INTRODUCTION

The gravity network of Norway was originally based on three pendulum gravity observations in Oslo, Bodø, and Hammerfest in 1955. Since then, postglacial land uplift has systematically reduced the individual gravity values. We have recalculated the gravity network based on absolute gravimetric observations with an FG5 in the three original sites supplemented by A10 observations in 24 first order points in southern Norway. This dataset at current epoch is used to derive gravity anomalies for comparison with GOCE global gravity models. We also validate GOCE by comparison with 1792 GNSS/leveling points. The spectral enhancement method (SEM) was applied to avoid the spectral inconsistency between terrestrial and satellite data. For this purpose, contributions of the EGM2008 model and a gravitational effect of a residual terrain model (RTM) were calculated.

DESCRIPTION OF THE GRAVITY AND THE GNSS/LEVELING DATA

The gravity reference frame in Norway consists of 286 primary stations, connected by relative gravimeters in early 1970s. Four stations (Hammerfest, Bodø, Trondheim, and Oslo) were observed with FG5-226 (see Fig. 1) between 2005 and 2011. Absolute gravity values were derived from these time series and referred to September 2011. At this time a campaign covering 21 primary stations were observed with A10-020 (see Fig. 1). Attached to the primary stations are loops of 7791 secondary gravity stations, measured in the 1970s and early 1980s. The entire dataset was redrafted with respect to the absolute gravity values obtained with the FG5 and A10 instruments. This transformation compensates for the effects of postglacial uplift. We have selected 4556 points south of latitude 65° N as test field for the GOCE global gravitational field models (GGFMs).

We have also validated the GOCE GGFMs relative to the set of GNSS/leveling data compiled by the Norwegian Mapping Authority. The set of GNSS/leveling data consists of 1792 stations south of latitude 65° N. The leveled heights are listed in the vertical system NN2000, with epoch 2000.0. The GNSS heights are referred to epoch 2009.58. This introduces a 10-year postglacial effect, since the land uplift varies from 1 mm/year in southwest to 6 mm/year in the northeast sections of our test field south of 65° N. To perform consistent comparison with the GOCE GGFMs we have also applied tidal correction to the leveled heights.

The distribution of the gravity anomalies is depicted in Fig. 2. The gravity stations are distributed more or less regularly over the test field ranging from -103.017 mGal to 193.142 mGal, with a standard deviation of 45.724 mGal and a mean value of 14.560 mGal.

The geometrical height anomalies derived from the GNSS and the leveled heights are depicted in Fig. 2. The gravity stations are distributed more or less regularly over the test field ranging from -32.344 m in southwest to 6 mm/year in the northeast sections of the test field south of 65° N. To perform consistent comparison with the GOCE GGFMs we have also applied tidal correction to the leveled heights.

ACCURACY OF THE SEM:

Expected accuracy of the SEM (Hirt et al., 2011) for the gravity and the height anomalies has been investigated firstly. The low frequency contribution has been computed from EGM2008 (Pavlis et al., 2008) model by the GRAFIM software (Jamnik and Šprlák, 2006). The high frequency contribution has been calculated in terms of the RTM (Forsberg, 1984) by a newly developed program. Statistics of the differences between the observed and the modeled quantities is given in Tab. 1. Spatial behavior of the differences is depicted in Fig. 3.

VALIDATION OF GOCE GGFMs

Secondly, GOCE GGFMs listed in Tab. 2 have been validated using the gravity and the height anomalies within the test fields. Low frequencies of the EGM2008 have been substituted by those provided by the GOCE GGFMs. Varying maximum degree and order (d/o) of the spherical harmonic expansion has been considered. Behavior of the standard deviations between the observed and the modeled quantities as a function of the maximum d/o of the GOCE GGFMs is depicted in Fig. 4.

CONCLUSIONS:

- homogeneous sets of the gravity and the height anomalies have been produced based on new terrestrial measurements,
- modeling of the RTM effect is crucial for the gravity anomalies,
- pure EGM2008 field fits better to the height anomalies,
- performance of the GOCE GGFMs is very similar,
- the GOCE GGFMs are comparable with EGM2008 up to d/o ~220,
- validation by gravity anomalies does not suggest any improvements of the GOCE GGFMs with respect to EGM2008,
- validation by height anomalies suggests significant improvements delivered by the GOCE GGFMs between d/o 100-200.

REFERENCES:


Tab. 1: Statistics of the differences between the observed and the modeled quantities: (Top) gravity anomalies, (Bottom) height anomalies.

Tab. 2: Characteristic of the validated GGFMs.