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Global trends and variability in integrated water vapour from ground-based GPS data and atmospheric models

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A high-quality, consistent, global, long-term dataset of integrated water vapour (IWV) was produced from Global Positioning System (GPS) measurements at more than 400 sites over the globe among which 120 sites have more than 15 years of data. The GPS delay data were converted to IWV using surface pressure and weighted mean temperature estimates from ERA-Interim reanalysis. A two-step screening method was developed to detect and remove outliers in the IWV data. It is based on: 1) GPS data processing information and delay formal errors, and 2) intercomparison with ERA-Interim reanalysis data. The GPS IWV data are also homogenized to correct for offsets due to instrumental changes and other unknown factors. The differential homogenization method uses ERA-Interim IWV as a reference. The resulting GPS data are used to document the mean distribution, the global trends and the variability of IWV over the period 1995-2010, and are analysed in coherence with precipitation and surface temperature data (from observations and ERA-Interim reanalysis). These data are also used to assess global climate model simulations extracted from the IPCC AR5 archive. Large coherent spatial patterns of moistening and drying are evidenced but significant discrepancies are also seen between GPS measurements, reanalysis and climate models in various regions. In terms of variability, the monthly mean anomalies are intercompared. The temporal correlation between GPS and the climate model simulations is overall quite small but the spatial variation of the magnitude of the anomalies is globally well simulated. GPS IWV data prove to be useful to validate global climate model simulations and highlight deficiencies in their representation of the water cycle.