Geophysical Research Abstracts
Vol. 19, EGU2017-7556-1, 2017
EGU General Assembly 2017

How land degradation affects the carbon balance and its component processes: case of study in SE Spain

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The concept of land degradation stems from the loss of an ecosystem's biological productivity, which in turn relies on several degradation processes such as long-term loss of natural vegetation, depletion of soil nutrients, soil compaction or water and wind erosion. In this context, desertification means land degradation in arid, semi-arid and dry sub-humid areas due to climatic and/or human factors. Currently, drylands occupy more than one third of the global terrestrial surface and will probably expand under future climate change scenarios. Drylands′ key role in the global C balance has been demonstrated, but the effects of desertification and/or climate change on C sequestration by these ecosystems needs further research.
In the present study, we compare net carbon exchange between two experimental sites representing a "degraded" and "non-degraded" grazed semiarid grasslands, separated by ∼15 km in SE Spain, via eddy covariance measurements over 6 years, with high variability in precipitation magnitude and distribution. Results show a striking difference in the annual C balances with average emissions of 196 ± 40 and -23 ± 20 g C m^{-2} yr^{-1} for the "degraded" and "non-degraded" sites, respectively. At the seasonal scale, differing patterns in net CO_2 fluxes were detected over both growing and dry seasons. As expected, larger net C uptake over longer periods was observed in the "non-degraded" site, however, much greater net C release was measured in the "degraded" site over drought period. We tested differences in all monitored meteorological, ambient and subsoil variables and found most relevant that CO_2 at 1.50 m belowground was around 1000 ppm higher in the "degraded" site. Thus, we believe that subterranean ventilation of this vadose zone CO_2, observed at both sites, largely drives the differences in C dynamics between them. Overall, the 12 site-years of data allow direct exploration of the roles of climate and land degradation in the biological and non-biological processes that ultimately control the C sequestration capacity of semiarid ecosystems.