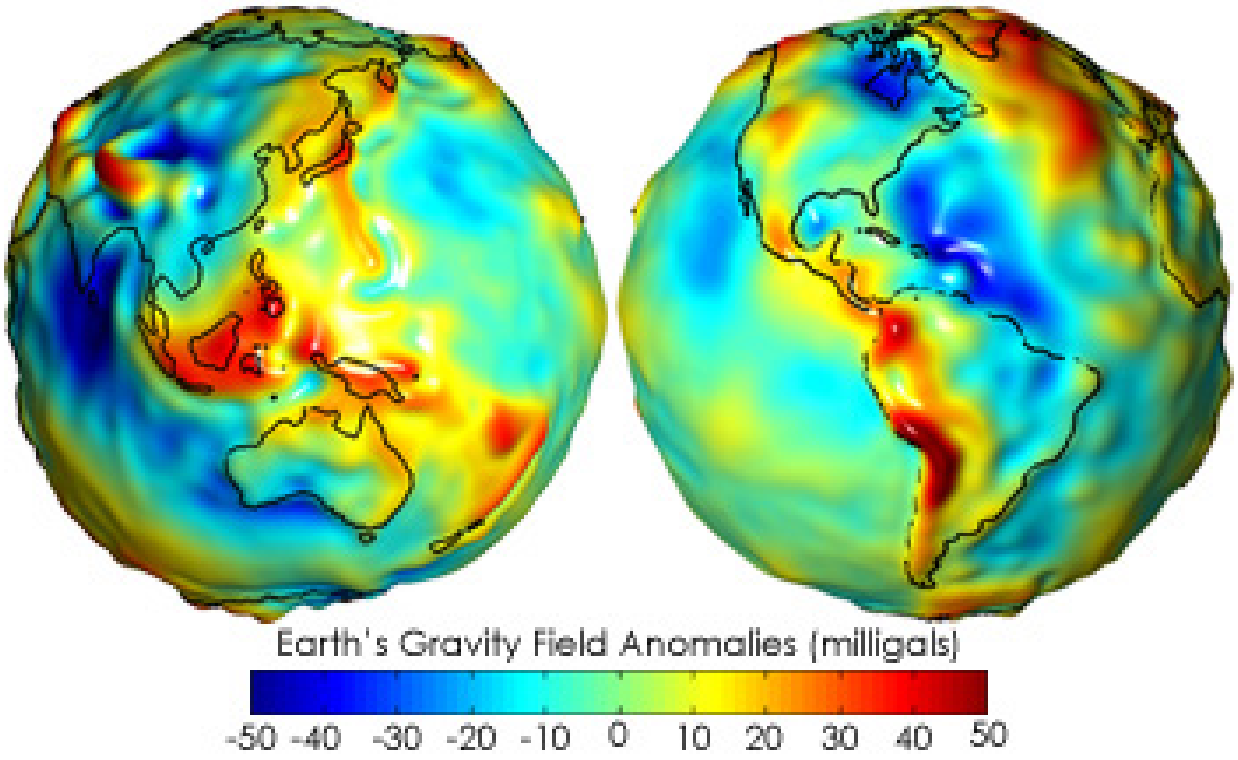
Online Surveying FE 208

Lecture 22 supplement

Coordinate Systems

The **geoid** is defined as the surface of the earth's gravity field, which approximates mean sea level. It is perpendicular to the direction of gravity pull. Since the mass of the Earth is not uniform at all points, the magnitude of gravity varies, and the shape of the geoid is irregular.

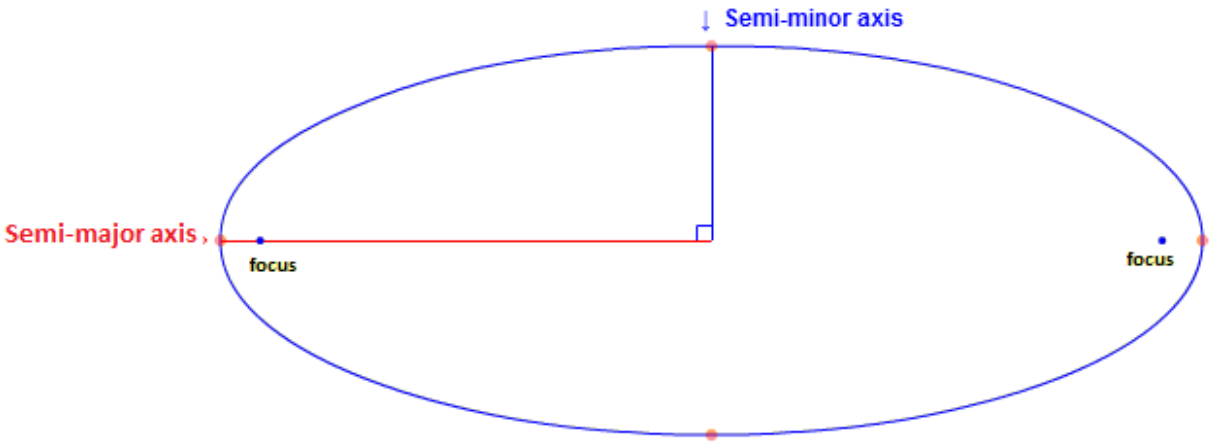


Question: If you started a level loop from the east coast at 0.00' at seal level, when you got to the west coast, would you be at 0.00'?

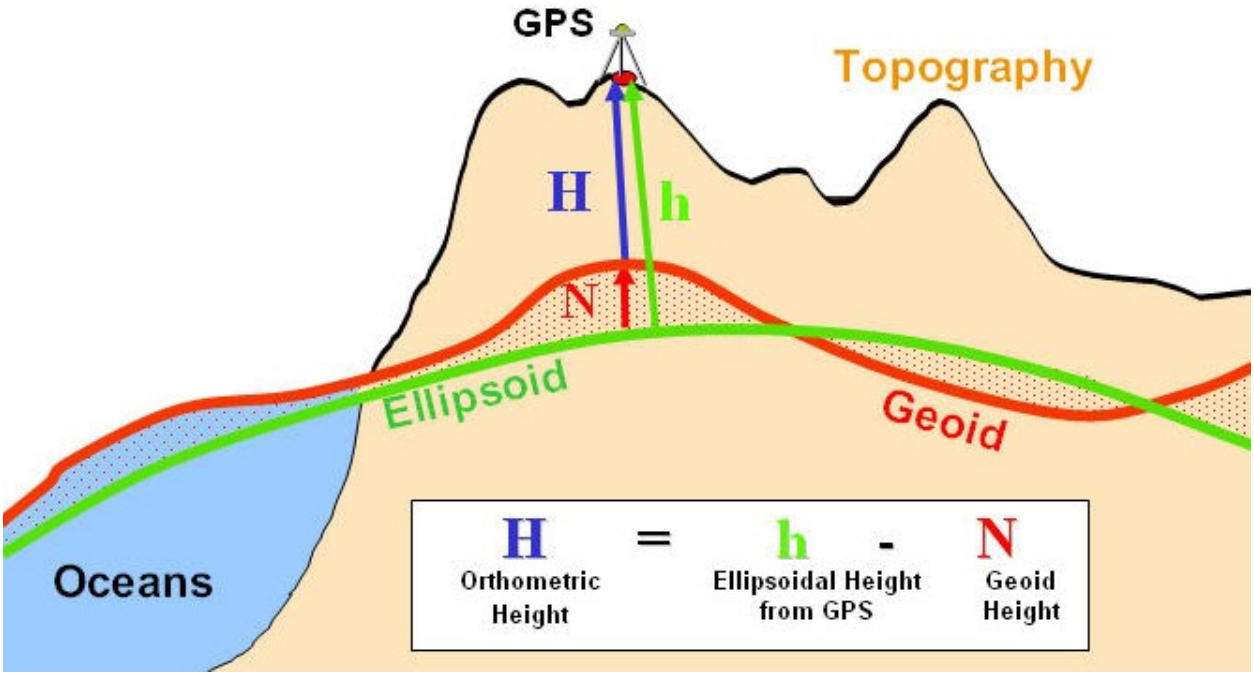
a **reference ellipsoid** is a mathematically-defined surface that approximates the geoid, the truer figure of the Earth, or other planetary body. Because of their relative simplicity, reference

ellipsoids are used as a preferred surface on which geodetic network computations are performed and point coordinates such as latitude, longitude, and elevation are defined.

Currently the most common reference ellipsoid used, and that used in the context of the Global Positioning System, is the one defined by WGS 84.

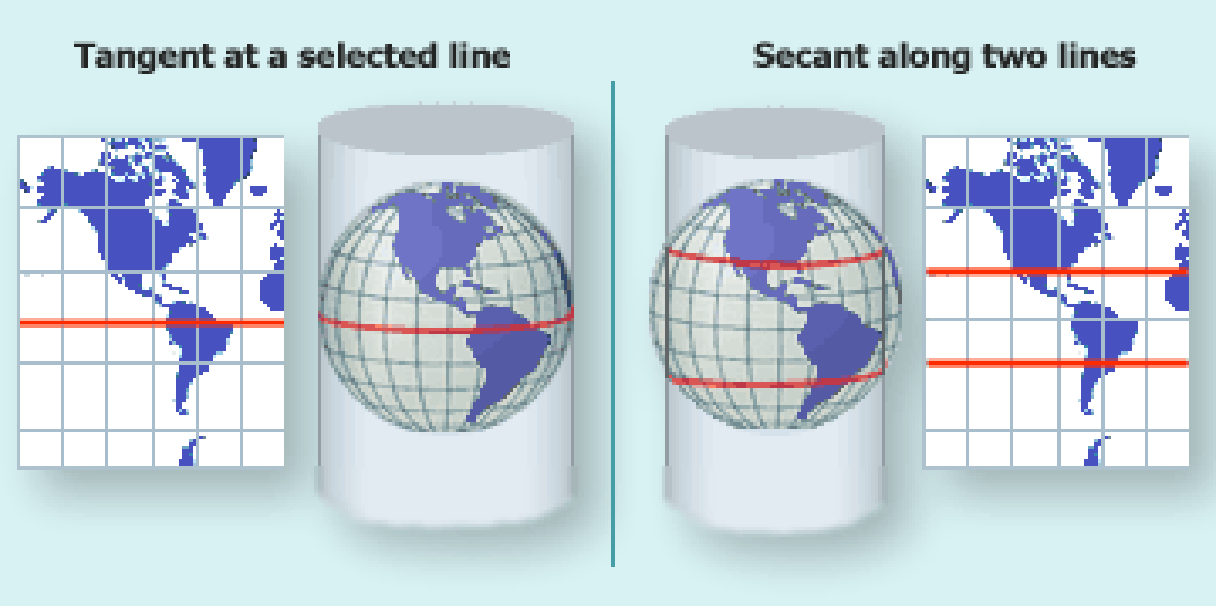


Name	Equatorial axis (m)	Polar axis (m)	Inverse flattening, $1/f$
Airy 1830	6 377 563.4	6 356 256.9	299.324 975 3
Clarke 1866	6 378 206.4	6 356 583.8	294.978 698 2
Bessel 1841	6 377 397.155	6 356 078.965	299.152 843 4
International 1924	6 378 388	6 356 911.9	297
Krasovsky 1940	6 378 245	6 356 863	298.299 738 1
GRS 1980	6 378 137	6 356 752.3141	298.257 222 101
WGS 1984	6 378 137	6 356 752.3142	298.257 223 563
Sphere (6371 km)	6 371 000	6 371 000	∞

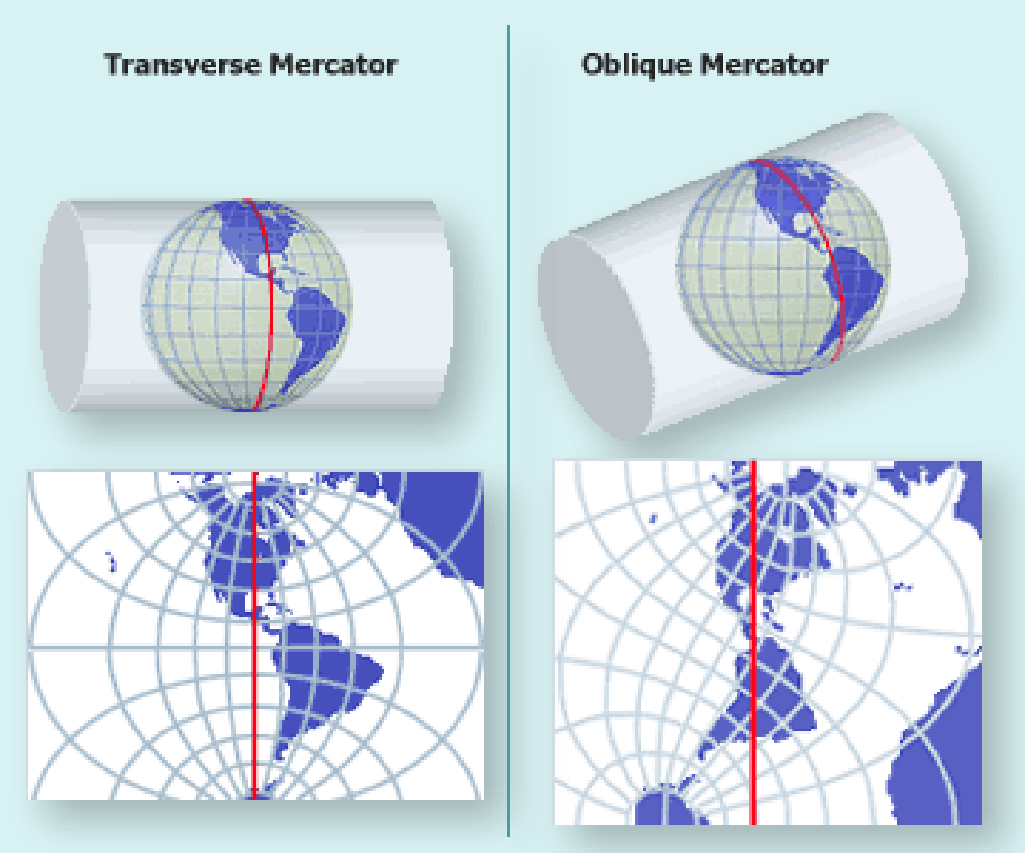


A **map projection** is a systematic transformation of the latitudes and longitudes of locations on the surface of a sphere or an ellipsoid into locations on a plane.[1] Map projections are necessary for creating maps. All map projections distort the surface in some fashion. Depending on the purpose of the map, some distortions are acceptable and others are not; therefore different map projections exist in order to preserve some properties of the sphere-like body at the expense of other properties. There is no limit to the number of possible map projections.

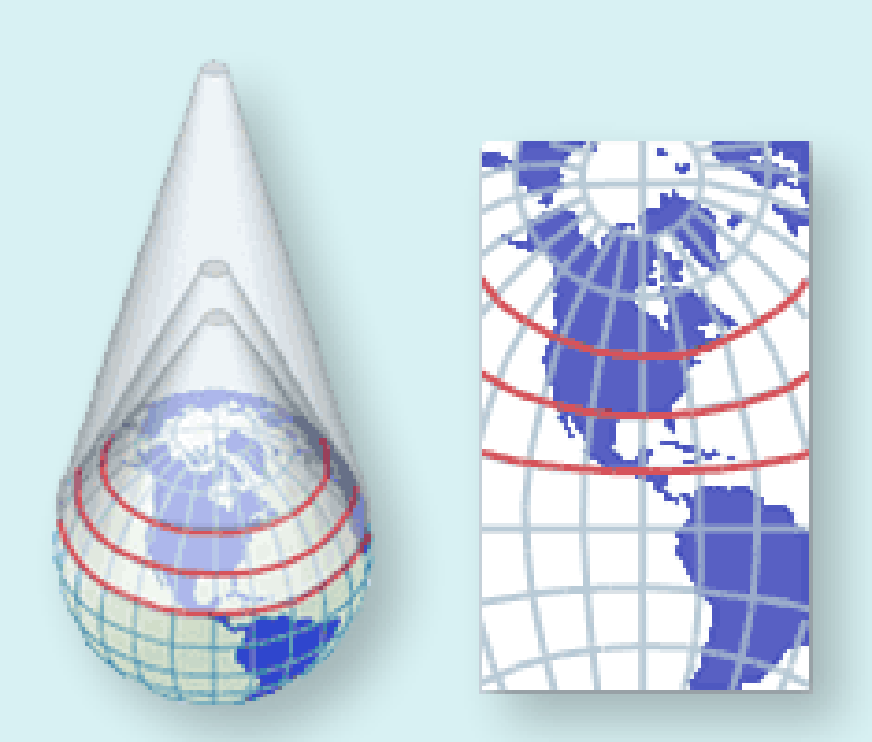
A cylindrical projection projects information from the spherical Earth to a cylinder. The cylinder may be either tangent to the Earth along a selected line, or may be secant (intersect the Earth) along two lines. Imagine that once the Earth's surface is projected, the cylinder is unwrapped to form a flat surface. The lines where the cylinder is tangent or secant are the places with the least distortion.



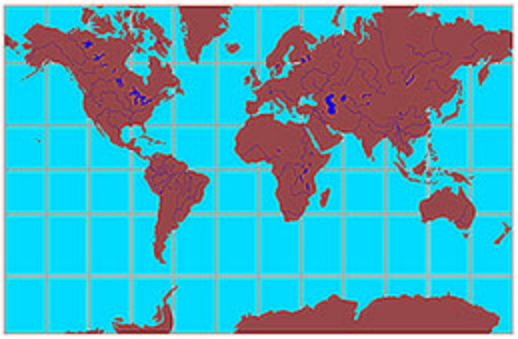
A Mercator projection is created using a cylinder tangent at the equator. A Transverse Mercator projection is created using a cylinder that is tangent at a selected meridian. An Oblique Mercator projection is created using a cylinder that is tangent along a great circle other than the equator or a meridian.



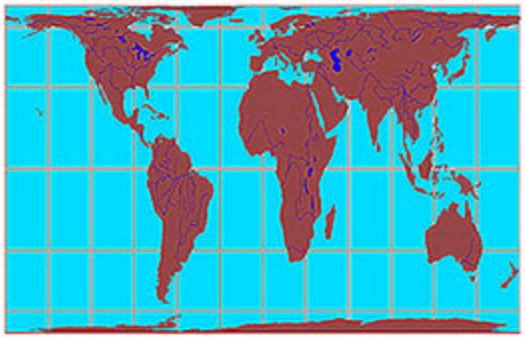
A conic projection projects information from the spherical Earth to a cone that is either tangent to the Earth at a single parallel, or that is secant at two standard parallels. Once the projection is complete, the cone is unwrapped to form a flat surface. The lines where the cone is tangent or secant are the places with the least distortion. A polyconic projection uses a series of cones to reduce distortion.



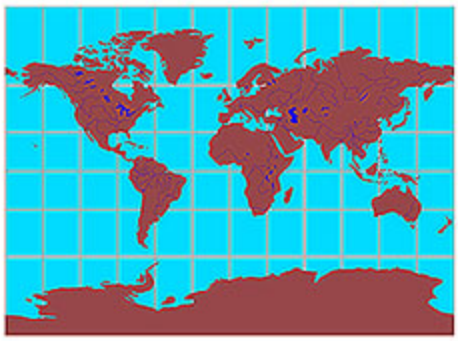
There are four basic characteristics of a map that are distorted to some degree, depending on the projection used. These characteristics include distance, direction, shape, and area.



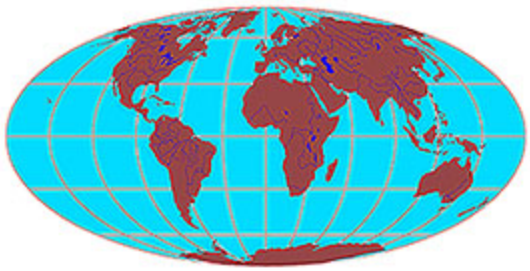
Mercator Projection



Gall-Peters Projection



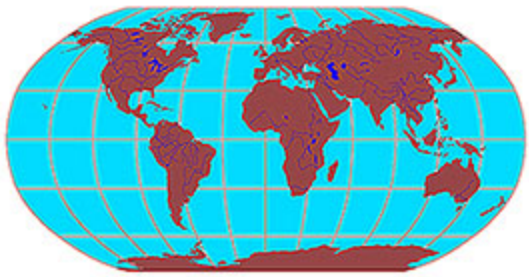
Miller Cylindrical Projection



Mollweide Projection

Goode's Homolosine Equal-area Projection

Sinusoidal Equal-Area Projection



Robinson Projection

The trouble with Mercator

Because Mercator misrepresents the true areas of nations and continents, it can lead to misunderstanding — intentional or unintentional. Here are two ways that Mercator promoted particular political interests in the second half of the twentieth century.

The Cold War

During the Cold War, maps of "us" and "them" were often drawn to emphasize the threat represented by the USSR and its allies. The Mercator projection was the perfect choice for anti-communist cartographers: because the USSR was at such high latitudes, Mercator stretches it out of proportion to its true size. In the map below, the Warsaw Pact nations become a sprawling red menace:

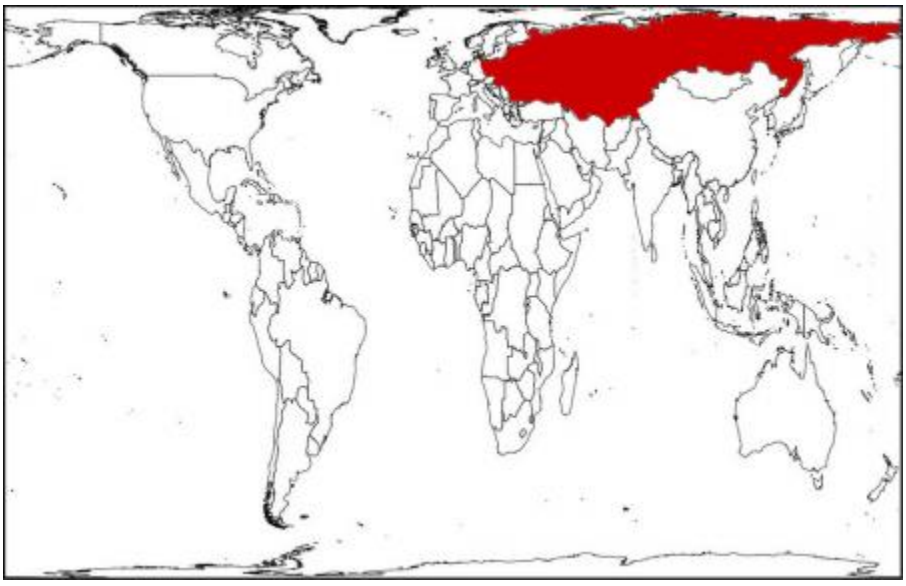
Figure 10-1. Map of the world, drawn using Mercator projection, with Warsaw Pact nations shaded red.

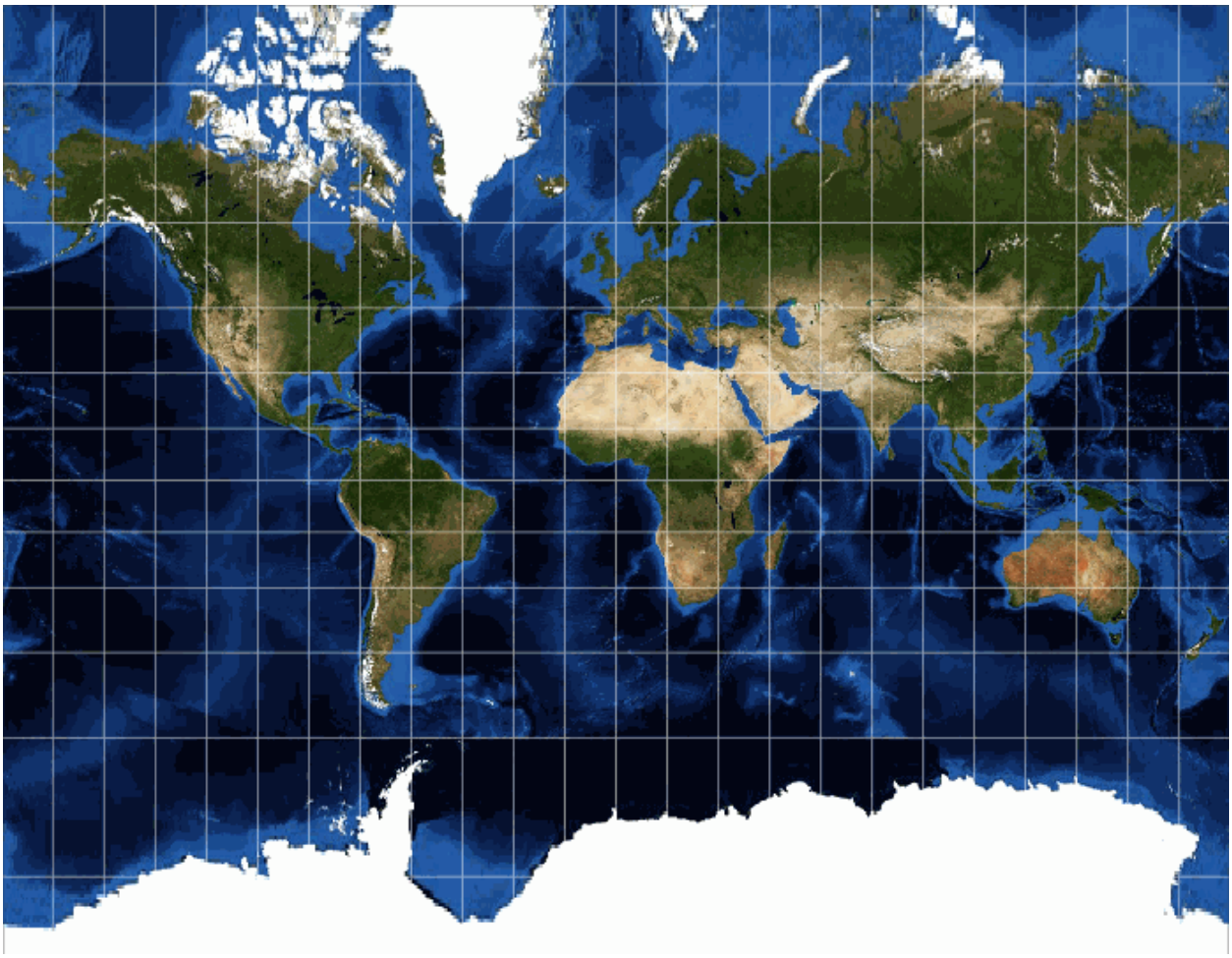
Redrawn in Robinson projection — a popular compromise between equal-area and conformal mapping — the USSR becomes a little less menacing.

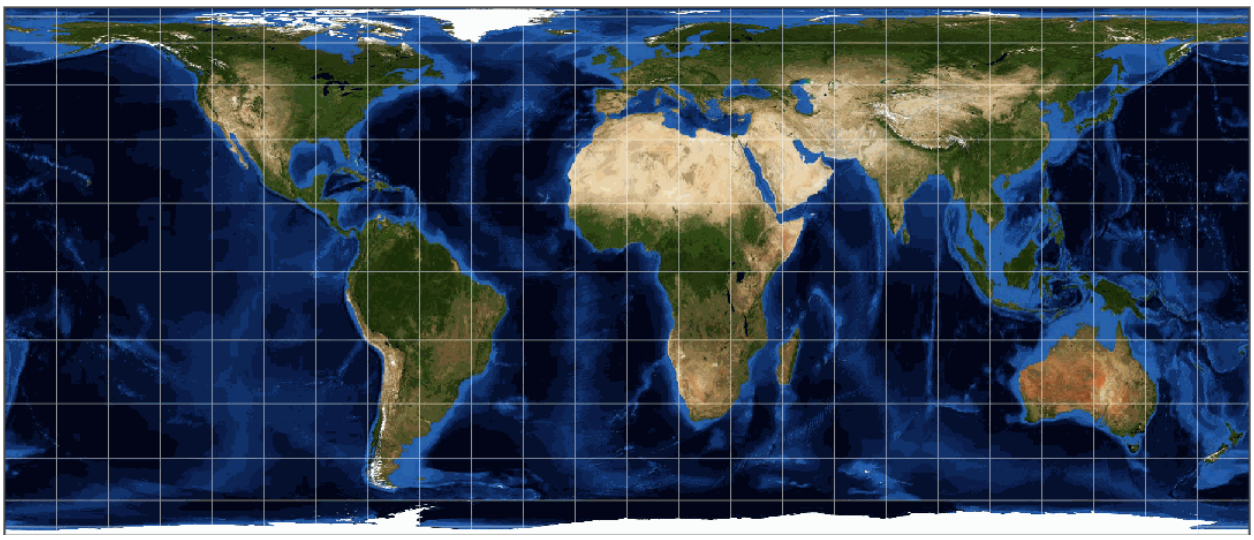
Figure 10-2. Redrawn in Robinson projection.

Now redraw it again in the Peters equal-area projection, and the USSR shrinks to its true size.

Figure 10-3. Redrawn in Peters equal-area projection.







Equal area distorts as you approach the poles