Basic Geodesy

Issue 10 February 2006

Mercator Projection

Roger Foster, Kurt Schulz, and Craig Rollins
Coordinate System Analysis Team (CSAT)

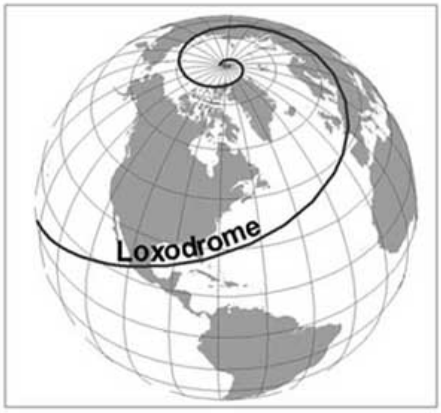
This article will be the first of four discussing the projections predominately used by NGA. The Mercator projection is used extensively for surface and subsurface hydrographic charts. It is a cylindrical projection, with the cylinder axis parallel to the ellipsoidal polar axis.

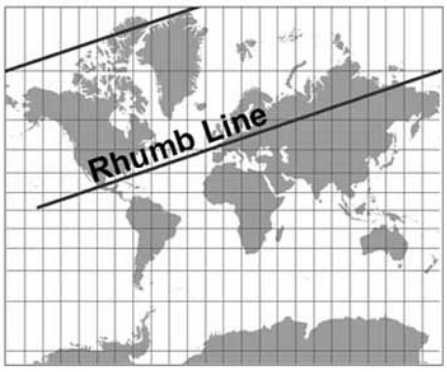
Developed by Gerard Mercator in the 16th century, the Mercator projection was very innovative because it was **conformal**. Conformal projections are important because, unlike other projections, local areas retain their true shape; angles between linear features are true; parallels and meridians intersect at ninety-degree angles; and at any point on the map, scale is the same in all directions. These properties are vital for map users who wish to derive or record accurate data such as bearings, positions, and distances. That is why NGA uses conformal projections for its standard maps and charts.

Mercator's remarkable innovation was in the **spacing of the parallels**. Mercator kept the meridians of his map as equally spaced vertical lines, but he adjusted the spacing of the parallels to maintain conformality, increasing the spacing further from the equator. Years later, tables were published specifying the amount of spacing for every degree of latitude. Later still, a simple mathematical formula was found that further refined the spacing of the parallels and replaced the extensive tables. This was the beginning of map projections as mathematical functions rather than mere geometrical constructions.

In addition to conformality, an important property of the Mercator projection is that **loxodromes**, or lines of constant direction, appear as straight lines, known as **rhumb lines**. The properties of conformality, straight rhumb lines, and meridians as equally spaced vertical lines make the Mercator projection most favored for hydrographic charts.

Because of its grand history, the Mercator projection remains popular for world maps, perhaps inappropriately. For the entire world, it greatly distorts areas (compare the relative sizes of Greenland to South America on both a globe and a hydrographic chart shown below); it cannot display the north and south poles; and its scale function varies widely from equator to pole. However, these problems are virtually eliminated on large-scale Mercator charts of local areas.





Next Article

The next article will discuss the Polar Stereographic projection which is frequently used by NGA to produce maps and charts in the polar areas.