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Labrador Sea water transport rates and pathways in the subpolar North Atlantic Ocean

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Labrador Sea Water (LSW) formed by deep convection in the Labrador Sea during winter is transported via different pathways out of the deep Labrador Sea and is an integral part of North Atlantic Deep Water and the meridional overturning circulation. Associated with the formation and spreading of LSW is the uptake and distribution of anthropogenic tracers from the atmosphere, such as CO2 and CFCs. LSW transport is therefore of global interest regarding carbon uptake and climate. Previous studies have shown that LSW is advected by geostrophic flow along three primary pathways: southward with the deep western boundary current around Flemish Cap, east through deep gaps in the Mid-Atlantic Ridge, and northeast into the Irminger Basin through an internal recirculation.

The total tracer transport is achieved through a combination of advection and diffusion, however. Our approach is therefore to calculate transit time distributions (TTDs) from advection/diffusion simulations of the western subpolar North Atlantic. TTDs represent the advective component of the flow, and also capture the range of spreading time scales related to the diffusive component. We use the horizontal velocity field at 1500 m depth derived from WOCE float data. Tracers are injected at the location where measurements show the greatest convection depths. Experiments are performed with both uniform diffusivity and spatially varying diffusivity based on measurements of eddy kinetic energy.

Results show that tracer spreads preferably along the three pathways mentioned above, but at different rates. A relatively high uniform diffusivity gives mean transit times between approximately 20 years in the Labrador Sea to about 100 years near Biscay. Lower diffusivity gives greater mean transit times that exceed 100 years in some cases. Deep recirculations play an important role in dispersing tracer, especially by bringing

young and old fluid into contact with each other.