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Interannual variability of Net Ecosystem CO_2 Exchange and its component fluxes in a subalpine Mediterranean ecosystem (SE Spain)

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Recent decades under climate change have seen increasing interest in quantifying the carbon (C) balance of different terrestrial ecosystems, and their behavior as sources or sinks of C. Both CO_2 exchange between terrestrial ecosystems and the atmosphere and identification of its drivers are key to understanding land-surface feedbacks to climate change. The eddy covariance (EC) technique allows measurements of net ecosystem C exchange (NEE) from short to long time scales. In addition, flux partitioning models can extract the components of net CO_2 fluxes, including both biological processes of photosynthesis or gross primary production (GPP) and respiration (Reco), and also abiotic drivers like subsoil CO_2 ventilation (VE), which is of particular relevance in semiarid environments. The importance of abiotic processes together with the strong interannual variability of precipitation, which strongly affects CO_2 fluxes, complicates the accurate characterization of the C balance in semiarid landscapes.

In this study, we examine 10 years of interannual variability of NEE and its components at a subalpine karstic plateau, El Llano de los Juanes, in the Sierra de Gádor (Almería, SE Spain). Results show annual NEE ranging from 55 g C m-2 (net emission) to -54 g C m-2 (net uptake). Among C flux components, GPP was the greatest contributing 42-57% of summed component magnitudes, while contributions by Reco and VE ranged from 27 to 46% and from 3 to 18%, respectively. Annual precipitation during the studied period exhibited high interannual variability, ranging from 210 mm to 1374 mm. Annual precipitation explained 50% of the variance in Reco, 59% of that in GPP, and 56% for VE. While Reco and GPP were positively correlated with annual precipitation (correlation coefficient, R, of 0.71 and 0.77, respectively), VE showed negative correlation with this driver (R = -0.74). During the driest year (2004-2005), annual GPP and Reco reached their lowest values, while contribution of VE to annual NEE reached its highest value. There were also positive correlations with annual evapotranspiration (R = 0.71 for Reco and 0.64 for GPP), which explained 51% and 42% of the variance in Reco and GPP, respectively. Despite the variability in CO_2 fluxes depending on the year, we can conclude that this ecosystem is approximately carbon neutral over a decade. Our results highlight the importance of considering interannual variability in CO_2 fluxes, and also the need to account for abiotic contributions to the C balance in semiarid ecosystems, especially during dry years, to better predict the roles of these ecosystems in the global C balance.