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Variability of middle atmospheric water vapor: From diurnal to decadal patterns

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Atmospheric water vapor is a key climate parameter. Long-term observations from ground and space are required to study trends and the variability on different time scales. In the stratosphere and mesosphere, H_2O can be used as a tracer to study atmospheric waves. Different retrieval data sets of middle atmospheric water vapor as obtained by the water vapor radiometer MIAWARA, operated near Bern (46.88° N, 7.46° E), are investigated to study: **(1)** diurnal amplitudes in comparison to SD-WACCM simulations, **(2)** prominent quasi 18-hour waves during winter, **(3)** the long-term evolution of quasi 2-day waves (Q2DWs), **(4)** the coupling between mesospheric H_2O and the 27-day solar rotation cycle, **(5)** the seasonal cycle as most obvious periodicity of the mid-latitudes and **(6)** the decadal trend of H_2O from the mid-stratosphere to the upper mesosphere.

We present key results from the above mentioned investigations performed in the last five years. We highlight that for instance the highest individual Q2DW amplitudes reach $0.8\,\mathrm{ppm}$ and monthly mean Q2DW spectra show a broad variability of periods between 38 and $64\,\mathrm{h}$. Autobicoherence spectra revealed a non-linear link between diurnal tides, quasi 18-h waves and Q2DWs. At a longer time scale we observe 27-day periodicities in our water vapor data which are negatively correlated to the solar Lyman-α variability and the correlation coefficient reaches values up to -0.4. Further we use a multilinear parametric trend model to assess the H_2O trend since April 2007. First results indicate an anticorrelation to ozone trends from the upper stratosphere to the lower mesosphere. Above the stratopause at $0.3\,\mathrm{hPa}$ a positive H_2O trend of about $0.2\,\mathrm{ppm/decade}$ could be detected and a stronger negative trend of about $-0.8\,\mathrm{ppm/decade}$ in the upper mesosphere.