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The role of local gravity information in the unification of the North American vertical datums

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The GOCE-based satellite-only global geopotential models (GGMs) perform better than the earlier satellite-only GGMs in North America and it has therefore been decided that the North American vertical datums can be unified by means of a third generation GOCE GGM. Our previous studies showed that such a GGM of a maximum degree 180 has an appreciably large omission error at the North American tide gauges as shown by the use of the EGM2008 model and the regional geoid models CGG2010 (in Canada) and USGG2012 (in the USA). This omission error affects the computed vertical datum offsets with respect to a global equipotential surface. Therefore, the local gravity information must be included in the computation of the local geopotential at the tide gauge stations.

Various approaches have been used for the combination of the GGMs and local gravity information for geoid determination. Most of these approaches are based on the remove-restore technique combined with a deterministic or stochastic method to modify Stokes's kernel. A different method for this combination is the improvement/extension of a GGM using additional local gravity information, which is often referred to as tailoring. The combination of a GOCE GGM and local gravity information can also be realized through the optimal combination of the GOCE GGM and EGM2008, which contains part of the local gravity information. The main objective of this study is to test and select an optimal approach for combining a GOCE GGM and local gravity data in the proximity of the available tide gauge stations in North America. For this purpose, a detailed qualitative comparison of the aforementioned different combination schemes is performed in order to see which one is preferable from a theoretical and practical point of view. The best approach should be computationally efficient and provide the best regional geoid heights (compared to the GNSS/levelling ones). The effect of the different approaches on the estimated datum offsets will be investigated, as well. The selected approach will be used in the computation of the local geopotential in the North American coastal regions for the purpose of the unification of the North American vertical datums.

Keywords: Vertical datum offset, Tide gauge, North America, Local gravity information, Geoid, GOCE, Global Geopotential Model (GGM)