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Summertime sea-ice reduction related to a drastic change in mixed layer depth and ice deformation in the Eastern Arctic Ocean

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Compared to the 30-years average, the 2010 summer has anomalously low ice concentration in the Eastern Arctic Ocean. This study examines summertime sea-ice reduction in the Central and Eastern Arctic Oceans from a viewpoint of a coupled system of oceanic surface mixed layer and sea-ice movement. A Polar Ocean Profiling System (POPS) was deployed in mid-April 2010 near the North Pole, surrounded by an array of four GPS buoys each deployed 10 miles from POPS. We obtain vertical oceanic profiles of temperature and salinity from the POPS drift track. The buoy array enables us to calculate ice deformation variables such as divergence/convergence, relative vorticity and shear with hourly resolution. The POPS and buoy arrays drifted in the Amundsen Basin close to the Nansen-Gakkel Ridge (NGR) between April and mid-June. During this period, the POPS profiles exhibited the surface mixed layer thickness being $\sim$50 m except for a couple of events corresponding to remarkable ice divergence. Then, the POPS moved across a frontal region, corresponding to the NGR, between the Amundsen Basin and Nansen Basin (i.e. Arctic Ocean and North Atlantic origin water masses) from late June to late July, and the surface mixed layer depth decreased to $\sim$15 m. After crossing this front, water temperature in the mixed layer increased to 0.2–0.4 degree higher than the freezing point. After the rapid change of the mixed layer structure, the buoy arrays showed a dramatic increase in drift and deformation response to wind. For example, an inertial oscillation, with a time period of $\sim$12 hours, was clearly observed, indicating that the sea ice pack experienced reduced internal ice stress. We infer that the mixed layer temperature above freezing point contributed to the weakening of the ice strength and then it leads the rapid ice reduction. It also suggests less ice formation in last winter over the North Atlantic origin water masses in the Nansen Basin. From the end of July, the ice movement was close to free drift, and ice divergence was observed. Our drifting buoy analysis suggests the possibility that warm upper ocean temperature originating from the North Atlantic Ocean, increased area of first year ice, and the rapid ice divergence observed by our buoy arrays were a trigger of the anomalous ice reduction in the Eastern Arctic Ocean through the ice albedo feedback.