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Biomass burning aerosol over the Amazon during SAMBBA: impact of chemical composition on radiative properties

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Biomass burning represents one of the largest sources of particulate matter to the atmosphere, resulting in a significant perturbation to the Earth's radiative balance coupled with serious impacts on public health. Globally, biomass burning aerosols are thought to exert a small warming effect but with the uncertainty being 4 times greater than the central estimate. On regional scales, the impact is substantially greater, particularly in areas such as the Amazon Basin where large, intense and frequent burning occurs on an annual basis for several months. Absorption by atmospheric aerosols is underestimated by models over South America, which points to significant uncertainties relating to Black Carbon (BC) aerosol properties.

Initial results from the South American Biomass Burning Analysis (SAMBBA) field experiment, which took place during September and October 2012 over Brazil on-board the UK Facility for Airborne Atmospheric Measurement (FAAM) BAe-146 research aircraft, are presented here. Aerosol chemical composition was measured by an Aerodyne Aerosol Mass Spectrometer (AMS) and a DMT Single Particle Soot Photometer (SP2). The physical, chemical and optical properties of the aerosols across the region will be characterized in order to establish the impact of biomass burning on regional air quality, weather and climate.

The aircraft sampled a range of conditions including sampling of pristine Rainforest, fresh biomass burning plumes, regional haze and elevated biomass burning layers within the free troposphere. The aircraft sampled biomass burning aerosol across the southern Amazon in the states of Rondonia and Mato Grosso, as well as in a Cerrado (Savannah-like) region in Tocantins state. This presented a range of fire conditions, both in terms of their number, intensity, vegetation-type and their combustion efficiencies. Near-source sampling of fires in Rainforest environments suggested that smouldering combustion dominated, while flaming combustion dominated in the Cerrado. This led to significant differences in aerosol chemical composition, particularly in terms of the BC content, with BC being enhanced in the Cerrado region compared with the Rainforest environment. This was reflected in the single scattering albedo of the regional smoke haze, with values of 0.9 observed in the Rainforest environments compared with a value of 0.8 in the Cerrado region. This contrast results in a net cooling and warming respectively in terms of the aerosol direct radiative effect.

BC-containing particles were found to be rapidly coated in the near-field, while the organic aerosol component was observed to oxidise rapidly upon advection and dilution downwind of major smoke plumes. Significant differences in the coating thickness of the BC-containing particles were observed when comparing the Rainforest and Cerrado environments. Such properties have important implications for the life cycle and formation of particulate material, as well as their optical and radiative properties.

The results presented enhance our knowledge of biomass burning aerosol in a sensitive region of the globe, where relatively few measurement campaigns have taken place previously.