Atmos. Chem. Phys. Discuss., 9, C12244–C12247, 2010
www.atmos-chem-phys-discuss.net/9/C12244/2010/

Atmospheric
Chemistry
and Physics
Discussions

Interactive comment on "Modelling the reversible uptake of chemical species in the gas phase by ice particles formed in a convective cloud" *by* V. Marécal et al.

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Received and published: 26 April 2010

1. General

About the similar order of magnitude of the two approaches, the answer is partly yes since the evaporation of ice is able to reduce the trace gas mixing ratio in the bulk of the ice. Taking into account trapping only would lead to a continuous increase of this mixing ratio. Otherwise we do not know how to explain the similar order of magnitude uptake obtained by the two approaches. Note that even if uptake is of a similar order of magnitude, there are some differences.

About the differences between one and two moment computation expenses: we agree

that the change from one to two moment microphysics will be smaller compared to the introduction of ice uptake for several chemical species. We have removed this argument in the revised version of the paper. We only argue now that we have run a sensitivity simulation with the single-moment scheme to evaluate the impact of the microphysical scheme chosen on ice uptake.

About the number of lines on the trapping and Langmuir result figures: we have chosen 7 trajectories corresponding to the different types of situations encountered within the convective cloud. The objective of these plots is to illustrate the diversity of the results depending on the trajectories chosen. We do not feel that we should reduce this number because we would miss some interesting situations. We also give the mean values for the Langmuir results in Table 1 as complementary information. We have made the plots as readable as possible with different colours that can be easily distinguished.

2. Specific

Abstract. We agree that "size distributions" is not the right word. We have changed in the revised version to the "concentrations". For the two moment simulation, concentrations of snow and aggregates as well as the mixing ratios are interpolated on the selected trajectories.

Page 24363. Modification done in the revised version.

Page 24363. About the liquid phase. We agree that ice microphysics acts between 273 K and 235K together with liquid phase processes. We have changed the text which was not clear on this point.

Page 24363. About freezing through the activation of ice nucleus. We agree and we have added your remark in the revised version.

Page 24368. Line 20. The model was designed using as prognostic variables the mixing ratios of rain, 5 categories of ice and total water. Water vapour and liquid cloud mixing ratios are diagnosed in the following manner: rvl = rtotal water - rpristine –

rsnow – raggregates – rgraupel – rhail –rrain where r is the mixing ratio. Then if rvl < saturation mixing ratio, rliquid cloud=0 and rwater vapour =rvl If rvl >= saturation mixing ratio, rwater vapour = saturation mixing ratio and rliquid cloud=rvl- rwater vapour Both the single and two moment microphysical schemes were designed in the 1990s and this was surely done to save computing resources since it requires one equation less than if water vapour and liquid cloud mixing ratios are prognostic variables. The revised version of our paper has been changed to explain more clearly how water vapour and liquid cloud mixing ratios are diagnosed.

Page 24368. Line 25. We agree that the definition of the ice categories depend on the model. This is now mentioned in the revised version.

Page 24370. Yes we see graupels at temperatures below 235 K but only at the beginning of the trajectories. Their mixing ratio is close to the mixing ratio of aggregates but vanishes very rapidly with time due to sedimentation. The definition of graupels in our microphysics code is from Walko and al. (1995) who designed the model microphysics: "Graupel is an intermediate density hydrometeor. It is spherical in shape and formed by moderate to heavy riming and/or partial melting of the pristine, snow and aggregates. Graupel is allowed to carry up to only a low-percentage of liquid". We agree that graupel at low temperature carry probably a very low percentage of or no liquid water and could be included in our definition of "dry ice". Nevertheless due to their intermediate density (aggregates as well as pristine ice and snow are low density hydrometeor) and their spherical shape, the surface area of graupel is much lower than the surface area of the aggregates, pristine ice and snow. In the revised paper we add a new section (section 5) to discuss about graupels. We show that their impact is very low in both the Langmuir and the trapping approach.

Page 24370. Line 22. Modification done in the revised version.

Page 24375. Line 21. Modification done in the revised version.

Page 24376. No this is not true. As said before about this equation, the shape of

pristine ice and snow are assumed to be hexagonal columns. Agreggates are assumed to be formed 'n' hexagonal columns. In the revised version, we have removed the definition of the coefficients of the mass diameter relationship just before the equation, to be clearer. This definition is not needed on this part of the paper. This definition is now given in part 4.2. Also, as suggested by another referee the writing of this equation has been simplified and an index i has been added to each parameter corresponding to one particular ice category.

Page 24376. Line 16. Modification done in the revised version.

Page 24376. Line 23. Modification done in the revised version.

Page 24376. Line 27. Modification done in the revised version.

Page 24383. The value of the shape parameter used is now given in the revised version

Page 24384. Yes this growth rate is known. It is given by the generally accepted Pruppacher and Klett, (1997) growth rate. This was stated in part 4.1. To be clearer, it is also stated in this part of the revised version.

Page 24385. Line 8. We do not refer to the suppression of the growth of ice crystals by nitric acid. The saturation effect we are referring to is the fact that the number of adsorbed molecules per ice surface unit has a maximum value Nmax which depend on the gas species. When the gas concentration is high, this maximum value can be reached. In this case, no more gas molecules can be adsorbed by the ice surface. We have modified the text to clarify this point.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 24361, 2009.