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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Ground-based remote sensing of HDO/H_2O ratio profiles: introduction and validation of an innovative retrieval approach" *by* M. Schneider et al.

Anonymous Referee #1

Received and published: 17 August 2006

Schneider et al present a very detailed description of an improved analysis method for retrieving coarse vertical profiles of isotopic fractionation (specifically the D/H ratio) in tropospheric water vapour from ground-based solar FTIR remote sensing measurements. The aims and justification of the work are important - water vapour plays a major role in the radiative balance of the atmosphere, its content varies by orders of magnitude with altitude and is very variable, making it a difficult species to measure well, and isotopic analysis provides a powerful and valuable tracer for the history of air masses. Solar FTIR measurements are geographically sparse, with less than 10 suitable high altitude sites globally, but some of these have existing long records of measurements which could be analysed to provide a climatology of water vapour isotopes.

The method includes both treating the water vapour concentration in log space, and retrieving the isotopic ratio directly by optimal estimation rather than as a ratio of two optimally estimated species, H2O and HDO (which ignores a high degree of correlation between the two). The justification and description of the method and error analysis is treated in very great detail, making it a very long paper. (For the future, shorter would be easier to read!) However, we are left with a useful tutorial in retrieval theory and solid knowledge of the errors and limitations when interpreting the retrieved isotopic data. The method is in principle applicable to other isotopic species, but large fractionations may be required to achieve useful accuracy, so the applicability might be limited.

My major general comment and request to the authors is to ask the question "How useful is the demonstrated accuracy/precision of these retrievals, and to what uses could the analyses be put?" Although clearly an improvement over the conventional analysis, errors are still of the order of 15-50% of the actual isotopic fractionations, and as Fig 22 shows, this precision is barely sufficient to resolve any significant variability, certainly on short timescales. Thus in the discussion at the bottom of p 5294, I ask if this lack of expected correlation with seasonal temperature variations is really real? What about other errors which might correlate (eg on-average higher zenith angles in summer with lower average absorption depths). Are the "outliers" really outliers in a normal distribution around the running mean? At what probablility level? Arguably the most interesting variability is on day-to-day or synoptic timescales, but the achieved accuracy does not seem sufficient to be useful on this timescale. What do the authors perceive as the most useful applications of the new analysis methods?

I recommend that the work is suited to publication in ACP after addressing the general comment above and the specific corrections and clarifications below.

Specific comments:

P5271 L 7: ...unstable conditions...

L 17: ratio not ration

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P5274 L 4: ...main part of the residuals.

P5275 L 4: ...completely independently of each other, ...(adverb not adjective)

P5278 L 3: "...the difference between the slopes of ln(H2O) and ln(HDO)" Slopes with respect to what? Please clarify.

P5280 L 6: replace uncertainty with variability

L 8: ... respond similarly (adverb)

P5282 L1: ...and covariance disregards the fact that ...

P5284 L10: good estimation ... (singular)

P5284 L15: prevents the detection of fine structures

P5284 L23: On the contrary...

P5287 L21: The meaning of "inconsistency" is unclear. Do you mean ... "and secondly that the errors in gamma of H2O and HDO are independent". See also P5288 L22 and L 26.

P5291 L17: remove comma after constraint

P5291 L 18: This is a large... (not "an")

P5291-92. Comparison with Ehhalt's measurements. Must the present measurements agree with Ehhalt? I agree that the maximum in delD at 6km is unlikely given Ehhalt's measurements, but the text reads strongly as if the two sets of measurements must agree within the measurement errors, which they are not required to do. I would soften the word "indicate " in line 20 and use "suggest".

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 5269, 2006.

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