Surface Energy Budget, Boundary Layer Structure and Synoptic/Orographic Influences at Arctic Climate Observatories for the Study of Environmental Arctic Change (SEARCH)

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Beginning in 2004 instrumentation was installed at Alert (82.5°N, 62.3°W) and Eureka (80.0°N, 85.9°W), Ellesmere Island, Canada, to help understand the processes changing Arctic climate. These enhancements are being made in collaboration with Environment Canada, and supplement data from Barrow, AK, and data previously obtained on the pack ice during the Surface Heat Flux of the Arctic Ocean (SHEBA) experiment in 1998. The installations include a Baseline Surface Radiation Network suite of instruments (http://bsrn.ethz.ch/), a soil temperature probe to monitor active layer, and a sonic anemometer at Alert to measure the complete surface energy budget; and cloud radar and lidar systems at Eureka to monitor the cloud macro- and microphysical properties. Additional measurements at Alert include basic meteorological observations, spectral optical depth, all-sky images, condensation nuclei counter, three-channel nephelometer and a Particle Soot/Absorption Photometer to monitor aerosol light absorption as part of a Global Atmosphere Watch facility (http://www.wmo.ch/web/arep/gaw/gaw_home.html).

In addition, meteorological stations have existed near both of these sites for many years, and include synoptic sounding measurements. Analyses suggest that significant differences in the individual surface energy budget terms, which often represent different physical processes, exist between the pack ice site and the land sites (Figure 1). Furthermore, the high meso-alpha scale terrain features (100-500 km) have a dominant influence to direct the synoptically-driven, boundary-layer airflow at both Eureka and Alert, and this airflow is further modulated by the local terrain. The diagnosis and understanding of the atmospheric processes local to these sites are crucial for the future interpretation of how the trends in the near-surface climatological measurements at these sites are related to Arctic and global climate changes.

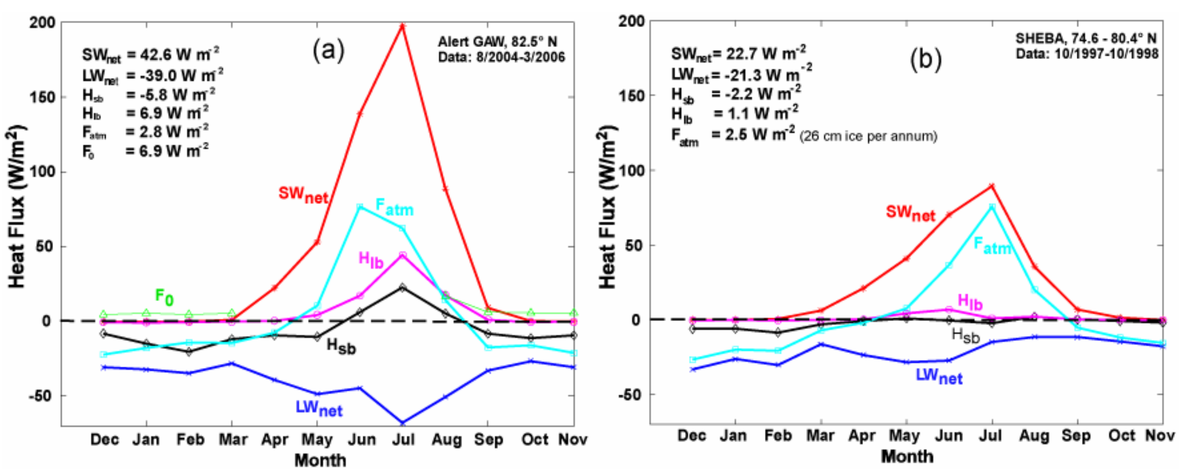

Figure 1. Annual cycle of monthly mean surface energy budget terms at a land site (a, Alert) and a pack ice site (b, SHEBA). Even though the net atmospheric flux at the surface (Fatm) is nearly the same for the two sites, the land site shows much greater net shortwave radiation because of the lower summer albedo. This is offset by the greater longwave radiative loss and turbulent latent heat flux at the land site due to the warmer summer surface temperatures and the less frequent occurrence of summertime clouds. The net annual Fatm at SHEBA accounted for about 75% of the measured net loss of 35 cm of ice that year (20% of the original ice thickness). The net annual Fatm at Alert likely went into melting the 48 cm of snow (~17 cm ice equivalent) and as a net heat flux (F0) into the soil.