GPS Newsletter – General

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## The Onestep Transformation

Vol. 01, No. 8's newsletter explained the basics of the Classical 3D Transformation. In this Newsletter, we continue with an alternative approach which can be more useful in some situations: The **Onestep** Transformation.

## When to use it…

Imagine a site where the co-ordinates of the control points are based on a purely local grid. The co-ordinate values within this grid are totally arbitrary and are in no way connected with any ellipsoid or map projection. Obviously the Classical 3D approach cannot be used here, as Cartesian co-ordinates cannot be calculated from such a grid.

Or imagine some of the control points which you wish to use have only position co-ordinates or the height co-ordinate is unreliable. In such a case you would like to separate the position transformation from the height transformation.

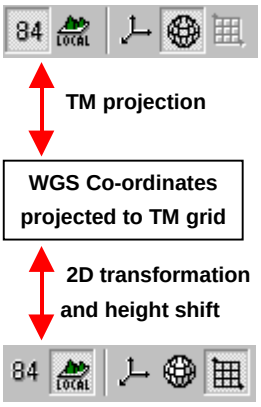
The **Onestep** transformation can be used for both these situations.

## How does it work?

It is important to remember that the **position** and **height** components of this transformation are treated separately.

For the **position transformation**, the WGS84 geodetic co-ordinates of the points to be used in the transformation computation are projected onto a grid using a temporary Transverse Mercator projection. The central meridian of this projection passes through the centre of gravity of the common points. This results in **preliminary grid co-ordinates** for the WGS84 points.

Then these **preliminary grid co-ordinates** are matched with the **local grid control points** in order to compute the **easting** and **northing shifts**, the **rotation** and the **scale factor** between these two sets of points. (This is known as a Classical 2D transformation).




If only **one** height control point is used, the WGS84 heights are simply shifted to fit to that one local height control point. If **two** height control points are used an average plane is computed, if **three** or more height control points are used, a best fitting tilted plane is computed to approximate the local heights.

## Any disadvantage?

The only real disadvantage of the Onestep approach is that it is limited to areas of about 10km square. This is mainly because no projection scale factor is applied and to compute the preliminary WGS84 grid co-ordinates, a standard TM projection is used.

How big can the errors grow if the area is extended? This is very hard to answer and mainly depends on how quickly the scale factor of the local points change within the area. However, the errors may sometimes quickly reach several centimetres.

Heights may also no longer be accurately modelled with the plane approximation. This problem can be resolved by using a local geoid model. (Use of geoid models is discussed in detail in a future newsletter)

## Transformations in General

Regardless of what transformation type is used, there are a few guidelines that should always be followed.

1. Firstly and most importantly is the **distribution of the common points**. Ideally the common points should surround the area in which you want to apply the transformation. Do not extrapolate transformations too far outside the area covered by the common points.

2. A Onestep transformation **can be used with only one common point**. Note however, that such a transformation cannot correct a local grid which is not rotated to the true Geodetic North, and additionally no scale factor can be calculated.

3. Always **check the residuals** after computing a transformation. On the sensor the residuals are shown in the **COORDSYS \Residuals** panel and in SKI-Pro Datum&Map in the **Results** view. The point with the biggest residual is not necessarily an outlier, but you may try to improve the transformation by excluding this point. Note that the remaining control points should still be evenly distributed.

## Remember…

- Neither the **Ellipsoid** nor the **Projection** have to be known to calculate a Onestep transformation.
- Common points can be given in **position and height**, in **position only** or even in **height only**.
- Applying Onestep transformations is limited to smaller areas than Classical 3D transformations.

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