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Surface Buoyant Plumes from Melting Icebergs in the Labrador Sea

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Canada's Department of Fisheries and Oceans (DFO) conducts annual surveys in the Labrador Sea along the repeat hydrography line AR7W. Since 2012, these shipboard surveys have been supplemented by underway CTD and optical measurements in the upper 200 m layer conducted with the towed undulating platform Moving Vessel Profiler (MVP). The MVP hydrographic data reveal rich variability of the upper layer salinity field on different spatial scales. The occupation of the AR7W line in May 2013 was followed by the experiment aimed at resolving the imprint of melting drifting icebergs on the upper layer thermohaline characteristics in the Labrador Sea. Here we present observations around two icebergs: the first iceberg drifted in relatively warm water of Atlantic origin ($\sim$2.5-3.1^{0}C) off Greenland, while the second iceberg was on the Labrador shelf in cold water below 0^{0}C. Both icebergs had a lengthscale of O(100 m). In both cases surface buoyant plumes fed by melt water and attached to the iceberg were observed. The plumes were evident in the anomalous thermohaline characteristics of the seawater. Their density anomalies were sufficiently strong to produce visible frontal structures, which imply a development of the intrinsic dynamics associated with a plume. The first plume formed over a time interval of $\sim$10 hr, while the second plume formed over several days and extended for more than 1 km (tenfold the iceberg's size). Strong vertical displacements of the pycnocline were observed near the second iceberg. They are interpreted as the internal wave wake. This interpretation is based on the temporal scale of these oscillations (local buoyancy frequency), as well as on the spatial orientation of these waves with respect to the iceberg drift relative to the pycnocline. The observed internal waves partially overlapped with the plume and affected its structure. The saline seawater splashing by swell contributed to the surface melting of the icebergs. Scaling analysis of the observed plume suggests that it could be in the "rotational" dynamic regime with recirculating anticyclonic flow. In this case the melt water is trapped in the plume and affects the iceberg's thermodynamics and the rate of melt. These effects are likely to be more pronounced near bigger icebergs or ice islands, and will be a focus of our future observational campaign.