Current rates of change in pH and calcium carbonate saturation in the high latitude North Atlantic Ocean

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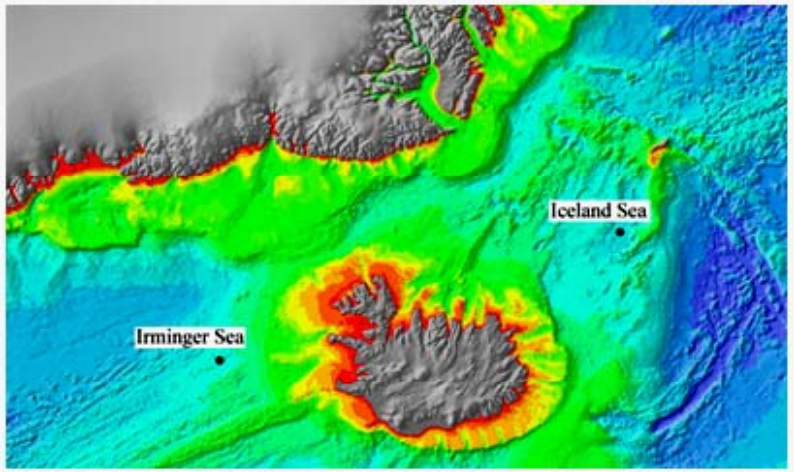
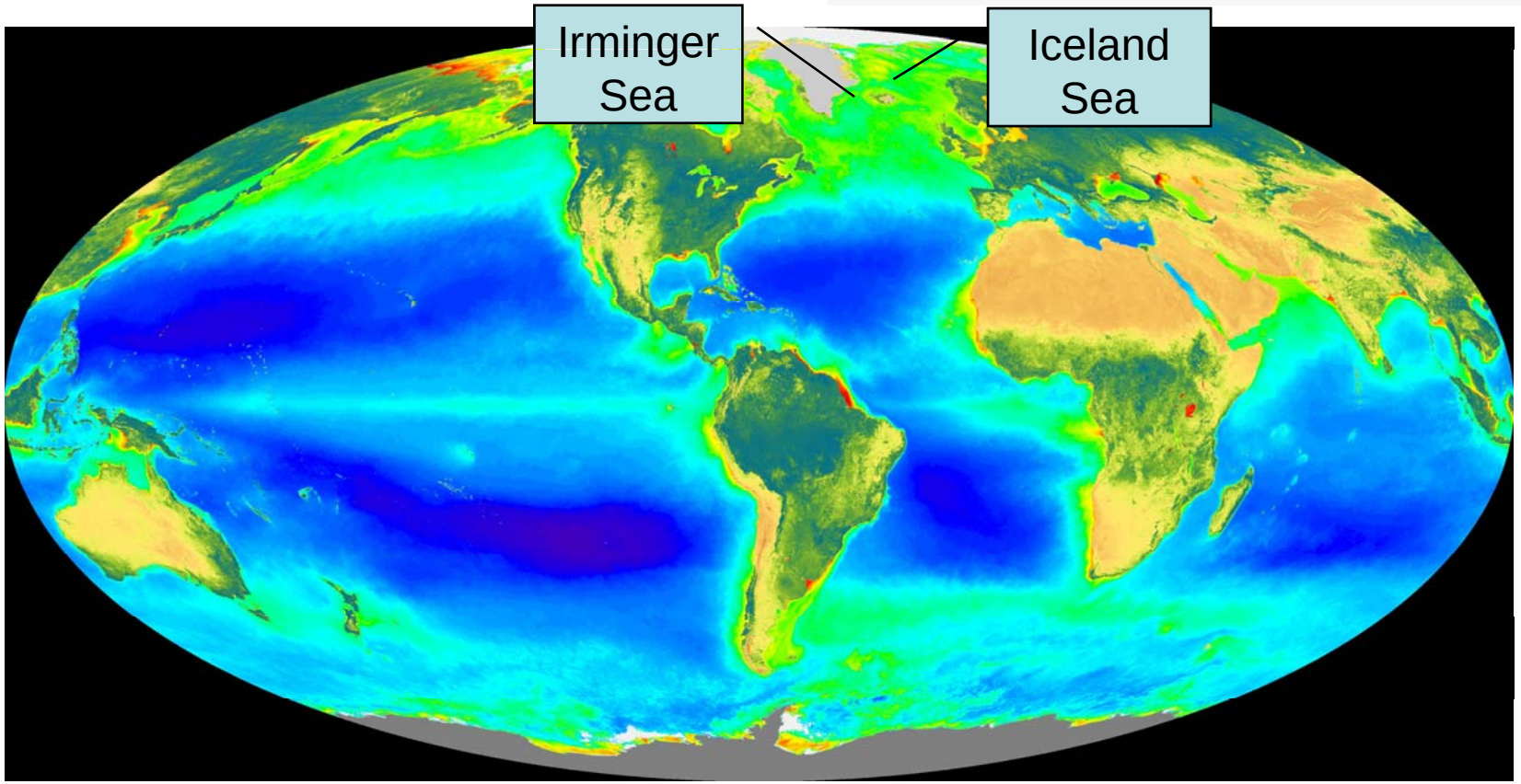
2nd Symposium on the Ocean in a High-CO2 World

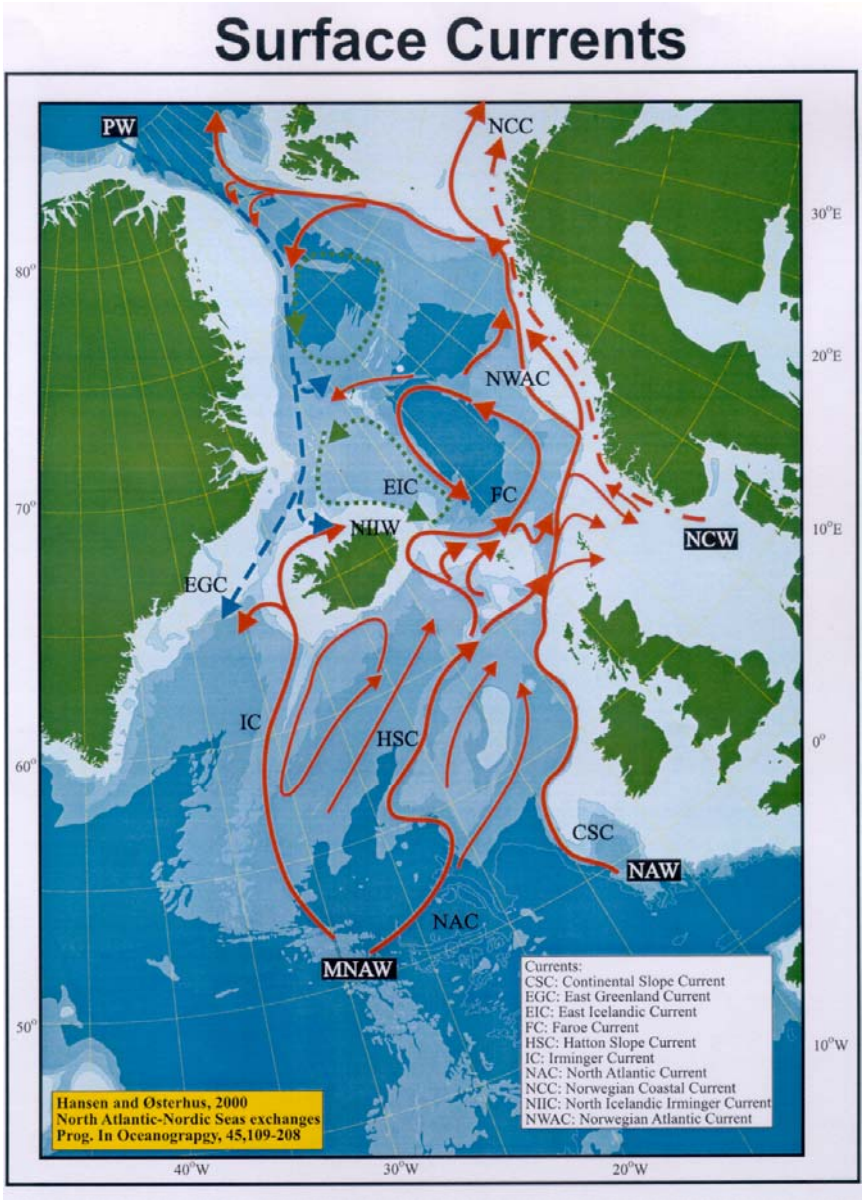
Time series since 1983 from high latitude Atlantic:

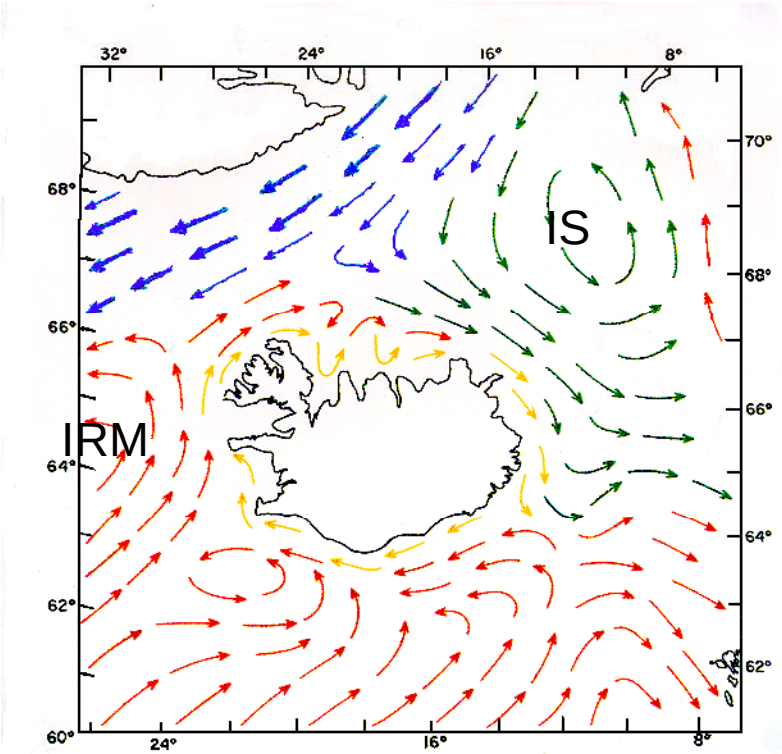
- Irminger Sea with relatively warm and saline water derived from the North Atlantic Drift and the

- Iceland Sea with cold water from the Arctic

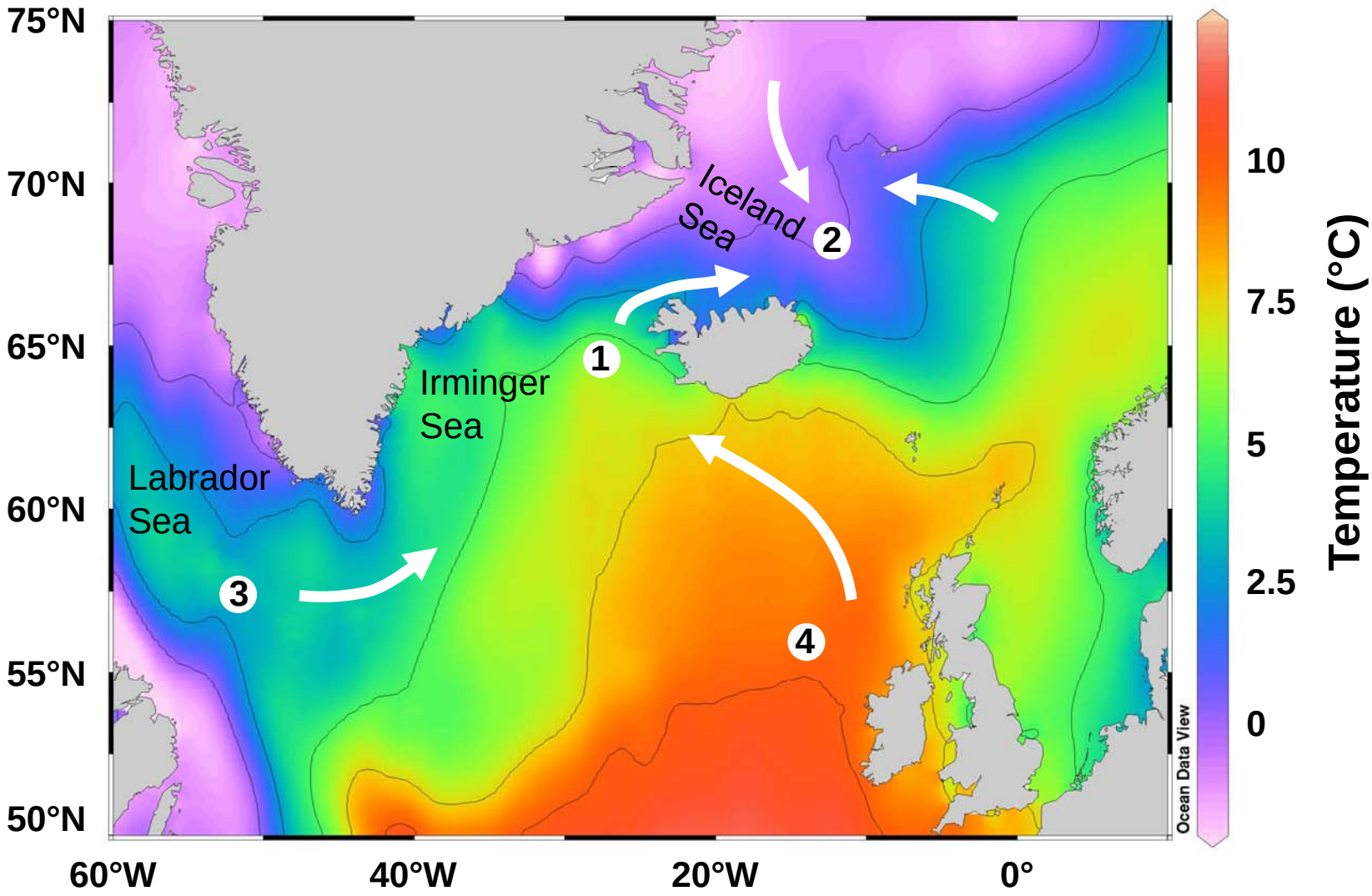






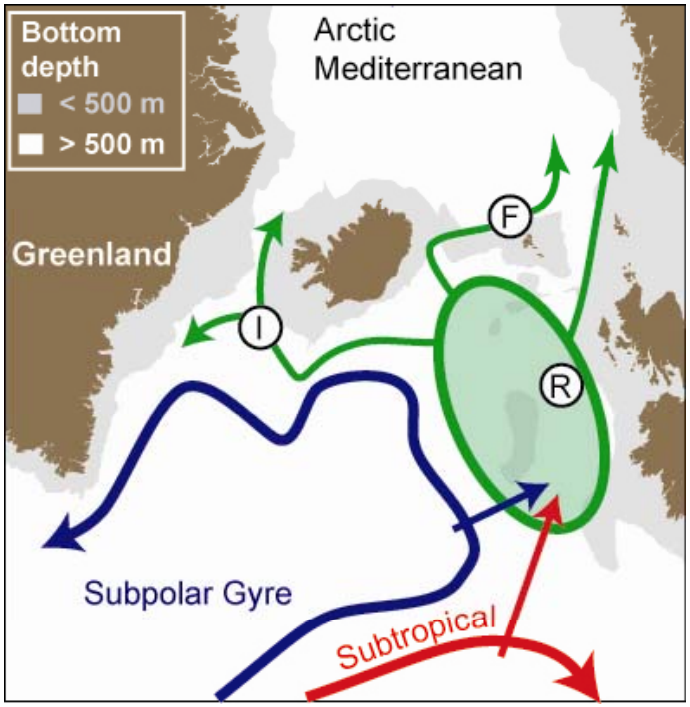


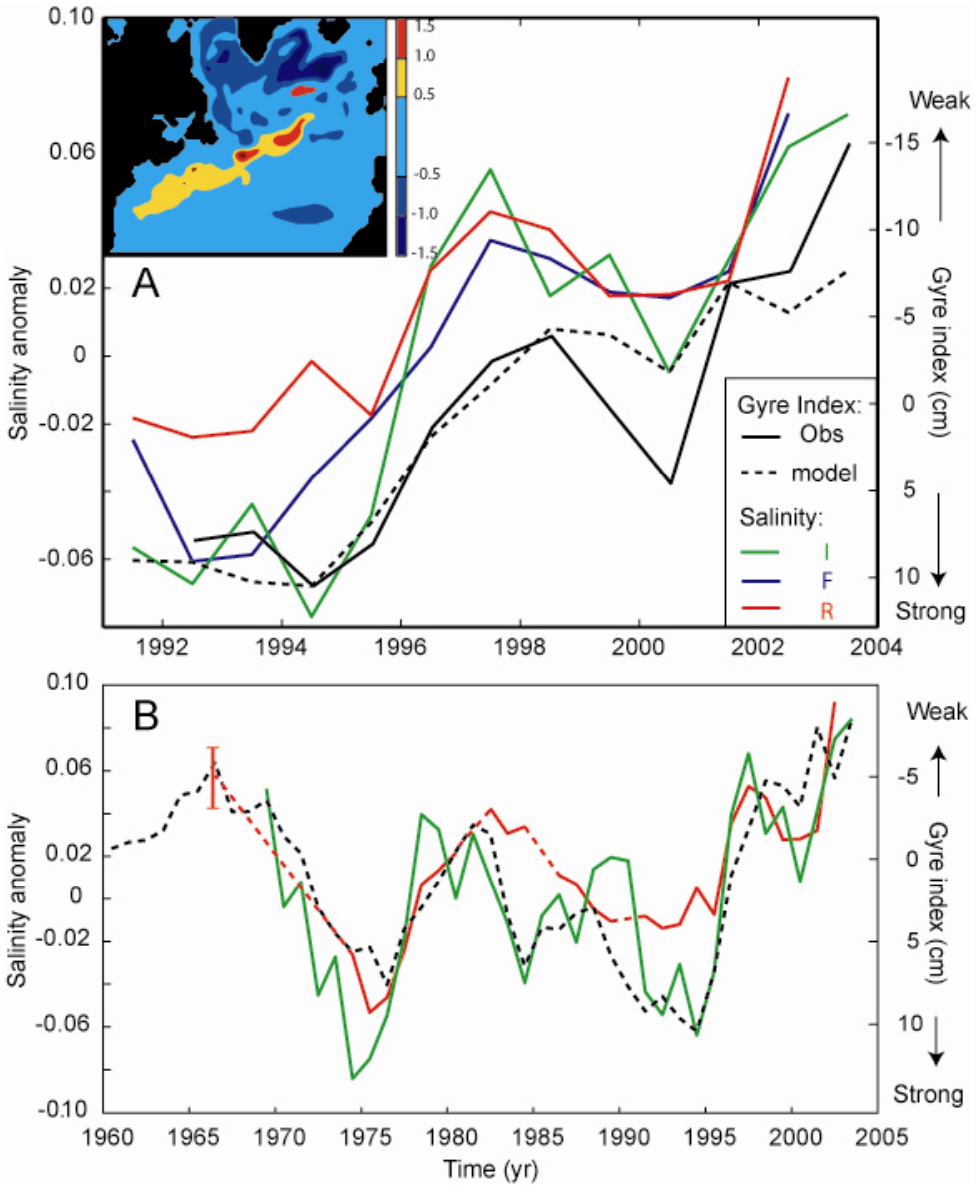
Atlantic Water S>35 Polar Water S<34.4 , Arctic Water S34.6-34.8

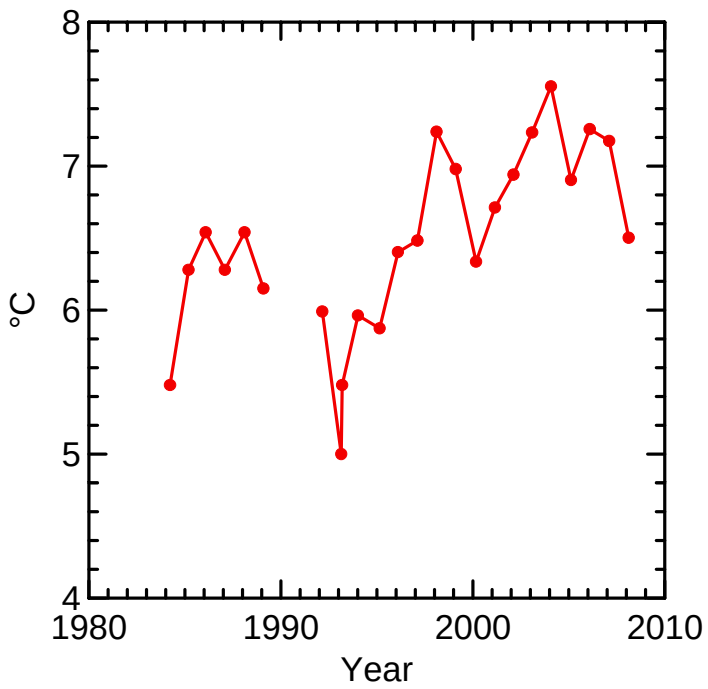


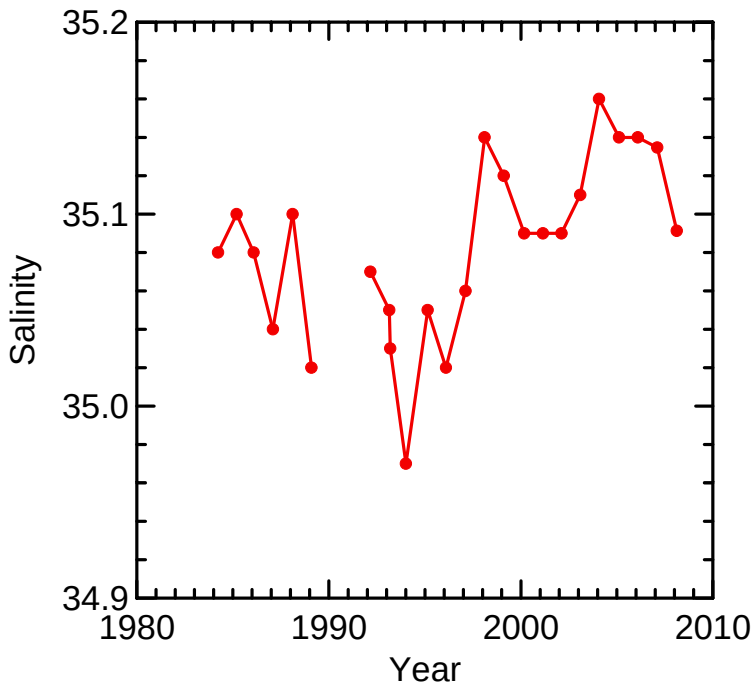
Irminger, 1, and Iceland Sea, 2, time series stations. Arrows indicate directions of influences on t and S properties.

Hátún et al., 2005, Science (309), 1841.

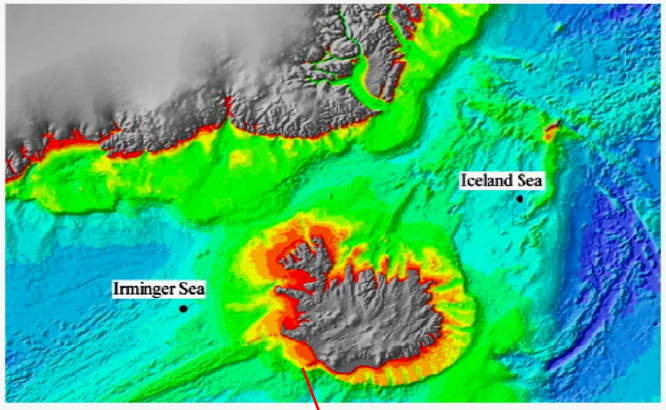








Irminger Sea time serie station: Warmer and more saline after 1997

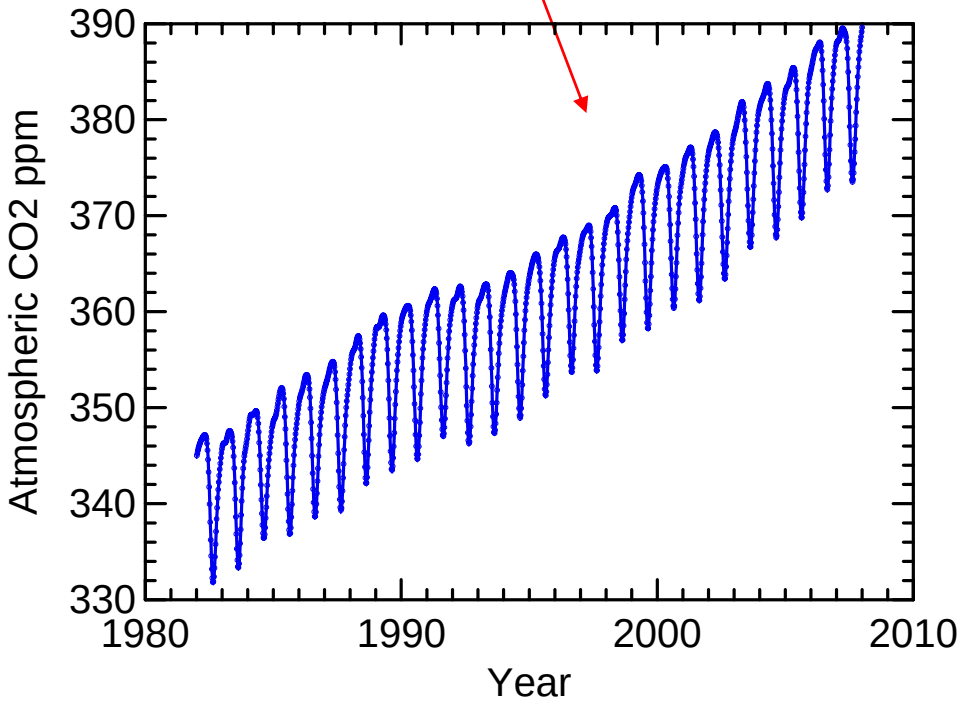


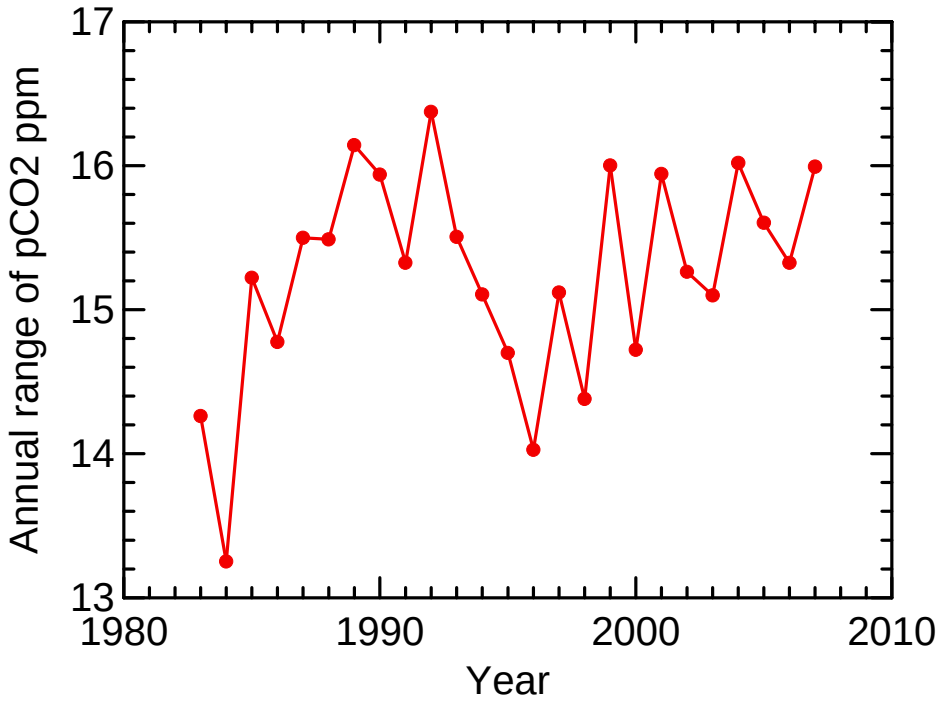
Atmospheric CO2 from the Vestmann Islands:

ICE, Globalview-CO2

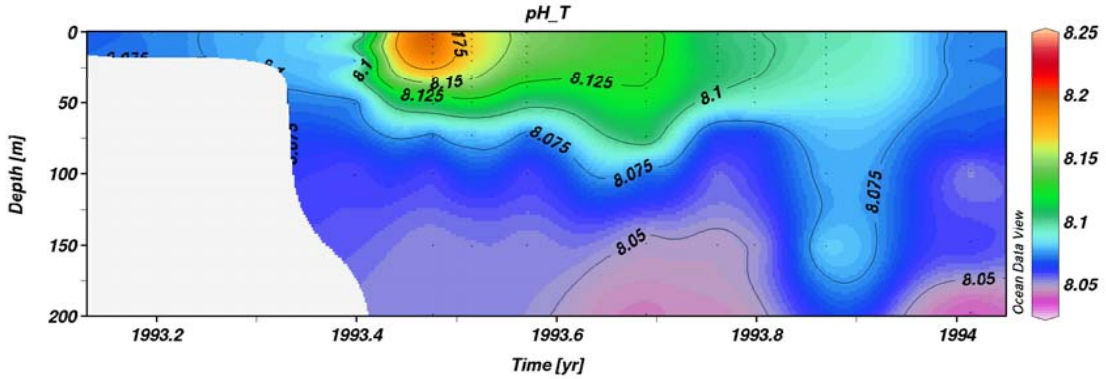
Strong seasonality
Annual amplitude 13-17 ppm

ICE, (*GLOBALVIEW-CO2*, 2006)

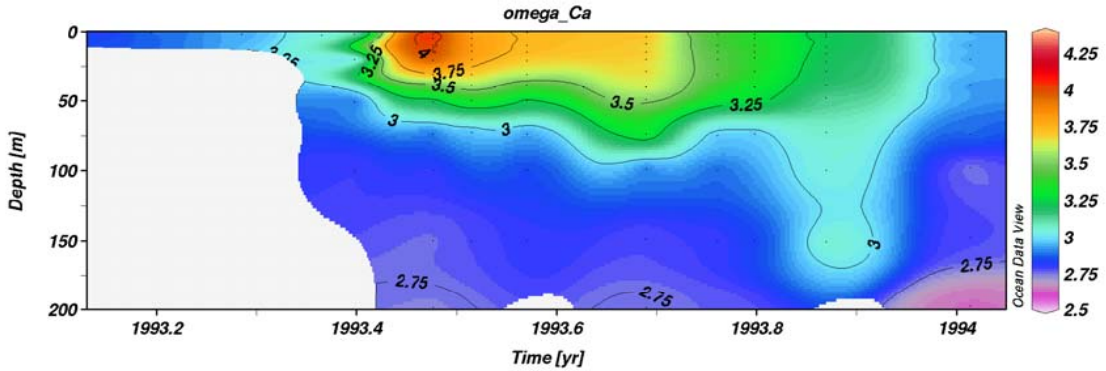




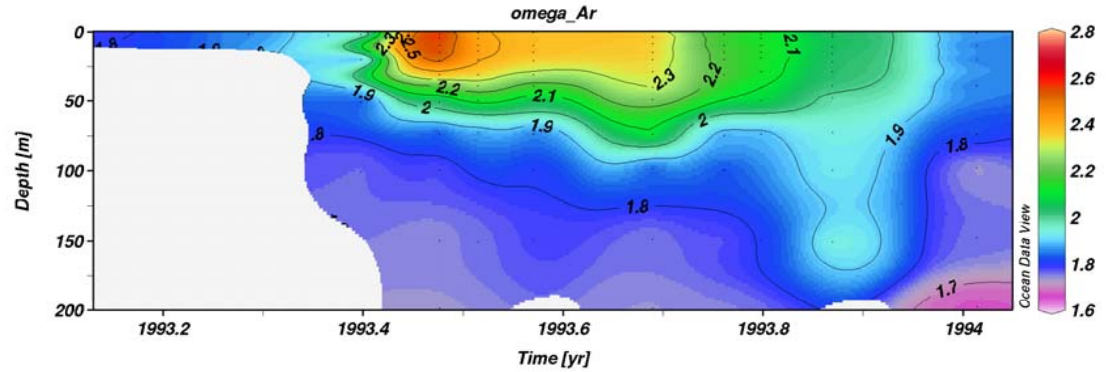
Irminger Sea – Seasonal Cycle 1993



pH



Ω_ca

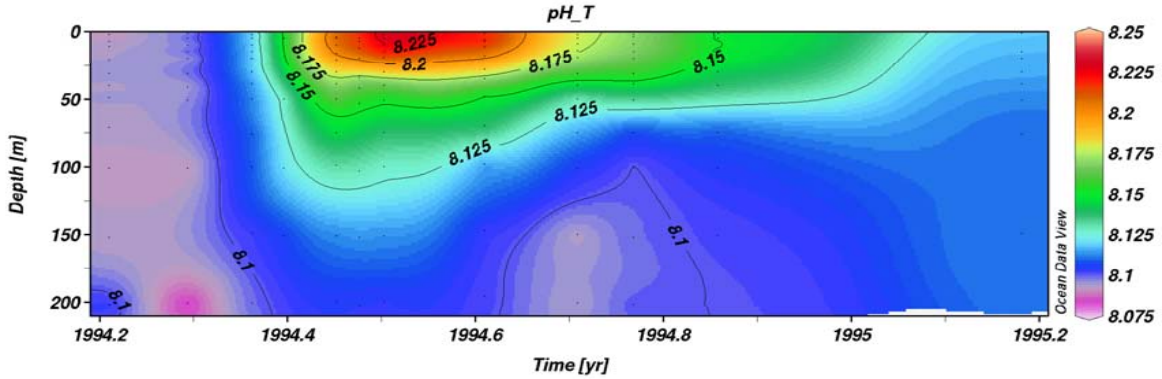


Ω_ar

Seasonal pH amplitude: 0.169

CO_2 sink:
-0.5 mol CO_2 m^{-2} yr^{-1}

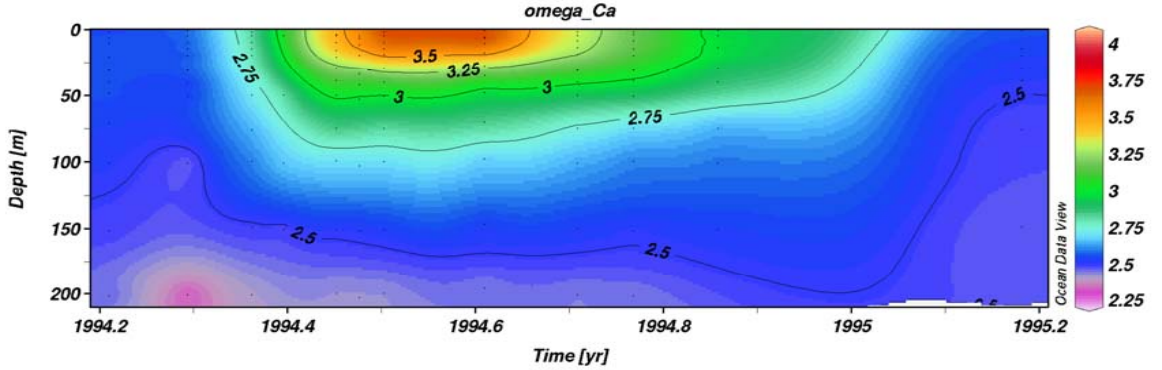
Iceland Sea – Seasonal Cycle 1994



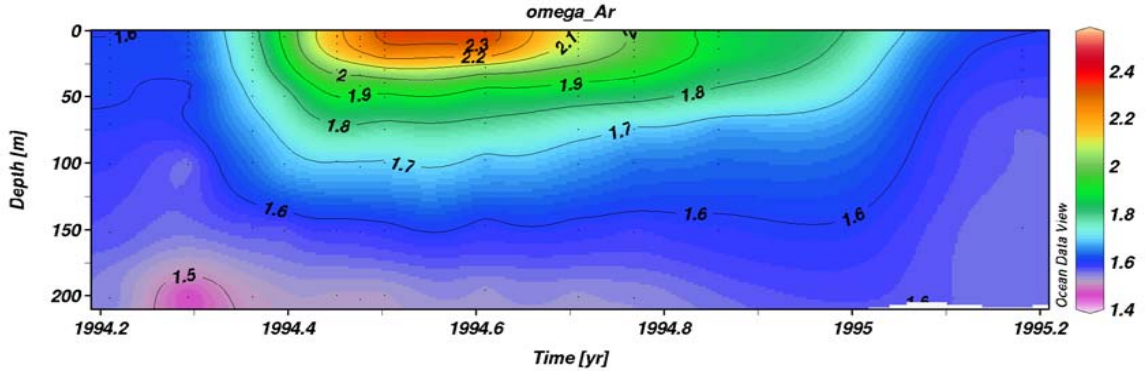
pH

Seasonal pH amplitude: 0.230

CO_2 sink:
-4.4 mol CO_2 m^{-2} yr^{-1}



Ω_ca



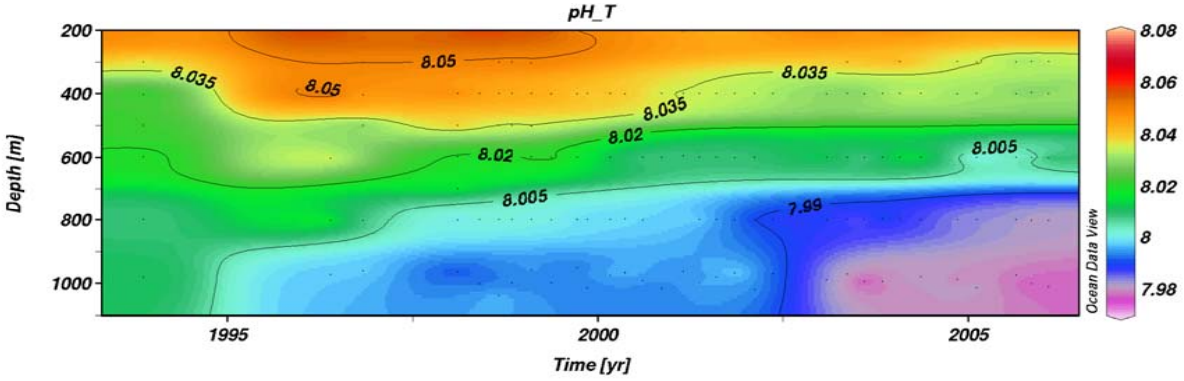
Ω_ar

For the evaluation of long term pCO2 changes:

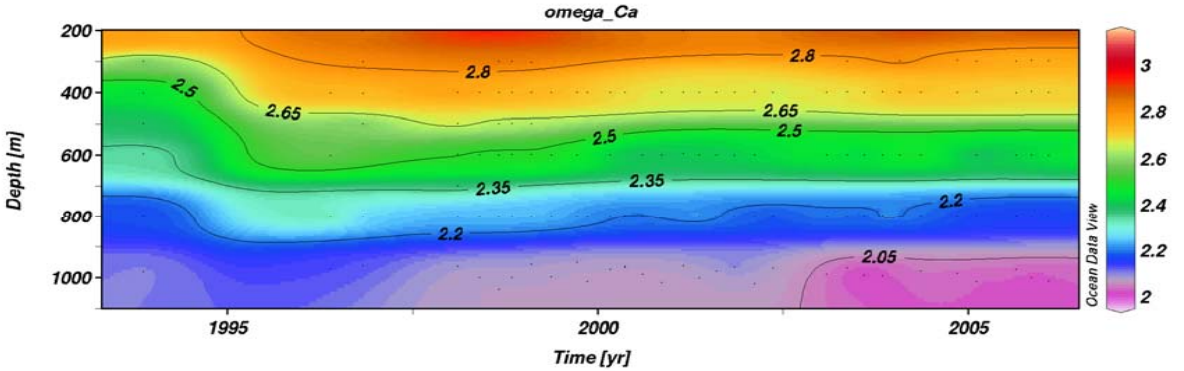
- Minimise the effects of biology; Use winter observations, Jan-March, from surface layer

- Hydrographic variability and Salinity-Alkalinity-TCO_2 characteristics of different waters

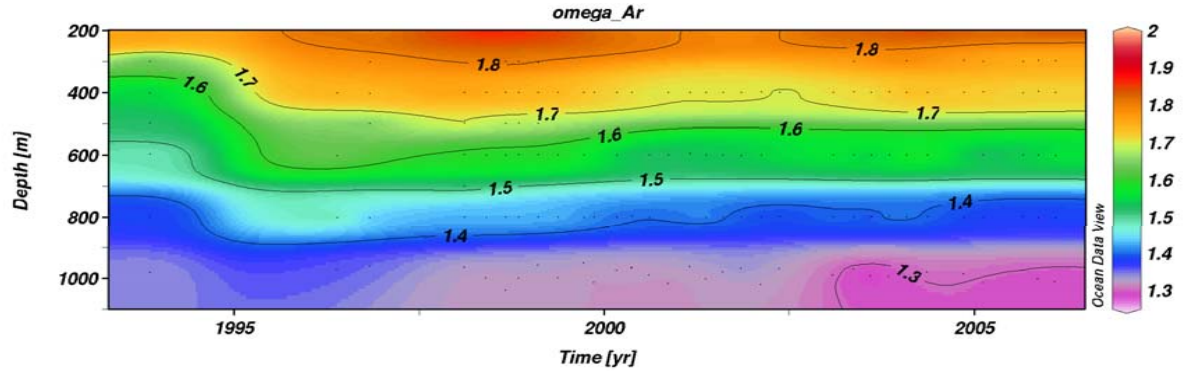
Irminger Sea, 200-1000 m depth, 1993-2006



pH

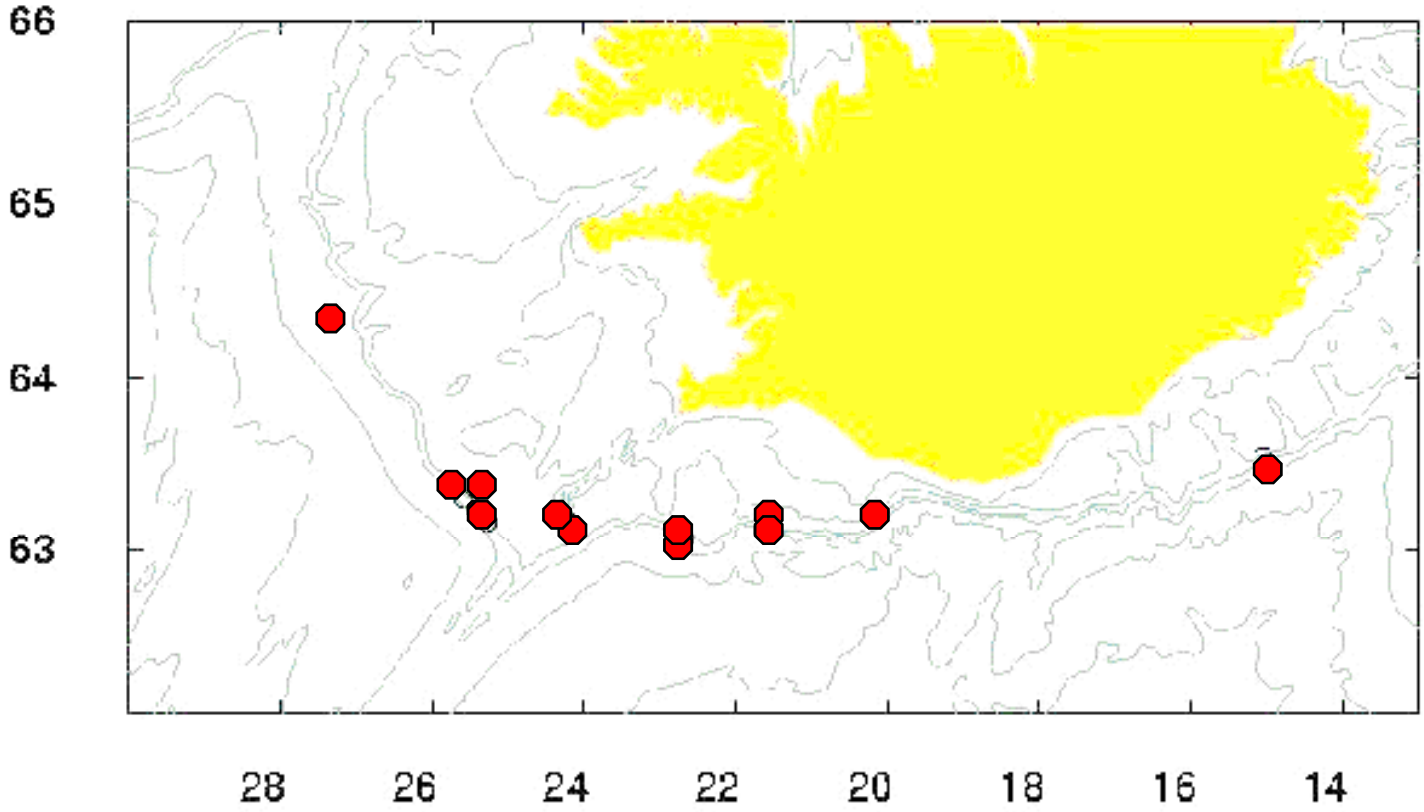


Ω_ca

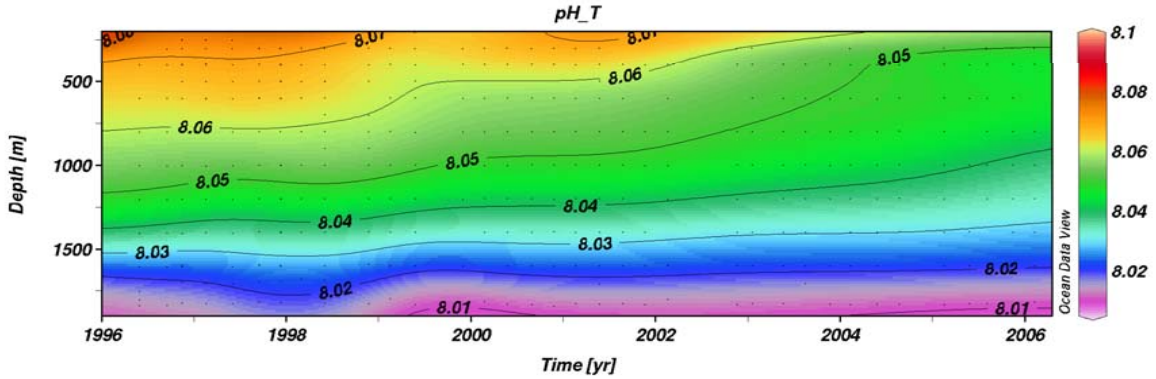


Ω_ar

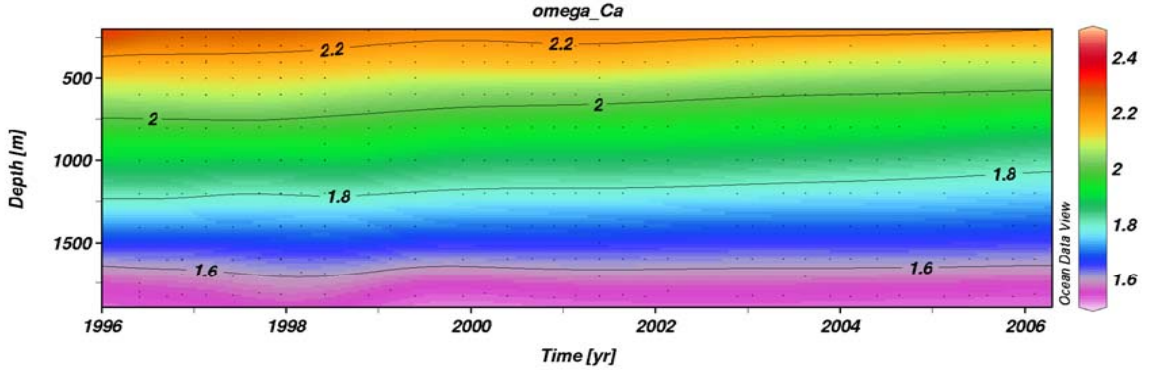
Distribution of records of *Lophelia pertusa* in Icelandic waters (map provided by S.A. Steingrímsson). Mostly in the depth range 200-600 m.



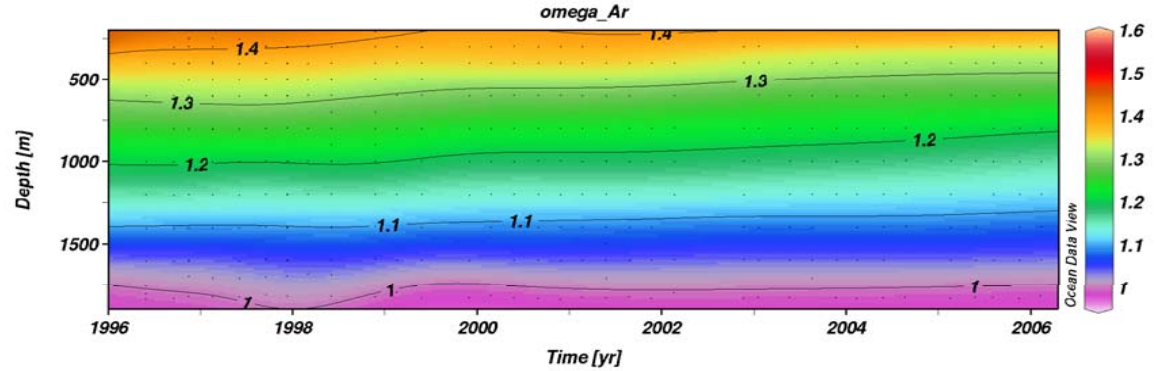
Iceland Sea, 200-1900 m depth, 1996-2006



pH



Ω_{ca}



Ω_{ar}

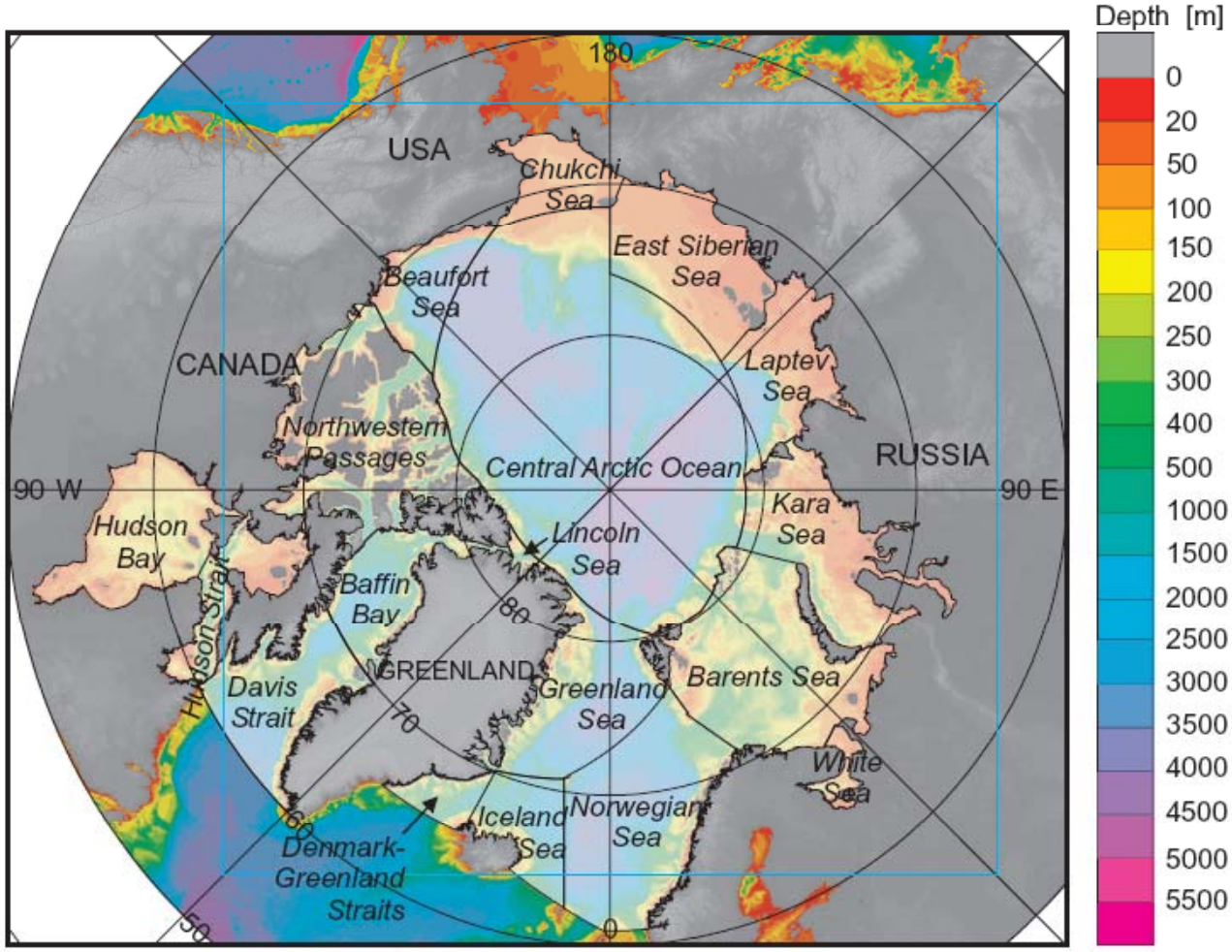
Stable water mass

600-800 m depth:
pH change -0.0024/yr

Large sea floor areas are becoming undersaturated w.r.t. aragonite

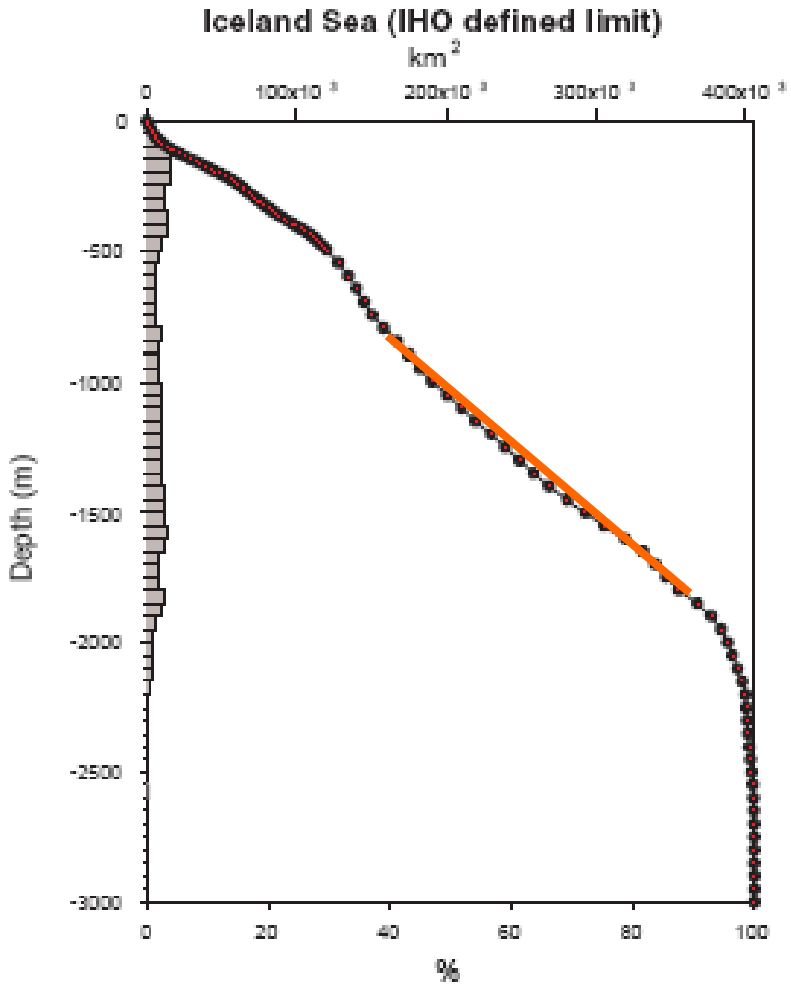
IHO defined limits of the Arctic Ocean and constituent Seas

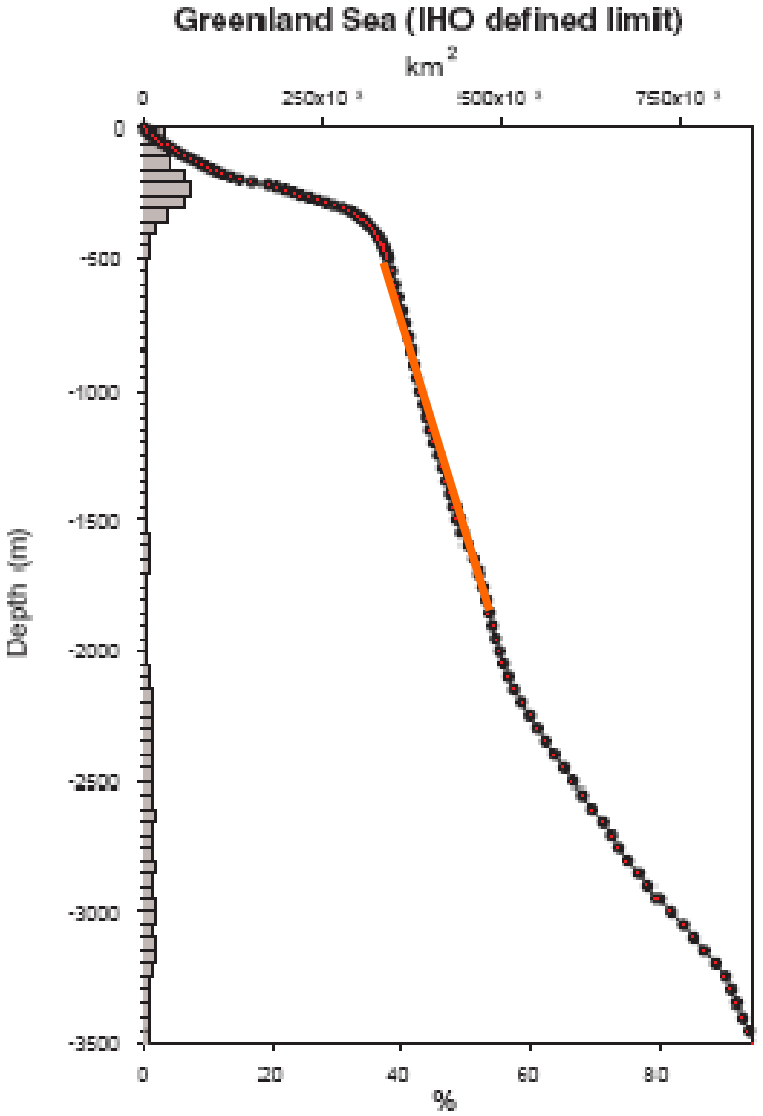
(Martin Jakobsson, 2002)



Iceland Sea Area: 406000 km^2 Mean depth: 1026 m

Sea floor areas and rising carbonate saturation horizons





Iceland Sea

Slopes: 200 km²/m

Greenland Sea

120 km²/m

Conclusions

- The rate of pH decrease in the sub-polar Atlantic is presently similar to that in the sub-tropical Atlantic.
- It is necessary to take account of hydrographic changes in evaluation of carbon chemistry time series data.
- The rate of pH decrease is 50% faster in the arctic waters of the Iceland Sea.
- Due to the hypsographic characteristics of the Iceland Sea, larger sea floor areas are becoming undersaturated
- w.r.t. aragonite than in adjacent arctic seas.

Thank you

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