The ACCESS-OM2 coupled global ocean - sea ice model suite

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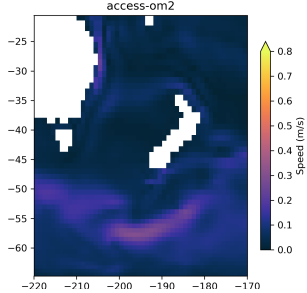
Model Development

- Why should we develop our own models?
  1. Need experience in the community.
  2. Configure for our priorities.
  3. Contribute to the global research landscape.
- Divide model development into two parts:
  1. Code
  2. Configurations

Consistent global configurations at **three horizontal resolutions**

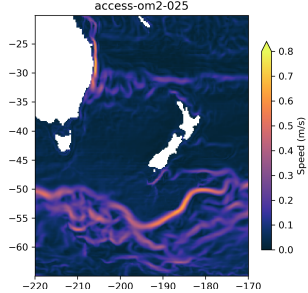
ACCESS-OM2

- 1° horizontal grid
  360 × 300 cells, 24–111 km
- 50 z^* levels
  Δz = 2.3–220 m
- fast and cheap
  ∼ 24min/yr, 0.1 kCPU hr/yr
  on 252 PEs, dt=5400 s
- many multi-century experiments
- not eddy-resolving



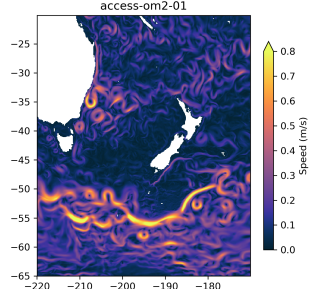
ACCESS-OM2-025

- 0.25° horizontal grid
  1440 × 1080 cells, 6.0–27.8 km
- 50 z^* levels
  Δz = 2.3–220 m
- fairly fast, less cheap
  105 min/yr, 4.5 kCPU hr/yr
  on 1824 PEs, dt=1800 s
- several multi-century experiments
- eddy "permitting"



ACCESS-OM2-01

- 0.1° horizontal grid
  3600 × 2700 cells, 2.2–11.1 km
- 75 z^* levels
  Δz = 1.1–198 m
- slow, expensive
  9 hr/yr, 55–65 kCPU hr/yr
  on 5096 PEs, dt=600 s
- several multi-decade experiments
- eddy-rich



ACCESS-OM2 unifies & improves ACCESS & Bluelink ocean-sea ice code

- ACCESS-OM2 at 1° is the ocean-sea ice component of ACCESS-CM2.
- ACCESS-OM2-025 pioneers development of 0.25° ocean and sea ice components for future versions of the ACCESS coupled climate model.
- ACCESS-OM2-01 will be the new dynamical core of Bluelink (OceanMAPSv4.0), to extend Bluelink reanalyses and forecasts to global coverage, including sea ice.
- **The code, multi-resolution configurations, inputs and outputs are available** for ocean and sea ice studies on timescales up to multidecadal (at high resolution) or multicentennial (at low resolution).

ACCESS-OM2 is being developed by **COSIMA (cosima.org.au)**, via ARC Linkage:

- **ANU** (Hogg), **UNSW** (England, Spence), **UTas** (Heil, Nikurashin), **CSIRO** (Oke), **Australian Antarctic Division** (Heil), **BoM** (Brassington)

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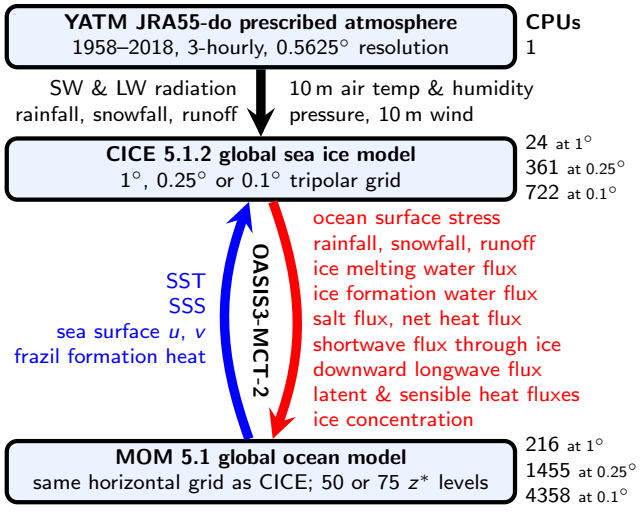
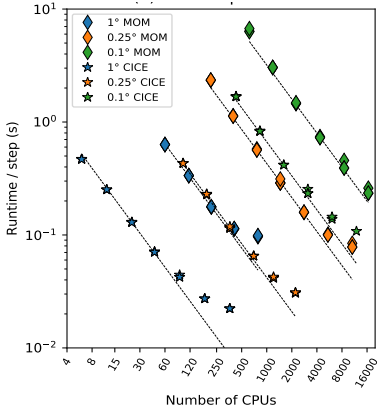
ACCESS-OM2 coupled model components and parallel scaling





For 0.1° configuration

- MOM scales to 16,000 CPUs.
- CICE scales to 2000 CPUs.
- get 6 model months within 5 hr job limit.

Model runs

ACCESS-OM2 (1°) (Abhishek Savita)

- 300-yr run: five 1958–2017 JRA55-do cycles starting from WOA13

ACCESS-OM2-025 (0.25°) (Andy Hogg)

- 300-yr run: five 1958–2017 JRA55-do cycles, starting from WOA13

ACCESS-OM2-01 (0.1°) (Andrew Kiss) ▶

- 33-yr run, JRA55-do 1985–2017, spunup with 40 years of repeated May 1984 – April 1985 JRA55-do forcing starting from WOA13

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Geoscientific Model Development Discussions
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ACCESS-OM2: A Global Ocean-Sea Ice Model at Three Resolutions

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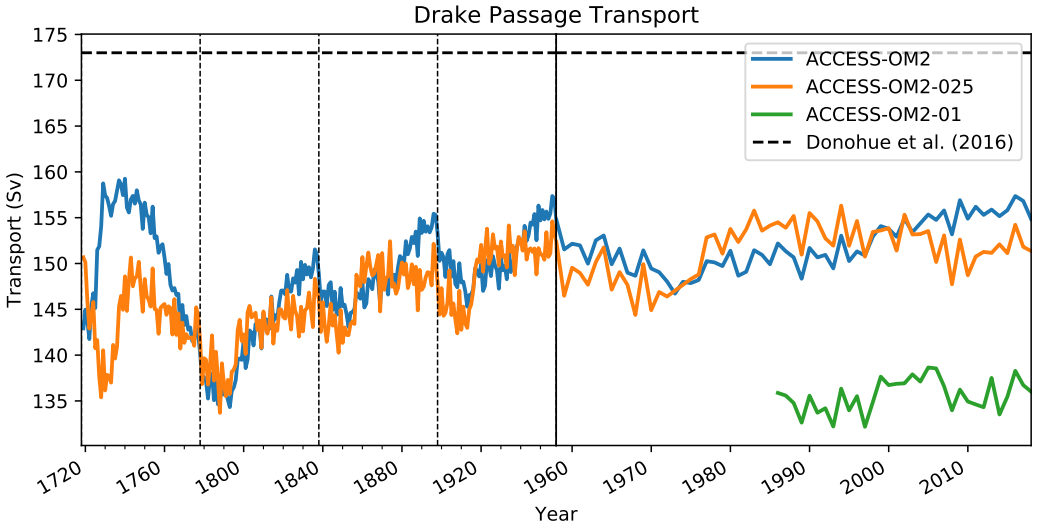
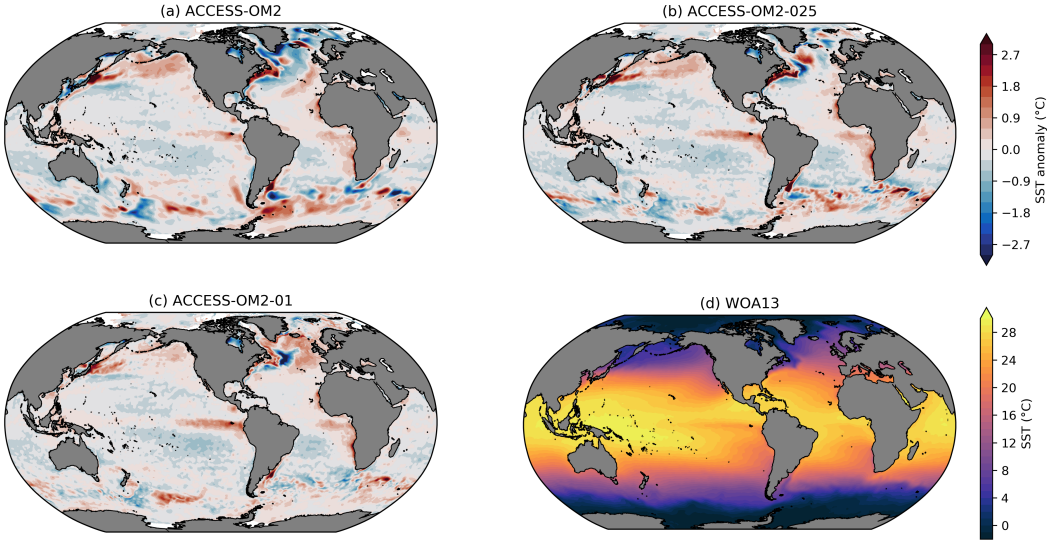


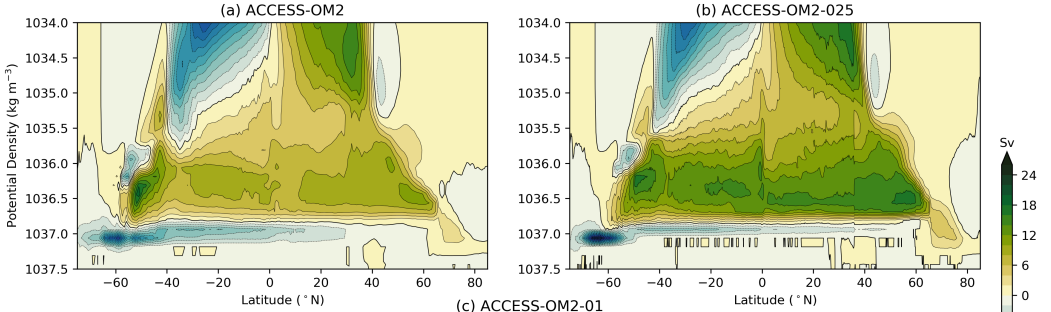
Four 60-year JRA55-do cycles

Fifth cycle (expanded time scale)

1993–2017 mean SST bias relative to WOA13



1993–2017 mean overturning streamfunction



AABW at 40°S

1°	6–10 Sv
0.25°	6–10 Sv
0.1°	12–15 Sv
obs.	20–50 Sv

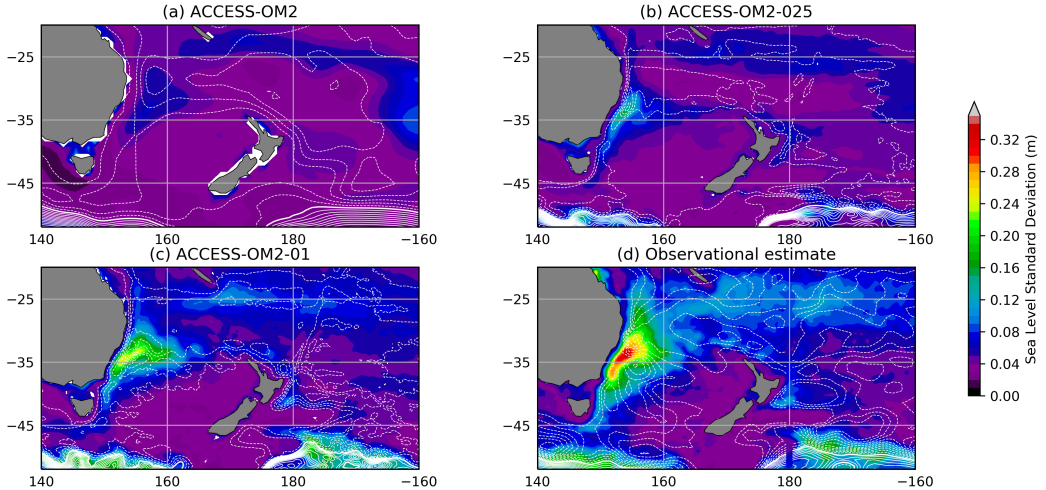
obs: Sloyan & Rintoul 2001
Lumpkin & Speer 2007
Talley 2013

AMOC at 26°N

1°	8–10 Sv
0.25°	12–16 Sv
0.1°	14–22 Sv
obs.	17.2 Sv

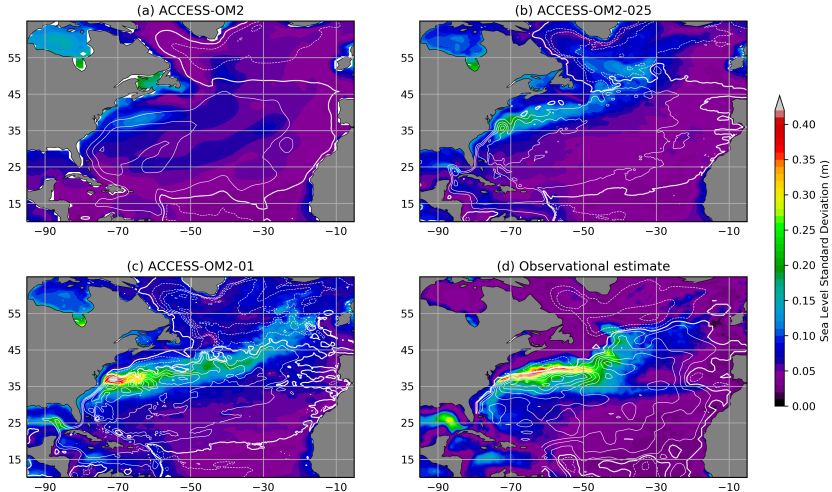
obs: McCarthy et al. 2015

EAC barotropic streamfunction and SSH variability



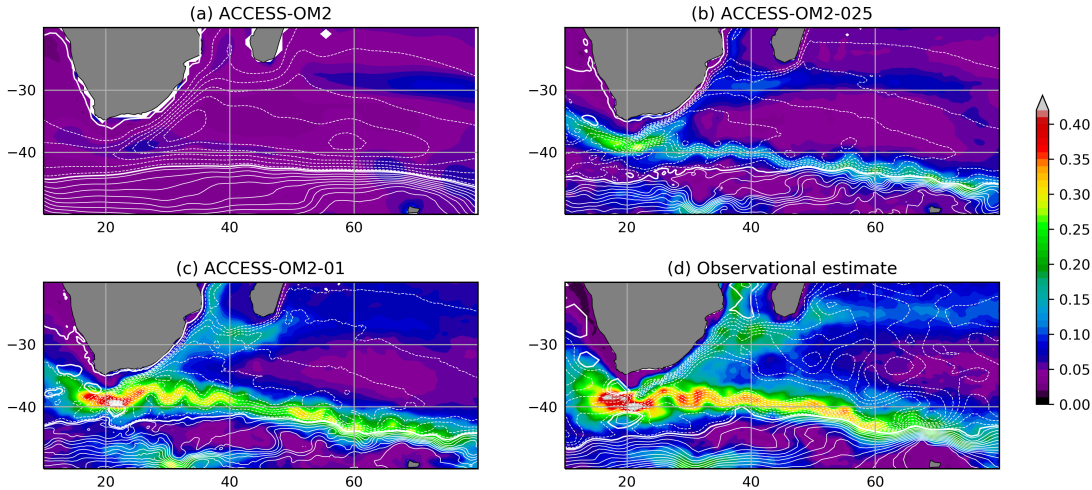
Obs: AVISO and Colin de Verdiére & Ollitrault, JPO 2016

Gulf Stream barotropic streamfunction and SSH variability



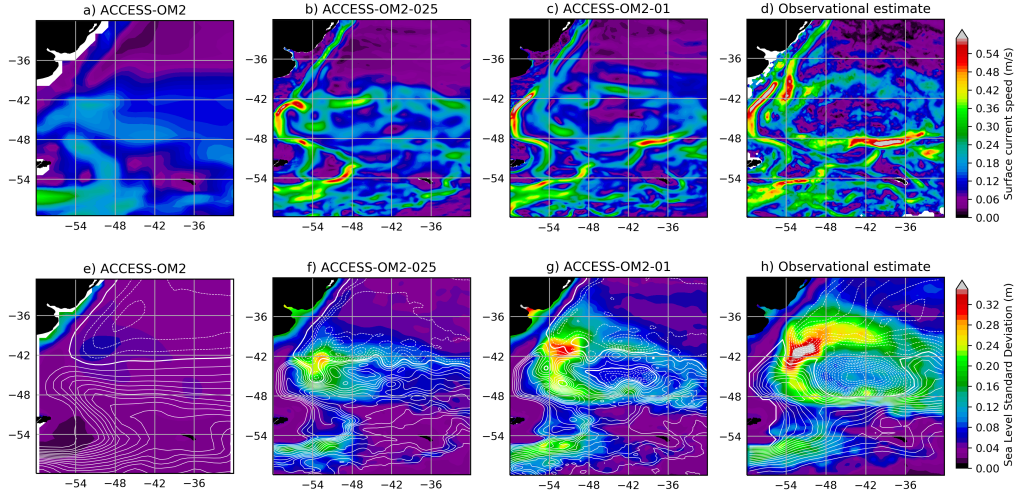
Obs: AVISO and Colin de Verdiére & Ollitrault, JPO 2016

Agulhas barotropic streamfunction and SSH variability



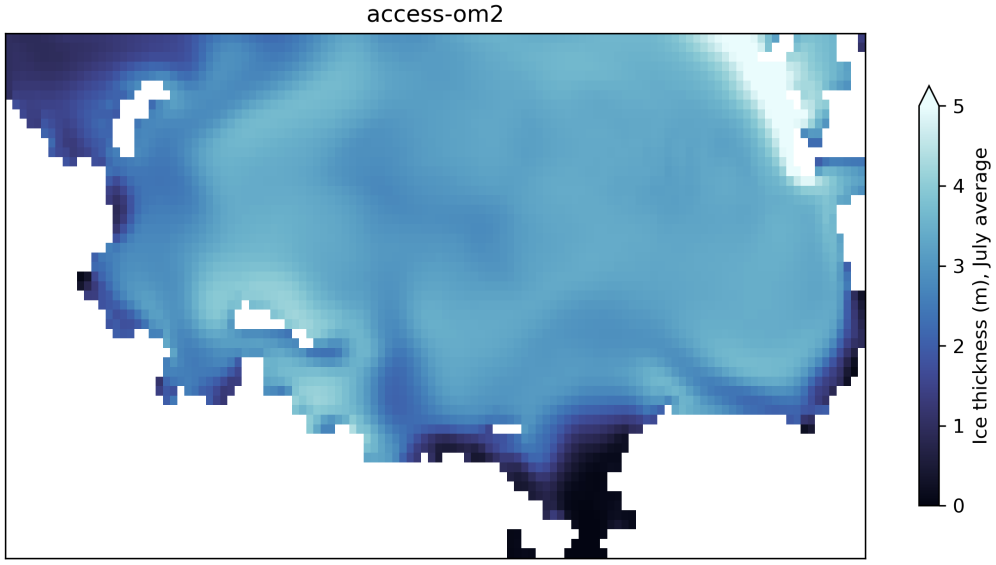
Obs: AVISO and Colin de Verdiére & Ollitrault, JPO 2016

Brazil-Malvinas speed, barotropic streamfunction and SSH variability

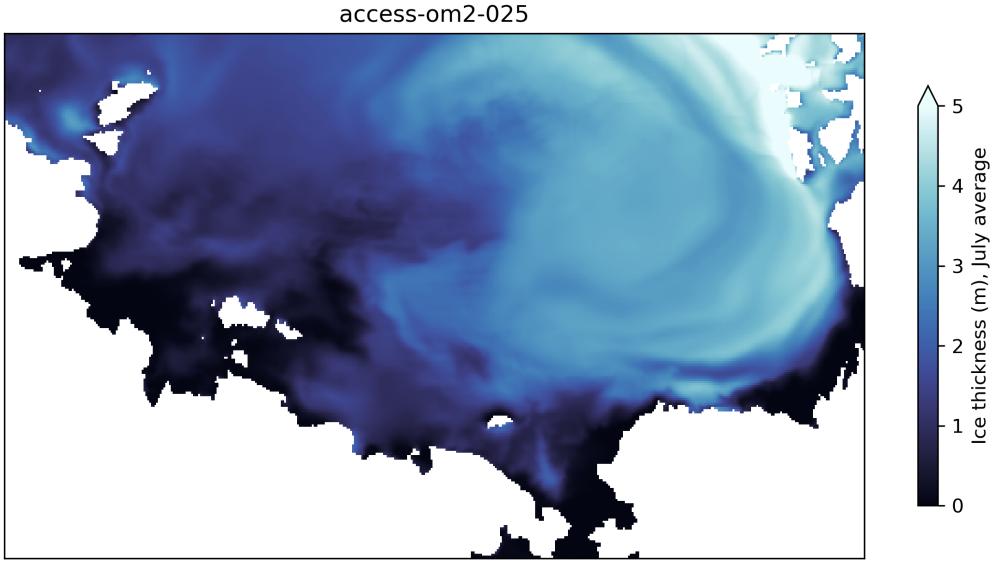


Obs: Laurindo et al., DSR 2017, AVISO and Colin de Verdiére & Ollitrault, JPO 2016

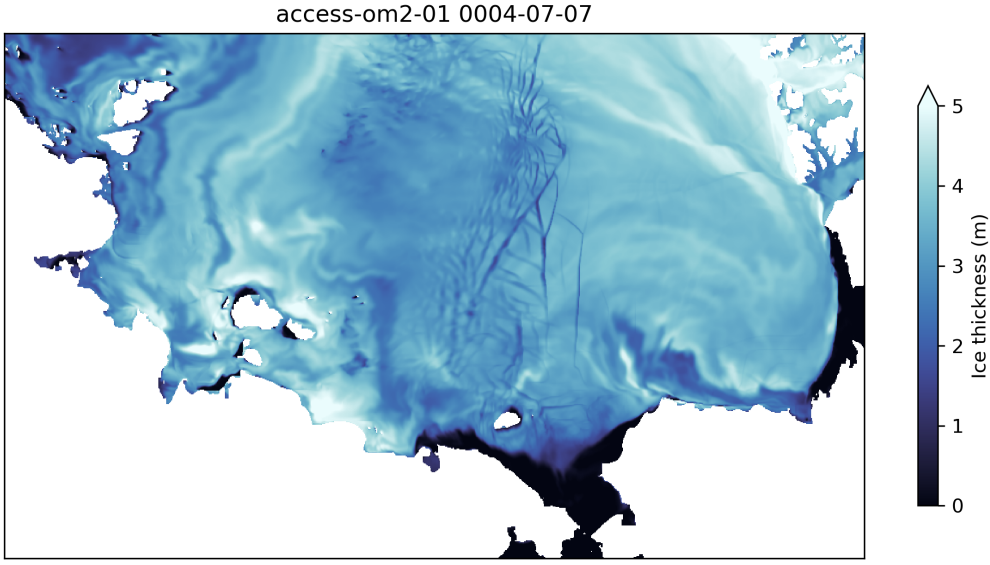
Arctic sea ice thickness at 1° (Laptev & Beaufort Seas)



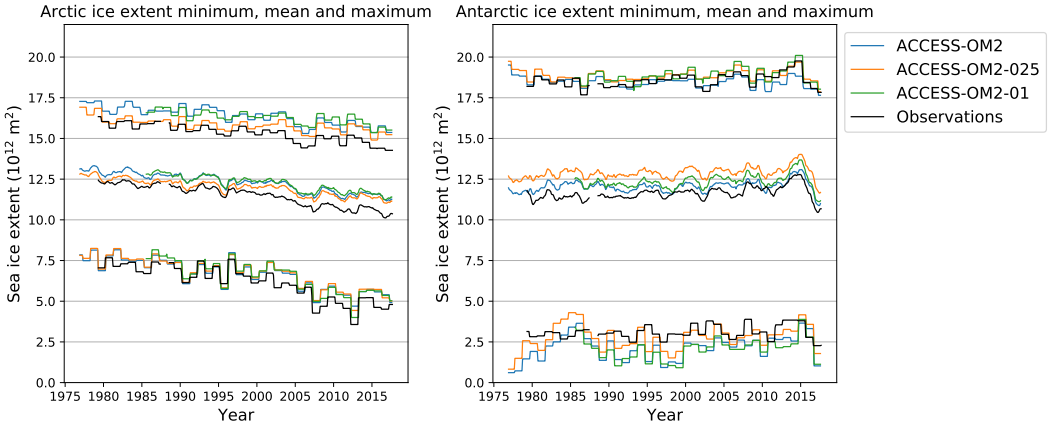
Arctic sea ice thickness at 0.25° (Laptev & Beaufort Seas)



Arctic sea ice thickness at 0.1° (Laptev & Beaufort Seas) ▶

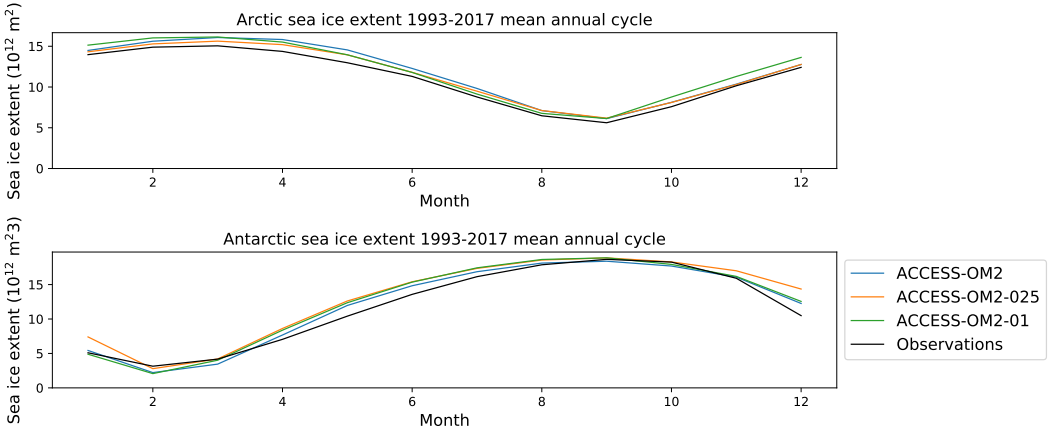


Sea ice extent: running 12-month min, mean and max



Obs: NOAA/NSIDC G02135 Sea Ice Index v3 (Fetterer et al., 2017)

1993–2017 mean annual cycle of sea ice extent



Obs: NOAA/NSIDC G02135 Sea Ice Index v3 (Fetterer et al., 2017)

Summary

- ACCESS-OM2 is a global coupled ocean - sea ice model at 3 resolutions, unifying and improving ACCESS and Bluelink codebases and configurations
  - Multiple resolutions are suitable for studies of resolution dependence and parameterisation
  - Parallel scaling to very high CPU counts
  - Model biases reduced at high resolution
- We have focussed on building a community around the development of the model: **C**onsortium for **O**cean **S**ea **I**ce **M**odelling in **A**ustralia – **COSIMA**
  - website: see **cosima.org.au**
  - weekly "MOM" video meetings
  - code: **https://github.com/COSIMA/access-om2**
  - analysis: **https://github.com/COSIMA/cosima-cookbook**
- Many projects now using ACCESS-OM2 suite output data and models: WBC dynamics, heat transports, marine heatwaves, eddy tracking, bottom water, etc.

The COSIMA community

cosima.org.au

github.com/COSIMA

- 2016 workshop: 20 talks, 38 participants
- 2017 workshop: 26 talks, 34 participants
- 2018 workshop: 30 talks, 49 participants (pictured)
- 30 authors on ACCESS-OM2 model description paper
- 60 users of ACCESS-OM2 models and data
- ARC Linkage: ANU, UNSW, UTas, AAD, BoM, CSIRO
- Model code, configurations & outputs all freely available

Paper in review at GMDD

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