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MIXING, OVERTURNING AND WATER MASS TRANSFORMATION IN THE ARCTIC OCEAN

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The net rates of diapycnal mixing, overturning and water mass transformation in the Arctic Ocean are determined from a quasi-synoptic observational estimate of the flow and physical fluxes across the region's boundary[1]. The Arctic Ocean is found to host a double overturning cell, in which 1.8 Sv of the Atlantic Water entering from the Nordic Seas upwells diapycnally into lighter near-surface waters, and 1.2 Sv downwells into denser intermediate and deep layers. A simple model of the buoyancy budget of the Arctic Ocean incorporating diapycnal mixing and air-sea-ice buoyancy exchanges suggests that the upper overturning cell is underpinned by diapycnal mixing at a rate of ~2 x 10^{-6} m^2 s^{-1}, and that the lower overturning cell is sustained by oceanic buoyancy loss at a rate of ~7 x 10^7 m^4 s^{-3}. The consistency of these values with the collection of in situ microstructure measurements of diapycnal mixing obtained to date and with existing climatological estimates of air-sea-buoyancy exchanges is examined, and the energetics of the overturning circulation discussed. Implications for the likely future evolution of the Arctic Ocean's overturning and water mass transformations will be considered on the basis of the present balance of processes and predicted changes in external forcings.

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[1] Tsubouchi, T., S. Bacon, A. C. Naveira Garabato, Y. Aksenov, S. W. Laxon, E. Fahrbach, A. Beszczynska-Moeller, E. Hansen, C. M. Lee and R. B. Ingvaldsen, 2012. The Arctic Ocean in summer: A quasi-synoptic inverse estimate of boundary fluxes and water mass transformation. J. Geophys. Res. 117, C01024, doi:10.1029/2011JC007174.