Global model simulations of the impact of transport sectors emissions on atmospheric aerosol and climate

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Emissions from the transport sectors (land transport, shipping and aviation) are among the major sources of tropospheric aerosol. Aerosol particles can have a significant impact on climate and can affect air quality, in particular in urban, densely populated areas, resulting in adverse health effects. The emissions from the transport sectors are expected to grow in the near future, especially in the developing countries. At the same time, various mitigation strategies are being applied in order to reduce air pollution and climate impacts.

In this work we use the EMAC-MADE global aerosol model to quantify the impact of transport emissions on global aerosol (Figure 1). We consider a present-day (2000) scenario and four future (2030) RCP scenarios from the CMIP5 emission dataset developed in support of IPCC AR5. Number emissions are also included in the model and derived from mass emissions under different assumptions on the size distribution of particles emitted by the three transport sectors. Additional sensitivity experiments are performed to quantify the effects of the uncertainties related to such assumptions.

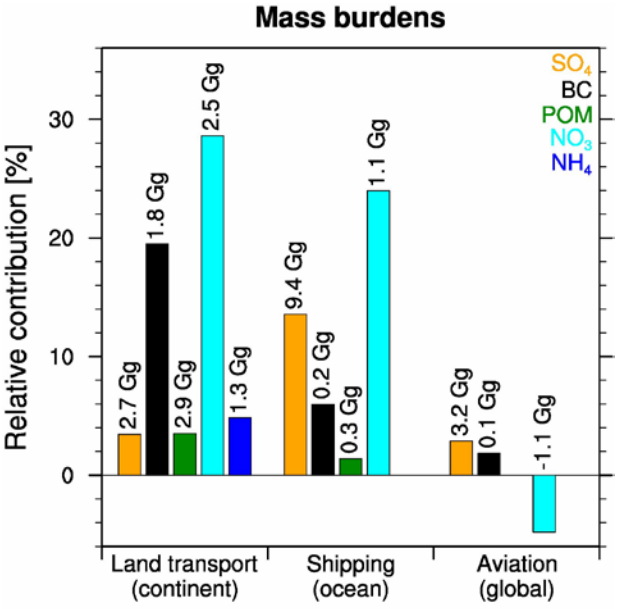

Figure 1. Relative contributions of the transport sectors to the multi-year average mass burdens of different aerosol components for the three transport sectors. The value on top of each bar shows the corresponding absolute contributions. The analysis is based on global simulations considering year 2000 emissions.

The model simulations show that the impact of the transport sectors closely matches the emission patterns. Land transport is the most important source of black carbon pollution in the USA, Europe and the Arabian Peninsula (Figure 2). Shipping strongly contributes to aerosol sulphate concentrations along the most-travelled routes of the northern Atlantic and northern Pacific oceans, with a significant effect also along the coastlines. The impact of aviation is mostly confined to the upper-troposphere (7 – 12 km), in the northern mid-latitudes, although significant effects are also simulated at the ground, due to the emissions from landing and take-off cycles.

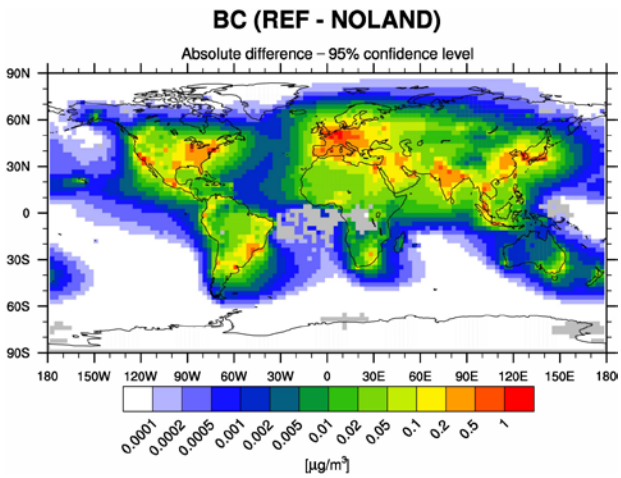

Figure 2. Absolute impact of land transport on BC surface-level concentration for year 2000 emissions. Non-significant grid-points are masked out in gray.

The simulations further reveal that transport-induced perturbations of particle number concentrations are very sensitive to the assumptions on the size distribution of emitted particles, with the largest uncertainties simulated for the land transport sector.

The climate impacts, due to aerosol direct and indirect radiative effects, are strongest for the shipping sector, as a consequence of large effects of sulphate aerosol on low marine clouds.

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