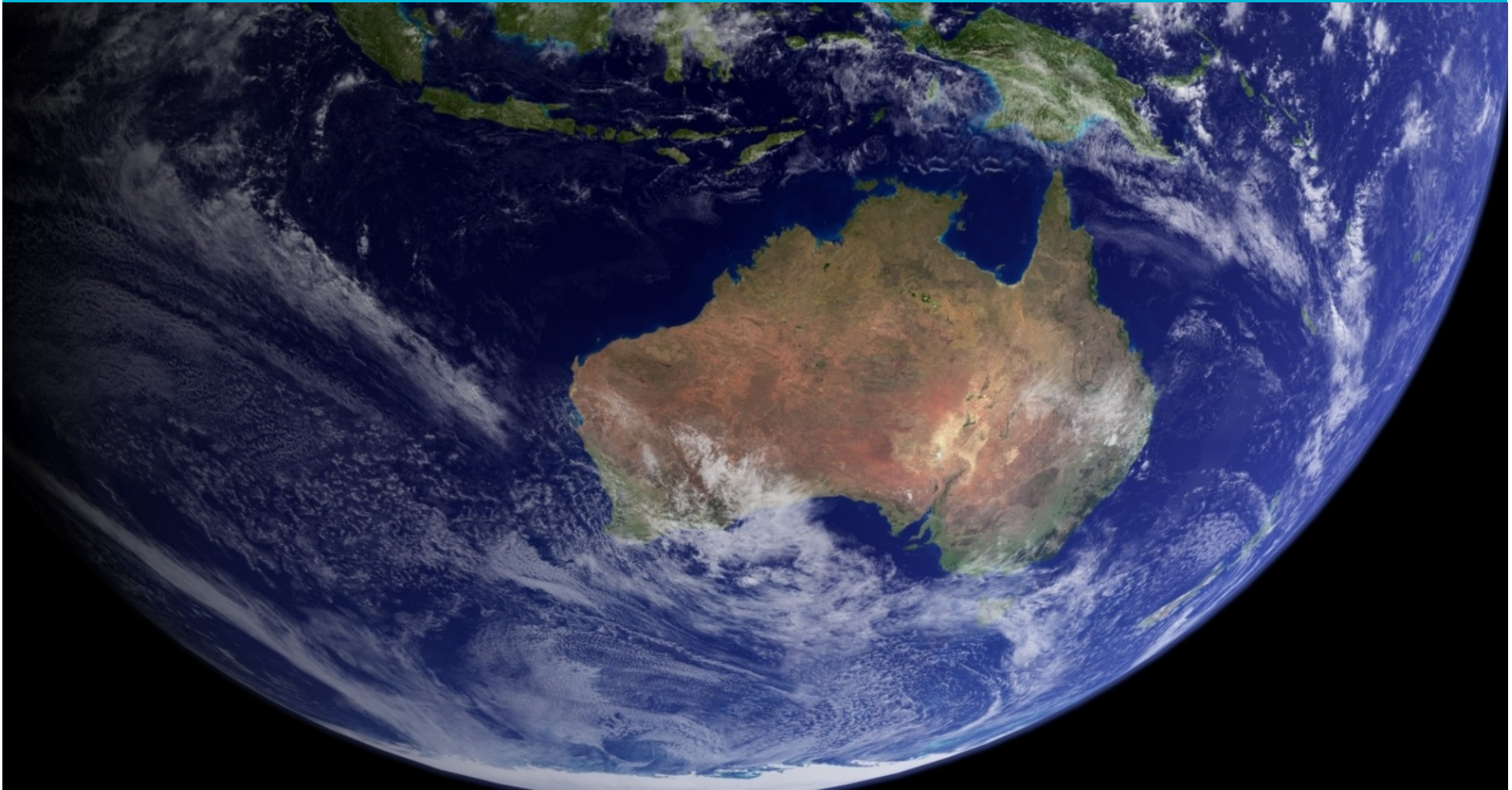


ACCESS and VrESM for CMIP6



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Outline

1) **ACCESS**: Australian Community Climate and Earth System Simulator Used across CSIRO, Bureau of Meteorology and universities (in various forms)

- Brief overview of ACCESS models
 - Working versions of ACCESS climate model
 - Current ACCESS development (ACCESS-CM2, ACCESS-ESM2)
- ACCESS CMIP6 plan, issues

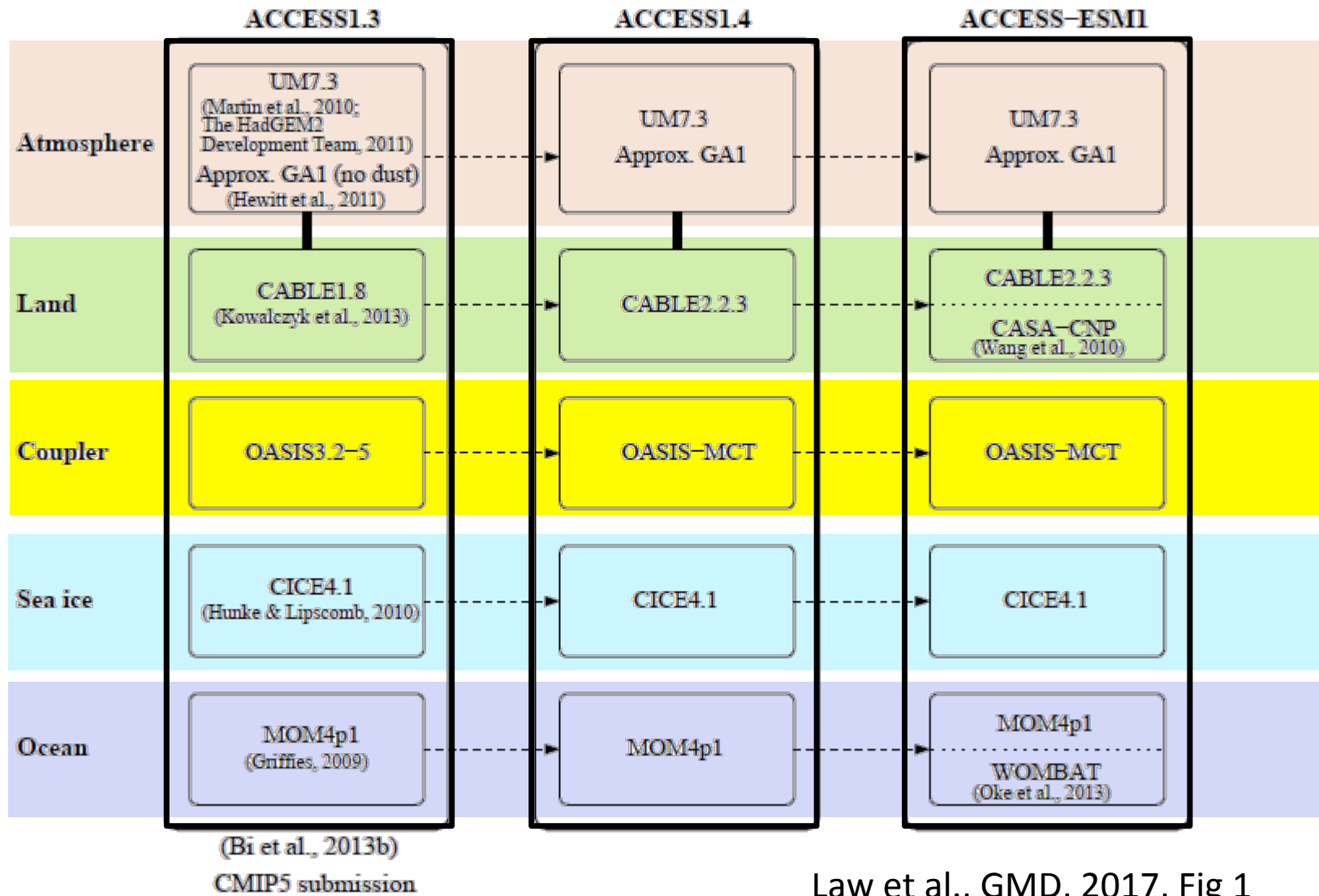
2) **VrESM**: Variable resolution Earth System Model (South Africa)

- Model introduction
- CMIP6 Simulations

CABLE: Community Atmosphere Biosphere Land Exchange

Standalone and coupled to multiple atmospheric models. 100+ registered users from ~20 Australian institutions and ~14 other countries

Working Versions of ACCESS Climate Model



ACCESS-CM2 and ACCESS-ESM2

Features

- New Versions of All Components:
 - Atmosphere: UM10.6/GA7.1 (N96, 85 levels, active aerosol)
 - Land: CABLE2.x /JULES
 - Ocean: MOM5 (1-deg)
 - Sea ice: CICE5 (1-deg) (multi-layer)
 - Coupler: OASIS3-MCT (parallel coupling)
- New Framework/Control System: cylc-rose

History

- 2014/15 started from ACCESS1.4 framework → Prototype version ACCESS-CM2 (with UM8.6/GA6)
- 2016 switched to cylc-rose system → Beta version ACCESS-CM2 (with UM10.3/GA7)
- **2017 (March) upgraded UM to UM10.6/GA7.1** → Official version ACCESS-CM2
- ACCESS-ESM2 will turn on biogeochemistry in CABLE and use WOMBAT (ocean biogeochemistry)
 - Developing land-use change capability

ACCESS CMIP6 Plan (MIP Commitments)

- **DECK/historical** – Simon Marsland (CSIRO)
- **ScenarioMIP** – Simon Marsland
- **DAMIP** (detection/attribution) – David Karoly (**ARCCSS**)
- **C4MIP, LS3MIP, LUMIP** (landuse) – Rachel Law(CSIRO)
- **OMIP, FAFMIP** (oceans) – Simon Marsland
- **GeoMIP** (geoengineering) – Andrew Lenton(CSIRO)
- **RFMIP** — Simon Marland

Horizontal resolution: (UM) N96 + (MOM/CICE) 1-deg
(Very limited computing and storage resource)

ARCCSS: Australian Research Council Centre of Excellence for Climate System Science

We are falling behind the timeline.....

- Experience with CMIP6 forcings: **No**
- Have you yet started any simulations: **No**
- First results from CMIP6 simulations: **June 2018**
- When are you planning to submit model output from the DECK to the ESGF? **June-Aug 2018**
- When are you planning to submit model output from the CMIP6 historical simulations to the ESGF? **June-Aug 2018**
- When are you planning to submit CMIP6-Endorsed MIPs experiments to the ESGF: **TBD**
- Have you yet started filling the ES-DOC questionnaire? **???**

CMIP6: ACCESS-ESM1 or ACCESS-CM2?

- ACCESS-ESM1 “nearly” ready for CMIP6 commitments
 - A sub-set of CMIP5-type experiments has been conducted
 - CMIP6 forcing (courtesy of Met Office) needs to be “remapped”
 - Land use change capability to be included

or

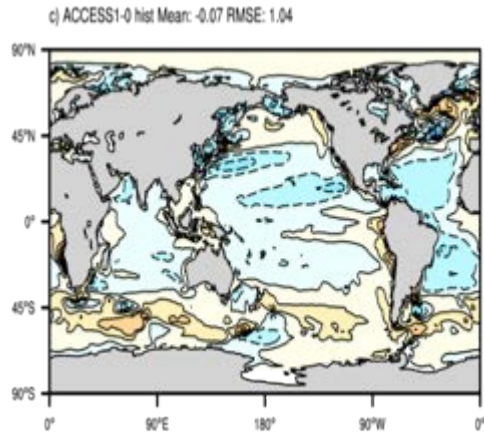
- ACCESS-CM2 to be frozen by the end of 2017
 - Jules version PD simulation performance is not satisfying
 - CABLE implementation has just been completed
 - Preindustrial spin-up has just started (subject to debug/tuning)

Which one? To Be Decided.....

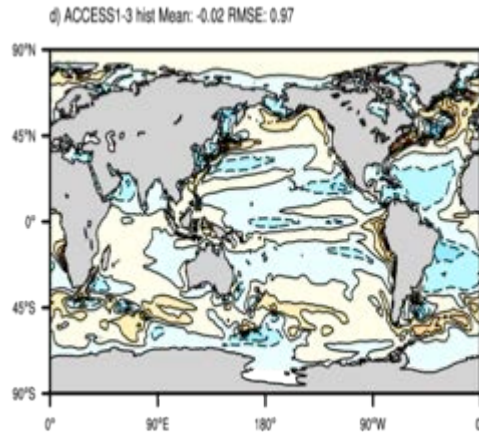
- Why behind timeline?
 - CSIRO job cut chaos → climate research/modelling nearly wiped out
 - Serious short of resource – key researchers/modelers/supports gone
 - Strong dependence on collaborations

Large SO warm biases & poor AA sea ice simulation in ACCESS-CM2

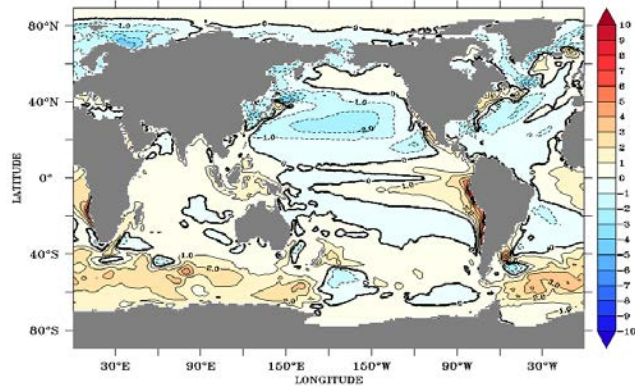
ACCESS1.0 N9601



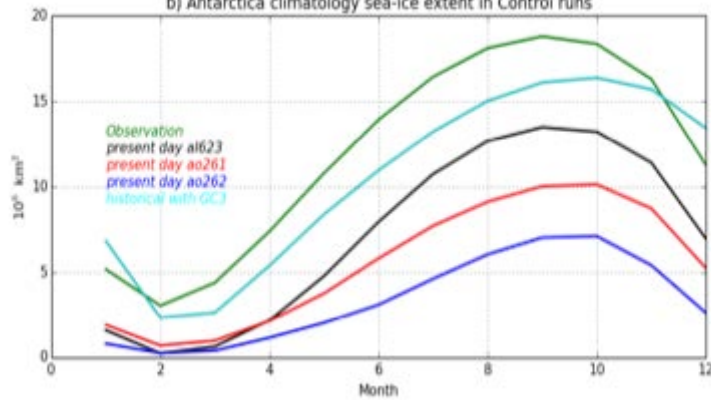
ACCESS1.3 N9601



**ACCESS-CM2 N9601
(PD yrs 171-200)**

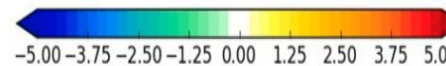
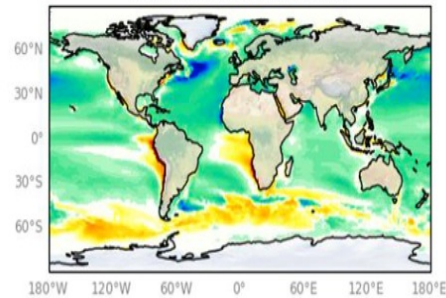


b) Antarctica climatology sea-ice extent in Control runs



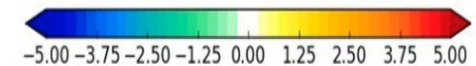
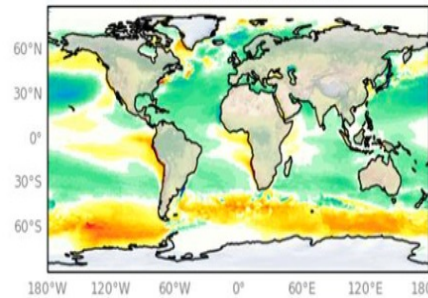
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u-af872 minus ESA CCI SST

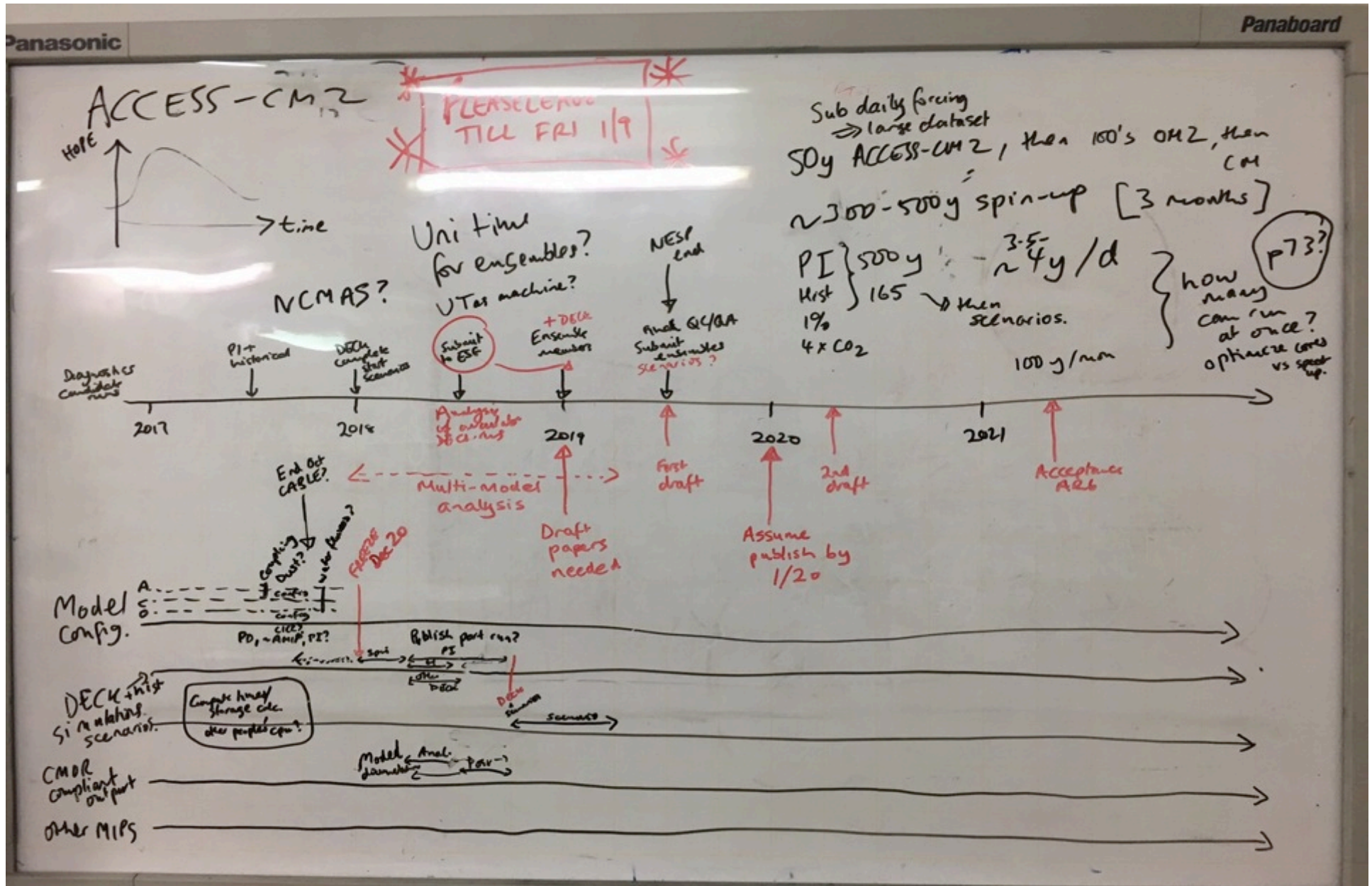


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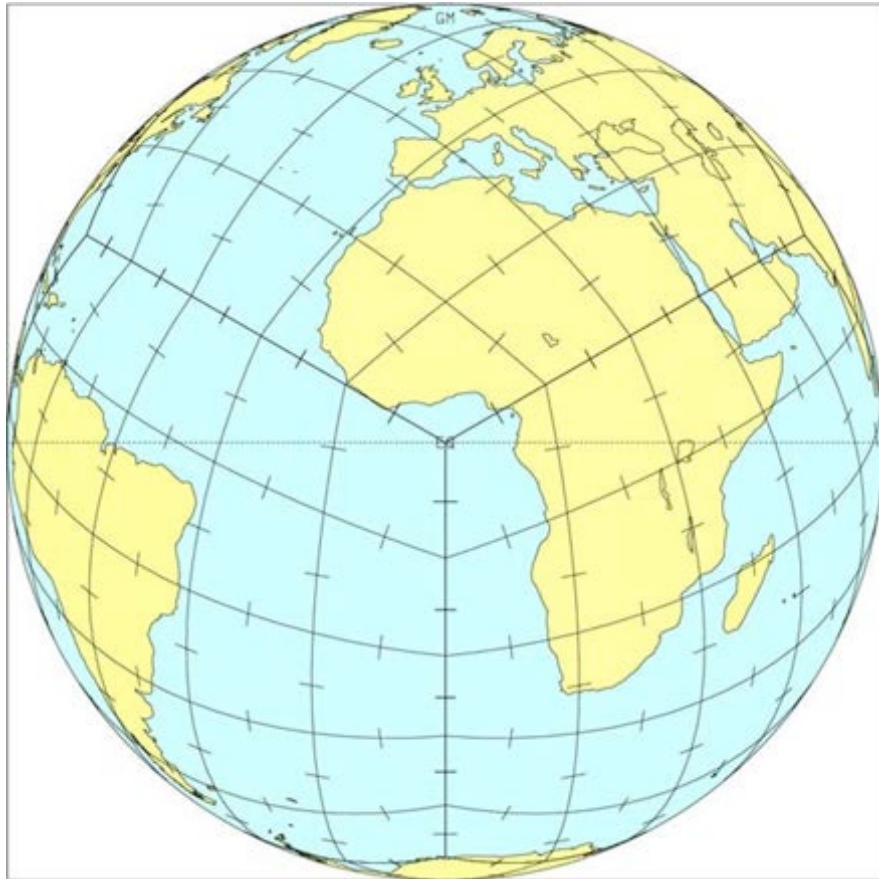
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ACCESS CMIP6 Submission Agenda



Variable-resolution Earth System Model (VrESM)

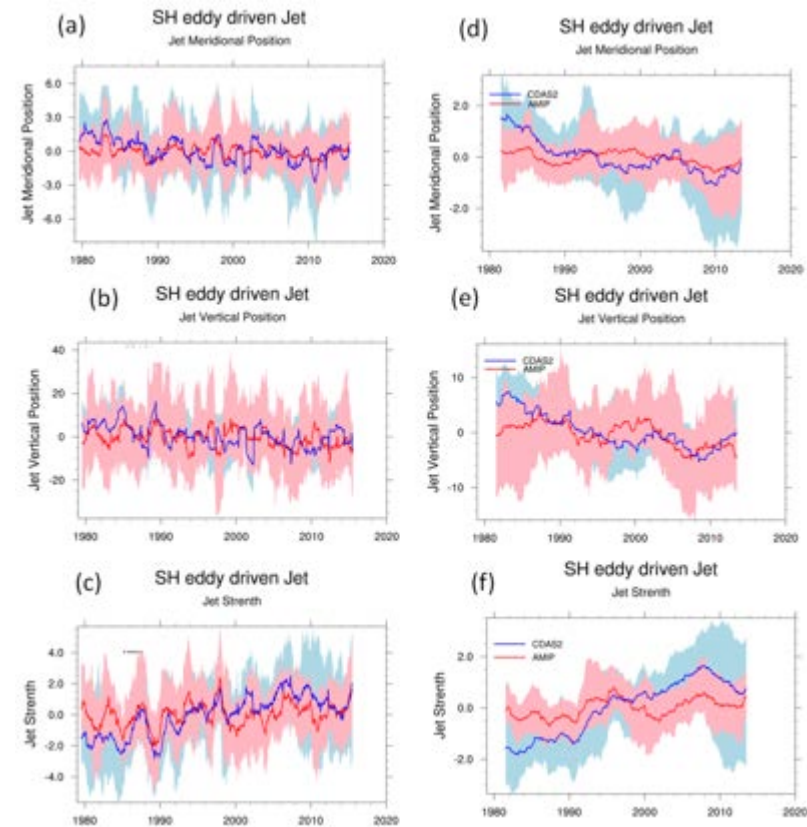


The Variable-resolution Earth System Model (VrESM): A CSIR-CSIRO collaboration

- First African-based ESM, developed through an African lens, very first time contribution of Africa to CMIP effort
- Atmospheric component: Conformal-cubic atmospheric model (**CCAM**) of CSIRO (Australia)
- Ocean component: Variable-cubic ocean model (**VCOM**) of CSIR (South Africa)
- Land-component: CSIRO Atmosphere-Biosphere Land Exchange model (**CABLE**)
- Ocean biochemistry: **PISCES** (from LOCEAN)
- Cube-based grid: options available for conformal-cubic, equi-angular gnomonic cubic or equal area (UJ); quasi-uniform 50 km res grid in horizontal;
- **New** ocean model VCOM and also CCAM never applied in CMIP before!

VrESM CMIP6 simulations

- Key VrESM areas of focus:
 - numerics on cube-based grids;
 - convective rainfall parameterisation – African focus; southern African biomass burning aerosols and Atlantic Sc cloud deck;
 - parameterisations for plant-functional types in African savannahs;
 - parameterisations for Southern Ocean sub-mesoscale eddies and carbon fluxes
- VrESM **DECK and historical** runs are to be submitted by May 2018.
- VrESM **ScenarioMIP** is to be submitted by September 2018.
- VrESM is also to contribute to **CMIP, HighresMIP and PMIP** in 2019
- VrESM development is led by Francois Engelbrecht (CSIR, South Africa; fengelbrecht@csir.co.za)



Time evolution of the SH jet stream meridional position (a), vertical position (b) and strength (c) in CMIP6 AMIP simulations (red) and NCEP reanalysis (blue) for 1-yr running mean daily anomalies. The corresponding 5-yr running mean anomalies are shown in (d) to (f)

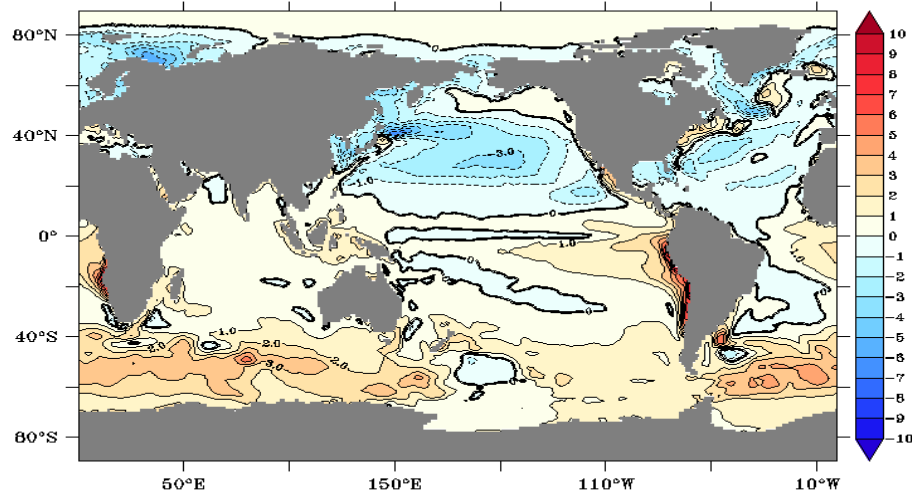
Thank you

OCEAN AND ATMOSPHERE FLAGSHIP
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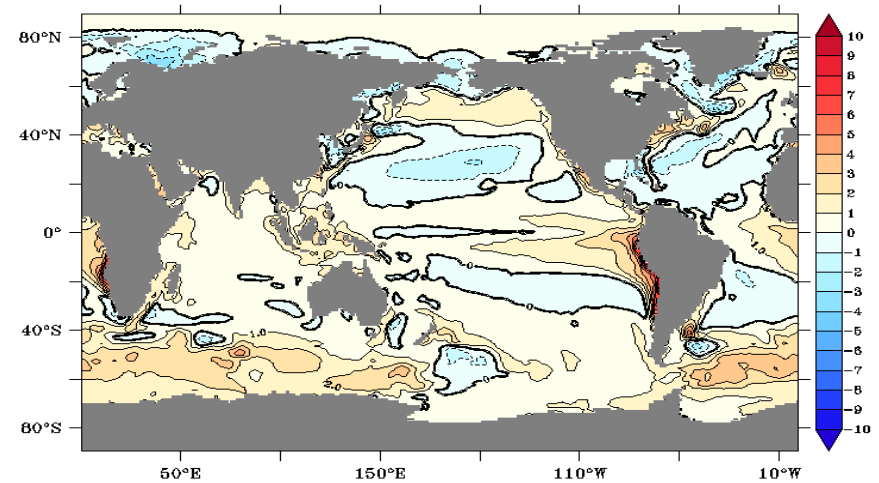


Annual Mean SST Bias (model yrs 101-130 vs Obs 1971-2000)

ACCESS-CM2 with GA7



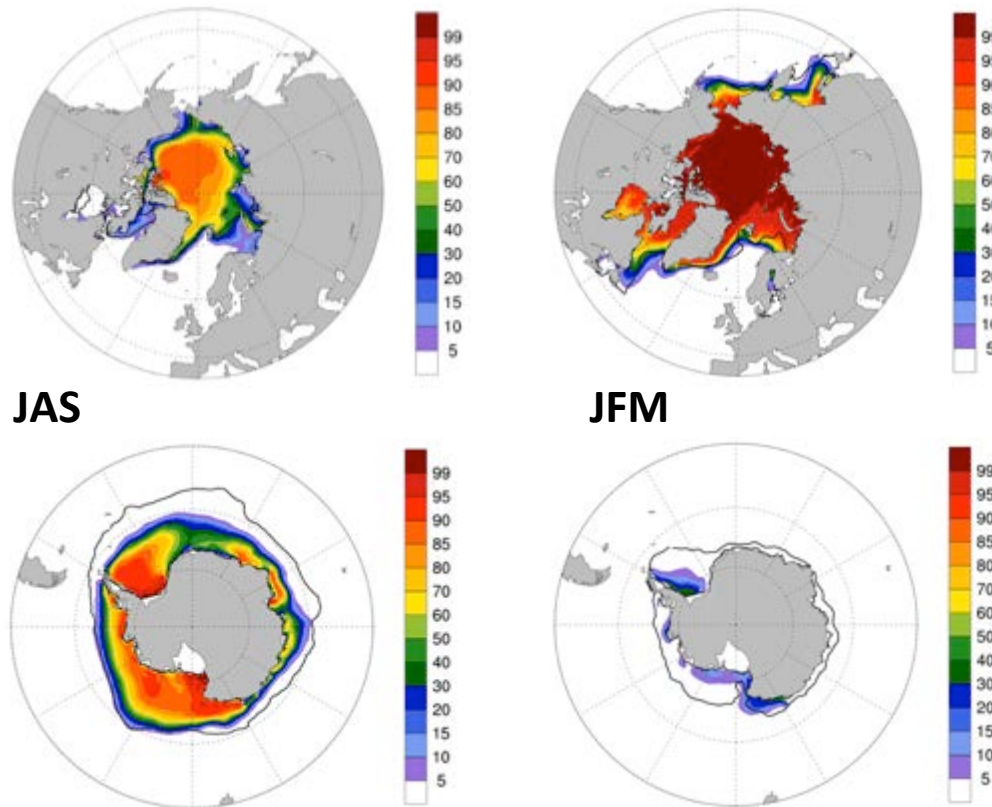
ACCESS-CM2 with GA7.1



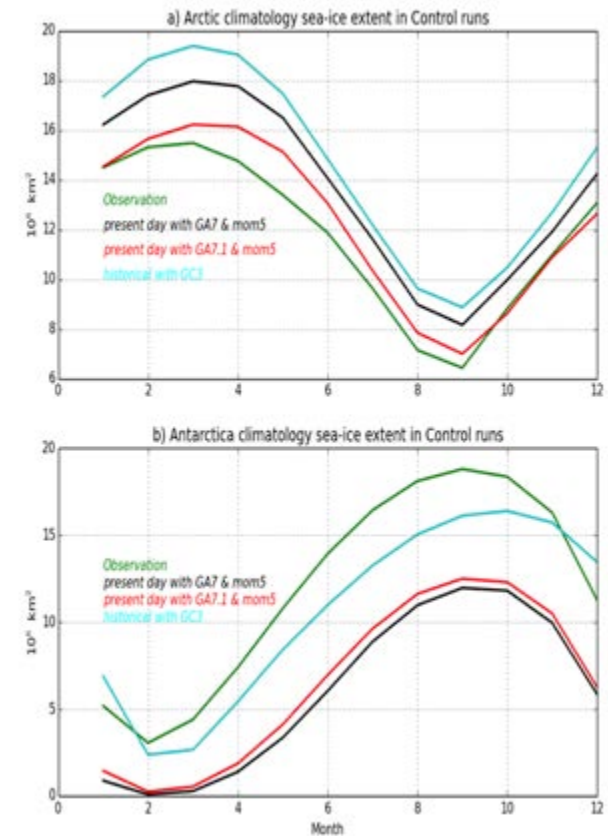
- GA7.1 version ACCESS-CM2 shows significantly reduced SST biases, particularly in the NH.
- Southern Ocean is also noticeably improved but still too warm to allow sea ice to exist through summer.

Sea ice (ACCESS-CM2 with GA7.1)

Ice concentration



Sea ice extent (area)



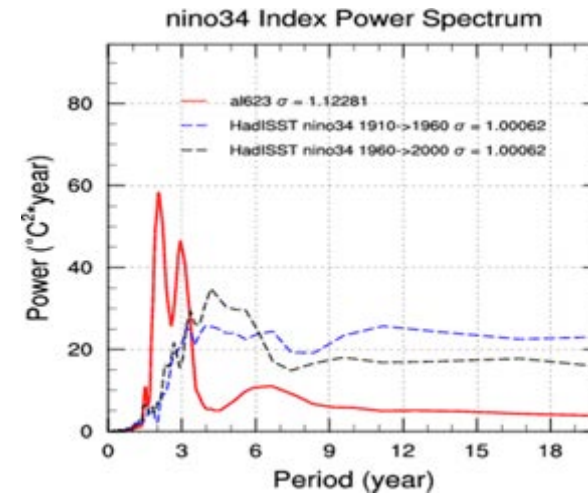
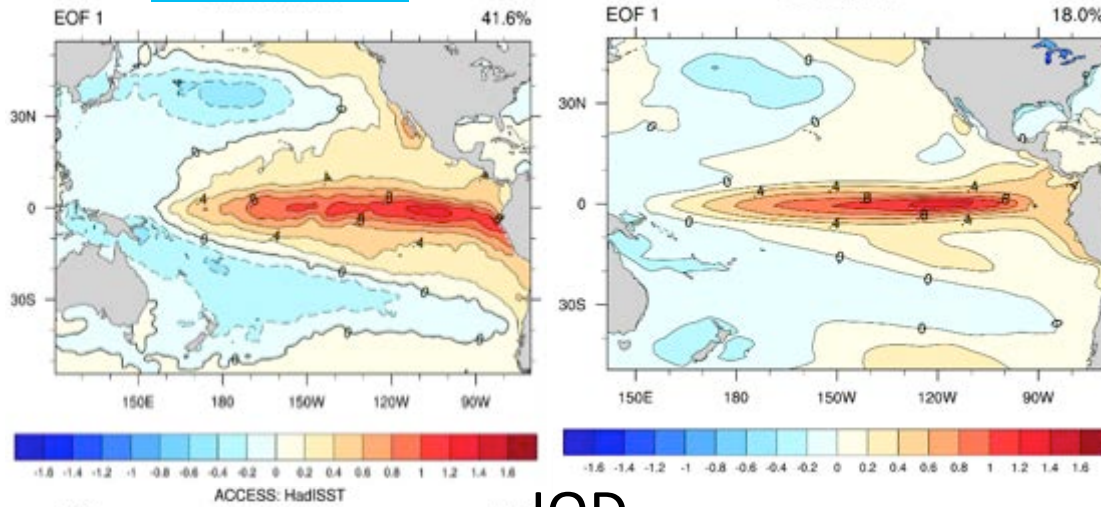
GA7.1 version ACCESS-CM2 produces slightly more realistic sea ice extents in both hemispheres, but still nearly no ice survives through summer around Antarctica because of SO warm biases.

Australian Climate Drivers (ENSO and IOD)

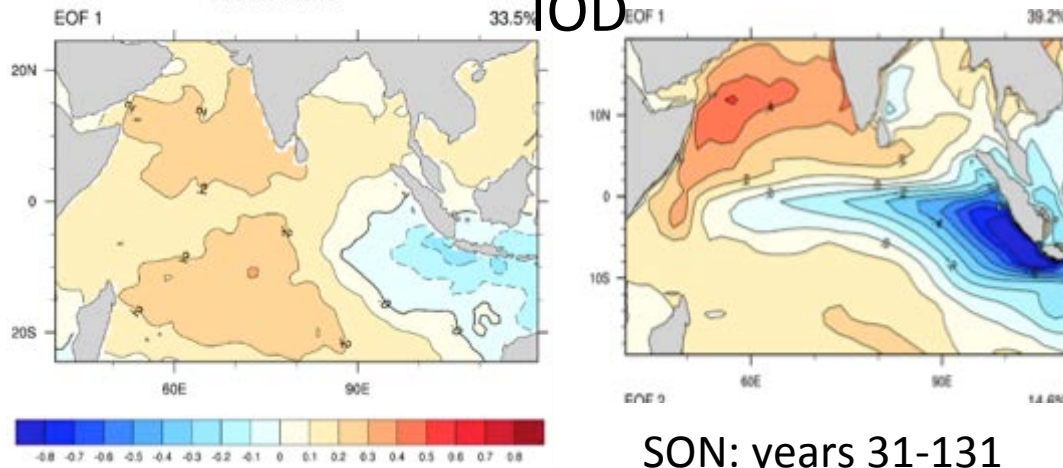
HadISST

ENSO

ACCESS-CM2 with GA7.1



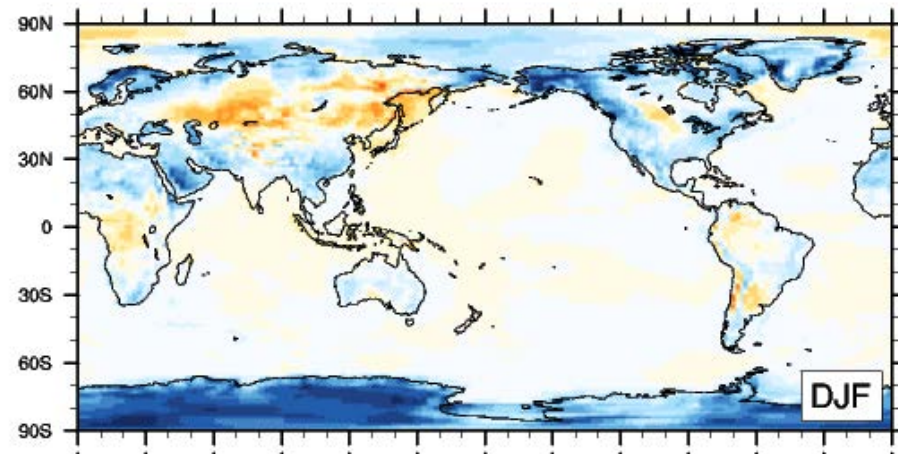
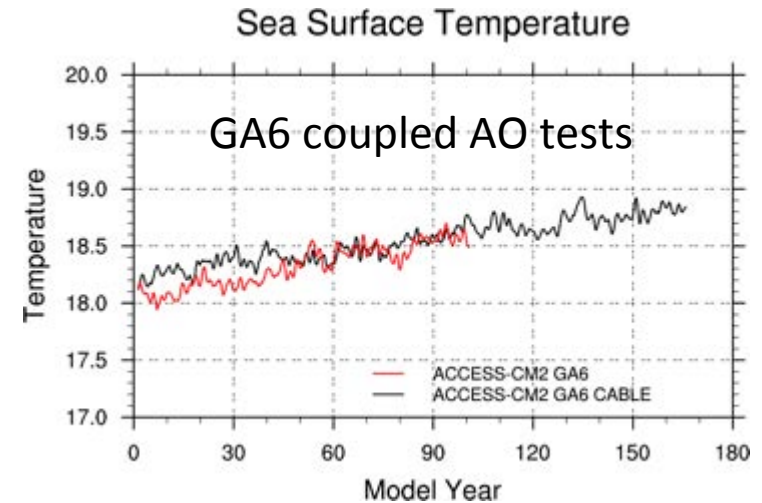
Nino3.4 Power Spectrum



SON: years 31-131

CABLE update

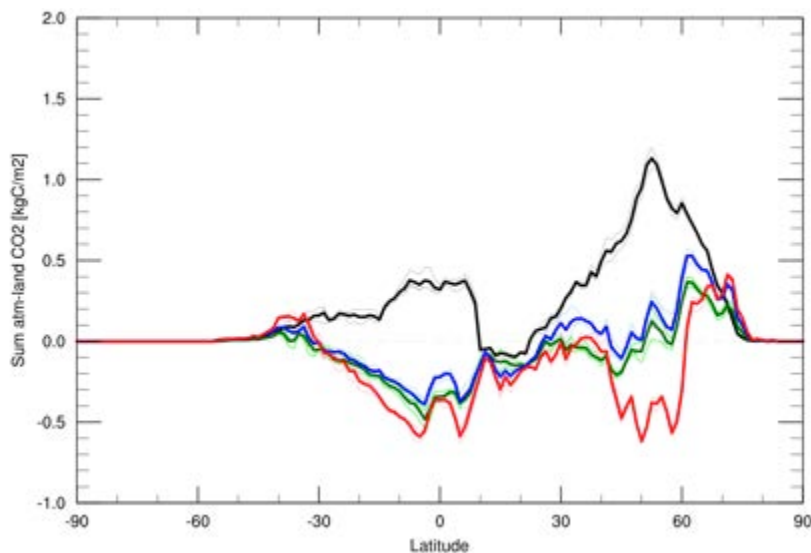
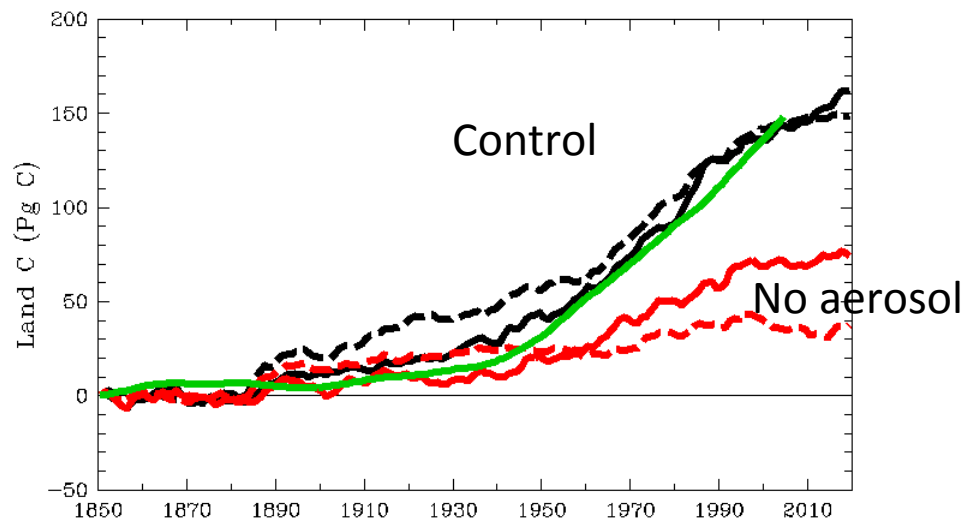
- Coupled run with GA6 configuration
- AMIP test runs with UM10.6/GA7 (GA7.1)
- Code consolidation
- Configuration testing



Screen level temperature bias
(short preliminary test, GA7)

ACCESS-ESM1: Analysis of CMIP5-type experiments

Sensitivity of land carbon uptake from 1850 in simulations with/without aerosols and prescribed or interactive atmospheric CO₂. Significant reduction in land carbon uptake if no aerosols (because warmer). Moderated when carbon-climate feedback included.

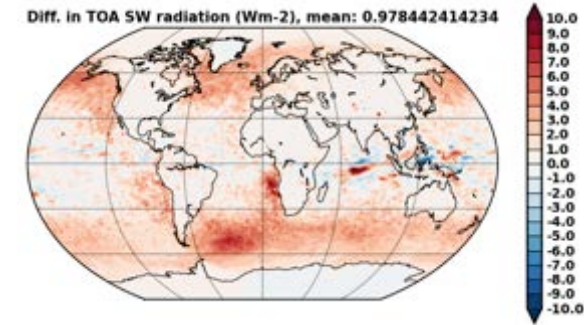


Latitudinal distribution of land carbon uptake: historical (black) and future (to 2100) scenarios (RCP2.6, 4.5, 8.5).

Change from land carbon uptake to land carbon release at almost all latitudes. Influence of nutrient limitation.

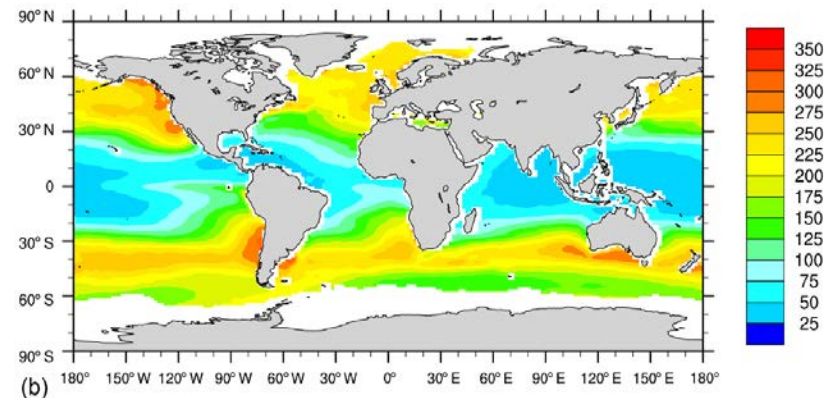
Chemistry and aerosol

- New primary marine emission param. added at vn10.6 (based on Gantt et al., 2015, GMD)
 - Addresses model underestimate in marine aerosol



- New ozone ocean dry dep. param. (Luhar et al., 2017, ACP)
 - Addresses overestimate in ozone dry dep to ocean -> revise ozone budget

Rel. diff. in O3 ddep velocity between old and new schemes



- Coupled chemistry-climate model in development
 - ACCESS-CM2/ESM2 + CheST/StratTrop