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On the optimum way to estimate geoid's potential value at the era of altimetry satellites

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Geoid according to the definition of Gauss and Listing is an equipotential surface that fits to global Mean Sea Level (MSL) in least square sense. This definition tells us that computation of geoid requires both knowledge of global MSL and gravity field information. Nowadays thanks to satellite altimetry missions, computation of global MSL with very high degree of precision has become possible. Besides recent developments in satellite, airborne and ground gravity observations have resulted in development of most reliable geopotential model, than ever before. Those geopotential models could be regarded as current best tools for the global gravity field modeling, specially at the sea areas, where we do not have any topography as we do on the continents, and as such a medium resolution spherical or ellipsoidal harmonic expansion to degree/order 360/360 could be regarded an adequate (adequate in resolution) gravity field model in those areas. Geoid can be viewed both in "geometry space" and in "potential space". In geometry space, the geoid can be specified point-wise by its location with respect to a reference ellipsoid, i.e. geodetic longitude, geodetic latitude, geoidal height. This presentation is the objective of geoid computation activities. However, geoid may also be considered in potential space. By potential space we mean a space where its elements are potential values. Therefore, in potential space an equipotential surface is identified by just one scalar value, which is, its gravity potential. This means in potential space the geoid is simply "potential = geoid's potential value W_0". Along this way of thinking we can also define transformation from geometry space into potential space as computation of potential value at a given point in space. This means, for example, an ellipsoidal or a spherical harmonic expansion is a transformation formula from geometry space into potential space. Therefore, if we take a geopotential model (a set of spherical or ellipsoidal harmonic coefficients) and compute the potential val-

ues at the points identifying a MSL model, we are transforming MSL from geometry space into potential space. Now, having the MSL in potential space we can attempt to compute the geoid according to Gauss-Listing definition, i.e. finding an equipotential surface that fits to MSL in an optimum way, but since we are in potential space this definition must be modified to: “a potential value which best fits to the potential values at MSL points in least square sense”. A value best fitting to a set of other values in least square sense, is simply the “mean” of those values. This means that the mean value of the computed potential values at MSL points is exactly geoid based on the Gauss-Listing definition. That “mean” value, i.e. “geoid in potential space”, is geoid potential value W_0 if be viewed from geometry space. A short conclusion of what has been said is that: Geoid potential value W_0 thanks to modern satellite altimetry missions and modern geopotential models is a determinable quantity and could by all means be considered as one of the fundamental parameters of geodesy. Existence of various MSL models, computed by different groups and schools as well as variety of geopotential models being computed by different global centers motivated us in this paper to make a thorough investigation over the existing MSL and geopotential models and study their effect on the geoid’s potential values which can be computed based on those models. The details of this investigation, which could lead to selection of a geoid’s potential value W_0 as the “current best estimate of geoid’s potential value” is given in this research.