Practical Considerations in Implementing a Geoid Monitoring Service

Kevin Ahlgren (USA)

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SUMMARY

The National Oceanic and Atmospheric Administration's (NOAA) National Geodetic Survey (NGS) is planning on incorporating a dynamic geopotential model as part of datum modernization in 2022. This time-dependent model, known as the Geoid Monitoring Service (GeMS), will encompass dynamic versions of a geoid model, a gravity model, deflections of the vertical (DOV), and a digital elevation model (DEM). The overall purpose of these dynamic models is to provide the most up-to-date information to surveyors and other geodetic professionals in order to support disaster management; smart, four-dimensional cities; and spatial infrastructure.

This paper will present the critical aspects of the GeMS project that will eventually be utilized to build a dynamic geopotential model. These aspects include the relevant geophysical phenomena that cause temporal changes to the geopotential field, the types of geodetic methods that can be used to observe these changes, and how to validate the accuracy of the model.

Any mass redistribution of the Earth's material can create changes to the geoid surface and geopotential field. The typical mass changes that drive geoid change at mm-levels are post-glacial rebound (PGR), present day ice-mass changes, changes in hydrology (including ground water storage, snow, etc.), large earthquakes, and volcanic eruptions just to name a few. These phenomena typically have a certain temporal signature being either secular, annual, seasonal, or instantaneous. For the secular signatures typically associated with large geographic features like PGR, satellite gravity provided by the GRACE and GRACE-FO satellites is ideal to observe these signals. At seasonal time signatures and short spatial wavelengths, more localized surveys and geophysical models must be included to capture changes to the geoid.

Ultimately, the magnitudes that NGS expects to see are at the mm/yr-level for geoid undulations,

microGal/yr-level for gravity, milli-arcsecond/yr-level for DOVs, and cm/yr-level for a DEM. While these magnitudes might seem too small to be of concern, the precision of geodetic instruments and infrastructure is increasing exponentially, and it was only a few decades ago that meter level was thought to be enough precision for the geoid.