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Consequences of more extreme precipitation regimes for ecosystem fluxes in seasonally dry woodlands and forests

Laurent Misson (1), Rodrigo Vargas (7), Franco Miglietta (3), Walter Oechel (4), Joao Pereira (5), Dan Yakir (6), Gabriel Pita (8), and Timothy Martin (2)

(1) CNRS / CEFE, CEFE, France (laurent.misson@cefe.cnrs.fr), (2) University of Florida, (3) CNR, Italy, (4) San Diego State University, (5) Universidade Técnica de Lisboa, (6) Weizmann Institute of Science, (7) University of california, Berkeley, (8) Instituto Superior Tecnico Lisboa

As climate changes, the main changes in precipitation will likely be in the intensity, frequency and duration of events. It has been suggested that these changes will be more important for ecosystems biogeochemical cycles than the effects of changes in average precipitation, atmospheric warming or increased CO2 concentration. Although more extreme rainfall regimes are now being confirmed, the ecological implications of greater intra-annual variability have received attention only recently and results have been contradictory so far. In addition, most of the information available is for annual plant communities and perennial grasslands while data on woodland and forests are nonexistent. Specific questions addressed here are: (1) How precipitation event size, frequency and seasonal distribution influence fluxes independently of total precipitation quantities in woodland and forest ecosystems? (2) Is the effect of precipitation event size, frequency and distribution stronger than the effect of total precipitation quantity? (3) Do xeric and mesic woodland/forests differ in sensitivity to these factors? (4) How are these patterns different for GPP, RE and the resulting NEP? For this analysis, we used data from the FLUXNET “La Thuile” dataset. We found that total annual precipitation positively influences GPP and RE. In addition, precipitation frequency positively influences these fluxes independent of total precipitation quantities, but only for xeric sites where total annual precipitation was below 800 mm. The effect was of the same relative magnitude as the effect of total annual precipitation. Both factors have a stronger effect on GPP than RE, and thus positively influence NEP. Precipitation frequency was negatively related to mean precipitation event size, interval between precipitation events, mean atmospheric VPD and cumulative soil water stress, providing a mechanistic understanding of the relationship between precipitation frequency and ecosystem fluxes. A consequence of these relationships is a decrease in light and rainfall use efficiency with decreasing precipitation frequency, but only for the xeric sites. The importance of these results for ecosystem vulnerability and vegetation-climate feedback under future climate changes will be discussed.