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A global vertical datum defined by the conventional geoid potential and the Earth ellipsoid parameters

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According to the classical Gauss–Listing definition, the geoid is the equipotential surface of the Earth's gravity field that in a least-squares sense best fits the undisturbed mean sea level. This equipotential surface, except for its zero-degree harmonic, can be characterized using the Earth's Global Gravity Models (GGM). Although nowadays, the satellite altimetry technique provides the absolute geoid height over oceans that can be used to calibrate the unknown zero-degree harmonic of the gravimetric geoid models, this technique cannot be utilized to estimate the geometric parameters of the Mean Earth Ellipsoid (MEE). In this study, we perform joint estimation of W_0 , which defines the zero datum of vertical coordinates, and the MEE parameters relying on a new approach and on the newest gravity field, mean sea surface, and mean dynamic topography models. As our approach utilizes both satellite altimetry observations and a GGM model, we consider different aspects of the input data to evaluate the sensitivity of our estimations to the input data. Unlike previous studies, our results show that it is not sufficient to use only the satellite-component of a quasi-stationary GGM to estimate W_0 . In addition, our results confirm a high sensitivity of the applied approach to the altimetry-based geoid heights, i.e. mean sea surface and mean dynamic topography models. Moreover, as W_0 should be considered a quasi-stationary parameter, we quantify the effect of time-dependent Earth's gravity field changes as well as the time-dependent sea-level changes on the estimation of W_0 . Our computations resulted in the geoid potential $W_0 = 62636848.102 \pm 0.004 \text{ m}^2\text{s}^{-2}$ and the semi-major and -minor axes of the MEE, $a = 6378137.678 \pm 0.0003 \text{ m}$ and $b = 6356752.964 \pm 0.0005 \text{ m}$, which are 0.678 and 0.650 m larger than those axes of the GRS80 reference ellipsoid, respectively. Moreover, a new estimation for the geocentric gravitational constant was obtained as $GM = (398600460.55 \pm 0.03) \times 10^6 \text{ m}^3\text{s}^{-2}$.