Phenological changes for 10 years and the influence on ecosystem productivity in a larch forest at the foot of Mt. Fuji

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Phenological changes such as earlier budding or flowering and later leaf coloring and leaf fall have been reported around the world along with recent global warming. Phenology is an important index for climate change, and is also one of valuable factors to regulate the carbon cycle in terrestrial ecosystems. As the phenological responses to environment vary across species, assessment of long-term phenological trend for each species is required. In this study, we investigated the phenology of a Japanese larch forest by near-surface remote sensing, and analyzed the relationship between the phenology and climate change and also the influence of phenology on the forest ecosystem productivity derived from CO_2 flux observation.
Our study was conducted in a larch plantation at Fuji-hokuroku flux observation site (Fujiyoshida city, Yamanashi). About 87 % of the canopy is dominated by 60-year-old Japanese larch (*Larix kaempferi*) and the maximum LAI of the canopy was 3.2 m^2 m^{-2} in 2012. CO_2 flux and micro meteorological factors have been measured by eddy covariance method for ten years since 2006. For phenological observation, reflectance from the canopy has been continuously observed on the observation tower by using two spectral radiometers (upward and downward) and digital cameras. The vegetation index to detect seasonal changes of the canopy greenness was calculated as Green Ratio: GR=G/(R+G+B). The start and end dates of the growing season were determined from the days when the time series of GR indicated the maximum rate of increase and decrease. Then relationships of the yearly variations of phenology, temperature, net ecosystem exchange (NEE) and gross primary production (GPP) were analyzed.
As results, the mean dates of start and end of growing season were Apr. 23 and Nov. 8, with large amplitudes of 12 and 8 days respectively. Significant earlier or later phenological trend was not found across these ten years from 2006 to 2015. The mean annual growing season length was 198.5±4.1 days. The start and end dates were significantly related to the mean temperature respectively during Mar.-Apr. and during Sep.-Oct. The phenological responses to temperature were −4.5 day/ºC (R^2 = 0.88) in spring and 2.3 day/ºC (R^2 = 0.74) in autumn. In addition, the influences of phenology on GPP and NEE during spring (Apr. and May) and autumn (Oct. and Nov) were indicated. Meanwhile, yearly variations in annual GPP and NEE were more influenced by the decrease of summer productivities due to thinning and typhoon than phenological factors.

Keywords: Phenology, Growing season, Climate change, Carbon cycle, GPP

