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Global maps of water vapor trends and correlation of the water vapor distribution to different teleconnection indices derived from 20 years of combined GOME-SCIAMACHY-GOME-2 observations

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Water vapor is the most important natural greenhouse gas. Since it is highly variable and involved in several climate feedbacks global observations of water vapor are very important. In this study we use a consistent 20 years data set (1995 – 2015) of water vapor derived from satellite observations in the red spectral range. The data set was obtained by carefully merging observations from GOME, SCIAMACHY and GOME-2 during their respective overlap periods. Comparison of the satellite data set to radio sonde and GPS observations indicates that the satellite data set is stable within 1% over the 20 years period.

We fit a model function including a linear trend as well as several teleconnection indices to the satellite time series on a 1° x 1° grid. For many regions on earth, e.g. Central Europe, positive trends (up to 15% over 20 years) are derived, but for several regions, e.g. the South-East Pacific, also negative trends (up to -10% over 20 years) are found. These trend patterns are overall consistent with global trend patterns of surface temperatures.

We also found very clear global correlation patterns of the water vapor time series and different teleconnection indices: El Niño-Southern Oscillation (ENSO), North Atlantic Oscillation (NAO), Pacific Decadal Oscillation (PDO), Pacific North American Pattern (PNA), and the Quasi-Biennial Oscillation (QBO). We perform a comparison study between global model simulations and satellite measurements using the same model function. This comparison provides insights into the quality of the model representation with respect to real climate phenomena.