IAG 2021 Beijing June 28–July 2 2021

Geodesy for a sustainable Earth

Beijing • June 28-July 2, 2021

Scientific Assembly of the International Association of Geodesy

The impact of the EOT20 global ocean tide model on space geodetic measurements, satellite orbits and derived geodetic parameters

Mathis Bloßfeld, Michael Hart-Davis, Matthias Glomsda, Denise Dettmering, DGFI-TUM, Munich, Germany

Within the analysis of space geodetic measurements, tidal effects caused by the ocean have to be taken into account. Besides the **displacement of reference points** connected to the Earth's crust, which can reach up to several cm, the **gravitational acceleration** acting on near-Earth satellites is affected by global ocean tides. For the analysis of Very Long Baseline Interferometry (VLBI) observations, only the first corrections have to be considered, whereas for the analysis of Satellite Laser Ranging (SLR) observations, both corrections are necessary as near-Earth satellites are observed.

EOT20 is the latest model in a series of **empirical ocean tide (EOT) models** derived using residual tidal analysis of multi-mission satellite altimetry at DGFI-TUM.

The aim of the EOT20 model is to **improve the coastal estimation of tides** while remaining consistent in the open ocean.

EOT20 takes advantage of the inclusion of more recent satellite altimetry data as well as more missions, the use of the updated FES2014 tidal model as the reference to estimate residual signals, the inclusion of the ALES retracker and improved coastline representation.

For the validation of the EOT20 model, three different experiments are presented:

- **tide gauge analysis**,
- **estimation of Earth Orientation Parameters (EOP) using VLBI**,
- **precise orbit determination (POD) based on SLR**.

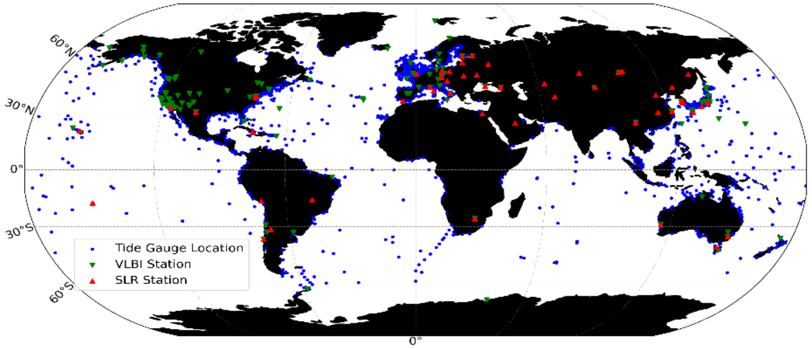

Fig. 1: Distribution of tide gauges, VLBI and SLR stations used for the three experiments.

Tide Gauge analysis

For 8 major tidal constituents, Tab. 1 shows the single RMS and the overall RSS of the tide gauge differences w.r.t. 5 global ocean tide models. FES2014 and EOT20 perform best for some constituents, the EOT20 model shows the smallest RSS.

Constituent	GOT4.8	DTU16	EOT11a	FES2014	EOT20
M2	5.313	4.02	4.839	3.587	**3.352**
N2	1.326	0.908	1.311	0.805	**0.802**
S2	2.484	1.480	2.330	1.434	**1.411**
K2	1.159	0.848	1.093	**0.744**	0.783
K1	1.214	1.051	1.209	**0.866**	0.906
O1	0.981	0.837	0.843	0.673	**0.653**
P1	0.785	0.807	0.772	**0.664**	0.687
Q1	0.384	0.359	0.383	**0.276**	0.360
RSS	6.38	4.741	5.888	4.224	**4.042**

Tab. 1: Root Mean Square (RMS) and RSS (Root Sum Square) of tide gauge differences in cm (taken from Hart-Davis et al., 2021).

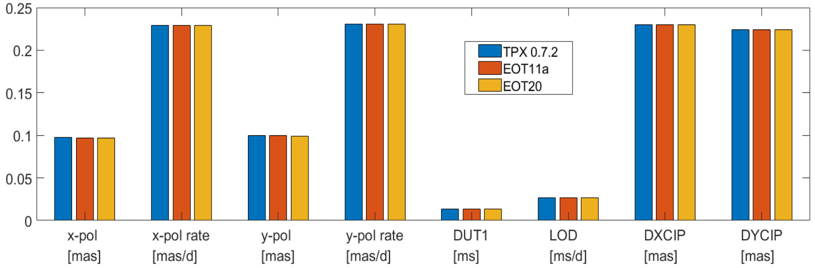

Fig. 2: Weighted RMS of EOP corrections to IERS 14 C04.

Estimation of EOP using VLBI

The estimated EOP are validated w.r.t. the official IERS 14 C04 time series. Using different global ocean tide models does not significantly affect the differences (see Fig. 2), which might be caused by the fact that most VLBI telescopes are not located in coastal areas where oceanic tidal effects are largest.

POD based on SLR

The SLR orbit RMS values show only minor differences for all of the analyzed satellites. Etalon-2 and LAGEOS-2 behave similar to Etalon-1 and LAGEOS-1.

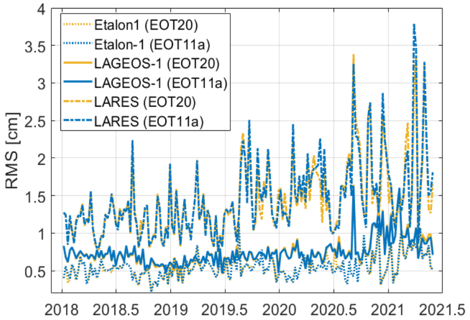

Fig. 3: SLR orbit RMS for 3 different satellites.

Conclusion

The tide gauge analysis proves the **good overall performance** of the new EOT20 model especially in coastal areas. Based on the other two experiments, one can conclude that the **effect is rather small for VLBI- and SLR-derived geodetic parameters** since those stations are not placed in coastal areas (see Fig. 1). For the satellite orbits, the difference between EOT11a and EOT20 is rather negligible.

The authors want to acknowledge Prof. Torsten Mayer-Guerr from TU Graz for converting the gridded EOT20 model information into spherical harmonics and equivalent water heights. Furthermore, the authors want to thank the ocean tide loading provider at Chalmers University for the computation of EOT20-based site displacements.

The model description is currently in review at https://doi.org/10.5194/essd-2021-97, the data is available at https://doi.org/10.17882/79489.