

# Review of “Climatology of middle atmospheric water vapour above the ALOMAR observatory in northern Norway” by K. Hallgren et al.

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The paper describes profile measurements of mesospheric water vapor above northern Norway acquired by a ground based microwave radiometer between 1996 and 2010. Based on these observations the authors estimate a climatology and trend in mesospheric water vapor.

The data presented are certainly of interest however, I have several concerns which need to be addressed before the paper is suitable for publication in ACP:

1) The dataset, stemming from an instrument which went through several changes, needs to be homogenized and validated against other datasets before a trend analysis can be performed. I would like to at least see a figure similar to Fig. 3 and 7 in [2]. The instruments they use for this comparison also cover the latitude of ALOMAR.

In addition Table 1 indicates that v3.1 and v3.2 and v3.2 and v3.3 have been operational with an overlap. I would like to see both versions in Fig. 1.

2) Please present AVK for each instrumental set up.

3) When you estimate trends please describe how you do it and give error estimates including the description on how you estimate them. What is the reason to do the trend analysis separately for summer and winter? For me it would make sense to remove the climatology from the dataset in order to make trends more visible. Error estimates for the trend at each altitude?

What influence does the solar cycle have on mesospheric water vapor? Should you not consider it?

4) For me it is not entirely clear what new findings this paper presents compared to H2010. Emphasis this more clearly.

## Structure and Style

Please ask a native English speaker to correct the language. The text could be much more concise.

I think the paper would benefit from a clearer structuring with more titles. In addition I think you should have an own section for the discussion on similarities and differences to the results found by H2010.

Avoid general statements such as “...has received a lot of attention...”

Do not explain the word “trend” every time you use it. If you are not comfortable with the expression - use a different one.

## Specific comments

### Abstract

p.31532, l.10: The atmosphere ... .. 2.5 km thick. → Remove, this is misleading as the vertical resolution of the instrument is much coarser.

p.31532, l.14: By comparing the ... .. of our observations. → Please show this comparison in the paper.

### Introduction

In my opinion the introduction should be shortened, better structured and more focused on the subjects of the paper; which are water vapor trend and climatology in the mesosphere.

p.31532, l.23 - p31533, l24: Clearly shorten that part.

p.31533, l.21: During the summer ... .. into the atmosphere. → This statement is wrong!

p.31533, l.27: Give references for the long term evolution and say what they found instead of just saying: “...has received a lot of attention”.

p.31534, l.25: The authors... ..the polar latitudes. → There has been a recent ACE-FTS publication presenting and providing easy access to climatologies of several species including water vapor [1]. This paper also mentions the UARS REFERENCE ATMOSPHERE PROJECT which provides easy accessible climatologies from various UARS measurements.

[http://uars.gsfc.nasa.gov/Public/Analysis/UARS/urap/reference\\_atmosphere\\_data\\_plots.html](http://uars.gsfc.nasa.gov/Public/Analysis/UARS/urap/reference_atmosphere_data_plots.html)

In my opinion it would make more sense to compare your climatology to these datasets instead of the AFGL reference atmosphere.

p.31533, l4: ...making available 15 years of ground based observations of water vapor above the ALOMAR observatory. → I do not see the data. Please attach it as a supplement if you write this...

p.31536. l6-l11: Remove as it does not seem relevant for the paper (in addition it is not well placed).

### Observations and retrieval

In Fig. 1 add markers where instrumental changes took place and describe them in a bit more detail.

p.31536, l4-l5: Only use the one or two most important references for the CTS.

p.31536, l14-l16: All back-ends... ..limited altitude. → Do you take this into account when looking at the data you retrieve at 80 km?

p.31536, l29: However, the actual vertical resolution of the instrument depends on the signal-to-noise ratio...→ are you sure this is the only factor?

p.31537, l3: real atmospheric data → reanalysis data.

p.31537, l7: Thus the main... ..year-to-year. → Reformulate.

p.31537, l11: Is there a reference showing how you calculate the errors, otherwise say a few words on how you do it.

p.31537, l19: Unfortunately,... ...therefore possible. → Compare them via Aura/MLS which was operational at that time.

p.31537, l24: Straub et al., 2011 compares an instrument similar to v3.4 to other ground based radiometers and MLS. How about the other versions of the instrument? Have they also been compared to other instruments?

## **Results and discussion**

In general I would like to have more description of what the figures show before you start to interpret and discuss.

p.31537, l26: Why do you interpolate?

p.31538, l7: A reduction... ...2001-2003. → I do not see that (please mark it in Fig.1). I see lower values at 80 km during the summers 2003, 2004 and 2005, but assume that this could be due to the fact that you use a spectrometer with a lower frequency resolution (channel spacing larger than Doppler width of the line) during that time (is that the case?).

p.31538, l20 - p.31539, l9: In my opinion this is not a result of this study nor a discussion of a result and should therefore go somewhere else. Maybe even in an own section showing differences and similarities of the dataset used in this paper to the one in H2010.

p.31539, l10: To get a... ...seasonal basis. → More detailed view in what sense? What is the motivation for this? Why not just subtract the climatology?

p.31539, l15: How is the trend estimated? Please show the data together with the regression line. Error estimates? Is the trend significant?

p.31539, l19-21: Similar to what... ...H2010 dataset. → Reformulate.

p.31539, l29 - p31540 l2: How can a negative trend be associated with an increase in water vapor?

p.31540, l5-10: I do not understand what you mean with that statement.

## **Sudden stratospheric warmings in the dataset**

Why is this section needed in this paper? It does not seem to contribute to the subject of water vapor trend and climatology in the mesosphere. If you want to keep this section give a clear motivation for it and link it to the rest of the paper. In addition support your findings with plots.

## **Yearly mean middle atmospheric water vapor above ALOMAR**

p.31542, l5: Attach the data as a supplement instead of printing them in a table.

p.31542, l7: variability → do you mean variance or standard deviation?

p.31542, l22 - p31543, l4: add plots to support your statements.

p.31543, l5-20: I think a description of the annual cycle in Fig. 3 in the context of the changing circulation and dynamic situation would be more helpful than just describing the changes throughout the year at isolated layers.

from p.31543, l21 onward: Use more recent climatologies (e.g. ACE, UARS) to compare to.

## References

- [1] A. Jones, K. A. Walker, J. J. Jin, J. R. Taylor, C. D. Boone, P. F. Bernath, S. Brohede, G. L. Manney, S. McLeod, R. Hughes, and W. H. Daffer. Technical note: A trace gas climatology derived from the atmospheric chemistry experiment fourier transform spectrometer (ace-fts) data set. *Atmospheric Chemistry and Physics*, 12:5207–5220, 2012.
- [2] G. E. Nedoluha, R. M. Gomez, B. C. Hicks, J. E. Wrotny, C. Boone, and A. Lambert. Water vapor measurements in the mesosphere from mauna loa over solar cycle 23. *Journal Of Geophysical Research*, 114(D23303):D23303, 2009.