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UPDATED SEA ICE CODE AND ATMOSPHERIC FORCING IMPROVE THE ANTARCTIC SUMMER SEA ICE OF AN OCEAN MODEL

MOTIVATION

The ocean and sea ice play an important role in the Antarctic climate system, and the atmosphere plays an important role in forcing the sea ice and the ocean. A better understanding of these interactions is needed to understand recent changes and anticipate future changes in the Antarctic.

CONCLUSIONS

- The models simulate interannual variability of sea ice area reasonably well. (Fig. 1)
- The ERA5 CICE6 model area is closest to the NSIDC Climate data record observation. (Fig. 1)
- Sea ice extent is close to observed for all models for all seasons except in JFM, where the models underestimates the sea ice extent. The runs using CICE6 with ERA5 forcing is closest to the observed. (Fig. 2)
- Sea ice volume increases when changing forcing from ERA Interim to ERA 5 and decreases when changing sea ice model from CICE 5 to CICE 6. (Fig 2)
- The mixed layer depth has a similar pattern to observations. (Fig 3.)
- Important watermasses are well represented by the model, with cold waters being slightly fresher in the CICE6 run. (Fig. 4)
- The basal melt rate decreases when changing atmospheric forcing from ERA Interim to ERA 5 and increases sligtly when changing sea ice model from CICE 5 to CICE 6. (Fig 5)

THE MODEL

- The ocean model is Rutgers ROMS 3.7 and the sea-ice model is CICE5.1.2 (MetROMS-Iceshelf), or CICE6.1.3 in the upgraded version (MetROMS-UHel).
- The sea-ice and ocean models are linked using the MCT coupler
- The model employs ocean-ice shelf thermodynamics.
- Its domain extends up to 30°S with a ¼° lat-lon horizontal resolution and 31 terrain following levels, making the horizontal resolution 5 – 20km.
- Atmospheric forcing is from ERA-Interim or ERA 5, depending on the run (Table 1), and lateral boundary conditions from ECCO2 ocean reanalysis.
- The model includes the Biogeochemistry module BEC (Biogeochemical Elemental Cycling) for ROMS (not shown).

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Table 1: The atmospheric forcing and sea ice model of the different model runs.

Model run	Atmospheric forcing	Sea ice model
C5EI	ERA Interim	CICE 5
C5E5	ERA 5	CICE 5
C6EI	ERA Interim	CICE 6
C5E5	ERA 5	CICE 6

RESULTS

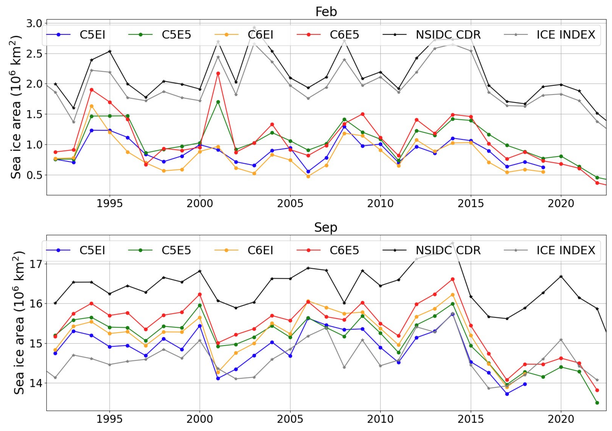

Figure 1. February and September Southern Ocean monthly average sea ice for the four different model runs (blue, green, yellow, red) and for Sea Ice index (gray) and NSIDC Climate Data Record sea ice concentration (black) in 1992 – 2022. modelled (color) and observed (black, grey) sea ice area.

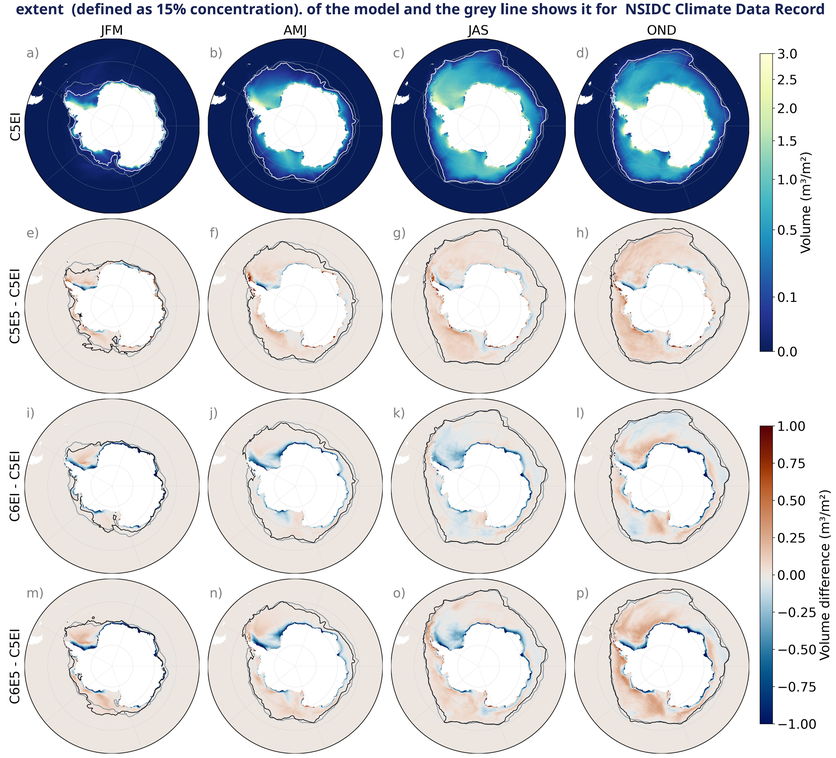

Figure 2. Sea ice seasonal mean volume [m³/m²] 1992 – 2018 of model run C5EI (a – d) and volume differences (e – p) between C5EI and the other model runs (C5E5, C6EI, C6E5). The black (white) line shows the sea ice extent (defined as 15% concentration). of the model and the grey line shows it for NSIDC Climate Data Record

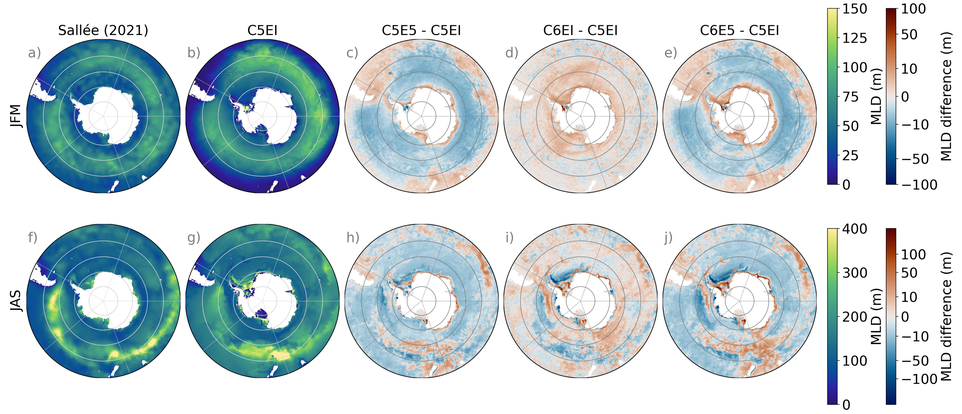

Figure 3. Summer (JFM) and Winter (JAS) mixed layer depth (MLD) in meters. From left to right; Sallee (2021) 50 year climatology (a,f), C5EI model simulations (b, g), and difference between C5EI and the other (C5E5, C6EI, C6E5) model runs (c – e, h – j). The Sallee (2021) climatology is calculated from observations 1970 – 2018 and the model runs are from 1992 – 2018. Note the different scales on colorbars for summer and winter

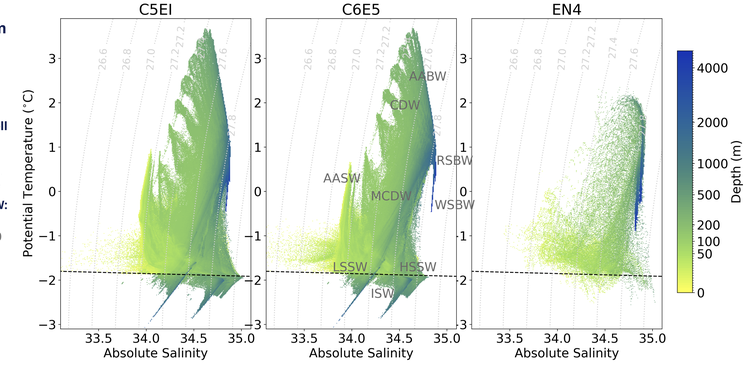

Figure 4. Modelled CICE5 ERA Interim (left), CICE6 ERA5 (middle) and EN4 observed (right) 1996-2018 TS-diagrams from south of 65°S with main water masses in grey:
AABW: Antarctic Bottom Water, WSBW: Weddell Sea Bottom Water, RSBW: Ross Sea Bottom Water, CDW: Circumpolar Deep Water, MCDW: Modified Circumpolar Deep Water, LSSW: Low-Salinity Shelf Water, HSSW: High-Salinity Shelf Water, AASW: Antarctic Surface Water, and ISW: Ice-Shelf Water.
The EN4 data version 4.2.2, bias correction g10

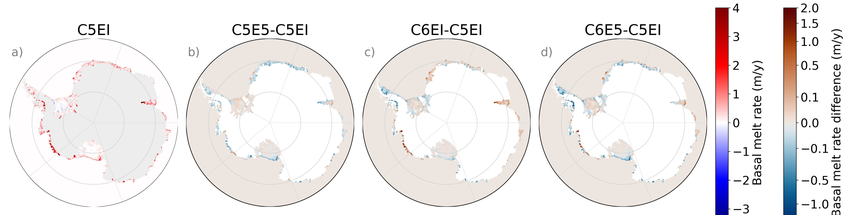

Figure 5. Average basal melt rate [m/y] from 1996 – 2018. For (a) C5EI model run and (b – d) difference between the C5EI model run and the other (C5E5, C6EI, C6E5) model runs.

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