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Global IWV trends and variability in atmospheric reanalyses and GPS observations

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Water vapour is the dominant greenhouse gas and a key component of the global water and energy cycle. It plays thus an important role in the response of the climate system to global warming. At global scale, the amount of water vapour is mainly controlled by temperature according to the Clausius-Clapeyron relation (about 7%/K). At regional scale, many deviations to this relation are simulated and observed, both over ocean and land. Model simulations and observations both suffer from many source of uncertainties which limit our present knowledge of moist processes and future predictions of the impact of global warming (e.g. change in precipitation).

The goal of this study is to assess integrated water vapour (IWV) trends and variability from various global atmospheric models using GNSS observations. Here we will focus mainly on two reanalyses, ERA-Interim and MERRA-2, and GNSS IWV data from a global network including 120 stations for the period from January 1995 to December 2010.

Seasonal means, variability, and trends are analysed. A general good agreement is found for the means and variability, except for a few GNSS stations where representativeness issues and inhomogeneities (in the GNSS data) are suspected. Trends were estimated from the monthly means and seasonal means. Significant positive and negative trends are observed globally from the monthly means. Seasonal trends are found to be different (sometimes opposite between winter and summer), and more intense, which emphasizes the influence of atmospheric circulation on water vapour trends. The trends from the two reanalyses are shown to disagree in several regions in the tropics and in Antarctica. Differences in the data actually assimilated in the two reanalysis are suspected. However, in data sparse regions such as central and north Africa, differences in model physics might play a role as well. A small number of GNSS stations showed large and opposite trends compared to the modelsreanalyses. At these sites, interruptions in the time series and inhomogeneities (abrupt or gradual changes in the means) are evidenced. A careful and systematic investigation of IWV differences between GNSS and reanalyses helped to qualify both data sources and prompted for a cautious interpretation of IWV trends.