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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.

Anonymous Referee #1

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1 General

The paper uses the BRAMS model (a version of RAMS tailored to Brazil) to simulate a storm using different bulk microphysics schemes. Afterwards off-line calculations are done to derive the properties that air trajectories would encounter as they move through the cloud. These air trajectories are used to undertake further off-line calculations of the uptake of chemical species by ice particles using different approaches: the Langmuir isotherms and trapping theory which it is argued is more relevant.

While differences between the two approaches are evident on average it is shown that

the two approaches give a similar order of magnitude uptake. Is this because the trapped species can be released under evaporation of ice?

You state that there is a large difference between 1 moment and 2 moment schemes in terms of computation expense. I am not sure if this is really true. Compared to holding different chemical species and calculating their uptake it must be a small increase in computation expense.

There are some typos and some parts where the manuscript lacks clarity. Most (but not all) of the typos I found are in the specific comments below as are parts which I thought lacked clarity.

I found it difficult to compare the results of the trapping theory and the Langmuir isotherms in the way the results were presented. There are quite a lot of lines on some plots. Perhaps some kind of average of this could be plotted in the final manuscript to highlight the main differences between the two approaches.

2 Specific

- Abstract – confusing to say that size distributions were extracted. They are usually diagnosed from the bulk properties.
- Page 24363 "since deep convection is frequent" should be "where deep convection is frequent".
- Also – when you state that the liquid phase is dominant to 235 K I am not sure this is valid in general as the clouds may glaciate depending on their intensity and how many ice nuclei are present. If you prefer to keep this it I would suggest finding a reference that supports this.
- Last line on this page you state that chemical species are retained when drops

freeze by riming, but surely they could also freeze through the activation of an ice nucleus.

- Page 24368 – line 20 – why are water vapour, and liquid cloud diagnosed? They should be prognostic model variables shouldn't they?
- Line 25 – usually your definition of snow would be called graupel and your definition of aggregates would be called snow in most typical models. Is this worth mentioning to avoid confusion?
- Page 24370 - Line 12 – it seems that neglecting uptake onto graupel could underestimate uptake especially if the grapuel is at temperatures below -40C where there would not be any liquid water on its surface. I suspect that this is true even at higher temperatures. Do you see graupel at these altitudes in the simulation?
- Line 22 – thanks (due) to advection.
- Page 24375 – line 21 - "who fitted (to) the data given in Hobbs".
- Page 24376 – in equation 9 it is not clear what you have done to derive the area from the mass-size relation parameters and the size distribution. I am guessing that you have made an assumption that the particles are spherical. It this true? If so it should be stated for clarity.
- Page 24376 - line 16 "relatively" should be "relative "
- Line 23 – should be "Off the 7 selected..."
- Line 27 - "in which surface area(s)"
- Page 24383 – equation 14 assumes that your value for the shape parameter of the distribution is equal to 2. I think it would be better if you said this after making the substitution.

- Page 24384 – it seems like in equation 17 you have assumed that growth rate of individual crystals is known. Is it? There seems to be some assumptions that need starting here?
- Page 24385 – line 8 – what do you mean by "the saturation effect of gas adsorption"? And why does this decrease the trapping rate at high gas concentrations? You also mention this on page 24387, line 27, but dont explain what you mean. I think you are referring to the suppression of the growth of the ice crystals by nitric acid (as described by Gao et al) , but how is this modelled?

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