Integrating the process-based simulation model DNDC into GIS

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There is a general agreement among scientists that several trace gases, such as methane (CH_4), nitrous oxide (N_2O), nitric oxide (NO), and ammonia (NH_3), affect global climate change because of their radiative or chemical effects in the atmosphere (Li, 2000). The major source of the four trace gases is soil. Agricultural land-use imposes a great deal of disturbance on soils by farming practices including tillage, fertilisation, irrigation, manure amendment, weeding, and liming. These anthropogenic activities elevate soil trace gas emissions and, hence, play an important role in the atmospheric balance of the trace gases. While field measurements have contributed extensively to our understanding in spatial and temporal variation of trace gas fluxes at site-scale, there is still a lack of methodologies to assess emissions at regional scale. To fill that gap we propose a framework which integrates the mechanistic trace gas simulation model DNDC (Li et al., 1992; 2000) in a geographical information system (GIS). The GIS-architecture is based on ArcObjects (ESRI, 2001) providing the spatially distributed input parameters, such as soil, climate, and farming-practise at field-scale, for the DNDC model. The simulation model is wrapped in a COM (Component Object Model)-server allowing distributed run-time linking to the GIS. To reduce the lengthy calculation time our architecture allows distributing calculation load over several computers on a network by employing the DCOM (Distributed Component Object Model) technology in a “work crew” threading model (Hart, 2001). This paper describes the software architecture and presents first results of a simulation study of trace gas emissions of an agricultural homogeneous region in South-West-Germany at field scale.

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