Seasonal Processes

Local and remote imagery tell story of growing season length linked to temperature, precipitation

Snow season and growing season length are strongly controlled by temperature and precipitation. Spatial variation in snow and growing season length is driven in large part by elevation, latitude, and proximity to the coast (Figs. 1-2). Year-to-year variation is influenced by climate; e.g., cool spring temperatures and late-melting snowpack in 2008 resulted in a later start to the growing season in many areas of southwest Alaska. Warmer than average temperatures during strong El Niño years (e.g., 2002-2003) have been shown to influence lake ice (Reed et al. 2009) and are also expected to influence snow season length. A comparison of start of season (SOS) dates estimated from MODIS satellite data and Phenocam time-lapse photos shows reasonably close correspondence between the two data sources. Although our sample size is small, 75% of the Phenocam SOS dates are within 2 days of the MODIS-derived dates.

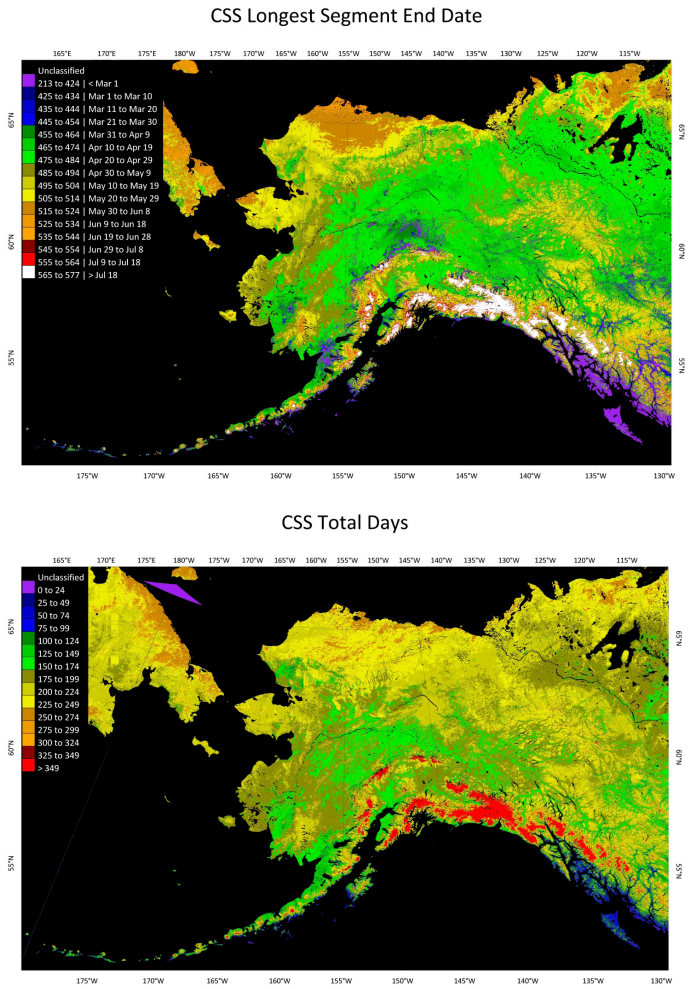

Fig. 1. Continuous snow season (CSS) metrics for the 2009-2010 snow year. Snow season length (top) and snowmelt date (bottom) are modeled from the MODIS snow product developed by the National Snow and Ice Data Center. The areas with the earliest snowmelt dates and shortest length of snow season are shown by cool colors (purple, blue, green). Areas with perennial or late-lying snow are shown in red.

Importance

This vital sign focuses on the seasonality of lake ice, snowpack, and vegetation growth. Climate variability affects the timing of these events, which in turn affect ecosystem processes. For example, the length of the snow season and the area covered by snow control the timing and volume of stream discharge. Snowmelt dates influence the timing of leaf-out, and both snowpack and forage availability affect wildlife movement.

The seasonal composite photo shows images taken by the the KEFJ Phenocam located near Exit Glaicer at the SNOTEL site. Photos left to right were taken on May 14, June 2, July 17, and September 30, 2013. The camera takes a photo every hour between 7 am and 7 pm.

Monitoring Approach

Since 2005, 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 seasonality. Currently, GINA serves MODIS and Advanced Very High Resolution Radiometer (AVHRR) data through web coverage (WCS) and mapping services (WMS). Growing season and snow season metrics (2001-2012) derived from eMODIS are available on GINA's website: http://www.gina.alaska.edu/projects. We are now working with GINA to develop comparable metrics for AVHRR data, which span a much longer period (1978-2012). Lake ice has been manually interpreted for 17 lakes (2001-2010) and uploaded into a SWAN database. Time-lapse cameras installed at three remote weather stations in SWAN have been used to capture data on the timing of snowfall, green-up, and senescence (2010-present). The photos have been processed to generate curves showing changes in "greenness" (an index of the spectral quality of foliage) through the growing season. We are using these data to explore methods for identifying start and end of season dates and for manually interpreting growing season and snow on/snow off dates that can be used to validate the MODIS-derived metrics.

The images from these stations are archived with the PhenoCam Network at Harvard Forest.

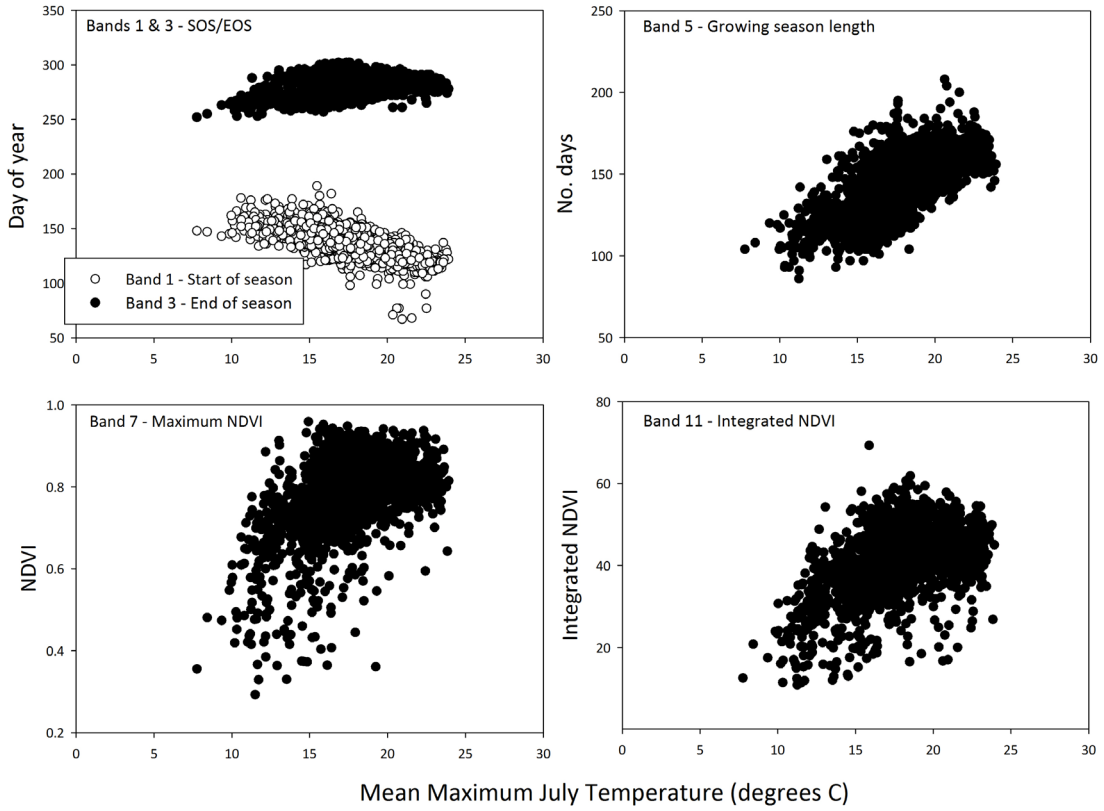

Fig.ure 2. Growing season length is strongly controlled by temperature. Panels above show the relationship between July maximum temperature and growing season metrics measured across Alaska. The MODIS metrics represent an average of 12 years of data (2000-2011) for 2500 random points assigned statewide. Temperature data are derived from the PRISM data set (1971-2000). Areas of the state that have the warmest summer temperatures (e.g., Interior AK) also had the longest growing season, mainly due to earlier start of season dates. Temperature did not affect peak biomass, estimated by maximum NDVI (Normalized Difference Vegetation Index; a graphical indicator used to analyze remote sensing measurements to assess the presence of live green vegetation).

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References

Reed B, Budde M, Spencer P, Miller A. 2009. Integration of MODIS-derived metrics to assess interannual variability in snowpack, lake ice and NDVI in southwest Alaska. Remote Sensing of Environment 113:1443-1452.