DKRZ – Project 80
Climate effects of emissions from the transport sector

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Motivation:

- Large contribution of the transport sector to global anthropogenic emissions
- Greater growth rates of activity in the transport sector than in other sectors
- Large uncertainties in the quantification of transport-induced non-CO_2 climatic impacts

Objective:

- Quantification of the climate effects of non-CO_2 emissions from land-based transport, shipping, and aviation

Specific subjects

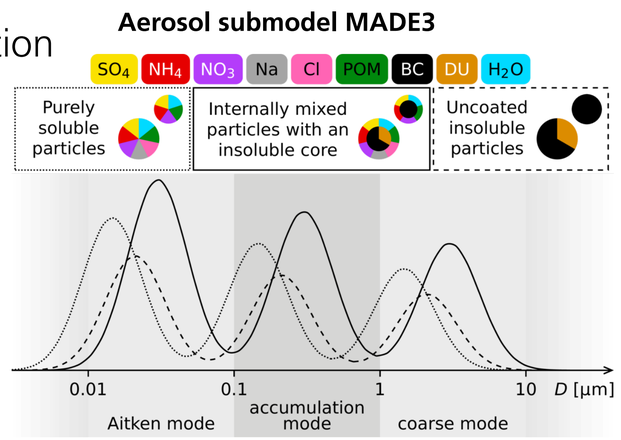
- Effects of global transport emissions on the atmospheric aerosol
- Related effects on clouds and radiation
- Individual effects of land-based transport, shipping, and aviation
- Climate effects of transport emissions in future scenarios
- Climate effects of local (e.g., German) emissions
- Climate sensitivity and feedback analysis for non-CO_2 impact components
- Improved representation of transport-induced effects in the chemistry-climate model system EMAC

Aerosol model development

Development of MADE3, a new version of the aerosol submodel MADE, and implementation in EMAC2.50

→ Improved representation of aerosol number concentration, size distribution, and composition

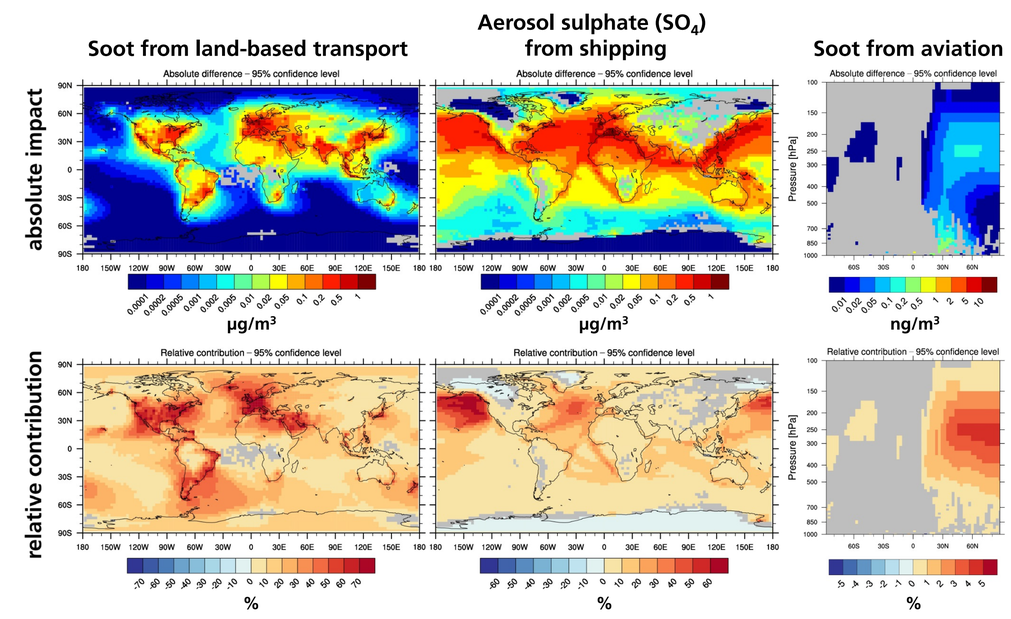
→ Representation of different aerosol mixing states



Goal: Improved quantification of transport-induced aerosol effects (specifically on upper tropospheric ice clouds)

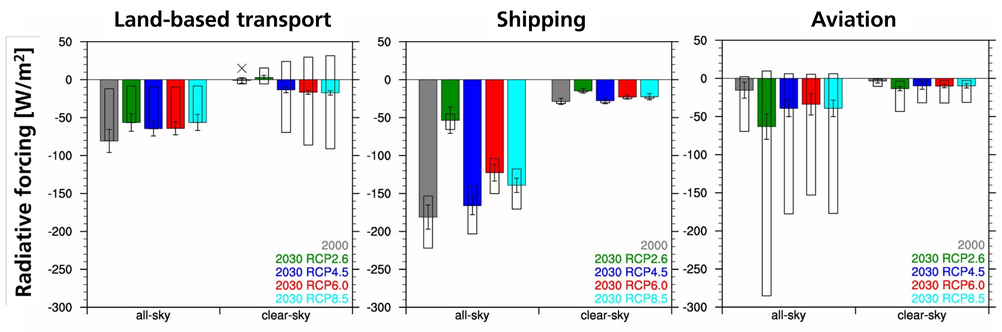
Effects of aerosol from global transport emissions

Application of EMAC including the aerosol submodel MADE



Transport-induced aerosols

→ Increased concentrations of climatically relevant constituents due to global transport emissions



Effects of transport-induced aerosols on clouds and radiation

→ Important contributions to total anthropogenic radiative forcing in 2000 and future (2030) scenarios

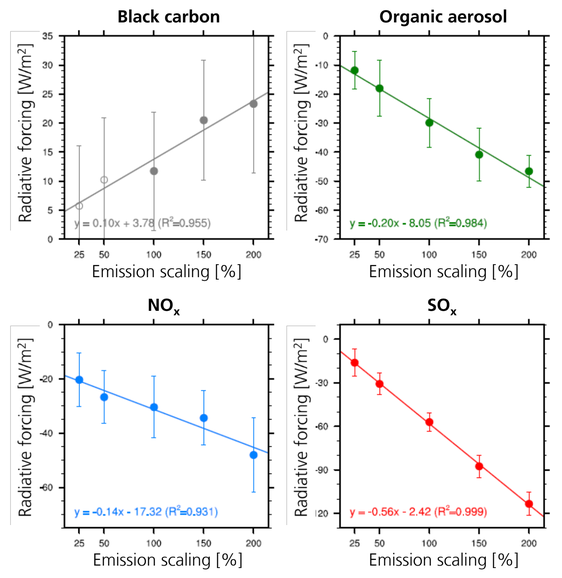
→ Aerosol radiative forcing dominated by cloud effects

Effects of local emissions

Effects of "small" emission sources (e.g. German transport) below significance level of global aerosol-climate models

→ Derivation of aerosol-climate response functions from EMAC simulations by variation of total European anthropogenic emissions of aerosol and precursor species

→ Radiative forcing of small emission perturbations



Climate sensitivity analysis for non-CO_2 effects

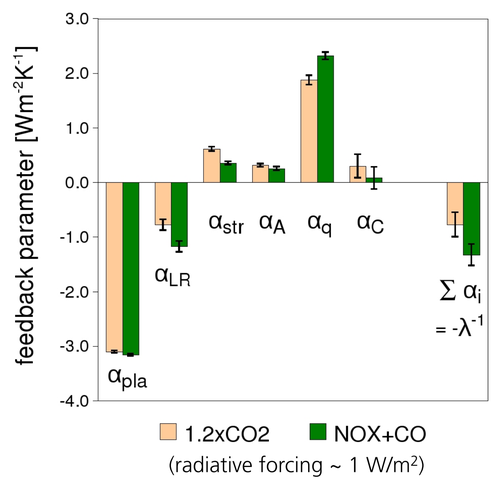
EMAC simulations with mixed layer ocean:

a) Non-CO_2 perturbation: increase of NO_x and CO emissions (NOX+CO)

b) CO_2 perturbation: increase of CO_2 (1.2xCO2)

→ Calculation of individual feedback parameters α_i with offline radiative transfer model

→ Weaker climate sensitivity λ for NOX+CO



Feedback parameters

surface temp. α_{pla}	albedo α_A
lapse rate α_{LR}	water vapour α_q
stratospheric temp. α_{str}	clouds α_C

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19.10.2015