Decadal changes of phenological patterns over Arctic tundra biome

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Abstract

The northern high latitudes have experienced a continuous and accelerated trend of warming during the past 30 years, with most recent decade ranks the warmest years since 1850. Warmer springs are especially evident throughout the Arctic. Meanwhile, Arctic sea ice declined rapidly to unprecedented low extents in all months, with late summer experiences the most significant declining. Warming in the north is also evident from observations of early melting of snow and reducing snow cover. Now a key question is: in the warmth limited northern biome, what will happen to the phenological patterns of tundra vegetation as the global climate warms and seasonality of air temperature, sea ice, and snow cover shift? To answer the question we examined the onset of vegetation greenness, senescence of greenness, length of growing season, and dates of peak greenness along Arctic bioclimatic gradients (subzones) to see how they change over years. Here, we combine multi-scale sub-pixel analysis and remote sensing time-series analysis to investigate recent decadal changes in vegetation phenology along spatial gradients of summer temperature and vegetation in the Arctic. The datasets used here are AVHRR 15-day 8 km time series, AVHRR 8-day 1 km dataset, and MODIS 8-day 500m collection 5 NDVI dataset. There were detectable changes in phenological pattern over tundra biome in past two decades. Increases of vegetation greenness were observed in most of the summer periods in low arctic and mid-summer in high arctic. Peak greenness appeared earlier in high arctic and declined slower after peak in low arctic. Generally, tundra plants were having longer and stronger photosynthesis activities, and therefore increased annual vegetation productivities. Field studies have observed early growth and enhanced peak growth of many deciduous shrub species in tundra plant communities. These changes in seasonality are very likely to alter surface albedo and heat budget, modify plant photosynthesis/respiration and soil microbial activities, and even change hydrological patterns in the arctic. Next step, data fusing and assimilation of multi-sensor remote sensing data time series with process models will be applied to create a comparable vegetation phenological dataset to improve our understanding on shifting of seasonality of tundra vegetation.