Northward migration of the ice edge and deep Arctic convection

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As the sea ice edge is retreating northwards, the deep convection in the north Atlantic and the Nordic Seas connected to the strong heat fluxes close to the sea ice edge, follows. Moreover, with the projected disappearance of sea ice in the Arctic in the recent future, the deep convection in the North Atlantic and Nordic Seas is projected to disappear. Currently, deep convection has been observed in an until recently ice covered region north of Svalbard. One of the many immediate consequences is acidification of the Nordic Seas due to the recent emergence of deep convection affecting cold water corals in this region. Conversely, as the ice cover is retreating towards the east coast of Greenland, currents previously insulated by sea ice are ventilated and densified as they flow southwards leading to new deep convection.

Climate projections of sea ice edge and convection

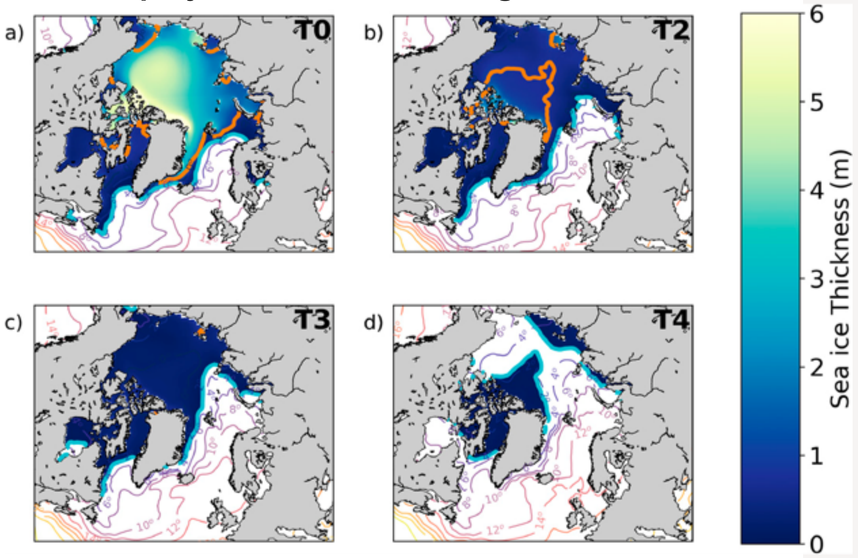

Figure 1: Yearly mean sea ice thickness (shading) and sea surface temperature (contour lines) for (a) 1970–80, (b) 2050–60, (c) 2090–2100, and (d) 2130–40 in the EC-Earth-PISM RCP8.5 simulation. The blue (March) and orange (September) lines indicate the sea ice edge [1].

The sea ice edge is projected to retreat northwards (figure 1). Therefore, the cooling at the sea ice edge driving the convection pattern in the North Atlantic and Nordic Seas are predicted to first shift northwards, following the ice edge, before effectively ceasing altogether in the distant future (figure 2) [1].

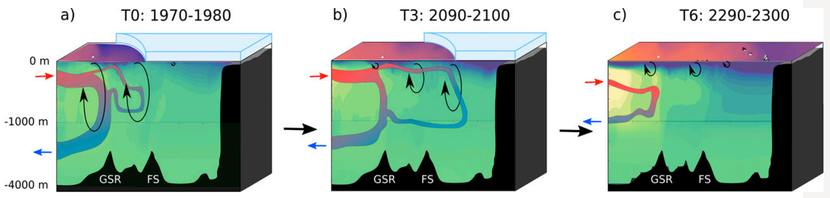

Figure 2: The evolution of the deep convection under the retreat of the sea ice edge [1].

Biological Impacts

Deep convection leads to increase in PH in deeper layers and a decrease of the aragonite saturation depth (figure 4). This especially affects the carbonite skeleton of cold-water corals in this depth in a negative way [2].

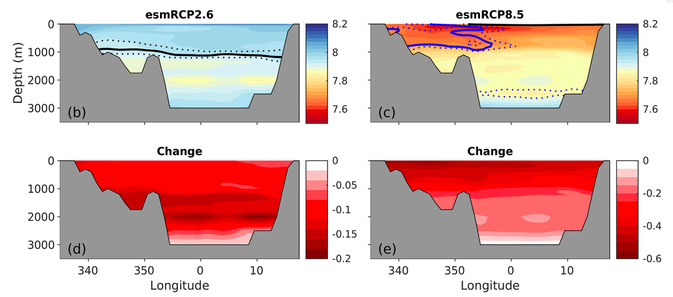

Figure 3: Zonal cross sections (at 70N) of future (2090–2099) pH under the emission-driven esmRCP2.6 and esmRCP8.5 [2].

In the esmRCP8.5 scenario, all the reefs will vanish by 2100 due to the dissolution of the shells (Figure 5).

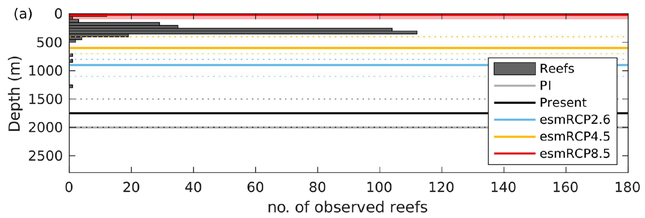

Figure 4: The number of observed reef sites per 50m depth interval together with the aragonite saturation horizons (solid lines) in the Nordic Seas for the past (1850–1879), present day (1980–2005), and future (2070–2099) under the esmRCP2.6, esmRCP4.5, and esmRCP8.5 scenarios [2]

Re-ventilation of Atlantic water

The retreat of the ice edge along Greenland's eastern coast has been found to cause re-ventilation of the water masses in the East Greenland Current (figure 6). If this mechanism persists, it can act to mitigate the effects of the projected diminishing open ocean convection [4].

Deep convection observed in the Arctic Ocean

Deep convection has already been observed north of Svalbard (figure 3), a region previously covered by sea ice [3].

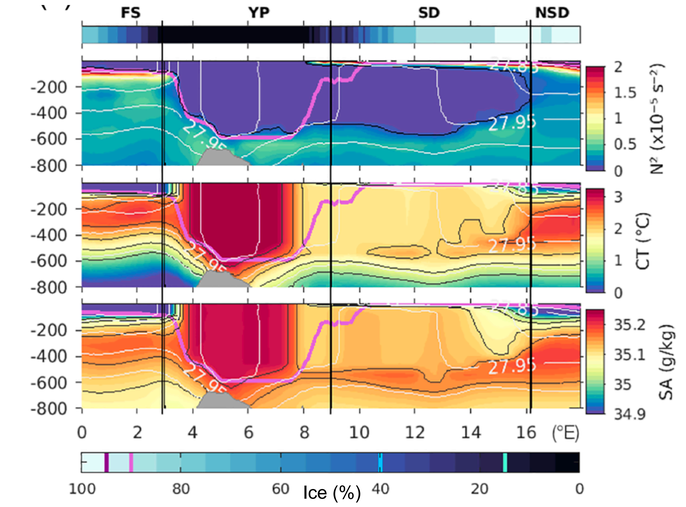

Figure 5: Properties of a transect north of Svalbard (81.5N) from March 2018. (top panel) Sea-ice cover (%), (second panel) Brunt-Väisälä frequency, (third panel) conservative temperature, and (lower panel) absolute salinity [3].

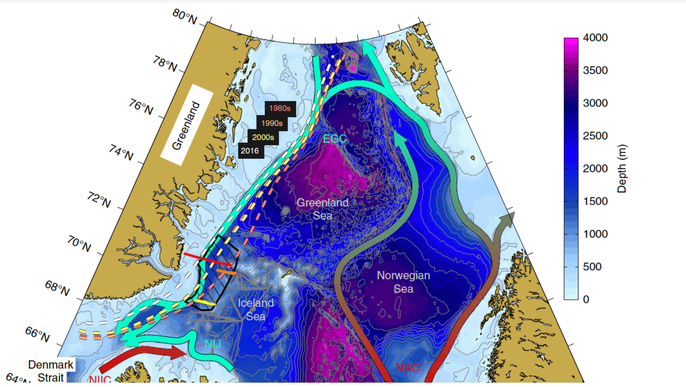

Figure 6: Schematic of currents and ice edge retreat in the Nordic Seas [4]

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