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A bottom-up perspective of the net land methanol flux: synthesis of global eddy covariance flux measurements

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Methanol (CH3OH) is, after methane, the second most abundant VOC in the troposphere and globally represents nearly 20% of the total biospheric VOC emissions. With typical concentrations of 1-10 ppb in the continental boundary layer, methanol plays a crucial role in atmospheric chemistry, which needs to be evaluated in the light of ongoing changes in land use and climate.

Previous global methanol budgets have approached the net land flux by summing up the various emission terms (namely primary biogenic and anthropogenic emissions, plant decay and biomass burning) and by subtracting dry and wet deposition, resulting in a net land flux in the range of 75-245 Tg y-1. The data underlying these budget calculations largely stem from small-scale leaf gas exchange measurements and while recently column-integrated remotely sensed methanol concentrations have become available for constraining budget calculations, there have been few attempts to contrast model calculations with direct net ecosystem-scale methanol flux measurements. Here we use eddy covariance methanol flux measurements from 8 sites in Europe and North America to study the magnitude of and controls on the diurnal and seasonal variability in the net ecosystem methanol flux.

In correspondence with leaf-level literature, our data show that methanol emission and its strong environmental and biotic control (by temperature and stomatal conductance) prevailed at the more productive (agricultural) sites and at a perturbed forest site. In contrast, at more natural, less productive sites substantial deposition of methanol occurred, in particular during periods of surface wetness. These deposition processes are poorly represented by currently available temperature/light and/or production-driven modelling algorithms. A new framework for modelling the bi-directional land-atmosphere methanol exchange is proposed which accounts for the production of methanol in leaves, the regulation of leaf methanol emission by stomatal conductance and the bi-directional methanol exchange within plant canopies as governed by surface wetness and ambient methanol concentrations.