EGU22-12118, updated on 20 Aug 2022
https://doi.org/10.5194/egusphere-egu22-12118
EGU General Assembly 2022

Comparative study of two Mediterranean pine forests demonstrates a dominant effects of soil moisture supply over atmospheric VPD in influencing gross primary productivity

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Forest grown in semi-arid regions are facing severe drought limitations, nevertheless they are still a considerable component of the global carbon cycle. Drought limitations on ecosystem carbon fluxes can be caused either by limited soil moisture supply, mainly expressed through the soil water content (SWC), or enhanced atmospheric demand, expressed through the atmospheric VPD. However, these two parameters are generally strongly correlated and the distinguish of their differential effects on ecosystem level processes is difficult. While soil water content is mainly affected by the local precipitation patterns, VPD is strongly affected by the air temperature. Both quantities are expected to alter under the current climate change scenarios, but the rise in temperature is expected to result in amplified increased in VPD. The ability to quantify the differential effects of SWC and VPD on ecosystem productivity is, therefore, critical for making predictions about future forest productivity and survival in the Mediterranean region under the ongoing climate change.

In this study we attempt to make a distinction between the impact of soil moisture and VPD on water limitations on GPP in Aleppo pine forests in Greece and in Israel. For the aim of the study, we performed GPP estimates for two Mediterranean sites in the two study sites that differ in water supply and local VPD. The separation of SWC and VPD limitations was achieved by the use of generalized additive models. Our results indicate that the parameter that dominates drought limitations in Aleppo pine is SWC, while VPD has a secondary and lesser effect.

Aleppo pine is a conifer species representing one of the major components of Mediterranean ecosystems, which is, in turn, one of the most vulnerable regions to climate change. The results imply, therefore, that the potentially enhanced increase in VPD, caused by rising temperatures in these regions, is likely to have a limited effect on future carbon fluxes, which will depend more strongly on trends in precipitation pattern.