Modeling the Effects of Management Practices on N_2O Emissions, Nitrate Leaching and Biomass Production on Arable Soils in Haean Catchment

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Process-based biogeochemical models can be used to predict the impact of various agricultural management practices on plant nitrogen use efficiency and nitrogen losses to the environment such as GHG emissions and nitrate leaching by analyzing the interactions between management practices, primary drivers such as climate, soil properties, crop types, etc., and biogeochemical reactions. In this study we applied the Landscape-DNDC model, which combines and unifies functions of Agricultural-DNDC and Forest-DNDC for simulation of C and N turnover, GHG emissions, nitrate leaching and plant growth for a Korean arable field cultivated with radish *(Raphanus sativus* L.) and soybean (*Glycine max*).

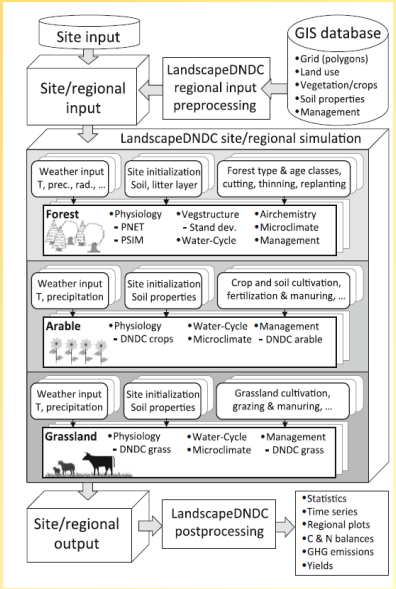


Fig. 1. Landscape-DNDC model framework

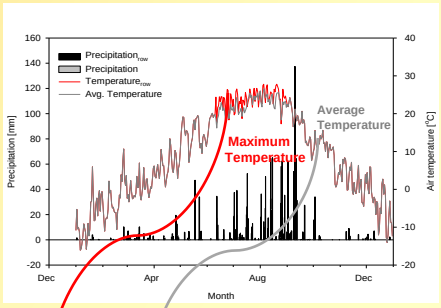
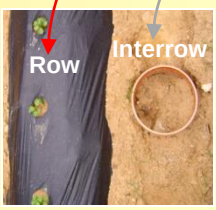


Fig. 2. Daily precipitation and average temperature at the study site in 2010



- Row with black plastic mulch: **90% of the maximum temperature and 50% of the annual precipitation**
- Interrow without plastic mulch: **Actual weather**

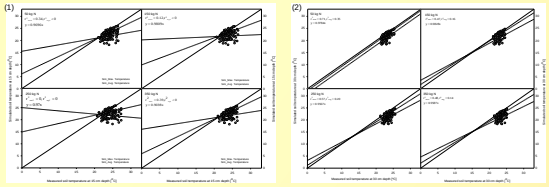


Fig. 3. Comparison of measured and simulated soil temperature with avg. temperature (open circle) and 90% of the max. (closed circle) temperature at (1) 15 and (2) 30 cm depth. **Results of a linear regression showed that the model simulated soil temperature with 90% of the maximum temperature better than with the average temperature.**

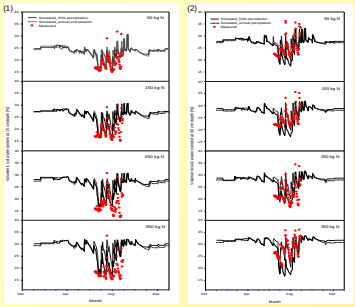


Fig. 4. Measured and simulated soil water content at (1) 15 and (2) 30 cm depth. Solid lines represent the simulated soil water content with 50% of the annual precipitation in rows covered with black plastic mulch.

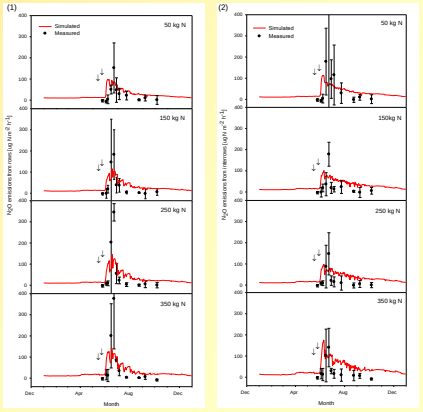


Fig. 5. Measured and simulated N_2O emissions from (1) rows and (2) interrows. Bars represent standard deviations of measurements. Arrows indicate time and date of N fertilizer application. **Simulated N_2O emissions around 52-63 (28-66) µg N m^{-2} h^{-1} in rows and 55-73 (27-78) µg N m^{-2} h^{-1} in interrows.**

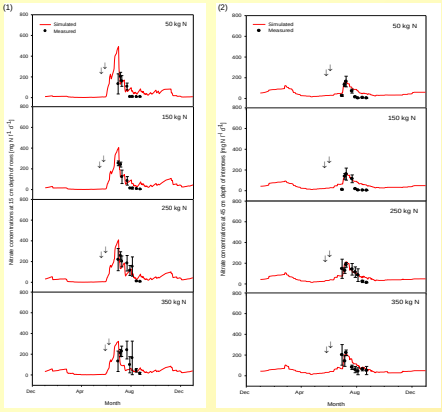


Fig. 6. Measured and simulated nitrate concentration in (1) rows at 15 cm depth and (2) interrows at 45 cm depth. Bars represent standard deviations of measurements. Arrows indicate time and date of N fertilizer application. **Model simulated N concentrations around 126-196 (measured 61-117) kg N ha^{-1} in rows at 15 cm depth and 91-125 (measured 53-108) kg N ha^{-1} in interrows at 45 cm depth.**

Table 1. Simulated annual N_2O emissions and nitrate leaching

N treatment [kg N ha^{-1} yr^{-1}]	N_2O_Row [kg N ha^{-1} yr^{-1}]	N_2O_Interrow [kg N ha^{-1} yr^{-1}]	NO_3_Row [kg N ha^{-1} yr^{-1}]	NO_3_Interrow [kg N ha^{-1} yr^{-1}]
50	2.06	2.37	264.3	452.3
150	2.16	2.44	275.8	426.5
250	2.34	2.46	283.4	420.0
350	2.38	3.16	290.0	403.4

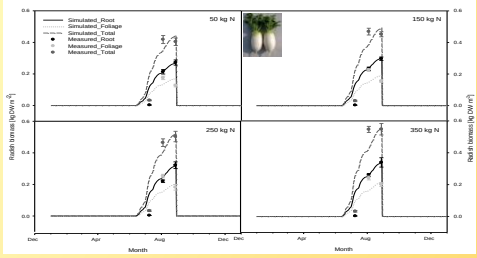


Fig. 7. Measured (circle) and simulated (line) radish biomass. Bars represent standard errors of measurements. Both measured and simulated radish biomass slightly increased as the increase of N fertilizer rates; **350 (5.6) > 250 (5.2) > 150 (4.9) > 50 kg N ha^{-1} (4.4 t DW ha^{-1}) at the last harvest (175 day) by Landscape-DNDC**

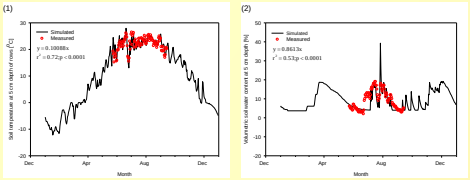


Fig. 8. Measured and simulated (1) soil temperature and (2) soil water content at 5 cm depth of rows. **Simulated soil temperature and water content agreed well with measurements.**

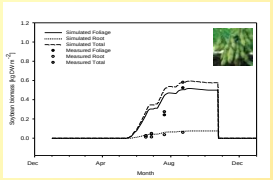


Fig. 9. Measured and simulated soybean biomass; **Sim. total biomass was the same as the measurement (5.8 t DW ha^{-1})**

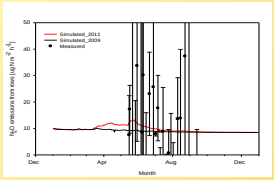


Fig. 10. Measured ('11) and simulated N_2O emissions from soybean field with 2009 and 2011 weather data

Further Research

- Simulations of dryland crops (Chinese cabbage and Potato)
- Simulations of three forest sites
- Landscape-scale application of Landscape-DNDC linked to GIS database