Ground-based GNSS for Meteorological Applications in Ghana

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Key words: GNSS/GPS; Climate monitoring; ERA5; Meteorology; Precipitable Water Vapour; Statistical measures; Water vapour

SUMMARY

Atmospheric water vapour is a critical and abundant greenhouse gas with significant implications for weather forecasting and climate monitoring. However, its spatial and temporal variability poses challenges to accurate observation. The low-latitude region, particularly Ghana, experiences large amounts and inhomogeneous water vapour content due to its proximity to the equator, making it susceptible to rapid weather changes over time. Severe weather forecasting in Ghana can be challenging due to the high spatiotemporal variability of water vapour. Water vapour content is under-sampled in the current meteorological and climate observing systems due to the lack of accurate, dense and continuous observation of water vapour data in Ghana, hampering the ability to keep track of water vapour in the atmosphere. To address this issue, the Global Navigation Satellite System (GNSS) offers continuous, accurate, and all-weather observations of water vapour through ground-based GNSS receivers. Ghana has seen an increase in the establishment and distribution of GNSS Continuously Operating Reference Stations (CORS), providing a more comprehensive dataset for retrieving and understanding Precipitable Water Vapour (PWV) in the country for meteorological and climatological applications. This study presents daily GNSS-derived PWV data from 49 established GNSS CORS in Ghana, utilising GNSS observation data from 2020. The GNSS-derived PWV values are compared with the fifth-generation reanalysis dataset from the European Centre for Medium-Range Weather Forecasts (ECMWF, ERA5) using various statistical measures, including Mean Bias (MB), Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and the correlation coefficient (R). The statistical analysis demonstrates that ground-based GNSS-derived PWV data in Ghana exhibit a high level of accuracy, with MB, MAE, RMSE, and R of 1.29 mm, 2.10 mm, 2.68 mm, and 0.9563, respectively. These findings emphasise the reliability and precision of GNSS-based observations for monitoring atmospheric water vapour in Ghana, offering valuable insights for weather forecasting and climate

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