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Unification of height systems in the frame of GGOS

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Most of the existing vertical reference systems do not fulfil the accuracy requirements of modern Geodesy. They refer to local sea surface levels, are stationary (do not consider variations in time), realize different physical height types (orthometric, normal, normal-orthometric, etc.), and their combination in a global frame presents uncertainties at the metre level. To provide a precise geodetic infrastructure for monitoring the Earth system, the Global Geodetic Observing System (GGOS) of the International Association of Geodesy (IAG), promotes the standardization of the height systems worldwide. The main purpose is to establish a global gravity field-related vertical reference system that (1) supports a highly-precise (at cm-level) combination of physical and geometric heights worldwide, (2) allows the unification of all existing local height datums, and (3) guarantees vertical coordinates with global consistency (the same accuracy everywhere) and long-term stability (the same order of accuracy at any time). Under this umbrella, the present contribution concentrates on the definition and realization of a conventional global vertical reference system; the standardization of the geodetic data referring to the existing height systems; and the formulation of appropriate strategies for the precise transformation of the local height datums into the global vertical reference system. The proposed vertical reference system is based on two components: a geometric component consisting of ellipsoidal heights as coordinates and a level ellipsoid as the reference surface, and a physical component comprising geopotential numbers as coordinates and an equipotential surface defined by a conventional W0 value as the reference surface. The definition of the physical component is based on potential parameters in order to provide reference to any type of physical heights (normal, orthometric, etc.). The conversion of geopotential numbers into metric heights and the modelling of the reference surface (geoid or quasigeoid determination) are considered as steps of the realization. The vertical datum unification strategy is based on (1) the physical connection of height datums to determine their discrepancies, (2) joint analysis of satellite altimetry and tide gauge records to determine time variations of sea level at reference tide gauges, (3) combination of geometrical and physical heights in a well-distributed and high-precise reference frame to estimate the relationship between the individual vertical levels and the global one, and (4) analysis of GNSS time series at reference tide gauges to separate crustal movements from sea level changes. The final vertical transformation parameters are provided by the common adjustment of the observation equations derived from these methods.