Geophysical Research Abstracts
Vol. 21, EGU2019-11814, 2019
EGU General Assembly 2019

Understanding the centennial-scale human-natural interactions using an integrated terrestrial model MIROC-INTEG under ISIMIP2b

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Changing-climate, -human society, and -ecosystems interact mutually within the earth system. To assess the potential impacts of climate and socioeconomic changes on each system and identify sustainable pathways, it is critical to better understand the interconnectedness among human-natural systems. While 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. In this context, the MIROC integrated terrestrial model (MIROC-INTEG) was developed. The modeling framework is composed of five process-based natural/human subcomponents. At its core is a land surface model (MATSIRO), which is coupled to three human components; water use (H08), crop production(PRYSBI2) and land use (TELMO). An ecosystem model (VISIT) calculates the C and N cycles among atmosphere-vegetation-soil. Although 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 2b simulation protocol (ISIMIP2b) with as its inputs an ensemble of bias-corrected forcing data of four general circulation models covering preindustrial, historical, and future time-periods under four representative concentration pathways. ISIMIP2b provides a unique opportunity for validation of simulation skill in comparison with other models' under a consistent protocol. Using temporally-downscaled 3 hourly climate forcing data and considering anthropogenic activities, MIROC-INTEG simulated agro-hydrological condition at a spatial resolution of 0.5°, globally.

Within this contribution we present the first results of MIROC-INTEG looking specifically at the centennial-scale human-natural interactions over the period 1661-2099 and its consequences for long-term changes in fundamental hydrological variables, emphasizing on hydrological extremes. The results are presented at global, regional and large-basin scale and are compared against existing ISIMIP2b runs of the hydrological models H08 and CWatM.