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# The key role of aerosol-radiation-interactions on cloud formation and precipitation in the Amazon

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Biomass burning (BB) aerosols can influence regional and global climate through interactions with radiation, clouds, and precipitation. Here, we investigate the impact of BB aerosols on the energy balance and hydrological cycle over the Amazon Basin during the dry season. We performed WRF-Chem simulations for a range of different BB emission scenarios to explore and characterize nonlinear effects and individual contributions from aerosol–radiation interactions (ARIs) and aerosol–cloud interactions (ACIs). For scenarios representing the lower and upper limits of BB emission estimates for recent years (2002–2016), we obtained total regional BB aerosol radiative forcings of -0.2 and 1.5$Wm^{-2}$, respectively, showing that the influence of BB aerosols on the regional energy balance can range from modest cooling to strong warming. We find that ACIs dominate at low BB emission rates and low aerosol optical depth (AOD), leading to an increased cloud liquid water path (LWP) and negative radiative forcing, whereas ARIs dominate at high BB emission rates and high AOD, leading to a reduction of LWP and positive radiative forcing. In all scenarios, BB aerosols led to a decrease in the frequency of occurrence and rate of precipitation, caused primarily by ACI effects at low aerosol loading and by ARI effects at high aerosol loading. Overall, our results show that ACIs tend to saturate at high aerosol loading, whereas the strength of ARIs continues to increase and plays a more important role in highly polluted episodes and regions. This should hold not only for BB aerosols over the Amazon, but also for other light-absorbing aerosols such as fossil fuel combustion aerosols in industrialized and densely populated areas. The importance of ARIs at high aerosol loading highlights the need for accurately characterizing aerosol optical properties in the investigation of aerosol effects on clouds, precipitation, and climate.