Interaction of climate, ecosystem, water resources, and land use investigated with Integrated Terrestrial Model: a bio-geophysical land surface model with human component

*Tokuta Yokohata[1], Gen Sakurai[2], Tsuguki Kinoshita[3], Pokhrel Yadu[4], Yusuke Sato[5], Akihiko Ito[1], Naota Hanasaki[1], Tomoko Nitta[6], Yoshimitsu Masaki[7], Masashi Okada[1], Seita Emori[1]

1. National Institute for Environmental Studies, 2. National Agriculture and Food Research Organization, 3. Ibaraki University, 4. Michigan State University, 5. International Institute for Applied System Analysis, 6. University of Tokyo, 7. Hirosaki University

Future climate changes possibly affect eco-system services, water resources, food production, energy supply, etc. It is important to understand the interaction between the changes in these complicated factors. In the present study, we develop an integrated terrestrial model which describes the natural biogeophysical environment as well as human activities. In the integrated model, a global vegetation model VISIT (Ito et al. 2012), water resource model H08 (Hanasaki et al. 2008, Pokhrel et al. 2012), crop growth model PRYSBI2 (Sakurai et al. 2015), and land use model TeLMO (Kinoshita et al., in preparation) are coupled to a land surface model MATSIRO (Takata et al. 2003, Nitta et al. 2014), which is a component of global climate model MIROC (Watanabe et al. 2010). Output variables of each sub-model are passed to other sub-models during the time integration. The time intervals of variable exchange are from hourly to monthly or yearly. For example, the crop yields [t/ha] calculated by PRYSBI2 is used in TEMO which calculate the land use change (crop or natural vegetation area) of next year. The projected land-use map is used in all other sub-models. The water resource model H08 considers the irrigation process (water withdrawal from rivers) as well as dam operations in large rivers, which affects the state of the soil moisture and the river flows in the land surface model. We will present the state of the model development, and results from the historical and future simulation. In the historical simulation, we validated the model output such as irrigated water, crop yield, ecosystem productions, and cropland area by comparing to the observed or reanalysis data. Based on the future simulation, we also assessed the interactions of changes in climate, ecosystems (natural vegetation and cropland), water resources, and land use.

Keywords: Climate change, Land use, Land ecosystem, Water resources