Journal of Arid Environments 115 (2015) 1–9

Contents lists available at ScienceDirect

Journal of Arid Environments

journal homepage: www.elsevier.com/locate/jaridenv

Seasonality of net carbon exchanges of Mediterranean ecosystems across an altitudinal gradient

P. Serrano-Ortiz [a, *, 1], A. Were [b], B.R. Reverter [c], L. Villagarcía [d], F. Domingo [b], A.J. Dolman [e], A.S. Kowalski [a, 1]

[a] Departamento de Física Aplicada, Universidad de Granada, 18071 Granada, Spain
[b] Estación Experimental de Zonas Áridas, CSIC, 04001 Almería, Spain
[c] Departamento de Ciências Fundamentais e Sociais, Universidade Federal da Paraíba Campus II, Areia 58397-000, PB, Brazil
[d] Departamento de Sistemas Físicos, Químicos y Naturales, Universidad Pablo Olavide, 41013 Sevilla, Spain
[e] Department of Earth Sciences, VU University Amsterdam, Amsterdam, Netherlands

ARTICLE INFO

Article history:
Received 20 January 2014
Received in revised form
25 June 2014
Accepted 6 December 2014
Available online

Keywords:
Carbon fixation
Eddy covariance
Evapotranspiration
Photosynthesis
Mediterranean ecosystems
Respiration

ABSTRACT

In the present climate change context it is important to understand the carbon balance seasonality of Mediterranean areas, that will suffer important changes in precipitation according to the last climate change predictions. This work analyzed the seasonality of carbon exchanges of three Mediterranean ecosystems according to a variety of water and temperature regimes due to differences in altitude (alpine, subalpine and lowland). Results show that the timing and duration of the growing season depended on temperature at the alpine site, while the dependence on water availability increased as altitude decreased. Thus, maximum values of net carbon uptake occurred in late spring for the alpine and subalpine sites (up to 60 and 30 gC m^{-2} $month^{-1}$ respectively) whereas the lowland site absorbed carbon throughout winter (up to 30 gC m^{-2} $month^{-1}$). Similarly increases in aridity conditions resulted in monthly increases in carbon emissions during dry periods. Thus from May to October, the lowland emitted up to 60°gC°m^{-2}°$month^{-1}$, the subalpine emitted half that with a delay of two months, whereas the alpine site continued with slight uptake sequestration. Finally, the EVI could be used to provide reasonably accurate estimates of photosynthesis (R^2 around 0.6) but this relation varies depending on the site.

1. Introduction

The Mediterranean climate is distinctly characterized by mild temperatures (*T*) and asynchronous patterns of precipitation, versus light and *T*. The dry summer characteristic of this climate makes Mediterranean ecosystems very sensitive to climate change via land degradation, which can decrease the potential for plant carbon (C) assimilation (Mouat and Lancaster, 2006). In addition, the C and water balances are tightly linked as precipitation pulses (Inglima et al., 2009), soil water content (Rey et al., 2005), and the timing of precipitation (Xu and Baldocchi, 2004) have been shown to exert strong controls on the C balance. As predictions for climate change in this region indicate a decrease in water availability (via decreases in rain events and total precipitation (IPCC, 2007)), the link between the C and water cycles is expected to be tighter as the growing period is shortened due to drought (Janssens et al., 2005; Baldocchi, 2008). Therefore, monitoring and understanding the seasonality of net C exchanges in Mediterranean ecosystems and how they are linked to the water balance is essential to be able to understand the effects that future climate change will exert on the behavior of these ecosystems as sources or sinks of CO_2.

Grasslands and shrublands, representing the first stages of colonization in Mediterranean ecosystems, are the main vegetation types due to years of human intervention, deforestation and desertification (Dato et al., 2010). Moreover, in recent decades, 18.3 million ha of European agricultural areas (globally, 235 million ha) were abandoned (Rounsevell et al., 2003, 2006; FAO, 2004). This

* Corresponding author. Departamento de Física Aplicada, Universidad de Granada, 18071 Granada, Spain.
E-mail addresses: penelope@ugr.es (P. Serrano-Ortiz), anawere@eeza.csic.es (A. Were), borja@cca.ufpb.br (B.R. Reverter), lvilsai@upo.es (L. Villagarcía), poveda@eeza.csic.es (F. Domingo), han.dolman@falw.vu.nl (A.J. Dolman), andyk@ugr.es (A.S. Kowalski).
[1] Instituto Interuniversitario del Sistema Tierra en Andalucía, Centro Andaluz de Medio Ambiente (IISTA-CEAMA), 18006 Granada, Spain.

http://dx.doi.org/10.1016/j.jaridenv.2014.12.003
0140-1963/