A Kalman-Filter-Based Approach to Combining Earth Orientation Series

Richard S. Gross

Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, USA; ph. 1-818-354-4010; fax: 1-818-393-6890; email: Richard.Gross@jpl.nasa.gov

An approach, based upon the use of a Kalman filter, that is currently employed at the Jet Propulsion Laboratory (JPL) for combining independent measurements of the Earth's orientation is presented. Since changes in the Earth's orientation can be described as a randomly excited stochastic process, the uncertainty in our knowledge of the Earth's orientation grows rapidly in the absence of measurements. Consequently, it is important to analyze each measurement at its measurement epoch, rather than at some nearby, regularized epoch as is commonly done in normal-point methods of combining data sets. The Kalman filter methodology allows for an objective accounting of this uncertainty growth between measurements since it contains a model for the process, and in the absence of measurements uses this model to propagate forward in time the state vector and its covariance matrix. Kalman filters are therefore an effective means of dealing with irregularly spaced data sets since the state vector and state covariance matrix can be propagated to the measurement epoch regardless of whether or not the measurements are equi-spaced, thereby facilitating the combination of measurements taken at different epochs (not necessarily uniformly spaced in time) and with different precision. In addition, the use of a Kalman filter allows each measurement series to be processed in its own natural reference frame, whether it be the usual universal time-polar motion (UTPM) frame of GPS, SLR, and multibaseline VLBI measurements, the transverse-vertical-length (TVL) frame of single baseline VLBI measurements, or the variation of latitude-UT0-degenerate (VUD) frame of single station LLR measurements. As an example of this approach to combining Earth orientation series, a description is given of a combination, SPACE98, that has been generated recently at JPL.