Geophysical Research Abstracts
Vol. 17, EGU2015-14450, 2015
EGU General Assembly 2015

Terrestrial Reference Frame from GPS and SLR

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We present strategies for realizing the terrestrial reference frame (TRF) using tracking data from terrestrial GPS receivers alone and in tandem with the GRACE and LAGEOS satellites. We generate solutions without apriori ties to the International Terrestrial Reference Frame (ITRF). Our approach relies on processing multi-day orbit arcs to take advantage of the satellite dynamics, GPS receiver and transmitter calibrations derived from low-Earth orbiter (LEO) data, and estimation strategies tuned for realizing a stable and accurate TRF. We furthermore take advantage of the geometric diversity provided by GPS tracking from GRACE, and explore the impacts of including ground-based satellite laser range (SLR) measurements to LAGEOS-1 and -2 with local ties relating the two geodetic techniques. We process data from 2003-2014 and compute Helmert transformations relative to ITRF/IGb08. With GPS alone we achieve a 3D origin offset and rate of <7 mm and <1 mm/yr, and reduce the offset to <4 mm when GRACE is included in the global solutions. Scale bias and rate are 3.1 ppb and 0.01 ppb/yr in either solution. Including SLR tracking from 11 ground stations to the LAGEOS satellites from 2012-2014 yields a reduction in scale bias of 0.5-1.0 ppb depending on the weight assigned to the SLR measurements. However, scatter is increased due to the relatively sparse SLR tracking network. We conclude with approaches for improving the TRF realized from GPS and SLR combined at the measurement level.