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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "A modelling study of moisture redistribution by thin cirrus clouds" *by* T. Dinh et al.

Anonymous Referee #2

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General comment:

In this study a 2D model is used for investigating moisture transport in the tropical tropopause layer, driven by cirrus clouds. Two idealized scenarios (dry vs. moist) are investigated in order to determine the impact of environmental conditions and physical processes on moisture transport. The model results are investigated using an Eulerian and a Lagrangian point of view. This is an appropriate contribution to ACP; however, some issues must be clarified before this manuscript can be accepted for publication. In the following I will explain my concerns in detail.

Major points

1. The entry of water vapour into the stratosphere or equivalently the issue of dehydration is closely related to the microphysical issue of low ice number concentrations in the TTL. Low concentrations would lead to less effective relaxation to equilibrium of the clouds; thus, high water vapour concentrations will remain and may be transported into the stratosphere. This correlation should be emphasized in the study in more details. Actually, ice crystal number concentrations and relative humidities obtained during the long-term simulation should be evaluated. The number concentrations should be compared with measurements as reported by Krämer et al. (2009) and Jensen et al. (2010). The simulations should mostly produce low concentrations, since the large-scale forcing is quite small. Thus, I would expect that the cloud should contain (high) ice supersaturation; in terms of the analysis of the upward water vapour transport, this might be an issue since for downward moisture transport during cloud lifting, less supersaturation outside the cloud is required. Thus, the distribution of relative humidity inside/outside clouds should be checked carefully.
2. Although the model might be explained in details in former publications, please repeat the key details of the microphysics parameterisation and the dynamics (e.g. underlying equations). The resolution of the model seems to be quite unbalanced, the horizontal grid spacing is quite large compared to the vertical spacing. The size distribution seems to be quite narrow, I would expect ice crystals larger than 50 micron in the TTL. The radiation parameterisation is not clear to me. Do you use an explicit radiation transfer model for calculating heating rates of ice crystals online? Please clarify these issues.
3. The setup of the scenarios is not clear at all. Vertical profiles of relative humidity and temperature would help; it is not clear how the humidity profiles look like for the different cases (dry vs. moist). In addition, the stratification is of high interest, since during the simulation the stable layers are destabilized by radiation feedback. As remarked above, it would be interesting if a change in stratification

would crucially change the results (i.e. the moisture transport). Please be aware of that the absolute values of the RHi profile in Jensen et al. (2005) are much too high and can be explained by measurement errors (see recent comparison and evaluation by Fahey et al., 2014).

Minor points:

1. The cloud evolution (as shown in fig. 2) should be explained in more details, since this is the major result leading to differences between dry and moist profiles. For instance, you have to explain why the ice crystals become larger in the moist scenario. Which processes lead to larger crystals, is it just enhanced diffusional growth or do other processes play a role? 2D plots of relative humidity and ice mass/number concentrations might also help for clarification.

2. It seems that the forcing of the whole scenario is exclusively given by large scale Kelvin waves. Although this might be appropriate for an idealized investigation, the role of gravity waves in the TTL and their impact on cirrus clouds should not be neglected. Former studies addressed this issue from a microphysical point of view (e.g. Spichtinger & Krämer, 2013; Jensen and Pfister, 2004) and it should be mentioned at least.

3. Figure 6 is very hard to understand; maybe you could try to make a simple version of it to explain the main features in a simpler way.

Technical comments

The supplement is not very user-friendly; it would be much better to upload the short movies in a common format instead of embedding them into a pdf file. Please change the format of the supplement accordingly.

References

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