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Subterranean ventilation: a key but poorly known process affecting the carbon balance of semi-arid ecosystems

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Subterranean ventilation, conceived as the advective transport of CO_2-rich air from the vadose zone to the atmosphere through a porous media (i.e. soil or snow; Sánchez-Cañete et al., 2013), has arisen as an important process contributing to the carbon (C) balance of Mediterranean ecosystems (Kowalski et al., 2008; Sánchez-Cañete et al., 2011; Serrano-Ortiz et al., 2014), apart from other well-known biotic processes (i.e. plant photosynthesis, autotrophic and heterotrophic respiration). Recent studies have linked this subterranean CO_2 release to fluctuations in the friction velocity or wind speed under drought conditions when water-free soil pores enable air transport (Rey et al., 2012a, 2013), however, barometric pressure variations has been suggested as another important driver (Sánchez-Cañete et al., 2013).

In this study, we investigate this process in newly studied semi-arid grassland located in SE Spain, as the ideal ecosystem to do so given the great length of the dry season and the slight biotic activity limited to the winter season. Preliminary results, based on unpublished analyzed eddy covariance data and subterranean CO_2 molar fraction measurements, confirm the presence of ventilation events from May to October for seven years 2009-2015. During these events, increases in the friction velocity correlates with sizeable CO_2 emissions of up to ca.10 μmol m^{-2} s^{-1}, and CO_2 molar fraction regularly drops 2000-3000 ppm just after the turbulence peak, at several depths below the soil surface (0.15 and 1.5 m). Additionally, during the driest period (July-August), the friction velocity explains from 37% to 57% of the net C emission variability. On the other hand, the model residuals do not show a significant relationship, neither with air pressure nor with soil water content. Overall, the results found in this newly monitored site demonstrate, as shown by past research, the relevance of subterranean ventilation as a key process in the C balance of Mediterranean ecosystems.