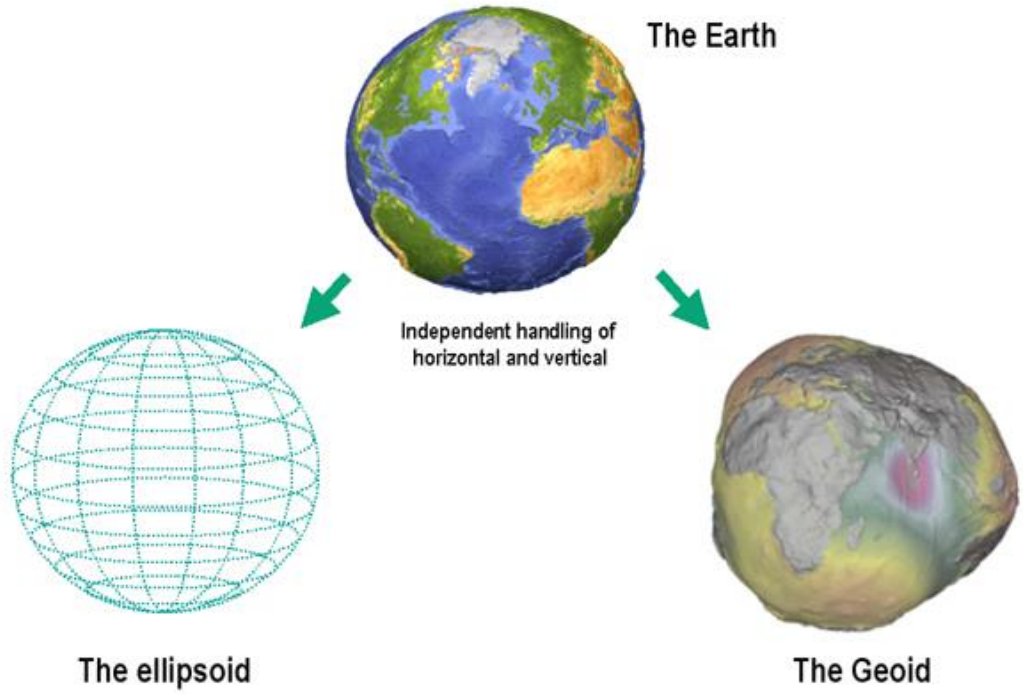
SPHEROID AND GEOID

The geoid is defined as the surface of the earth's gravity field, which is approximately the same as mean sea level. It is perpendicular to the direction of gravity pull. Since the mass of the earth is not uniform at all points, and the direction of gravity changes, the shape of the geoid is irregular.

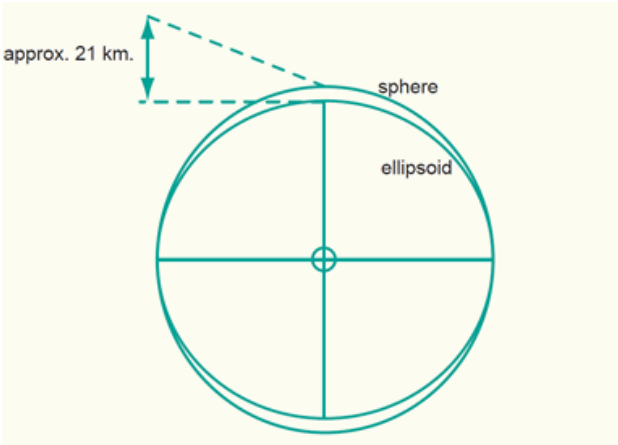
We can simplify matters by imagining that the entire Earth's surface is covered by water. If we ignore tidal and current effects on this 'global ocean', the resultant water surface is affected only by gravity. This has an effect on the shape of this surface because the direction of gravity - more commonly known as plumb line - is dependent on the mass distribution inside the Earth. Due to irregularities or mass anomalies in this distribution the 'global ocean' results in an undulated surface. This surface is called the Geoid. The plumb line through any surface point is always perpendicular to it.

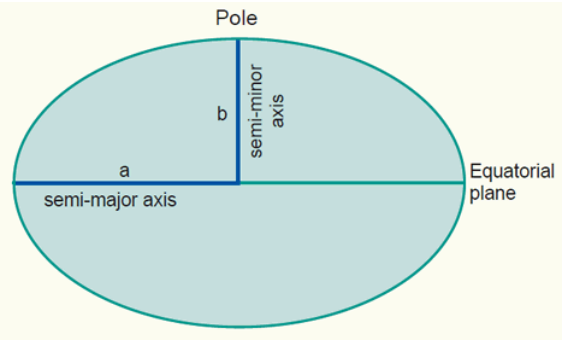
Where a mass deficiency exists, the Geoid will dip below the mean ellipsoid. Conversely, where a mass surplus exists, the Geoid will rise above the mean ellipsoid. These influences cause the Geoid to deviate from a mean ellipsoidal shape by up to +/- 100 meters. The deviation between the Geoid and an ellipsoid is called the geoid separation (N) or geoid undulation. The biggest presently known undulations are the minimum in the Indian Ocean with N = -100 meters and the maximum in the northern part of the Atlantic Ocean with N = +70 meters.



A spheroid is a three-dimensional shape created from a two-dimensional ellipse. The ellipse is an oval, with a major axis (the longer axis) and a minor axis (the shorter axis). If you rotate the ellipse, the shape of the rotated figure is the spheroid.

Above, we have defined a physical surface, the Geoid, as a reference surface for heights. We also need a reference surface for the description of the horizontal coordinates (i.e. geographic coordinates) of points of interest. Since we will later project these horizontal coordinates onto a mapping plane, the reference surface for horizontal coordinates requires a mathematical definition and description. The most convenient geometric reference is the oblate ellipsoid. It provides a relatively simple figure which fits the Geoid to a first order approximation, though for small scale mapping purposes a sphere may be used. An ellipsoid is formed when an ellipse is rotated about its minor axis. This ellipse which defines an ellipsoid or spheroid is called a meridian ellipse (notice that ellipsoid and spheroid are used here as equivalent and interchangeable words).





As can be seen from the dimensions of the Earth ellipsoid, the semi-major axis a and the semi-minor axis b differ only by a bit more than 21 kilometres. A better impression on the Earth's dimensions may be achieved if we refer to a more "human scale". Considering a sphere of approximately 6 metre in diameter then the ellipsoid is derived by compressing the sphere at each pole by 1 cm only. This compression is rather small compared to the dimension of the semi-major axis a.