NATURAL ENVIRONMENT RESEARCH COUNCIL

National Oceanography Centre
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ROAM – European Shelf and Arctic modelling

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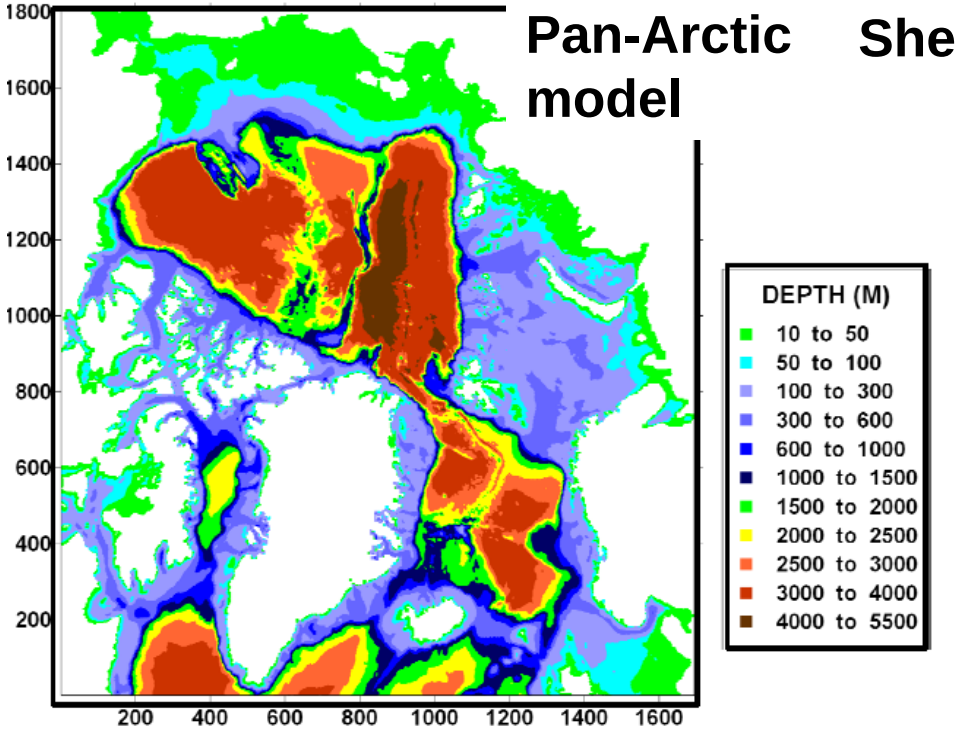
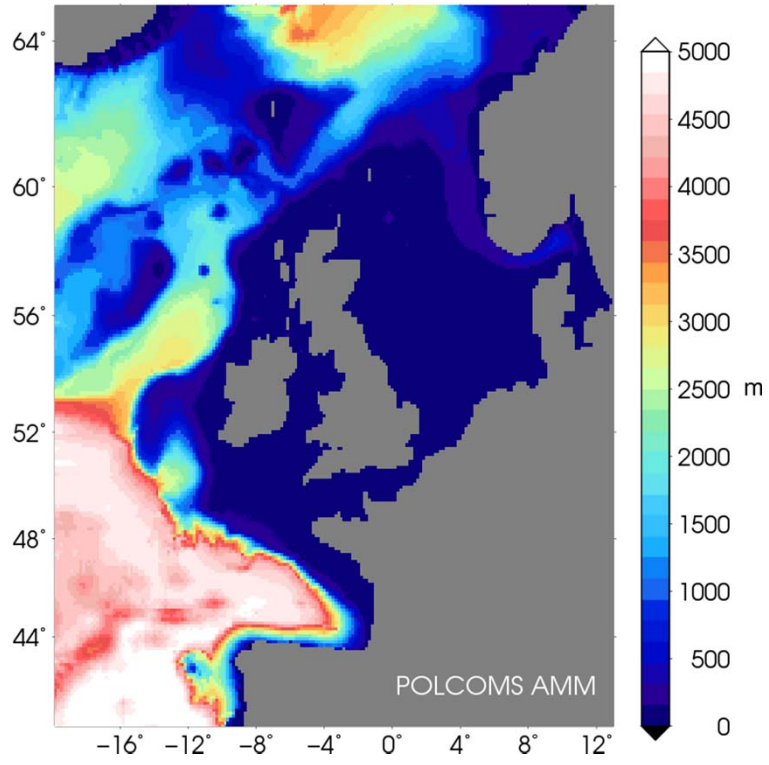
Introduction

- Hydrodynamic modelling using NEMO-shelf
  - 7km and 3.5km Arctic regional model
  - 7km NW European Shelf model
- Coupling to ERSEM (NWES) and MEDUSA (NWES, Arctic)

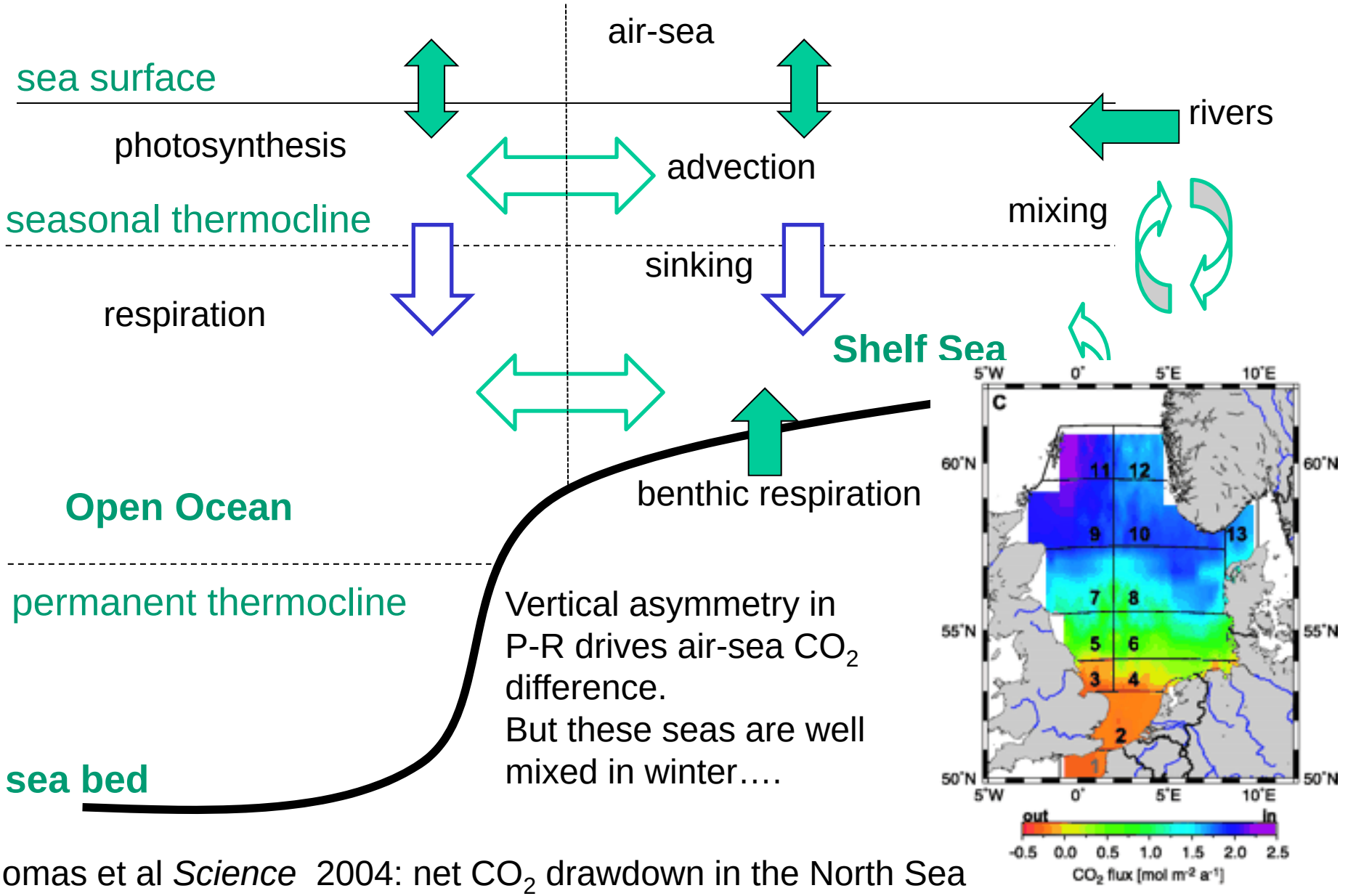
Pan-Arctic model



NW European Shelf model

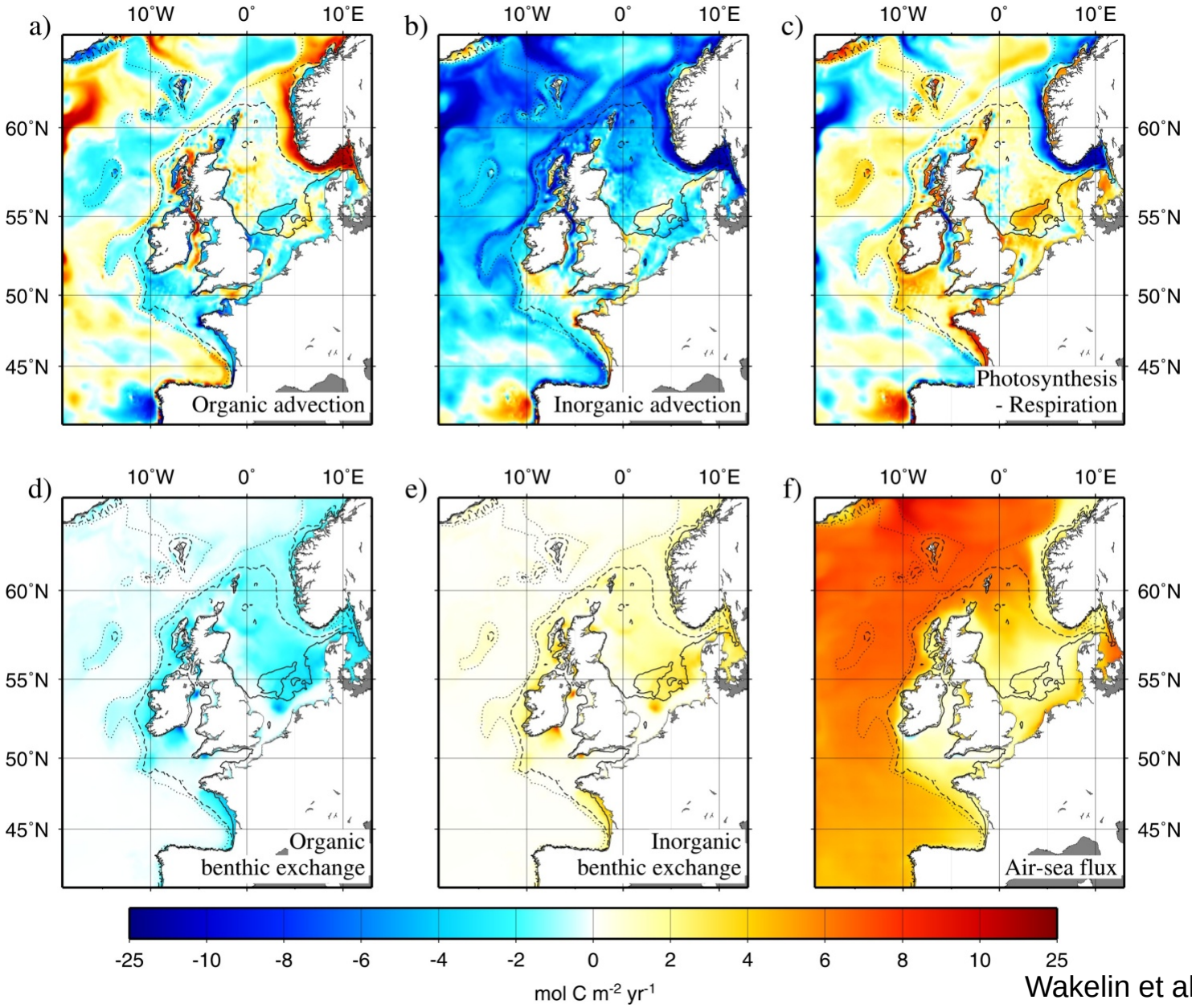


The shelf-sea carbon pump



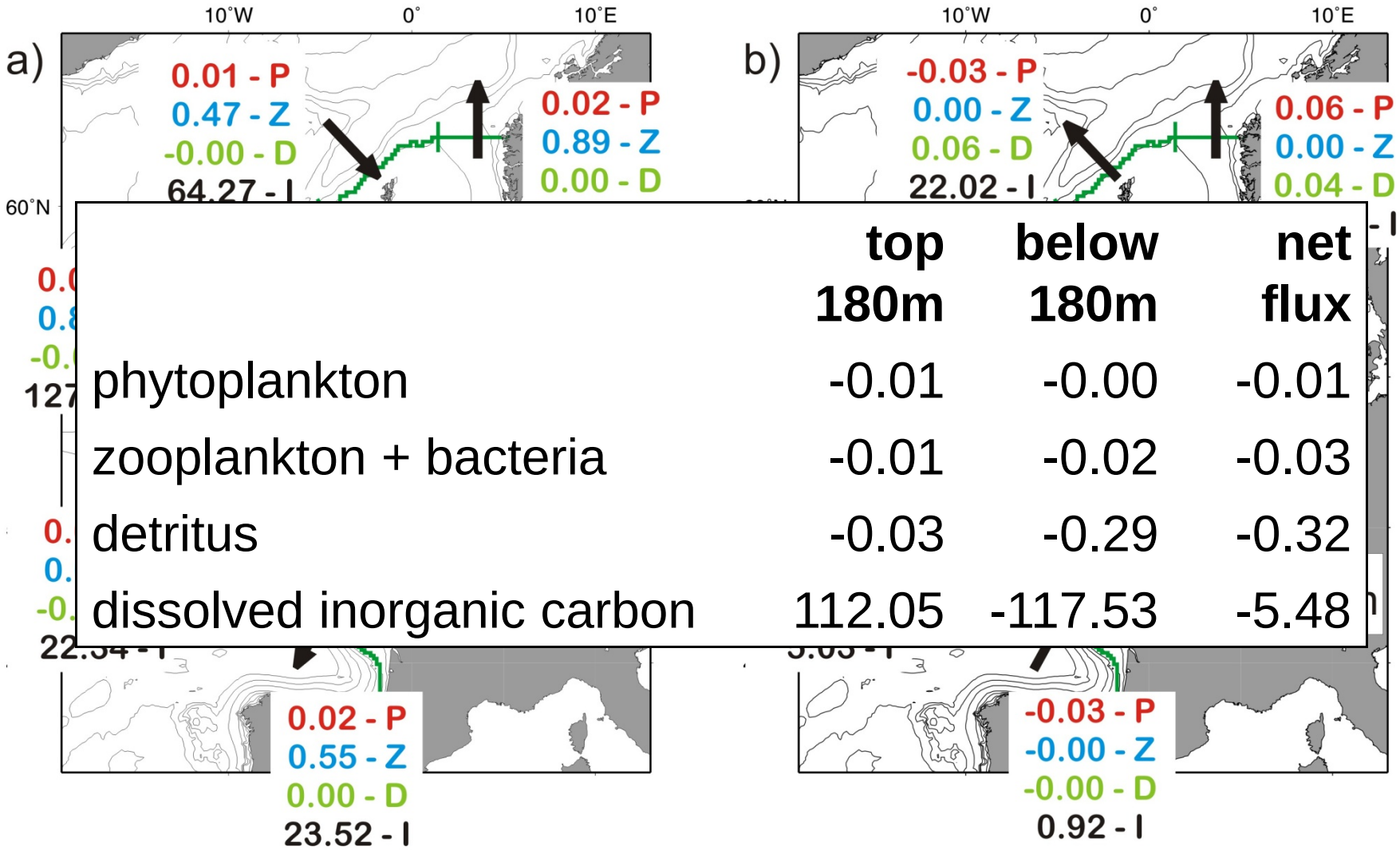
Thomas et al *Science* 2004: net CO_2 drawdown in the North Sea

Carbon budget terms (1989-2004)



Wakelin et al. JGR, in press

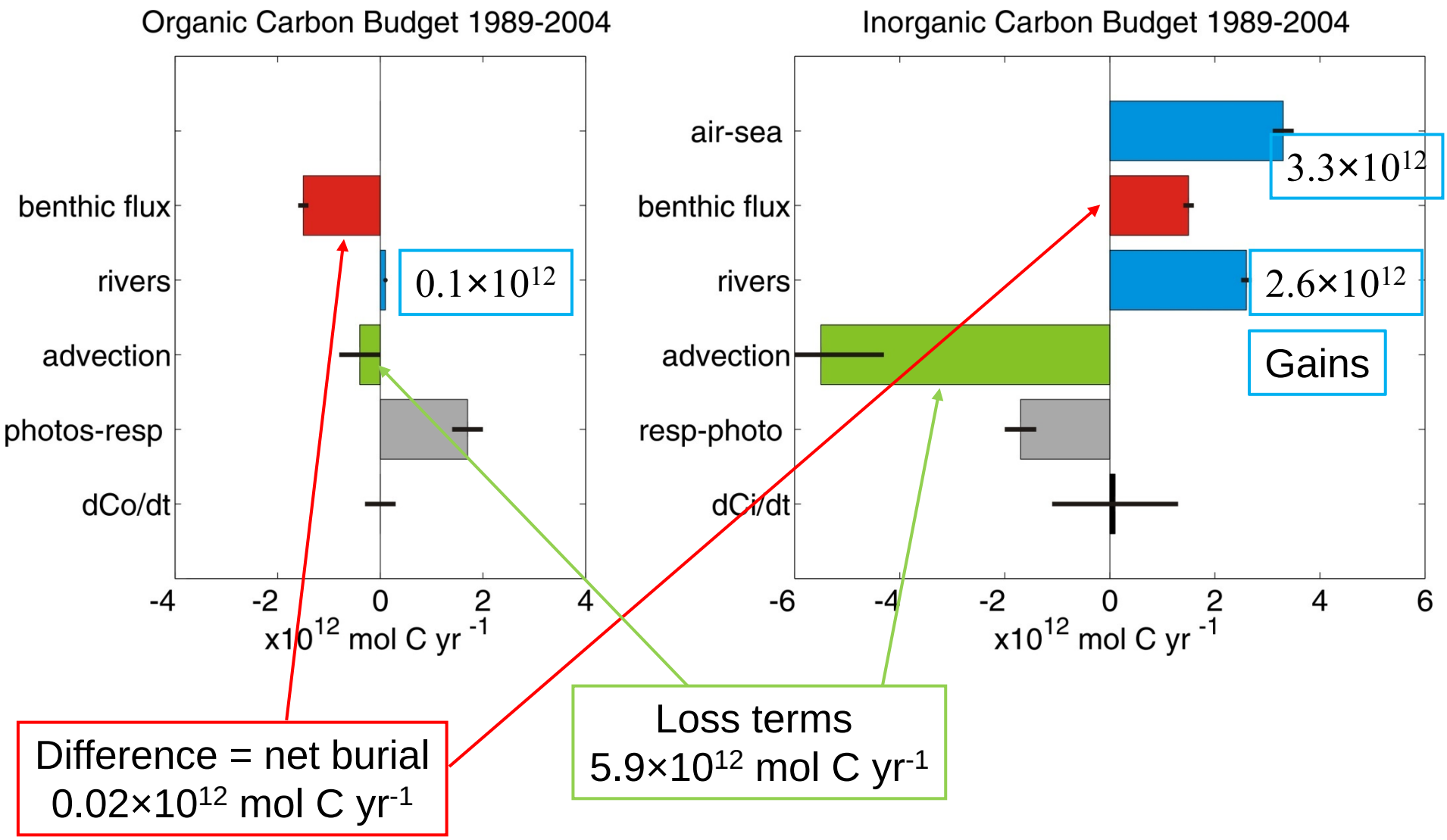
Ocean-shelf carbon exchange ($\times 10^{12}$ mol C yr^{-1}) 1989-2004



	top 180m	below 180m	net flux
phytoplankton	-0.01	-0.00	-0.01
zooplankton + bacteria	-0.01	-0.02	-0.03
detritus	-0.03	-0.29	-0.32
dissolved inorganic carbon	112.05	-117.53	-5.48

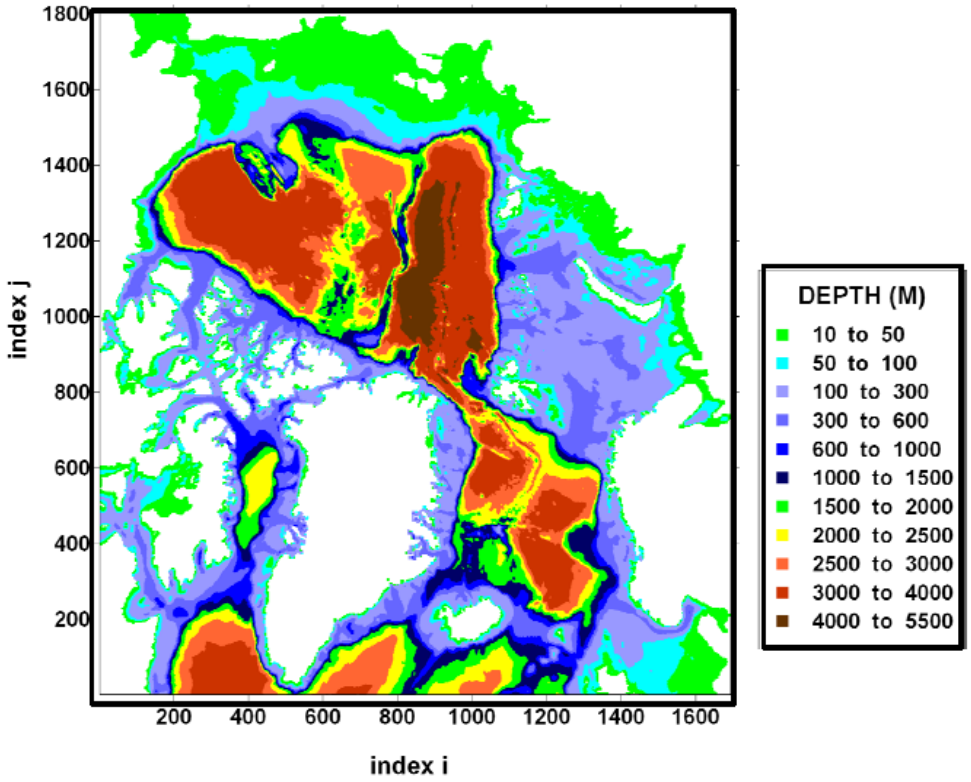
Carbon transport across the 200m isobath for **P** - total phytoplankton, **Z** - total zooplankton + bacteria, **D** - detritus and **I** - dissolved inorganic carbon (DIC)

Shelf-wide carbon budget (1989–2004)



NOC(L) NEMO-shelf pan-Arctic Ocean model

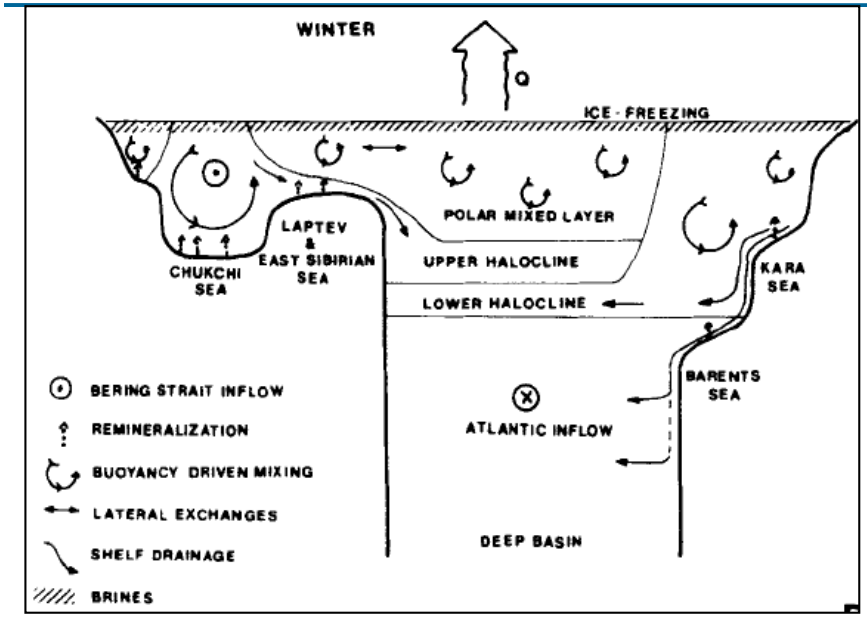
- **50% of basin is shallower than 500m**
- **steep slope breaks and ridges**
- **strong tides on the shelf**
- **shelf convection (cascading) is extremely important for carbon storage and should be resolved /parameterised**



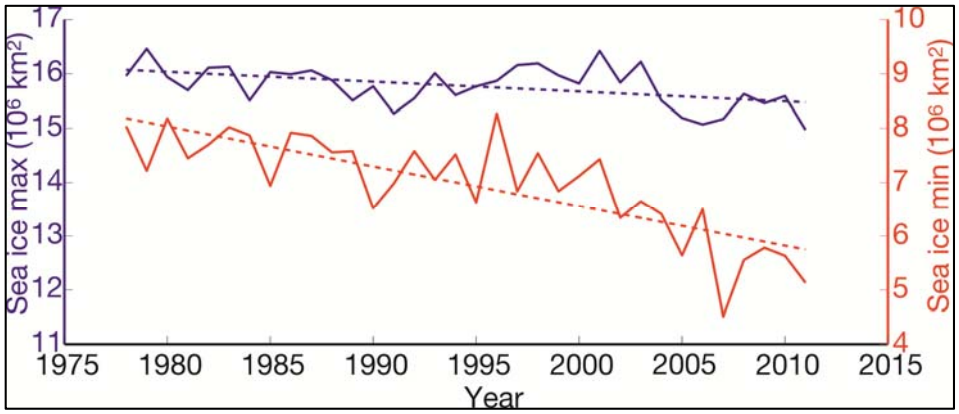
NEMO with focus on shelf seas = NEMO-SHELF
Horizontal resolution : 1/32^{o} & 1/16^{o} (~ 3.5km & 7km) in the rotated coordinates system and 1/6^{o} (~18km) as a test domain

Task : to resolve long fast waves, bottom boundary layer, tides, eddies, river mouth … with low background vertical and horizontal diffusivity

Motivation: cascades – carbon feedback?



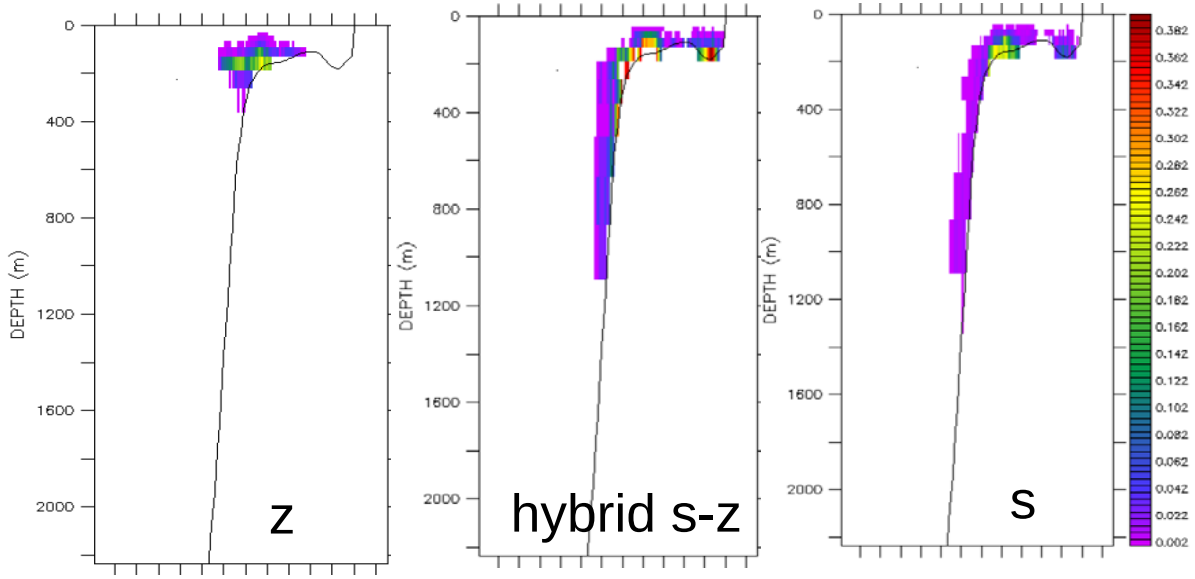
Cascading is an efficient way of removing nutrients and dissolved gases from the surface ocean to the deep (Rudels et al, 1991).

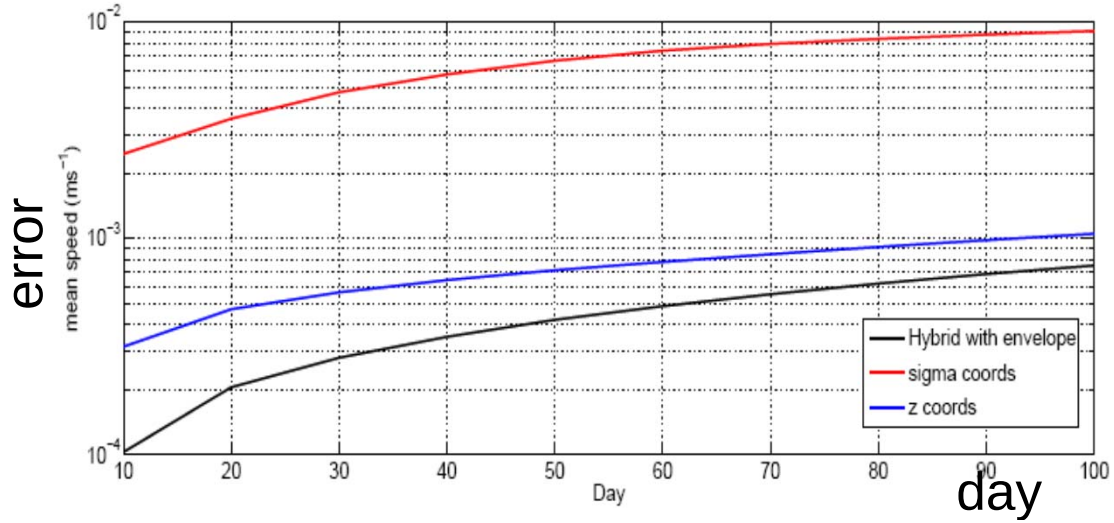


Observed changes in sea ice min and max

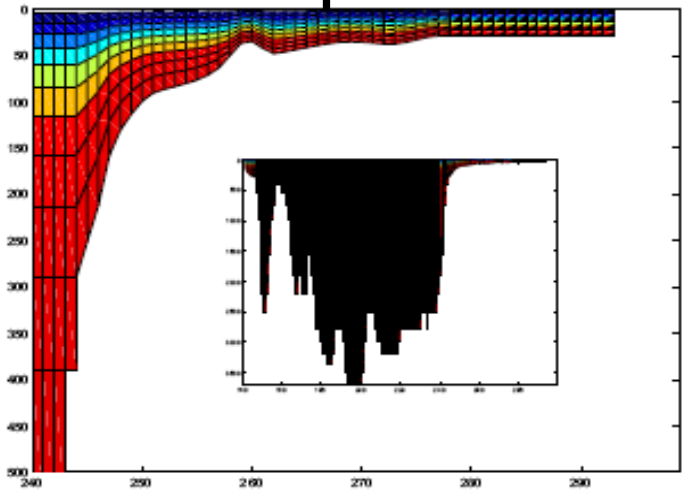
New vertical coordinates: s-z hybrid with enveloping topography

Model tests to find optimal depth of sigma layer in order to resolve cascading



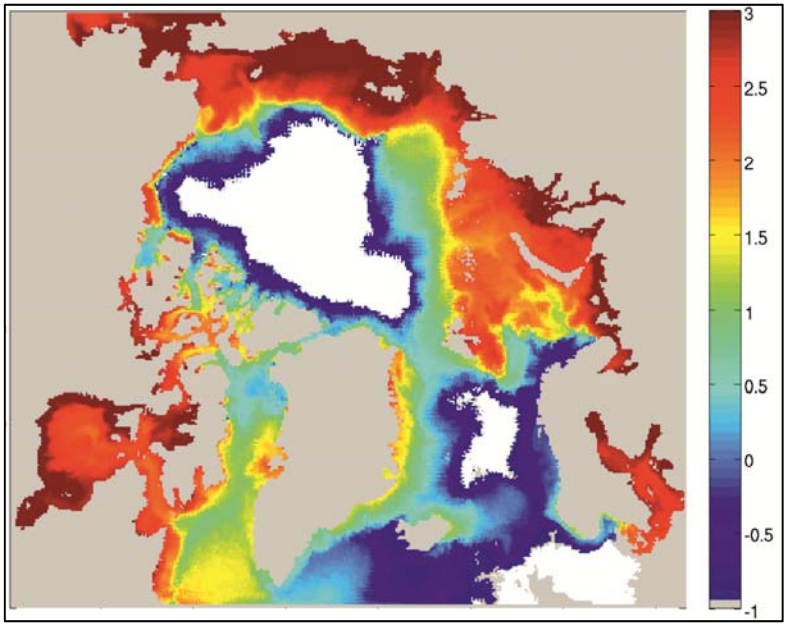


s-z hybrid coordinates with envelop

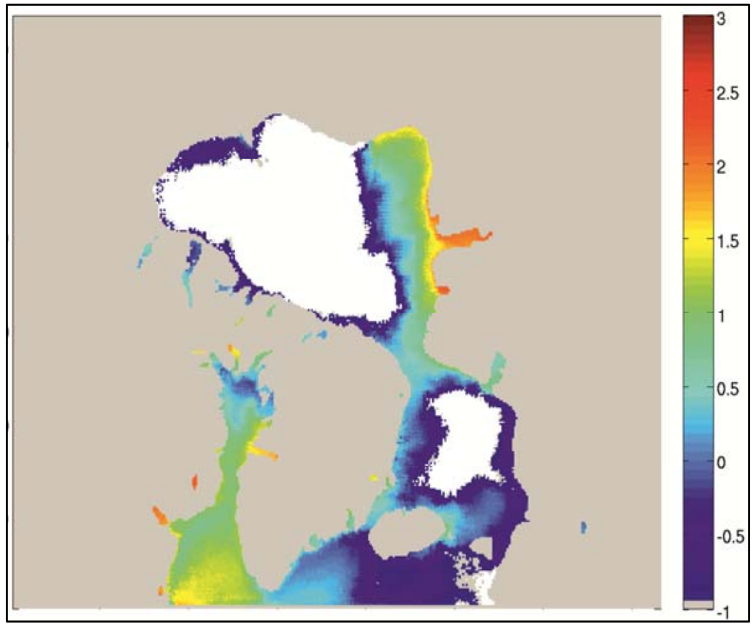


Brine rejection tracer introduced to the model

Passive tracer tracking the salt added to the ocean when sea ice forms

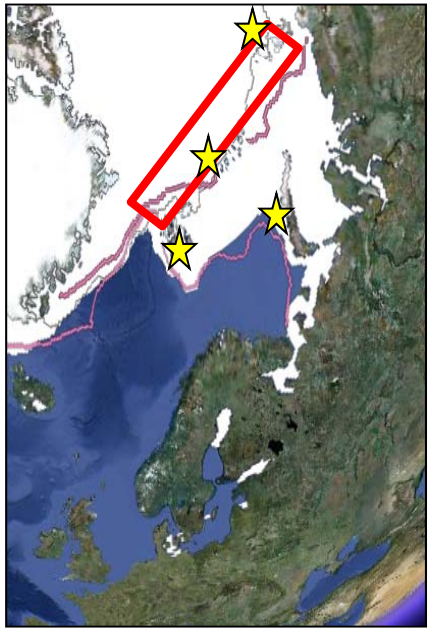


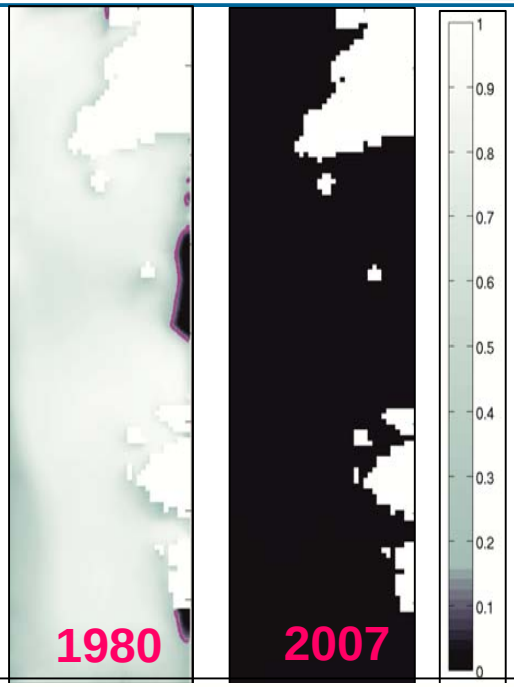
Brine tracer concentration on the surface due to ice formation

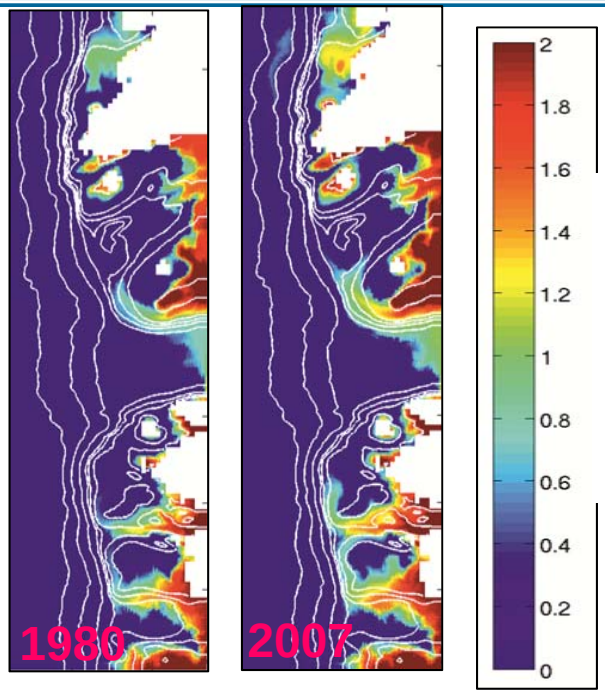


Brine concentration at 300m due to cascading

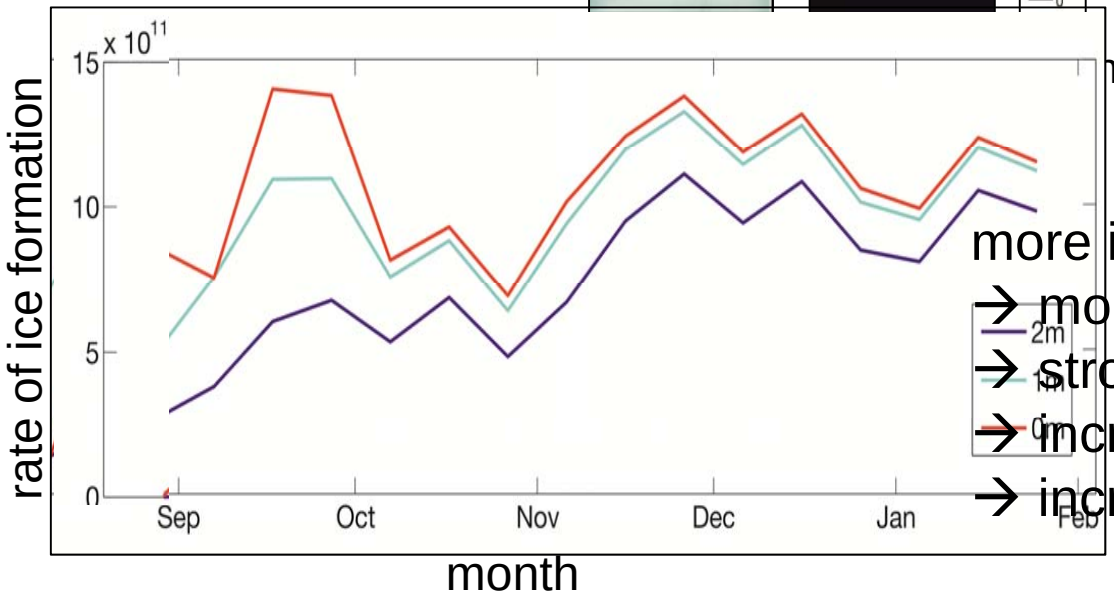
The changing Arctic







Concentration of brine tracer at the bottom layer



more ice free shelf in summer
→ more ice formation in winter
→ stronger cascading
→ increase in transport of brine
→ increase in transport of carbon ?

Conclusions and next steps

- **NW European Shelf**

  a sink for atmospheric CO_2 – shelf edge regions tend to be strong sinks

Next steps:

- *coupled NEMO-ERSEM hindcasts*
- *comparisons with NEMO-MEDUSA*

- **Arctic regional model**

  warming → more seasonal sea ice → more brine exported to the deep ocean

Next steps:

- *NEMO-MEDUSA experiments*
  - *explore further the carbon feedback hypothesis*
  - *study the effects of tides on ecosystem*