Overview of the ACCESS-OM2 model suite

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COSIMA workshop, 7–8 May 2018, Canberra

ACCESS-OM2

ACCESS-OM2 is being developed by COSIMA for nationwide use in ocean sea-ice modeling.

Model components:

- **Ocean model**: Modular Ocean Model (MOM) 5.1
- **Sea-ice model**: CICE 5.1
- **Coupler**: OASIS3-MCT
- **Prescribed JRA55-do atmospheric forcing** via MATM:
  - 0.5625°, 3-hourly
  - Repeat year (e.g. 1 May 1984 – 30 April 1985) for spinup
  - Interannual forcing (via YATM) undergoing testing
- **Initial condition and salt restoring:** World Ocean Atlas 2013v2
- **Grids**:
  - global (90°N – 81°S); tripolar in Arctic; Mercator for 65°N – 65°S
  - **three resolutions:** 1°, 0.25°, 0.1° horizontal resolution
  - z^* vertical coordinate, 75 levels, Δz=1.1 – 198 m (for 0.1° configuration)
- **Compute**: 1200 PUs (CICE) + 4358 PUs (MOM) + 1 PU (MATM) at 0.1°

ACCESS-OM2 is available in **three resolutions**

ACCESS-OM2

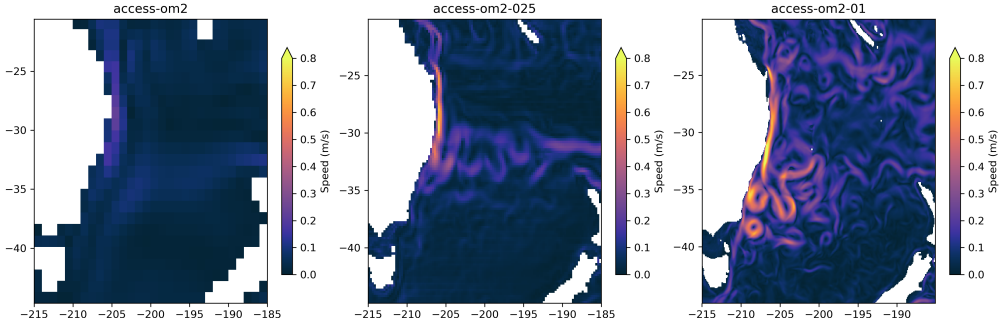
- 1° horizontal grid
- 50, 75 or 100 levels
- fast and cheap
  ∼ 16min/yr on 252 PEs, dt=5400s
- not eddy-resolving

ACCESS-OM2-025

- 0.25° horizontal grid
- 50 levels
- fairly fast, less cheap
  < 60min/yr on 1960 PEs, dt=1800s
- eddy permitting

ACCESS-OM2-01

- 0.1° horizontal grid
- 75 levels
- slow, expensive
  17–24hr/yr on 5559 PEs, dt=300–400s
- eddy resolving



ACCESS-OM2 vs. ACCESS-OM, OFAM3, etc.

- ACCESS-OM2 updates and extends ACCESS-OM and OFAM3
- Uses same MOM, CICE and OASIS versions as ACCESS-CM2 (1°)
- Builds on experience with ACCESS-OM, MOM-SIS-025 and MOM-SIS-01
- Newer forcing, bathy & sea ice than MOM-SIS-01 (Spence et al., 2017)

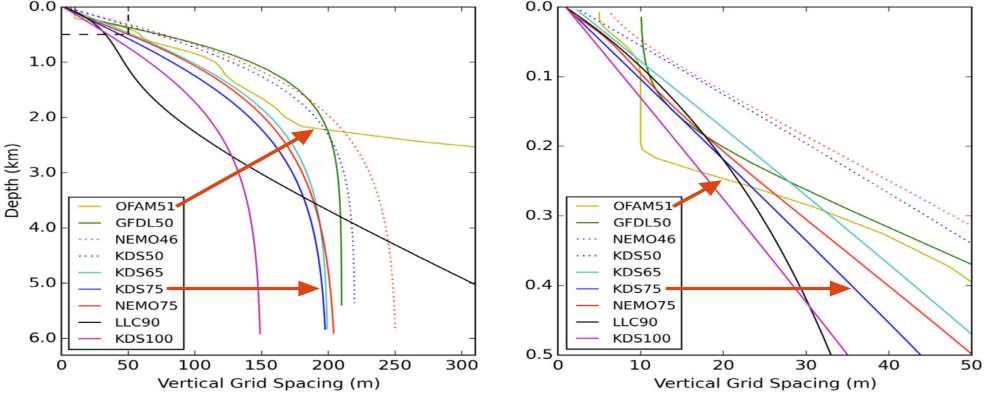
	ACCESS-OM	**OFAM3**	**ACCESS-OM2**
Ocean	MOM 4.1	MOM 4.1	**MOM 5.1**
Sea ice	CICE 4.1	—	**CICE 5.1**
Coupler	OASIS 3.25	—	**OASIS 3-MCT**
Grid	global tripolar, z^*	75°S–75°N only, z^*	**global** tripolar, z^*
Resolution	1°, 360×300×50	0.1°, 3600×1500×51, Δz=5 – 1000m	**0.1°, 3600×2700×75, Δz=1.1 – 198m** (also 0.25° and 1°)

Vertical resolution

75 level vertical grid is finer than OFAM3 at all depths other than 100 – 260 m and finer than GFDL50 and NEMO46 at all depths.

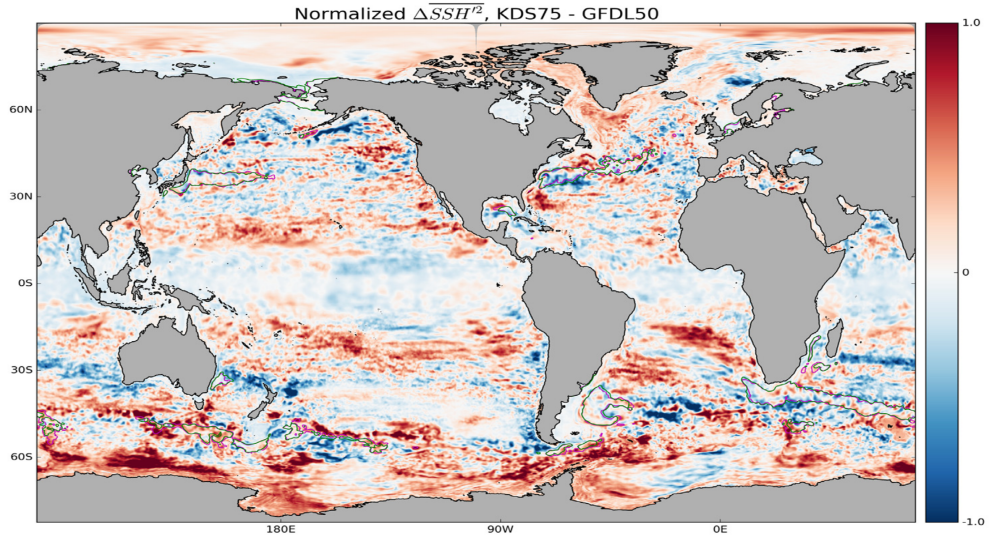
Δz=1.1 – 198 m (cf. 5 – 1000 m in OFAM3)

Spacing optimised for resolving baroclinic modes.



(Stewart et al., 2017)

SSH variance: 75 vs. 50 levels



(Stewart et al., 2017)

Technical progress in the ACCESS-OM2 suite

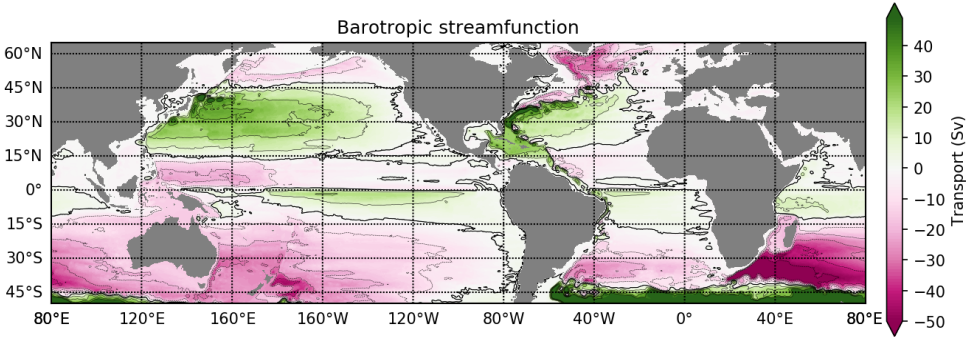
All resolutions:

- JRA55-do v1.3 atmospheric forcing (1984-5, 1990-1 or 2003-4 repeat-year, 0.5625°, 3-hourly) in addition to CORE NYF (2°, 6-hourly)
- SCRIP regridding for OASIS3-MCT does not scale to 0.1°
  - Use ESMF_RegridWeightGen instead; also allows smoother conservative interpolation—needed when model is finer than forcing (Nic Hannah)
- Online runoff remapping by MATM via KDTREE2, with spatially variable conservative flux limiting (Nic Hannah)
- Fixed forcing interpolation issues and ocean-ice instabilities
- Fixed runoff and flux balance problems

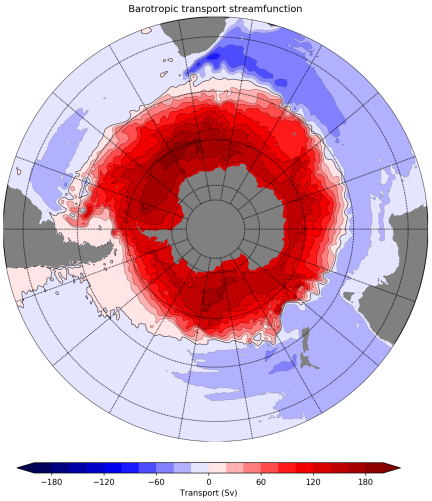
In addition, at 0.1°:

- New global bathymetry based on GEBCO 2014 30sec data (Russ Fiedler)
- Improved vertical resolution: 75 levels, Δz=1.1 – 198m, max = 5808m, spacing optimised for resolving baroclinic modes (Stewart et al., 2017)
- Resolved issues with ice formation in fresh regions driving salinity below zero (Russ Fiedler)

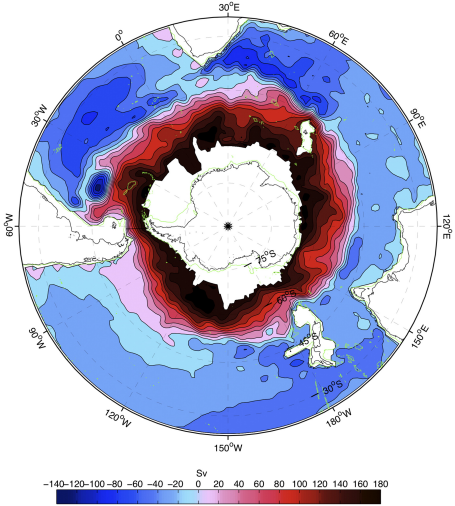
Barotropic transport (10-year mean)



ACC barotropic transport

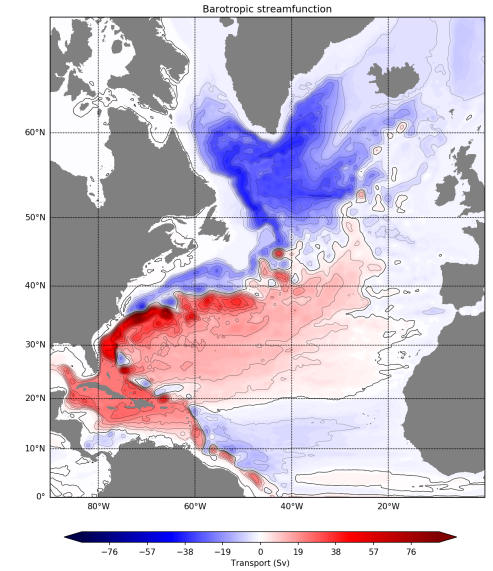


ACCESS-OM2-01 10-year mean
137 Sv at Drake Passage

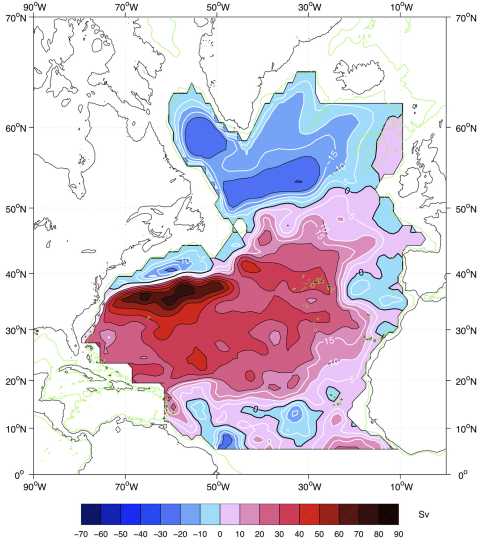


Obs (WOA & Argo): 175 Sv at DP
Colin de Verdiére & Ollitrault, JPO 2016

Gulf Stream barotropic transport



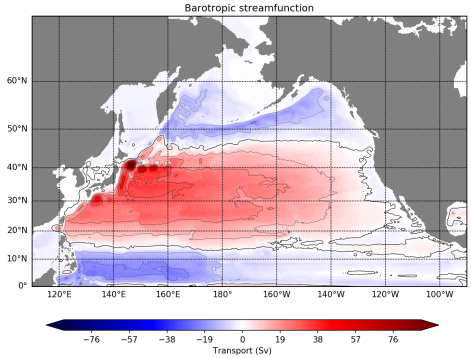
ACCESS-OM2-01 10-year mean



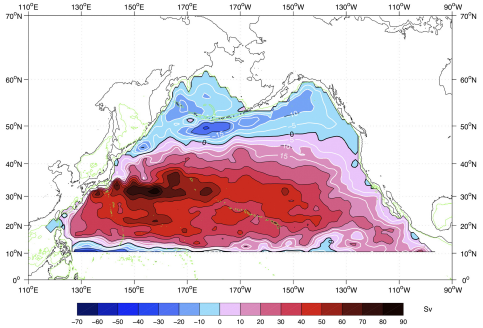
Obs (WOA & Argo)

Colin de Verdiére & Ollitrault, JPO 2016

Kuroshio barotropic transport

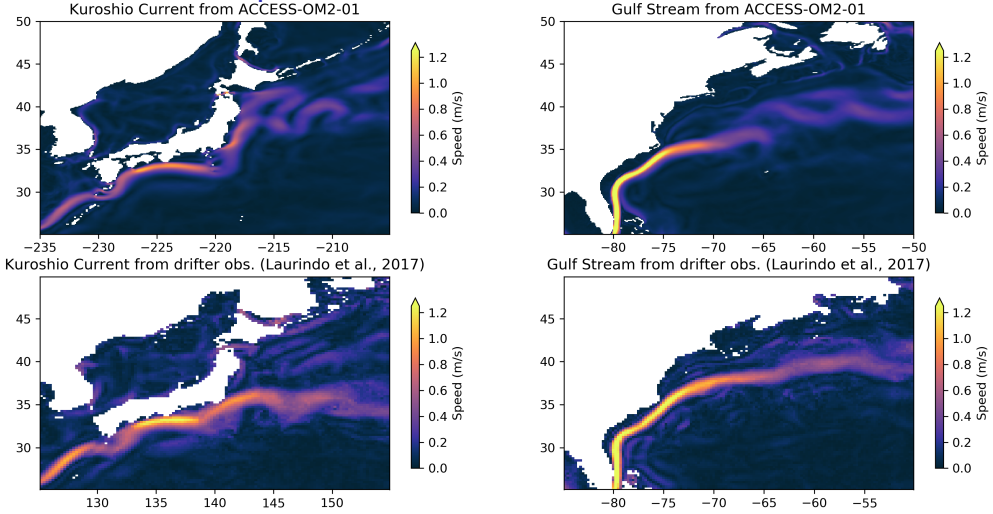


ACCESS-OM2-01 10-year mean
Kuroshio separates late



Obs (WOA & Argo)
Colin de Verdiére & Ollitrault, JPO 2016

Surface current speed vs. drifter obs.

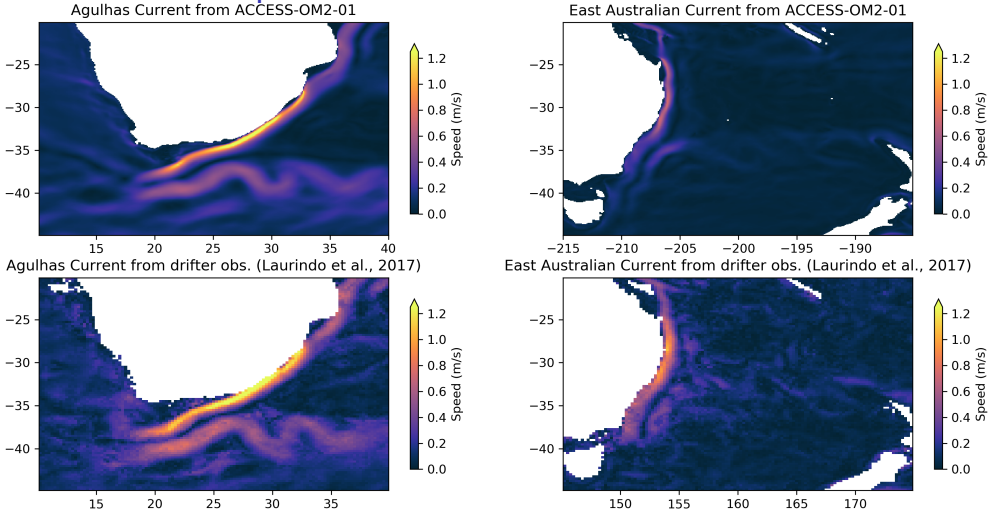


model: 10-year mean surface current

obs: 1979 – 2015 mean from drifters at 15 m (Laurindo et al., 2017)

thanks to Fanghua Wu

Surface current speed vs. drifter obs.

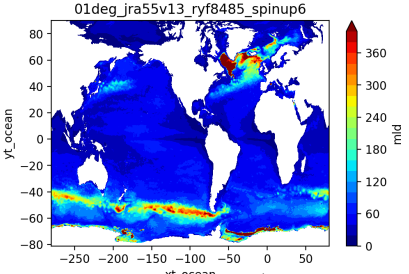


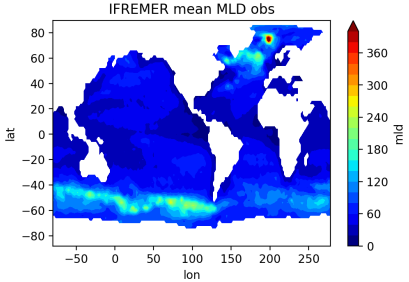
model: 10-year mean surface current

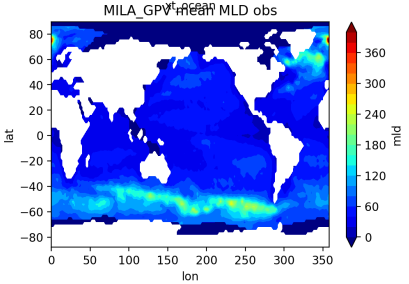
obs: 1979 – 2015 mean from drifters at 15 m (Laurindo et al., 2017)

thanks to Fanghua Wu

Mixed layer depth (annual mean)

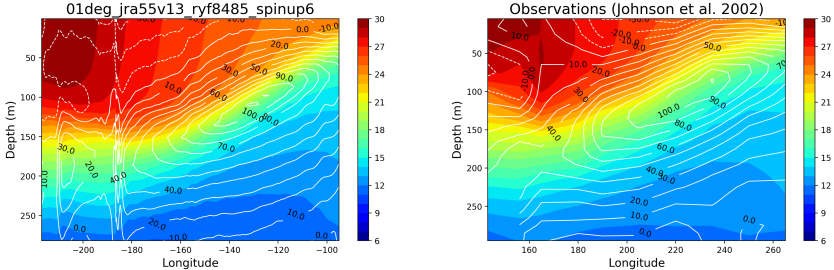




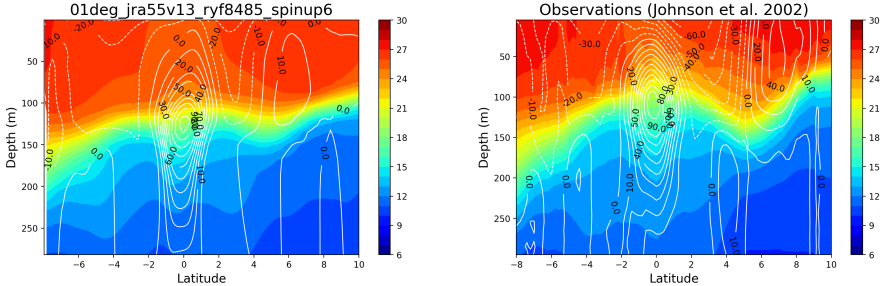


thanks to Fanghua Wu

Equatorial Pacific 10-year mean temperature & eastward velocity



Across equator at 140W:



Future steps

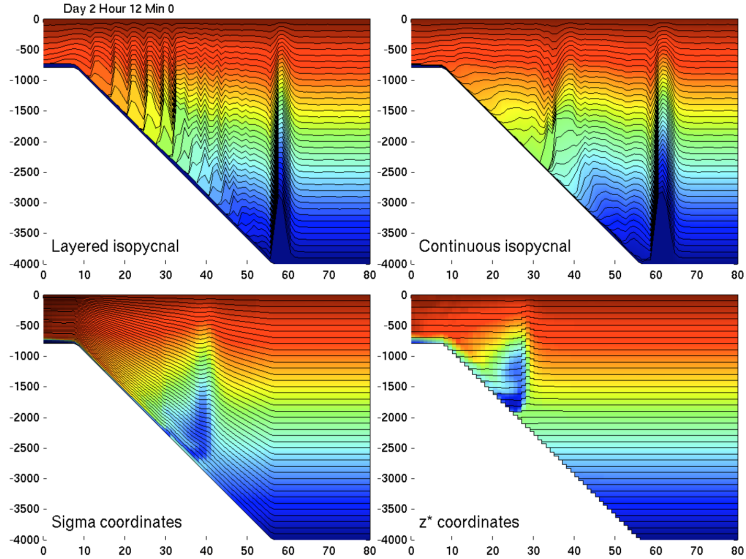
ACCESS-OM2-01

- Continue repeat-year spinup and validation
- Improve stability and performance
- Interannual JRA55-do forcing

MOM6

- MOM6 is GFDL's new ocean model.
- Arbitrary Lagrangian-Eulerian (ALE) vertical scheme:
  - Smooth transitions between geopotential, isopycnal and sigma coordinates;
  - No vertical CFL limit (layers can vanish near coast);
  - Long passive tracer timesteps (for BGC).
- C-grid (narrower straits, easier bathymetry setup).
- We are currently operating in idealised configurations and contributing to strong open source community (with GFDL, NCAR, Rutgers, ...)
- COSIMA work on MOM6 will begin during 2018.

Arbitrary Lagrangian-Eulerian (ALE) vertical scheme



White et al. JCP 2009 https://adcroft.github.io/assets/pdf/ALE_workshop_NCWCP_2016.pdf

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COSIMA
Consortium for Ocean-Sea Ice Modelling in Australia

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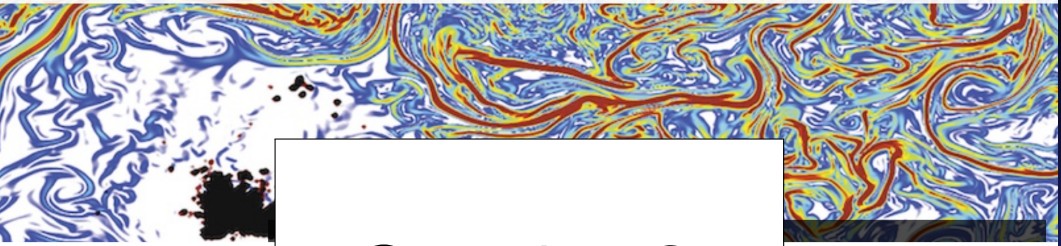
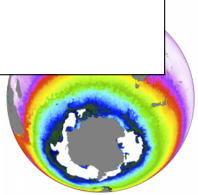


Questions?

COSIMA stands for the **Consortium for Ocean-Sea Ice Modelling in Australia**. We are comprised of a number of university nodes (ANU, UNSW, UTas, UAdelaide) and the major publicly-funded research agencies (Bureau of Meteorology, Australian Antarctic Division and the CSIRO). We are strongly supported by the National Computational Infrastructure and the Australian Research Council.



To engage with COSIMA, you might like to:

- Register for the COSIMA website and contribute your latest work;
- Enrol in the COSIMA-announce email list to receive our updates; and
- Contribute your model analysis code to the COSIMA Cookbook.

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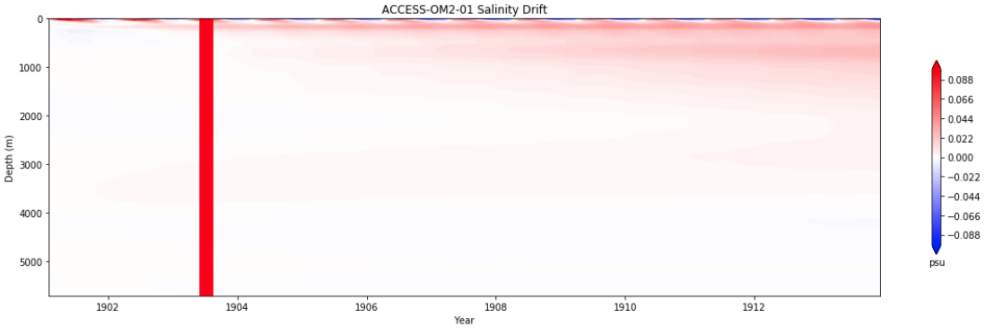
Progress

Future

CICE 5.1 details

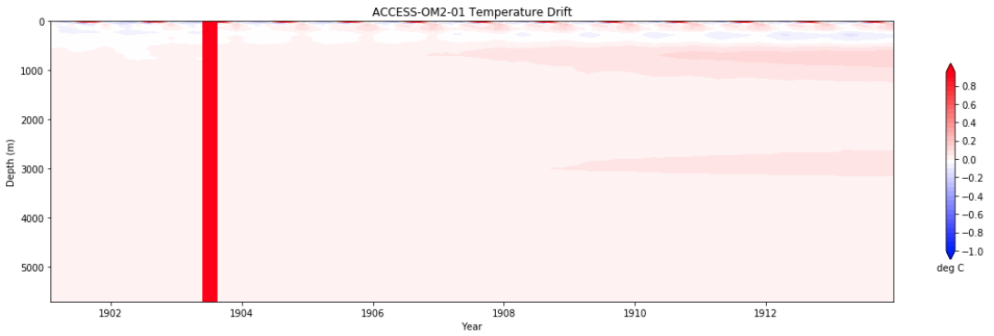
- 4 ice layers + 1 snow
- 5 thickness categories
- mushy ice thermodynamics (for now)
- classic EVP dynamics (for now)
- melt ponds

Salinity drift



thanks to Fanghua Wu

Temperature drift



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