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Troposphere delay modeling in SLR solutions

Recent studies on troposphere delay in Satellite Laser Ranging show that considering the currently neglected horizontal gradients of the troposphere delay reduces the residuals of SLR observations at low elevation angles as well as improves the consistency between SLR and other space geodetic techniques, such as Global Navigation Satellite Systems (GNSS) or Very-Long Baseline Interferometry (VLBI). Therefore, modeling of horizontal gradients should be considered in SLR solutions using one of the newly-developed models available.

In this work, we examine 3 solutions, with respect to the standard FCULa approach. We consider: Potsdam Mapping Function (PMF) for optical frequencies with linear horizontal gradients and mapping function coefficients; Vienna Mapping Function (VMF3o) for optical frequencies, with a separation of the mapping function for the hydrostatic and non-hydrostatic delays and horizontal gradients; and the standard Mendes–Pavlis mapping function with a simple parametric model of the horizontal gradients based on 16-year time series of horizontal gradients derived from Numerical Weather Models. To conduct this experiment, we use SLR observations to passive geodetic satellites LAGEOS-1, LAGEOS-2, and LARES.

For all proposed solutions, we observe an improvement of the SLR observation residuals especially for low elevation angles and an improvement of the consistency between pole coordinates and the combined solution C04 when compared to the standard solution without horizontal gradients. Low-orbiting satellites, such as LARES, are characterized by a large number of observations at lower elevation angles. Hence, the proper modeling of horizontal gradiants is especially important when including LARES to the standard ILRS solutions.