

The middle-atmosphere is a region of great importance for life on Earth: it comprises 90% of the ozone, shielding life forms from damaging solar radiation. One of its main component consists in aerosols. Aerosols are liquid or solid particles in suspension in the atmosphere, presenting a great variability in shape, origin, composition and concentration. In the stratosphere, they mainly originate from large volcanic eruptions able to inject sulphuric gasses at high altitude and to form, after condensation, liquid droplets of a mixture of sulphuric acid and water. Stratospheric aerosols are important atmospheric constituents for climate issues due to their impact on the physico-chemistry and the radiative budget of the atmosphere. After a major eruption, volcanic aerosols strongly affect the thermal structure of the lower stratosphere by scattering solar radiation. They hence contribute, albeit in a very uncertain way, to the modification of the interactions between the upper troposphere/lower stratosphere (UT/LS) as well as the dynamics of the stratosphere, known to be strengthened under the influence of global warming. Stratospheric aerosols also play a direct role in the formation of polar stratospheric clouds (PSC). For all these reasons, the study of volcanic eruptions and the characterization of all aspects of stratospheric aerosols using the most recent knowledge and scientific results is a major issue of climate change.

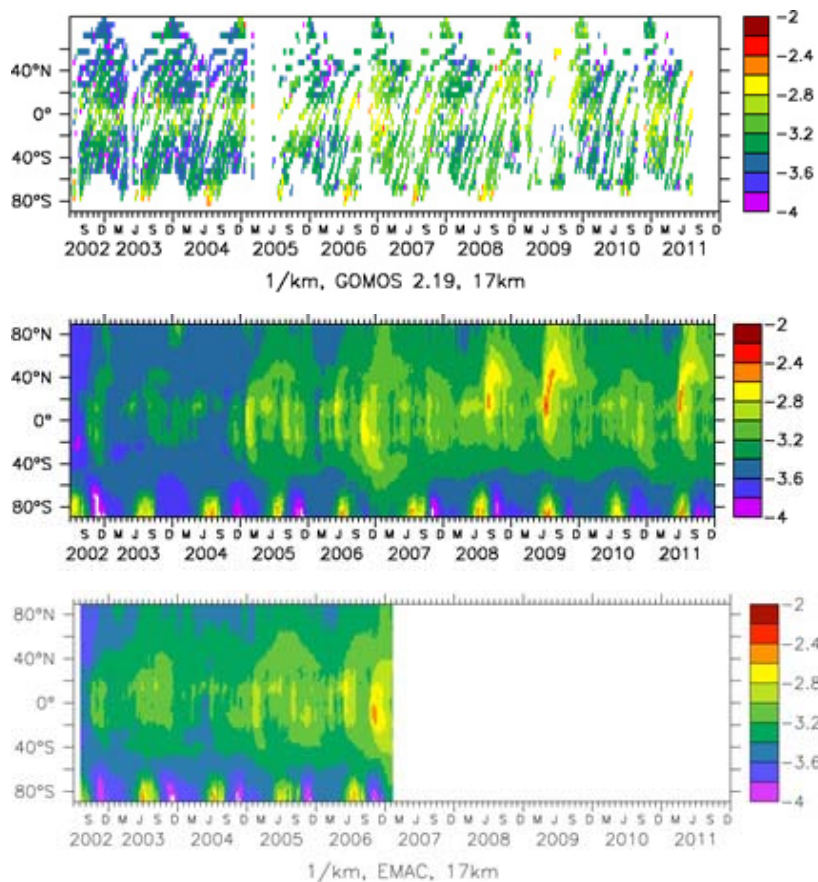
After 2000, an increase of the stratospheric aerosol load was observed, and a debate arose on the respective role of natural (mainly volcanic) and anthropogenic aerosols in this evolution. It is now known that (mainly tropical) volcanoes injecting up to the high troposphere also contribute to the stratospheric aerosol burden, volcanic plumes finding a pathway toward the stratosphere. The Asian summer monsoon system is a notable contributor to this evolution. The aerosol forcing trend has been estimated (Solomon et al., Science, 2016), but doesn't correspond to the impact of the contribution of the major eruption after 2000. Hence, a crucial aspect is to make an inventory of volcanic eruptions including small and medium tropospheric eruptions (injecting at least 15 kt of sulfur species above 14 km) to assess the real volcanic contribution to the stratospheric aerosol load.

MIMOSA-5 addresses all these issues and aims at the characterization of stratospheric aerosols and a better understanding of the role of volcanic eruptions in the evolution of the atmosphere. The project is organized following two main axes: the characterization and modelling activities, and the processing of stratospheric aerosol measurements focussing on GOMOS, a stellar occultation instrument that flown on the ENVISAT satellite from 2002 and 2012.

Using a new algorithm, AerGOM, which improves significantly the GOMOS aerosol retrieval with respect to the operational retrieval algorithm by providing the extinction spectral dependence, the priority was put on MIMOSA-5's second axis, with as main objective the production of time series tailoring optimally the needs of the climate modelling community. Several aspects were considered, including the evaluation, thorough analysis and improvement of AerGOM, its extended validation with respect to the retrieval of radiative properties (extinction) and of the particle size distribution from the extinction spectral profile.

An extensive preparatory work was also measurements in support to the ESA Aerosol_CCI project, which led to the derivation of climate data records for the extinction, optical depth and related Angström coefficients for the whole ENVISAT period (2002-2012).

Modelling mainly relied upon EMAC, a state-of-the-art aerosol, to simulate optimally the aerosol evolution during the post-2000 period. This collaboration with the Max-Planck Institute in Mainz, Germany, resulted in the elaboration of an inventory of the global aerosol load from small, medium and large volcanic eruptions to assess more precisely the volcanic aerosol load, and the corresponding radiative forcing. Latest results show that the new estimate of the aerosol load from this study, including GOMOS data from the climate data records produced in Aerosol_CCI with supporting activities from MIMOSA-5, is able to reproduce much better the observed evolution of the global radiative forcing than the previous estimates. The following figure illustrates this result.



The first panel shows a time series representing the stratospheric aerosol extinction at 550 nm and 17 km from the present work, the second panel shows a simulation using the EMAC model of the corresponding extinction evolution published by Brühl et al., 2015, and the lower panel presents the latest results of the same simulation, including AerGOM data from Aerosol_CCI realized with the support of the present work (Courtesy C. Brühl, MPI-Mainz, Germany). It is visible that the extinction level in the latest figure has increased.

Thanks to the activities described above, final results of MIMOSA-5 and the related Aerosol_CCI project could also improve the agreement of aerosol time series with IPCC requirements for this Essential Climate Variable and provide the aerosol records needed for the Climate Modelling Community. The achievement in terms of aerosol products and algorithm retrieval make them a reference dataset for validation purpose and for the derivation of stratospheric corrections for tropospheric measurements from space. Know-how acquired from the pioneering GOMOS experiment is also indispensable for the preparation of future missions based on the same experimental principle, such as the ALTIUS experiment, currently developed under the leadership van BIRA-IASB, the Host Institution.