EGU2020-2833
https://doi.org/10.5194/egusphere-egu2020-2833
EGU General Assembly 2020

A unified diagnostic platform to quantify the source of uncertainty in modelling global SOC dynamics

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As the largest carbon reservoir in biosphere, soil organic carbon (SOC) has been extensively studied. However, the large uncertainty of modeling SOC impedes the accurate prediction of global carbon dynamics in response to climate change. Thus, evaluating and tracing the sources of large uncertainty in predicting SOC dynamics by Earth system models are the urgently needed to improve our understanding and predicting capability. Although great efforts have been made to predict land C storage using multiple models, disentangle uncertainty sources among models are still extremely difficult. To take this challenge, we developed a Matrix-based ensemble Model Inter-comparison Platform (MeMIP). MeMIP is an integrated platform to quantify the various sources of uncertainty under a unified framework. MeMIP is embedded a new community-based ESM, Community Integrated Earth System Model (CIESM) and implemented in the super-computing cluster in Wuxi, China. Within the MeMIP, multiple SOC decomposition schemes from different land models (e.g. CLM-CENTURY, CLM-BGC, LPJ-GUESS, JULES and CABLE) have been re -constructed in a unified matrix model format. With the unified format of matrix model, the inter-model differences can be quantitatively attributed to the sources by using the traceability analysis. In this study, we analyzed how SOC decomposition schemes and the vertical resolved SOC exchange structure (VR structure) influences SOC prediction with the three-dimension parameter output (NPP, residence time and carbon storage potential) space. The results indicate that model with the VR structure result in significantly higher SOC predictions and introduced higher uncertainty than single layer models. It is mainly due to increased residence time, which is also very sensitive to future warming. The identified major uncertain components are targets for improvement via data assimilation. Overall, MeMIP provides a modeling platform that not only unifies all land carbon cycle models in the matrix form but also offers traceability analysis to identify sources of uncertainty and data assimilation to constrain multiple model ensemble prediction.