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Understanding the annual salinity cycle of the Denmark Strait Overflow

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Between the Denmark Strait Sill and Cape Farewell, the Denmark Strait Overflow (DSO), which forms the densest waters of the North Atlantic, exhibits an annual salinity cycle. This is characterised by freshening in winter/spring and a saltier phase in summer/autumn. Freshening, which begins in winter, varies in intensity annually between 0.02 and 0.07. There is also spatial variability; stronger freshening is found higher on the continental slope in the lighter layers of the overflow plume, whilst there is weaker freshening in its core. To investigate the pathway of these annual freshening events, we analysed moored data from a key DSO source water region north of the Strait, at approximately 68N. Using concurrent downstream salinity data from a single MicroCAT deployed in the DSO, at 63.5N, we were able to track monthly-seasonal salinity variability between the two locations with a lagged correlation analysis. The direction of flow through the upstream mooring array is variable on monthly-seasonal timescales, hence we removed the northward component to focus on the salinity of the water being advected southward only. In 2011-12, the water advecting south between 300 and 500m upstream is highly correlated ($p<0.05$) with the downstream timeseries at a lag time of 10 weeks. Two upstream freshening events in oct-nov 2011 and feb-mar 2012 are followed by downstream freshening 10 weeks after. Upstream freshening events are associated with deepening of DSO source water. We propose that this process reduces the subsequent modification of DSO source water by light Atlantic Water, delivered to the Denmark Strait by the Irminger Current. This enables the fresh component of DSO source water to propagate into the DSO plume relatively unmodified. To test this hypothesis, we examine CTD data between the Kögur array and the Denmark Strait sill to analyse the seasonality and modification of DSO source water in Denmark Strait.