Simulating the future impacts of transport emissions on atmospheric aerosol and climate

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Context

Emissions from the transport sectors (land transport, shipping and aviation) are among the major sources of tropospheric aerosol. Aerosol particles affect climate and air quality, resulting also in adverse health effects. Traffic volumes are projected to grow in the near future, with remarkable regional differences, while various mitigation strategies are being applied in order to reduce air pollution and climate effects.

Method

We use the global chemistry-climate model EMAC, coupled to the aerosol module MADE, to quantify the impact of transport emissions on global aerosol in 2000 and 2030 for the four RCP scenarios from the CMIP5 emission dataset. Since the size distribution of emitted particles and its conversion during the dispersion to larger scales is particularly uncertain, we perform additional sensitivity simulations with different size distribution assumptions.

Results

The model simulations reveal that emissions of aerosols (and aerosol precursor species) have an important contribution to the overall climate impact of the transport sectors, comparable and often larger than the effect of CO_2 and other compounds. The bulk of the aerosol-induced radiative forcing is attributable to aerosol interactions with warm clouds. Shipping contributes the largest forcing, due to the large amount of emitted sulfur species. A remarkably negative forcing is also found for aviation, which can impact warm clouds during the aircraft ascending and descending phases. The shipping sector is projected to decrease its climate impact in 2030, after the implementation of new regulations reducing the fuel sulphur content. A slight decrease is also simulated for land transport. Aviation is the only sector for which an increased climate impact is foreseen.

In addition to the limitations intrinsic to the parameterization of the aerosol-cloud interactions in the model, large uncertainties in these estimates derive from the assumptions on the size of emitted particles.