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Along track spectral analysis of satellite altimetry observations for Mean Sea Level modeling

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In this paper the repeatability property of the TOPEX/Poseidon (T/P) satellite altimetry is used to develop time series of sea surface variations along the satellite's tracks. Ten years of T/P satellite altimetry within the cycles $11 - 370$ (i.e. 360 cycles) are extracted from 254 files per cycle in MGDR-B binary format, from the source ftp://podaac.jpl.nasa.gov/pub/ to provide the required data. Next, the extracted data (44 MB data of approximately 360×435000 point sea level observation within 360 cycles) are corrected for all corrections proposed by JPL except the tidal variations. The location of sea level observations within cycle 11 of T/P is used to develop time series of repeated sea level observations from the other 359 cycles with a search area of 3 km around the observation points of the cycle 11. The aforementioned procedure resulted in more than 435000 time series of repeated sea level observations with on average 250 observations per each time series along track of T/P satellite altimetry observations. Having prepared the time series, a linear function is fitted to the observations of each time series by least square method. The constant part of the linear function provided us with the Mean Sea Level (MSL) at each computational point. The computed linear model is next removed from the time series and the remaining signal is subjected to least square spectral analysis for the estimation of the 6 tidal constituents namely O_1, P_1, K_1, N_2, M_2, S_2. The accuracy of the computed tidal constituents is verified by the comparison of amplitudes computed by our models with those computed at 98 submerged tidal stations with uniform global distribution. Taking the computed amplitude of the tidal constituents at the submerged tide gauge

stations as the "benchmarks" the relative accuracies of our tidal models are computed as follows: 0.038 for O_1, 0.024 for P_1, 0.005 for K_1, 0.123 for N_2, 0.008 for M_2 and 0.021 for S_2 component. This comparison shows that our tidal models are in very high agreement with the tidal constituents computed at the submerged tide gauge stations. The highlights of the research can be summarized as follows:

1. Development of 254 profiles of MSL along track of T/P satellite altimetry.
2. Reduction of the along track observation noise by application of a Gausian filter, generated by a moving weighted average over 11 observations with the weight computed from Normal probability density distribution with the variance of 0.5.
3. Verification of the computed MSL in this research with that of M.C. Kim, 1998. The average difference of this comparison is estimated to be 6.4 cm.
4. Comparison of the computed MSL with that of R.H. Rapp, 1994, which is the standard JPL MSL model and can be found in T/P data files.
5. Development of an interpolated $1^\circ \times 1^\circ$ MSL grid using the along track computed MSL values and the comparison with the same resolution MSL values computed by R.H. Rapp, 1994. The average difference of this comparison is -16.04 mm.

In short, the main achievements of this research are new models for MSL and 6 tidal constituents with verified accuracy and correctness.