Promoting the hypothesis that vertical can be the strongest component of a GPS determined position

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In a description of the "LSAW Conference RTK Network Discussion Roundtable" in a recent GPS World Newsletter, Eric Gakstatter identifies vertical accuracy as the weakest link in the use of RTK/RTN. That is the standard line and the experience of many users. Such does not need to be the case. The hypothesis is that vertical can be the strongest component if simultaneous data from all GPS satellites transmitting radially to the Earth are used.

"The 3-D Global Spatial Data Model: Foundation of the Spatial Data Infrastructure" is a book written by Earl F. Burkholder and published by CRC Press in April 2008. It describes how the geocentric Earth-centered Earth-fixed (ECEF) coordinate system can be used efficiently and beneficially to handle spatial data anywhere within the birdcage of GNSS satellites. Spatial data accuracy of any computed/derived point or quantity can be readily available via the stochastic component of the global spatial data model (GSDM).

Consider that current limitations on vertical accuracy are imposed by using only those data from satellites above the horizon at a given location. For vertical, the geometry is less than optimal and experience has confirmed the expectation that horizontal is stronger than vertical. However, if data from all satellites are collected simultaneously on a network of points around the Earth and if the network of points (including the RTN and the point occupied by the single user) is treated as a deformable solid, then vertical will ultimately be proven to be the strongest component.

We in the user community need to be careful what we ask for – such results will also show that the distance from the Earth's center of mass to a point on the surface of the Earth (ellipsoid height) has diurnal variations known as Earth tides. Practical usage will also need to consider absolute and relative issues. The absolute position undergoes diurnal changes but an adopted mean position will be more useful in most applications (an adopted mean is already standard practice in using the conventional terrestrial pole as opposed to the Earth's instantaneous spin axis and in publication of the ECEF coordinates of the DoD control stations – see Table 9.1 in the 3-D book). The scientific community is largely concerned with absolute positioning issues and the user community should be aware of them. However, the spatial data user community is typically more concerned with relative issues in two ways; 1) once the vertical position of a point is reliably determined, what is the current value with respect to what it was last week or last year and 2) what is the current value with respect to other points in the same project/region?

As stated in the 3-D book, ultimately spatial data users worldwide will use a single world vertical datum of ellipsoid heights. Changes will be due to earthquakes such as the recent one in Chile.

Additional references (and links to them) can be found on the Global COGO web site.

#29 "The Digital Revolution Begets the Global Spatial Data Model" published in the 15 April 2003 issue of EOS Transactions of the American Geophysical Union.

#34 "A 3D Datum for a 3D World" published in Geospatial Solutions Magazine, Vol. 14, No. 5, May 2004.

#44 "The Digital Revolution – Whither Now?" GIM Magazine, September 2006

#47 "Challenge/Opportunity for Spatial Data Users World-wide" by EFB posted January 2007.