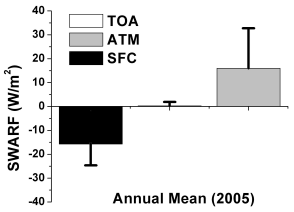
First Observation-Based Estimates of Cloud-Free Aerosol Radiative Forcing Across China

Research Highlight

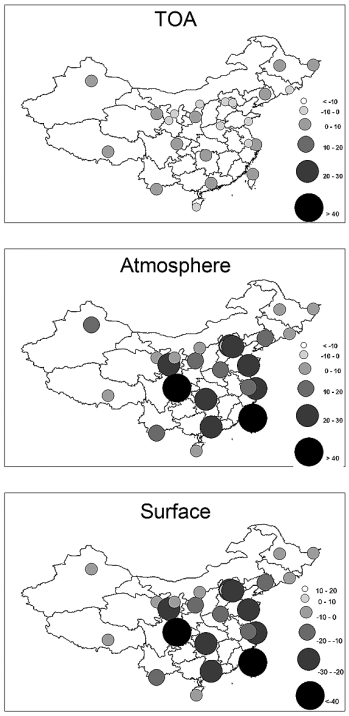
Heavy loading of aerosols in China is widely known, but little is known about their impact on regional radiation budgets, which is often expressed as aerosol radiative forcing (ARF). Depending on their composition, aerosols can absorb a substantial amount of solar radiation, leading to a warming of the atmosphere and cooling of the surface. Many investigations have been made to characterize atmospheric aerosols and their radiative effects around the world, but few observation-based estimates of ARF have been made due to lack of actual measurements.

Using an extensive set of aerosol observational data as input to a radiative transfer model, the first observation-based estimate of ARF across China is obtained. Model input data include aerosol optical depth measurements made at 25 stations distributed across China, single-scattering albedos estimated from a combination of satellite and ground measurements, surface albedo data retrieved from the satellite-borne MODIS, and ozone data from a Total Ozone Mapping Spectrometer (TOMS). Aerosol radiative forcing is computed at the top, bottom, and interior of the atmosphere.

Nationwide diurnal mean aerosol forcings are 15.7 ± 9.0 at the surface, 0.3 ± 1.6 at the TOA, and 16.0 ± 9.2 W m#2 inside the atmospheric column. The near-balanced SWARF for the atmosphere-surface system indicates the presence of strong absorbing aerosols across the region that almost entirely offset the effect of aerosol scattering. The huge amount of solar radiation trapped inside the atmosphere by aerosols is a significant source of heating to the atmosphere, especially within the lower atmosphere. This can substantially alter atmospheric stability and influence the dynamic system. The validity of the method is demonstrated using independent ground and satellite observations. Uncertainties of our estimates are also quantified.



Mean annual shortwave aerosol radiative forcing (SWARF) averaged across China.



Spatial variation of the annual mean SW aerosol radiative forcing.

Reference(s)

Contributors

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Working Group(s)

Aerosol Life Cycle