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Effects of the third rotation angle concerning the oblique aspect of a map projection

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1. Parameters that defines oblique aspect of a map projection

Oblique aspect is sometimes used in map projections, for example, aiming at reducing distortions at desired locations represented on a specific map. Functions of latitude and longitude that transform to the plane coordinates are used in a map projection, where simple functions can be derived in normal aspect because in this aspect poles and/or equator are used as the reference. When necessary, coordinate transformation on the sphere are applied to obtain transverse aspect formulas or oblique aspect formulas.

Many of existing literatures on map projection often explain that oblique aspect formulas are obtained by coordinate transformation that treats an arbitrary point on the sphere as if it is the new pole(*). This implies that the number of parameters specifying the transformation is two, namely latitude and longitude of the point. But rotation in three dimensional space is specified by three parameters, such as Euler angles. The first two rotation angles of the Euler angles correspond to the latitude and longitude parameters. Therefore the third rotation angle that rotates around the new z axis is left behind.

This means the third rotation is necessary if one wants to make complete oblique aspect transformation. Without the third rotation, north or south poles are always located on the central meridian on the map and this constrains free representation of a map. For example the so-called Atlantis projection that is a kind of oblique Mollweide projection requires the third rotation.

2. Examination on the effect of the third rotation angle

We now examine the effect of this third rotation on the map representation according to the categories of map projections.

The third rotation merely rotates the map around the center of the projection (standard point) in case of azimuthal projections where oblique aspects are often used. This does not change the shape and size of the figures drawn on the map. It rotates around center of the fan in case of conic projection and moves laterally in case of cylindrical projections and does not change the shape of figures on the map, too. The third rotation does not change the shape of figures on the map for these projections with high symmetry.

However, it actually changes the shape of figures in other map projections such as pseudo-cylindricals.

3. The meaning to consider the third rotation in oblique aspect

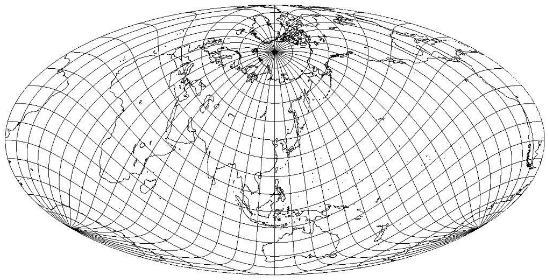
By comparing the cases using three rotations and two rotations, we consider the meaning and effect of the third rotation as follows.

(1) Some arrangement of land distribution on a map requires the third rotation in oblique map projection. Therefore this rotation is necessary.

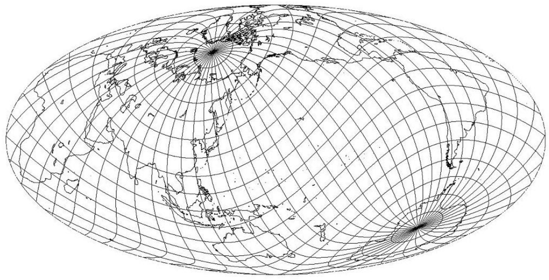
(2) Using three rotation angles for oblique aspect is theoretically consistent because spatial rotation is expressed by three rotation angles.

(3) Graticules of oblique Mollweide projection, for example, become complex curves and unfamiliar continent shapes are shown. But this is also a map representation that keeps the characteristics (eg. equal-area) of the projection. These representations may help to understand distortions of familiar map projections.

(*) Snyder (1987) properly writes with mathematical formulas that three rotation angles are required for oblique transformation.



Oblique Mollweide projection where 60W, 50N is represented as a pole
Antarctica is divided into two.



Oblique Mollweide projection where 60W, 50N is represented as a pole and 55 degrees rotated around it.
No continents are divided by the edge of the map.

Keywords: map representation, map projection, oblique aspect, Euler angles, spatial rotation