The Fusion of GNSS with FY-4A Satellite Observations for Atmospheric Water Vapor Tomography Using an Improved Node-based Parameterization Method

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Abstract

High spatio-temporal resolution atmospheric water vapor can be retrieved using Global Navigation Satellite System (GNSS) tomography technique, in which the remaining ill-posed problem of the tomography system is a vital issue to be addressed. Presently, various data from different sensors, e.g., radio occultation refractivity, AIRS profiles, and MODIS/InSAR precipitable water vapor (PWV) products, are fused into the GNSS tomographic system to deal with the problem. However, the low revisit time or sparse distribution of these observations restrict their contributions to GNSS tomography. In this study, we propose a new fusion of GNSS data and the next-generation layer precipitable water (LPW) observations derived from FengYun-4A (FY-4A) geostationary meteorological satellite. FY-4A LPW products are characterised by high temporal resolution (15 min) and appropriate spatial resolution (4 km) over three atmospheric layers (surface to 0.9, 0.9-0.7, and 0.7-0.3 in sigma vertical coordinate). Besides, an improved parameterization method based on node tomography model is developed to fully exploit the advantages of FY-4A PWV signals. Five experimental schemes based on FY-4A observations and simultaneous GNSS data over the Xuzhou area are implemented to validate the proposed approach. The FY-4A LPW products are calibrated by GNSS and ERA5 data with the in-house software COMEDIE at first. The results show that after combing GNSS and FY-4A LPW data, the mean root-mean-square-error (RMSE) and bias of the tomographic solutions are decreased by 31% and 35%, respectively. This combination is promising to improve reconstruction quality of atmospheric water vapor distribution.