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Simulating simultaneous nitrification and denitrification in mobile and immobile soil water regions of the vadose zone

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Nitrogen losses from tile-drained soils are influenced by non-equilibrium transport and by various transformation processes. Nitrification and denitrification are biological processes within the soil nitrogen cycle proceeding under contrasting redox conditions. Therefore they are regarded as separate processes with respect to time and/or location. Recently, there is increasing evidence that nitrification and denitrification occur simultaneously and in close vicinity to each other in agriculturally cultivated soils. Our hypothesis is that immobile soil water regions hold high water contents over long periods and thus are more often anaerobic than the adjacent mobile water regions that change their water contents more dynamically in response to variable atmospheric conditions. Physically, the immobile regions are located inside soil aggregates with rather small pores while the mobile regions are assigned to the inter-aggregate space. Concerning the nitrogen cycling, nitrate can be produced from added ammonium in the aerated mobile regions, and then be transferred into the water saturated immobile regions (aggregates) where the reductive denitrification process is taking place. During dry and sufficiently warm periods, nitrification can also occur within the unsaturated immobile region. The basic idea of this study was to investigate long term nitrate transport as affected by both soil water mobility and nitrogen metabolization. To follow the objective, we extended the two dimensional mobile immobile model for variable saturated flow and transport (2D-MIM), as implemented in HYDRUS-2D, with a relatively simple nitrogen metabolism model, where the nitrogen reaction rates in each, the mobile and immobile regions, are functions of bulk soil temperature and the mobile and immobile water contents. First results showed that the modified 2D-MIM model could simulate simultaneous aerobic and anaerobic processes and re-

produce the general observed nitrate concentration pattern of a tile drained field site. Due to convective transport and limited exchange between water regions, nitrate concentrations fluctuated stronger in the mobile regions than in the immobile regions.