Estimation of tundra and forest understory vegetation phenology in Alaska from time-lapse cameras and satellite measurements

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Satellite observation offers quantitative information of large-scale phonological timings using the seasonal patterns in vegetation indices. How can we interpret the satellite-derived phenology in sparse evergreen needleleaf forests? One can expect majority of the satellite signals must be related to understory vegetation. However, none of studies have shown how understory seasonality affects in determining the start of season (SOS, budburst timing) and the end of season (EOS, leaf-fall timing). We quantify the understory vegetation SOS and EOS from time-lapse camera images installed at the understory of nine Alaskan black spruce and four tundra sites. SOS and EOS were also estimated by two independent satellite measurements (Terre-MODIS and SPOT-VEGETATION) using three different satellite-based methods. The results from time-lapse cameras show the SOS timings of understory vascular plants in boreal forest sites were on average at DOY 140, which was 10 days earlier than the tundra sites (DOY 150.2) due to earlier snow thaw and temperature increase. On the other hands, the EOSs in the forest sites were as early as those of tundra sites (DOY 251.8 for forest sites and DOY 250.1 for tundra sites, which are in the early September). Satellite estimates did not reflect the autumn understory EOS well. The understory EOS evaluated by the time-lapse cameras was on average of 26 days earlier than that of the satellite based EOS estimated by the threshold of NDVI. Radiative transfer analysis revealed that increasing solar zenith angle in autumn enhanced the fraction of reflected light from overstory. Consequently NDVI has little change or could increase until the day of continuous snow cover day. Using the results of 26 days difference between understory and the satellite-derived EOSs, we constructed a diagnostic climatological map of understory EOS. It showed that the EOSs in most of Alaskan forests are before the mid-September (DOY 260).