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Biogeochemical-hydrological processes simulated by an Earth system model MIROC-ES2L

Abstract:

Biogeochemical processes on the Earth are strongly controlled by hydrological processes. In the terrestrial carbon cycle process, for example, available soil water controls photosynthetic rate, and the decomposition rate of soil organic matter is regulated by soil moisture conditions. In addition, terrestrial nitrogen cycle processes are also driven by hydrologic processes, like wet nitrogen deposition, soil denitrification, and nitrogen loss via runoff to rivers. In the latest ESM version of MIROC ("MIROC-ES2L"), such interactions within climate-hydrology-carbon-nitrogen cycle system are considered explicitly. As a result, perturbations of human activities on biogeochemical processes and their impacts on climate can now be depicted by simulations. In this presentation, we will give a brief introduction of this model (Hajima et al. 2020, GMD) and present some of our works, which focus on terrestrial nitrogen runoff through rivers and its impact on marine ecosystems (Yamamoto et al. (2022), Sci. Adv). In Hajima et al. (2020), the terrestrial ecosystem module "VISIT" and the marine ecosystem module "OECO2" are coupled to the state-of-the-art climate model "MIROC" to represent the interaction between global climate and biogeochemical processes. To simulate the perturbations to biogeochemistry by human activities, information on fossil fuel CO2 emissions and land use change information is prescribed and given to the model. For the nitrogen cycle, the model also takes into account perturbations from human activities, such as historical changes in the amount of N fertilizer application and the areal change of cropland. In Yamamoto et al. (2022), various simulations were performed considering nutrient supply from rivers and the atmosphere to the oceans and showed that these have a positive impact on ocean primary production. This positive impact from the external nutrient inputs is suggested to offset the reduction of ocean primary productivity due to global warming and resultant ocean stratification.