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Time-variable Structure of the VLBI-SLR Scale Bias assessed with KALREF

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The International Terrestrial Reference System (ITRS) has consistently adopted for most of its realizations a scale definition relying on both VLBI and SLR. Generally associated with the metric structure of the space (i.e. the way in which distances and angles are determined in the 3D Euclidean space), the concept of scale in TRS definition is rather subtle: the scale is never an absolute entity and only scale differences of one space-geodetic (SG) observing system relative to another are meaningful. In this respect, quantifying the degree to which the interferometric (i.e. VLBI) and optical (i.e. SLR) scales differ is a fundamental prerequisite for any TRF combination, whose analysis informs the way in which the two systems' scales have to be handled within the frame reduction.

In analyzing the VLBI-SLR scale bias, the Laboratoire de Recherches en Géodésie of the Institut Géographique National (IGN) consistently found for ITRF2005, ITRF2008, and ITRF2014 statistically significant scale differences in the order of 7-9 mm (at the epoch January 1 2005) with scale drifts ranging from 0.1-0.5 mm/yr. In contrast to IGN, the analyses carried out at the Deutsches Geodätisches Forschungsinstitut of the Technische Universität München for the release of DTRF2005, DTRF2008, and DTRF2014 consistently pointed out the absence of systematic effects between VLBI's and SLR's scale.

In this study, we assess the VLBI-SLR scale differences within the framework developed for the analysis of JTRF2014, the combined TRF produced at the Jet Propulsion Laboratory (JPL) of California Institute of Technology (Caltech). Computed with a Kalman filter and smoother approach to terrestrial reference frames (KALREF) determination, JTRF2014 constitutes a sub-secular frame adopting a time-series representation. From KALREF's standpoint, the analysis of the VLBI-SLR scale bias amounts to executing a frame combination wherein SG solutions from the four techniques get assimilated at a weekly time step, the VLBI (or equivalently the SLR) scale does not get adjusted, and an instantaneous scale parameter mapping SLR to VLBI (or equivalently VLBI to SLR) gets estimated.

As a result of the data assimilation, a time series of the instantaneous scale differences between SLR and VLBI is derived. Such scale differences reflect time-variable metric differences of the two observing systems estimated through a common sub-network of co-located stations connected through local tie measurements, thus depending upon the local tie values, their uncertainties, the structure of the co-motion constraints applied, and the geometry of the global observing network.