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Interactive comment on “Global cloud and precipitation chemistry and wet deposition: tropospheric model simulations with ECHAM5/MESSy1” by H. Tost et al.

H. Tost et al.

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Comments to Referee #2

We thank the referee for his helpful comments to which we reply in the following: First of all, the model used in this study is not a chemistry transport model (CTM), as the referee stated, but an atmospheric chemistry general circulation model (AC-GCM) (ECHAM5/MESSy), not using offline fields for meteorological data, but with online calculated dynamics (see Sect. Model description).

Point 1:

The referee suggests adding an analysis of the precipitation distribution in this paper rather than pointing to papers in which this analysis has been performed. Since the

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paper of Tost et al.(2006) uses the same horizontal and vertical resolution and the same comparison with GPCP data, we refrain from repeating this analysis here, but will give some additional information (correlation, normalised standard deviation, bias) in a table for some regions and adding some general remarks how well the precipitation distribution is reproduced by the model. Additionally, the same analysis using a different vertical resolution is also done in the ACPD version of Jöckel et al.(2006).

Point 2:

The differences in the dynamics are caused partly by the feedback of chemistry and water vapour during the chemical integration of the gas phase reaction system. Since the water vapour is a chemical reactive species it can react with several compounds, especially in the upper troposphere lower stratosphere the oxidation of CH_4 produces H_2O . Due to the coupled system of differential equations for the chemistry calculations, a change in one species (e.g. HNO_3) can result in small changes in oxidant rates, which are non-linearly transported, and can lead to slightly different oxidant concentration in the water vapour producing reactions. Furthermore, the partitioning of HNO_3 in polar stratospheric clouds into nitric acid trihydrate (NAT) and gaseous HNO_3 is directly dependent on the nitric acid content of the atmosphere. This directly influences the stratospheric water vapour due to the partitioning into NAT and ice on PSCs, and their sedimentation, redistributing water vapour which has a feedback on the dynamics. However, it is tested, that these changes are small and meteorology is almost identical, especially since some weak nudging is used as well.

Point 3:

During this review phase I received an update on the IDAF observation data, which has also been used in Dentener et al.(2006). This data contains substantially higher values than the first dataset used in our ACPD paper. The analysis will be repeated with the newer data. Additionally, the emissions of our study are different from those of Dentener et al.(2006). A description of the emissions used in this study can be found in Jöckel et al.(2006), Kerkweg et al.(2006), Ganzeveld et al.(2006) and are based on the EDGAR3.2_FASTTRACK database.

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Point 4:

The aqueous phase processes involved are the uptake into the droplets and the conversion to diol. Compared with the chemical reaction speed of several gas phase reactions and the dry deposition, the wet deposition represents a smaller sink in our model setup. This formulation will be clarified in the revised version. Due to the current limitations of treating the ice phase in the scavenging process this retention after freezing is not considered, since the droplet freezing is not considered at all. In case the liquid water content becomes too small for liquid phase calculations, the remaining HCHO is released into the gas phase.

Point 5:

Reaction A4105 includes HCHO, but is only part of the COM setup (label Sc), and not of SCM or EASY as stated in the manuscript.

Point 6:

The section about ozone will be rewritten, supporting the statements by some more figures in the supplement, i.e. analysis of NO_x .

Point 7:

The coarse resolution and the neglect of a detailed stratosphere (only very few levels) results in overestimated ozone and other compounds with enhanced stratospheric production as HNO_3 at the highest model levels. These high values propagate downward by mixing. Since a fixed boundary condition would represent a different source of these species at the upper model boundary, such conditions were not used because they would mask other chemical effects in the troposphere caused by the different treatment of the liquid phase chemistry. Point 8:

If it is aimed at: 'EASY2 seems to agree very well with the observations, however as mentioned above, the deposition sinks are much stronger than in the observations and other simulations.' It is meant to agree with respect to R and σ^* with the HNO_3 , but not with respect to the total deposition values, i.e. it is likely to be caused by some compensating errors.

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