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Large eddy simulation of heat entrainment under Arctic sea ice[1]

ESHWAN RAMUDU, RENSKE GELDERLOOS, Johns Hopkins University, DI YANG, University of Houston, CHARLES MENEVEAU, ANAND GNANADESIKAN, Johns Hopkins University — Sea ice cover in the Arctic has declined rapidly in recent decades. To better understand ice loss through bottom melting, we choose to study the Canada Basin of the Arctic Ocean, which is characterized by a perennial anomalously warm Pacific Summer Water (PSW) layer residing at the base of the mixed layer and a summertime Near-Surface Temperature Maximum (NSTM) layer trapping heat from solar radiation. The interaction of these warm layers with a moving ice basal surface is investigated using large eddy simulation. We find that the presence of the NSTM enhances heat entrainment from the mixed layer. Another conclusion from our work is that there is no heat entrained from the PSW layer, even at the largest ice-drift velocity of 0.3 m s^{-1} considered. We propose a scaling law for the heat flux at the ice basal surface which depends on the initial temperature anomaly in the NSTM layer and the ice-drift velocity. A case study of 'The Great Arctic Cyclone of 2012' gives a turbulent heat flux from the mixed layer that is approximately 70% of the total ocean-to-ice heat flux estimated from the PIOMAS model often used for short-term predictions. Present results highlight the need for large-scale climate models to account for the NSTM layer.

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