The influence of considering atmospheric wind field for atmospheric drag on SLR orbit determination

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Precise Orbit Determination (POD) of Satellite Laser Ranging (SLR)-tracked satellites is stepping towards millimeter-level precision, which requires further refinement of satellite perturbation models and consideration of more detailed perturbation force models that were not previously taken into accounted. Atmospheric drag is one of the main perturbative forces acting on a Low Earth Orbit (LEO) satellite, however, the atmospheric wind speed associated with atmospheric drag has not been considered in International Laser Ranging Service (ILRS) regular data processing. Therefore, in order to analyze the magnitude of atmospheric wind speed influence on POD of SLR satellites, this paper applies HWM14 (Horizontal Wind Model 14) atmospheric wind speed model to perform POD of LARES, Ajisai, Starlette, Stella, Larets satellites and analyses the results. The results show that after applying HWM14 atmospheric wind speed model, the SLR observation residual WRMS (Weighted Root Mean Square) value for LARES, Starlette, Stella, Larets satellites reach 1.04 cm, 2.13 cm, 1.73 cm, 3.36 cm, respectively, which are reduced by 0.10 cm, 0.30 cm, 0.00 cm, 0.05 cm, respectively. However, for Ajisai, one has an almost the same orbit residual WRMS value of 2.88 cm. The 3D (three-dimensional) orbit overlapping arcs error for LARES is 17.53 cm, which is reduced by 1.75 cm; for Starlette it is 19.12 cm, which is reduced by 0.96 cm; for Stella there is almost same orbit overlapping arcs error of 34.9 cm. The accuracy of orbit forecast for 1 day and 3 days for LARES reaches 147.57 cm and 163.96 cm, respectively, which is improved by 0.04 cm and 20.73 cm in the T (Tangential) direction, respectively. The accuracy of orbit forecast for 1 day and 3 days for Stella reaches 191.77 cm and 308.52 cm, respectively, which is improved by 1.95 cm and 6.74 cm in the T direction, respectively. The accuracy of orbit forecast for 1 day and 3 days for Larets reaches 6.18 m and 145.26 m, respectively, which is improved by 7.81 m and 473.61 m in the T direction, respectively. Above results display that considering HWM14 atmospheric wind speed model has a certain improvement for POD of LARES, Starlette, Stella and Larets. Therefore, the influence of atmospheric wind speed should be considered in the SLR POD and regular data processing.