Stratospheric Aerosol CDR

Climate Data Record of Stratospheric Aerosols

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In Short

- Retrieval of stratospheric aerosol extinction coefficients from space borne observations of the scattered solar light in limb-viewing geometry.
- Creation of a multi-instrument long-term time series of the stratospheric aerosol extinction coefficient
- Radiative forcing and interaction between the stratospheric ozone and aerosol.

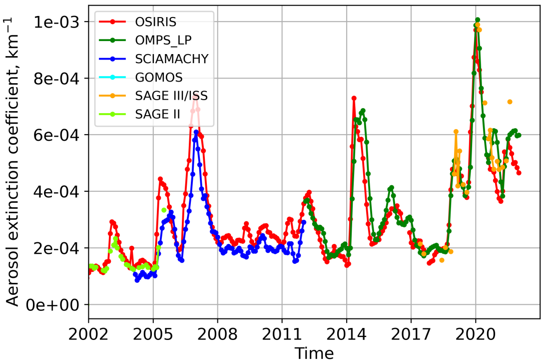

Figure 1: *Stratospheric aerosol extinction coefficients from different space-borne instruments at an altitude of 21 km in tropics.*

Stratospheric aerosols play an important role in the Earth system and in the climate. Through the scattering of solar radiation back to space and by heating the stratosphere through the absorption of thermal infrared radiation upwelling from the troposphere, stratospheric aerosols impact the radiative forcing and thus the energy balance of the Earth's atmosphere. By providing a surface for heterogeneous reactions, which release halogens, stratospheric aerosols contribute to the catalytic depletion of ozone. Because of a strong coupling between the stratospheric aerosols, stratospheric ozone amount, and thermal balance and dynamics of the atmosphere, it is essential to consider realistic aerosol information in modeling studies and in the interpretation of the measurements related to the stratosphere. The information about stratospheric aerosols and their influence on climate is also of high importance for analyses related to geoengineering.

One of the characteristics widely used to describe the amount of stratospheric aerosol is its extinction coefficient. As discussed e.g. by [13], at a first approximation the aerosol extinction coefficient can be used to estimate the radiative forcing and thus quantify the implication for ozone and climate change. While several data sets of the stratospheric aerosol extinction coefficient exist [2,4,9,13], there were only a few studies jointly analyzing aerosol records from multiple instruments. A merged time series of the aerosol extinction coefficient using SAGE II [10] and OSIRIS [8] aerosol data was first presented by [11]. The GloSSAG aerosol climatology presented by [14] is an extension of the climatology described by [11] including the earlier observations from 1979 to 1984, extending the coverage of the data set during the SAGE II measurement period and adding CALIPSO [15] observations after 2006. This climatology, however, intentionally minimizes the number of instruments used while focusing on the data coverage. As a consequence the data sets from the European instruments at Envisat (SCIAMACHY [3], GOMOS [1]) and joint NASA/NOAA Suomi NPP OMPS mission [7] are not included.

In the framework of the ESA-CREST project [5] a collaboration between the Finnish Meteorological Institute and the University of Bremen was established to create a merged long-term multi-mission aerosol record (climate data record) with the main objective to increase the reliability of the data set by including multiple instruments measuring similar atmospheric quantities in the post-SAGE II period. Figure 1 shows example time series from different space-borne instruments, which are used to create the merged time series. The plot shows original data sets before the application of the de-biasing and merging procedure.

Although significant improvements of the underlying single instrument data sets (from SCIAMACHY, GOMOS and OMPS-LP) have been achieved in the framework of the ESA-CREST project, some remaining issues were identified. The most challenging regions are the middle and high southern latitudes, where, because of the observational geometry, the scattering signal measured by the space-borne limb-scatter instruments is lowest, which results in the lowest signal-to-noise ratios along the orbit. Preliminary investigations performed on a limited test sample indicated, however, a potential for a further improvement of the results by optimizing the retrieval approach.

This project aims at a final optimization of the retrieval algorithms and a processing of the entire measurement data form SCIAMACHY (2002-2012) and OMPS-LP (2012 - present) instruments, creation of the improved data sets of the aerosol extinction coefficients and performing comparisons with independent data sets. The ultimate goal of this project is including the improved results in the final merged data set.

Single instrument data sets of the aerosol extinction coefficients, as they will be obtained in the course of this project, are of importance for the comparisons with models, to estimate the radiative forcing due to single volcanic eruptions, and to perform high quality ozone retrievals, which require information on the stratospheric aerosol. The merged data set, which will be created form the single instrument data sets obtained within this project, is important for initialization of climate model runs, creating proxies to be used in the determination of ozone trends and estimation of long-term changes in the global radiative forcing. The data sets resulting from this study will be used for the investigation of the interaction between the changes in the stratospheric ozone and aerosol loading and of the influence of the stratospheric aerosols on the observed ozone trends, which is to be performed within the currently running ESA-OREGANO project [6].

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More Information

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Project Partners

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DFG Subject Area

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