EFFECTS OF EMISSIONS ON CURRENT AND FUTURE RAINFALL

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SCIENCE QUESTIONS AND OBJECTIVES

This project will be the first observation-based investigation of the climate change feedbacks involving precipitation, cloud formation and aerosols in the South American rural subtropics. São Paulo State the main area of study, occupies an area of 248 x 106 km2, with a population of more than 40 million inhabitants, and its GDP (2009) is around US$ 550 billion. The economy is based on agriculture and associated industries. In addition to the world's largest contiguous area of sugar cane cultivation, these regions also produce coffee, oranges and livestock. The region is a natural laboratory for such a study, due to large differences in seasonal weather patterns, with distinct wet and dry periods, and well-defined sources of anthropogenic aerosols, especially agricultural biomass burning.

The project concerns to understand how changes in agricultural practices and land use, amongst other anthropogenic factors, will affect precipitation patterns, due to the influence of changing emissions on the nature of atmospheric aerosols and cloud condensation nuclei. Alteration of the hydrological cycle will have consequences for the availability of water resources, which will affect direct supplies to agricultural, industrial and domestic consumers, as well as hydroelectric power generation capacity. We propose to study the relationships between aerosol physical and chemical properties, cloud droplet size, and the distribution, duration and intensity of precipitation. Field observations will provide the necessary information required to describe the influence of aerosols from different sources on rainfall patterns. We expect to be able to demonstrate whether the impact of anthropogenic activity will in the future be beneficial or detrimental to agriculture and the wider environment, considering the processes of cloud formation, precipitation, and therefore water supply, under different development scenarios. We propose to Identify relationships between aerosol size distributions, cloud characteristics, precipitation patterns, and atmospheric electrical discharges; analyze the physical and chemical properties of atmospheric aerosols to establish relationships between composition and size distribution; relate aerosol hygroscopic properties to their size, chemical composition, and origin; investigate the influences of major aerosol classes, such as biomass burning aerosols or re-suspended dusts, on precipitation frequency, intensity, and duration; use source apportionment modeling to identify aerosol sources, suggesting how changes in anthropogenic sources will alter the nature of atmospheric aerosols and, consequently, cloud formation and precipitation.

Figure 1. Biomass burning and aerosols

CURRENT RESULTS AND PERSPECTIVES

In the study region, large particles derive almost exclusively from resuspended dusts, which once airborne may be modified by scavenging of reactive gases, producing soluble compounds that increase the hygroscopicity of the particles. Smaller particles are emitted directly during combustion processes, or are formed in secondary reactions involving gaseous precursors during atmospheric transport. Road vehicle emissions are a constant source of both primary aerosols and precursors in the region, while agricultural biomass burning is a very large source of atmospheric pollution, during the dry season and when meteorological conditions are favorable for the activity

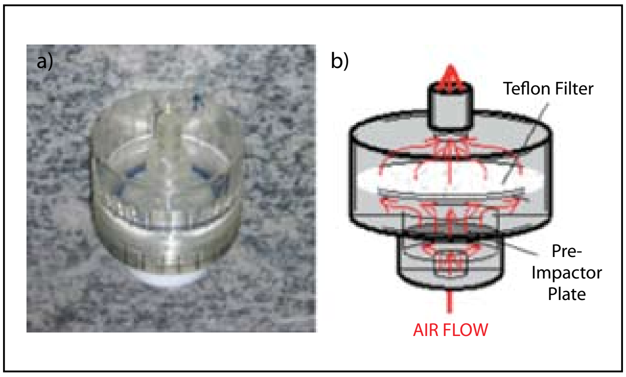

Figure 2. Aerosol sampling

The relationship between the presence of biomass burning aerosols and cloud droplet effective radius (re) was studied. Aerosols emitted during agricultural biomass burning and transported to cloud level during daytime convection caused a reduction in cloud droplet effective radius. An increase in the number concentrations of particles >0.3 µm at night was due to hygroscopic aerosol growth, and confirmed that the particles could act as efficient cloud condensation nuclei. During periods of lower biomass burning activity, it was possible to detect the presence of aerosols that had increased in size due to cloud processing, which also reflected differences in particle chemical composition between periods of low and high biomass burning intensity. The results confirm the viability of using ground based aerosol measurements, together with remotely sensed cloud parameters, in order to identify relationships between anthropogenic aerosols and cloud formation.

RELATED PUBLICATIONS

Allen AG, Machado CMD, Cardoso AA. Measurements and modeling of reactive nitrogen deposition in southeast Brazil. *Environmental Pollution*. 2011. *In press*.

da Silva LC, Allen AG, Cardoso AA. Influence of agricultural biomass burning on cloud droplet size. *Under submission*.

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