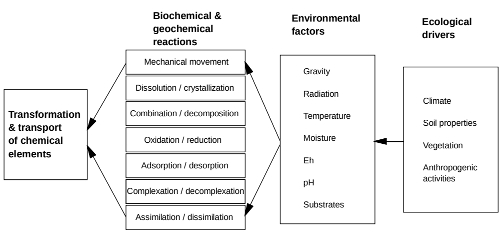
DNDC and Its Applications

Changsheng Li

Institute for the Study of Earth, Oceans and Space
University of New Hampshire

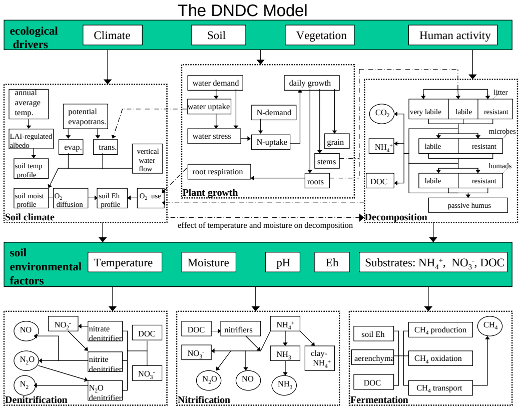
DNDC stands for **Den**itrification and **Dec**omposition, two processes dominating loss of N and C from soil into the atmosphere, respectively.

Biogeochemical Model is a Mathematical Expression of Biogeochemical Field



The DNDC model is a result of more than 10-year international efforts with researchers from the U.S., China, Germany, the U.K., Canada, Australia, New Zealand, the Netherlands, and Japan.

The DNDC Model



Input Parameters

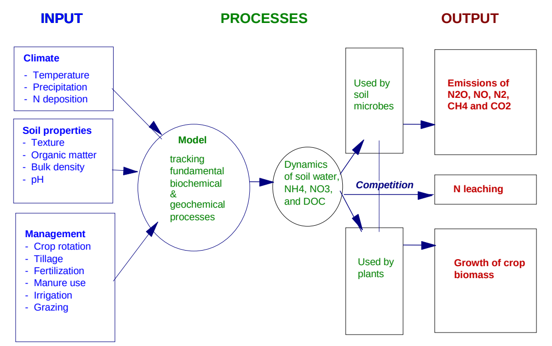
1. Climate:
   - Daily air temperature and precipitation;
   - Solar radiation;
   - Atmospheric N deposition;
2. Soil:
   - Bulk density;
   - Texture (clay fraction);
   - Total organic C content;
   - pH;
3. Management:
   - Crop type and rotation;
   - Tillage;
   - Irrigation;
   - Fertilization;
   - Manure amendment;
   - Grazing

Output

1. Crop: - Photosynthesis;
  - Respiration;
  - Water and N demands/uptake;
  - Biomass allocation;
  - Yield and litter production;

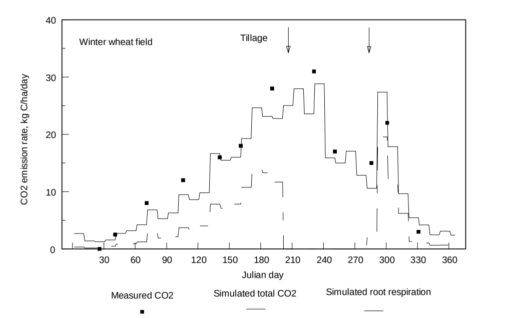
2. Soil: - Temperature, moisture, pH and Eh profiles;
  - SOC dynamics;
  - N leaching;
  - Emissions of N_2O, NO, N_2, NH_3, CH_4 and CO_2

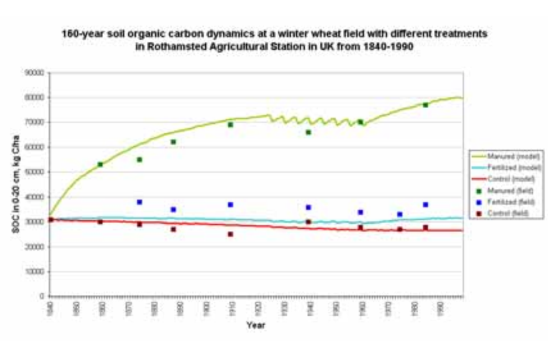
Biogeochemical Model Predicts Impacts of Alternative Management on Crop Yield and Environmental Safety

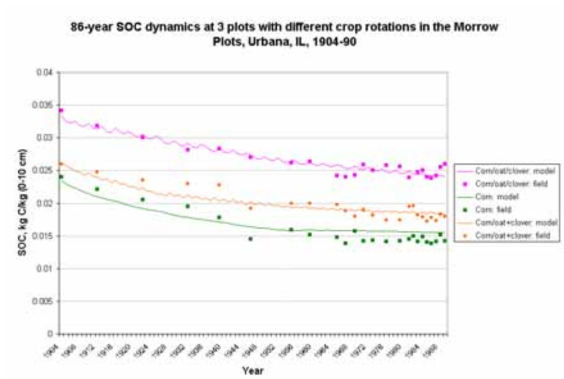


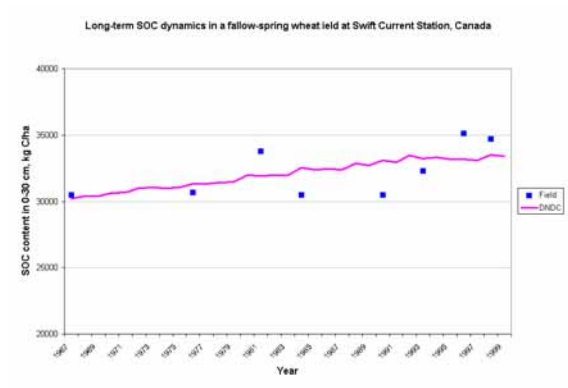
Model Validation

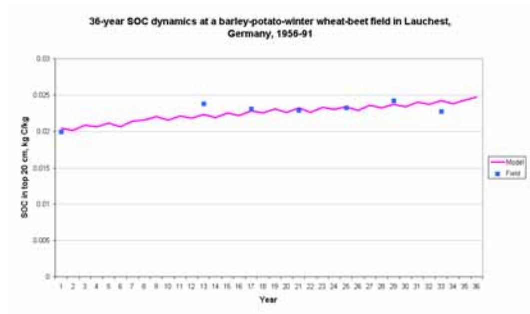
Comparison on CO2 emissions from a silty loam soil in a tilled and fertilized witer wheat field in Columbia, Missouri

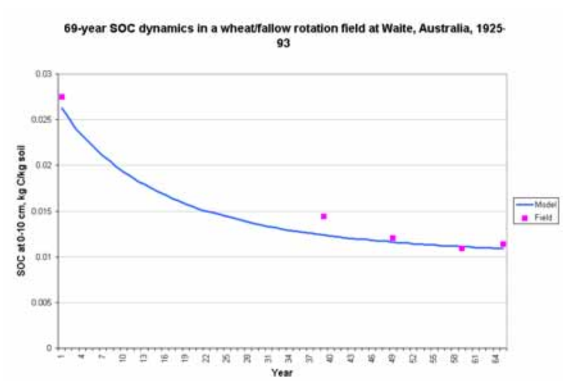


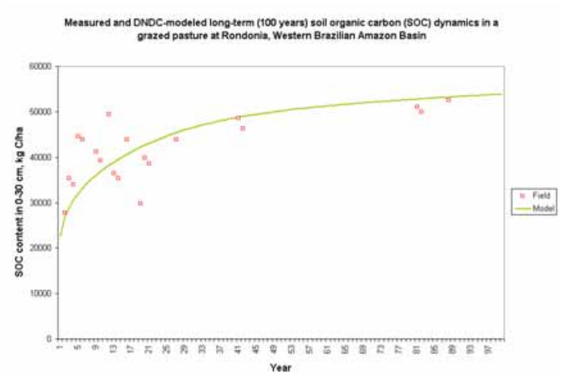


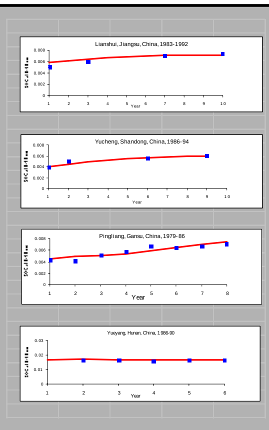










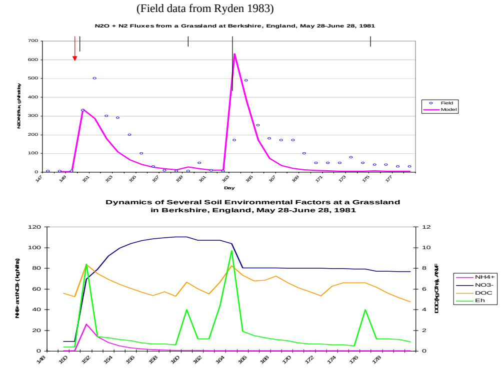


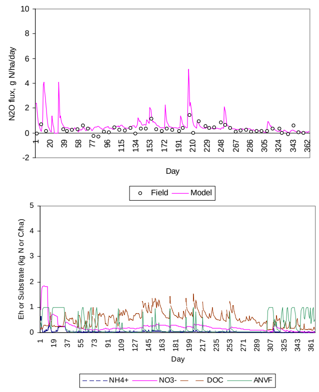
DNDC captured long-term SOC dynamics observed at four crop fields in China

- Lianshui, Jiangsu
- Yucheng, Shandong
- Pingliang, Gansu
- Yueyiang, Hunan

Two N2O peaks were caused by fertilization and rainfalls at a grassland in England

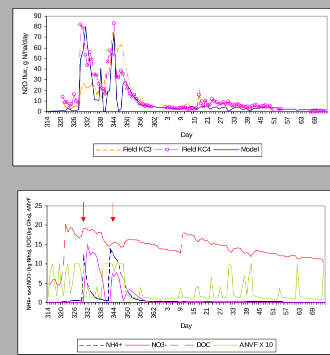
(Field data from Ryden 1983)





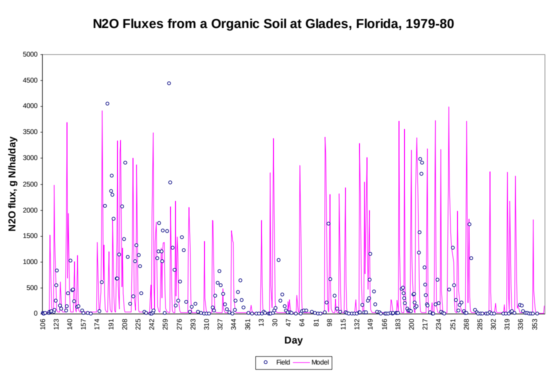
Low N2O fluxes were measured at a grassland in Colorado. Both nitrate and DOC were limiting factors.

(Field data from Mosier et al., 1996)

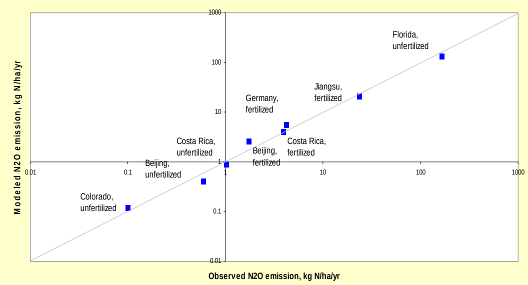


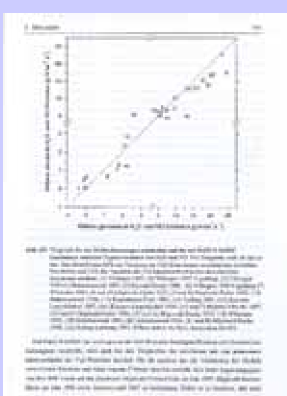
Two high peaks of N2O flux were caused by fertilization at a corn field in Costa Rica, 1994.

(Field data from Crill et al., 1999)



Comparison of Measured and Modeled N_2O Fluxes from 8 Agricultural Sites In the U.S., China, Germany, and Costa Rica

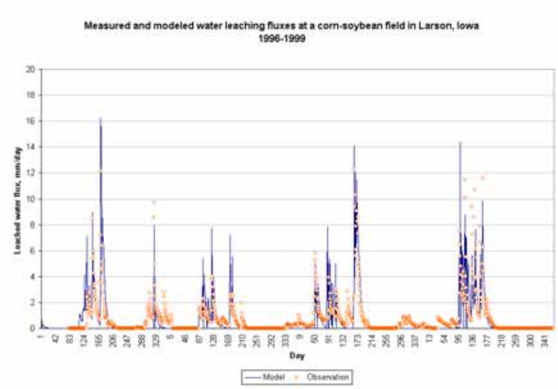


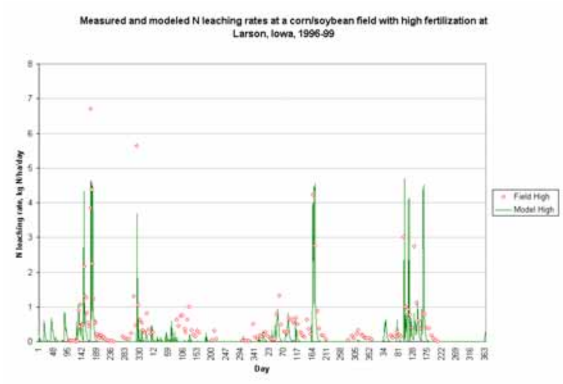


N_2O and NO from Forests:

Comparisons between observed and modeled fluxes from 28 forest stands in Europe and the U.S.

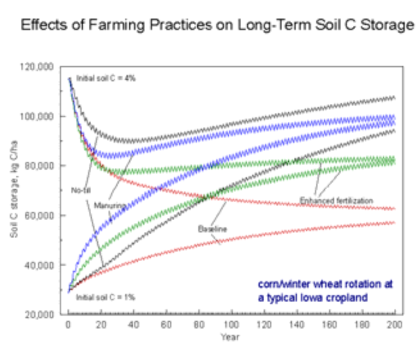
(from dissertation of Florian Stange, Fraunhofer Institute for Atmospheric Environmental Studies, Garmisch-Patenkerchin, Germany, 2000)

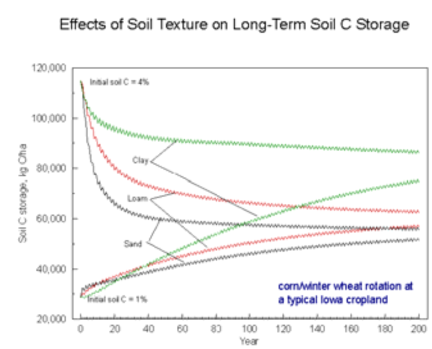


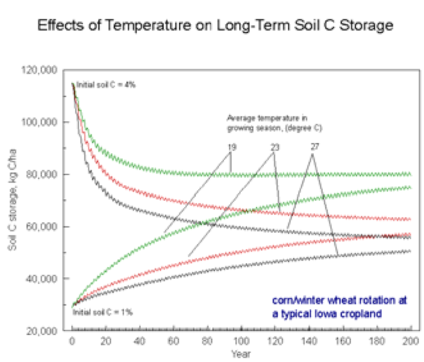


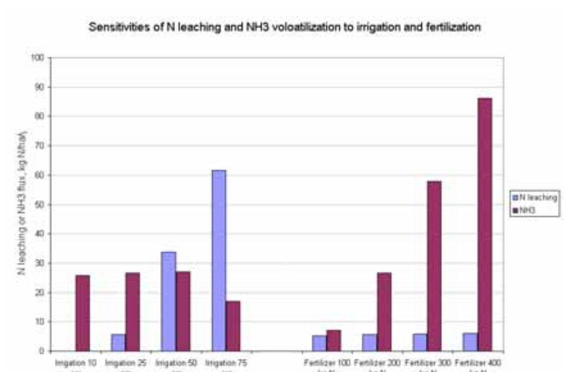
Application 1:

Predicting mitigation options





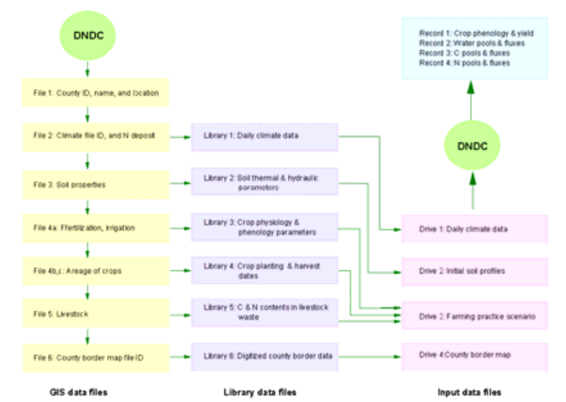




Application 2:

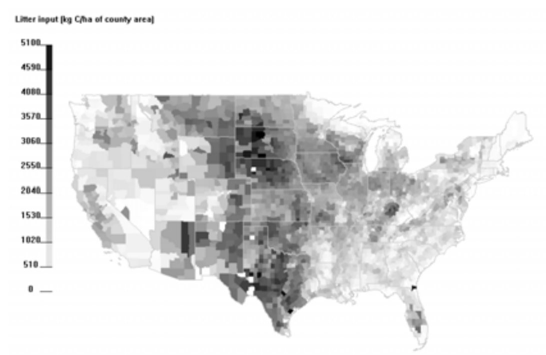
Regional Inventory

DNDC Working with Databases at Regional Scale

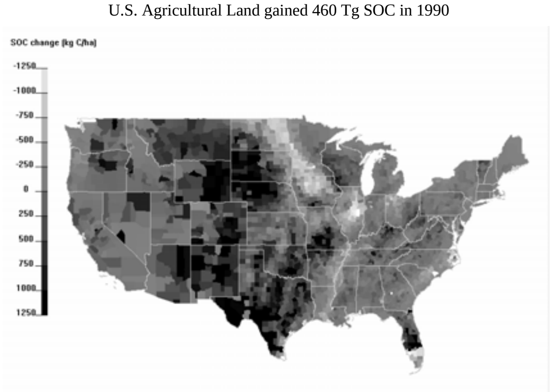


U.S. agricultural land emitted 876 Tg CO_2-C in 1990

U.S. agricultural land received 1153 Tg residue-C in 1990

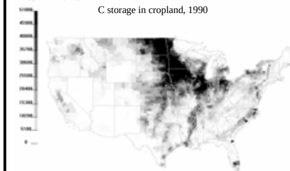


U.S. Agricultural Land gained 460 Tg SOC in 1990

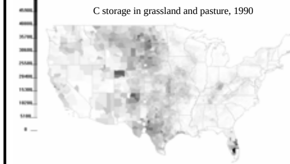


DNDC-Modeled C Storage in and Fluxes from Agricultural Land in the U.S. in 1990

C storage in cropland, 1990



C storage in grassland and pasture, 1990



	Cropland	Grassland and pasture
Acreage (million ha)	141.2	204.5
C storage in 0-30 cm (Tg C)	7898.8	4155.7
Incorporated plant residue (Tg C)	331.7	821.4
Manure amendment (Tg C)	81.0	76.5
CO2 emission (Tg C)	446.8	428.7
CH4 emission (Tg C)	0.05	-0.03
DOC leaching (Tg C)	7.9	2.4
SOC change (Tg C)	-7.0	466.9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