B07-O21

TIDES STIR UP ATLANTIC WATER HEAT ALONG THE ARCTIC OCEAN CONTINENTAL SLOPE

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The largest oceanic heat input to the Arctic results from inflowing Atlantic water, which is at its warmest for 2,000 years[1,2], yet the fate of this heat remains uncertain[3]. This is partly because the water's relatively high salinity, and thus density, lead it to enter the Arctic Ocean at intermediate depths. A key pathway linking the Atlantic water heat to overlying, colder waters (and ultimately to the sea surface and sea ice) is vertical cross-gradient mixing. Mixing is generally weak within the Arctic Ocean basins, with very modest heat fluxes (0.05 – 0.3 Wm^{-2}) arising from double diffusion[4,5]. However, previous geographically limited observations have indicated substantially enhanced turbulent mixing rates over rough topography [6,7]. Here we present new pan-Arctic microstructure measurements of turbulent kinetic energy dissipation which further show that the enhanced continental slope dissipation rate is found to vary significantly with both topographic steepness and longitude, while appearing insensitive to sea-ice conditions. Tides are identified as the main energy source supporting this enhanced turbulent dissipation, which results from an interaction of the geographically-variable barotropic tide with the steep topography of the Arctic continental slope. North of Svalbard, this tide-topography interaction generates vertical heat fluxes of more than 50 W m^{-2}. As Arctic sea ice declines, the increased transfer of momentum from the atmosphere to the ocean will accelerate the large-scale currents while generating evermore near-inertial sheared currents that will act to expand mixing hotspots over other areas of rough topography in the future Arctic Ocean.

The contrast between the doubly-diffusive central Arctic Ocean basins and the more turbulent continental slope regions highlights how enhanced mixing in relatively small regions can have a large impact on total heat budgets. Likewise, where time-series observations of turbulent dissipation in the Arctic Ocean and shelves has been available[8,9], it is clear that very short bursts of vigorous dissipation can dominate the time-averaged mixing rates. Thus the the main challenge in accurately resolving Arctic turbulent dissipations and its impact on sea ice and ocean-atmosphere exchange of heat and momentum is in acquiring time-series observations of turbulence over a variety of time-scales from tidal to mesoscale eddy to seasonal.

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