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Processes Impacting Atmosphere-Surface Exchanges at Arctic Terrestrial Sites

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Surface energy fluxes are key to the annual cycle of near-surface and soil temperature and biologic activity in the Arctic. While these energy fluxes are undoubtedly changing to produce the changes observed in the Arctic ecosystem over the last few decades, measurements have generally not been available to quantify what processes are regulating these fluxes and what is determining the characteristics of these annual cycles. The U.S. National Oceanic and Atmospheric Administration has established, or contributed to the establishment of, several terrestrial "supersites" around the perimeter of the Arctic Ocean at which detailed measurements of atmospheric structure, surface fluxes, and soil thermal properties are being made. These sites include Barrow, Alaska; Eureka and Alert, Canada; and Tiksi, Russia. Atmospheric structure measurements vary, but include radiosoundings at all sites and remote sensing of clouds at two sites. Additionally, fluxes of sensible heat and momentum are made at all of the sites, while fluxes of moisture and CO_2 are made at two of the sites. Soil temperatures are also measured in the upper 120 cm at all sites, which is deep enough to define the soil active layer. The sites have been operating between 3 years (Tiksi) and 24 years (Barrow). While all sites are located north of 71° N, the summer vegetation range from lush tundra grasses to rocky soils with little vegetation.

This presentation will illustrate some of the atmospheric processes that are key for determining the annual energy and temperature cycles at these sites, and some of the key characteristics that lead to differences in, for instance, the length of the summer soil active layer between the sites. Atmospheric features and processes such as cloud characteristics, snowfall, downslope wind events, and sea-breezes have impacts on the annual energy cycle. The presence of a "zero curtain" period, when autumn surface temperature remains approximately constant at the freezing point for up to a month, seems to be a characteristic of the autumn freeze-up in the annual energy cycle at some of the sites.