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Evaluation and inversion of a coupled CO_2 transport and carbon turnover model

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Soil respiration is usually divided in a fraction originating from root respiration and a heterotrophic fraction produced by the microbial decomposition of soil organic carbon. This paper reports on the coupling of a one-dimensional water, heat and CO_2 flux model (SOILCO2) with a pool concept of carbon turnover (RothC) for the prediction of soil heterotrophic respiration. In order to test this coupled model, it was applied to a bare soil experimental plot located in Bornim, Germany. Soil temperature and soil water content measurements were used for comparison with the respective model predictions. An 8 years data set of CO_2 efflux measurements, covering a broad range of atmospheric conditions, was used to evaluate the model. In a first step we quantified the improvement of the CO_2 efflux prediction due to the coupling of the flux model with a pool concept of carbon turnover. The humus pool decomposition rate constant and its soil water content dependent reduction were derived from the first five years of CO_2 efflux measurements using inverse modelling. The following three years of measurements were used to validate the model. The overall model performance of CO_2 efflux predictions was acceptable with the measured and simulated mean daily respiration being 0.861 and 0.868 g C m^{-2} d^{-1}, respectively, and a mean absolute difference between modelled and measured rates of 0.21 g C m^{-2} d^{-1}. The inverse estimation of the humus decomposition rate constant resulted in a value of 0.04 y^{-1}, which is higher than the default value in RothC. This is attributed to the agricultural practice during the experiment.