Evaluation of riverine heat inflow in the Arctic Ocean modeling

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River water is known as important sources of freshwater and nutrients in the Arctic Ocean. Its spatial distribution has been widely visualized using observed chemical properties and numerical tracer experiments. However, continuous monitoring of the volume flux is limited only at major river stations. A substantial amount of uncertainties still remains particularly on ungauged rivers. We compared a couple of river water discharge datasets in the Arctic Ocean modeling. The Arctic Ocean Model Intercomparison Project (AOMIP) traditionally adopted monthly climatology of 13 major rivers, which was based on the R-ArcticNET data archive. The ungauged inflow was added under simple assumption. A daily discharge dataset covering most Arctic sea coasts and multiple decades was recently developed by combining land runoff of the Japanese 55-year reanalysis for driving ocean and sea ice models (JRA55-do) and drainage of the Catchment-based macro-scale floodplain scheme (CaMa-Flood). Another daily discharge dataset was provided using the coupled hydrological and biogeochemical model (CHANGE) and the Total Runoff Integrating Pathways scheme version 2 (TRIP2). An originality of the third dataset is explicit calculation of river ice and snow loading so that the gridded data of river water temperature are also available.
In this study, to evaluate an impact of riverine heat inflow on sea ice in the Arctic Ocean, decadal experiments for 1979–2013 were performed using the Center for Climate System Research Ocean Component model version 4.9 (COCO4.9) in the pan-Arctic regional framework. The horizontal grid size was set to approximately 25 km, and atmospheric forcing components were constructed from the National Centers for Environmental Prediction–Climate Forecast System Reanalysis (NCEP–CFSR). First, the riverine volume inflow was given by three datasets, respectively, so that the sensitivity of sea ice and hydrography was checked. The model results in these cases showed similar interannual variability of sea ice thickness and sea surface salinity in each sub-domain (e.g., Kara and Beaufort seas). We then incorporated the river water temperature into the model experiment. The annual mean sea ice thickness in this case produced negative anomaly over the Siberian shelves and in the southern Canada Basin. The seasonal transitions in sea ice concentration and sea surface temperature indicated that riverine heat inflow into the Arctic Ocean accelerated summer sea ice opening and sea surface warming in the vicinity of major river mouths.

Keywords: Arctic Ocean model, land–ocean interaction, river water temperature, sea ice melting