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# Impacts of biomass burning aerosol on weather forecasting over South America

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The high concentration of aerosol particles and trace gases observed in the Amazonian and Central Brazilian atmosphere during the dry season (Austral winter) is associated with intense anthropogenic biomass burning activity. Ozone, carbon monoxide, nitrogen oxides and aerosol particle concentrations over South America (SA) and surrounding ocean areas are regulated by biomass burning emissions from savannah and forest fires. A regional smoke plume covering an area of about 4 to 5 million km2 has been frequently observed through remote sensing. The elevated concentrations of aerosol particles in the Amazonian atmosphere during the fire season results in a sharp increase in scattering and absorption of incoming sunlight, with the aerosol optical depth at 500 nm increasing from values below 0.1 in the wet season to 0.9 in average but peaking around 3.5 in the fire season. This perturbation of solar radiation flux affects the energy budgets of the surface and troposphere, and thus causes a direct radiative forcing of the climate and as a result (semi-direct forcing) a modification of cloud processes and precipitation. The presence of an aerosol layer reduces the amount of solar energy arriving surface and thereby produces a negative (cooling) radiative forcing at the surface. Values of −20 to −70 W m−2 have been reported for this forcing in Amazonia. On the other hand, the absorption of light by the light-absorbing carbon component of the smoke aerosol leads to a warming of the tropospheric layers in which the smoke resides. This results in a stabilization of the atmosphere and consequently a reduction of cloudiness. A second strong effect of aerosol particles emitted trough biomass burning is the changes in cloud microphysics, development and structure. The presence of biomass burning aerosols (BBA) in the atmosphere also modifies the solar radiative balance by changing cloud microphysics (frequently also called the indirect effect). These particles act as cloud condensation and ice nuclei, promoting changes in the cloud drops spectrum and, consequently, altering the cloud albedo and precipitation. In this work, we apply the limited-area atmospheric model Coupled Chemistry-Aerosol-Tracer Transport model to the Brazilian developments on the Regional Atmospheric Modeling System (CCATT-BRAMS) to simulate impacts of BBA on weather forecasting over SA. CCATT-BRAMS includes key processes to simulate BBA emission, transport, deposition and effects on radiation balance and cloud microphysics. Emission is based on real time remote sensing data and includes the plume rise mechanism to better represent the vertical mass distribution. The grid-scale transport, which uses a monotonic advection scheme, and the sub-grid scale transport (diffusion in PBL and by moist convection) are on-line with the atmospheric model. The aerosol model is monodisperse and its interaction with radiation is based on a modified version of the Community Aerosol and Radiation Model for Atmosphere (CARMA). Here the prescription of aerosol intensive optical properties, specifically extinction efficiency, single scattering albedo and asymmetry parameter are from a climatological size distribution and complex refractive index derived from several AERONET sites long term measurements in the Amazon Basin. Effects of aerosol on precipitation are included in the cloud microphysics through a cloud condensation nuclei (CCN) field modified by the BBA concentration. Impacts on convective precipitation are simulated by a recently developed convective parameterization, employing an autoconversion and evaporation schemes dependent on the CCN field at cloud base. The impacts of BBA on 5-day weather forecasting over SA are evaluated using observations from the Brazilian weather stations and remote sensing (e.g., TRMM rainfall estimation). We quantify the impacts evaluating both temperature and dew point temperature 2 meters above local surface (ALS), 24h accumulated precipitation and wind speed 10 meters ALS.