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On the origin and propagation of Denmark Strait Overflow Water Anomalies in the Irminger Basin

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Denmark Strait Overflow Water (DSOW) supplies the densest contribution to North Atlantic Deep Water and is monitored at several locations in the subpolar North Atlantic. We present an analysis of observed hydrographic (temperature and salinity) and velocity time series from three multiple-mooring arrays to quantify the variability and to track anomalies of DSOW: (1) at the Denmark Strait sill, (2) at 180 km downstream (south of Dohrn Bank) and (3) at a further 320 km downstream on the east Greenland continental slope near Tasiilaq (formerly Angmagssalik). The aim of the combined arrays is to cover the overflow plume and its modifications due to its descent and mixing with ambient waters from the sill of Denmark Strait to approx. 2000 m depth in the northern Irminger Basin.

Eddy variability dominates the high frequency variations in all DSOW records. Variability on time scales from interannual to weekly is present at all moorings, but no long term trends are detected in the time series. The seasonal cycle is of no importance for the properties measured at the sill, but its significance increases with downstream distance. A low pass filter (cut-off at 20 days) is applied to the time series in order to remove synoptic scale variations: single eddies are likely not traceable and probably merge with each other or fade along the descending pathway of the DSOW plume.

The hydrographic time series from different moorings within each mooring array show coherent signals, while the velocity fluctuations are only weakly correlated. Lagged correlations of anomalies between the arrays reveal propagation from the sill of Denmark Strait to the Angmagssalik array in potential temperature with an average propagation time of 16 days. Despite a difference of 1.5°C between the mean temperatures at both arrays, which are about 500 km away from each other, temperature anomalies can be traced along the DSOW pathway. In contrast, the correlations in salinity are low and only significant from the Dohrn Bank array to Angmagssalik.

Entrainment of warm and saline Atlantic Water and fresher water from the East Greenland Current (via the East Greenland Spill Jet) can explain the whole range of hydrographic changes in the DSOW measured downstream of the sill. Changes in the entrained water masses and in the mixing ratio can thus strongly influence the salinity variability of DSOW. Fresh anomalies found in downstream measurements of DSOW within the Deep Western Boundary Current can therefore not be attributed to Arctic climate variability in a straightforward way.