P054B-3241: Record deep convective
in the Irminger Sea

Observations from the LOCO mooring during winter 2014-2015

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Abstract

Anomalously strong cooling over the Irminger Sea during the winter of 2014-2015 caused record depths convective mixing at the LOCO (Long-term Ocean Circulation Observations) mooring. The deep mixing eroded the intermediate salinity minimum associated with Labrador Sea Water (LSW) and replaced it with a cold, fresh homogeneous layer rich in oxygen. This layer was seen to extend across the basin in the hydrographic section of summer 2015, suggesting that a significant part of the basin participated in the mixing. This strong convection event was forced by exceptionally strong surface buoyancy fluxes. The 2015 hydrography is reminiscent of the situation in the 1990s when a large volume of homogeneous water filled the Irminger basin.

The LOCO mooring

The LOCO mooring has been maintained in the central Irminger Sea by the Royal Netherlands Institute for Sea Research (NIOZ) since September 2003. The mooring is outfitted with a CTD profiler that records daily hydrographic profiles between 150 and 2400 m depth. Its location is near the center of the cyclonic Irminger gyre (Fig. 1) where the stratification is weak and surface cooling is provided by the Greenland Tip Jet. The adjacent hydrographic AR7E section is surveyed nearly annually.

Figure 1. Location of the LOCO mooring (red dot) in the Irminger Sea. The blue lines show contours of sea surface height associated with the cyclonic Irminger gyre. Black dots are the hydrographic stations occupied in July 2015. Argo data within 150 km of the LOCO mooring (red circle) were used to fill observational gaps in the LOCO time series.

Mixing and forcing

Local deep mixing was first observed at the LOCO mooring during the winter of 2007-2008 (Fig. 2). Although deep (800 m), this mixing did not substantially penetrated the layer of LSW present in the basin. During the winter of 2014-2015 active mixed layer depths reached down to 1200 m and stratification was reduced down to 1400 m, making it the strongest convective event directly observed in the Irminger Sea. The mixing replaced the LSW layer with a newly formed local convective water with a distinct dissolved oxygen maximum (Fig. 3).

Strong surface buoyancy loss during the winter of 2014-2015 allowed for this distinct convective event. The surface heat fluxes (Fig. 2) were both stronger than usual and lasted for an additional month, making this winter significantly stronger than that of 2007-2008.

Discussion

The convective water formed in the Irminger Sea in 2014-2015 occupies the density space associated with upper LSW, a class of LSW formed in the 2000s. Remarkably little restratification had taken place between the end of winter and July, resulting in a stratification (Fig. 4) similar to that observed in the 1990s (although still shallower and more saline).

The winter mean surface forcing of the winter of 2014-2015 was very similar to that of 1990s (1992-1993: 121 Wm⁻², 1993-1994: 124 Wm⁻² and 2014-2015: 123 Wm⁻²), suggesting that the water classified as LSW in the 1990 was likely also locally formed and a wider area must be taking into account when discussing the future of convection and related AMOC changes.

Figure 2. Time series of stratification, mixed layer depths and surface heat fluxes. The bottom panel shows the stratification (log10 of potential vorticity) and the mixed layer depth (black marks) at the LOCO mooring. Two observational gaps were filled using Argo data. The top panel shows surface fluxes (ERA INTERIM) over the mooring. Monthly means are blue, winter means (Nov through Apr) are in red.

Figure 3. Hydrographic section surveyed in July 2015 by RV Pelagia. Shown are potential temperature (top), salinity (middle) and dissolved oxygen (bottom). Station locations are displayed on the top.

Figure 4. Salinity profiles from the AR7E repeat section in the Irminger Sea from 1991 to present. Profiles in the center of the basin were averaged along isopycnals to obtain smooth profiles.

References


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