Water vapour trends in Switzerland

from radiometry, FTIR and GNSS ground stations

Leonie Bernet[1], Elmar Brockmann[2], Thomas von Clarmann[3], Niklaus Kämpfer[1], Emmanuel Mahieu[4], Christian Mätzler[1], Gunter Stober[1], and Klemens Hocke[1]

[1]Institute of Applied Physics & Oeschger Centre for Climate Change Research, University of Bern, Switzerland
[2]Federal Office of Topography, swisstopo, Wabern, Switzerland
[3]Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology, Karlsruhe, Germany
[4]Institute of Astrophysics and Geophysics, University of Liège, Liège, Belgium

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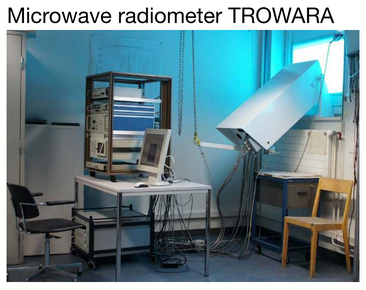
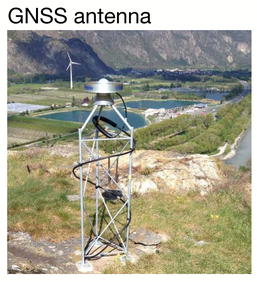
Integrated water vapour (IWV) data sets

- Microwave radiometer TROWARA, Bern (575m), Switzerland: hourly resolution (1995 to 2018)
- FTIR spectrometer, Jungfraujoch (3580m), Switzerland: clear-sky measurements (1995 to 2018)
- GNSS stations in Switzerland from the AGNES[1] network: hourly resolution (2000 to 2018)
- Reanalyses data MERRA-2 and ERA5: 0.5° lat x 0.625° lon and 0.25° lat x 0.25° lon (1995 to 2018)

Microwave radiometer TROWARA

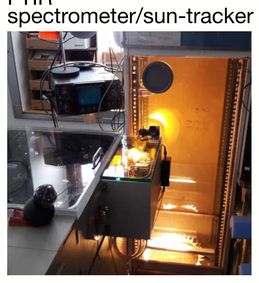


GNSS antenna



FTIR sun-tracker on Jungfraujoch

FTIR spectrometer/sun-tracker



Objectives

Atmospheric water vapour plays a crucial role in the climate system. It is not only a strong greenhouse gas, but also affects various atmospheric processes. The amount of water vapour is directly related to changes in temperature. Assessing the change of water vapour in a warming climate is therefore of utmost importance.

We analyse data of column integrated water vapour (IWV) in Switzerland, using radiometer, FTIR, GNSS and reanalysis data. We assess how IWV changed in the last 24 years and we investigate the relation to temperature changes.

Conclusions

- Integrated water vapour (IWV) around Bern agrees within 5% and shows trends of 2 to 5% per decade. The trends are highest in June and November.
- At Jungfraujoch, FTIR and GNSS agree well, especially after an antenna update. IWV trends at Jungfraujoch are not significant.
- GNSS trends in Switzerland are on average 3.7% per decade. Jumps due to antenna changes have been incorporated in the GNSS trend analysis.
- The IWV trend significance increases with altitude.
- Temperature changes at Bern can partly explain changes in IWV, except in the winter months.

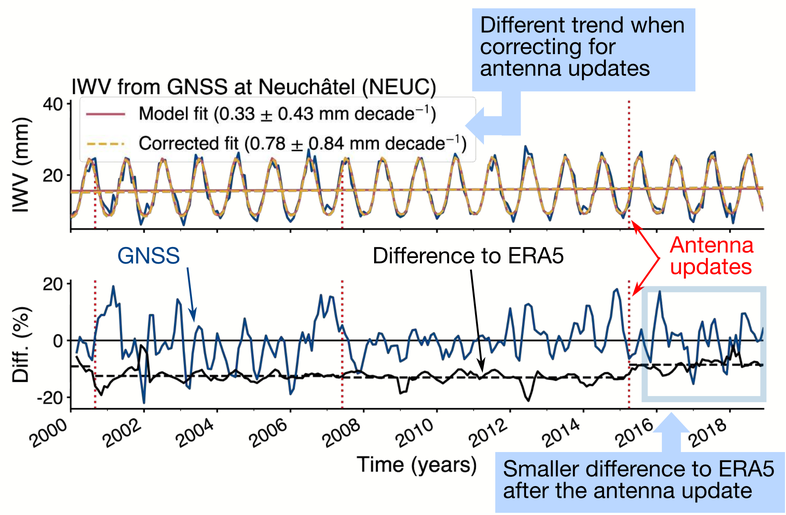
Trend methodology

Trend analysis

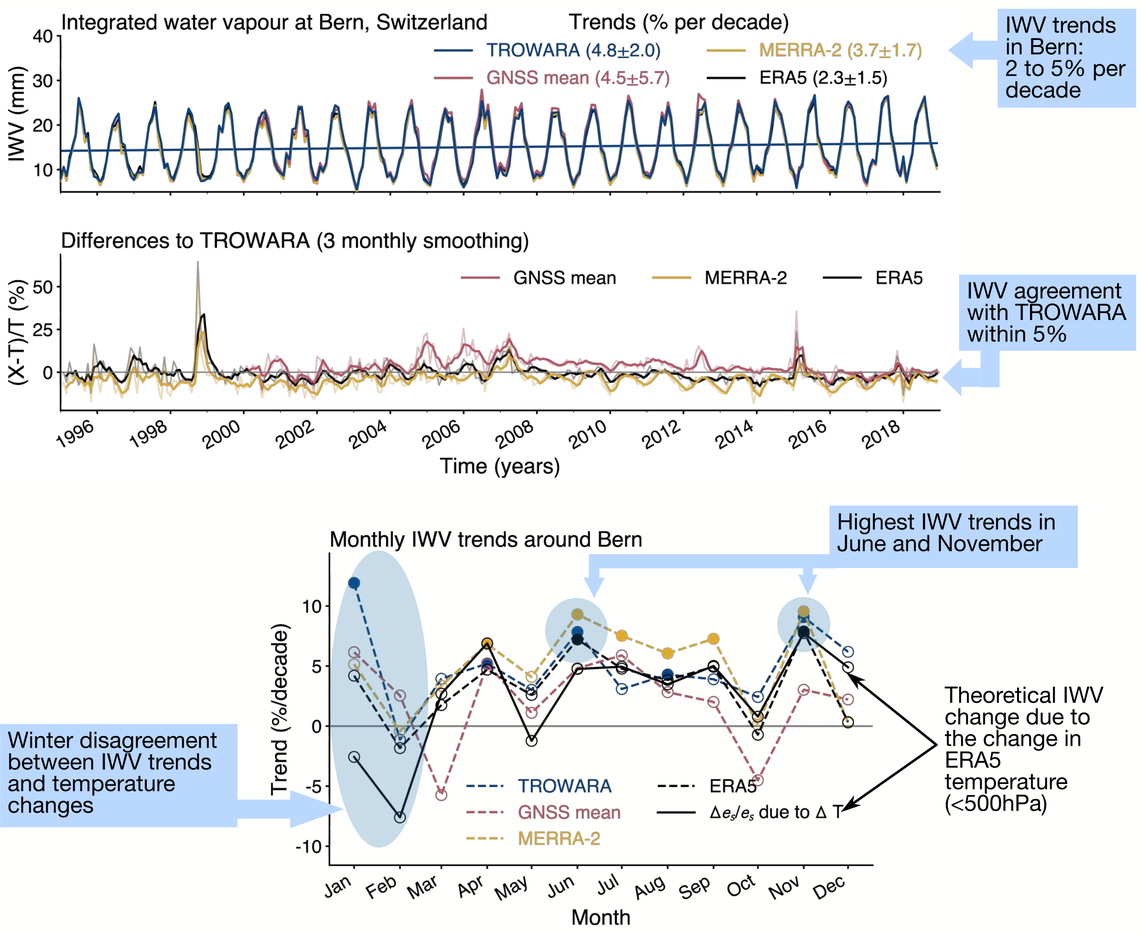
- Multilinear regression model[2] including a seasonal cycle and three overtones of the annual cycle
- Data uncertainties considered by a full error covariance matrix
- Error correlations are determined in an iterative process to optimize the model fit

Jumps in the time series

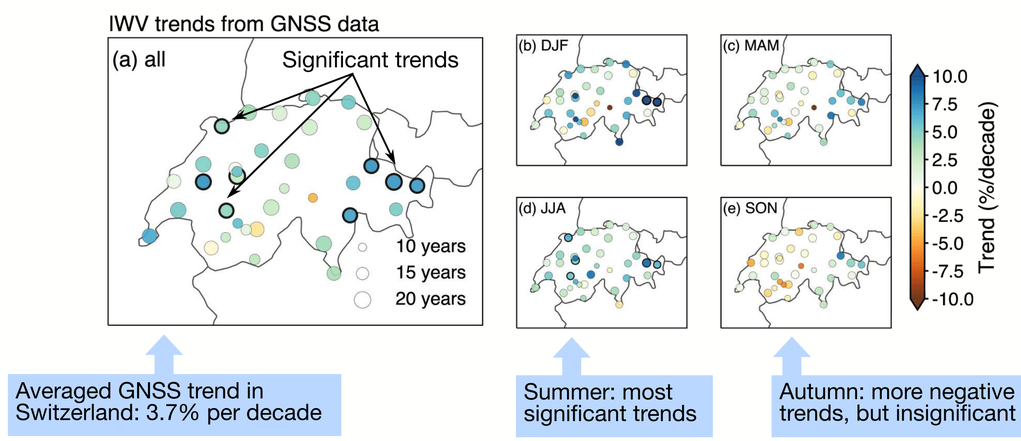
- Trends can be falsified by data jumps due to instrumental changes (e.g. antenna updates)
- Such jumps due to antenna updates are considered in the model fit for GNSS trends

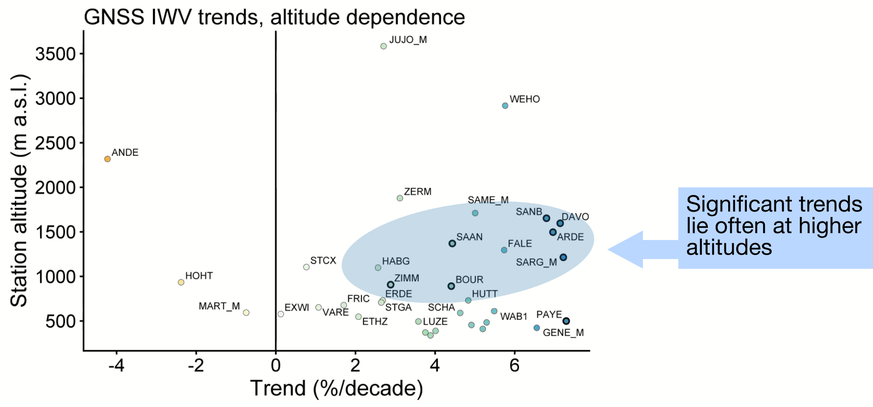


Water vapour in Bern



Trends from GNSS data





Water vapour at Jungfraujoch

Trends from reanalysis data

For more information:

Bernet, L., Brockmann, E., von Clarmann, T., Kämpfer, N., Mahieu, E., Mätzler, C., Stober, G., and Hocke, K.: Trends of atmospheric water vapour in Switzerland from ground-based radiometry, FTIR and GNSS data, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-77, in review, 2020.

References:

[1] Automated GNSS Network for Switzerland, http://pnac.swisstopo.admin.ch/pages/en/agnes.html
[2] T. von Clarmann et al., Technical note: Trend estimation from irregularly sampled, correlated data. Atmos. Chem. Phys. 10, 6737–6747 (2010).

Acknowlegement:

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