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Comparison of VLBI TRF solutions based on Kalman filtering and recent ITRS realizations

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Compared to previous prominent global terrestrial reference frames (TRF) solutions, such as the ITRF2008 or DTRF2008, the current accuracy requirements demand among other things extended parameterization to account for various non-linear signals present in the time series of station coordinates. The next generation of TRFs, built upon geodetic data until the end of 2014, employs different approaches to tackle in particular seasonal variations and post-seismic deformations. The ITRF2014, developed at the International Earth Rotation and Reference Systems Service (IERS) Combination Center (CC) at Institut Géographique National, introduces harmonic, exponential and logarithmic functions to take into account aforementioned effects. In contrast, the ITRS realization of the IERS CC at Jet Propulsion Laboratory is based on Kalman filtering, which allows coordinate variations to be modeled in a stochastic sense besides the parameterized linear and seasonal signals.

In our study, we compare these multi-technique TRFs with solutions solely based on VLBI data, including 104 radio telescopes and 4239 VLBI sessions, covering a time span of 34 years. We calculated a VLBI TRF based on the traditional least-squares adjustment of session-wise normal equations, and an ensemble of Kalman filter and smoother solutions with different parameterizations and stochastic models. In particular, we investigate the impact of different process noise levels for station coordinates, the choice of stochastic processes, e.g. random walks, and the application of time- and station-dependent noise models. For instance, we find that the estimation of seasonal signals, while important for predictions, does not affect the filtered coordinate time series when observational data is available. Furthermore, post-seismic deformations after major earthquakes require the process noise to be scaled accordingly. For instance, we detected coordinate differences of up to 5 cm immediately after the Chile 2010 earthquake when changing the process noise by a factor of 10. Finally, we investigated velocity differences and found the RMS of the differences between the VLBI solutions reaching 0.3 mm/yr for stations with good observational history.