Sub-decadal variations in the Irminger Sea and South Iceland shelf ecosystem: mechanisms and potential for predictability

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The strength of the North Atlantic subpolar gyre exhibits, apart from the well-known longer-term variability such as the mid-1990s weakening, subdecadal scale peaks, which so far received only little attention in the literature. These peaks coincide with peaks in the variability of marine ecosystems in the northeastern North Atlantic, as for example the zooplankton abundance on the South Iceland shelf. The latter closely covaries with the oceanic zooplankton abundance in the Irminger Sea. Here we use a simulation with the Max Planck Institute Ocean Model (MPI-OM) forced with atmospheric reanalysis field to investigate mechanisms underlying the subdecadal scale variations in the zooplankton abundance, both oceanic and on the shelf.

The oceanic zooplankton abundance in the Irminger Sea closely covaries with the local mixed layer depth in March. The correlation between the mixed layer depth in the Irminger Sea and the atmospheric forcing points towards a remote influence from the Labrador Sea region. In the latter, strong heat loss leads to the formation of intermediate and deep waters, which are advected into the Irminger Sea. The advected relatively dense and weakly stratified water masses from the Labrador Sea region make the water column in the Irminger Sea more susceptible for deep mixing. Apart from this preconditioning effect, there might also be advection of nutrients and zooplankton from the large reservoirs in the convective western subpolar gyre.

High concentrations of zooplankton in the Irminger Sea are found near the subarctic front, which is in general a biologically productive region. Shifts of this frontal source region towards Iceland coincide with peaks in the zooplankton abundance on the South Iceland shelf. Any influx of zooplankton from the frontal region onto the South Iceland shelf will oppose the mean flow field, but previous studies and particle tracking experiments using the flow fields from the MPI-OM simulation indicate that near-surface advection from the Irminger Sea onto the South Iceland shelf is possible, at least in years when the subarctic front is shifted eastwards.