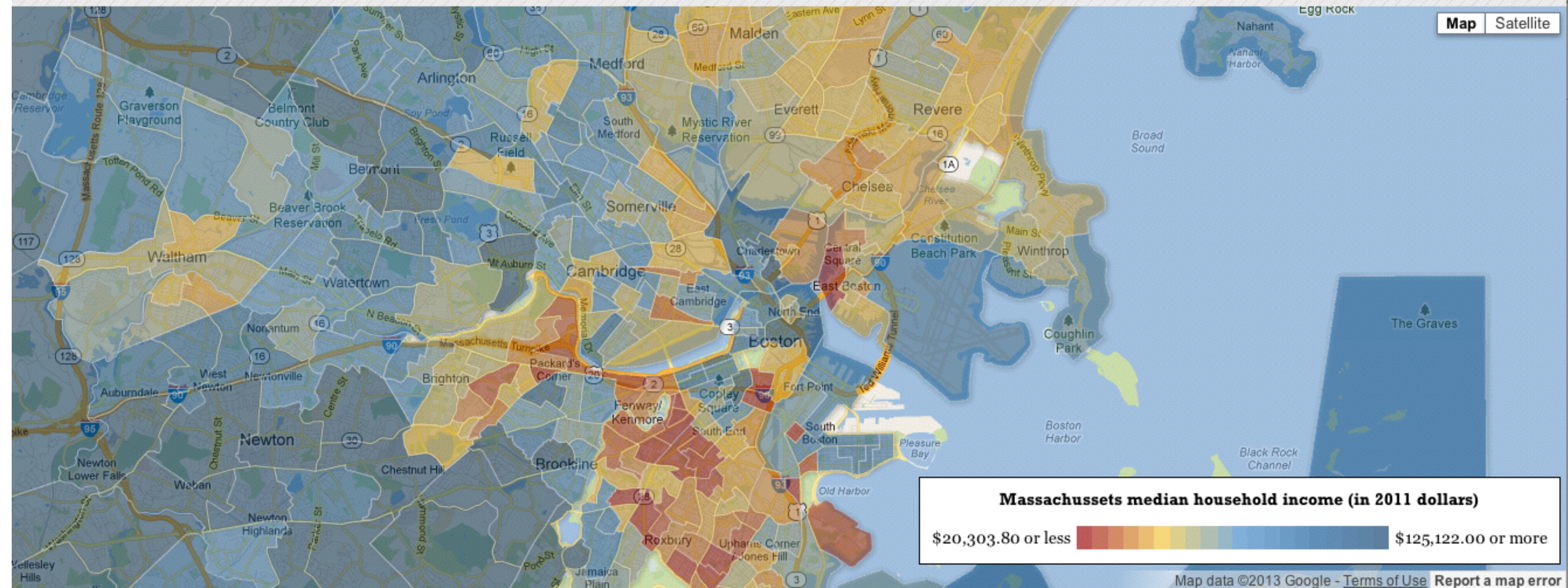


Rich Blocks, Poor Blocks

A map of income and rent in every neighborhood in every city in America

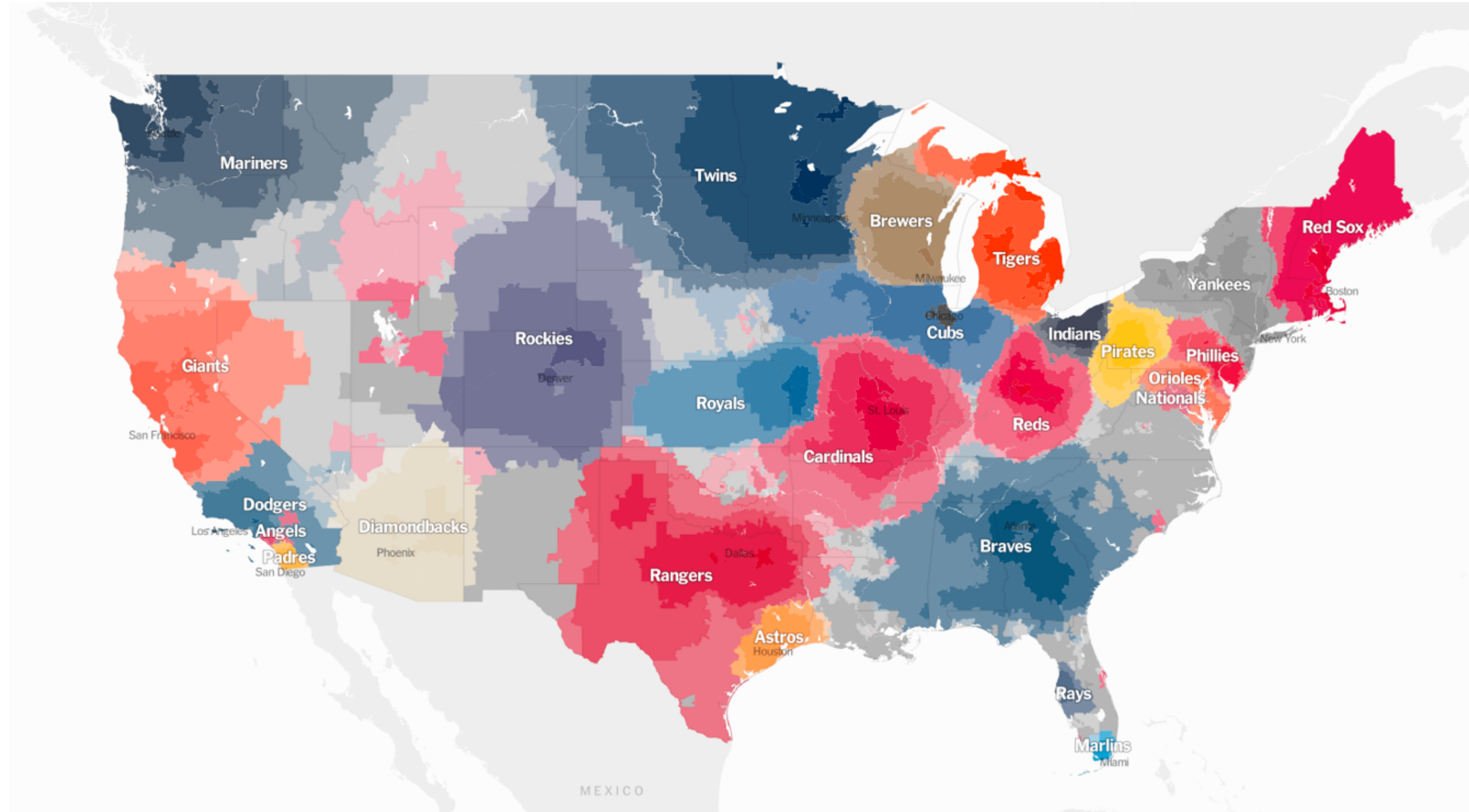
Enter a city name or address and pick a state -- or just pick a state from the dropdown. (☐ I'm colorblind)

(NOTE: Loading taking long? Zoom in or out. No map? Reload, or choose another browser. **And if you want more economic details, click any part of the map after you click "Search."**)

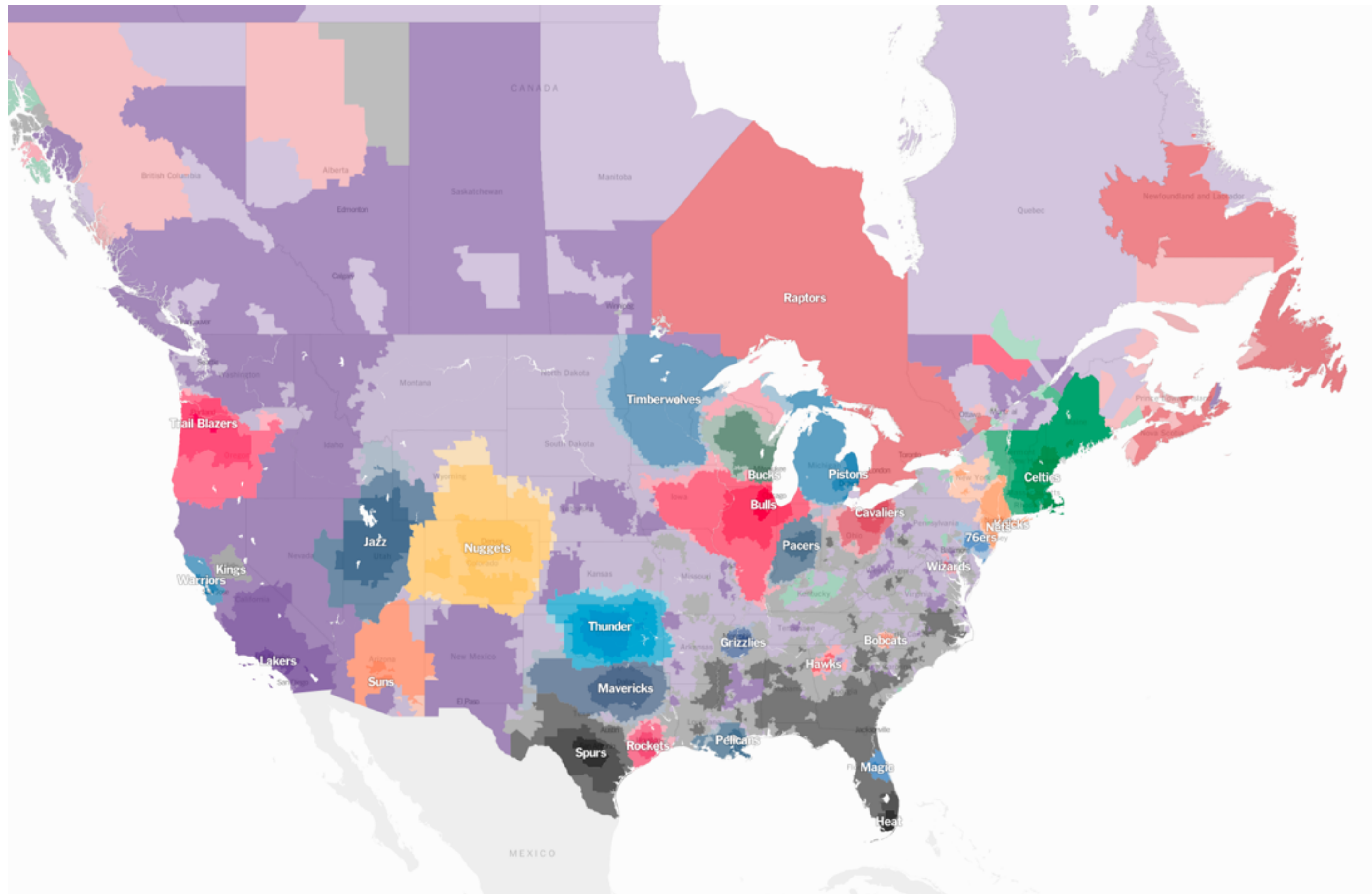


Source on all data: 2007-2011 [American Community Survey](#). For more info, see the ACS' definitions for [income](#) and [rent](#). All map boundaries are [Census Tracts](#).

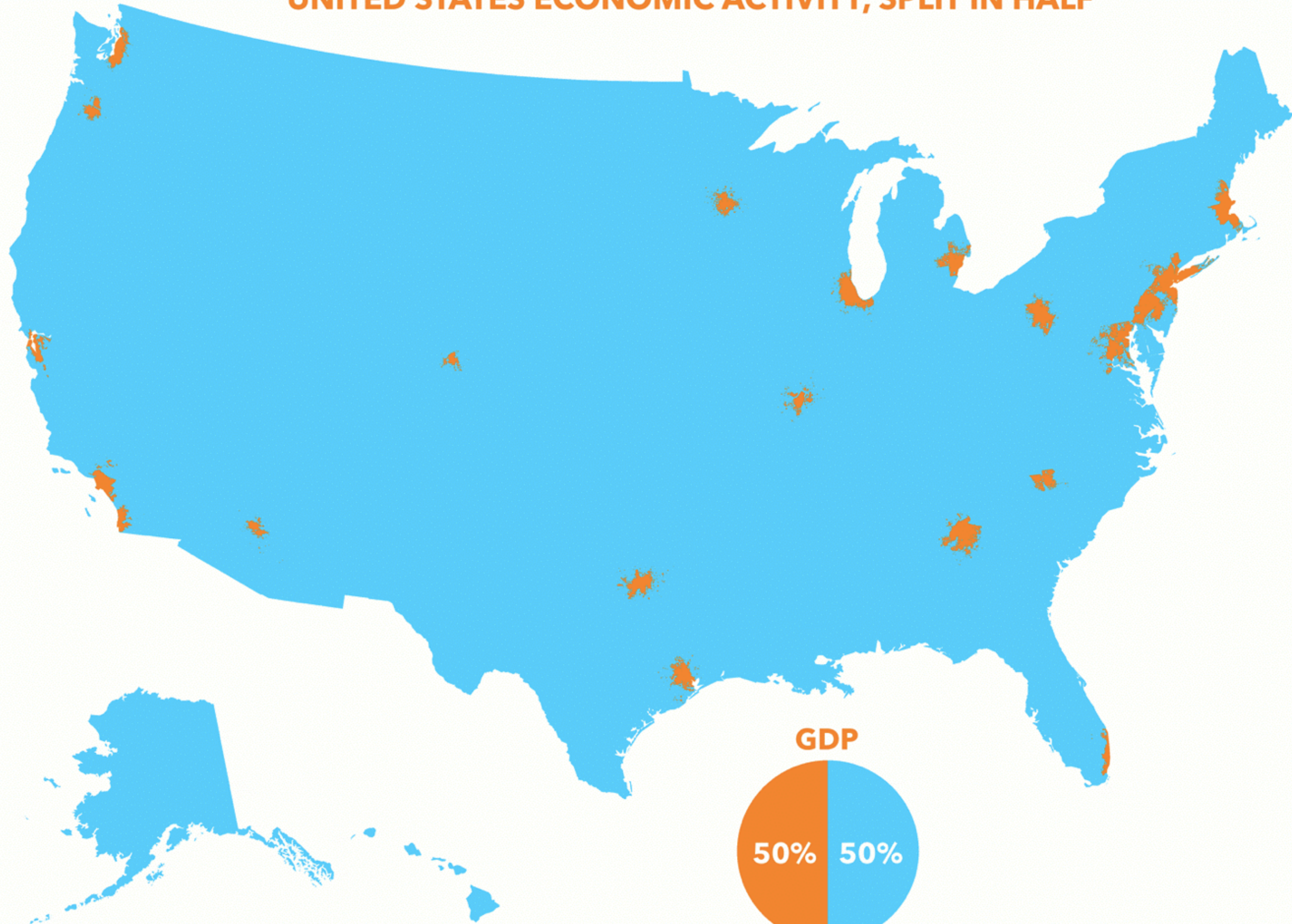
Baseball Territories



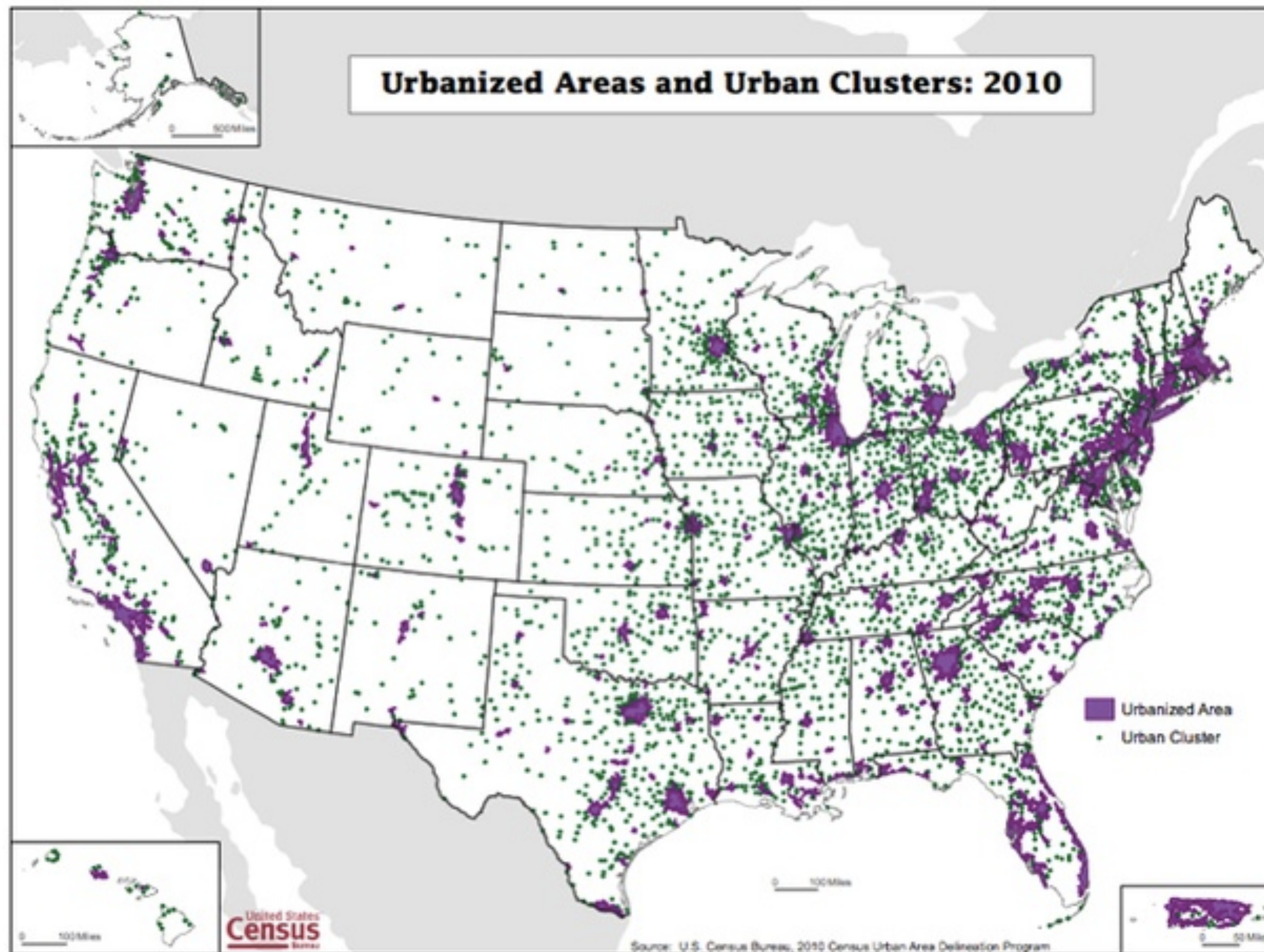
Lakers Dominate Basketball



UNITED STATES ECONOMIC ACTIVITY, SPLIT IN HALF



atrubetskoy on Reddit 



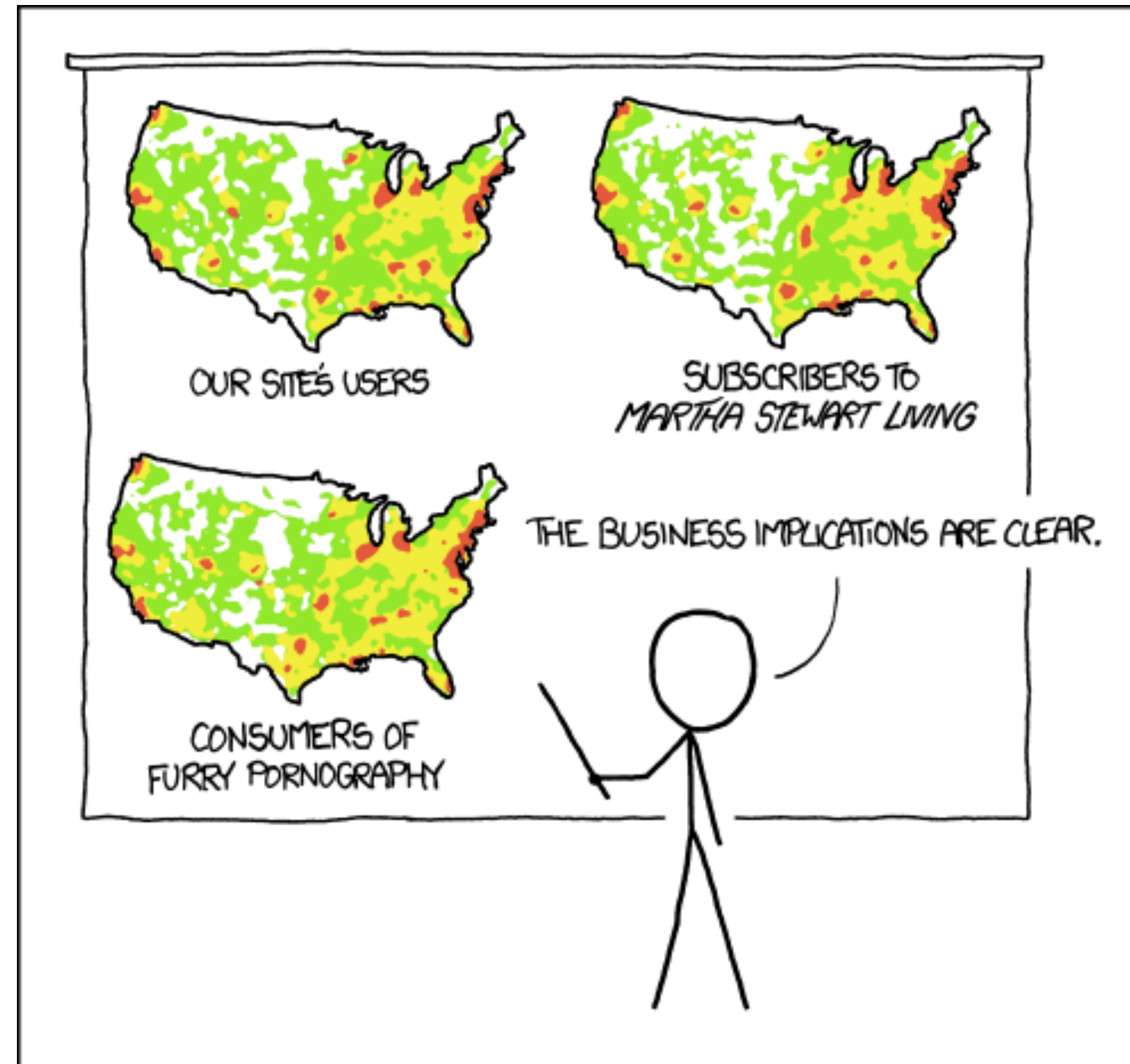
John Burn-Murdoch ✓
@jburnmurdoch



+ Follow

@visualisingdata Dude, it's a really bad map. a) it's a classic example of this xkcd.com/1138/, b) see this: twitter.com/YAN0/status/43...

↩ Reply ↻ Retweet ★ Favorite ... More



PET PEEVE #208:
GEOGRAPHIC PROFILE MAPS WHICH ARE
BASICALLY JUST POPULATION MAPS

Where We Live...

Unlike many developed countries, the U.S. keeps growing. We are also moving south and west. But compared with China or India, the nation is a vast prairie

Our families are getting smaller—with one vital exception. Compared with those of Europe and Japan, the U.S. population is younger and more colorful because of the continued arrival of immigrants and their higher-than-average birthrates. Of the 100 million Americans who will join us in the next 37 years, half will be immigrants or their children. In the next few decades, 97% of the world's population growth will occur in the developing world; the U.S. is the largest developed country in the world that is still growing at a healthy clip. That matters, strategically, economical-

Ala.; Possum Trot, Ky.; or Lonelyville, N.Y. But they are all probably close to someone's idea of paradise. —By Nancy Gibbs

80% of the U.S. population lives in a metropolitan area
Populations of top five shown

The entire state of Wyoming (pop. 509,300) has fewer people than the Harrisburg, Pa., metro area

3. Chicago metro area (pop. 9,443,400)

4. Philadelphia metro area (pop. 5,823,200)

1. New York City metro area (pop. 18,747,300)

Seattle

Billings

Rapid City

Cleveland

Boston

Las Vegas

Salt Lake City

Denver

Phoenix

2. Los Angeles metro area (pop. 12,923,500)

Honolulu

Houston

Tampa

Miami

Loving County, Texas, is the least populated county in the lower 48 states, with 62 residents

5. Dallas-Fort Worth metro area (pop. 5,819,500)

New Jersey is the most densely populated state, with 1,134 people per square mile

Puerto Rico

Fairbanks

Anchorage

Alaska is the most sparsely populated state, with 1 person per square mile

0 1 10 100 1,000 10,000 100,000
Population density per square mile (2.6 sq km)

Sources: U.S. Census Bureau; LandScan 2003/UT-Battelle, LLC

<http://www.visualisingdata.com/index.php/2014/02/defending-the-incredible-gdp-map/>

Robert Kosara February 22nd, 2014 at 4:13 am

The problem here is not that it could be interesting to see population density, but that the claim is that something other than population density is revealed, which is simply not true. Why not make a chart of population density instead? This incredible map shows you where 50% of the people in the U.S. live!

If this were really about GDP, it would be per capita. That would be interesting. Income per capita is certainly higher in New York City than in Dallas, for example. But how do NYC and L.A. compare? What about other areas? And how does income compare to cost of living? Etc.

The reason this is getting any attention at all is because it's a map. If it were a bar chart or similar, people would just ignore it. But no matter how simple or obvious your data, once it's shown on a map, people find it interesting.

<http://www.thefunctionalart.com/2014/02/the-incredible-gdp-map-that-shows-that.html>



Alberto Cairo February 22, 2014 at 7:43 AM

Another analogy: Simplistic graphics like this (only one or two data points; no nuances, exceptions, details) are the equivalent of writing just a headline when you should be writing that headline PLUS a complete news story to provide background information.

Reply



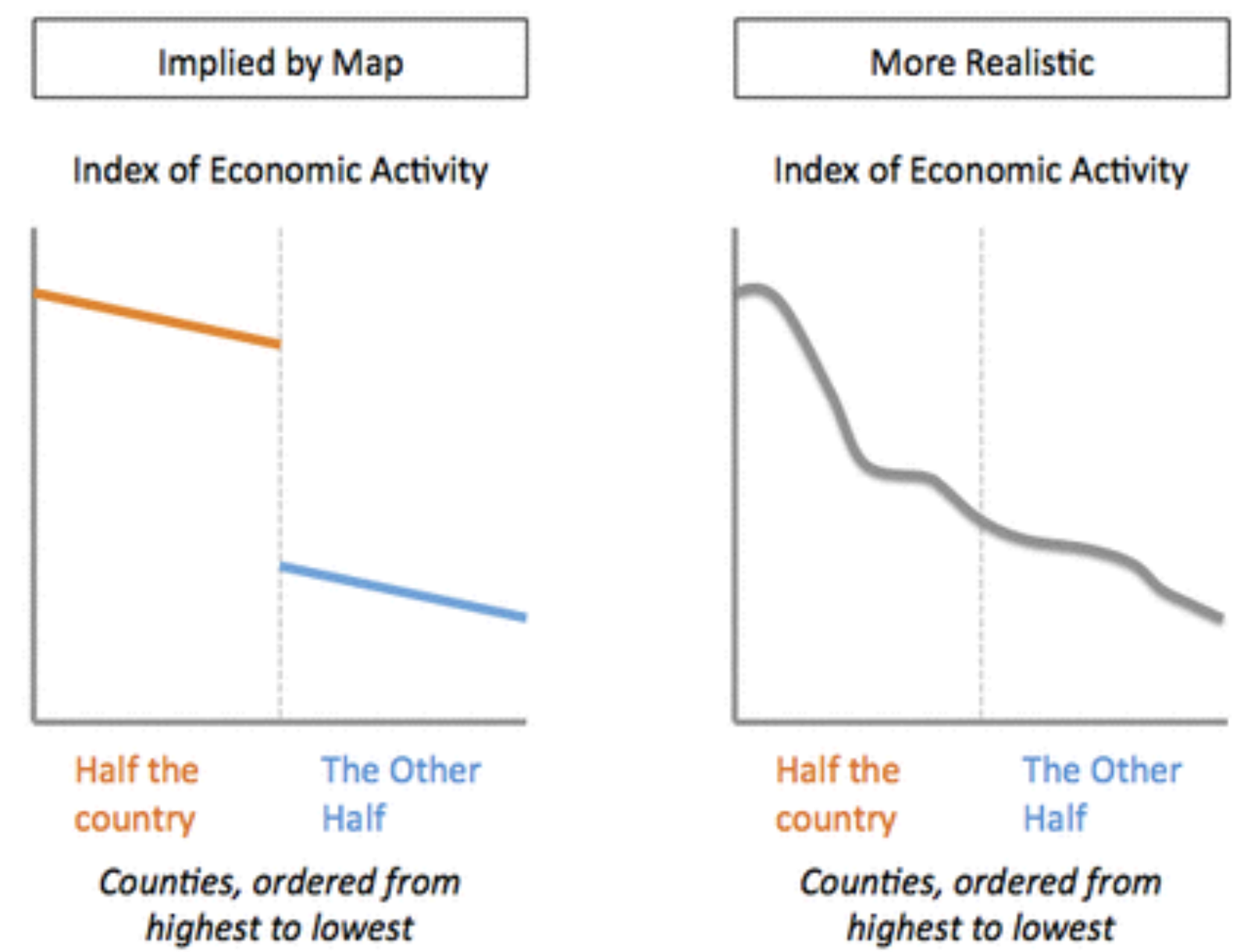
Stephen Few February 22, 2014 at 9:44 AM

In our modern world of news aggregators, few people read beyond the headlines. Knowing a few sound bytes and bullet points is what passes for being informed. Few take time to think beyond a superficial level. Most producers of infographics encourage this through their designs, in part because they embody this in their own thinking.

Reply

The map does not make false claims but it leads readers to the conclusion that the orange areas are much more important than the blue region (equal economic activity but much smaller area). The first problem is that the types of economic activities are vastly different between those regions, and this significant factor is ignored.

The second problem is that the designer over-aggregated the data. All counties (or zip codes) are classified into two groups ("split in half") when in fact, the level of economic activity at the level of counties (or zip codes) is a gradient. Imagine plotting the economic activity index by county, ordered from the highest to the lowest. Do we see a dramatic drop-off after counting out half the counties (i.e., the pattern shown on the left chart below)? Or are we more likely to see the pattern shown on the right? If you see a distribution like the one shown on the right, would you summarize that with just two segments?



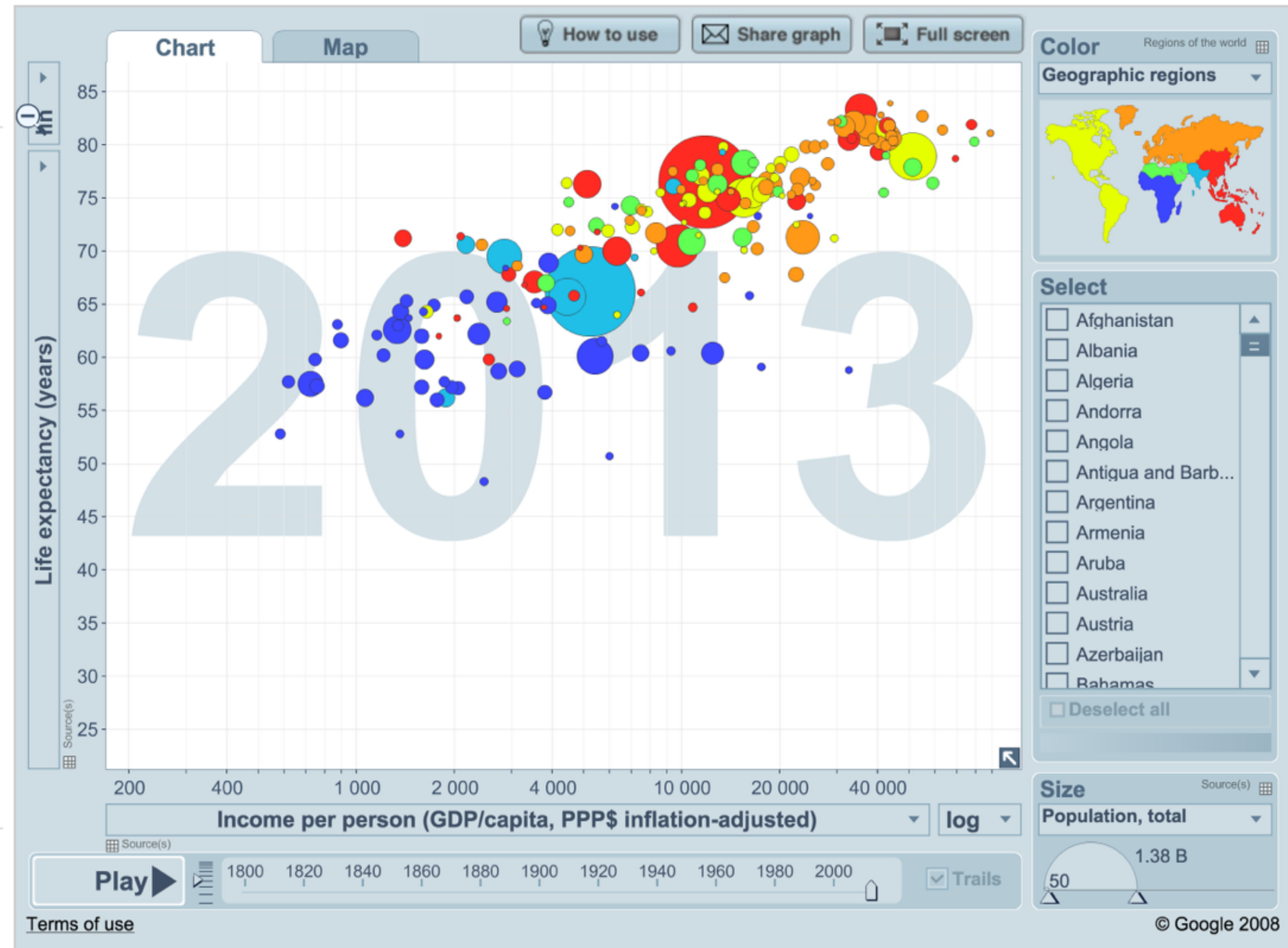
Design Critique

GapMinder

<https://goo.gl/Fcx28n>

Tool:

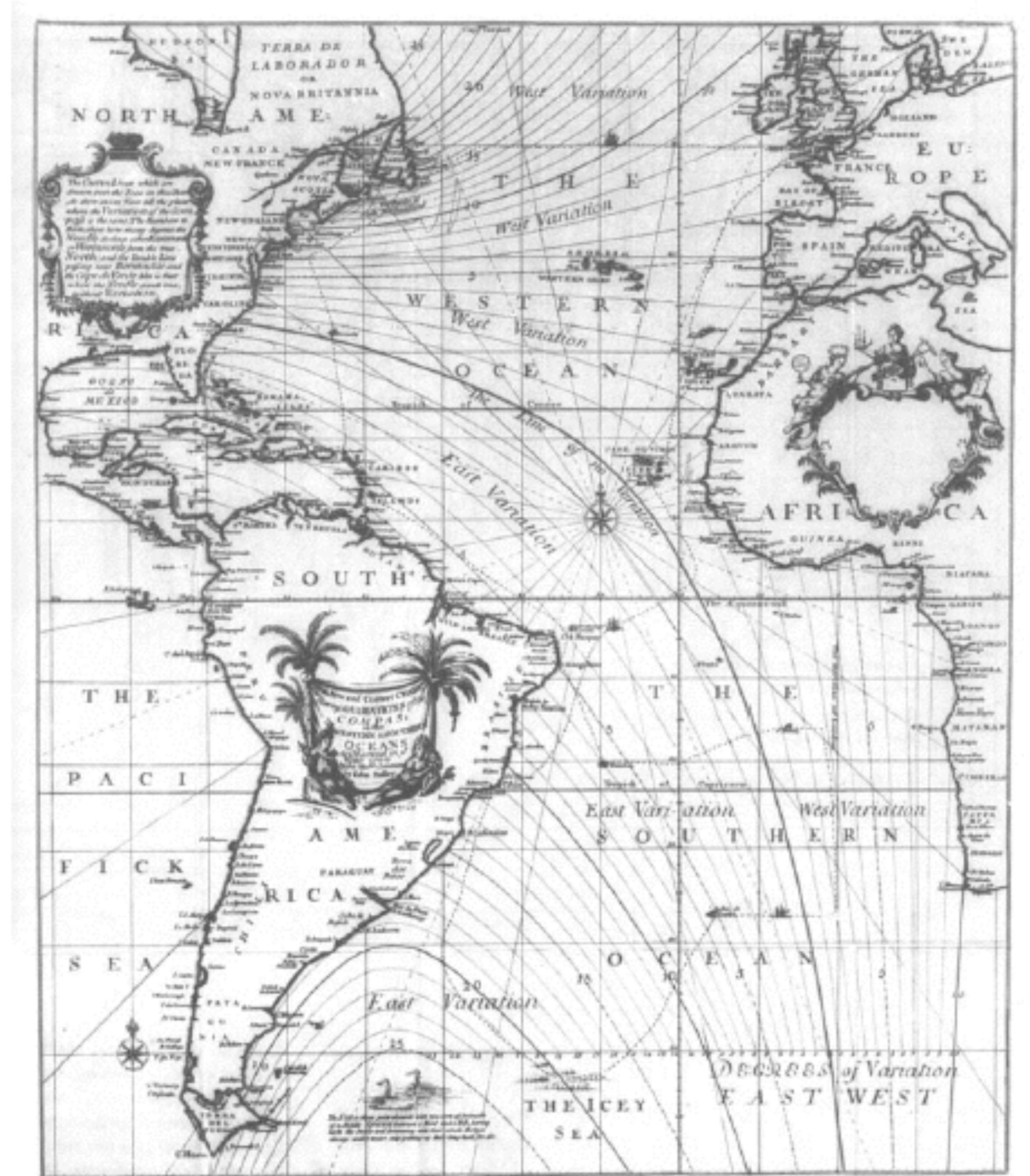
<http://goo.gl/jWNOUb>



Contour (Isopleth) Maps

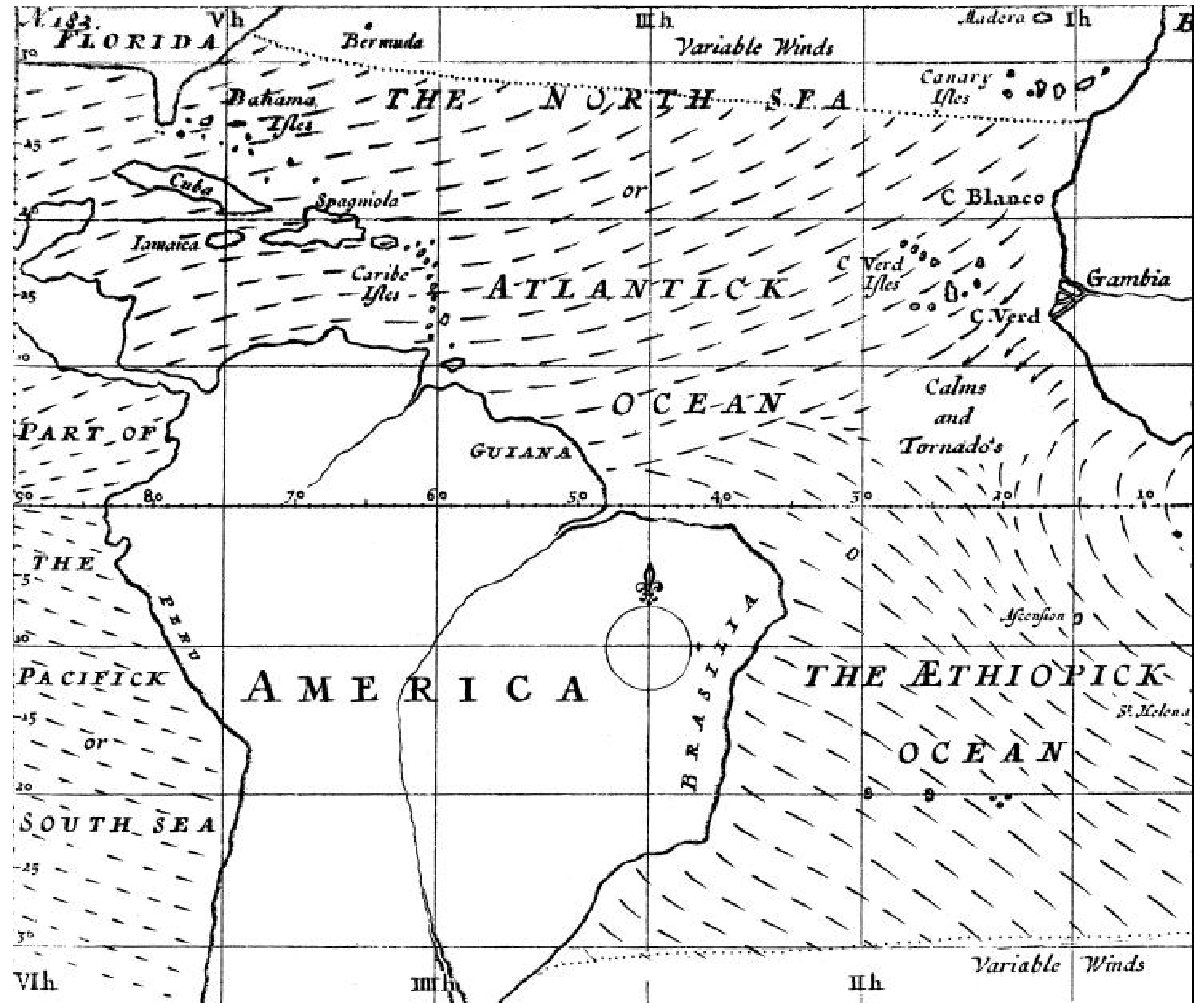
Early Contour Map

Halley's lines of equal magnetic declination, 1701

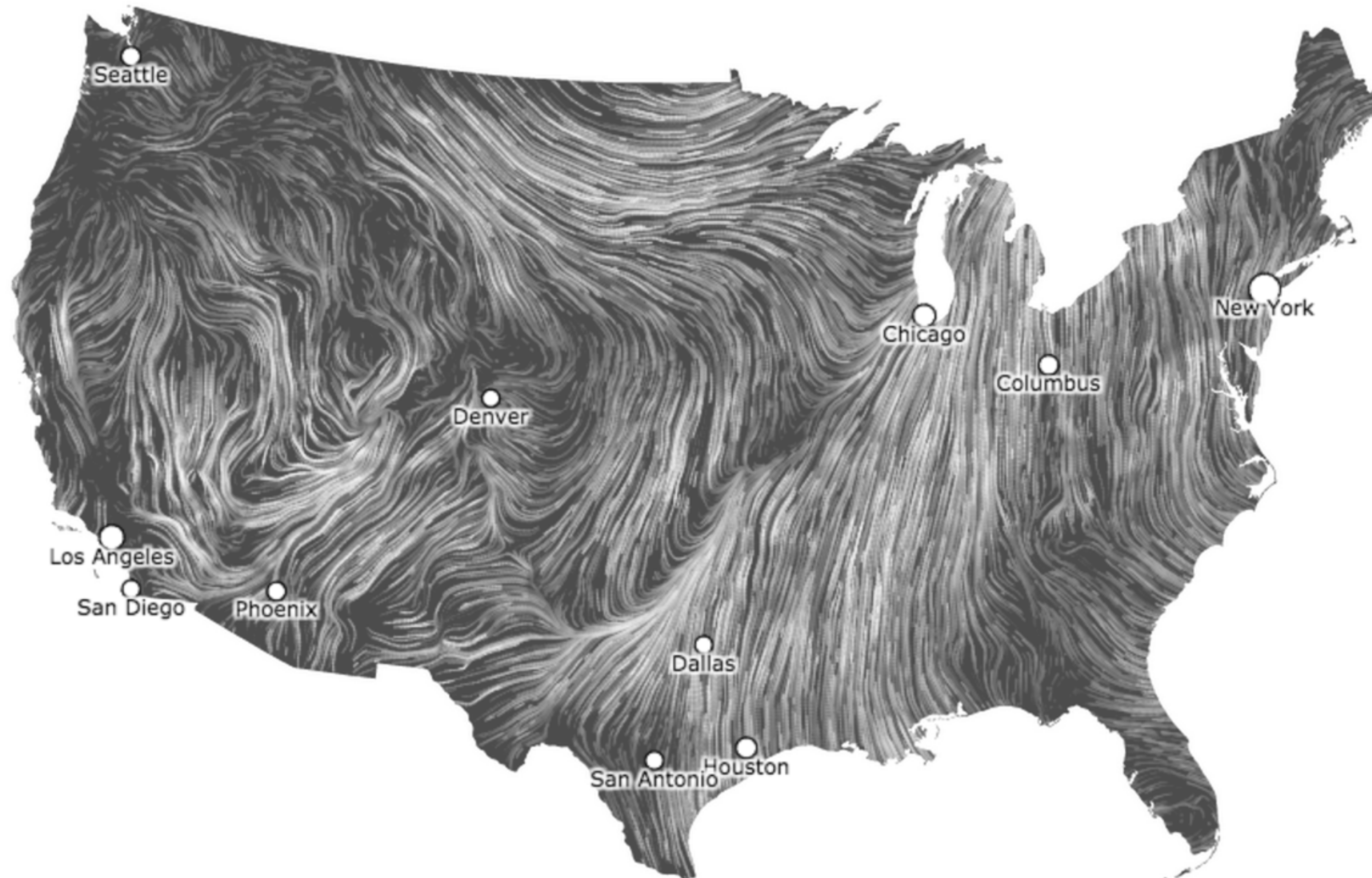


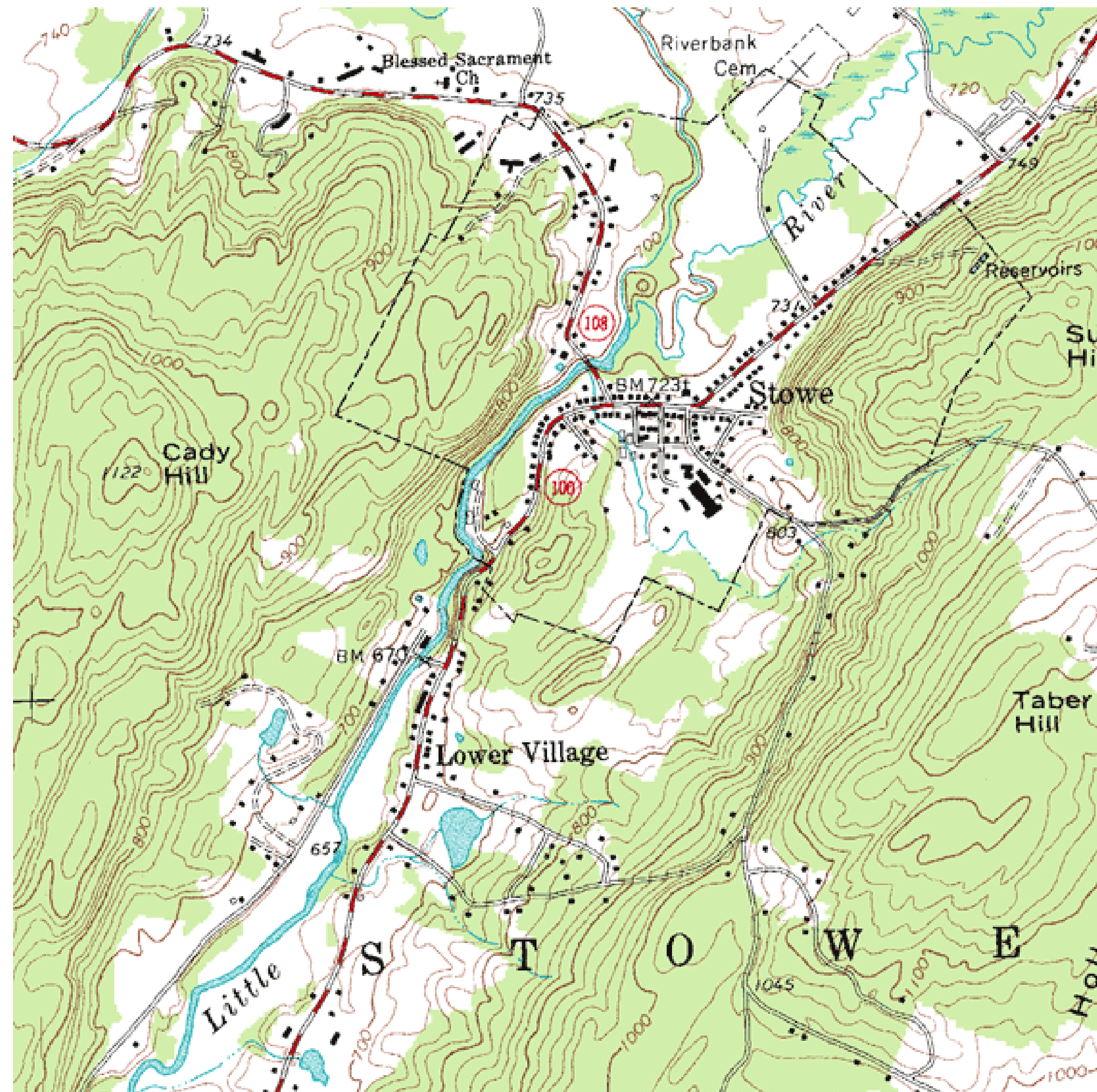
Early Weather Map

Halley's wind map, 1686

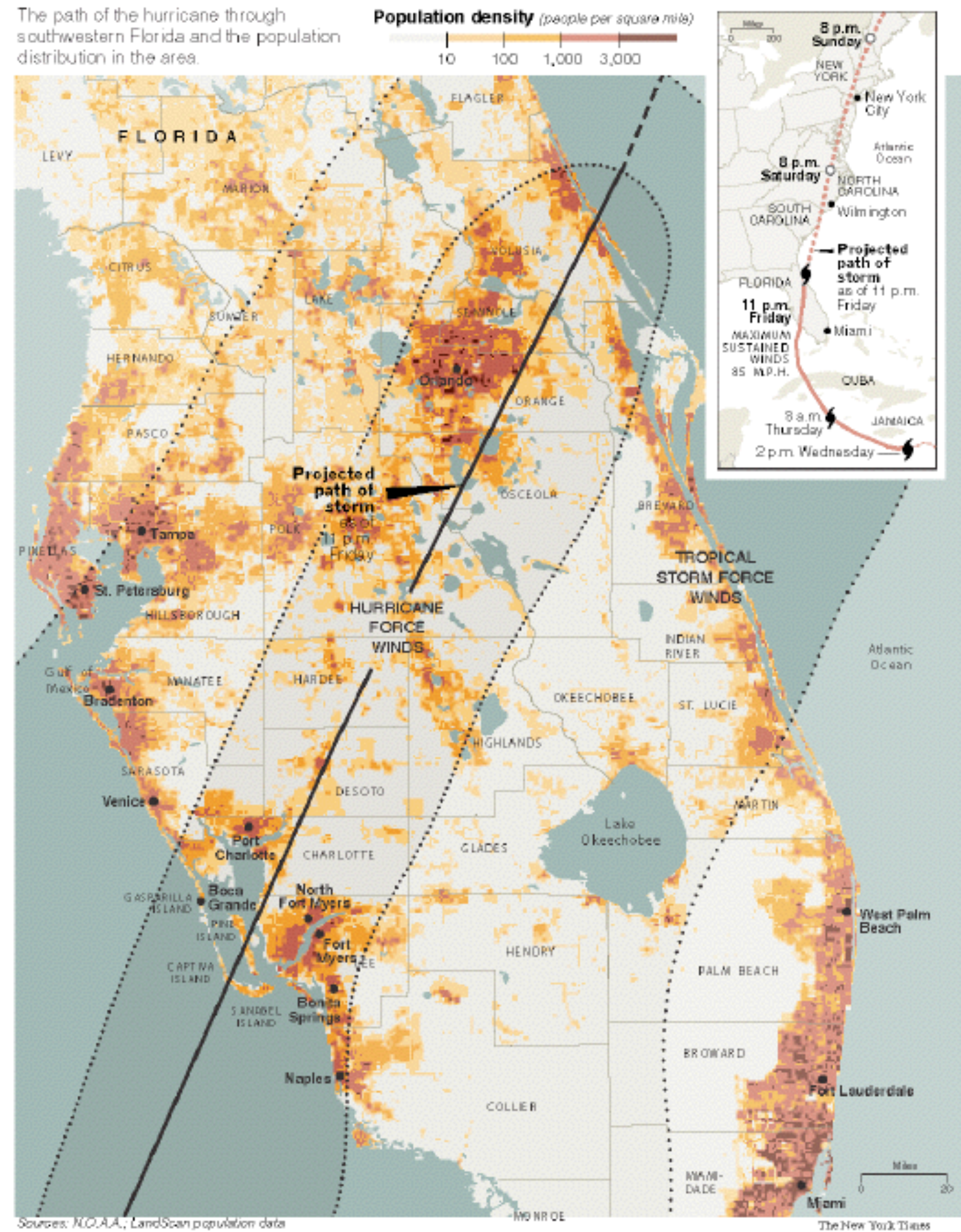


Wind Map





The path of the hurricane through southwestern Florida and the population distribution in the area.



Sources: N.O.A., LandScan population data

The New York Times

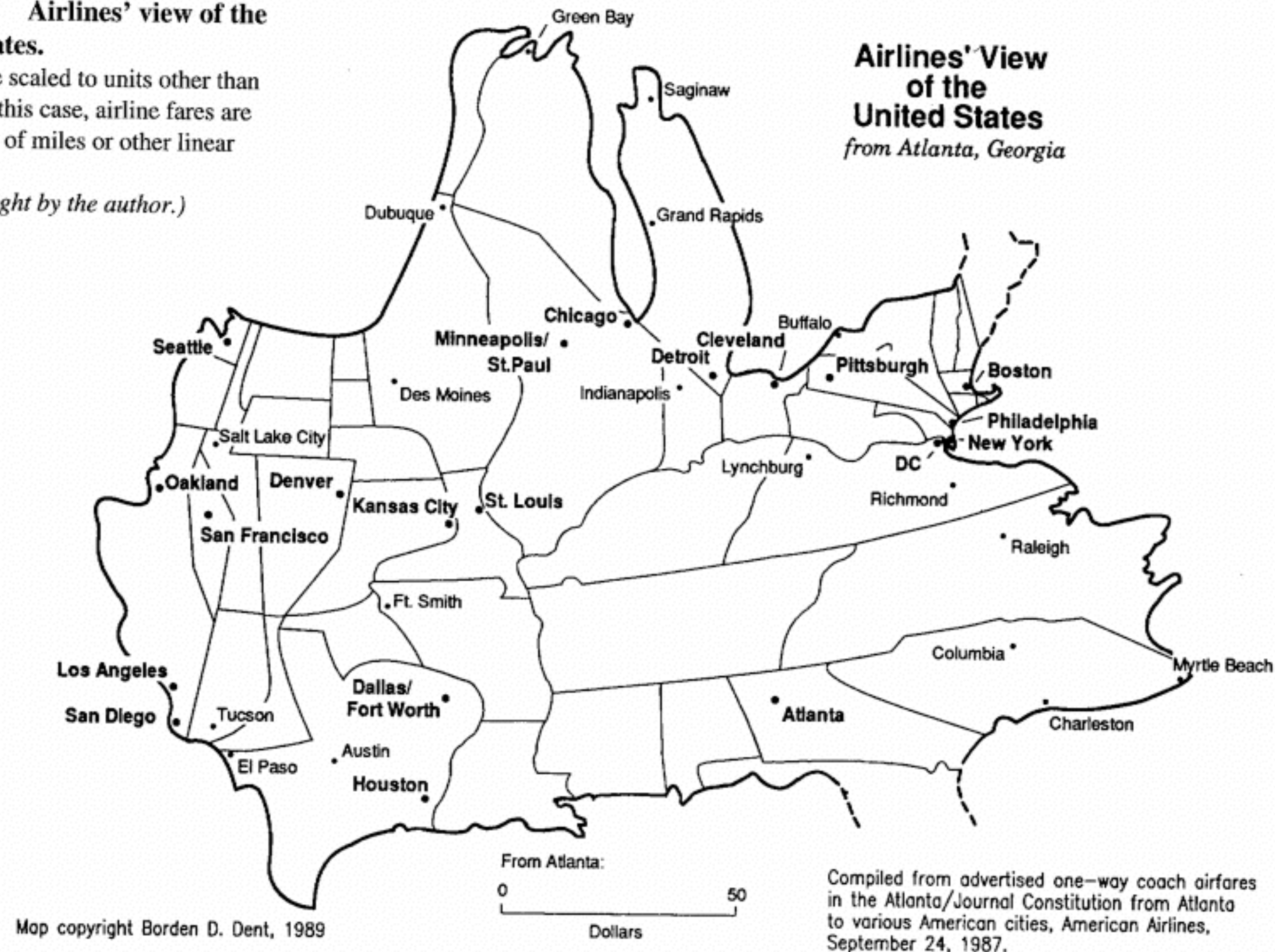
Cartograms

Scale Distance by Data

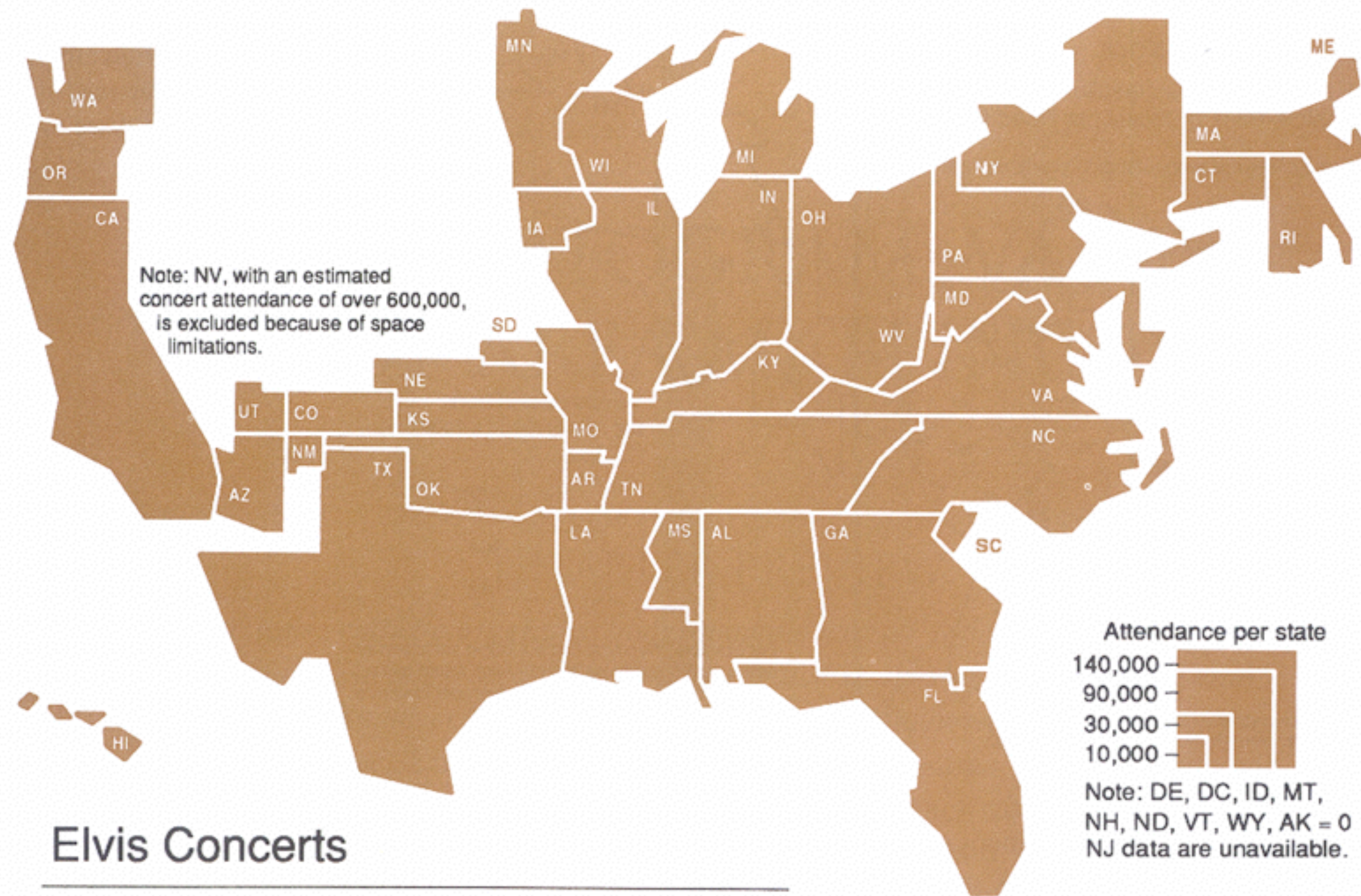
Figure 1.8 Airlines' view of the United States.

Maps can be scaled to units other than distance. In this case, airline fares are used instead of miles or other linear units.

(Map copyright by the author.)



Scale Area by Data



Elvis Concerts

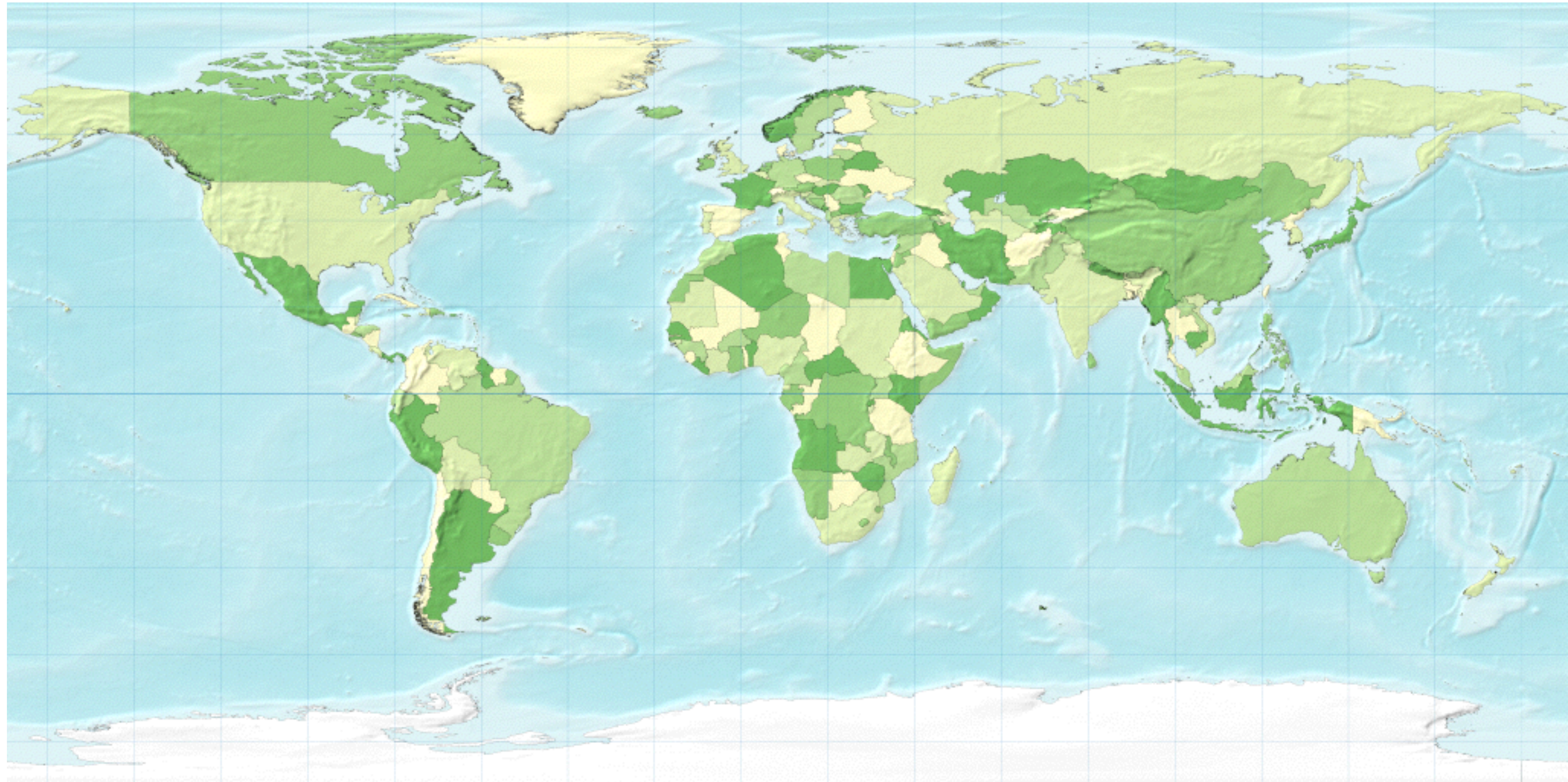
Attendance per State, 1970 - 1977

Source: Stanley, David E., with Frank Coffey. The Elvis Encyclopedia. Santa Monica, CA.: General Publishing Group, Inc , 1994.

© 1995 Andrew Dent and Linda Turnbull

Dent, "Cartography"
Based on slide from Hanrahan

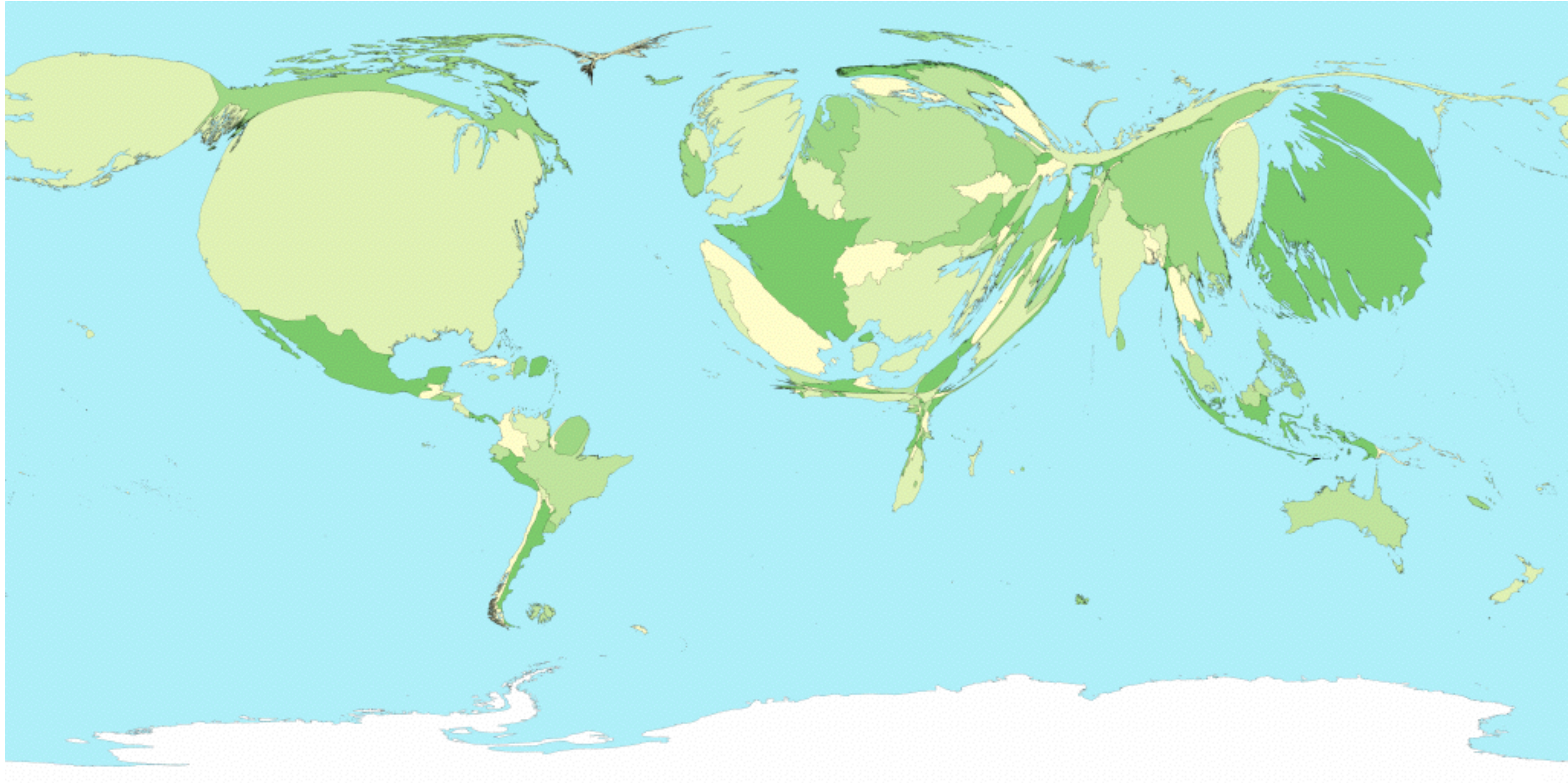
The World



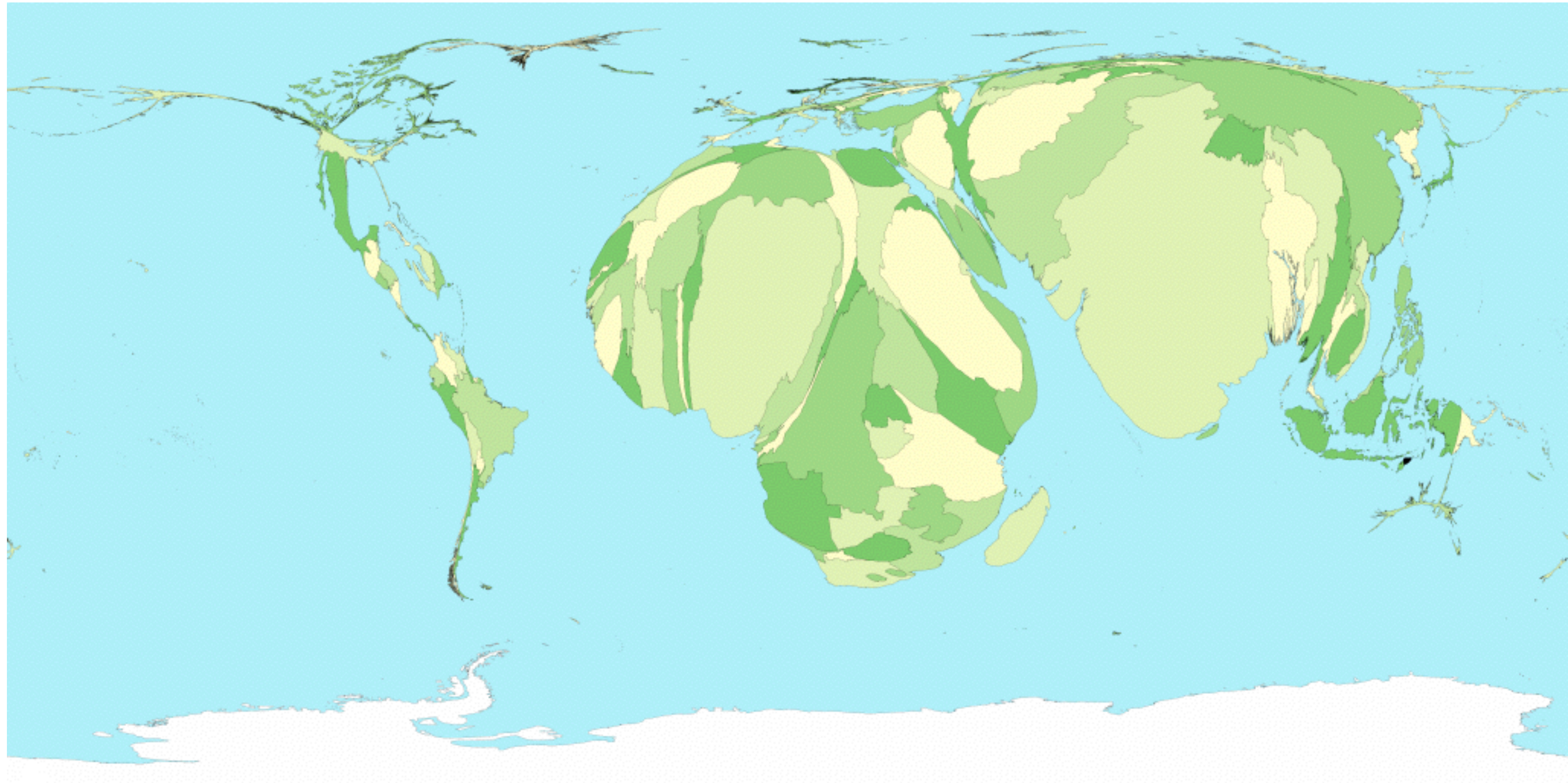
Population



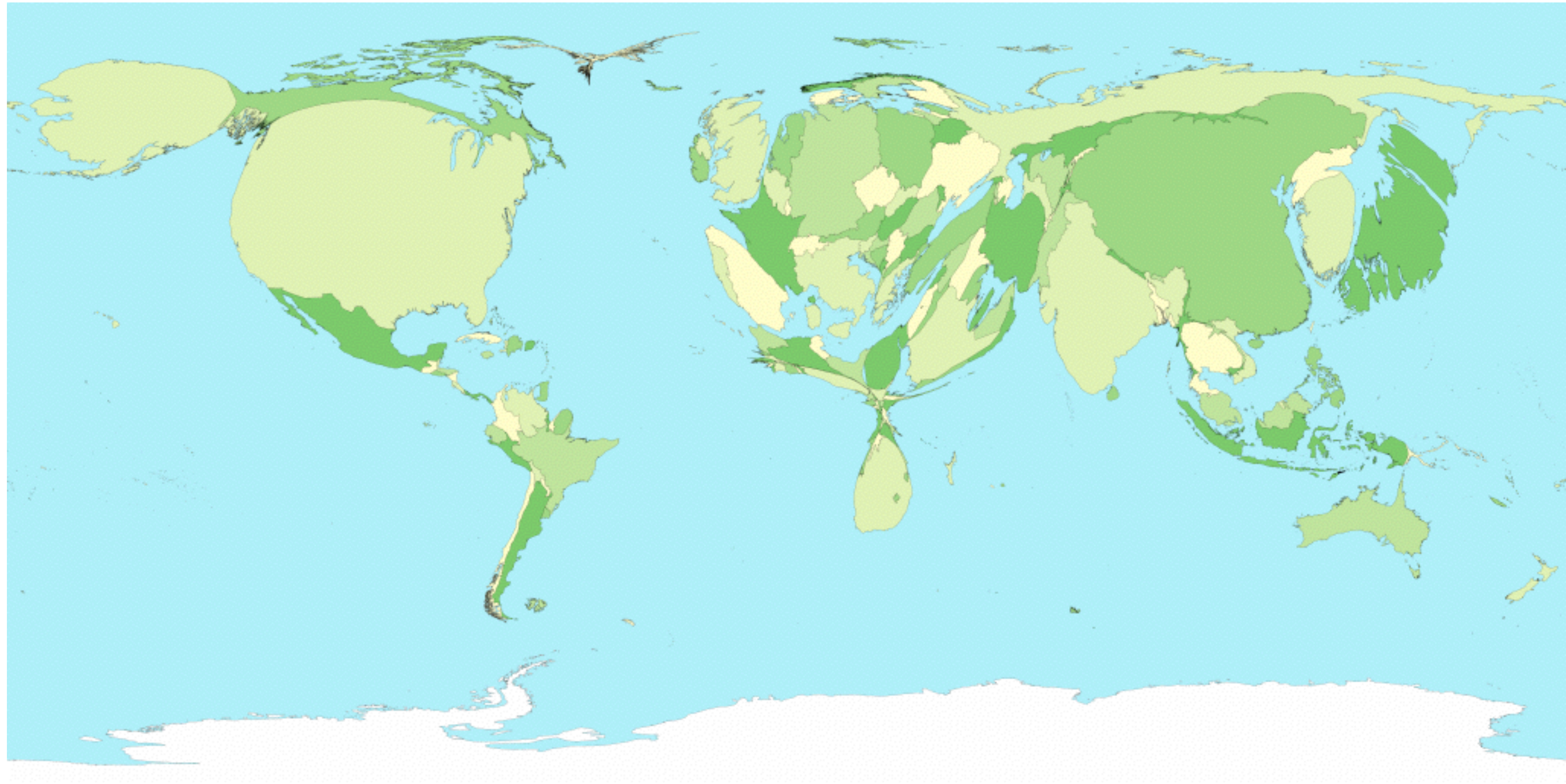
GDP



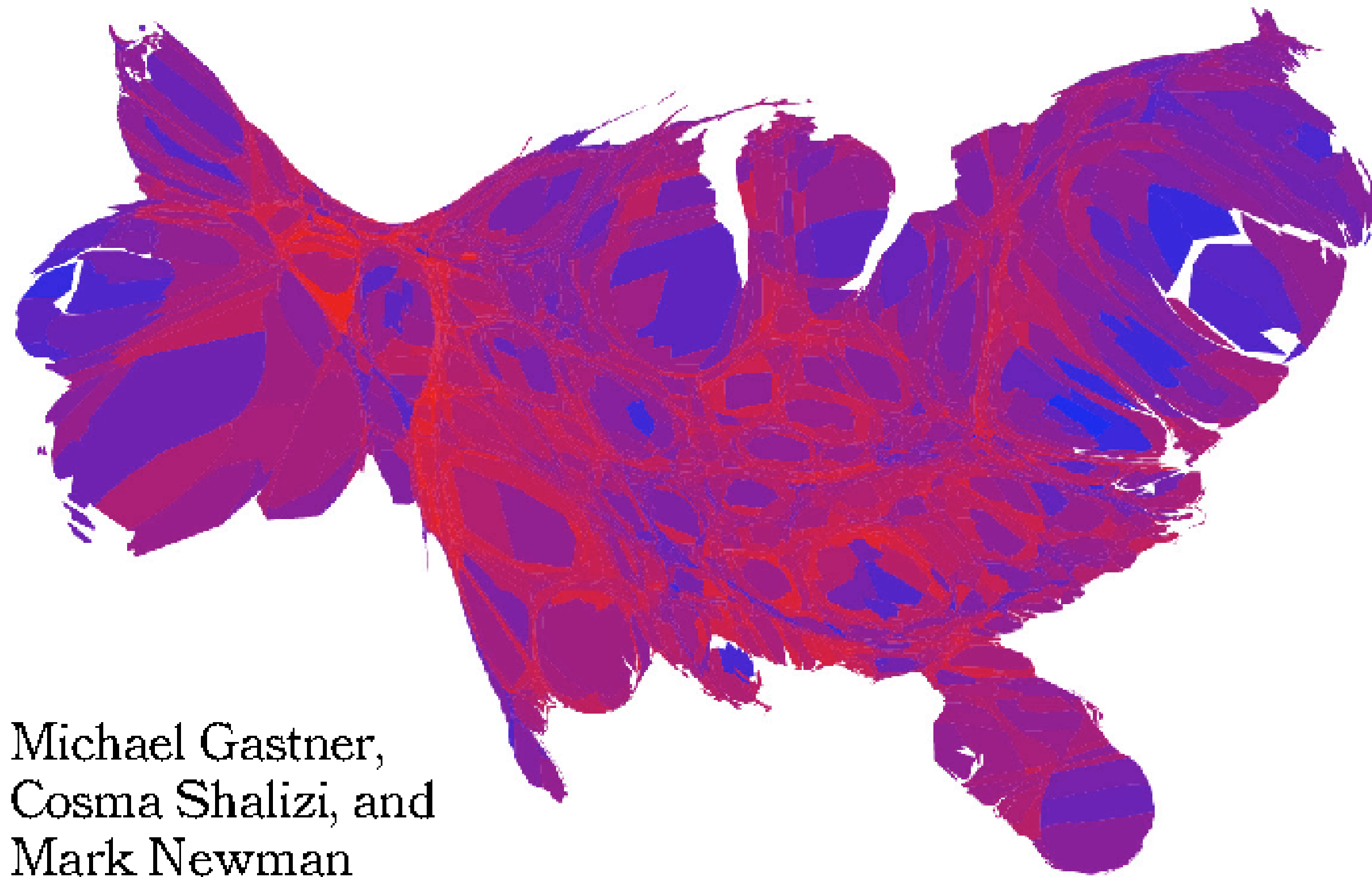
Child Mortality



Greenhouse Emissions

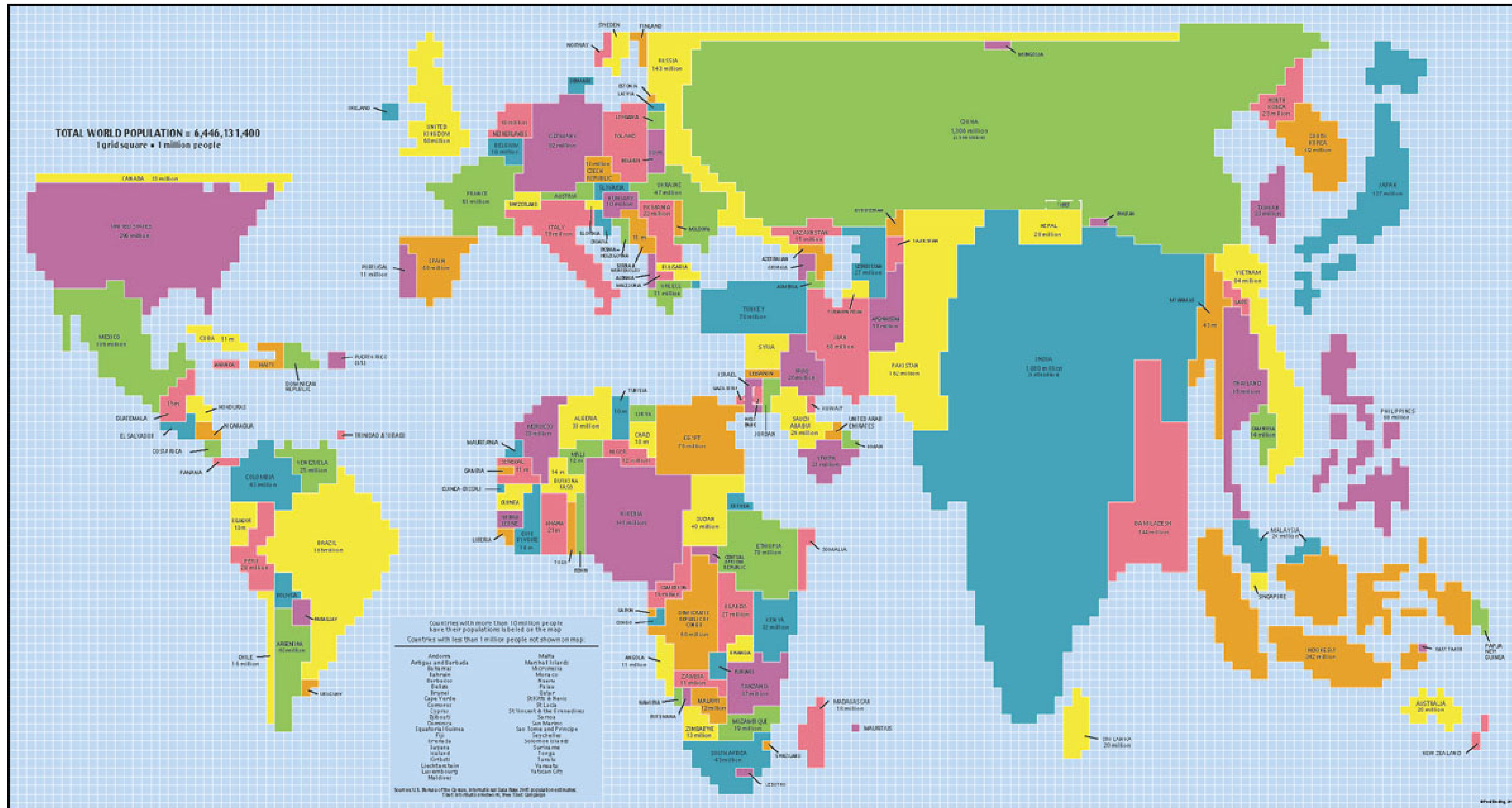


Kerry vs. Bush 2004



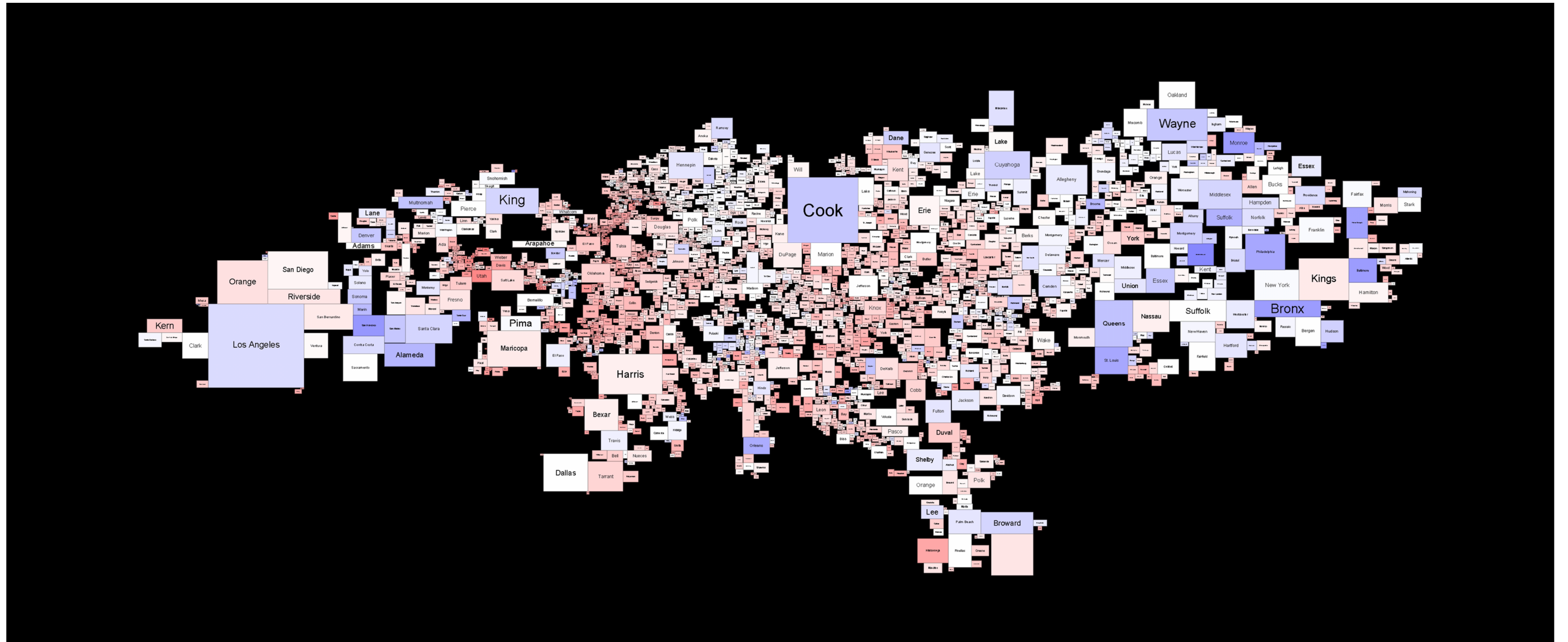
Michael Gastner,
Cosma Shalizi, and
Mark Newman
University of Michigan

Rectangular Cartograms

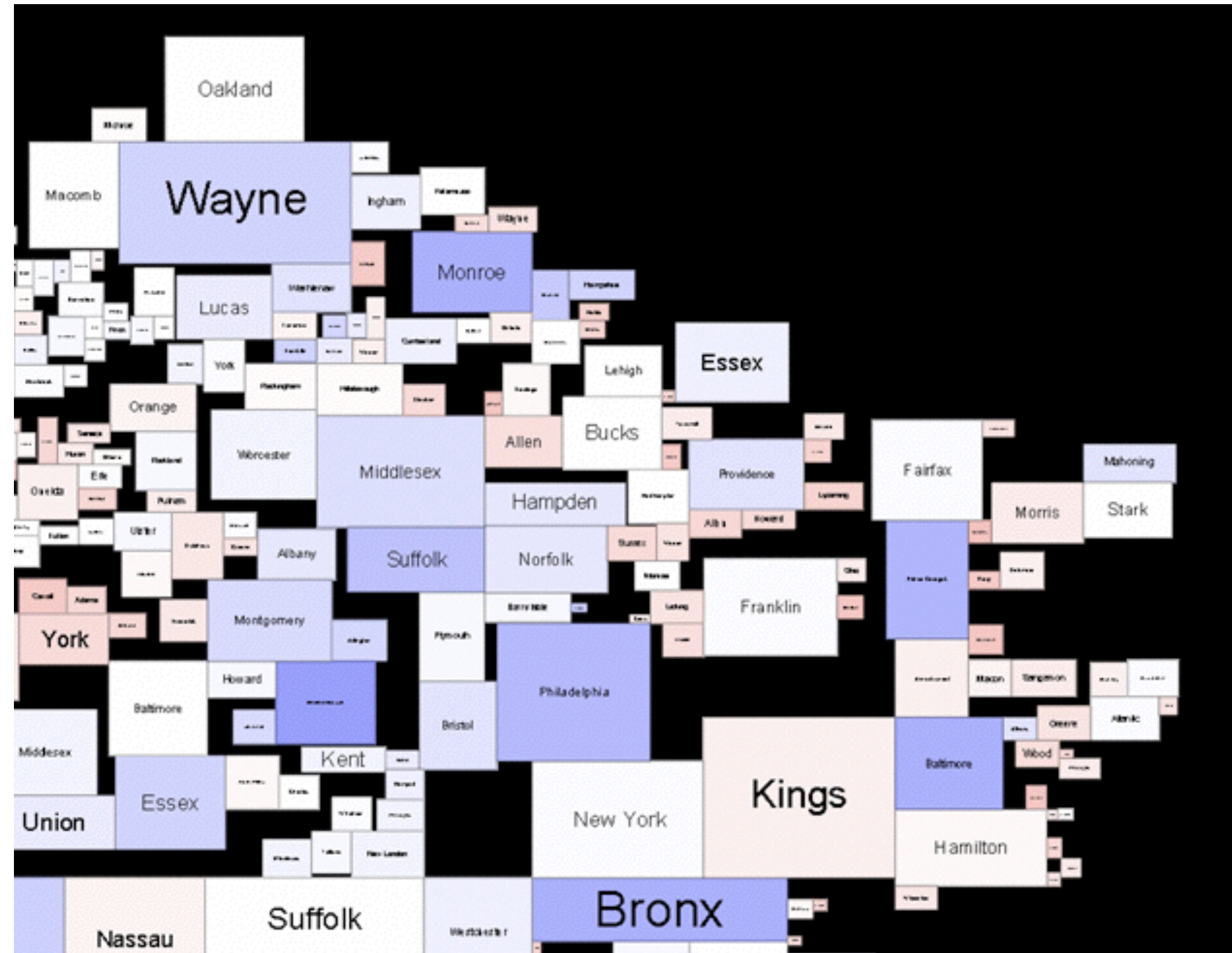


World Population Cartogram Poster Drawn by Hand

Bush vs. Kerry, 2004



Heilman, Keim, Panse, Sips,
“RecMap: Rectangular Map
Approximations”
Based on image from Keim



Heilman, Keim, Panse, Sips,
“RecMap: Rectangular Map
Approximations”
Based on image from Keim

September 4, 2008

 E-MAIL | [FEEDBACK](#)

What Your Global Neighbors Are Buying

How people spend their discretionary income – the cash that goes to clothing, electronics, recreation, household goods, alcohol – depends a lot on where they live. People in Greece spend almost 13 times more money on clothing as they do on electronics. People living in Japan spend more on recreation than they do on clothing, electronics and household goods combined. Americans spend a lot of money on everything. [Related Article](#)

CLOTHING & FOOTWEAR

ELECTRONICS

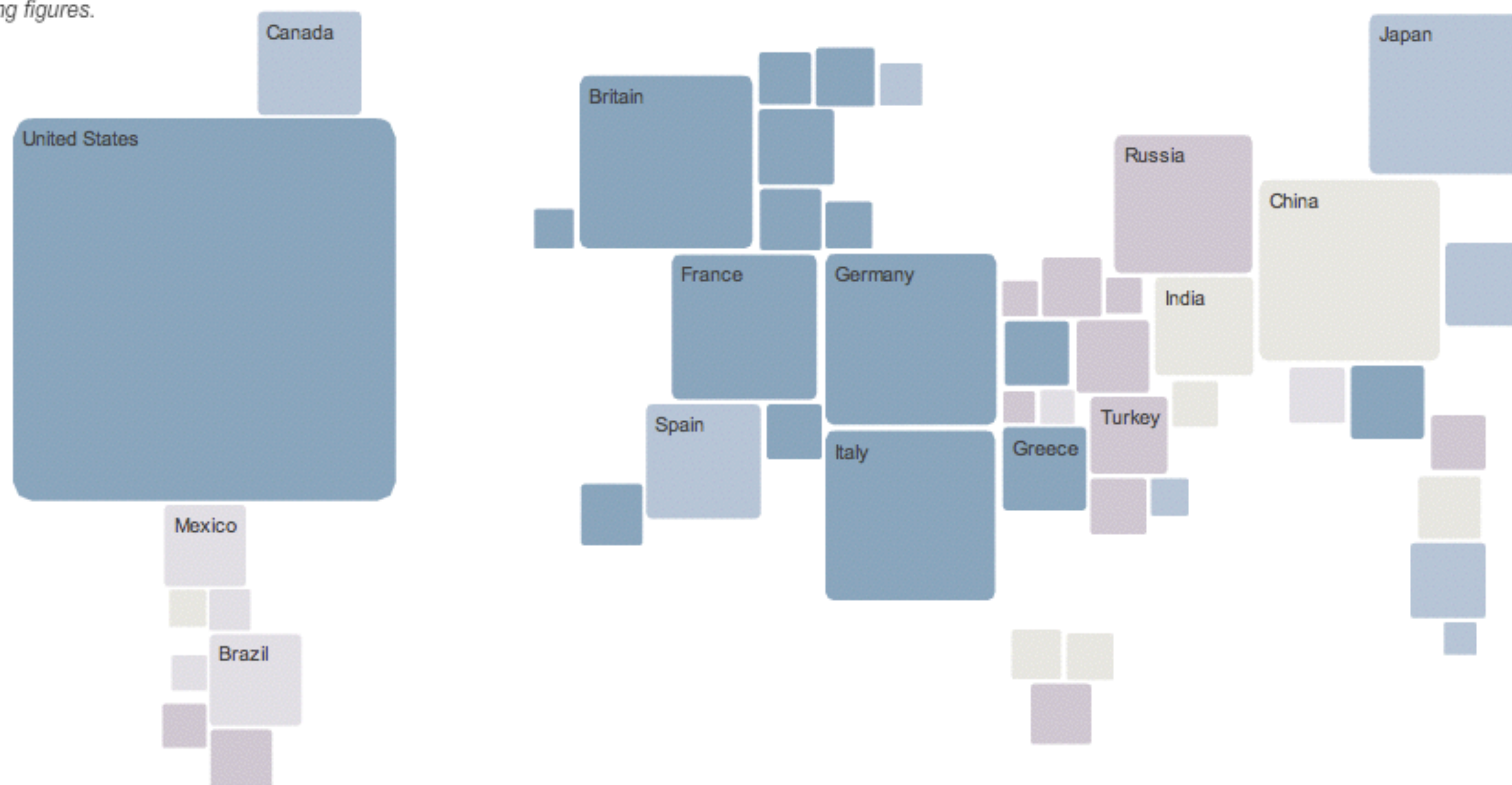
ALCOHOL & TOBACCO

HOUSEHOLD GOODS

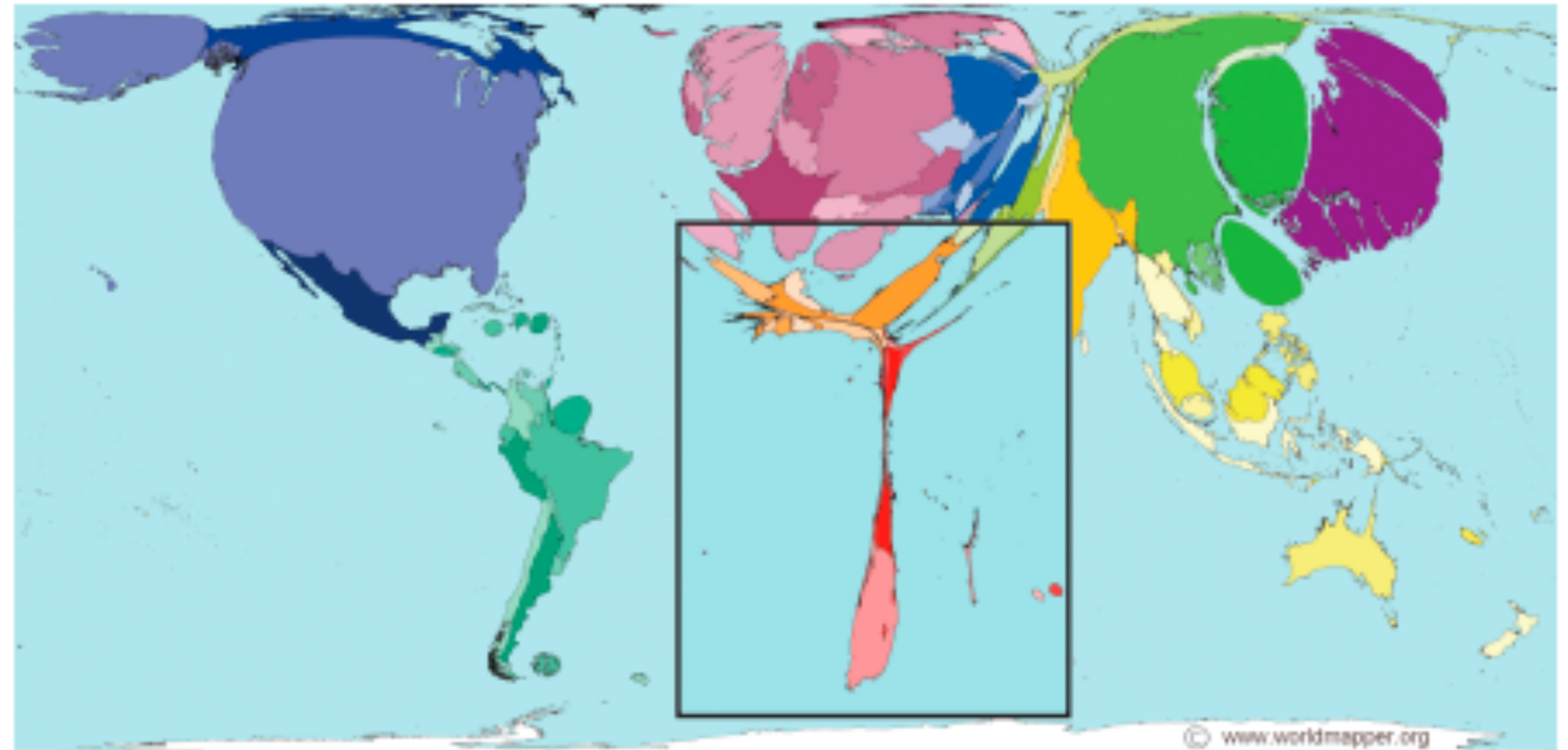
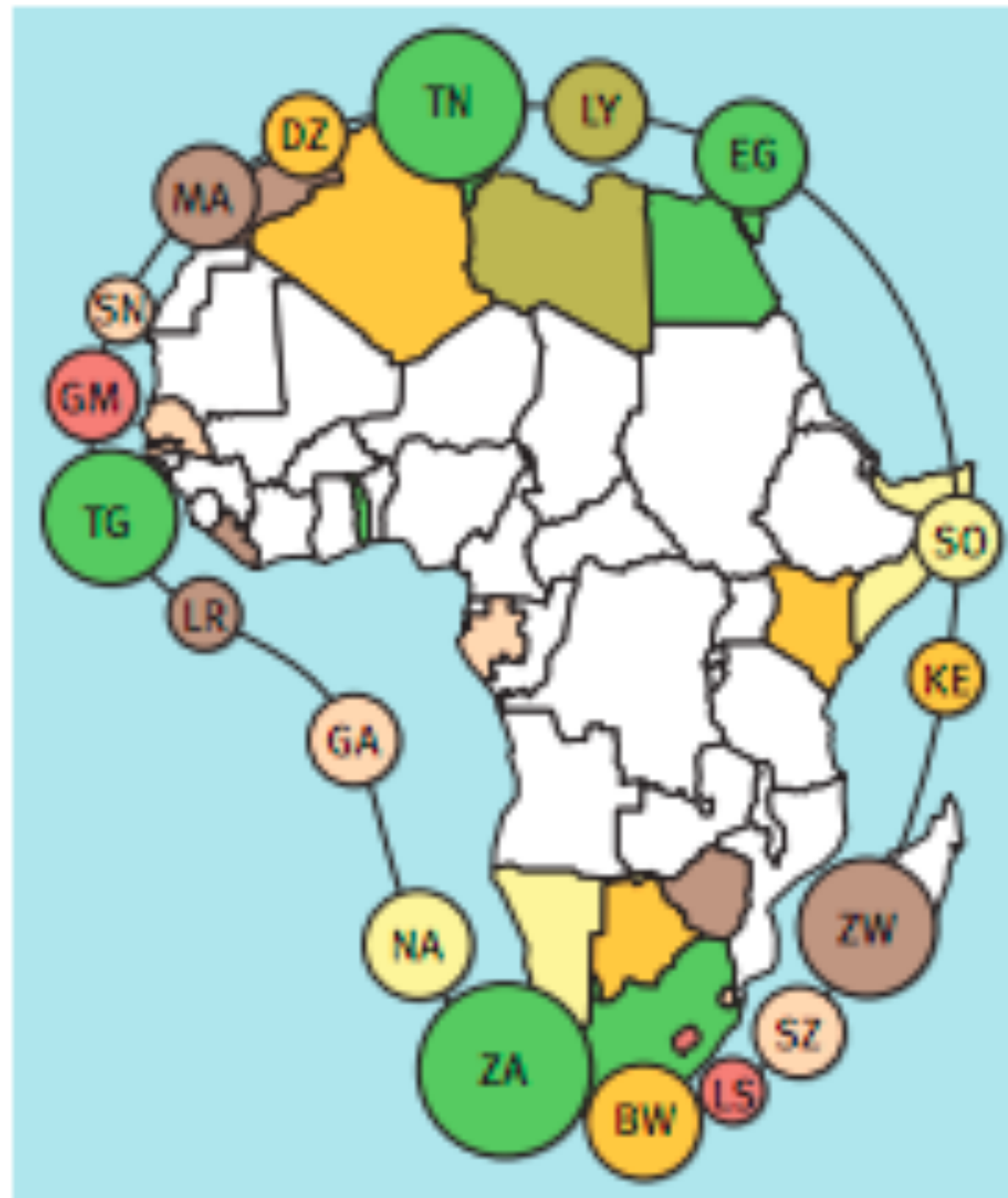
RECREATION

Boxes represent selected countries and are scaled according to total spending in 2007.

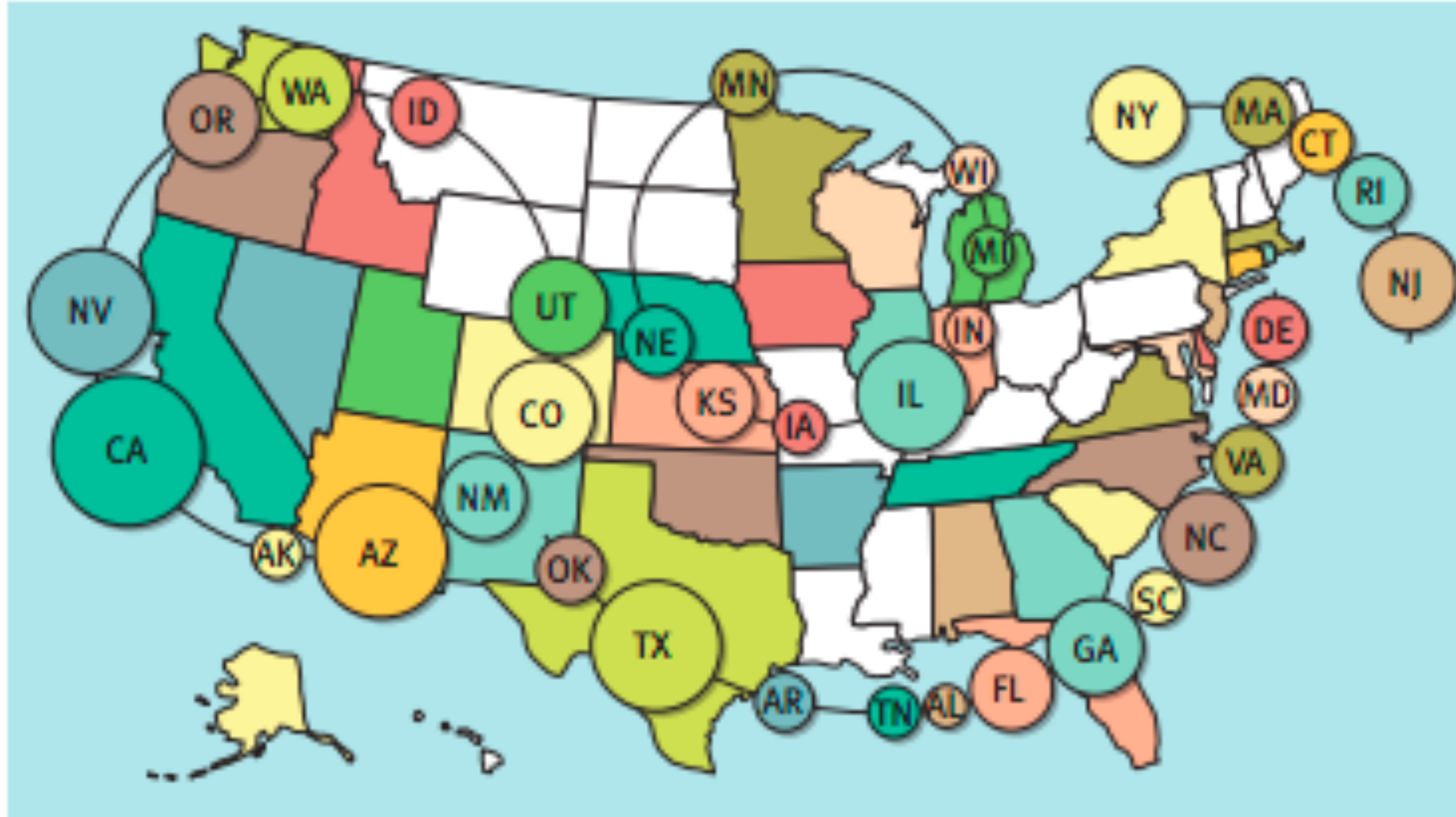
Roll over countries to see spending figures.



Necklace Maps

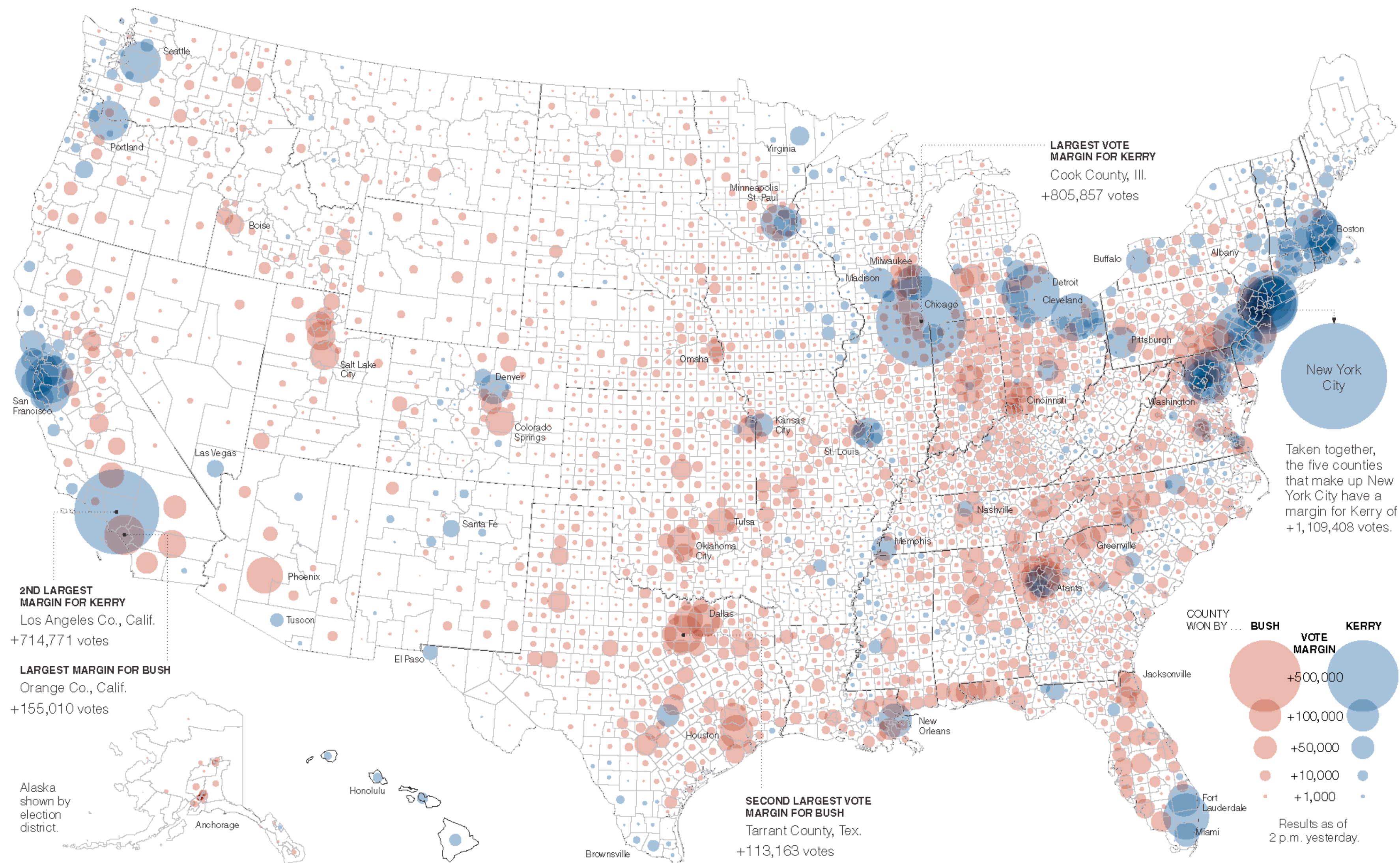


Internet Users in Africa



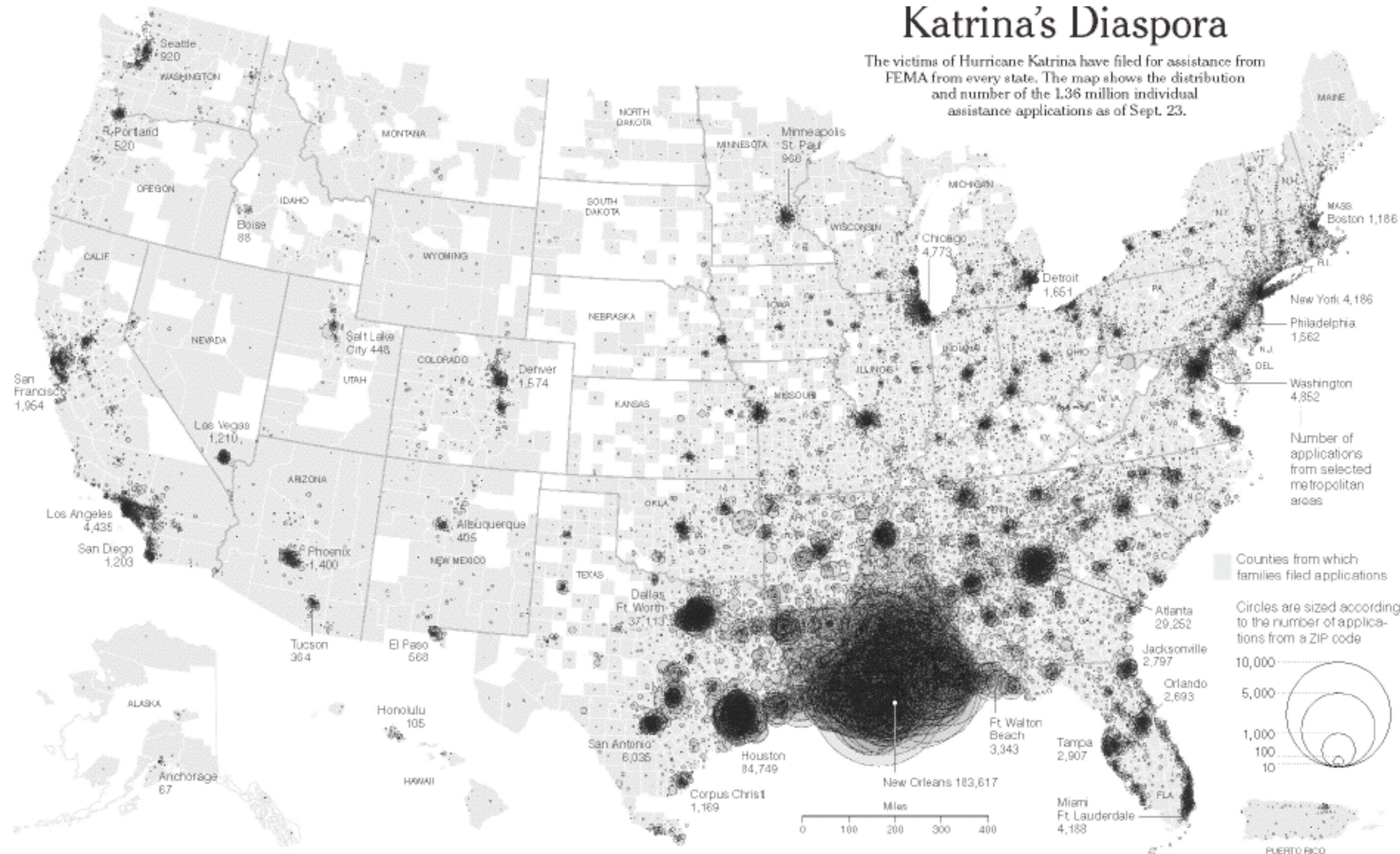
Illegal Immigrants in the US

Proportional Symbol Maps



Katrina's Diaspora

The victims of Hurricane Katrina have filed for assistance from FEMA from every state. The map shows the distribution and number of the 1.36 million individual assistance applications as of Sept. 23.



They are scattered through all 50 states, the District of Columbia and Puerto Rico — 623 in Utah, 1,114 in Kansas, 101 way out in Alaska. They are clustered by the thousands in large Southern cities like Dallas, Atlanta and Memphis, and huddled in handfuls in unlikely hamlets like Shell Knob, Mo. (pop. 1,393) and Fountain Run, Ky. (pop. 236).

Evacuees fled Hurricane Katrina and the floods that followed in caravans of cars and fleets of buses, on helicopters and

emerges of where they landed, based on ZIP codes from which applications for aid were submitted to the Federal Emergency Management Agency as of Sept. 23.

Of 1,356,704 applications, 86 percent came from Louisiana, Mississippi, Texas and Alabama. But 35,539 families were more than 1,000 miles from the Gulf — among the farthest: one in Nome, Alaska, 3,931 miles from the French Quarter and another in Lihue, Hawaii, 4,279 miles away.

Residents of New Orleans, a city that

centers. On average, the applicants came from counties where blacks were 28 percent of the population, more than twice the national average.

Baton Rouge, La., appears to be temporary home to 10 percent of evacuees, Houston 6.25 percent. But after the top 18 hubs, applicants are spread like the wind that whipped through their old neighborhoods: none of the other 900-plus metropolitan areas has even 1 percent of the total.

Some 4,000 ZIP codes — among them

Applications by state

Louisiana	523,149	38.6%
Mississippi	383,840	28.3%
Texas	156,895	11.6%
Alabama	109,469	8.1%
Georgia	35,342	2.6%
Florida	31,005	2.3%
Tennessee	15,529	1.1%
Arkansas	11,027	0.8%
California	10,953	0.8%
Illinois	4,400	0.3%

Applications by distance from New Orleans

MILES	APPLICANTS	PCT.
0-100	626,232	46.2%
100-200	338,080	24.9%
200-400	184,169	13.6%
400-800	143,497	10.6%
800-1,600	45,371	3.3%
1,600-3,200	13,403	1.0%
3,200+	232	0.0%

Distances could not be calculated for 0.4 percent of applications.

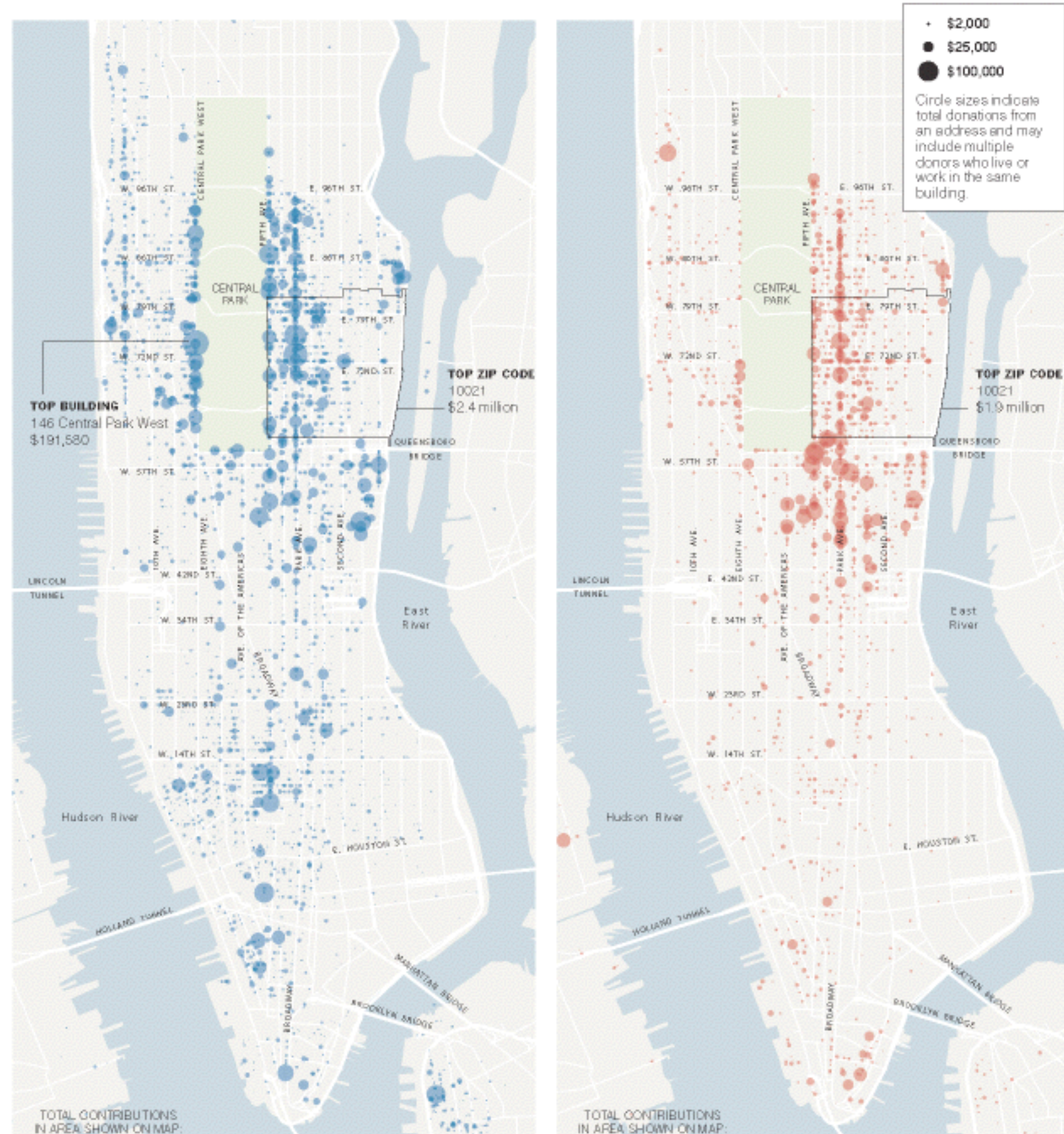
JOHN KERRY
and the Democratic National Committee

Contributions to each
candidate and his party's
national committee

→ **GEORGE W. BUSH**
and the Republican National Committee

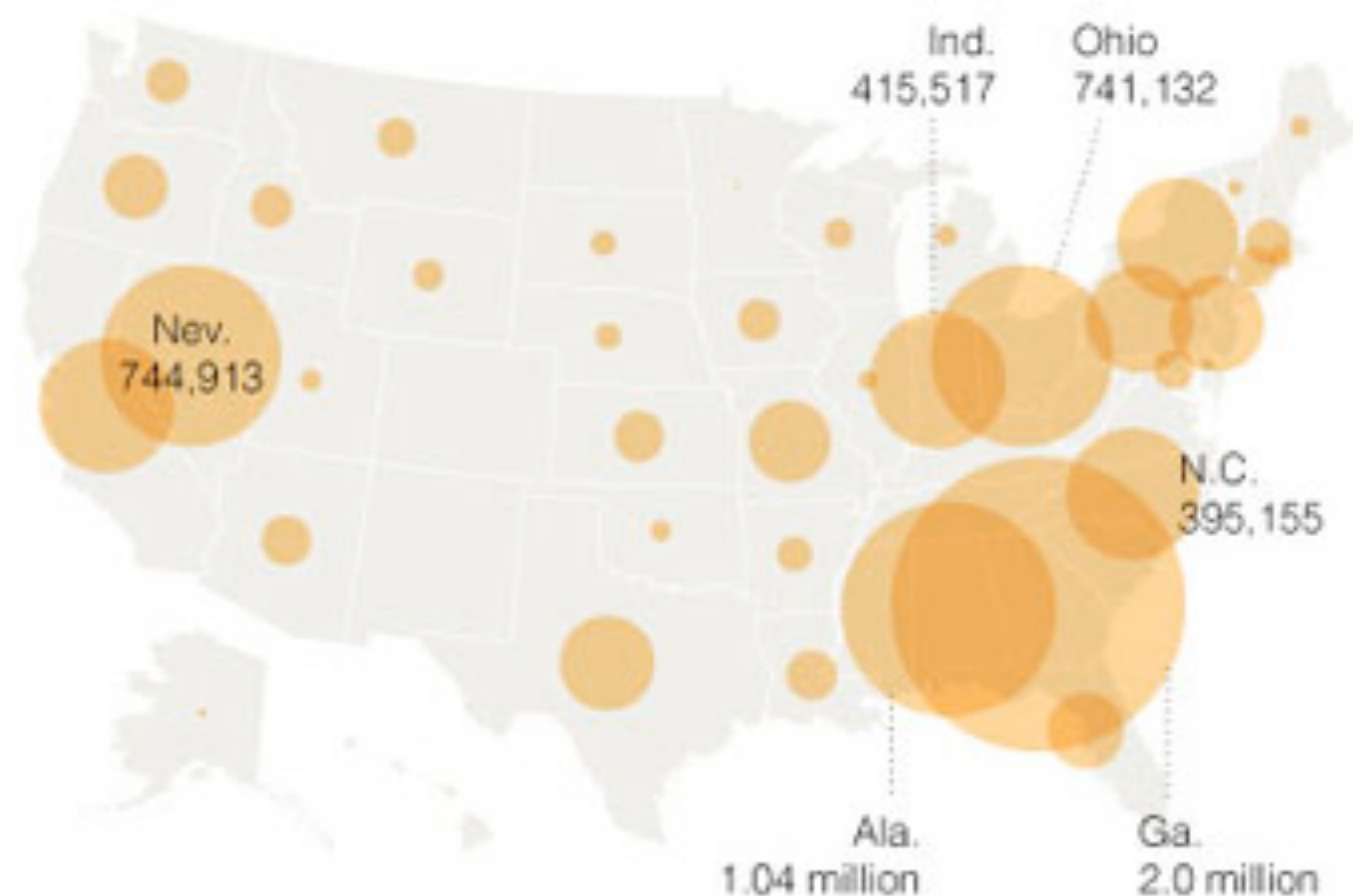
Manhattan

For both sides, the top ZIP code in the nation for contributions was 10021 on the Upper East Side. Mr. Kerry's appeal, however, was greater throughout much of the rest of Manhattan, bringing in more money than Mr. Bush and the R.N.C. in areas like the Upper West Side, Greenwich Village and SoHo.



Killer circles threaten America

- No sides
- Area equal to πr^2
- Extremely round
- Often fatal
- North Dakota, New Mexico, Colorado remain circle-free

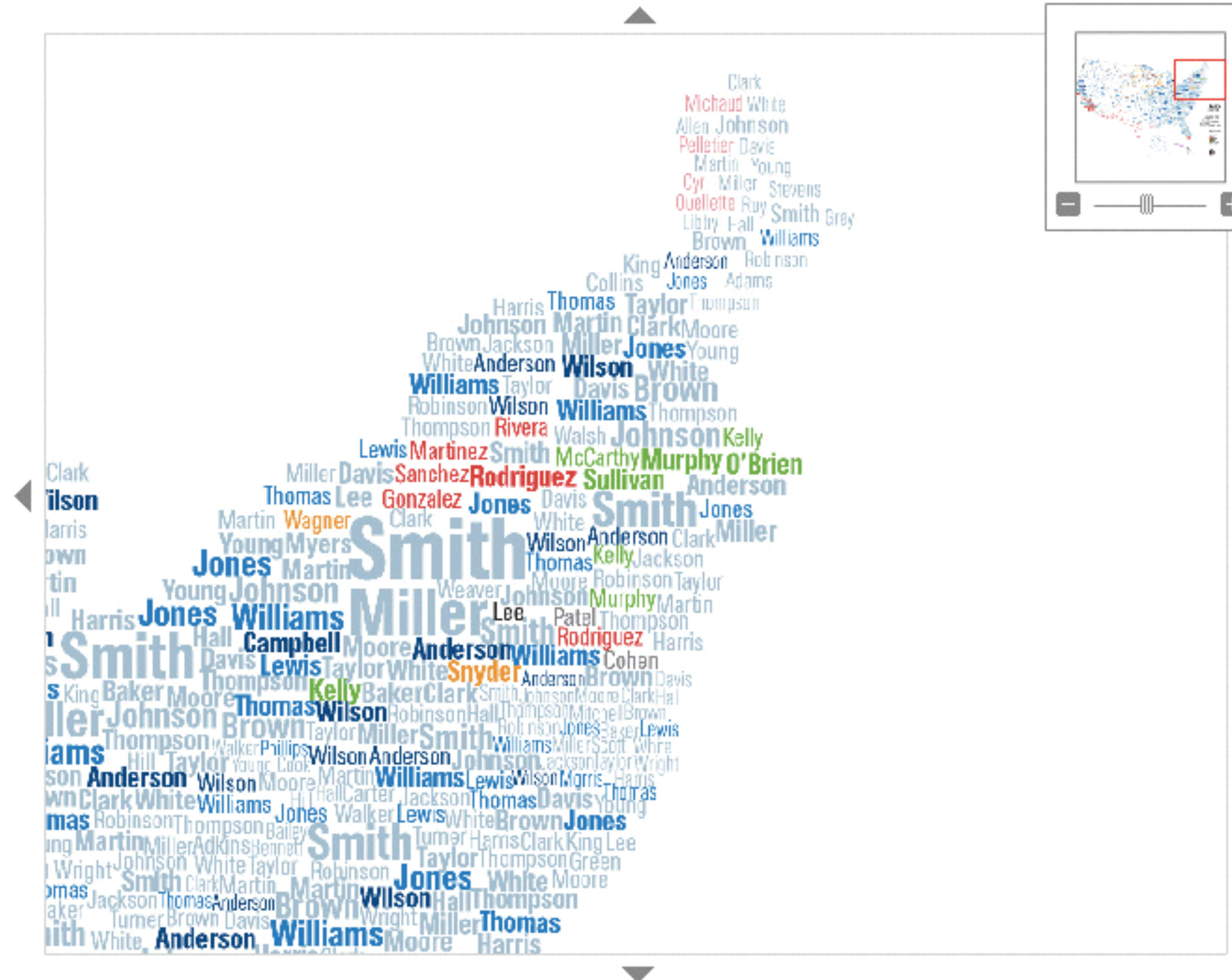


How are Americans reacting to the growing geometric menace?

What's in a Surname?

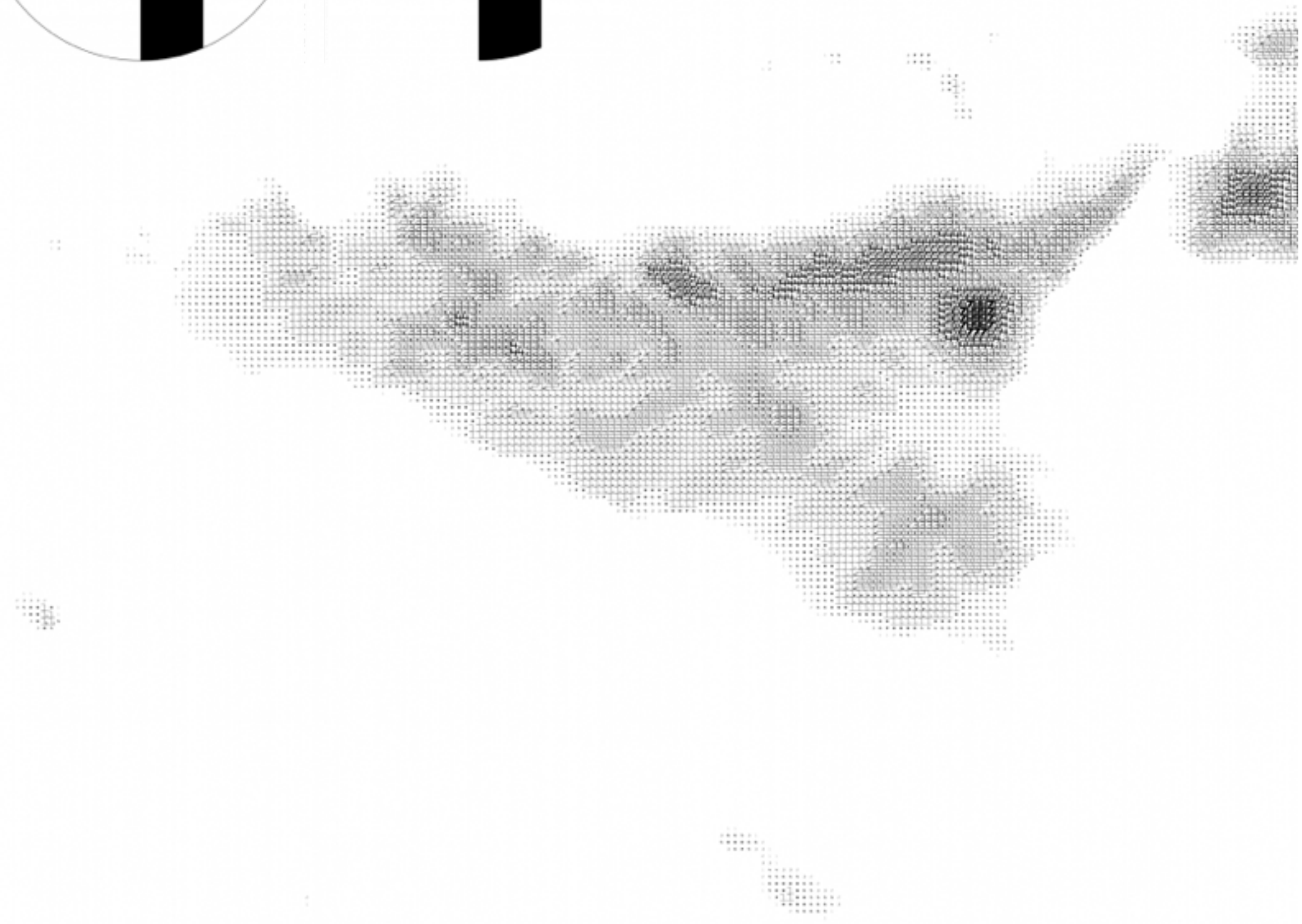
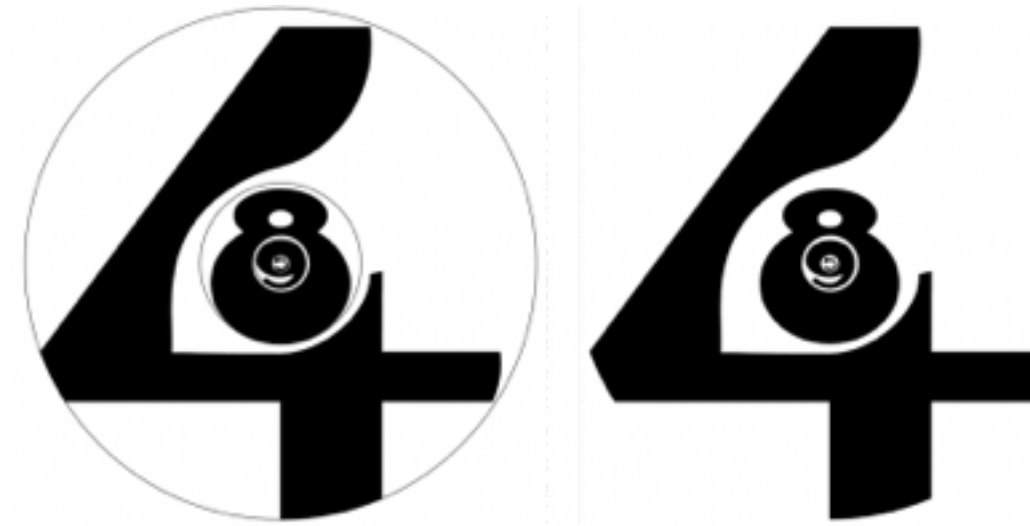
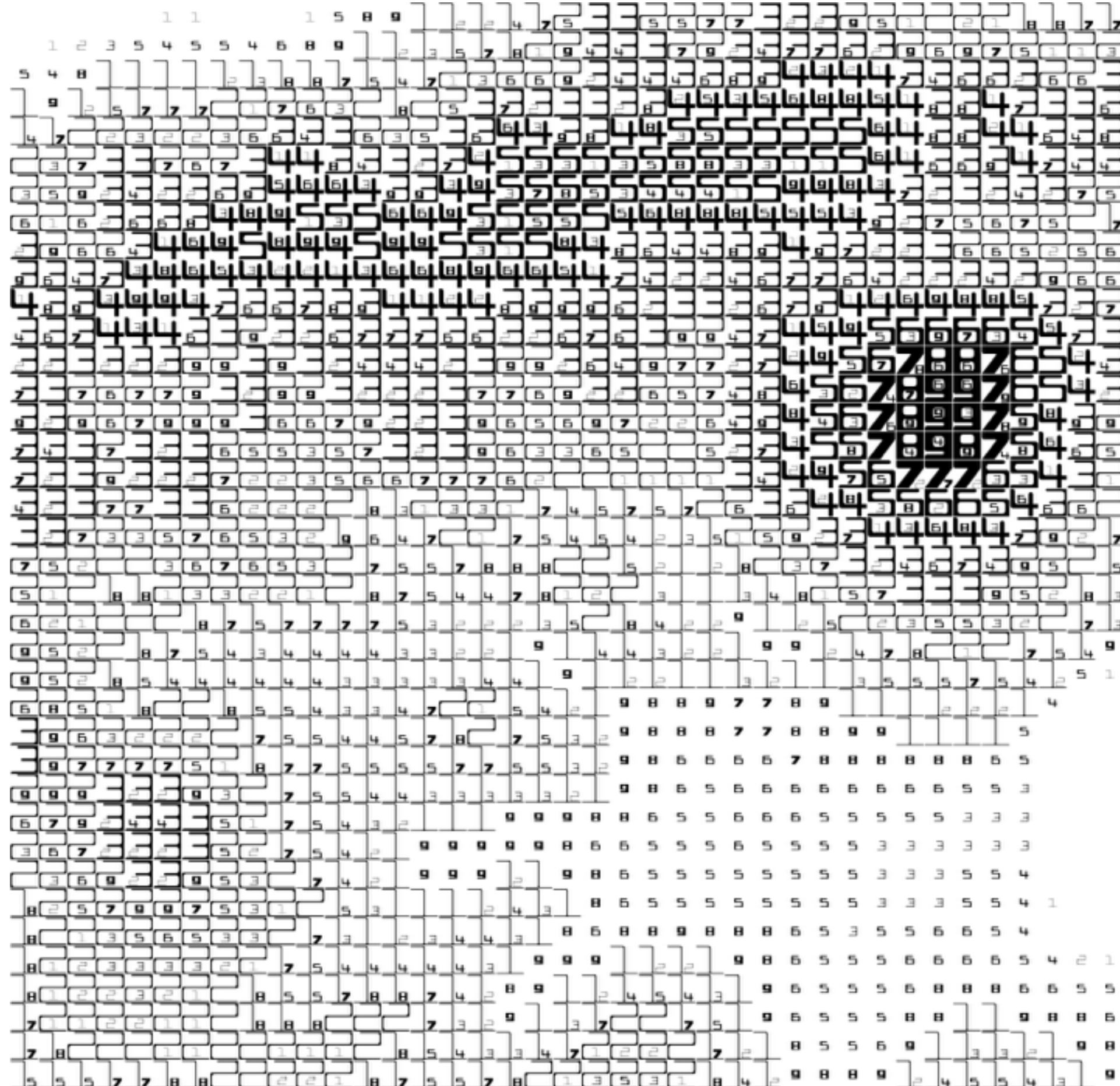
[Facebook](#) [Twitter](#) [More »](#)

America is a nation of Smiths, Johnsons, and Sullivans—but also of Garcias and Nguyens. Zoom in on the map below to see what surnames proliferate in your part of the country.



FatFonts

1 2 3 4 5 6 7 8 9

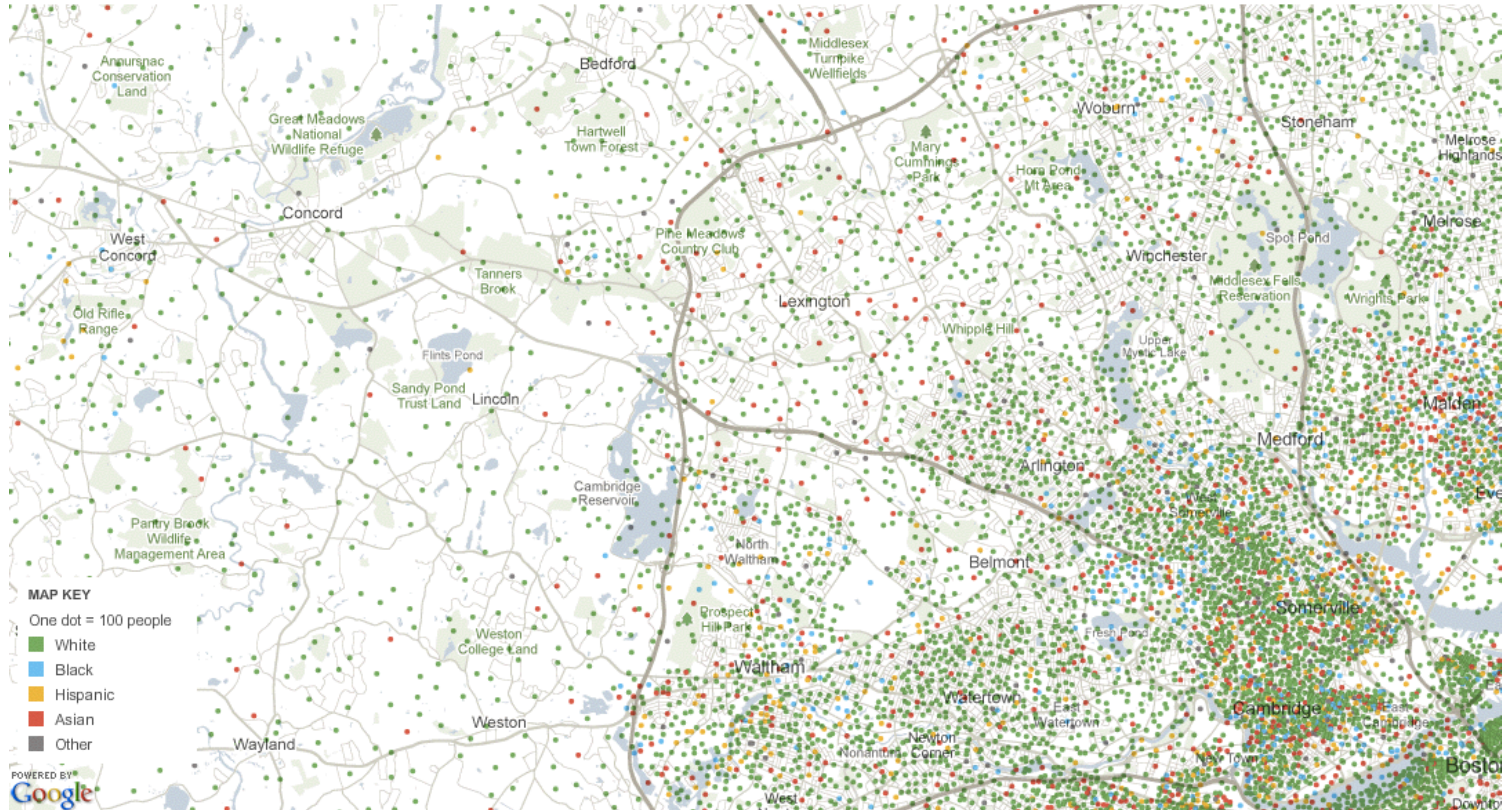


Mapping America: Every City, Every Block

Find s

Browse local data from the Census Bureau's American Community Survey, based on samples from 2005 to 2009. Because these figures are based on samples, they are subject to a margin of error, particularly in places with a low population, and are best regarded as estimates.

Distribution of racial and ethnic groups

[View More Maps](#)

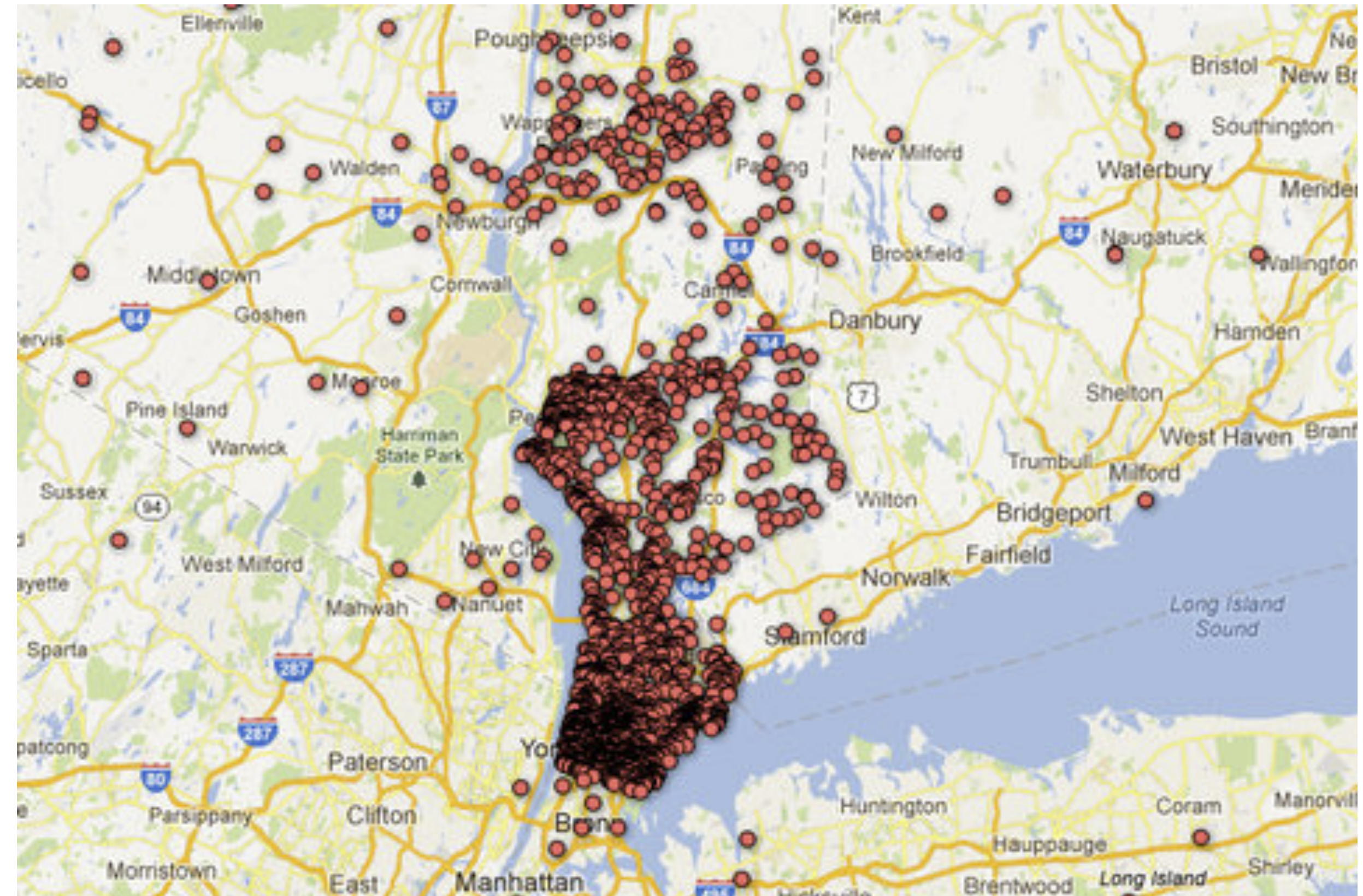
NYT, 2010

Visualizing Addresses of Gun Owners

Published after Connecticut school killings

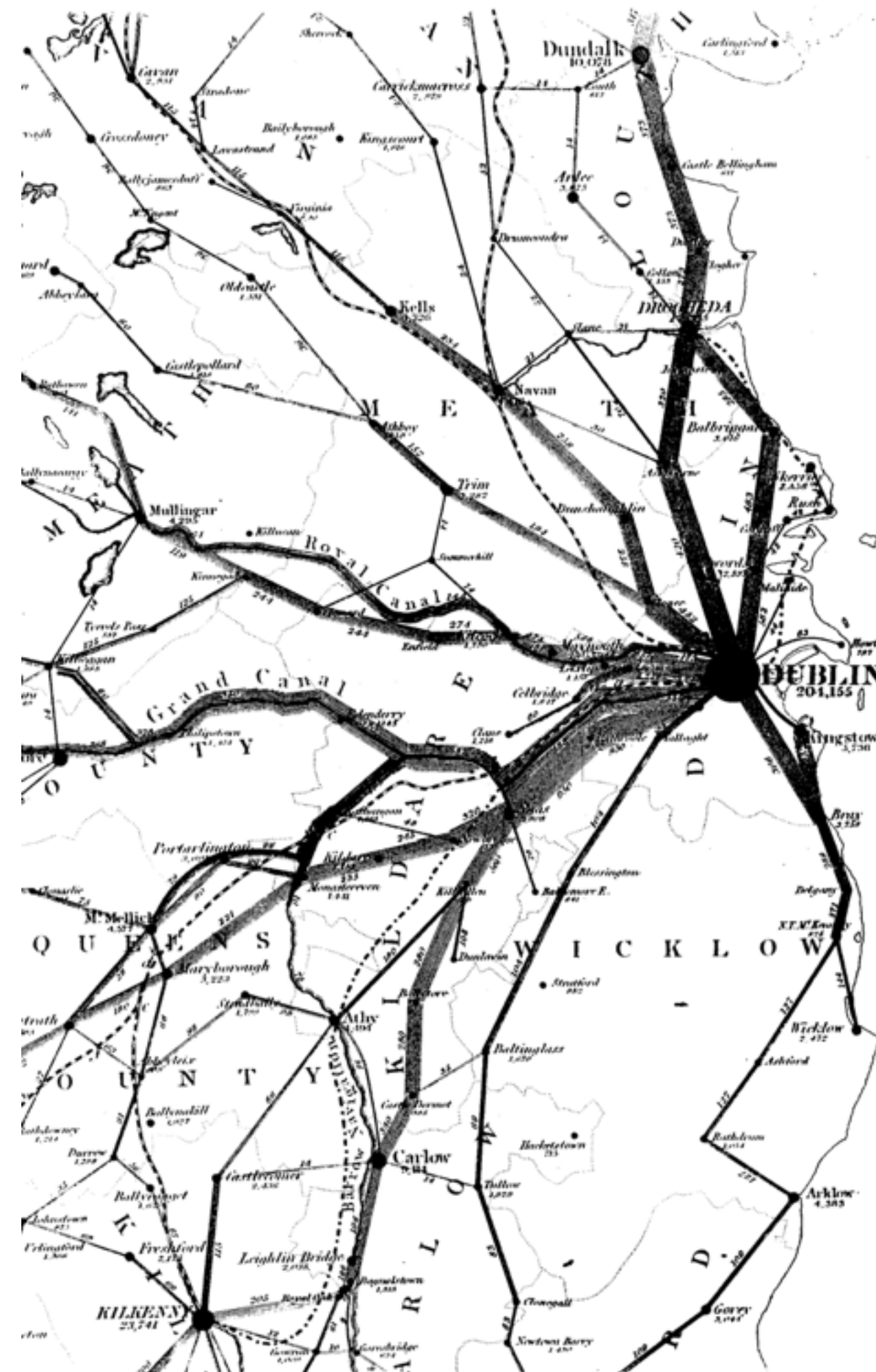
What are the ethics of visualization?

Data is public: is making it accessible problematic?



Flow Maps

Early Flow Map

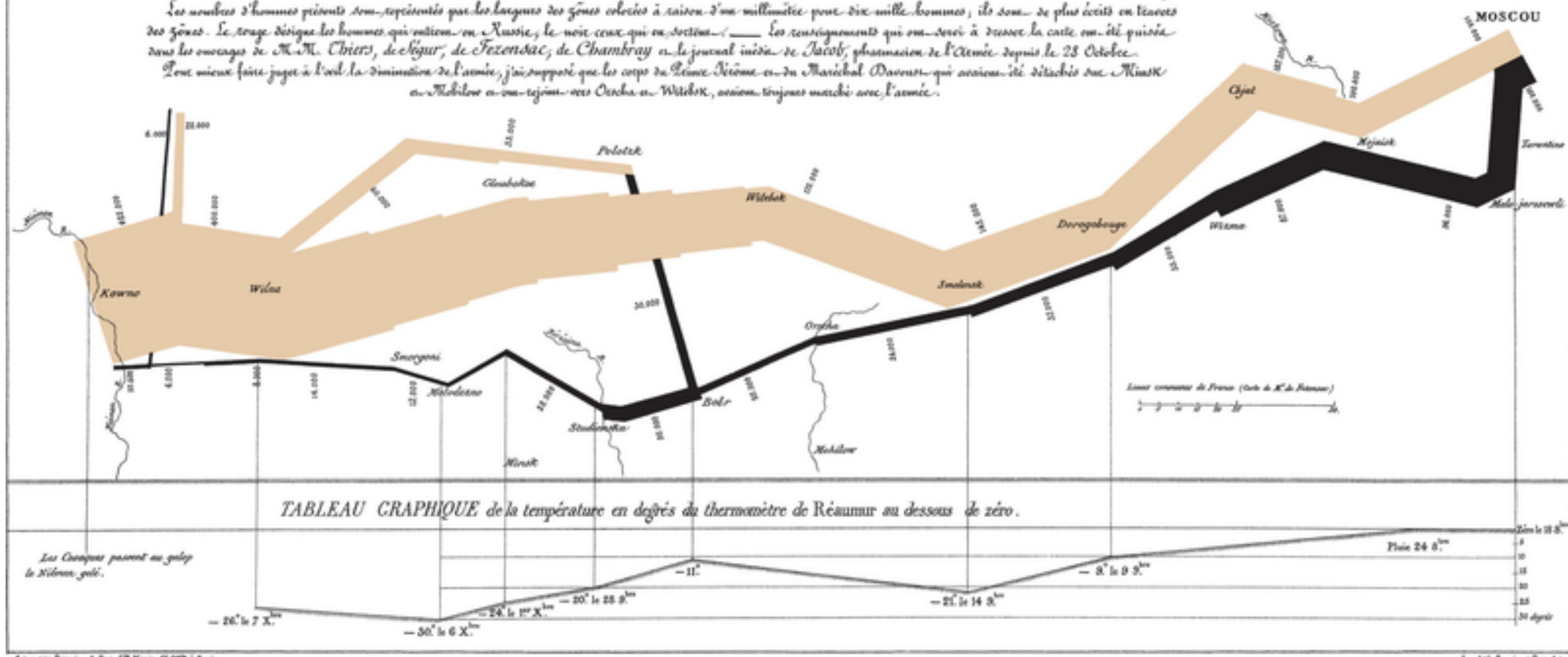


Transportation of Passengers
in Ireland
Henry Drury Harness, 1837

Carte Figurative des postes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.

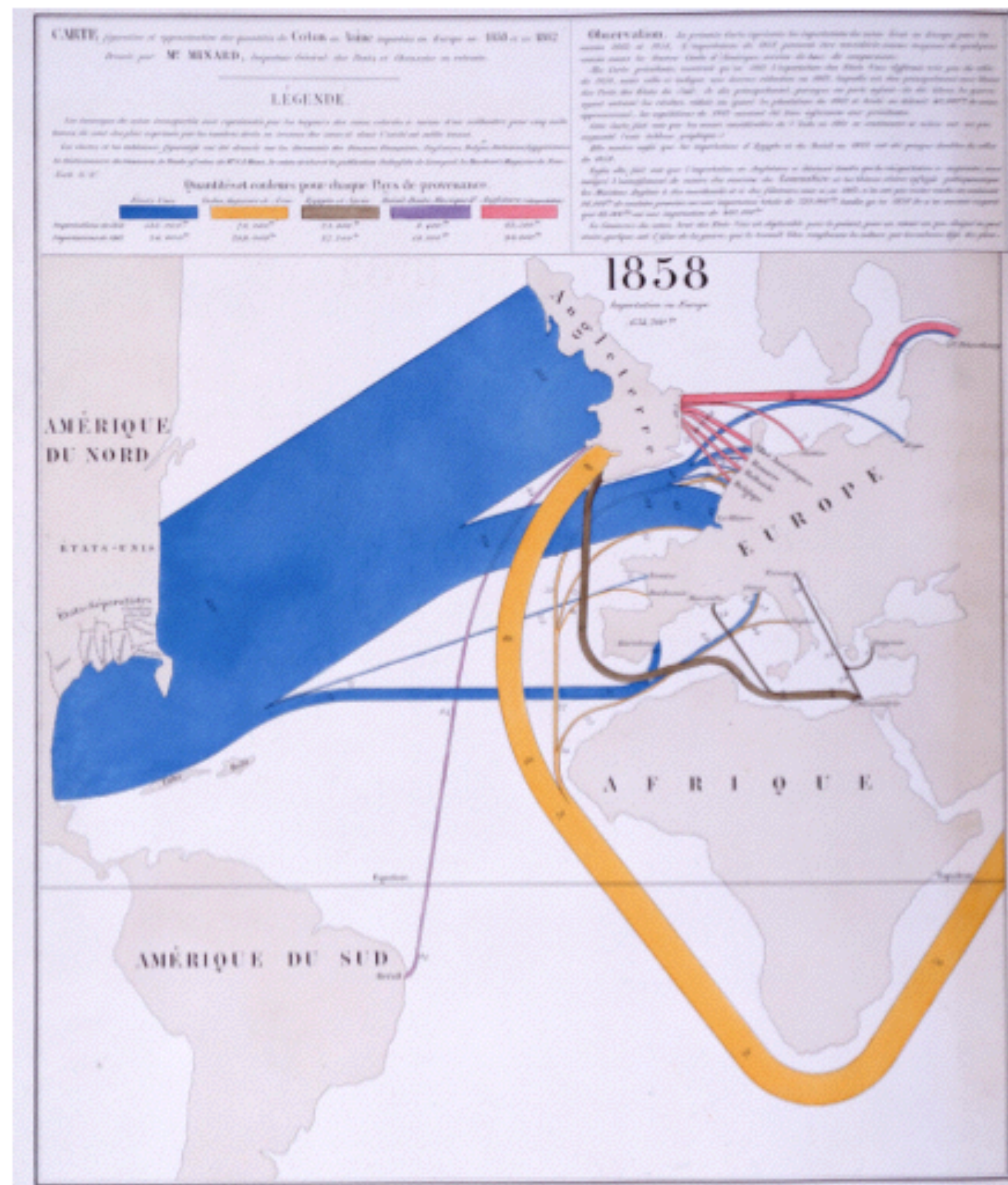
Reçu par M. Missard, Inspecteur Général des Ponts et Chaussées en retraite Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en lettres des zones. Le rouge désigne les hommes qui naissent en Russie, le noir ceux qui en sont nés. — Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. M. Chiers, de Léjard, de Fozensac, de Chambray et le journal indien de Jacob, pharmacien de l'armée depuis le 28 octobre. Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Jérôme et du Maréchal Davout qui avaient été détachés sur KIEV et MIELIKOÛ en ont rejoint avec ORSKA et WITIKOÛ, avaient toujours marché avec l'armée.



Effect of US Civil War on Cotton Trade

Before



After



11.5k

[f Share](#)

1.7k

[t Tweet](#)

440

[in Share](#)

4.8k

[su Submit](#)

385

[g +1](#)

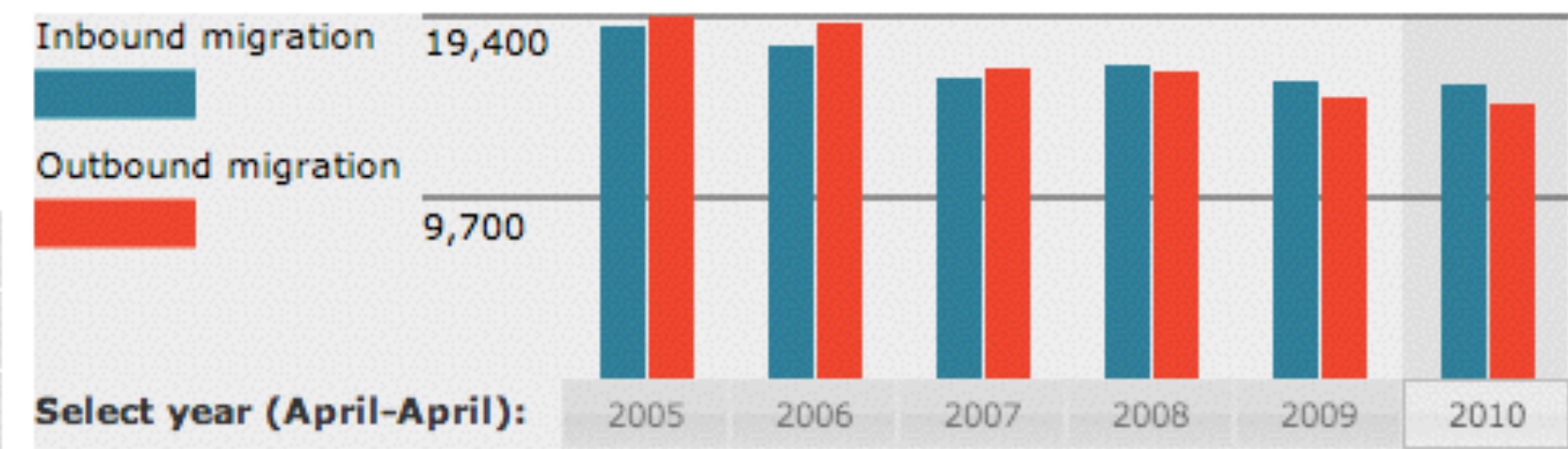
791

[reddit](#)

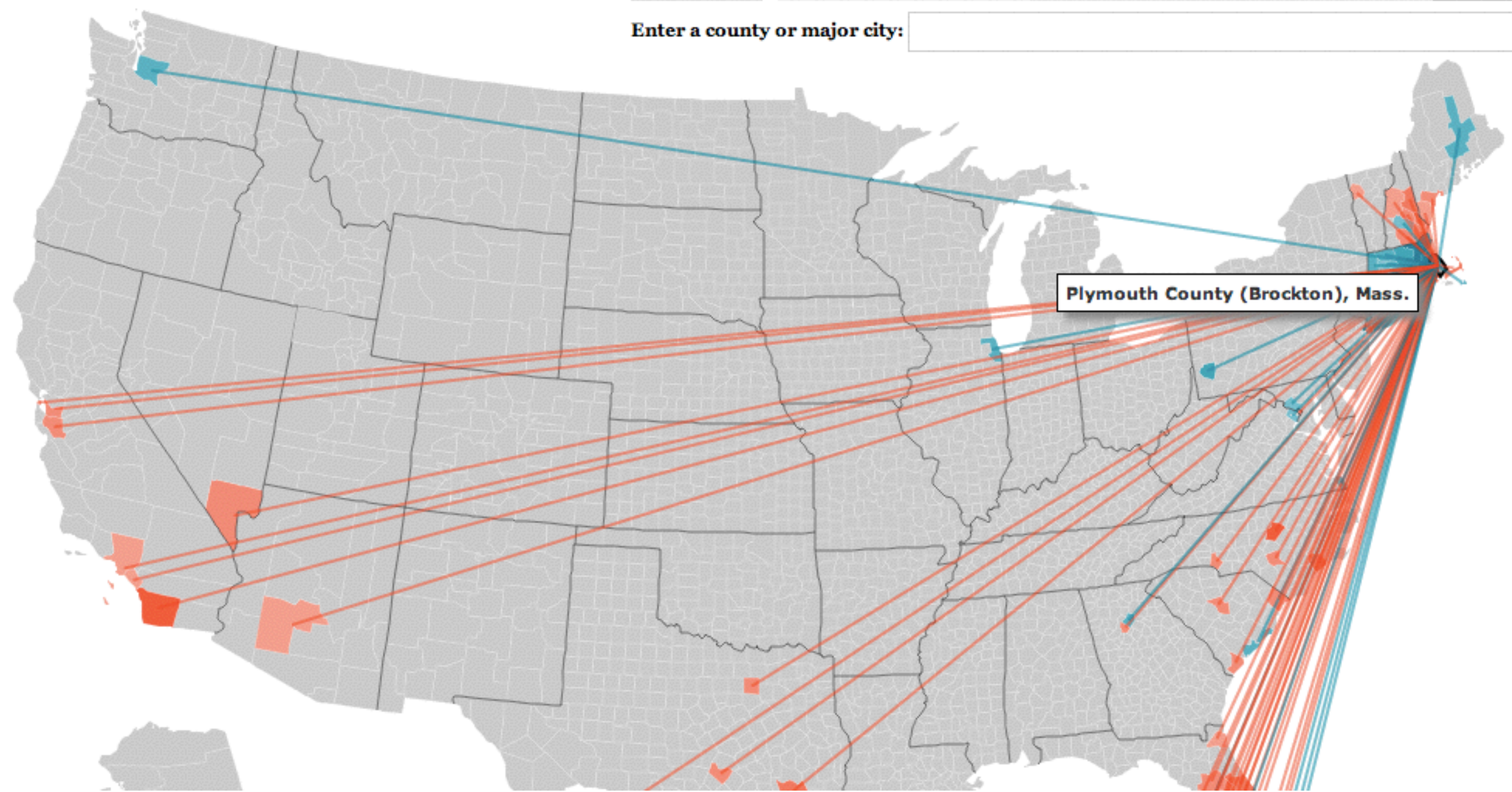
Plymouth County (Brockton), Mass.

Population (2010): 494,919
Population (2005): 486,292
Inbound income per cap. (2010): \$32,500
Outbound income per cap. (2010): \$29,300
Non-migrant income per cap. (2010): \$33,000

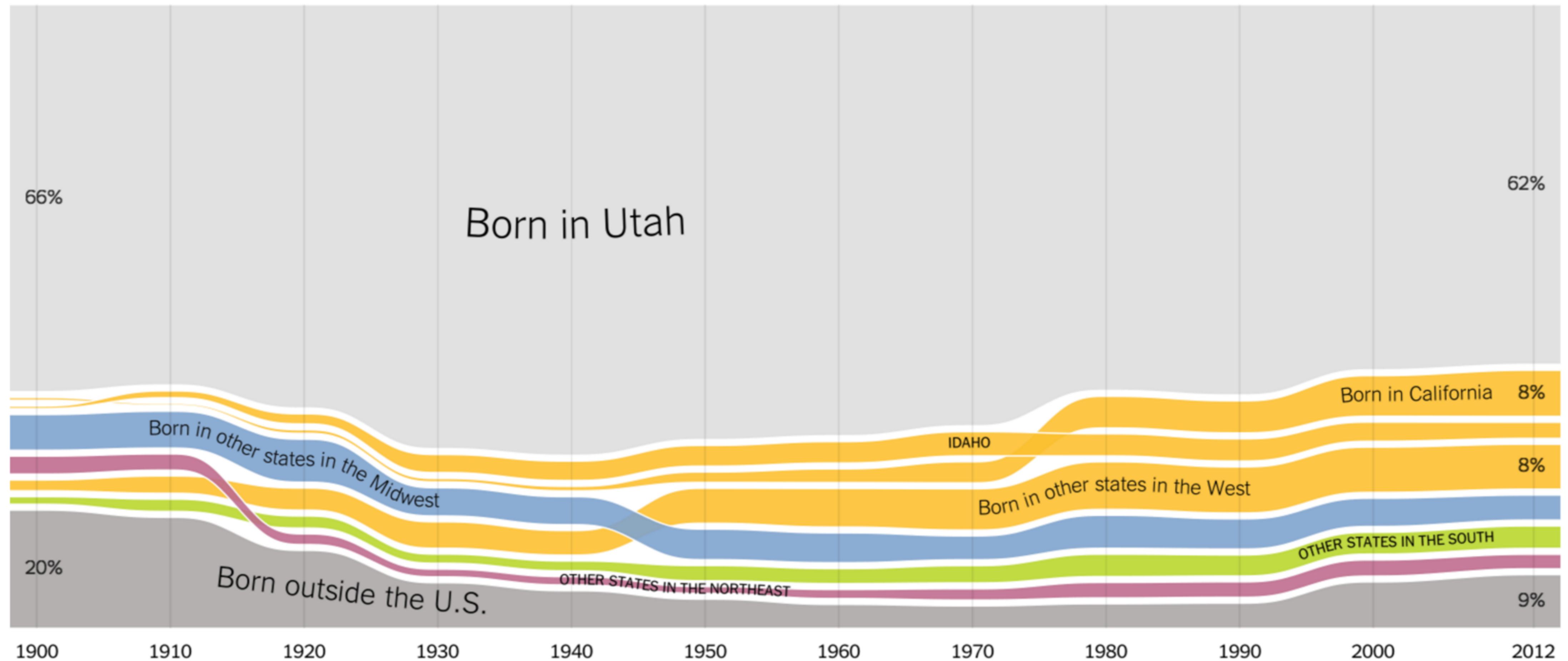
[Hide Lines](#)
[x Clear](#)
[Share](#)



Enter a county or major city:

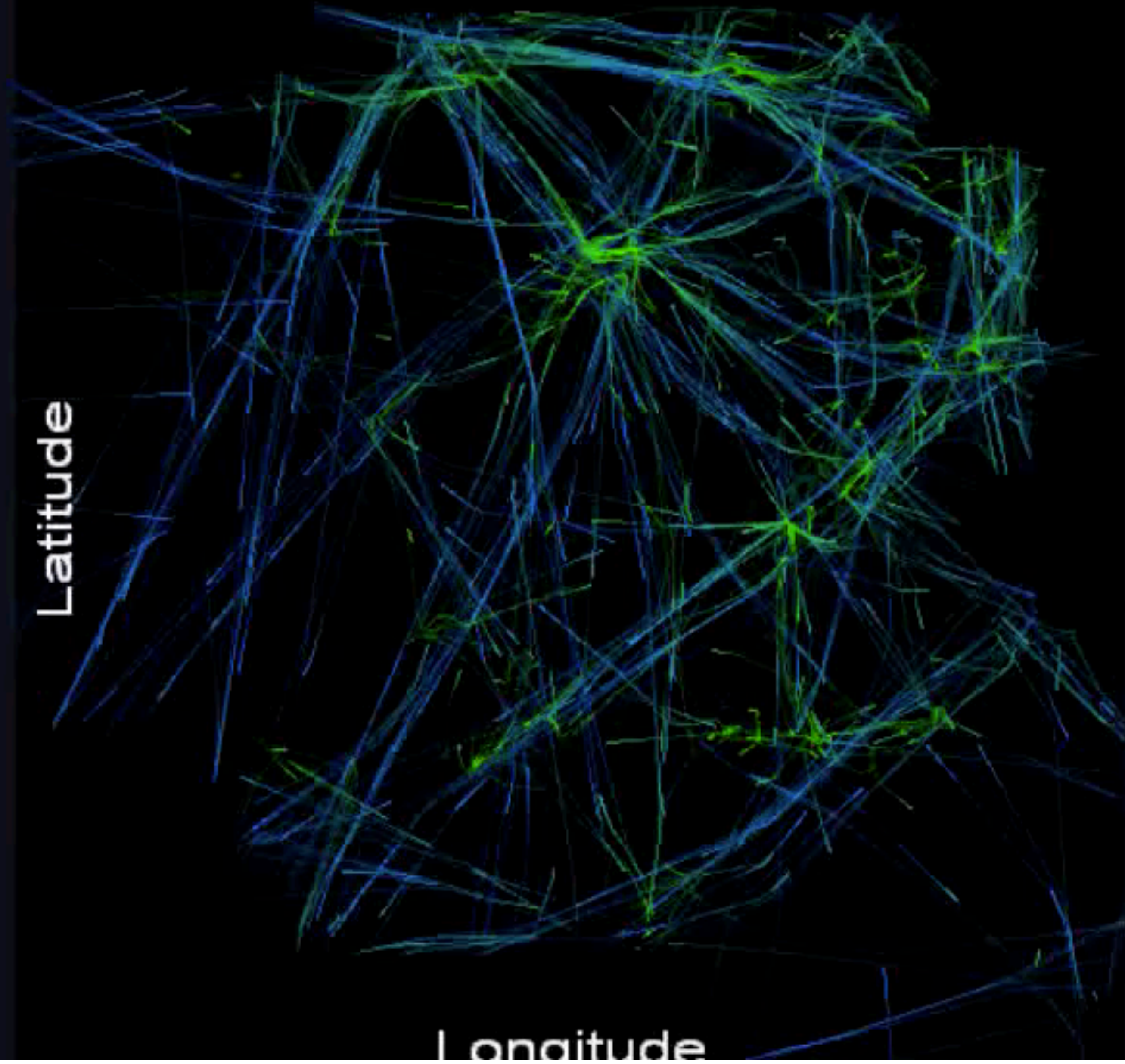


Non-spatial Representation



Latitude

Longitude



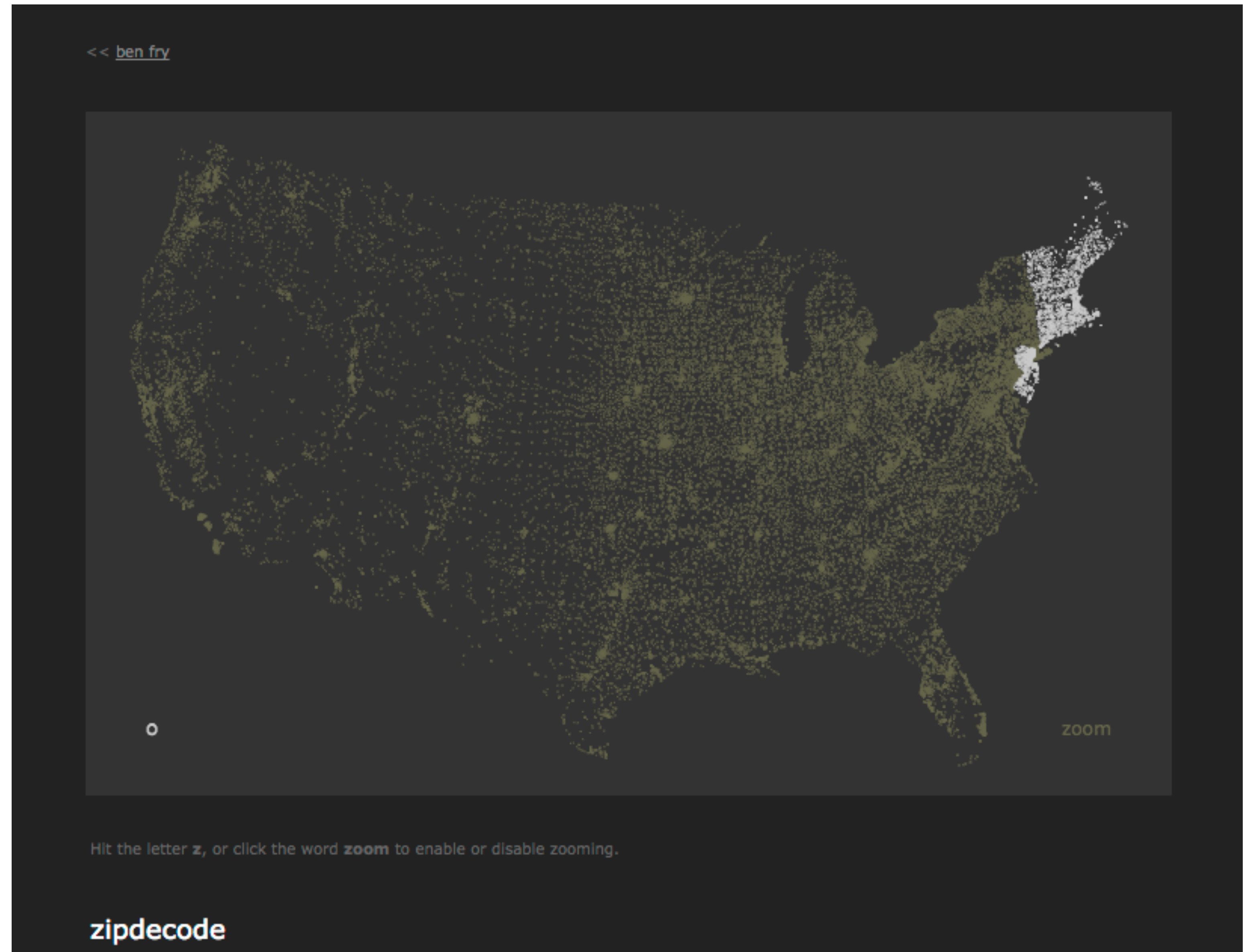
Data Driven Maps

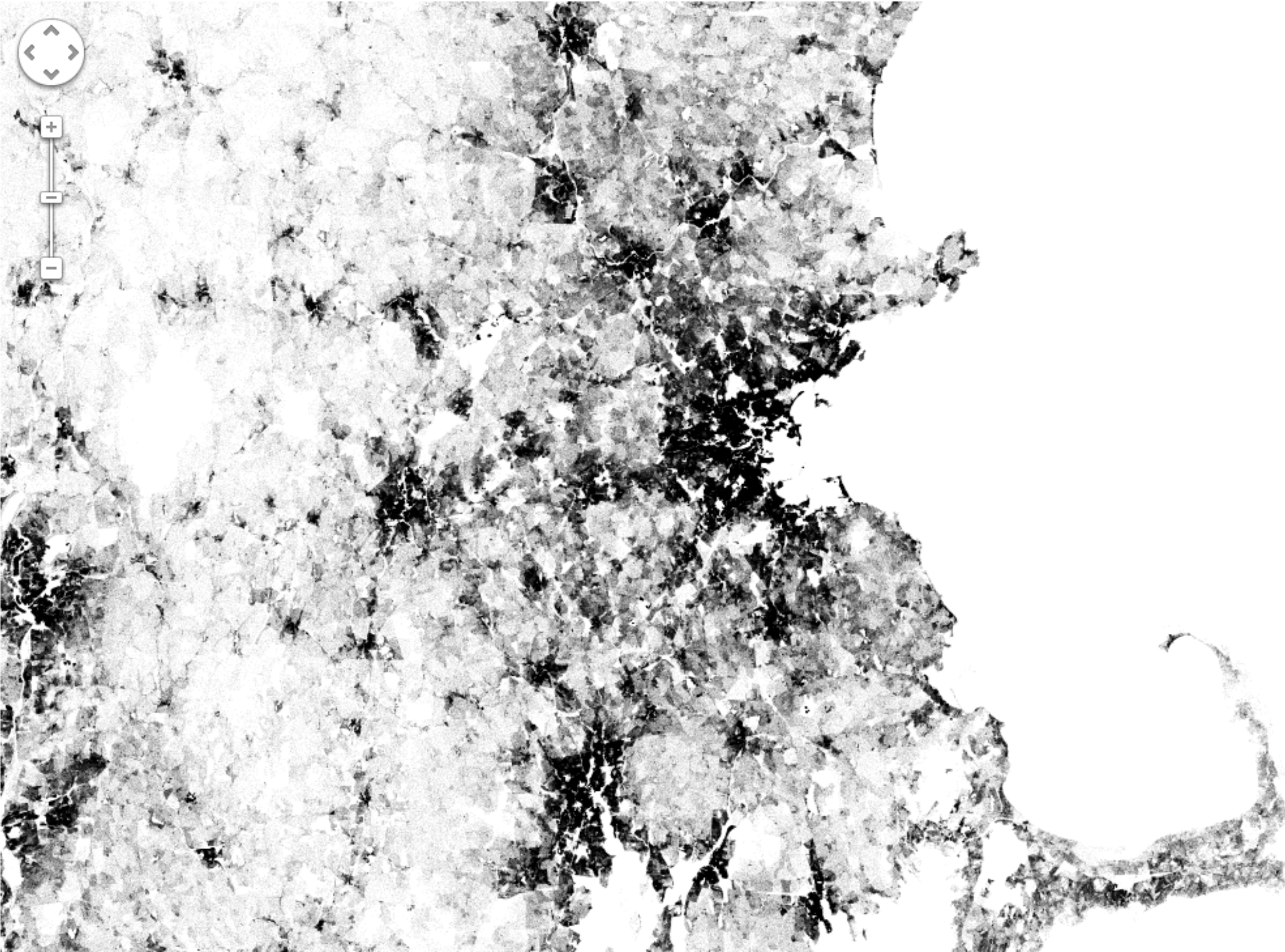
Data Driven Maps

Idea: don't use a map to render on top

Let the data make up the map

ZipDecode





[show labels](#) [link to this map](#)

Census Dotmap

What's all this?

This is a map of every person counted by the 2010 US and 2011 Canadian censuses. The map has **341,817,095** dots - one for each person.

Why?

I wanted an image of human settlement patterns unmediated by proxies like city boundaries, arterial roads, state lines, &c. Also, it was an interesting challenge.

Who is responsible for this?

The US and Canadian censuses, mostly. I made the map. I'm [Brandon Martin-Anderson](#). [Kieran Huggins](#) came to the rescue with spare server capacity and technical advice once this took off.

How?

I wrote a Python script to generate points from US Census block-level counts, and then generated the tiles with Processing. Here's [more detail for the interested](#).

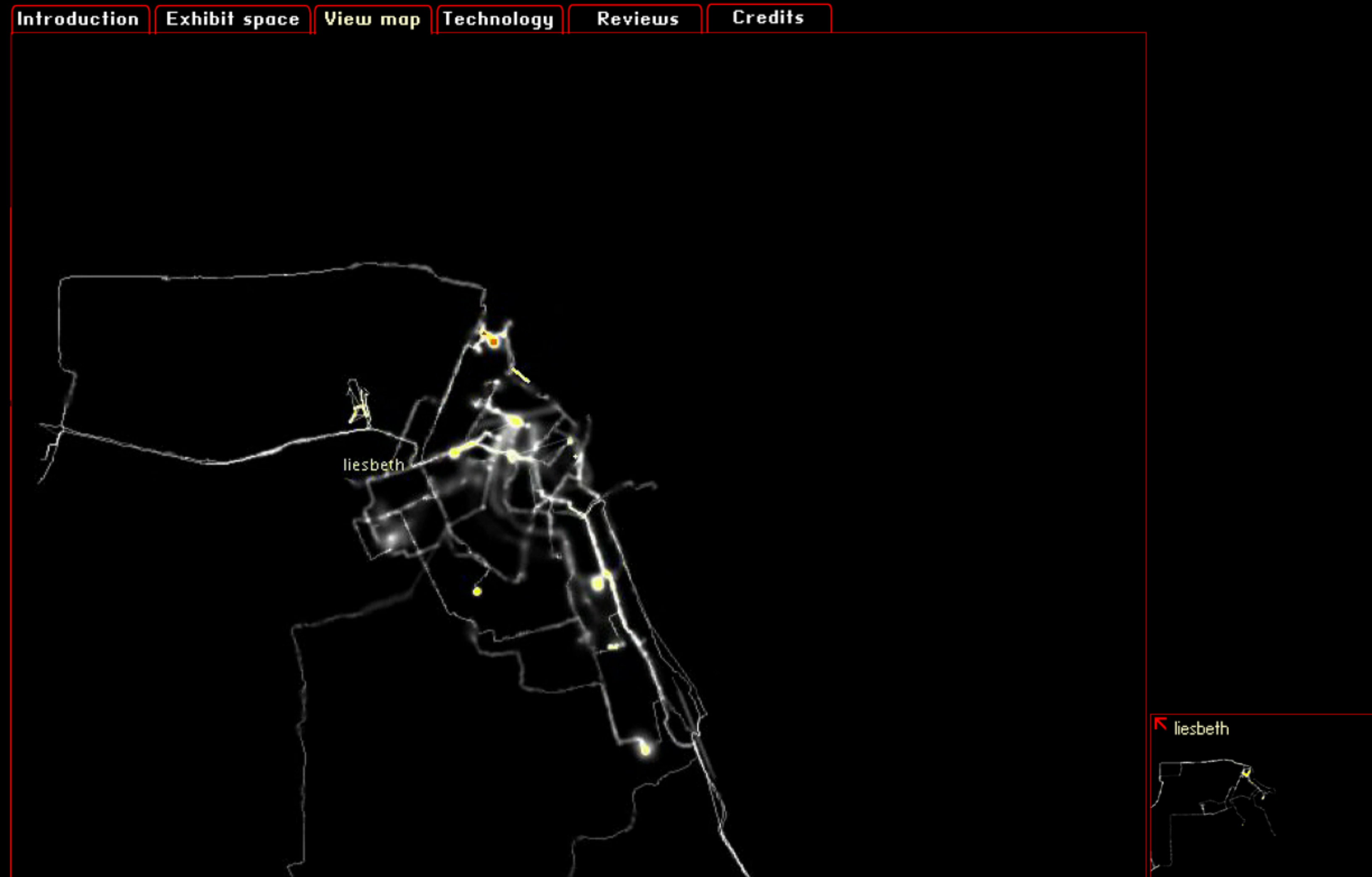
ZipScribble



ZIPScribble Map: USA

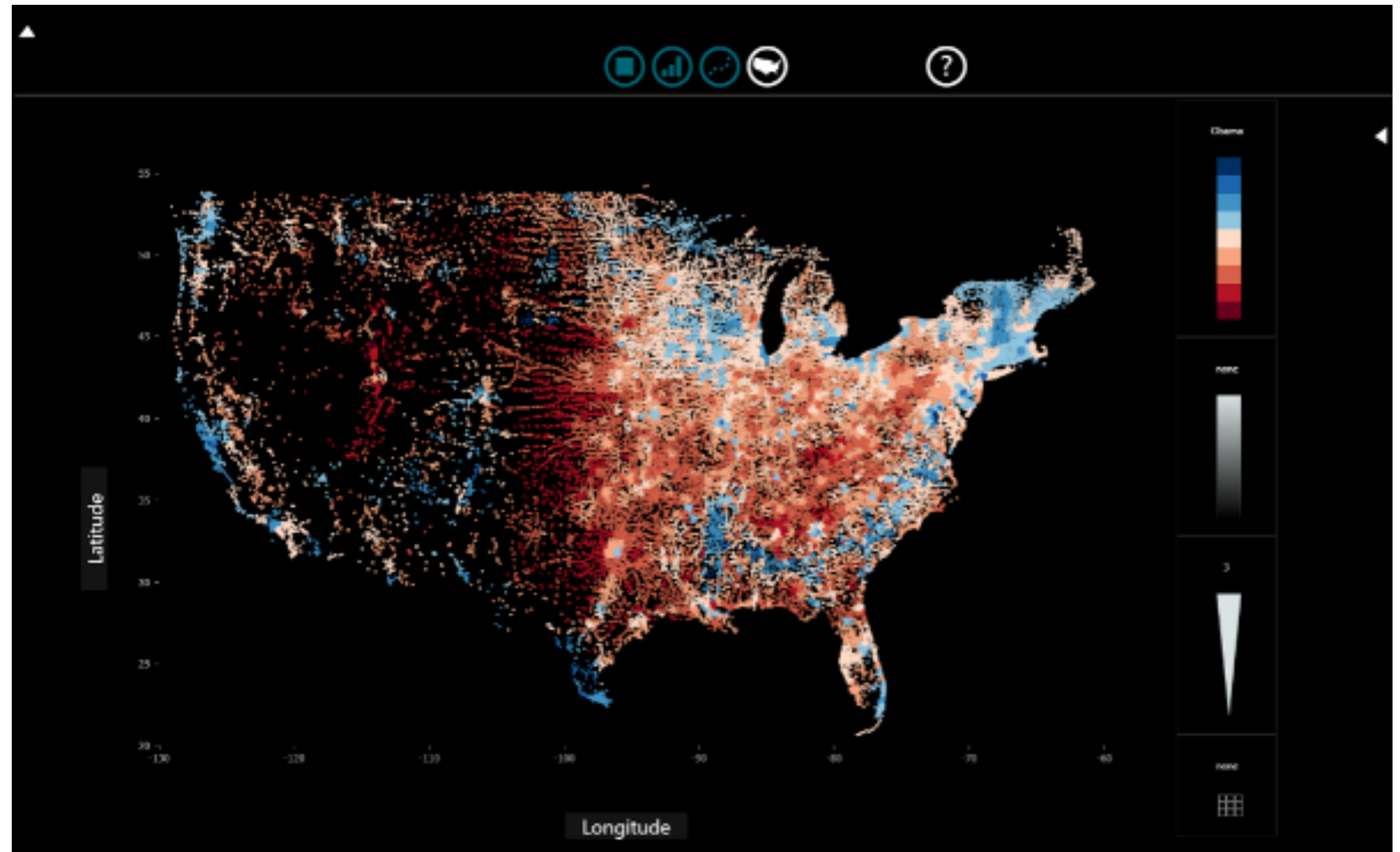
Robert Kosara | EagerEyes.org

Amsterdam RealTime

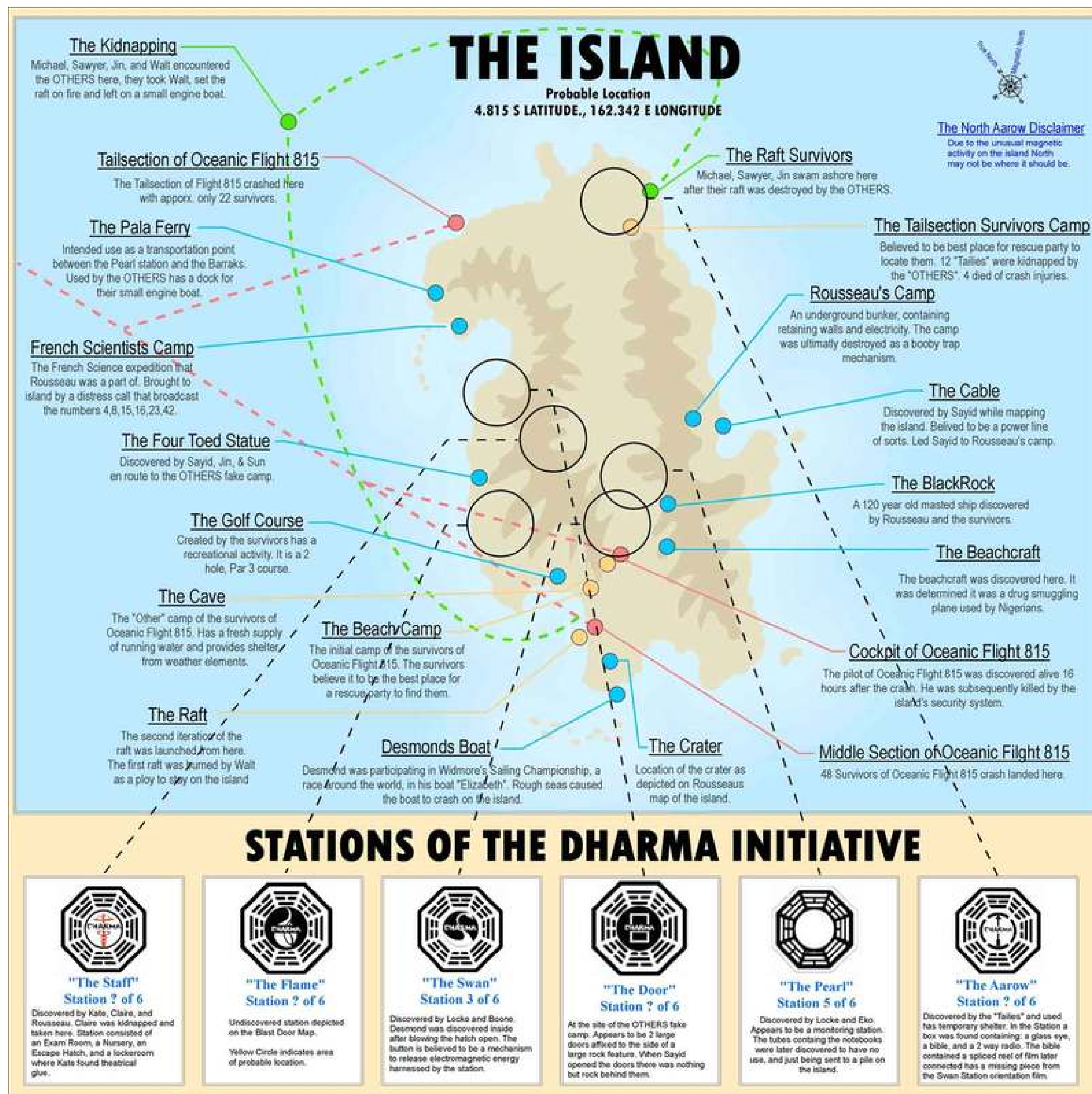


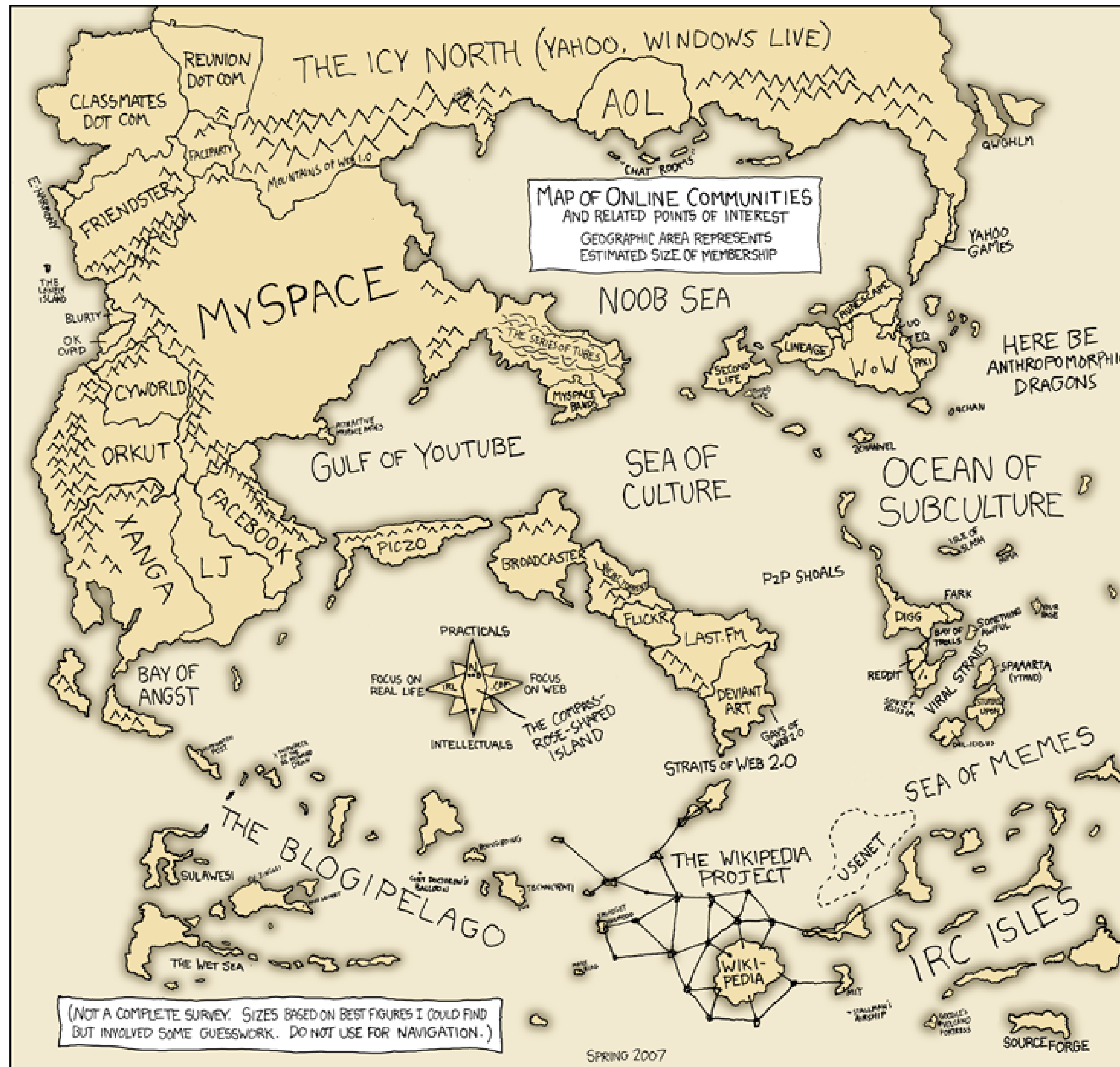
SandDance

Arrange Particles
to create visualizations



Thematic Maps





2007

One hour in front of the TV

