

EGU23-4061, updated on 29 Feb 2024

<https://doi.org/10.5194/egusphere-egu23-4061>

EGU General Assembly 2023

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Atmospheric and soil water stress on ecosystem carbon and water use during flash droughts

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The combination of flash droughts and high temperature may have a significant effect on the ecosystem because of the soil and atmospheric moisture deficits. However, the stress of soil and atmospheric moisture deficits on carbon and water use of the ecosystem during flash droughts, particularly during the drought periods with hot conditions, are unclear over a large region. In this study, we decoupled the atmospheric and soil water stress over eastern China by using vegetation remote sensing products during flash droughts and their sub-periods that are accompanied by high temperature and intense radiation. The results showed that soil moisture (SM) stress on gross primary productivity (GPP) was significantly greater than the vapor pressure deficit (VPD) stress over eastern China, especially in humid area. In contrast, the atmospheric water stress in the North China Plain was more significant. By excluding the radiation effect, high VPD dominated the water stress on light use efficiency (LUE) in over 55% of the areas during flash droughts. For the hot periods of flash droughts, the GPP subject to VPD stress increased from 8% to 36% of the areas, especially in semi-arid and semi-humid regions. The concurrent hot and drought conditions also increased water use efficiency (WUE) for most areas. Moreover, the effect of water stress on LUE and WUE was similar to that during flash droughts. The reason may be that during hot periods of flash drought, the rise in VPD led to a decrease in vegetation stomatal conductance, which further reduced GPP, photosynthetically active radiation absorbed by vegetation and evapotranspiration at the similar rate.