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Exploring the responses of structural and physiological phenology to climate and nutrient availability jointly using PhenoCams and flux towers

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Climate change and human-induced stoichiometric imbalances are altering ecosystems across the globe. However, phenology, as the one of first-order control on productivity, has not been well studied with regard to its response to the above environmental changes. With co-located PhenoCams and eddy covariance (EC) towers in a large scale nutrients manipulation experiment (MANIP) in a Mediterranean tree-grass ecosystem, we intend to understand how the structural (i.e. greenness) and physiological phenology (i.e. max gross primary productivity – GPPmax) reacts to the imbalanced availability of nutrients and meteorological changes.

Three experimental EC towers are located approximately 500 m apart from each other. Their footprints are manipulated with addition of nitrogen, nitrogen and phosphorus or not fertilized, serving as control. A PhenoCam was installed on the top of each EC tower. GPPmax was derived from EC flux tower measurements and green chromatic coordinates (GCC) was computed from PhenoCams. Then we extracted phenological metrics (i.e. transition dates; slopes and amplitudes of phenological profiles) and their uncertainties from time series of GCC and GPPmax. By comparing the extracted phenological metrics before and after nutrients manipulation, we showed that fertilization increases the speed of green-up and accelerates the senescence of dry-down, which is likely attributed to faster depletion of soil water at fertilized sites due to higher demand of transpiration at dry-down period. By applying statistical models and random forest method, we found meteorological factors like temperature and precipitation are the most important drivers for structural and physiological phenology. The relative importance of the availability of nutrients contributing to phenology is also quantified under different climate change scenarios. We expect that the joint use of proximal remote sensing and EC techniques, in conjunction with models, can help us to better reveal processes of environmental factors mediate the structural and physiological phenology under different nutrient availability.