Spatial and Temporal Variability of GPS-Derived Precipitable Water Vapor from 2020 to 2025 in the Philippines

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ABSTRACT

Variations in atmospheric water vapor directly influence the global energy balance, weather processes, and climate dynamics. Precipitable water vapor (PWV), a key indicator for atmospheric water vapor content, is conventionally measured using various observational techniques, including radiosondes, ground-based microwave radiometers, Global Positioning System (GPS) receivers, and satellite remote sensing sensors. Compensating for the spatial and operational limitations of other methods, ground-based GPS receivers offer continuous, cost-effective, and weather-independent water vapor tracking by estimating PWV from signal propagation delays caused by the troposphere. However, despite the expanding number of GPS stations across the Philippines, there is a limited number of studies leveraging GPS-derived PWV, with prior investigations primarily confined to a few site locations. Hence, this study will utilize six years (2020-2025) of GPS observations to retrieve PWV and investigate its spatial and temporal variability across the entire archipelago. The accuracy of GPS-derived PWV estimates will be validated against collocated radiosonde observations using root mean square error (RMSE), mean bias error (MBE), and Pearson's correlation coefficient (r). The study will then decompose and analyze the spatial distribution and temporal variability of PWV to reveal trends, dominant periodicities, and short-term fluctuations associated with atmospheric circulation dynamics. Moreover, given the complex regional interactions between PWV and rainfall, their relationship will be quantified and evaluated at collocated GPS receivers and synoptic stations using correlation analysis. The findings of this study can provide critical insights into the characteristics and behavior of atmospheric water vapor over the country. Furthermore, this study aims to demonstrate the potential of GPS to enhance nationwide atmospheric moisture monitoring, which is valuable for weather prediction and climate modeling.

Keywords: Precipitable water vapor, GPS meteorology, variability, Philippines, rainfall