

Effects of land use on surface-atmosphere exchanges of trace gases and energy in Borneo: Comparing fluxes over oil palm plantations and a rainforest

Abstract

This paper reports measurements of land-atmosphere fluxes of sensible and latent heat, momentum, CO₂, volatile organic compounds (VOCs), NO, NO₂, N₂O and O₃ over a 30 m high rainforest canopy and a 12 m high oil palm plantation in the same region of Sabah in Borneo between April and July 2008. The daytime maximum CO₂ flux to the two canopies differs by approximately a factor of 2, 1200 mg C m⁻²h⁻¹ for the oil palm and 700 mg C m⁻²h⁻¹ for the rainforest, with the oil palm plantation showing a substantially greater quantum efficiency. Total VOC emissions are also larger over the oil palm than over the rainforest by a factor of 3. Emissions of isoprene from the oil palm canopy represented 80 per cent of the VOC emissions and exceeded those over the rainforest in similar light and temperature conditions by on average a factor of 5. Substantial emissions of estragole (1-allyl-4-methoxybenzene) from the oil palm plantation were detected and no trace of this VOC was detected in or above the rainforest. Deposition velocities for O₃ to the rainforest were a factor of 2 larger than over oil palm. Emissions of nitrous oxide were larger from the soils of the oil palm plantation than from the soils of the rainforest by approximately 25 per cent. It is clear from the measurements that the large change in the species composition generated by replacing rainforest with oil palm leads to profound changes in the net exchange of most of the trace gases measured, and thus on the chemical composition of the boundary layer over these surfaces.