EGU24-17562, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-17562
EGU General Assembly 2024

Drivers of compound drought-heat extremes across recent decades

Josephin Kroll[1], Ruth Stephan[1], Harald Rieder[2], Jens Hesselbjerg Christensen[3], and Rene Orth[1]
[1]University of Freiburg, Modelling of Biogeochemical Systems, Germany
[2]Institute of Meteorology and Climatology, Department of Water, Atmosphere and Environment, University of Natural Resources and Life Sciences, Vienna
[3]University of Copenhagen, Denmark

The joint occurrence of droughts and heat waves is expected to change with advancing climate change. While drought and heat themselves can already have major impacts on ecosystems and society, their compound occurrence can lead to amplified effects. Previous studies have analyzed changes in the occurrences frequency of compound drought-heat events and found increasing trends in some regions. In this study, we revisit these occurrence trends and additionally analyze the mechanisms that couple drought and heat as well as their changes in space and time. Considering drought as deficit of soil moisture and heat as an extreme temperature, evapotranspiration (ET) is the main physical process connecting both extremes. Therefore, we focus particularly on ET anomalies, because higher-than-normal ET during drought-heat events indicates that heat is inducing drought (heat -> drought) as high temperatures lead to high vapor pressure deficit which increases ET that in turn depletes soil moisture. Vice versa, lower-than-normal ET suggests drought is triggering hot temperatures (drought -> heat) as low soil moisture limits ET such that more of the incoming radiation is partitioned to sensible heat flux and hence warming the air. To better understand the underlying controls of these ET anomalies, we analyze their drivers by considering anomalies of precipitation, radiation, vapor pressure deficit and Leaf Area Index, which are in turn linked to anomalies in atmospheric circulation. Finally, we compare the relevance of these drivers, and of the drought -> heat vs. heat -> drought mechanisms in space, and link them with aridity and land cover type. In our analysis, we employ weekly data from the ERA5 reanalysis alongside gridded products derived with machine learning methods which were trained with in-situ observations. We define drought and heat with a percentile based approach filtering the lowest (< 5th percentile) absolute soil moisture values and highest (> 95th percentile) absolute temperatures at each grid cell. Understanding the mechanisms behind compound drought-heat extremes can help improve related forecasts, and to validate and constrain model projections of trends in these events.