A DYNAMIC REFERENCE SURFACE FOR HEIGHTS IN CANADA

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The purpose of this paper is twofold, namely (i) to present the developed dynamic geoid model based on the most recent satellite GRACE data and terrestrial data over Canada and (ii) to provide a methodology for incorporating the dynamic geoid as the new height datum in Canada. The move towards a modernized geoid-based vertical datum to replace the existing (and outdated) official height datum CGVD28 involves incorporating the dynamic nature of the regional geoid model, which includes secular changes of up to +1.5 mm/year as a result of the on-going mass transport beneath the uplifting/subsiding Earth's crust. Modelling the regional geoid dynamic variations has been facilitated due to the improved accuracy of the regional geoid model, which is computed using the latest high quality and resolution global gravity models.

Cet article vise deux buts, notamment : (i) de présenter le modèle dynamique du géoïde basé sur les plus récentes données du satellite GRACE et des données terrestres au-dessus du Canada et (ii) de fournir une méthodologie pour incorporer le géoïde dynamique comme nouvelle référence altimétrique au Canada. Le changement visant à utiliser une nouvelle référence altimétrique modernisée basée sur le géoïde pour remplacer la référence altimétrique officielle (désuète) de 1928 (CGVD28) implique l'incorporation de la nature dynamique du modèle de géoïde régional qui comprend des changements séculaires jusqu'à +1,5 mm/année à cause du transfert continuel de masse sous l'écorce terrestre (soulèvement / affaissement). La modélisation des variations dynamiques du géoïde régional a été facilitée grâce à l'exactitude améliorée du modèle de géoïde régional qui est calculé à l'aide des modèles de gravité mondiaux de grande qualité et résolution les plus récents.

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1. Introduction

The official reference surface (vertical datum) for orthometric heights in Canada is the Canadian Geodetic Vertical Datum of 1928 (CGVD28), which is constrained to the mean sea level of five tide gauges on the Pacific and Atlantic coasts and is accessible through a vertical control network of more than 80 000 benchmarks distributed over 150 000 km of levelling lines [*Véronneau* 2002]. Postglacial rebound in this region [*Peltier* 2004] has caused significant uplift/subsidence of the benchmarks of the vertical control network. Thus, large systematic errors exist in the network, which adds to the significant east-west tilting because of the datum's mean sea level constraints. Moreover, local motion of the benchmarks, limited spatial coverage and accessibility, and the high maintenance cost of the control network have led towards the need for a modernized vertical datum based on the most accurate regional geoid model [*Véronneau et al.* 2006]. This new datum will be accessible via Global Navigation Satelite System (GNSS) positioning. It is also envisioned that the new Canadian geoid-based datum will be compatible with a future global vertical datum (world height system), which is crucial for studies related to large-scale geodynamics and geo-hazards processes.

The accurate determination of orthometric heights via GNSS/levelling requires a centimetre(s) accuracy of the regional geoid [*Huang et al*. 2006]. The present-day theory for computing the regional geoid for Canada meets this requirement [*Vanícek et al.* 1999]. From a practical viewpoint, however, several important factors need to be addressed, namely (i) incorporating the latest and most accurate global geoid models provided by Gravity Recovery and Climate Experiment (GRACE) and the recently-launched Gravity Field and Steady-state Ocean Circulation Explorer (GOCE) satellite missions, (ii) updating the regional gravity database, (iii) using high accuracy digital terrain and crustal density models, and (iv) incorporating the dynamic changes in the geoid in the new vertical datum. The geoid in North America experiences large secular rise of up to 1.5 mm/year (in the vicinity of Hudson Bay) as a result of the on-going mass transport beneath the uplifting/subsiding Earth's crust as well as secular changes in sea level. Over a time period of 5 to 10