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How recent spring precipitation changes compromised Maritime pine radial wood growth and density in southern Portugal

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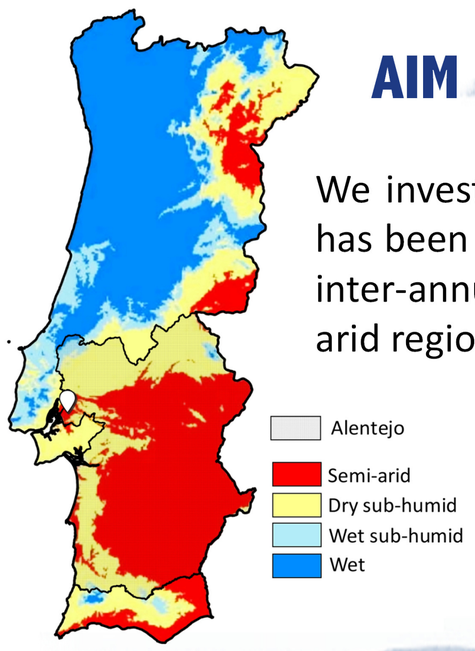


AIM

We investigated whether *Pinus pinaster* (Ait) has been affected by changes in seasonal and inter-annual precipitation patterns in a semi-arid region of Portugal since the late 1950s.

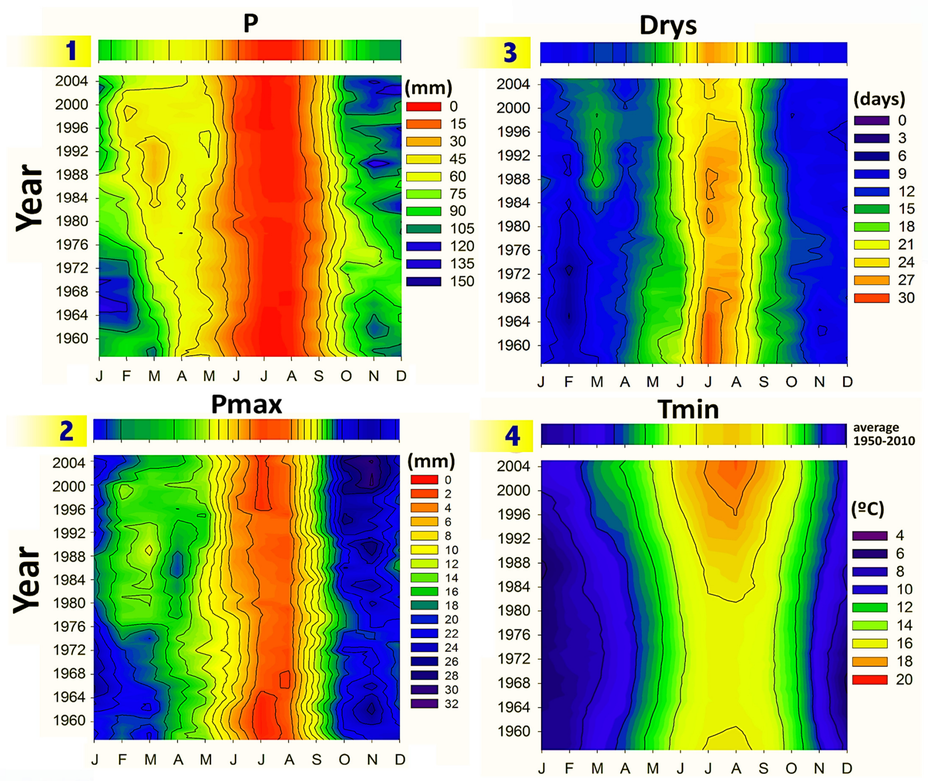
In this study we analyze how wood radial growth and density responded to those changes.

METHODS

Meteorological datasets covering the period 1950-2012 were retrieved from ECA&D European Climate Assessment & Dataset and the Observations gridded dataset form the EU-FP6 project ENSEMBLES. Climate data presented on Fig1-4 are moving averages of 15 years.

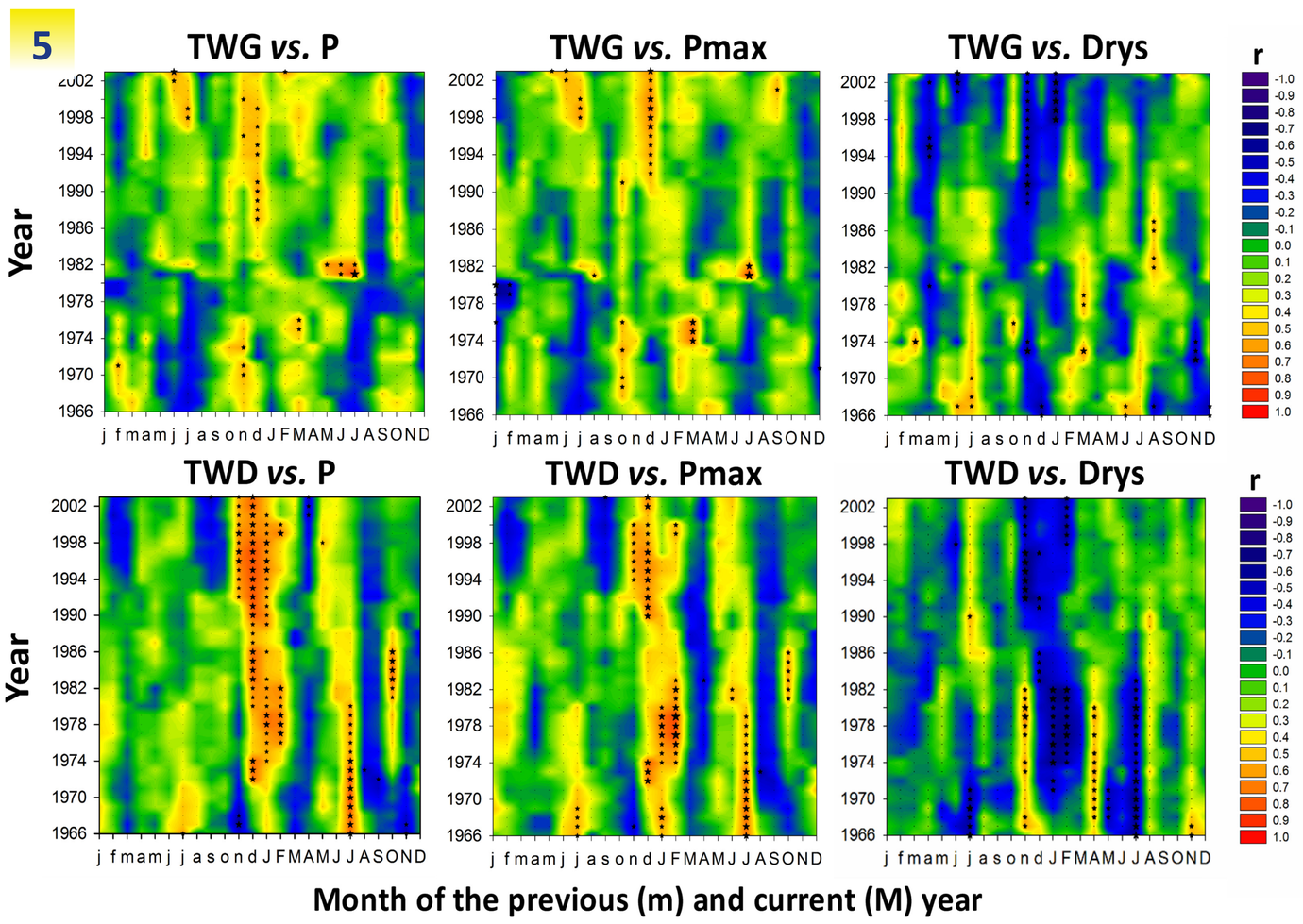
The temporal evolution of the climate-growth relationship (Fig5) was analyzed by computing the Pearson correlation coefficients (*r*) between the dendrochronological time-series and the monthly climatic times-series for the common period of 1958-2011. *r* values were calculated considering a moving window of 15-yr intervals.

RECENT CLIMATE EVOLUTION



- There was a sharp decline of monthly precipitation in spring (P) from 1950 to 2012 progressively spreading from spring to the prior late winter (P, Fig1). This spring trend accentuated since 1980 with lower maximum daily precipitations (Pmax, Fig2) and dryspell since ~1980 (Drys, Fig3). Also Pmax (Fig2) weakened in February-March while it intensifying in fall since the 1980s.
- A combined raise of minimum temperature (Tmin, Fig4) since the late 1970s induced a higher evapotranspiration rate driving the local water balance towards unfavorable spring water deficit leading to early water stress for *P. pinaster* during the usual peak of the growth period.

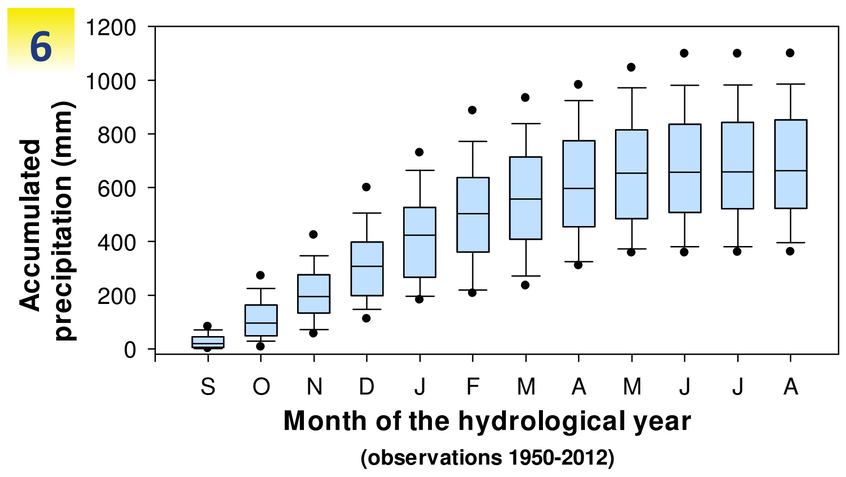
EFFECT ON WOOD GROWTH AND DENSITY



- Tree radial growth (TWG) positively responded to increased of winter Pmax since the 1990s (Fig5). By contrast, the depletion of spring precipitation (P) had a growing negative impact on wood xylogenesis and density mostly since the 1990s (Fig5).
- *P. pinaster*'s radial density (TWD) shows that trees mostly relied on spring precipitation of the current growing season at a juvenile stage (Fig 5).
- After trees turned 20 years old (~1980) wood xylogenesis and density was consistently and positively correlated to winter P and Pmax while negatively correlated to winter dryspells (Fig5). The significant correlations were mostly concentrated in winter preceding the ring formation, when xylogenesis is dormant [1] and groundwater recharge is mostly completed (Fig6) [2]. At this age *P. pinaster*'s deep root system is already well developped [3] and able to reach and use groundwater [4] down to 7m depth [5].

CONCLUSIONS

- Since 1990, the accumulation of inauspicious years with insufficient stored water at the beginning of the growing season decreased the length of the growing period resulting in thinner wood cell walls and lower ring width, density and thus quality.
- Mature maritime pine has been mostly affected by fall to winter P and recently by spring P preceding the growing period. Our results highlight the importance of deep water storage preceding the growth period and the depth of the groundwater table for *P. pinaster* to cope with droughts in a semi-arid environment [6].



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