Part 4: Chart Projections (1)

Practical Geodesy

In previous articles we have seen how to describe the shape of the earth and how to identify coordinates and heights. This is usually enough for the automated processing and storage of geographic data. But humans are a visual species and we want to see a map on paper or on a computer screen.

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The largest globe in the world, the Unisphere in New York (source: www.bretl.com).

It is, however, not all that easy to construct an image of a spherically-shaped object, such as the earth, on the flat surface of a piece of paper or a computer screen. Try to flatten an orange peel on a tabletop (preferably not that of your employer). During the flattening, also called projecting in geodesy, the peel will distort and fracture.

Globe

The only correct image of the earth is obtained on a spherical surface such as a globe. This is the main reason why this method was the most popular way of portraying the earth until well after the middle ages. The advantage of the globe is that it represents the world in the correct context; there are no distortions, distances are displayed correctly and continents have their true shape. There are, however, some disadvantages to using a globe. Distances are displayed correctly but are hard to obtain. Determining an area is even harder due to the curvature of the globe, but perhaps the greatest disadvantage is that we need a huge globe to display small states correctly. Even on the largest globe in the world, the Unisphere in New York City which has a diameter of 120 feet or 36.57 meters, a small state is only a few decimeters in length. This means that it can show no more detail than the average roadmap on a globe whose size is fairly impractical for day-to-day use.

Projection

For day-to-day use we need a method to project the sphere (ellipsoid) onto a flat surface. We have already seen that this cannot be done without creating some kind of distortion. The trick is to keep the distortions to a minimum.

Depending on the purpose, and therefore on which distortion needs to be minimal, there are three main types of projection. The three types are:

- Conformal projections or true angle projections.
- Equivalent projections or true area projections.
- Equidistant projections or true length projections.

Conformal Projections

In this type of projection, directions and angles are projected undistorted onto the map. Meridians and parallels will therefore cut each other at right angles. The most common conformal projection is the Mercator projection. Almost all sea charts are based on this projection, making it possible to plot compass courses directly onto the chart and vice versa.

Equivalent Projections

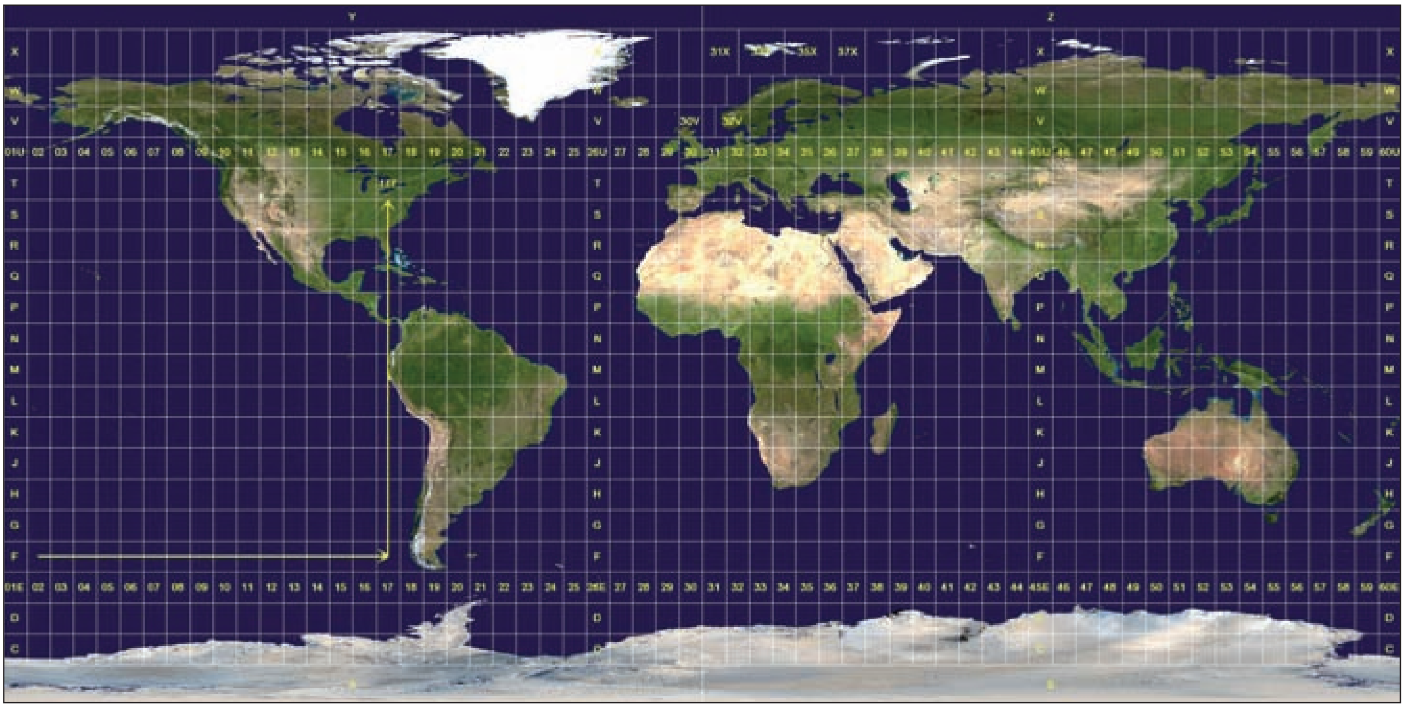
These projections display areas correctly. This does not necessarily mean that the length and width are displayed correctly; only that the product is displayed correctly. Geographers often use this type of projection since the (area) scale of the chart is constant throughout the chart and, as such, countries are displayed in their correct size although not their correct shape. Examples of popular equivalent projections are the Albers and the Mollweide projections.

Equidistant projections

In this projection, the distance between two points along one or more lines remains undistorted. Examples of equidistant projections are the Plate Caree and the equidistant polar projection for displaying areas around the North and South Poles.

Projection Type

Another method for classifying projections is based upon the surface on which the projection is made. Again, there are three main



Zoning within the Universal Transverse Mercator projection (source: wikipedia).

types of projection surface:

- Cylinder
- Cone
- Flat surface.

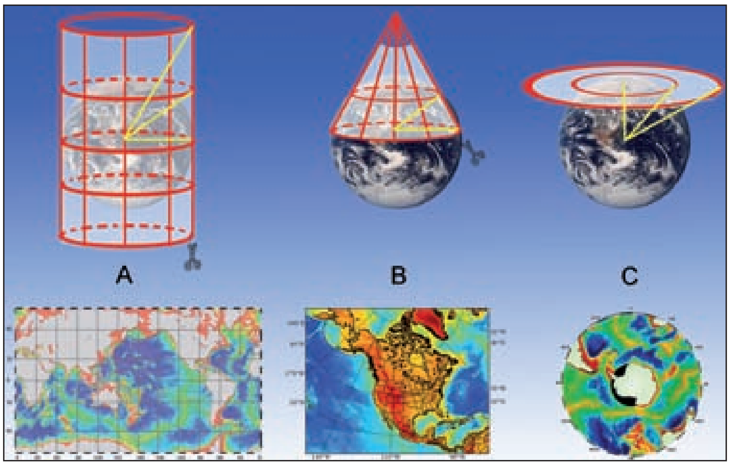
A projection is constructed by drawing an imaginary line from the center of the earth towards the point to be projected on the earth's surface. By extending this line until it intersects the projection surface the point is projected. When all the points have been projected on, for example, a cylinder, the projection surface is cut open and spread out, thus creating the chart.

Cylindrical Projections

With cylindrical projections, a tube or cylinder is placed around the earth. Depending on the attitude of the cylinder with respect to the earth axis, the projection is called a longitudinal (cylinder axis parallel to the earth axis), transversal (axis parallel to the equator) or oblique projection (axis at a certain angle). The most important cylindrical projection is the Mercator projection. The longitudinal or normal Mercator projection is used for sea charts. The transverse Mercator is often used for countries such as Germany that are elongated in the north-south direction. The oblique version is used for elongated countries such as Indonesia that are not fully north-south or east-west.

Universal Transverse Mercator

A special form of the transverse Mercator is the Universal Transverse Mercator (UTM) projection. This is a transverse Mercator projection with a number of fixed parameters. The earth is, for example, divided into zones that are each 6° wide and 8° high. The first longitudinal zone, number 1, starts at the date line (180° east / west) and has a so-called central meridian at 177° west. The first latitude zone starts at the South Pole and is assigned the letter A. Coordinates within a longitudinal zone are defined by the number of meters the point is east of the central meridian and north of the equator on a certain ellipsoid. The North Sea oil and gas industry uses this projection quite often in combination with the European Datum 1950 (ED50). A projection that is closely related to the UTM projection is the Military Grid Reference System (MGRS) used by armies worldwide. With this projection, coordinates are only given within a latitude zone.



Different projection methods and the resulting chart images. A: Longitudinal Mercator; B: Lambert conformal; C: Azimuthal polar projection.

Conical Projections

Conical projections use a cone as the projection surface. Depending on the actual projection, this cone touches the earth (one parallel) or cuts through it (two parallel). Conical projections are often used for countries that are elongated in an east-west direction such as Belgium, which uses the Lambert projection. Another conical projection that is often used is the Albers projection.

Azimuthal Projections

Azimuthal projections use a flat projection surface where the projection is done from a central projection point. The projection point usually lies at the center of the earth but, for example, the stereographic projection uses a projection point that lies at the opposite side of the earth to the center of the projection. This type of projection is ideal for portraying areas where there is no preference for either a north-south or east-west direction, such as the area around the poles.

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