

The Aerosol Indirect Effect

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The interaction of aerosols with clouds gives rise to one of the largest sources of uncertainty in assessments of climate change caused by humans. Modeling studies that include such interactions render assessments of climate change utterly uncertain. Estimates of the effects of aerosols on clouds based on correlations of aerosol burdens and cloud properties derived from satellite observations are flawed. The correlations may be affected by a number of physical processes which could have little to do with aerosol-cloud interactions. Furthermore, both clouds and aerosols respond to the thermodynamics of their environment, further complicating the determination cloud-aerosol interactions. Nonetheless, observations of the response of marine stratocumulus to aerosols generated by ships off the west coast of the U.S. show the clouds responding in ways predicted by large eddy simulation cloud models. While polluted clouds lose liquid water, rather than gain liquid water as climate model simulations predict, the loss is less than 10%. The increase in cloud cover fraction due to the increase in particulate pollution, on the other hand, has an effect on cloud radiative forcing that is comparable to that for the changes in droplet numbers and radii. These results suggest a strategy for developing empirically based bounds of the aerosol indirect radiative forcing.