EGU21-2646
https://doi.org/10.5194/egusphere-egu21-2646
EGU General Assembly 2021

Estimating variations in Earth rotation using GPS, GLONASS, and Galileo

Radosław Zajdel, Krzysztof Sośnica, Grzegorz Bury, and Kamil Kazmierski
Wroclaw University of Environmental and Life Sciences, Institute of Geodesy and Geoinformatics, Wrocław, Poland
(radoslaw.zajdel@upwr.edu.pl)

Variations in the Earth's rotation can be examined in the low-frequency and high-frequency temporal scales. The low-frequency variations are dominated by the annual and Chandler wobbles, while the high-frequency variations are primarily caused by tidal effects and mass redistributions within the system Earth. Depending on the purpose, the Earth Rotation Parameters (ERPs) can be estimated in different time resolutions using space-geodetic techniques, especially using GNSS. However, the residual signals between different space geodetic techniques or satellite constellations indicate system-specific differences, which have to be correctly identified.

This research provides the daily, and sub-daily series of Earth Rotation Parameters (ERPs) estimated using GPS, GLONASS, and Galileo observations. We test different sampling intervals of estimated ERPs from 1h to 24h. The GNSS-based sub-daily estimates have been compared with the external models of variations in ERPs induced by the ocean tides from the IERS 2010 Conventions, a new model by Desai-Sibois, and the VLBI-based model by Gipson.

Any system-specific ERPs are affected by the orbital and draconitic signals. The orbital signals are visible in all system-specific ERPs at the periods that arise from the resonance between the Earth's rotation and the satellite revolution period, e.g., 8.87h, 34.22h, 3.4 days, 10 days for Galileo; 7.66h, 21.29h, 3.9 days, 7.9 days for GLONASS; 7.98h (S3 tidal term), 11.97h (S2 tidal term), 23.93h (S1 tidal term) for GPS. In the Galileo and GLONASS solutions, the artificial non-tidal signals' amplitudes can reach up to 30 μas. The GPS-derived sub-daily ERPs suffer from the overlapping periods of the diurnal and semidiurnal tidal terms and the harmonics of the GPS revolution period. After recovery of 38 sub-daily tidal terms, the Galileo-based model is more consistent with the external models than the GPS-based model, especially in the prograde diurnal band. The results confirmed that the Desai–Sibois model is more consistent with GNSS observations than the currently recommended model by the IERS 2010 Conventions. Moreover, GPS-based length-of-day (LoD) is systematically biased with respect to the IERS-C04-14 values with a mean offset of −22.4 μs/day, because of the deep resonance 2:1 between the satellite revolution period and the Earth rotation. The Galileo-based and GLONASS-based solutions are almost entirely free of this issue. Against the individual system-specific solutions, the multi-GNSS solution is not affected by most of the system-specific artifacts. Thus, multi-GNSS solutions are clearly beneficial for the estimation of both daily and sub-daily ERPs.