Geophysical Research Abstracts,
Vol. 11, EGU2009-7497-1, 2009
EGU General Assembly 2009

Calibration of a lumped nitrogen model in a Mediterranean forested catchment named Fuirosos, (Catalonia).

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Following the philosophy of the process-based INCA-N model (Wade et al., 2004), a recently developed hydrological model, LU4 was extended through the inclusion of processes representing the inorganic nitrogen cycle to create a new model of nitrogen dynamics LU4-N capable of application in Mediterranean systems, which share processes from both wet and arid/semiarid environments (Gallart et al., 2002). This new model represents an advance on the INCA-N model for which problems where observed when simulating the hydrology of Mediterranean catchments (Bernal et al., 2004). The LU4-N model integrates hydrological and N processes in catchment and simulates daily discharge and daily NO3-N and NH4-N concentration. The lumped hydrological model LU4 has been already applied to the Fuirosos catchment giving acceptable results (Medici et al., 2008). The model provides a simplified conceptualization of nitrogen cycle in soil and into the shallow perched saturated zone. It uses a zero order reaction kinetic equation to simulate the mineralization process and first order equation to simulate non-biological fixation, nitrification, denitrification, plant uptake and immobilization. The model structure includes a soil moisture threshold for all the considered soil biological processes. The model also includes two first order reaction equations to simulate the adsorption/desorption dynamic in soil. In the shallow perched aquifer, nitrification and denitrification are the only processes allowed to occur. The calibration period for the N-submodel was the same considered for the calibration of the hydrological model LU4 and it covers approximately three hydrological years (from October 1999 to August 2002). The LU4-N model was also tested against observed data recorded at Fuirosos from August 2002 to June 2003. The LU4-N model was able to match the observed daily pattern for the calibration period, while it was unable to match satisfactorily the daily observed ammonium concentration. Nevertheless, the model could reproduce the monthly loads of ammonium to a first approximation. The results suggest that the soil nitrogen cycle in Fuirosos, seems to be mainly influenced by the rain episodes that induce catchment re-wetting. According to our model conceptualization, microbial processes occur in pulses stimulated by soil moisture increasing after rain. When soil moisture is not limiting, nitrification, immobilization and denitrification occur and cause an initial pulse of nitrate due to the accumulated amount of available N-NH4. This “pulse behaviour” is considered characteristic of semiarid and arid systems where processes are limited by water limitation, and it is supported by the ratio between mineralization and nitrification that has been shown to be around 10:1 or more (Serrasoles et al., 1999; Bernal et al., 2004), contrasting with the ratio of 3:1 that is commonly reported in temperate systems. Our results show that in Fuirosos considering the LU4-N model, the ratio is on average around 7:1. To conclude, it has to be highlighted that the model tends to overestimate the nitrate production during catchment wetting-up and also did not perform very well during the validation period. This may suggests that some key mechanism is missing. A possible mechanism to be taken into account is higher plant uptake and in particular the role played by the riparian zone.