Green-up and brown-down: Modelling grassland foliage phenology responses to soil moisture availability

Jinyan Yang[1], Belinda Medlyn[1], Craig Barton[1], Amber Churchill[1], Martin De Kauwe[2], Mingkai Jiang[1], Arjunan Krishnananthaselvan[1], David Tissue[1], Elise Pendall[1], and Sally Power[1]

[1]Western Sydney University Hawkesbury Institute for the Environment
[2]University of Bristol School of Biological Sciences

April 27, 2022

Abstract

Grassland responses to drought are strongly mediated by leaf phenology, with greening and browning being highly sensitive to soil moisture. However, this process is represented overly simplistically in most vegetation models, limiting their capacity to predict grassland responses to global change factors. We derive functions representing grassland phenological responses to soil water content (SWC), by fitting an empirical model to greenness data. Data were obtained from fixed cameras (phenocams) monitoring phenology at several grassland experiments in Sydney, Australia. The data-model synthesis showed that the sensitivity of growth to SWC exhibited a concave-down response in most species. For senescence, we found a strong nonlinear increase in senescence rate with declining SWC. Both findings contradict common assumptions in vegetation models. Incorporating nonlinear responses in the empirical model reduced the error in cover predictions by 12%. Model evaluation against data from drought treatments indicated that differential sensitivity of phenology to SWC helps explain differences among species' responses to variable rainfall. Our work provides a new methodology, and new evidence, to support the development of improved representations of grassland phenology for vegetation models.

Hosted file

`yang et al 2022.docx` available at https://authorea.com/users/479016/articles/567007-green-up-and-brown-down-modelling-grassland-foliage-phenology-responses-to-soil-moisture-availability