Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2016-1065-RC2, 2017
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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Enhanced Stratospheric Water Vapor over the Summertime Continental United States and the Role of Overshooting Convection" *by* Robert L. Herman et al.

Anonymous Referee #2

Received and published: 15 January 2017

Review of "Enhanced Stratospheric Water Vapor over the Summertime Continental United States and the Role of Overshooting Convection" by Herman et al.

This paper presents direct airborne measurements of water injection into the lowermost stratosphere over the continental United States by convective overshooting tops and relates these to individual overshooting events through trajectory analysis.

The study is generally well written, however, the overall result and conclusion is somewhat weak. I would recommend this paper for publication only after major revisions, for which I give suggestions below.

Major comments:

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Discussion paper

The observations themselves are not new and a number of previous studies have clearly indicated that overshooting convection may transport water ice into the stratosphere, where it evaporates and increases the stratospheric water vapor concentration. The novelty of this study is that it links observed water vapor enhancements to possible overshooting top events through trajectory analysis. This result, while new, is not very surprising and leaves the paper with a rather insignificant result. The paper would benefit strongly from a discussion of the significance of this result and a much enhanced statistical analysis using their entire observational set. The authors indicated that they have many more observations during this campaign but chose to show only three examples. The authors might want to use their entire data set and increase their statistical analysis. Their only statistical argument is at the end of the discussion, where they use only MLS data to state, that the impact is small. However, their own data (Figure 4) shows nicely, that MLS misses the highest concentrations due to its strong vertical averaging, which will heavily skew the result. Since the water vapor enhancements seem present on a very large scale, it would be good to see the entire data set for this campaign. The authors could then attempt to make a statistical analysis on how well they can relate these enhancements to OT events, what their temporal distribution may have been, and if there could be some preferred regions. In the past water vapor instruments onboard the high altitude aircraft have shown significant disagreements. The authors state, that the other instruments show similar results. It would be good to actually show these, which would support the confidence in the observations themselves.

Minor comments:

The manuscript should try to stick to one vertical coordinate and add other vertical coordinates only as additional information, e.g '90 hPa (370 K)'. Figure 4 uses pressure as vertical coordinate for consistency with MLS. Therefore, this could be the vertical coordinate system of choice. The profile figures may add approximate potential temperature as additional vertical axis for reference.

Most data shown in Figure 4 repeat between panels a-c. This figure could be combined

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into one panel with MLS data color coded roughly following the aircraft data.

The use of green dots in Figures 5-7 is confusing. Panels c seem to indicate coincidences with relaxed conditions, whereas panels b seem to indicate all overshooting top events in the given time frame to show convective regions. This should be clarified.

There are several references to “stratospheric background levels”. How where these background levels defined for this purpose? Are the profiles west of the Rocky Mountains considered “background” or did the authors use something else to define what the background is for this purpose? If they used the West Coast profiles, then they should briefly discuss the meteorology and exclude that these are more typical high latitude profiles. Could it be that the “background” is not as low as the authors assume?

There is obviously a large uncertainty in the detection and assignment of OT events. It would be good if the authors discussed how this uncertainty impacts their identification of possibly source events. What is the lifetime of a typical overshooting top? How many are likely to be missed by the OT detection algorithm? Especially on the events that are closer to the observations, can the authors identify individual events that are best candidates?

Line 118-119: better: ‘ . . . was drier than the 10 year MLS record . . .’

Line 129-130: better ‘. . . the storm systems from which they may have originated, it is necessary . . .’

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-1065, 2016.

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