Why are there different versions of the World Map?

Adapted from Axis Maps

Have you ever looked a map of the world and been confused? "Why is that country so big?" or "Why is that so far away?" Different versions of the World Map exist because there are all sorts of problems with taking a three-dimensional planet and trying to flatten it out to fit on a piece of paper. So, different cartographers – geographers who make maps for a living – have come up with different strategies to do this whole "flattening" process, which has led to some pretty interesting differences in each version of the World Map. Read the article below to see what kinds of differences the cartographers have chosen to deal with in each map.

Flattening the Earth

It's impossible to flatten the Earth without distorting it in some fashion. Consider an orange peel: if you want to try and lay it flat, you have to stretch it, squash it, and tear it. Likewise with the Earth—if we want to make a map, we need to distort the Earth's surface to flatten it. The good news is that map projections allow us to distort systematically; we know exactly how things are being stretched or squashed at any given point. We have many different map projections because each has different patterns of distortion—there is more than one way to flatten an orange peel. Some projections can even preserve certain features of the Earth without distorting them, though they can't preserve everything.

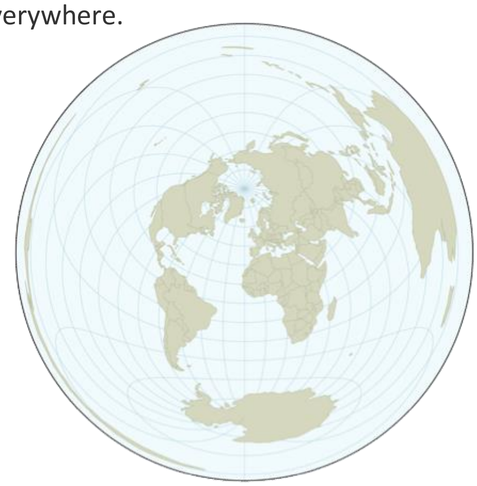
Projection Properties

We often talk about map projections in terms of the ways in which they distort or preserve certain things about the Earth, which we call *projection properties*. There are four main properties: **Area** (how big or small parts of the world are), **form** (the shape of different parts of the world), **distance** (how far apart difference parts of the world are shown), and **directions** (where different parts of the world are shown in relation to one another).

Area — Some projections distort areas, such as the Mercator projection, shown to the left. Notice how Greenland is about as big as South America on a Mercator projection. In reality, South America is eight times larger than Greenland. The Mercator projection doesn't preserve area correctly, especially as you get closer to the poles.

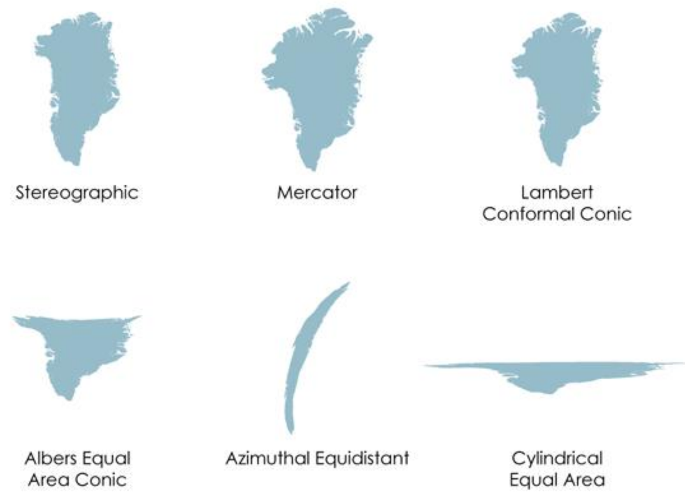
On the other hand, one kind of projection that doesn't distort area is the Cylindrical Equal Area, shown the right. Notice here how Greenland looks the right size as compared to South America. Projections which preserve areas are called *equivalent* or *equal-area* projections. A map projection either preserves areas everywhere, or distorts it everywhere. This is an all-or-nothing property.

Form — Some projections distort the "form" of features, such as the Azimuthal Equidistant projection, shown in the lower right corner. On this projection, look at how Australia, on the far right, is unrecognizable, and New Zealand is stretched out into a ring around the left edge of the map. This projection does not preserve the "look" or the "form" of places. It stretches or twists or squashes them, instead.



Contrast the last map with a Lambert Conformal Conic, shown the left, which preserves the general form of the landmasses.

Projections like this are called *conformal* projections. Under the hood, this property is actually a little more complex: comformal projections actually preserve local angles. But what that boils down to for cartographers is that places look more like themselves.



Check out the example to the right: six different versions of Greenland. Here, Greenland is shown as it appears on three conformal projections (top row) and three non-conformal projections (bottom row).

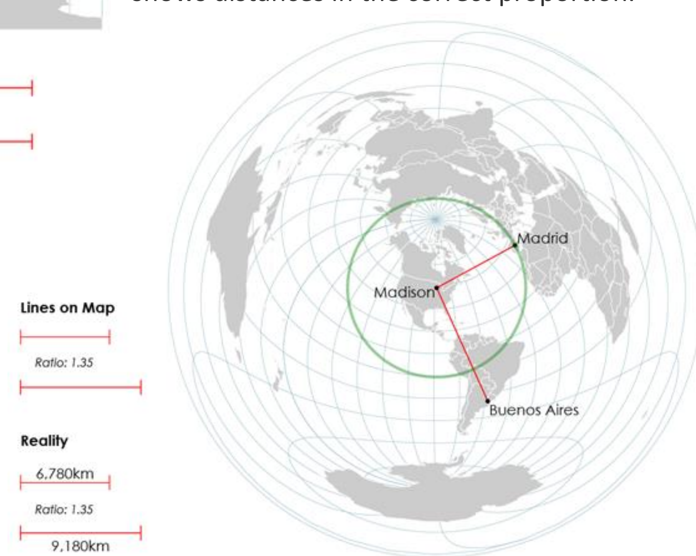
Notice how the conformal projections keep Greenland looking Greenlandy. The shape changes some, and parts of the island get larger or smaller, but they all have the same general form, even if they aren't exactly alike. In the same way, a rectangle and a square have the same general "form" despite being different shapes, whereas a square and a circle do not. Like equal-area, this property is all-or-nothing; your projection either preserves forms everywhere on the map, or it doesn't preserve them anywhere.

Distance — Most projections distort distances, like the Equirectangular projection, shown to the left.

A trip from Madison to Buenos Aires is much farther than a trip from Madison to Madrid, but on an Equirectangular projection, both of those trips looks like they're the same length. That's because this is a projection that does not preserve distance.

On the other hand, the Azimuthal Equidistant projection (below, in the bottom right corner) shows distances in the correct proportion.

There's a catch, though. While we have map projections that can preserve **areas** or **form** everywhere on the map, there isn't one that can preserve **distances** everywhere. There are only projections that let you preserve distances relative to just one or two points on the map. Distances to and from the center of an Azimuthal Equidistant map are shown correctly, but distances between any other two points are distorted. When a projection preserves distance, we call it *equidistant*.



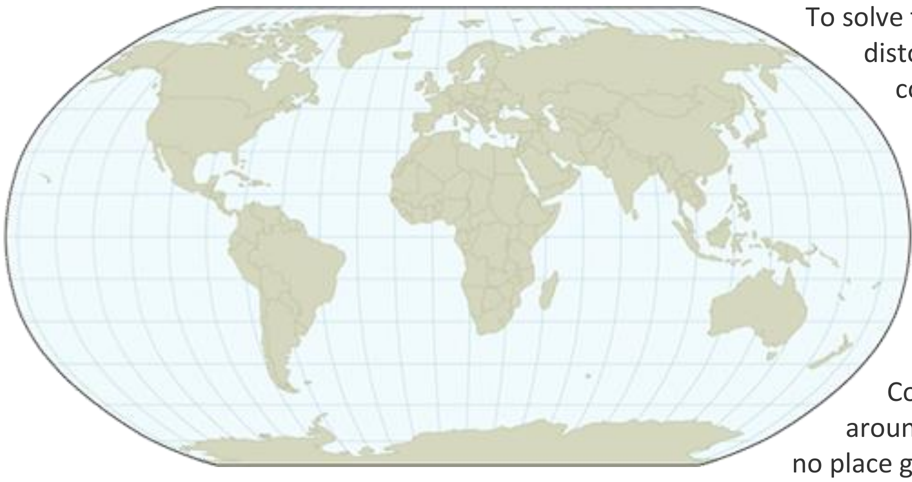
The properties of area, distance, and form are mutually exclusive.
If you have a map projection that preserves one, it will distort the other two.

Directions — Sometimes a straight line isn't the shortest path! New York City and Istanbul are on nearly the same line of latitude, about 41ºN. That means that if you head due east on a straight line from New York, you'll reach Istanbul. But that doesn't mean that this is the shortest distance between the two cities.

In this image, there's a line which shows the straightest, simplest path between New York and Istanbul, which is simply to point yourself east and start flying. But the curved line above it shows the way you should go if you'd like to travel the least distance while getting there. Because the Earth's surface is curved, the shortest paths around it are curved, too. [*This can be a bit confusing, but makes more sense if you try it yourself: find a globe and place a piece of string on it. Pin one end to New York and one to Istanbul, and pull the string taut. You'll notice that the string covers the exact same path as the curved route in the map above.*]
We call these curved shortest-distance paths *great circle* routes.
Some projections, like the Mercator above, prefer the straight lines, and others, like the Stereographic projection, shown to the right, prefers the great circles.

These projections that prefer the great circles are called *azimuthal* projections, and, unfortunately, much like the equidistant projections, it only works for one point at a time. In the Stereographic to the right, the projection is centered on New York. Only straight lines coming into or going out of New York will be great circles. A straight line between Madrid and Casablanca, for example, won't be.

Compromises — Do nothing perfect, but most things well enough. If you skim through the example images above, you may notice that, as a general trend, distortions tend to get worse and worse as you get near the edges of the map. There's usually one area that looks alright and isn't too distorted, and then things start to get crazy the farther you move away from that area. As an example, on the Azimuthal Equidistant above, Australia's shape gets distorted heavily, but the British Isles look fine. As a general rule, the larger the area your map shows, the worse distortions will be, especially as you move away from the center. What all this means is that we are most worried about distortions when we are doing things like mapping the world, and less when we are mapping smaller areas like cities or states.



To solve the problem of world maps having such severe distortions at the edges, people have come up with compromise projections. These special projections represent trade offs: while most projections have minimal distortion in one area but distort heavily as you move away from that area, compromise projections distort a moderate amount everywhere. The Robinson projection, shown to the left, is one example of a compromise projection.

Compromise projections spread the distortion around somewhat evenly. The plus side of this is that no place gets ridiculously distorted. This is what makes compromise projections good for world maps. The downside is that there's no longer a special area that has almost no distortion, like you might find on most other projections. Compromise projections spread the distortion more evenly throughout the world. Compromise projections don't preserve **areas** or **forms** or **distances**, but they get close on all of them. They have a low level of distortion overall, even if they don't preserve any one thing exactly.