Geophysical Research Abstracts,
Vol. 11, EGU2009-9739, 2009
EGU General Assembly 2009

An unconventional approach to estimate the exchange of reactive trace gases at the soil - trunk space interface of a steep mountain forest site

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On steep (45˚) mountain sites, flux measurements of trace gases (particularly those of reactive trace gases) by conventional techniques (e.g., eddy covariance, aerodynamic gradient, modified Bowen ratio; dynamic chambers) are difficult, if not impossible. However, even at a steep mountainous forest site, vertical concentration gradients can be measured quite easily in the first meter above the forest floor. But there, vertical flux divergences have to be expected due to fast (photo-)chemical reactions between reactive trace gases during the (slow) turbulent transport in this layer. Particularly the determination of the bulk (turbulent) transfer velocity v_{tr} (necessary to infer corresponding fluxes from concentration gradients) may require unconventional approaches under these conditions. One requires the combination of measurements of vertical concentration differences and soil surface fluxes of non-reactive trace gases, such as ^{222}Rn and/or CO_2 (surface fluxes by static chambers). Once the bulk transfer velocity within the first meter of the trunk space has been determined, it could be applied to vertical concentration differences of reactive trace gases (NO, NO_2, O_3) in order to infer corresponding surface fluxes (which have to be corrected for the fast (photo-)chemical reactions of the NO-NO_2-O_3 triad).

We will present results obtained during a field experiment in a steep Bavarian mountainous spruce forest, Hohenpeissenberg (47,801˚N, 11,009˚E, 943 m a.s.l.) performed in September-October 2005. Mean bulk transfer velocities in the first meter of the trunk space was determined by the above mentioned approach and ranged between 0.005 and 0.03 m s^{-1} (equivalent to a bulk turbulent exchange coefficient of 0.45 – 5 x 10^{-2} m^2 s^{-1}).

Corresponding fluxes of NO, NO_2, and O_3 were corrected for their flux divergencies due to fast chemical interconversions by a new flux gradient numerical algorithm. We will present diel variations of bulk transfer velocites, concentrations, vertical concentration differences, and derived surface fluxes of NO, NO_2, and O_3 for a two week period in September 2005. The overwhelming effect of near surface thermodynamic stability on surface fluxes will be discussed.