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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Water Vapour and Methane Coupling in the Stratosphere observed with SCIAMACHY Solar Occultation Measurements" *by* Stefan Noël et al.

Anonymous Referee #3

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This study nicely presents the SCIAMACHY H2O and CH4 measurements and their relationship. The SCIAMACHY measurements are a very valuable addition to the available H2O and CH4 measurements in the middle atmosphere over the period 2003-2012, and the results shown here are scientifically valuable.

However, in much of the text the authors seem to be trying very hard to create a mystery where there is none. There is (1) a QBO signature in H2O crossing the tropical tropopause and (2) a QBO signal due to changes in transport (age-of-air) which causes a variation in the amount of CH4 that has been oxidized to produce H2O. The authors repeatedly overemphasize the importance of small tropospheric CH4 variations on the

observed variations in stratospheric H2O. While gradually increasing anthropogenic CH4 is a very important driver of long-term change in H2O, variations in CH4 entering the stratosphere are only marginally relevant to the variations observed in these measurements, which span a decade. Small changes in tropopause temperature are a far more important driver of interannual changes in H2O entering the stratosphere as has been shown by many authors (e.g. Dessler et al., JGR 2014).

Figure 11 is appropriate for a review paper on atmospheric dynamics, and might be appropriate if the authors were running a dynamical model to compare with their measurements, but it seems inappropriate here.

On page 14 line 7 they state: "This is not the case for methane, which could explain the missing QBO signature in the methane time series at 17km." There is no need for a "could" here. The H2O entering is governed by tropopause temperatures, and the CH4 is not.

In paragraph following this (and in the last sentence of the conclusion) they again try to overemphasize the importance of CH4. There is nothing inherently wrong with pointing out that changes in CH4 may play a small part in the observed changes of H2O, but an increase of 8 ppbv/yr in CH4 over 4 years would yield only at most $\sim$0.064 ppmv of H2O over 4 years. This looks small when compared to the observed variations in potential water, and if CH4 were the major driver of these variations potential water would not show decreases. Only finally, at the end of this paragraph, do the authors mention that: "However, from the current data set an additional influence of varying tropospheric water vapour input on the observed increase of potential water cannot be ruled out." This is certainly the primary driver of the variations in potential water, as is well understood. In the last sentence of the manuscript the authors again seem to only reluctantly accept that "possibly in combination with changes of water vapour" are important. Presumably this refers to changes in water vapour entering the stratosphere, but even that is not clear.

Then, in the final paragraph of the discussion they say: “A remaining open issue is the QBO signal observed in both methane and water vapour at higher stratospheric altitudes. . . . Therefore the QBO signal has to be carried by methane, but as can be seen at lower altitudes the methane entering the stratosphere is not varied by QBO.” This is all well understood, as the authors finally admit in the second half of this paragraph.

The abstract is similarly unnecessarily confusing. First, the phrase “SCIAMACHY methane and water vapour time series reveals that stratospheric methane and water vapour are strongly correlated”. The implication seems to be that this is a new result. Please rephrase this as “reveals [or, better yet, “shows”] the expected anticorrelation between methane and water vapour”. The next sentence reads: “Above about 20km most of the water vapour seems to be produced by methane, but short-term fluctuations and a temporal variation on a scale of 5–6 years are observed.” First, there is no reason for a “seems” here. The authors should be able to calculate how much of the observed water vapour is produced by methane. Secondly, I do not understand how the second part of this sentence follows from the first following a “but”. I finally have to admit that I do not understand what new point the authors are trying to make in the last sentence of the abstract.

A few minor additional points in the text:

I don’t understand the statement on page 2 line 19: “roughly conserved in the stratosphere if no changes in mixing of air masses occur”. What does “changes in mixing of air masses” mean?

On page 9 line 6: “the remaining sensitivity of the retrieval method to aerosol” is rather a roundabout way of saying “errors in the water vapour retrieval due to aerosols”. This is essentially what the authors say in the next line.

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