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Changes of spring phenology effects on the dynamics of carbon cycle in grasslands

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Global warming is dramatically altering the plant phenology of terrestrial ecosystems, while plant phenology plays an important role in carbon exchange processes. Despite the great number of studies on the grassland ecosystem, the changes of spring phenology effects on the dynamics of carbon cycle in grasslands still remain unclear. Here, we used eddy covariance measurements of net ecosystem productivity (NEP) from nine FLUXNET sites (73 site-years of data) in grasslands to investigate the relationships between the changes of spring phenology and the dynamics of carbon cycle (including gross ecosystem production (GEP), ecosystem respiration (ER), and NEP) on a ten-day scale. In this study, flux sites retained that at least five years of eddy covariance observations, in which 75 percent or more of measured and good quality gap-fill data included in those years. The time series of daily GEP data fitted based on the double logistic method using the TIMESAT software package, then SOS (start of growing season) and EOS (end of growing season) were identified when the first and last 10% of the seasonal amplitude (= GEP_{max} – GEP_{min}) were reached. The results showed that (1) with a 1-day advance of SOS increasing GEP and NEP by 1.21 $\sim$ 5.45 g C $m^{-2}$and 0.68 $\sim$ 4.16g C m^{-2} respectively at most sites (seven-ninths), but a weak influence on ER (only a ten-day ER significantly related with the changes of SOS at most sites). (2) the advance of SOS mainly caused a significant increase on GEP or NEP during the 20 – 50 days after the onset of SOS, but a weak significant impact on GEP and NEP during the middle and late period of growing season at most sites. (3) the advance of SOS caused a significant decrease on GEP or NEP during the middle period of growing season at a few sites. The universal laws found in our study were that the advance of SOS show a weak significant impact on ER, while mainly caused a significant increase on GEP or NEP during the early period of growing season but a weak influence during the subsequent period at most sites. This helps to further understand the influences of spring phenological changes on the dynamics of carbon cycle in grasslands.