Developing a fast aerosol microphysical model for large scale simulations of aircraft impact

X. Vancassel[1], R. Tahir[1], R. Grainger[1], and H. Rogers[2]

[1] Atmospheric, Oceanic, and Planetary Physics, University of Oxford, United Kingdom

[2] Centre for Atmospheric Sciences, Department of Chemistry, University of Cambridge, United Kingdom

Introduction

The stratospheric impact of gaseous species injected by aircraft as well as the subsequent formation of volatile particles remains an open research field. The possible enhancement of the background aerosol surface area density (SAD) (Kärcher and Meilinger, 1998) is likely to modify heterogeneous reactions rates, and thus to change the composition of the stratosphere (especially ozone). A Stratospheric Aerosol Microphysical Model (SAMM) using semi implicit schemes has been written in order to simulate aerosol processes occurring under stratospheric conditions (nucleation of H_2SO_4-H_2O droplets, coagulation, condensation, sedimentation). Sensitivity study results are presented in Figure 1.

Results

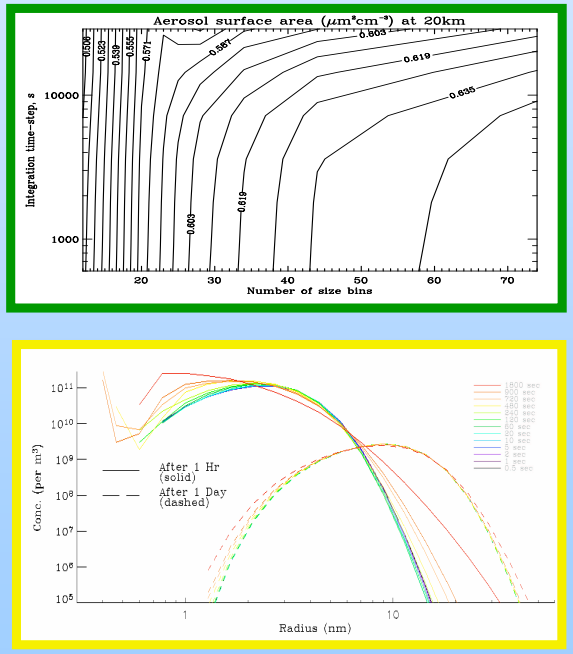

Figure 1. SAD Sensitivity results to time-step duration and number of bins.

The integration of such a model in a CTM should properly describe the effect of both gas and particles injection from aircraft (but could be extended to volcanic perturbations) on stratospheric composition.

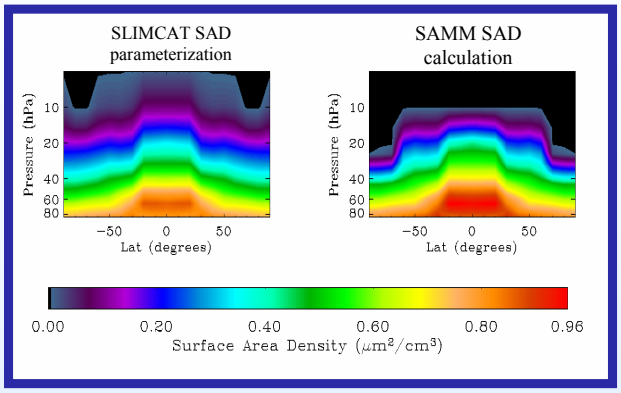

Figure 2. Surface Area Density (SAD) determined at 0° long. using either SLIMCAT parameterization or microphysical calculations (SAMM).

Figure 2 illustrates the difference in SAD determined using either an equilibrium parameterization or a full microphysical model. Discrepancies can be seen at high altitudes where SAMM predicts no aerosol presence, contrary to SLIMCAT results. In addition SAMM predicts larger SAD values at other altitudes. The impact of these discrepancies on chemistry is a function of various parameters such as temperature. For some regions, the dO_x/dNO_x ratio at equilibrium can vary by a factor 5 when we enhance the initial NO_X concentration by 20% (see Figure 3) .

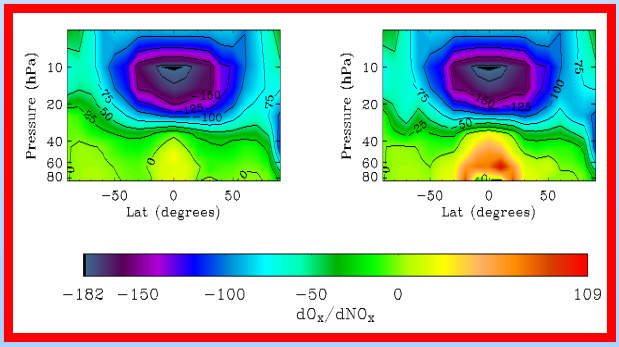

Figure 3. Comparison of the ratio dO_x/dNO_x using the SLIMCAT SAD parameterization (left) or SAMM (right)

Further development

We have started investigating the effect of NO_x, H_2O and H_2SO_4 on O_x species using a box model version of SLIMCAT. The integration of a microphysical model in a 3D model will allow impact studies of aircraft and volcanoes on the global stratosphere.