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Atmospheric delay modeling with horizontal gradients for SLR observations

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Satellite Laser Ranging (SLR) is the fundamental space geodetic technique providing precise scientific products, such as geocenter motion, station coordinates, Earth rotation parameters, gravity field coefficients, as well as the global scale of the reference frame. For obtaining high-quality products, a proper modeling of the optical signal delay in the atmosphere is needed. Currently, in the SLR data processing scheme, the horizontal gradients of the troposphere delay are neglected. This neglect may lead to inconsistencies between other techniques of space geodesy, such as GNSS, VLBI, and DORIS. These techniques are based on microwave observations and all of them operationally employ the asymmetricity of the atmosphere above the observing stations by estimating or including horizontal gradients from external models.

In this contribution, we evaluate the short-term and long-term sensitivity of SLR observations to horizontal gradients of the troposphere delay. We check the possibility of estimating gradients from SLR tracking to LAGEOS-1 and LAGEOS-2 satellites. The SLR-derived gradients are compared to GNSS results for SLR-GNSS co-located stations. Moreover, we compare SLR gradients to those obtained using numerical weather model predictions. Finally, we introduce the gradients based on numerical weather models and adapted to optical wavelengths to 12-years of reprocessed SLR observations to LAGEOS satellites. A classical solution that assumes a full atmospheric symmetricity above SLR stations is compared to the corresponding solution with troposphere horizontal gradients. The impact on the parameters typically obtained from SLR observations is investigated, including the repeatability of SLR station coordinates, geocenter motion, Earth rotation parameters, i.e. pole coordinates and Length-of-day, as well as SLR range biases.