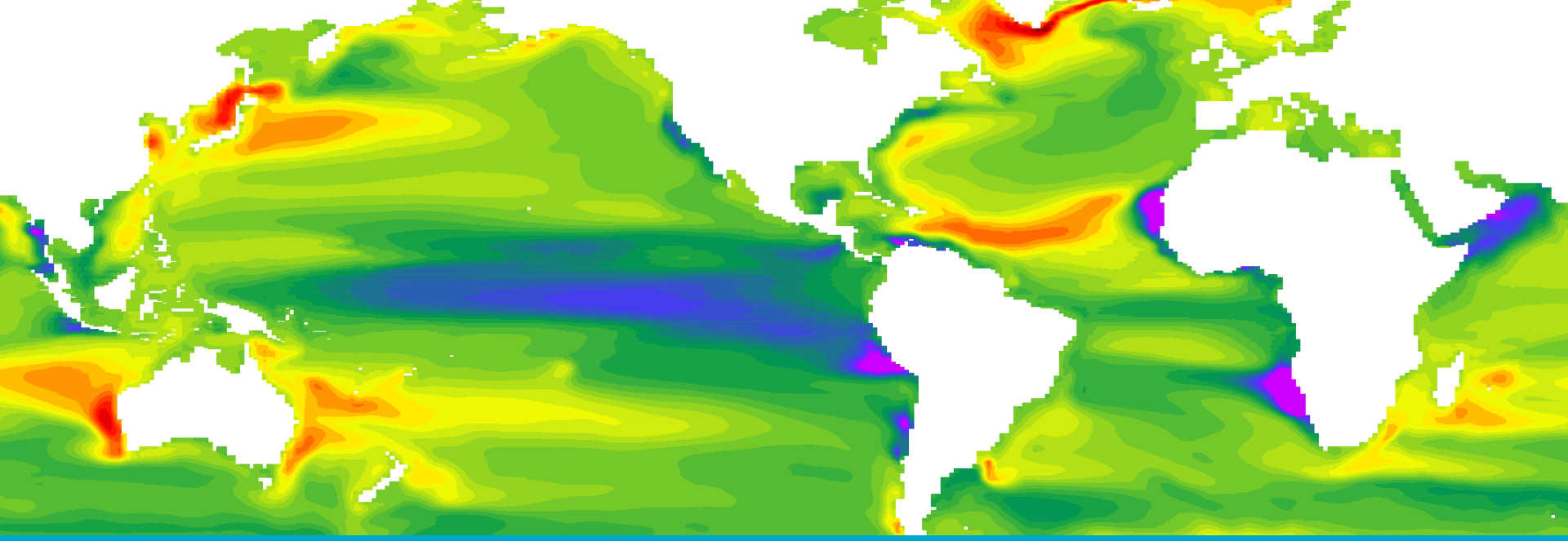

The carbon cycle in ACCESS-ESM1

Model description and Pre-Industrial Simulation

Rachel Law, T. Ziehn, R. Matear, L. Stevens, A. Lenton, Y.P. Wang, D. Bi, H. Yan

19 May 2015

OCEANS AND ATMOSPHERE FLAGSHIP
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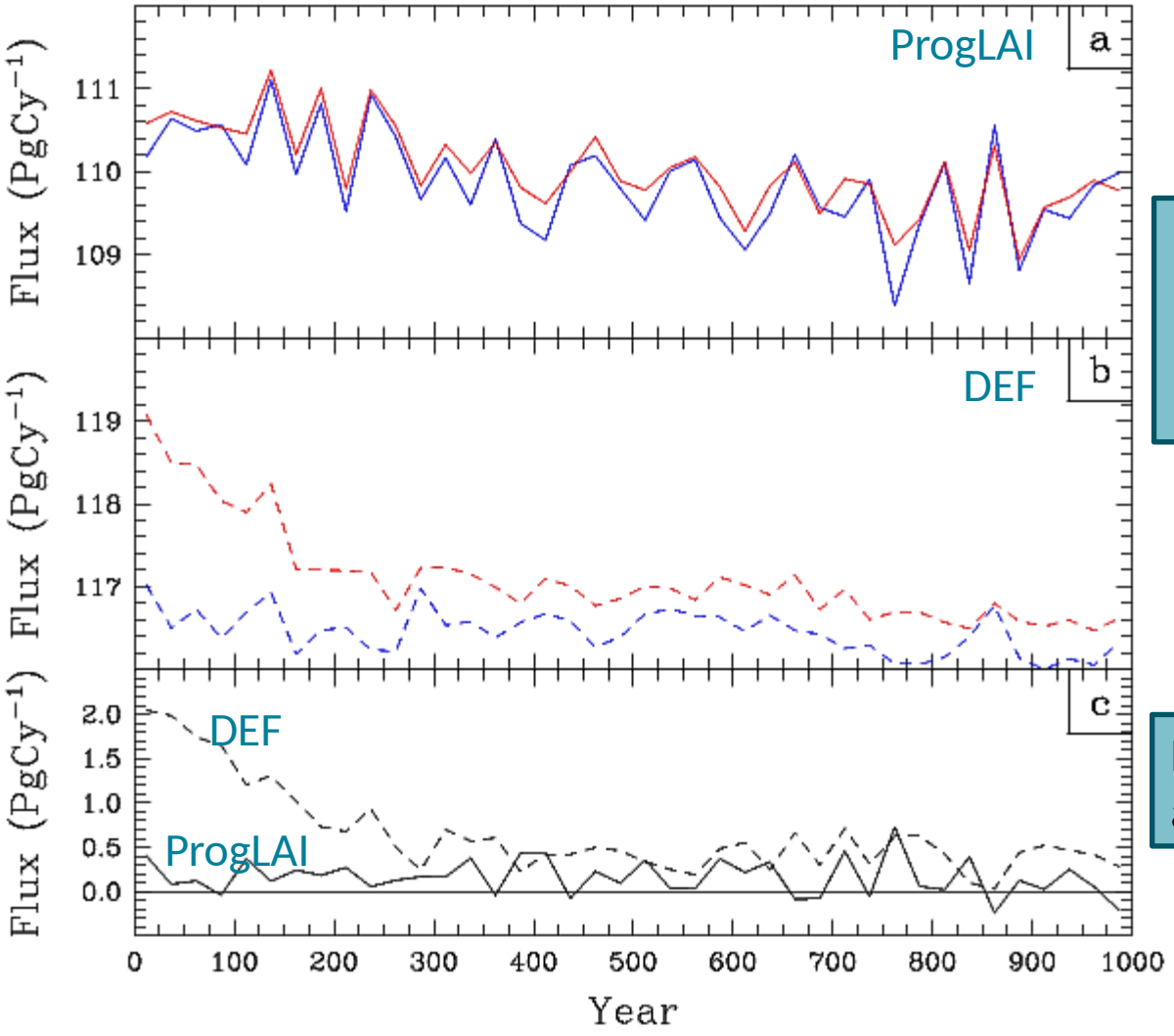
ACCESS-ESM1

- ACCESS1.4
  - UM7.3 (~GA1.0)
  - MOM4p1
  - CABLE2.2.3
  - CICE4.1
  - OASIS-MCT
- ACCESS-ESM1
  - CABLE2.2.3 with l_casacnp=.TRUE., icycle=3 (CNP)
  - WOMBAT for ocean carbon
- Pre-industrial simulations
  - DEF – default, prescribed leaf area index, standard ocean carbon parameters
    - 1000 years
  - ProgLAI – prognostic leaf area index
    - 1000 years
    - Slight warming of climate (TAS 14.59±0.11 compared to 14.22±0.10°C)
  - AltOCN – alternate ocean carbon parameters (and numerically stable WOMBAT)
    - 500 years

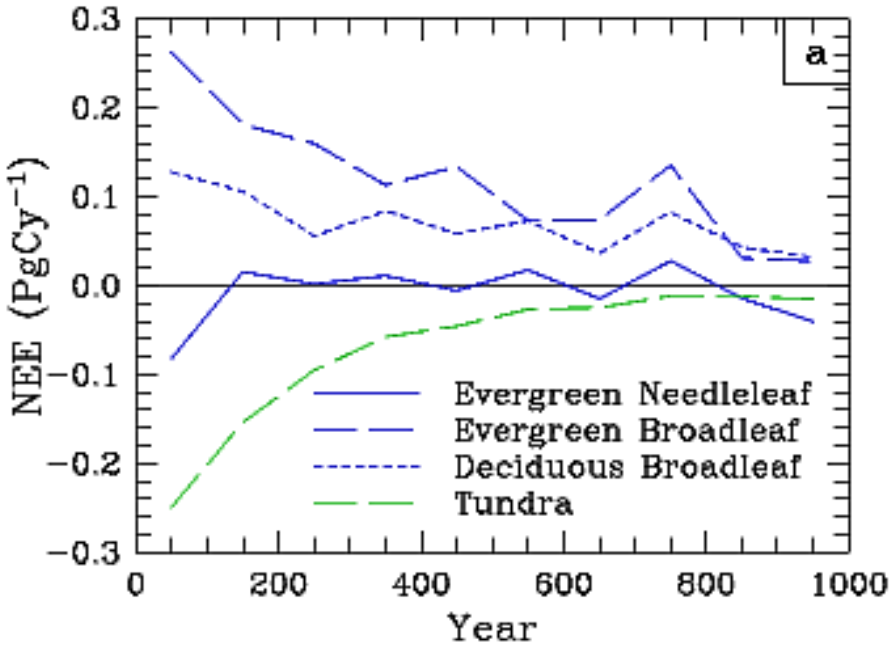
Land flux equilibration

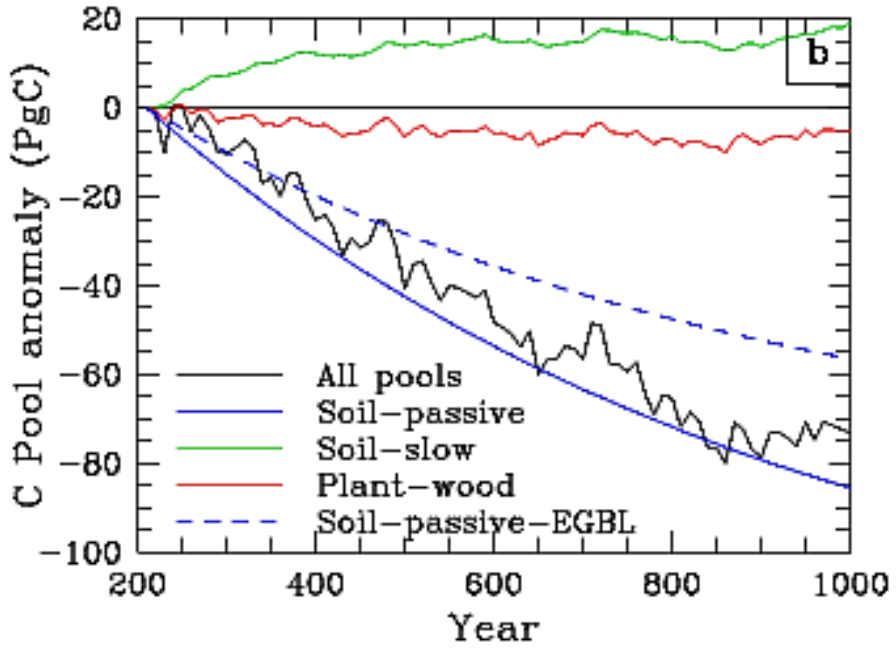


Blue – GPP (photosynthesis)
Red – total respiration

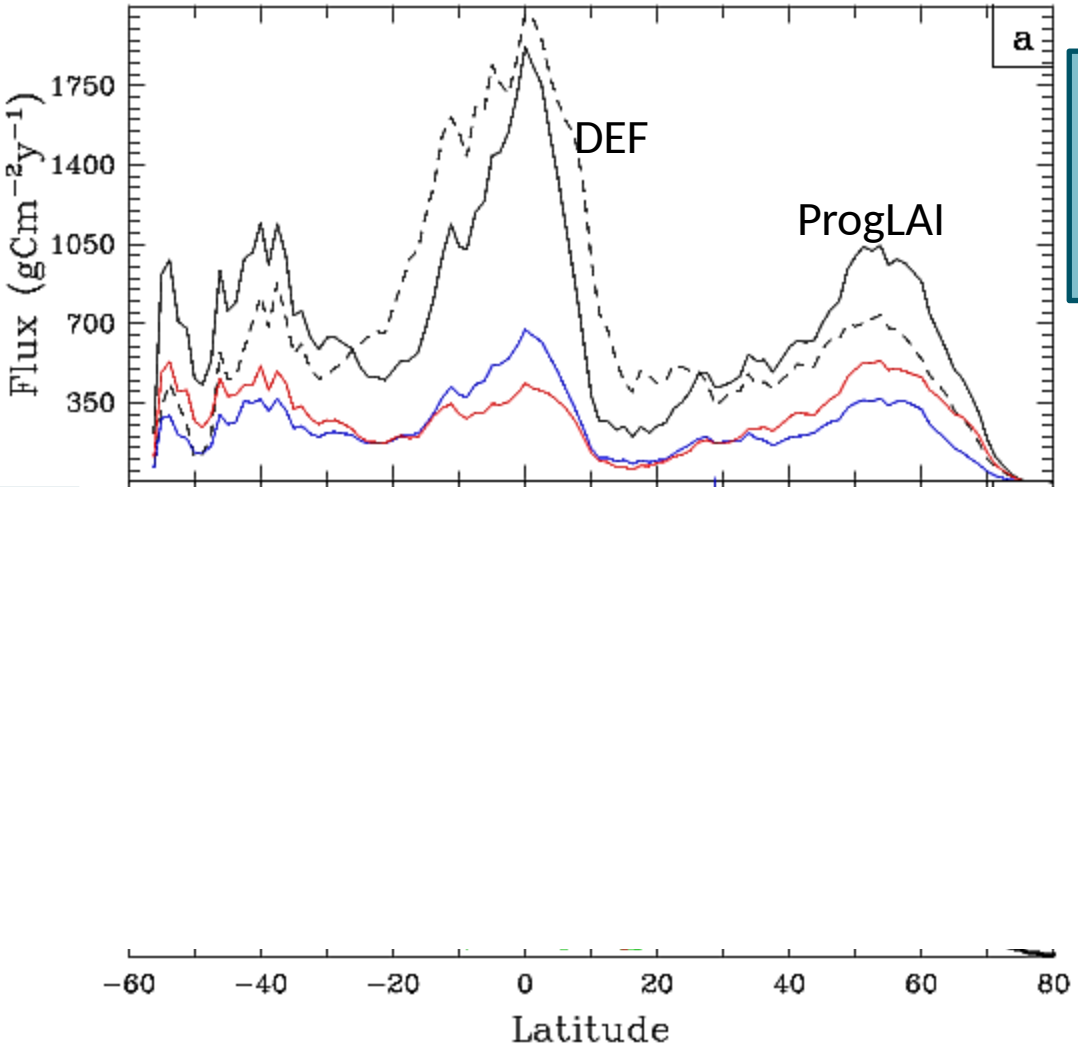
NEE – flux to atmosphere

Land flux and carbon pools - ProgLAI





Land carbon flux distribution and LAI

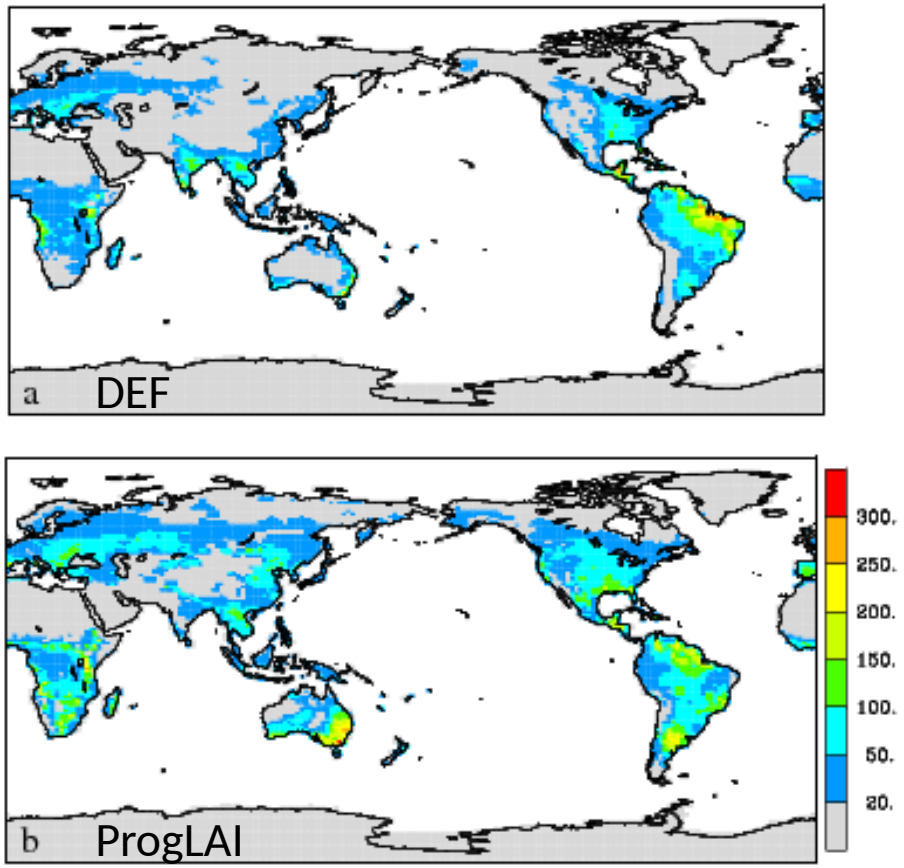


Zonal mean – land only
Black – GPP
Blue – plant respiration
Red – soil respiration

Interannual variability

	DEF	ProgLAI
GPP	1.17	1.87
Leaf Resp	0.26	0.75
Plant Resp	0.17	0.27
Soil Resp	0.27	0.32
NEE	1.40	1.21

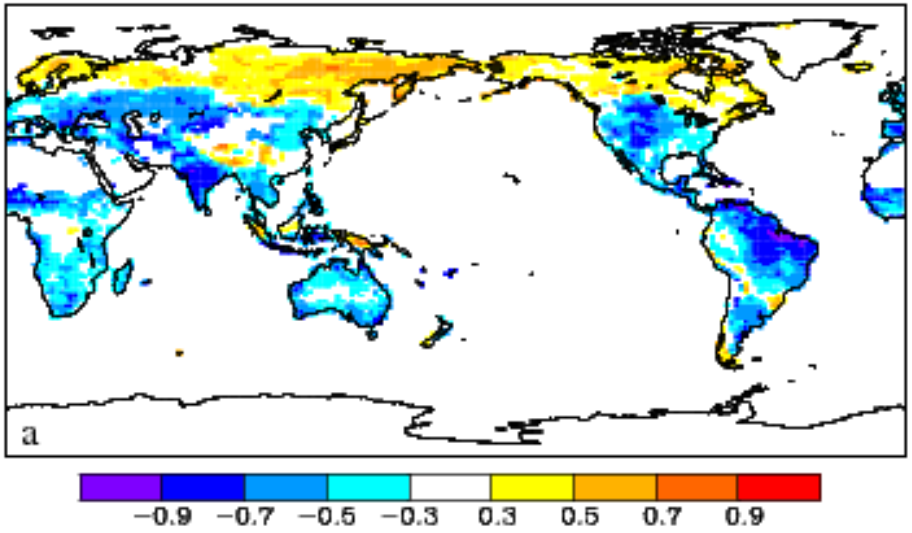
NEE standard deviation ($gCm^{-2}y^{-1}$)



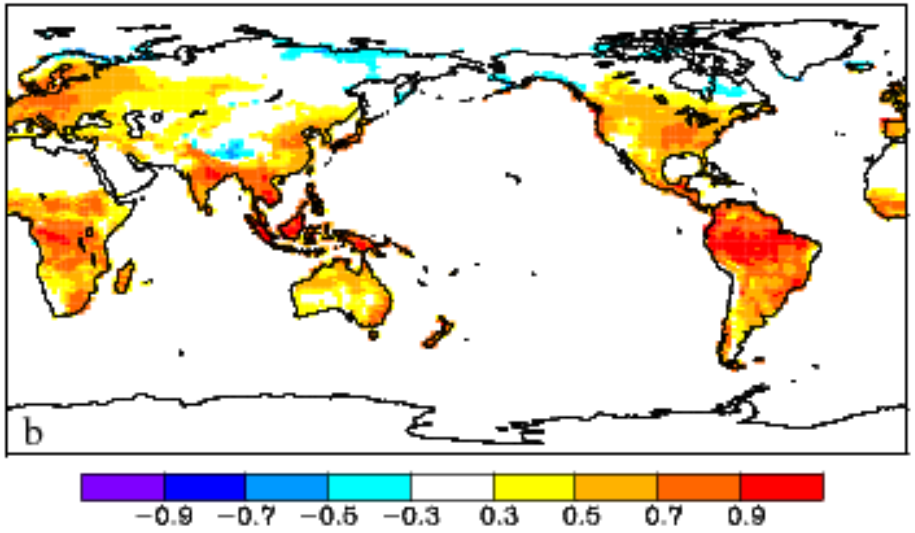
Climate drivers for interannual variability

Correlation between annual land carbon flux to the atmosphere and

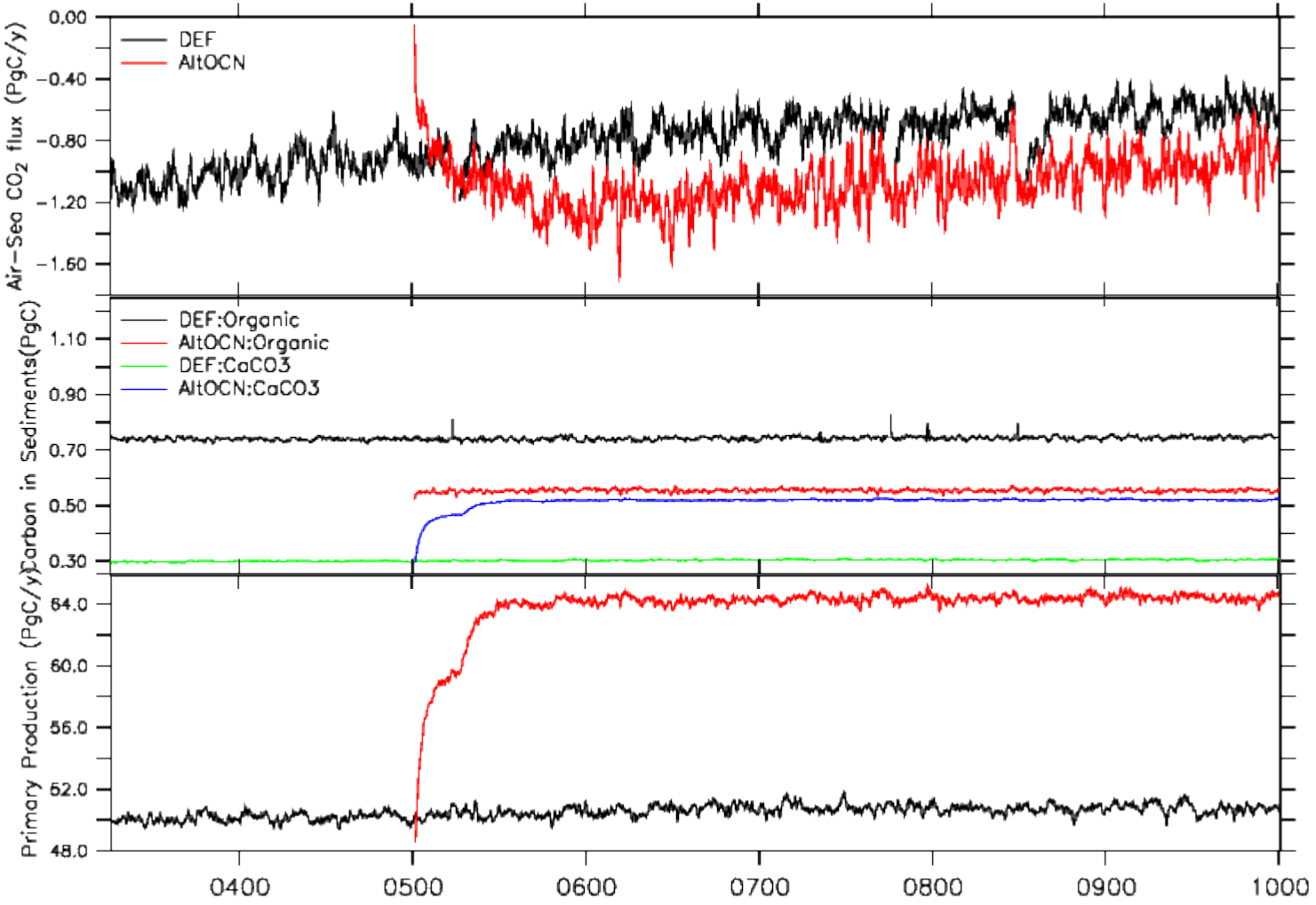
precipitation



surface air temperature



Ocean carbon flux equilibration

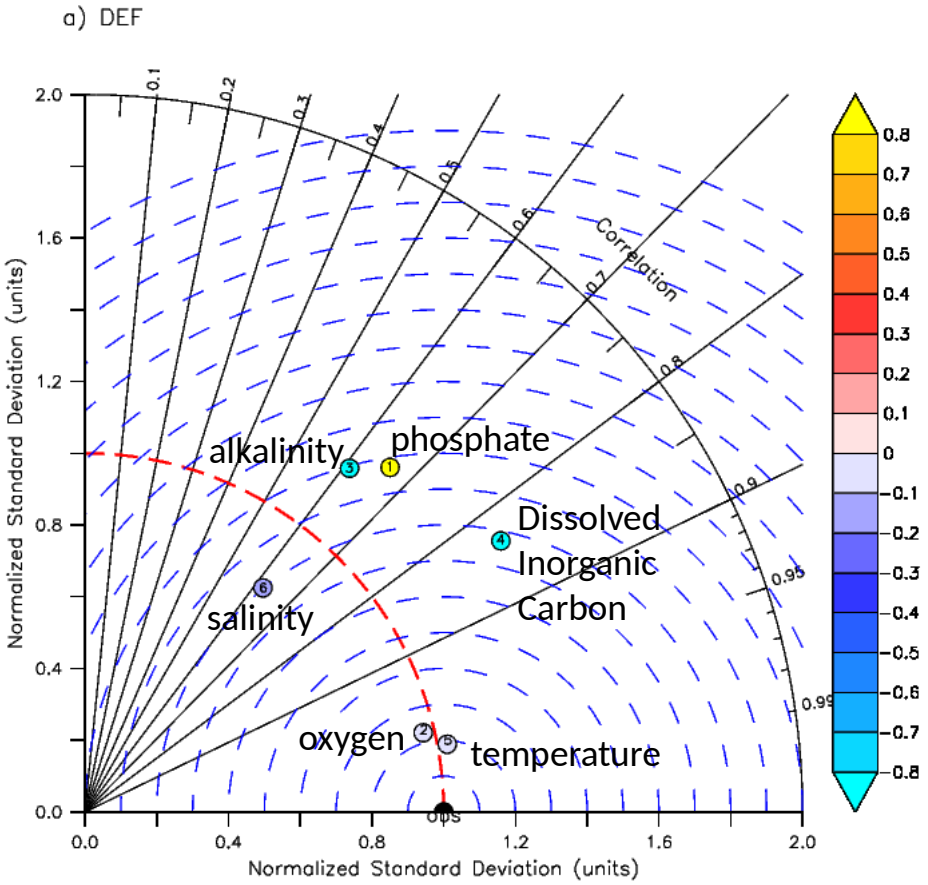


Air-Sea CO_2 flux

Carbon in sediment

Primary production

Assessment against surface observations

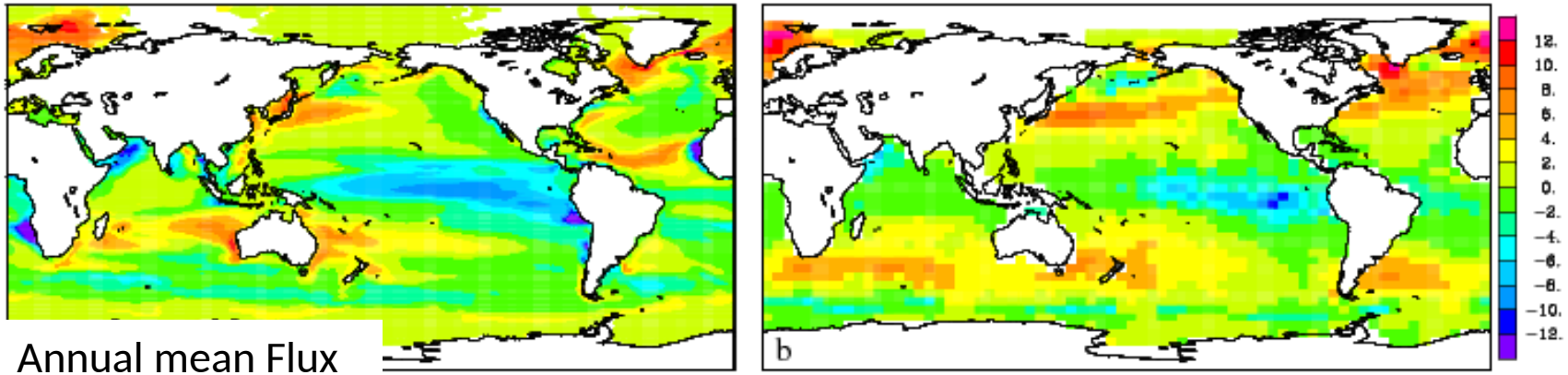


Taylor diagram comparing modelled and observed annual mean climatologies:
Correlation
Normalised standard deviation
Normalised bias (colour)

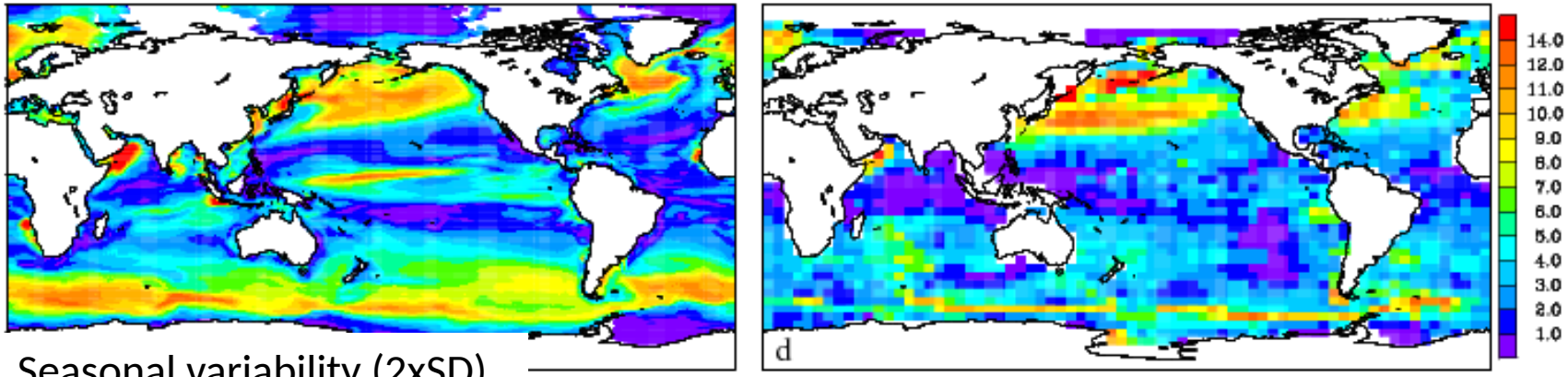
Air-sea flux distribution and seasonality

ACCESS-ESM1:DEF

Observed: Takahashi et al. (2009)



Annual mean Flux

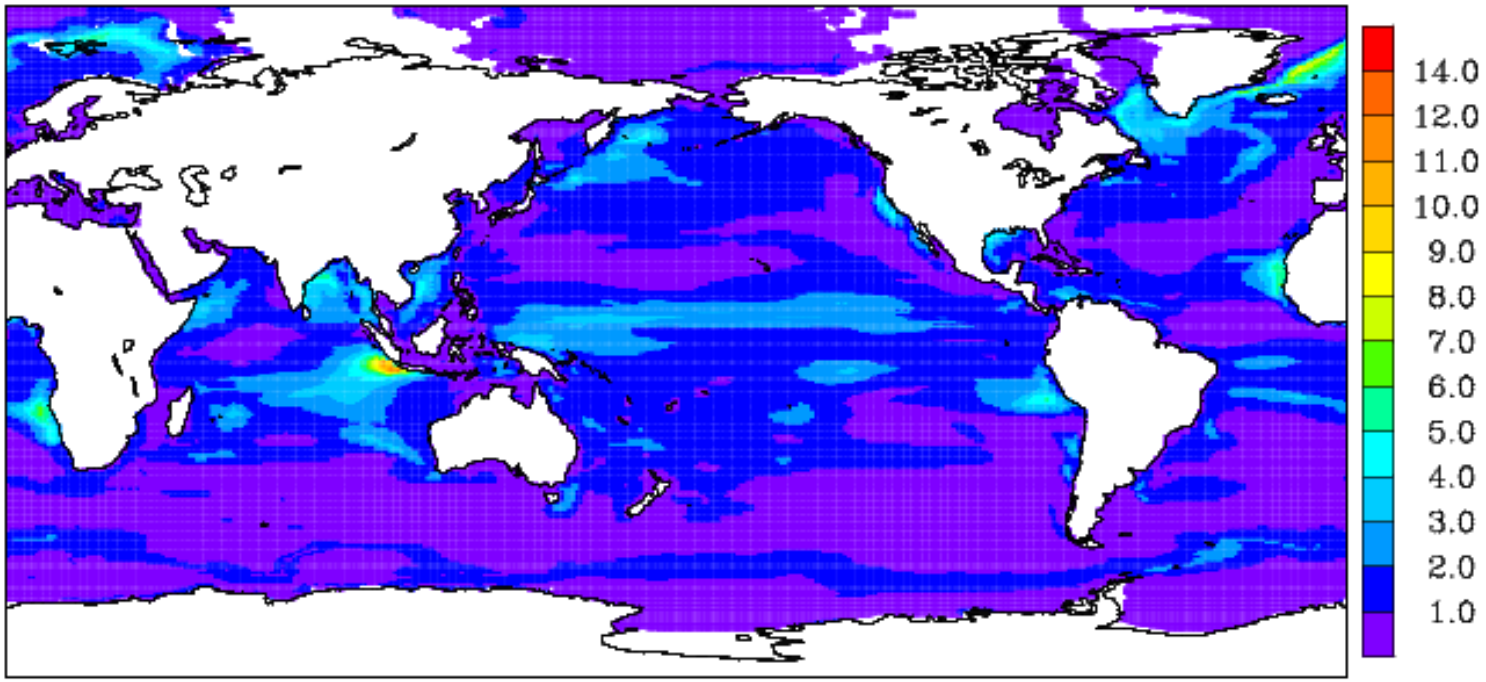


Seasonal variability (2xSD)

Units: mmol m^{-2} day^{-1}

Interannual variability

Interannual variability (2xSD) of air-sea CO_2 flux from DEF simulation



Units: mmol m^{-2} day^{-1}

Conclusions

- Simulations are generally realistic
- Improvements to target
  - Land carbon conservation when low rainfall makes sustaining vegetation difficult
  - Land carbon fluxes may be over sensitive to climate (moisture) variability
  - Excessive uptake of alkalinity in surface water → outgassing carbon
  - Underestimated export of particulate organic carbon → too much phosphate
- Carbon cycle impacted by physical model biases
  - Low rainfall biases (e.g. Indian monsoon)
  - Cold tongue bias, surface salinity biases
- Law et al., 'The carbon cycle in the Australian Climate and Earth System Simulator (ACCESS-ESM1). 1. Model description and pre-industrial simulation', to be submitted to Geosci. Model. Dev. (possible ACCESS special issue)

Thank you

Earth System Modelling
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