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Characterising coarse PBA dynamics in real-time above and below a tropical rainforest canopy using a dual channel UV fluorescence aerosol spectrometer.

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Primary biogenic aerosols (PBA) are used by organisms as a means to propagate their genetic material, either by transport of the organisms themselves, such as bacterial clusters and viruses, or of their reproductive components in the case of fungi and plants that release spores and pollen. Many studies have suggested PBA might be important for initiation of cloud formation and subsequent precipitation evolution by acting as cloud condensation nuclei (CCN) or possibly as ice nuclei (IN). This link is inferred from laboratory studies demonstrating the high activation efficiency of PBA at warm temperatures, coupled with observations that biological particles are ubiquitous in the atmosphere. Despite more than two hundred years of research (e.g. Ehrenberg, 1830) information on the abundance, composition and more importantly the sources and heterogeneity of PBA on global scales is still lacking.

The first estimates of global average PBA emission rates based on observations and budget calculations were provided by Elbert et al. (2007). They demonstrate that fungi contribute a major fraction of the observed coarse PBA PM_{10} mass (particles with diameters between 1-10 μ m), particularly Acomycota (AAM) and Basidiomycota (ABM) commonly seen in tropical regions. These species discharge their spores via so-called "active wet" mechanisms that eject spores inside liquid droplets. Elbert et al. (2007) estimate a global average spore emission rate for ABM of $\sim$17-50 Tg yr^{-1}, corresponding to a global average abundance of $\sim$1 μg m^{-3} and a net emission rate for all fungal spores of 50 Tg yr^{-1}. Uncertainty in the latter estimate is significant compared to the result, placed at 50-1000 Tg yr^{-1}. Nonetheless, these calculations demonstrate the potential importance of PBA and particularly fungal spores in the tropics, where up to half of the coarse mode particulate loading is PBA, and potentially in the global organic aerosol budget.

Data was collected using the WIBS-3: a low-cost, portable single-particle dual channel UV fluorescence spectrometer (Kaye et al., 2008) capable of detecting PBA by inducing fluorescence in two so-called biofluorophores - one present during metabolism and the other an amino acid - in the particle size range 1 μm < D_p < 20 μm. Real-time PBA measurements were performed above and below the canopy of a tropical rainforest in Borneo, Malaysia as part of the Oxidant and Particle Photochemical Processes (OP3) and the Aerosol Coupling in the Earth System (ACES) projects. PBA were found to dominate the coarse loading at D_p > 2 μm. In qualitative agreement with measurements of culturable airborne material in a tropical forest's understory (Gilbert, 2005) a diurnal cycle of PBA number concentration is present, reaching a maximum of $\sim$4000 l^{-1} at local midnight and falling to $\sim$100 l^{-1} around midday. The role of the planetary boundary layer's collapse and re-establishment in dictating this variation in is also investigated using LIDAR data. Transient PBA concentration spikes lasting several minutes are superposed on the smooth underlying diurnal variation and occur at similar times each day. Nucleopore filter samples were also taken in-situ and analysed under an Environmental scanning electron microscope (ESEM) in Manchester. The images obtained showed the PBA fraction to be dominated by fungal spores of diameter 2-5 μm, from various species including ABM. Since such species tend to release spores in bursts at regular times this appears to account for the PBA concentration spikes.