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Line-by-line calculation of aerosol radiative forcing for radiative-convective climate model

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In the FAR and earlier IPCC assessment reports radiative forcing (RF) defined as “change in net (down minus up) irradiance (solar plus longwave; in W m^{-2}) at the tropopause after allowing for stratospheric temperatures to readjust to radiative equilibrium, but with surface and tropospheric temperatures and state held fixed at the unperturbed values”. Radiative forcing is widely used to assess and compare the anthropogenic and natural causes of climate change. The concept of RF came from early studies of the climate response to changes in solar insolation and CO_2, using simple radiative-convective models.

The RF for different types of tropospheric and stratospheric aerosols is calculated using the line-by-line models developed in the Russian Research Center “Kurchatov Institute". The results of RF calculation is use as driving force for average global vertical temperature profile, calculated by radiative-convective model, developed in A.M. Obukhov Institute of Atmospheric Physics.

If microphysical and optical properties and amount of aerosol are known LBL methods could calculate aerosol RF with most accuracy in the case of global homogenous aerosol distribution. Even in this spatially-homogeneous case the RCM response to different RF is not linear and straightforward.

The results of LBL and RCM calculations show that in cloudy atmosphere the aerosol forcing temperature effects much strongly depend of vertical aerosol distribution than in the cloudless atmosphere.

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