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Interactive comment on "Processes influencing lower stratospheric water vapour in monsoon anticyclones: insights from Lagrangian modeling" *by* Nuria Pilar Plaza et al.

Anonymous Referee #2

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This paper is based on a Lagrangian model CLaMS and mainly use the domain filling strategy to explore the influence of several processes to lower stratospheric water vapor, including temperature, methane oxidation, ice microphysics, small scale mixing, and tropospheric mixing. The authors pay attention to the Asian and North American regions, as well as compare it with the influence globally. They compare the model simulation result by adding each process and consider horizontal distribution, seasonal cycle, and the intra-seasonal anomaly of lower stratospheric water vapor. A comparison between the standard CLaMS model and the Lagrangian Trajectory Filling (LTF) strategy also has been made, and the authors discuss why the LTF strategy is dry-biased. Overall, the scientific topic the authors are exploring is of great interest in the

field of stratospheric water vapor. However, based on the concern of the scientific rigor of the model design, I recommend a major revision before publishing this paper.

General comments:

One big issue is the influence of individual factors is calculated as the difference between model simulations with and without this factor. For example, using the difference between the water vapor mixing ratio in CIRRUS and CHEM to represent ice effects. However, this value may yield different model designs. E.g., if compare the difference between the experiment VMIX, and the experiment with the same setting as VMIX but do not include the ice microphysics, will the value be the same as the difference between CIRRUS and CHEM experiments? Since the authors are trying to compare the contribution from different factors, more reasonable experiment settings or sensitivity tests would be the comparing STANDARD experiment and the experiments removing individual processes.

The second issue is that the Stratosphere-Troposphere filling experiment simulates closer results to the observation, so it is not clear why all of the previous experiments exploring the influence from chemical and physical processes are based on LTF strategy, instead of directly based on ST-Filling. At least the authors should provide an explanation of why most of the conclusions in this paper are drawn based on LTF stead of ST-filling.

Another recommendation is to add a sensitivity test based on the supersaturation level to the experiments if possible. It may influence the estimation of the influence of ice microphysics. And may also explain the low biased LTF simulation result.

The convection information derived from the ERAi troposphere is not reliable. The grid in ERAi is too coarse to capture deep convections into the stratosphere. Lacking convection is another possible reason for the low biased LTF simulation result. It may also influence the estimation of the influence of ice microphysics.

The last major issue is about the sensitivity test of water vapor in LTF in section 4.2. The authors conclude that there are many empty bins, or gaps, over the humid regions, and result in underestimation of the water vapor mixing ratio in LTF experiments. The question is if these gaps could be avoided, for example, by initiating air parcels on a denser grid. It seems that having empty bins is an indicator of not enough air parcels.

In addition, there are some minor issues:

Line 7 - . . .water vapor in that region and including it in the model simulation. . . -Is 'that' means AMA region?

Line 153 - . . .the water vapor simulated by this experiment corresponds to the Lowest Mixing Ratio (LMR) encountered by each air parcels along its trajectory - Is it an initial h2o mixing ratio or an upper bound of mixing ratio along the path? E.g. the lowest mixing ratio of some parcels may be very high.

Line 164 - the third experiment, CIRRUS. . . - Is the supersaturation level still 100% when considering the ice micro-physics? 100% may not be a realistic level.

Figure A1 – how do you calculate the water vapor mixing ratio on 80 hPa in MLS? By interpolation?

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