GPS Solut (2013) 17:237–246
DOI 10.1007/s10291-012-0274-8

ORIGINAL ARTICLE

Evaluation of the ITRF2008 GPS vertical velocities using satellite antenna z-offsets

X. Collilieux · R. Schmid

Received: 21 April 2011 / Accepted: 7 June 2012 / Published online: 11 July 2012

Abstract We develop a method to evaluate the terrestrial reference frame (TRF) scale rate error using Global Positioning System (GPS) satellite antenna phase center offset (APCO) parameters and apply it to ITRF2008. We search for the TRF in which *z*-APCO parameters have the smallest drift. In order to provide realistic error bars for the *z*-APCO drifts, we pay attention to model periodic variations and auto-correlated noise processes in the *z*-APCO time series. We will show that the GPS scale rate with respect to a frame is, as a first approximation, proportional to the estimated mean *z*-APCO trend if that frame is used to constrain station positions. Thus, an ITRF2008 scale rate error between −0.27 and −0.06 mm/yr depending on the GPS analysis center can be estimated, which demonstrates the high quality of the newly constructed ITRF2008. We will also demonstrate that the traditional estimates of the GPS scale rate from 7-parameter similarity transformations are consistent with our newly derived GPS scale rates with respect to ITRF2008 within two sigmas. We find using International GNSS Service (IGS) products that the traditional approach is relevant for scale rate determination even if some of the *z*-APCO values supplied by the IGS were not simultaneously calibrated. As the scale rate is related to the accuracy of vertical velocities, our estimates supply a conservative evaluation that can be used for error budget computation.

Keywords Terrestrial reference frame · GPS · Satellite antenna phase center · Space geodetic techniques · Kalman filter

X. Collilieux (✉)
IGN, LAREG/GRGS, 6-8 avenue Blaise Pascal,
77455 Marne La Vallée Cedex 2, France
e-mail: xavier.collilieux@ign.fr

X. Collilieux
GRGS, Marne La Vallée Cedex 2, France

R. Schmid
Institut für Astronomische und Physikalische Geodäsie,
Technische Universität München, Arcisstr. 21,
80333 Munich, Germany

Introduction

Vertical station velocities obtained from different space geodetic techniques at co-location sites are not fully consistent due to modeling errors and/or differences in the conventional frame definition (Altamimi et al. 2002). The velocity differences are usually compensated by means of scaling factors for the station positions and vertical velocities together with additional translation parameters. Whereas the quality of the origin of different velocity fields has been assessed using post-glacial rebound models (Argus 2007), rigid plate motion models (Kogan and Steblov 2008) or tide gauge records (Collilieux and Wöppelmann 2011), only few studies assessed the velocity field scale rate independently from satellite laser ranging (SLR) data, Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) or very long baseline interferometry (VLBI) (Bouin and Wöppelmann 2010; Ray et al. 2010; Wu et al. 2011). Sea level rise estimation is a relevant example where an accurate scale and scale rate is needed for the adopted terrestrial reference frame (TRF). Both the calibration process of the absolute altimeter biases of the successive space altimetry missions (Bonnefond et al. 2011) and the land motion corrections of the tide gauge records using GPS (Collilieux and Wöppelmann 2011) require an accurate TRF scale.