Importance of tropospheric volcanic aerosol for indirect radiative forcing of climate

Anja Schmidt

School of Earth and Environment, University of Leeds, Leeds, UK

E-mail: a.schmidt@leeds.ac.uk

Observations and models have shown that continuously degassing volcanoes have a potentially large effect on the natural background aerosol loading and the radiative state of the atmosphere. We use a global aerosol microphysics model to quantify the impact of these volcanic emissions on the cloud albedo radiative forcing under pre-industrial (PI) and present-day (PD) conditions. We find that volcanic degassing increases global annual mean cloud droplet number concentrations by 40% under PI conditions, but by only 10% under PD conditions. Consequently, volcanic degassing causes a global annual mean cloud albedo effect of -1.06 W m^{-2} in the PI era but only -0.56 W m^{-2} in the PD era. This non-equal effect is explained partly by the lower background aerosol concentrations in the PI era, but also because more aerosol particles are produced per unit of volcanic sulphur emission in the PI atmosphere. The higher sensitivity of the PI atmosphere to volcanic emissions has an important consequence for the anthropogenic cloud radiative forcing because the large uncertainty in volcanic emissions translates into an uncertainty in the PI baseline cloud radiative state. Assuming a -50/+100% uncertainty range in the volcanic sulphur flux, we estimate the annual mean anthropogenic cloud albedo forcing to lie between -1.16 W m^{-2} and -0.86 W m^{-2}. Therefore, the volcanically induced uncertainty in the PI baseline cloud radiative state substantially adds to the already large uncertainty in the magnitude of the indirect radiative forcing of climate.

Reference:

Schmidt, A., Carslaw, K. S., Mann, G. W., Rap, A., Pringle, K. J., Spracklen, D. V., Wilson, M., and Forster, P. M.: Importance of tropospheric volcanic aerosol for indirect radiative forcing of climate, Atmos. Chem. Phys., 12, 7321-7339, doi:10.5194/acp-12-7321-2012, 2012.