

Neutrino Raycast Against Polar Stereographic Heightfield

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1 Data Format

Antarctic elevation and ice sheet data are provided by BEDMAP 2 in Antarctic polar stereographic projection. The projection plane is located at 71° south latitude and rays are cast down from the north pole to intersect the projection plane and ellipsoid. The angle is in ellipsoidal coordinates determined by WGS84.

2 Neutrino Raycast

The 3D raycast is parameterized with an initial position \vec{r}_0 , a direction \hat{d} , and a parameter τ , yielding

$$\vec{r}(\tau) = \vec{r}_0 + \tau \hat{d} \quad (1)$$

This ray traverses flat, unmodified 3D cartesian space, meaning that distance traversed by the ray is equal to τ .

The same ray may be parameterized in terms of normalized cartesian coordinates, meaning that the \vec{r}_0 terms r_x and r_y are divided by the equatorial radius R_{eq} of the WGS84 ellipsoid, and the r_z term is divided by the polar radius R_{po} . This yields a magnitude of radius relative to the local ellipsoidal radius, and a ray that intersects the ellipsoid where $r_{ellipsoidal}(\tau) = 1$. The magnitude of $r_{ellipsoidal}$ may be determined as follows:

$$r_{ellipsoidal} = \sqrt{\frac{r_x^2 + r_y^2}{R_{eq}^2} + \frac{r_z^2}{R_{po}^2} + 2t \left(\frac{r_x d_x + r_y d_y}{R_{eq}^2} + \frac{r_z d_z}{R_{po}^2} \right)} \quad (2)$$