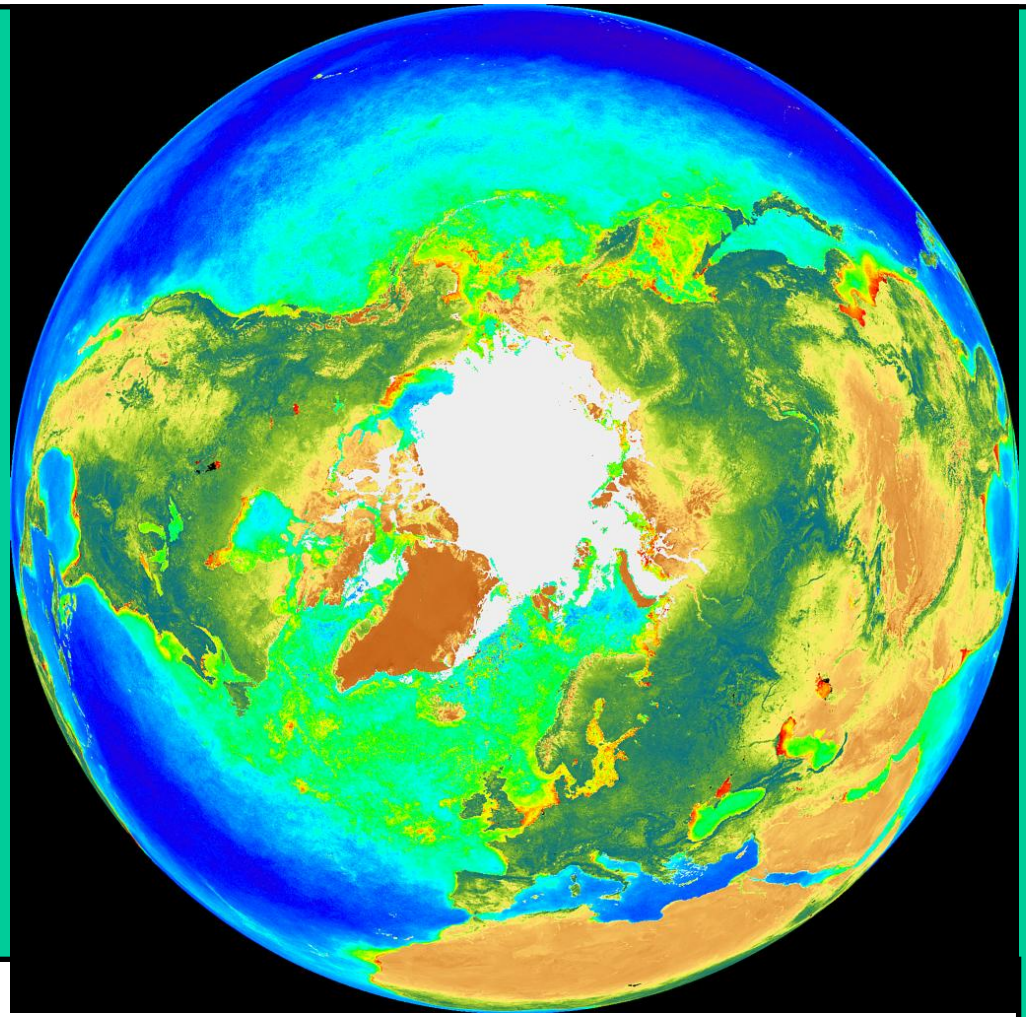
The boreal ocean in the enhanced greenhouse



Fisheries and Oceans Canada | Pêches et Océans Canada

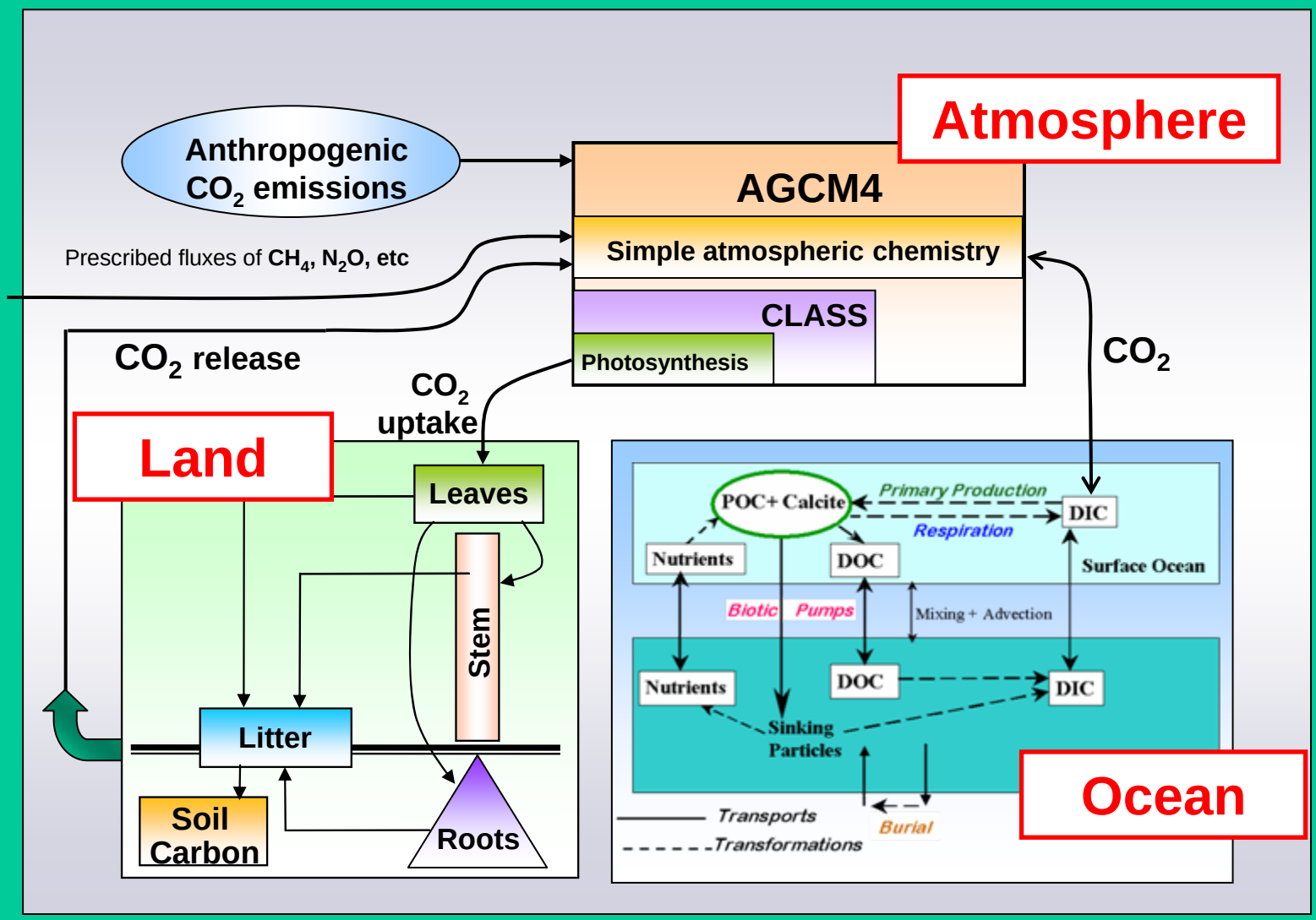
CCCma

IOS

James Christian
Institute of Ocean Sciences, Fisheries and Oceans Canada
and
Canadian Centre for Climate Modelling and Analysis

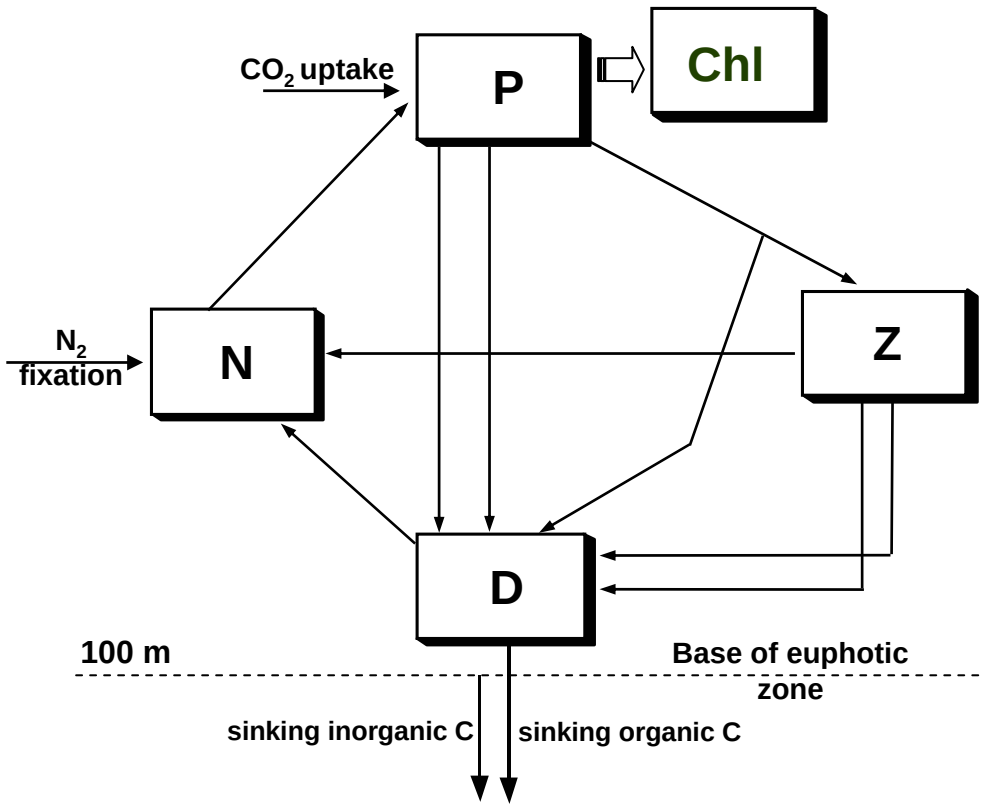
What sort of changes do we expect in the enhanced greenhouse?

- ocean uptake of atmospheric CO_2
- ocean acidification and calcium carbonate saturation state
- changes in biological processes
    - primary production
    - remineralization
    - dinitrogen fixation
    - calcification



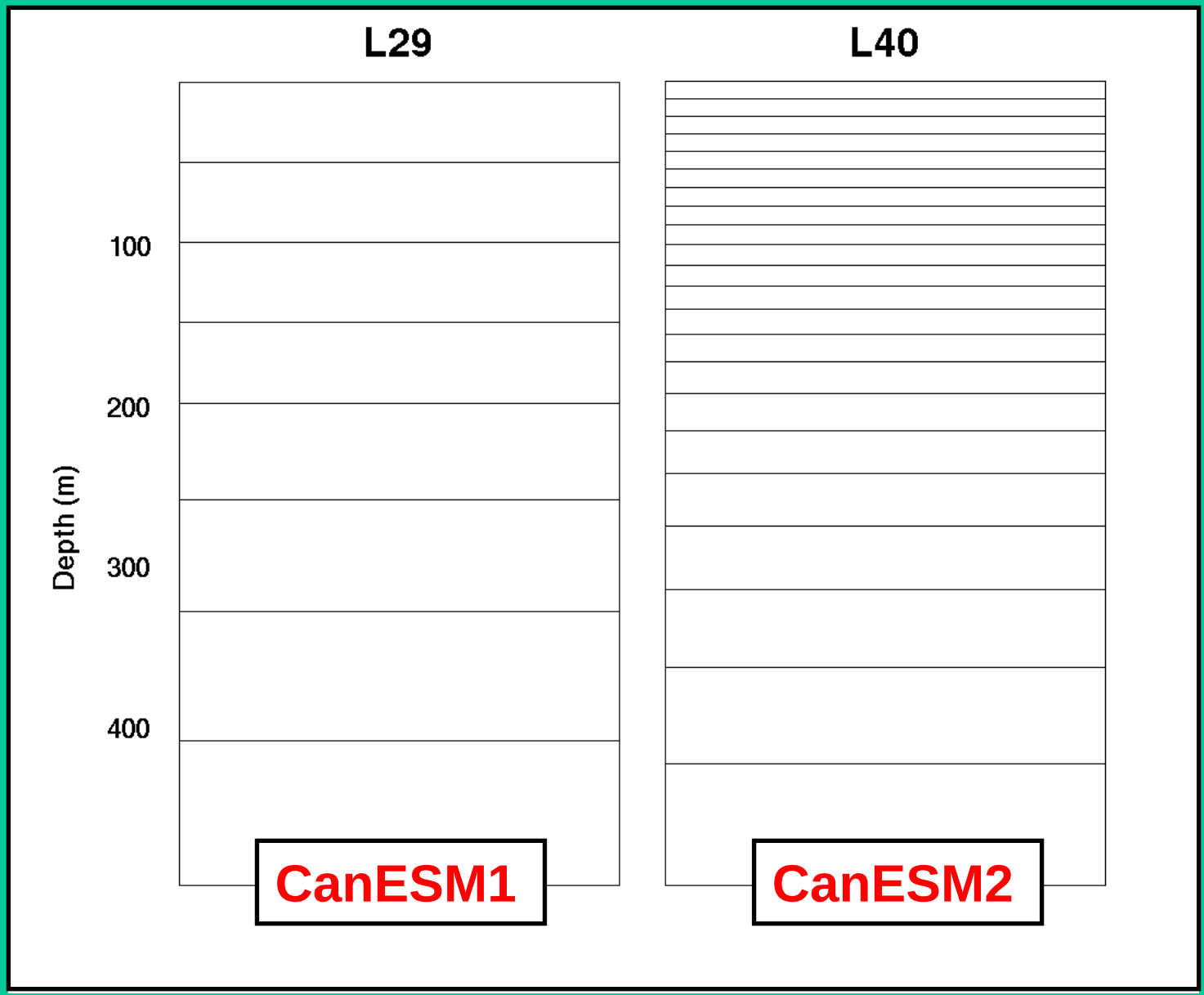
The Canadian Earth System Model (CanESM)

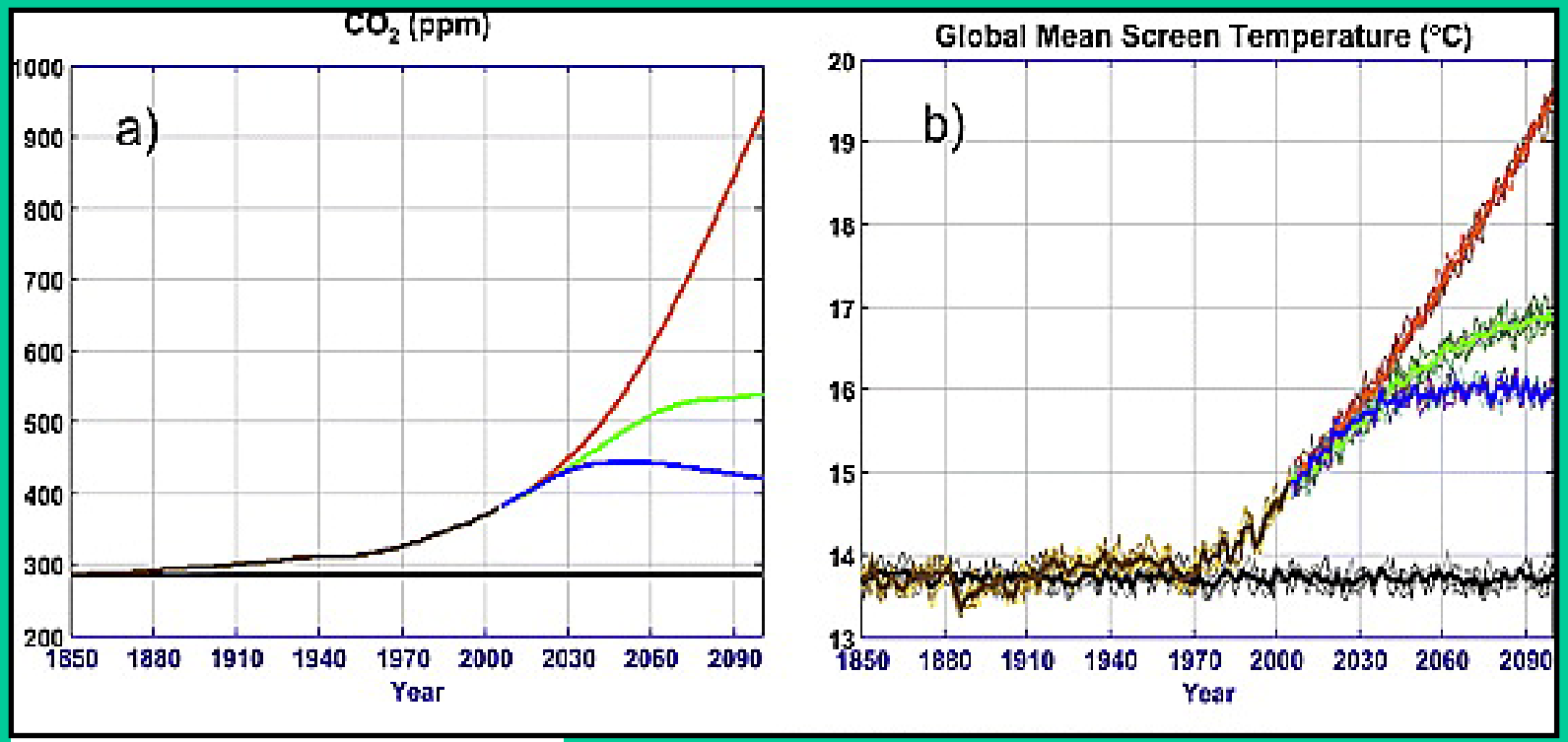
CanESM ocean ecosystem model

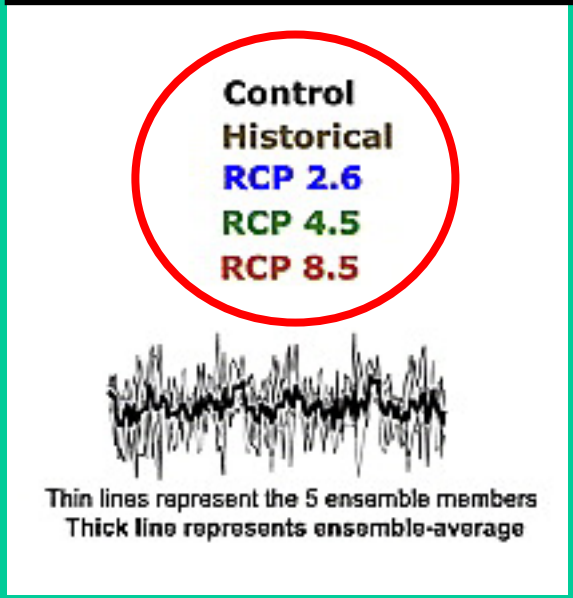


NPZD with simple parameterizations of photoacclimation, N_2 fixation, and calcification

Increased vertical resolution particularly in upper 200 m



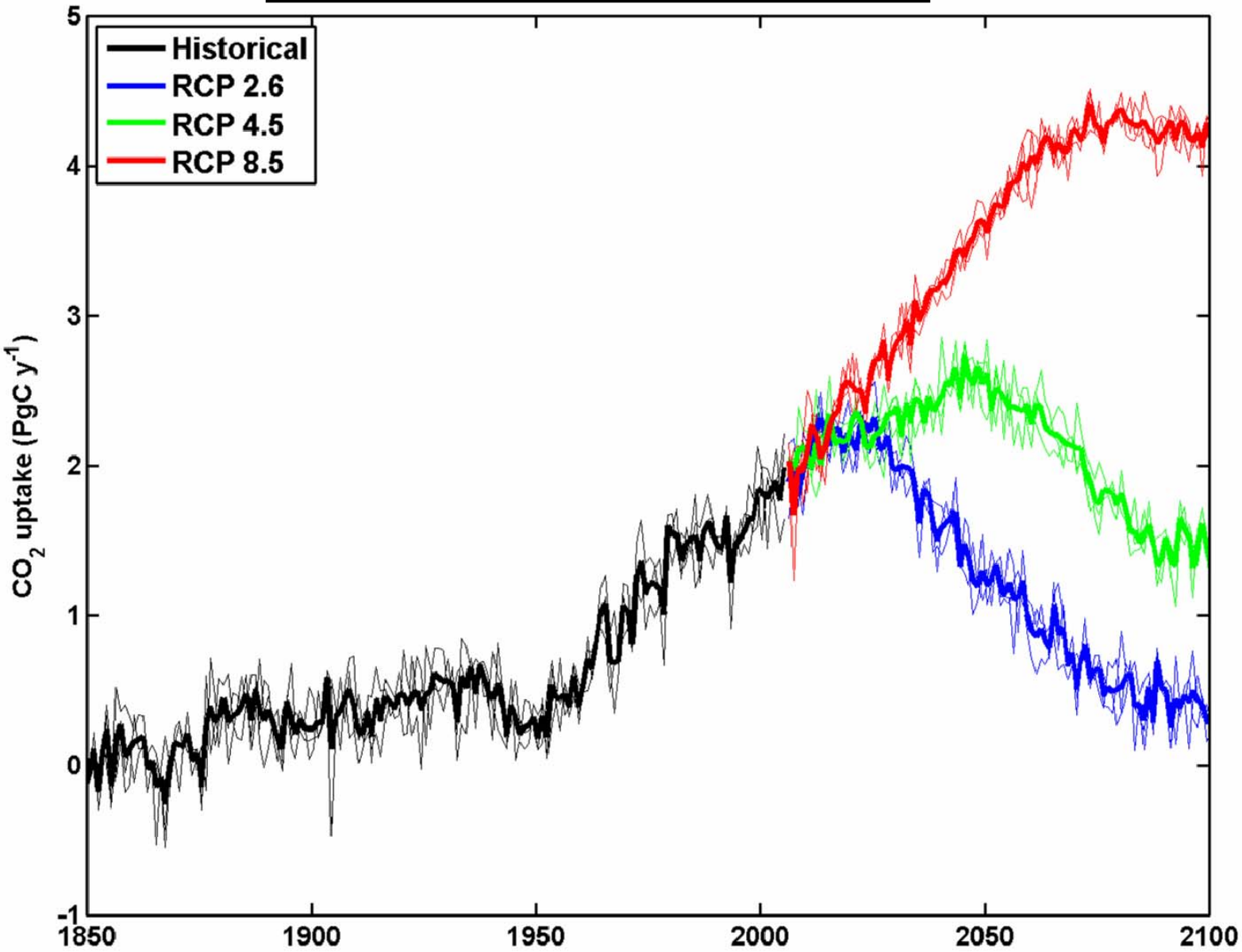




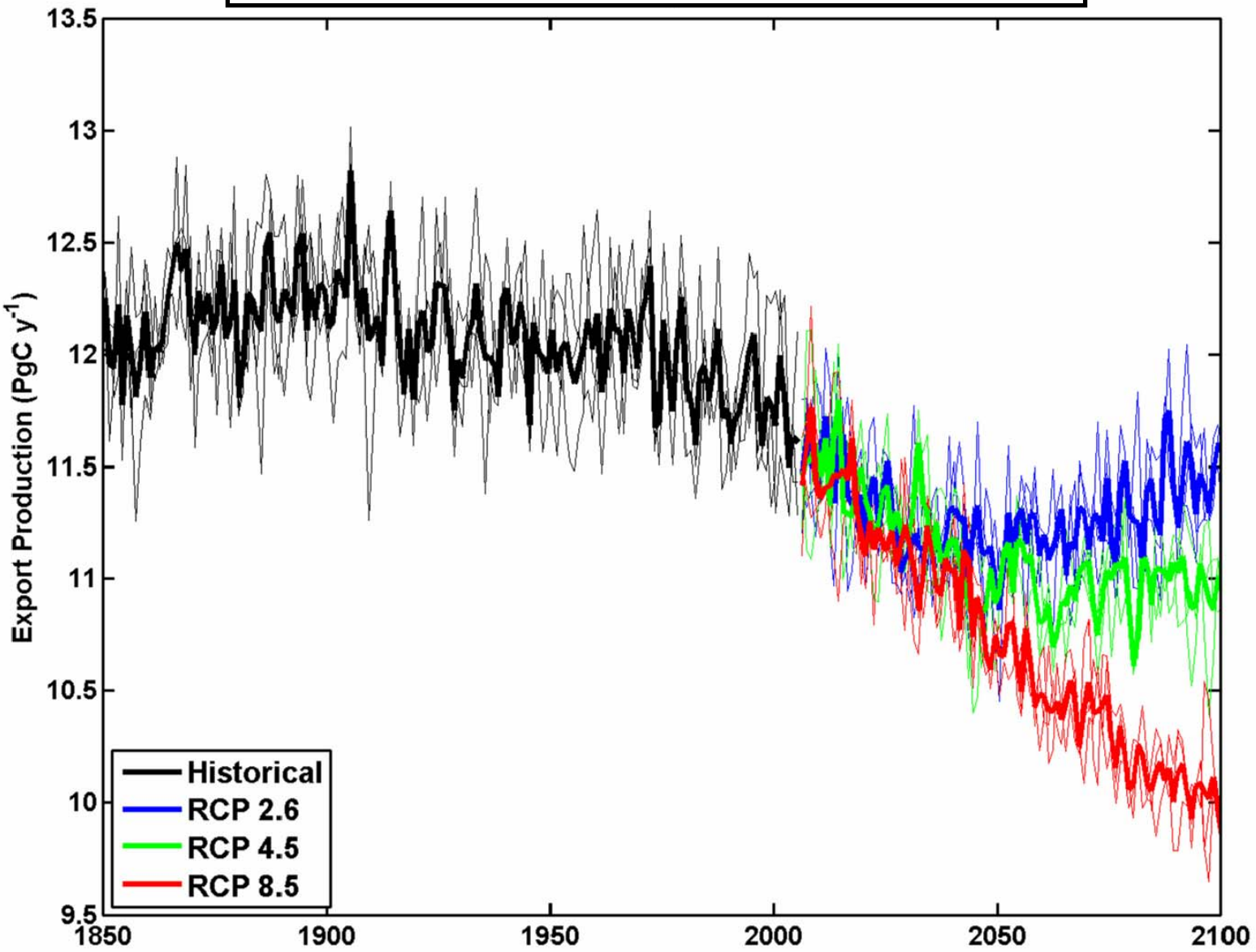
New for AR5: "representative concentration pathways" (RCP's)

Arora et al 2011 GRL

Global ocean CO_2 uptake

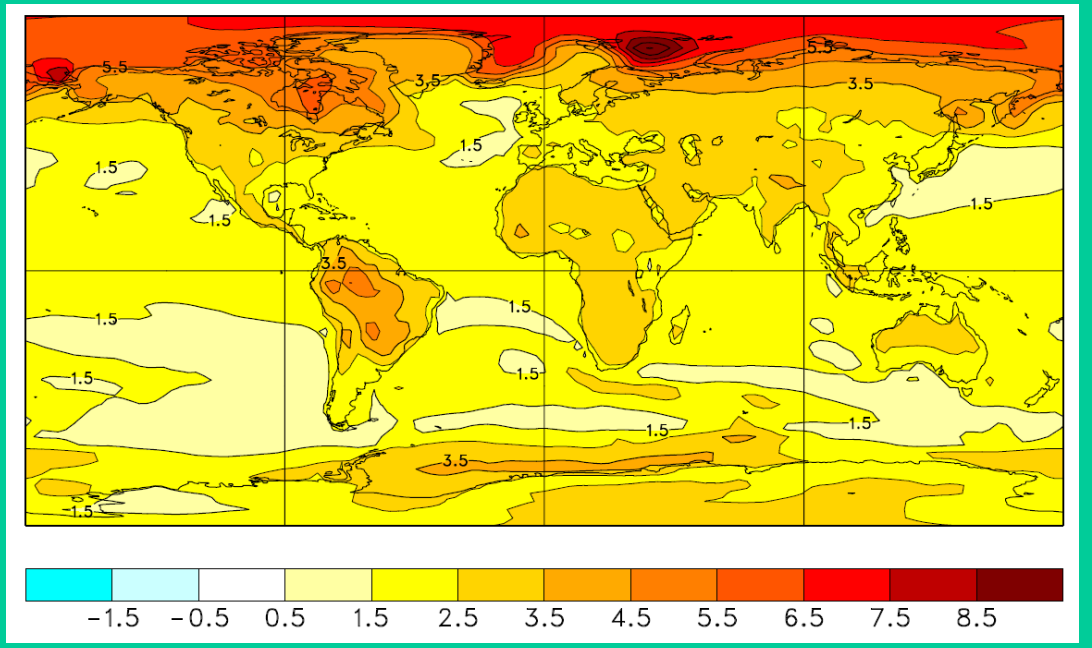


Global ocean export production



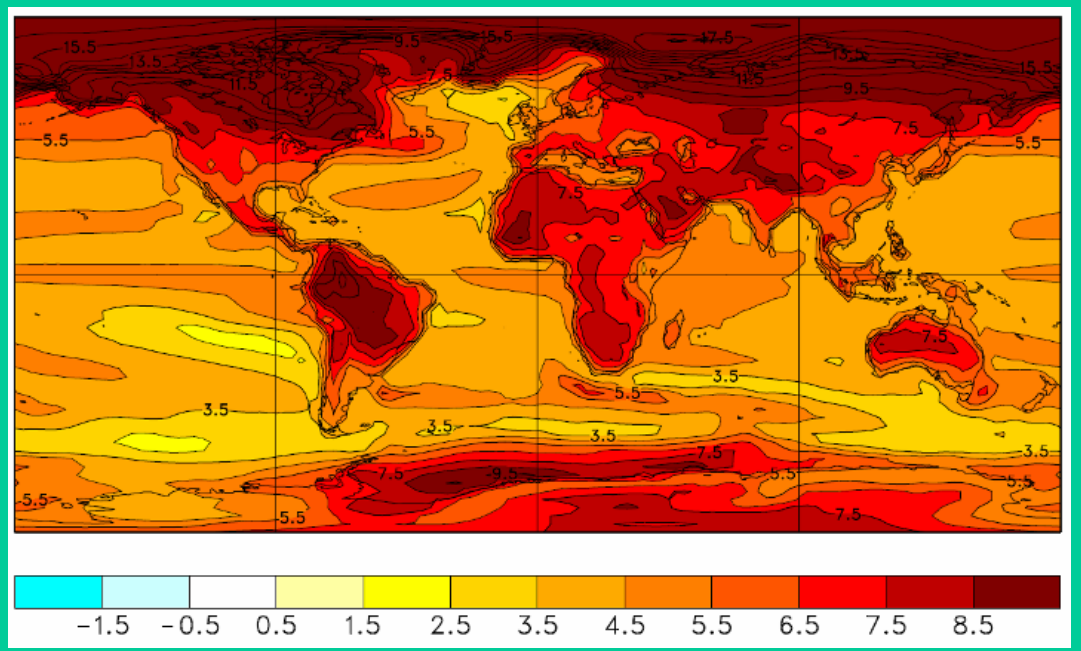
Global trends in surface temperature

RCP2.6



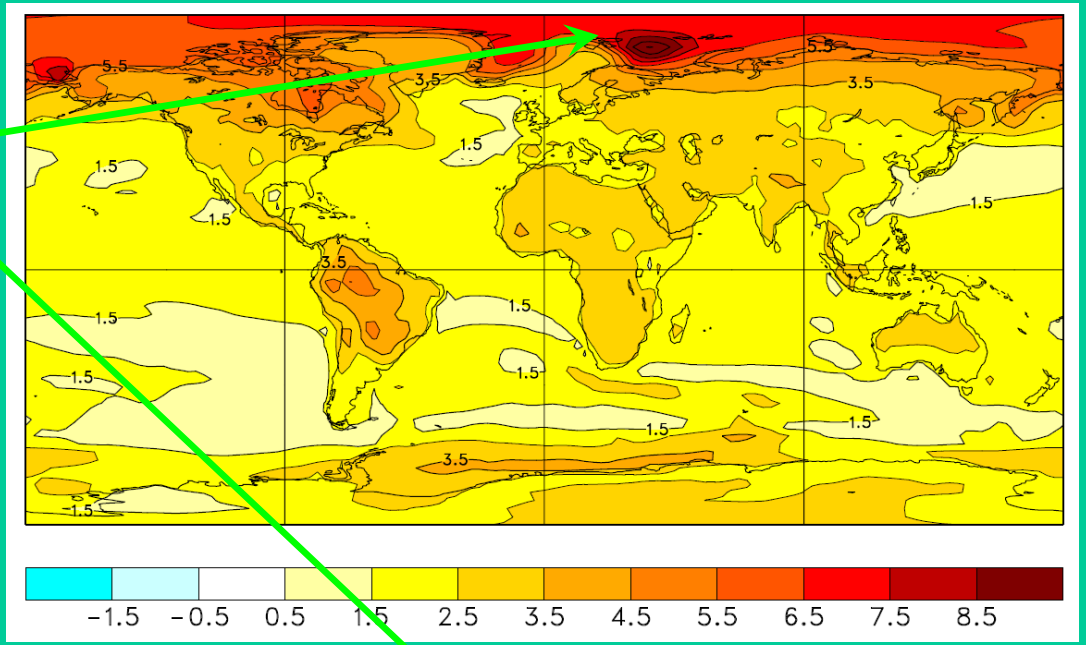
2100 difference from 1850

RCP8.5

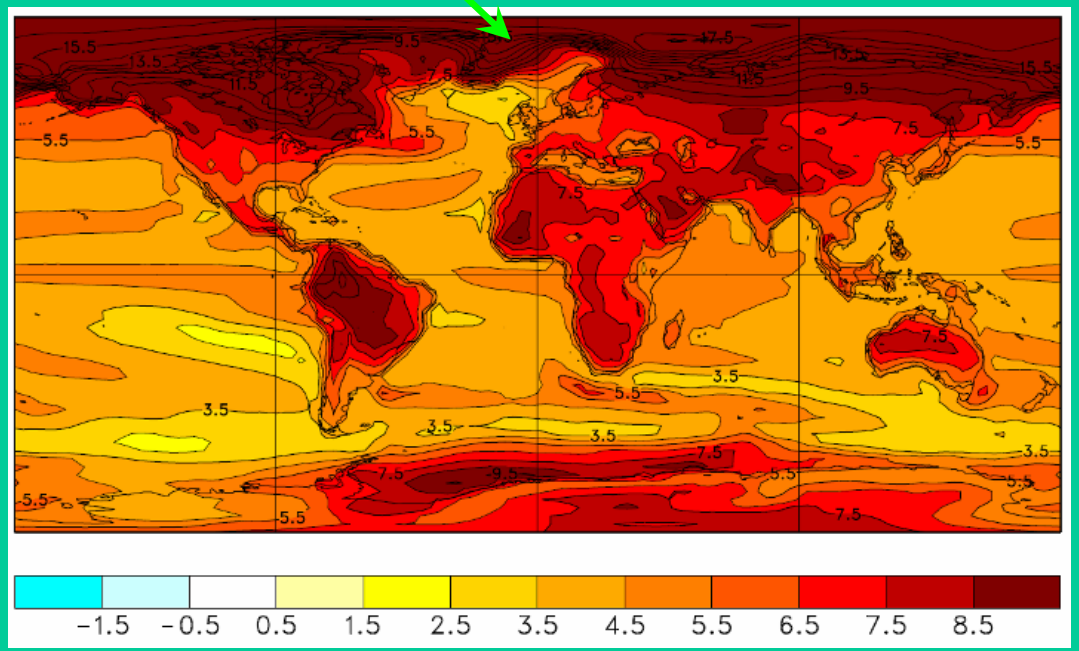


Largest in northern high latitudes

RCP2.6

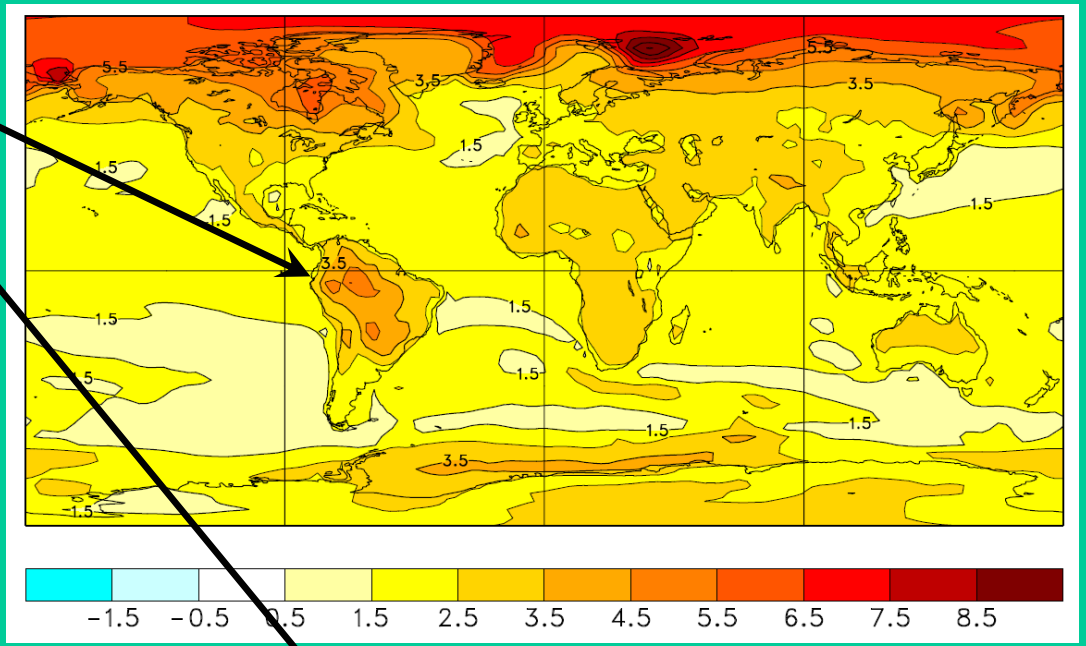


RCP8.5

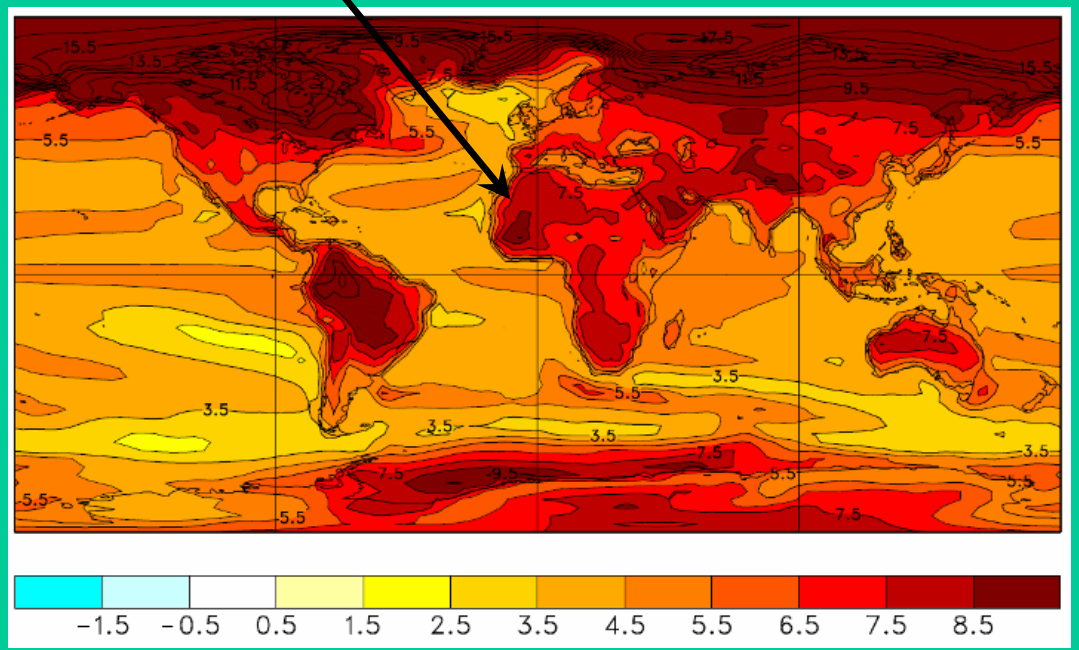


Largest over land

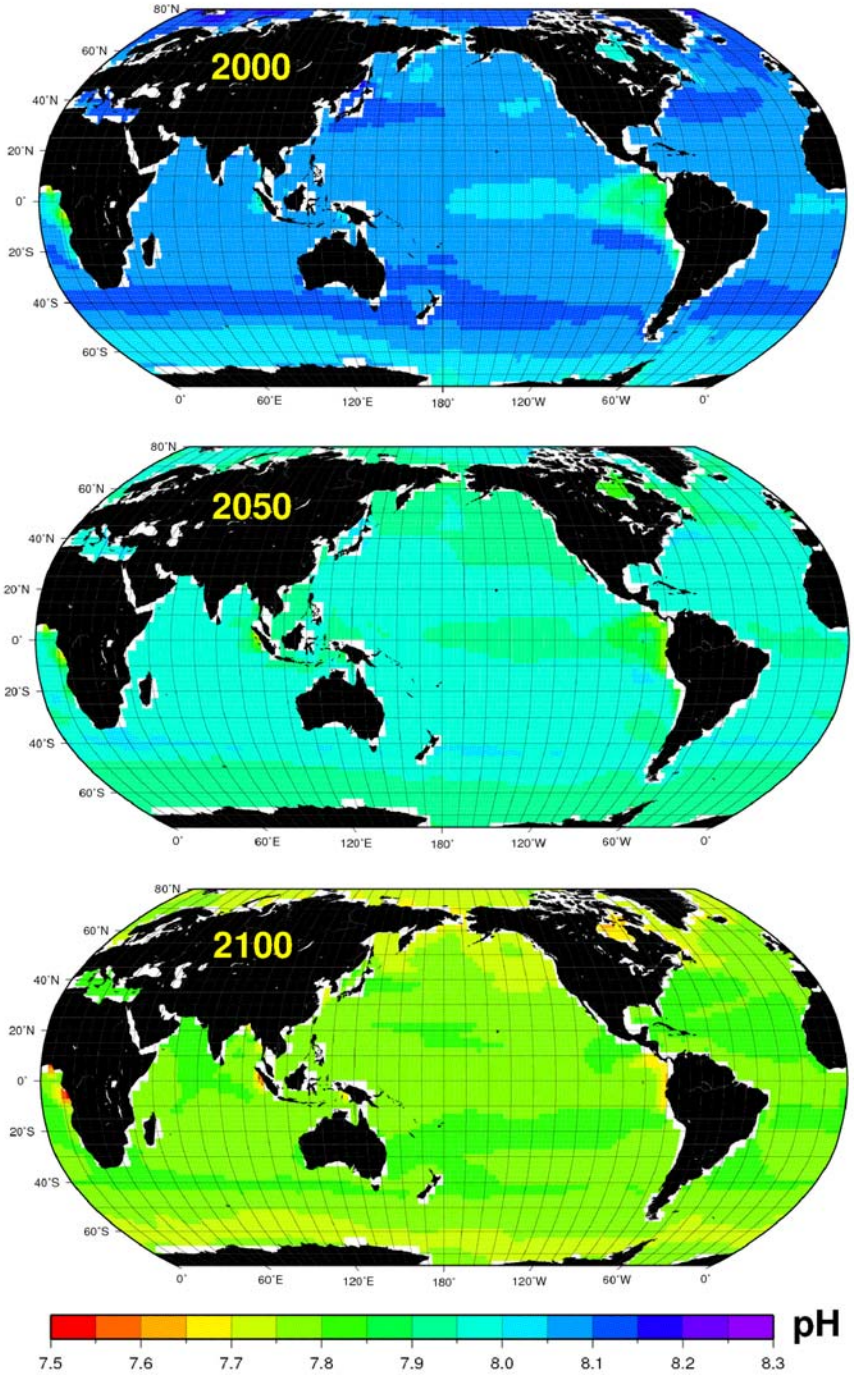
RCP2.6



RCP8.5

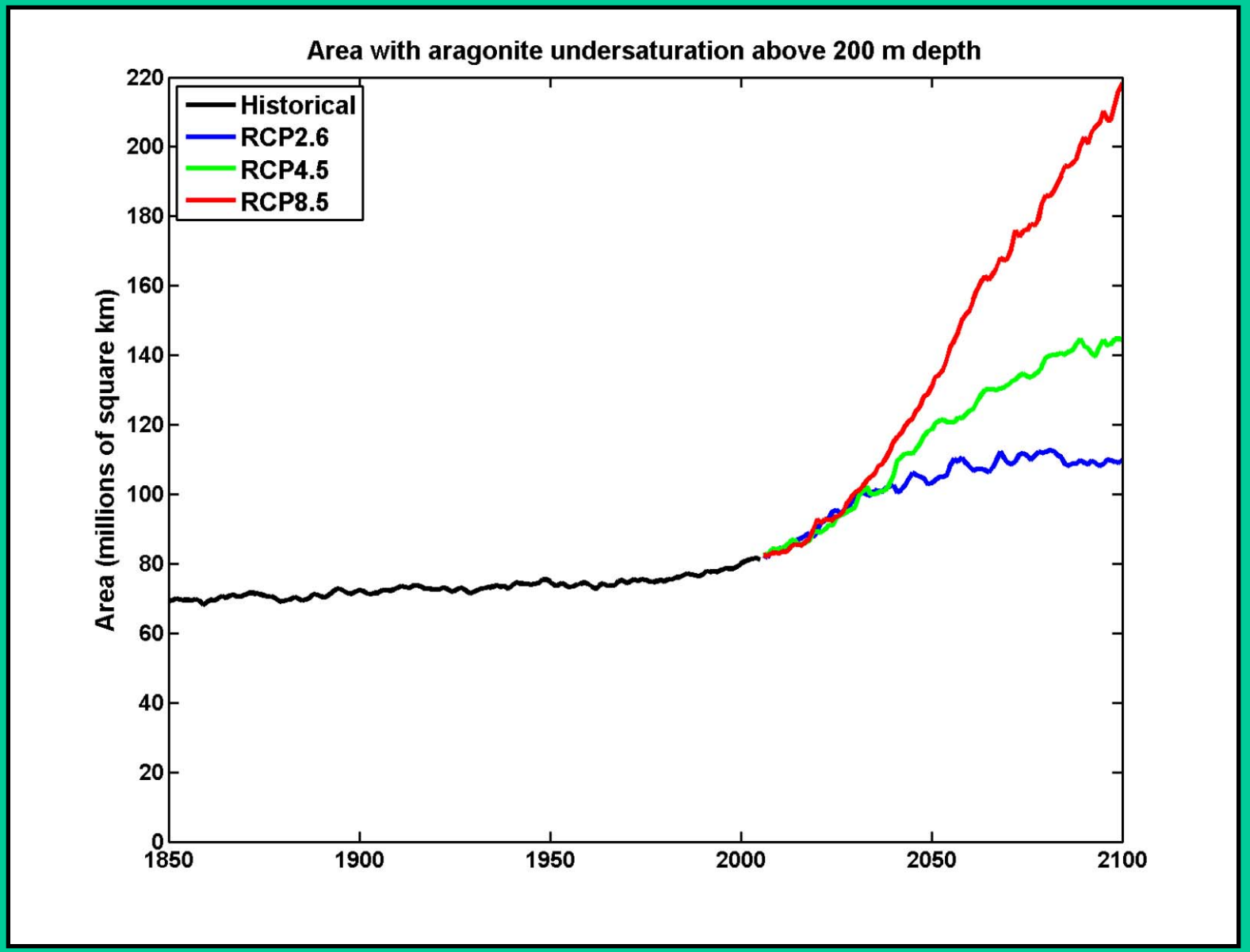


Global trends in ocean acidification

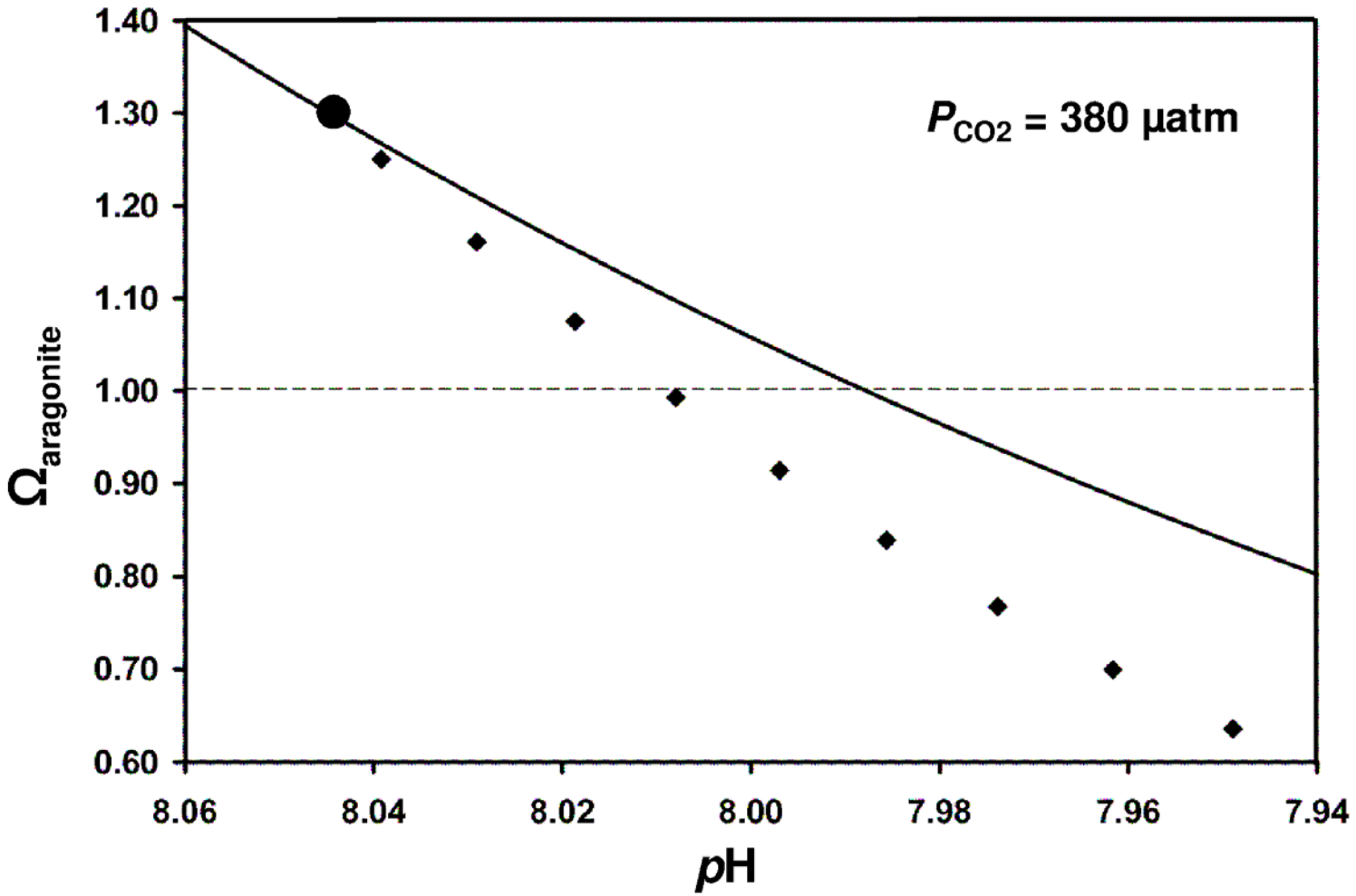


Denman et al. ICES J. Mar. Sci. in press

Area with near-surface undersaturation increases by up to a factor of ~3



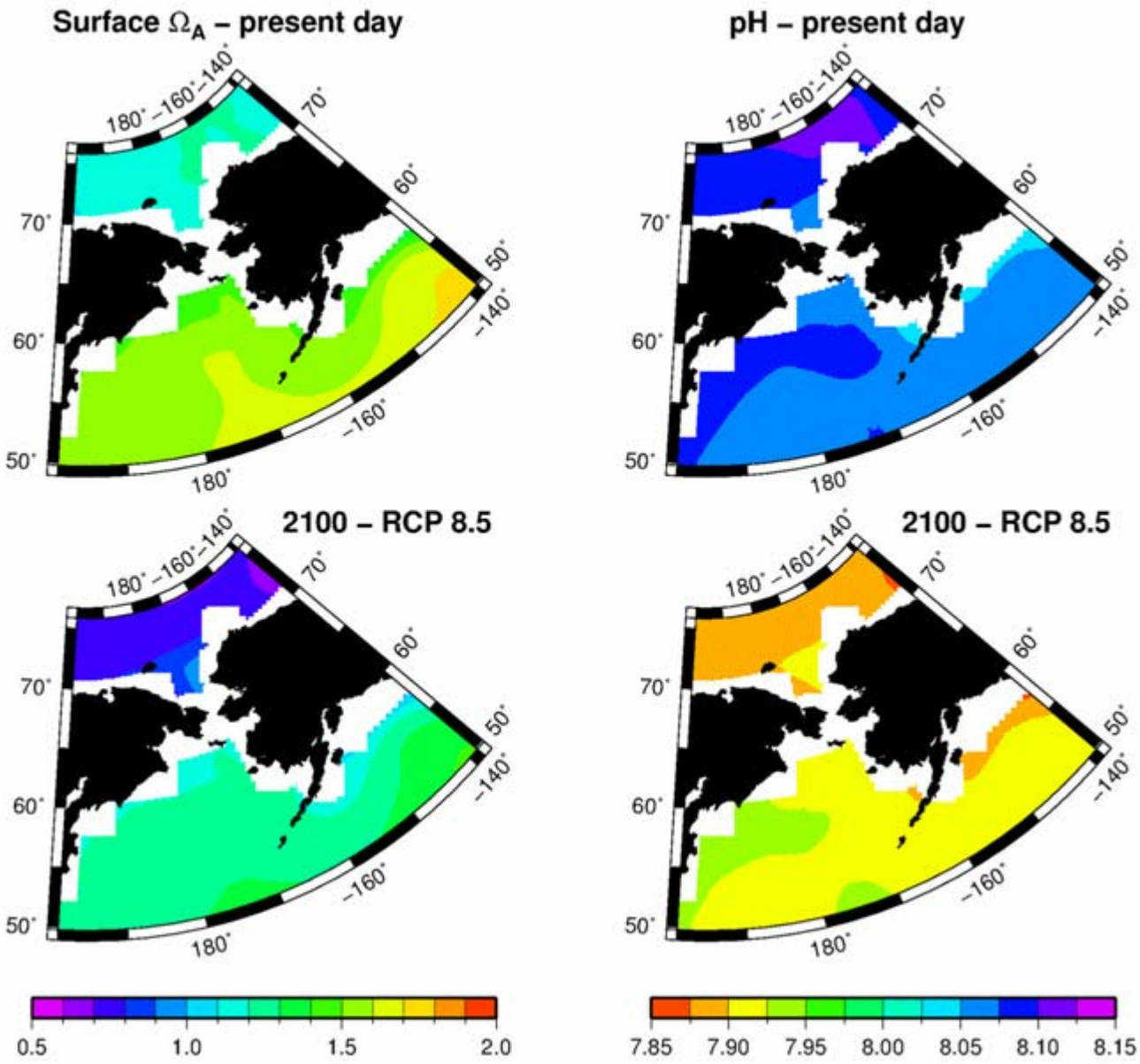
Undersaturation occurs at higher pH in boreal ocean



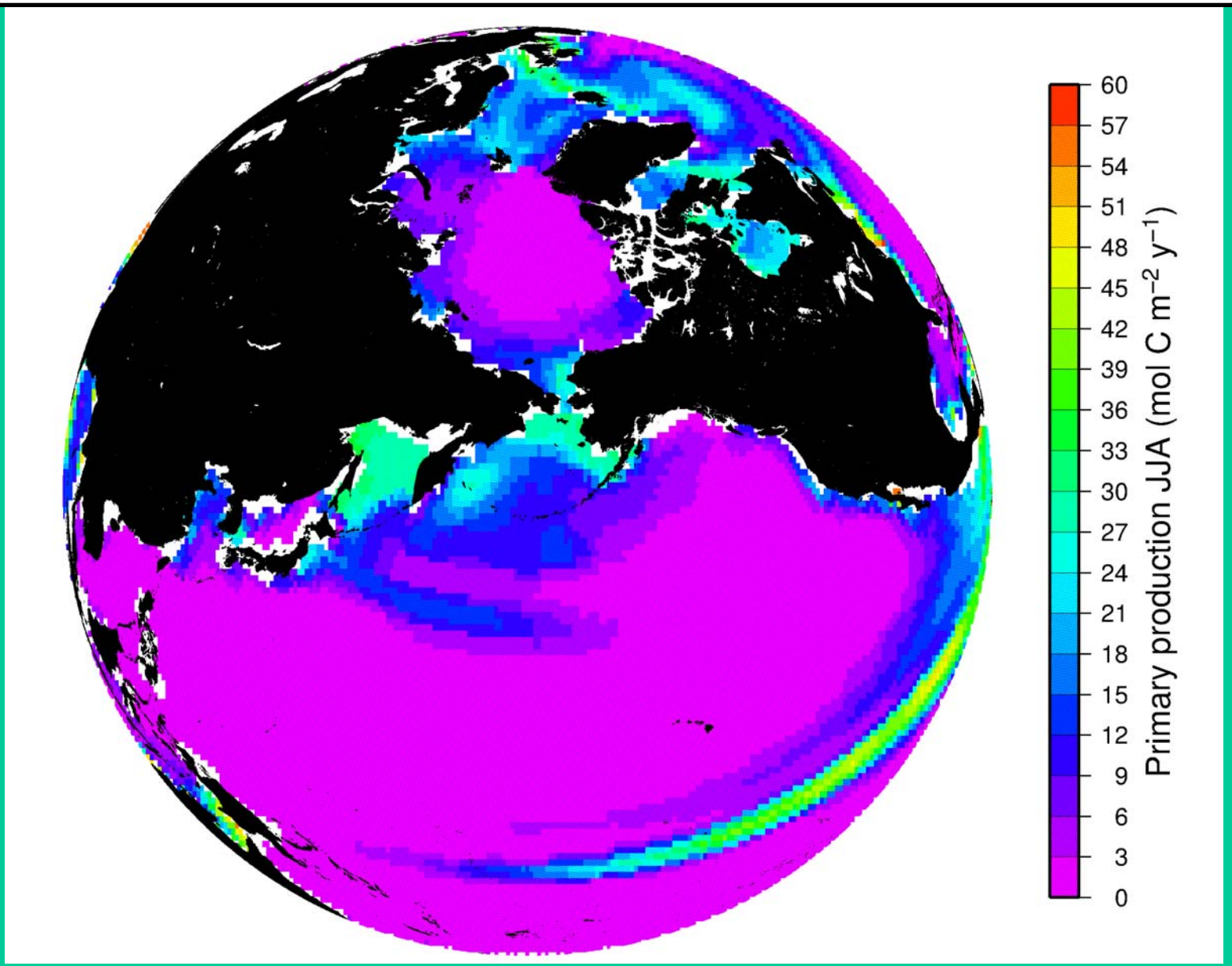
Denman et al. ICES J. Mar. Sci. in press

Aragonite saturation

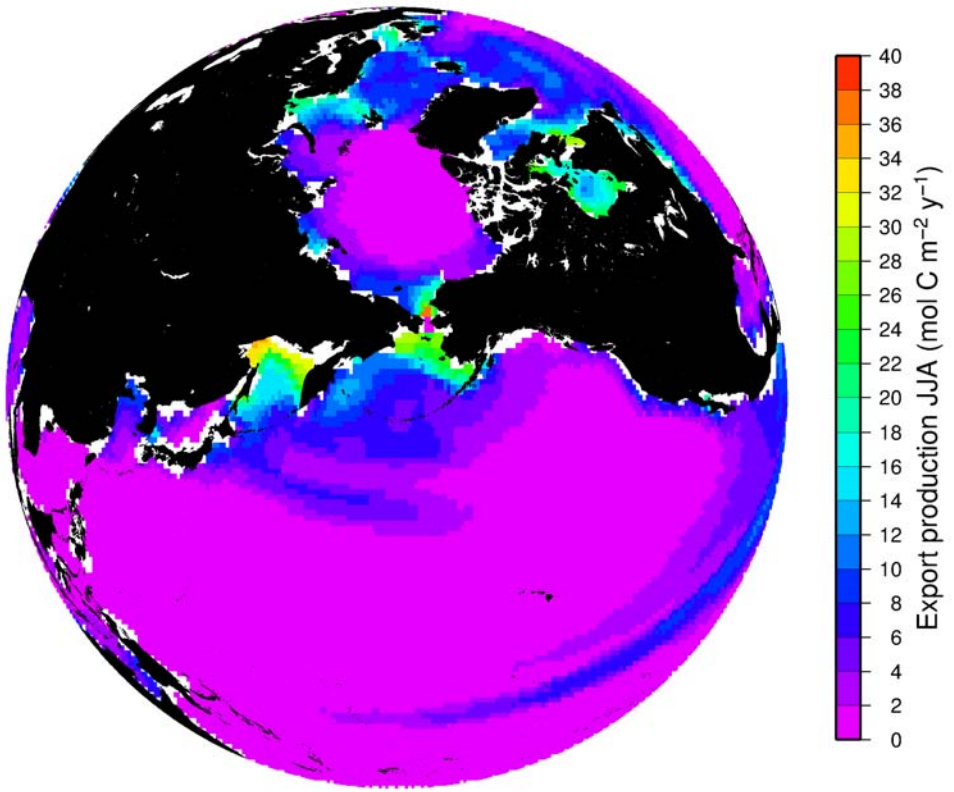
pH

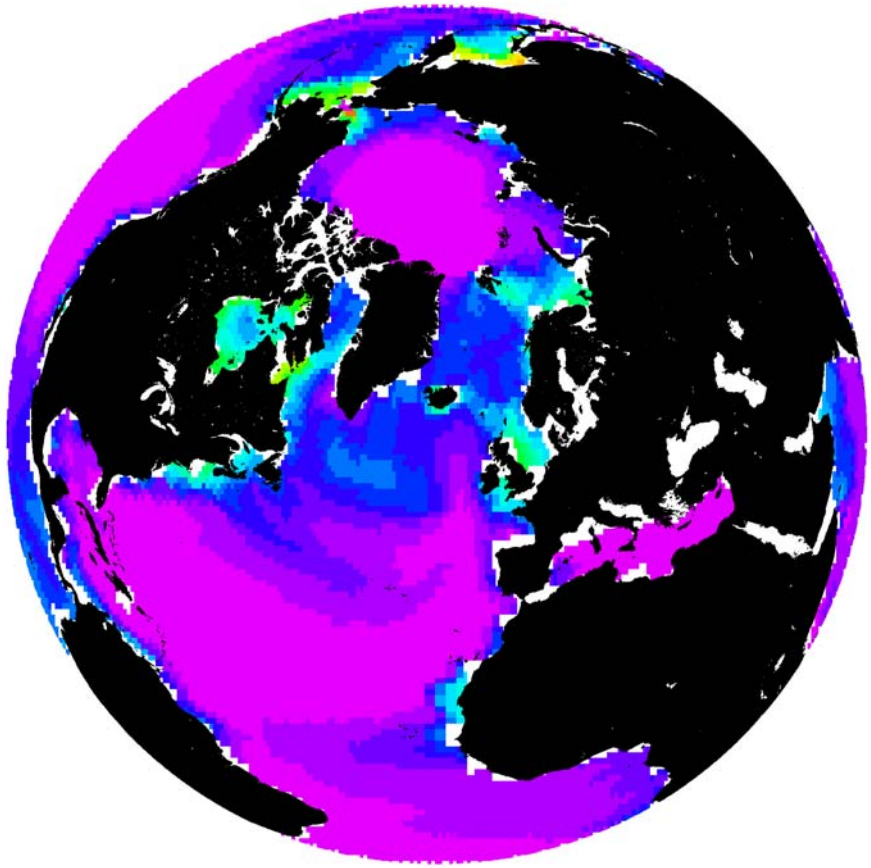


Subarctic seas have very high rates of primary production and export production, especially in summer

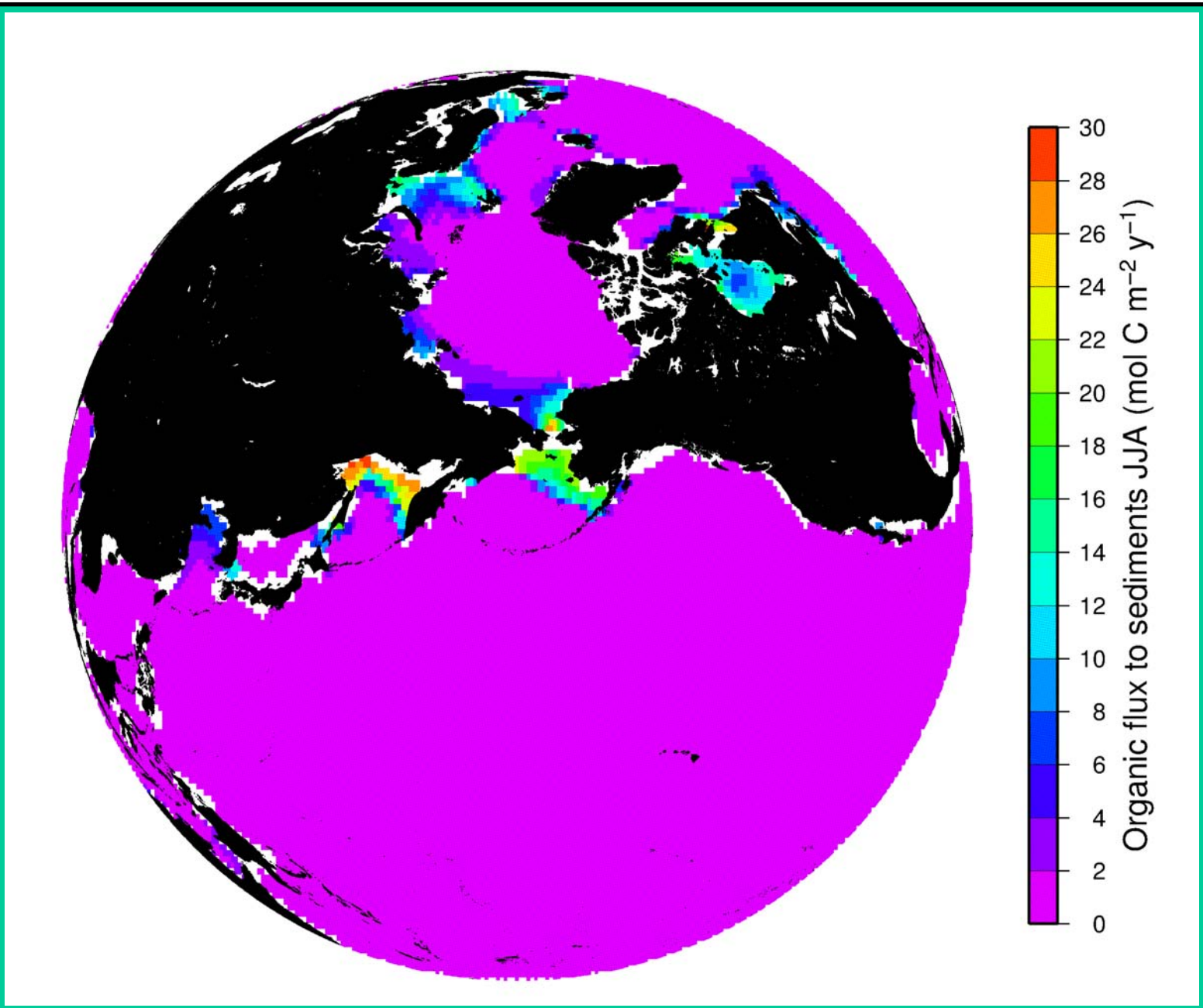


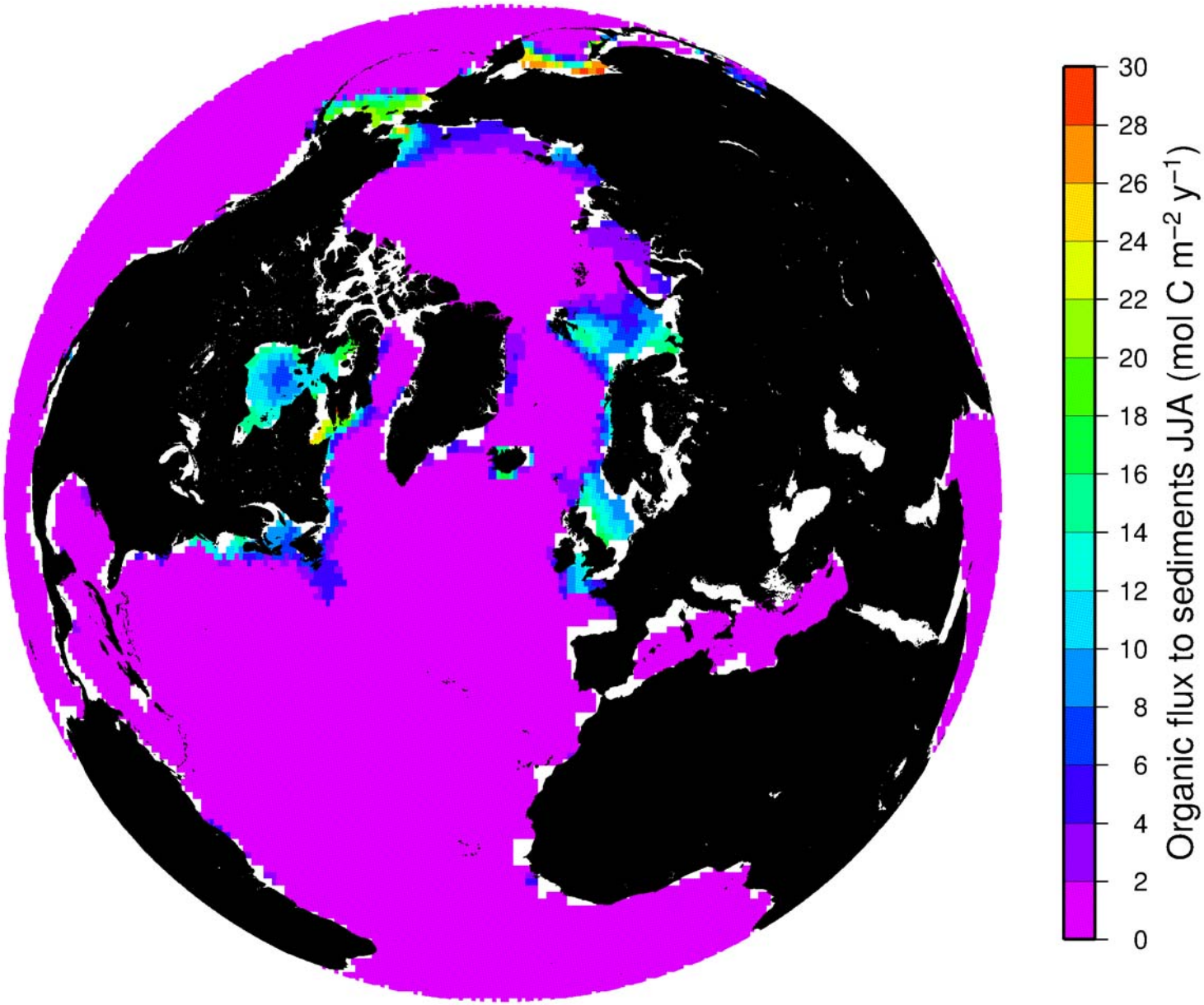
Organic carbon export from euphotic zone

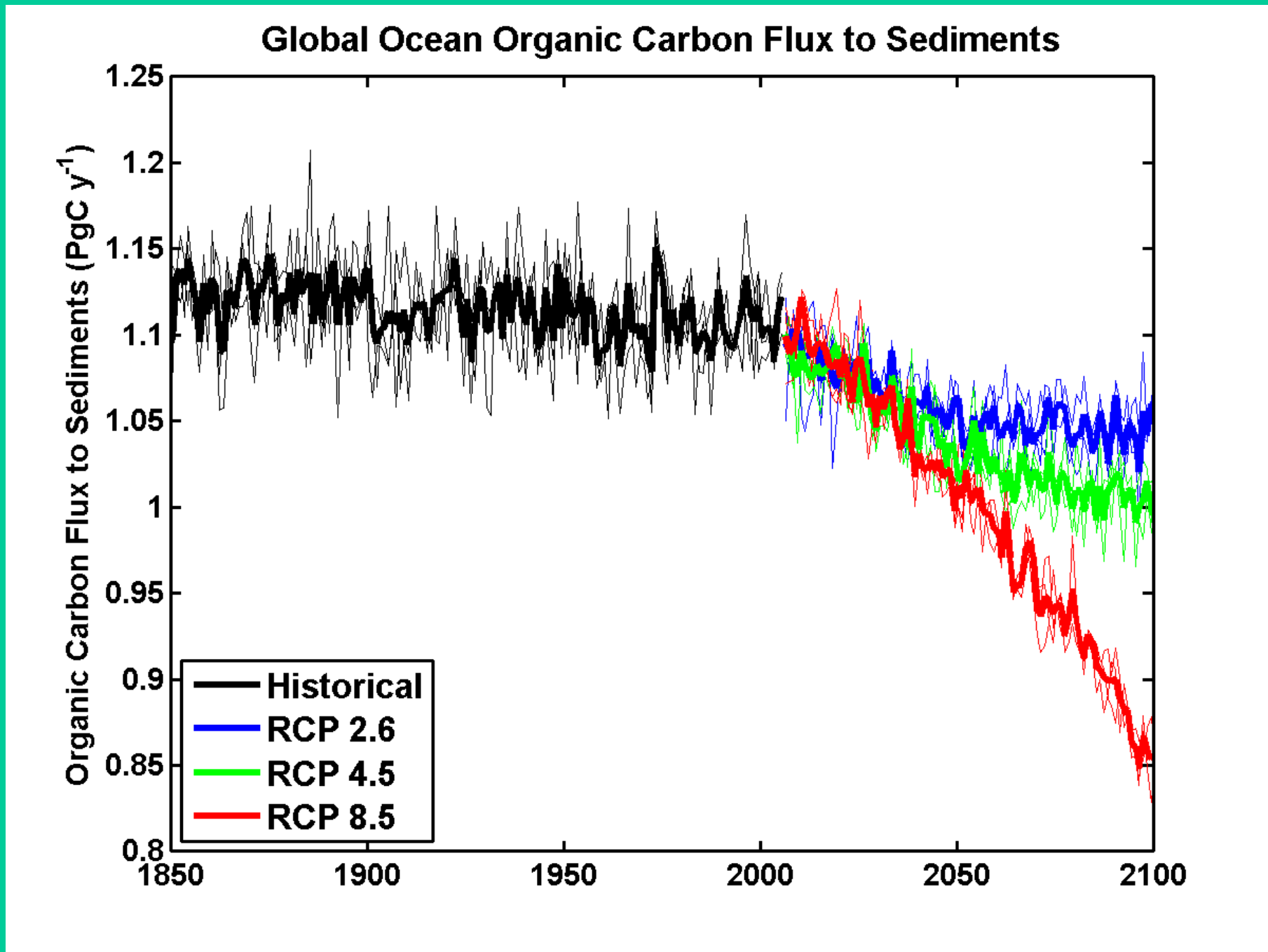




Subarctic seas dominate global flux of carbon to benthos




30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Organic flux to sediments JJA (mol C m^{-2} y^{-1})


Global Ocean Organic Carbon Flux to Sediments
Organic Carbon Flux to Sediments (PgC y-1)
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
1850
1900
1950
2000
2050
2100
Historical
RCP 2.6
RCP 4.5
RCP 8.5

Take home messages

- anthropogenic impact has existed throughout the modern era of ocean observation

- northern high latitude ocean is especially vulnerable to acidification due to freshwater inputs; carbonate mineral undersaturation occurs at higher pH than elsewhere

- area of aragonite undersaturation within top 200 m is projected to increase by 30 million to 150 million km^2, much of it in the northern high latitudes

- subarctic seas are regions of high organic carbon flux and deposition to benthos, which will likely decline especially under higher CO_2 scenarios