

Subject: Problem of grid option in **plot3d**

Hi MaplePrimes team,

I am struggling to display a correct projection of a sphere on a tangent plane disc of with Maple's **plot3d**, but the resulting grid is not correct somewhere despite of the increasing of number of grids. See picture below:

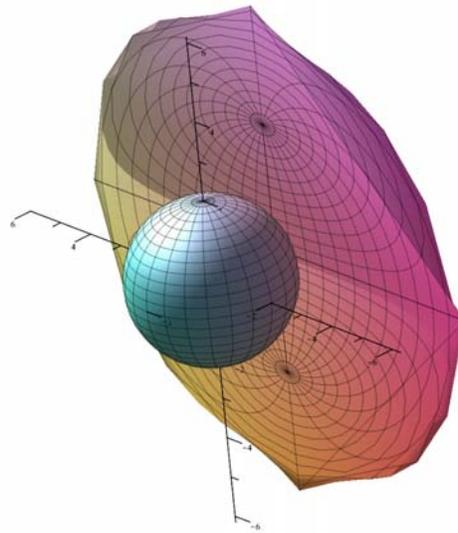


Fig. 1: The sphere projection on a tangent plane shows a grid problem.

How can I do to fix the problem of undesired grid when the mathematical equation is correct?

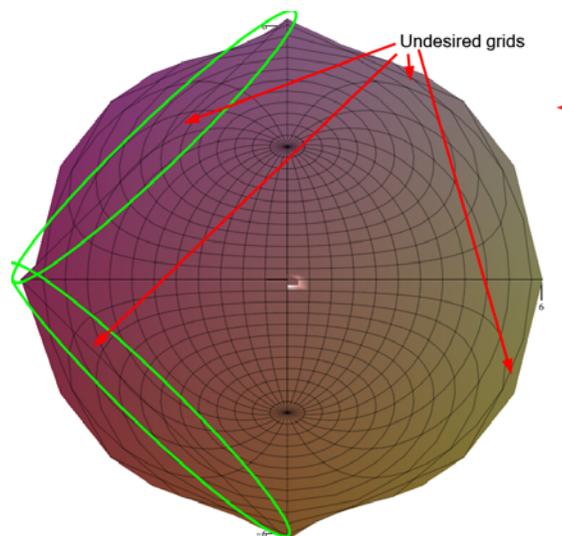


Fig. 2: Default 49-grid for Lambert projection showing wrong grids.

To increase the number of grids such that grid = [1000, 1000], grid = [2000, 2000] or higher, or the idea of removing just one row grid row or one column grid like [299, 299] changes absolutely nothing. It still results some crossing meshes that hide desired projected map. Even the use of the option *numpoints* fails.

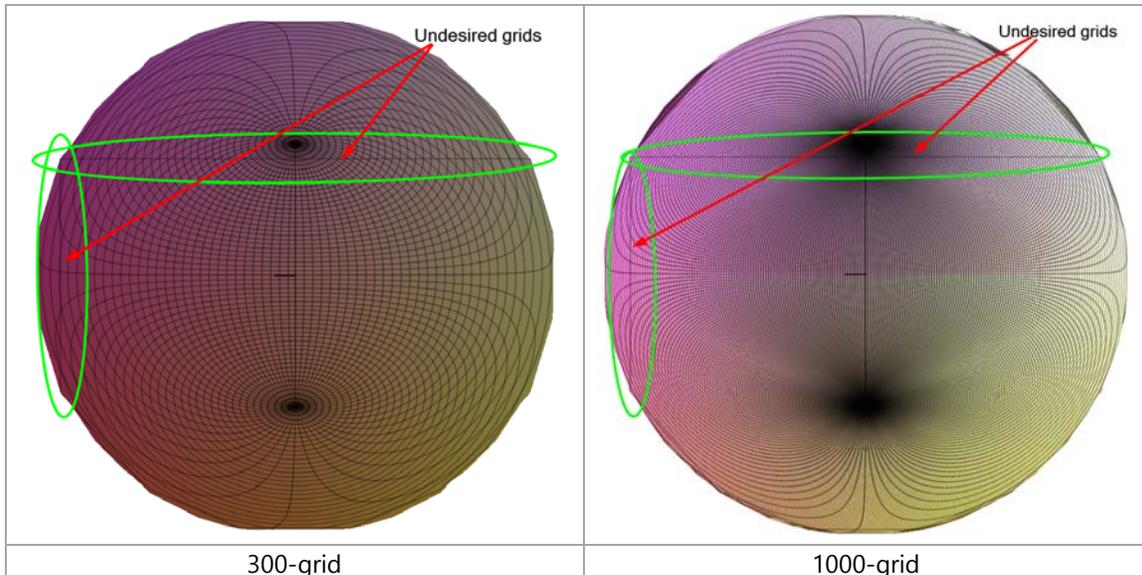


Fig. 3: Higher grid for Lambert projection showing wrong grids.

Here, my parametric equations:

- The **sphere** equation is

$$S := (\theta, \varphi) \rightarrow R * e_r(\theta, \varphi)$$

Where,

The unit radial vector (US coordinates system) is:

$$e_r := (\theta, \varphi) \rightarrow \cos(\theta) * \cos(\varphi) * e_x + \cos(\theta) * \sin(\varphi) * e_y + \sin(\theta) * e_z:$$

$$e_x := <1, 0, 0>: \quad e_y := <0, 1, 0>: \quad e_z := <0, 0, 1>:$$

- θ : latitude or elevation variable;
- φ : longitude or azimuthal variable
- R is the radius

Then,

- The projection on **plane** (Lambert projection) is

$$P := (\theta, \varphi) \rightarrow X_0 + R * \alpha(\theta, \varphi) * e_p(\theta, \varphi):$$

Where

$X_0 := S(\theta_0, \varphi_0)$ Free tangent point belonging both to the sphere and the plane disc.

$\alpha := (\theta, \varphi) \rightarrow \arccos(\cos(\varphi - \varphi_0) \cdot \cos(\theta) \cdot \cos(\theta_0) + \sin(\theta) \cdot \sin(\theta_0))$:

α is the arc angle of radius R between X_0 and any point on the sphere.

$e_p := (\theta, \varphi) \rightarrow e_N(\theta, \varphi) \&x e_{r0}$: Crossproduct

e_p is the polar direction from fixed point X_0 to any point $X = S(\theta, \varphi)$ on the sphere

```
e_N := (\theta, \varphi) -> if      evalf(abs(\varphi - \varphi_0) - \pi) = 0 then
                        e_{\theta_0} #Arbitrary elevation unit vector, but unimportant now.
                        else  UNITVECTOR(e_{r0} &x e_r(\theta, \varphi))
                        fi:
```

Where,

The unit tangential elevation vector

$e_{\theta_0} := -\sin(\theta_0) \cdot \cos(\varphi_0) \cdot e_x - \sin(\theta_0) \cdot \sin(\varphi_0) \cdot e_y + \cos(\theta_0) \cdot e_z$:

The unit radial vector at X_0

$e_{r0} := e_r(\theta_0, \varphi_0)$

Note that **implicitplot3d**-based method is not really preferred here because it is very high cost in grids unlike the parametric equation method which responds in few seconds at high grid number ~ 2000 with modern computer.

My Goal:

My final objective is to plot a world map projection of the Earth called **Lambert Azimuthal Equal-Area** (abbreviated **LAEA**) projection following any geographic coordinates involving the latitude = φ and the longitude = λ , all input angle can be in degree angle, but internally compiled in radian.

For that, I insert an initial **equiarectangular projection** of world map in the Maple's **plot3d** option.

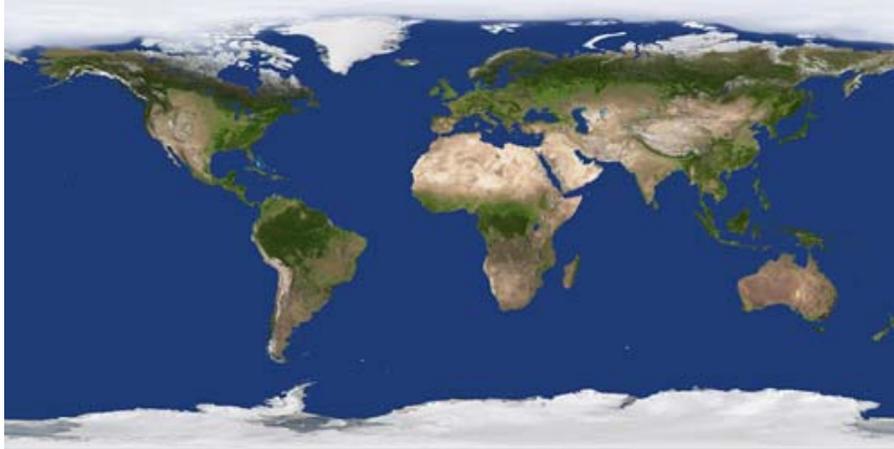


Fig 4. Initial equirectangular projection of world map (low 500-pixel image for test and large 1000-pixel or higher resolution for definitive image).

The astute now is to arrange the ranges such that the surface equation is defined on

$$\phi = -\pi/2 \dots \pi/2 \quad \text{and} \quad \lambda = 0 \dots 2\pi$$

And taking account the image scanning (Width x Height) have to be swept however in the range:

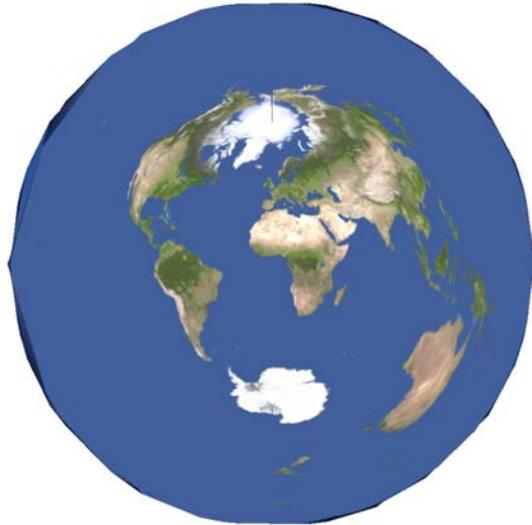
$$\lambda = 0 \dots 2\pi \quad \text{then} \quad \phi = 0 \dots \pi,$$

Then, I get this instruction without to detail all options:

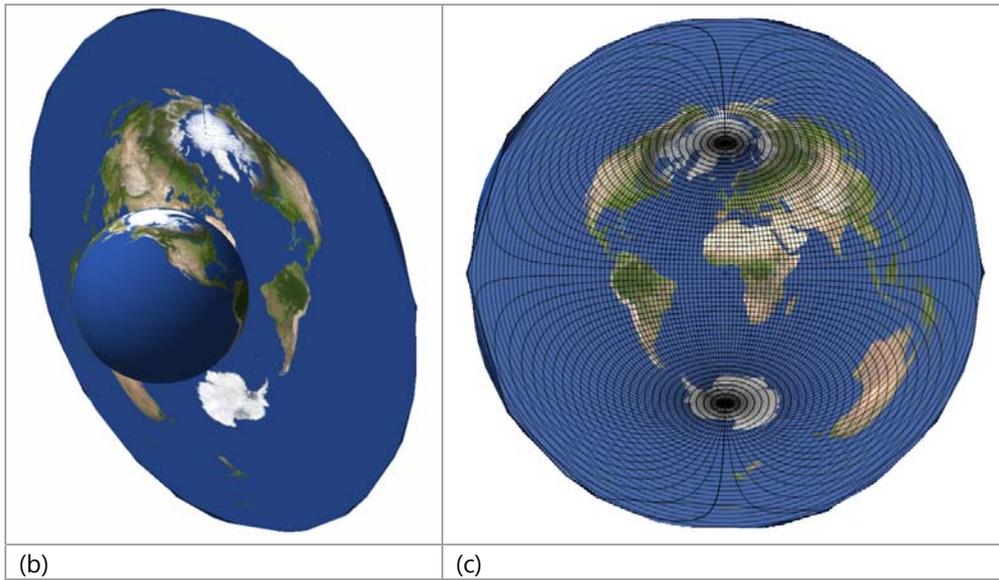
plot3d($S(\phi - \text{Pi}/2, g(\lambda - \text{Pi}))$, $\lambda = 0 \dots 2*\text{Pi}$, $\phi = 0 \dots \text{Pi}$, **image** = "C:\....\World_map.jpg", ...)

where g is a longitudinal λ -periodic function on $0 \dots 2\pi$ in the objective to keep the continuity of the map at any longitude.

Here, the first result of LAEA projection at $\varphi = 0$ and $\lambda = 0$



(a)



(b)

(c)

Fig 5. LAEA projection near latitude = 0 and longitude = 0 shows negligible grid failure at circular edge.

So now, the problem begins worse when input begins far from $(0^{\circ}, 0^{\circ})$, for instance $(60^{\circ}, -90^{\circ})$.

In fact, the overall resulting map seems to be correct, but it is unfortunately hidden by an unnecessary secondary grid layer trending an undesirable shortcut grid lines explained at the beginning of this report.

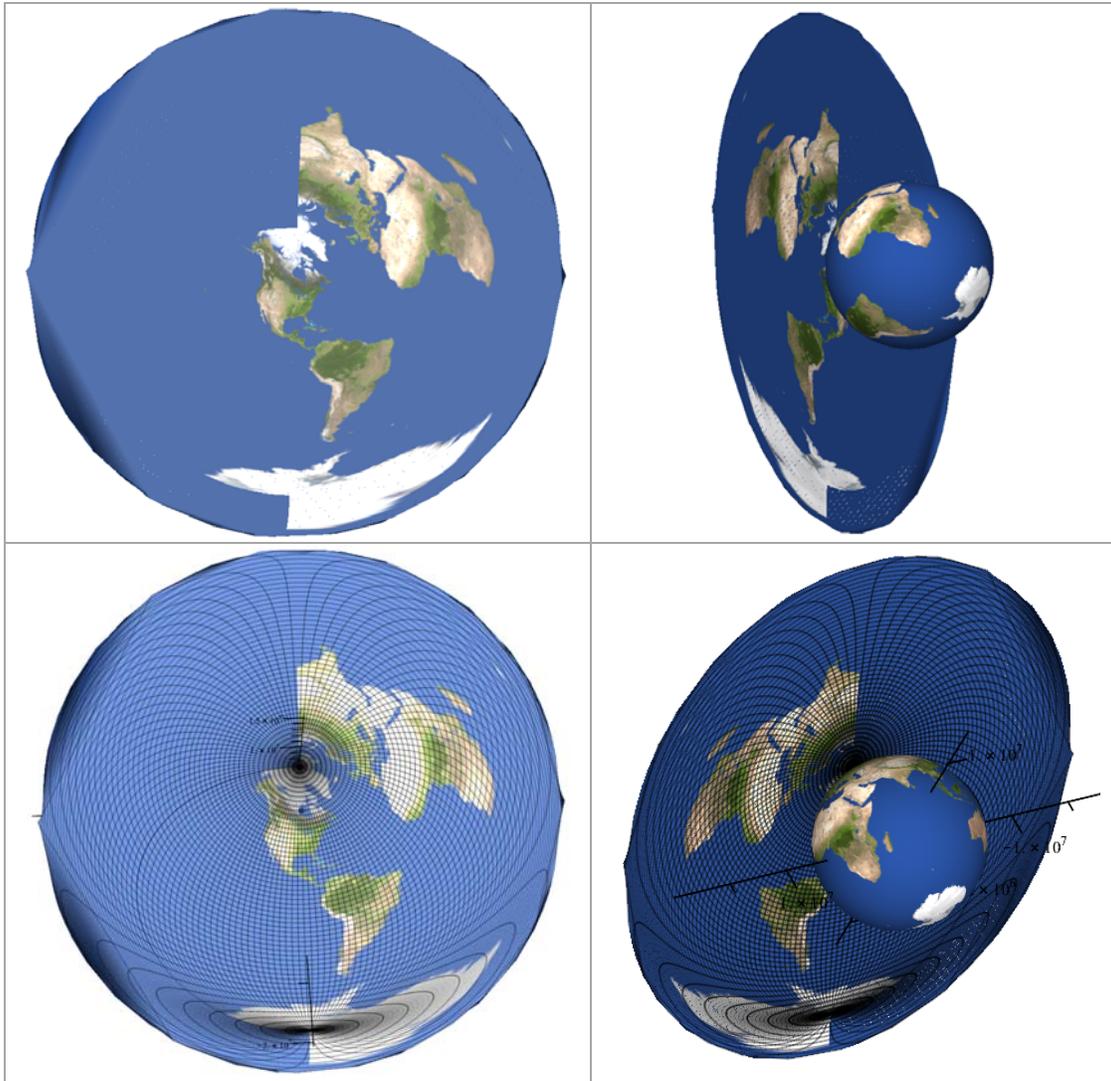


Fig 6. Wrong grids seem to be the source of mask problem for LAEA projection at any φ, λ .

Thank you for your time.

Best.

Guy.