A novel methodology for large-scale daily assessment of the direct radiative forcing of smoke aerosols

Abstract
A new methodology was developed for obtaining daily retrievals of the direct radiative forcing of aerosols (24h-DARF) at the top of the atmosphere (TOA) using satellite remote sensing. Simultaneous CERES (Clouds and Earth's Radiant Energy System) shortwave flux at the top of the atmosphere and MODIS (Moderate Resolution Spectroradiometer) aerosol optical depth (AOD) retrievals were used. To analyse the impact of forest smoke on the radiation balance, this methodology was applied over the Amazonia during the peak of the biomass burning season from 2000 to 2009. To assess the spatial distribution of the DARF, background smoke-free scenes were selected. The fluxes at the TOA under clean conditions (F-cl) were estimated as a function of the illumination geometry (θ(0)) for each 0.5 degrees x 0.5 degrees grid cell. The instantaneous DARF was obtained as the difference between the clean (F-cl(θ(0))) and the polluted flux at the TOA measured by CERES in each cell (F-pol(θ(0))). The radiative transfer code SBDART (Santa Barbara DISORT Radiative Transfer model) was used to expand instantaneous DARFs to 24 h averages. This new methodology was applied to assess the DARF both at high temporal resolution and over a large area in Amazonia. The spatial distribution shows that the mean 24h-DARF can be as high as -30 W m(-2) over some regions. The temporal variability of the 24h-DARF along the biomass burning season was also studied and showed large intraseasonal and interannual variability. We showed that our methodology considerably reduces statistical sources of uncertainties in the estimate of the DARF, when compared to previous approaches. DARF assessments using the new methodology agree well with ground-based measurements and radiative transfer models. This demonstrates the robustness of the new proposed methodology for assessing the radiative forcing for biomass burning aerosols. To our knowledge, this is the first time that satellite remote sensing assessments of the DARF have been compared with ground-based DARF estimates. (AU)