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An experimental Kalman filter approach to the International Terrestrial Reference Frame realization

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To monitor global geophysical changes with realistic uncertainties using millimeter-precision geodesy, it is essential to define, realize and maintain the International Terrestrial Reference Frame (ITRF) consistently and accurately. Precise determinations of geocentric site positions and motions, satellite orbits, geocenter motion, Earth orientation and its variations, mean sea level rise, and polar ice mass changes at various time scales all depend critically on the accuracy and stability of the ITRF. By definition, the ITRF is a secular frame based on a linear model and consisting of mean epoch positions and velocities for a global set of stations. It is needed to serve as a standard reference frame in which geophysical results can be formulated and compared. The neglected up-to centimeter-level non-linear station motion can bias the linear station velocities, which can be significantly compounded for stations with short time-span. Here, we conceptually define an experimental reference frame with its origin at the nearly instantaneous center-of-mass (CM) of the total Earth system, by specifying the frame and combining different technique data weekly (daily for Earth orientation parameters). For co-located sites, available local ties are applied only once; but site motions are usually constrained to be the same. A Kalman filter and smoother algorithm has been developed and coupled to the ITRF/CATREF software to solve for geocentric coordinate time series, as well as a model of secular, periodical and stochastic motion components. Preliminary results using linear and linear plus sinusoidal motion models without stochastic components compare very favorably with the ITRF2005 solution. With only a subset of the ITRF2005 input data time series from 1996 onward, we have obtained reference frame solutions that differ from ITRF2005 in origin by 0.6 mm and 0.3 mm/yr. Filtering strategies and time series results will also be presented.