Expressions for modelling the bathymetry-generated gravitational field quantities by means of the spherical bathymetric functions

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The currently available global geopotential models and the global elevation and bathymetry data allow modelling the topography corrected and bathymetry stripped reference gravity field to a very high spectral resolution (up to degree 2160 of spherical harmonics) using methods for a spherical harmonic analysis and synthesis of the gravity field. When modelling the topography corrected and crust density contrast stripped reference gravity field, additional stripping corrections are applied due to the ice, sediment and other major known density contrasts within the Earth's crust. The currently available data of global crustal density structures have, however, a very low resolution and accuracy. The compilation of the global crust density contrast stripped gravity field is thus limited to a low spectral resolution, typically up to degree 180 of spherical harmonics. In this study, we derive the expressions used in forward modelling of the bathymetry-generated gravitational field quantities and the corresponding bathymetric stripping corrections to gravity field quantities by means of the spherical bathymetric (ocean bottom depth) functions. The expressions for the potential and its radial derivative are formulated for the adopted constant (average) ocean saltwater density contrast and for the spherical approximation of the geoid surface. The numerical examples are given for the gravitational potential and attraction generated by the ocean density contrast. These gravitational field quantities are computed from the coefficients of the Global Bathymetric Model (GBM) complete to degree and order 180. The GBM numerical coefficients describe globally the depths of the sea floor. The mean value of the ocean saltwater density contrast 1640 kg m-3 (i.e., difference of the reference mean crustal density 2670 kg m-3 and the mean ocean saltwater density 1030 kg m-3) is adopted. The GBM coefficients are generated from the 5×5 arc-min global bathymetry data of the ETOPO5 (provided by the NOAA's National Geophysical Data Centre). The computation is realized globally on a 1×1 arc-deg geographical grid at the Earth's surface.