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Effects of historical changes in land-use, 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, in particular the emission of climatically relevant biogenic nitrogen trace gases (NO, N_2O) due to land-use changes, increases in N fertiliser application and atmospheric deposition of reactive nitrogen. These changes are evaluated relative to a baseline simulation taking historical climatic changes and increases in atmospheric CO_2 concentrations 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. Based on our global modelling results we identify key important processes and 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.