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Prospects of Space Geodesy to Monitor Atmospheric Moisture and Atmospheric Net-Water Fluxes

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Accurate representation of the time-variable atmospheric state is achieved by assimilating numerous and disparse observations into numerical weather models (NWM). The four-dimensional atmospheric density distribution, a derivative of essential meteorological variables, affect among else how electromagnetic signals propagate through Earth's atmosphere and how satellites orbit through Earth's gravity field. Atmospheric refraction to which microwave signals are subjected as they traverse the electrically neutral atmosphere is quantified e.g., during the GNSS data analysis, and holds valuable information about the water vapor distribution in the vicinity of the ground stations. Satellite gravimetry as realized by the GRACE and GRACE-FO missions is sensitive to mass redistribution within Earth's fluid envelope, including but not limited to the atmosphere and the terrestrail water storage, and also to high-frequency variations stemming from the time-integrated effect of precipitation and evapotranspiration. In this contribution we employ two state-of-the-art meso-beta scale NWM (ECMWF's latest reanalysis ERA5 and DWD's operational model ICON-global) as well as ERA5's ensemble members to demonstrate that tropospheric mosture distribution and net atmospheric freshwater fluxes are quite uncertain in modern NWM in comparison to other quantities such as hydrostatic atmospheric mass and that certain space geodetic observing systems such as GNSS and GRACE-FO are appropriate tools to monitor them, thus enhancing the accuracy of weather prediction.