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Instantaneous Reference Frame Realization by Means of Combination of Space Geodesy Techniques Onboard Jason-2 Satellite

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Terrestrial reference frames are realized by sets of station coordinates that are estimated over a longer period of time using a combination of different space geodesy techniques. However, in the precise orbit determination (POD) of LEO satellites using GPS, reference stations on the ground are not directly used to estimate the orbit of the LEO satellite. Compared to SLR and DORIS, LEO POD based on GPS uses an intermediate reference frame represented by the GPS satellite orbits and epoch-wise estimates of high-rate GPS satellite clocks. Any error in the GPS satellite orbits and clocks, or this intermediate space-based reference frame, will directly propagate into LEO orbit and directly alias into gravity field determination (as in the case of GOCE) or altimetry results (as in the case of JASON-2).

To demonstrate this, one can take two different GPS orbit and clock solutions from two of the most accurate IGS Analysis Centers and compare the estimated LEO orbits in the spectral domain. The quality of the instantaneous reference frame realized by the GPS satellites will more strongly affect LEO satellites in very low orbits (like GOCE) than satellites in a high LEO orbit (like JASON-2), due to the use of kinematic or very reduced-dynamic POD approaches for the lower orbit altitudes. POD for JASON-2 satellite require a rather modest number of estimated orbital parameters and it is comparable to the GPS orbit parameterisation. Furthermore, as concerns non-gravitational forces, satellites in a high LEO orbit are mainly affected by the solar radiation pressure, whereas satellites in very low LEO orbit, considering solar radiation, are mainly affected by the air-drag. Satellites in the higher orbits are very good candidates for the combination of space geodesy techniques, like GPS, DORIS and SLR. With the collocation of different space geodesy techniques onboard JASON-2 satellite, one can connect all GPS satellites in the GPS constellation in only about 90 minutes, and all ground SLR and DORIS stations at the same time. One could imagine JASON-2 satellite as a station with well-defined ties between different space geodesy techniques collocated on the same satellite, flying below the constellation of GPS satellites and above the ground networks of the different space geodesy techniques.

Here we show first results in combined processing of ground and spaceborne GPS, DORIS and SLR measurements and estimation of reference frame parameters, including station coordinates of different space geodesy techniques, troposphere zenith delays, Earth rotation parameters, geocenter coordinates and GPS satellite orbit and high-rate clock parameters. We analyse the impact of the LEO data on the global reference frame parameters and possible improvements they can bring. This is a continuation of the work performed with the GPS data from the JASON-1 satellite, where a strong impact on the global parameters has already been demonstrated by means of variance-covariance analysis. In order to validate results of the instantaneous reference frame realization materialised by the GPS orbits and clocks, we make use of kinematic POD to map errors in the instantaneous reference frame realization along the GOCE and JASON-2 orbit. In the next step, we show how by means of kinematic POD it is possible to construct a global map, given on a reference sphere in the LEO orbit, and monitor geographically correlated errors of the instantaneous reference frame realisation.