Arctic summer sea-ice seasonal simulation with a coupled model: Evaluation of mean features and biases

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Journal of Earth System Sciences, (accepted)

Abstract: Current state of the art weather/climate models are representation of the fully coupled aspects of the components of the earth system. Sea-ice is one of the most important components of these models. Simulation of sea-ice in these models is a challenging problem. In this study, evaluation of the hind-cast data of 14 boreal summer seasons with global coupled model HadGEM3 in its seasonal set-up has been performed over the Arctic region from 9th May start dates. Along with the biases of the sea-ice variables, related atmosphere and oceanic variables have also been examined. The model evaluation is focused on seasonal mean of sea-ice concentration, sea-ice thickness, ocean surface current, SST, ice-drift velocity and sea-ice extent. To diagnose the sea-ice biases, atmospheric variables like, 10m wind, 2m air temperature, sea-level pressure and ocean sub-surface temperatures were also examined. The sea-ice variables were compared with GIOMAS data set. The atmospheric and the oceanic variables were compared with the ERA Interim and the ECMWF Ocean re-analysis (ORAP5) data sets respectively. The model could simulate the sea-ice concentration and thickness patterns reasonably well in the Arctic Circle. However, both sea-ice concentration and thickness in the model are underestimated compared to observations. A positive (warm) bias is seen both in 2m air temperature and SST, which are consistent with the negative sea-ice bias. Biases in ocean current and related ice drift are not related to biases in the atmospheric winds. The magnitude of the oceanic subsurface warm biases is seen to be gradually decreasing with depth, but consistent with sea-ice biases. These analyses indicate a possibility of deeper warm subsurface water in the western Arctic Ocean sector (Pacific and Atlantic exchanges) affecting the negative biases in the sea-ice at the surface. The model is able to simulate reasonably well the summer sea-ice melting process and its inter-annual variability, and has useable skill for application purpose.

Keywords: Arctic sea-ice, Model Simulation, Coupled Model, Sea-ice verification