Generalized Equip-Difference Parallel Polyconical Projection Method for the Global Map

Hao Xiaoguang[①②] Xue Huaiping[①]
(①Institute of Geodesy and Geophysics, Chinese Academy of Sciences, Wuhan 430077)
(②Survey Department of Tongji University, Shanghai 200092)

Abstract

The present global map is characterized by using the longitude as vertical coordinate and utilizing the latitude as horizontal coordinate, its disadvantage is that a great deformation occurs in both north pole region and south pole region, and it isn't coordinated with the surrounding region relations. To overcome shortcomings, this paper puts forward a method to draw the global map by employing the latitude as vertical coordinate, give out concepts of generalized longitude and generalized latitude, derives the mathematical relation equations between generalized longitude-latitude and conventional longitude-latitude, draws the sketch of a new global map so that the generalized equip-difference parallel polyconical projection method for the global map is worked out. In this new global map, land figure and area of the whole world suit very well with that on the terrestrial globe, relationship among the lands is clear. For this reason, this new global map basically plays the role of a terrestrial globe, so it is called plane terrestrial globe.

Key words: latitude, vertical coordinate, global map

1. Introduction

The present global map[1-3] is usually characterized by using the longitude as vertical coordinate and utilizing the latitude as horizontal coordinate (the following is called the "meridian global map" for short). A defect of this global map is that great deformation occurs in both north pole region and south pole region, and it isn't coordinated with the surrounding region relations. For example, on the terrestrial globe the Ataractic continent's figure area is 1.8-fold as much as Australia's figure-area, but in literature [1-3] the Antarctic continent's figure-area is 3.8-fold as much as Australia's figure area. Besides, Antarctic continent's figure on the terrestrial globe looks like a peacock, but in the literature [1-3] it is different. Similarly, in literature [1-3] occurs a great deformation in the north of Russia, Canada and Greenland. In addition to this, in main map of literature [1-3] it is difficult to mark both the north pole and the south pole, and coordinative relation to the surrounding regions, for this reason, two circular auxiliary maps beyond the main map are used to show.

To overcome above mentioned shortcoming of the meridian global map, letting the latitude be vertical coordiilate and longitude be horizontal coordinate to draw the global map (the following is called "paralle1 global map"). A defect of parallel global map is that a large deformation occurs in regions of both the east end and the west end, and it isn't coordinated with the surrounding region relations.

Thus, the disadvantage of the meridian global map is just the right advantage of the parallel global map, and the reverse is also true (and vice versa). Both of them construct the "twin global map" with interdependence and complementarity. Owing to the small earth's flattening, the twin global map can be drawn using the earth as a sphere.

2. Mathematical relations between generalized longitude-latitude and conventional longitude-latitude

In the meridian global map the longitude line is meridian circle, latitude line is parallel circle, meridian lines intersect at north pole N and south pole S, for spherical coordinate, λ denotes the longitude (-180°, 180°), φ the latitude (-90°, 90°). It can be seen from Fig.1 that the relation between rectangular coordinate and longitude-latitude is as follows

$$x = R\cos\varphi\cos\lambda\,,\quad y = R\cos\varphi\sin\lambda\,,\quad z = R\sin\varphi \qquad (1)$$

$$\varphi = arctg(\frac{z}{\sqrt{x^2+y^2}})\,,\quad \lambda = arctg(\frac{y}{x}) \qquad (2)$$

Where R is mean radius of the earth.

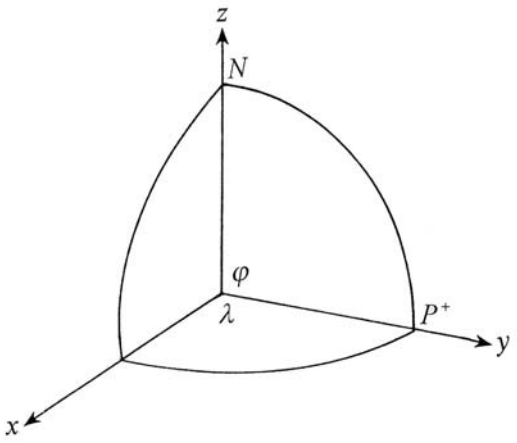

Fig.1
Conventional longitude-latitude

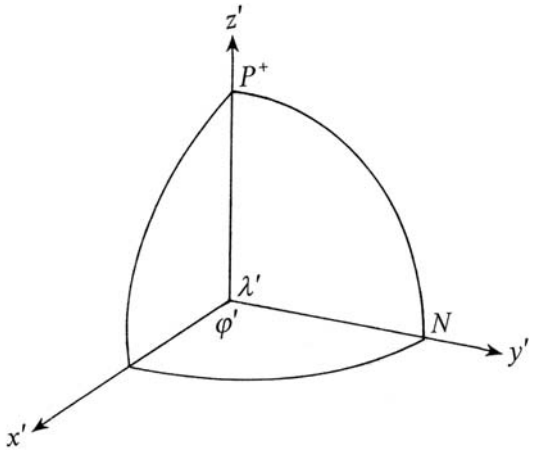

Fig.2
Generalized longitude-latitude

The parallel global map is the "reverse" of the meridian global map, a point P^+ taken from the equator is "positive pole" of the parallel global map (its role corresponds to the north pole of the meridian global map), passing through the point P^+ and spherical core connecting straight line intersect at another point P^- of the equator, this point is "negative pole" of the parallel global map (its role corresponds to the south pole of the meridian global map), λ' denotes the generalized longitude (-90°, 90°) , φ' the generalized latitude (-180°, 180°), in the parallel global map, the "generallzed latitude line" is "generalized meridian circle", "generalized longitude line" is "generalized parallel circle". The

generalized meridian lines converge and intersect at point P^+ and P^-.

To concisely express relations between generalized longitude-latitude and conventional longitude-latitude, taking the point (λ=90°, φ=0°) as point P^+, then the point (λ=-90°, φ=0°) is point P^-, it can be seen from Fig.2 that relation between rectangular coordinate and generalized longitude-latitude is shown in the following

$$x' = R\cos\varphi'\cos\lambda',\quad y' = R\cos\varphi'\sin\lambda',\quad z' = R\sin\varphi' \qquad (3)$$

$$\varphi' = arctg(\frac{z'}{\sqrt{x'^2 + y'^2}}),\quad \lambda' = arctg(\frac{y'}{x'}) \qquad (4)$$

we know from Fig.1 and Fig.2 that

$$x' = -x,\quad y' = z,\quad z' = y \qquad (5)$$

substituting (5) in (1) we have

$$x' = -R\cos\varphi\cos\lambda,\quad y' = R\sin\varphi,\quad z' = R\cos\varphi\sin\lambda \qquad (6)$$

substituting (6) in (4) we get

$$\varphi' = arctg(\frac{\cos\varphi\sin\lambda}{\sqrt{\cos^2\varphi\ \ \cos^2\lambda + \sin^2\varphi}}),\quad \lambda' = arctg(\frac{\sin\varphi}{\cos\varphi\cos\lambda}) \qquad (7)$$

the expression mentioned above is mathematical relation equation of calculating generalized longitude-latitude by conventional longitude-latitude.

Substituting (5) in (3) we have

$$x = -R\cos\varphi'\cos\lambda',\quad y = R\sin\varphi',\quad z = R\cos\varphi'\sin\lambda' \qquad (8)$$

substituting (8) in (2) we obtain

$$\varphi = arctg(\frac{\cos\varphi'\sin\lambda'}{\sqrt{\cos^2\varphi'\ \ \cos^2\lambda' + \sin^2\varphi'}}),\quad \lambda = arctg(\frac{\sin\varphi'}{\cos\varphi'\cos\lambda'}) \qquad (9)$$

the above mentioned expression is mathematical relation equation of calculating conventional longitude-latitude by generalized longitude-latitude.

3.Concise map

The mathematical method for drawing the parallel global map is that first we transform conventional longitude-latitude into generalized longitude-latitude for topographic point and longitude-latitude net by use of (7), and then, based on "generalized longitude-latitude" of topographic point and conventional longitude-latitude net, the parallel global map is drawn up using equip-difference parallel polyconical projection method[4]. The "generalized longitude-latitude" defined in this paper is only a transitive mathematical method for projection transform, but "generalized longitude-latitude net" never appears in the parallel

global map. Not to lose the universality, this projection method can be called "generalized equip-difference parallel polyconical projection".

To enable "both positive pole and negative pole" of the parallel global map to fall into the sea, avoiding a huge land deformation in east-west direction, we take the point (λ=60°, φ=0°) as P^+ point, then the point (λ=-120°, φ=0°) is P^- point. In literature [1-3], east longitude 150° line is central vertical coordinate line and equator is central horizontal coordinate line (see Fig.3). Then exchanging the central horizontal coordinate line for central vertical coordinate line, according to the generalized equip-difference parallel polyconicat projection method, a concise scheme of parallel global map with naught-latitude as central vertical coordinate line (naught latitude global map) can be drawn up, see Fig.4.

Fig.5 is a concise scheme of meridian global map with naught longitude as central vertical coordinate line (naught longitude globat map)[5].

To express each nation without being separated from the land in the global map, choosing north latitude 60° as central vertical coordinate line, a parallel global map can be made, see Fig.6.

Since the distinction between generalized equip-difference parallel polyconical projection method and conventional equip-difference parallel polyconical projection method is only to exchange longitude to latitude for vertical coordinate, therefore, deformation of the parallel global map and meridian global map are on the whole the same.

Present Chinese global map is "surrounding the Pacific ocean pattern" (see Fig.3), and naught longitude global map is "surrounding the Atlantic ocean pattern" (see Fig.4). But two-thirds of the world lands are in the North Hemisphere, thus "surrounding the Arctic ocean" is very important. Fig.6 is just the global map of "surrounding the Arctic ocean pattern".

4.Discussion

It can be shown from Fig.6 that by use of the parallel global map, the lands of the whole world can be drawn up on a plane completely without producing the huge deformation in area and figure similar to those in the Antarctic continent, north Russian, north Canada and north Greenland shown in literature [1-3], also without producing the similar condition to that Greenland in literature [1-3] is divided into two parts. South pole and north pole, and its coordination with the surrounding region relations in Fig.6 are very clear, it is no longer to need auxiliary scheme to complement the main map in literature [1-3].

In the meridian global map, the east-west direction is relative. In the parallel global map, the south-north is relative. The earth is a sphere, "south-north" and "east-west" should be completely "equal". If it is said that "south-north" is absolute, then "east-west" is also absolute, if it is said that "east-west" is relative, then "south-north" is relative. For example, going toward east from Wuhan can reach Shanghai, similarly, going toward west around the earth (a circuit) also reaches Shanghai. For instance, going toward north from Wuhan can arrive in Beijing,

similarly, going toward south around the earth (a circuit) can arrive in Beijing. Maybe, one viewpoint considers that earth rotation is from west to east, therefore south-north direction is absolute, east-west direction is relative, in fact, the earth is not only rotation, but also revolution, the solar system the earth is located in is moving, the Galaxy the solar system is placed in is moving, too. These movements shouldn't be connected with earth's direction together. Since the earth is basically an inertial system. It can be seen from Einstein's relativity principle that in inertial system any physical experiment done can't determine the movement state of the inertial system itself[6]. Thus, people on the earth don't feel whether the earth is moving, earth rotation doesn't influence people's direction feeling.

Phylosophically, the parallel global map and the meridian global map belong to the category of a pair unity of opposites. Mathematically, it is an exchange of horizontal coordinate axis of the global map for vertical coordinate axis. In cartography, coordinate "exchange axis" isn't bringing forth new idea, for example, vertical coordinate of Gauss projection is X axis, its horizontal coordinate is Y axis.

In Fig.6, the figure and area of lands in the whole world is similar to those of lands on a terrestrial globe, relationship among the lands is clear, so it is called "plane terrestrial globe".

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The first author: Hao Xiaoguang, male, Dr. of science, senior engineer, was born in May, 1958, graduated from Survey Department of Tongji Univ. in 1982. Principal fields: Geodesy and Earth Gravity.

Address: Institute of Geodesy and Geophysics, Chinese Academy of Sciences, Xudong Road 174, Wuhan Hubei 430077, P.R.China

Tel:86-27-86783401, **Fax:**86-27-86783841, **E-mail:**hxg@asch.whigg.ac.cn

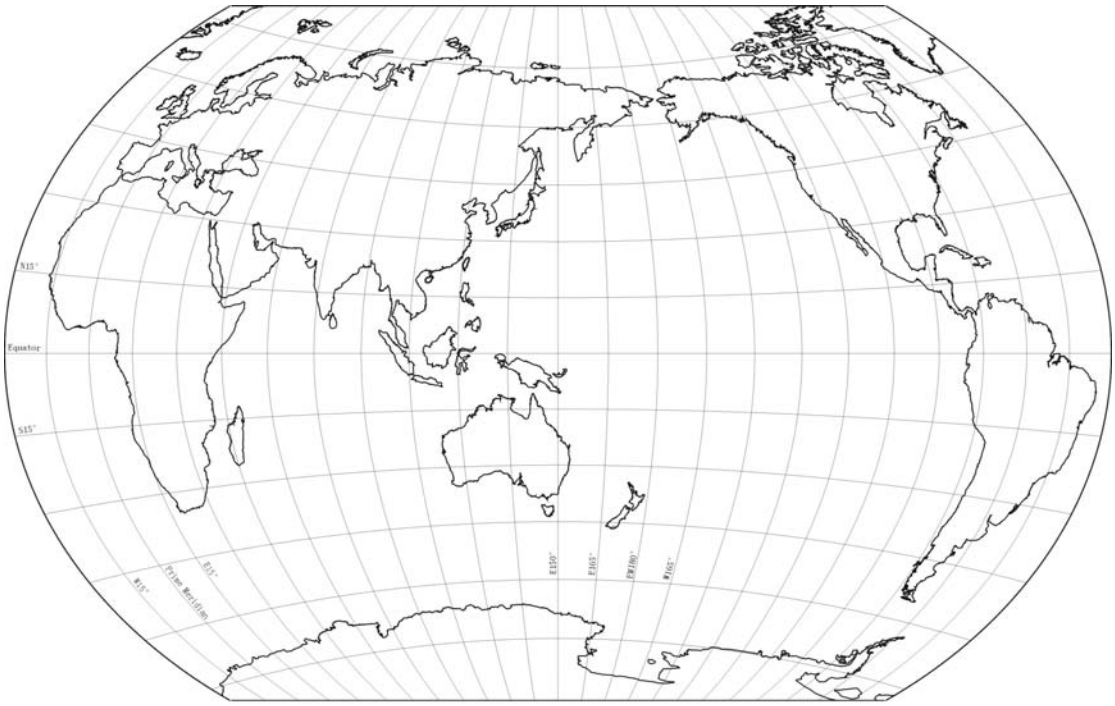

Fig.3 Present Chinese Global Map

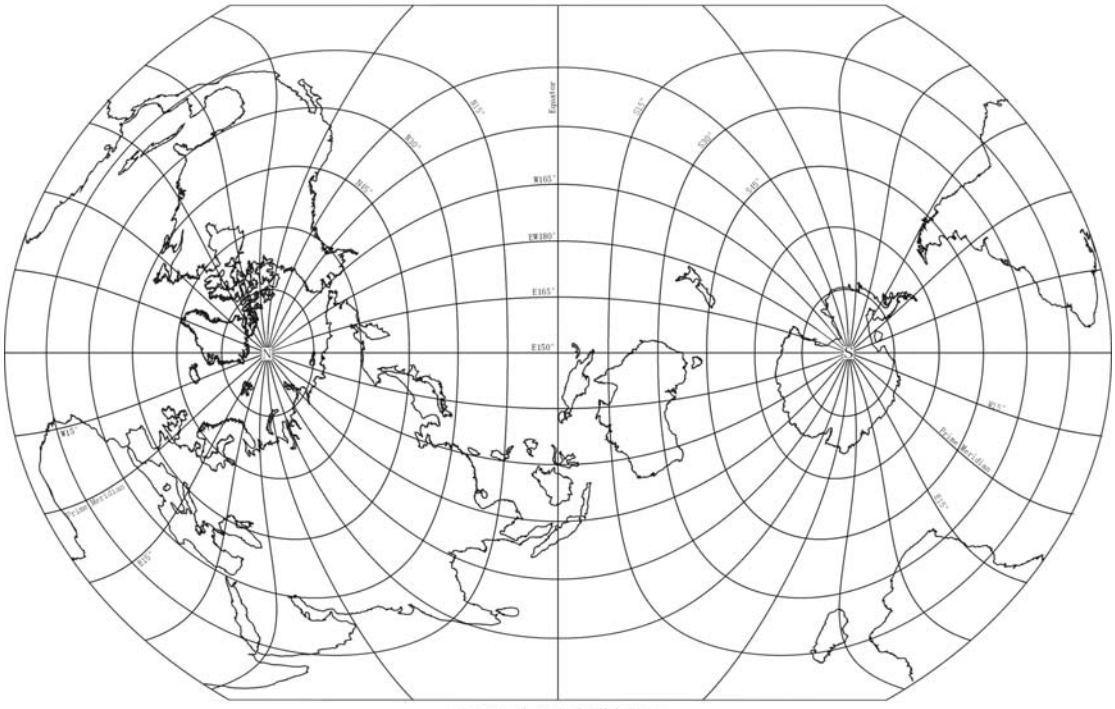

Fig.4 Naught Latitude Global Map

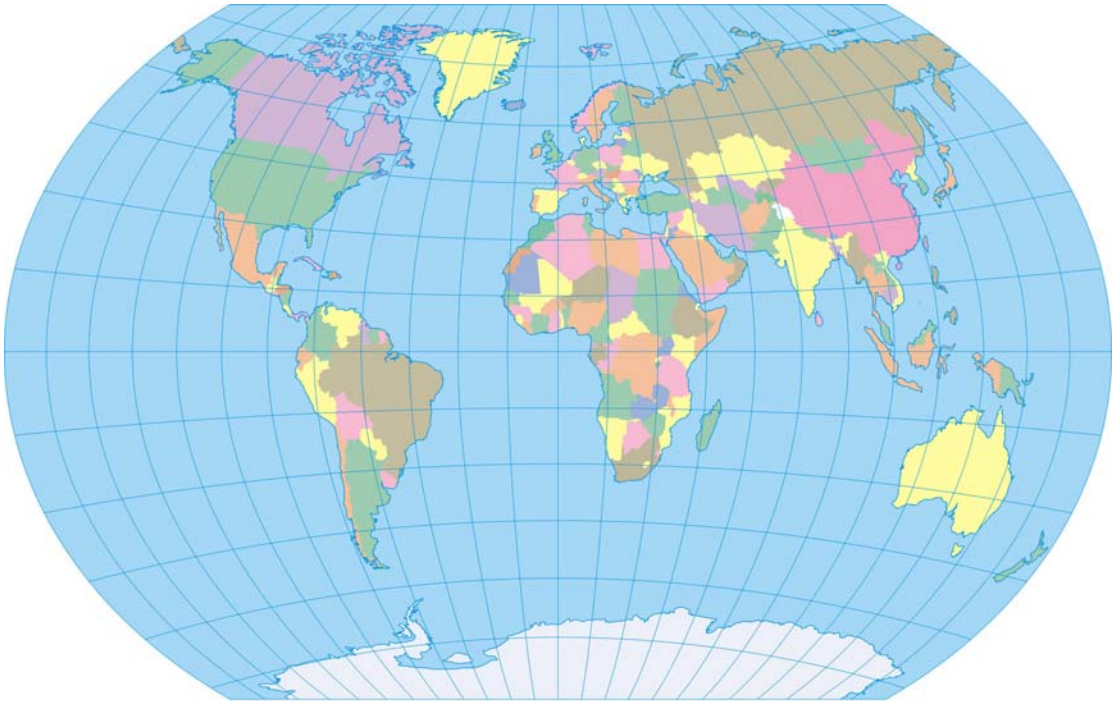

Fig.5 Naught Longitude Global Map

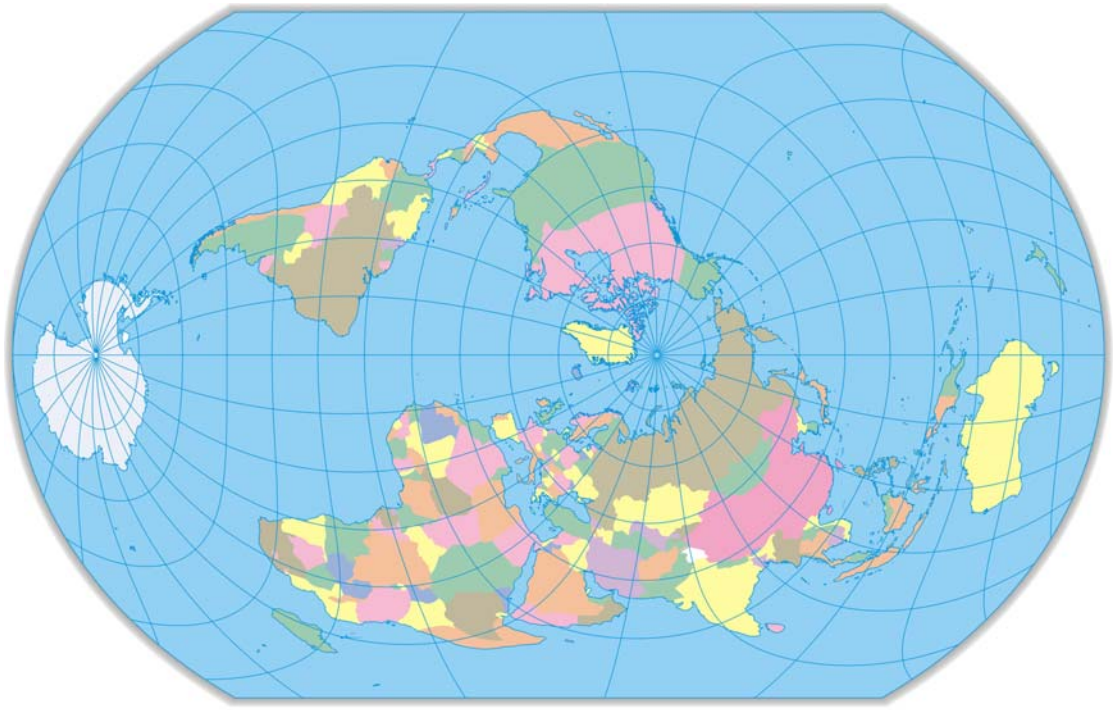

Fig.6 Plane Terrestrial Globe