Challenges of Producing Reliable Transformations in Greenland

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SUMMARY

The local reference frame in Greenland, GR96, is a plate-fixed reference frame equivalent to ETRS89 in Europe or NAD83 in North America, formally defined as ITRF94 with a reference epoch of 1996,623. The back-bone of GR96 is four monuments on the west coast of Greenland. Around 250 geodetic markers has been GNSS surveyed in the period 1996--2001 and given reliable GR96 coordinates using a Helmert transformation based on repeated measurements of the foundational monuments.

Transformations to and from GR96 has never been published, in principle making GR96 a passive reference frame only accessible through geodetic markers on the ground. Best practice for the last twenty years has been to use differential GNSS by placing a base GNSS-station at a marker that has an official GR96 coordinate. This has been sufficient up until now, however, there is an increasingly higher demand for access to the local reference frame. The main driver of this demand is the on-going topographical re-mapping of Greenland as well as advances within engineering and scientific applications.

Greenland is subject to substantial intra-plate deformation which consists of two components: 1) a stable deformation caused by glacial isostatic adjustment (GIA) and 2) elastic deformation that fluctuates from year to year caused by changes in the mass of the ice sheet. Airborne and satellite-borne radar or laser sensors are used to repeatedly map glacier surface elevations to estimate volume changes of the ice-sheet. From the volume changes of the ice-sheet the elastic deformation of the bedrock can be estimated. Currently, three GIA models for Greenland exist, however, they are very different in nature; thus, depending on choice of GIA model, conclusions on assessment of the modeled elastic uplift may vary

significantly.

The dynamic nature of the Greenlandic bedrock poses several problems with regards to coordinate transformations. Intra-plate deformation needs to be handled, as well as movement of the North-American tectonic plate. The latter is mostly solved by the ITRF2014 plate motion model although using the GNET GNSS network a refined set of parameters with a better local fit can be produced. A better understanding of the GIA signal in Greenland is necessary. A new model based on both modern satellite based measurements and historical data such as old maps and aerial photographs will be created.

This presentation will present the challenges of defining new transformations for GR96 as well as showing examples of how those challenges can be overcome.