Optimal parameters for the ocean's nutrient, carbon, and oxygen cycles compensate for circulation biases but replumb the biological pump

Benoît Pasquier, Mark Holzer, Matthew A Chamberlain,
Richard J Matear, Nathaniel L Bindoff, François W Primeau

Australian Government
Australian Research Council
DP210101650

UNSW SYDNEY

CSIRO

UNIVERSITY of TASMANIA

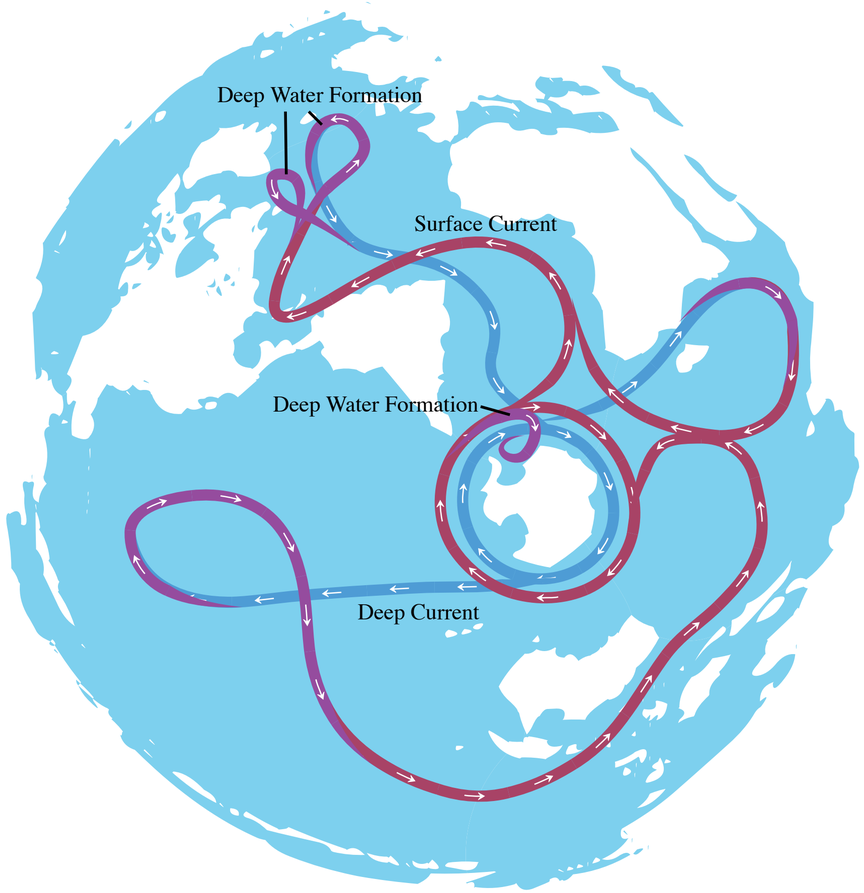
UCI

Biogeochemistry model

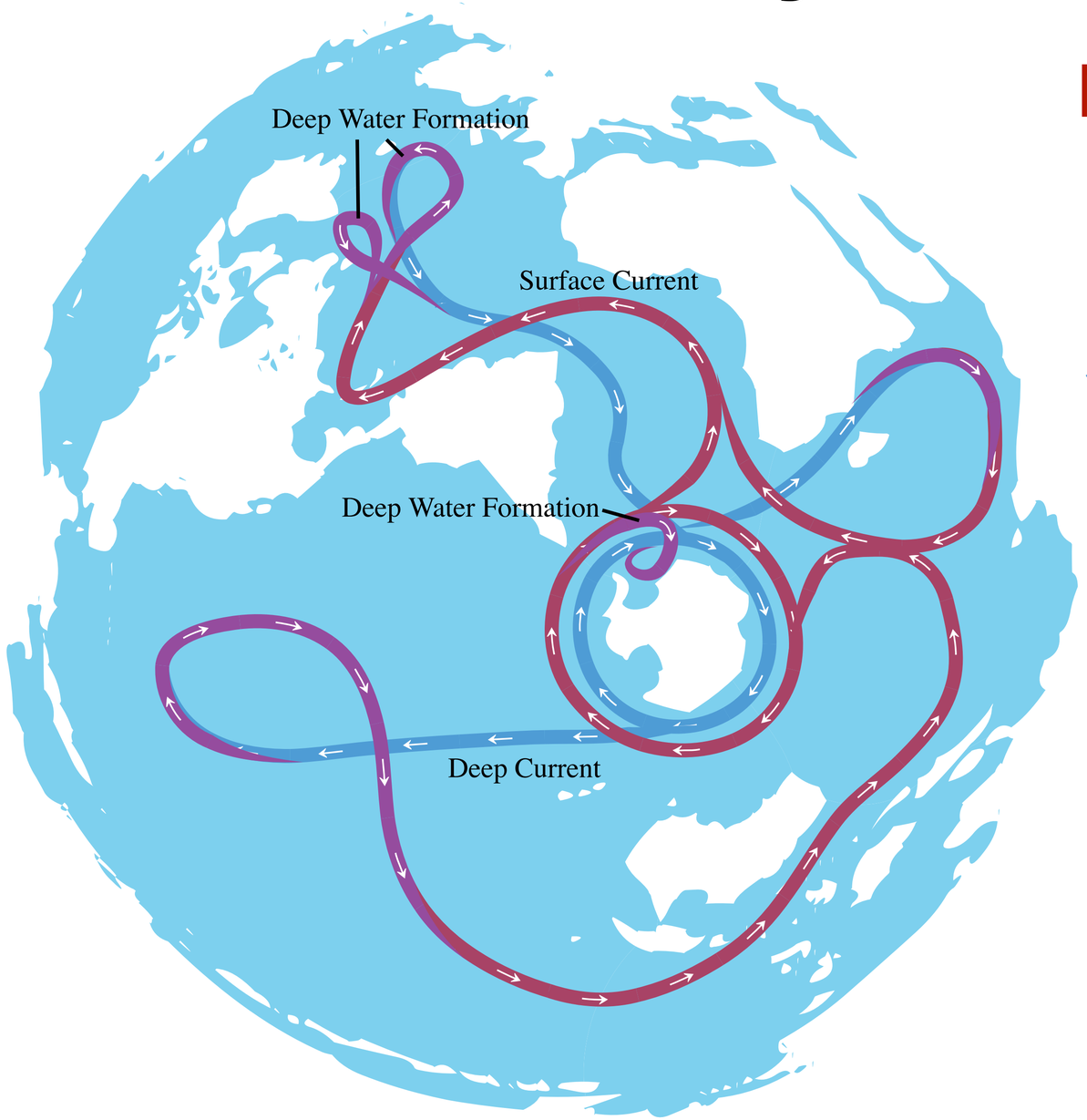
PCO2

P, C, O_2 cycles

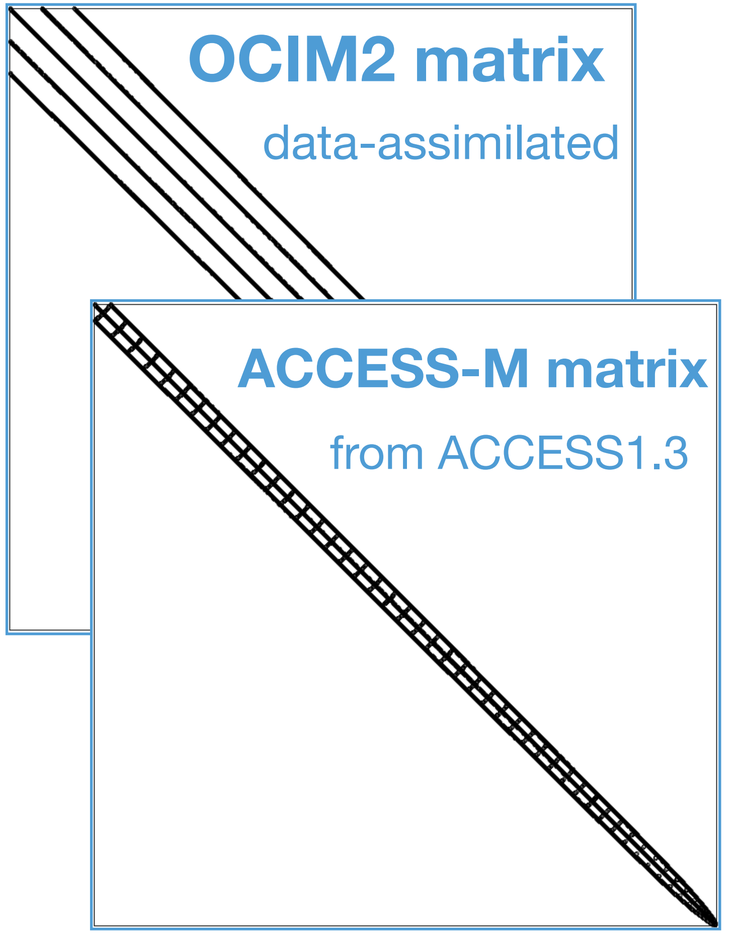
Ocean circulation model



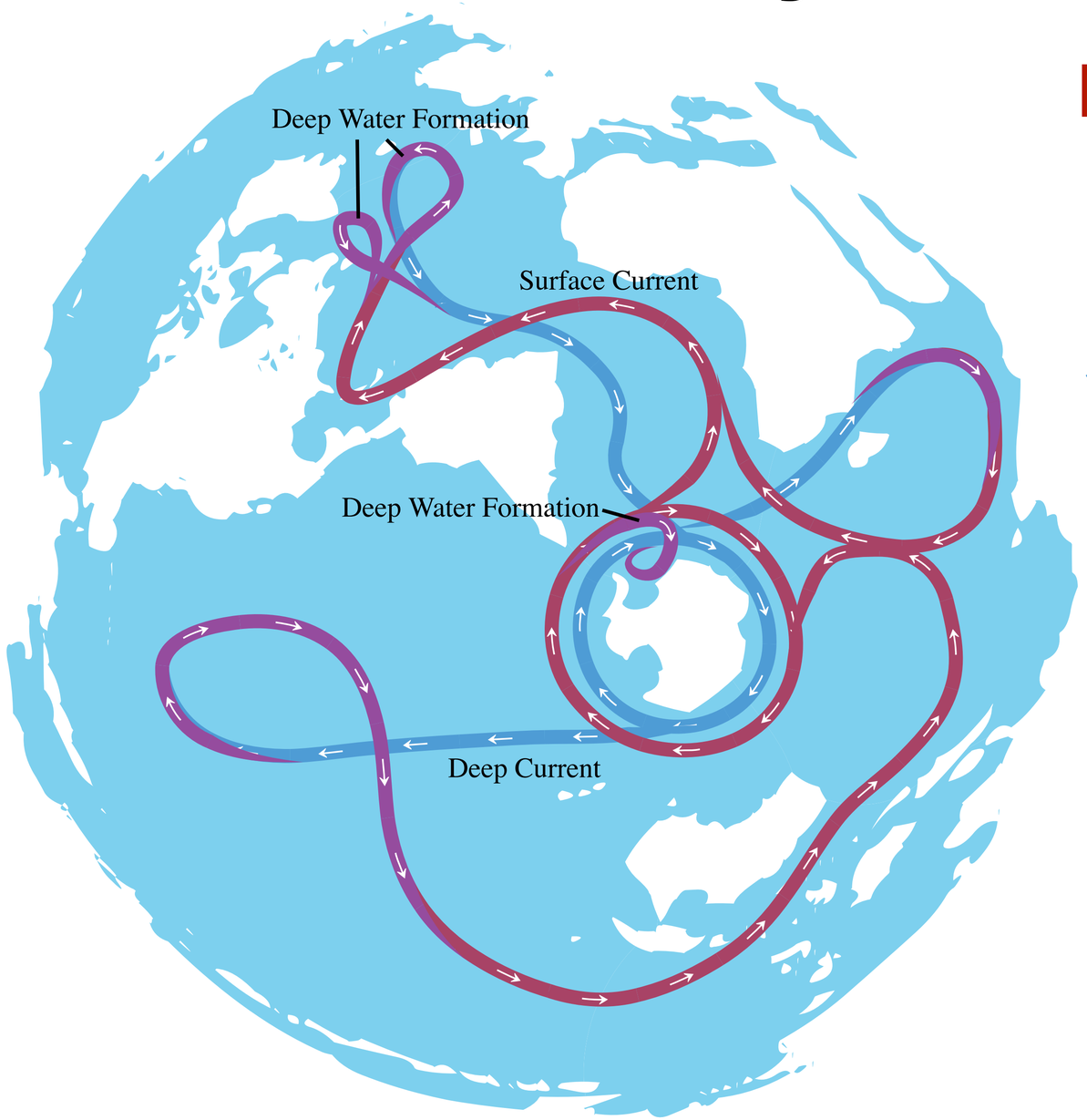
Steady-state ocean circulation



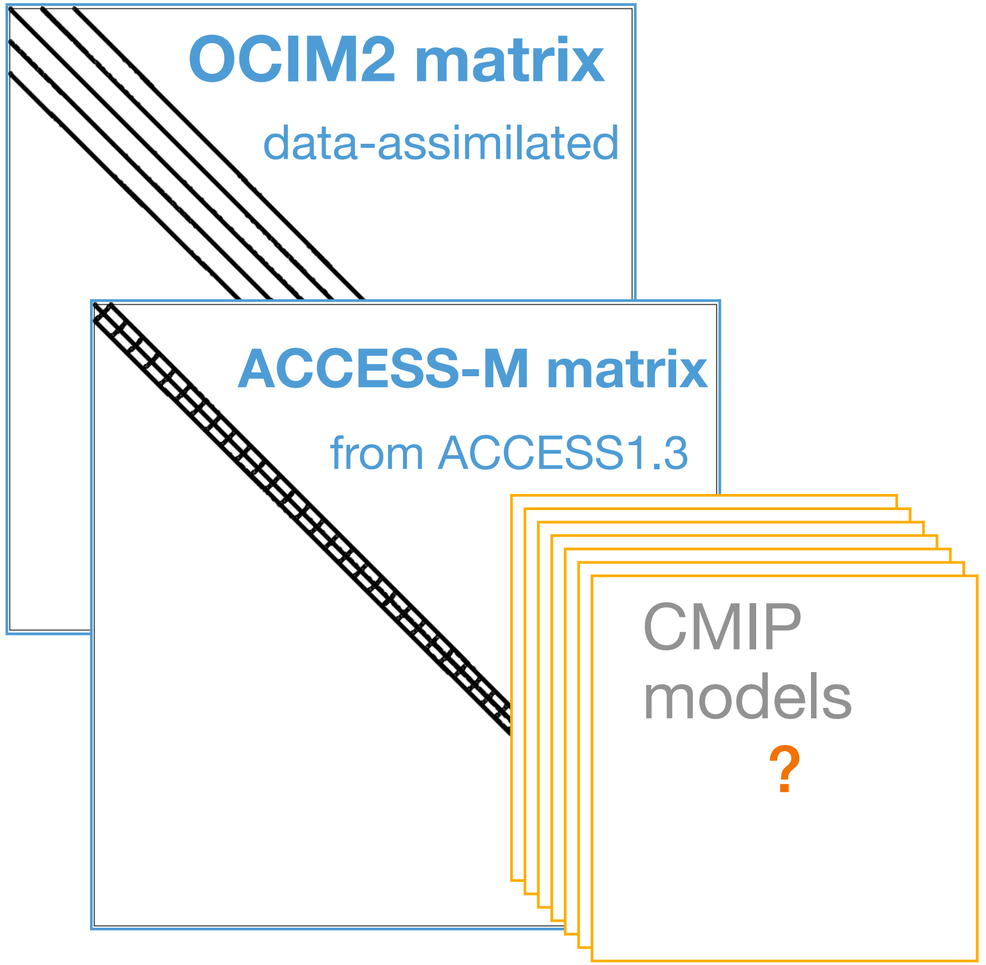
No time stepping! No spinup!



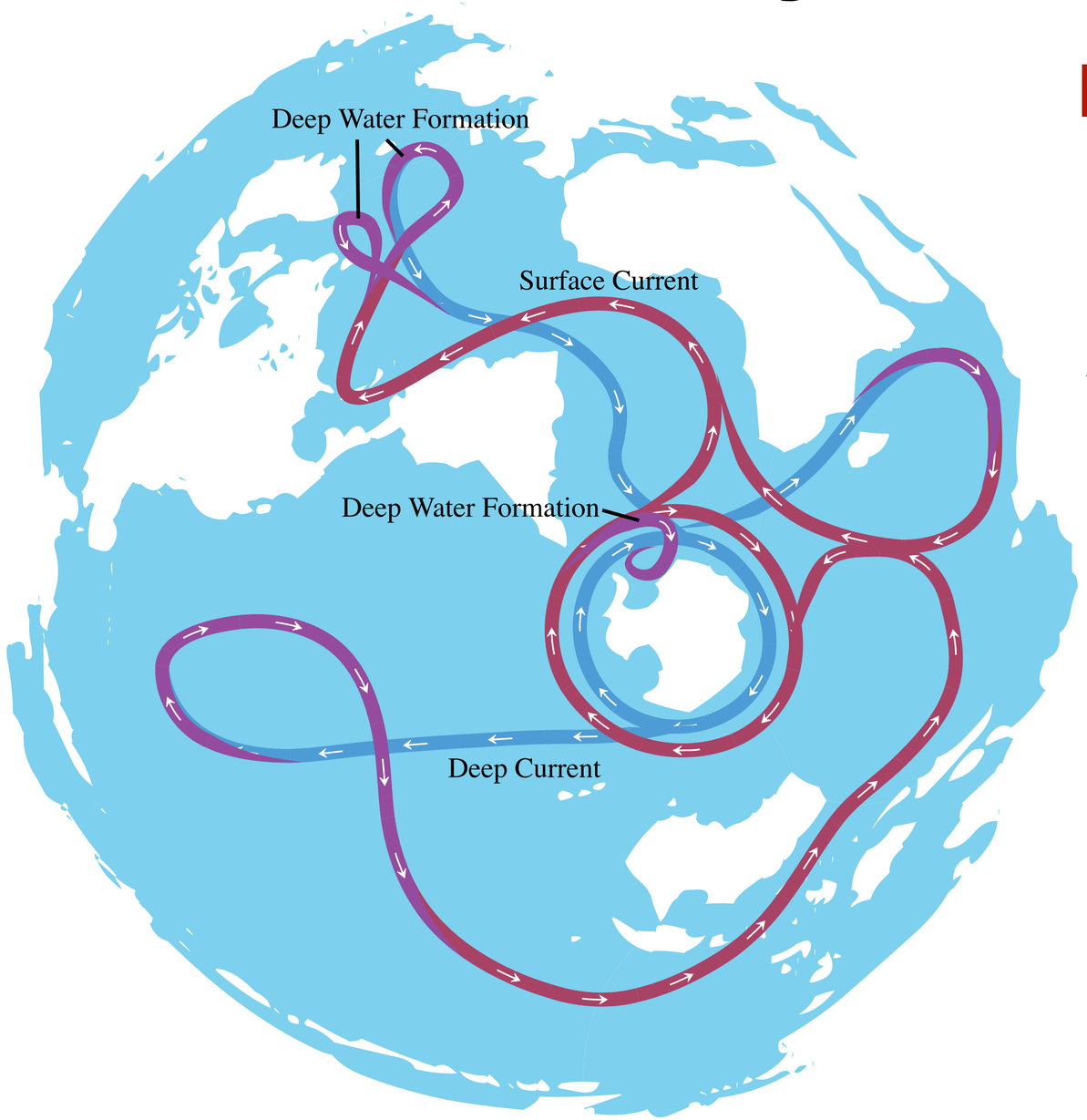
Steady-state ocean circulation



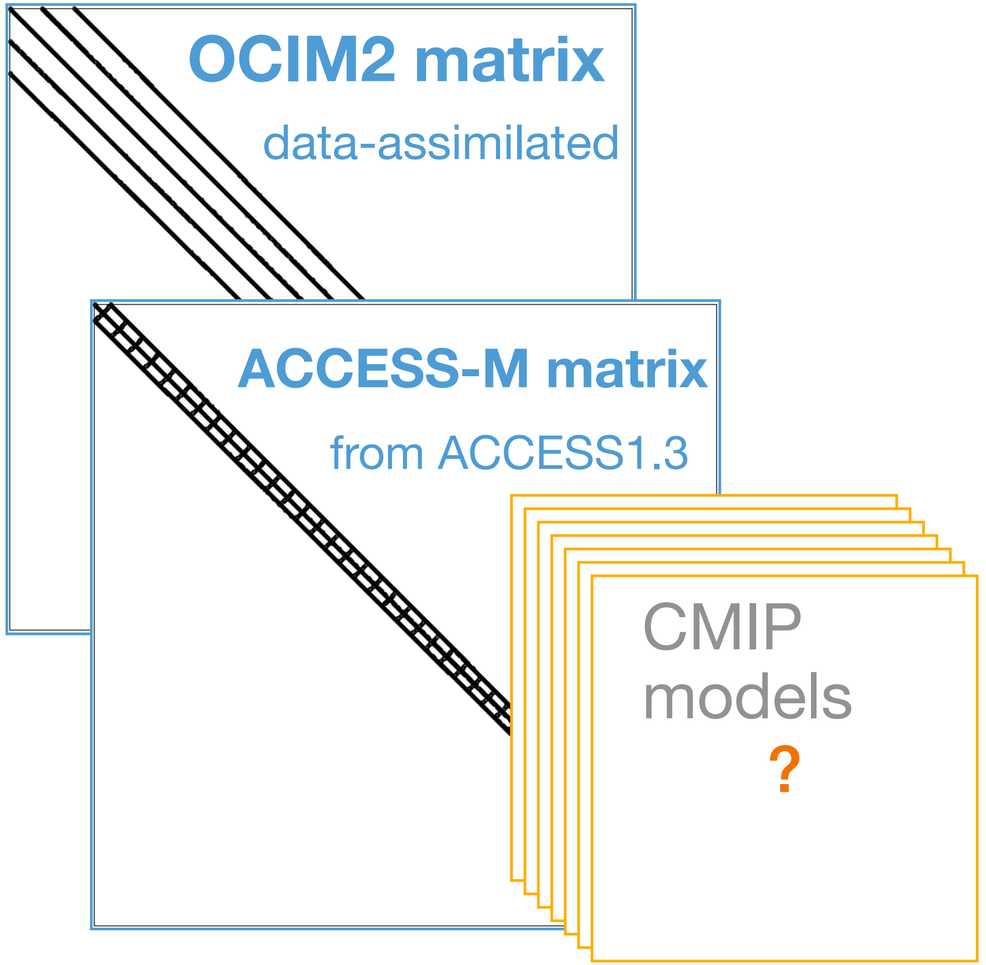
No time stepping! No spinup!



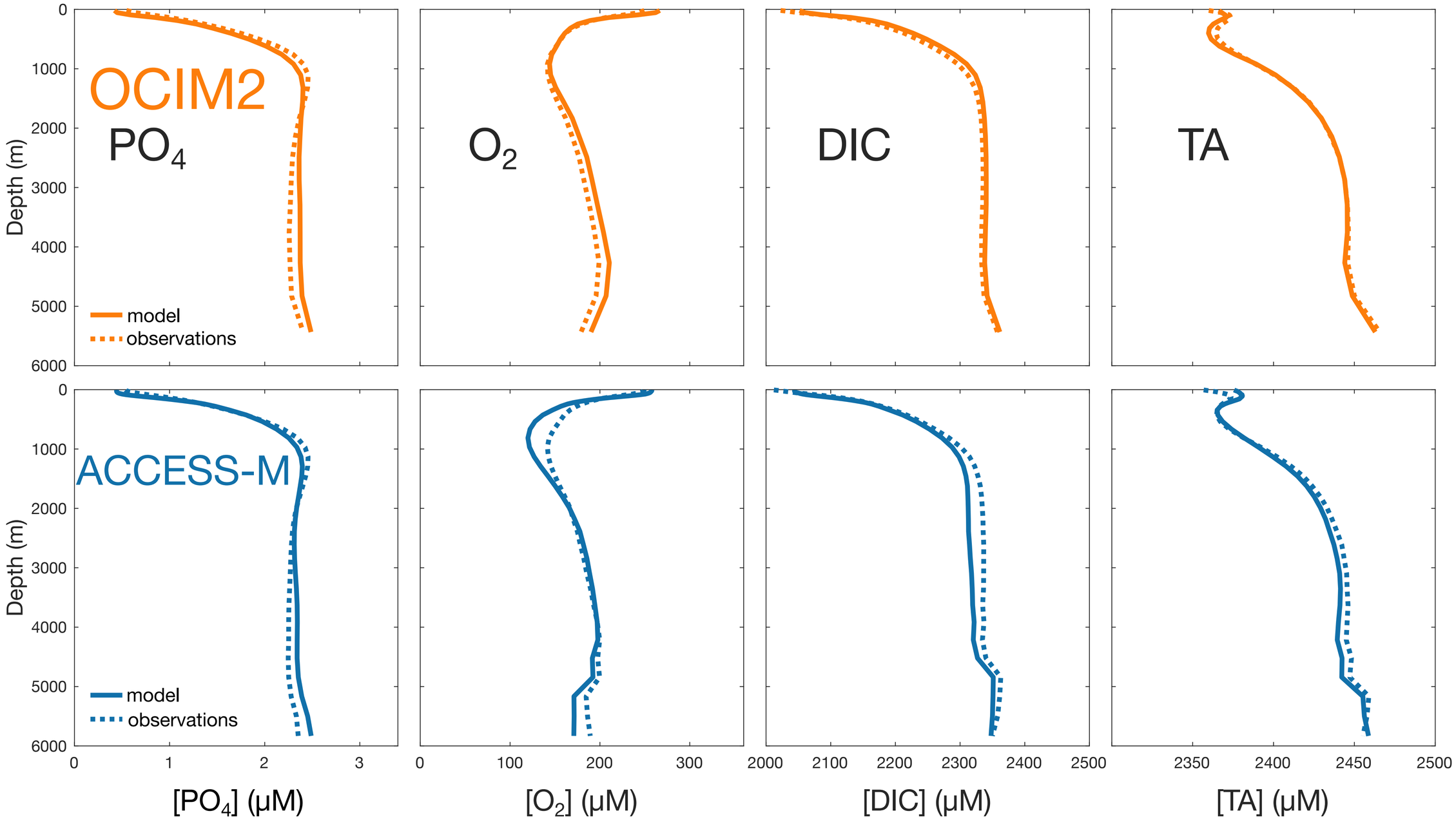
Steady-state ocean circulation



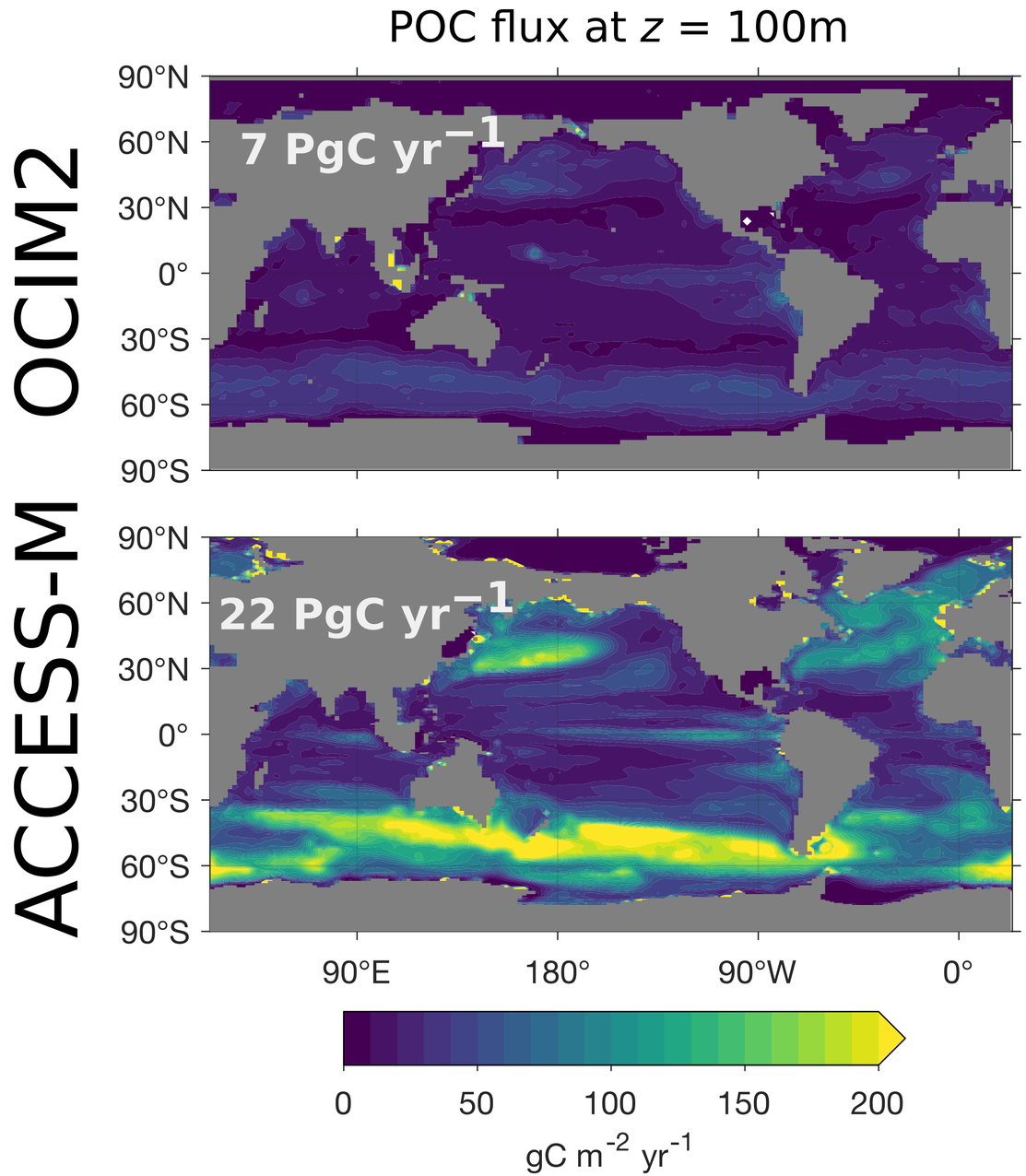
No time stepping! No spinup!



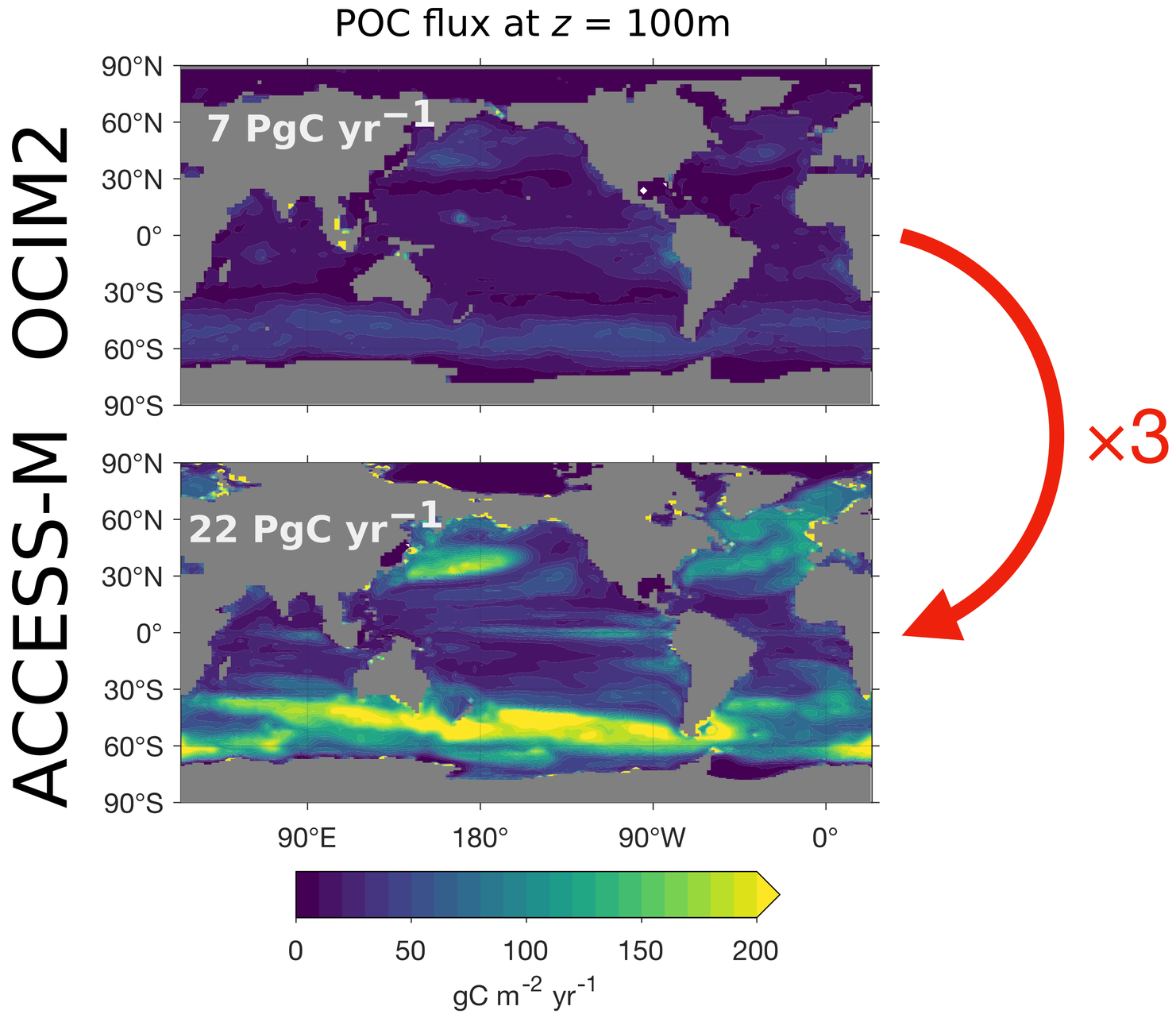
Model vs observations



Carbon export is larger for ACCESS-M

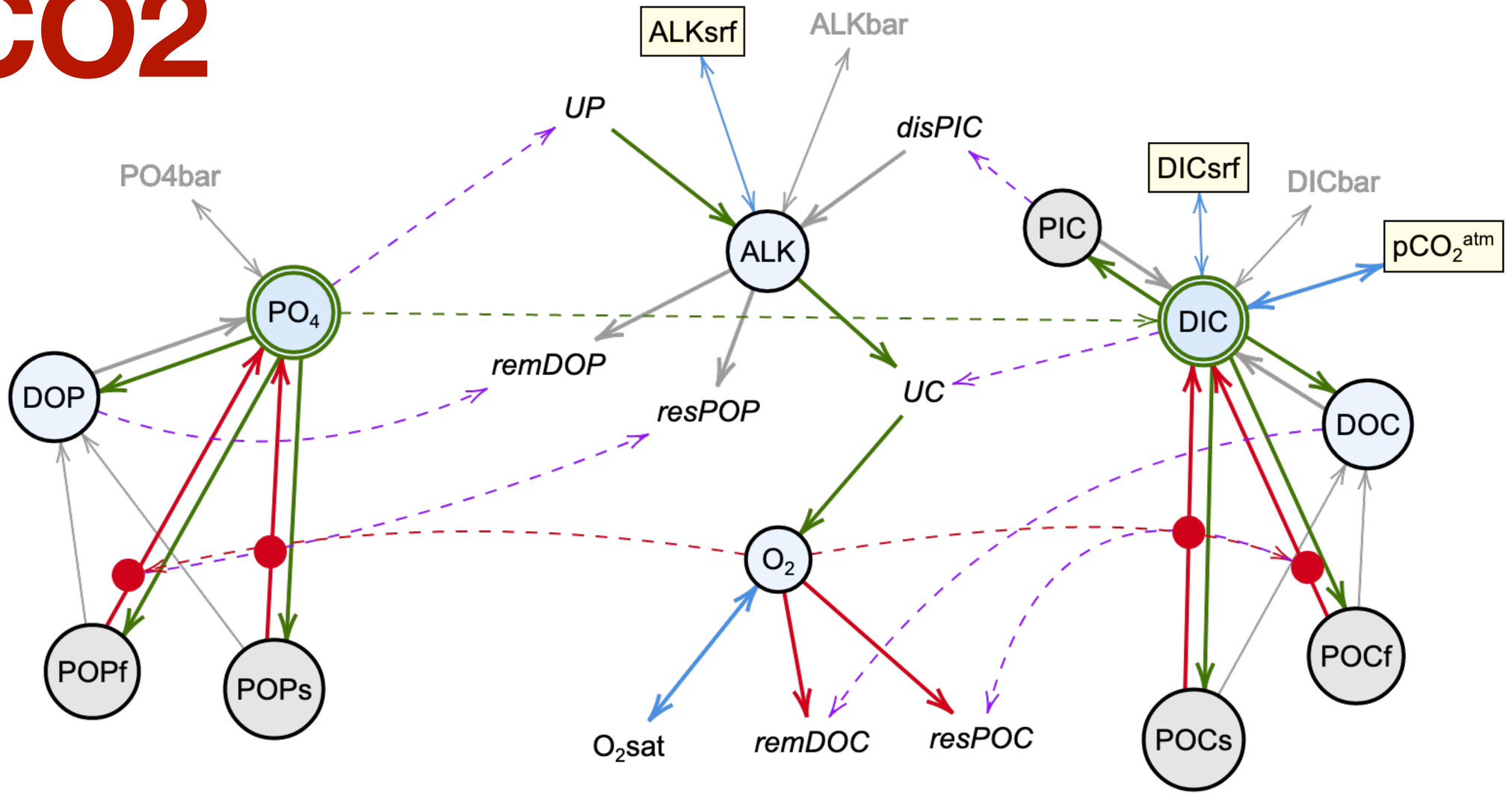


Carbon export is larger for ACCESS-M

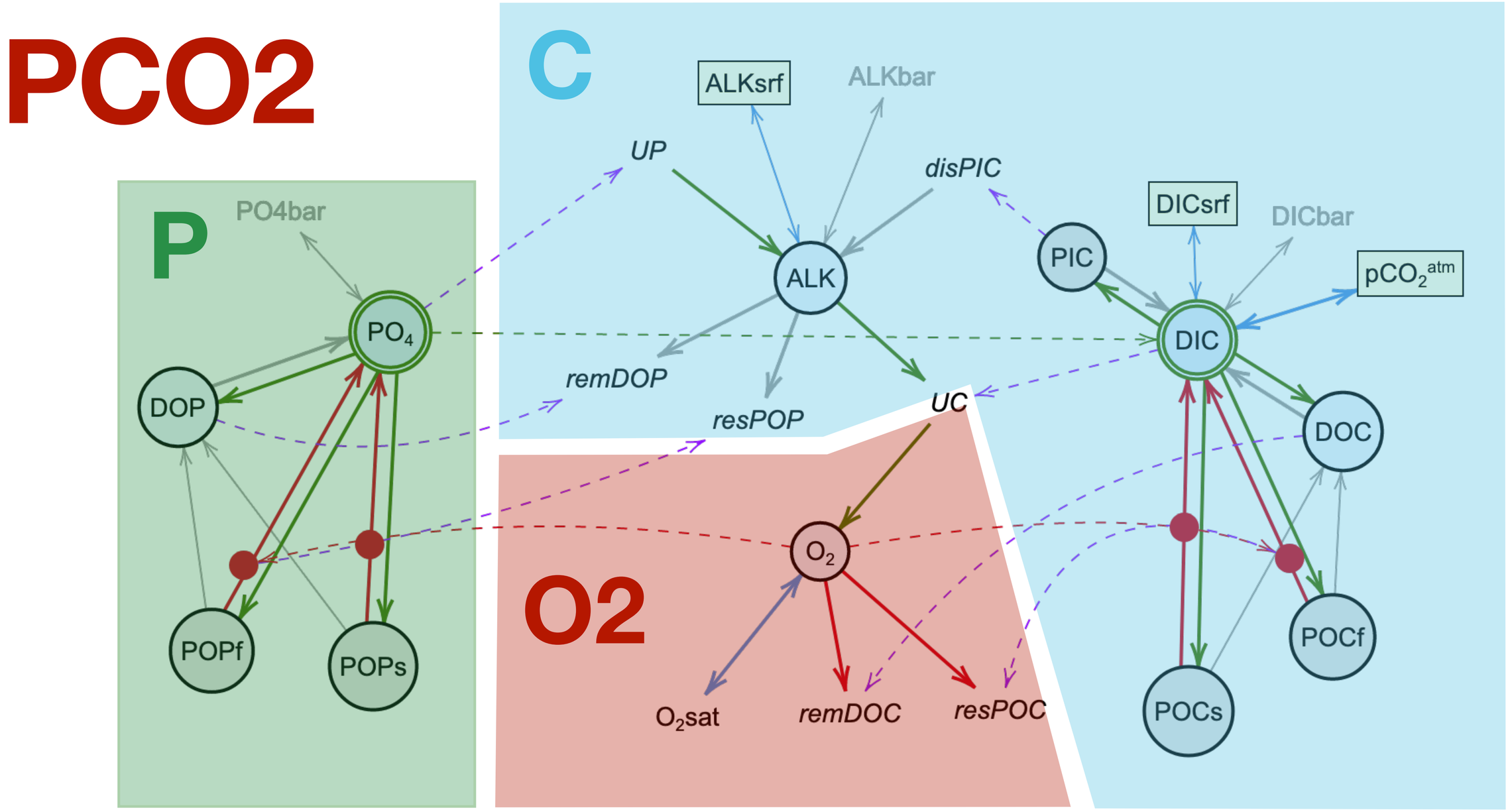


Biogeochemistry model

PCO2

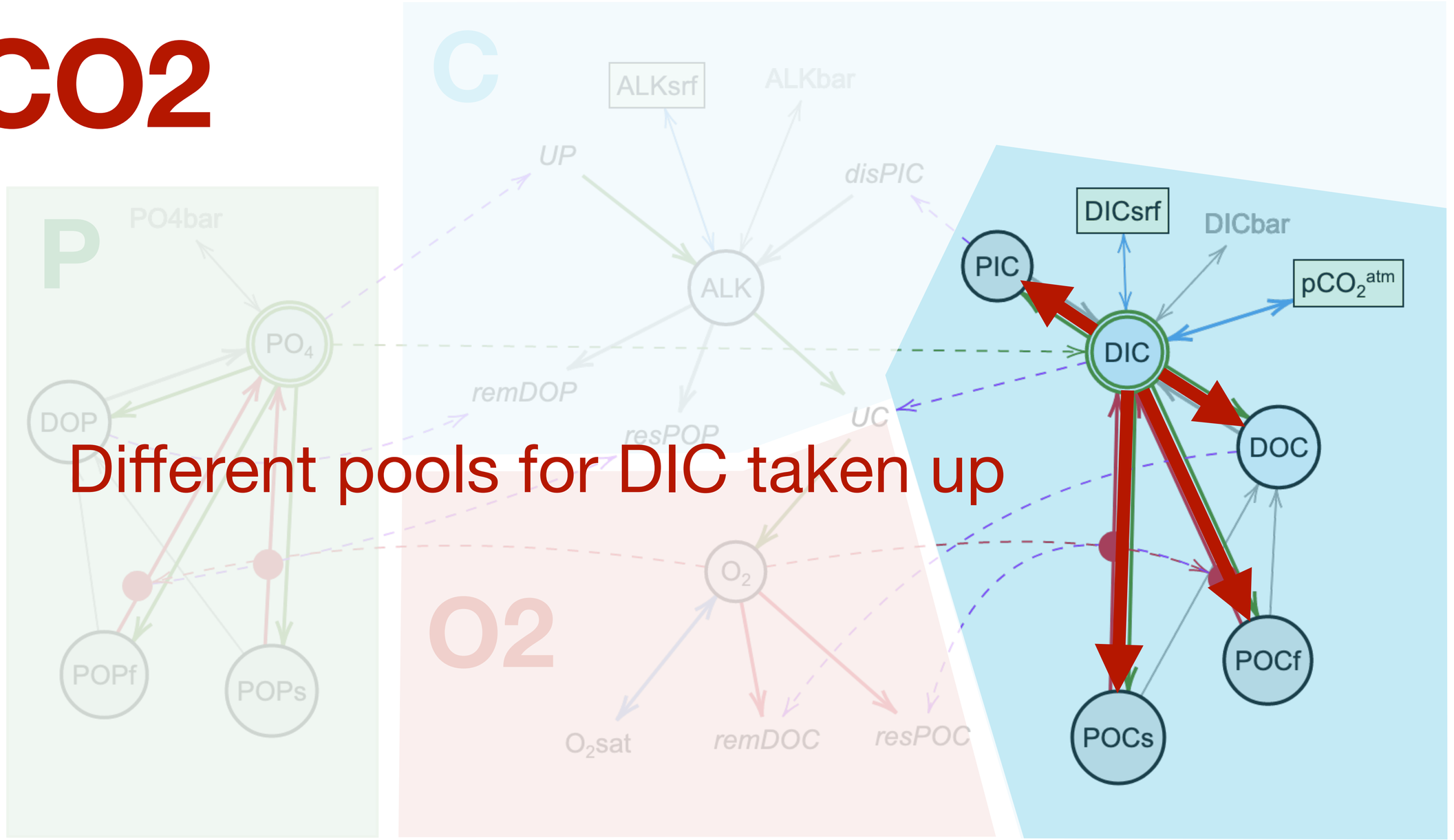


Biogeochemistry model



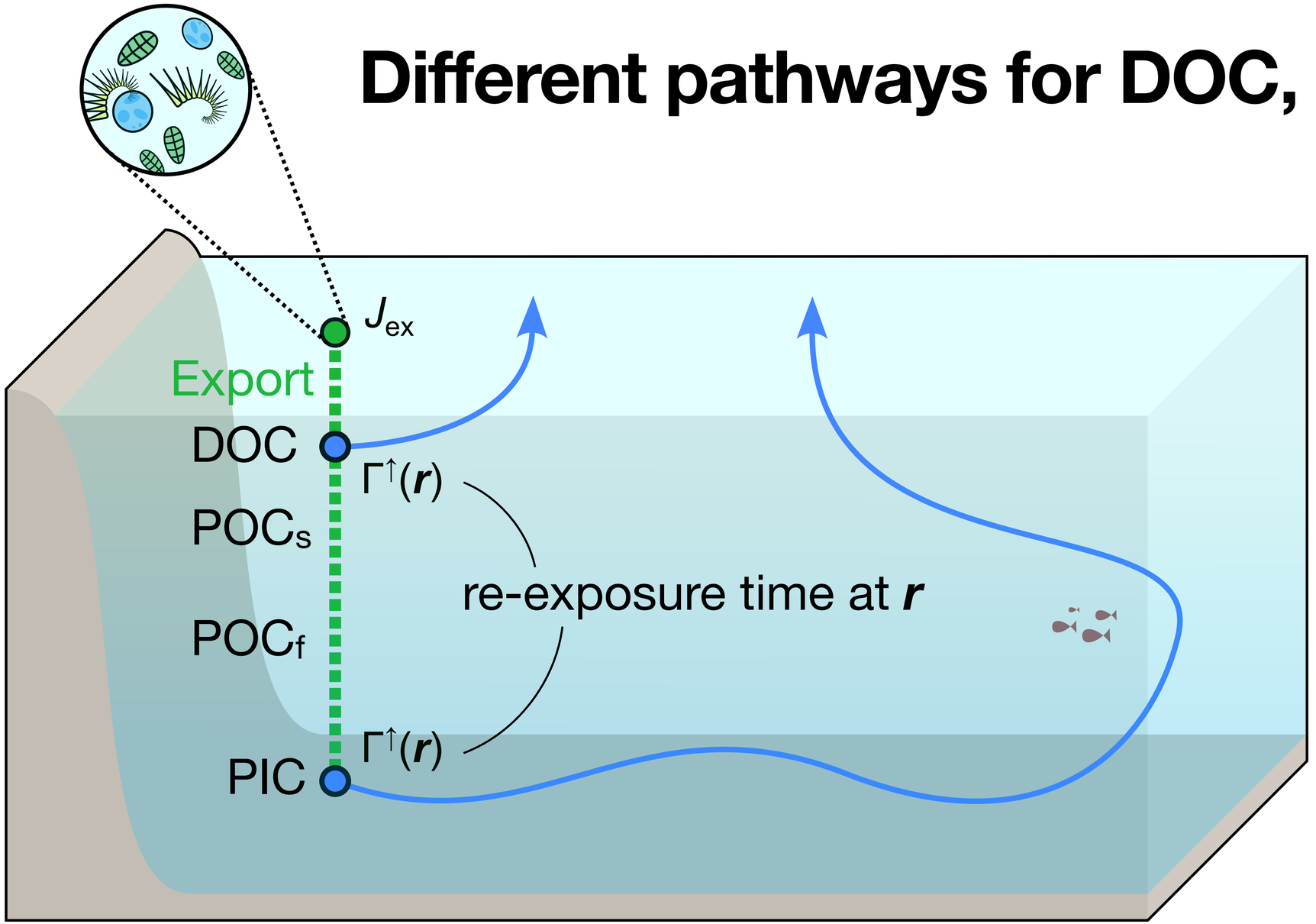
Biogeochemistry model

PCO2



Different pools for DIC taken up

Different pathways for DOC, POC, PIC

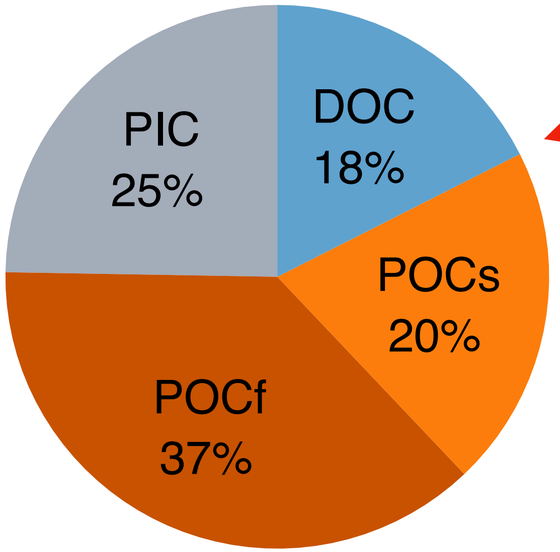


Regenerated DIC inventory from POC, DOC, and PIC

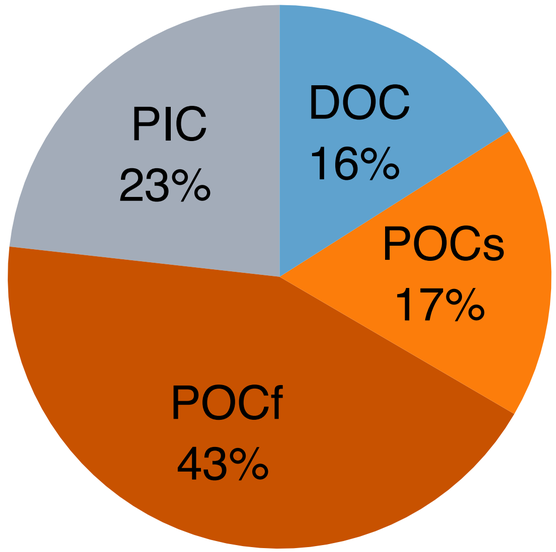
OCIM2

ACCESS-M

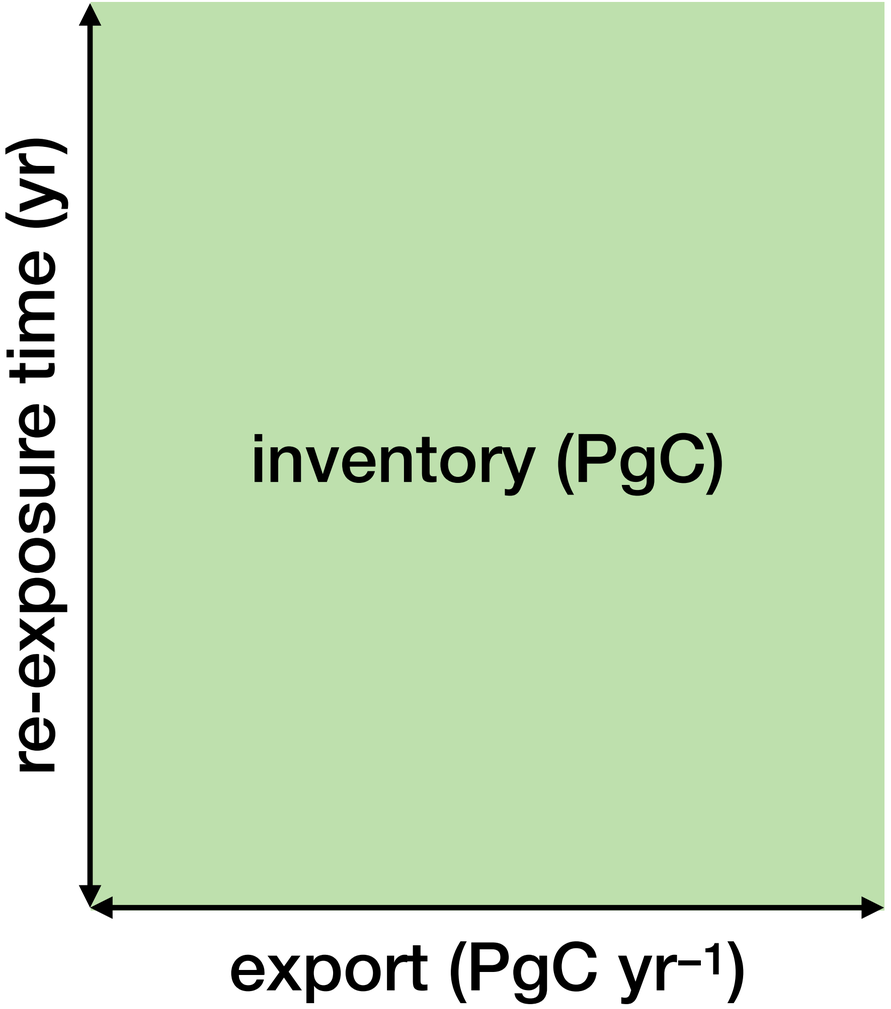
similar



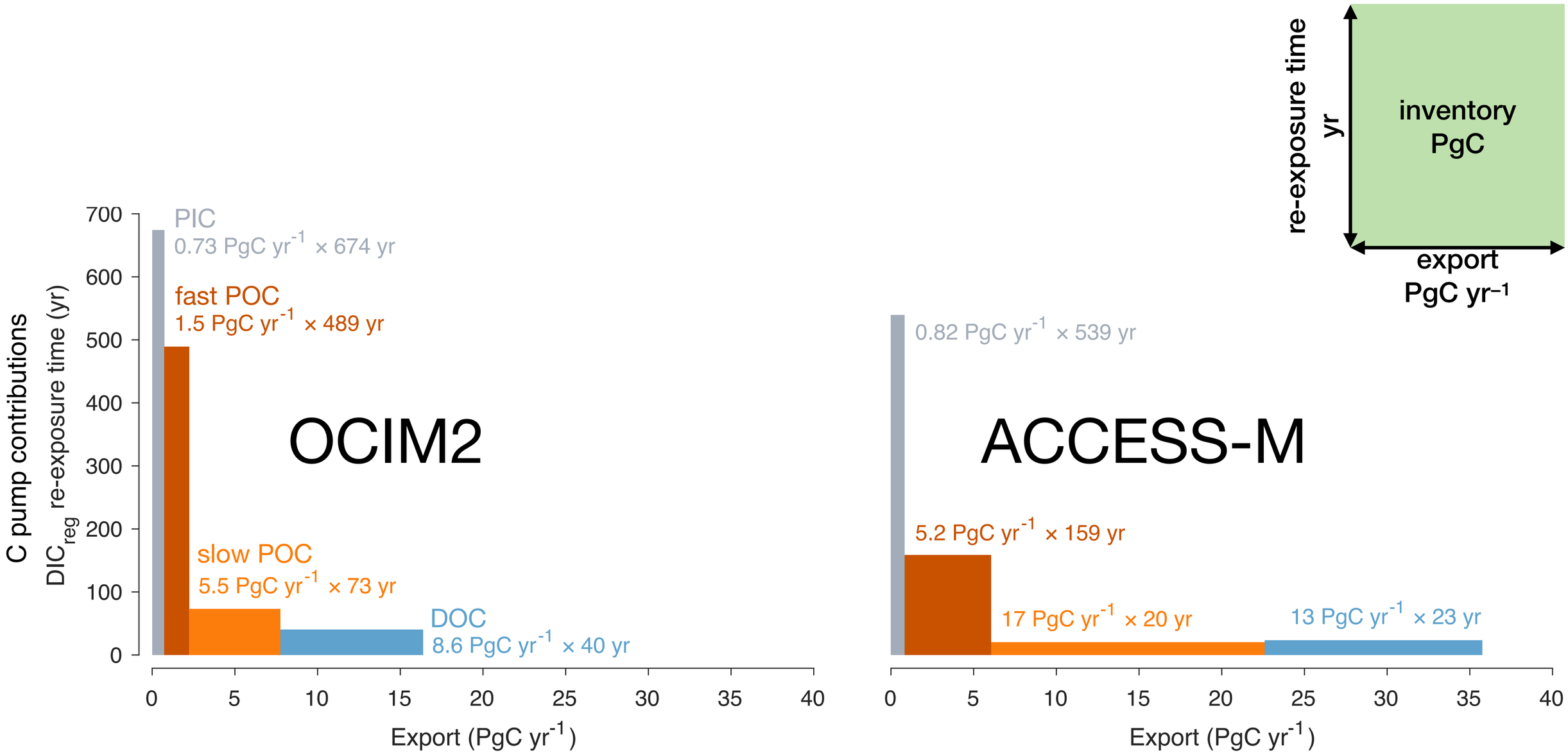
DICreg / DIC = 5.4 %



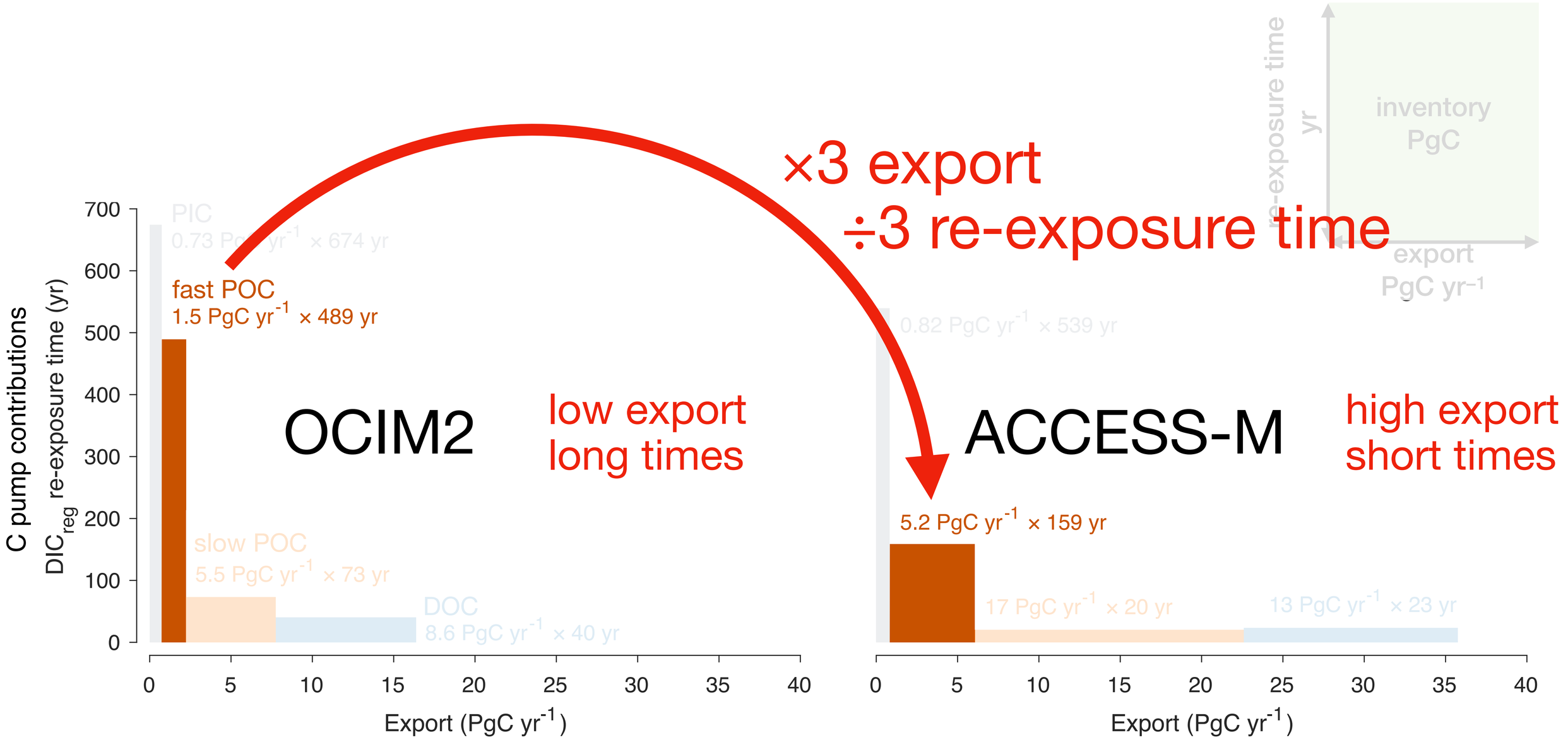
Regenerated inventory = export × re-exposure time



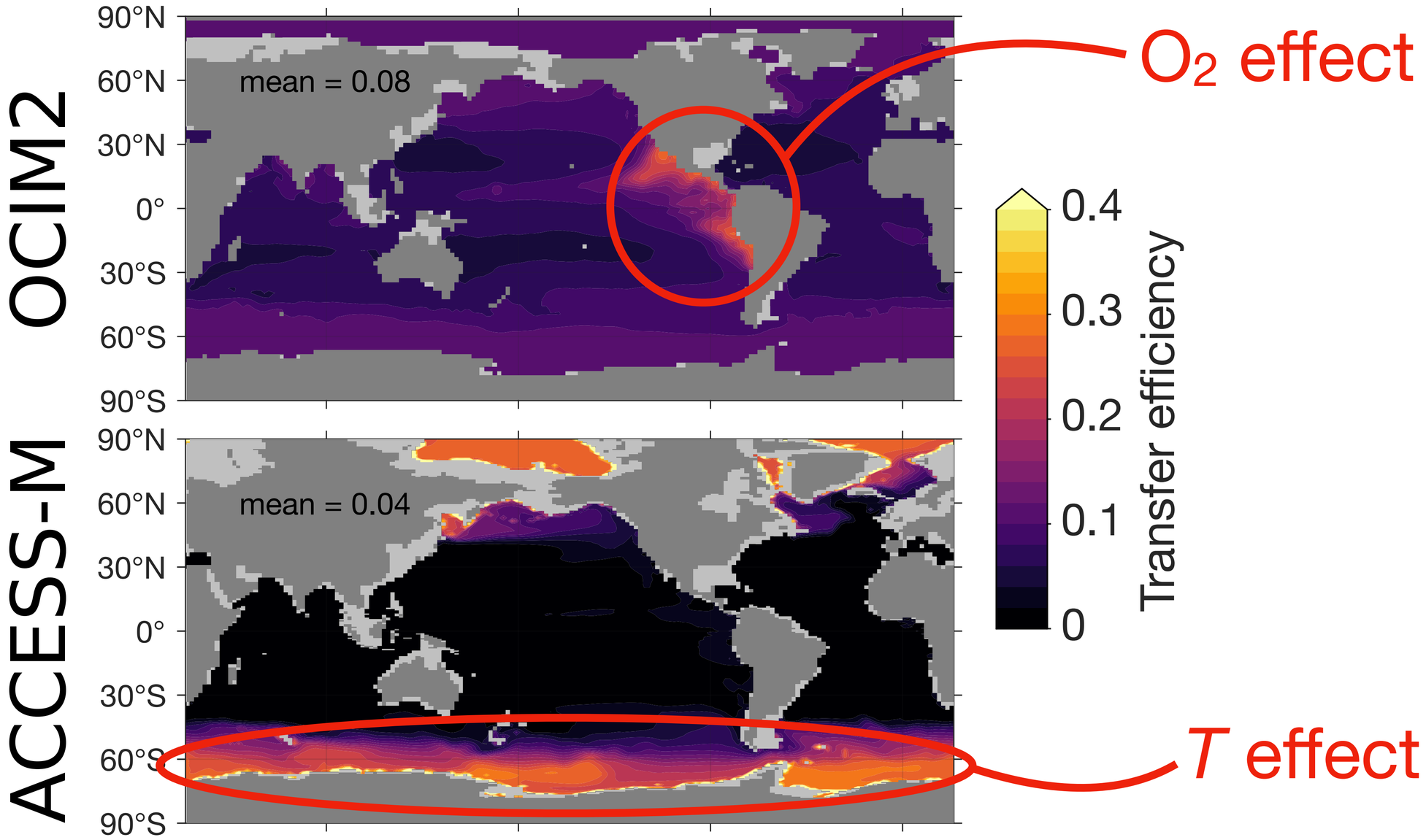
Regenerated inventory = export × re-exposure time



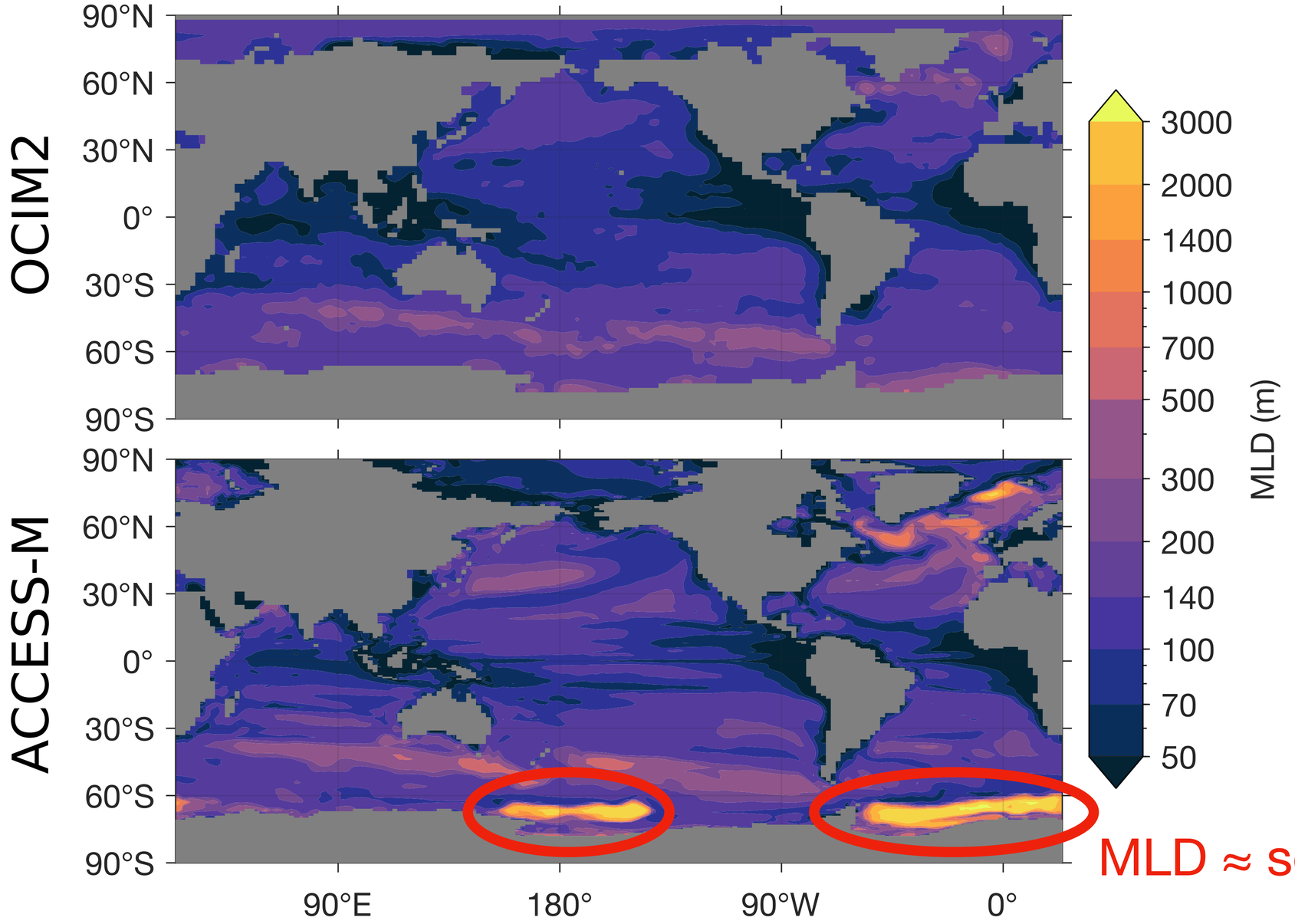
Regenerated inventory = export × re-exposure time



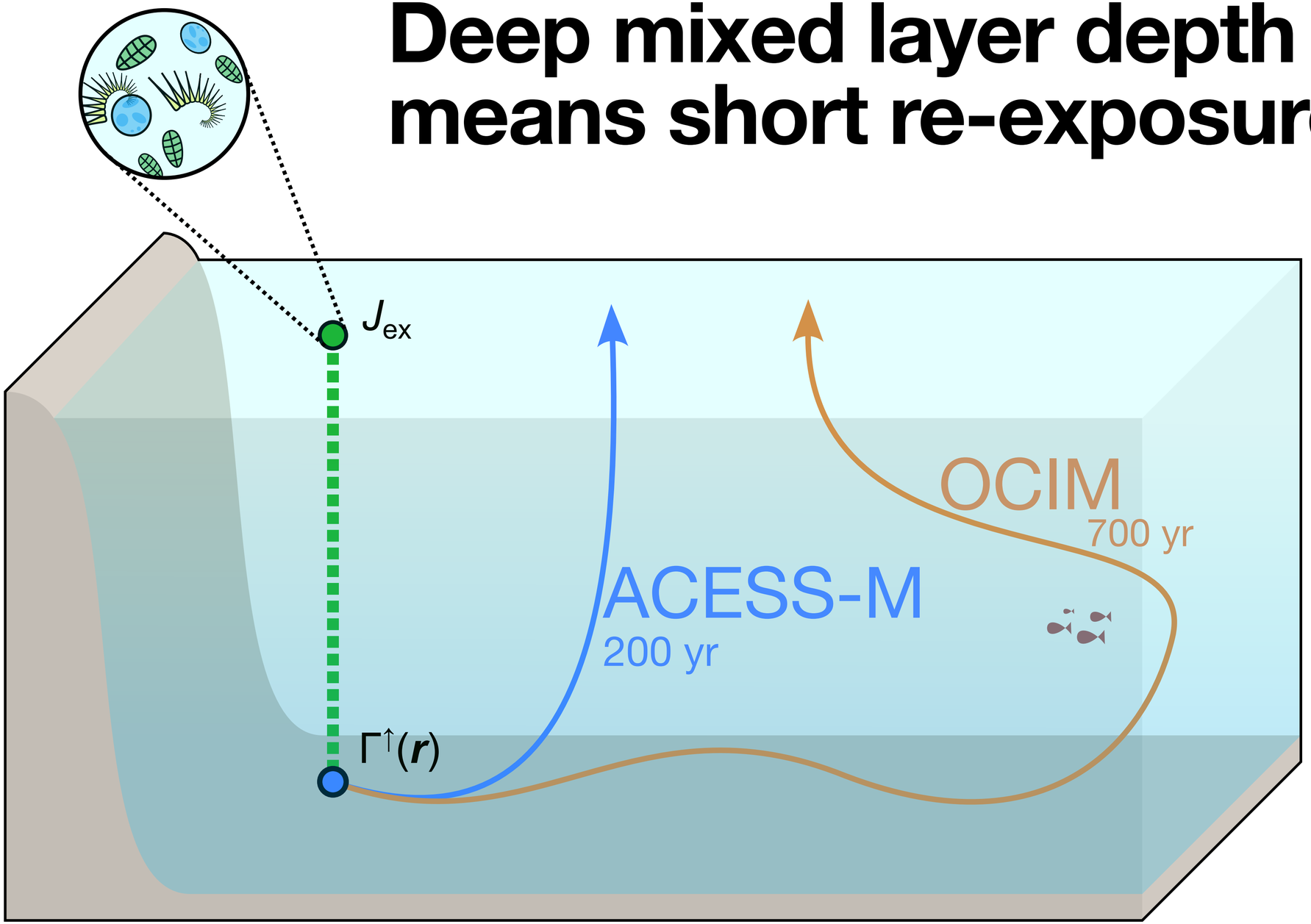
POC_f transfer efficiency 500m below euphoric zone



Mixed layer depth



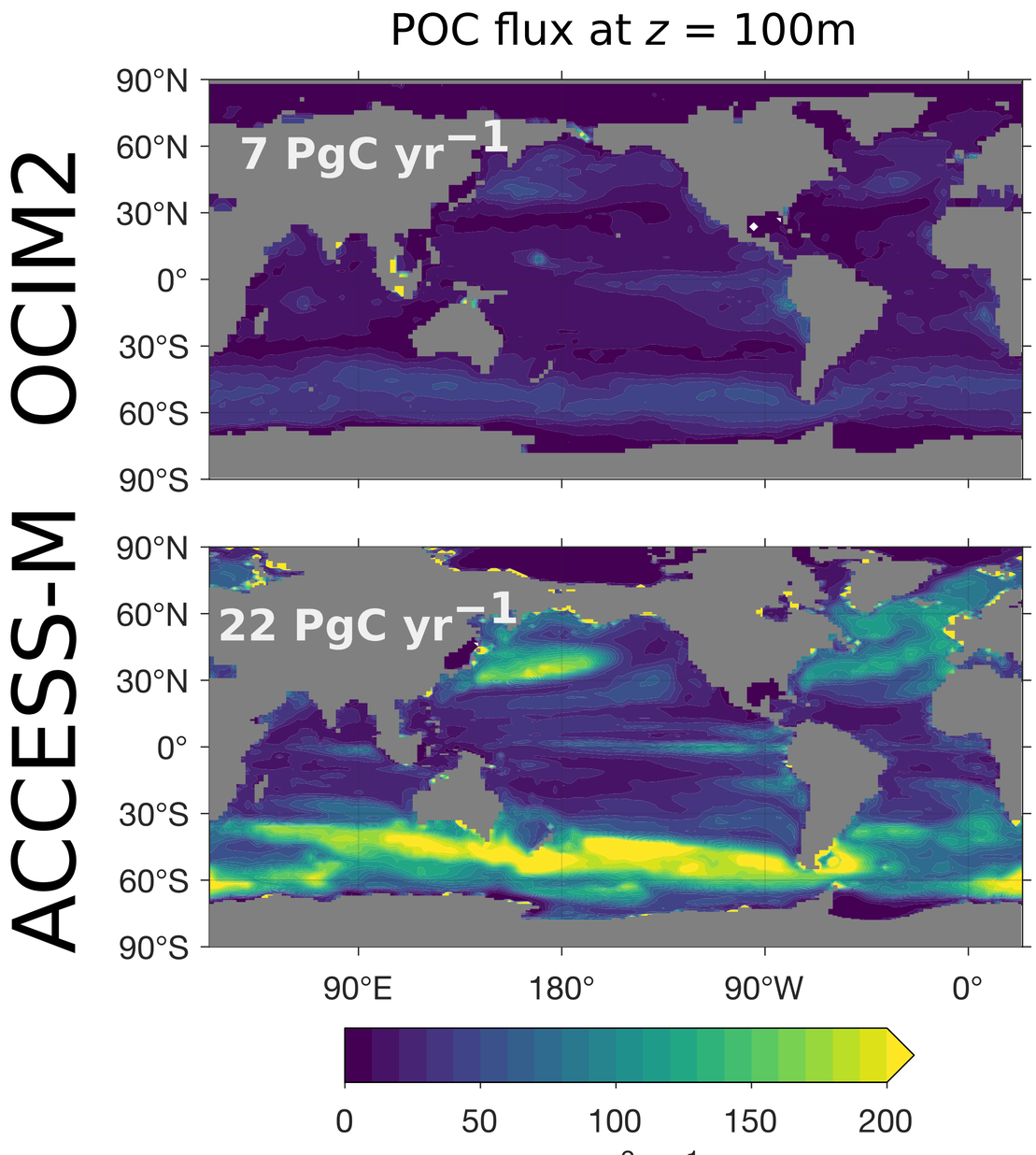
Deep mixed layer depth means short re-exposure time



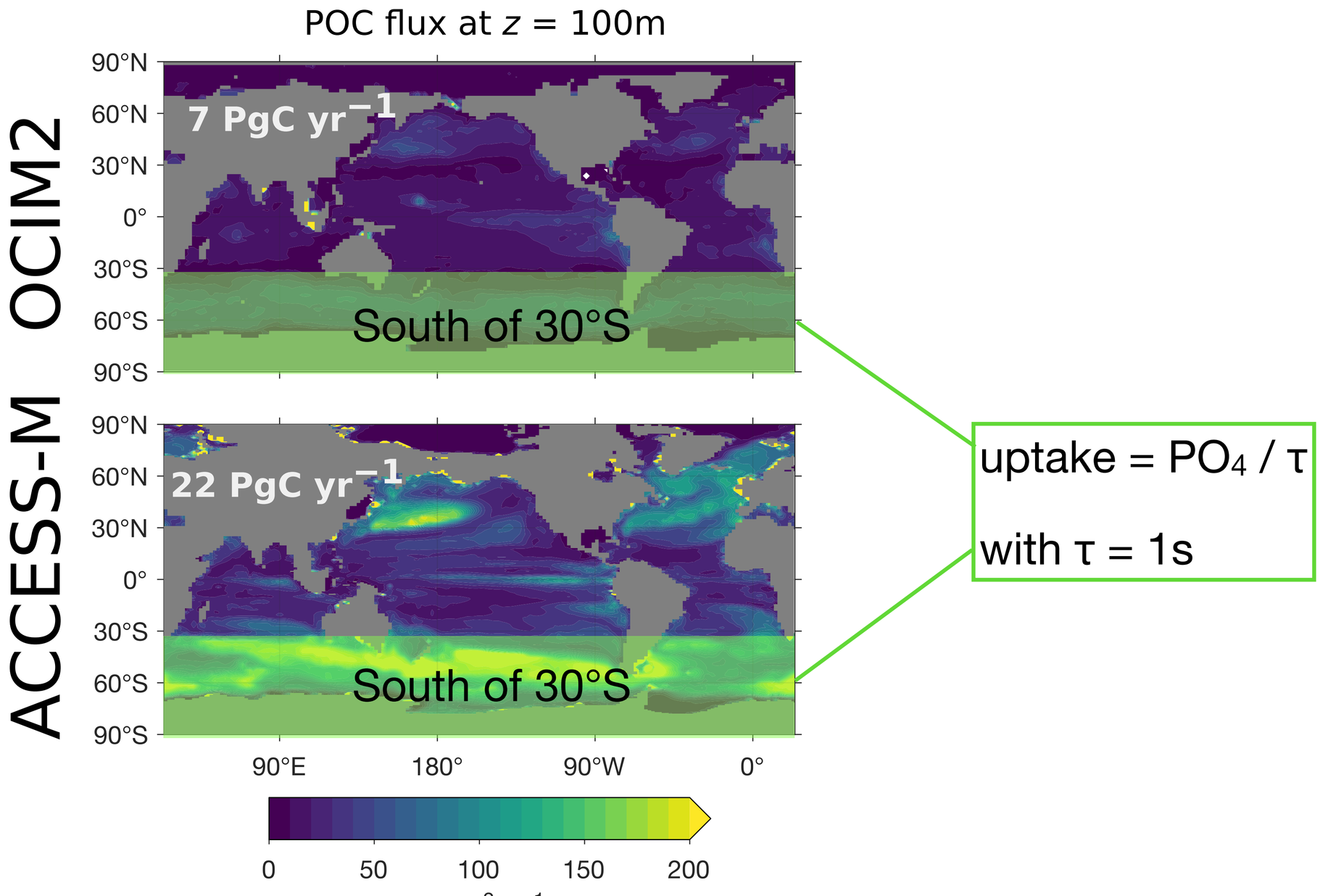
So what?

It affects the response to perturbations!

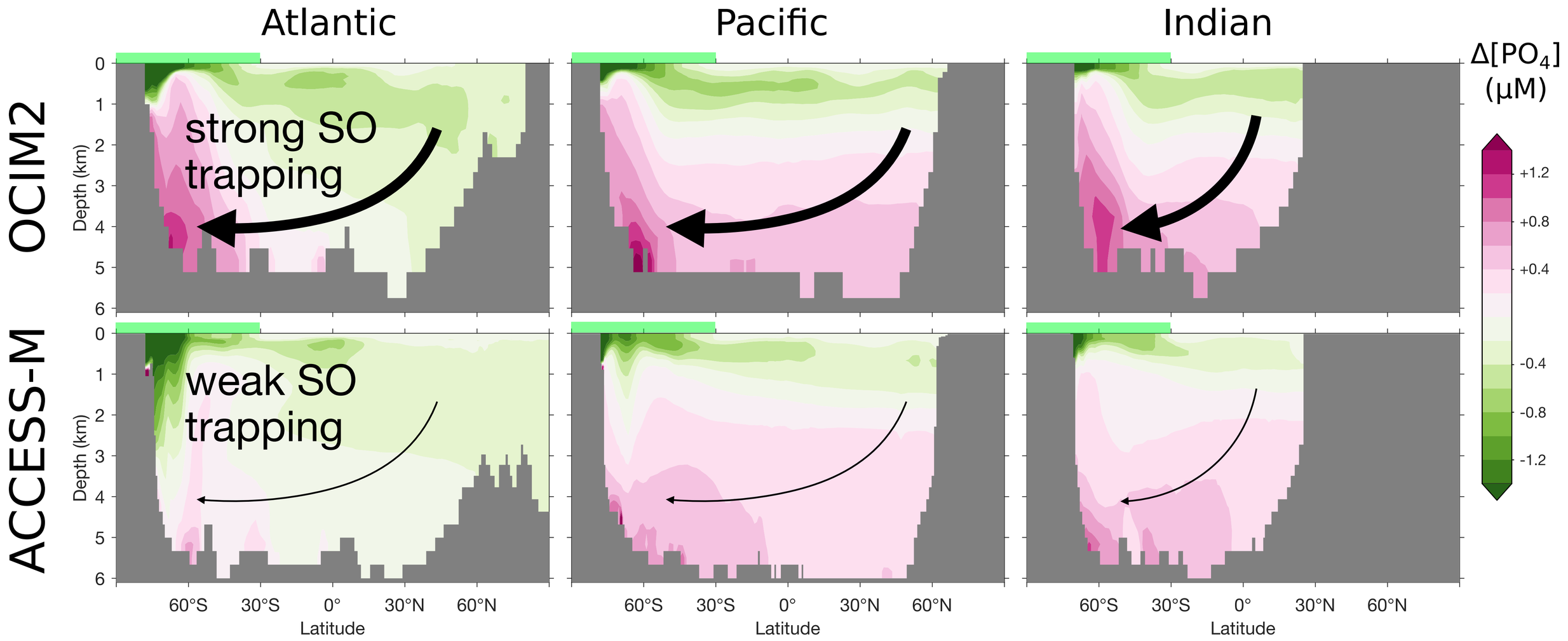
Crank up Southern Ocean productivity



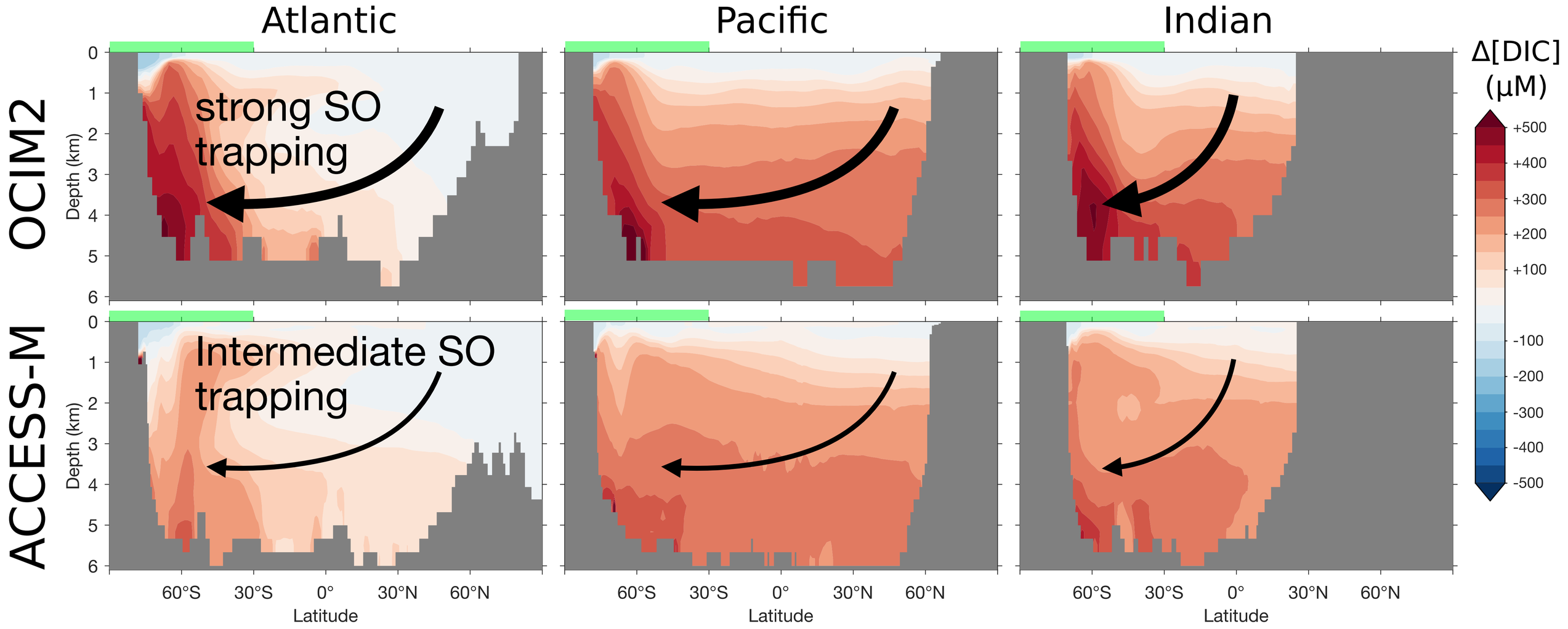
Crank up Southern Ocean productivity



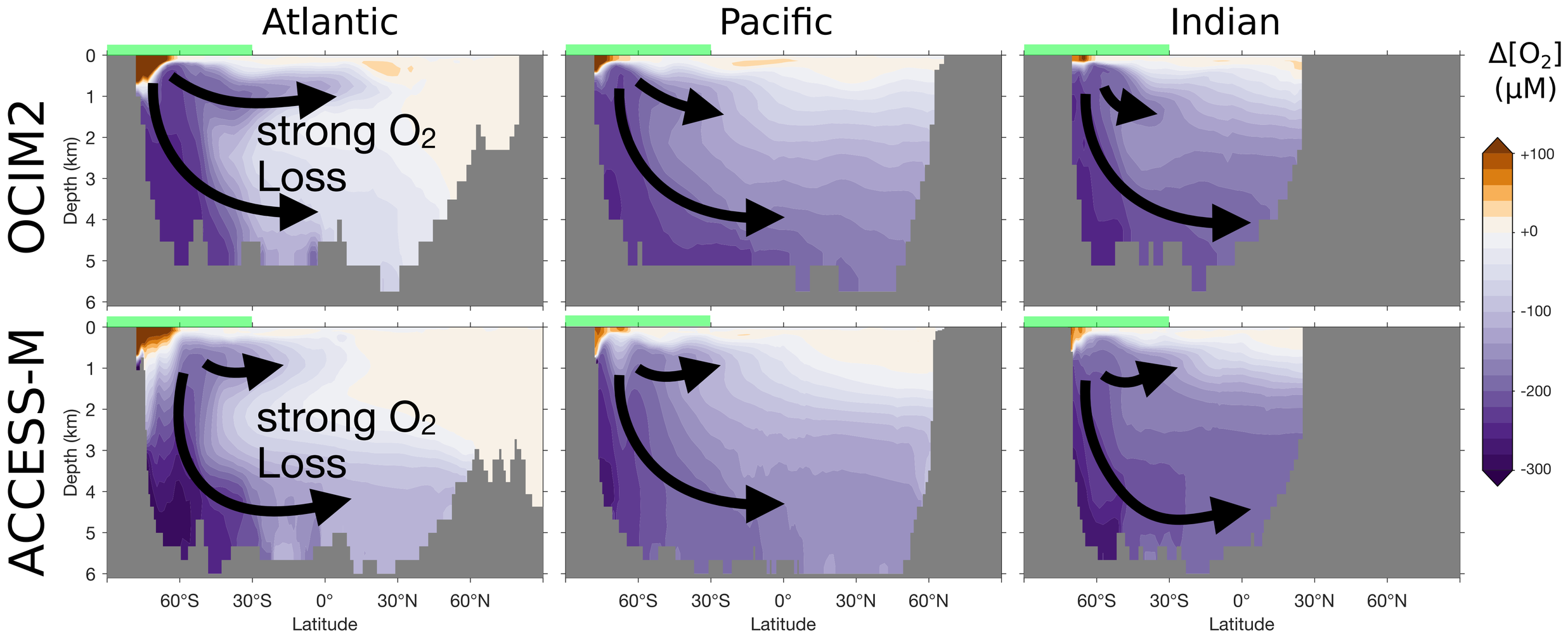
PO_4 response



DIC response



O_2 response


Atlantic
Pacific
Indian
OCIM2
ACCESS-M
strong O2 Loss
strong O2 Loss
Depth (km)
0
1
2
3
4
5
6
60°S
30°S
0°
30°N
60°N
Latitude
Δ[O2] (μM)
+100
+0
-100
-200
-300

Take home

A good fit is not enough…

Watch out for key metrics of circulation and pump (**export**, **re-exposure time**, **regenerated inventories**)!

Why? Because they **shape the response to perturbations** like climate change.

Follow-up work on response to future change in circulation at Ocean Sciences