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Weather and climate impacts of biomass burning aerosols during the dry season in Amazonia

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Amazonia is a major global source of biomass burning aerosols (BBA) with impacts on weather and climate. BBA can be represented in weather models, with satellite-observed fires used to provide emissions fields, but such emissions normally require tuning to give realistic aerosol fields in models. Here, we investigate the two-way coupling between BBA and regional weather during the South American Biomass Burning Analysis (SAMBBA) field campaign, using both a set of short-range (2-day) forecasts and nested 20-day runs with the Met Office Unified Model (MetUM).
Short-range forecasts with parametrised convection show that BBA exert an overall cooling influence on the Earth–atmosphere system, although some levels of the atmosphere are directly warmed by the absorption of solar radiation: BBA reduce the clear-sky net radiation at the surface by 15 ± 1 W m−2 and reduces net top-of-atmosphere radiation by 8 ± 1 W m−2, with a direct atmospheric warming of 7 ± 1 W m−2. BBA-induced reductions in all-sky radiation are smaller in magnitude, but of the same sign. The differences in heating induced by BBA lead to a more anticyclonic circulation at 700 hPa. BBA cools the boundary layer, but warms air above, reducing the BL depth by around 19 m. Locally, on a 150 km scale, changes in precipitation reach around 4 mm day^{-1} due to changes in the location of convection, with BBA leading to fewer rain events that are more intense, which may be linked to the BBA changing the vertical profile of stability in the lower atmosphere. The localised changes in rainfall tend to average out to give a 5 % (0.06 mm day^{-1}) decrease in total precipitation, but the change in regional water budget is dominated by decreased evapotranspiration from the reduced net surface fluxes (0.2 to 0.3 mm day^{-1}). The results show that although including BBA either prognostoically, or through a climatology, improves forecasts, but differences between the impacts of prognostic and climatological aerosol are small and not statistically significant. Twenty-day MetUM simulations with prognostic aerosol and both parameterised and explicit convection are then used to investigate both the impacts of BBA on regional climate over a longer period, and how this depends on the representation of convection and how the representation of convection affects the distribution and impacts of BBA. Results show that the light widespread parametrised rain gives different aerosol removal to the localised intense explicit convection.