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Impact of springtime biomass-burning aerosols on radiative forcing over northern Thailand during the 7SEAS campaign

Shantanu Kumar Pani (1), Sheng-Hsiang Wang (1), Neng-Huei Lin (1,5), Chung-Te Lee (2), Si-Chee Tsay (3), Brent Holben (3), Serm Janjai (4), Ta-Chih Hsiao (2), Ming-Tung Chuang (2), and Somporn Chantara (5)

(1) Department of Atmospheric Sciences, National Central University, Taoyuan, Taiwan, Province Of China (shantanukumarpani@gmail.com), (2) Graduate Institute of Environmental Engineering, National Central University, Taoyuan, Taiwan, (3) Goddard Space Flight Center, NASA, Greenbelt, Maryland, USA, (4) Department of Physics, Faculty of Science, Silpakorn University, Nakhon Pathom, Thailand, (5) Chemistry Department and Environmental Science Program, Chiang Mai University, Chiang Mai, Thailand

Biomass-burning (BB) aerosols are the significant contributor to the regional/global aerosol loading and radiation budgets. BB aerosols affect the radiation budget of the earth and atmosphere by scattering and absorbing directly the incoming solar and outgoing terrestrial radiation. These aerosols can exert either cooling or warming effect on climate, depending on the balance between scattering and absorption. BB activities in the form of wildland forest fires and agricultural crop burning are very pronounced in the Indochina peninsular regions in Southeast Asia mainly in spring (late February to April) season. The region of interest includes Doi Ang Khang (19.93° N, 99.05° E, 1536 msl) in northern Thailand, as part of the Seven South East Asian Studies (7-SEAS)/BASELInE (Biomass-burning Aerosols & Stratocumulus Environment: Lifecycles & Interactions Experiment) campaign in 2013. In this study, for the first time, the direct aerosol radiative effects of BB aerosols over near-source BB emissions, during the peak loading spring season, in northern Indochina were investigated by using ground-based physical, chemical, and optical properties of aerosols as well as the aerosol optical and radiative transfer models. Information on aerosol parameters in the field campaign was used in the OPAC (Optical Properties of Aerosols and Clouds) model to estimate various optical properties corresponding to aerosol compositions. Clear-sky shortwave direct aerosol radiative effects were further estimated with a raditive transfer model SBDART (Santa Barbara DISORT Atmospheric Radiative Transfer). The columnar aerosol optical depth (AOD500) was found to be ranged from 0.26 to 1.13 (with the mean value 0.71 ± 0.24). Fine-mode (fine mode fraction $\approx$0.98, angstrom exponent $\approx$1.8) and significantly absorbing aerosols (columnar single-scattering albedo $\approx$0.89, asymmetry-parameter $\approx$0.67 at 441 nm wavelength) dominated in this region. Water soluble and black carbon (BC) aerosols mainly dominate the both surface mass concentration and the columnar burden. The BC contributed only 6% to the aerosol mass loading, but its contribution to the total AOD and net atmospheric forcing were 12% and 75%, respectively. The mean radiative forcing was –6.8 to –8.7 W m–2 at the top-of-atmosphere and –28 to –33 W m–2 at surface. Furthermore BC aerosols contributed 45–49% to the surface radiative forcing along with the water soluble aerosols (49–52%), thus, significantly contributing to solar dimming