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GPD+ wet tropospheric corrections for eight altimetric missions for the Sea Level ECV generation

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Due to its large spatio-temporal variability, the delay induced by the water vapour and liquid water content of the atmosphere in the altimeter signal or wet tropospheric correction (WTC) is still one of the largest sources of uncertainty in satellite altimetry.
In the scope of the Sea Level (SL) Climate Change Initiative (cci) project, the University of Porto (UPorto) has been developing methods to improve the WTC (Fernandes et al., 2015). Started as a coastal algorithm to remove land effects in the microwave radiometers (MWR) on board altimeter missions, the GNSS-derived Path Delay (GPD) methodology evolved to cover the open ocean, including high latitudes, correcting for invalid observations due to land, ice and rain contamination, band instrument malfunction.
The most recent version of the algorithm, GPD Plus (GPD+) computes wet path delays based on: i) WTC from the on-board MWR measurements, whenever they exist and are valid; ii) new WTC values estimated through space-time objective analysis of all available data sources, whenever the previous are considered invalid. In the estimation of the new WTC values, the following data sets are used: valid measurements from the on-board MWR, water vapour products derived from a set of 17 scanning imaging radiometers (SI-MWR) on board various remote sensing satellites and tropospheric delays derived from Global Navigation Satellite Systems (GNSS) coastal and island stations. In the estimation process, WTC derived from an atmospheric model such as the European Centre for Medium-range Weather Forecasts (ECMWF) ReAnalysis (ERA) Interim or the operational (Op) model are used as first guess, which is the adopted value in the absence of measurements.
The corrections are provided for all missions used to generate the SL Essential Climate Variable (ECV): TOPEX/Poseidon- T/P, Jason-1, Jason-2, ERS-1, ERS-2, Envisat, CryoSat-2 and SARAL/ALtiKa.
To ensure consistency and long term stability of the WTC datasets, the radiometers used in the GPD+ estimations have been inter-calibrated against the stable and independently-calibrated Special Sensor Microwave Imager (SSM/I) and SSMI/I Sounder (SSM/IS) sensors on-board the Defense Meteorological Satellite Program satellite series (F10, F11, F13, F14, F16 and F17).
The new products reduce the sea level anomaly variance, both along-track and at crossovers with respect to previous non-calibrated versions and to other WTC data sets such as AVISO Composite (Comp) correction and atmospheric models. Improvements are particularly significant for TP and all ESA missions, especially in the coastal regions and at high latitudes. In comparison with previous GPD versions, the main impacts are on the sea level trends at decadal time scales and on regional sea level trends. For CryoSat-2, the GPD+ WTC improves the SL ECV when compared to the baseline correction from the ECMWF Op model. In view to obtain the best WTC for use in the version 2 of the SL_cci ECV, new products are under development, based on recently released on-board MWR WTC for missions such as Jason-1, Envisat and SARAL.

Fernandes, M.J., Clara Lázaro, Michaël Ablain, Nelson Pires, Improved wet path delays for all ESA and reference altimetric missions, Remote Sensing of Environment, Volume 169, November 2015, Pages 50-74, ISSN 0034-4257, http://dx.doi.org/10.1016/j.rse.2015.07.023