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Modelling the gas diffusivity in porous media using physical-statistical model

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Monitoring of gases including CO2 is an important tool for process studies in terrestrial carbon research with consideration of climate change. Diffusion of gas and vapour molecules, from zones of high concentration to zones of lower concentrations, highly contributes to ventilation of soil and other agricultural media. Mathematical modeling of gas diffusion in soil is difficult and complicated due to its dependence on numerous environmental factors. The major factors determining the diffusion of gases in the soil are texture, porosity, water content, temperature and pressure. We propose physical-statistical model approach to predict gas diffusion with consideration of the above variables. Gaseous diffusion in the soil will be imitated by diffusion through the capillary pores connected in parallel, in series or in a mixed way, taking into account the pore volume. Diffusion will be characterized by the ratio of the soil gas diffusion coefficient D in the soil and in the atmosphere D0. The volumes of pores of various radii in the soil, not occupied by water, as derived from water retention curve was used in the model as input data. Model parameters were established based on the standard gas diffusion data in the soil. The model was tested with the diffusion of soil air, helium and krypton-85 both in the plowed soil after sowing and artificial capillary system. The results obtained from the physical-statistical model were in a good agreement with the measured data (R2> 0.96). The mean square error and maximum relative error for the tested model were MSE = 0.00043, MRE = 21.7 %, respectively.