GPS Newsletter – General

A One Page Newsletter On System 500 GPS, Vol 01, No. 20.

Ellipsoidal and Orthometric Heights and Geoid Models

This newsletter continues on from newsletter Vol. 01, No. 19 and discusses **orthometric heights** and **geoid models.** Newsletter Vol. 01, No. 21 it will show how geoid models are used in SKI-Pro.

The Geoid and Orthometric Heights

Newsletter Vol. 01, No. 19 described that an ellipsoidal height is the height of a point above the (WGS84 or local) ellipsoid.

An orthometric height can be similarly described – it is the distance of a point above the **Geoid** measured along the plumb line through the point. This sounds straightforward, but first we must define what exactly is the Geoid. Is it the shape of the ground on which we physically walk? Or is it some other surface?

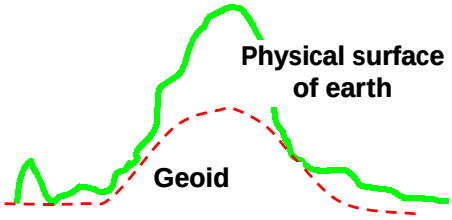
And then a big question to answer - how can we measure orthometric heights with GPS?

The Geoid

In geodetic terms a geoid is a **gravitational equi-potential surface** which roughly coincides with the global ocean surface. At any position on this surface, the gravitational force to the earth is the same as at any other position. This surface may be represented by a mathematical model which is called a **Geoid Model**.

Try to think of the geoid as a "levelling surface". If you were to use a level instrument and level all the way around the world, when you came back to your exact start point, you would (theoretically) have a closing error of 0. In effect you would have measured heights relative to a geoid. Whenever height differences are measured between two points with a levelling instrument, orthometric height differences are being measured.

Note, the geoid does not necessarily follow the physical shape of the ground. In mountainous regions, the level of the geoid may differ significantly from ground



level.

If a geoid model models the geoid over the whole of the earth, then this is called a **Global Geoid Model**. (**EGM96** is a global geoid model and is supplied on all SKI-Pro CDs) The advantage of these geoid models is that they are freely available and cover the whole of the earth, but may not be as accurate as required.

Many countries also provide geoid models valid only for that country or part of that country – these are called **Local Geoid Models** (the **Danish**, **Dutch**, **Swiss** and some **USA** geoid models are supplied on all SKI-Pro CDs). These geoid models tend to be more accurate than a Global Geoid Model, but can only be used over a limited area.

Of course, there are an infinite number of equi-potential surfaces. As already stated, the surface that is normally chosen for a global geoid model is the one that coincides best with the global ocean surface. However the surface that may be chosen for a local geoid model is the surface that is the best fit to that country's levelling datum.

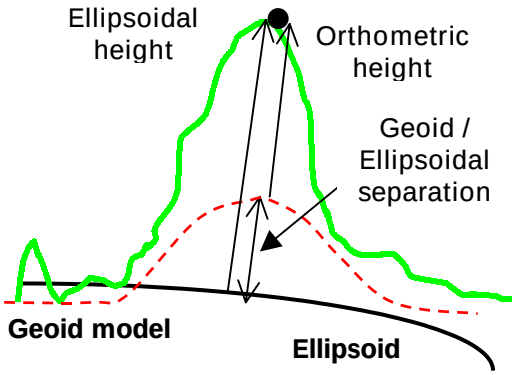
Orthometric Heights and GPS

As described in Newsletter Vol. 01, No. 19, points measured with GPS directly result in ellipsoidal heights. So how can GPS be used to measure orthometric heights? The answer is that it is only possible "indirectly" – by using a geoid model.

All geoid models describe the distances between the geoid and a reference datum - the **Geoid Separation** – normally called **N**. The reference datum is normally an ellipsoid and is the datum to which the geoid separations should be applied. For example, when creating a new geoid model in SKI-Pro, the **WGS84** ellipsoid should be selected to be used with **EGM96**. In the US, we are currently using Geoid 99.

So, measuring a point with GPS provides the ellipsoidal height of that point and knowing the geoid separation at that point (taken from the geoid model), it is then possible to compute the orthometric height of the point measured with GPS. Thus,

Ell height = Ortho height + N



Remember…

- An **orthometric height** is the distance of a point above the **Geoid** measured along the plumb line.
- The geoid is a gravitational equi-potential surface.
- Knowing the ellipsoidal height and the geoid separation, allows the orthometric height to be computed.

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