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Global Water Vapor Trends from Ground-Based GNSS Measurements and Homogenized Radiosonde Data

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Atmospheric water vapor is the single largest greenhouse gas in the atmosphere. It plays a crucial role in Earth's energy and water cycles. Thus, how atmospheric water vapor and humidity change under global warming is of vital importance. The atmospheric precipitable water (PW) derived from measurements of ground based Global Navigation Satellite Systems (GNSS) are especially useful for studying water vapour variability because of its continuous sampling, high accuracy, and long-term stability. The long-term stability of raw GNSS measurements and SI traceability make it appealing for long-term water vapour trend analysis.

This study focuses on documenting and understanding long-term PW trends using two datasets, NCAR global, 2-hourly ground-based GNSS PW dataset and NCAR homogenized daily radiosonde data. In this talk, we will show the following results. First, we will present the 15-year (1997-2011) PW trends at $\sim$70 GNSS stations where continuous data are available and compare the trends with that derived from the radiosonde data at $\sim$800 stations for the periods of both 1997-2011 and 1973-2011. The comparison will shed light on both spatial and temporal representativeness of the GNSS derived trends. The uncertainty of the GNSS PW trends will also be quantified to study the statistical significance of the trends. Second, the variability of PW trends with the time of the day will be studied given the high temporal resolution of the GNSS-PW dataset. The atmospheric temperatures during day and night respond differently to the increase of the anthropogenic greenhouse gases. So the question is whether and how the atmospheric water vapour long-term changes behave differently during day and night. Third, we will investigate the relationship of the long-term PW variability with atmospheric temperature and other variables to understand what attributes to the increase or decrease of PW trends.