Sea ice forecast for polar region using coupled model

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Abstract

National Centre for Medium Range Weather Forecasting (NCMRWF) configured the Global Coupled model version 2 (GC2) with a full dynamical ocean and sea-ice components. GC2 coupled model consist of Unified Model (NCUM) at 65 km horizontal resolution and 25 km Nucleus European Modeling of Ocean (NEMO) ocean model and Los Alamos sea ice model (CICE). In the coupled model, both the atmosphere and the ocean model are initialized using the operational NCMRWF Unified Model (~17 km) and NEMO Variational Assimilation. In this study, we evaluated the sea ice forecast over the Maitri station, Antarctica, during the period of Mar-Apr 2019. This study explains the growth of sea-ice in Antarctic and also the selected region around Maitri station during this period and how it is predicted in the forecasts from day 1 to day 15. The forecasts are able to predict the growth of sea ice well despite there is a notable systematic growth in the bias.

1 Introduction

Sea-ice is one of the most important components of earth's climate system. The sea-ice insulates the ocean beneath it by reflecting the solar radiation back to the atmosphere. Drastic melting Arctic sea-ice is considered as one of the direct impacts of climate change due to increasing global temperature. Melting of sea-ice affects the albedo feedback hence the Earth's heat budget. Melting of sea-ice results in exposing a large area of Open Ocean and more heat is getting absorbed in the surface of the Earth. The last four decades the scientific community has been grateful to space borne measurements of various parameters. Different sensors onboard polar and geosynchronous satellites measure the Earth continuously which gives the advantage of large spatial and temporal coverage. Changes in the Arctic and Antarctic sea ice are one of the most direct indicators of climate change (Feltham 2015). The large scale retreat of sea-ice in the Arctic (Serreze *et al.*2007; Parkinson and Cavalieri 2012; Serreze and Stroeve 2015) and the recent decreasing changes in the Antarctic (Parkinson 2019) have been a major concern.

2. Coupled Model Set-up and Data used

At the National Centre for Medium Range Weather Forecasting (NCMRWF), the coupled model has the similar set-up as the GloSea4 system of UKMO (Arribas et al. 2011). The model implementation details are presented by Mitra et al. (2013). This model setup has been jointly developed further for monsoon prediction over South Asia. The basic model frame work is the HadGEM3 model of UKMO. The HadGEM3 model (Hewitt et al. 2011) frame work comprises of atmospheric model, UM, ocean model, NEMO and the sea-ice model, CICE. These three models are coupled using OASIS coupler. The atmospheric model has a spatial resolution of 1.875° × 1.25° in the horizontal, with 85 layers in the vertical (50 levels are below 18 km). The NEMO ocean model has a spatial resolution of 1/4° × 1/4° in horizontal and 75 vertical layers with a very fine resolution in the ocean near surface. In this study, the daily forecasts of sea ice up to 15 days for Antarctic has been compared with daily analysis. A seasonal sea-ice forecast evaluation of the HadGEM3 model over the Arctic is performed by Saheed et al. (2018).

3. Results and Discussion

The results of NCMRWF coupled model sea ice forecast and analysis is presented. Figure 1 shows the sea ice concentration bias for the selected region, (10E-30E,65S-70S), which includes the Indian Antarctic Station, Maitri. There is a systematic increase in the bias from day-1 to day-15. Similar is the case of sea-ice thickness despite there is positive and negative bias pattern. Antarctic sea-ice extent (Figure 3) shows that the sea ice analysis and day-5 to day-15. It can be seen that sea ice extent is increasing from March to April, which is captured well even in day-15 forecast. The overestimates of sea ice by the model increase with the lead times. It is interesting to note the seasonal dependency of these overestimates, with model forecasts matching well with analysis even in day-15 forecast in early March, while large overestimates are seen by April end. The reasons for this seasonal dependency in model biases need further analysis.

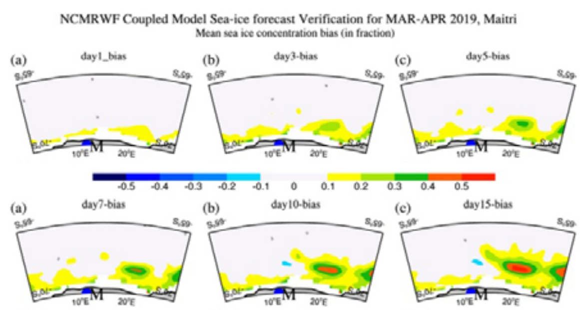

Figure 1. Sea Ice concentration forecast bias (in fraction) near the Antarctic station, Maitri.

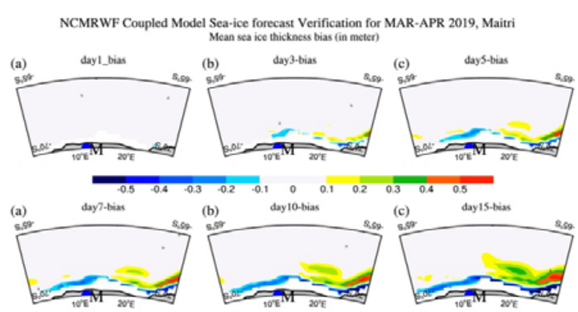

Figure 2. Sea Ice thickness forecast bias (in meter) near the Antarctic station, Maitri.

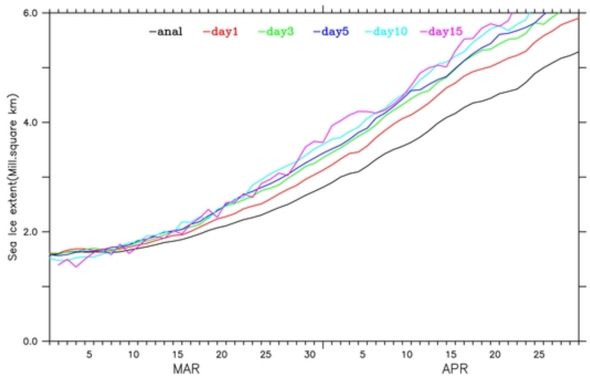

Figure 3. Antarctic sea-ice extent for Mar-April, 2019.

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