3. PLANE RECTANGULAR COORDINATE SYSTEMS - *A) THE ELLIPSOID / GEOID*

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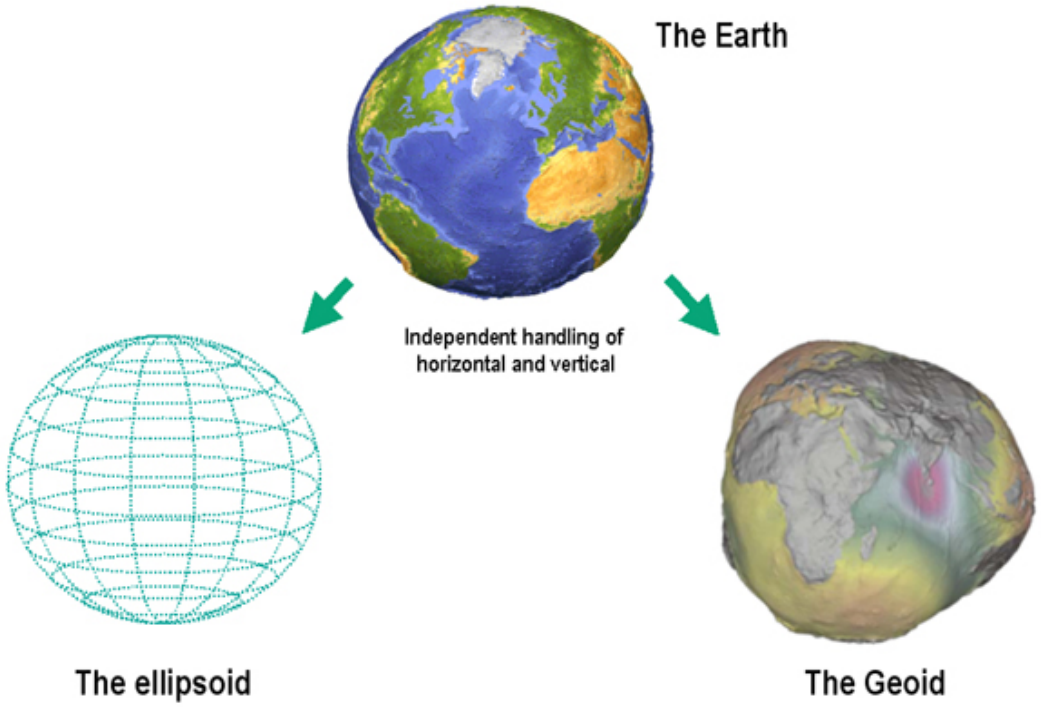
Up till now we have regarded the Earth as a perfect sphere, but it is not. It is not only flattened on the poles, but its surface is also irregular, and that is why we call it a geoid. In order to represent it with the least possible distortion, we try to project this geoid on an ellipsoid that fits our area best. There are both geoids that fit a particular part of the world best and geoids that fit the geoid best globally. For GPS measurements we opt for a global system.

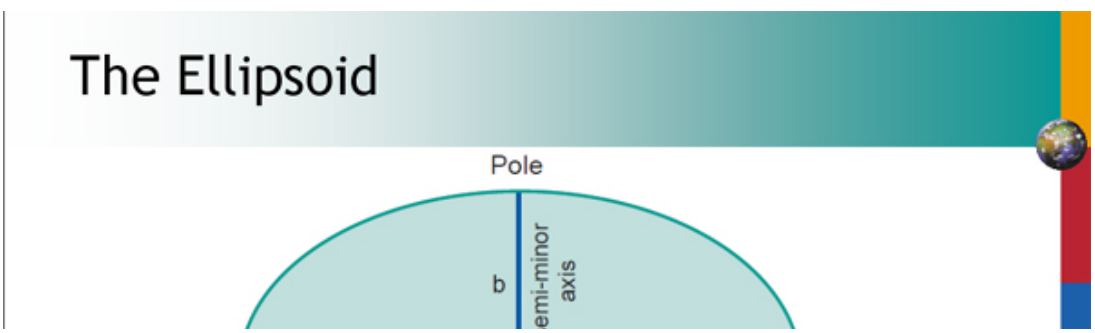


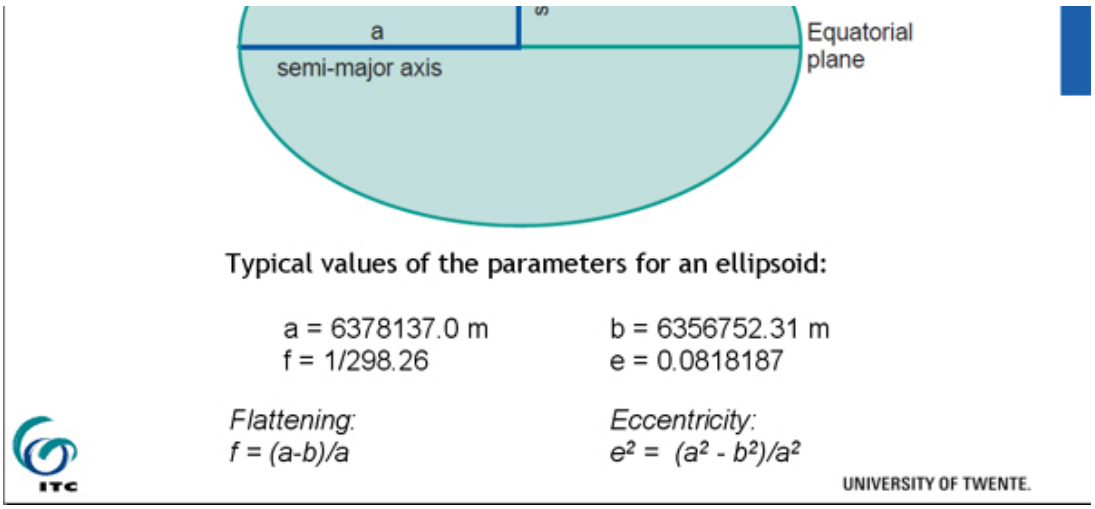
Source: Knippers, 2010

In words, Wiki defines an (reference) ellipsoid as:

> *"... a mathematically-defined surface that approximates the geoid, the truer figure of the Earth, or other planetary body. Because of their relative simplicity, reference ellipsoids are used as a preferred surface on which geodetic network computations are performed and point coordinates such as latitude, longitude, and elevation are defined.....*
>
> *..... Mathematically, a reference ellipsoid is usually an oblate (flattened) spheroid with two different axes: An equatorial radius (the semi-major axis a), and a polar radius (the semi-minor axis b)".*

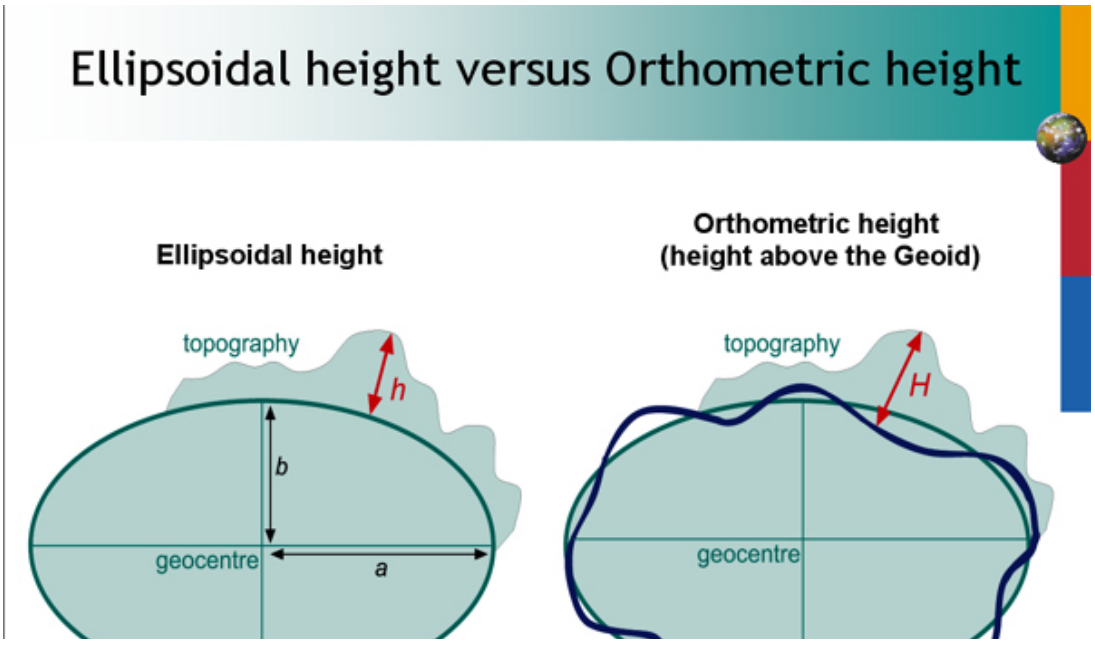
See image below for typical parameters for an ellipsoid.





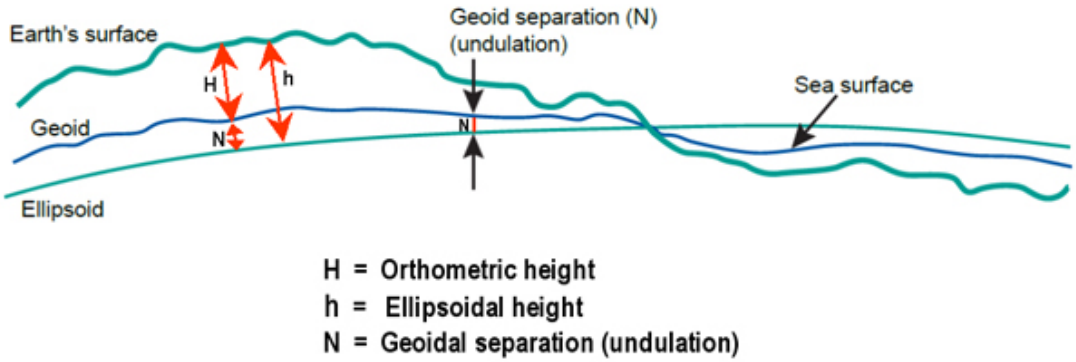
Source: Knippers, 2010

The Geoid is used to describe heights.



Source: Knippers, 2010

In order to establish the Geoid as reference for heights, the ocean's water level is registered at coastal places over several years using tide gauges (mareographs). Averaging the registrations largely eliminates variations of the sea level with time. The resulting water level represents an approximation to the Geoid and is called the mean sea level.

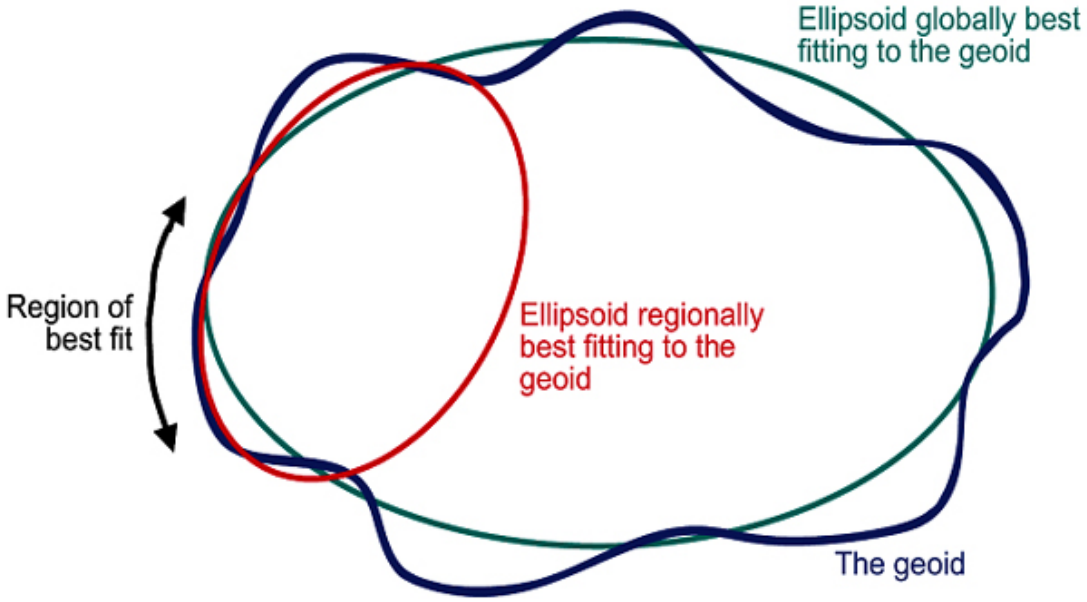


Source: Knippers, 2010

The geoidal undulation (N) is the separation between the geoid and an ellipsoid. It varies globally between ±110 m.

There are also several realizations of ***local*** mean sea levels (also called ***local vertical datums***) in the world. They are parallel to the Geoid but offset by up to a couple of meters. This offset is due to local phenomena such as ocean currents, tides, coastal winds, water temperature and salinity at the location of the tide-gauge.Care must be taken when using heights from another local vertical datum. This might be the case in the border area of adjacent nations.

Countries establish a horizontal (or geodetic) datum (see next paragraph), which is an ellipsoid with a fixed position, so that the ellipsoid best fits the surface of the area of interest (the country)



Source: Knippers, 2002

Commonly used ellipsoids are:

Name	*Date*	*a (m)*	*b (m)*	*Use*
Everest	1830	6377276	6356079	India, Burma, Sri Lanka
Bessel	1841	6377397	6356079	Central Europe, Chile, Indonesia
Airy	1849	6377563	6356257	Great brittain
Clarke	1866	6378206	6356584	North America, Philippines
Clarke	1880	6378249	6356515	France, Africa (parts)
Helmert	1907	6378200	6256818	Africa (parts)
International (or Hayford)	1924	6378388	6356912	World
Krasovsky	1940	6378245	6356863	Russia, Eastern Europe
GRS80	1980	6378137	6356752	North America
WGS84	1984	6378137	6356752	World (GPS measurements)

In the next paragraph more information is given on geodetic datums.

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