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Analysis of tropospheric parameter time series obtained with various types of GNSS antenna phase center models

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Water vapour is a key variable of the water cycle and plays a special role in many atmospheric processes controlling the weather and climate. Nowadays, extreme weather events, such as storms, floods, landslides, heat waves and droughts are the main concerns of society. The Global Navigation Satellite System (GNSS) is one of the few tools that can be used as an atmospheric water vapour sensor and, simultaneously, provide continuous, unbiased, precise and robust atmosphere condition information. A significant impact on the tropospheric parameter determination in the processing of satellite observations has undoubtedly GNSS antenna phase centers model.

Therefore, the aim of our study is to investigate the impact of different GNSS antenna calibration models on the quality of the tropospheric parameter series applied for climate applications. We analyse the zenith total delays (ZTD) obtained from GNSS data processing and afterwards converted integrated water vapour (IWV). Three years of GNSS data collected at 40 European Reference Frame (EUREF) Permanent GNSS Network (EPN) stations were processed with the NAPEOS software. Precise Point Positioning (PPP) technique utilizing European Space Agency (ESA) precise satellite orbits and clocks was used to estimate the parameters. Several different processing variants were processed and inter-compared. The first group of solutions was obtained by applying the International GNSS Service (IGS) type-mean Phase Center Correction (PCC) models. In the second and third groups of solutions, PCC models from respectively individual field robot calibration and calibration in an anechoic chamber were used. All solutions were processed using GPS and Galileo observations. Moreover, in order to validate and assess the quality of the GNSS solutions, the tropospheric parameters obtained from ERA5 reanalysis were compared with GNSS estimates.

In general, the results of the study show that the NAPEOS software can provide high quality GNSS tropospheric delay time series. The initial results indicate that the impact of applying different PCC model calibrations is not negligible. ZTD estimates obtained from variants using ROBOT and IGS14 calibration are closer to ERA5 than estimates from variants that used calibrations in an anechoic chamber. In addition, multi-GNSS processing variants are closer to ERA5 than GPS only or Galileo only processing variants. The results also depend on the equipment (receiver and antenna) of the stations. Validation against the data from climate reanalysis confirms that all GNSS approaches provide high-quality ZTD estimates. Furthermore, there is a high agreement in the IWV

distributions between GNSS and ERA5.