Geosci. Model Dev. Discuss., 4, C396–C398, 2011
www.geosci-model-dev-discuss.net/4/C396/2011/

Geoscientific Model Development Discussions

Interactive comment on "Modeling and computation of effective emissions: a position paper" *by* R. Paoli et al.

R. Paoli et al.

paoli@cerfacs.fr

Received and published: 25 June 2011

Response to referee 3

1) We agree with your remark that sources other than NOx emissions are likely to have similar or higher impact on global radiative forcing -although substantial uncertainty exists today in the quantification of this impact as in the case of contrail-cirrus for aviation and aerosol chemistry for maritime transport. We would like to clarify however that the purpose of our paper was not to evaluate the radiative forcing perturbations due to aircraft or ship emissions (which is remarkably done in Lee et al. 2009 paper) nor to discuss the different physico-chemical processes (chemical kinetics, microphysics, radiative transfer model, etc.) that are included in present regional/global models. The idea was rather to focus on one "technical" aspect of the problem, i.e. how to han-

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

dle (with the methods developed in the literature) the sub-grid chemical perturbations associated to emissions from concentrated sources into large-scale models (in this sense we think the paper best fits the scopes of Geoscientific Model Development). It is true that although effective emissions are sub-grid parameterizations derived for general chemical mechanisms, their implementation into global models was mostly limited to NOx-ozone chemistry. This is mainly due to the fact that NOx chemistry is strongly non-linear inside the plume because of the high NOx concentration, and then significant sub-grid nonhomogeneities are to be expected at the scale of GCM/CTM grid-boxes (which contain the plume or part of it). On the other hand, no special sub-grid parameterization is required for CH4 because their characteristic timescales are generally much larger than typical plume dilution timescale. In other words, the effects of chemical reactions involving CH4 can be handled using standard CTM chemistry as if CH4 were instantaneously diluted at the scale of the grid-box and react with ambient ozone. To summarize, the direct (NOx) effect of plume chemical processes is to lessen the ozone formation due to the aircraft traffic by 10 to 20%; the indirect effect is that the CH4 lifetime will be less affected by the ozone change than if the plume processes were neglected. However the latter effect does not need any specific parameterization, it will be handled by the resolved part of the model equations. The evaluation of the overall net effect is thus beyond the scope of the present paper, in the case of ERR approach however, we are implementing a plume parameterization in the CNRM-CCM model and the evaluation of the impact of this parameterization on the RF forcing and the climate impact due to air traffic will be investigated in that context.

2) We added a table summarizing the main features of the existing. We also mentioned in the Conclusions the potential non-linear effects of heterogeneous chemistry in particular that involving HNO3 and N205 at particle surface, and also possible extension to contrail-cirrus (which requires specific treatment of plume microphysics). These topics are relevant to both aircraft and ship emissions and certainly deserve careful attention and further investigation. Common response to the three referees. We agree that validation is a critical task for atmospheric models. In addition to validation, verification is

GMDD

4, C396–C398, 2011

another important ingredient to assess the quality of physical models or computational methods as those described here. We added a new section (Sec. 6 in the revised version of the paper) to discuss these problems.

3) Yes, we agree the title was misleading; the content of our paper better fits the idea of a review of existing methods. We changed the title as: “Review of effective emissions modeling and computation”.

4) Yes (we corrected some of the figure captions where the references were not properly mentioned).

5) We reduced the number of equations, however we chose not to add another section of Acronyms: we think that the meaning of symbols can be better explained in the text following the equations.

6) We added the suggested references in the Introduction and discussed in the Conclusions the extension of plume process parameterizations.

7) We are aware that the results from Kraabol et al. 2002 differ from Mejer 2001 and Vohralik et al. 2008 when using the same ECF methodology. Since we do not know how the method is practically implemented in their global models, we cannot answer with certainty who's right although Kraabol et al. seem to overestimate the reduction of ozone production by plume processes. This could be due to the fact that in the ECF method some ozone is also produced in the plume and this has to be accounted in the ozone budget at grid-box level when ECF are integrated in the global model). In the new section 6 we give some indications on verification of plume paramterizations from the point of view of their implementation into complex atmospheric models.

8) We added the reference.

Interactive comment on Geosci. Model Dev. Discuss., 4, 137, 2011.