Geophysical Research Abstracts
Vol. 21, EGU2019-6954, 2019
EGU General Assembly 2019

Responses of vegetation photosynthetic phenology to elevated CO_2 and climate warming: evidence from natural "urban laboratories"

Songhan Wang (1), Yongguang Zhang (1), Weimin Ju (1), Josep Peñuelas (2), Alessandro Cescatti (3), Yuyu Zhou (4), Yongshuo Fu (5), Alfredo Huete (6), and Min Liu (7)

(1) Nanjing university, International Institute for Earth System Sciences, China (wangsonghan2@gmail.com), (2) CSIC, Global ecology Unit CREAF-CSIC-UAB, Bellaterra 08193, Catalonia, Spain., (3) European Commission, Joint Research Centre, Directorate for Sustainable Resources, Ispra, Italy., (4) Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011, USA, (5) College of water sciences, Beijing Normal University, Beijing, China., (6) School of Life Sciences, University of Technology Sydney, NSW 2007, Australia., (7) Shanghai Key Laboratory for Urban Ecological Processes and Eco-Restoration, School of Ecological and Environmental Sciences, East China Normal University, Shanghai 200241, China.

The timing and duration of photosynthetic activity (i.e. photosynthetic phenology), plays an important role in the terrestrial ecosystem carbon cycles and is substantially affected by climate change. However, because the difficulties of accurately manipulating field CO_2 and temperature, the limited spatial coverage and vegetation species coverage, till present our knowledge about the photosynthetic phenology shifts and its associated environmental drivers are still limited.

Here we follow a novel approach and develop our study on the unexplored opportunities offered by cities, the area most manipulated by humans. Our approach is based on the simple consideration that plants in cities are exposed to higher temperatures (because of the heat island effect) and CO_2 concentrations (because of the large CO_2 emissions) than in the surrounding rural areas. Therefore, plants in cities are experiencing today the climate and atmospheric composition that will occur in nature several decades ahead. Building on this evidence, by making innovative use of recent high-resolution retrievals of vegetation sun-induced fluorescence (SIF) and atmospheric CO_2 from satellite platform (OCO-2), we explored how the differences in environmental conditions between the urban and the neighbouring rural areas are impacting vegetation photosynthetic phenology in 880 cities, used as "natural laboratories" spread across the whole Northern Hemisphere.

We found that vegetation photosynthetic activity began earlier (-5.6 ± 0.7 days), peaked earlier (-4.9 ± 0.9 days) and ended later (4.6 ± 0.8 days) in urban conditions than in neighboring rural areas. Interestingly the shift in the phenology of photosynthesis proved to be 2–4 folds larger than that in leaf phenology typically observed and reported in the literature. And surprisingly, these anomalies are not merely caused by climate warming but also, and more significantly, by the CO_2 enrichment, especially for the autumn phenology. Then we used these sensitivities to project phenology shifts under four RCP climate scenarios, predicting that vegetation will have prolonged photosynthetic seasons in the coming two decades.

This observation-driven study, using urban laboratories, demonstrates the high sensitivity of photosynthetic phenology to both daytime temperature and atmospheric CO_2, and predicts a substantial extension of the photosynthetic season in response to future climate change across the Northern Hemisphere. Ultimately, these experimental findings of actual vegetation responses to future conditions will provide important constraints to earth system models and shed new light on the increasing terrestrial carbon sink. This study also indicates that the realistic urban environments can provide a promising way for vegetation physiological studies based on SIF observations.