Project: **1128**

Project title: **Investigation of the influence of air pollution on DMS and its role in the Earth's climate**

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Report period: **2021-01-01 to 2021-08-31**

In the current allocation period, further computing time has been used for a global modelling study on the effect of DMS chemistry on the formation of gas-phase MSA, and sulfate and their impact on radiation, using the climate-chemistry model ECHAM6.3-HAM2.3-MOZ1.0. For this purpose, the current DMS scheme in the model has been updated and extended for a more realistic representation. It includes now a reactive uptake of MSIA on aerosol surfaces to be in line with the importance of multiphase chemistry on MSA formation. Furthermore, due to recent investigations on DMS chemistry and suggestions from reviewers the H-atom abstraction channel has been revised to yield exclusively SO_2 (see Figure 1). The simulations have been performed for the year 2017, as here MSA gas-phase measurements are available to verify the simulations at Northern and Southern Hemisphere. Calculation show that the uptake coefficient is very sensitive towards aerosol particle acidity. Therefore, sensitivity studies have been performed by varying the uptake coefficient to investigate the corresponding effect on MSA formation. In addition, a simulation with the parameterization as included in the aerosol module HAM has been performed.

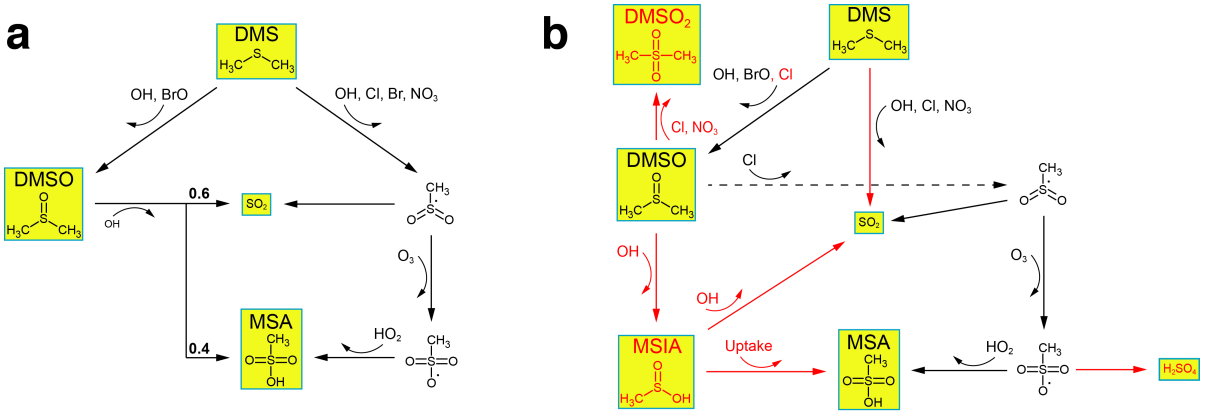

Figure 1 The applied DMS oxidation schemes with the simulationssimulations. (a) for the simulation 'MOZART' and (b) for the simulations 'GAMMA001', 'GAMMA01', 'GAMMA1' and 'VARIED'.

In the different sensitivity studies strong differences have been simulated regarding the yield of gas-phase MSA, SO_2 and H_2SO_4 and subsequently formation of sulfate. It could be shown that the consideration of the reactive uptake of MSIA leads to a better comparison of the simulated with field measurements for gas-phase MSA (comparisons are shown in Figure 2g and 2h). Furthermore, in the simulations with parametrised gas-phase MSA formation high concentrations in high altitudes are modelled. As MSA formation is strongly linked to aqueous-phase chemistry, this result shows possible biases in the current DMS-Oxidation scheme, which importance on the depending radiation budget has to be further analysed in more detail.

Overall, the simulations indicate the importance of a more detailed DMS oxidation description in chemistry-climate models, as the formation of stable intermediate products (DMSO and MSIA) results in strong changes in the simulation of the Arctic radiative forcing. Furthermore, multiphase chemistry processes drive the formation of MSA in the gas-phase influencing the simulated sulfate concentration, especially at the Southern Ocean.

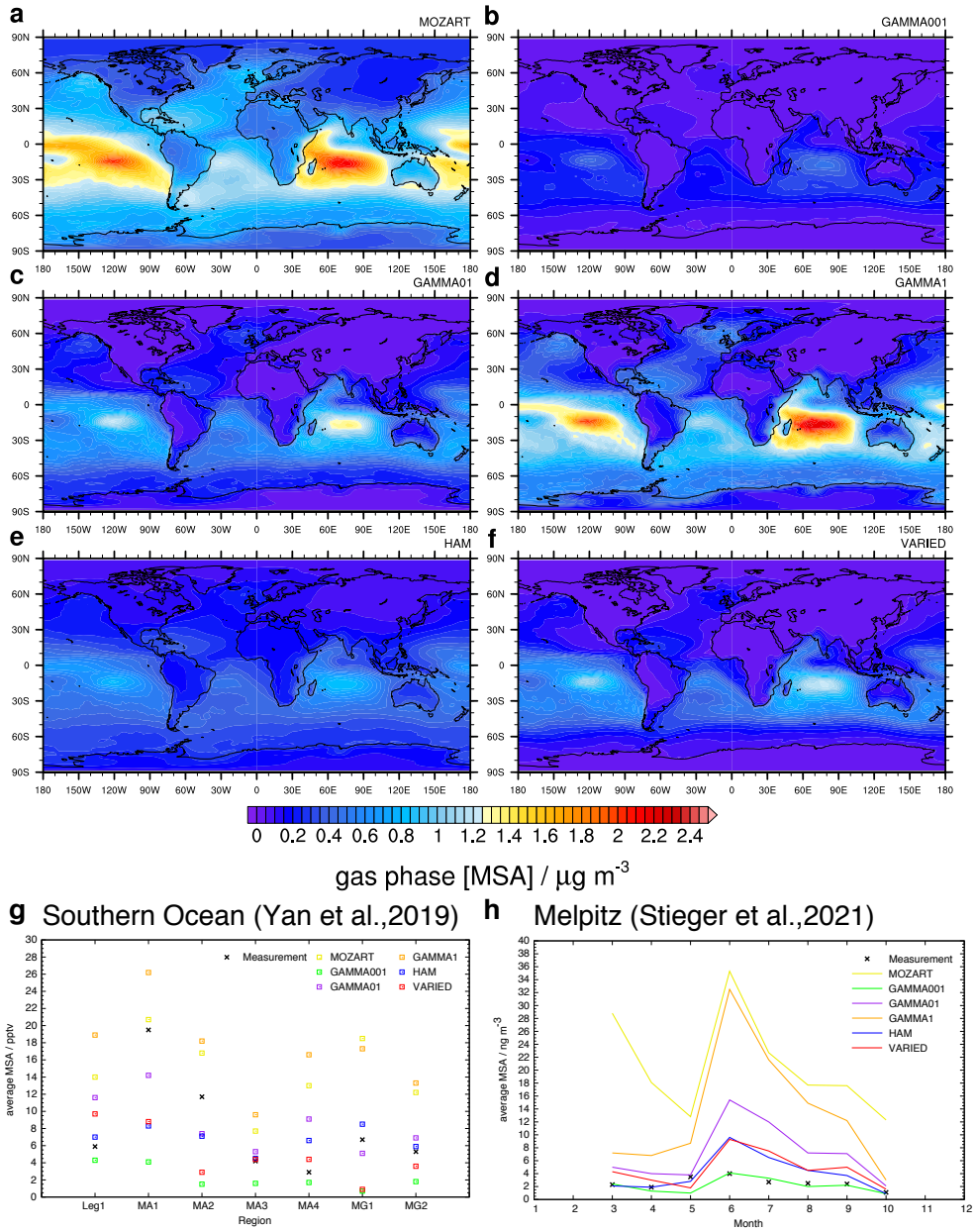

Figure 2 Modeled mixing ratio of MSA averaged over time, height and longitude. Furthermore, the simulated MSA concentrations are compared with field measurements performed in 2017.

A paper with the results has been currently published in the high-impact journal Geophysical Research Letters (doi: 10.1029/2021GL094068).

Furthermore, errors regarding the implementation of the Henry's Law coefficient for SO_2 in the aerosol module HAM has been found during the project. Additional control simulations of 5 years with the wrong and correct value were performed that reveal differences between -8 to 8 W m^{-2} on global scale when comparing the right with the false values. An query to solve this problem in the code has been raised.

Follow-up simulations are planned that incorporate new findings for other VOCs incorporated in ECHAM-HAMMOZ, how these affect the oxidation of DMS as well as simulations to investigate the effect of enhanced forest and grassland fires in a warming climate.