

The Third Release of GOCE Gravity Field Models - Overview and Performance Analysis

Thomas Gruber⁽¹⁾, P.N.A.M Visser⁽²⁾

⁽¹⁾Institute of Astronomical and Physical Geodesy, Technische Universität München, Germany, e-mail: Thomas.Grubertum.de

⁽²⁾Delft Institute of Earth Observation and Space Systems (DEOS), Delft University of Technology, The Netherlands, e-mail: p.n.a.m.visser@tudelft.nl

Introduction: New GOCE gravity field models based on about 12 months of valid data have been released recently to the user community. They were obtained based on different processing strategies and reflect the state-of-the-art of GOCE gravity field models. As part of the product validation activities of ESA's science processing facility (HPF), these GOCE gravity field models are extensively tested by different methods. Long wavelengths are evaluated by the analysis of orbit residuals computed for a number of satellites, while the overall geoid performance is analyzed by comparison of the global models to independent GPS-levelling derived geoid heights. The poster gives an overview of the available GOCE models and shows some selected results of the model validation.

GOCE Gravity Models Overview

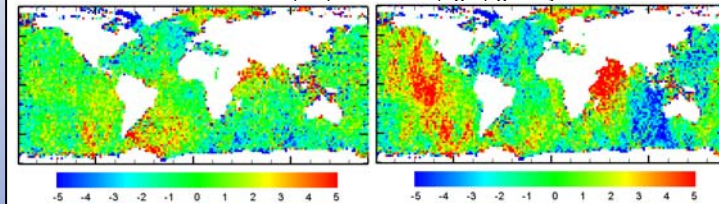
Model	Product Name	Data	D/O	Characteristics
DIR1	EGM_GOC_2_20091101T000000_20100111T235959_0002	2 Months	240	Direct : Prior model (combined) plus GOCE orbits & gradiometry
TIM1	EGM_GOC_2_20091101T000000_20100111T000000_0002	2 Months	224	Time-wise : Pure GOCE (kin. orbits & gradiometry)
SPW1	EGM_GOC_2_20091030T005757_20100111T073815_0002	2 Months	210	Space-wise : GRACE low d/o plus GOCE gradiometry
DIR2	EGM_GOC_2_20091101T000000_20100630T235959_0002	6 Months	240	Direct : Prior model (GRACE-only) plus GOCE orbits & gradiometry
TIM2	EGM_GOC_2_20091101T000000_20100705T235500_0002	6 Months	250	Time-wise : Pure GOCE (kin. orbits & gradiometry)
SPW2	EGM_GOC_2_20091031T000000_20100705T235959_0001	6 Months	240	Space-wise: Pure GOCE (kin. Orbits & gradiometry)
DIR3	EGM_GOC_2_20091101T000000_20110419T235959_0001	1 Year	240	Direct : Prior model (GRACE-only normals) plus GOCE gradiometry
TIM3	EGM_GOC_2_20091101T000000_20110430T235959_0001	1 Year	250	Time-wise : Pure GOCE (kin. orbits & gradiometry)

Orbit Fit Results

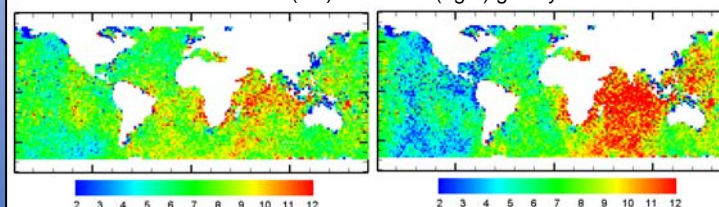
RMS-of-fit of tracking observations for ERS-2.

Model	SLR (cm)	PRARE RNG (cm)	PRARE RR (mm/s)	SXO (cm)	DXO (cm)
EIGEN-5C	4.3	4.1	0.25	6.7	6.9
DIR3	4.2	4.0	0.25	6.8	7.0
TIM1	5.0	4.6	0.28	7.3	7.4
TIM3	4.5	4.2	0.26	7.0	7.3

Mean of ERS-2 single-satellite altimeter crossover residuals averaged in 2°x2° bins for the EIGEN-5S (left) and TIM3 (right) gravity field models.



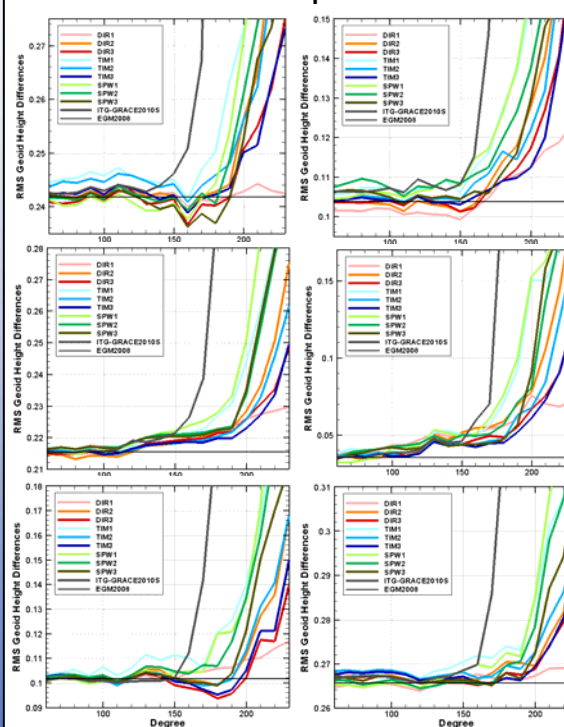
Mean of ERS-2/TOPEX dual-sat. altimeter crossover residuals averaged in 2°x2° bins for the EIGEN-5S (left) and TIM3 (right) gravity field models.



RMS (cm) of geographically averaged ERS-2 single- (SXO) and ERS-2/TOPEX dual-satellite altimeter crossover (DXO) residuals.

	EIGEN-5S	DIR3	TIM1	TIM3
SXO 2°x2°	2.1	2.2	3.3	3.0
DXO 2°x2°	1.9	2.4	2.9	3.0

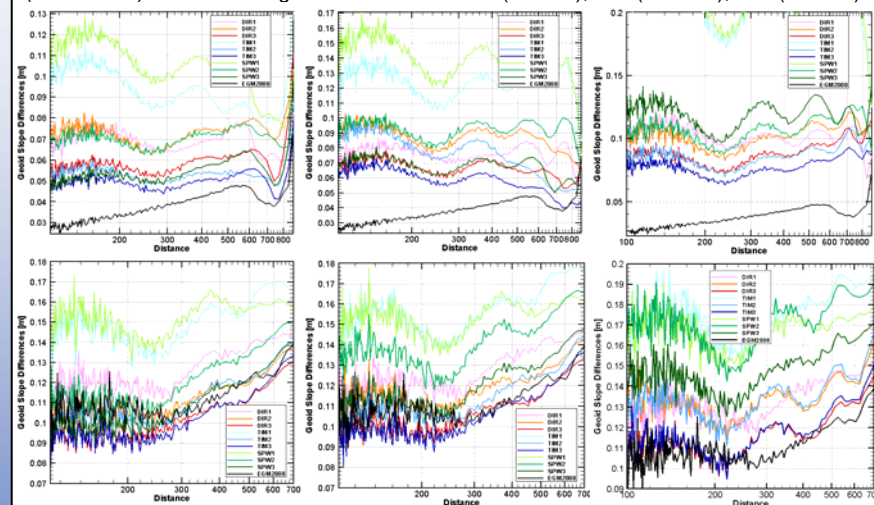
Geoid Comparison Results



RMS of geoid height differences (height anomaly differences in case of European and German data set) after subtraction of mean value in [cm] per degree of truncation for GOCE and other global gravity field models. Top row: Australia (left), Canada (right). Middle row: Europe (left), Germany (right). Bottom row: Japan (left), USA (right).

Geoid Comparison Results

RMS of geoid slope differences per distance class for Germany (top row) and Japan (bottom row) for various degrees of truncation 180 (1st col.), 190 (2nd col.), 200 (3rd col.).



Conclusions

- (1) Compared to pre-launch models, all released GOCE gravity field models show a degraded performance in precise orbit determination for the selected satellites. There are indications that higher degree and order gravity field terms need to be estimated to properly take into account the error level of the GPS-levelling data.
- (2) GOCE data provide significant new information for the medium to higher spatial resolution of the Earth's gravity field. When analyzing the results obtained with the high quality GPS-levelling data in Germany we can conclude that the geoid accuracy is at the level of 4-5 cm at degree 200 (corresponding 100 km in the spatial domain) taking into account the error level of the GPS-levelling data. For the spectral range between degree 150 and 200 one can identify improved performance wrt. EGM2008, which can be addressed to the GOCE data (see e.g. Japan).

Acknowledgment: GPS levelling data for have been provided for validation purposes by AUSLIG, BKG, the Japanese Geographical Survey Institute, NGS and Natural Resources of Canada. We are thankful to Ch. Hirt, who provided RTM estimates for the omission error for the German GPS-levelling data set. The NASA Goddard Space Flight Center is acknowledged for kindly providing the GEODYN software. This work was performed in the framework of ESA contract „GOCE High Level Processing Facility“.

Reference: Gruber Th., Visser P.N.A.M., Ackermann C., Hosse M.: Validation of GOCE Gravity Field Models by Means of Orbit Residuals and Geoid Comparison; Journal of Geodesy, Vol. 85, Nr. 11, pp 845-860, Springer, ISSN 0949-7714, DOI: 10.1007/s00190-011-0486-7, 2011