TJ12.4 Aerosol Indirect Effect on Tropospheric Ozone via Lightning

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Aerosol Indirect Effect on Tropospheric Ozone via Lightning
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Recorded Presentation

Tropospheric ozone (O3) is a pollutant and major greenhouse gas and its radiative forcing is still uncertain. Inadequate understanding of processes related to O3 production, in particular those natural ones such as lightning, contributes to this uncertainty. Here we demonstrate a new effect of aerosol particles on O3 production by affecting lightning activity and lightning-generated NOx. We find that lightning flash rate increases at a remarkable rate of 30 times or more per unit of aerosol optical depth. We provide observational evidence that indicates the observed increase in lightning activity is caused by the influx of aerosols from a volcano. Satellite data analyses show O3 is increased as a result of aerosol-induced increase in lightning and lightning produced NOx. Model simulations with prescribed lightning change support the satellite data analysis. O3 production increase from this aerosol-lightning-ozone link is concentrated in the upper troposphere, where O3 is most efficient as a greenhouse gas. Our findings thus suggest a stronger O3 historical radiative forcing because this link implies lower lightning-generated NOx and lower O3, especially in the upper troposphere, in preindustrial time. Aerosol forcing therefore has a warming component via its effect on O3 production and this component has mostly been ignored in previous studies of climate forcing related to O3 and aerosols. Sensitivity simulations suggest that 4-8% increase of column tropospheric ozone, mainly in the tropics, is expected if aerosol-lightning-ozone link is parameterized, depending on the background emission scenario. We note, however, substantial uncertainties remain on the exact magnitude of aerosol effect on tropospheric O3 via lightning. The challenges for obtaining a quantitative global estimate of this effect are also discussed. Our results have significant implications for understanding past and projecting future tropospheric O3 forcing as well as wildfire changes and call for integrated investigations of the coupled aerosol-cloud-chemistry system.

See more of: Chemistry-Aerosol-Cloud/Climate Interactions: From Ocean to Continents, Part II
See more of: Fifth Symposium on Aerosol-Cloud-Climate Interactions

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