

Drivers and Environmental Responses to the Changing Annual Snow Cycle of Northern Alaska

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Linkages between atmospheric, ecological and biogeochemical variables in the changing Arctic are analyzed using long-term measurements at the NOAA/GMD Barrow Atmospheric Baseline Observatory (BRW) near Utqiagvik (formerly Barrow), Alaska. Two key variables are the date when snow disappears in spring, as determined primarily by atmospheric dynamics, precipitation, air temperature, winter snow accumulation and cloud cover, as well as the date of onset of snowpack in autumn that is additionally influenced by ocean temperature and sea ice extent. In 2015 and 2016 the snow melted early at Utqiagvik due mainly to anomalous warmth during May of both years attributed to atmospheric circulation patterns, with 2016 having the record earliest snowmelt. These years are discussed in the context of a 115-year snowmelt record at Utqiagvik with a trend toward earlier melting since the mid-1970s (-2.86 days/decade, 1975-2016). At nearby Cooper Island, where a colony of seabirds, Black Guillemots, have been monitored since 1975, timing of egg laying is correlated with Utqiagvik snowmelt with 2015 and 2016 being the earliest years in the 42-year record. Ice-out at a nearby freshwater lagoon is also correlated with Utqiagvik snowmelt. The date when snow begins to accumulate in autumn at Utqiagvik shows a trend towards later dates (+4.6 days/decade, 1975-2016), with 2016 the latest on record. The impacts of a lengthening snow-free season on regional phenology, soil temperatures, fluxes of gases from the tundra, and relationships to regional sea ice conditions are discussed. Better understanding of these interactions is needed to predict the annual snow cycles in the region at seasonal to decadal scales, and to anticipate coupled environmental responses.

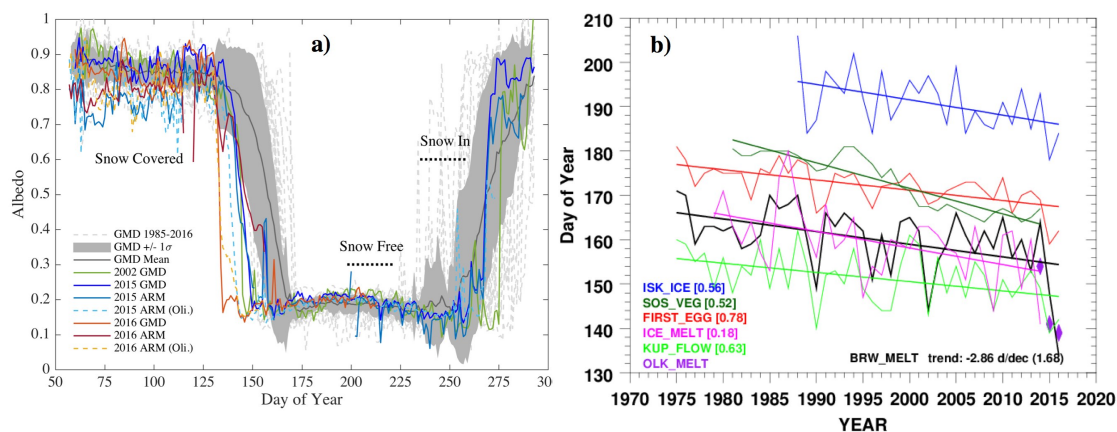


Figure 1. (a) Daily mean albedo from BRW measurements: 1987-2016. Select years from BRW, Utqiagvik Atmospheric Radiation Measurement (ARM) site, and Oliktok (ARM) also shown. (b) BRW snowmelt dates alongside other regional metrics for the onset of spring: ice-out date in Isaktoak Lagoon (ISK_ICE), onset of flow >10K cfs in the Kuparuk River (KUP_FLOW), start of the vegetation growing season based on normalized difference vegetation index (SOS_VEG), date of first Black Guillemot egg (FIRST_EGG), and mean melt onset date over regional sea ice (ICE_MELT). Oliktok snowmelt dates shown with diamonds. Correlations (r) with BRW snowmelt dates are in brackets. The value in parentheses is the 95% CI for the snowmelt trend.