## PROJECT INFORMATION

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| **Project title:** | **Illustration of multi-seasonal meteorological pathways to reduced forest productivity in Europe in 2000-2020** |
| **Project ID:** | 228 |
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## PROJECT DESCRIPTION

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The impact of heatwaves and droughts on forests itself is mediated by the interplay with preceding atmospheric anomalies. First of all, hot-dry compound extremes have an impact which exceeds that of the summed univariate extremes, such as during the hot droughts in 2003 and 2018. Longer-persisting or sequentially occurring droughts also disturb forests beyond the cumulated individual impacts, as the initial drought (period) exerts a negative legacy effect on the following drought (period). However, drought legacy effects have also been discussed as providing acclimation to following droughts. Besides warm summers and tree age, seasonal precipitation variability was driving tree mortality since 2000 in Europe. Furthermore, in parts of central and northern Europe, favorably warm, sunny, and sufficiently wet conditions in spring 2018 aggravated the negative impacts of the following summer drought on forest growth, as the early start into the growing season made vegetation strongly deplete soil moisture. A stormy autumn or winter season providing deadwood followed by a hot-dry growing season, which limits tree defense mechanisms, is a sequence that strongly promotes large-scale bark beetle outbreaks. And lastly, hot-dry spring and summer conditions together with fuel availability control the dynamics of forest fires, occurring frequently and most intensely in the Mediterranean. These storylines highlight that in addition to the co-occurrence of heat and drought, their embedding in the entire climatic timeline is crucially determining the resulting forest damage.
In the light of well-documented trends in temperature and precipitation, and in places modulated by atmospheric circulation changes, a better understanding of forest disturbances and the underlying meteorological processes is highly relevant to assess the potentially far-reaching ecosystem impacts. Well-aware of the important role of soil moisture in mediating between precipitation and (temperature-dependent) evapotranspiration, we focus on meteorological variables only. Therefore, in this study, we introduce and exploit a methodology that can serve as a very pragmatic starting point to investigate the meteorological processes leading to reduced forest productivity on continental scales. Here we demonstrate the potential of this approach by addressing the following main research questions: 1) When and where did large-scale reductions in forest productivity occur in Europe in summer 2000–2020?, 2) which sequence and combination of temperature and precipitation anomalies led to these events?, and 3) which local or synoptic-scale meteorological processes were relevant to these events? To that end, we first develop maps of reduced forest productivity in the temperate and Mediterranean biome in Europe in summers 2000–2020, inferred from a unified identification scheme based on MODIS terra vegetation greenness. **We aim to compare the MODIS derived information with ICP Forests "Visual Assessment of Crown Condition" from Level I plots.** We then consider the temperature-precipitation evolution over a year prior to such events to highlight a variety of meteorological sequences of interest.