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Essential Geodetic Variables: Earth Orientation Parameters

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The Global Geodetic Observing System (GGOS) of the International Association of Geodesy (IAG) provides the basis on which future advances in geosciences can be built. By considering the Earth system as a whole (including the geosphere, hydrosphere, cryosphere, atmosphere and biosphere), monitoring Earth system components and their interactions by geodetic techniques and studying them from the geodetic point of view, the geodetic community provides the global geosciences community with a powerful tool consisting mainly of high-quality services, standards and references, and theoretical and observational innovations. A new initiative within GGOS is to define Essential Geodetic Variables. Essential Geodetic Variables (EGVs) are observed variables that are crucial (essential) to characterizing the geodetic properties of the Earth and that are key to sustainable geodetic observations. Once a list of EGVs has been determined, requirements can be assigned to them such as the accuracy with which the variables need to be determined, their spatial and temporal resolution, latency, etc. These requirements on the EGVs can then be used to assign requirements to EGV-dependent products like the terrestrial reference frame. The EGV requirements can also be used to derive requirements on the systems that are used to observe the EGVs, helping to lead to a more sustainable geodetic observing system for reference frame determination and numerous other scientific and societal applications.

For the Earth's rotation, the essential variables can be considered to be the five Earth orientation parameters (EOPs), namely, the x- and y-components of polar motion (x_p, y_p), the x- and y -components of nutation/precession (X, Y), and the spin parameter UT1. Related to these five Essential Earth Rotation Variables are the sub-variables of their time rates-of-change and the derived variables of the excitation functions (χ_x, χ_y, and length-of-day). The Essential Earth Rotation Variables are currently observed by the operational techniques of lunar and satellite laser ranging, very long baseline interferometry, global navigation satellite systems, and Doppler orbitography and radiopositioning integrated by satellite. In the future, the emerging techniques of ring laser gyroscopes and superfluid helium gyroscopes can be expected to routinely observe parameters related to the Essential Earth Rotation Variables. The GGOS requirements on the five Essential Earth Rotation Variables (that is, on the five EOPs) are "ERP-001-EOP: Earth Orientation Parameters will be determined with an accuracy of 1 mm, a temporal resolution of 1 hour, and a latency of 1 week; near real-time determinations of the Earth Orientation Parameters will be determined with an accuracy of 3 mm" (Plag and Pearlman, 2009, p. 223). Currently, the best-determined EOPs have an accuracy of about 1 mm, a temporal resolution of about 1 day, and a latency of about 2 weeks (Ray et al., 2017; http://www.igs.org/products). Thus, while the GGOS

accuracy requirement on the Essential Earth Rotation Variables is currently being met, at least for some of the variables, the GGOS resolution and latency requirements are not being met.