Global0p25 WOMBAT Experiments

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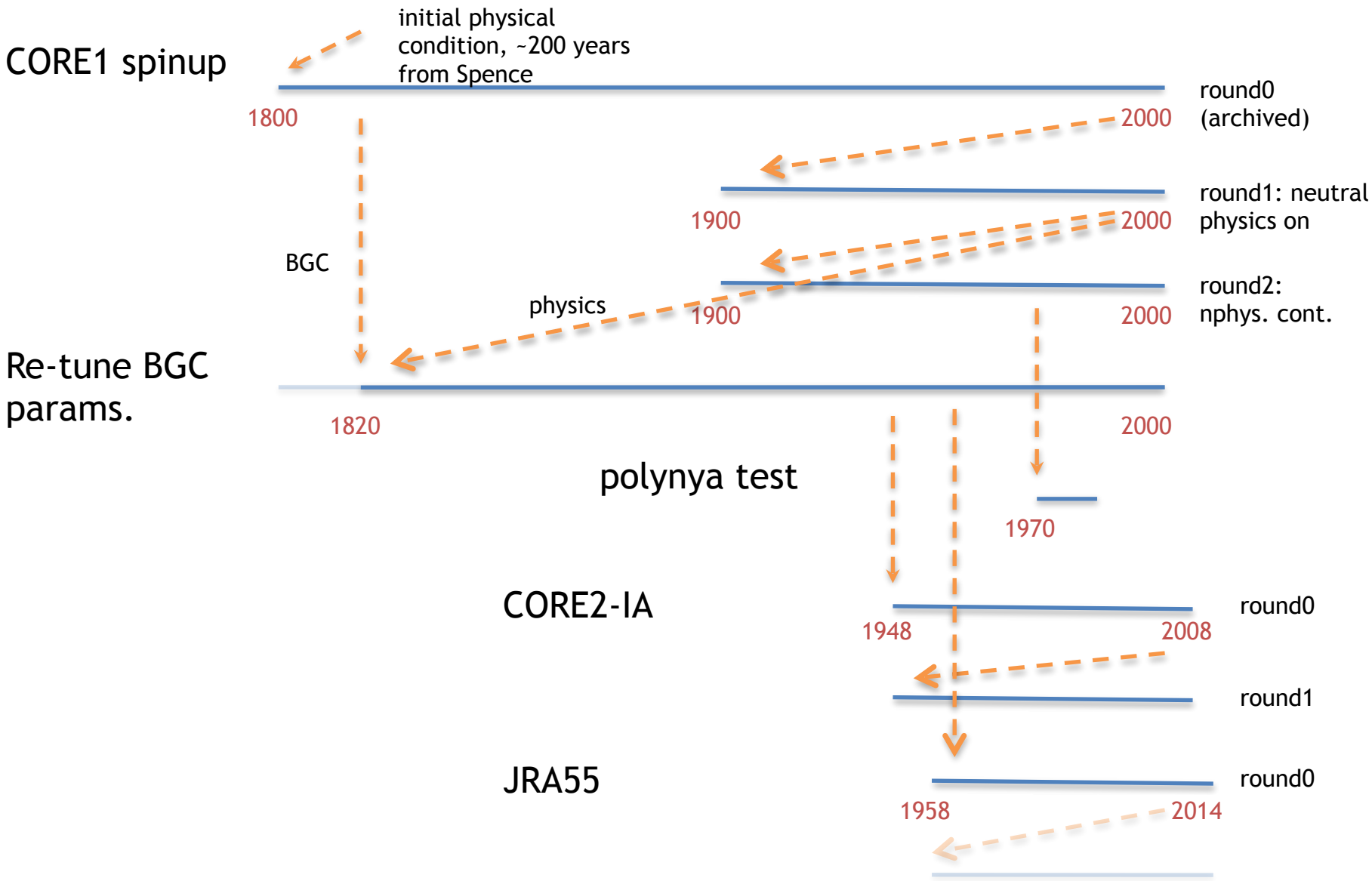
with Richard and Paul S.

Introduction

- Overview of a series of ocean experiments with 0.25 deg resolution with ocean biogeochemistry (WOMBAT).
  - Show good reproduction of observed BGC fields, when neutral physical processes are included.
- Compare results from experiments with inter annual variability; CORE2 and JRA-55.

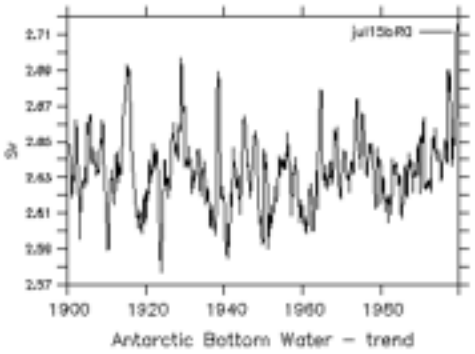
Experiment Map

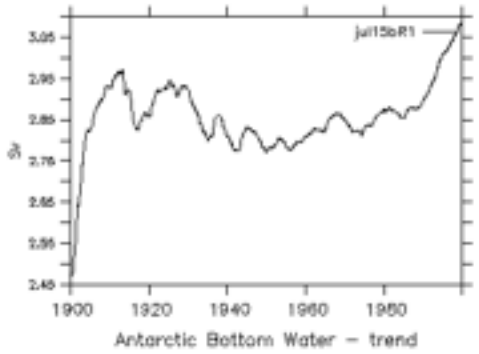


Antarctic Bottom Water

- Low values of bottom water; better with neutral physics. See also ALK sections.

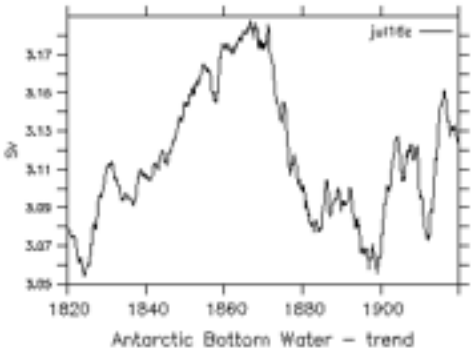
No nphys





Nphys

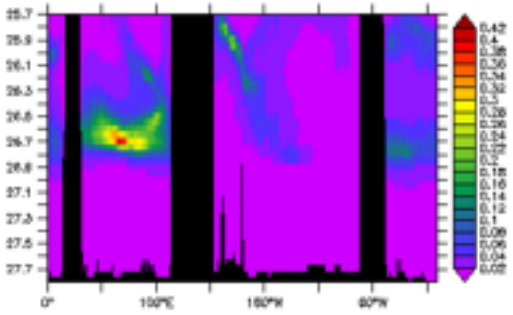
Nphys + edit BGC

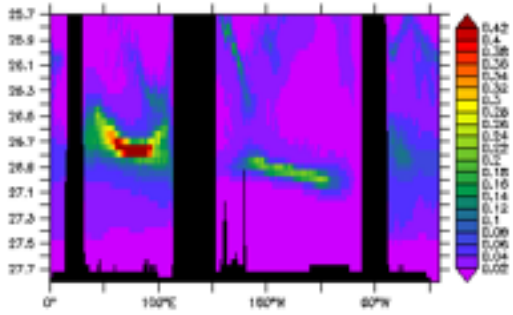


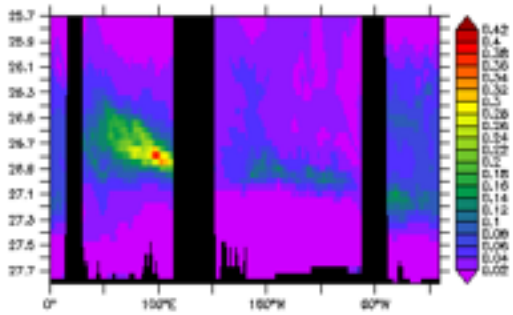
(Obs.)

CFC 30°S sections

- Neutral physics puts CFC into more realistic density classes.

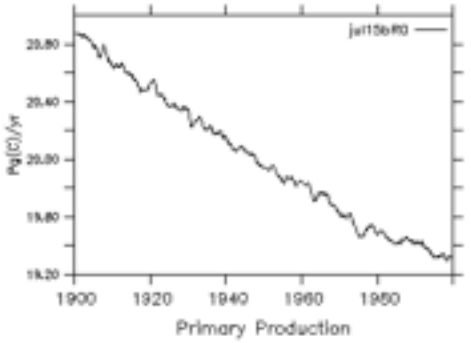


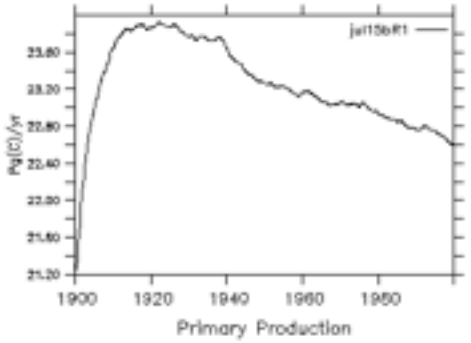




Total Primary Production

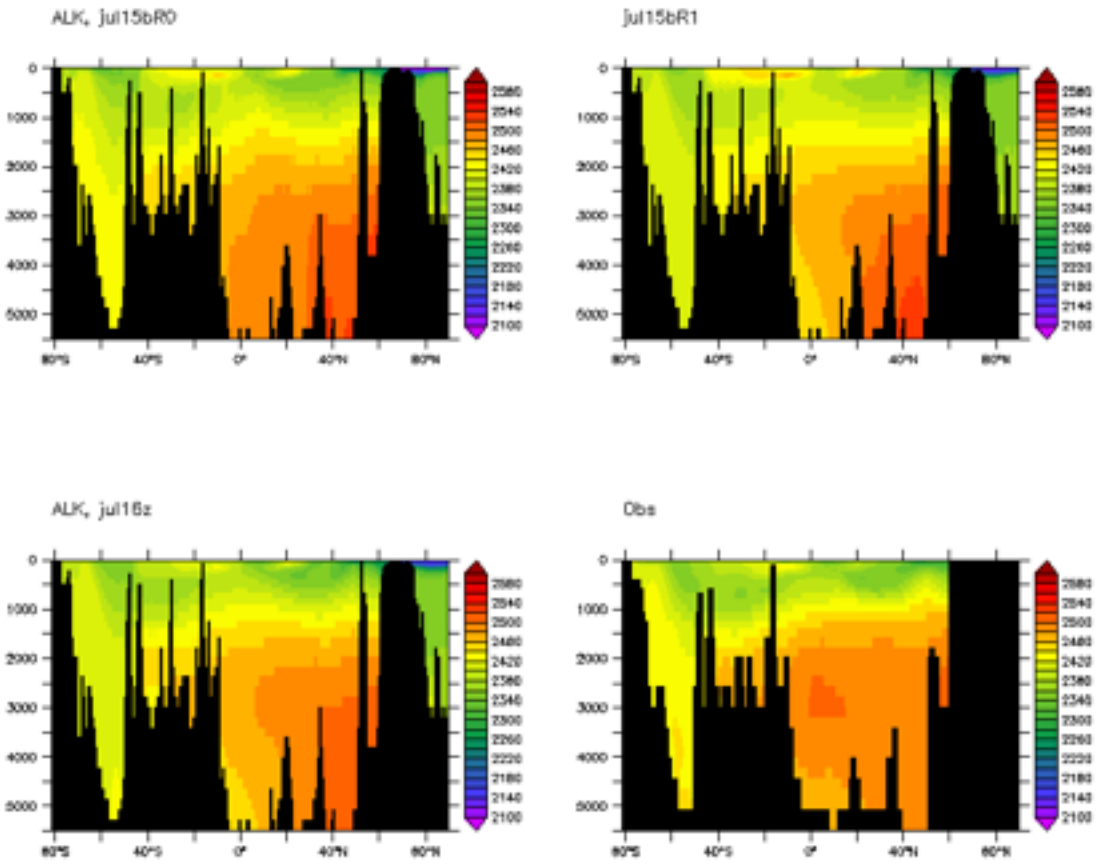
- Productivity was low and getting lower in the initial experiment (expected range 40 – 50 Pg(C)/yr). Switching to neutral physics helped, but trend was still lower. Better results in jun16z after modifying BGC parameters (sinking of detritus to 22m/day, background iron to 0.3 μmol/m3).





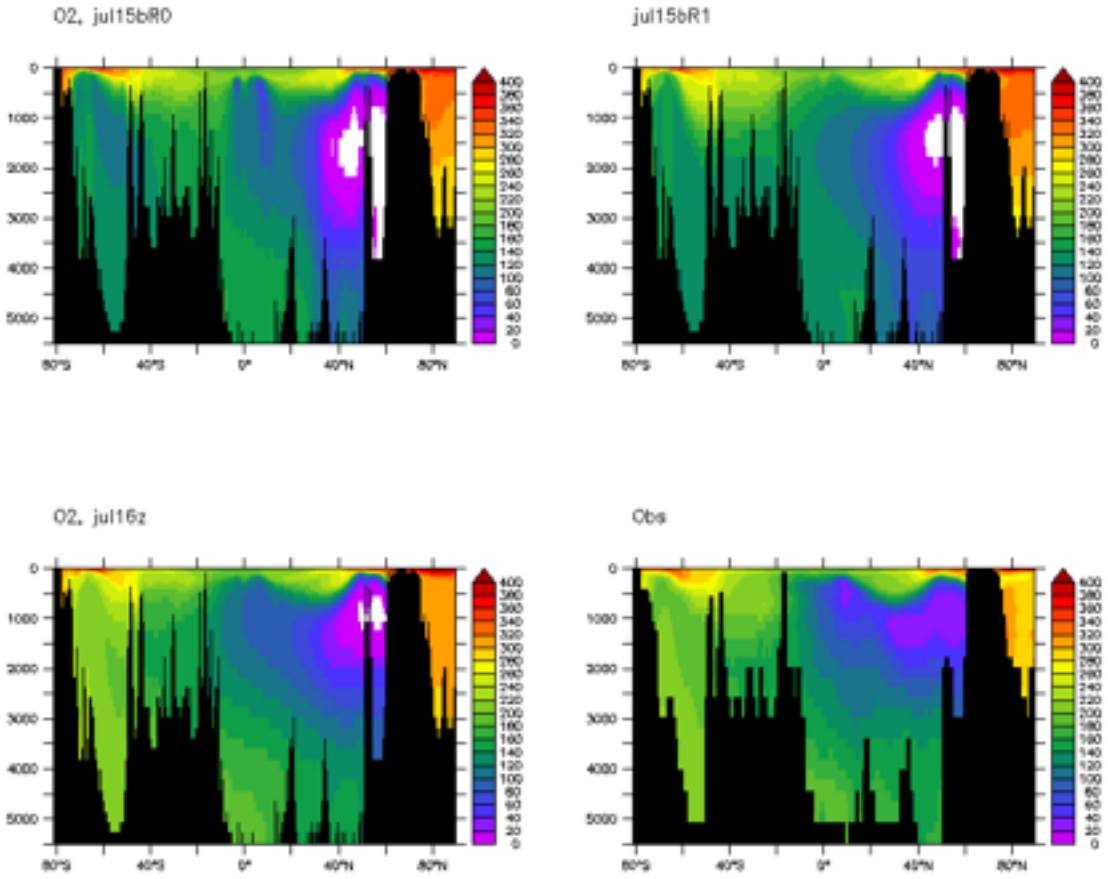
Alkalinity 180°E Section

- Good reproduction of observations; more bottom water with neutral physics.



Oxygen 180°E Section

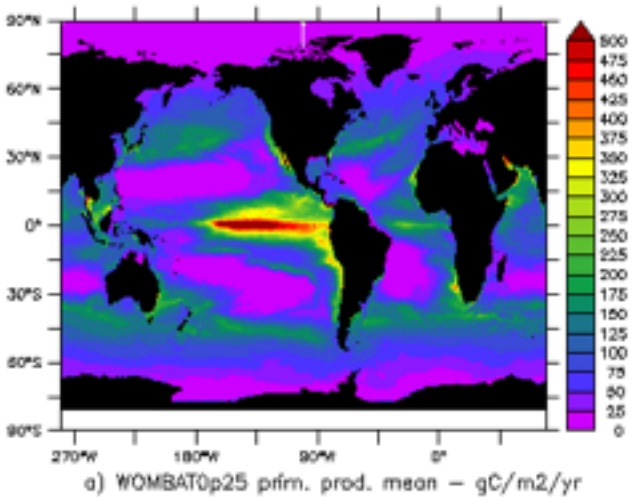
- Artifacts below Equator without neutral physics. Extent of oxygen minimum in N. Pacific better in new BGC parameters of jun16z, compared to observations.



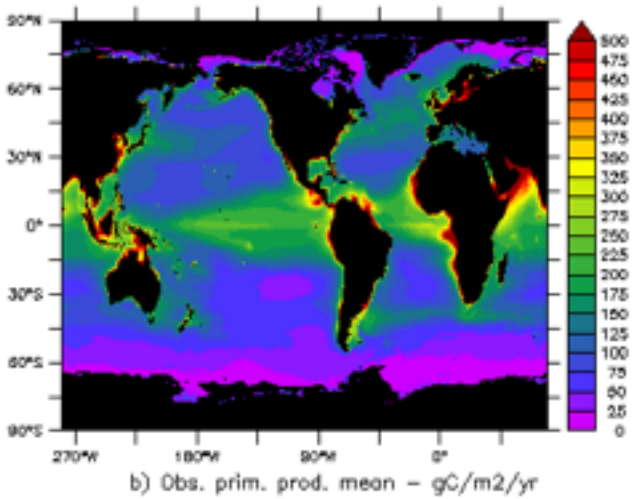
Case for Neutral Physics in 0.25 models

- Antarctic Bottom Water is more realistic with nphys; both in estimated volume transports and in effect on BGC tracers (alkalinity).
- CFC subducted into realistic water masses.
- BGC productivity is improved.
- Unrealistic BGC tracer fields (oxygen) in thermocline without nphys.

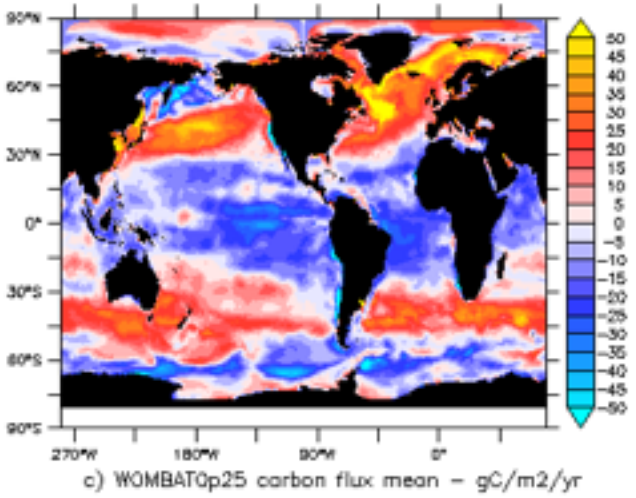
BGC fluxes – simulated and observed



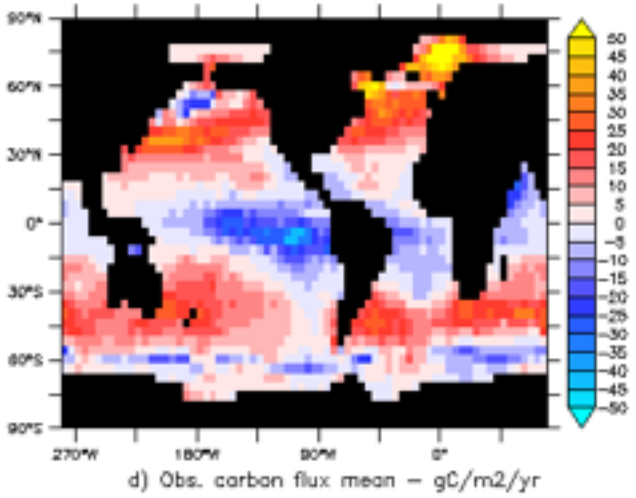
a) WOMBAT0p25 prim. prod. mean – gC/m2/yr



b) Obs. prim. prod. mean – gC/m2/yr



c) WOMBAT0p25 carbon flux mean – gC/m2/yr

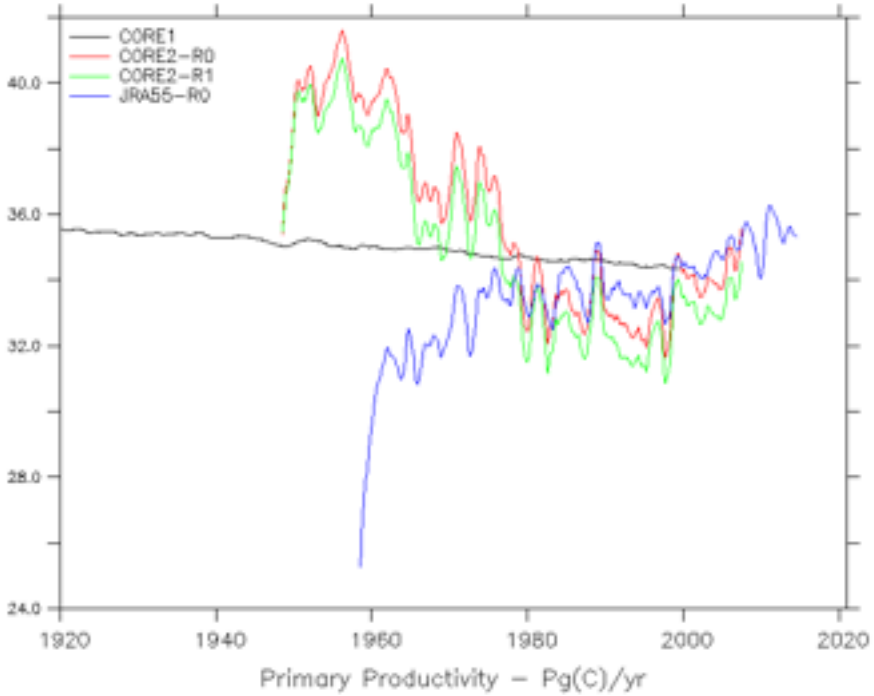


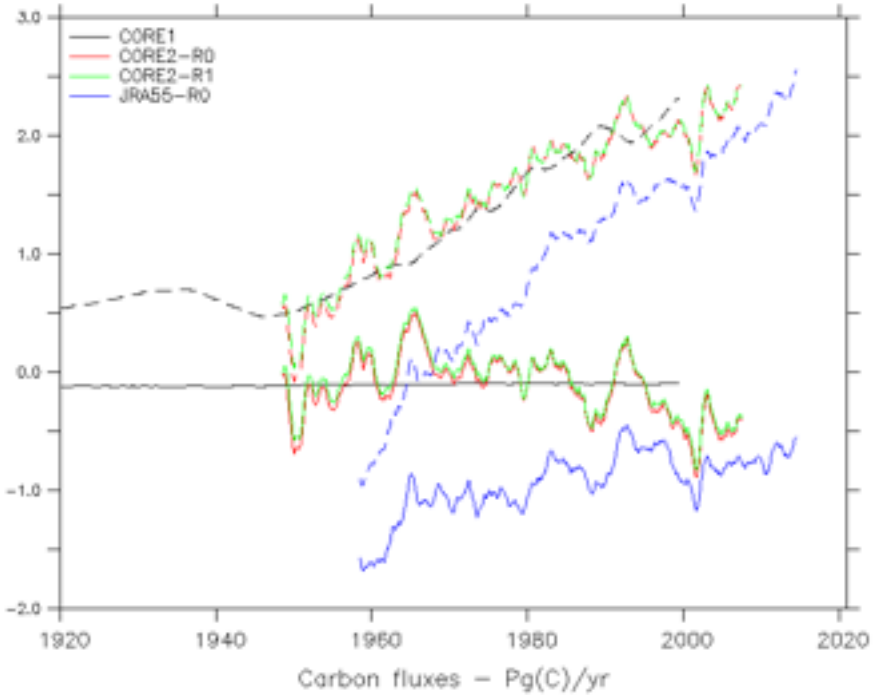
d) Obs. carbon flux mean – gC/m2/yr

Interannual Variability Experiments

- Two rounds of CORE2 (1948-2007)
- One round of JRA55 (1958-2014)
- Ocean state from CORE1 spinup with neutral physics.
- Tuned BGC parameters.

Interannual Variability Experiments

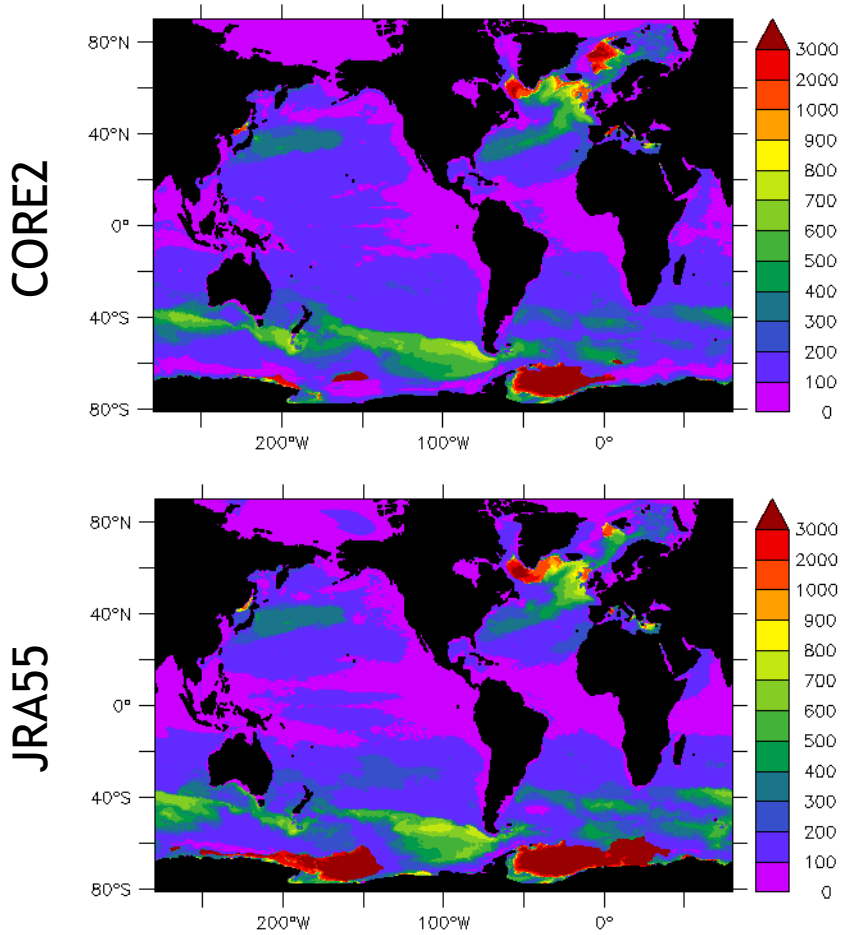


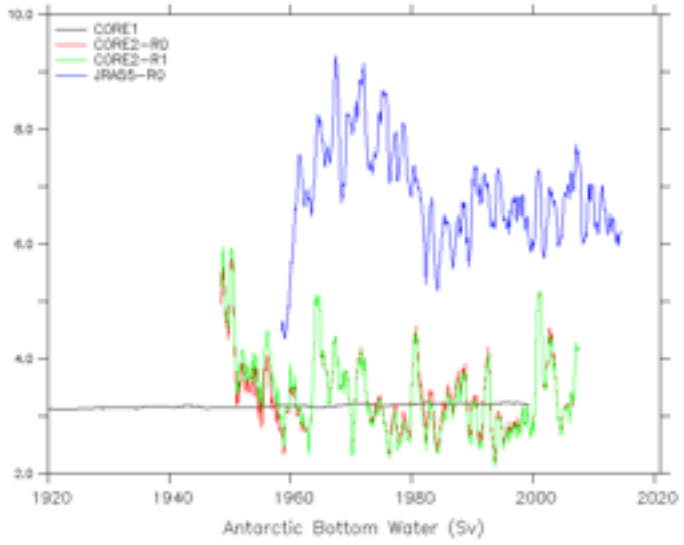


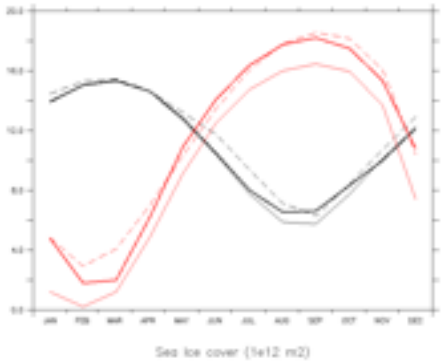
- Small drift in productivity, carbon flux almost balanced with no drift!!
- Negligible shock switching CORE1 to CORE2; two rounds of CORE2 repeat well.
- Switch to JRA55 produces shock in ocean state.
  Some similar features with CORE2, needs second round.
- Outgassing of carbon in JRA55; further spinup or tune up of ocean model…

Interannual Variability Experiments

Max. MLD (m)







Obs (dash), CORE2 (thick), JRA55 (thin)

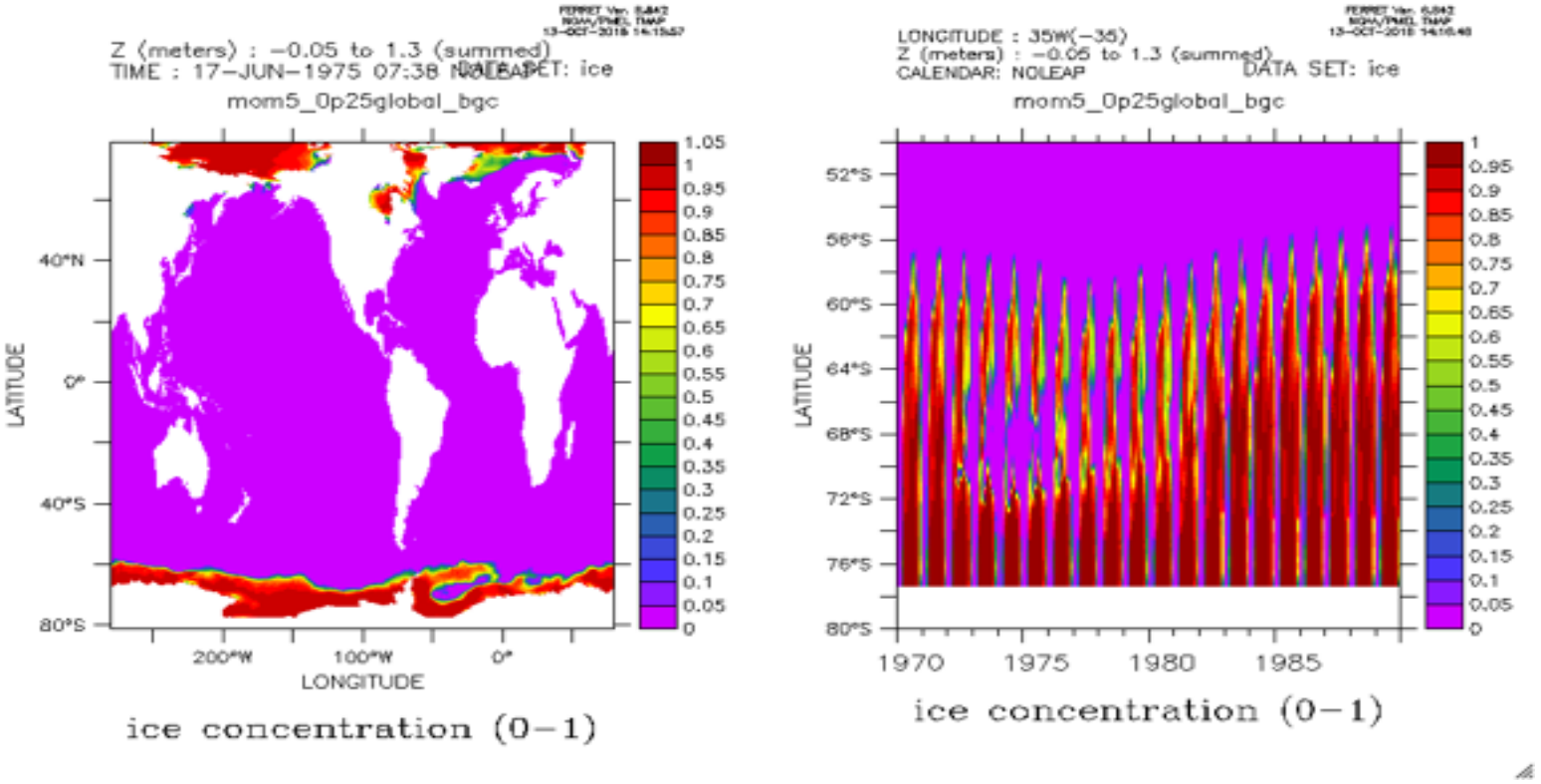
JRA experiment shows less Antarctic sea ice, deeper maximum MLD and higher value for bottom water formation.

Summary

- Neutral physics significantly improves the circulation.
  - CFC subducted into observed water densities.
  - AABW, small improvement in estimated flow, deep water tracers more realistic.
  - BGC productivity/tracers more realistic.
- Good representation of BGC fluxes and tracer fields in ocean model.
  - Ready for further studies/implementation into 0p25 ESM.
- Experiment with JRA shows some bias, needs second round, perhaps tuning of physics.

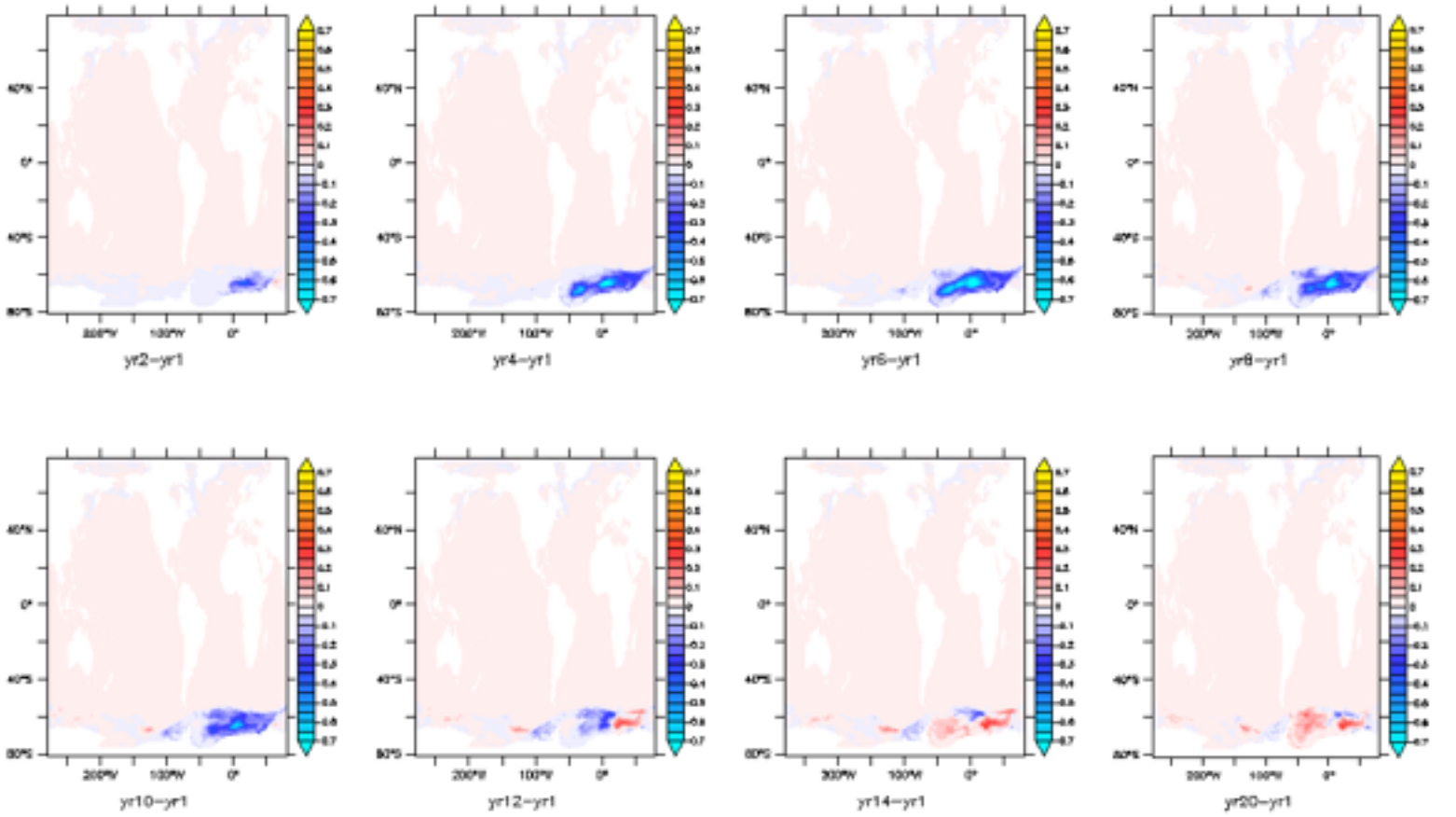
- Thank you

Polynya Experiment



Wind anomalies ~ 20-60 E, 65-55 S for ten years. Polynya opens within few years; starts closing before wind anomalies finished. Extra sea ice after wind switched back to CORE1.

Polynya Experiment



Anomalies on annual ice cover with respect to first year