1st TERRABITES Symposium
Hamburg, Germany, 9-11 February 2010
TERRABITES-29-1

Effect of historical changes in land cover, N fertiliser application and atmospheric N deposition on terrestrial carbon and nitrogen fluxes

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We present a first estimate of the consequences of historical anthropogenic perturbations of the terrestrial carbon and nitrogen balances due to land-cover changes, increases in N fertiliser application and atmospheric N deposition. These changes are evaluated relative to a baseline simulation taking historical climatic changes and increases in atmospheric CO_2concentrations into account. The estimates are obtained using the global, process-based terrestrial ecosystem model O-CN, which encodes a mechanistic understanding of the coupling between terrestrial C and N dynamics for twelve global vegetation types. In particular, O-CN estimates N trace gas emissions using a process-based approach.

Evaluation exercises show that the simulated effect of N additions on vegetation productivity and net C storage agrees well with observations from a range of field studies and manipulation experiments. N trace gas emissions fall well within the observed ranges for individual vegetation types and global biomes, however, site-scale analyses reveal model deficiencies in capturing the temporal dynamics of NO and N_2O emissions. These are mostly related to the simplified treatment of soil hydrology in O-CN.

Our results show that land cover changes and fertiliser applications have dramatically increased N and C cycling rates over the past five decades. We give a first estimate of the net effect of these changes on nitrogen controlled greenhouse gas balances. Based on our global modelling results we identify key processes and important regions for which further observations, as well as model development and validation work are required to provide a comprehensive assessment of the effect of anthropogenic activities on nitrogen controlled greenhouse gas balances.