

Estimate of radiative forcing and regional feedback of Asian biomass burning aerosols during the period of TRACE-P

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Abstract

The regional radiative impact of biomass burning aerosols in Asia is estimated using the new and detailed emission data during the experimental period of Transport and Chemical Evolution over the Pacific (TRACE-P) in March, 2001. Integration of the Fifth-Generation NCAR / Penn State Mesoscale Model (MM5), USA NOAA Hybrid Single-Particle Lagrangian Integrated Transport model (HYSPLIT) and a solar radiative transfer model (CLIRAD-SW) allow us to simulate the spatial and temporal distributions of black carbon (BC) and organic carbon (OC) aerosols from biomass burning in the South Asian region. It also allows us to estimate further their aerosol optical properties and radiative forcing. We find an anticyclone over Bay of Bengal dominates the transport of pollutants of South Asian region. The monthly mean surface concentration of OC and BC is $1.2 \mu\text{g m}^{-3}$ in this region. Western Myanmar has the maximum value, with the concentration reaching $14.1 \mu\text{g m}^{-3}$. The monthly mean all-sky direct shortwave radiative forcing ranges from -1.65 to 1.42 W m^{-2} at the top of the atmosphere and from -0.03 to -9.06 W m^{-2} at surface, resulting in an increase of the atmospheric heating rate from 0.01 to $0.2 \text{ }^\circ\text{C day}^{-1}$. Owing to the spatial distributions of the AOD (Aerosol Optical Depth) ratio (OC/BC) and the surface albedo, there is a strong gradient of heating rate near the source regions, which may modify local circulations. Overall, biomass burning aerosols result in less solar irradiance reaching the Earth's surface, but greater heat in the lower atmosphere. We suggest such an effect will affect the dynamic and thermodynamic processes in the atmosphere and further impact the regional hydrological cycle and rainfall. In this study, the regional meteorological feedback due to biomass burning aerosol forcing also be addressed. The variation of accumulate precipitation in March 2001 shows more than $\pm 500 \text{ mm}$ in the southern Asia.