Large estragole fluxes from oil palms in Borneo

Abstract

During two field campaigns (OP3 and ACES), which ran in Borneo in 2008, we measured large emissions of estragole (methyl chavicol; IUPAC systematic name 1-allyl-4-methoxybenzene; CAS number 140-67-0) in ambient air above oil palm canopies (0.81 mgm-2 h-1 and 3.2 ppbv for mean midday fluxes and mixing ratios respectively) and subsequently from flower enclosures. However, we did not detect this compound at a nearby rainforest. Estragole is a known attractant of the African oil palm weevil (Elaeidobius kamerunicus), which pollinates oil palms (Elaeis guineensis). There has been recent interest in the biogenic emissions of estragole but it is normally not included in atmospheric models of biogenic emissions and atmospheric chemistry despite its relatively high potential for secondary organic aerosol formation from photooxidation and high reactivity with OH radical. We report the first direct canopy-scale measurements of estragole fluxes from tropical oil palms by the virtual disjunct eddy covariance technique and compare them with previously reported data for estragole emissions from Ponderosa pine. Flowers, rather than leaves, appear to be the main source of estragole from oil palms; we derive a global estimate of estragole emissions from oil palm plantations of ~0.5 Tg y-1. The observed ecosystem mean fluxes (0.44 mgm-2 h-1) and mean ambient volume mixing ratios (3.0 ppbv) of estragole are the highest reported so far. The value for midday mixing ratios is not much different from the total average as, unlike other VOCs (e.g. isoprene), the main peak occurred in the evening rather than in the middle of the day. Despite this, we show that the estragole flux can be parameterised using a modified G06 algorithm for emission. However, the model underestimates the afternoon peak even though a similar approach works well for isoprene. Our measurements suggest that this biogenic compound may have an impact on regional atmospheric chemistry that previously has not been accounted for in models and could become more important in the future due to expansion of the areas of oil palm plantation.