

## ***Interactive comment on “A solar signal in lower stratospheric water vapour?” by T. Schieferdecker et al.***

### **Anonymous Referee #1**

Received and published: 9 June 2015

The paper describes the analysis of combined time series of HALOE and MIPAS water vapour data with respect to the influence of a solar cycle.

The authors claim that they see a solar cycle in the water vapour signal at the tropopause. They use a multi-linear regression method to predict water vapour with the proxies of El Niño and QBO to better understand the temporal variations of water vapour in the lower stratosphere. They assert that the residual can be made smaller by considering also the 11-year solar cycle effect in the regression. The consideration of the solar signal seems to be important because it has a non-negligible influence on the water vapour trend.

The paper is clearly structured.

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One weakness of this paper is the shortness of the water vapour time series because only one full solar cycle is considered. Another weakness is that the proposed relationship is insufficiently supported by evidence of a viable physical mechanism. The authors present their results in comparison to other publications. Especially the discussion concerning the ‘bottom-up’ mechanism is not clear to me, because Gray et al (2010) put the apparent relationship between solar forcing and SSTs into question because this relationship would imply a climate sensitivity that is inconsistent with evidence from earlier centuries. If we suppose that such a relationship exists we are still not done. The next question then is: How can a solar cycle-induced SST signal be imprinted on the lower stratosphere water vapour? Unfortunately, the authors provide only an insufficient physical explanation for such an influence. The authors cite from White et al (1997) that globally! averaged SST anomalies show highest correlations with solar activity with a lag of 1-2 year. From Decker and Dameris they cite that higher SSTs amplify deep convection locally and induce a strengthening of upwelling. But stronger upwelling leads to a colder tropopause and thus less moisture. Please provide a clear and consistent explanation of the process that leads to the proposed relation.

Because of the weak statistics the authors should avoid bold statements like ‘solved a conundrum’ etc. Conclusions should be stated more modestly. Examples are detailed below.

Abstract, line 12: Due to the fact that less than two solar cycles are represented in the data you cannot conclude stringently from the regression analysis, that there is actual a solar signal at the tropical tropopause. Better say ‘here seems to be a solar signal’ or ‘here is a signal with a 11 year period similar as the solar signal’

Page 12354, line 15: Why is this a conclusion from your results?

Page 12354 line 17: ‘The negative water vapour trends obtained...can solve the water vapour conundrum...’ This sentence is not understandable. Please give a more detailed explanation.

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Page 12364, line 12ff: The comparison of phase shift and age of air calculations is not understandable. Could you please provide a formula and more information about the age of air you used for your calculation. It is neither clear to me why you cite the paper of Stiller et al. in which only the time period of AOA from 2002-2010 is recognized.

Fig. 10 Page 12386: Please explain the sentence: Positive values represent delays of the solar signal in water vapour larger than the stratospheric mean age of air. It is not clear to me, how you calculated the values of fig. 10.

Page 12365, line 6: Explain what you mean by "in some cases".

Page 12366, line 25: Explain, in more detail, what you have done or omit this sentence. It is not traceable why on the one hand a temperature anomaly of 1K magnitude with respect to a saturation vapour pressure over ice can explain half of the amplitude of water vapour and on the other hand a 2K variation from the regression analysis would explain 2/3?

Page 12367, line 10: This sentence is misleading, because you analysed a time lag between solar cycle and water vapour and not temperature. Please omit it or provide a time series of MIPAS cold point temperatures.

Page 12368, line 26: leave out part of the sentence beginning with: which by their nature are a descriptive rather than an explaining quantity. It is an unnecessary explanation. Trends by nature depend also on the length and the selected period of the time series and are therefore arbitrary.

Page 12369, line 27: The sentence "including the solar cycle ...has the potential to resolve the water vapour conundrum" sounds a bit odd. Better say it in less pretentious words.

Page 12369, line 27: "But at least it can be said that in descriptive terms ..." In this sentence you qualify your results, which is suitable. Nevertheless during the whole text you stated that it is the solar signal that is imprinted on the water vapour time series. It

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would be better to formulate it more cautiously, also in the rest of the text.

Please add a sentences to the discussion section, that a possible mechanism related to an Atmosphere/Ocean internal variability might also be possible, as you cannot exclude other mechanisms or other forcing factors operating on similar timescales as the solar cycle.

Accordingly I recommend the paper for publication only after major revision.

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Interactive comment on Atmos. Chem. Phys. Discuss., 15, 12353, 2015.

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