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Contrasting sea-ice and open-water boundary layers during melt and freeze-up seasons: Some result from the Arctic Clouds in Summer Experiment.

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With more open water present in the Arctic summer, an understanding of atmospheric processes over open-water and sea-ice surfaces as summer turns into autumn and ice starts forming becomes increasingly important. The Arctic Clouds in Summer Experiment (ACSE) was conducted in a mix of open water and sea ice in the eastern Arctic along the Siberian shelf during late summer and early autumn 2014, providing detailed observations of the seasonal transition, from melt to freeze. Measurements were taken over both ice-free and ice-covered surfaces, offering an insight to the role of the surface state in shaping the lower troposphere and the boundary-layer conditions as summer turned into autumn.

During summer, strong surface inversions persisted over sea ice, while well-mixed boundary layers capped by elevated inversions were frequent over open-water. The former were often associated with advection of warm air from adjacent open-water or land surfaces, whereas the latter were due to a positive buoyancy flux from the warm ocean surface. Fog and stratus clouds often persisted over the ice, whereas low-level liquid-water clouds developed over open water. These differences largely disappeared in autumn, when mixed-phase clouds capped by elevated inversions dominated in both ice-free and ice-covered conditions. Low-level-jets occurred $\sim$20-25% of the time in both seasons. The observations indicate that these jets were typically initiated at air-mass boundaries or along the ice edge in autumn, while in summer they appeared to be inertial oscillations initiated by partial frictional decoupling as warm air was advected in over the sea ice. The start of the autumn season was related to an abrupt change in atmospheric conditions, rather than to the gradual change in solar radiation. The autumn onset appeared as a rapid cooling of the whole atmosphere and the freeze up followed as the warm surface lost heat to the atmosphere.

While the surface type had a pronounced impact on boundary-layer structure in summer, the surface was often warmer than the atmosphere in autumn, regardless of surface type. Hence the autumn boundary-layer structure was more dependent on synoptic scale meteorology.