Interannual Variability in the Length of Growing Season across the Contiguous US as Observed from MODIS, VIIRS, and Tower Vegetation Index Time Series Data

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Vegetation phenology is considered one key variable to understand climate change impacts on plant productivity. Spectral vegetation index (VI) time series data from polar-orbiting satellites such as Moderate Resolution Imaging Spectroradiometer (MODIS), have widely been used to characterize vegetation phenology at various spatial and temporal scales. They have shown to be valuable tools in discerning various phenological metrics, such as the start and end of growing seasons (SOS and EOS), and have recently been used to quantify interannual variability in the length of growing season (GSL) at regional and global scales. Assuring the quality of satellite-derived GSL is critical to characterize directions and magnitudes of shifts in GSL, which are linked to the changes in plant productivity. The objective of this study was to assess the quality of satellite-derived GSL in characterizing the relative impacts of the SOS and EOS changes to the GSL interannual variability by an intercomparison with in-situ optical sensor data. The GSL derived from MODIS (2003-2015) and Visible Infrared Imaging Radiometer Suite (VIIRS) (2012-2015) VI time series data were compared with those derived from in-situ (Tower) VI time series data (2003-2015), which were derived from in-situ tower optical sensor data, at 11 AmeriFlux sites located across a range of biomes in the contiguous US (CONUS). The SOS and EOS metrics were obtained from all the three datasets by fitting logistic function for each year, and the GSL was calculated as the difference between the SOS and EOS. Relative contributions of the changes in SOS and EOS to the GSL interannual variability were evaluated using the ratios of the absolute changes in SOS to that of GSL. Year-to-year changes in MODIS and VIIRS GSLs corresponded well with those from the Tower GSL although some biases were observed for some sites (R^2>0.68, p<0.01). The relative contributions of the SOS and EOS varied across sites (SOS contribution=20~93%), which were seen in all the three datasets. The stronger SOS contributions (>50%) were seen at many of the sites located in the mid-latitudinal region (37.5°N~42.5°N), whereas EOS showed stronger contributions (>50%) at those sites located in the southwestern part of the CONUS. These relative contributions changed temporally but the observed spatial patterns were consistent. These results indicate that the satellite-derived GSL is capable of characterizing the interannual variability of GSL in the CONUS. Further analysis at additional locations may help to assure the quality of satellite-derived GSL and to better understand GSL interannual variability under climate change.

Keywords: vegetation phenology, growing season length, MODIS, VIIRS, in-situ radiation data

