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Application of satellite altimetry derived Mean Sea Level as a boundary data for an iterative gravimetric boundary value problem approach to the Sea Surface Topography and the marine geoid computations

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In this paper a new iterative methodology for the Gravimetric Boundary Value Problem (GBVP) approach to the "Sea Surface Topography (SST)" and the "marine geoid computations" based on satellite altimetry derived "Mean Sea Level (MSL)" as a boundary data is presented. The developed methodology can be described algorithmically as follows: (i) Owing to the fact that MSL is not an equipotential surface, the MSL differences between neighboring points along the satellite altimetry tracks are written as a function of (a) potential at the all MSL points (in which one point is considered as the reference point), and (b) the geoid difference between the neighboring points. (ii) Next, the potential space between MSL "down or up" to the reference ellipsoid is made harmonic by removing the effect of a proper reference gravity potential field. (iii) Having generated harmonic gravitational potential field between the MSL and the reference ellipsoid, from the integral solution of the Laplace differential equation, a boundary operator is developed in a way that its "observations" be the residual MSL height differences and its "unknowns" be: (a) the residual potential values on the surface of the reference ellipsoid, (b) the potential at the reference point (one of the MSL points), and (c) the geoidal height difference between the neighboring points. (iv) In the first iteration, the geoid height differences are set equal to

MSL differences so that they be removed from the unknowns of the aforementioned boundary operator. (v) Having computed the potential value at the reference point and knowing the potential differences, the gravity potential values at the MSL points are computed. (vi) Having done the abovementioned computations for the whole sea areas, the mean value of the potential at MSL points results in the geoid's potential value. (vii) Having computed the geoid's potential value, its difference from the MSL potential value provides the SST in terms of potential difference. (viii) Converting the potential difference due to SST to its equivalent height difference will results in SST. (ix) Subtraction of the computed SST from satellite altimetry derived MSL results in the point-wise marine geoid computations. (x) Having computed the marine geoid the next iteration can be started from step (iii) until the convergence of the estimated values for unknowns be achieved. The developed methodology is applied the SST and marine geoid computations at three test regions in the Pacific, Atlantic, and Indian Oceans.