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Subpolar Mode Water in the northeastern Atlantic: origin and transformation

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Subpolar Mode Waters (SPMW) are the primary water masses that participate in the upper flow of the overturning circulation and provide the water that is eventually transformed into the several components of the North Atlantic Deep Water (McCartney and Talley, 1982). SPMWs constitute the surface layer along each of the several branches of the North Atlantic Current (NAC) and their density increase gradually following the flow downstream. The processes that lead to the transformation and formation of the Subpolar Mode Water (SPMW) in the eastern North Atlantic are investigated from observational data. Air-sea flux data from the National Oceanography Center, Southampton (NOCS), and hydrographic data from the A24 cruise collected during the World Ocean Circulation Experiment (WOCE) are used to estimate the contribution of diapycnal and isopycnal fluxes to SPMW transport. The surface diapycnal volume flux is the dominant source of SPMW. In the North Atlantic subpolar gyre the diapycnal volume flux occurs along the main branches of the North Atlantic Current (NAC) and it has an average transport of 14 +- 6.5 Sv, with a maximum of 21.5 Sv across the 27.3sigma_theta isopycnal. The regional distribution of the diapycnal flux on isopycnal surfaces is computed to identify the areas with the largest diapycnal flux. These regions coincide with the location of SPMW. It is shown that the surface diapycnal flux is associated with obduction and subduction through the permanent pycnocline. Therefore, the water involved in the transformation of SPMWs is continuously exchanged with the ocean interior. In addition, we suggest that subduction is not associated with smooth advection from the mixed layer to the ocean interior, but is interpreted as water mass loss due to entrainment into the deep overflows of the subpolar gyre. The isopycnal component of the SPMW throughput is estimated from the geostrophic transport across the A24 section from Greenland to Scotland and is

10% to 40% of the diapycnal flux.