INTRODUCTION

Danmark Strait Overflow Water (DSOW) constitutes the densest portion of North Atlantic Deep Water, which feeds the lower limb of the Atlantic Meridional Overturning Circulation (AMOC). Based on recent studies it is believed that DSOW approaches the sill via three pathways: the Shelfbreak East Greenland Current (EGC), the North Icelandic Jet (NIJ), and theSeparated EGC (Figure 1).

Moored measurements in the strait indicate that the hydrographic structure of the overflow varies on timescales of 1-5 days[1-3]. These fluctuations have been attributed to the intermittent passage of large, cold, dense water layers called boluses. Boluses were first observed in 1955 in hydrographic sections south of Denmark Strait and have since been identified in various observational datasets and numerical models [4-11]. Different mechanisms have been proposed to explain their formation including baroclinic instability and barotropic surface-intensified jets [12,13]. However, no consensus on their origin presently exists.

The goal of this study is to characterize the hydrographic structure of the different DSOW constituents at the sill, before the water descends into the Irminger Basin, and investigate their origin. We use temperature and salinity (T/S) data from 111 shipboard transects occupied in the vicinity of the sill, collected between 1990 and 2012.

WHAT ARE BOLUSES?

We have developed a set of criteria to objectively identify the large, homogeneous boluses in the hydrographic sections occupied across Denmark Strait. In particular, boluses are defined as weakly stratified water with Brunt-Väisälä frequencies less than or equal to 2.0 x 10^{-4} s^{-1}. They must also occupy more than 65% of the trough in Denmark Strait (the region deeper than ~500 m) and extend at least 150 m above sill depth. (The results are not overly sensitive to these size constraints.)

Boluses defined as such are present in 41% of the synoptic sections across the sill in Denmark Strait (Figure 2), and they constitute the coldest and densest component of the overflow (Figure 3).

SIGNIFICANCE OF BOLUSES

When boluses pass through Denmark Strait the deep isopycnals are raised upwards as much as 150 m (Figure 4). Assuming a constant advective speed of 0.2 m/s (representative of the overflow [14]), the transport of DSOW increases by more than a Sverdrup (Table 1). The overflow water is also significantly colder and denser in the presence of boluses.

ORIGIN OF BOLUS WATER

The densest water in Denmark Strait occupies a narrow range of temperature and salinity (Figure 5a). The location of this mode in T/S space generally coincides with the boluses: nearly 72% of the mode water is contained within these features. Water with the same T/S properties of the mode in Figure 5a is found upstream of the Denmark Strait in the NIJ and central Icelandic Sea (Figure 5b). This is consistent with a previous modeling study [14] suggesting that the Iceland Sea Gyre is the primary source of the NIJ water that feeds Denmark Strait.

Table 1: Mean and standard errors of the potential temperature and density of the overflow water (denoted as T and σ, respectively) at the sill.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Standard Error</th>
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</thead>
<tbody>
<tr>
<td>Potential Energy</td>
<td>0.517</td>
<td>0.039</td>
</tr>
<tr>
<td>Density (kg/m^3)</td>
<td>27.980</td>
<td>0.003</td>
</tr>
<tr>
<td>Transport (Sv)</td>
<td>4.445</td>
<td>0.002</td>
</tr>
</tbody>
</table>

REFERENCES