Geophysical Research Abstracts
Vol. 21, EGU2019-4456, 2019
EGU General Assembly 2019


# Gas Transport through Soils and across the Soil-Atmosphere-Interface dependent on gas density, soil moisture and wind conditions: Darcy-Scale Experiments and Computational Modeling

Lisa Maria Bahlmann (1), Insa Neuweiler (1), Kathleen Smits (2), Katharina Heck (3), and Edward Coltman (3)

(1) Leibniz University Hannover, Institute of Fluid Mechanics and Environmental Physics in Civil Engineering , Faculty of Civil Engineering and Geodetic Science, Germany (bahlmann@hydromech.uni-hannover.de), (2) University of Texas at Arlington, Department of Civil Engineering, (3) University of Stuttgart, Department of Hydromechanics and Modelling of Hydrosystems

Transport in the gas phase of the unsaturated zone can be the key process in spreading of soil pollutants or other gas components due to the short time scales in comparison to liquid phase transport. Gas migration through the soil depends on many factors, such as soil characteristics and saturation conditions as well as gas properties. Furthermore, transport through the upper soil layer can be influenced by the atmospheric conditions above the soil. A thorough understanding of the impact of these factors is indispensable when attempting to quantify mass fluxes of gaseous pollutants, volatile organic compounds or green house gases emitted from the soil.

To address these issues, quasi-2-dimensional Darcy-scale gas migration experiments were conducted in a sand tank with an overlying wind tunnel. A gas inlet was positioned at the sand tank bottom. Soil moisture was regulated via a constant head device also connected to the bottom of the tank. The tank was equipped with a total of 53 sensors to continuously measure gas component concentration, soil moisture and temperature profiles. Furthermore, wind velocities, air temperature and air humidity were measured at different locations inside the wind tunnel. At the beginning of each experiment, steady-state conditions were established by applying a constant mass flow at the gas inlet. After reaching the steady-state, the gas supply was stopped. Subsequently, sensor monitoring was maintained until all the gas left the tank into the wind tunnel. This experimental process was performed for four different wind velocities and with dry and partially saturated sand. Furthermore, three gases with distinct differences in gas density were tested, leading to a total of 18 experiments.

Experimental results show that all three factors (gas density, wind velocity and soil moisture content) influence the transport processes, but to different extends. As expected, steady-state gas profiles vary with density. Varying the wind conditions, has no apparent effect on the concentration profiles during the steady-state. Where as changing the sand from dry to partially saturated, leads to increased gas concentrations. After stopping the gas supply, gas density shows the expected effects, denser gases remain longer in the tank than lighter gases. Increasing the wind velocity leads to a distinct decrease in transport times. Partially saturation of the sand causes a significant increase of transport times and enhances the wind velocity effects.

In order to test to which degree standard modeling concepts can be used to predict mass fluxes, numerical simulations of the experiments were carried out with the model environment DUMUX (Dune for Multi-(Phase, Component, Scale, ...) flow and transport in porous media). To capture the influence of the wind velocity on the gas transport, a coupled porous medium-free flow model was chosen. Experimental and simulation results will be discussed in this contribution.

Keywords: Gas transport - Density-driven flow - Unsaturated soil - Multiphase-multicomponent flow - Porous-medium/free-flow interface