

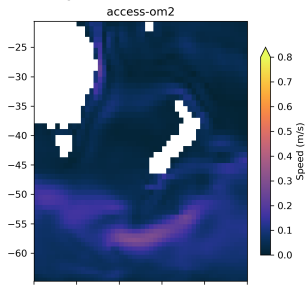
ACCESS-OM2 update

Andrew Kiss (ANU)
and many, many contributors
from the COSIMA community

Consistent global configurations at **three horizontal resolutions**

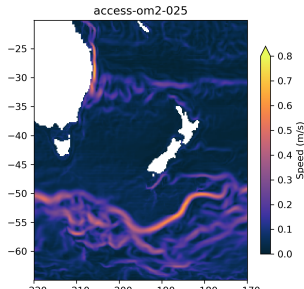
ACCESS-OM2

- ▶ not eddy-resolving
- ▶ 1° horizontal grid
360 $\times$ 300 cells, 24–111 km
- ▶ 50 z^* levels
 $\Delta z = 2.3$ –220 m
- ▶ fast and cheap
 ~ 24 min/yr, 0.1 kCPU hr/yr
on 252 PEs, dt=5400 s
- ▶ suits many-century experiments



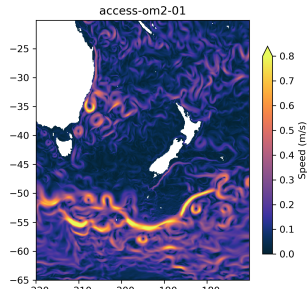
ACCESS-OM2-025

- ▶ eddy “permitting”
- ▶ 0.25° horizontal grid
1440 $\times$ 1080 cells, 6.0–27.8 km
- ▶ 50 z^* levels
 $\Delta z = 2.3$ –220 m
- ▶ fairly fast, less cheap
105 min/yr, 4.5 kCPU hr/yr
on 1824 PEs, dt=1800 s
- ▶ suits few-century experiments



ACCESS-OM2-01

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



The COSIMA community — motto: *“the community comes first”*



Linkages

The ACCESS-OM2 suite links Australia's climate modelling, ocean forecasting, and university oceanographic research communities:

- ▶ **ACCESS-OM2 at 1° is the ocean and sea-ice component used in the new ACCESS-CM2 coupled climate model**, as part of NESP Earth Systems and Climate Change Hub Project 2.1 “Preparing ACCESS for CMIP6” (Marsland, Bi, Dobrohotoff, Sullivan, Dias and Savita)
- ▶ **ACCESS-OM2-01 to be used for the next generation of Bluelink**, starting with reanalysis (BRAN2020), leading to OceanMAPSv4.0 with ocean and sea-ice ensemble data assimilation, extending Bluelink reanalyses and forecasts to global coverage, including sea ice (Sandery, Sakov, Brassington, Chamberlain, Divakaran, Oke, Fiedler, et al.)
- ▶ **ACCESS-OM2 code, multi-resolution configurations, inputs and outputs are freely available to researchers**

Underway research projects using the ACCESS-OM2 suite

1. **Tracer transport in thermodynamics coordinates**

Holmes, Zika, England, Bladwell, Huguenin-Virchaux, Spence, Stewart, Hogg, Griffies

2. **Ocean heat recycling during El Nino**

Maurice Huguenin-Virchaux, Ryan Holmes, Matthew England

3. **Ocean heat storage in response to changing ocean circulation processes**

Boeira Dias, Fiedler, Marsland, Domingues, Clément, Rintoul, McDonagh, Mata, Savita

4. **Understanding drivers and mechanisms for the Southern Ocean heat uptake and redistribution**

Kewei Lyu, Xuebin Zhang, and John Church

5. **Dense shelf water T/S characteristics**

Claire Yung

6. **Analysis of the Ross and Weddell Gyres in ACCESS-OM2**

Julia Neme and Matthew England

7. **Lagrangian methods to examine future change in ocean tracer movement**

Annette Stellema, Alex Sen Gupta

Underway research projects (cont'd)

8. **Antarctic shelf circulation and connectivity using Lagrangian particles**
Hannah Dawson, Adele Morrison, Veronica Tamsitt and Matthew England
9. **Lagrangian trajectories on the Antarctic shelf**
Jemma Jeffree
10. **Antarctic sea ice biases, parameter sensitivity and optimisation**
Andrew Kiss, Andy Hogg, Paul Sandery, Petra Heil, Matthew England
11. **Analysis of September 2016 extreme Antarctic sea ice loss**
Will Hobbs, Andrew Kiss, Amelie Meyer, Matthew England and Julie Arblaster
12. **Model evaluation of Antarctic sea ice volume**
Will Hobbs
13. **Mechanisms of Antarctic sea ice predictability**
Stephy Libera, Will Hobbs, Andreas Klocker, Amelie Meyer, Richard Matear
14. **Antarctic sea-ice distribution in ACCESS-OM2**
Petra Heil, Phoebe Hudson, Andrew Kiss

Underway research projects (cont'd)

15. **Linkage of Antarctic coastal polynyas (sea ice properties and water mass properties) to climate indices like the Southern Annular Mode**
Zhaoru Zhang, Matthew England
16. **Antarctic coastal polynyas and dense water production**
Phoebe Hudson, Yevgeny Aksenov, Petra Heil
17. **Southern Ocean standing meander and sea level anomalies: over 20 years of trends**
A Meyer, C Langlais, N Constantinou, C Chapman, B Legresy, A Hogg, N Bindoff
18. **Low-frequency variability**
Navid Constantinou
19. **Western boundary current dynamics in ACCESS-OM2-01**
Xihan Zhang, Andrew Kiss
20. **ACCESS-OM2 inter-comparison of key oceanic processes around Australia at 1, 0.25 and 1/10 degree**
Earl Duran, Matthew England, Paul Spence

Underway research projects (cont'd)

21. **Understanding what drives seasonality in Southern Ocean eddies**

Shweta Sharma, Matthew England, Shane Keating, Ryan Holmes

22. **Kinetic energy trends in mesoscale eddies**

Josué Martínez-Moreno, Andy Hogg, Andrew Kiss, Navid Constantinou, Adele Morrison

23. **Mesoscale eddy detection**

Michael Denes, Gary Froyland, Shane Keating

24. **Ocean-sea-ice responses to extreme SAM conditions**

Stewart, England, Hogg & Chapman

25. **Ideal Age in extreme SAM experiments**

Darryn Waugh

26. **The impact of tides on near-Antarctic ocean circulation**

Adele Morrison, Andy Hogg, Matt England, Paul Spence, Stephen Griffies

27. **Impact on ocean circulation of the removal of the West Antarctic Ice-Sheet**

Alfonso Acosta Goncalves, Laurie Menviel, Andy Hogg, Katrin Meissner

Underway research projects (cont'd)

28. **Changes to near Antarctic ocean circulation in response to increasing glacial meltwater inputs**

Ruth Moorman, Adele Morrison, Andy Hogg

29. **Teleconnection of ENSO to the Amundsen Sea Low on the Southern Ocean Mixed-Layer Depth**

Qian Li, Matthew England

30. **Response of Southern Ocean to Wind and Thermal Forcing across Different Model Resolutions**

Qian Li, Matthew England and Andy Hogg

31. **Understanding the role of transport barriers in ocean ventilation**

Andreas Klocker

32. **Ocean-ice interaction in subpolar Southern Ocean generates ocean pycnocline**

A. Klocker, A. Naveira Garabato, A. Forryan, C. de Lavergne, S. Rintoul

Underway research projects (cont'd)

33. **ArgoMaps: a new analysis system to grid all observations using the Bluelink Ensemble DA system**

Peter Oke

34. **Biogeochemistry modelling with ACCESS-OM2**

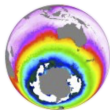
Hakase Hayashida, Richard Matear, Pete Strutton

35. **Influence of seasonal forcing variability on the mean state of the Indonesian Seas (1/25° MITgcm regional model forced at boundaries by ACCESS-OM2-01)**

Océane Richet, Bernadette Sloyan, Beatriz Peña-Molino, Maxim Nikurashin, Susan Wijffels

...and more? Let me know!

Papers & theses using ACCESS-OM2 code or output — add yours!



Publications using COSIMA's ACCESS-OM2 ocean-sea ice model

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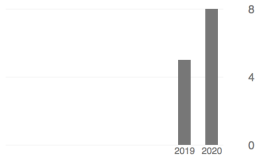
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[ACCESS-OM2 v1.0: a global ocean-sea ice model at three resolutions](#)

AE Kiss, AMC Hogg, N Hannah, F Boeira Dias, GB Brassington, ...
Geoscientific Model Development 13 (2), 401-442

8

2020

[Interdependence of internal tide and lee wave generation at abyssal hills: global calculations](#)

CJ Shakespeare
Journal of Physical Oceanography 50 (3), 655-677

2

2020

[A search for the Tasman Front](#)

PR Oke, GS Pilo, K Ridgway, A Kiss, T Rykova
Journal of Marine Systems 199, 103217

2

2019

[The Atlantic meridional overturning circulation in high resolution models](#)

JJM Hirschi, B Barnier, C Böning, A Blastoch, AT Blaker, A Coward, ...
Journal of Geophysical Research: Oceans, e2019JC015522

1

2020

[Sensitivity of marine heatwave metrics to ocean model resolution](#)

GS Pilo, NJ Holbrook, AE Kiss, AMC Hogg
Geophysical Research Letters 46 (24), 14604-14612

1

2019

[JRA55-do-based repeat year forcing datasets for driving ocean-sea-ice models](#)

KD Stewart, WM Kim, S Urakawa, AMC Hogg, S Yeager, H Tsujino, ...
Ocean Modelling 147, 101557

2020

Published research using the ACCESS-OM2 suite

1. **ACCESS-OM2 v1.0: a global ocean-sea ice model at three resolutions**

Kiss, Hogg, Hannah, Boeira Dias, Brassington, Chamberlain, Chapman, et al.

Geoscientific Model Development 13 (2), 401-442, 2020

<https://doi.org/10.5194/gmd-13-401-2020>

2. **Interdependence of internal tide and lee wave generation at abyssal hills**

Callum Shakespeare

Journal of Physical Oceanography 50 (3), 655-677, 2020

<https://doi.org/10.1175/JPO-D-19-0179.1>

3. **A search for the Tasman Front**

Peter Oke, Gabriela Pilo, Ken Ridgway, Andrew Kiss, Tatiana Rykova

Journal of Marine Systems 199, 103217, 2019

<https://doi.org/10.1016/j.jmarsys.2019.103217>

4. **The Atlantic meridional overturning circulation in high resolution models**

Hirschi, Barnier, Boning, Biastoch, . . . Kiss, . . . Spence, et al.

Journal of Geophysical Research: Oceans, e2019JC015522, 2020

<https://doi.org/10.1029/2019JC015522>

5. **Sensitivity of marine heatwave metrics to ocean model resolution**

Gabriela S. Pilo, Neil Holbrook, Andrew Kiss, Andy Hogg

Geophysical Research Letters 46 (24), 14604-14612, 2020

<https://doi.org/10.1029/2019GL084928>

Published research (cont'd)

6. **JRA55-based repeat year forcing datasets for driving ocean-sea-ice models**

Stewart, Kim, Urakawa, Hogg, Yeager, Tsujino, Nakano, Kiss & Danabasoglu

Ocean Modelling 147, 101557, 2020

<https://doi.org/10.1016/j.ocemod.2019.101557>

7. **On the Superposition of Mean Advective and Eddy-Induced Transports in Global Ocean Heat and Salt Budgets**

F. Boeira Dias, C. Domingues, S. Marsland, S. Griffies, S. Rintoul, R. Matear, R. Fiedler

Journal of Climate 33 (3), 1121-1140, 2020

<https://doi.org/10.1175/JCLI-D-19-0418.1>

8. **Surface Ocean Warming Around Australia Driven by Interannual Variability and Long-Term Trends in Southern Hemisphere Westerlies**

Earl Duran, Matthew England, Paul Spence

Geophysical Research Letters 47, e2019GL086605, 2020

<https://doi.org/10.1029/2019GL086605>

9. **Southern Ocean heat and momentum uptake are sensitive to the vertical resolution at the ocean surface**

Kial Stewart, Andy Hogg

Ocean Modelling 143, 101456, 2019

<https://doi.org/10.1016/j.ocemod.2019.101456>

Slack and Github

The screenshot shows the ARCCSS Slack workspace. The left sidebar lists channels: #accessom2report, #cm2-om2-harmonisation, #cosima (selected), #general, #mam5-basal-melt, #news, #om2dev, #payu, #payudev, #python, #support, #twg, Direct messages, Slackbot, aekis (you), aidan, aidan, andy, aidan, nic, andy, nic, and Maurice Hugarin. The main window shows the #cosima channel with a message from @Paul Leopardi about testing and forking a run. A thread is open for this message, showing a code snippet for setting environment variables and a response from Ed Doddridge. The thread also shows a code snippet for setting environment variables and a response from Ed Doddridge.

The screenshot shows the Github repository page for COSIMA/access-om2. The repository has 400 commits, 12 branches, 0 packages, 3 releases, and 7 contributors. The latest commit is by aekis, titled 'Merge branch 'fast-105-JRA25-v1p4'', 2 days ago. The repository includes a table of files and their commit history:

File	Commit	Time
control	update configuration submodules in control directory	2 days ago
doc/static	Add system architecture diagram, referenced in the wiki, #109	17 months ago
src	update source code submodules	16 days ago
test	fix /g/data paths for gadi - #188	2 months ago
tools	fix /g/data paths for gadi - #188	2 months ago
gignone	Update to latest executables and control submodules	12 months ago
gitmodules	Remove minimal and core config submodules #183	21 days ago
travis.yml	Update .travis.yml	2 years ago
MOM_diagnostics.txt	core support in hasheve (untested)	3 years ago
README.md	Updated README.md	16 days ago
accessom.yml	Added travis testing for PEP8	2 years ago
hasheve-public.sh	fix /g/data paths for gadi - #188	2 months ago
hasheve.sh	Update to latest executables and control submodules	12 months ago
install.sh	Altered scripts to use build_on_gadi script in libaccessom2	5 months ago

cosima, om2dev, payu channels in ARCCSS w'space
for informal discussions / questions

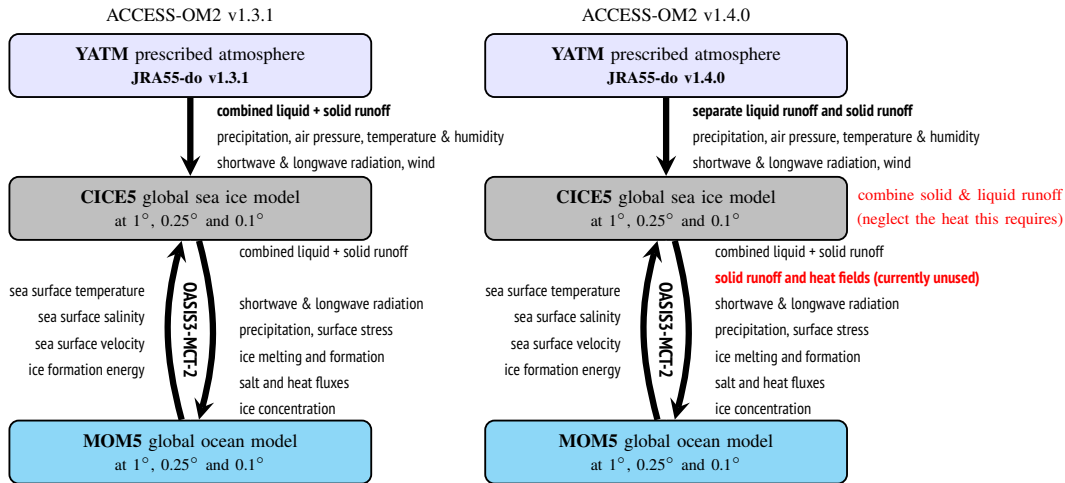
<https://github.com/COSIMA/access-om2>
post requests/bugs as "issues"
see wiki for usage (to be updated)
click "watch" in access-om2 and submodules

ACCESS-OM2 developments since v1.0 (GMD paper)

Nic Hannah, Russ Fiedler, Aidan Heerdegen, Andrew Kiss,
Marshall Ward, Rui Yang, Paul Leopardi, Peter Dobrohotoff

- ▶ Porting to Gadi (libraries; performance and reproducibility; ik11)
- ▶ Halved computational cost of 0.1° model
- ▶ JRA55-do v1.4.0 support
- ▶ FAFMIP support
- ▶ ACCESS-OM2 and ACCESS-CM2 codebases harmonised
- ▶ Payu manifests: track all inputs, restarts, executables via git
- ▶ Many improvements and bug fixes
- ▶ Major COSIMA Cookbook improvements (Angus Gibson, James Munroe)

JRA55-do v1.4.0 is now supported (Nic Hannah)



ACCESS-OM2 coupled model components and performance

YATM JRA55-do prescribed atmosphere

1958–2018, 3-hourly, 0.5625° resolution

OASIS3-MCT-2 ↓ coupler

CICE 5.1.2 global sea ice model

1° , 0.25° or 0.1° tripolar grid

OASIS3-MCT-2 ↑ coupler

MOM 5.1 global ocean model

same horizontal grid as CICE; 50 or 75 z^* levels

CPUs

1

24 at 1°

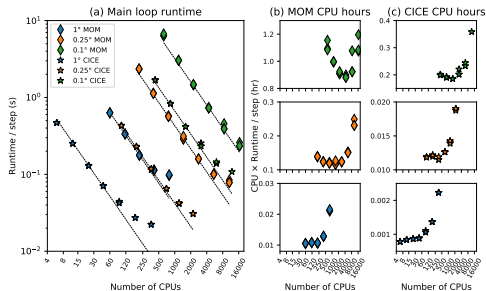
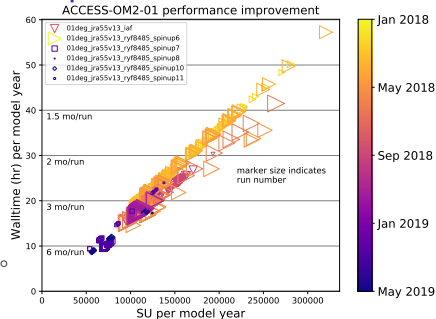
361 at 0.25°

722 at 0.1°

216 at 1°

1455 at 0.25°

4358 at 0.1°

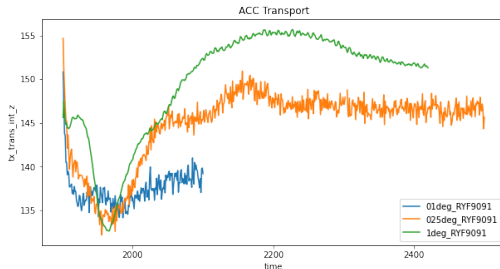
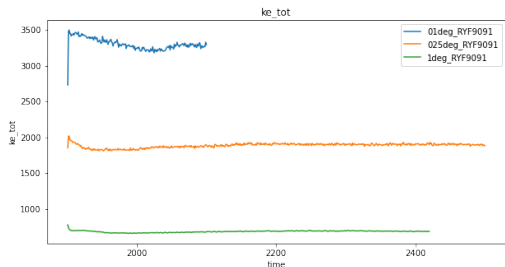


Major development effort greatly improved model performance and stability, particularly at 0.1° :

- ▶ MOM scales linearly up to 16,000 CPUs.
- ▶ CICE scales linearly up to 2000 CPUs.
- ▶ Runs about 8% faster on Gadi than Raijin broadwell (but SUs are 60% more expensive)

New 0.1° 1990–91 repeat-year run (Andy Hogg)

- ▶ JRA55-do v1.3.0 May 1990 – April 1991 RYF (more neutral than 1984-85)
- ▶ 200 years completed
- ▶ Useful as a control case for perturbation experiments
- ▶ Output: **/g/data/ik11/outputs/access-om2-01/01deg_jra55v13_ryf9091**
 - ▶ available for anyone to look at (join ik11 via <https://my.nci.org.au/mancini>)
 - ▶ includes some daily data (but is being cleaned up / reduced)



Run	years	submissions	crashes	MSU	walltime	human time
RYF8485	48	662	184	6.5	1,108 hr	11 mo.
RYF9091	50	202	6	3.3	512 hr	2 mo.

Coming soon

- ▶ Version 2.0.0: bug fixes and configuration improvements
- ▶ New 1958–2017 IAF spinup at 0.1° (Andrew Kiss)
- ▶ WOMBAT biogeochemistry (Russ Fiedler)
- ▶ Parallel I/O for CICE (makes daily output practical)
- ▶ Additive and multiplicative forcing perturbations (Nic Hannah, Andrew Kiss)
- ▶ High-resolution regional MOM6 (Angus Gibson)
- ▶ ACCESS-OM3: Ocean (MOM6) - sea ice (CICE6) - BGC (WOMBAT) - waves (WWIII)

Summary

- ▶ ACCESS-OM2 is a global coupled ocean - sea ice model at 3 resolutions, unifying and improving ACCESS-CM2 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
 - ▶ Collaborative development: code, configs, inputs, outputs, analysis scripts etc. all freely available
 - ▶ code: **<https://github.com/COSIMA/access-om2>**
 - ▶ output: **`/g/data3/hh5/tmp/cosima`** and **`/g/data/ik11/outputs`**
- ▶ Many projects now using ACCESS-OM2 suite output data and models

Technical progress since v1.0 (GMD paper)

Main ACCESS-OM2 changes

- ▶ update install script for Gadi
- ▶ update configurations and source code
- ▶ improve load balancing: halved computational cost of 0.1° model

<https://github.com/COSIMA/access-om2/compare/43c1fc2...master>

Technical progress since v1.0 (GMD paper)

Main changes to configurations

- ▶ Gadi compatibility
- ▶ use JRA55-do v1.4.0
- ▶ harmonisation across all configurations
- ▶ use relative winds in calculation of stress on ice
- ▶ uniform $1 \times 10^{-6} \text{ m}^2\text{s}^{-1}$ vertical diffusivity at 0.1°
- ▶ fix inputs (WOA initial conds, vertical grid, interpolation, topography, CICE grid)
- ▶ fixes: use prognostic conservative temperature, fix Rayleigh damping, albedo, etc
- ▶ halved expense of 0.1° runs
- ▶ automatically sweep and resubmit on specific errors
- ▶ use latest executables and mppnccombine-fast

Details: https://github.com/COSIMA/1deg_jra55_iaf/compare/285ce2f...master

https://github.com/COSIMA/1deg_jra55_ryf/compare/f0287b1...master

https://github.com/COSIMA/025deg_jra55_iaf/compare/0eaeda7...master

https://github.com/COSIMA/025deg_jra55_ryf/compare/03206fd...master

https://github.com/COSIMA/01deg_jra55_iaf/compare/c2a991d...master

https://github.com/COSIMA/01deg_jra55_ryf/compare/60f5ee6...master

Technical progress since v1.0 (GMD paper)

Main MOM5 changes

- ▶ Gadi compatibility
- ▶ JRA55-do v1.4.0 support
- ▶ code harmonisation with ACCESS-CM2
- ▶ FAFMIP support
- ▶ WOMBAT biogeochemistry (soon!)
- ▶ new mandatory min_thickness namelist item in ocean_topog_nml
- ▶ bug fixes (e.g. transport_on_nrho, t[xy]_trans_theta_gm)
- ▶ new diagnostics (frazil_3d, u_dot_grad_vert_pv)
- ▶ performance improvements (e.g. tidal mixing, submesoscale)
- ▶ use updated NetCDF and OpenMPI

Details: <https://github.com/mom-ocean/MOM5/compare/afe80bf...master>

Technical progress since v1.0 (GMD paper)

Main CICE5 changes

- ▶ Gadi compatibility
- ▶ JRA55-do v1.4.0 support
- ▶ code harmonisation with ACCESS-CM2
- ▶ support sectrobin and improve layout
- ▶ support stress calculation using absolute wind
- ▶ timers
- ▶ merge in latest commits (incl. bug fixes) from <https://github.com/CICE-Consortium/CICE-svn-trunk>
- ▶ bug fixes (e.g. date handling)
- ▶ compress output
- ▶ parallel output via PIO (soon!)
- ▶ use updated NetCDF and OpenMPI

Details: <https://github.com/COSIMA/cice5/compare/076b14f...master>

Technical progress since v1.0 (GMD paper)

Main YATM and libaccessom2 changes

- ▶ Gadi compatibility
- ▶ JRA55-do v1.4.0 support
- ▶ support multiplicative scaling of forcing
- ▶ bug fixes, e.g. in calendar management
- ▶ use submodules for dependencies
- ▶ use updated NetCDF, OpenMPI, Oasis3-MCT-2.0, datetime-fortran, json-fortran

Details: <https://github.com/COSIMA/libaccessom2/compare/e8ad372...master>

Technical progress since v1.0 (GMD paper)

Main Payu changes

- ▶ Gadi compatibility
- ▶ manifests: track all input files, restarts and executables
- ▶ auto-resubmit on specified errors
- ▶ updated documentation
- ▶ bug fixes

Details: <https://github.com/payu-org/payu/compare/89375e9...master>