Comments to manuscript egusphere-2026-989: Increase of water vapour above the Swiss Plateau from 1995 to 2025 observed by ground-based microwave radiometry

By Hocke et al.

Overview:

The manuscript presents results of an analysis of 30 years of integrated water vapor from a microwave radiometer (TROWARA) located in Bern, Swizerland and compares the decadal trend with the trend from the ERA5 reanalysis product. Results show a positive water vapor trend at the site (0.08 ± 0.01mm/year for TROWARA and 0.06 ± 0.01mm/year for ERA5).

General comments:

The topic addressed in the paper, namely the multidecadal trend of water vapor in a warming atmosphere is relevant because of uncertainties still surrounding the role of water vapor as an amplifier of warming. Ground based observations provide good complementary information to satellite observations. Multidecadal, good quality ground-based observations are exceedingly rare and therefore deserve to be published.

As a general comment I suggest that the manuscript be improved through major revisions that strengthen the results. In particular I notice some weaknesses such as lack of error bars in the figures, lack of significance test on the trend analysis and need for more discussion on the significance of the trend vs. the natural water vapor variability at the site.

Multiple times in the manuscript the Clausius-Clapeyron is mentioned to explain the observed positive water vapor trend at the site and link it to the observed positive 2-m temperature trend from reanalysis. Although it is true that, globally, the increase in temperature can determine an increase in the water vapor, locally and seasonally there are many factors that can influence the rate at which vapor changes. The 7% increase of water vapor per 1^{o}C warming is true over the Ocean where you have enough water at the surface to sustain that change. In Bern, it is possible that the extra source of moisture comes from large scale circulation at higher altitudes in the troposphere. For example, synoptic patterns that transport moist or dry airmasses over the site and especially more or less clouds can contribute to water vapor trends and feedback that are distinct from the pure temperature effect. I think there should be more discussion on this.

Specific comments

Line 7 in Abstract: *"The relative IWV increase is 5.1%/decade"* Please provide the absolute trend in mm/decade for both radiometer and ERA5

Line 12 in Abstract: *"This strong increase of water vapour certainly has an impact on weather, climate, and hydrology."* I suggest removing this sentence from the abstract as this is not something that is evaluated in this work.

Line 14 in Introduction: *"The ERA5 reanalysis data of the 2m air temperature at Bern..."* Does Bern have measurements of 2-m temperature?

Line 17 in Introduction: *"...increase of man-made emissions of CO2 and CH4 (IPCC, 2013)."* Perhaps cite a more recent IPCC report (IPCC, 2023) that reflects the latest models and observations.

Line 57 in Introduction: *"20116".* Replace with 2016?

Line 83 in Section 2.1: *"the antenna elevation angle is 40°"*. I think this point deserves more discussion. Essentially the radiometer is measuring the PWV along a slant path through the atmosphere in one specific direction. How does this geometry affect what the radiometer is really measuring? Given the fact that the radiometer can see through tens of kilometers, the observations may be affected by water vapor that is not above the site. Additionally, could looking in one direction expose the measurements to biases due, for example, to prevailing wind patterns?

Line 90-103 in Section 2.1: Please specify the PWV retrieval uncertainty from the TROWARA instrument.

Line 118 in Section 2.2: *"The grid resolution is 0.25°".* It is useful to specify that this corresponds to approximately 25 square km at the latitude of the radiometer. This would place the radiosondes outside of the ERA5 grid?

Figure 2: In my opinion this figure would be more useful if it showed the monthly averages of the entire 30 years with standard deviation. As it is, the figure raises more questions than it answers. For example, it shows that TROWARA has on average 1 mm more PWV compared to radiosondes although later on is stated that TROWARA is lower 0.25 mm (on average over the 30 years).

Figure 2 caption: It would be useful to specify "*Monthly means of IWV at Bern* (TROWARA and ERA5) *and Payerne* (radiosondes and GNSS)" in the caption.

Figure 3: It is difficult to understand what this figure is telling us. Judging from figure 5 (shown later) it seems that the annual trend is essentially driven by 4 summer months and there is no trend in the other seasons. It is better to show the trend of the seasonal means for example (the mean DJF each year and show it with standard deviation). A significance test should also provide to what degree the seasonal trend is significant once the variability of the data is considered. A seasonal aggregation of the data would also help isolate the seasonal variability of the dataset. It will probably show that there is no trend except in summer.

Figure 4: Please add standard deviation or even better box plots of the distributions. It may be good to add the Payerne radiosondes as well. It may help understand the trend better.

Lines 178-182 in Section 4: Although ERA5 reanalysis is strongly anchored in radiosondes observations it doesn't reproduce them 100%. Especially in the low boundary layer and in regions of complex topography the ERA5 profiles (especially humidity) can have their own biases compared to radiosondes.

Generally, I would expect ERA5 PWV to have less diurnal variability compared to the TROWARA observations.

Lines 193-195 in Section 4: "*We are not aware..commercial outdoor radiometers".* Perhaps not from the HATPRO, but a recent publication of Lubin et al., acp, 26, 295–311, 2026, https://doi.org/10.5194/acp-26-295-2026 examines 25-year trends of PWV (among other things) at the North Slope of Alaska from commercial radiometers.

Figs 5 and 6: These 2 figures appear partially repetitive. The red line is the same (ERA5 IWV). I suggest they are shown in 1 figure with 3 lines.