Evaluation of Ocean and Sea-ice Model States in a 20-year Spin-up of 1/4deg UFS DATM-MOM6-CICE6 and HYCOM-CICE4 Models

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1. Introduction

NOAA/NCEP develops and runs operational ocean forecasting models at various horizontal resolutions (0.5 deg: CFSR; 1deg GODAS; 1/12 RTOFS-v2). The Unified Forecast System (UFS) being developed at NOAA aims to provide forecasts at seasonal to sub-seasonal (S2S) scales at 0.25 deg resolution. The purpose of this work is to evaluate the response of two ocean sea-ice coupled models to the same atmospheric forcing initialized from a state of rest.

To achieve that aim, several metrics, including model drifts, surface biases, sea-ice extent and volume will be used. This first step will then help quantify the impact of data assimilation. This paper describes the model setup and preliminary results.

2. Method

The ocean sea-ice coupled models, UFS DATM-MOM-CICE6 [1] and HYCOM-CICE4 [2], are set-up at 0.25 deg horizontal resolution based on the MOM6 grid with 41 vertical layers based on the HYCOM vertical grid. Both the models are initialized with the temperature and salinity profile from the World Ocean Atlas (WOA) 2018 climatological dataset and with surface forcing (air temperature, precipitation, etc.,) from the global ensemble forecast system (GEFS), for the period 2000-2019. For sea-ice concentration and thickness, the default initialization values from the CICE6 and CICE4 model were used. The model parameters are kept as close as possible in the two models.

3. Results

The average modeled and climatological (WOA18) sea surface temperature (SST) and sea surface salinity (SSS) are calculated for two periods: 2000-2005 and 2010-2019. The modeled SST and SSS bias are estimated from the difference between the two models and WOA18. Figures 1 and 2 show that the SST from the UFS DATM-MOM6-CICE6 is colder than the WOA18 climatology in the tropical open ocean while the HYCOM-CICE 4 SST is warmer for both periods compared. An increase in the cold bias in both models is seen for the period 2010-2019 (Figure 2).

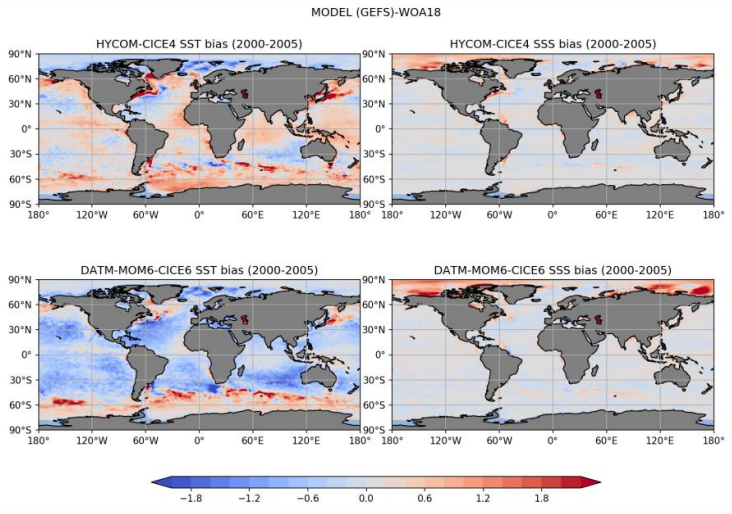

Figure 1 Bias of modeled (DATM-MOM6-CICE6 and HYCOM-CICE4) SST and SSS from WOA18 for the period 2000-2005.

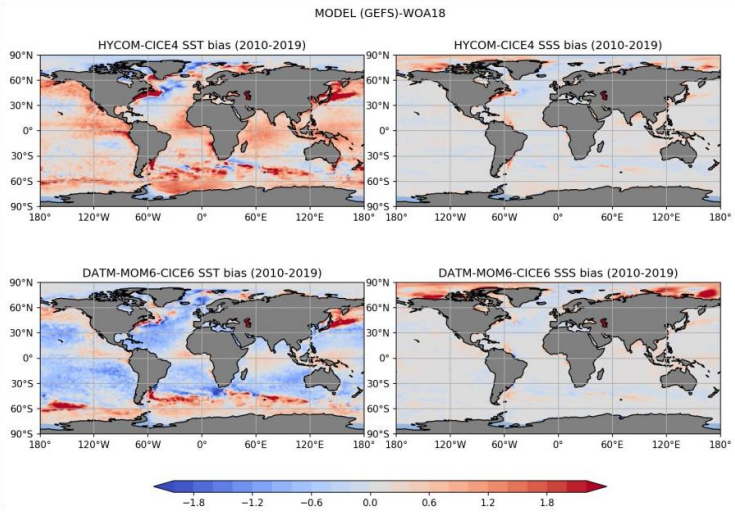

Figure 2 Bias of modeled (DATM-MOM6-CICE6 and HYCOM-CICE4) SST and SSS from WOA18 for the period 2010-2019.

The time-series of sea-ice extent (SIE), defined as the region covered with sea-ice with a threshold of 15% sea-ice concentration, and the total ice volume between the two models are shown in Figures 3 and 4 for the Arctic and the Antarctic. The total sea-ice volume from the two models is also compared against the Pan-Arctic Ice-Ocean Modeling and Assimilation System (PIOMAS) total ice volume. Figure 3 shows a reasonable comparison of the total sea-ice volume from the two models compared with PIOMAS. However, in the Antarctic the SIE and total sea-ice volume is larger in the DATM-MOM6-CICE6 than in HYCOM-CICE4.

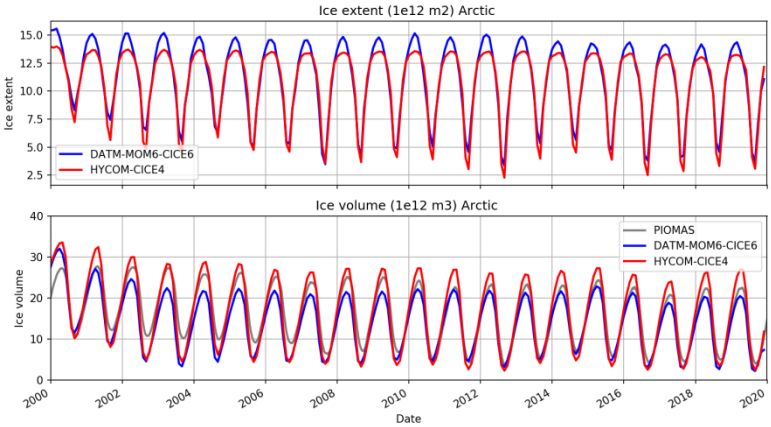

Figure 3 Sea-ice extent and total sea-ice volume for the period 2000-2019 in the Arctic between DATM-MOM6-CICE6 and HYCOM-CICE4. The total sea-ice volume is compared against PIOMAS[3].

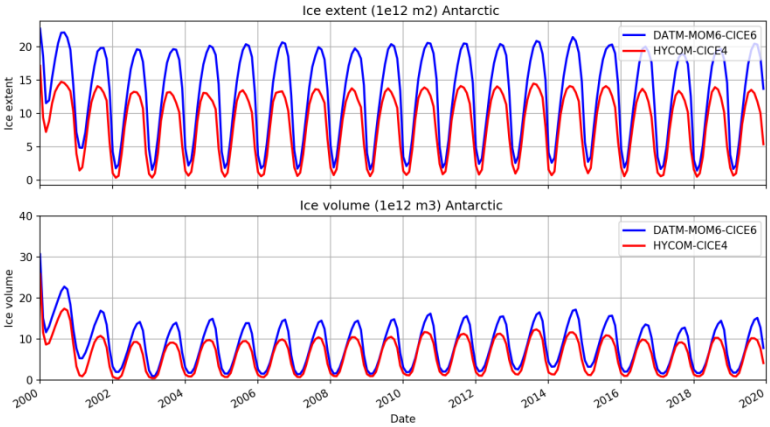

Figure 4 Sea-ice extent and total sea-ice volume for the period 2000-2019 in the Antarctic between DATM-MOM6-CICE6 and HYCOM-CICE4.

References

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