Projection Perspectives

10° Graticule | Select cities buffered at 500, 1,000, and 1,500 miles:
Washington, DC | Honolulu, HI | Belem, Brazil | Cape Town, South Africa | Manila, Philippines | Albörg, Denmark

Nikolas Hawley, September 2020 | Projection information provided by "Map Projections" Poster, USGS; Basemap provided by Esri

CLASSIFICATION

Conformal | Equidistant

DEVELOPABLE SURFACE

Cylindrical | Plane (Azimuthal)

Mercator

"Used for navigation or maps of equatorial regions. Any straight line on the map is a rhumb line (line of constant direction).

***Directions** along a rhumb line are true between any two points on map, but a rhumb line is usually not the shortest distance between points. (Sometimes used with Gnomonic map on which any straight line is on a great circle and shows shortest path between two points).*

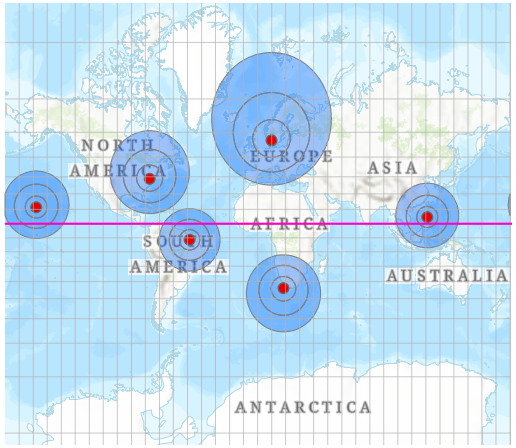
***Distances** are true only along Equator, but are reasonably correct within 15° of Equator; special scales can be used to measure distances along other parallels. Two particular parallels can be made correct in scale instead of the Equator.*

***Areas and shapes** of large areas are distorted. **Distortion** increases away from Equator and is extreme in polar regions. Map, however, is conformal in that angles and shapes within any small area (such as that shown by a USGS topographic map) are essentially true.*

The map is not perspective, equal area, or equidistant.

Equator and other parallels are straight lines (spacing increases toward poles) and meet meridians (equally spaced straight lines) at right angles. Poles are not shown."

Line of Tangency (Great Circle)



The Mercator's cylindrical developable surface wraps tangential to the Earth's equator, making area along the equator the least distorted. As stretching occurs longitudinally, equal stretching is matched latitudinally. So, 90° intersections of parallels and meridians are maintained, and shapes stretch proportionally (and drastically) towards the poles, maintaining relative shape, particularly in terms of local shapes and angles.

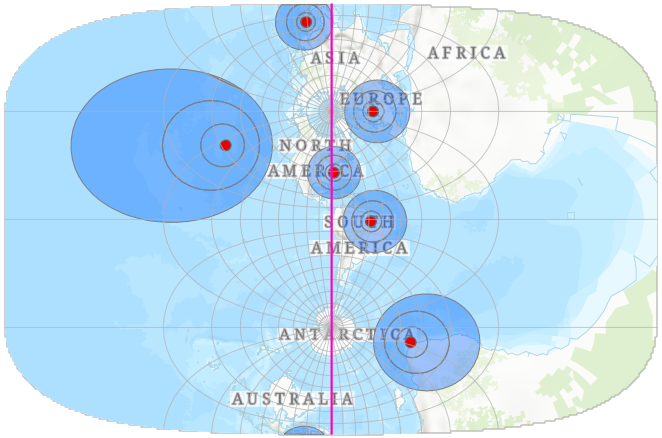
Transverse Mercator (Hotine)

"Used for mapping large areas that are mainly north-south in extent.

***Distances** are true only along the central meridian selected by the mapmaker or else along two lines parallel to it, but all distances, directions, shapes, and areas are reasonably accurate within 15° of the central meridian. Distortion of distances, directions, and size of areas increases rapidly outside the 15° band. Because the map is conformal, however, shapes and angles within any small area (such as that shown by a USGS topographic map) are essentially true.*

***Graticule spacing** increases away from central meridian. Equator is straight. Other parallels are complex curves concave toward nearest pole.*

Central meridian and each meridian 90° from it are straight. Other meridians are complex curves concave toward central meridian."



The Transverse Mercator Projection, like the Mercator, utilizes a cylindrical developable surface. However, in this case the tangential great circle runs along a meridian as opposed to the Equator. Any given meridian can be chosen as the central meridian to suit a particular area. This makes distances within areas close along the central meridian (and corresponding 180° opposite meridian) accurate. General shape is relatively maintained throughout, however, stretching now occurs further away from the meridian great circle, with increasing severity the further you get.

Stereographic

"Used by the USGS for maps of Antarctica and American Geographical Society for Arctic and Antarctic maps. May be used to map large continent-sized areas of similar extent in all directions. Used in geophysics to solve spherical geometry problems. Polar aspects used for topographic maps and charts for navigating in latitudes above 80°.

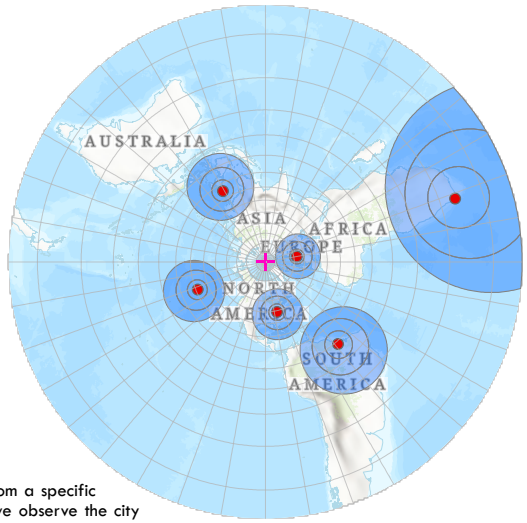
***Directions** true only from center point of projection. **Scale** increases away from center point. Any straight line through center point is a **great circle**. **Distortion** of areas and large shapes increases away from center point.*

*Map is **conformal** and perspective but **not** equal area or equidistant.*

Dates from 2nd century B.C. Ascribed to Hipparchus.

***Azimuthal** — Geometrically projected on a plane. Point of projection is at surface of globe opposite the point of tangency."*

Point of Tangency (Center of Projection)



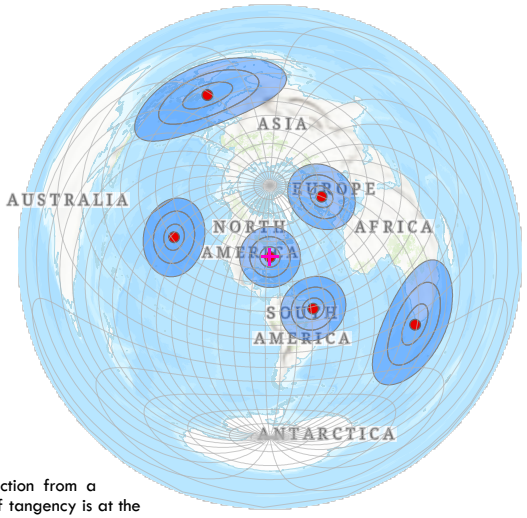
Azimuthal projections preserve direction (or an azimuth from a specific point) **only from the center point of the projection.** As we observe the city buffers along with the land geometry in this projection, you can see the proportional latitudinal and longitudinal stretching as you get further and further form the pole or tangent point. Since the stretching occurs radially, the circles maintain their shape very well, as well as other local geometries. However, beyond the Equator, the stretching drastically distorts **distances and areas**, making areas look increasingly larger and blown up compared to those areas closer to the point of tangency (the N pole).

Azimuthal Equidistant

"Used by USGS in the National Atlas of the United States of America™ and for large-scale mapping of Micronesia. Useful for showing airline distances from center point of projection. Useful for seismic and radio work. Oblique aspect used for atlas maps of continents and world maps for radio and aviation use. Polar aspect used for world maps, maps of polar hemispheres, and United Nations emblem.

***Distances and directions** to all places true only from center point of projection. Distances correct between points along straight lines through center. All other distances incorrect. Any straight line drawn through center point is on a great circle. Distortion of areas and shapes increases away from center point.*

***Azimuthal** — Mathematically projected on a plane tangent to any point on globe. Polar aspect is tangent only at pole."*



Azimuthal Equidistant, like Stereographic, preserves direction from a point of tangency. This particular map's center and point of tangency is at the Zero Milestone Monument outside the south lawn of the White House in Washington, DC. In addition to preserving direction, the Azimuthal Equidistant projection also preserves distance from this point of tangency. Preserving both direction and distance distorts shapes severely the further and further away you get from the point of tangency, as can be seen through the globular shapes that the city buffers morph to as they get further from DC.