EGU General Assembly 2020

EGU2020-18115
https://doi.org/10.5194/egusphere-egu2020-18115
EGU General Assembly 2020

Investigating the sensitivity of direct, semi-direct and indirect effects of aerosols to changes in the emissions of individual aerosol species using a climate model.

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Atmospheric aerosols emitted from both natural and anthropogenic sources play a crucial role in the Earth's radiation budget and regulating its climate. The mechanisms through which aerosols influence the radiation budget of the Earth is often classified as direct, semi-direct, and indirect effects of aerosols. It is important to understand the perturbation caused in the radiation budget of the Earth due to changing emissions of individual aerosol species and their precursors not only for estimating the responses of the climate system to such perturbations but also to be able to attribute these responses to changes in specific aerosol species and their sources for planning any mitigation or adaptation strategy to any undesirable consequences of climate change caused by aerosols. In the present study we use the Community Atmosphere Model version 5.3 (CAM5.3) to quantify the direct, semi-direct, and indirect aerosol radiative forcing due to changes in the emissions of individual aerosol species or their precursors from the pre-industrial (PI) to present day (PD) period following a new methodology proposed by Ghan et al. (2012) involving additional radiative diagnostics with neglected absorption and scattering of aerosols, whereas absorption and scattering of aerosols for the actual model setup remains unchanged. A series of systematically designed simulations with concentrations of individual aerosol species set to zero are conducted in order to estimate the direct, semi-direct, and indirect aerosol radiative forcing due to the corresponding aerosol species. Our preliminary results shows the global annual mean value of direct Short-Wave radiative forcing (DRF) at TOA due to all aerosols to be around -0.01W/m^2, while the Cloud radiative forcing (CRF) to be around -1.5W/m^2. The bias in the aerosol radiative forcing estimates as per the old conventional method are almost -0.55W/m^2 for DRF which is nearly 60 times the DRF estimated using the new approach and 0.23W/m^2 for CRF which is almost 15.43% of the total CRF at TOA respectively. Interestingly, for the South Asian region, the DRF based on the new approach is found to be positve in almost across south Asia (0.097 W/m^2) thereby signifying a trapping of energy in the atmosphere due to aerosols, whereas according to the old conventional method the DRF is estimated to be around -0.59 W/m^2 signifying a loss of energy in the atmosphere due to aerosols. Similarly a difference of about 1 W/m^2 is noted in the estimates of CRF as per the new and the old methods of estimating radiative forcing. More results with greater details on the contribution of individual aerosols towards the total aerosol radiative forcing and other important meteorological parameters will be presented.