OpenADB: An Open Altimeter Database providing high-quality altimeter data and products

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OpenADB – Website
http://openadb.dgfi.badw.de

Introduction

The **Open Altimeter Database (OpenADB**) holds satellite altimeter data and high-level products developed by the Deutsches Geodätisches Forschungsinstitut, DGFI (German Geodetic Research Institute).

Currently, OpenADB contains the following products:

- **Sea Surface Heights (SSH)**
- **Sea Level Anomalies (SLA)**
- **Global and Regional Mean Sea Level Time Series**
- **Database for Hydrological Time Series over Inland Waters (DAHITI)**
- **Instantaneous Dynamic Ocean Topography Profiles (iDOT)**
- **Empirical Ocean Tide Model Corrections (EOT)**
- **Vertical Total Electron Content (VTEC)**

Next to the products, OpenADB provides additional tools for users working in altimetry:

- **Pass Locator**
- **Mission Information**

As the underlying data for the products we use the latest Geophysical Data Records (GDR/SGDR) which are available for the different satellite altimeter mission. Furthermore we apply the best suitable geophysical corrections for the wet troposphere, try troposphere, ionosphere, etc. Also the range biases between different altimeter missions are considered.

All value-added products, provided by the OpenADB are free accessible after a short registration on the OpenADB website (**http://openadb.dgfi.badw.de**).

References:

- *Bosch W., Savcenko R.:* ***On estimating the dynamic ocean topography.*** *In: Mertikas S.P. (Ed.): Gravity, Geoid and Earth Observation, IAG Symposia 135: 263-269, Springer, DOI:10.1007/978-3-642-10634-7_34, 2010*
- *Bosch W., Dettmering D., Schwatke C.:* ***Multi-Mission Cross-Calibration of Satellite Altimeters: Constructing a Long-Term Data Record for Global and Regional Sea Level Change Studies****. Remote Sensing, 6(3), 2255-2281, 10.3390/rs6032255, 2014*
- *Dettmering D., Bosch W.:* ***Global Calibration of Jason-2 by Multi-Mission Crossover Analysis.*** *Marine Geodesy, 33:S1, 150-161, DOI:10.1080/01490419.2010.487779, 2010*
- *Savcenko R. and Bosch W.:* ***EOT11a - Empirical Ocean Tide Model From Multi-Mission Satellite Altimetry.*** *DGFI Report No. 89, 2012*
- *Schwatke C., Bosch W., Dettmering D. Göttl F., Boergens E. :* ***Database for Hydrological Time Series of Inland Waters (DAHITI).*** *Ocean Surface Topography Science Team Meeting 2014, Lake Constance, Germany, 2014-10-30*
- *Schwatke C., Bosch W.:* ***Kalman filter Approach for geophysical lake level Time Series using multi-mission Altimetry.*** *20 Years of Progress in Radar Altimetry, Venice, Italy, 2012-09-24/29*

Acknowledgement:

OpenADB data holdings are based on altimetry missions operated by CNES/NASA (TOPEX, Jason-1), ESA (ERS-1/2, Envisat, Cryosat-2), USNavy/NOAA (GFO), CNES/NASA/Eumetsat/NOAA (Jason-2), and ISRO/CNES (Saral). The original data sets are disseminated by AVISO, ESA, NOAA, and PODAAC.

Empirical Ocean Tide Model (EOT)

EOT08a, EOT10a, and EOT11a are global solutions for the amplitudes and phases of the most dominant ocean tide constituents based on an empirical analysis of multi-mission satellite altimetry data. The models were obtained by means of residual harmonic analysis of multi-mission altimeter data with respect to FES2004, a hydrodynamic model widely used for altimetry and long time taken as reference model in GRACE gravity field modeling. The most recent model is EOT11a. In shallow water areas the M2 and S2 constituents show numerous extended patterns with residual amplitudes of up to 15 cm.

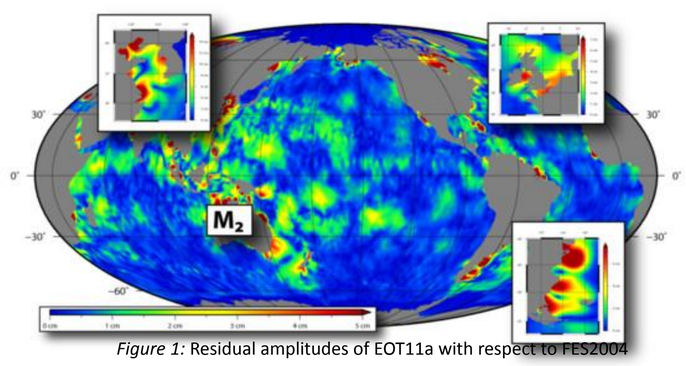

Figure 1: Residual amplitudes of EOT11a with respect to FES2004

Other major constituents and the non-linear shallow water tide M4 hit residual amplitudes up to 5 cm. Validation at altimeter crossovers and with independent bottom pressure data confirm the significance of these findings. A correlation analysis proves the separability of the analyzed constituents. [Savcenko et al, 2012]

Instantaneous Dynamic Ocean Topography Profiles (iDOT)

The instantaneous DOT profiles (iDOT) are derived as deviation between the actual sea surface heights h and the geoid heights N along individual profiles observed by nearly all satellite altimeter missions operating since end of 1992 following the "profile approach", developed by Bosch & Savcenko (2010).

Both, h and N are consistently filtered by a Gauss-type filter with different half widths (69 and 120 km). This way, the iDOT profiles realize smoothed snapshots of the ocean topography and may be used to characterize the temporal evolution of the DOT since late 1992.

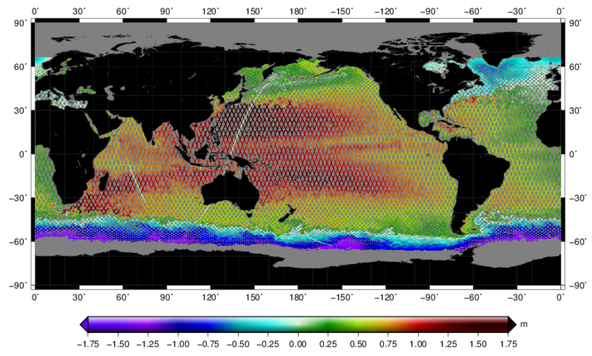

Figure 2: Instantaneous Dynamic Ocean Topography Profiles of Cycle 166 from Jason1

Moreover, as the data of all satellite altimeter missions have been carefully harmonized and cross-calibrated in advance [Dettmering & Bosch 2013, 2010], it should be possible to merge and combine iDOT profiles of any mission in order to improve the spatial and temporal resolution. Due to the filter length of 69 km the iDOT profiles carry the signature of meso-scale pattern and can be taken to illustrate evolution and kinematics of Eddies and of the geostrophic velocity field.

Database for Hydrological Time Series of Inland Waters (DAHITI)

DAHITI is a database which provides time series for lakes, rivers, reservoirs and wetlands from multi-mission satellite altimetry [Schwatke et al, 2014].
Currently the DAHITI database contains time series of about 210 worldwide distributed inland waters.

Figure 3: Data Holding of DAHITI

See also poster in session „Science Results: Inland waters“

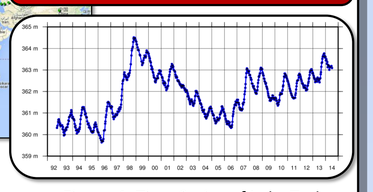

Figure 4: Time Series of Lake Turkana

The estimated water levels are computed by a Kalman Filter approach [Schwatke et al, 2012]. The preprocessing includes the calculation of all heights for each individual altimeter measurement. Depending on the water body extent high-frequent or retracked altimeter data are used. In the retracking step, all altimeter waveforms are first classfied by using the method of “Support Vector Machine (SVM)”. Afterwards, all classified altimeter data are retracked by an assigned retracking algorithm.
Before running the Kalman Filter outliers are rejected by different criteria. After running the Kalman Filter for every time step a mean height of the water level considering an error limit is estimated.

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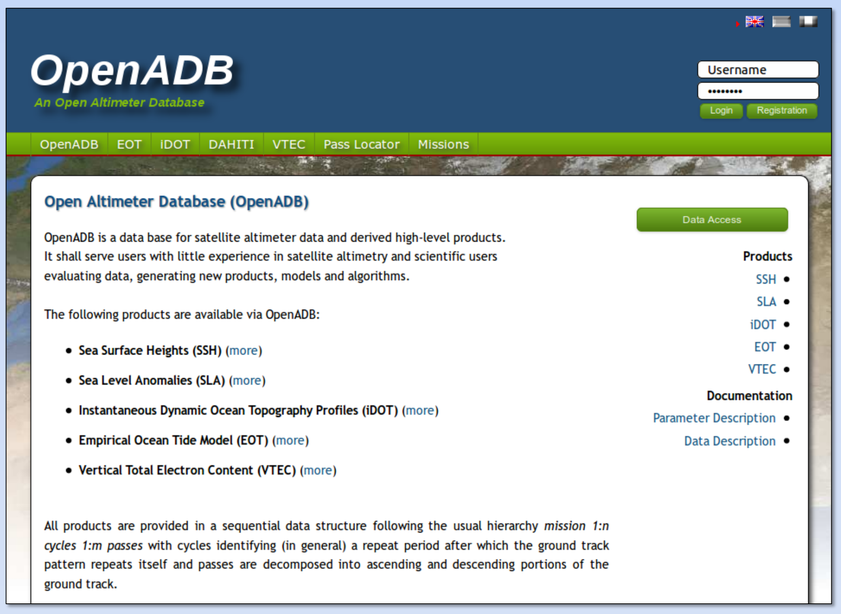
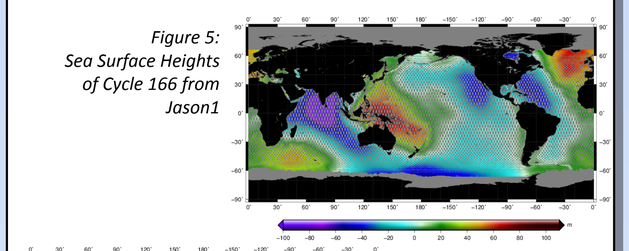


Sea Surface Heights (SSH) and Sea Level Anomalies (SLA)

Sea Surface Heights (SSH) and Sea Level Anomalies (SLA) are generated for each profile of all available satellite altimeter missions.
All measurements are corrected by the most actual geophysical corrections (e.g. tides and atmospheric delays). Moreover, as the data of all missions have been carefully harmonized and cross-calibrated in advance [Bosch et al., 2014], it is possible to merge and combine SLA/SSH of any mission in order to improve the spatial and temporal resolution.

Figure 5: Sea Surface Heights of Cycle 166 from Jason1



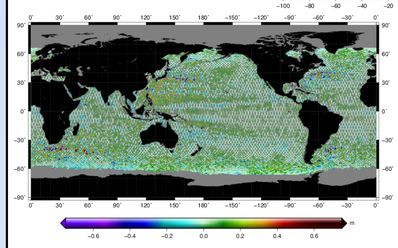


Figure 6: Sea Level Anomalies of Cycle 166 from Jason1

The SLA describe the difference between the actual sea surface height (SSH) and a long-term mean sea surface height (MSSH).

Global and Regional Mean Sea Level

Time series of global and regional mean sea level variations are provided by OpenADB.
Multi-mission satellite altimetry is used for the estimation of the mean sea level without considering glacial isostatic adjustment. Furthermore seasonal variations remain in the time series.

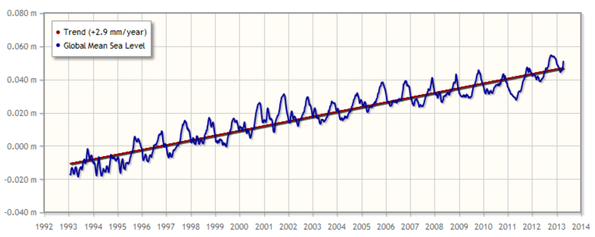


Figure 7: Global Mean Sea Level Variation with respect to a Mean Sea Surface between 1993-2013

In addition to the global mean sea level also regional mean sea level for regions such as Mediterranean Sea, Caribbean Sea, Gulf of Mexico, etc. are available.

Vertical Total Electron Content (VTEC)

Vertical Total Electron Content (VTEC) is provided for each profile of all satellite altimeter missions with dual-frequency altimeters. They are derived from the difference of the measurements of the two frequencies and converted from metric ionospheric corrections to electrons per square-meter directly beneath the satellite (given in TECU). To get rid of noise a 20 sec median filter is applied for smoothing the data along the profiles.

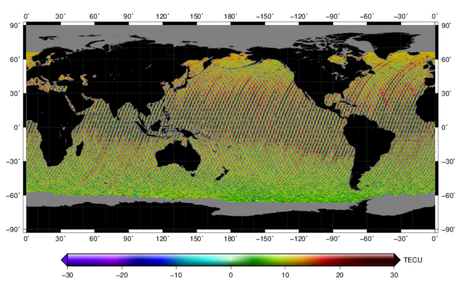


Figure 8: VTEC of Cycle 166 from Jason1

Pass Locator

The Pass Locator is a tool on OpenADB for the visualization of average satellite altimeter tracks via Google Maps. By clicking on a altimeter tracks the associated pass numbers is shown.

The following tracks are displayed by the Pass Locator:

- Topex/Poseidon, Jason-1, Jason-2
- Topex-EM, Jason1-EM
- Envisat, ERS-1c, ERS-1g, ERS-2, Saral/AltiKA
- Envisat-EM
- GFO
- Cryosat-2
- HY-2A

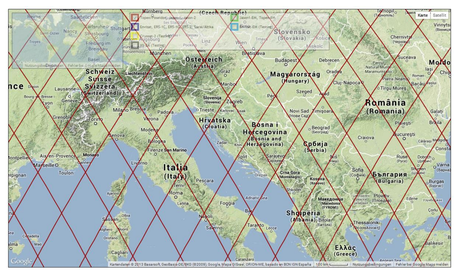


Figure 9: Pass Locator showing Topex tracks

Missions

OpenADB provides also additional information about all altimeter satellites.

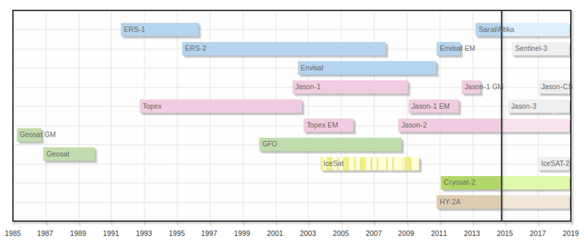


Figure 10: Overview of all satellite altimeter missions since 1985

General Information such as launch date, agency, mass, etc. are provided for each altimeter satellite. Furthermore, orbit information such as inclination, eccentricity, etc. are available for every different flight configuration of the satellite.

The overview of each mission should help beginners and expert to find suitable information about the different satellite altimetry mission for their needs.

Ocean Surface Topography Science Team (OSTST) Meeting 2014, Lake Constance, Germany, 27-31 October 2014