



Alagnak

Aniakchak

Katmai

Kenai Fjords

Lake Clark

Seasonal Processes

Seasonal processes are natural cycles such as lake ice formation and break-up, snowpack accumulation and melt, and vegetation growth and senescence. Climate and ecological processes are integrally linked. For example, snow-covered area of a catchment, snow depth, snow water equivalent, and snow season length control the timing and volume of stream flow in the spring. Snowmelt dates influence the timing of leaf-out, and both snowpack and green-up influence wildlife movement at the start of the growing season. Spatial variation in snow and growing season length is driven in large part by elevation, latitude, and proximity to the ocean. Variation in lake ice affects lake temperatures and water levels, and largely controls human and wildlife travel routes over the course of the winter.

Methods

Since 2005, the Southwest Alaska Network (SWAN) has collaborated with the USGS-Earth Resources Observation Systems (EROS) Data Center and the University of Alaska Fairbanks-Geographic Information Network of Alaska (GINA) to use Moderate Resolution Imaging Spectroradiometer (MODIS) data to monitor changes in seasonal processes. Lake ice has been manually interpreted for 17 lakes on the Kenai and Alaska Peninsulas since 2001 (http://science.nature.nps.gov/im/units/swan/monitor/lake_ice_about.cfm; Figure 1). Growing



Jerry/Jeanette Mills

Wolves crossing Lake Telaquana, Lake Clark National Park and Preserve.

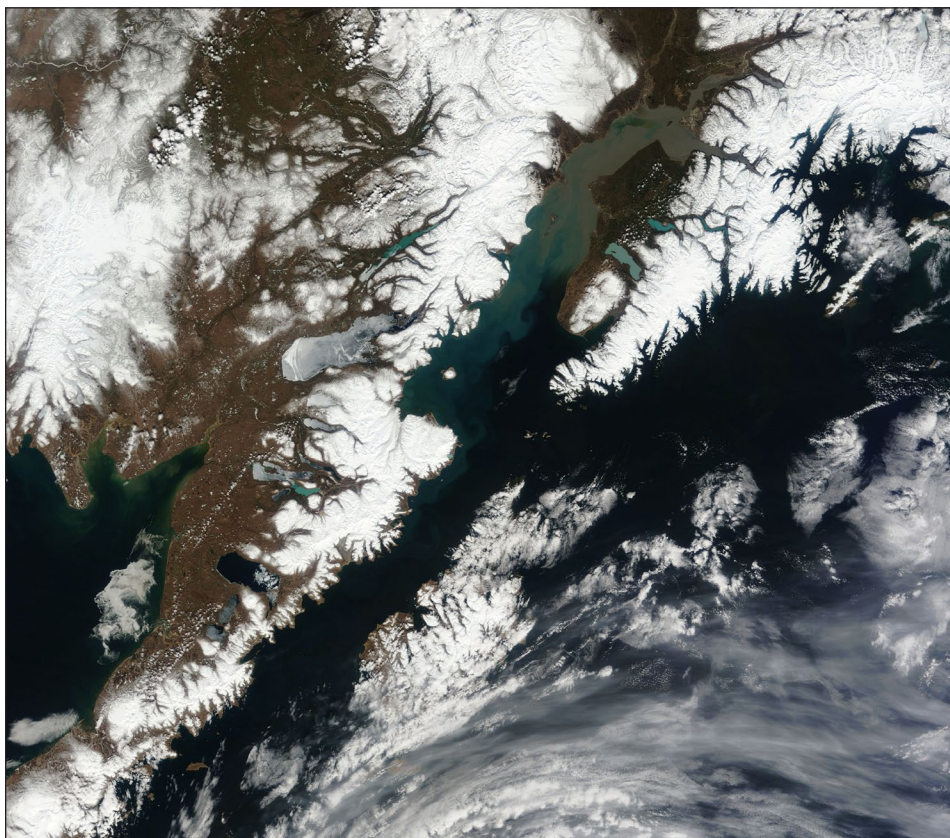


Figure 1. MODIS Terra image showing ice formation on Lake Iliamna and Naknek Lake, and snow cover extent, January 28, 2010. MODIS data are used to calculate lake ice, snow season, and growing season metrics.

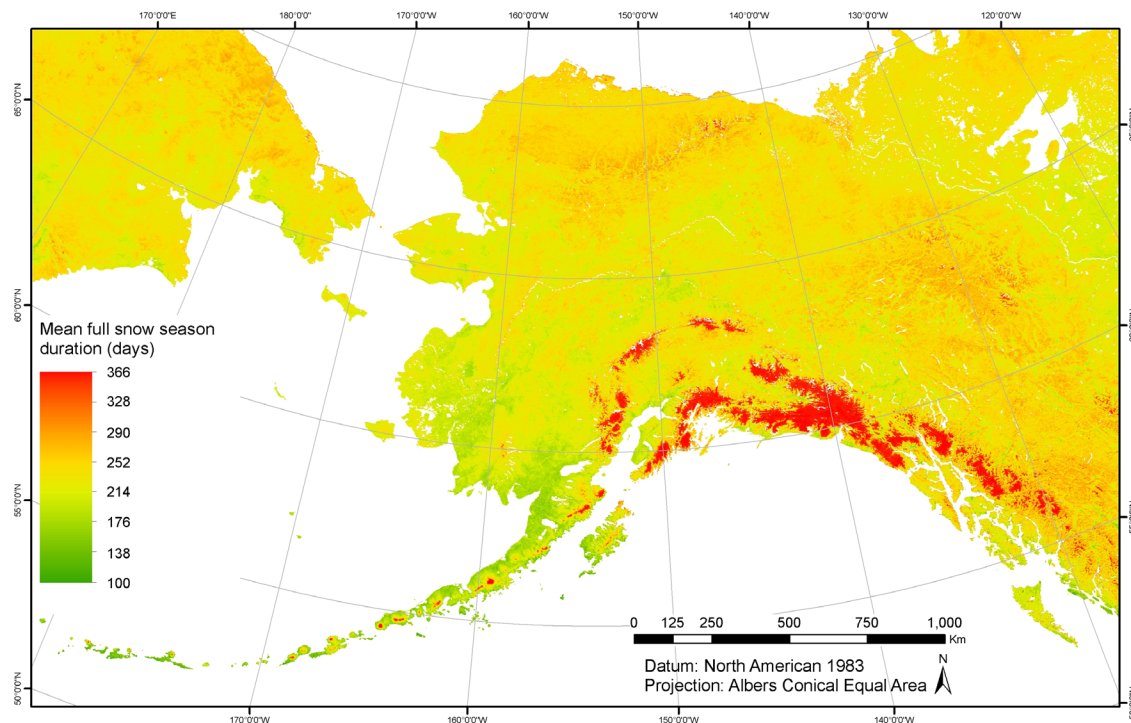


Figure 2. Mean full snow season duration across Alaska (2001–2013). Red areas indicate year-round snow on glaciers and permanent snowfields. Warm colors (orange) show areas of earliest snow onset or late snowmelt, whereas cooler colors (green) show areas with the shortest snow season; e.g., lowland coastal areas in southwest Alaska. (Figure from Lindsay et al. 2015).

season and snow season metrics derived from MODIS are available on GINA’s website (2001–2015; <http://www.gina.alaska.edu/projects>). Time-lapse cameras installed at three remote weather stations in SWAN parks have been used to capture data on the timing of snowfall, green-up, and senescence. Images are archived with the PhenoCam Network at Harvard Forest (2010–present).

Snow Season Length and Lake Ice Vary with Winter Temperature

Snow cover is highly variable in coastal areas of southwest Alaska where snow often melts out several times during a winter. These snow “on-off” events can occur up to four or more times a year in western Katmai and the Bristol Bay lowlands (Lindsay et al. 2015). Mean snow season length varies from year-round at the highest elevations, to less than 100 days (approximately 3 months) at some coastal sites (Figure 2). Lake ice can be similarly variable: typically lakes on the Kenai and Alaska

Peninsulas do not completely freeze (>90% ice cover) until mid-November or mid-January, and in some years, such as the strong El Niño winter of 2002–2003, and the warm winter of 2014–2015, the largest lakes did not freeze at all (Reed et al. 2009; Hayward et al. 2016). The interannual variability in freeze-up start dates likely reflects the characteristic oscillation between warm and cold temperatures over several weeks in the late fall and early winter. In contrast, break-up occurs more rapidly than freeze-up, and the timing of final break-up dates (<10% ice cover) generally range from late April to early May. Variability in break-up dates can be as great as 31 days, and changes in the timing of break-up dates are likely a better indicator of broad-scale climate effects than changes in the timing of freeze-up (Hayward et al. 2016).

To date, the 14-year lake ice record does not show a trend, although long-term (150-year) trends across the Northern Hemisphere indicate a decrease of up to 12 days per century in lake ice season length (1846–1995; Magnuson et al. 2000). Future reductions in the duration of lake ice cover in southwest

and southcentral Alaska would likely be associated with thinner ice, reduced albedo, warmer lake-water temperature, increased turbidity, increased light input, and decreased opportunities for winter recreation, ice-fishing, and trapping.

References

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