Indonesian Wildfires of 1997: Impact on Tropospheric Chemistry

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Abstract

The Indonesian wildfires of 1997 released large amounts of trace gases and aerosols (e.g., 30 Tg of carbon monoxide (CO)) from September to November. Using the GEOS-CHEM model of tropospheric chemistry and transport, we conducted a study of this burning event to estimate its impact on tropospheric chemistry. The model captures most of the daily variations of CO and ozone (O3) observed in the region affected by the pollution. Export of the pollution from the Indonesian region was primarily in the prevailing easterlies in the free troposphere to the tropical Indian Ocean where the bulk of the pollution lay between 20° N t t o 20°S from September to November. The tropospheric CO and O3 columns were elevated by more than 50% and 10%, respectively, over the tropical Indian Ocean because of the fires. Another important export pathway was to the tropical and subtropical South Pacific Ocean in the southern subtropical jet. A more episodic pathway occurred to the tropics and subtropics of the North Pacific Ocean. By December, the tropospheric column of CO from the fires had mixed zonally and somewhat symmetrically about the equator impacting both the northern and southern hemisphere similarly. The CO column was elevated by 10-20% from 30°N to 45°S in December, by 5-10% poleward of 45°S, and by less than 5% poleward of 45°N. The relative impact of the fires was lower in the northern hemisphere, as the background CO column is typically higher there. The fires decreased the concentration of the hydroxyl radical (OH) by more than a factor of two over much of the tropical Indian Ocean through consumption by CO, heterogeneous loss of odd-oxygen radicals (HOx) on black (BC) and organic carbon (OC) aerosols, and reduction of UV light by the aerosols. The net direct, shortwave radiative forcing at the top of the atmosphere of OC and BC aerosols from the fires was relatively small, as their distributions were similar, but of opposite signs. The net forcing at the surface, however, was large, about –10 W m-2 over most of the tropical Indian Ocean and as low as –150 W m-2 over the burning regions in Indonesia, indicating that aerosols from the fires significantly perturbed the tropical radiative budget. The calculated forcing of O3 was minor relative to those of BC and OC aerosols.

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