Towards CMIP6 Plans for participation by ACCESS

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Outline

- CMIP5 versions
- ACCESS-ESM1
- ACCESS-CM2/ESM2
- CMIP6 scope and timelines
- ACCESS contribution to CMIP6



ACCESS Climate Model - CMIP5 simulations

CMIP5 model versions

ACCESS1.0 and ACCESS1.3

- AOGCMs
- Resolution
 - Atmospheric ~130km (N96) L38
 - Ocean ~1deg. (enhanced equatorial/polar)
- Differ in land surface model
 ACCESS1.3 uses CABLE (vn1.8)
- Differ in atmospheric physics (esp. cloud)

CMIP5 simulations

- CORE experiments
- Historical ensembles, RCP simulations
- Output published on Earth System Grid (NCI node)
- Collaboration between CSIRO, Bureau and ARCCSS
- Computing done on NCI





Coupled Modelling – current systems

ACCESS1.4

- ACCESS1.3 (UM7.3 N96; MOM4p1 1°) plus
 - CABLE land surface model upgraded to CABLE2
 - Coupler upgraded to OASIS-MCT
 - Several fixes (e.g., CABLE/dust interface)

ACCESS-ESM1

- ACCESS1.4 plus
 - Terrestrial biogeochemistry (CASA-CNP as part of CABLE2)
 - Oceanic biogeochemistry (WOMBAT)
- Runs at ~8 years/day on 384 cores
- 'Workhorse' model for ESM science for near future
- Submission of simulations to CMIP6 not ruled out

New model version?

ACCESS-ESM1 – pluses:

- Can be used to address many questions in the carbon-climate feedback area
- Probably an appropriate model to enter in CMIP6 with focus on the ESM capability

ACCESS-ESM1 – minuses:

- Issues with tropical variability (ENSO, IOD, intraseasonal)
- Issues with aerosol radiative forcing
- Vertical resolution inadequate for some applications
- Atmospheric code becoming out of date
- UM community moving to new atmospheric models "GA6" and "GA7" (Partner interest in up-to-date physics!)



ACCESS-CM2/ESM2

ACCESS-CM2 (AOGCM)

- Atmosphere UK Met Office GA7.0 N96, L85, UM10.x, pending
- Ocean NOAA/GFDL MOM5.1
- Sea ice LANL CICE5.1
- Land surface CABLE2, pending

ACCESS-ESM2 (ESM for CMIP6)

ACCESS-CM2+

- Terrestrial biogeochemistry CASA-CNP
- Oceanic biogeochemistry WOMBAT (Matear, CSIRO)



Prototype ACCESS-CM2 now running

- Currently has GA6 atmosphere
- Currently has Jules land surface model
- Three versions different horizontal resolution

Resolution	Atmosphere	Ocean	Trial Simulation completed	Computing
Standard "N96O1"	N96 (~130 km)	1 deg.	200 years	496 cores, 5 y/d
Mixed "N960.25"	N96	0.25 deg.	200 years	2112 cores, 6 y/d
High "N216O.25"	N216 (~60 km)	0.25 deg.	2 years	2688 cores, 1.5 y/d

Indian Ocean Dipole (SON) ACCESS-CM2



(years 101-200)



SST Bias – ACCESS-CM2

N96O.25 version

N96O1 version



(years 151-200)

SST snapshot – ACCESS-CM2

Version N960.25 – 0.25 deg ocean

Sea Surface Temperature: 0005 JUN 12



ACCESS-CM2 atmospheric resolution





Aim 2017 commence production simulation release production version

~2019? commence production simulations release production version

Coupled Model Intercomparison Project phase 6 (CMIP6)

CMIP6

- Major international climate modelling activity getting underway
- Strict experimental protocol, in terms of model forcing and output data
- Will start in 2016, continue through 2020(+)
- Model output data will be available over the Earth System Grid
- Will support the IPCC 6th Assessment Report

CMIP6 – Broad scientific questions

- The specific experimental design is focused on three broad scientific questions:
 - 1. How does the Earth System respond to forcing?
 - 2. What are the origins and consequences of systematic model biases?
 - 3. How can we assess future climate changes given climate variability and uncertainties in scenarios?



CMIP6 schematic



DECK (entry card for CMIP)

- i. AMIP simulation (~1979-2014)
- ii. Pre-industrial control simulation
- iii. 1%/yr CO₂ increase
- iv. Abrupt 4xCO₂ run

CMIP6 Historical Simulation (entry card for CMIP6)

v. Historical simulation using CMIP6 forcings (1850-2014)

(DECK & CMIP6 Historical Simulation to be run for each model configuration used in the subsequent CMIP6-Endorsed MIPs) Proposals from CMIP6-Endorsed MIPs & Model Groups' Commitments to Participate in each MIP

Aerosols and Chemistry Model Intercomparison Project (AerChemMIP) Coupled Climate Carbon Cycle Model Intercomparison Project (C4MIP) Cloud Feedback Model Intercomparison Project (CFMIP) **Detection and Attribution Model Intercomparison Project (DAMIP) Decadal Climate Prediction Project (DCPP)** Flux-Anomaly-Forced Model Intercomparison Project (FAFMIP) **Geoengineering Model Intercomparison Project (GeoMIP)** Global Monsoons Model Intercomparison Project (GMMIP) High Resolution Model Intercomparison Project (HighResMIP) Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6) Land Surface, Snow and Soil Moisture MIP (LS3MIP) Land-Use Model Intercomparison Project (LUMIP) Ocean Model Intercomparison Project (OMIP) Palaeoclimate Modelling Intercomparison Project (PMIP) Radiative Forcing Model Intercomparison Project (RFMIP) Scenario Model Intercomparison Project (ScenarioMIP) Volcanic Forcings Model Intercomparison Project (VolMIP) Coordinated Regional Climate Downscaling Experiment (CORDEX) Dynamics and Variability of the Stratosphere-Troposphere System (DynVar) Sea-Ice Model Intercomparison Project (SIMIP) Vulnerability, Impacts, and Adaptation Advisory Board for CMIP6 (VIA AB)



Future Scenarios in CMIP6 (scenarioMIP)

Shared Socioeconomic Pathways



ScenarioMIP Tier 1

ScenarioMIP Tier 2

Finalize scenario choice, March 2015 (O'Neill, Tebaldi, van Vuuren)

CMIP6 Timeline



ACCESS participation in CMIP6

Role of CMIP participation

- Expected by partners and stakeholders demonstration of ACCESS as a world class system
- Facilitates contribution to IPCC and to projections formulation
- Model output is widely distributed via the Earth System Grid
- The CMIP experiments have been developed to address important science questions (e.g., WCRP "Grand Challenges").
- International influence E.g., facilitates Australian membership on WGCM, where design decisions on CMIP are made affecting both modellers and users.



CMIP6 MIP participation

MIP	Description	Contact	Commit?
DECK		Tony Hirst (CSIRO)	✓
scenarioMIP	revised conc. scenarios	Tony Hirst	\checkmark
DAMIP	detection/attribution	David Karoly (ARCCSS)	✓
CFMIP	cloud feedback	C. Franklin (CSIRO)	✓
GMMIP	global monsoons	Harun Rashid (CSIRO)	✓
OMIP	ocean/sea ice model	Simon Marsland (CSIRO)	✓
FAFMIP	flux anomaly forced	Simon Marsland	✓
C4MIP	coupled carbon cycle	Rachel Law (CSIRO)	✓
LS3MIP	land surface, snow, soil moisture	Rachel Law	✓
LUMIP	land-use	Rachel Law	aim
PMIP	paleoclimate	Duncan Ackerley (Monash)	aim
GEOMIP	geoengineering	Andrew Lenton (CSIRO)	aim

ACCESS timeline for CMIP6

Time	Step
March 2016	Final code in place (GA7 – UM10.x, CABLE2)
April-Sept 2016	Testing and tuning (N96O1, N96O.25)
Oct 2016 – Mar 2017	Perform final trial simulations
Mar 2017	Select final configuration(s)
April – Dec 2017	DECK and Tier 1 scenarioMIP simulations
2018	Other MIP simulations conducted

- N216 version continue in background next two years; lag above by ~2 years.
- ACCESS-ESM version (N96) with atmospheric chemistry continue testing UKCA next two years; lag above by ~2 years.

Versions: N96O1 versus N96O.25 for CMIP6?

- Our plan has been to go (first) with N96O1 version
- N96O.25 solution looks better overall
 - Now fast throughput (~6 years/day)
 - Significant stakeholder interest E.g., decadal prediction, ocean biogeochemistry

Clearly we continue with N96O.25 (as well)

- Why work with N96O1 at all? Computation requirement!
 - E.g., DAMIP 3000 years
 - o 25,000kSU for N96O.25
 - o 4,500kSU for N96O1

No need O.25 resolution for many key science questions (e.g., climate sensitivity)

Progress with N96O.25 has benefitted from strong Bureau compute support!

Summary

- ACCESS-CM2 under development
 - AOGCM running with GA6.0 and JULES multicentury simulations
 - CABLE incorporation still to be finalised, upgrade to GA7.0
 - Focus on lower resolution (N96) first
 - Subsequently develop higher resolution (N216)
- ACCESS-ESM2 will follow (using N96 version)
- Plan is for ACCESS-ESM2 to participate in CMIP6, including committed participation in 8 MIPs
- There are risks and uncertainties
 - CMIP6 funding for ACCESS-CM2 is available under NESP
 - Funding for ACCESS-ESM2 is less clear
 - Several model components are untested
 - Fall-backs are available

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Summary and future work

Work to do

- UM10.x with GA7
- CABLE2.x implementation
- Scalability performance improvement
- Model tuning scientific performance (about a year)

Risks

- CMIP6 funding for ACCESS-CM2 is available (NESP)
- Funding for ACCESS-ESM2 less certain (but likely, CSIRO)
- Compute/Storage: NCI commitment to CMIP6?
- Model untested: Fallbacks ACCESS1.4/ESM1 and ACCESS-CM2 (UM GA6.0)
- ACCESS staffing has declined 25% over last 3 years, but more experienced and growing collaboration with ARCCSS (5x Universities in Centre of Excellence)



Issue: Funding support ACCESS-ESM

ACCSP (+ institutional strategic) has supported ACCESS model development

- ACCESS coupled modelling
- ACCESS ESM (carbon cycle)
- ACCESS ESM (atmospheric chemistry)

NESP replaces ACCSP in July 2016.

- Supports ACCESS coupled modelling (and CMIP6 entry)
- Almost no support ACCESS ESM (carbon cycle)
- No support ACCESS ESM (atmospheric chemistry)



Many contingencies – regular review, and replan as required