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Oceanography

Wall Across the Atlantic

Drift Bottles Released by Students Confirm that the Gulf Stream Prevents Subarctic Surface Drifters from Escaping South

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We examined data on 1184 drift bottles launched by students between 2000 and 2007 from vessels of opportunity at locations scattered along the Canadian Maritimes and Greenland (Figure 1), supplemented with data from four bottles from historical records (Becher, 1843, 1852). The results confirm and extend observations of the geographic pattern of recoveries made in 1979–1980 using 9000 drifting cards released along the Labrador Shelf (Diemand et al., 1982), and the track of surface currents in the North Atlantic determined during 1990–2002 using satellite-tracked drifters with drogues (Brambilla and Talley, 2006).

To estimate the bottles' drift speeds, we assumed they traveled along pathways reported in the literature as shown in Figure 1 (Belkin et al., 1998; Belkin, 2004). Where multiple pathways were reasonable, we computed speed as the distance between the times of bottle launch and recovery averaged over all

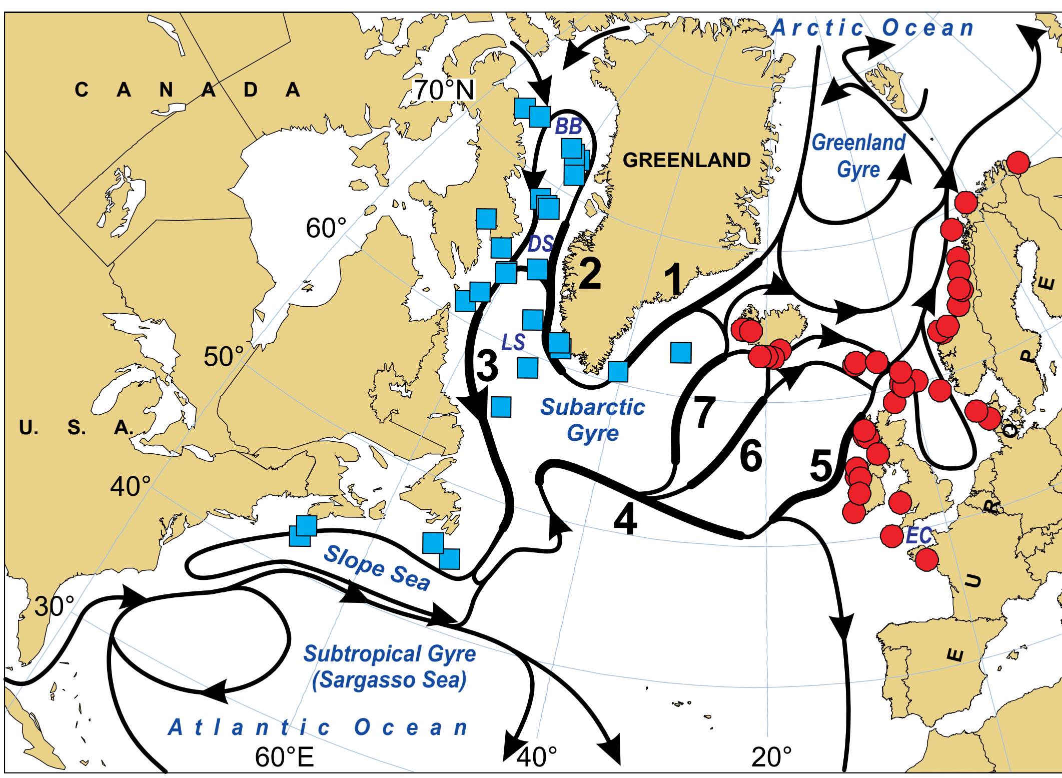

Figure 1. Bottle release (blue squares) and bottle recovery (red circles) locations, and probably drift pathways (surface currents; black lines) from the literature (Belkin et al., 1998; Belkin, 2004). Thickened segments mark regions (1–7) where velocities of satellite-tracked surface drift buoys were averaged (Brambilla and Talley, 2006). BB = Baffin Bay. DS = Davis Strait. EC = English Channel. LS = Labrador Sea.

possible pathways, excluding loops around the Subarctic Gyre, divided by the associated elapsed time.

To ascertain, as far as possible, if our bottle drifts were consistent with the satellite-tracked buoys, we superposed the histogram of 43 bottle speeds with the buoy speeds averaged in the seven areas along the drift ways (averages from Brambilla and Talley, 2006; Figure 2). The bottle and buoy speeds largely overlap, with 86% of the bottle speeds occurring in the range of the buoy speeds (6–23 cm s^{-1}). The median and mean bottle speeds (15.7 and 16.5 cm s^{-1}, respectively; standard deviation ± 6.5 cm s^{-1} for the mean) are nearly equal, and lie in the middle of the buoy speeds. Despite the unknown amount of time bottles are on shore before discovery, we detected no significant difference between bottle and buoy speeds.

In contrast to the often-obtained result that most drifters strand on the shores closest to the releases, 98.8% and 97.7% of all found cards and bottles, respectively, that were launched off Canada landed in Europe. Of the 1602 cards found, only 19 were recovered in Canada. Similarly, for the bottles, of 44 recoveries, only one was reported from Canada itself; the remainder was recovered in Europe, except one that crossed over into the Subtropical Gyre and drifted to Puerto Rico.

The bottles and cards found in Europe showed a large spatial disparity: 92–96% came from north of the English Channel, and only 5–8% from the south. These observations support the idea of nearly complete isolation of subarctic waters from subtropical waters. These major water masses are separated by the Gulf Stream, which acts like a wall across the Atlantic, a phenomenon noted from oceanographic section data (Smith et al., 1937; Bower et al., 1985), drifting cards (Diemand et al., 1982), and satellite-tracked surface drifter data (Brambilla and Talley, 2006). Data from the bottles, buoys, and cards make a persuasive case that the transatlantic wall guides surface drifters across the relatively short distance separating Canada and Greenland from Europe.

Diemand et al. (1982) designed their drift cards to mimic the drift of oil potentially spilled at known or proposed drilling sites along the coast of eastern Canada. Estimated oil resources in the West Greenland-East Canada sedimentary provinces exceed 10 billion barrels, making it one of the oil-richest Arctic regions (Gautier et al., 2009). The bottle and card data both suggest that if oil were spilled along East Canada and West Greenland, at the surface it would be transported away from shore, with some of the spill, depending on weathering and flotation, possibly ending up across the North Atlantic along European coasts north of the English Channel.

These results show the potential value of simple, citizen-based science to address complex problems.

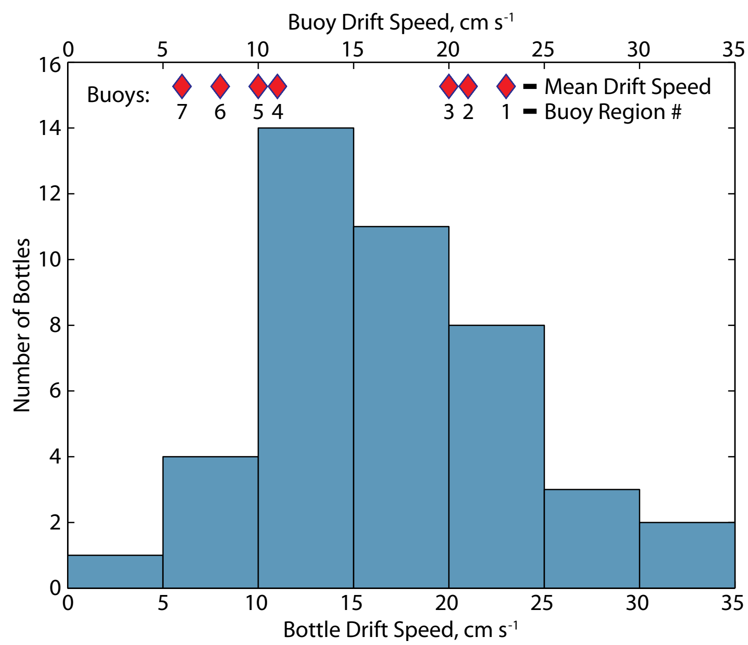

Figure 2. Speeds of bottles and surface drift buoys. Bottle speeds are represented by the histogram on which the region-mean buoy speeds from regions 1–7 (thickened segments in Figure 1) are shown with diamonds.

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