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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Simulation of trace gas redistribution by convective clouds - Liquid phase processes" *by* "Y. Yin et al."

Y. Yin et al.

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M. Barth:
Because marine clouds generally have larger cloud drops than continental clouds, would there be a greater difference in the vertical profile of the species for the marine case than for the continental case?
The authors:
Yes. There was a great difference between these two cases, which is apparent in the vertical profiles of the integrated species mass as a fraction of the mass of insoluble tracer (Figs. 6 and 8).
M. Barth:
The Fig. 12 caption should refer to Fig. 6 rather than Fig. 8 so that the reader can more easily compare the two figures.
The authors:

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This has been changed in the revised version.

M. Barth:

In this section the authors discuss the implications of their results for specific atmospheric gases. This is done by applying appropriate Henry s Law coefficients for particular species. However many of the species listed would not have an initial profile as was used in this study (i.e., large amount of species in the boundary layer, no species above the boundary layer). For example, ozone will be fairly constant in the troposphere with higher values in the upper troposphere. With entrainment included, how would the authors expect their results to differ if they included more representative initial profiles for each species?

The authors:

Figure 14 shows an attempt to summarise the model results for gases that are not restricted to the boundary layer. This figure can be used to estimate the transport of gases based on *any* initial profile. The figure shows the contributions that all model layers make to the gas abundance at all altitudes assuming a gas with an initially uniform vertical concentration. For example, for an insoluble tracer (panel a), gas from the source altitude of 3 km contributes 0.5–1 mol to the layer at 7 km and about 0.05 mol to the layer at 8 km. These contributions can simply be scaled according to any concentration profile for the source. It is apparent that the air at 1–2 km altitude contributes proportionately more to the 7 km layer than air from 3–4 km initial altitude. This enhanced contribution of the lower layers could be reversed if the initial gas abundance were much higher at 3–4 km than at 1–2 km.

M. Barth:

I am curious as to what the authors think are the next steps to improving their modeling effort. Would it be to include the calculation of pH, to include ice microphysics and interactions with chemical species, or some other process?

The authors:

Currently we are calculating redistribution of trace species by mixed-phase convective clouds. In these calculations, the effects on the redistribution of trace gases of uncer-

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tain retention coefficients and gas uptake efficiencies by ice-phase particles are being investigated. Given the large uncertainties in gas–aerosol partitioning processes, we expect similarly large uncertainties in the calculated gas transport in cold clouds.

M. Barth:

The results of this study and Barth et al (2001) indicate that Henry s Law equilibrium can be considered in some cases, particularly for low solubility species and when small drops are considered. To improve computational efficiency, would the authors recommend and make use of a hybrid approach for considering gas absorption (an example of such an approach is given in Barth et al, 2001)?

The authors:

Yes. Based on the results from Barth et al.(2001) and this study, a hybrid approach, in which gas absorption by cloud droplets and rain drops are treated differently for gases with different ranges of solubility is probably computationally more efficient, and therefore, is highly recommended.

Mary Barth:

M. Lawrence raises some important points regarding the results of Yin et al. I agree with Lawrence's criticism that the results should be examined over an integrated distance of the outflow region, rather than at one particular height. In addition, the results should to be integrated over time so that the large-scale modeler can better assess the influence of convection on upper tropospheric chemistry.

The authors:

This has been done in the revised version of the text.

Interactive comment on Atmos. Chem. Phys. Discuss., 1, 125, 2001.