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Estimate of aerosol indirect radiative forcing by combining satellite data and global models

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Aerosol impacts on clouds ("aerosol indirect effects") represent the largest uncertainty in the determination of the net anthropogenic climate forcing. While many estimates of the aerosol indirect radiative forcing already exist from global climate models, studies show that these are highly uncertain and probably biased towards too strongly negative values. On the other hand, no reliable estimate from satellite data alone exists, and it might even be impossible to measure concentrations of cloud condensation nuclei and to distinguish natural and anthropogenic aerosols from remote sensing.

We adopt here two different apporaches. In the first approach, we constrain the model parameterization of the aerosol indirect effects by the use of satellite retrievals. To do so we adjust an empirical relationship between aerosol mass concentration and cloud droplet number concentration in order to fit relationships obtained from MODIS and POLDER retrievals of aerosol and cloud properties. We achieve a new estimate of the first indirect effect which approximately halves the forcing from -0.9 Wm^{-2} to -0.4 W m^{-2} in the global annual mean. In the second approach, we separate situations with natural and anthropogenic aerosols using the model results and estimate the forcing using CERES measurements of radiative fluxes at the top of the atmosphere.