Understanding the centennial-scale human-natural interactions using an integrated terrestrial model MIROC-INTEG under ISIMIP2 project

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Within the earth system, changing-climate, -human society, and -ecosystems interact mutually. It is crucial to better understand the interconnectedness among such human-natural systems in order to assess the potential impacts of climate and socioeconomic changes on each system and identify sustainable pathways. Although existing earth system models and integrated assessment models are applicable to explore this field, parts of their natural and/or human processes tend to be simplified depending on their scope. Therefore, it still remains a challenge to improve integrated modeling frameworks. For these reasons, a process-based integrated terrestrial model, MIROC INTEGrated terrestrial model (MIROC-INTEG), was developed. The modeling framework is composed of five natural/human subcomponents. At its core is a land surface model (MATSIRO), which is coupled to three human modules; water use (H08), food and biofuel crop production(PRYSBI2) and land use change (TELMO). An ecosystem model (VISIT) calculates the C and N cycles among atmosphere-vegetation-soil. While each sub-model can run independently, MIROC-INTEG dynamically simulates their interactions, embracing the water-food-energy nexus within a system.

The goal of this study is to improve our quantitative understanding on coupled terrestrial systems at the global scale for past and future time-scales. Hence, we have run MIROC-INTEG following the Inter-Sectoral Impact Model Inter-comparison Project phase 2a (ISIMIP2a) and 2b (ISIMIP2b) simulation protocols. Using 3 hourly climate forcing data and considering anthropogenic activities, MIROC-INTEG simulated agro-hydrological condition at a spatial resolution of 0.5°, globally. As its inputs, ISIMIP2a makes use of three reanalysis-base metrological data for historical periods, and ISIMIP2b employs an ensemble of bias-corrected forcing data set of four general circulation models covering preindustrial, historical, and future time-periods under four representative concentration pathways. Furthermore, ISIMIP provides a unique opportunity for validation of simulation skill in comparison with other models’ under consistent protocols.
Within this contribution we present the first results of MIROC-INTEG looking specifically at the centennial-scale human-natural interactions over the period 1851-2099 and its consequences for long-term changes in fundamental hydrological variables. The results are presented at global, regional and large-basin scale and are compared against existing ISIMIP runs of other hydrological and land surface models.

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