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Modelling Hydrographic Changes in the Labrador Sea over the Past Five Decades

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Inter-annual to inter-decadal changes of hydrographic structure and circulation in the subpolar North Atlantic are studied using a coarse resolution ocean circulation model. The study covers 1949 through 2001, inclusive. A “time-mean state nudging” method is applied to assimilate the observed hydrographic climatology into the model. The method significantly reduces model biases in the long-term mean distribution of temperature and salinity, which commonly exist in coarse-resolution ocean models. By reducing the time-mean biases we also significantly improve the model’s representation of inter-annual to inter-decadal variations. In the central Labrador Sea, the model broadly reproduces the warming/salting and cooling/freshening variations of the Labrador Sea Water (LSW) as revealed by hydrographic observations. Model sensitivity experiments confirm that the low-frequency hydrographic changes in the central Labrador Sea are closely related to changes in the intensity and depth of deep convection. Changes in surface heat flux associated with the winter North Atlantic Oscillation (NAO) index play a major role in driving the changes in T-S and sea surface height (SSH). Changes in wind stress play a secondary role in driving these changes but are important in driving the changes in the depth-integrated circulation. The total changes in both SSH and depth-integrated circulation are almost a linear combination of the separate influences of variable buoyancy and momentum fluxes.