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Suspected time errors along the satellite laser ranging network and impact on the reference frame

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Systematic errors in the laser ranging technologies must be considered when considering the GGOS objective to maintain a network with an accuracy of 1 mm and a stability of 0.1 mm per year for the station ground coordinates in the ITRF. Range and Time biases are identified to be part of these systematic errors, for a major part, and are difficult to detect. Concerning the range bias, analysts and working groups estimate their values from LAGEOS-1 & 2 observations (c.f. Appleby et al. 2016). On the other hand, time errors are often neglected (they are presumed to be < 100 ns) and remain difficult to estimate (at this level), from using the observations of geodetic satellites passes and precise orbit determination (i.e. LAGEOS). The Time Transfer by Laser Link (T2L2) experiment on-board Jason-2 is a unique opportunity to determine, globally and independently, the synchronization of all laser stations.

Because of the low altitude of Jason-2, we computed the time transfer in non-common view from the Grasse primary station to all other SLR stations. We used a method to synchronize the whole network which consists of the integration of an Ultra Stable Oscillator (USO) frequency model, in order to take care of the frequency instabilities caused by the space environment. The integration provides a model which becomes an "on-orbit" time realization which can be connected to each of the SLR stations by the ground to space laser link. We estimated time biases per station, with a repeatability of 3 - 4 ns, for 25 stations which observe T2L2 regularly.

We investigated the effect on LAGEOS and Starlette orbits and we discuss the impact of time errors on the station coordinates. We show that the effects on the global POD are negligible (< 1 mm) but are at the level of 4 - 6 mm for the coordinates. We conclude and propose to introduce time errors in the future analyses (IDS and ILRS) that would lead to the computation of improved reference frame solutions.