

Sequentially Estimating and Updating Terrestrial Reference Frames

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Abstract. The terrestrial reference frame (TRF) is the foundation for virtually all space-based and ground-based Earth observations. Positions of objects are determined within an underlying TRF and the accuracy with which objects can be positioned ultimately depends on the accuracy of the TRF.

Requirements for TRFs have increased dramatically since the 1980s. Today, the most stringent requirement comes from critical sea level programs: a global accuracy of 1.0 mm and stability of 0.1 mm/yr is required. Future Earth observing satellites will have ever-increasing measurement capability and should lead to increasingly sophisticated models of the processes they are observing. The accuracy and stability of the TRF needs to dramatically improve in order to fully realize the measurement potential of the future Earth observing satellites.

Recent ITRFs have been produced at intervals of 3-6 years (ITRF2000, ITRF2005, ITRF2008, ITRF2014, ITRF2020). Between these realizations, users must rely on predictions of the motions of the reference stations. However, these predictions degrade with time leading to errors in products that depend on the ITRF. Updating the TRF more frequently would eliminate the need for multi-year predictions and hence eliminate this source of error in the TRFs.

JPL is developing a sequential estimation approach to realizing TRFs. This approach, which was used at JPL to produce JTRF2014 and which is being used to produce JTRF2020, is particularly well-suited to the task of updating the TRF in a timely manner. It is straightforward to save the state vector and its full covariance matrix at the end of a TRF solution. As more recent data become available, the filter can be re-started from the saved state and run forward in time, assimilating the new data until it ends, thereby updating the TRF. This process can then be repeated at regular intervals. JPL is currently planning on using this approach to update JTRF2020 at monthly intervals.