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Uptake of gaseous formaldehyde onto soil surfaces: a coated-wall flow tube study

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Gaseous formaldehyde (HCHO) is an important intermediate molecule and source of HO_2 radicals. However, discrepancies exist between model simulated and observed HCHO concentrations, suggesting missing sources or sinks in the HCHO budget. Multiphase processes on the surface of soil and airborne soil-derived particles have been suggested as an important mechanism for the production/removal of atmospheric trace gases and aerosols. In this work, the uptake of gaseous HCHO on soil surfaces were investigated through coated-wall flow tube experiments with HCHO concentration ranging from 10 to 40 ppbv. The results show that the adsorption of HCHO occurred on soil surfaces, and the uptake coefficient dropped gradually (i.e. by a factor of 5 after 1 hour) as the reactive surface sites were consumed. The HCHO uptake coefficient was found to be affected by the relative humidity (RH), decreasing from (2.4 $\pm$ 0.5) $\times$ 10-4 at 0% RH to (3.0 $\pm$ 0.08) $\times$ 10-5 at 70% RH, due to competition of water molecule absorption on the soil surface. A release of HCHO from reacted soil was also detected by applying zero air, suggesting the nature of reversible physical absorption and the existence of an equilibrium at the soil-gas interface. It implies that soil could be either a source or a sink for HCHO, depending on the ambient HCHO concentration. We also develop a Matlab program to calculate the uptake coefficient under laminar flow conditions based on the Cooney-Kim-Davis method.