Technical Note

GFZ GravIS RL06 Level-3 Products

Ocean Bottom Pressure Variability

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Introduction:

This Technical Note describes the processing scheme and product details of the Ocean Bottom Pressure (OBP) Variability Level-3 product that is visualized at the GFZ web portal GravIS (http://gravis.gfz-potsdam.de) and provided at GFZ's data archive ISDC.

Data Product Details:

OBP variability products are provided as gridded products divided into yearly batches.

Filenames: **GRAVIS-3_YYYY-----------_GFZOP_0600_OBP_GRID_GFZ_0001.nc**

where YYYY is the corresponding year (note that files may contain partial years)

Format: **NetCDF**

Product link: **ftp://isdcftp.gfz-potsdam.de/grace/GravIS/GFZ/Level-3/OBP**

Processing Details:

Satellite gravimetry as realized with the GRACE and GRACE-FO missions is sensitive to all mass variations in the ocean basins that are proportional to a change in hydrostatic pressure at the sea floor. OBP variations are caused by three distinctly different dynamic processes: (i) air masses as represented by variations in atmospheric surface pressure; (ii) changes in ocean mass due to an inflow of water from the continents into the ocean basin and regional re-distribution due to attraction effects of external masses located at the continents and in the atmosphere; and (iii) the re-distribution of water within the ocean basins in response to atmospheric surface winds, atmospheric surface pressure gradients, and ocean thermohaline effects (i.e., the general ocean circulation).

OBP estimates obtained from GRACE and GRACE-FO are provided at 1° latitude-longitude grids as defined over the world's ocean basins. The files each contain eight different variables (see variable names of the NetCDF files marked in **bold** below) providing

1) gravity-based barystatic sea-level pressure (**barslv**)
2) gravity-based barystatic sea-level pressure uncertainties (**error_barslv**)
3) gravity-based residual ocean circulation pressure (**resobp**)
4) gravity-based residual ocean circulation pressure uncertainties (**error_resobp**)
5) apparent gravity-based bottom pressure due to continental leakage (**leakage**)
6) apparent gravity-based bottom pressure due to continental leakage uncertainties (**error_leakage**)
7) background-model ocean circulation pressure (**model_ocean**)
8) background-model atmospheric surface pressure (**model_atmosphere**).

We use GFZ GravIS RL06 Level-2B coefficients (Dahle et al., 2019; http://gravis.gfz-potsdam.de/corrections) filtered with VDK5 and VDK2 and estimate trend as well as annual and semi-annual harmonics for both series. In view of the less dominant annual and semi-annual signals over the ocean compared to trend, we combine the trend component from VDK5 with the annual and semi-annual components and the remaining month-to-month and inter-annual variations from VDK2. As an additional correction which is not part of the Level-2B processing, co- and post-seismic deformations from megathrust earthquakes (magnitude > 8.8) are removed. Thus, the seismic events (i) Sumatra-Andaman 2004, (ii) Chile 2010, and (iii) Tohoku-Oki 2011 are taken into account. The empirical correction is based on a step function which is fitted to all available monthly solutions in a spherical cap with a radius of 1000 km centered at the epicenter and an exponential decay function which is fitted over two years following the main event (note that solutions from subsequent epochs are no longer statistically independent as soon as earthquake signals were empirically estimated and removed). The resulting sea-level variations contain both a distinct annual variation of the global mean sea-level, a pronounced positive trend, and additional strong seasonal pattern in regions characterized by Monsoon circulations in the atmosphere.

GRACE-based terrestrial water storage estimates and the associated atmospheric mass distributions as given by AOD1B (Dobslaw et al., 2017) are used to calculate a gravitationally consistent sea-level anomaly for each month based on the theory of Tamisiea et al. (2010). Differences between this sea-level pattern and ocean bottom pressure directly inferred from the Level-2B coefficients are interpreted as residual ocean circulation signals.

Preliminary analysis indicates that numerous features contained in those fields are likely related to instrument noise or gravity field modelling errors and thus should not be interpreted in terms of ocean dynamics. In particular regions close to the coast are likely to be affected by continental leakage so that those signals are provided separately to the users.

The signal estimates are accompanied by associated uncertainties that take into account the varying noise level from month to month associated with (i) the amount of available sensor data in a certain month which might be limited due to, e.g., satellite maneuvers; (ii) the actual ground track pattern which might be sparse during periods of occasional short repeat orbits; and (iii) the condition of the satellites' on-board batteries which impacts the maintenance of thermal stability and thereby the noise level of the science instruments. Further details on the statistical modeling of uncertainties; the further propagation of gridded errors to realistic estimates for regional averages under consideration of its spatial correlations; and plausibility checks based on the evaluation of results from GRACE-FO end-to-end simulations will be reported elsewhere (Boergens et al., in preparation).

It should be noted that a certain fraction of the time-variable gravity signal picked up by a satellite gravimetry mission is caused by atmospheric mass variability and the corresponding oceanic response to changes in, e.g., surface winds. The non-tidal de-aliasing product AOD1B (Dobslaw et al., 2017) has been used to subtract the atmospheric contribution -- and to a large extent also the ocean contribution -- already during the processing of the Level-2 monthly gravity fields. In order to provide users with some flexibility to restore those signals, the monthly mean estimates of both the atmospheric and the oceanic background models are provided as well.

Citation:

The GFZ GravIS RL06 OBP Level-3 product is published as data publication via GFZ Data Services and should be cited as follows:

Dobslaw, H., Dill, R., Zhang, L., Boergens, E. (2019): GFZ GravIS RL06 Ocean Bottom Pressure Anomalies. V. 1.0. GFZ Data Services. http://doi.org/10.5880/GFZ.GRAVIS_06_L3_OBP

References:

Dahle, C., Murböck, M. (2019): Post-processed GRACE/GRACE-FO Geopotential GSM Coefficients GFZ RL06 (Level-2B Product). V. 1.0. GFZ Data Services. http://doi.org/10.5880/GFZ.GRAVIS_06_L2B

Dobslaw, H., Bergmann-Wolf, I., Dill, R., Poropat, L., Thomas, M., Dahle, C., Esselborn, S., König, R., Flechtner, F. (2017): A new high-resolution model of non-tidal atmosphere and ocean mass variability for de-aliasing of satellite gravity observations: AOD1B RL06. Geophysical Journal International, 211, 1, pp. 263-269. http://doi.org/10.1093/gji/ggx302

Tamisiea, M., Hill, E., Ponte, R., Davis, J., Velicogna, I., Vinogradova, N. (2010): Impact of self-attraction and loading on the annual cycle in sea level. J. Geophys. Res., 115, C07004. http://doi.org/10.1029/2009JC005687