A brief review of current sea ice numerical models and sea ice modelling through two-way ocean-sea ice coupled model

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Prompted by the uncompromising effects of global climate change on the polar seas, in particular Arctic sea ice, there has been a staggering resurgence of interest in how ocean currents and waves are affected by sea ice fields of various kinds and how the sea ice that constitutes those ice fields is altered by the oceanic impacts. However, due to the lack of physical and dynamical knowledge related to the ocean-sea ice interaction processes and the limitations of current numerical modelling skills, in the most recent decades, accurate representation of the complex ocean-sea ice modelling still requires continuous efforts. In particular, the rapid decline of the sea ice cover in Arctic summer has contributed to increasing areas of ice-free ocean. This provides sufficient fetch for ocean waves with ongoing development.

Before investigating how ocean currents and/or waves interact with the sea ice through modelling, a comprehensive review related to the sea ice modelling is required. Here, we briefly reviewed current sea ice and coupled sea ice models. We found current sea ice models are developed based on three different theoretical models (i.e., thermal model with examples as D. L. Feltham et al (2006) *GRL*, E. C. Hunke et al (2010) *JGR: Oceans*, dynamical models with case as M. A. Hopkins et al (2004) *JRG: Oceans*, and thickness models such as W. H. Lipscomb et al (2001) *JGR: Oceans*). Currently, based on three theoretical models introduced above, different sea ice models have been constructed for operational forecasting, such as Los Alamos sea ice model (CICE) developed by U.S. Department of Energy (DOE) during the mid-1990s utilizing Arakawa-B grid (E. C. Hunke et al (2010) *Ocean Modelling*), Louvain-la-Neuve sea ice model (LIM) developed by the Centro Euro-Mediterraneo sui Cambiamenti Climatici utilizing the Arakawa-C grid (T. Fichefet and M. A. Maqueda (1997) *JGR: Oceans*), and sea ice simulator (SIS) developed by the U.S. Geophysical Fluid Dynamics Laboratory (GFDL) (W. Michael (2000) *JAOT*).

In this study, we, following A. Adcroft (2019) *JAMES,* applied the MOM6-S IS2 model for a sea ice hindcast in 2014 for studying the interaction between ocean currents and sea ice, particularly in Arctic. For future plan, the MOM6-SIS2 model would be adopted for a regional ocean-sea ice two-way coupled numerical model construction and further consider the impacts of ocean waves on the sea ice and oceanic field through the updated regional model. This, hopefully, can be utilized for future operational forecasting during the Arctic observation cruise.

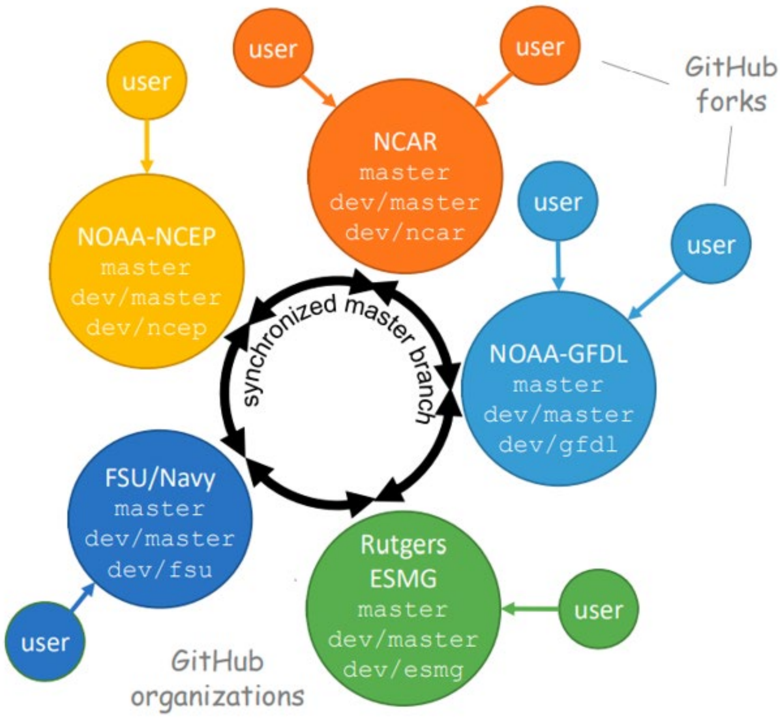

Fig1. Schematic illustration of the MOM6-SIS2 coupled numerical model from Adcroft et al. (2019) *JAMES*

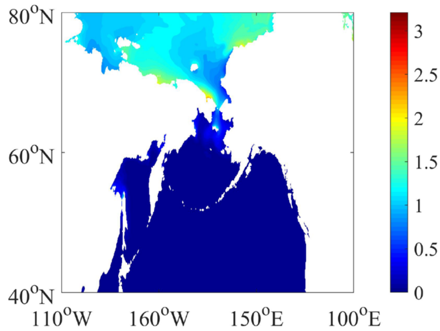

Fig2. Monthly average of sea ice thickness in January of 2014

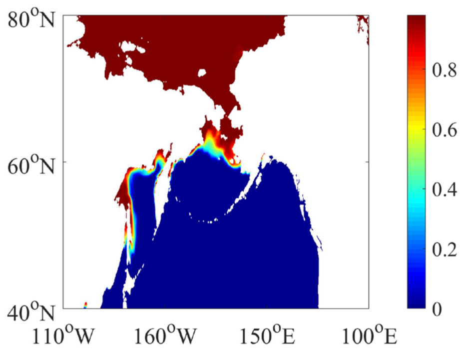

Fig3. Monthly average of sea ice concentration in January of 2014