Quantification of Modelling Uncertainties in an Ensemble of Carbon Simulations in Grasslands and Croplands


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- **Biogeochemical grassland and crop models** predict carbon (C) balances in agriculture
- **Simulations of C fluxes** are inherently uncertain (complex interactions, high temporal and spatial variability of measurements)
- We assessed C fluxes from 23 biogeochemical models with data from **three crop rotations and two temperate grasslands**

**Model name**
- Model-one
  - Holmes
  - AP3M, SoilWater
  - AP3M, SWAT
  - SPRINT
  - DNDC
  - CENTURY
- Model-two
  - CERES-ECO
  - MUSCLE
  - APSIM
  - ORCHIDEE
  - DISCOMET-MIP
  - PB
  - RECO

**Observed C fluxes** (GPP, NEE, RECO)
- C fluxes
- CO2 intensity

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**Fig 1.** Seasonal changes in ecosystem respiration (RECO), gross primary production, net ecosystem exchange (NEE), carbon use efficiency (CUE) and CO2-C intensity (IncO2-C) calculated over multiple years at C1 and C2 crop and G3 and G4 grassland sites, for five calibration stages (S1 to S5) and the observation (Obs). For each calibration stage, triangles demonstrate the multi model mean, black lines show multi-model median. Boxes delimit the 25th and 75th percentiles. Whiskers are 10th and 90th percentiles. Circles indicate outliers. For Obs, diamond shows the observed mean with its standard deviation.

**Fig 2.** Seasonal variability of ecosystem respiration (RECO), gross primary production (GPP), net ecosystem exchange (NEE), carbon use efficiency (CUE) and CO2-C intensity (IncO2-C) calculated over multiple years at C1, C2 and C3 crop and G3 and G4 grassland sites, for five calibration stages (S1 to S5) and the observations (Obs). Owing to largely different values of carbon use efficiency (CUE), they are presented with distinct scales for boreal soil, grassland and crop systems. For each calibration stage, triangles demonstrate the multi-model mean; black lines show multi-model median. Boxes delimit the 25th and 75th percentiles. Whiskers show 10th and 90th percentiles. Circles indicate outliers.

- Overall, the estimation of C fluxes was more uncertain in grasslands than in crops
- The model ensemble proved effective in representing C sequestration of grasslands and most of crops
- Elimination of fallow and enhancement of cropping intensity may increase C sequestration

Our study suggests a cautious use of large-scale, multi-model ensembles to estimate C fluxes in agricultural sites if some plant and soil observations are available locally for model calibration.