

Australia's Earth System Model:

ACCESS-ESM

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OCEANS AND ATMOSPHERE FLAGSHIP
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ACCESS-ESM1 Components

	ACCESS1.3		ACCESS1.4		ACCESS-ESM1		ACCESS-ESM2
Atmosphere	UM7.3 (Martin et al., 2010, 2011) Approx. GA1 (no dust) (Hewitt et al., 2011)	→	UM7.3 Approx. GA1	→	UM7.3 Approx. GA1	→	UM10.6 GA7.1
Land	CABLE1.8 (Kowalczyk et al., 2013)	→	CABLE2.2.3	→	CABLE2.2.3 CASA-CNP (Wang et al., 2010)	→	CABLE ??? CASA-CNP
Coupler	OASIS3.2-5	→	OASIS-MCT	→	OASIS-MCT	→	OASIS-MCT
Sea ice	CICE4.1 (Hunke & Lipscomb, 2010)	→	CICE4.1	→	CICE4.1	→	CICE5
Ocean	MOM4p1 (Griffies, 2009)	→	MOM4p1	→	MOM4p1 WOMBAT (Oke et al., 2013)	→	MOM5 WOMBAT

(Bi et al., 2013b)

CMIP5 submission

ACCESS-ESM1 Simulations (CMIP5 type)

1. Concentration driven (prescribed atmospheric CO₂)

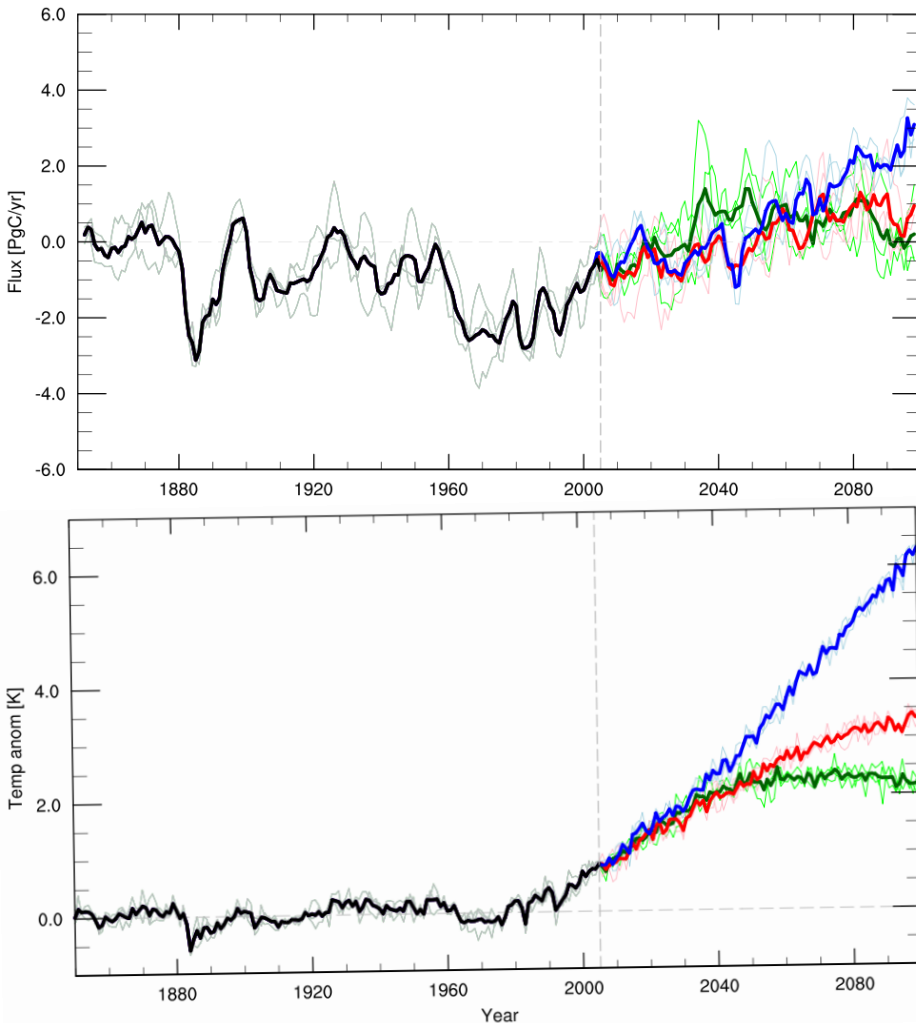
- a. Pre-industrial control run: 1000 years with PresLAI, 1000 years with ProgLAI
- b. Historical simulations: start at year 801 for PresLAI and 3 ensemble members for ProgLAI (start at years 801, 811 and 821)
- c. Future Scenarios: RCP2.6, RCP4.5 and RCP8.5 for PresLAI and ProgLAI, 3 ensemble members for ProgLAI
- d. Climate Sensitivity and feedback analysis: 1% increase CO₂ for ProgLAI and 4xCO₂ start from year 801 for ProgLAI
- e. Sensitivity to aerosols: no anthropogenic aerosols (kept at 1850 levels) start from year 801 for ProgLAI run (3 ensemble members)

2. Emission driven (prescribed CO₂ emissions)

- a. Pre-industrial control run: 200 years (start from year 801 from prescribed CO₂ run) for ProgLAI
- b. Historical simulations: start from year 901 for ProgLAI
- c. Future Scenarios: RCP8.5 for ProgLAI

https://accessdev.nci.org.au/trac/wiki/access/ACCESS_ESM1_catalogue

Land carbon uptake – 1850 to 2100



Land carbon uptake 1850-2005 Historical

Ensemble mean: **137 PgC*** (CMIP5 range for NEP: 24-1730 PgC (Shao et al., 2013))

Land carbon uptake 2006-2100 **RCP2.6**

Ensemble mean: **-39 PgC** (CMIP5: -75–200 PgC, (1 sigma) from AR5)

Land carbon uptake 2006-2100 **RCP4.5**

Ensemble mean: **-12 PgC** (CMIP5: 75–400 PgC, (1 sigma) from AR5, all models project increase in land carbon uptake)

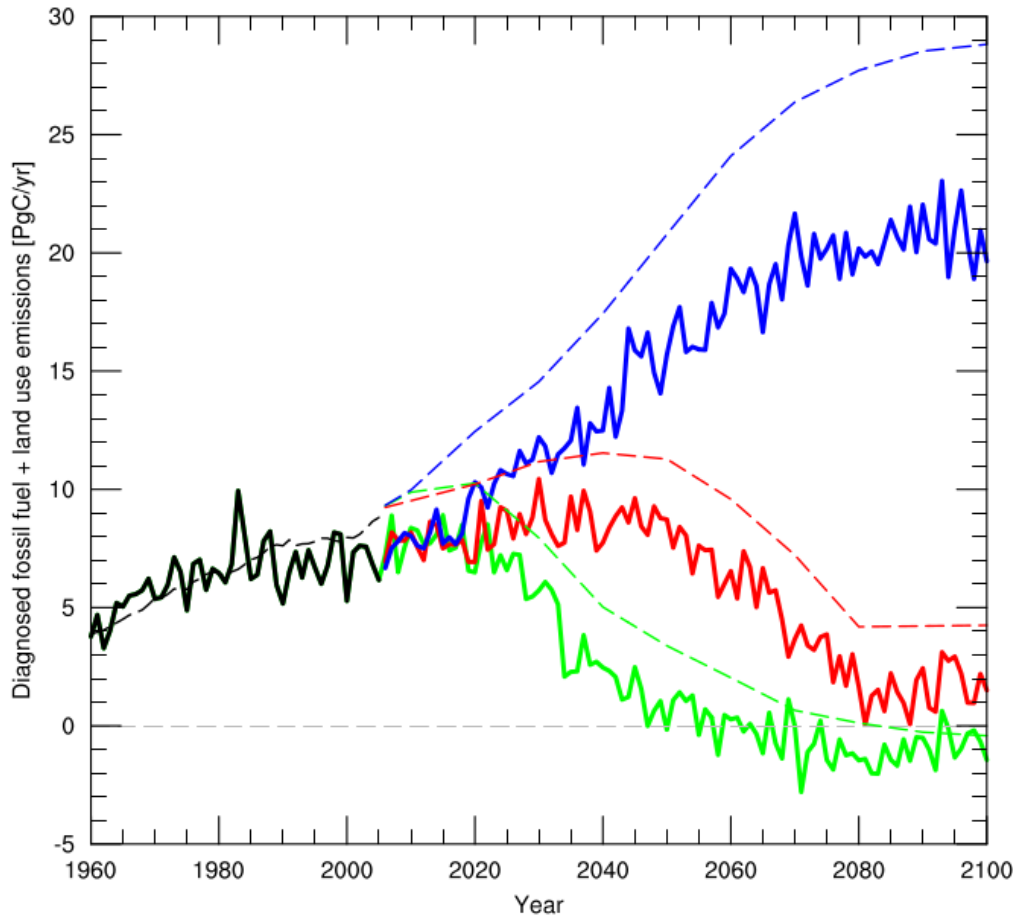
Land carbon uptake 2006-2100 **RCP8.5**

Ensemble mean: **-71 PgC** (CMIP5: -75–450 PgC, (1 sigma) from AR5)

*no land use change included in CABLE (155 PgC land use change emissions according to Houghton (2008))

Allowable emissions

Fossil + land-use = Prescribed atmospheric increase + land uptake + ocean uptake



	IAM	ACCESS
Historical	469 PgC	456 PgC
RCP2.6	381 PgC	202 PgC
RCP4.5	807 PgC	559 PgC
RCP8.5	1971 PgC	1471 PgC

Nutrient limitation in ACCESS-ESM1 results in lower allowable emissions than other models. Greater emission reductions required to stay below 2°C warming.

Summary and conclusions

- ACCESS-ESM1 well tested and documented:
 - Law, R. M., et al.: *The carbon cycle in the Australian Community Climate and Earth System Simulator (ACCESS-ESM1) – Part 1: Model description and pre-industrial simulation*, *Geosci. Model Dev.*, 10, 2567-2590, <https://doi.org/10.5194/gmd-10-2567-2017>, 2017.
 - Ziehn, T., et al.: *The carbon cycle in the Australian Community Climate and Earth System Simulator (ACCESS-ESM1) – Part 2: Historical simulations*, *Geosci. Model Dev.*, 10, 2591-2614, <https://doi.org/10.5194/gmd-10-2591-2017>, 2017.
- Need to address issues identified during simulations:
 - Carbon conservation
 - Prognostic LAI (evergreen needle leaf, C4 grass)
 - Carbon-climate feedback
- Make more use of existing results:
 - Future carbon uptake and regional impacts
 - Role of anthropogenic aerosols
 - Emission driven runs
- Prepare ACCESS-ESM2 for CMIP6