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On air-ice-ocean interactions under warming Arctic climate.

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As Arctic climate continues to warm causing its cryosphere to shrink questions are being asked about the persistence of this trend and the possibility for recovery. Some recent climate modeling studies predict that sea ice will recover from an ice free summer back to climatological conditions in just a few years. Such an outcome is possible in the model in main part due to the rapid removal and dissipation of all the excess heat accumulated in the upper ocean during an ice-free summer through the top of the atmosphere and through reduced advection of atmospheric heat from the lower latitudes. However, recent observational and other modeling studies suggest that the increasing duration and area of open water during the melt season allows significant accumulation of solar energy in the upper ocean, extending below the shallow and fresh summer mixed layer. In addition, summer Pacific water provides another source of increasingly warmer water above the halocline entering the western Arctic basin from the Chukchi shelves. While the upper mixed layer cools during fall and removes all its heat back to the atmosphere before freezing, the heat accumulated below the mixed layer continues into winter. However, the absolute magnitude and long term variability of the upper Arctic Ocean heat storage and fluxes under a decreasing sea ice cover are not well known from observations and are typically poorly represented in models. We analyze results from a regional high-resolution coupled model of the Arctic Ocean and its sea ice as well as from observations from the ice tethered profilers (ITPs) and ice mass balance buoys (IMBs) to quantify the heat storage in the upper ocean and to determine its relative importance in forcing sea ice melt. In particular, the thermodynamic coupling at the ice-ocean interface in the western Arctic Ocean is investigated. Under-ice ablation by anomalously warm water advected from the shelves and distributed below the surface layer by ocean currents and mesoscale eddies is found to explain a significant portion of the total variance of sea ice thickness in the western Arctic Ocean. We hypothesize that the excess oceanic heat that in recent years has been accumulating below the surface during summer is a critical initial factor in reducing ice concentration and thickness in the western Arctic Ocean at the early melting season and onwards the following year. This heat storage is expected to increase with future reductions of sea ice cover and not be readily removed later that year due to a strong stratification in fall and the buffering effect of sea ice cover in winter. Observational data and more realistic model representation of feedback processes in climate models between the upper ocean and the atmosphere under diminishing ice cover are critical to test this hypothesis and to advance Arctic climate prediction.