Geophysical Research Abstracts
Vol. 17, EGU2015-492-2, 2015
EGU General Assembly 2015

Modeling impacts of water and fertilizer management on ecosystem services from rice rotated crop systems in China

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Sustainable intensification in agriculture has stressed the need for management practices that could increase crop yields while simultaneously reducing environmental impacts. It is well recognized that water and nutrient management hold great promise to address these goals. This study uses the DNDC biogeochemical model to stimulate the impacts of water regime and nitrogen fertilizer management interactions on ecosystem services of rice rotated crop systems in China. County-level optimal nitrogen fertilizer application rates under various water management practices were captured and then multiple scenarios of water and nitrogen fertilizer management were set to more than 1600 counties with rice rotations in China. Results indicate that an national average of 15.7±5.9% (the mean value and standard deviation derive from variability of three water management practices) reduction of nitrogen fertilizer inputs can be achieved without significantly sacrificing rice yields. On a national scale, shallow flooding with optimal N application rates appear most potential to enhance ecosystem services, which led to 10.6% reduction of nitrogen fertilizer inputs, 34.3% decrease of total GHG emissions, 2.8% less of overall N loss (NH3 volatilization, denitrification and N leaching) and a 1.7% increase of rice yields compared to the baseline scenario. Regional GHG emissions mitigation derived from water regime change vary with soil properties and the multiple crop index. Among the main production regions of rice in China, the highest reduction happened in Jiangxu, Yunnan, Guizhou and Hubei (more than 40% reduction) with high SOC, high multiple crop index and low clay fraction. The highest reduction of GHG emissions derived from reducing current N application rate to optimal rate appeared in Zhejiang, Guangdong, Jiangsu where the serious over-application of mineral N exit. It was concluded that process models like DNDC would act an essential tool to identify sustainable agricultural management practices and evaluate their impacts on agro-ecosystem services.