Geophysical Research Abstracts
Vol. 20, EGU2018-15591, 2018
EGU General Assembly 2018

Riparian vegetation controls assimilatory NO_3-N uptake in anthropogenically impacted river networks

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Light controls assimilatory NO_3 uptake in anthropogenically impacted streams. Land use may modify in-stream assimilatory uptake through riparian vegetation induced changes of light regimes but quantitative estimates on seasonal variability are rare. In our studies we used multi-parameter sensor measurements to calculate assimilatory uptake via the diurnal nitrate amplitude method directly (small streams) or via metabolic rates (streams and rivers) and determined continually uptake rates for stream reaches from 1 to 6 stream order. Long term continuous 15 min data from a forest and agricultural stream reach and a lowland river within the Bode catchment (3200 km^2) revealed a strong correlation between assimilatory NO_3 uptake and growth primary production (GPP) for the forest (r^2=0.72) and agricultural (r^2=0.56) stream reach and the lowland river (r^2=0.65). The slopes of these regressions were in agreement with predicted assimilatory N-uptake based on additional metabolic data. Assimilatory NO_3 uptake was primarily controlled by light and was highest in summer for the agricultural streams and lowland river. High percentage uptake in the forest stream reaches was restricted to the spring period. Maximum NO_3 uptake was similar for the agricultural stream (270 mg N m$-$2 d^{-1}) and the lowland river (321 mg N m$-$2 d^{-1}). Using the subwatershed of the Selke river we up-scaled our findings to a whole stream network. We introduce a new modelling approach based on the multi-scale Hydrological Model (mHM-Nitrate) which allows considering both spatially distributed nitrogen loading as well as high spatial resolution river network uptake including the impact of riparian vegetation. We compared seasonal variation of simulated in-stream nitrate uptake predictions with calculated values using a nitrate assimilatory uptake approach generated from our high frequency sensor data. Our findings suggest that using new experimental data for parameterizing stream network models will allow to substantially improve continues modelling of in-stream nitrogen fluxes for whole river networks.