National Oceanography Centre

Detecting Model Based Polynyas for Deep Water Formation in the Southern Ocean

Benjamin I. Barton
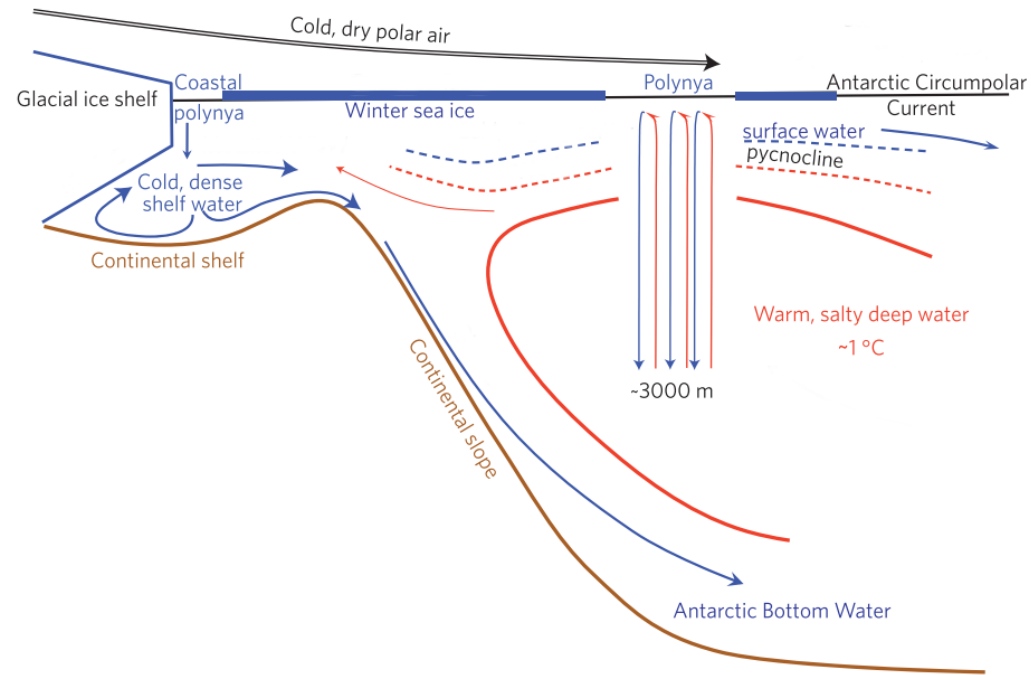A. J. George Nurser
Yevgeny Aksenov

Encore is the National Capability ORCHESTRA Extension
ENCORE!

Sharing is encouraged

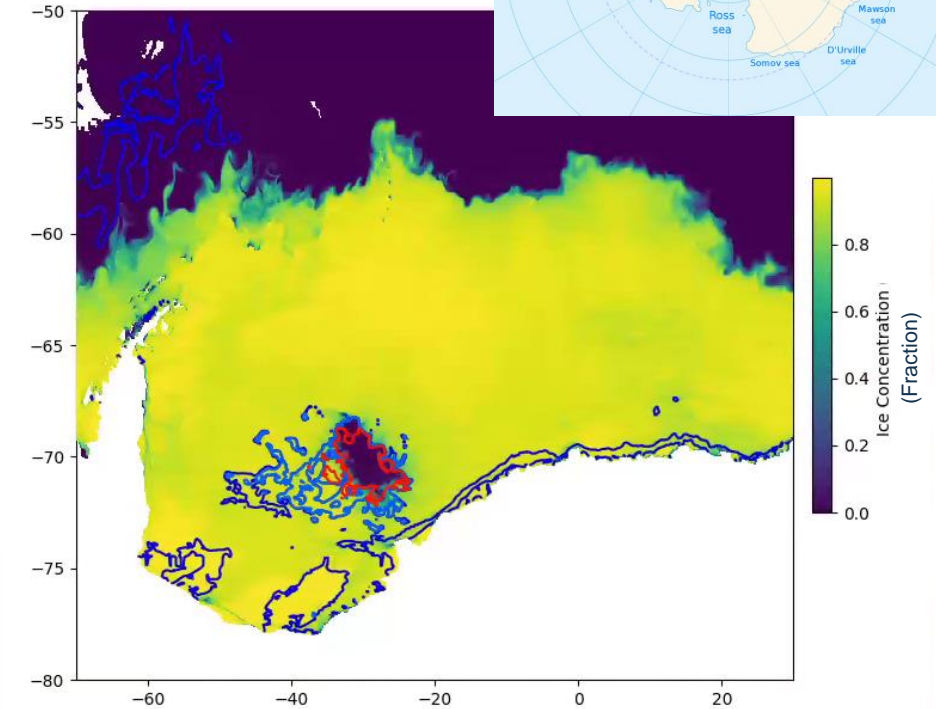https://doi.org/10.5194/egusphere-egu22-4235

Image from NASA

Introduction

- Polynya are open areas of sea ice where the ocean can cool and form dense water

- 2 types of polynya can occur:
    1. Coastal polynya (latent heat)
    2. Open water polynya (sensible heat)

Snapshot of model output from 1980-08-15. Sea ice concentration in colour and pycnocline contours at 400 m (dark blue), 1000 m (blue) and 4000 m (red)

Adapted from Gordon (2014)

Methods

National Oceanography Centre

- 2 models were used (here we show 1):
    1. Southern Ocean circumpolar NEMO at 1/12° (~9km) res. coupled to LIM3. A 40 year (1978 - 2018) simulation forced by JRA55 atmospheric reanalysis

- Satellite sea Ice data from the Operational Sea surface Temperature and Ice Analysis (OSTIA) project spanning 1982 - 2016. Feature resolution is 10 km (~1/12°)

- Sea ice type provinces (according to concentration) were categorized based on the methods of Stroeve et al. (2016). Details in the table.

Category	Sea ice concentration
Loose Ice	< 15%
Marginal Ice Zone (MIZ)	15 - 80%
Pack Ice	> 80%
Open Pack Ice	15 - 80\% within pack ice
Inner Open Water	< 15% within pack ice or MIZ
Coastal Polynya	< 80% within pack ice or MIZ, and adjacent to land

Results

- Open water polynya
  - Very deep pycnocline (>4000 m)
 - Thin (<0.4 m), low concentration (<0.2) sea ice
  - Inner Open Water

- Coastal polynya
  - Deep pycnocline (>400 m)
  - Thin sea ice (<0.4 m) but high concentration (>0.8)
  - Using thickness <0.4m as an criteria for Coastal Polynya Classification (d)
  - Tamura et al. (2016)
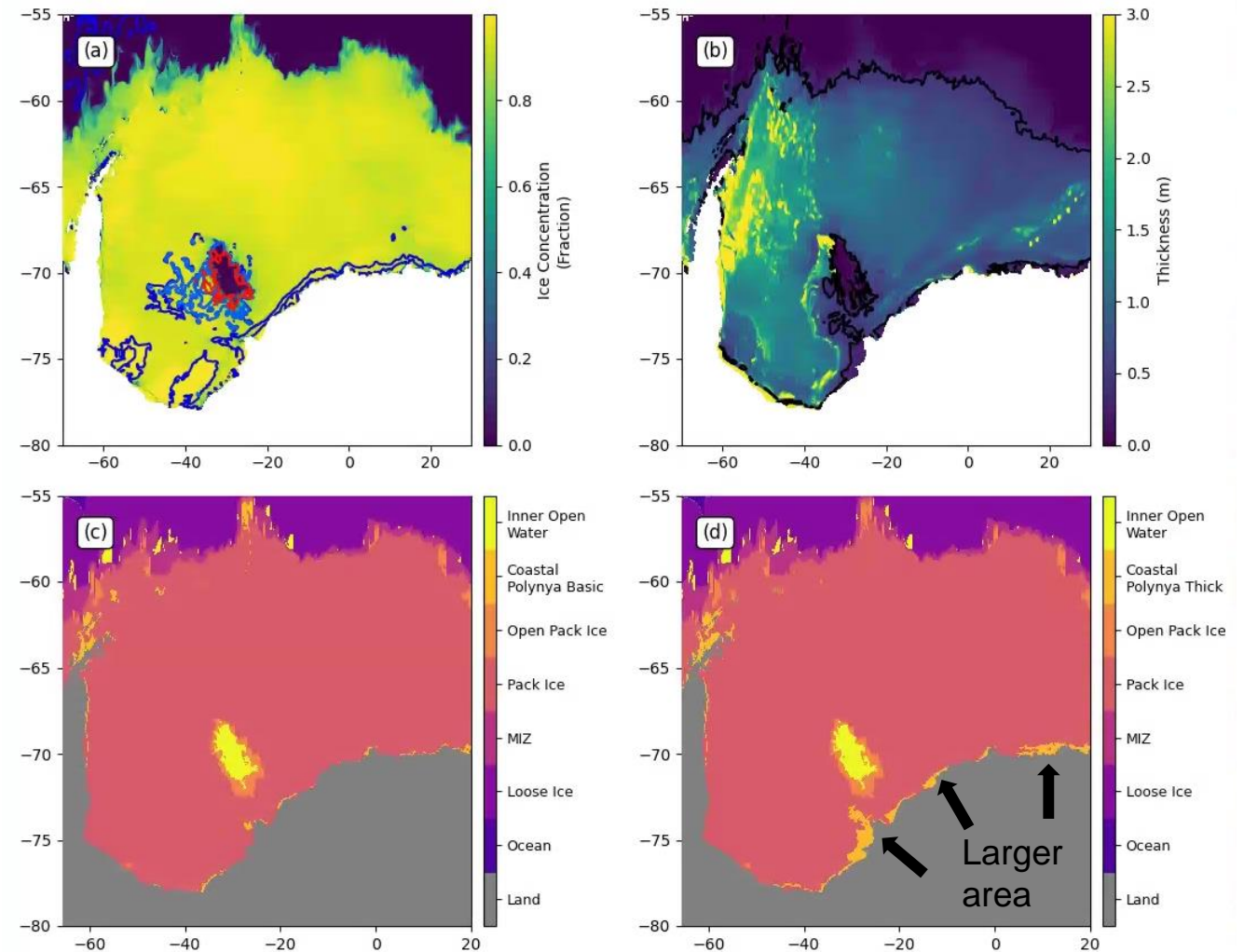
Snapshot of model output from 1980-08-15. (a) Sea ice concentration in colour and pycnocline contours at 400 m (dark blue), 1000 m (blue) and 4000 m (red). (b) Sea ice thickness, black contour at 0.4 m. (c) Sea ice types classification from concentration. (d) Sea ice classification from concentration and thickness.

Results

- Basic coastal polynya show no trend

- Thickness criteria coastal polynya show negative trend

- Satellite coastal polynya show negative trend

- Satellite and model show large interannual variation in area of coastal and open water polynyas
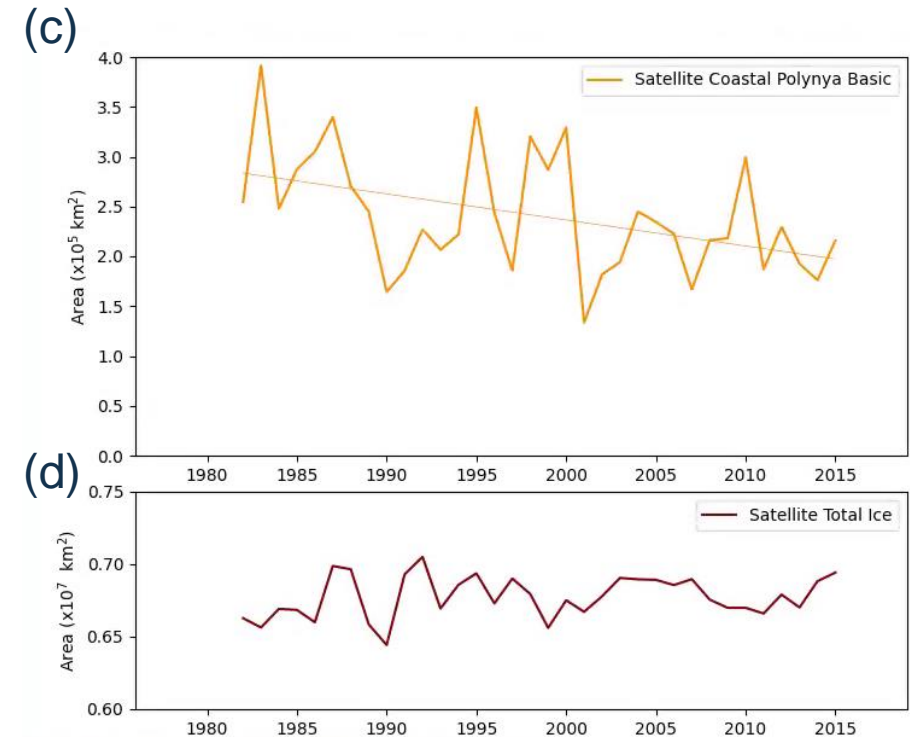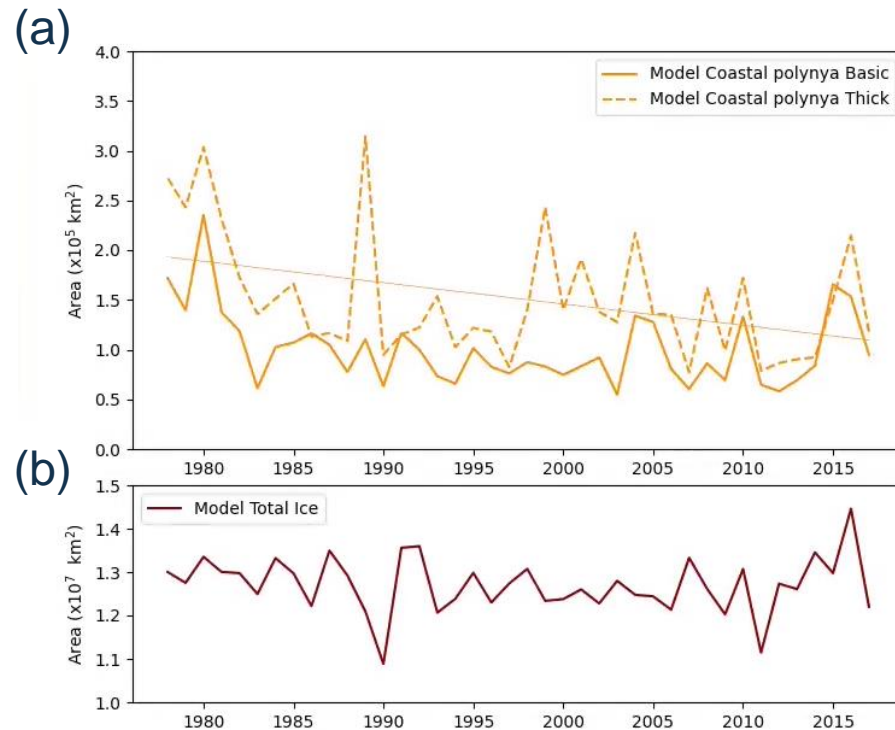
(a) Winter (Jun to Nov) sea ice categories in the Weddell Sea from the model. (b) Timeseries of total sea ice area in winter (Jun to Nov) in the Weddell Sea. (c) and (d) same but for satellite data.

Conclusion

- Deep water forms at polynyas in the Southern Ocean
- To quantify deep water formation in models we need to accurately classify polynya to understand the importance of sea ice in deep water formation
- Model polynya show the need to include sea ice thickness as a parameter of polynya classification
- There has been a decline in polynya area from 1980s to 2010s with large interannual variability

Presented by
Benjamin Barton
benbar@noc.ac.uk

https://doi.org/10.5194/egusphere-egu22-4235

Image from NASA