Ship emissions and their influence on large scale cloud fields

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Our study assesses the possibility of detecting an influence of global shipping emissions on the micro- and macrophysical properties of large-scale cloud fields in remote regions of the tropical oceans. We utilise cloud- and aerosol properties as retrieved from satellite measurements as well as results from global aerosol modelling for this purpose.

Our satellite data-based approach differs from many previous studies on ships' influence on clouds because we do not specifically attempt to detect and characterise linear features in stratocumulus cloud-decks known as 'ship tracks'. Ships emit large amounts of aerosols and aerosol precursor gases in remote oceanic areas thereby modifying the composition of marine boundary layer (MBL) aerosol composition and –concentration. It is this modification of MBL characteristics which may alter the properties of liquid water clouds on large scales; a factor which remains to be investigated by use of satellite- and model data.

For the satellite-data based part of our study, we combine cloud- and aerosol properties as derived from satellite measurements (MODIS) and ERA-Interim reanalysis data. We identify regions of large spatial contrast in shipping emissions from an up-to-date shipping emissions inventory. With this data, we separate 'clean' from 'polluted' oceanic regions by using the wind direction as provided by the reanalysis data. The reanalysis data also enable us to characterize the ambient meteorological conditions for the observed scenes.

For the modelling-based part of our study, we use the ECHAM5-HAM aerosol-climate model to assess the climate impact of shipping emissions provided by the shipping emissions inventory. We also sample the model data according to the sampling strategy of the satellite data.

The analysis of the satellite data reveals a potential Twomey-effect on the properties of large-scale cloud fields with regard to shipping emissions. Nevertheless, the results suggest that the observed effects could also be due to a change in dynamical drivers, such as a change in sea surface temperatures. This highlights the difficulty to separate aerosol effects from ambient conditions in satellite based studies. The modelling results generally confirm the findings from the satellite data analysis and enable us to pinpoint the effect of shipping emissions more precisely.

Amphibole antecrysts in deposits of Merapi volcano, Indonesia: A plutonic phase in extrusive magmas

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Amphibole crystals are present in, but typically in disequilibrium with, the high-K basaltic andesite deposits of Mount Merapi, an active stratovolcano of the Sunda volcanic arc at central Java, Indonesia [1-2]. These *antecrysts* form a potential tool for tracing the physical interaction between the deep and shallow parts of the magmatic system. Moreover, they provide a window into the plutonic REE (rare earth element) evolution of arc magmas, for which amphibole fractionation has been inferred to be a controlling process [3]. We studied amphibole antecrysts from block and ash flow deposits of the 1998 eruption by petrographic and EMP analysis of ten thin sections. Six samples with limited to no visible alteration were selected for REE (Quadrupole ICPMS) and radiogenic Sr and Nd isotope analyses (TIMS).

Major element trends combined with the Al based geobarometer that was developed by [4] indicate that amphibole crystallized from a basic magma at the base of the crust (20-31 km) and re-equilibrated with a more silicic magma at a shallower level (13-18 km). The crystals have similar Nd isotope compositions to the bulk rock whereas their Sr compositions are less radiogenic, most likely reflecting a lesser degree of crustal contamination with respect to later grown phases such as feldspar [5]. Both findings are consistent with a model in which magma ponds at the base of the crust, partially crystallizes and subsequently feeds a shallower, more silicic plumbing system that is increasingly affected by crustal contamination. REE ratios show high Dy/Yb and low La/Yb, but concentrations are typically too low to counterbalance the respectively low and high ratios of the hostrock. Fractionation of an additional phase with similar REE partitioning behaviour but with higher partition coefficients, possibly clinopyroxene, is therefore implied in the deeper parts of the Merapi system.

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