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Data-model comparison of global terrestrial carbon cycle simulations: what is the cause of difference?

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Numerical simulation approach is expected to play a key role in the global carbon cycle studies by integrating various observational data into a single framework and making predictions for global environmental change. However, models often provide inconsistent results on stocks and fluxes of carbon cycle, implying that these models have been weakly constrained and insufficiently validated by observational data. In this study, first, we examined what is the significant cause of inter-simulation differences (i.e. uncertainty) using two terrestrial ecosystem models (Sim-CYCLE and BEAMS) and three climate datasets (NCEP/NCAR, NCEP/DOE AMIP-II, and ERA40). It was found that both models provide different results when using different climate datasets, in terms of global productivity and carbon stocks and interannual variability of net biospheric exchange. A sensitivity analysis showed that among the climatic factors, inter-data difference in downward shortwave radiation is most critical. Also, the two models showed slightly different responsiveness to climatic data, such that BEAMS is more sensitive to solar radiation and Sim-CYCLE is more sensitive to soil moisture. Second, to address the importance of solar radiation (especially PAR) data, we performed a simulation using a sophisticated canopy photosynthesis model and fine PAR data (ISCCP-SRB). Finally, we found that the choice of climate data and ecosystem model can considerably affect the simulation result. Therefore, a more accurate climate dataset is required to obtain a consistent result, and further studies are required to better constrain terrestrial ecosystem models.