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Hydrography of the Labrador Sea in the first decade of the 21st century

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The Labrador Sea is a semi-enclosed western marginal basin of the subpolar North Atlantic. Despite its seeming isolation, the Labrador Sea plays a critical role in the climate system, circulation, heat and freshwater budgets of the North Atlantic.

The Labrador Sea is associated with distinctive temperature and salinity minima in the mid-depths of the North Atlantic Ocean. Such coolness and freshness of the sea result from extreme annual surface heat losses, and from convergence, transformation (by winter mixing) and subsequent export (by subpolar gyre and boundary currents) of freshwater coming here from the Arctic, atmosphere and land.

The largest full-depth changes of temperature and salinity observed in the modern instrumental oceanographic record are also attributed to the Labrador Sea. The key factors responsible for the prominent hydrographic changes are character and strength of the subpolar circulation, variability of the heat, salt and freshwater flux into the sea, and the loss of heat to the atmosphere. These factors also regulate, and, when combined with preceding stratification, determine the depth, properties and durability of winter mixed layer, which under "favorable" conditions can penetrate as deep as 1000 m, and, under sustained forcing, develop into an intermediate water mass, known as the Labrador Sea Water (LSW).

Deep winter missing or convection leading to production of LSW is the key mechanisms by which the intermediate waters of the North Atlantic are ventilated and renewed.

The dense water overflows crossing the Denmark Strait and Faroe-Shetland Channel form the Denmark Strait Overflow Water and Northeast Atlantic Deep Water, respectively, meet here with the convectively-formed LSW to form the deep limb of the Atlantic Meridional Overturning Circulation and hence are important components of the global climate system.

Recent variability in the properties of the intermediate and deep water masses of the Labrador Sea will be described by using annual springtime hydrographic, profiling float and altimeter data. It will be shown that the variability of intermediate-depth water is strongly influenced by the strength and duration of wintertime surface heat loss, and the advection of warmer more saline intermediate waters from the North Atlantic.

Four variations of LSW produced in different years were identified in the 2010 annual survey of the Labrador Sea. While gradually transforming in time, these waters have been preserved in different ranges of density and depth because of gradual weakening of winter convection since 2008, and are still distinguishable by their unique signatures in temperature, salinity and chemical tracers. The fate of each individual LSW class can now be followed by combining data from the annual oceanographic surveys and profiling Argo floats.