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Variations in the Realization of the Origin of the ITRF From Satellite Laser Ranging

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The International Terrestrial Reference Frame (ITRF) is the fundamental reference for the space- and ground-based observations of global change. As such, it is required to exhibit high accuracy and stability over extended periods of time. The goal of GGOS is to provide a frame with accuracy at epoch of 1 mm or better and a stability of 0.1 mm/y. Space geodesy groups support the establishment and maintenance of the ITRF for decades now, providing their series of products used by ITRS. In order to meet the stringent GGOS goal for future ITRF realizations, Space Geodesy is taking a two-pronged approach: modernizing the engineering components (ground and space segments), and revising the modeling standards to take advantage of recent improvements in many areas of geophysical modeling for system Earth components. This quest for higher accuracy and stability requires the close collaboration of space geodesy with all other scientific disciplines that study and monitor the Earth system components. As we gain improved understanding of these components, space geodesy adjusts its underlying modeling of the system to better and more completely describe it. This in turn results in an improved geodetic product (ITRF) for the scientific community and all other users. Laser Ranging (LR) supports this process since the very first years of space geodesy. With the proliferation of space techniques, LR and Satellite Laser Ranging (SLR) in particular, focused on the unique strength of the technique, in providing unbiased and very precise observations of the origin and scale of the ITRF. The origin of the ITRF is defined to coincide with the center of mass of the Earth system (geocenter). SLR realizes this origin as the focal point of the tracked satellite orbits, and being the only (nominally) unbiased ranging technique, it provides the best realization for it. The current practice is to provide a "snapshot" realization from the analysis of arcs spanning a week, selected as a compromise between the requirement for an accurate enough realization of the site positions and a short enough interval to minimize biasing the estimate from mass redistributions over that interval. A comparison of these weekly realizations to the static definition of the ITRF origin results in the time series of the so-called "geocenter variation" series. The series exhibit strong periodic signals, most notably at annual and semiannual and seasonal periods. These series can be used to "recover" the instantaneous (weekly-averaged) position of the network origin with respect to the geocenter for any instant covered by the series. Fitting a model for the dominant frequencies in the series, allows one to use this model for future and past time-intervals not covered by the observations. It is very important in this case that the user knows precisely the underlying models used in the SLR analysis, since the technique observes the lumped effect of mass redistributions in the Earth system, over and above what is forward-modeled in the analysis (if any). The more realistic the forward modeling used, the less significant the amplitudes of the "observed" geocenter variations. We will present and compare geocenter variations series based on different modeling underlying our SLR analysis, using the ITRF2008 as the reference.