Satellite observed impacts of wildfires on regional atmosphere composition and the shortwave radiative forcing: A multiple case study

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Emissions of aerosols and trace gases from wildfires and their direct shortwave radiative forcing (DSRF) at the top of atmosphere (TOA) were studied using satellite observations from Moderate-Resolution Imaging Spectroradiometer (MODIS), Atmospheric Infrared Sounder (AIRS), Clouds and Earth Radiant Energy System (CERES) on Auqa satellite, and Ozone Monitoring Instrument (OMI) on Aura satellite. The dominant fuel types of the selected fire cases in the Northeast of China (NEC), Siberia (in Russia), and California (in the USA) are cropland, mixed forest, and needle-leaf forest, respectively. For the cropland fire case in NEC, the fire radiative power (FRP, unit MJ^{-1}) based mass emission coefficients (Ce, unit g MJ^{-1}) of aerosol is 20.51±2.55 g MJ^{-1}, half that of the forest fire cases in Siberia (40.01±9.21 g MJ^{-1}) and California (45.23±8.81g MJ^{-1}), and the carbon monoxide (CO) Ce (23.94±11.83g MJ^{-1}) is about one third and half that of the forest fire cases in Siberia and California respectively. However, the NOx (NO2+NO) Ce (2.76±0.25g MJ^{-1}) of the cropland fire in NEC is nearly 3 times that of those forest fire cases. Ratios of NOx to aerosol, HCHO, and CO in the cropland case in NEC show much higher values than those in the forest fire cases. Despite of the differences of the Ce and the composition ratios, the DSRF efficiency of smoke aerosol at TOA show similar values among all fire cases. Our results highlight the large variability of emission rate and relative chemical composition but similar DRSF efficiencies of 20.09-22.93 Wm^{-2} per unit aerosol optical depth among wildfires, which would provide valuable information for understanding the impact of fire on air quality and climate.

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