

# WOMBAT developments in ACCESS and Bluelink

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# WOMBAT: Whole Ocean Model of Biogeochemistry And Trophic-dynamics.

Applied as a (NPZD) tracer package in MOM5.

- ACCESS
  - Ongoing progress on various fronts (PTO).
  - CMIP6 submission: stable and realistic, figures from Mackallah et al. 2022, ACCESS CMIP6 Dataset paper.
- Bluelink
  - Work towards the capability to simulate BGC and water optical properties in an operational ocean model.

# WOMBAT in ACCESS

- WOMBAT was part of ACCESS-ESM1.5 submission to CMIP6; produced a realistic and stable ocean-BGC state, output used widely.
- Submissions to Global Carbon Project.
- Working now in ACCESS-OM3: OMIP2 submission at 1-deg res., tested at 0.1 deg res.
- Code harmonised with MOM5@github.
- Scope for ongoing development:
  - eg. extra diagnostics, extra nutrients, extra phyto/zoo plankton classes, fix bias in oxygen flux, improve OBGC at regional scales, coastal processes.
  - Run at 0.25 resolution in preparation for future climate simulations (CMIP7?).
- Ongoing analysis of CMIP6 output...

# ACCESS Datasets paper



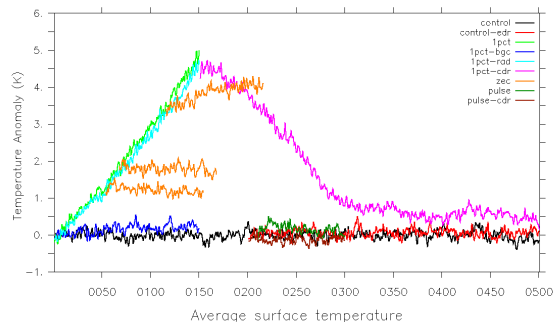
SPECIAL ISSUE | RESEARCH ARTICLE

<https://doi.org/10.1071/ES21031>

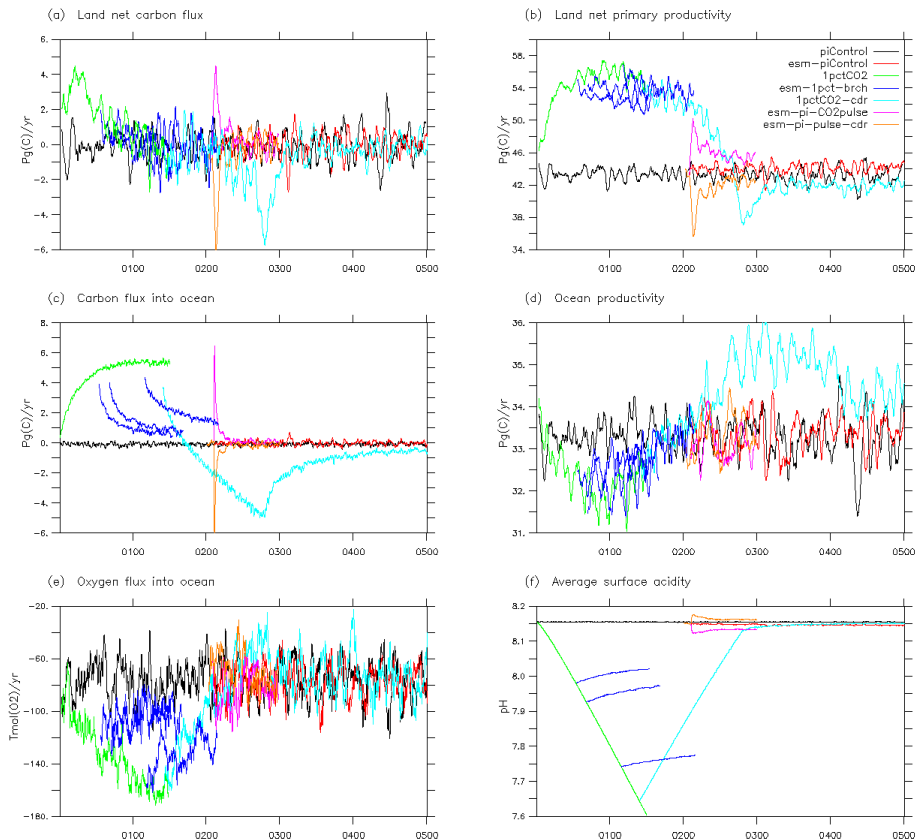


## ACCESS datasets for CMIP6: methodology and idealised experiments

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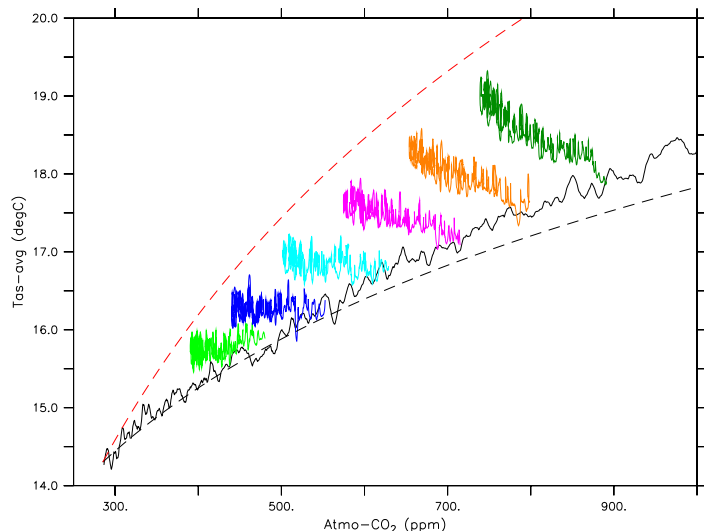


**Figure 3.** Trends in anomalies of average global surface temperature from extra idealised experiments with ACCESS-ESM1.5. For clarity, emission driven experiments (*esm-piControl*, *esm-pi-CO2pulse* and *esm-pi-cdr-pulse*) start at year 0201 rather than 0001. 12-month boxcar filters have been applied to all metrics.



**Figure 5.** Global biogeochemical metrics from idealised experiments; the *piControl*, *esm-piControl*, *1pctCO2-rev*, zero-emission and pulse experiments, with the same layout as Fig. 4. For clarity, emission driven experiments (*esm-piControl*, *pulse* and *pulse-cdr*) start at year 0201 rather than 0001.

# ACCESS-ESM1.5 – ZECMIP follow up experiments.



**Figure 10.** Global trends of average surface temperature with atmospheric CO<sub>2</sub> for the *1ptCO2* and ZEC branches. Dashed lines indicate the gradients following the transient climate response (black) and equilibrium climate sensitivity (red).

- Use the ESM interactive carbon cycle to simulate the climate under zero-emission pathways after varying amounts of carbon emissions/warming.
- Here, the climate traverses to the right as part of the warming *1ptCO2* experiment, closely following the Transient Climate Response (black, dashed).
- On switching to zero-emission scenarios, climates turn to the left towards the Equilibrium Climate Sensitivity trend (red).
- Since ECS > TCR, global temperatures can rise while atmospheric CO<sub>2</sub> is decreasing, driven by the slow response of the ocean to changes in the 'climate forcing,' the Southern Ocean in particular.

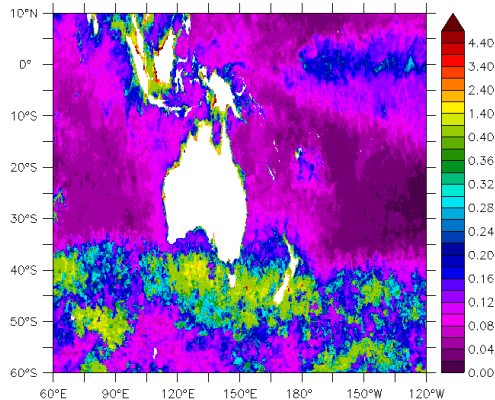
# WOMBAT in Bluelink

- Aim to simulate BGC and water optical properties in an operational oceanographic platform (OFAM), i.e. including data assimilation.
  - BGC in global model to produce boundary conditions for complex regional model.
- Experiments run with and without data assimilation to the model physics.

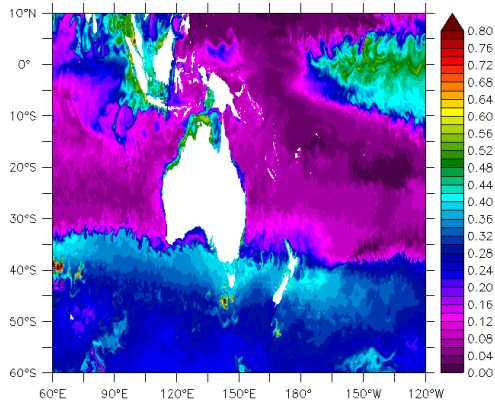
# WOMBAT in Bluelink

Shown below are 8-day averages of observations and experiments with (BRAN) and without (Free) data assimilation into the physical ocean state; note metrics are in different units so comparisons are qualitative here.

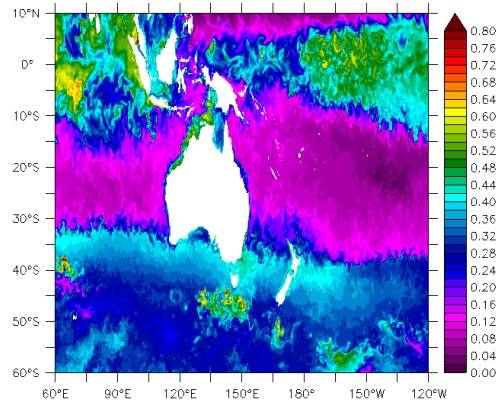
Extra nutrients in upper ocean drive higher productivity in BRAN in the tropics; like issues described in Park et al. 2018, doi:[10.1002/2017MS001223](https://doi.org/10.1002/2017MS001223), associated with the DA cycle and vertical processes.



Obs. — chlA (mg/m<sup>3</sup>)



FreeRun — phy (mmolN/m<sup>3</sup>)

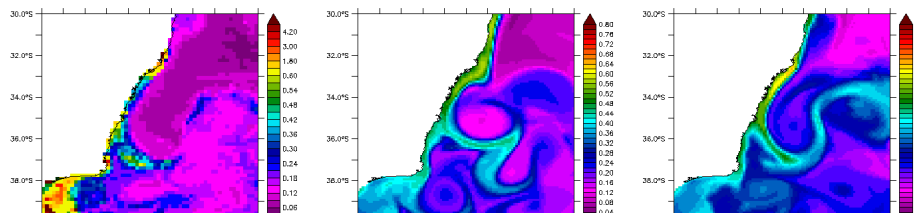


BRAN — phy (mmolN/m<sup>3</sup>)

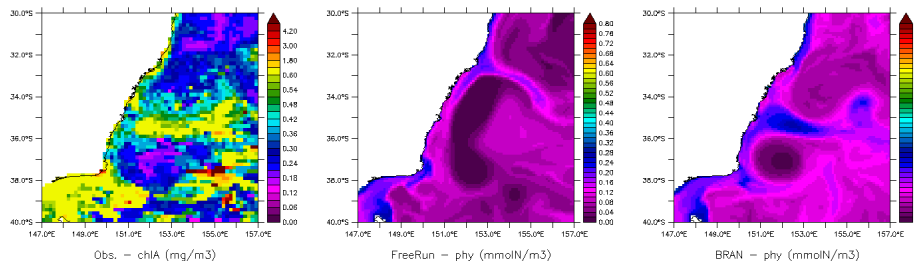
# WOMBAT in Bluelink

Good qualitative agreement of BRAN-BGC with observations in regions like the Tasman Sea with mesoscale eddies

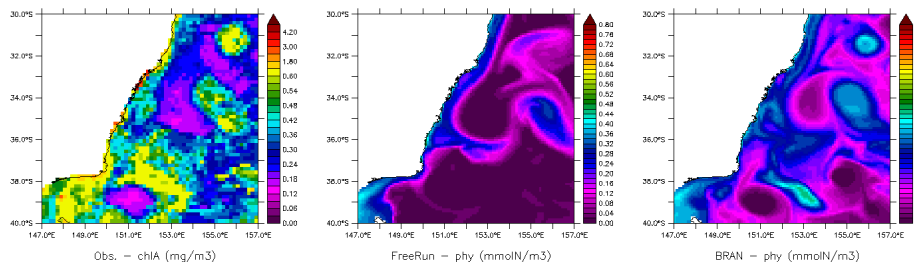
14 Feb



14 Jun



18 Sep  
2019



Observations

Free running

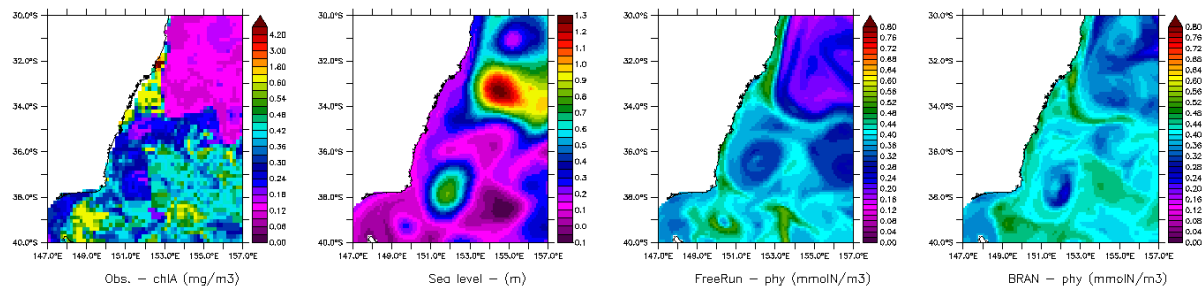
BRAN



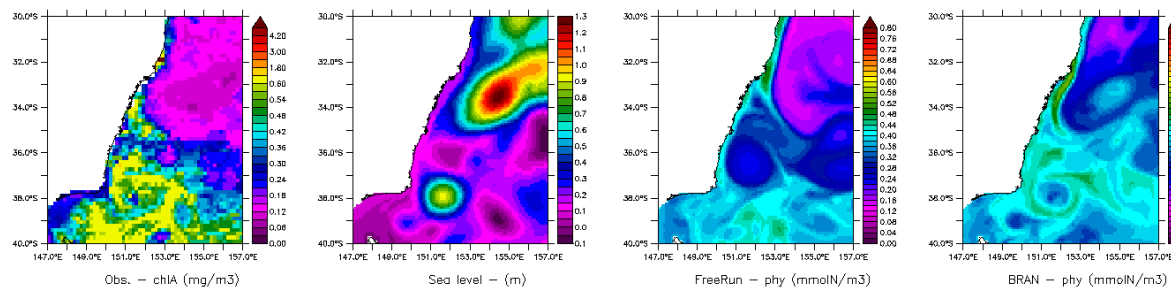
# WOMBAT in Bluelink

BRAN-BGC does a reasonable  
job simulating productivity in  
an observed eddy, though  
timing of the bloom is late in  
the model.

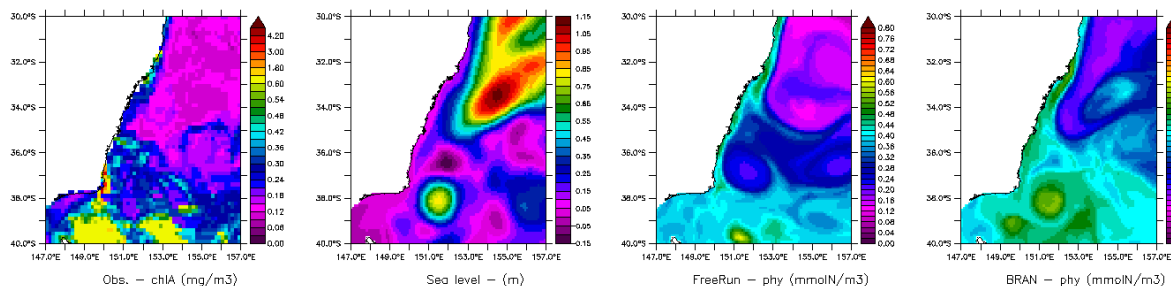
29 Nov



15 Dec



23 Dec  
2019



Observations

Sea level

Free running

BRAN

# Summary

- WOMBAT in ACCESS
  - Ongoing progress on various fronts, e.g.
    - > Harmonised code and working in ACCESS-OM3
    - > Fix to oxygen bias.
    - > Many ideas for new capabilities.
  - CMIP6 submission: output stable and realistic, used widely.
- WOMBAT in Bluelink
  - Work towards the capability to simulate BGC and water optical properties in operational ocean models.
    - > BGC in BRAN (with data assimilation of ocean physics) does a reasonable simulation of surface BGC in regions with mesoscale dynamics.