Seasonal and Latitudinal Variations of Surface Fluxes and Meteorological Variables at Arctic Terrestrial Sites

A.A. Grachev[1,2], T. Uttal[2], O. Persson[1,2], E.A. Konopleva-Akish[3,2], S.M. Crepinsek[1,2], C.J. Cox[1,2], C.W. Fairall[2], G. Lesins[4], A.P. Makshtas[5] and I.A. Repina[6]

[1]Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO 80309; 303-497-6436, E-mail: Andrey.Grachev@noaa.gov
[2]NOAA Earth System Research Laboratory, Physical Sciences Division (PSD), Boulder, CO 80305
[3]Science and Technology Corporation, Boulder, CO 80305
[4]Dalhousie University, Halifax, Nova Scotia, Canada
[5]Arctic and Antarctic Research Institute, St.Petersburg, Russia
[6]A.M. Obukhov Institute of Atmospheric Physics, Moscow, Russia

This study analyzes and discusses seasonal and latitudinal variations of surface fluxes and other ancillary data based on *in situ* measurements made at two long-term research observatories near the coast of the Arctic Ocean. The hourly averaged data collected at Eureka (Canadian territory of Nunavut) and Tiksi (East Siberia) located at two quite different latitudes (80.0° N and 71.6° N respectively) are analyzed in details to describe the seasons in the Arctic. The primary driver of latitudinal and seasonal variations in temperature and other parameters is the seasonally varying pattern of incident sunlight. The solar radiation at the 'top' of the atmosphere is a function of latitude (and time of year) and the higher latitudes (e.g., Eureka) generally receive the least cumulative amount of net solar radiation than lower latitudes (e.g., Tiksi) over the entire year. However, because of the combined effects of day length and solar zenith angle, Eureka receives more the incoming solar radiation than Tiksi in the middle of Arctic summer. Although Eureka and Tiksi are located at the different continents and at the different latitudes, the annual course of the surface meteorology and the surface fluxes are qualitatively very similar. The air and soil temperatures display the familiar strong seasonal trend with maximum of measured temperatures in midsummer and minimum during winter. According to our data, variation in incoming short-wave solar radiation led the seasonal pattern of the air and soil temperatures, and the turbulent fluxes. A length of the warm season (Arctic summer) is shorter and mid-summer amplitude of the turbulent fluxes near solar noon is generally less in Eureka than in Tiksi. During the dark Polar nights, long-lived stable boundary layers can last several months and air/ground temperatures are strongly controlled by long-wave radiation associated generally with cloud cover. The fact that Eureka receives more the total daily amount of the incoming solar radiation than Tiksi throughout the summer months, leads to some differences in the structure of the atmospheric boundary layer and the uppermost ground layer at the two Arctic stations in summer. This study describes a long-lived convective boundary layer (CBL) observed at Eureka during 2009-2014 summer seasons. Long-lived CBL is associated with almost continuous unstable stratification and upward sensible heat flux. However, such long-lived CBL is not observed in Tiksi. It was also found that the active layer (or thaw line) is deeper and the soil temperatures are higher at Eureka than at Tiksi.

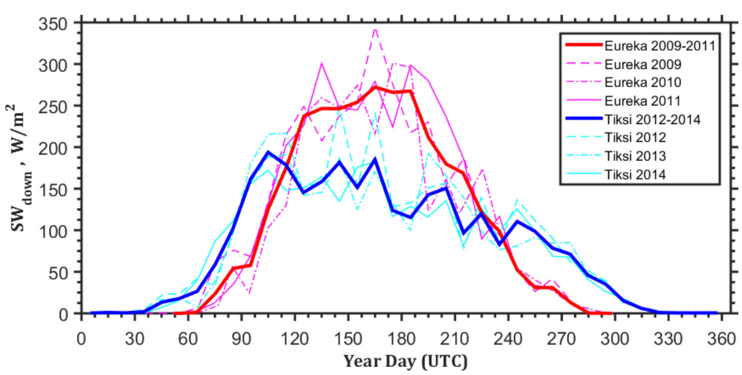

Figure 1. Annual cycle of short-wave (SW) downwelling radiation observed at Eureka in 2009-2011 and Tiksi in 2012-2014. The data are based on 10-day averaging of 1-hr radiation measurements.