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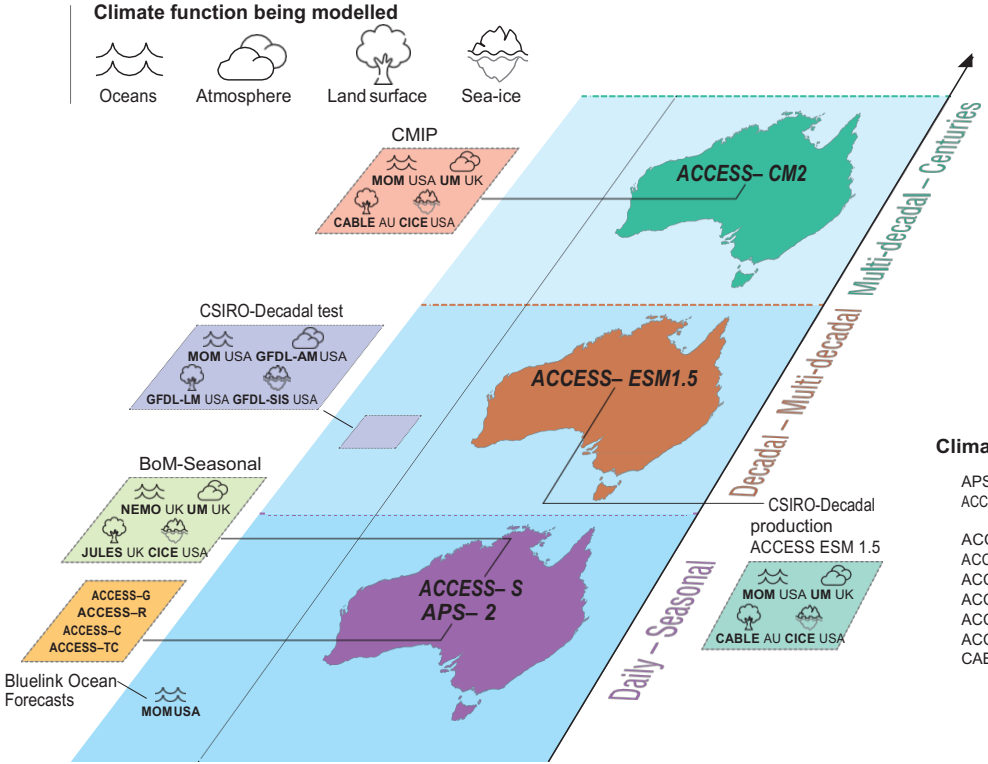
The ACCESS contributions to CMIP6

Simon Marsland (CSIRO), BoM R&D Workshop, 25th November 2020

What is ACCESS?



Climate model component glossary

APS	Australia Parallel Suite
ACCESS	Australian Community Climate and Earth System Simulator
ACCESS–CM2	ACCESS Coupled Model
ACCESS–ESM1.5	ACCESS Earth System Model
ACCESS–G	ACCESS Global
ACCESS–R	ACCESS Regional
ACCESS–S	ACCESS Seasonal
ACCESS–TC	ACCESS Tropical Cyclones
CABLE	Community Atmosphere Biosphere Land Exchange Model
CICE	Los Alamos sea ice model
GFDL	Geophysical Fluid Dynamics Laboratory
GFDL–AM	Atmospheric Model developed by GFDL
GFDL–LM	Land Model developed by GFDL
GFDL–SIS	Sea Ice Simulator developed by GFDL
JULES UK	Joint UK Land Environment Simulator
MOM	Modular Ocean Model
NEMO UK	Nucleus for European Modelling of the Ocean
UM	Unified Model

Source: **Climate science for Australia's future (NCSAC, 2019)**

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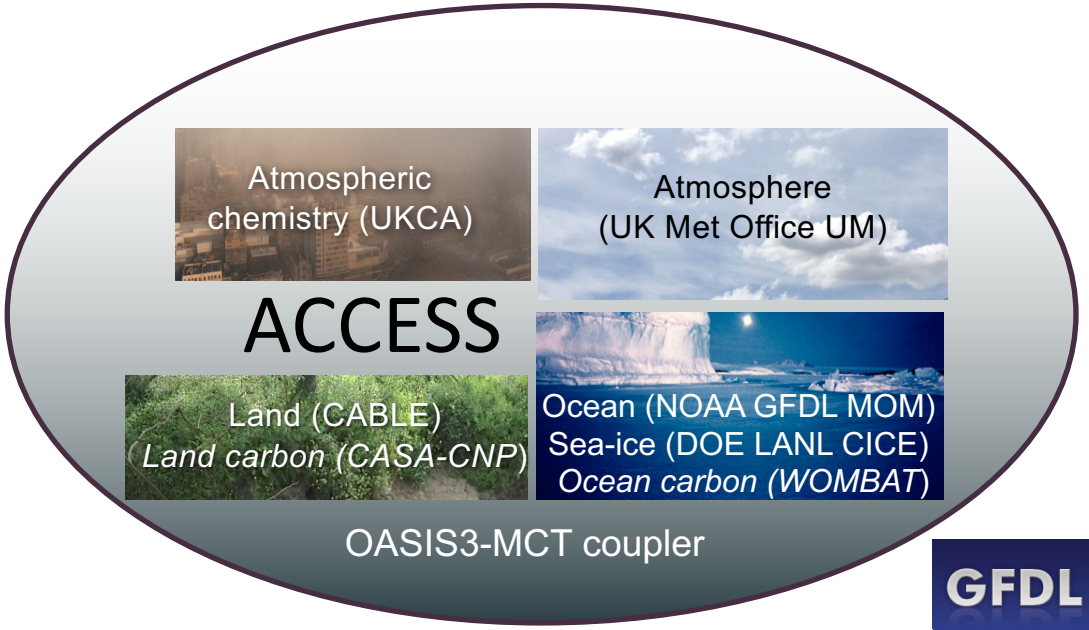
Australian Community Climate and Earth System Simulator

National effort since 2005

- All timescales, weather to climate
- Local and imported components
- CSIRO, BoM, Universities
- NCI

Support from

- NESP Earth System and Climate Change Hub



Met Office

NCMRWF

KMA
Korea Meteorological Administration

Australian Government
Bureau of Meteorology

CSIRO

NIWA
Taihoro Nukurangi

GFDL Geophysical Fluid Dynamics Laboratory

is-enes
INFRASTRUCTURE FOR THE EUROPEAN NETWORK FOR EARTH SYSTEM MODELLING

Los Alamos NATIONAL LABORATORY EST. 1943

ARC CENTRE OF EXCELLENCE FOR CLIMATE SYSTEM SCIENCE

climate extremes
ARC centre of excellence

Australian Government
Australian Research Council

NCI AUSTRALIA

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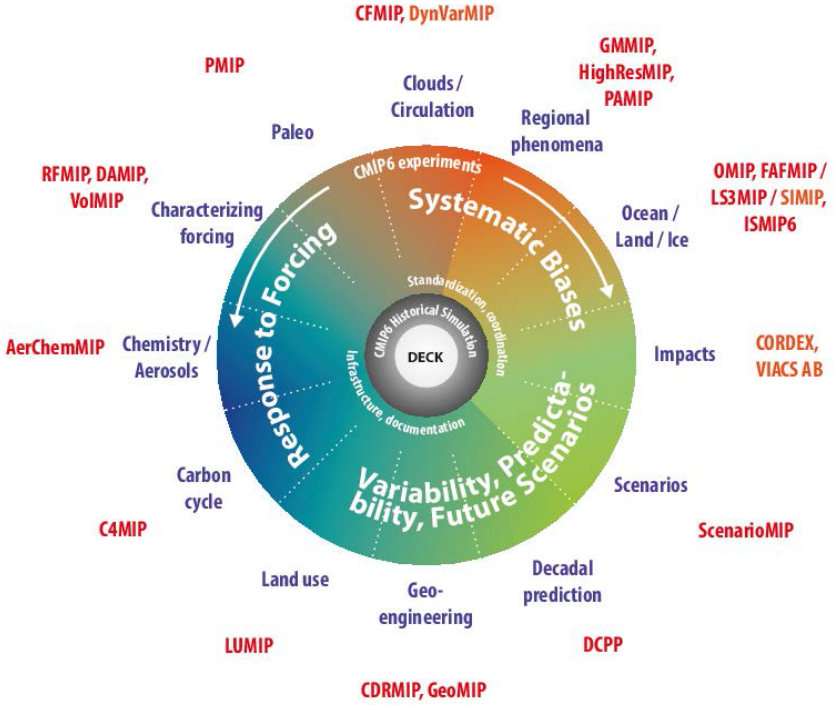
What is CMIP6?

- 3 Science Questions
  - Systematic Biases
  - Response to forcing
  - Variability, Predictability and Future Scenarios
- CMIP6 Controlled Vocabularies
  - 21 Model Intercomparison Projects
  - 53 centres/consortia
  - 137 registered models (103 on ESGF currently
  - 299 experiments
  - 104 tier 1 experiments
  - 20-40 PB data



Eyring et al., Geosci. Mod. Dev.(2016)

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The plan, 4 November 2015

ACCESS timeline for CMP6

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

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The reality

- 2016 – CSIRO less interested in climate science
  - ESCC Project 2.1 “Preparing ACCESS for CMIP6” July 2016-June 2019
- 2017 – Problems with UKMO GA7 – ozone, aerosols, clouds
  - November – ACCESS-ESM1.5 fallback
- 2018 – CMIP6 forcings are later than expected
- 2019 – Full steam ahead, but how to publish?
  - ESCC Project 5.1 “ACCESS Evaluation and Application” July 2019-December 2020
- 2020 – A mysterious virus rampages across the globe

CMIP6 experiments with ACCESS - outputs

MIP	Experiment	ACCESS-CM2	ACCESS-ESM1.5
CMIP	piControl	500y	900y (2000y)
	1pctCO2	1	1
	abrupt-4xCO2	1	2
	amip	4	3
	historical	3	10 (30)
	esm-piControl		500y
	esm-historical		10
ScenarioMIP	ssp126	3	10
	ssp245	3	10 (30)
	ssp370	3	10
	ssp585	3	10

CMIP6 experiments with ACCESS - outputs

MIPs	CM2	ESM1.5	OM2	OM2-025
FAFMIP	7			
C4MIP		10		
CDRMIP		3		
PMIP		1		
RFMIP	5	6		
DAMIP	(14)	9		
(OMIP)			(1)	(1)
CovidMIP		(60+)		

- **~45** different **experiments** (DECK + historical + 8 MIPs)
- **~10000** simulations **years**
- **~500 TB** of (raw) **output**
- **~4.7 million downloads** from ESGF so far

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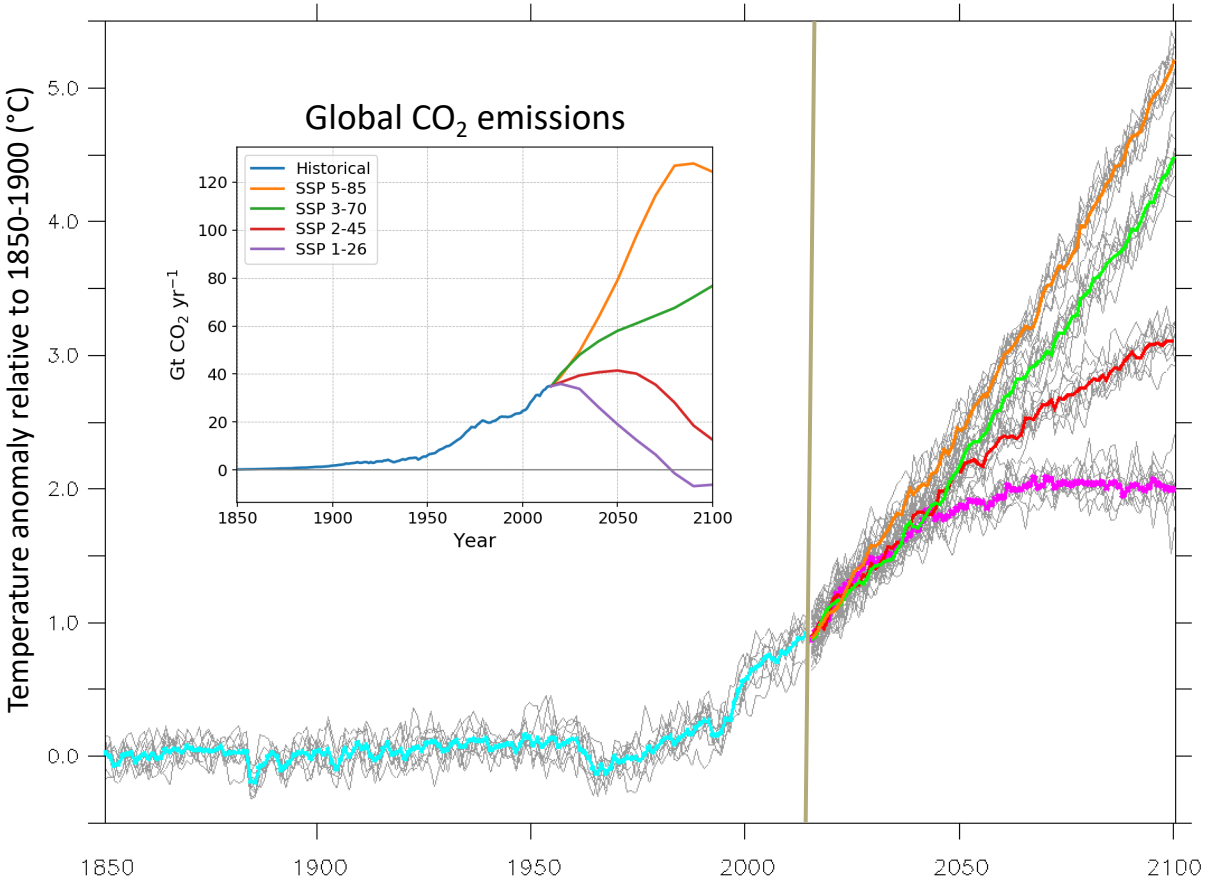
ACCESS CMIP6 next-user uptake

Model	ESGF # Downloads	ESGF Data downloads (TB)
ACCESS-CM2	2.8 M	87
ACCESS-ESM1.5	4.7 M	110

ACCESS-ESM1.5 stats:

- **~45** different **experiments** (DECK + historical + 8 MIPs)
- **~10000** simulations **years**
- **~500 TB** of (raw) **output**
- **~4.7 million downloads** from ESGF so far

ScenarioMIP – SSPs 10-member ensemble



5.21 °C SSP5-85

4.49 °C SSP3-70

3.11 °C SSP2-45

2.00 °C SSP1-26

0.92 °C Historical

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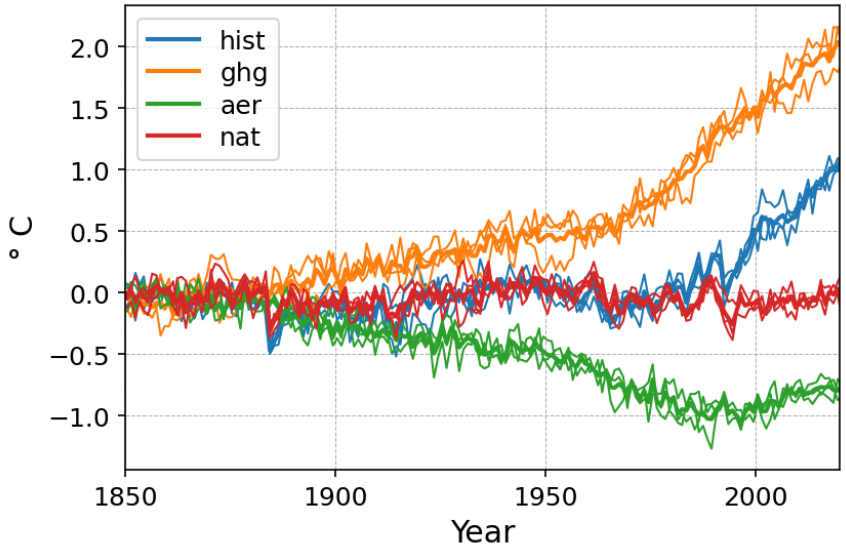
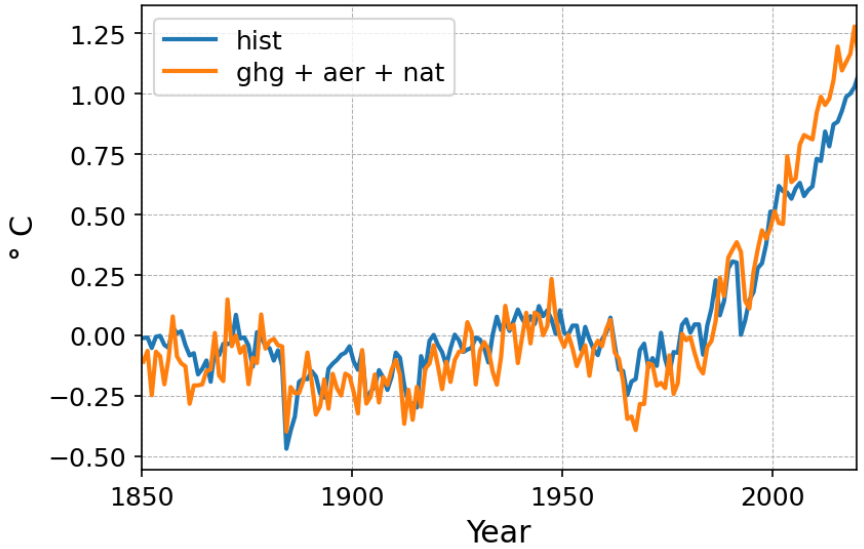
Slide courtesy Tilo Ziehn

ACCESS-CM2 DAMIP experiments

Global mean surface air temperature change





Slide courtesy Martin Dix

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Model description papers - 2020

RESEARCH ARTICLE (Open Access) Previous

Configuration and spin-up of ACCESS-CM2, the new generation Australian Community Climate and Earth System Simulator Coupled Model

Daohua Bi [A I], Martin Dix [A], Simon Marsland [A B C], Siobhan O'Farrell [A], Arnold Sullivan [A], Roger Bodman [D], Rachel Law [A], Ian Harman [E], Jhan Srbinovsky [A], Harun A. Rashid [A], Peter Dobrohotoff [A], Chloe Mackallah [A], Hailin Yan [F], Anthony Hirst [F], Abhishek Savita [A B C], Fabio Boeira Dias [A B C], Matthew Woodhouse [A], Russell Fiedler [G] and Aidan Heerdegen [C H]

+ Author Affiliations

Journal of Southern Hemisphere Earth Systems Science - https://doi.org/10.1071/ES19040

Submitted: 20 December 2019 Accepted: 29 June 2020 Published online: 8 October 2020

us

The Australian Earth System Model: ACCESS-ESM1.5

Tilo Ziehn [A D], Matthew A. Chamberlain [B], Rachel M. Law [A], Andrew Lenton [B], Roger W. Bodman [A C], Martin Dix [A], Lauren Stevens [A], Ying-Ping Wang [A] and Jhan Srbinovsky [A]

+ Author Affiliations

Journal of Southern Hemisphere Earth Systems Science - https://doi.org/10.1071/ES19035

Submitted: 23 December 2019 Accepted: 28 April 2020 Published online: 24 August 2020

- **Both models successfully submitted to CMIP6**
- **ACCESS-ESM1.5 is Australia's first Earth System Model contribution to CMIP**

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Recent ACCESS successes - 2020

- Feb/Mar - NCI-STRESS2020 project – ACCESS modelling (6 MSU)
- Mar – DAWE NESP2 funding opportunity announcement
  - – includes Climate Systems Hub with ACCESS modelling in-scope
- Apr – NCI Australasian Leadership Computing Grant (37M SU)
  - ACCESS Climate Modelling – ensembles and new MIPs
- Oct - ACCESS-NRI (NCRIS) $7.8M budget announcement
- Oct – “Getting Started with ACCESS-CM2 and ACCESS-ESM1.5” model release
  - Slides and recording: http://nespclimate.com.au/access-evaluation-and-application-5-1/
- Nov - COSIMA-II ARC Linkage Project – 4 years (ACCESS, MOM - ocean modelling)
- Nov - CLEX announces “ACCESS Modelling” as central to new research programme structure

Thank you!

- NCI
- CLEX/CMS
- Uni partners
- BoM
- International collaborators – especially UKMO
- ACCESS Team@CSIRO: Dave Bi, Roger Bodman, Matt Chamberlain, Martin Dix, Peter Dobrohotoff, Ian Harman, Rachel Law, Andrew Lenton, Chloe Mackallah, Siobhan O'Farrell, Harun Rashid, Jhan Srbinovsky, Abhishek Savita, Arnold Sullivan, Ying Ping Wang, Matthew Woodhouse and Tilo Ziehn

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CSIRO

Australian Government Bureau of Meteorology

Australian National University

MONASH University

THE UNIVERSITY OF MELBOURNE

UNSW SYDNEY

UNIVERSITY of TASMANIA

Equilibrium Climate Sensitivity

- Global mean surface temperature equilibration after 2xCO2
- Gregory method – abrupt-4xCO2 @ 150 years
- ACCESS-CM2 4.7K
- ACCESS-ESM1.5 3.9 K
- Issue of intense scrutiny in literature and forthcoming IPCC-AR6 WGI report (July 2021 IPCC 54 - Approval Session)