

GLOBAL RESEARCH ALLIANCE

ON AGRICULTURAL GREENHOUSE GASES

CROPLANDS RESEARCH GROUP:

Landscape Management of Agricultural System Network (LMAS)

Leader: Xunhua Zheng

CRG-GRA 2024 Annual, November 14th, 2024, San Antonio, USA

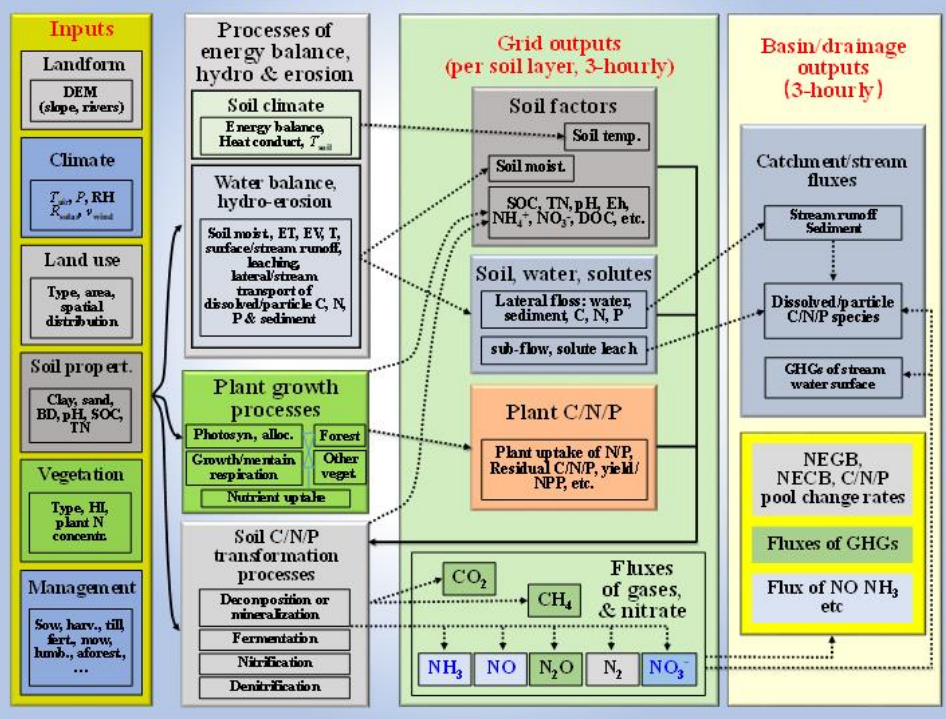
Activities/Accomplishment since last meeting: **LMAS**

CNMM-DNDC

was updated from V4.0 to V6.0

CNMM-DNDC 6.0

(a high-resolution process-oriented hydro-biogeochemical model)



Zhang *et al.*: 2018 STOTEN, 2021 BG, 2021 ACP, 2024 GMDD
Li *et al.*: 2022 BG, 2023 BG, 2024 AAS submitted

CNMM-DNDC is:

- a hydro-biogeochemical model;
- a DNDC family member with special features, such as space distribution (three dimensions), designs to facilitate universal applicability for ecosystems of all terrestrial land types (croplands, forests, grasslands, wetlands, aquatic ecosystems), soil hydro-erosion, and customized soil layers and resolutions;
- capable of revealing the effects of lateral water flows on GHG fluxes and other processes; and,
- a working model for the LMAS of GRA.

■ **CNMM-DNDC updates**

- **We updated the model from **version 4.0 to 6.0** to better facilitate catchment landscape simulations on C, N and P interactions through**
 - Incorporating the forest growth processes of F-GBC into CNMM-DNDC, thus improving the simulations of forest biogeochemistry,
 - Coupling Manure-DNDC processes with CNMM-DNDC to enable simulations of interactions between crop and livestock production systems.
- **We converted the latest CNMM-DNDC from its Windows version to Linux version (**CNMM-DNDC_Linux V1.0**) to enable simulation with large scale and high resolution.**
- **We submitted **two research articles** on model development** (Zhang et al., 2024, GMD Discussion; Li et al., 2024, AAS).
- **CNMM-DNDC as a part of **PEEX Modelling Platform**** (Mahura et al., 2024, Big Earth Data)

■ **CNMM-DNDC application**

- **CNMM-DNDC was applied by **three** local governments:**
 - a) for routine water quality prediction of a subtropical river drainage (in Chengdu);
 - b) for quantifying net ecosystem GHG balance (NEGB) of ecosystems in a sub-province region (in Shandong);
 - c) for quantifying forest carbon sequestration to service carbon trade (in Guangxi).
- **CNMM-DNDC is involved as a tool to implement **six** ongoing research projects:**
 - a) **four 5-year research projects** granted by the National Natural Science Foundation of China (total project found: equivalent to ~1.7 millions USD);
 - b) **two 3- to 4-year projects** granted by the Ministry of Sci. Tech. of China (total projects found: equivalent to ~0.7 millions USD).
- **CNMM-DNDC is used as the Terrestrial Biogeochemistry Module in the EarthLab** as the Earth Simulator of China, which was launched for use in 2023.

■ **CNMM-DNDC training/presentation/exhibition**

□ **Training involved in graduate education:**

- a) CNMM-DNDC **modelling practice** in a **graduate course** (20~20 students per year) in University of Chinese Academy of Sciences (UCAS): Biogeochemistry--Scientific Fundamentals and Modeling Approach.
- b) CNMM-DNDC as a **research tool** for master/Ph.D **students** from **five univessities**: UCAS, TU and FUAf of **China**; LSU and IAF of **Laos**.

□ **Social training and academic presentation:**

- a) **a nationwide training workshop** on CNMM-DNDC application (Beijing, April 18-21, 2024).
- b) **fourteen presentations** on CNMM-DNDC development and application in domestical/international academic conferences/workshops.

□ **Exhibition:**

- **Exhibition** to the **ASEAN Leaders' Summit 2024** on **forest C balance** predicted by CNMM-DNDC for Southeast Asia.

■ 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 CNMM-DNDC.
- ❑ **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 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).
- ❑ **Priority 2: To identify opportunities of cooperation other groups** (IRG, RRG and LRG of GRA to use CNMM-DNDC as a research tool).
- ❑ **Priority 3: To apply for international students** (through student program of UCAS or other universities, e.g., Henan Normal University).
- ❑ **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).

Latest CNMM-DNDC simulation test: Ecosystem fluxes of GHGs and N-SLCFs

Annual fluxes of N₂O, NO and NH₃ from terrestrial ecosystems

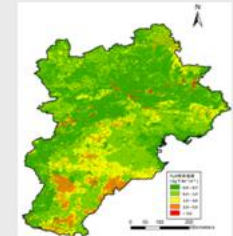
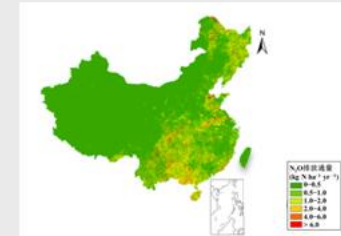
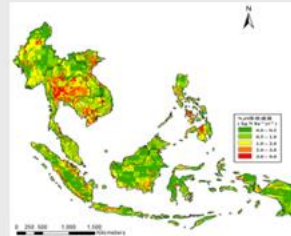
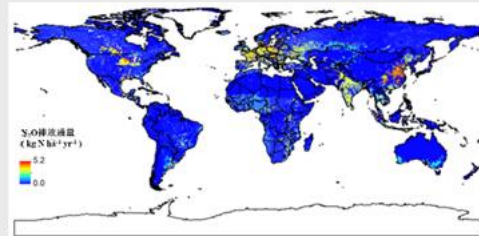
Globe
(10×10km²)

SEA
(10×10km²)

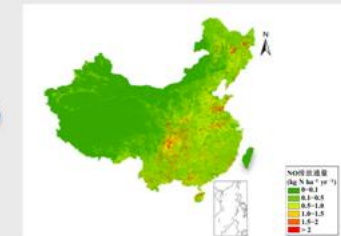
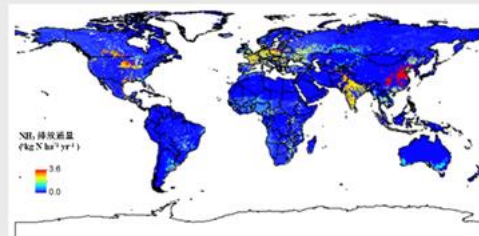
China
(1×1km²)

BJ-TJ-HB
(0.3×0.3km²)

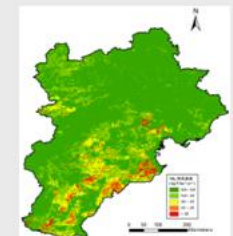
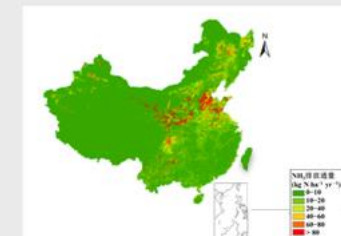
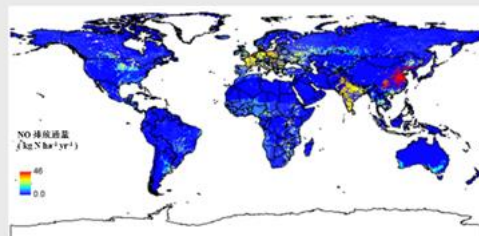
N₂O



NO



NH₃

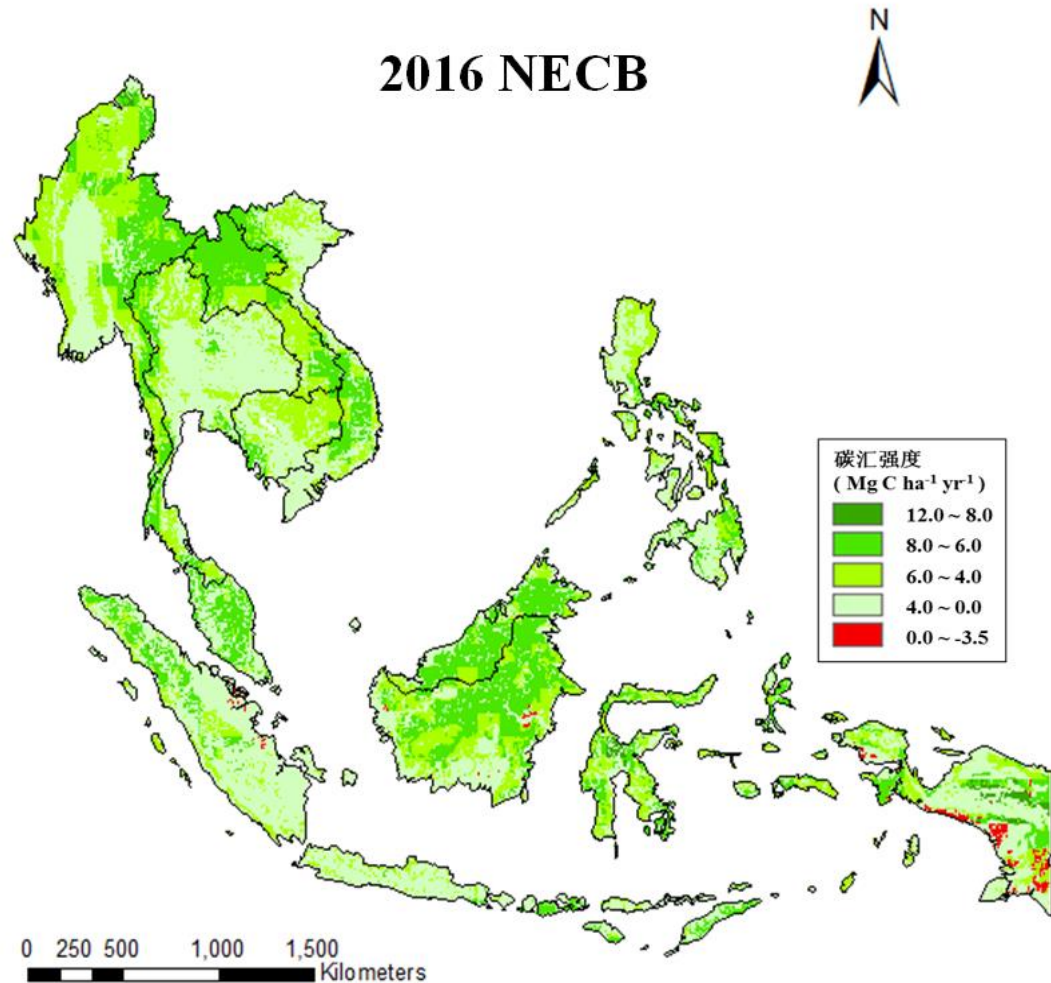


Latest CNMM-DNDC simulation test: Ecosystem fluxes of GHGs and N-SLCFs

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Southeast Asia (Sub-continent level)

Grid size:
 $10 \times 10 \text{ km}^2$



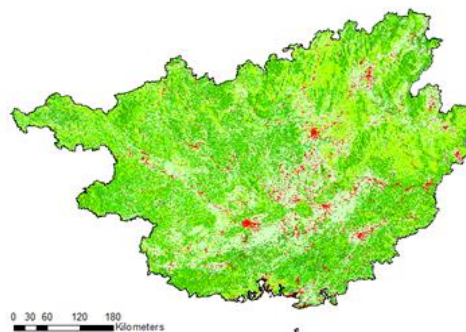
Latest CNMM-DNDC simulation test: Ecosystem fluxes of GHGs and N-SLCFs



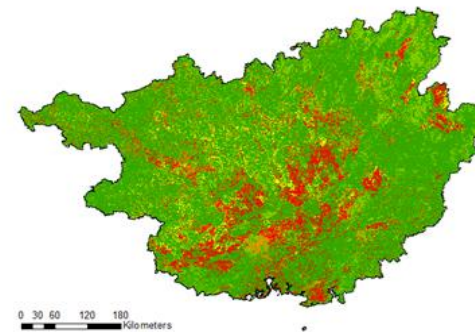
Guangxi (Province level)

Grid size:
 $0.9 \times 0.9 \text{ km}^2$

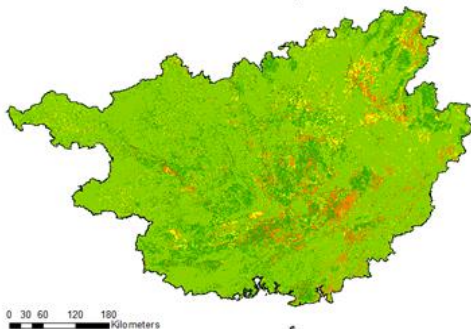
2020 NECB 



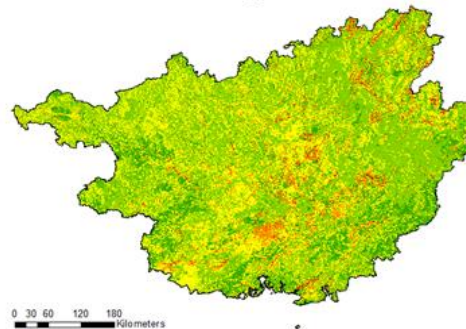
2020 NO 



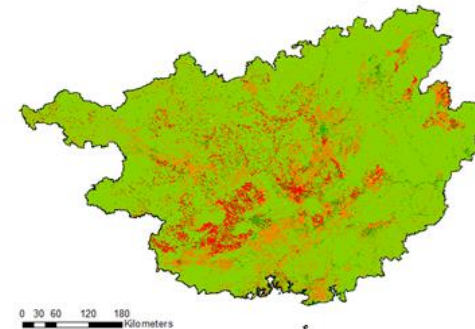
2020 CH₄ 



2020 N₂O 



2020 NH₃ 



Latest CNMM-DNDC simulation test: Ecosystem fluxes of GHGs and N-SLCFs

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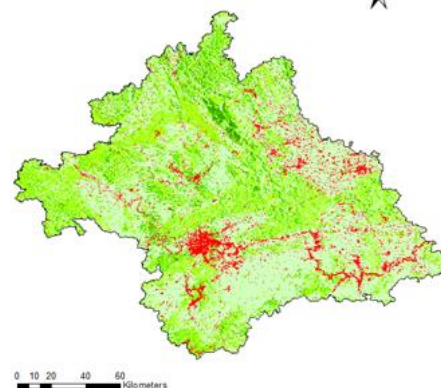
ON AGRICULTURAL GREENHOUSE GASES



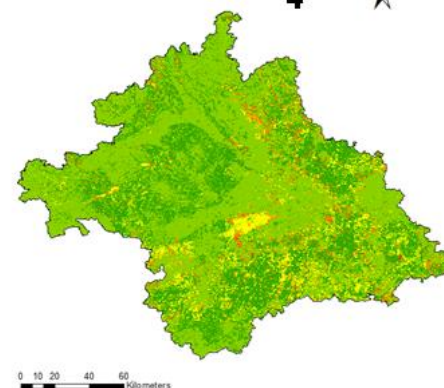
Nanning
(Sub-province)

Grid size:
 $0.3 \times 0.3 \text{ km}^2$

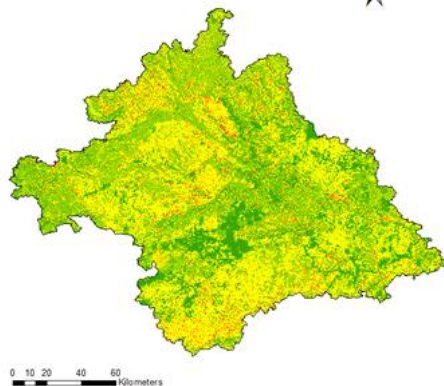
2020 NECB



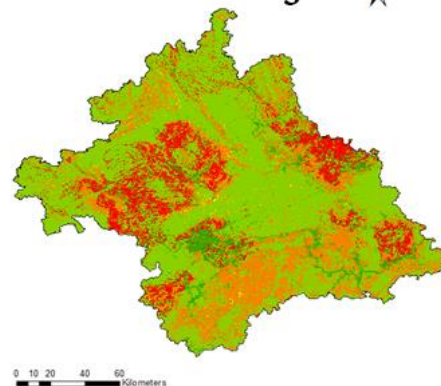
2020 CH₄



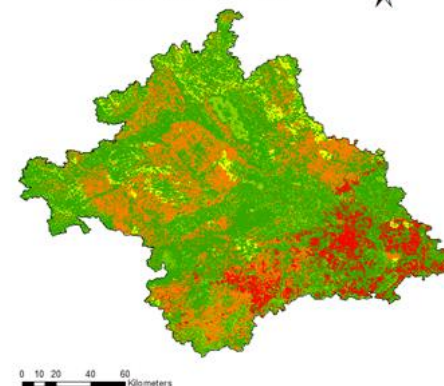
2020 N₂O



2020 NH₃



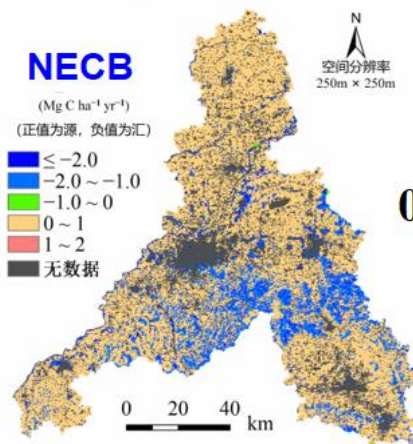
2020 NO



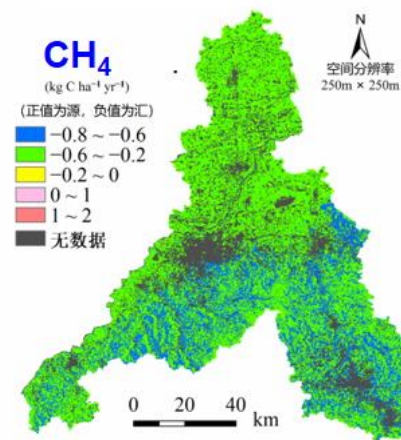
Latest CNMM-DNDC simulation test: Ecosystem fluxes of GHGs and N-SLCFs



2009 net CO₂ emission: -922×10^4 Mg C

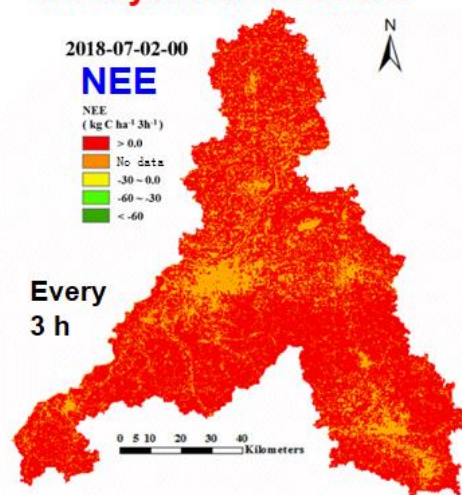


2009 CH₄ emission: -435.2 Mg C

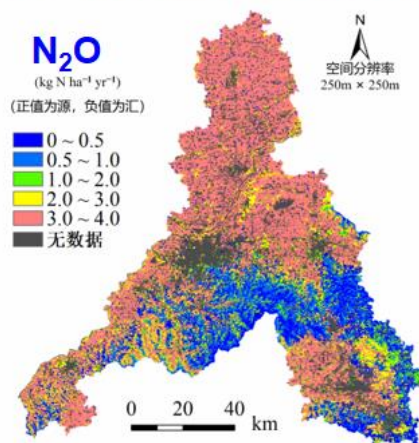


Grid size:
 0.3×0.3 km²

Ecosystems of Jinan



2009 N₂O emission: 1435 Mg N



2009 net GHG emission -862×10^4 Mg CO₂eq

