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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Brightening of the global cloud field by nitric acid and the associated radiative forcing" *by* R. Makkonen et al.

Anonymous Referee #1

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In this paper, the authors used an aerosol-climate model (ECHAM5-HAM2) to estimate the indirect forcing of nitrate acid gas in the present day and the future conditions, using off-line monthly mean nitrate acid gas concentrations from a chemistry model (ECHAM5-MOZ). The effects of nitrate acid on droplet activation is taken account through its modification on the activated fraction, based on the parameterization of Romakkaniemi et al. (2005). The present-day cloud albedo effect is -0.32 W/m2, while the total indirect effect is -0.46 W/m2. They further showed that the indirect effect of present-day nitrate acid gas can be enhanced in 2100 due to the decrease in CCN concentrations. Overall, this is interesting and timely study, as this provides the estimate of the indirect effects of nitrate acid, which has been missed in the literature. The manuscript is also well written. However, I do find it is important to put the forcing estimated here into context. So I would recommend the publication of this manuscript

after my following comments are addressed:

As the forcing estimate of nitrate acid gas is quite large here (0.32 W/m2 for cloud albedo effect, and -0.46 W/m2 for cloud lifetime effects), it is important to put these numbers in context. Here are three things that need further clarification in the manuscript:

i). How do nitrate acid gas concentrations used in this study compare with observations and other models? Off-line monthly nitrate acid gas concentrations are taken from ECHAM5-MOZ, as documented in Rast et al. (2012). Unfortunately, Rast et al. (2012) is still in preparation. So it is important to provide the information regarding these offline nitrate acid gas dataset, such as global burden, how they are compared with other model studies, how do surface concentrations compared with observations.

ii) Uncertainty in the parameterizaiton of Romakkaniemi et al. (2005). The nitrate effect on droplet activation is based on Romakkaniemi et al. (2005). What is the uncertainty in this parameterization? Is there any other parameterizations to treat the effects of nitrate acid gas on droplet activation?

iii) The anthropogenic aerosol indirect forcing other than nitrate acid gas in ECHAM5-HAM2. Here I wonder how the indirect forcing of nitrate acid gas compared with the other anthropogenic aerosol indirect forcing from the same model (present-day aerosols – preindustrial aerosols, without nitrate in ECHAM5-HAM2). A table to compare the indirect forcing of nitrate acid gas with that of anthropogenic aerosol indirect forcing as calculated by the ECHAM5-HAM2 will be desirable.

Specific comments:

p. 5229, line 26: how about coarse mode? The effect can be small, but these may affect how much nitrate acid available for the finer mode.

p. 5230, line 9: Rast et al. (2012) is still in preparation. So it is important to include the basic information about nitrate acid here, such as burden, distributions, and how nitrate

acid concentrations and burdens in this study compared with other published results?

p. 5230, lines 19-27: cloud albedo forcing. Are CDNC used here directly diagnosed from the scheme of Abdul-Razzak and Ghan? If this is the case, please clarify this here.

p. 5231, line 10-16: I understand the argument here, but I still think it is better to provide the anthropogenic indirect effect of nitrate acid gas, but not just the total indirect effects of nitrate acid gas, as the anthropogenic indirect effect of nitrate acid gas will have broader impact.

p. 5231, line 25-27: why does the enhancement in activation fraction increase with height? Also, are data shown in Figure 1 from the annual-mean value at each GCM grid? Section 3.2: how about the anthropogenic aerosol indirect forcing from the preindustrial time to the present-day? This can help to put the number you get here into context. As the magnitude of aerosol indirect forcing can vary a lot from different models, the relative magnitude will be more meaningful.

p. 5234, lines 18-19: I am not sure I understand this first part of this sentence ('even though ... in rather polluted areas'. Specifically, I am not sure the logic between the first part of the sentence and the second part of the sentence ('the results indicate ...').

p. 5228, line 22: remove 'other'.

p. 5229, line 12: surface to the 10hPa

p. 5232, line 4: 'more that' → 'more than'.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 5225, 2012.