

GLOBAL RESEARCH ALLIANCE

ON AGRICULTURAL GREENHOUSE GASES

CROPLANDS RESEARCH GROUP:

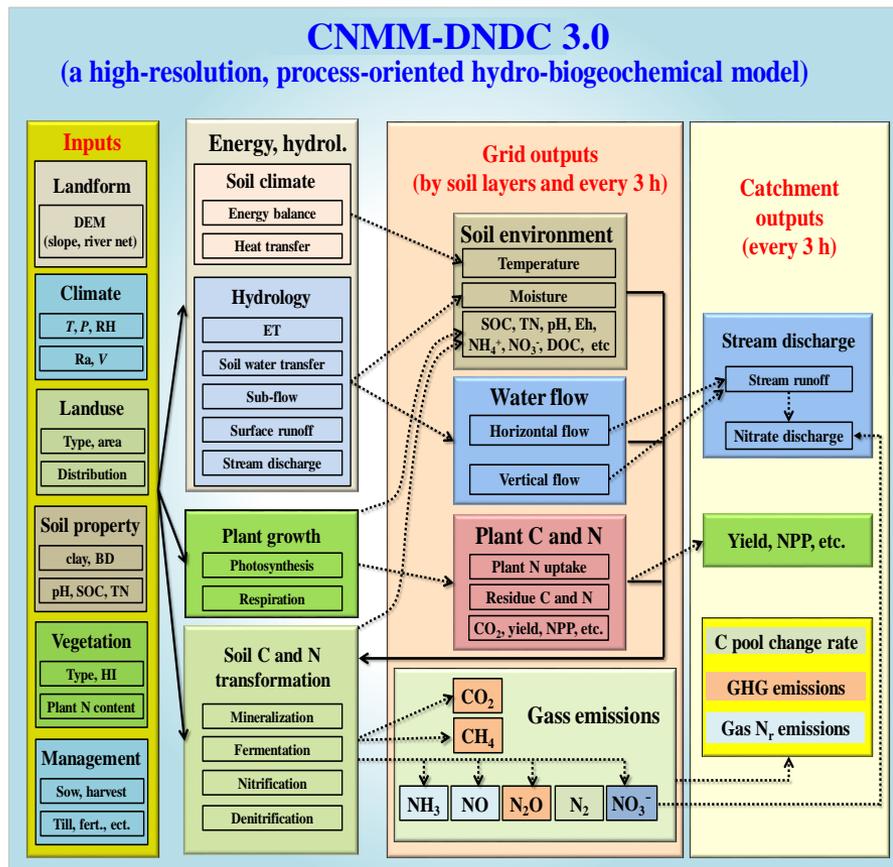
**Landscape Management of Agricultural System Network
(LAMs)**

Leader: Xunhua Zheng

Membership: 5 Countries (CN, GE, ES, FR, US)

Activities/Accomplishment since last meeting: **LMAS**

CNMM-DNDC updated



CNMM-DNDC is:

- a hydro-biogeochemical model;
- a DNDC family member with special features, such as space distribution (three dimensions), and customized resolutions;
- developed for all land types and inland waters; and,
- a core working model for the Landscape Management of Agriculture System Network (LMAS) of GRA.

■ **CNMM-DNDC updates**

- ❑ **We revised the model (version 2.0 to 3.0) to better facilitate catchment landscape simulation** through
 - adding soil erosion processes, referring the ROSE mechanisms,
 - adding the biogeochemical processes for inland waters (pool, lake, reservoir), and
 - modifying the processes for forest growth, referring to the Forest Biogeochemical Cycle (Forest-BGC) model.
- ❑ **We continued to validate the revised model version.**
- ❑ **We adapted the model to the Linux operation system to enable regional high-resolution 3D simulation** (Windows version still works at the site scale).

■ **CNMM-DNDC application**

- **High-resolution 3D simulations** by CNMM-DNDC were preliminarily carried out for some province or sub-province regions **to evaluate net land GHG balance** (i.e., $\text{CH}_4 + \text{N}_2\text{O} - \Delta\text{SOC}$ in 100a- CO_2e).
- **CNMM-DNDC is applied for water quality management of a lake** down town in a mega city (i.e., Chengdu) in southwest China. In this application, the updated model is used to calculate the inflows of water, nitrogen, phosphorus and sediments from all sub-catchments into the surface water through high-resolution ($100 \times 100\text{m}^2$ grids, every 3 h) simulation of the whole lake catchment ($\sim 300 \text{ km}^2$).

■ **CNMM-DNDC application**

- A five-year NSFC-UNEP cooperative research project “**Reduction Strategies and Decision-Supporting Tool for N₂O emission from cultivated uplands in China and Kenya**” (2022–2026) has been granted with ~0.5 million USD by the NSFC (the National Natural Science Foundation of China). In this project, **CNMM-DNDC is to be applied as the core model** for developing the decision-supporting tool.

Activities/Accomplishment since last meeting: **LMAS**

■ Research articles on CNMM-DNDC development

- **Zhang *et al.*, 2021, *Agr., Ecosys. & Environ.***
- **Zhang *et al.*, 2021, *Biogeosciences***
- **Li *et al.*, 2021, *Biogeosciences* (submitted)**

Zhang W, Li S, Han S, Zheng X *et al.*, 2021. Less intensive nitrate leaching from Phaeozems cultivated with maize generally occurs in northeast China. *Agriculture, Ecosystems and Environment* 310, 107303.

Zhang W, Yao Z, Li S, Zheng X *et al.*, 2021. An improved process-oriented hydro-biogeochemical model for simulating dynamic fluxes of methane and nitrous oxide in alpine ecosystems with seasonally frozen soils. *Biogeosciences* 18, 4211–4225.

Li S, Zhang W, Zheng X, Li Y *et al.*, 2021. Update a biogeochemical model with process-based algorithms to predict ammonia volatilization from fertilized uplands and rice paddy fields. *Biogeosciences* (lately submitted)

■ Research priorities

□ **Priority 1: To test/validate CNMM-DNDC applicability**

- Validation of the model with field observations in different terrestrial ecosystems, landscapes or catchments is urgently needed. In particular, validations by worldwide observations subject to different natural conditions or management practices are substantially necessary.
- GRA members and other countries/organizations are all welcome to join the validation and application of the CNMM-DNDC model.

□ **Priority 2: To further improve CNMM-DNDC functions**

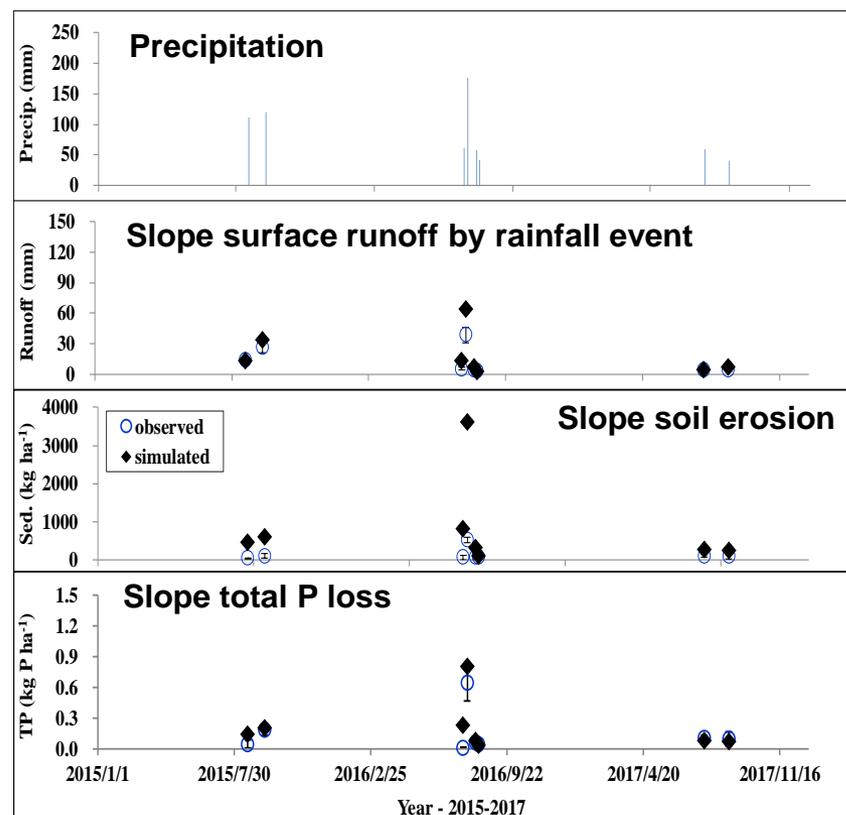
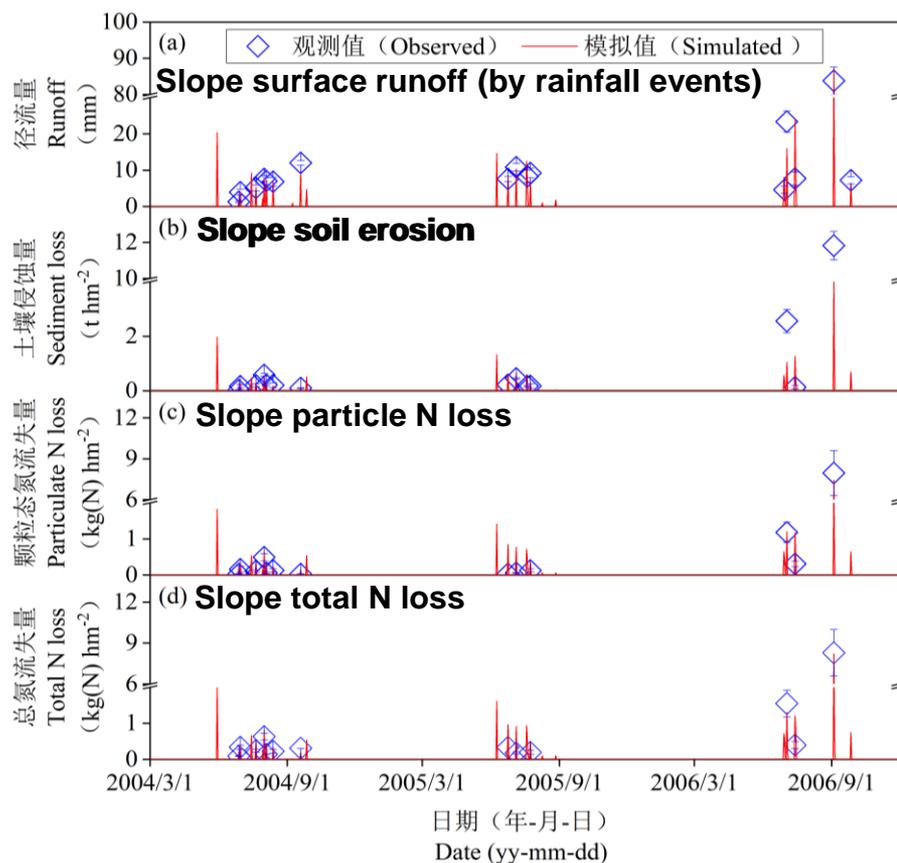
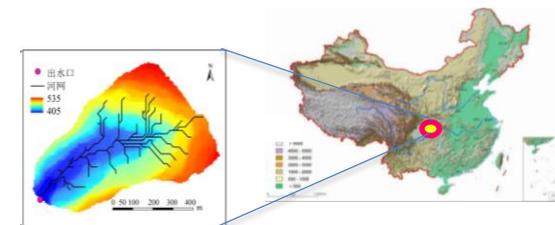
- To modify the model source codes to enable process-oriented simulations for complex cropping systems or agroforests with intercropping/interplanting features (This plan is delayed due to our failures in applying for project funds).
- To add a groundwater module to improve dynamical water balance simulation.
- To couple CNMM-DNDC with an atmospheric model to enable simulations on synergy and trade-off between GHG mitigation and erosion/pollution control.

■ Capability priorities

- ❑ **Priority 1: To apply for cooperation research projects** (bilateral or multi-lateral, such as NSFC-UNEP program projects).
- ❑ **Priority 2: To identify opportunities of cooperation other groups** (i.e., the Integrative Research Group or the Rice Research Group of GRA to use CNMM-DNDC as a research tool).
- ❑ **Priority 3: To apply for international students** (i.e., student program of the University of Chinese Academy of Sciences).
- ❑ **Priority 4: to apply for international postdoc positions in universities or the institutes of CAS** (by using fellowships from CAS or the National Post-Doctor Regulatory Commission of China).

Modified CNMM-DNDC validation: Subtropical catchment

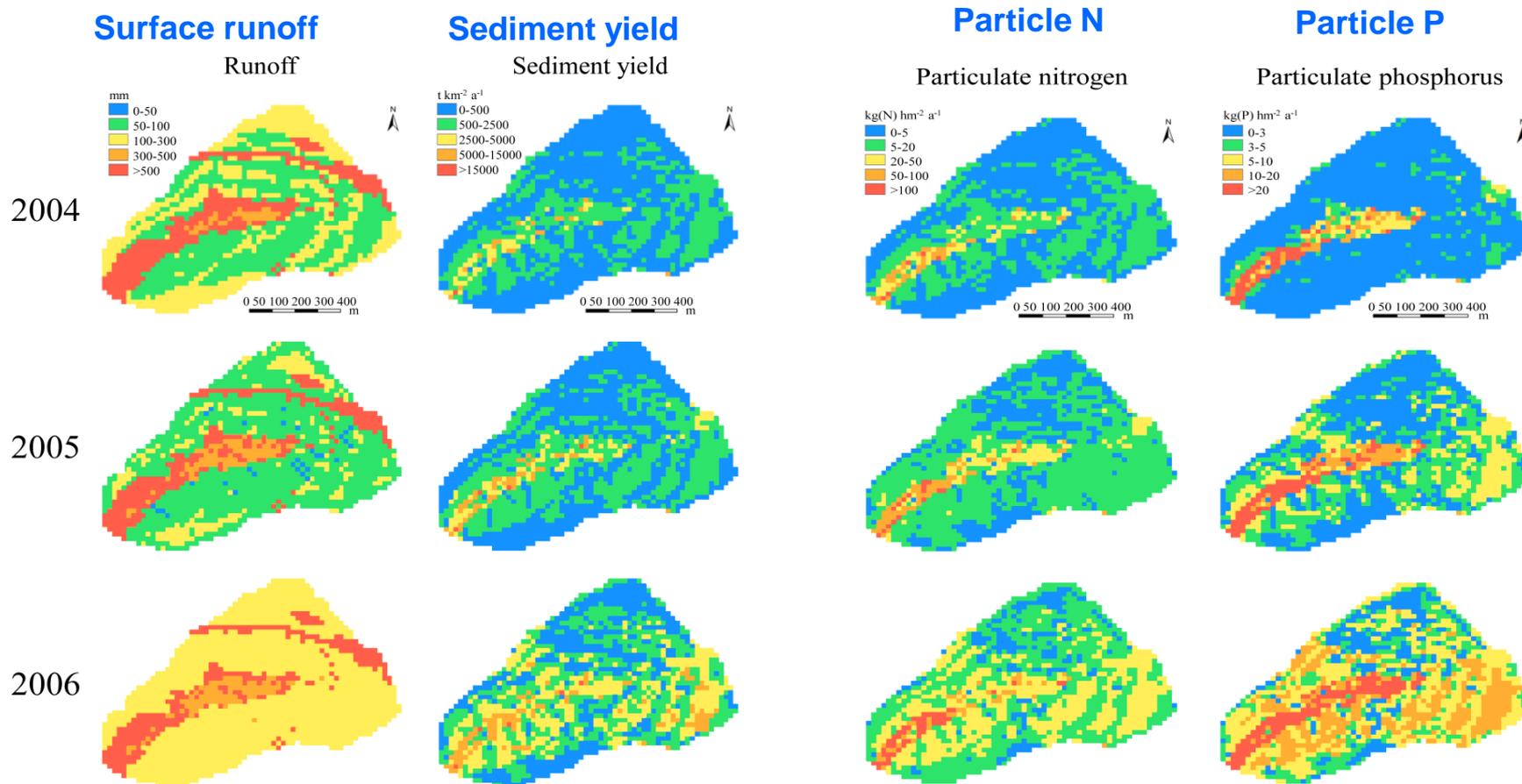
□ Slope experimental plots: surface runoff, sediment yield and particle N or P



Modified CNMM-DNDC validation: Subtropical catchment

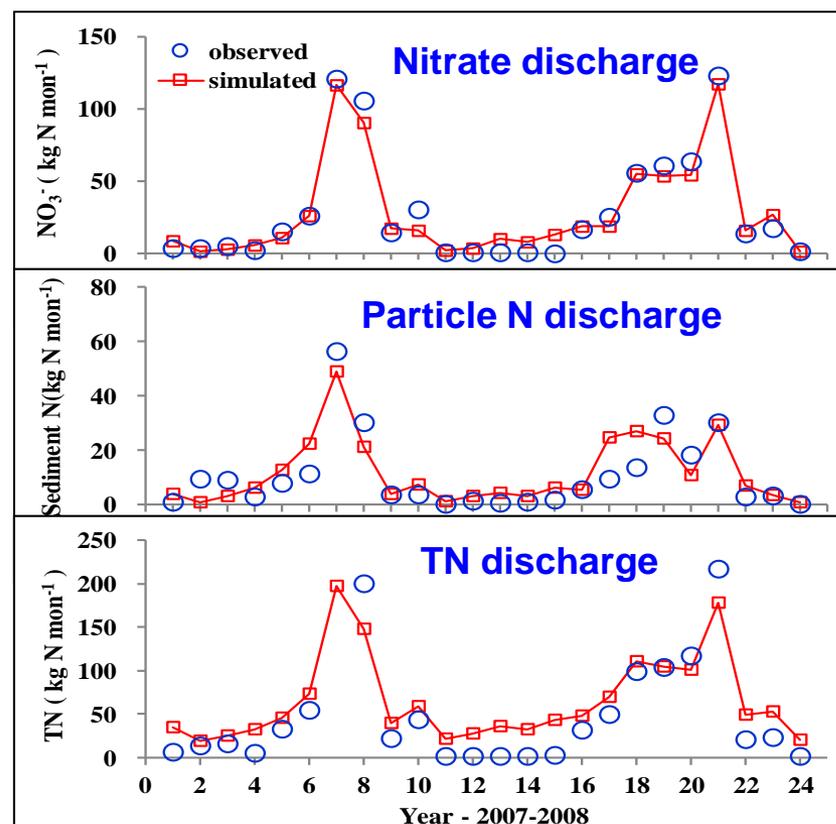
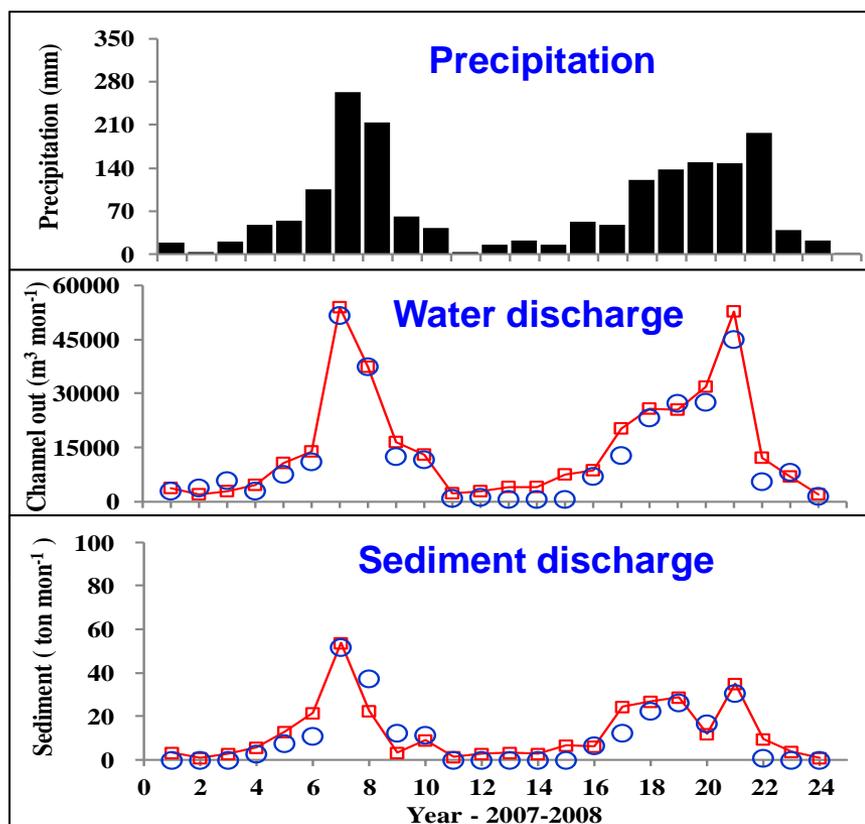
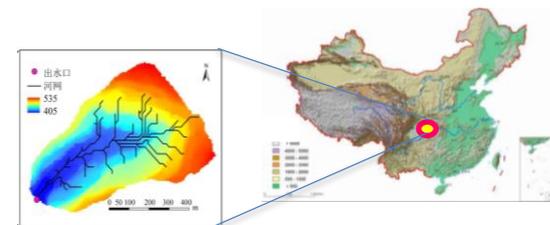
- Grids: surface runoff, sediment yield and particle N or P

Catchment area: 34ha
Grid size: 15×15 m²



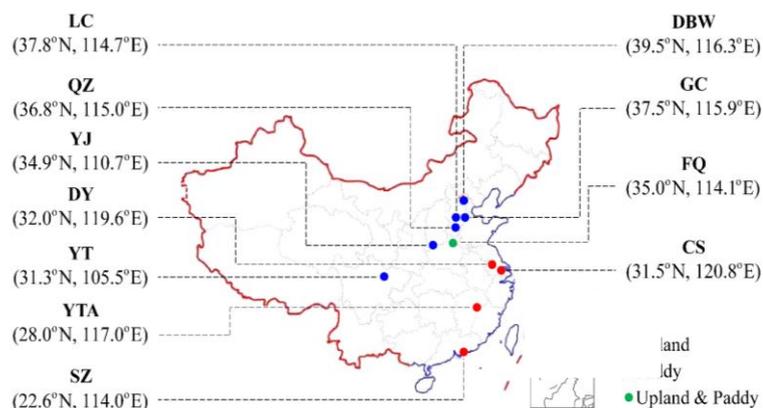
Modified CNMM-DNDC validation: Subtropical catchment

- **Catchment outlet: Discharges of water, sediment, nitrate, particle N and TN**



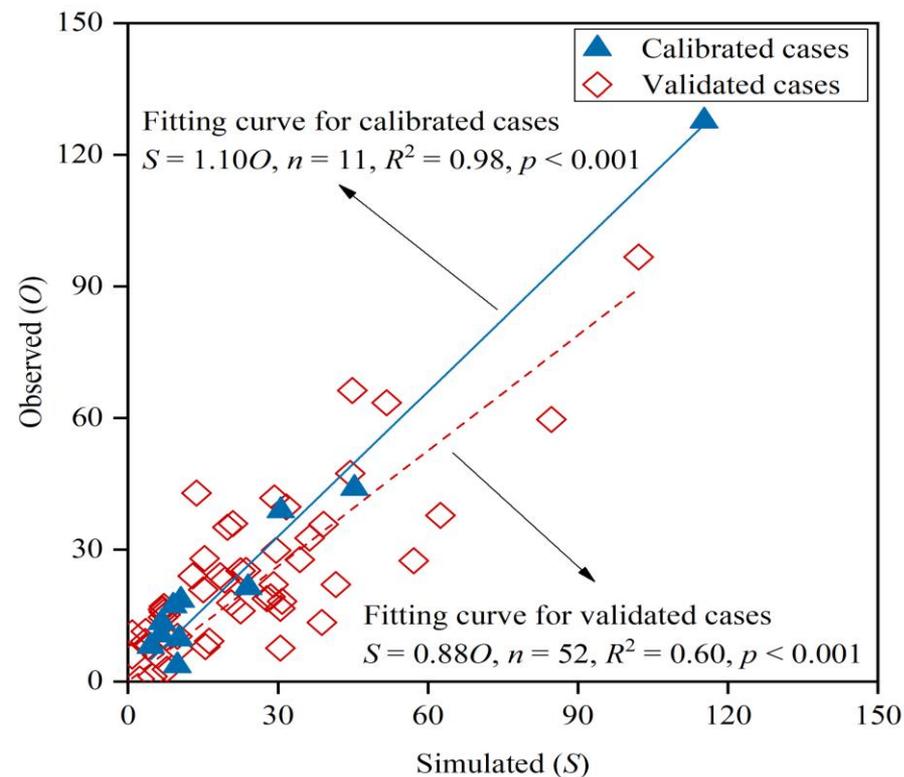
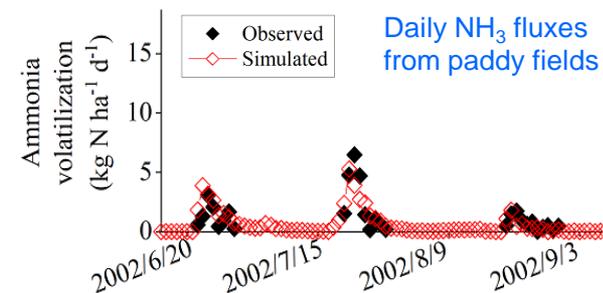
Modified CNMM-DNDC validation: Uplands & rice fields: NH_3 volatilizations

Validation of the modification for NH_3 volatilizations by N-fertilization events

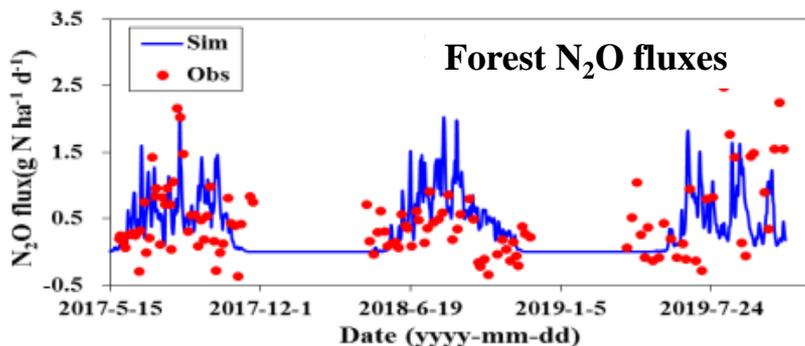
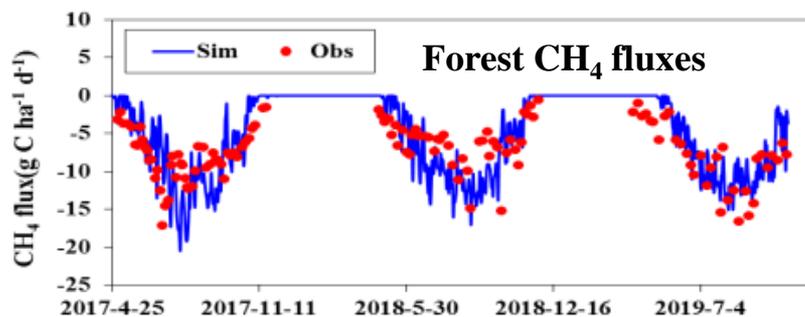
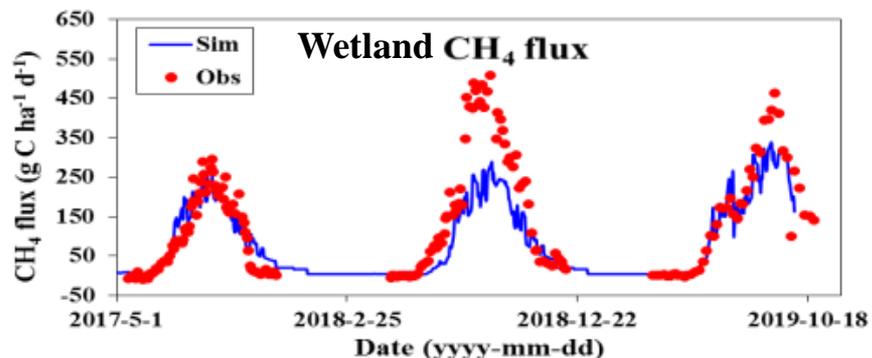


- Upland sites
- Paddy field sites
- Upland & paddy sites

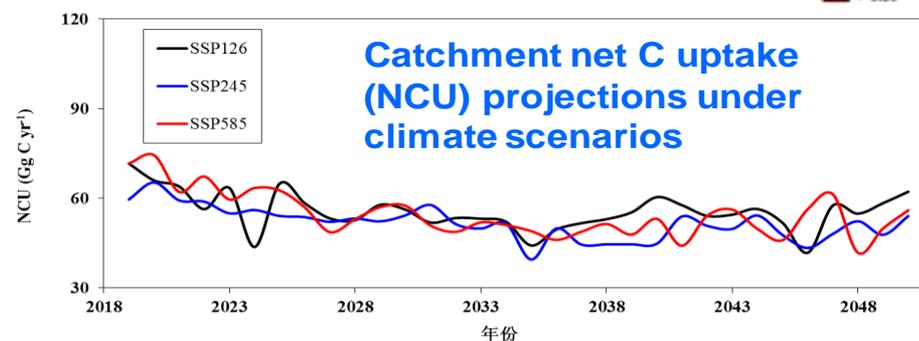
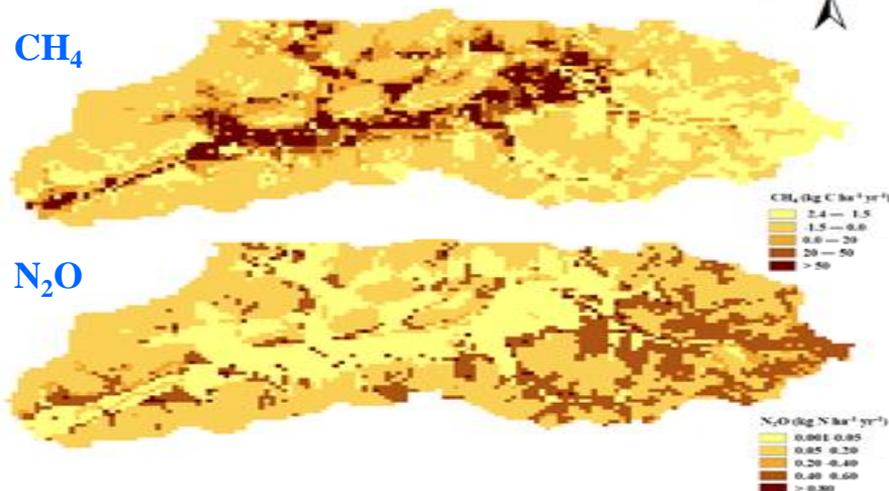
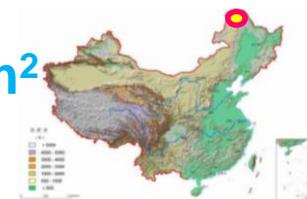
(Li et al., 2021, Agriculture System, submitted)



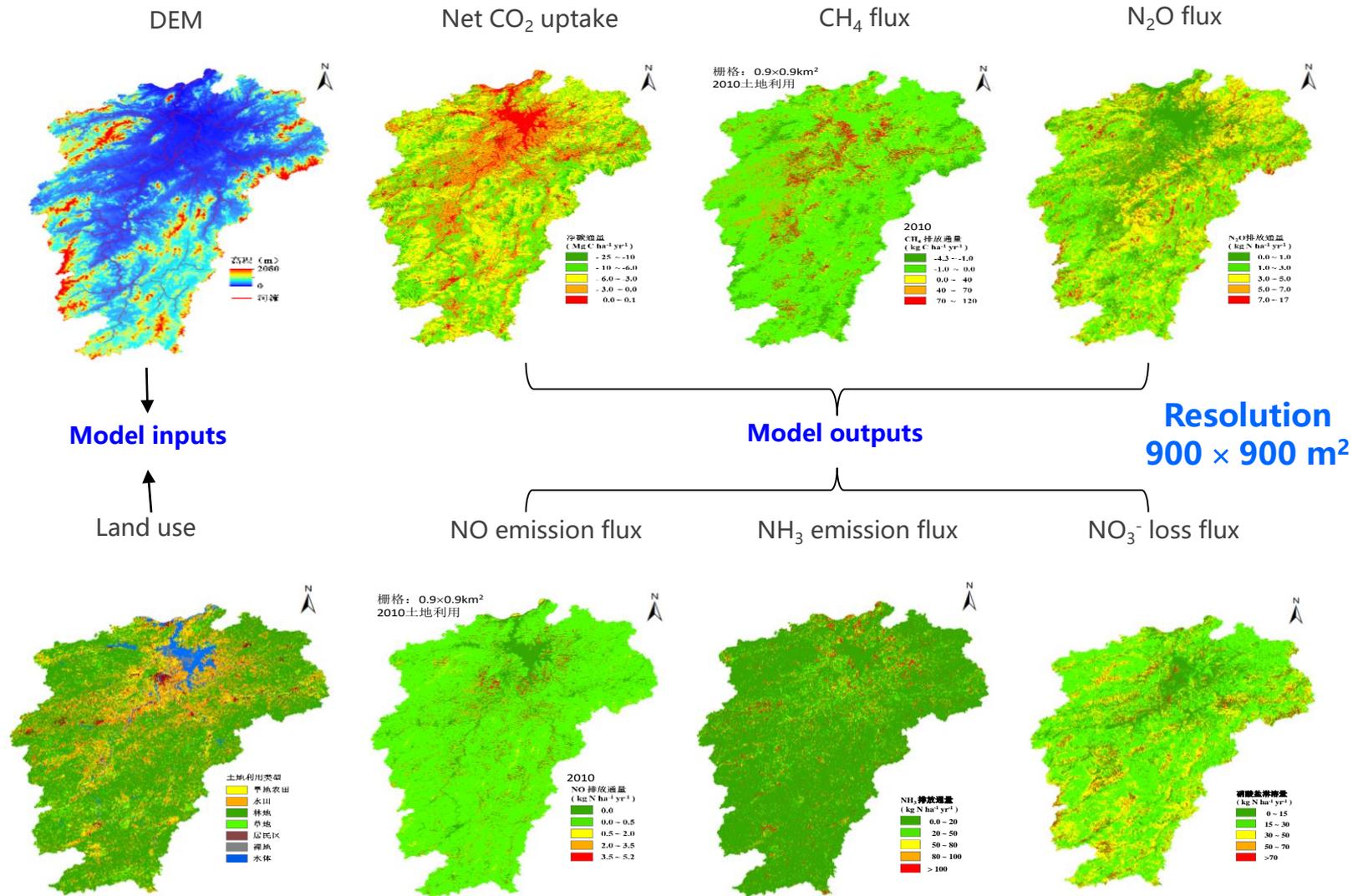
Modified CNMM-DNDC validation: Permafrost catchment



Catchment area: 350 km²
Grid size: 150×150 m²



Modified CNMM-DNDC application: A case of the Jiangxi Province



*Thanks very much
for your attention!*

