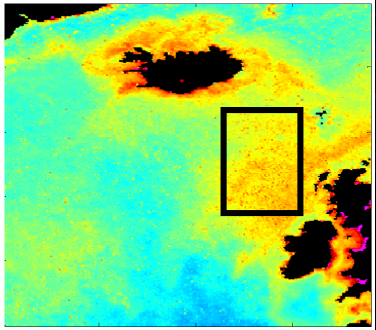
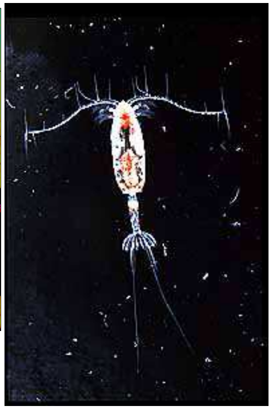




NACLIM

Labrador Sea convection blows life to the Northeastern Atlantic

Work in progress

Hjálmar Hátún, Katja Lohmann and others

Keywords:
Ocean-shelf exchange, sub-decadal variability, predictability, altimetry metric, *Calanus finmarchicus*

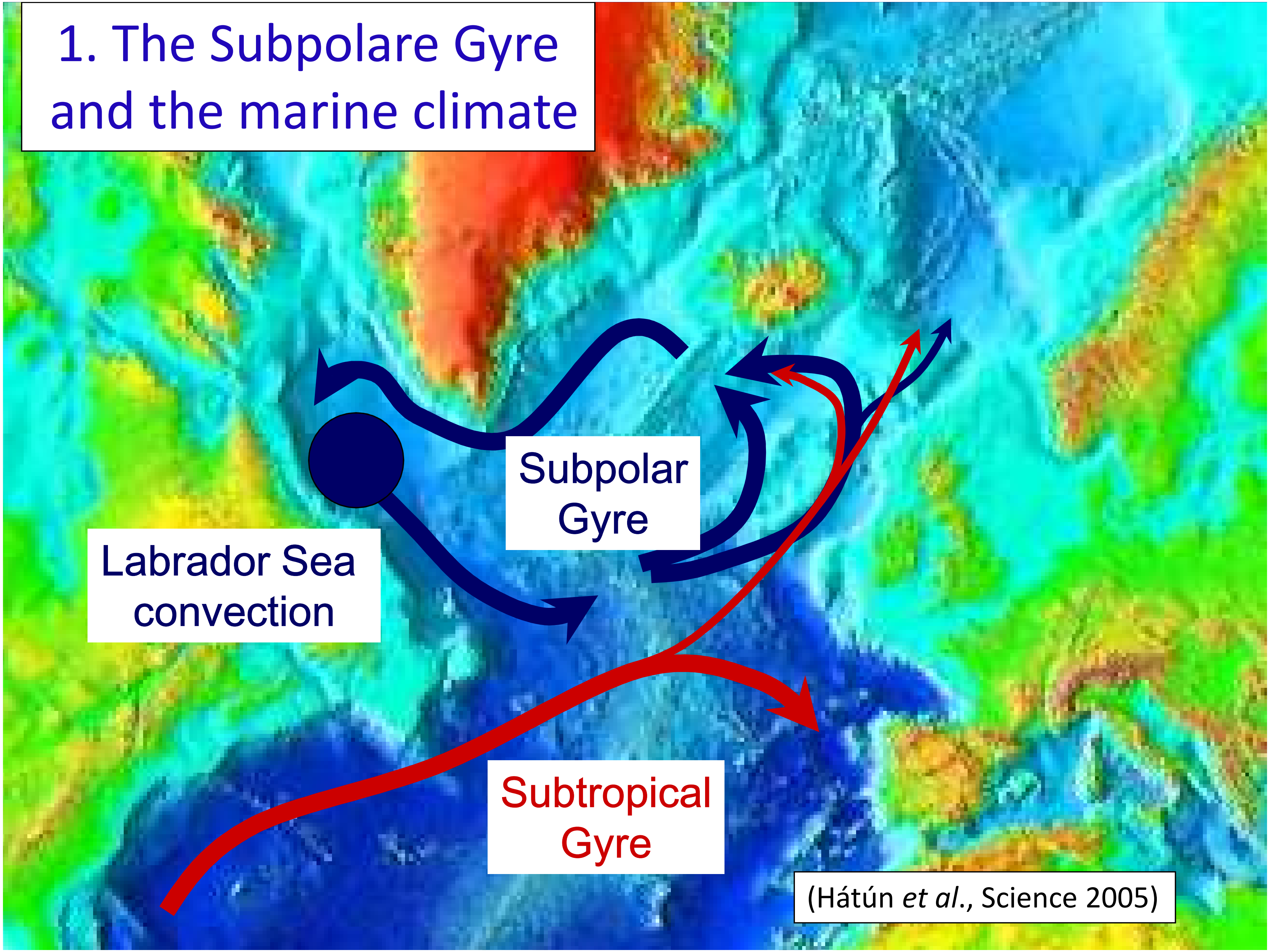
HAVSTOVAN
FAROE MARINE RESEARCH INSTITUTE

Max-Planck-Institut für Meteorologie

Outline

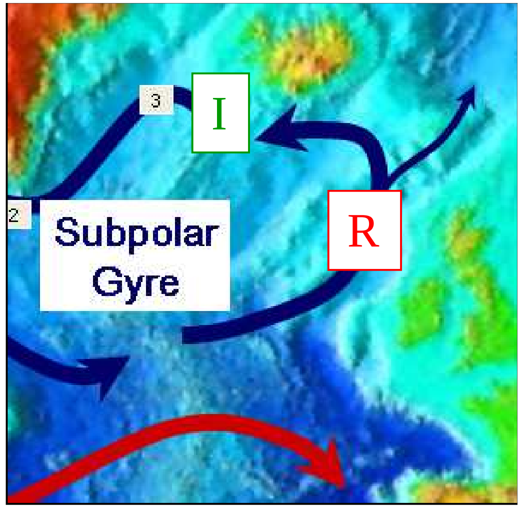
1. The subpolar gyre epicenter - a main food source
2. Mixed Layer Depth (MLD) a critical parameter
3. Remote driver → advection → predictability
4. Altimetry, a useful metric

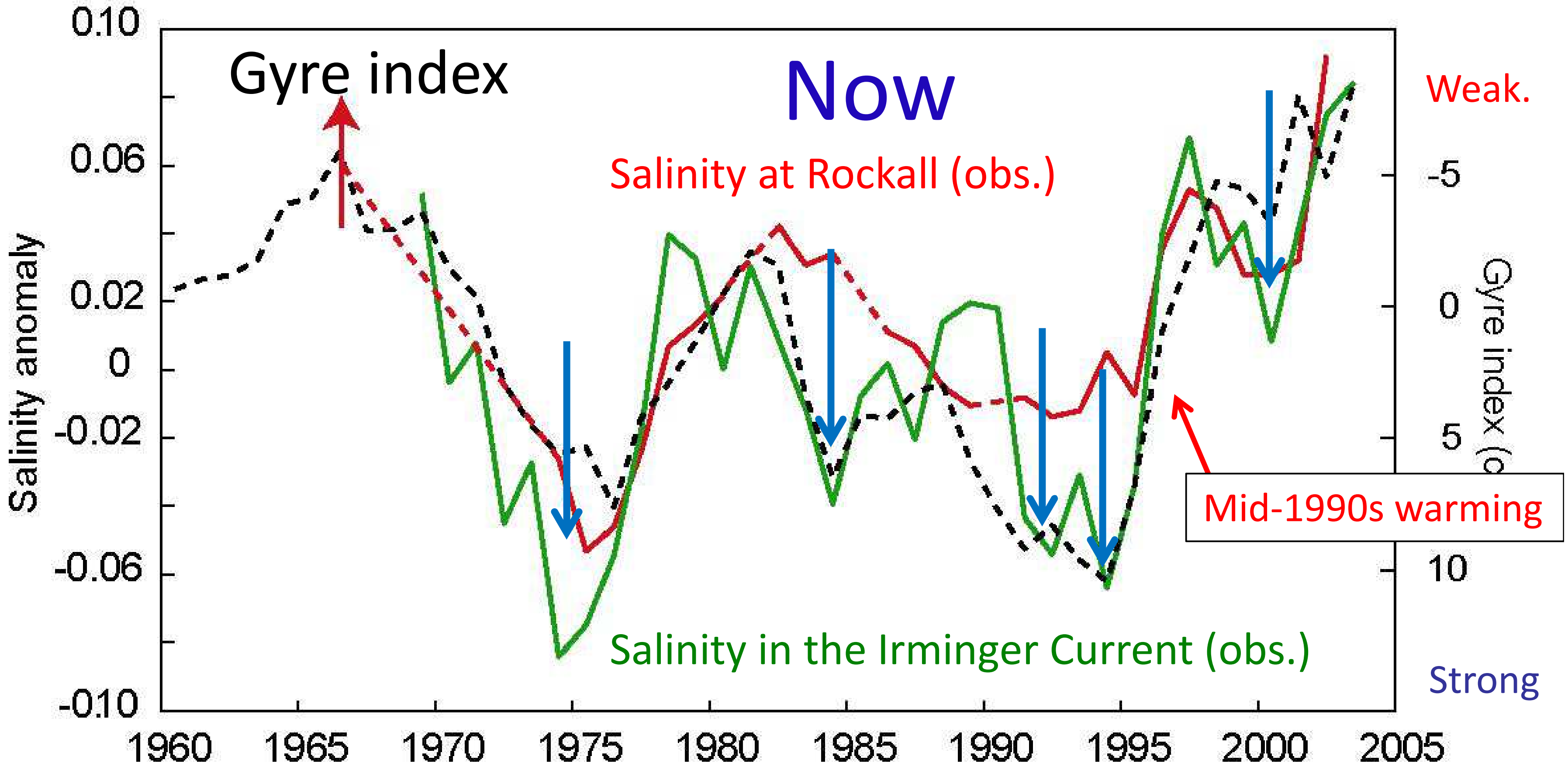
1. The Subpolare Gyre and the marine climate



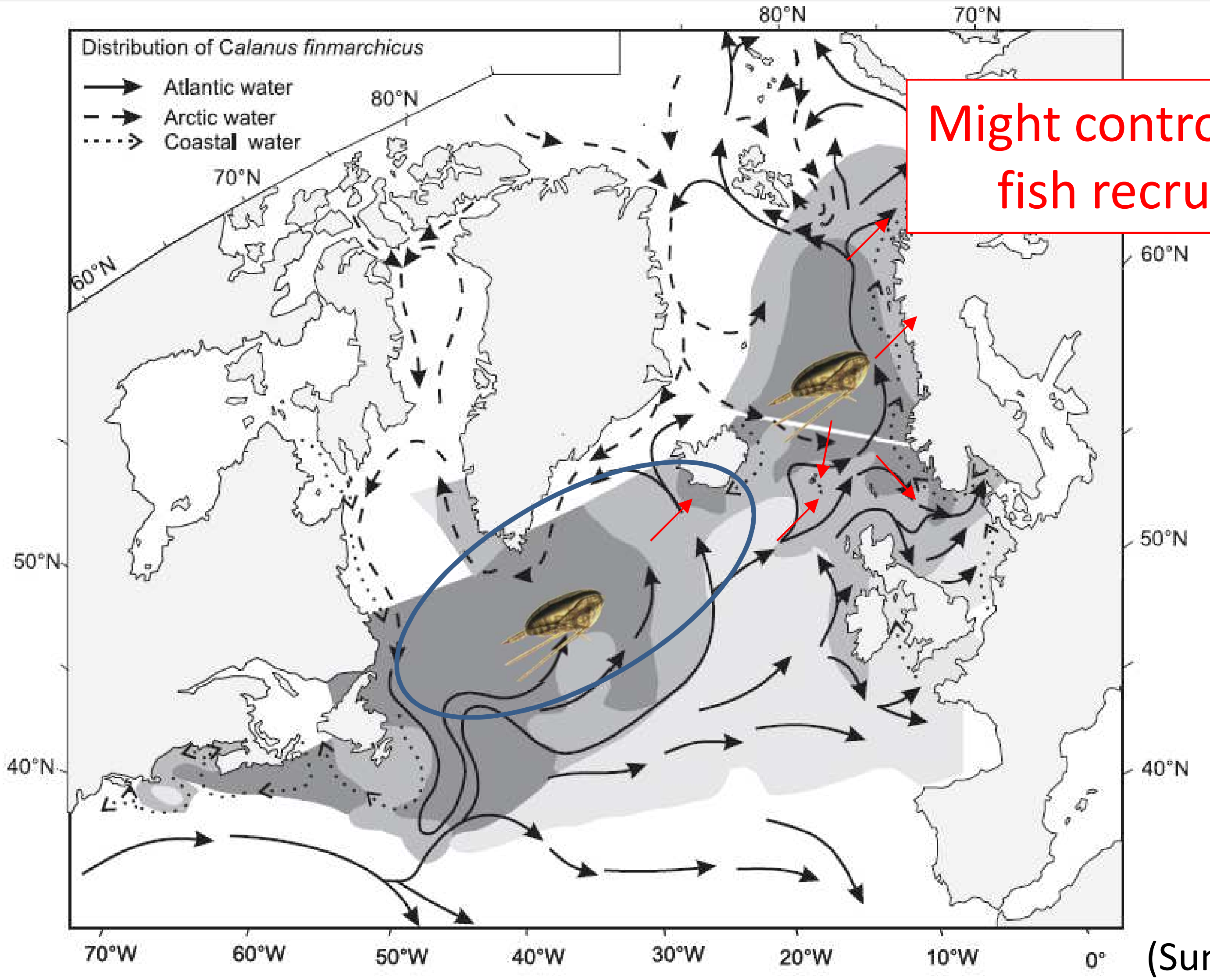
(Hátún *et al.*, Science 2005)

1. The Subpolare Gyre and the marine climate





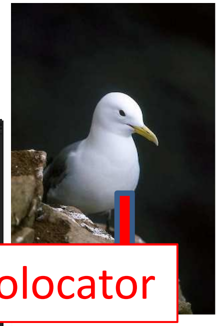
Zooplankton (*Calanus finmarchicus*) flushes from epicenters

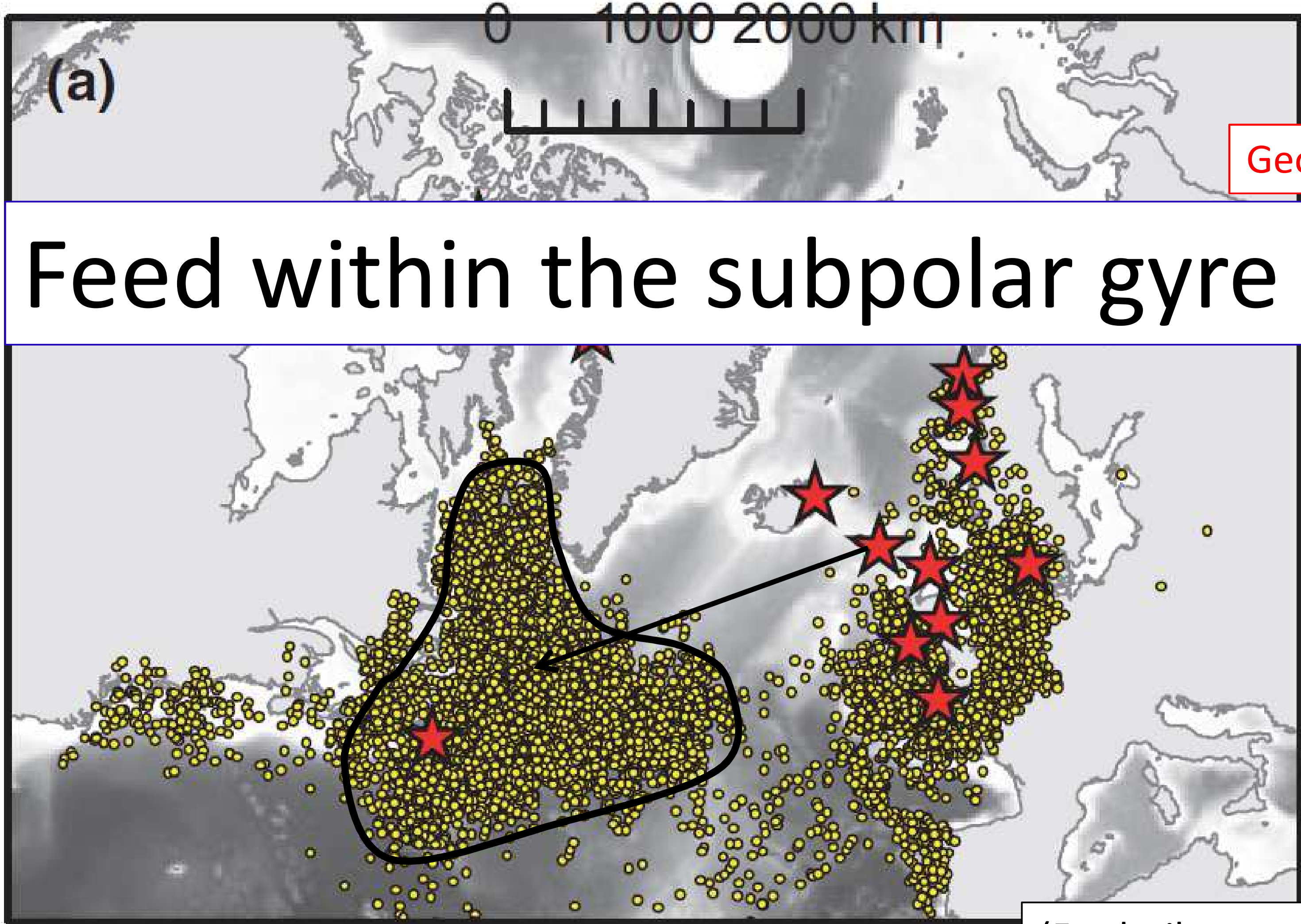


Might control on-shelf fish recruitment

(Sundby, 2000)

Winter migration of seabirds (kittiwakes)

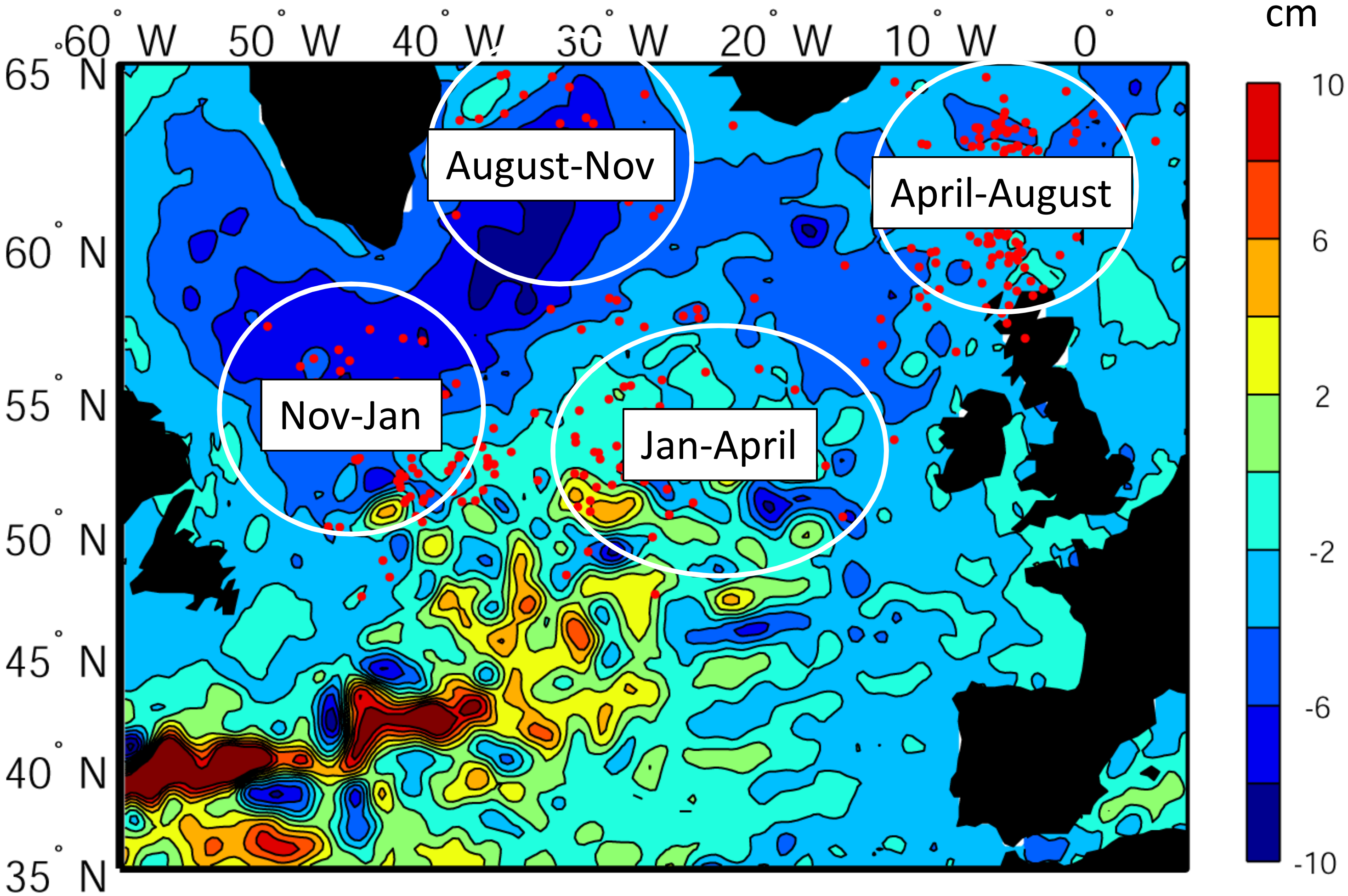




Feed within the subpolar gyre

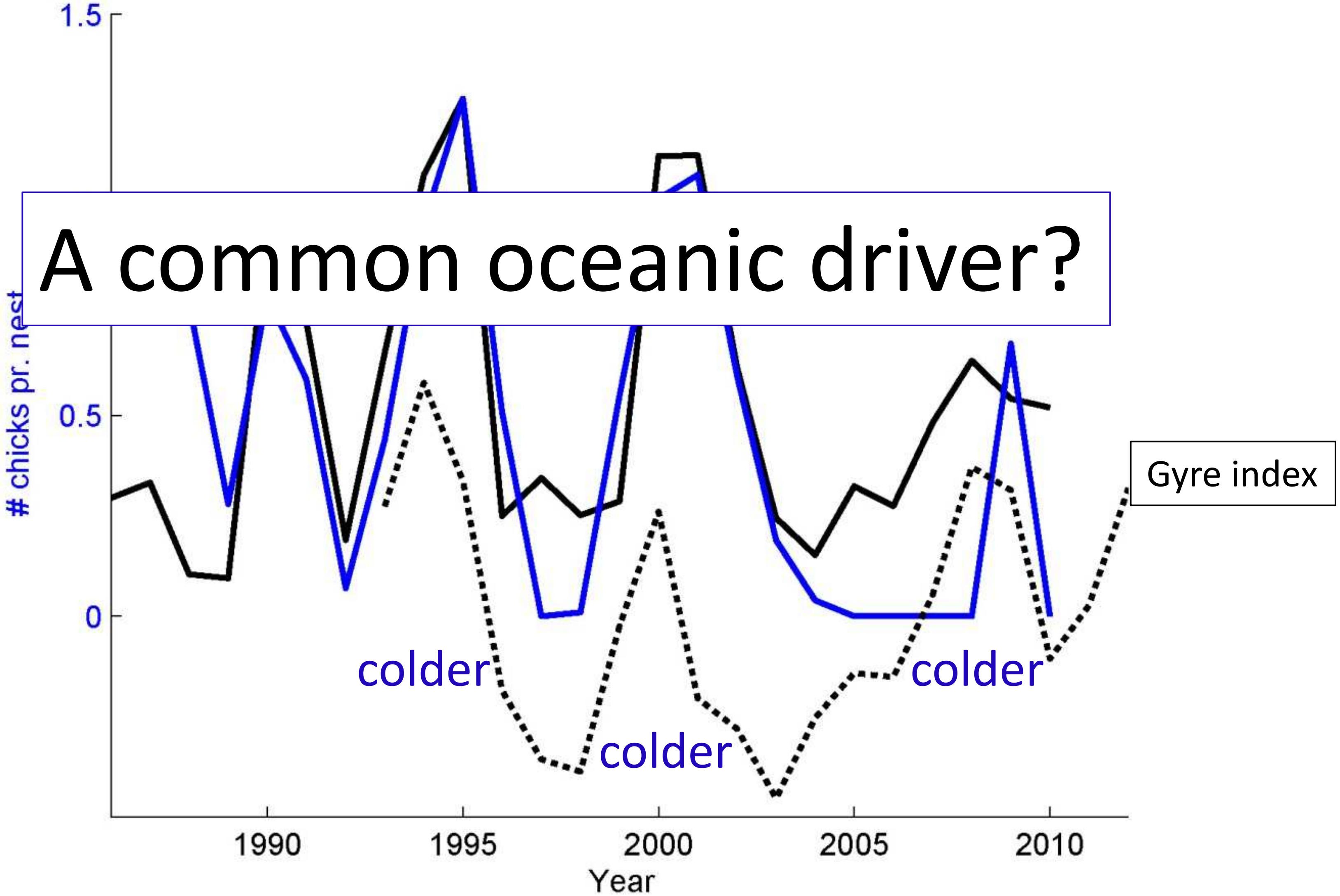
(Frederiksen, et al. 2011)

The *gyre mode* (SSH) and a kittiwake from the Faroes

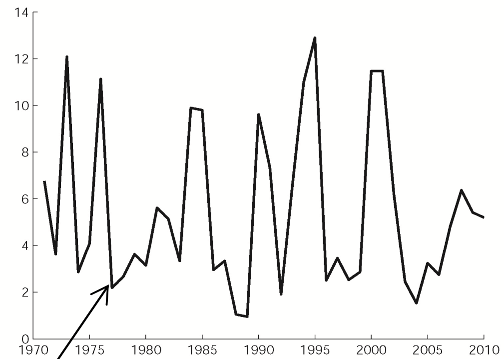


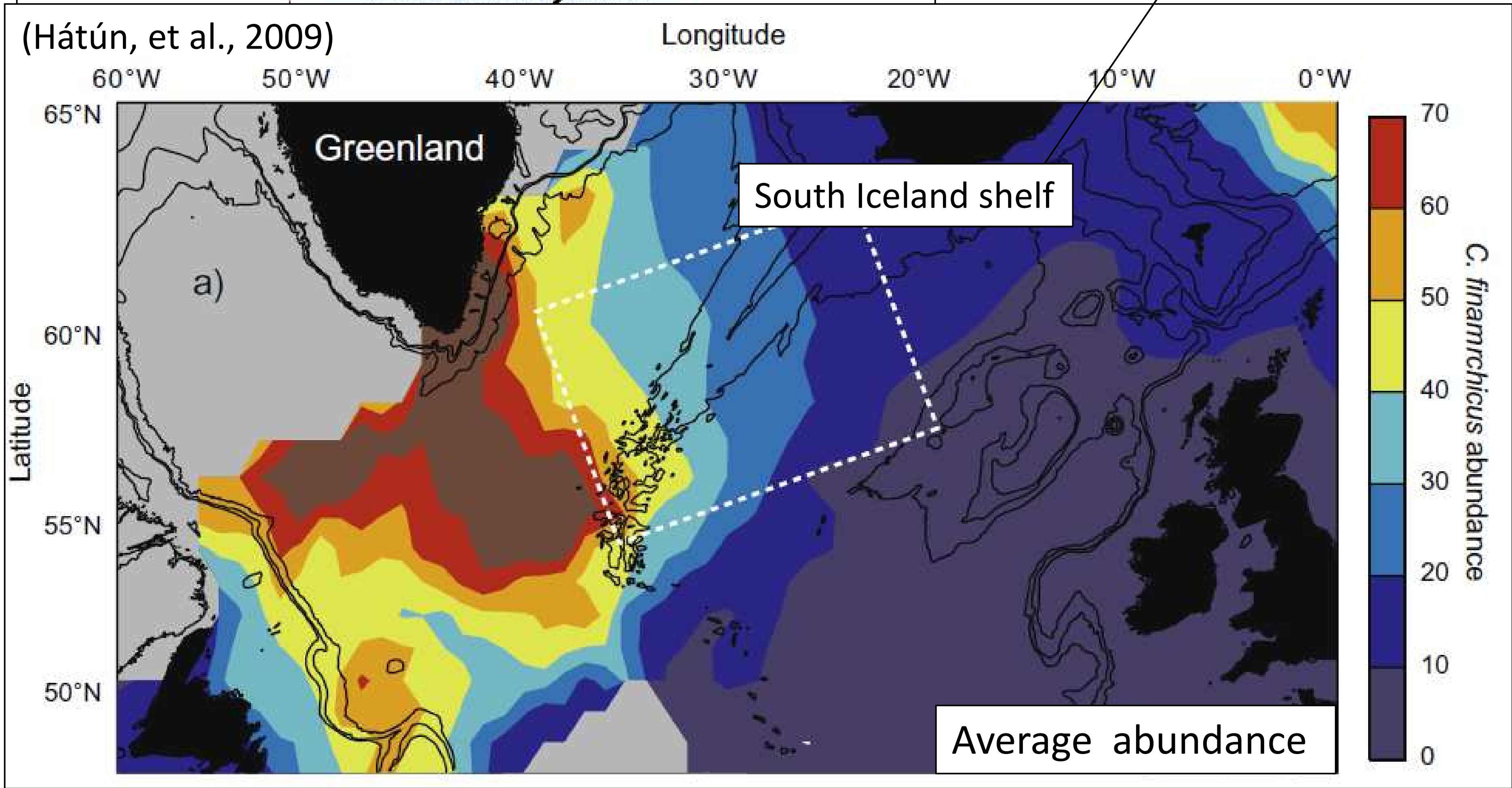
(June 2009 to July 2010)

De-trended gyre index, Iceland *Cal fin*  and Faroe kittiwakes 



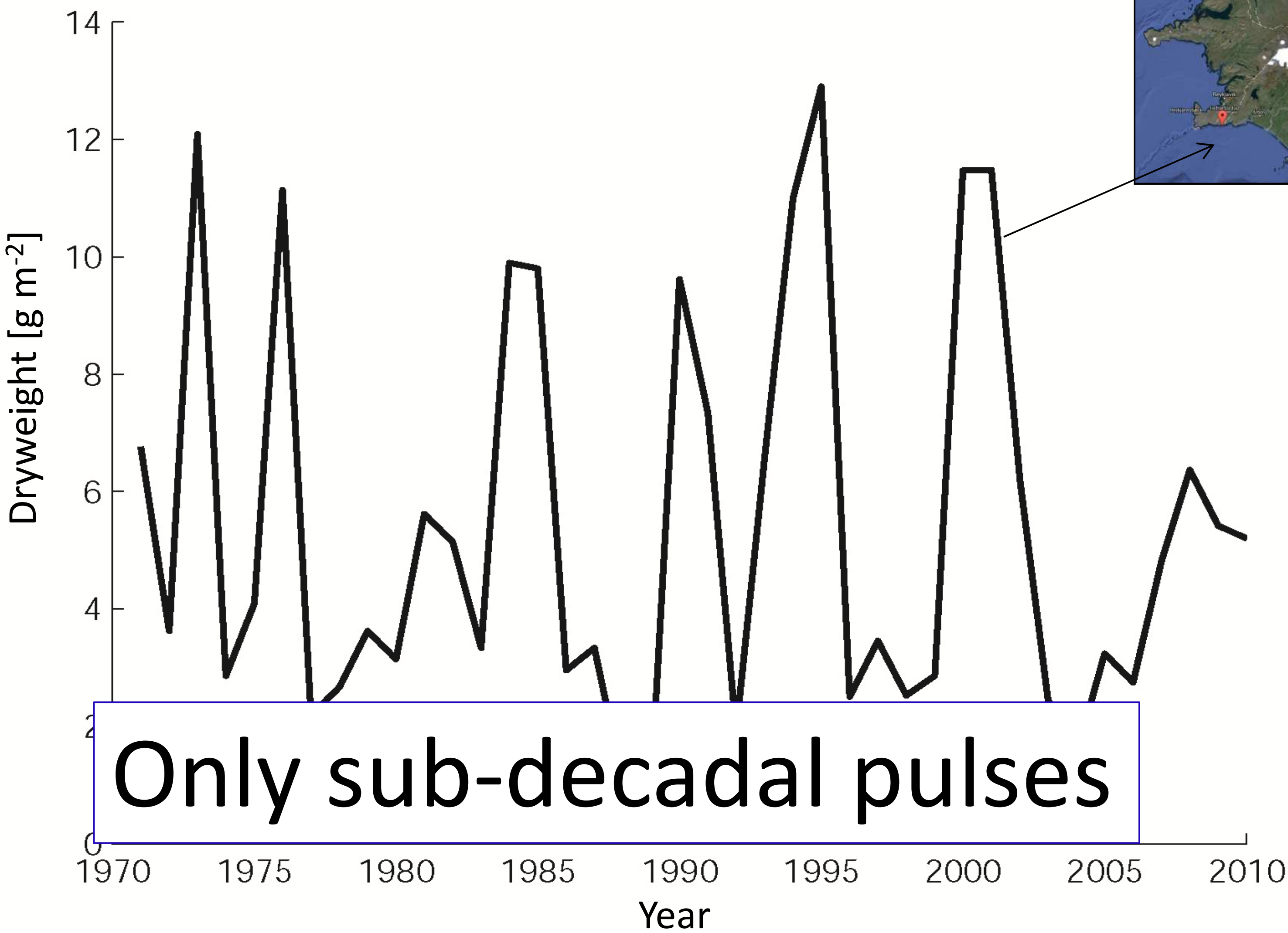
Continuous Plankton Recorder (CPR) (SAHFOS, Plymouth)





Zooplankton on the south Iceland shelf

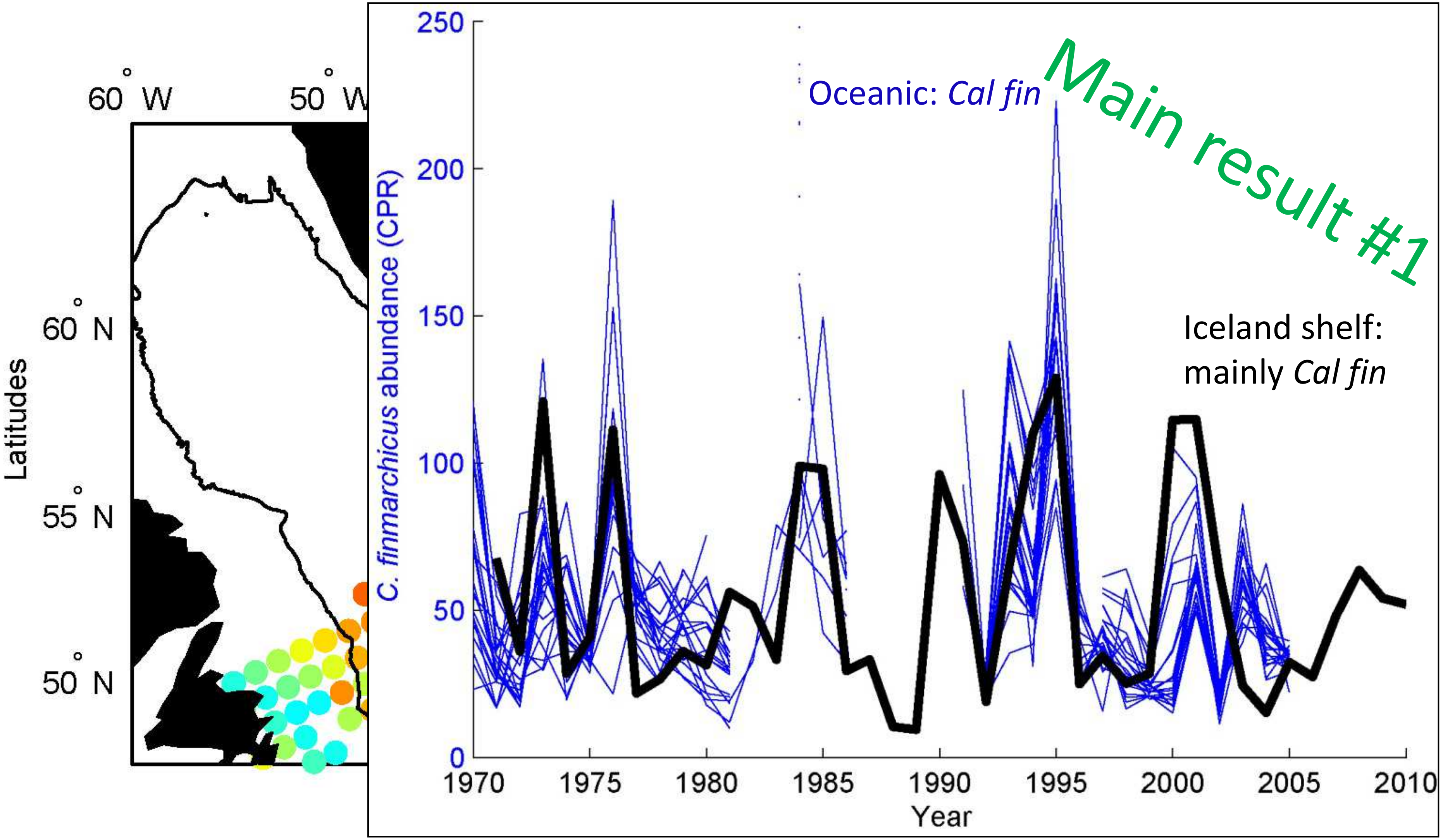
NB: Mainly *Calanus finmarchicus*

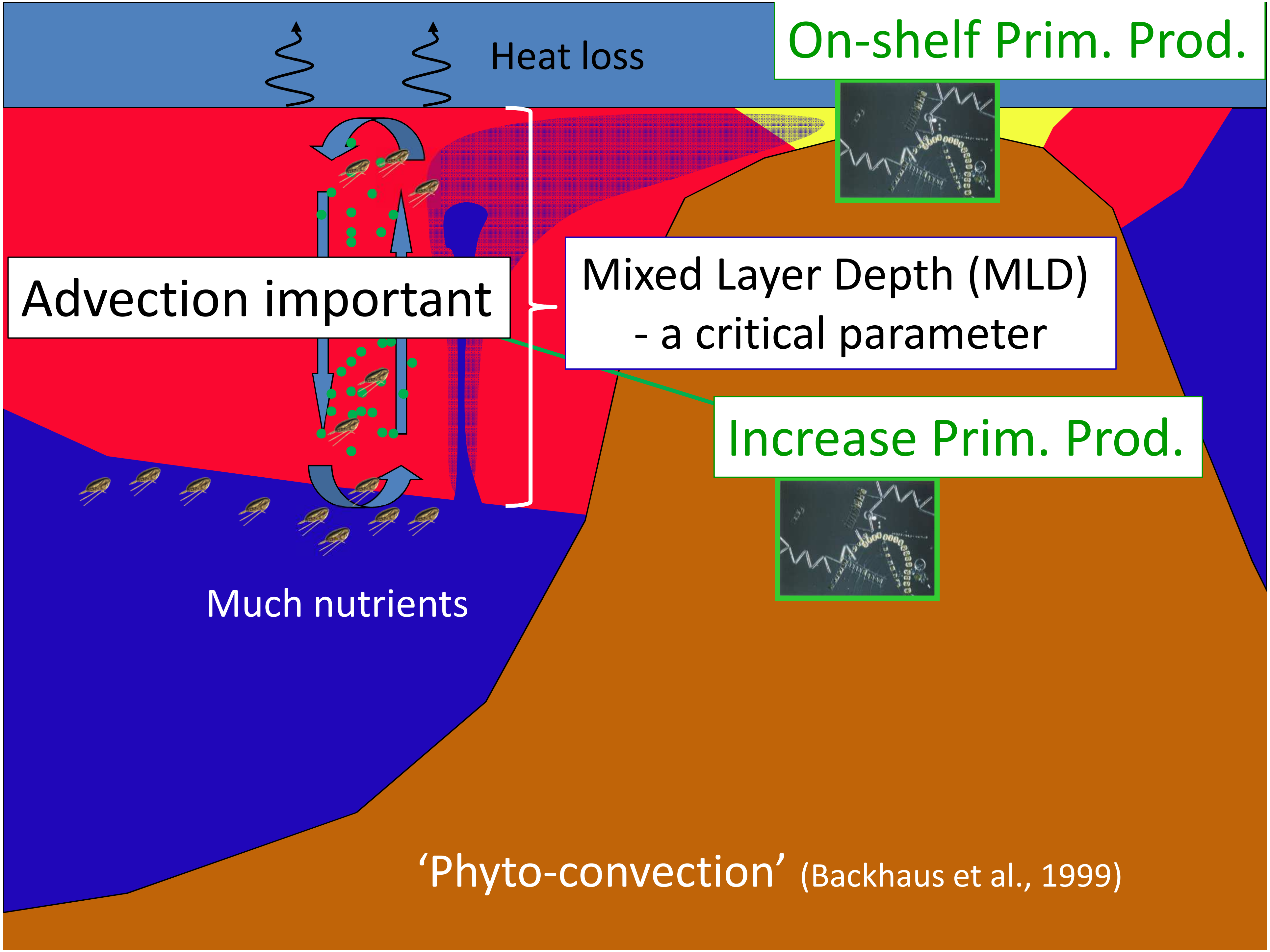


Only sub-decadal pulses

Shelf and oceanic zooplankton co-vary

Calanus finmarchicus (C5-C6)



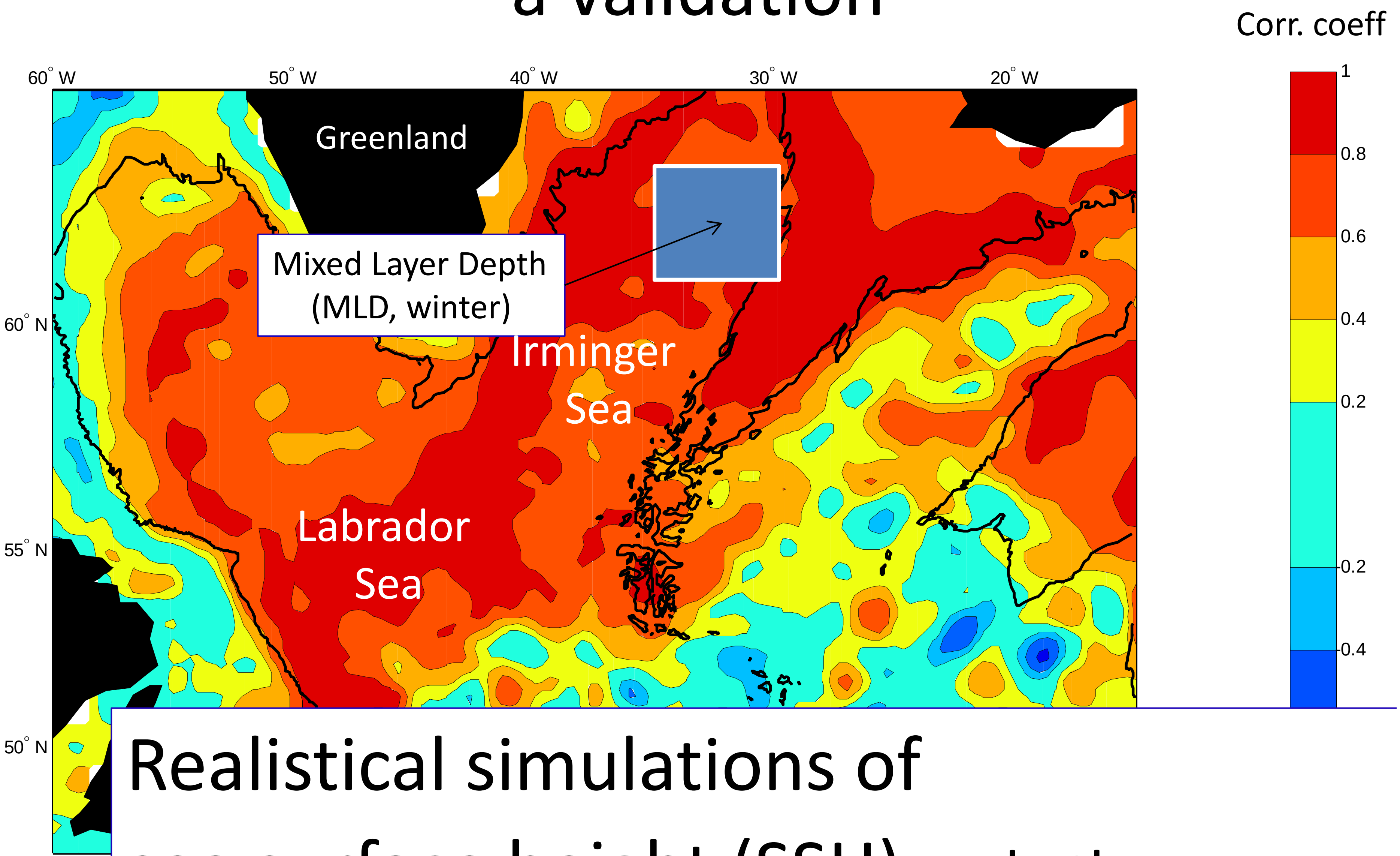


Heat loss
On-shelf Prim. Prod.
Advection important
Mixed Layer Depth (MLD)
- a critical parameter
Increase Prim. Prod.
Much nutrients
'Phyto-convection' (Backhaus et al., 1999)

MPI-OM

- **MPI ocean model forced with NCEP/NCAR reanalysis fields (1948 to 2010)**
- **Northern pole located over south Greenland**
- **Horizontal resolution of 15-25 km in the Irminger Sea**

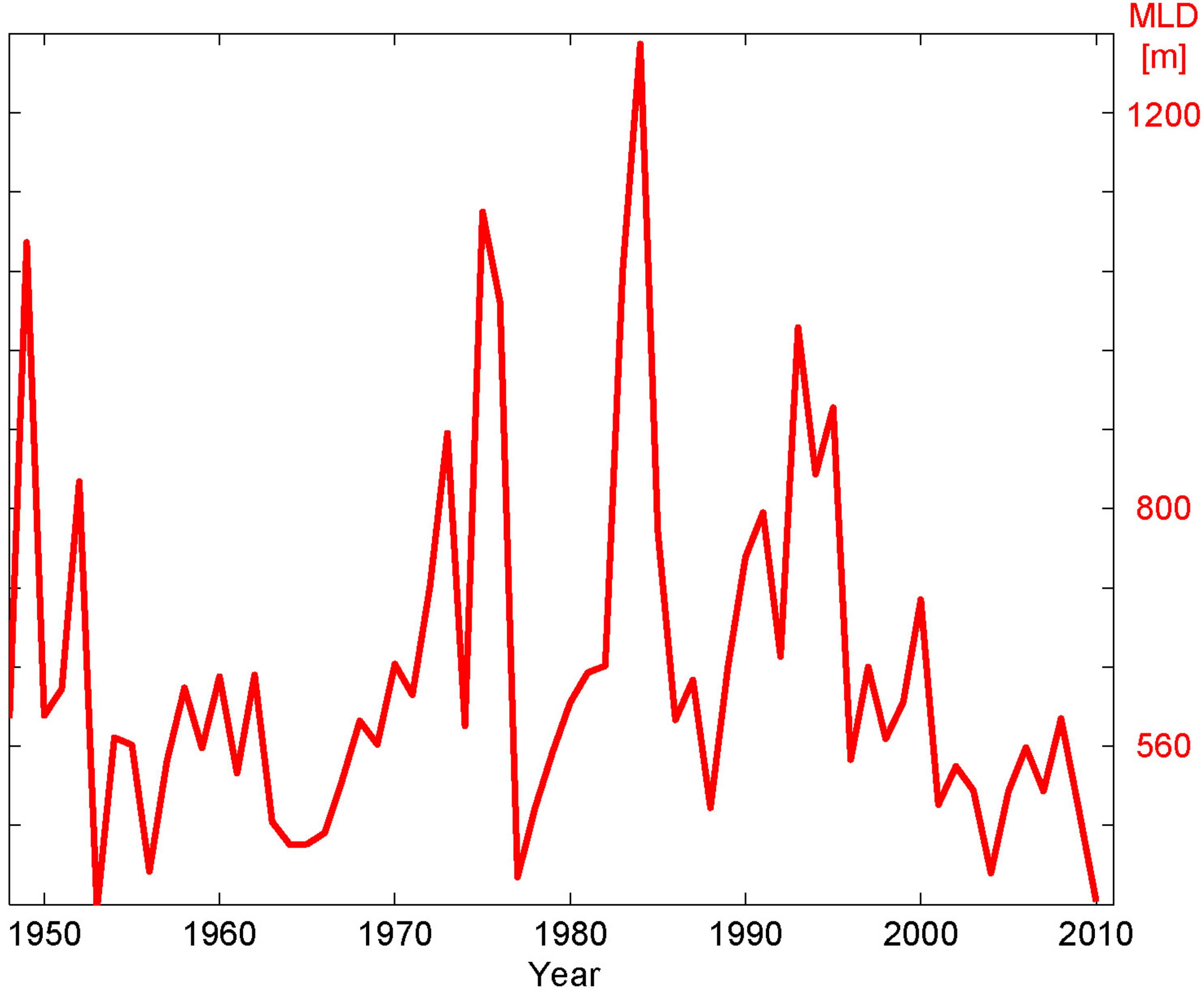
Altimetry and simulated SSH - a validation



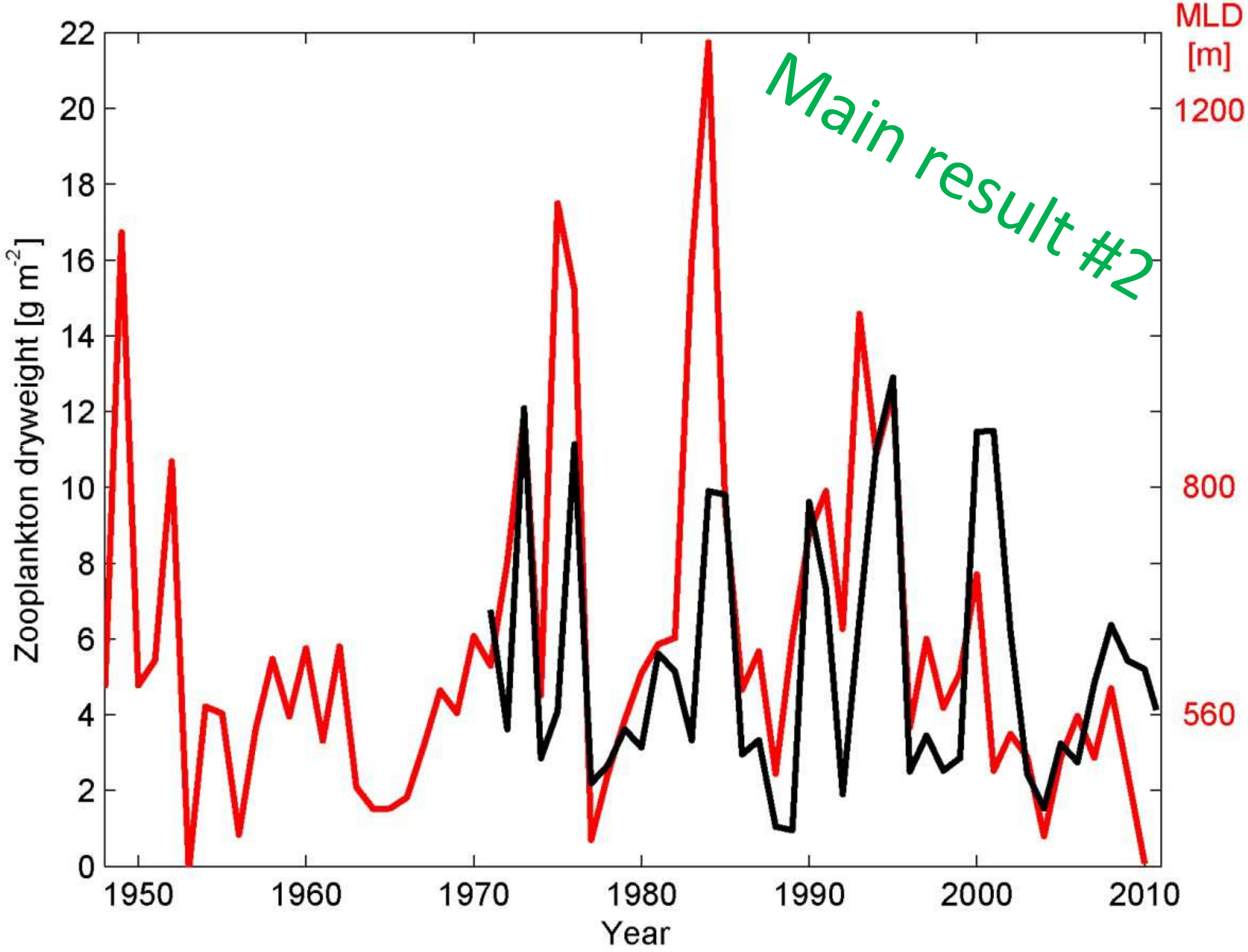
Realistical simulations of
sea surface height (SSH) and other param.

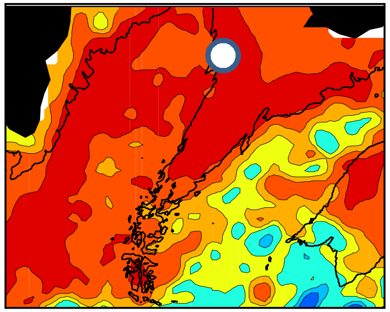
Simulated March MLDs

N. Irminger Sea (35-30°W, 61-63°N)



Simulated March MLDs and zooplankton on the south Iceland shelf

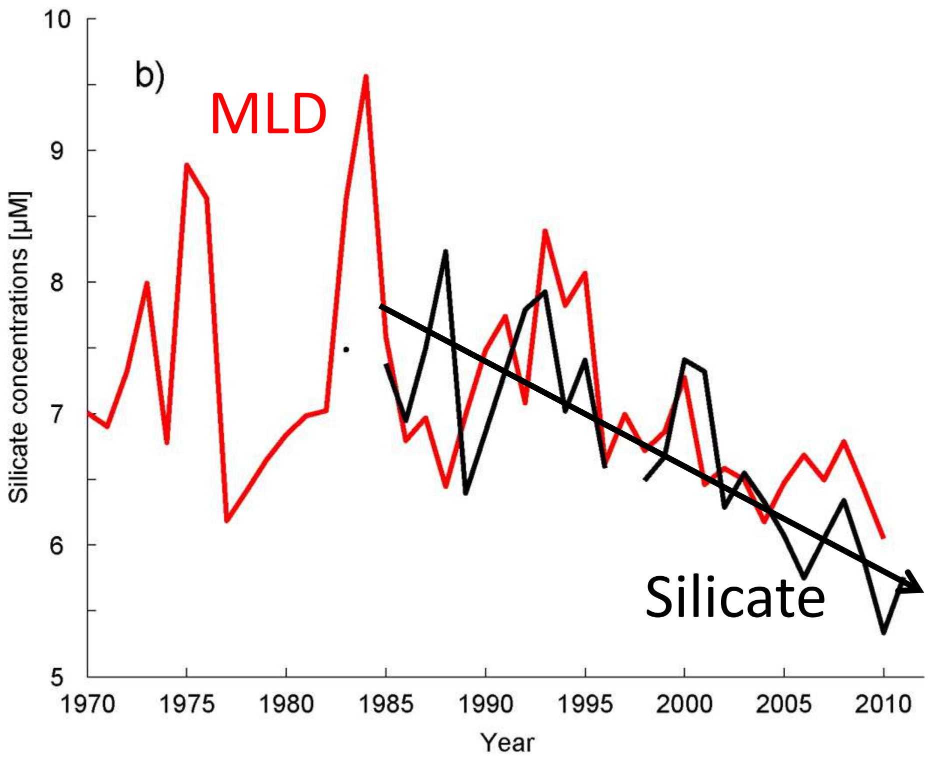




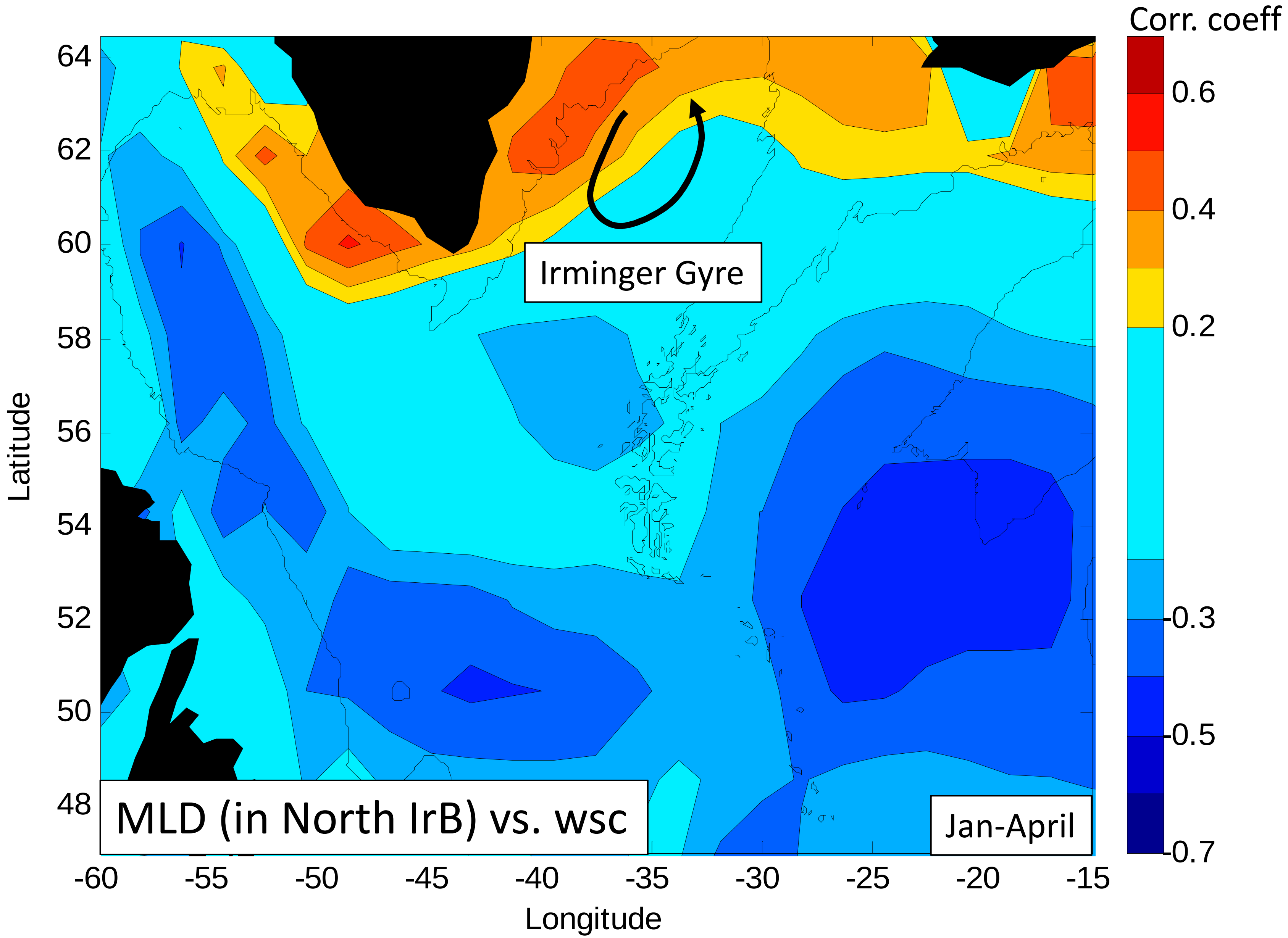
Nutrients
(pre-bloom)

A worrysome decline might change phytoplankton communities ☹
- like in Rey (2012)

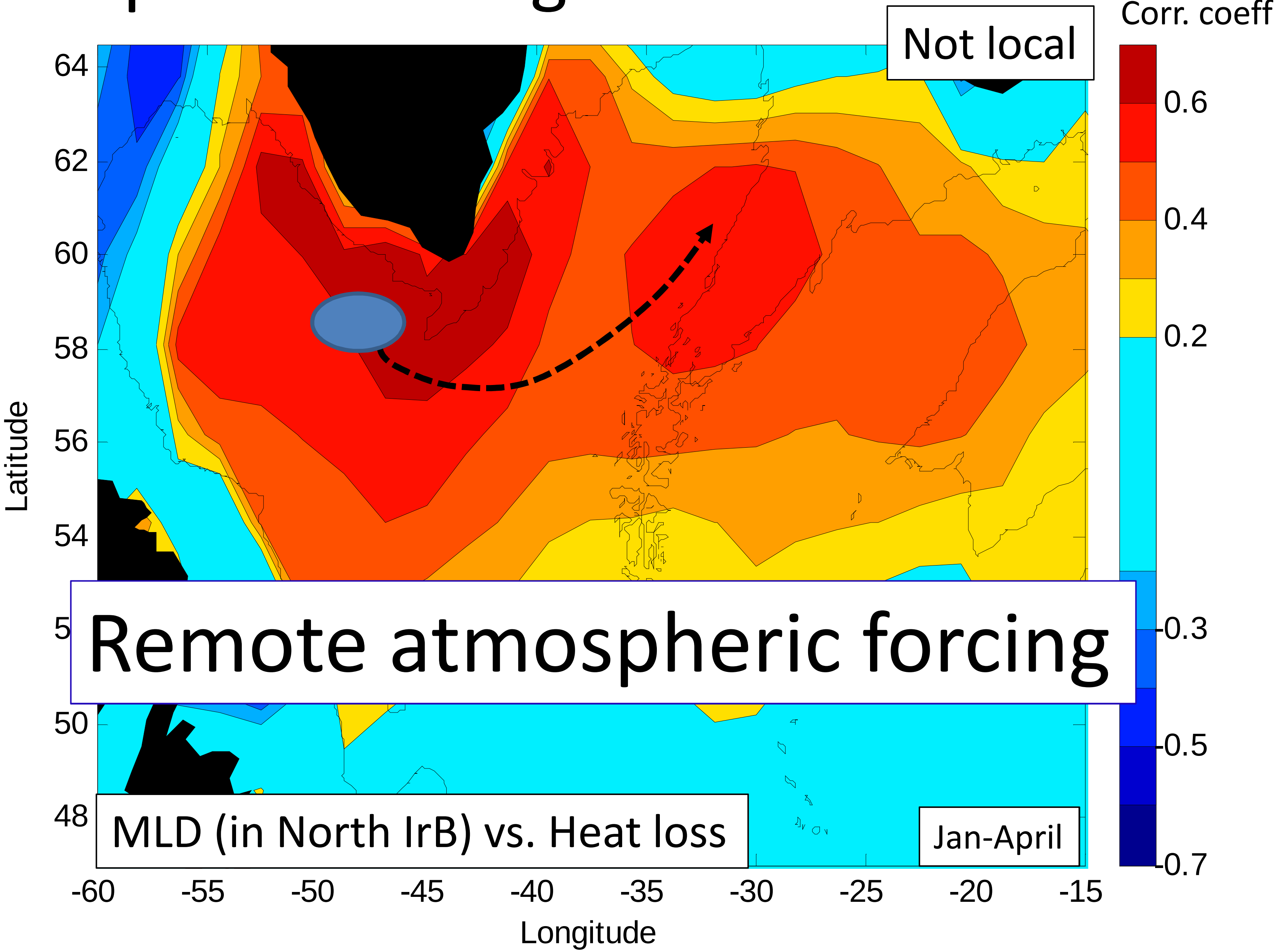
Pulses of nutrients during deeper mixing

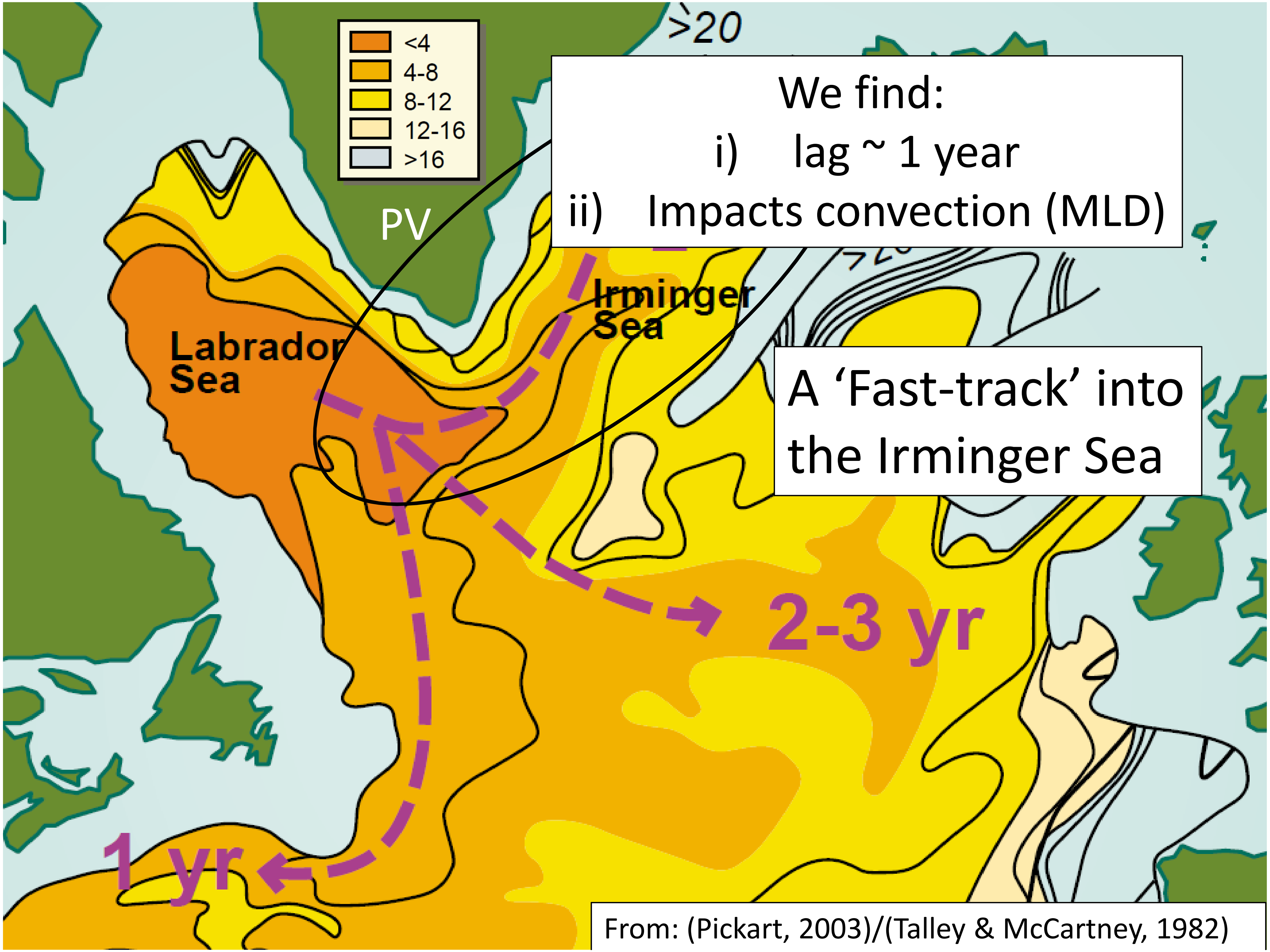


Atmospheric forcing: wind stress curl



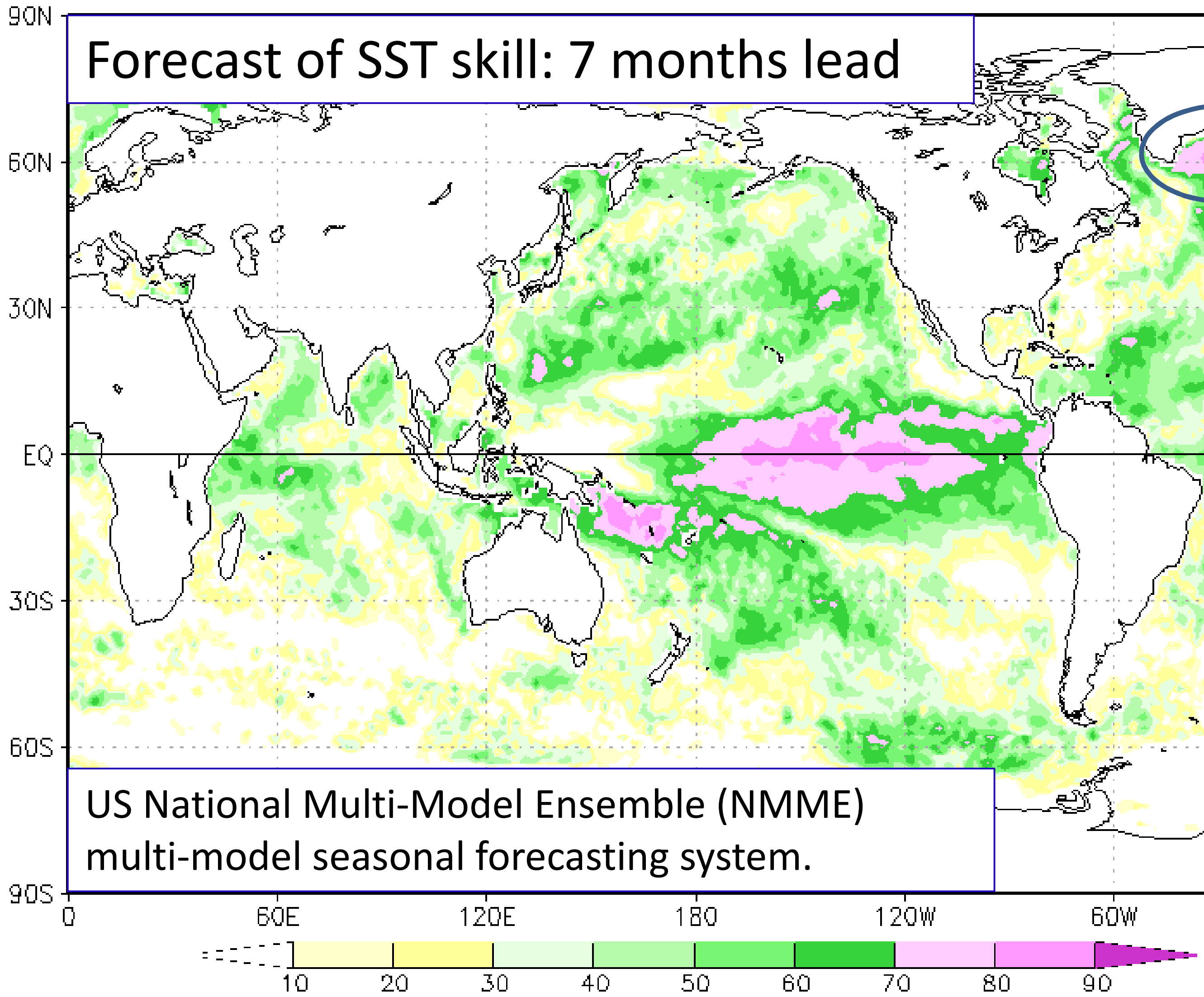
Atmospheric forcing: heat loss



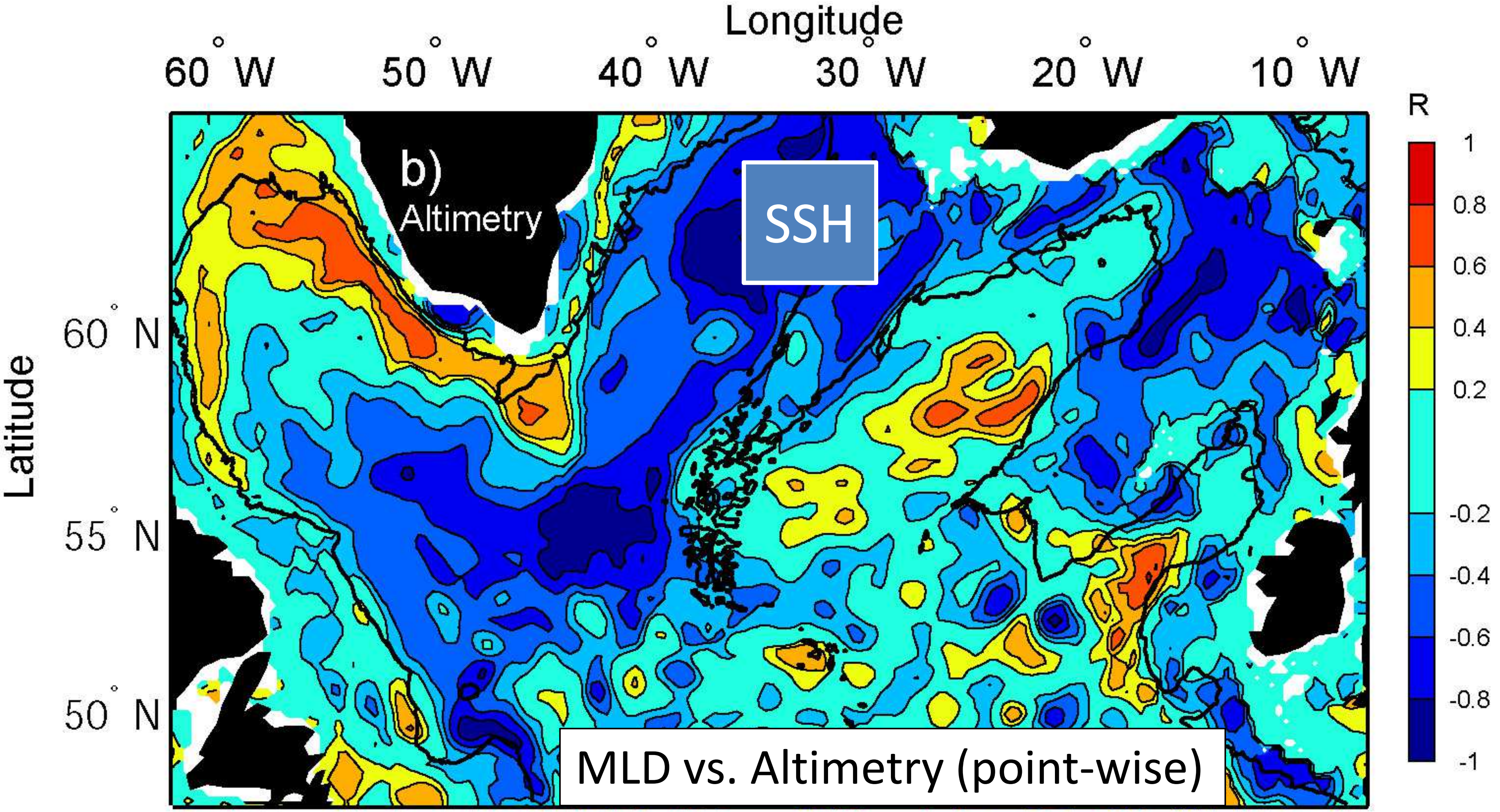


From: (Pickart, 2003)/(Talley & McCartney, 1982)

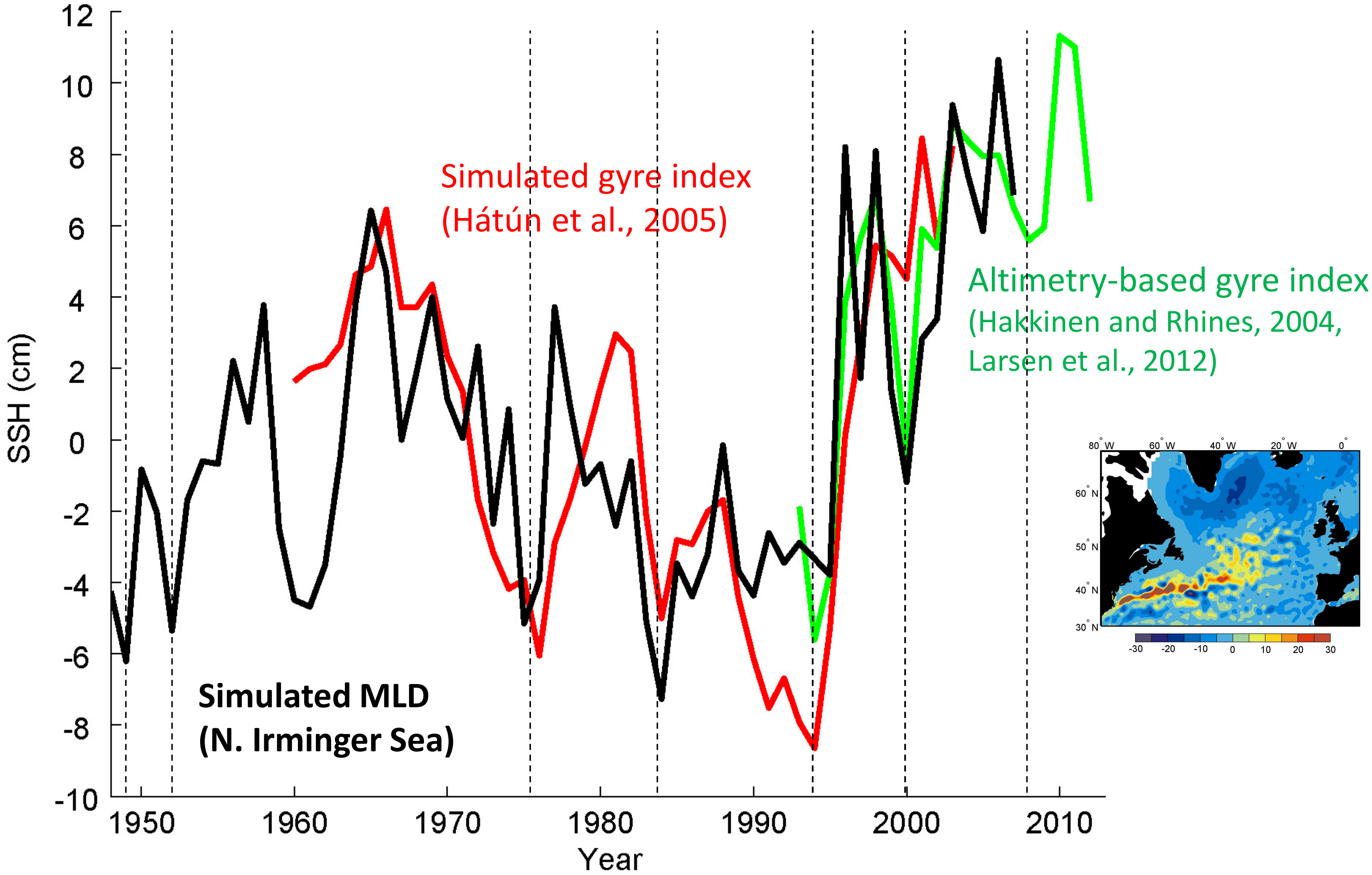
Predictability
Intra-seasonal to interannual



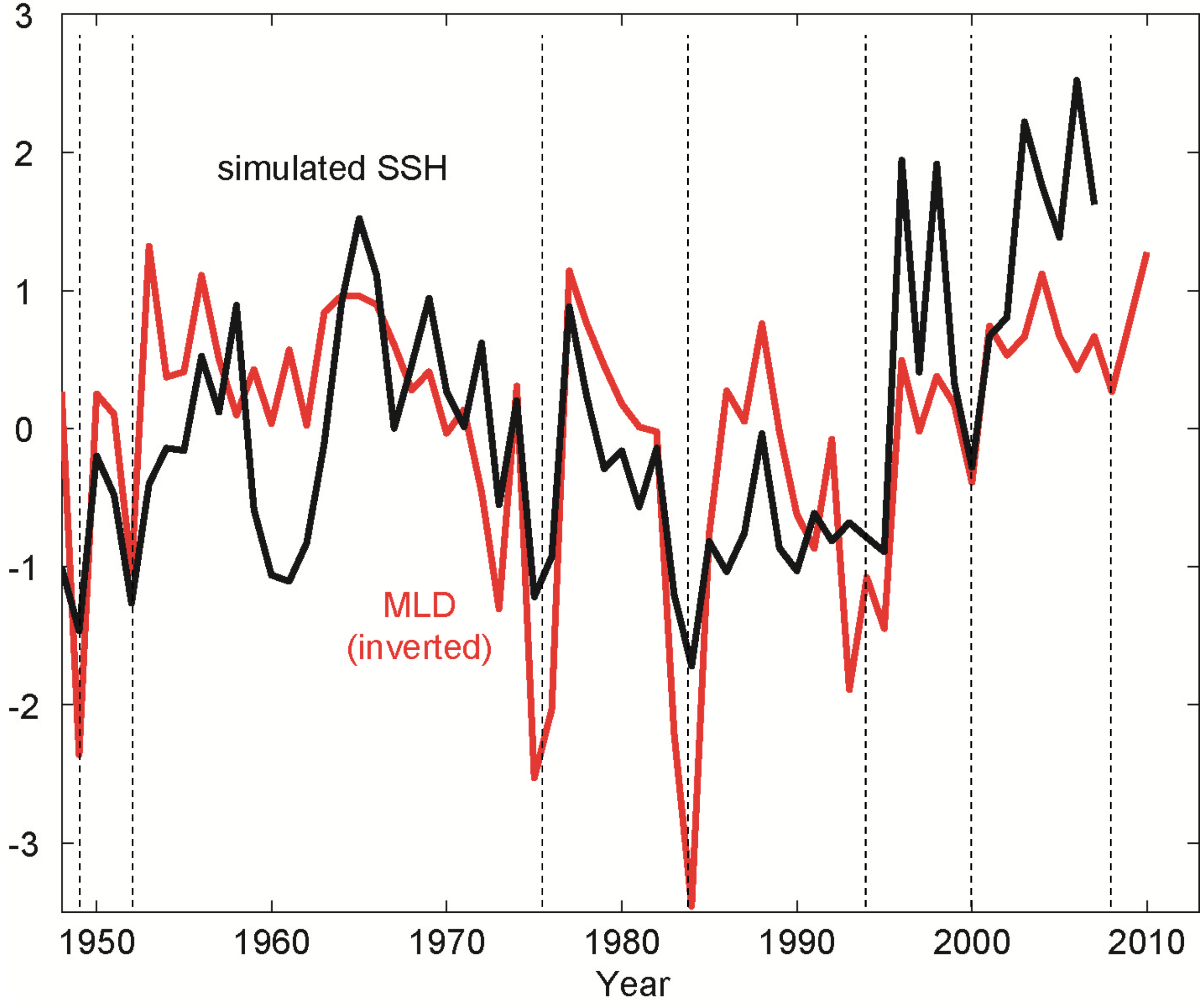
Altimetry: a good 'MLD-meter'
(in some regions)

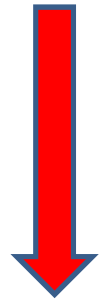


Gyre dynamics and the pulses



Gyre dynamics and the pulses



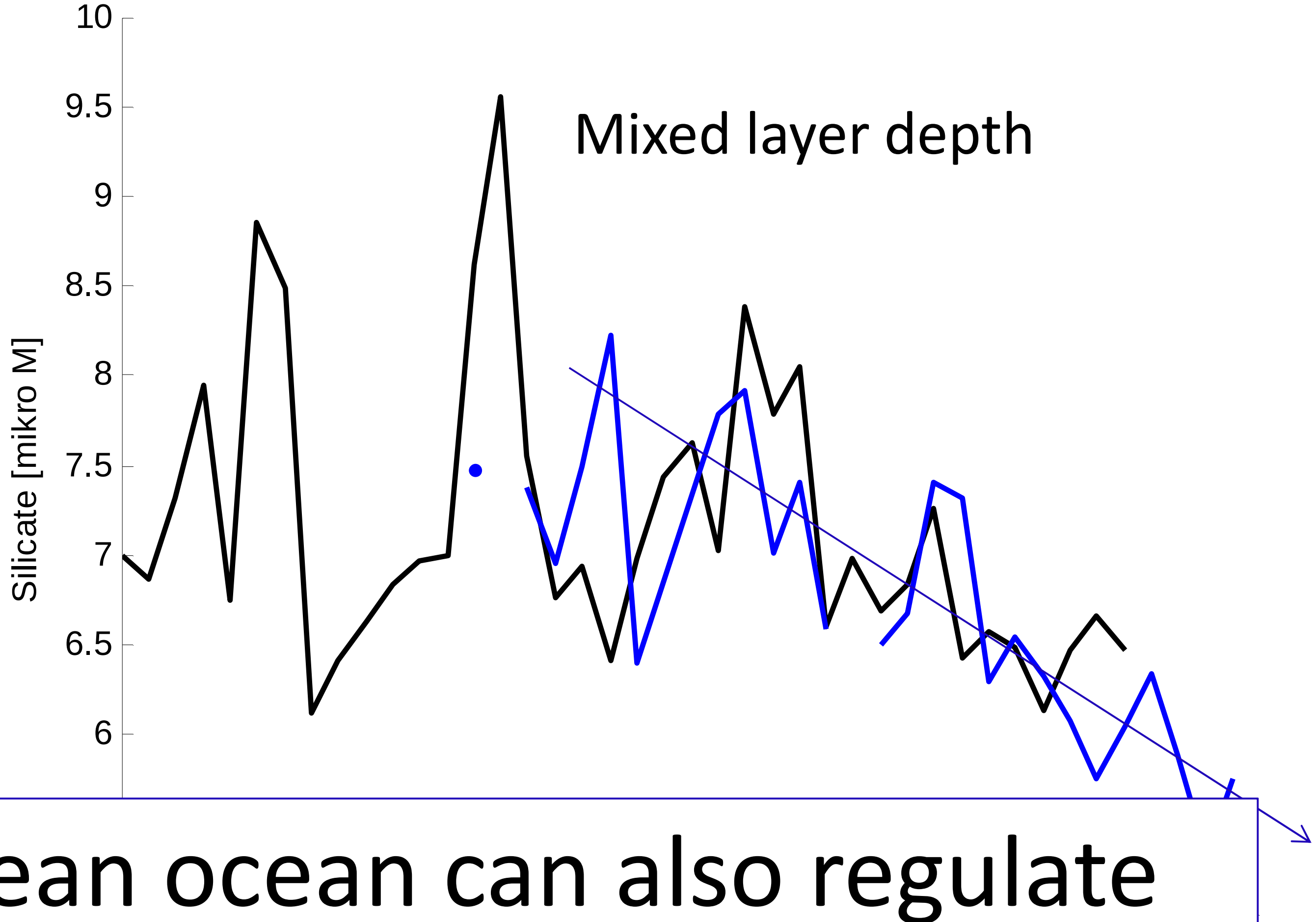


Deeper MLD, productive

Messages

- On-shelf zooplankton abundance is closely linked to concentrations of *C. finmarchicus* within the subpolar gyre
- The variability is closely linked to the winter mixed layer depths in the Irminger Sea
- Deep-water formation in the Labrador Sea, and advection towards Iceland, induces a potential for prediction (0.5 to 1.5 years ahead)

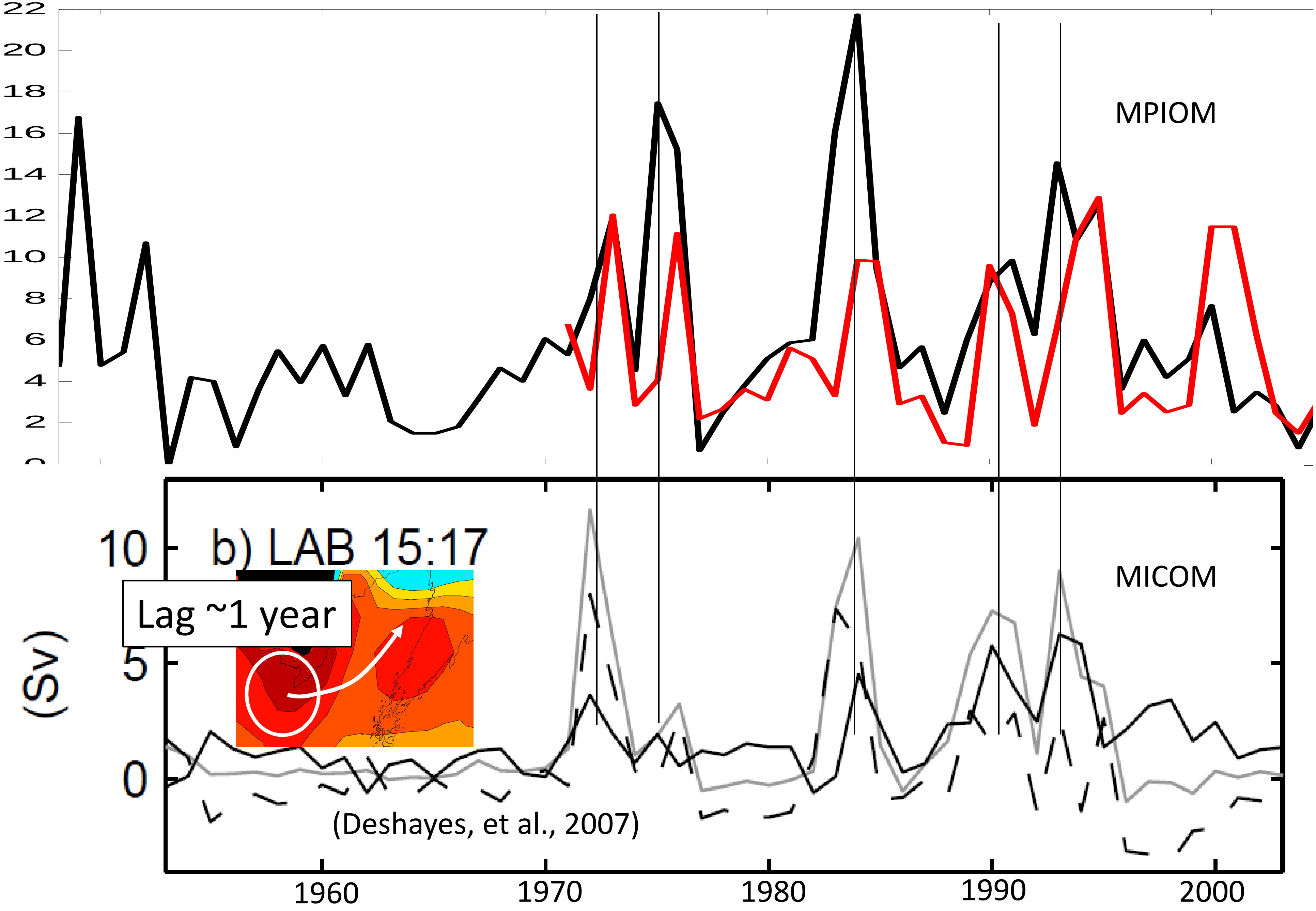
Nutrient decline



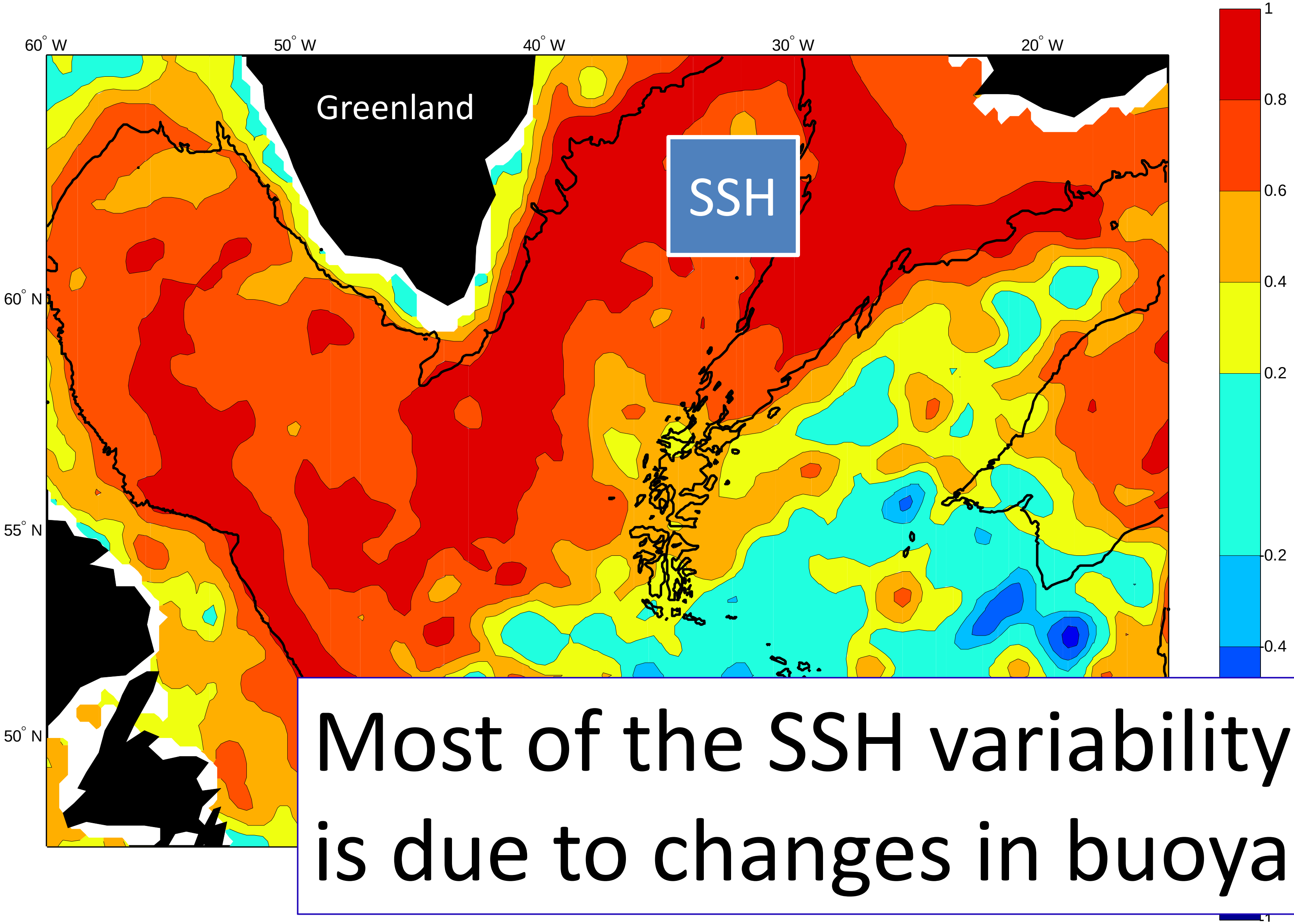
The opean ocean can also regulate the nutrient influx to the shelves

☹

Blows from the Lab Sea

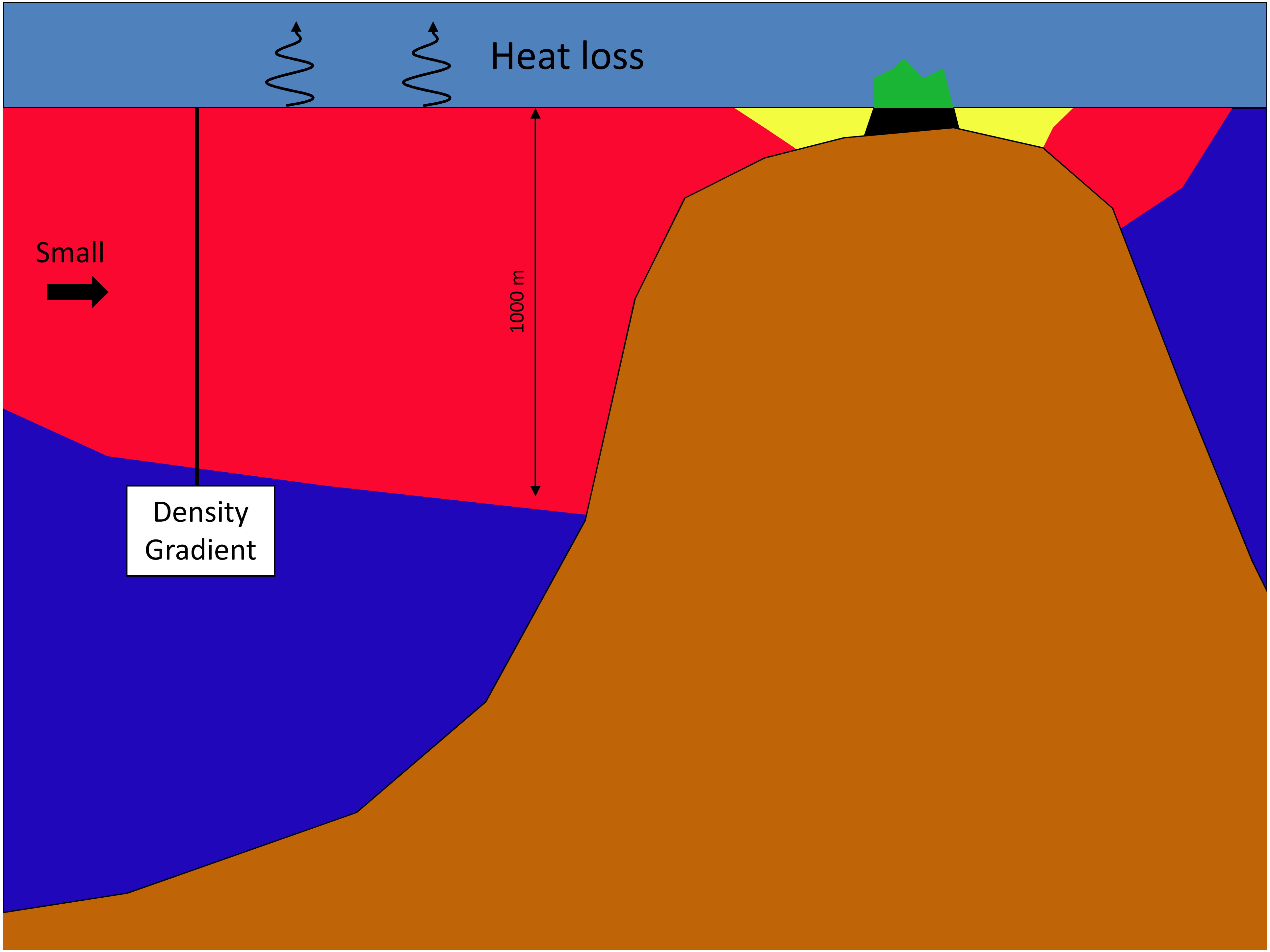


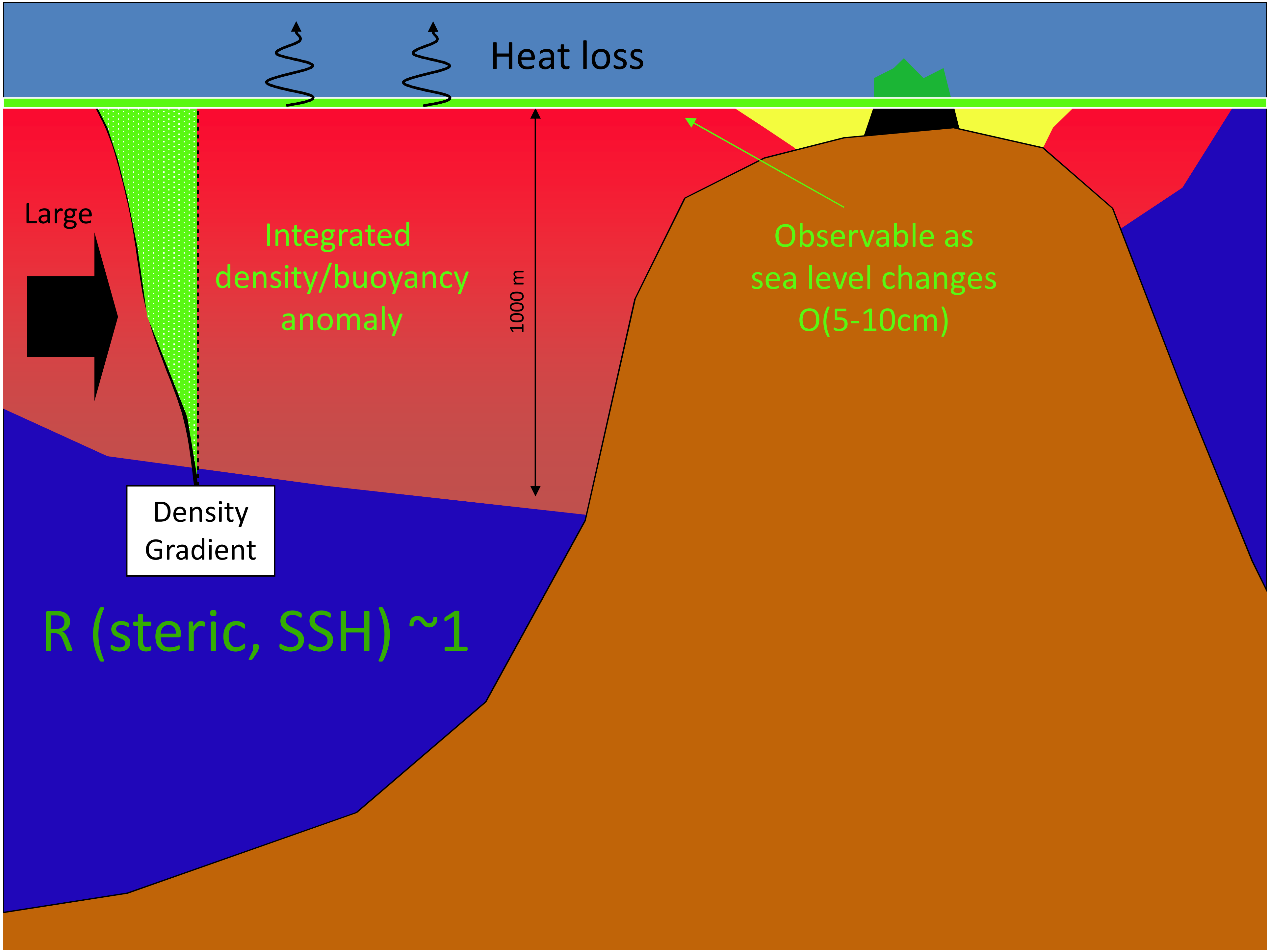
Altimetry and simulated steric (dynamic) height



Most of the SSH variability is due to changes in buoyancy

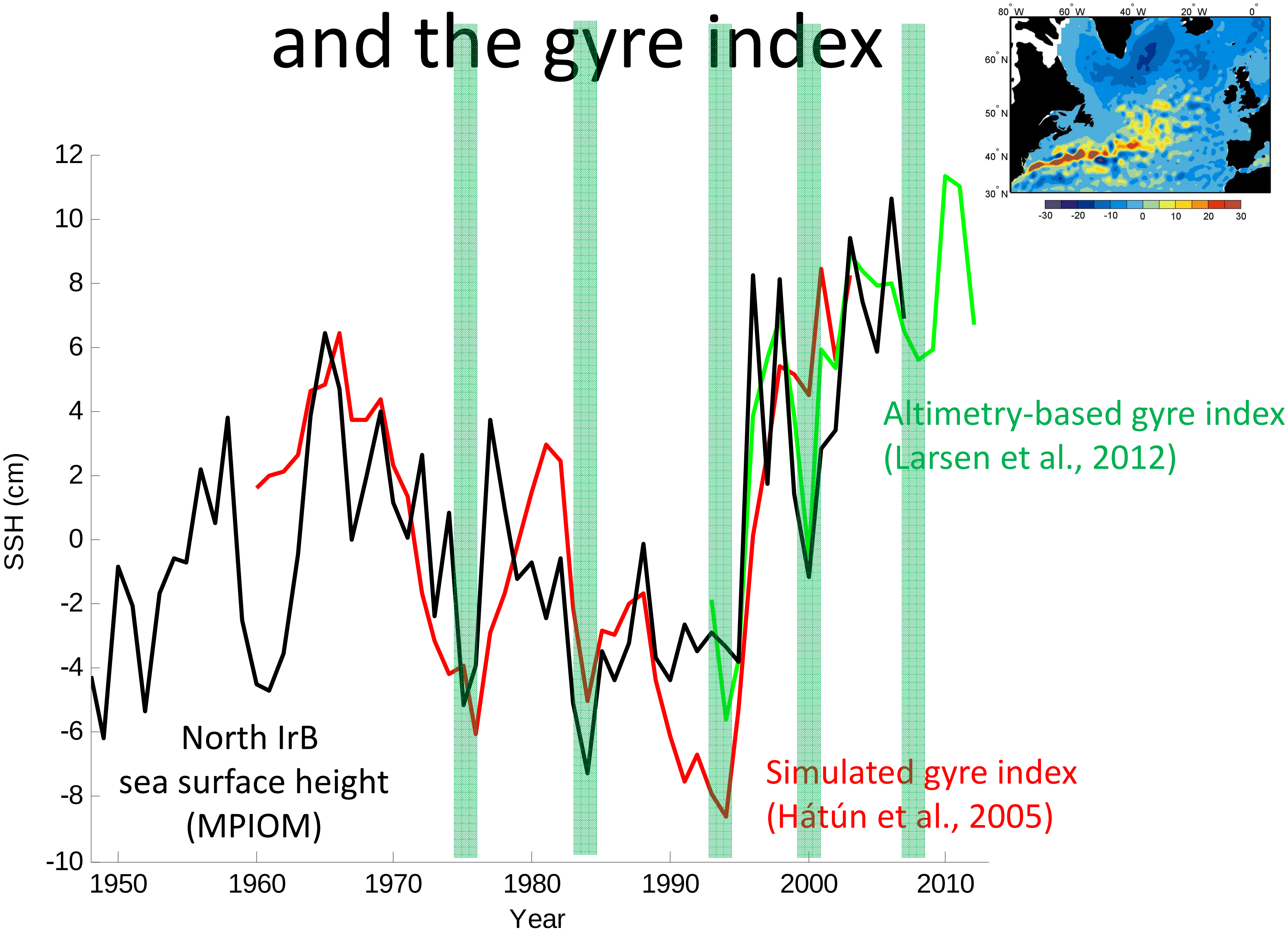
3. Altimetry – a useful metric


Heat loss
Small
1000 m
Density
Gradient

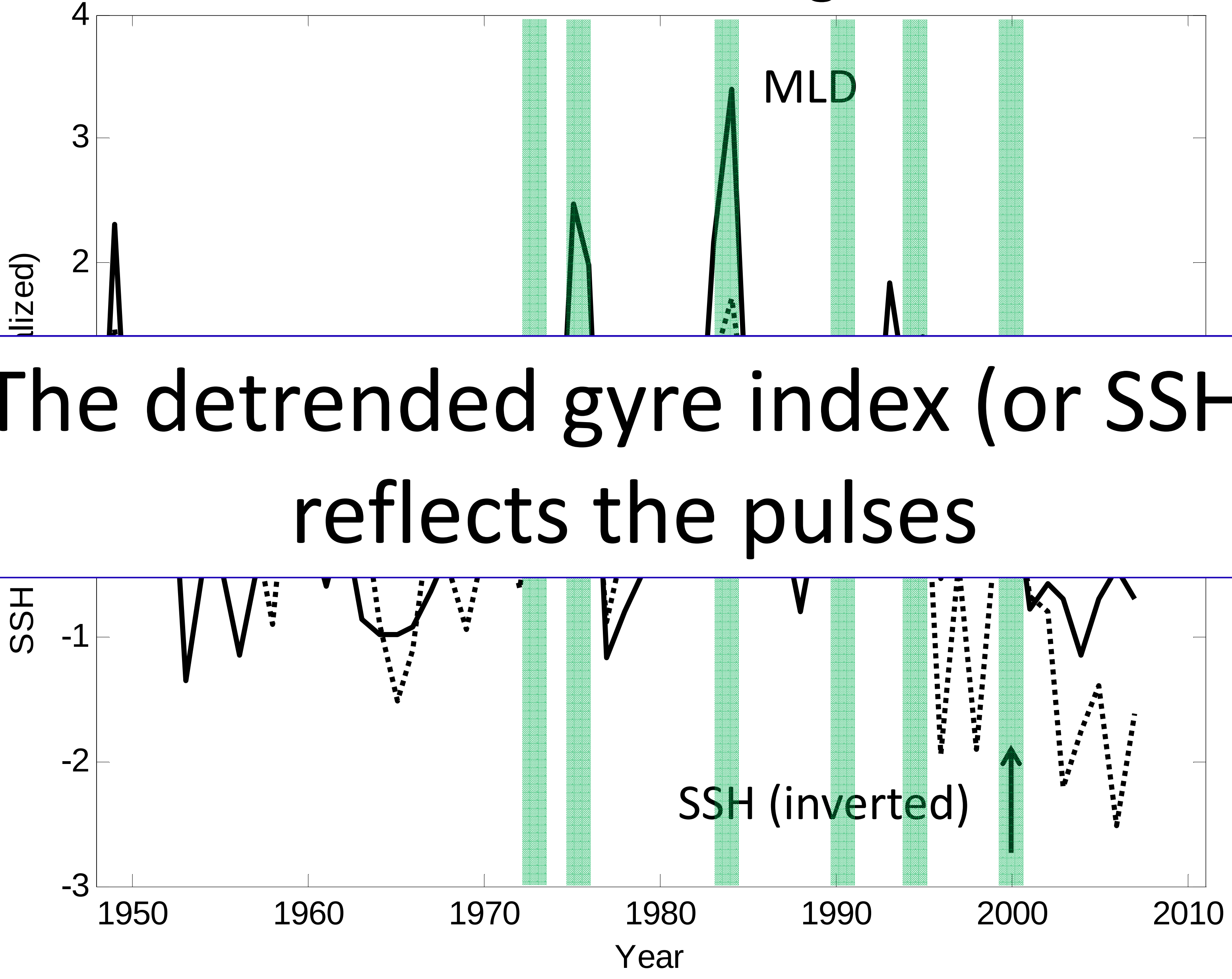


Heat loss
Large
Integrated density/buoyancy anomaly
1000 m
Observable as sea level changes O(5-10cm)
Density Gradient
R (steric, SSH) ~1

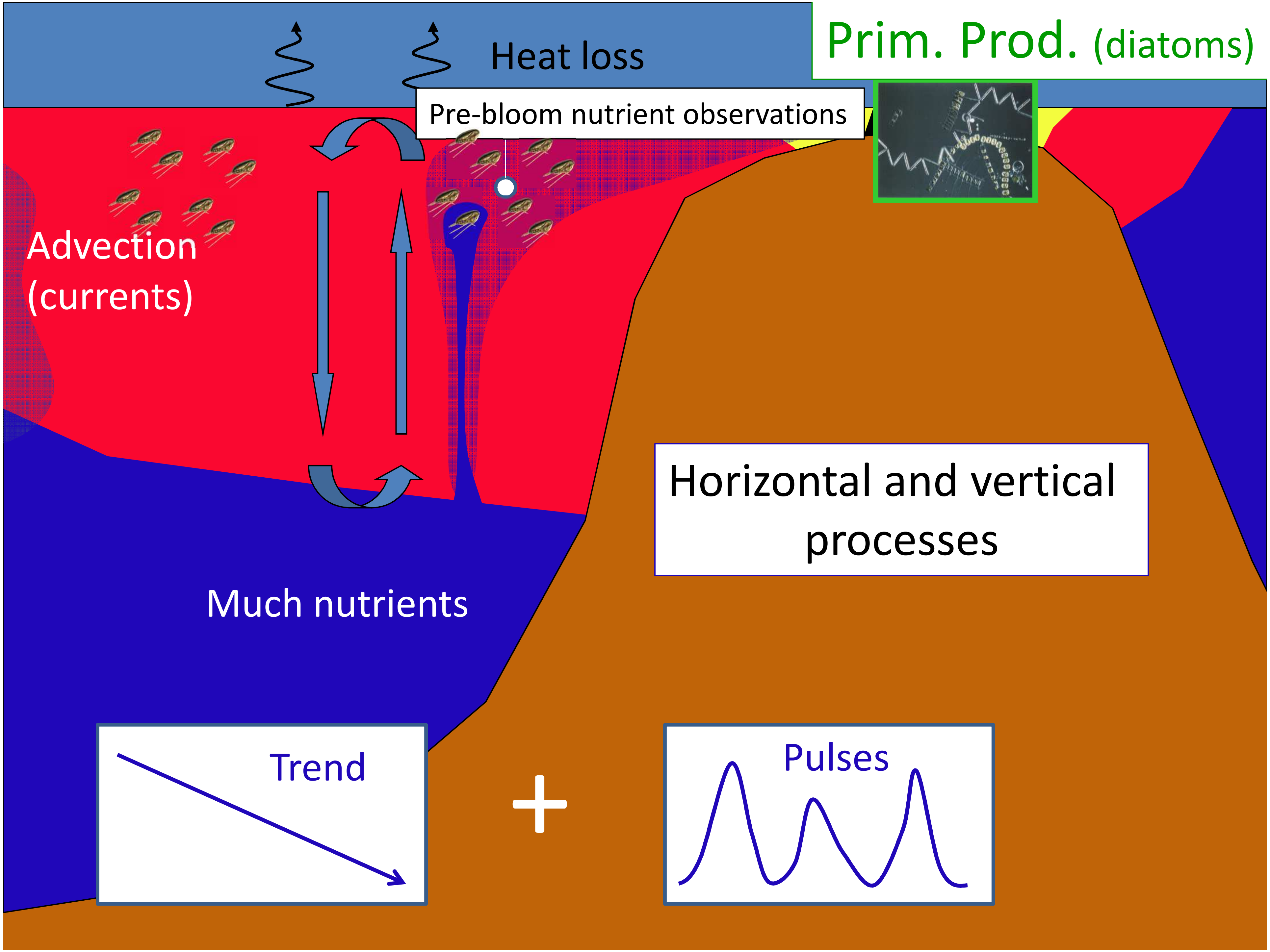
Pulses in the Northern Irminger Sea and the gyre index



Simulated MLD and SSH in the Northern Irminger Sea

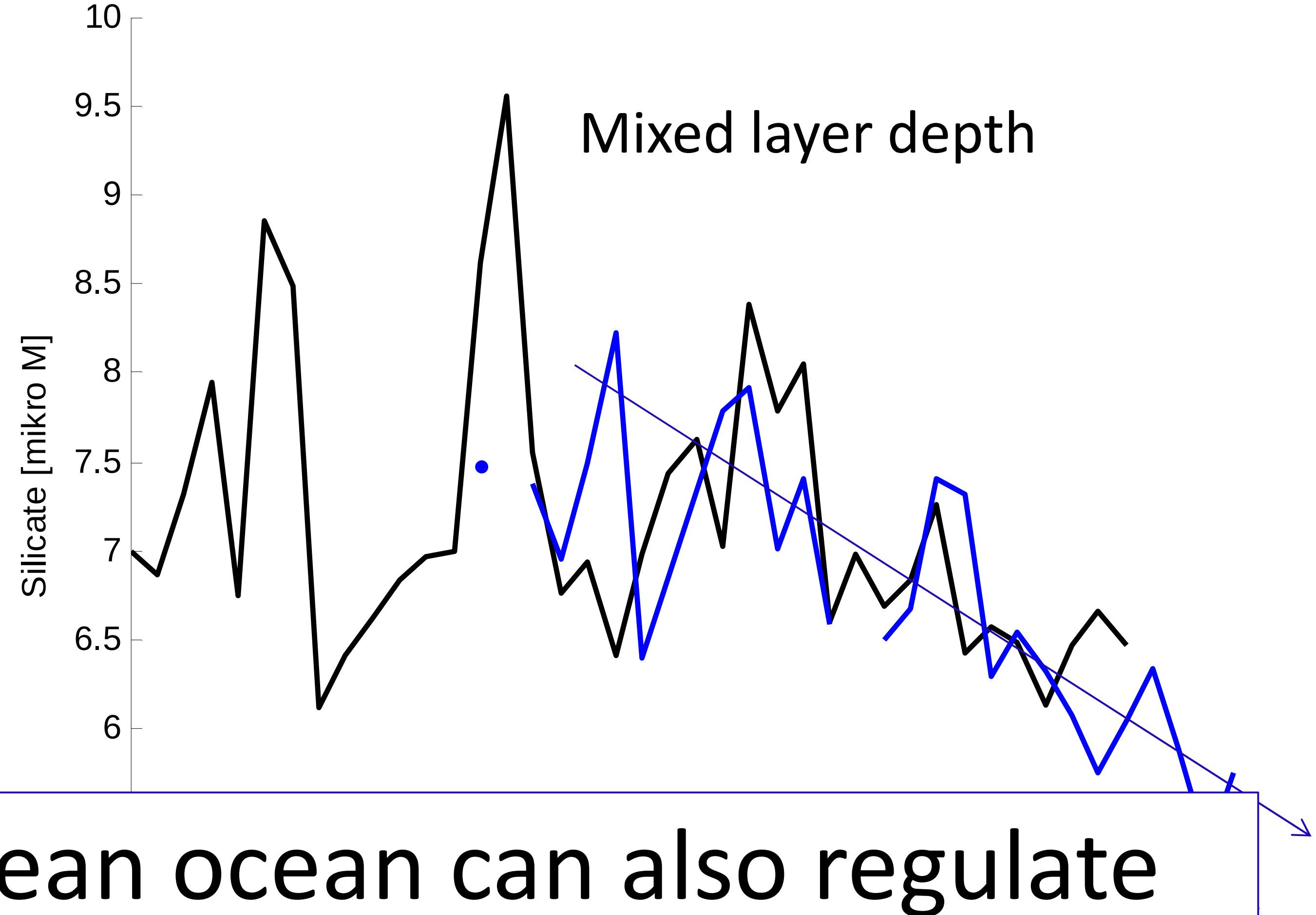


The detrended gyre index (or SSH) reflects the pulses



Heat loss
Prim. Prod. (diatoms)
Pre-bloom nutrient observations
Advection
(currents)
Horizontal and vertical processes
Much nutrients
Trend
+
Pulses

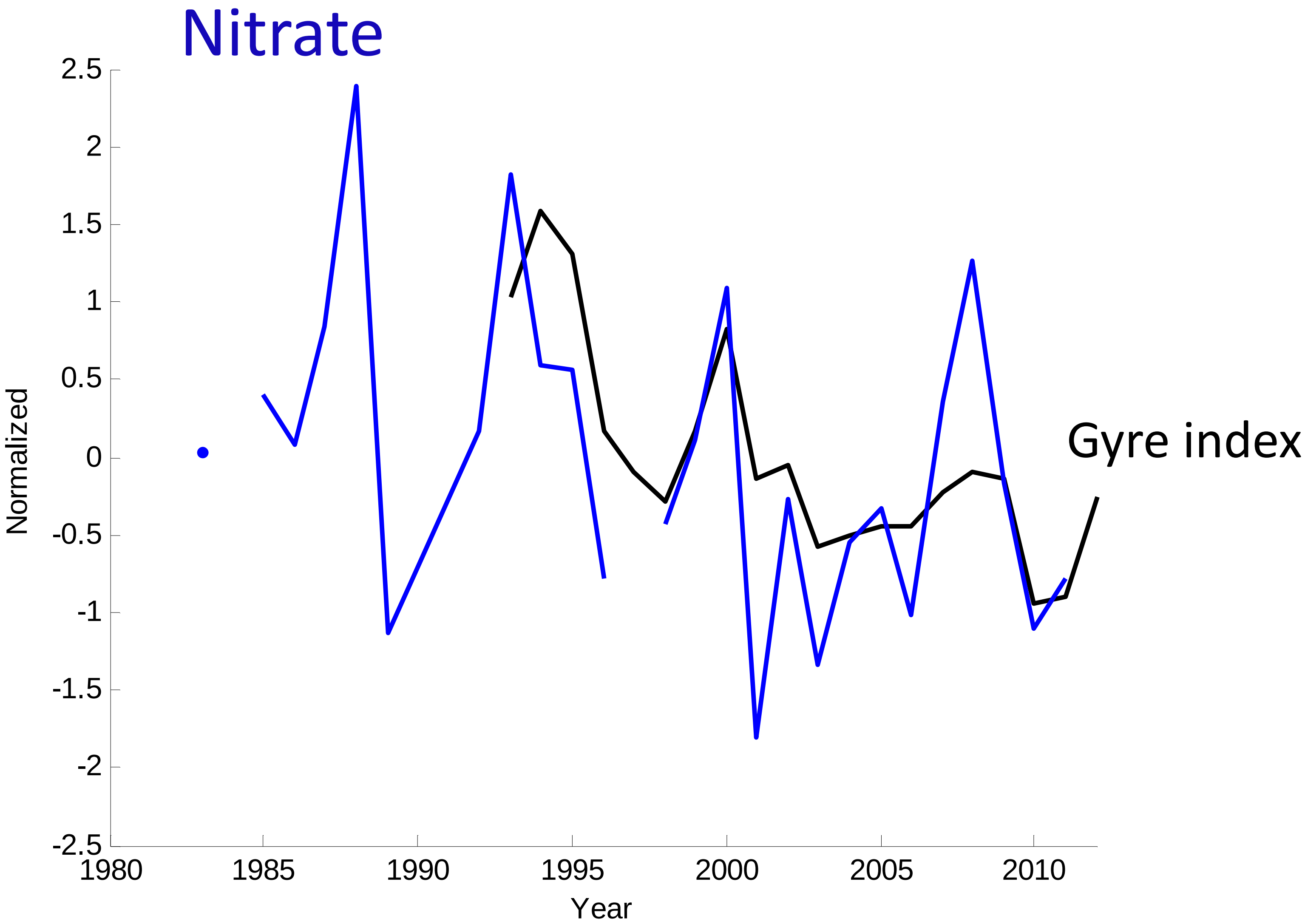
Nutrient decline



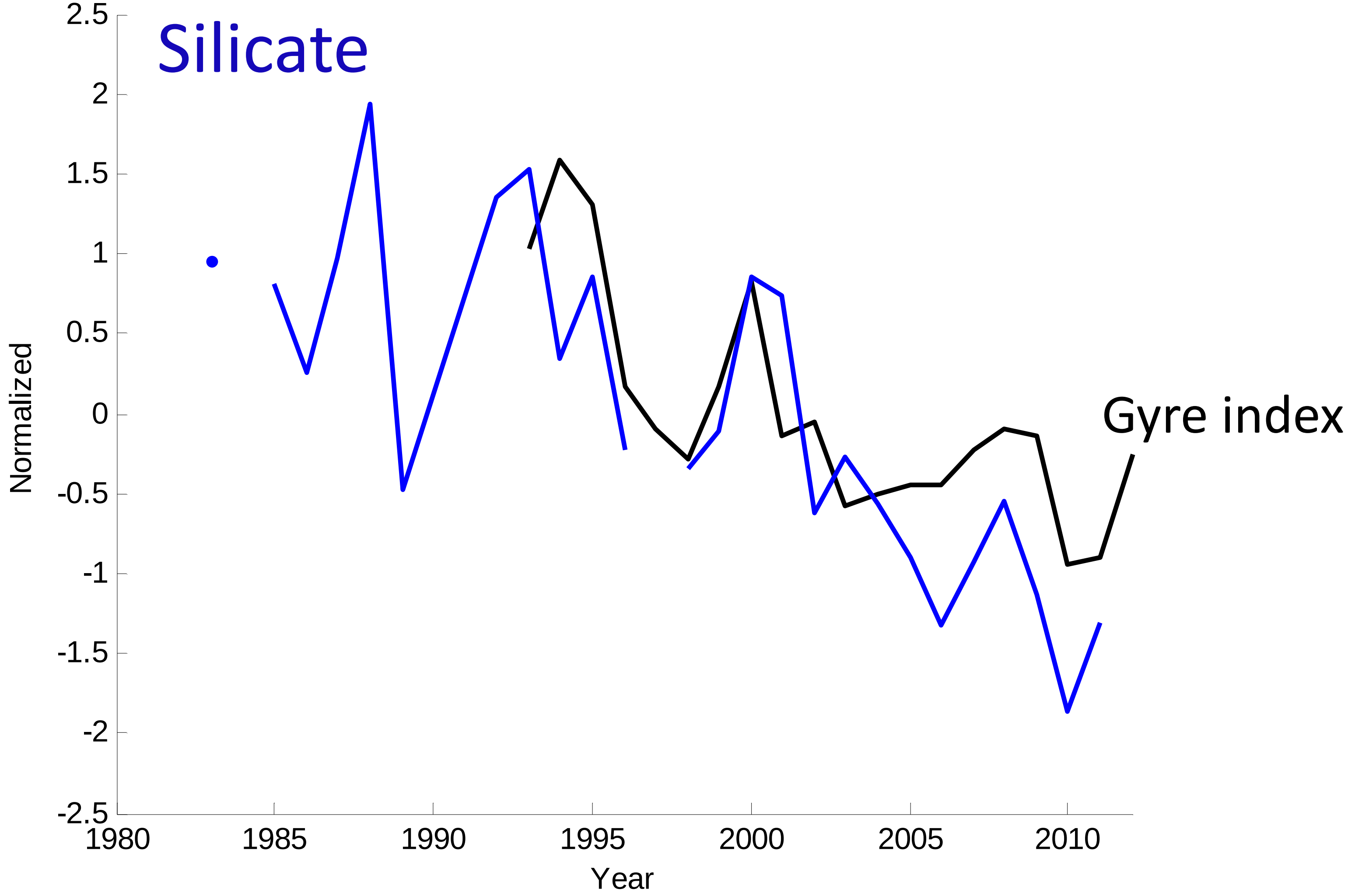
The opean ocean can also regulate the nutrient influx to the shelves

☹

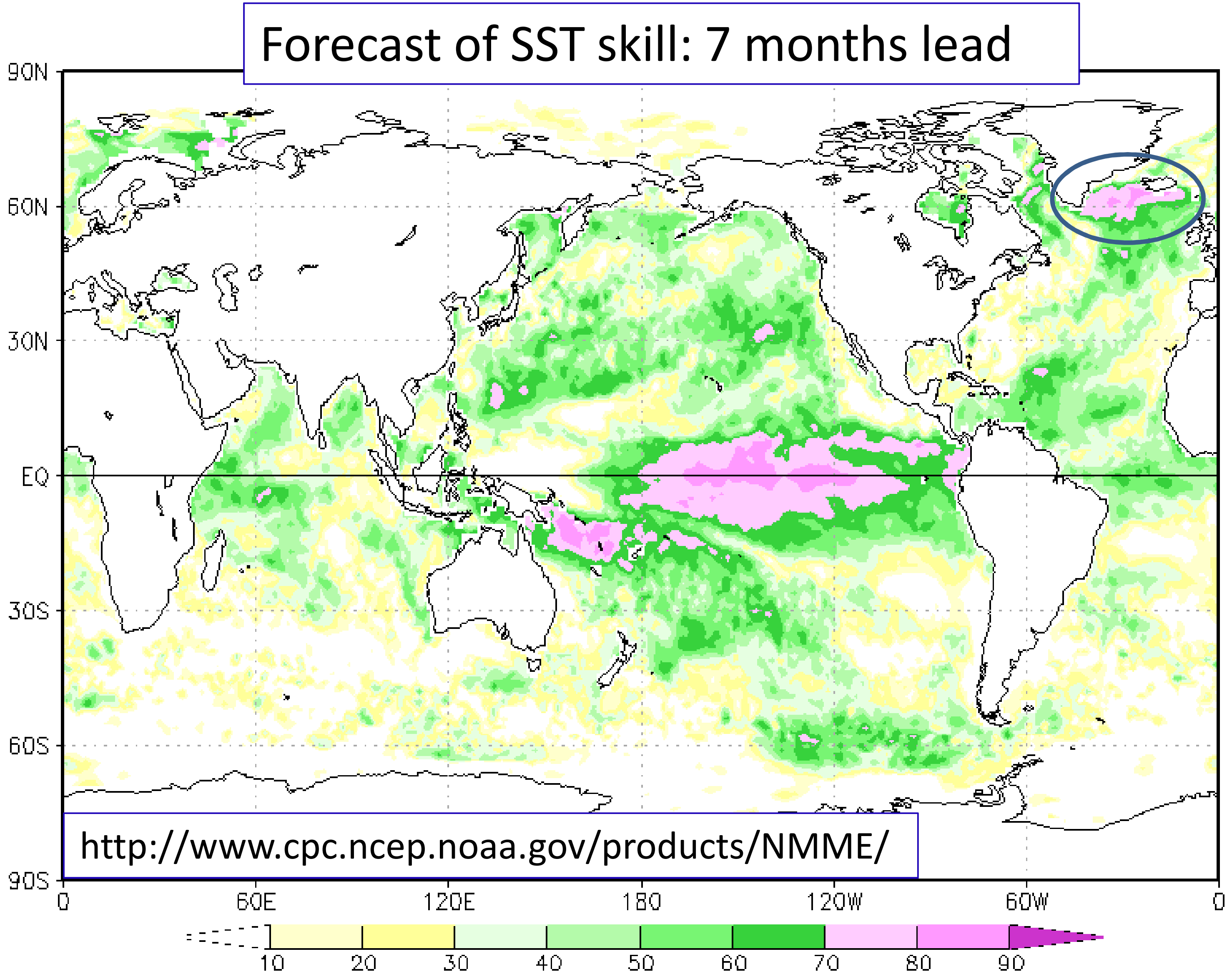
4. Nutrient decline



Nutrient decline



Seasonal predictability



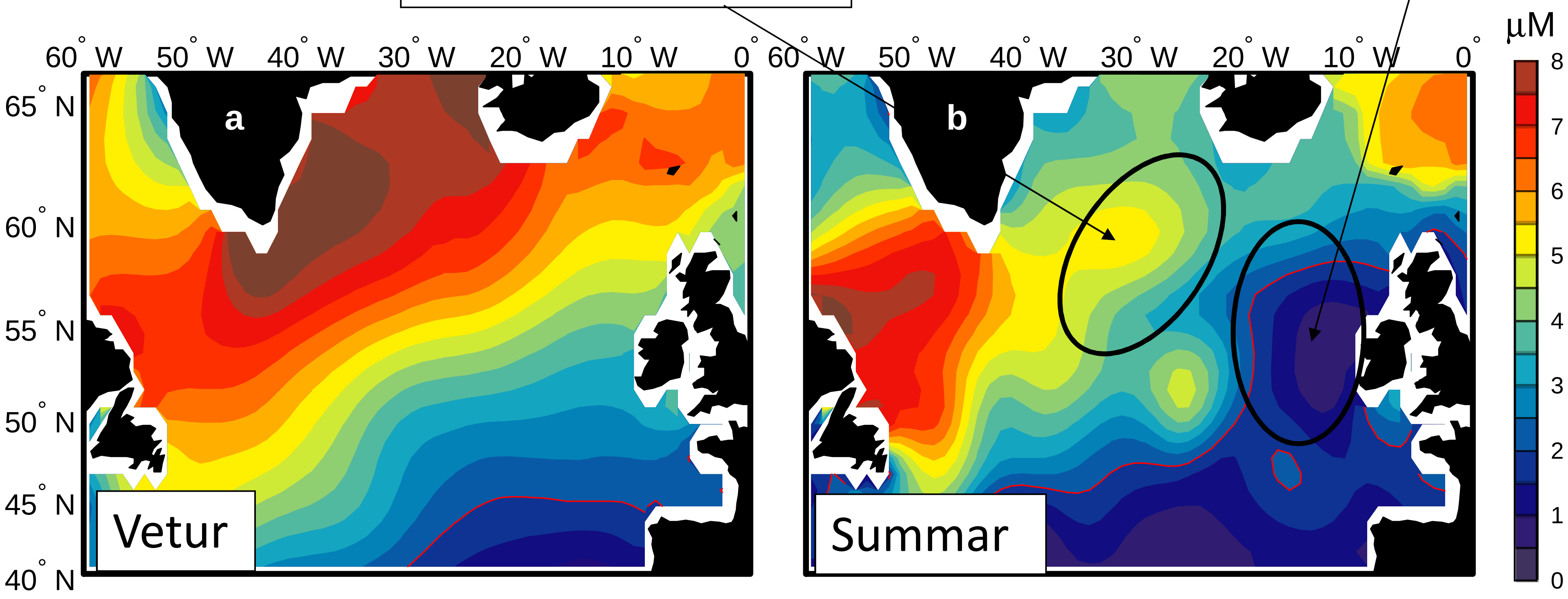
Messages

- Convective activity in the Irminger-Labrador Seas →
- More subarctic water
- More nutrients
- More zooplankton (*C. finmarchicus*)
  - Which advects towards and onto the Iceland shelf
  - After a 0.5 – 1.5 year time-lag
  - Fueling higher trophic levels
- Altimetry (SSH) is a useful metric for this process

Silikat

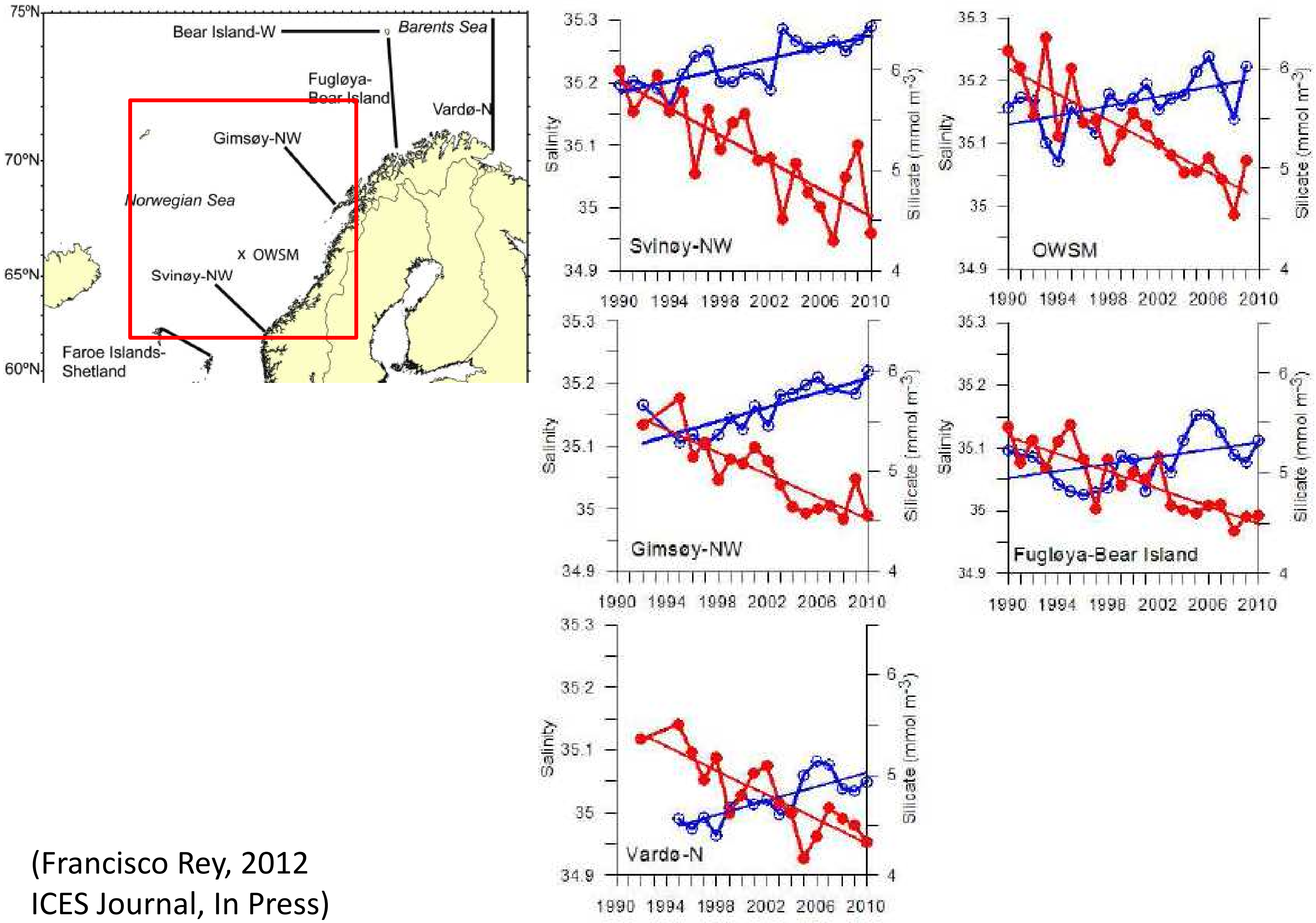
***Irminger Sea*:**
fekst,
nógv av Calanus og
nógv av silikati

***Bay of Biscay*:**
Salt,
lítið av Calanus og
lítið av silikati



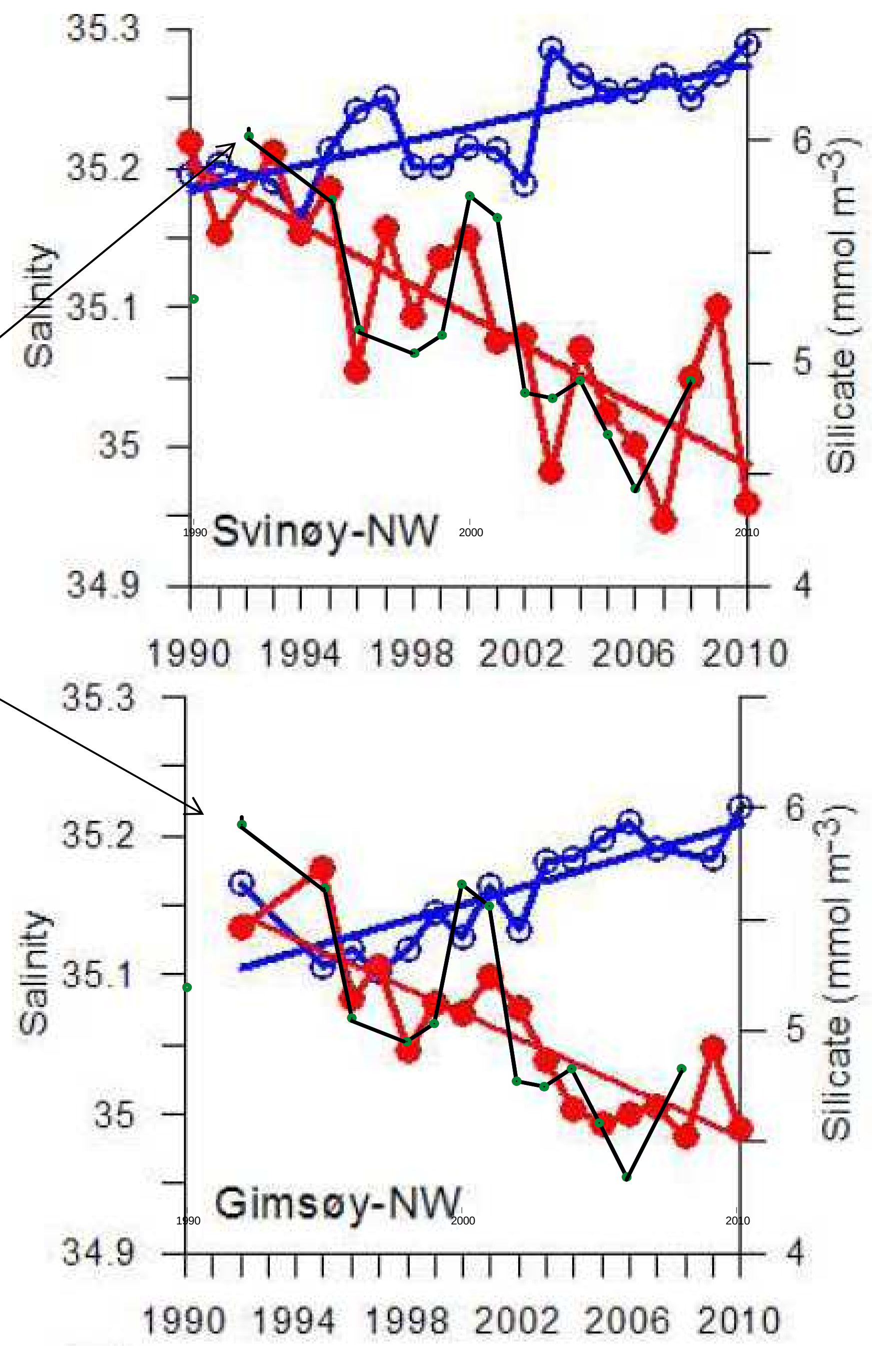
Silikat konsentrasjónir á 50 m dýpi

(kelda: WOA09)



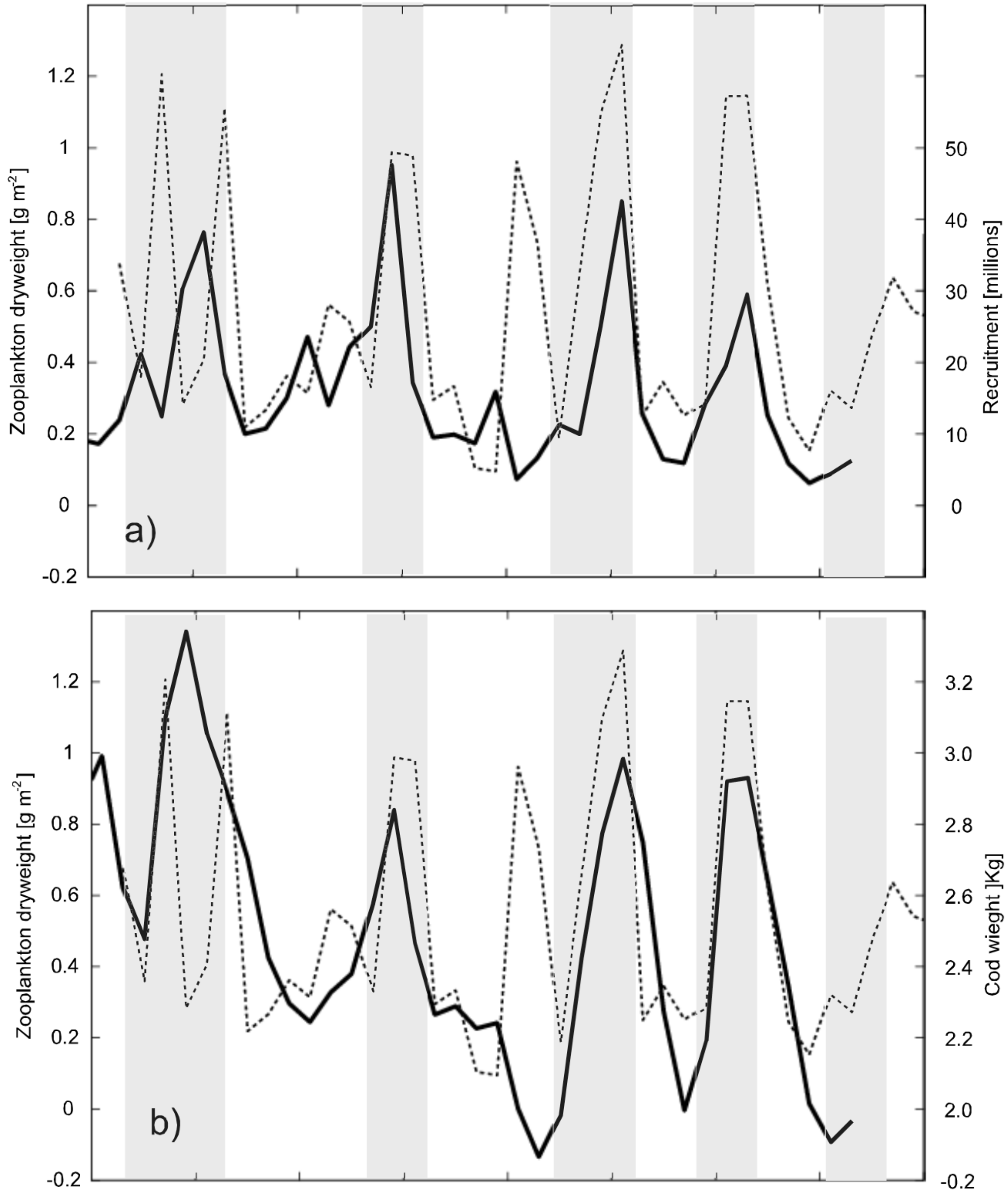
(Francisco Rey, 2012
ICES Journal, In Press)

And silicate south of Iceland
(Jón Ólafsson)

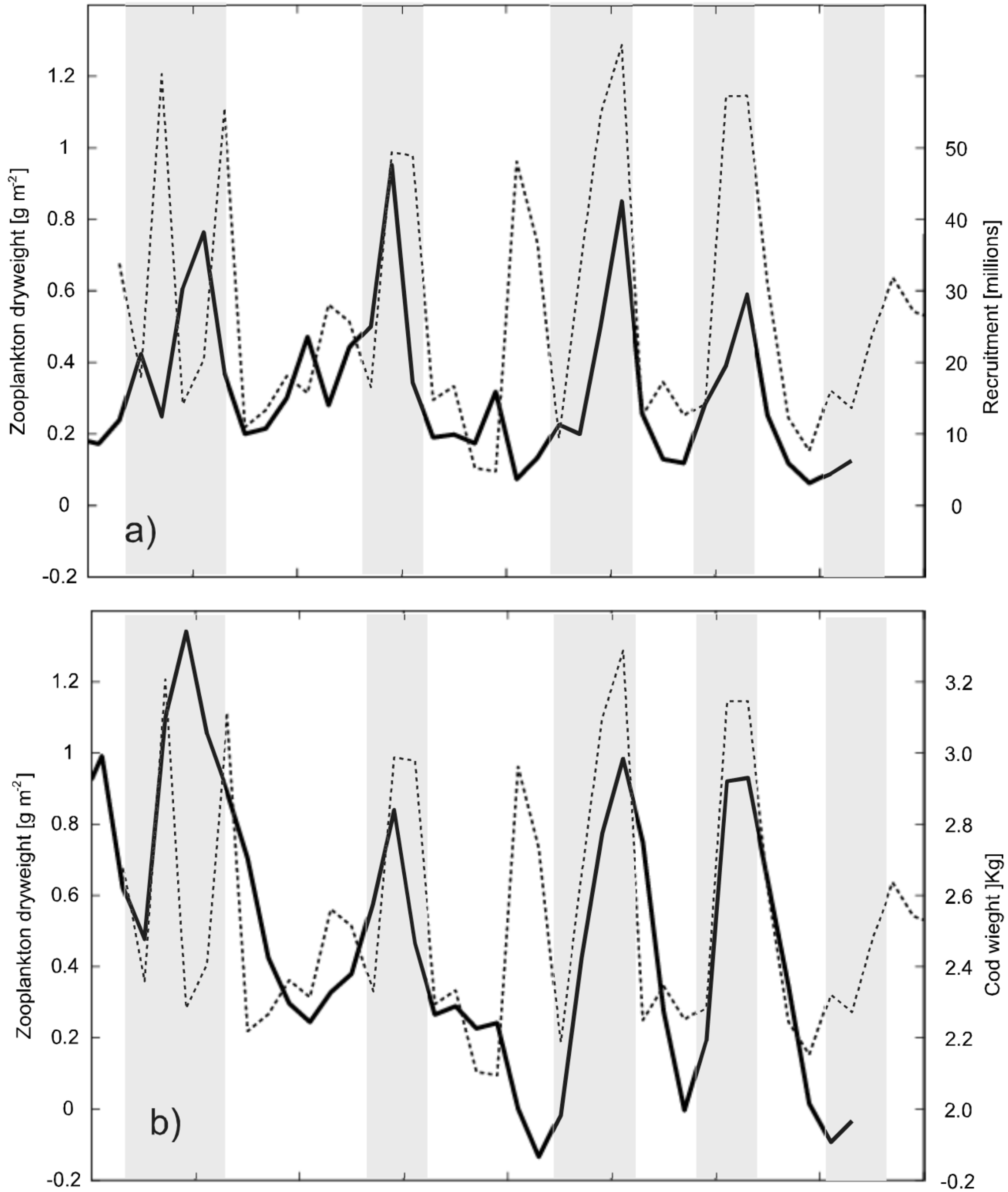


(Francisco Rey, 2011
ICES Journal, In Press)

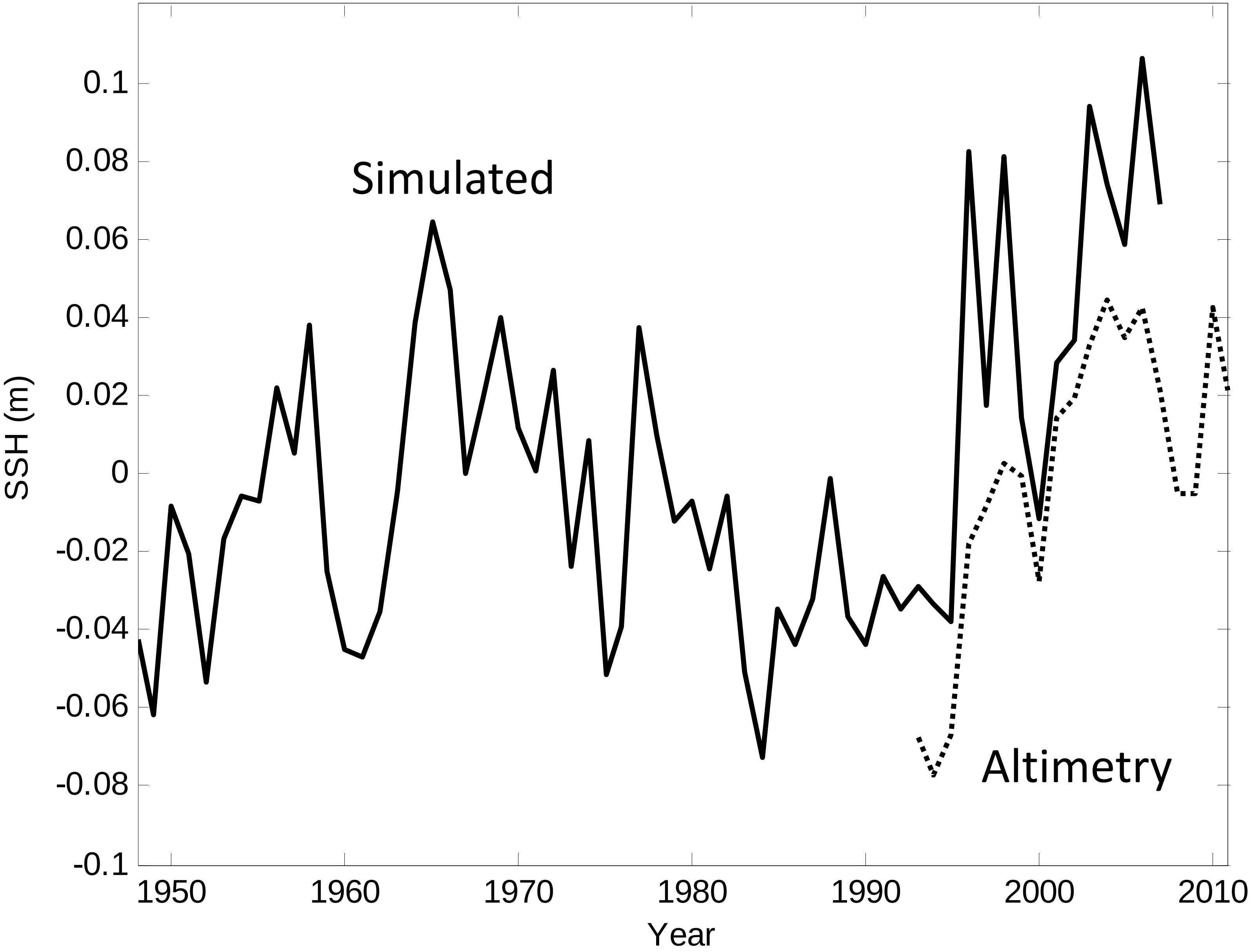
And
Faroe cod

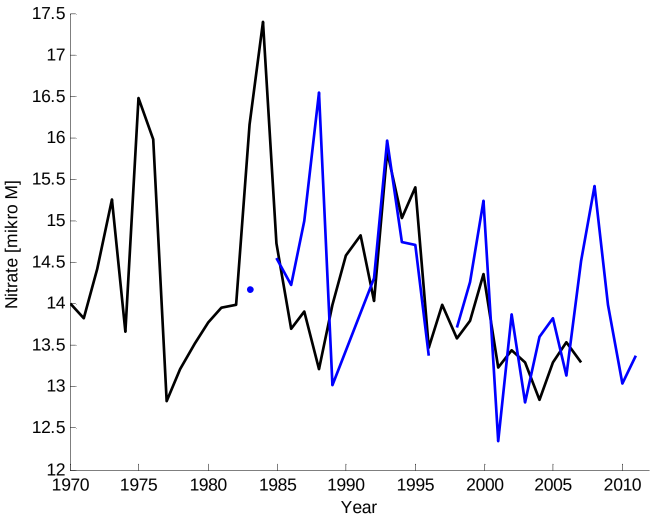
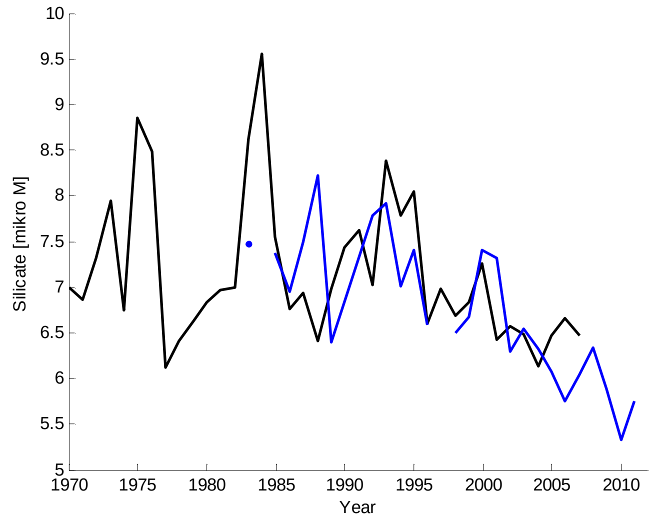
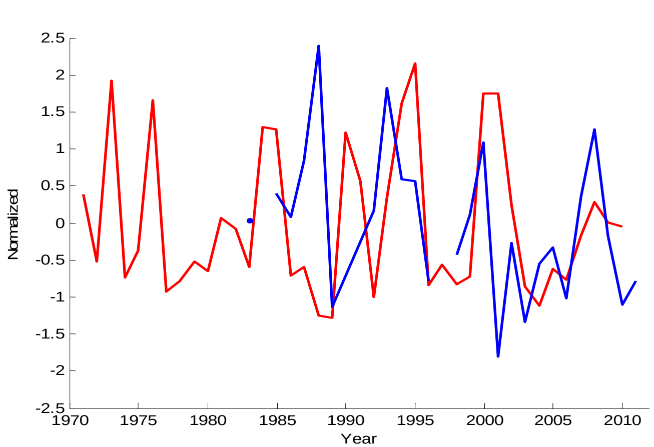
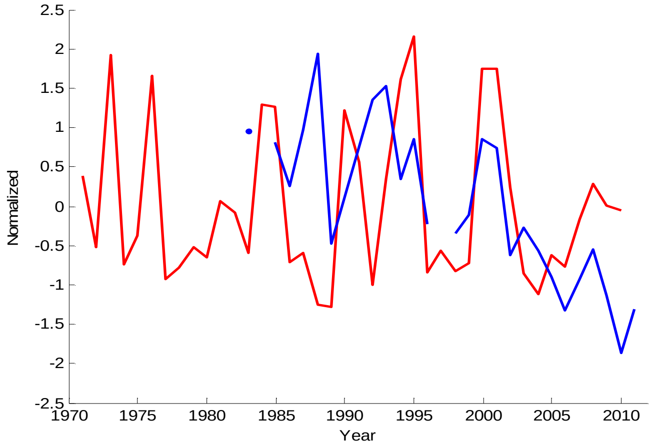
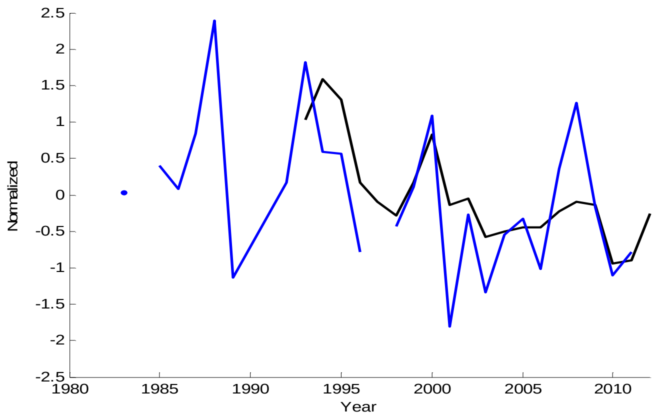
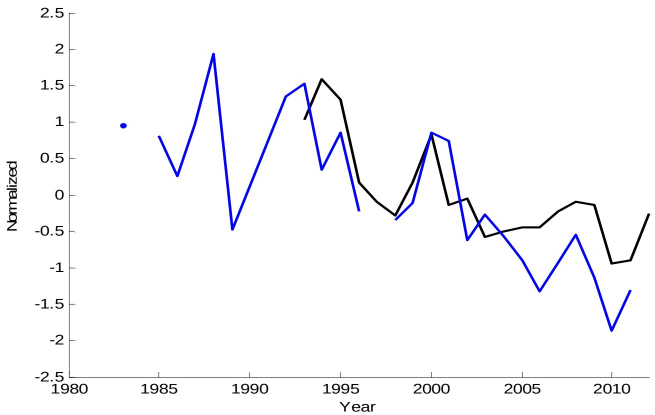


And
Faroe cod

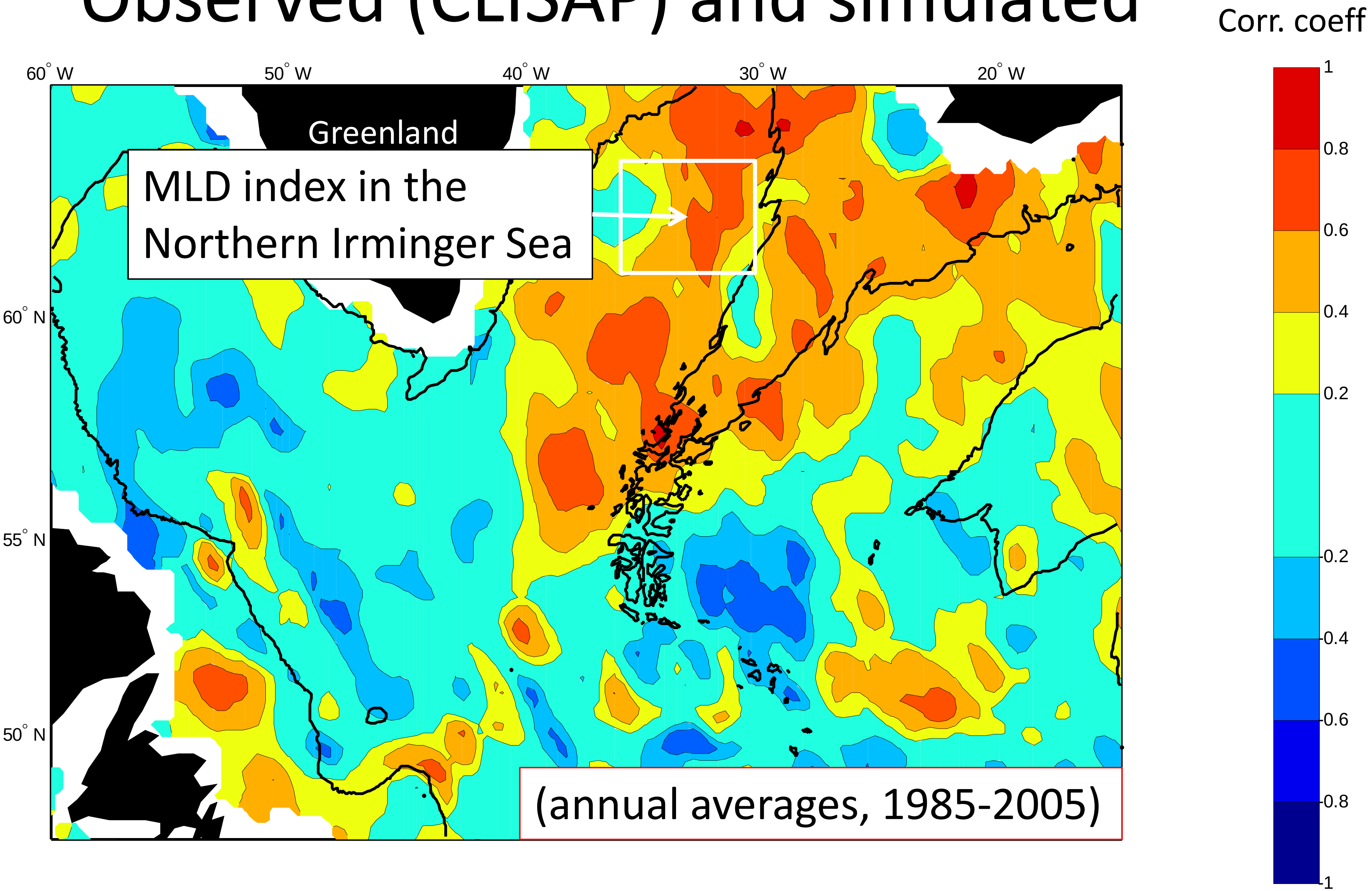


Sea surface height in the Northern Irminger Sea

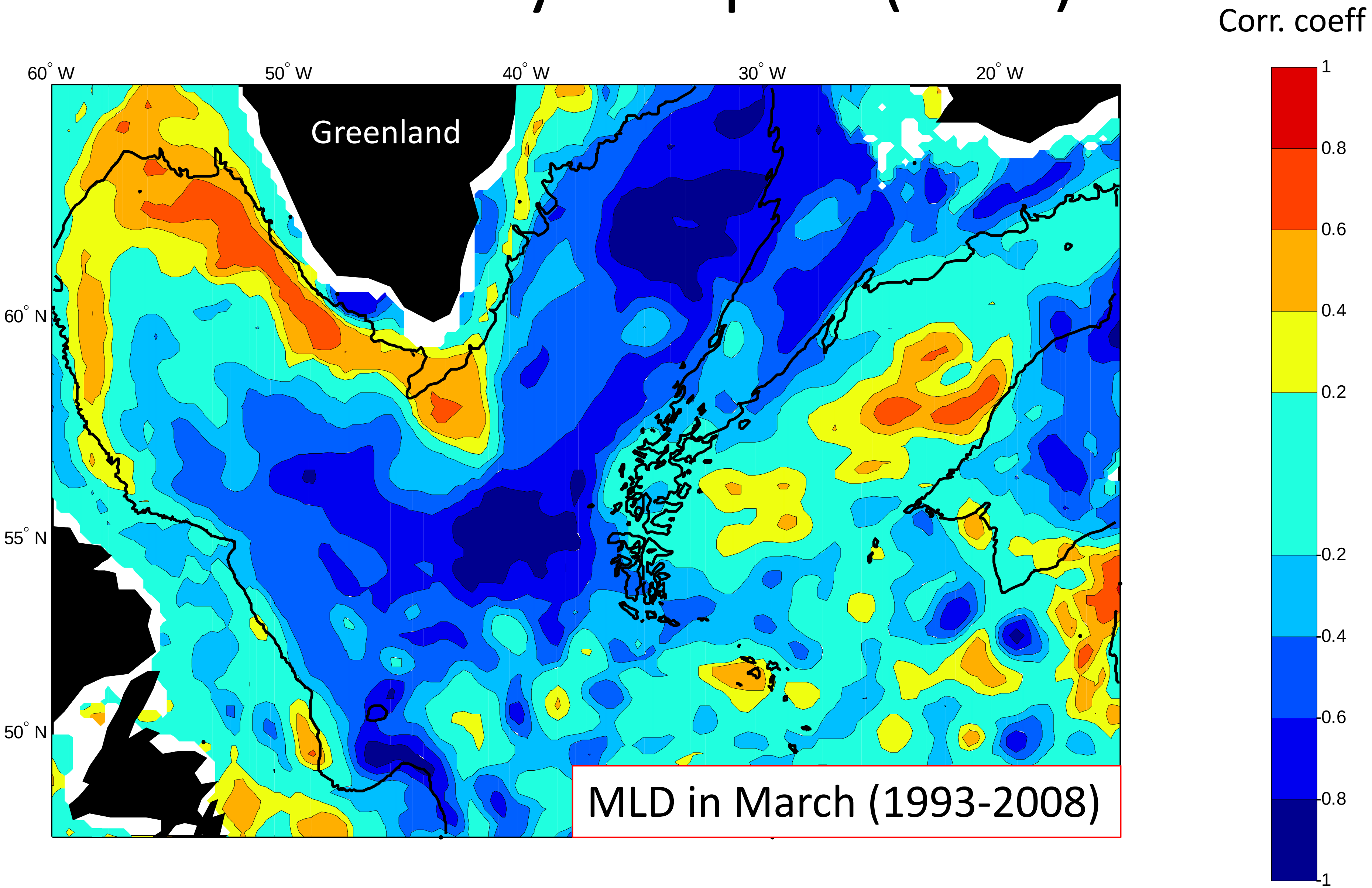



Nitrate [mikro M]
Year

Silicate [mikro M]
Year

Normalized
Year

Normalized
Year

Normalized
Year

Normalized
Year

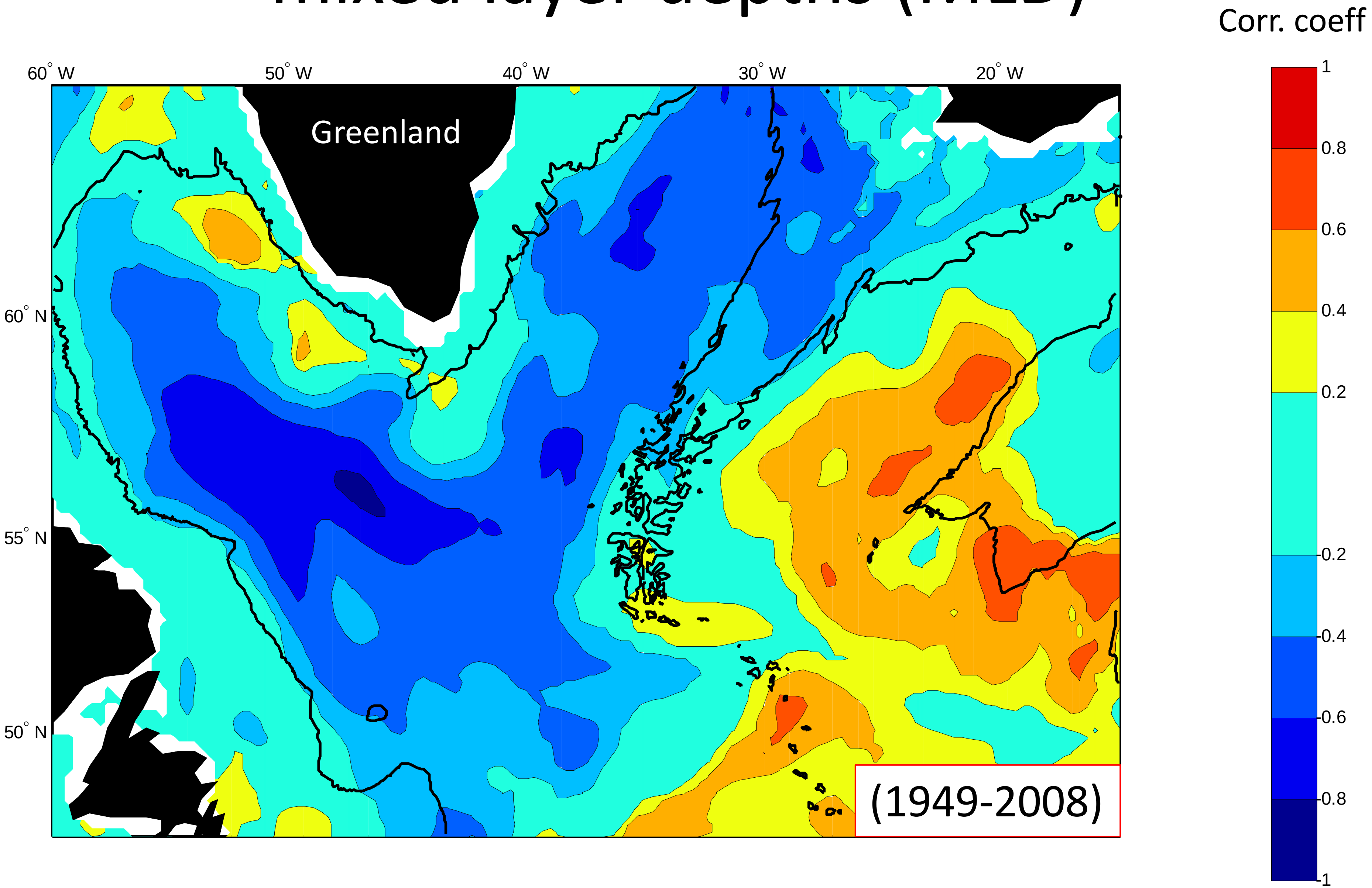
Surface salinities: Observed (CLISAP) and simulated



Altimetry and simulated mixed layer depths (MLD)



Simulated sea surface height and mixed layer depths (MLD)

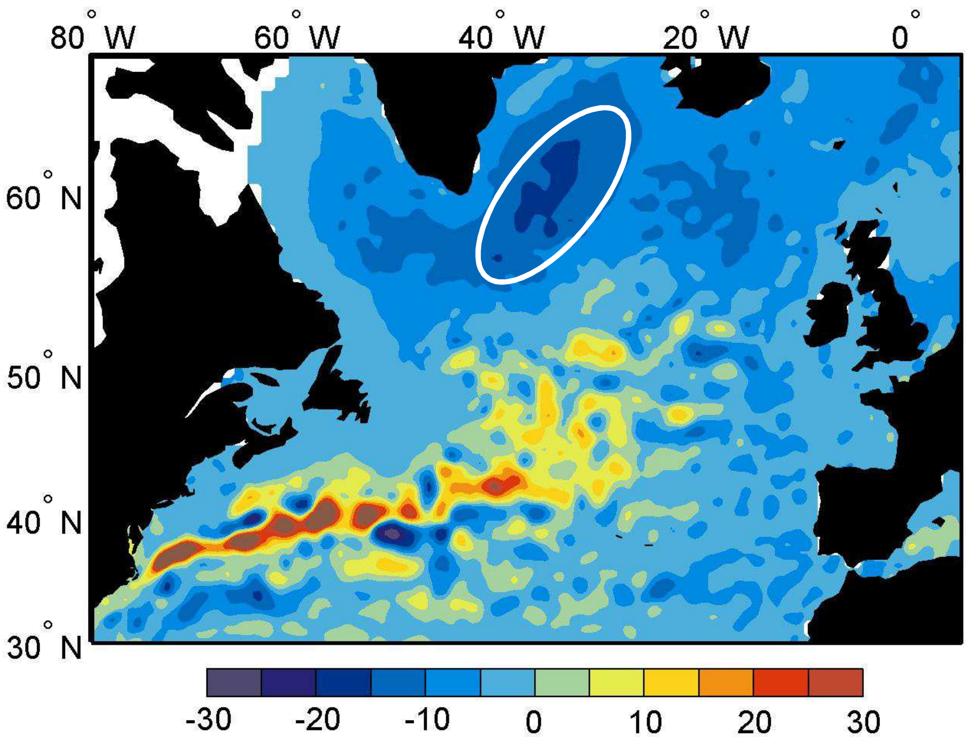


Sea surface height:

Gyre Mode

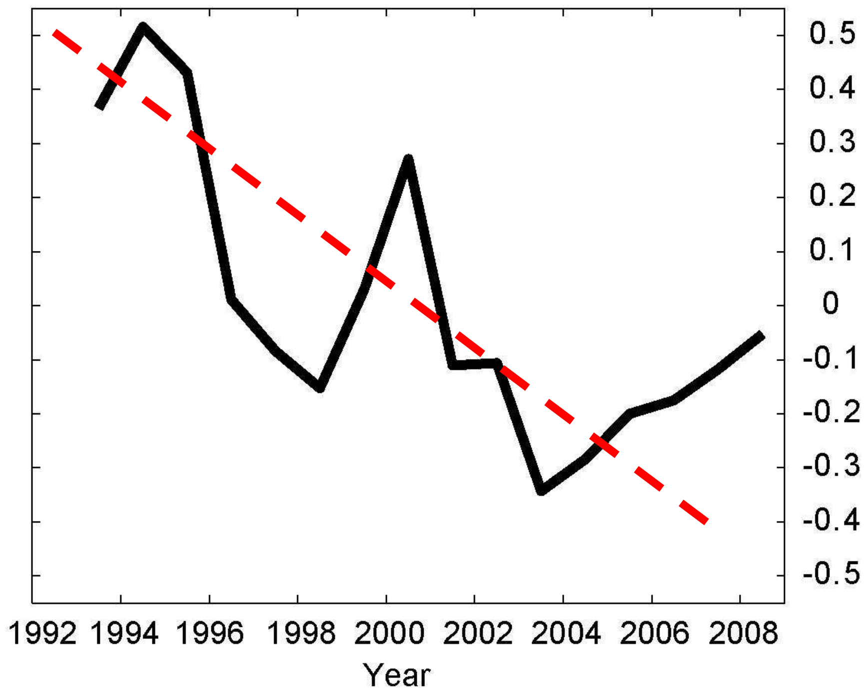
Satellite altimetry

Spatial pattern

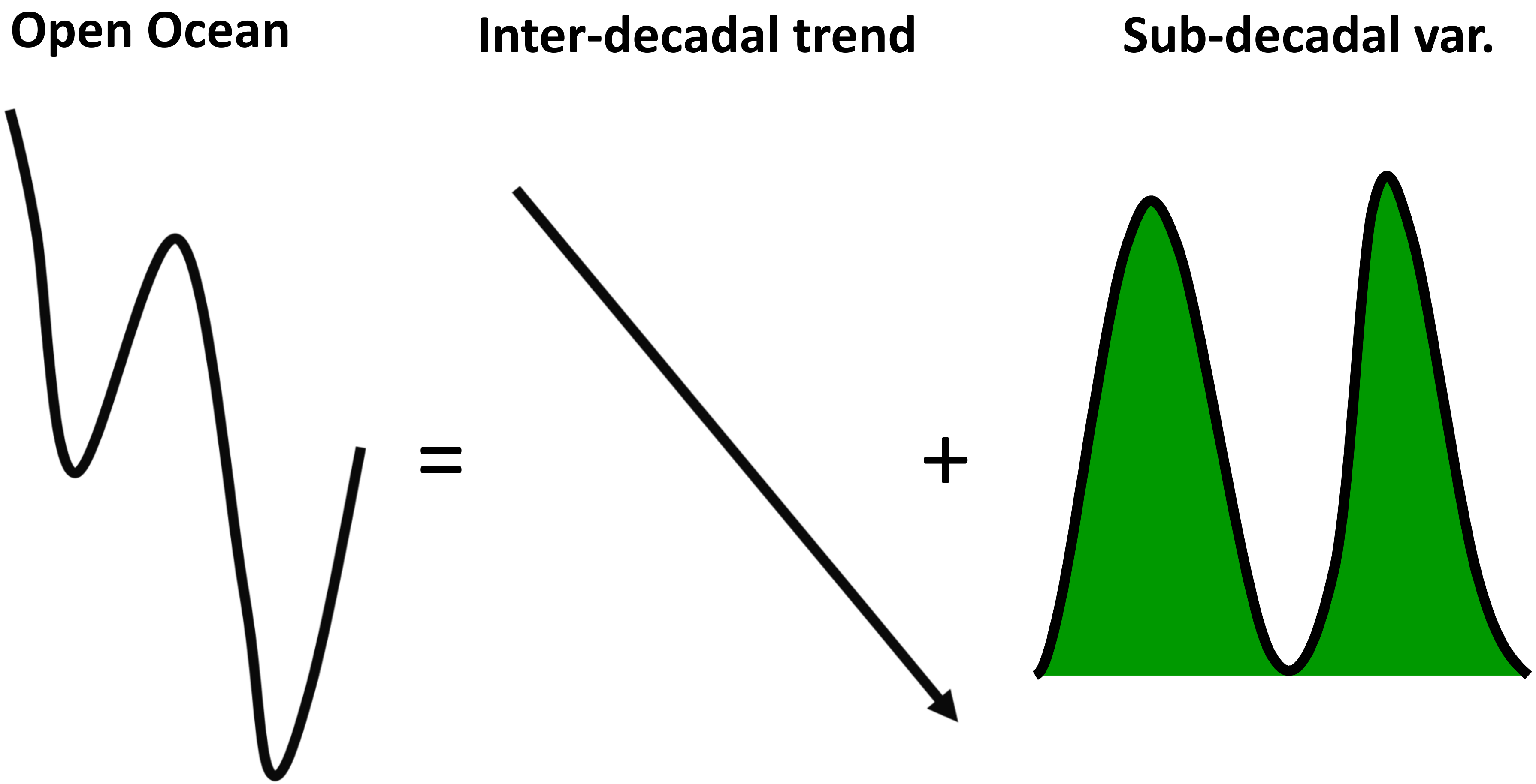


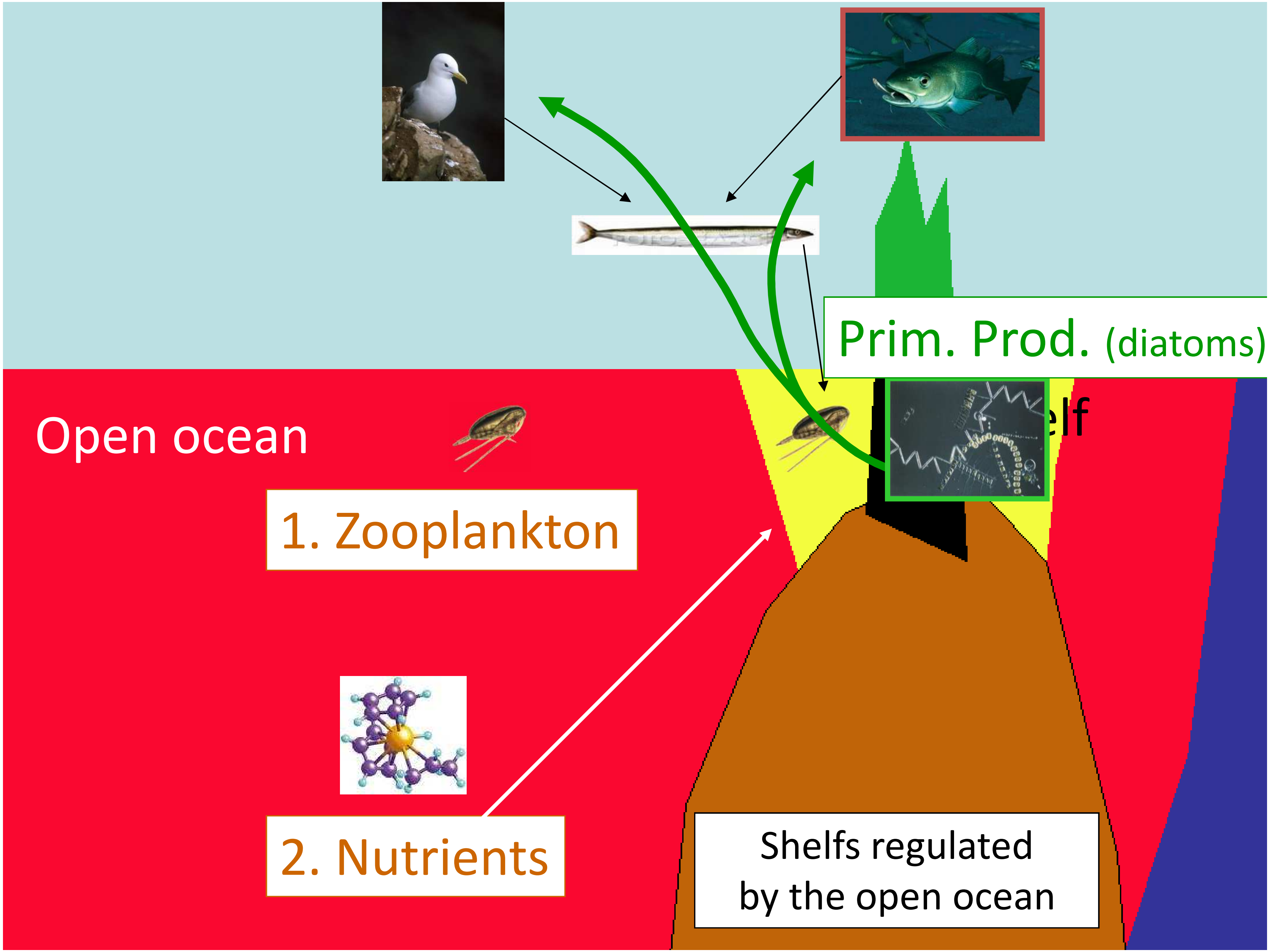
(Hakkinen and Rhines, 2004; Hátún et al. 2005)

Time series
(gyre index)

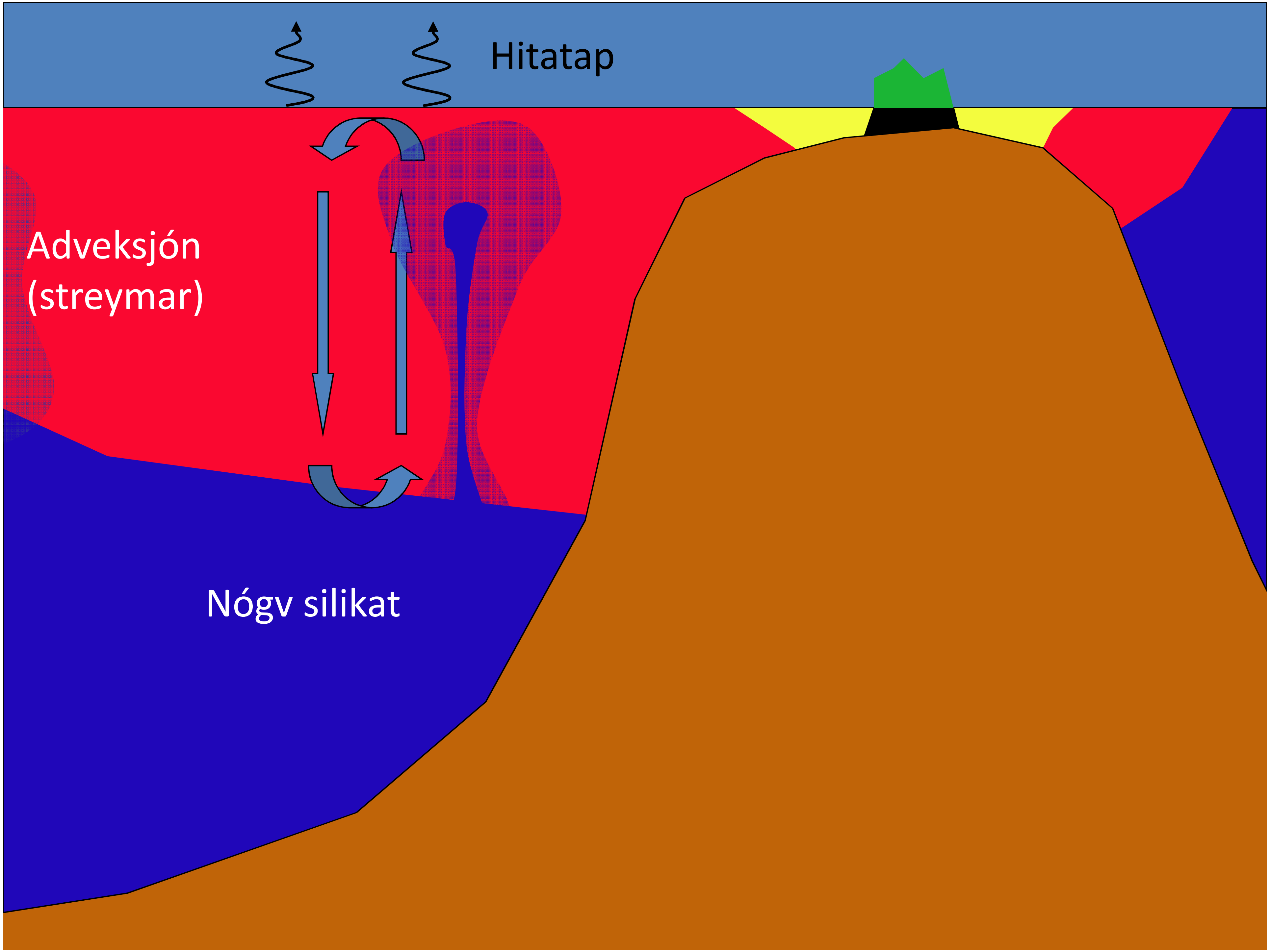


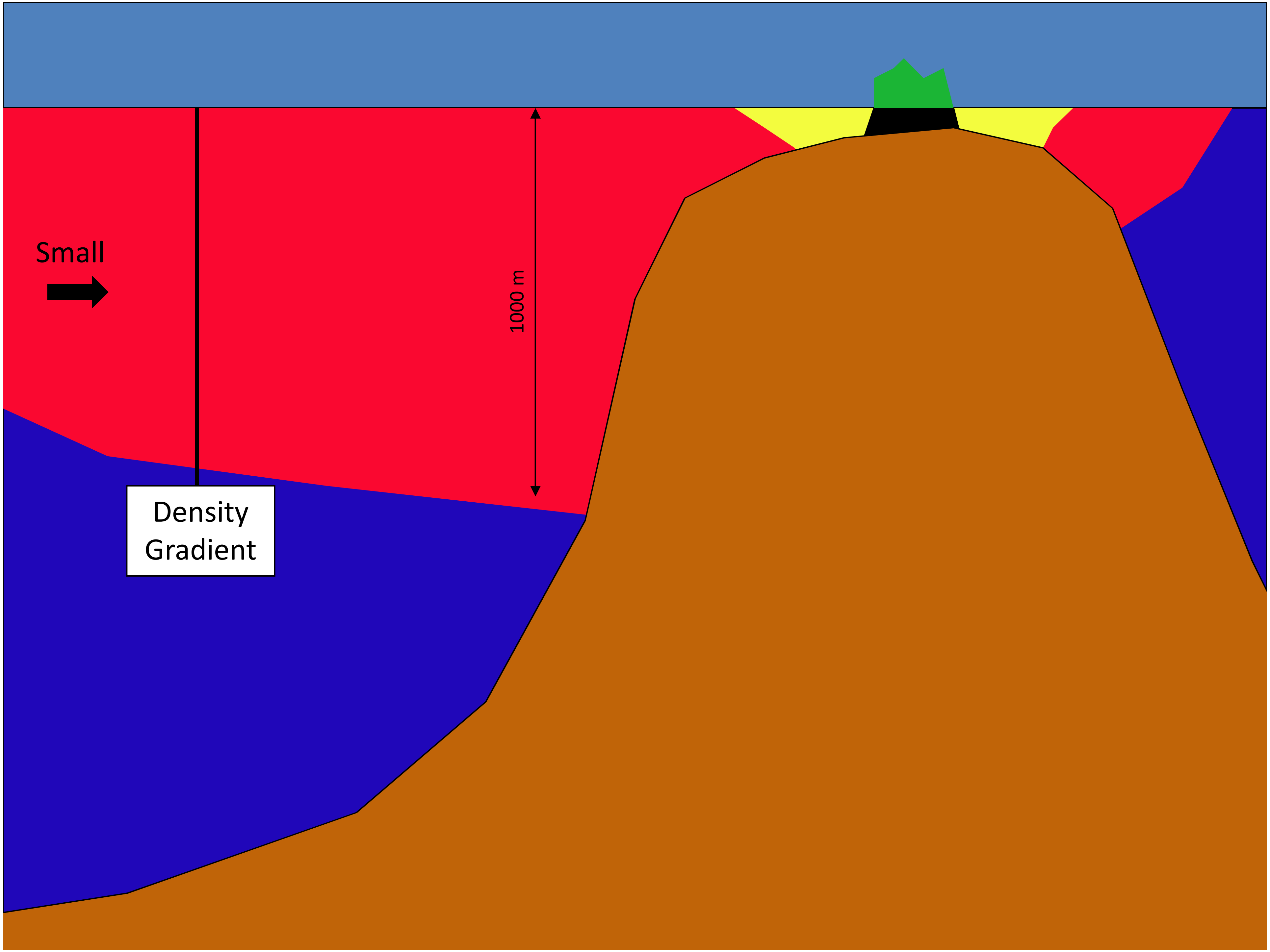
Sub-decadal pulses



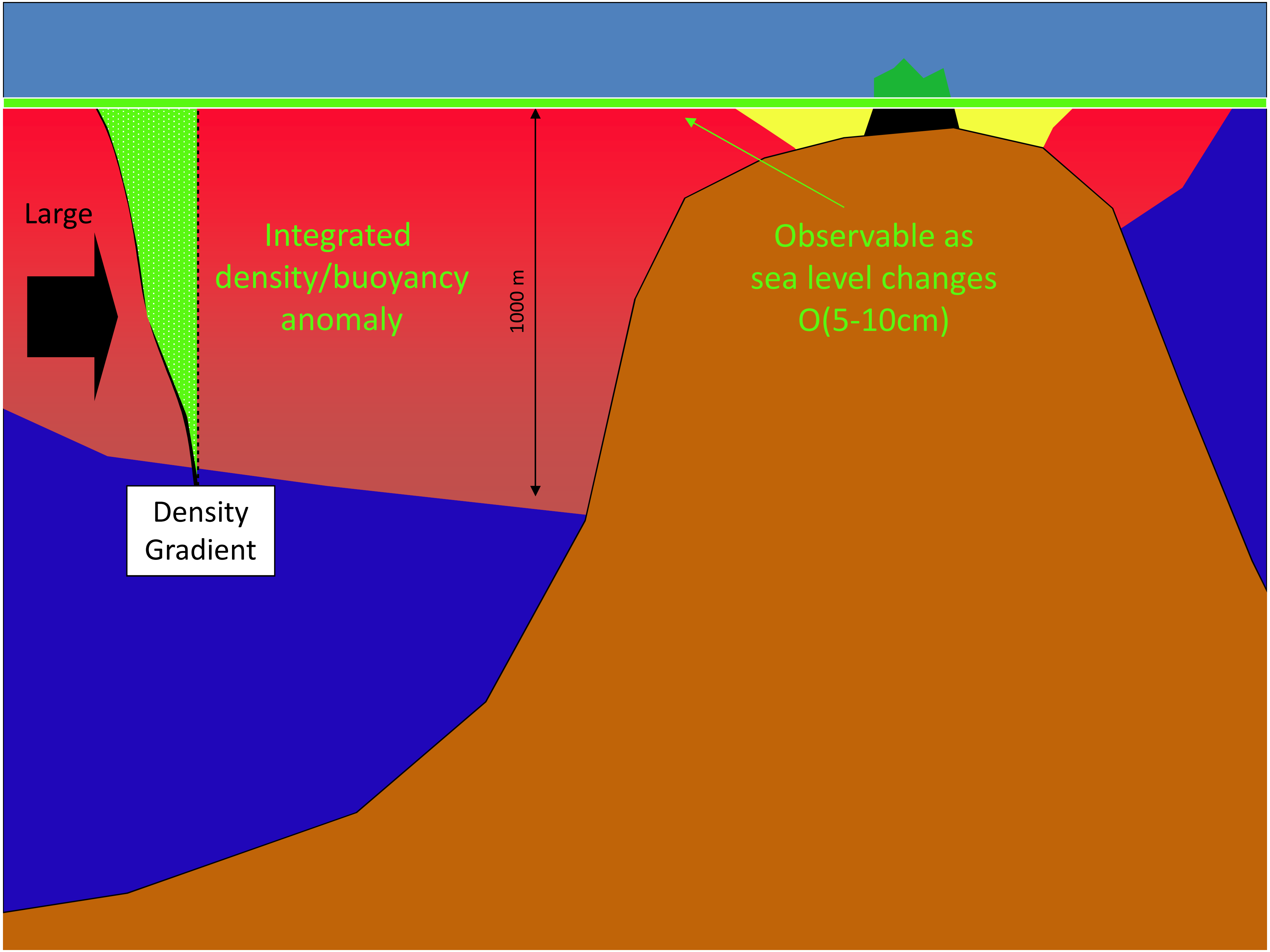


Prim. Prod. (diatoms)
Open ocean
1. Zooplankton
elf
2. Nutrients
Shelfs regulated
by the open ocean

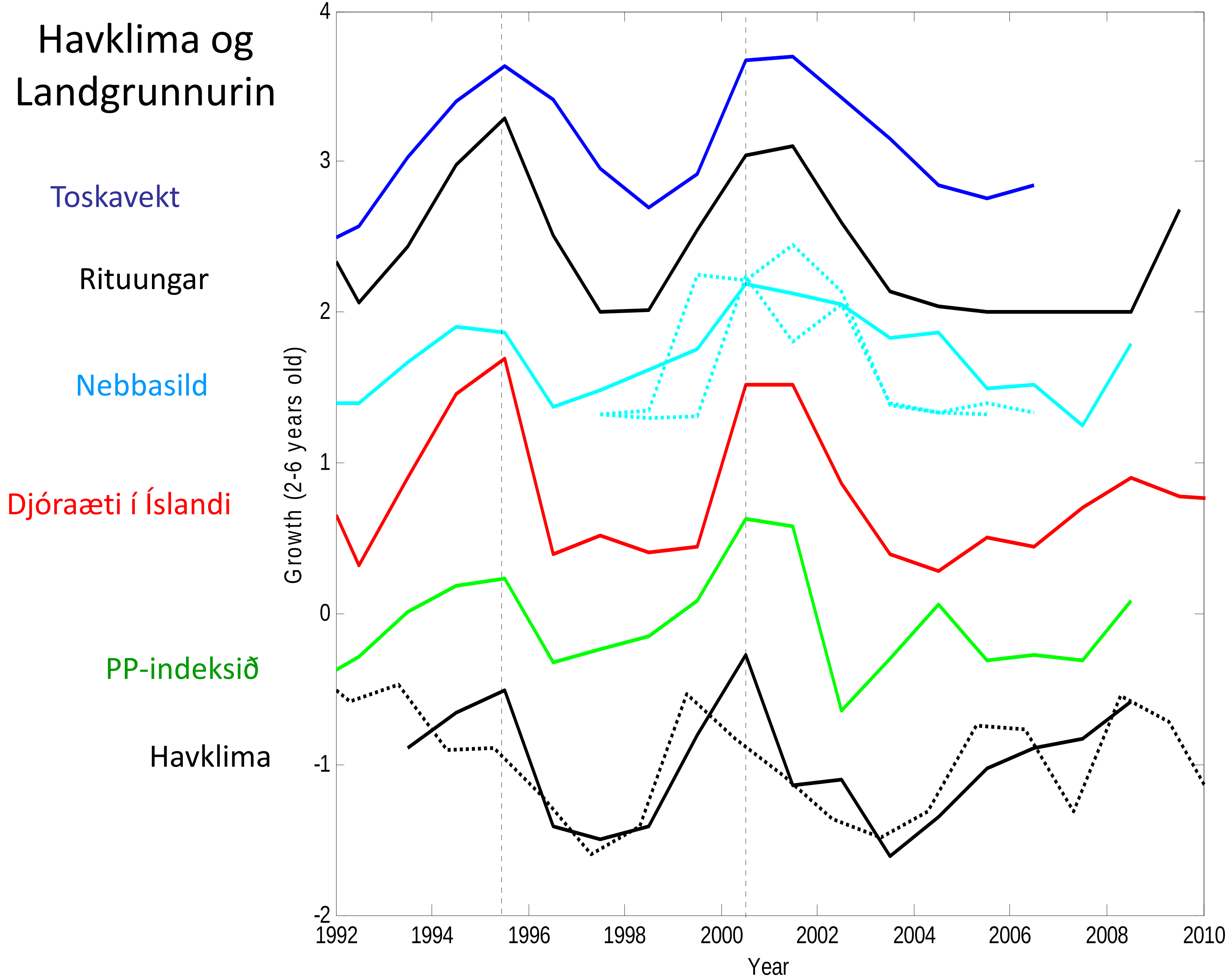

Hitatap
Adveksjón
(streymar)
Nógv silikat



Small
1000 m
Density Gradient


Large
Integrated
density/buoyancy
anomaly
1000 m
Observable as
sea level changes
O(5-10cm)
Density
Gradient

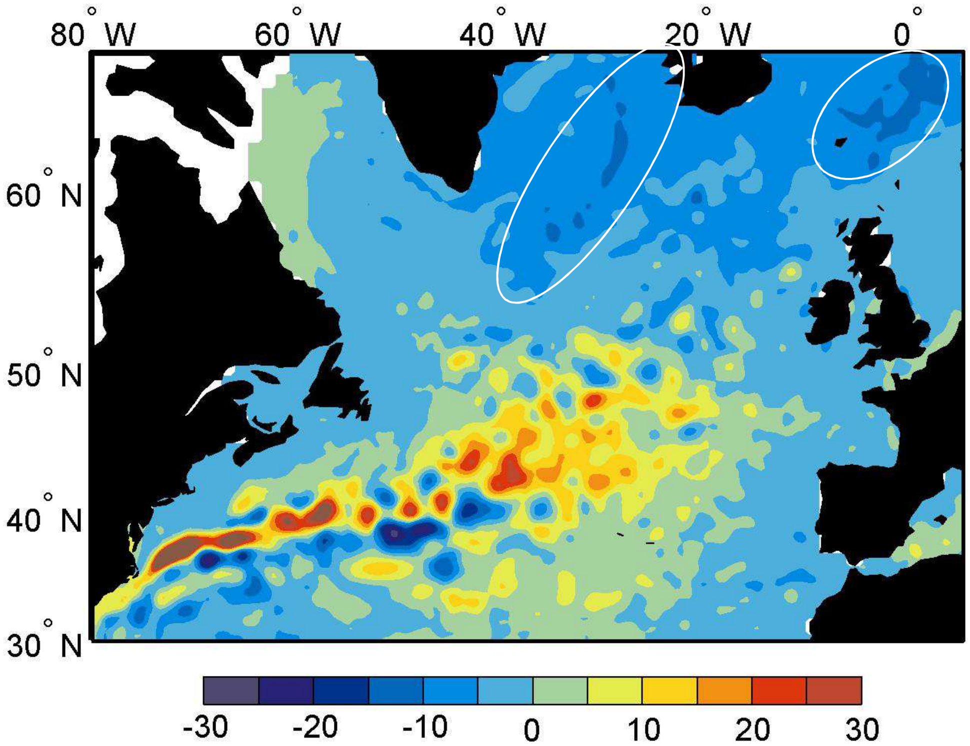
Havklima og Landgrunnurin

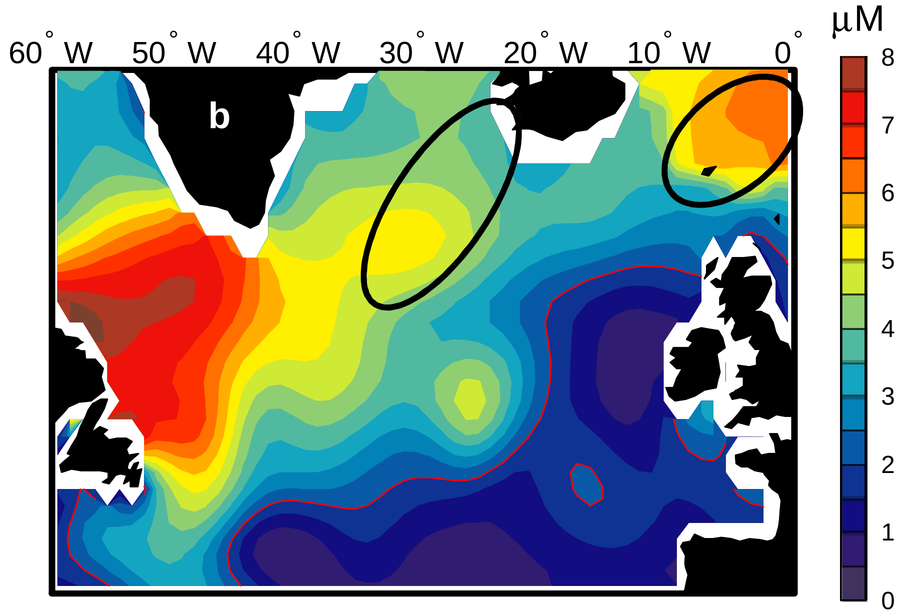


Sea surface height:

Sub-decadal oscillations (SDO)

Spatial pattern





Vestmannaeyjar archipelago

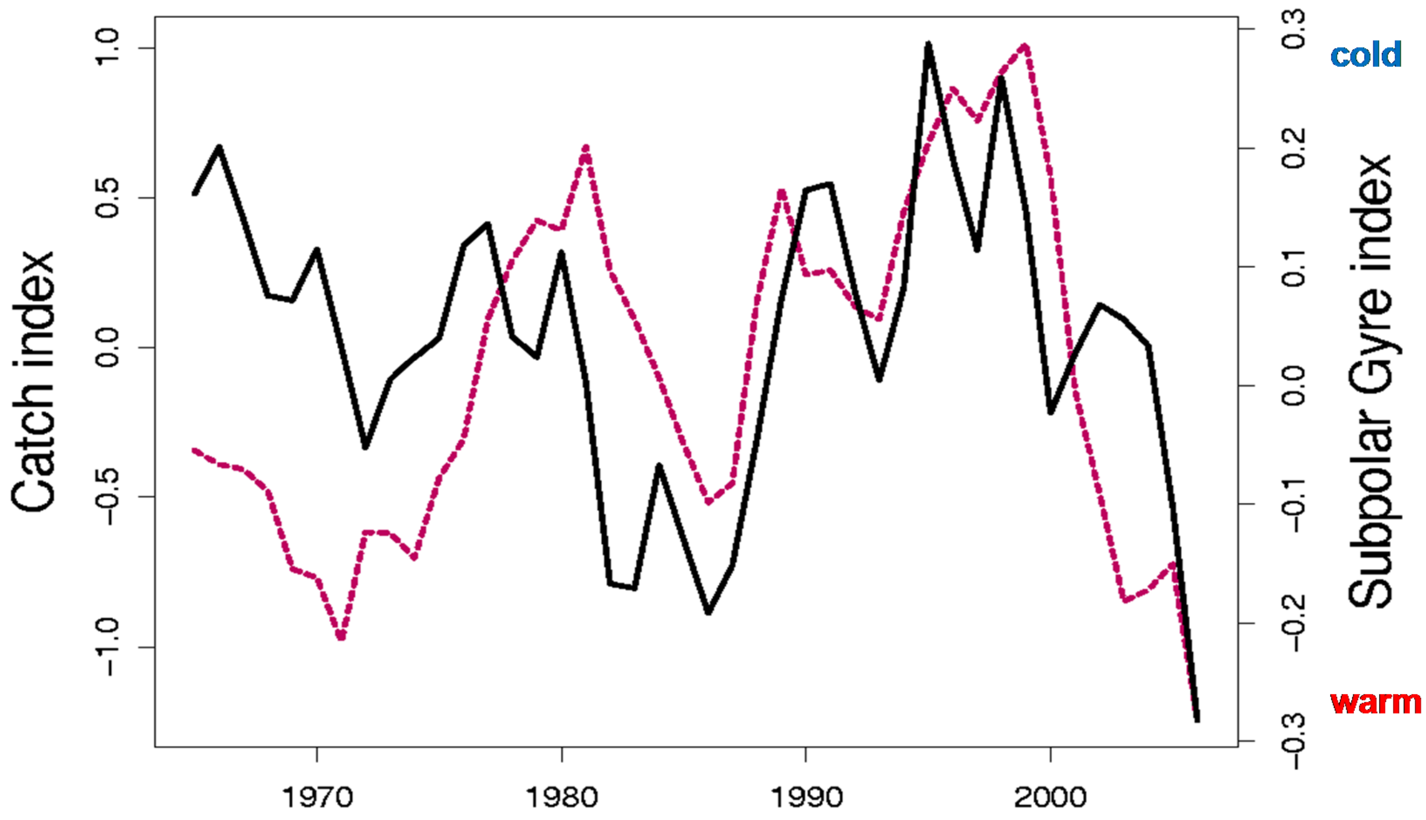
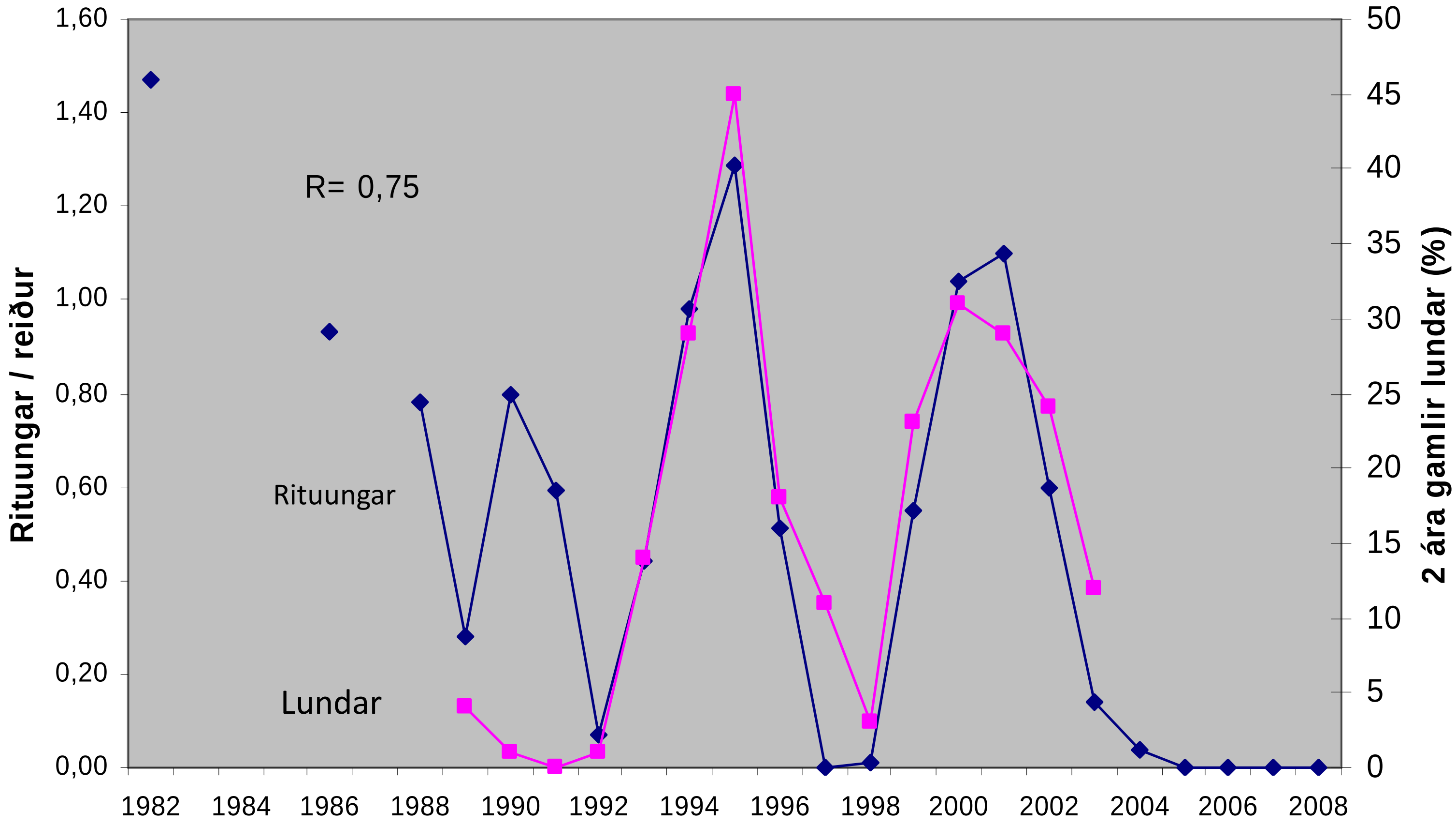


Figure 4. The Puffin catch index (black) compared with The Subpolar Gyre index 5 years earlier (dotted red). There was an overall positive correlation (r=0.42, n=42) between the two indices. A higher correlation was obtained when data from five out of six islands are underlying the Puffin catch (r=0.64, n=29)

Freydís Vigfúsdóttir, Yann Kolbeinsson and Jónas P. Jónasson

Rituungar/reiður og 2 ára gamlir lundar í fleygingafugli (%)

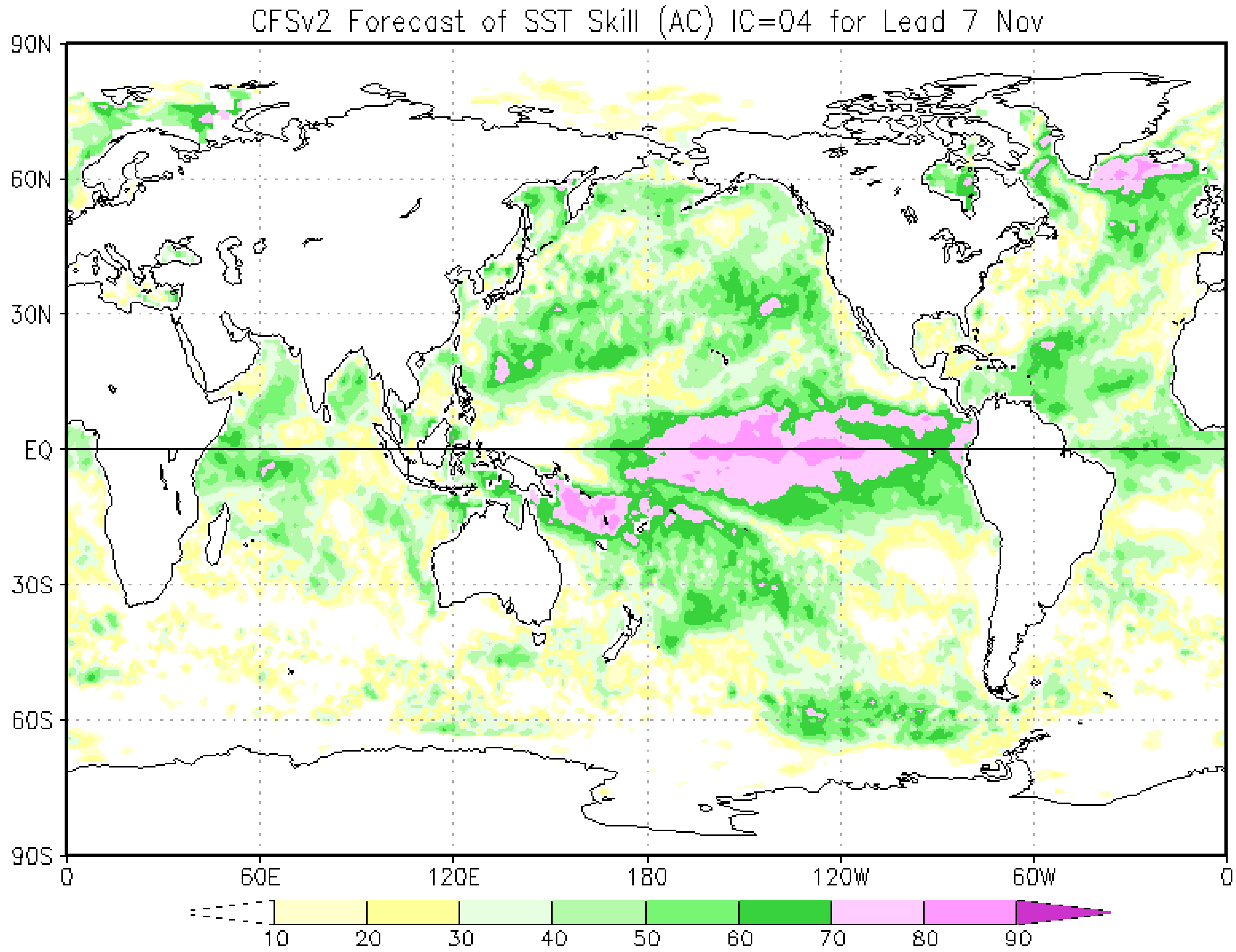


Framhald (gjørt í Hamburg):

Labrador Sea convection blows life to the Northeastern Atlantic

The subpolar gyre is an epicenter with large amounts of
the ecologically important zooplankton species *Calanus finmarchicus*.
Strong convection in the Labrador Sea inflates the subpolar gyre,
advects these subarctic waters, and the CalFin they contain, towards east.
This has a beneficial impact on the Iceland shelf ecosystem,
as well as for seabird colonies around the entire subpolar Atlantic.

Keywords:
Ocean-shelf exchange, sub-decadal variability,
predictability, altimetry metric, *Calanus finmarchicus*



CFSv2 Forecast of SST Skill (AC) IC=04 for Lead 7 Nov
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
10
20
30
40
50
60
70
80
90