Biogeosciences Division EGU

BG3.11 Forest under pressure: the need to understand causes and mechanisms related to forest vulnerability and dieback phenomena

Evaluation of canopy cover dynamics using phenological and productivity indices: the case of Mediterranean oak forests affected by dieback

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Forest die-off episodes and tree mortality phenomena have been broadly reported across all biomes

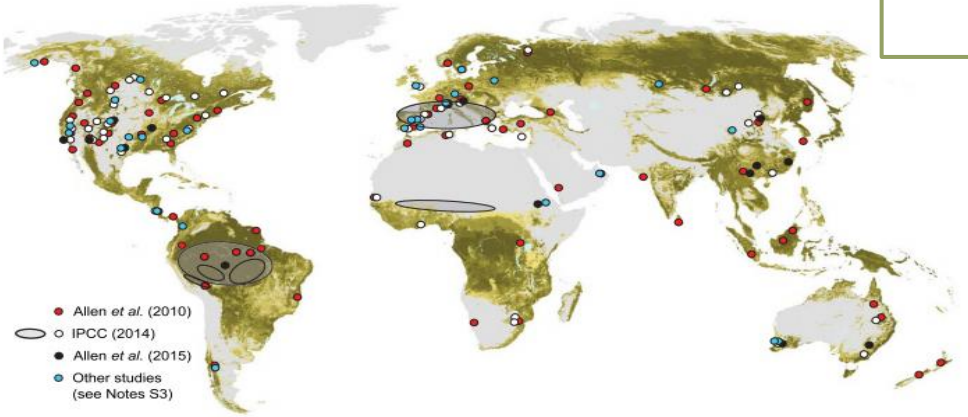


Fig. 2 Locations of substantial drought- and heat-induced tree mortality around the globe since 1970, documented by peer-reviewed studies, updated from Allen *et al.* (2015). Global forest cover (dark green) and other wooded regions (light green) based on FAO (2005). Studies compiled through 2009 (red dots) are summarized and listed in Allen *et al.* (2010); additional localities include the white dots and oval shapes derived from Figs 4–7 and its associated caption in IPCC (2014), the black dots from Fig. 2 in Allen *et al.* (2015), and additional localities (blue) from other recent publications listed in Supporting Information Notes S3.

Negative impacts on vegetation distributions, forest productivity and carbon stocks, related to **heat stress** and **drought spells**

Climate influence on **vegetation phenology**

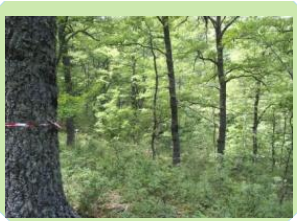
Implications on **forest ecosystem performance**
(*i.e.,*C uptake, nutrient reabsorption, frost damage)

Hartmann, et al. (2018). *Research frontiers for improving our understanding of drought-induced tree and forest mortality*. New Phytologist, 218(1), 15-28.
Yang et al. (2017). *New perspective on spring vegetation phenology and global climate change based on Tibetan Plateau tree-ring data*. Proceedings of the National Academy of Sciences, 114(27), 6966-6971.
Rita et al. (2020). *The impact of drought spells on forests depends on site conditions: The case of 2017 summer heat wave in southern Europe*. *Global Change Biology*

👉 The study represents the first effort to **untangle** the **phenological** dynamics of forest populations showing clear symptoms of **decline**

Gorgoglione
Q. cerris - Q. pubescens

San Paolo Albanese
Q. frainetto



The ecological and site-specific conditions (elevation, slope, aspect) of compared stands are similar

Research questions

- ❑ Is there a difference in terms of phenological metrics between nearby stands showing contrasting vigor, *i.e.*, dieback and non-dieback stands in the short term?
- ❑ Are phenological differences also being reflected in tree productivity?

Dieback Non-Dieback

Methodology

Copernicus dataset

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Sentinel 2A - 2B satellites

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Plant Phenology Index time series (2017-2020)

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Derivation of **PPI seasonal trajectories**

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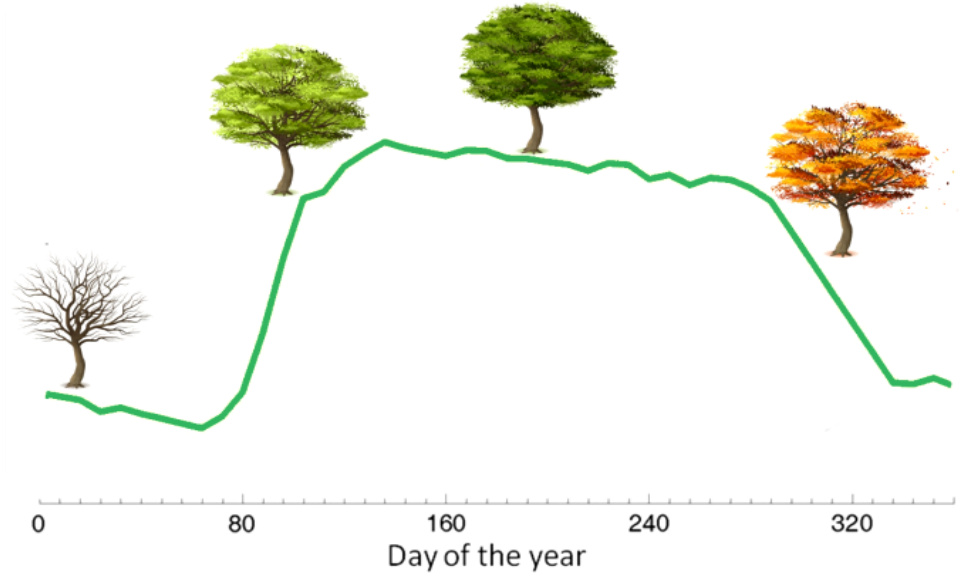
Evaluation of **phenological metrics**



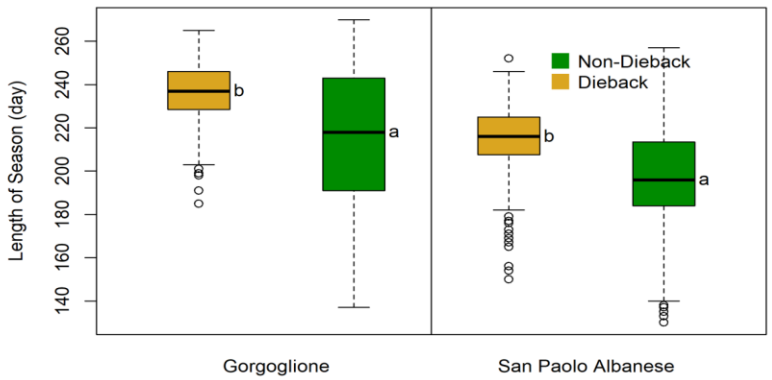
→ Extraction of **phenological metrics** for each site

→ **Analysis of Variance** using R function '*aov*'

→ Post-hoc Tukey's HSD using R function '*TukeyHSD*' for **a pair-wise comparison of means**

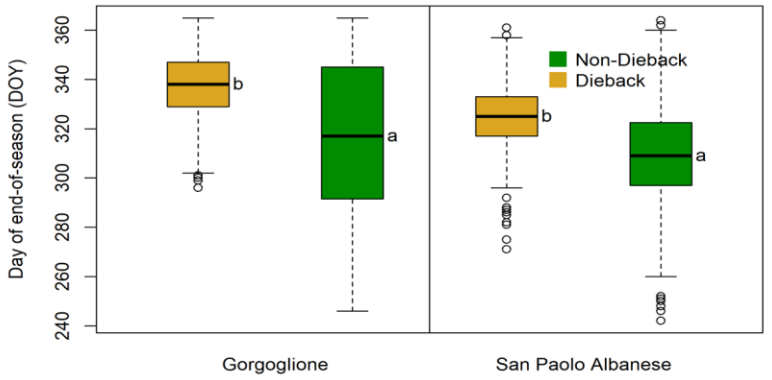
Phenological metrics evaluation

End of the growing season



Boxplots refer to the **day of end of season** (DOY) for **D** and **ND** stands for each site

Length of Season

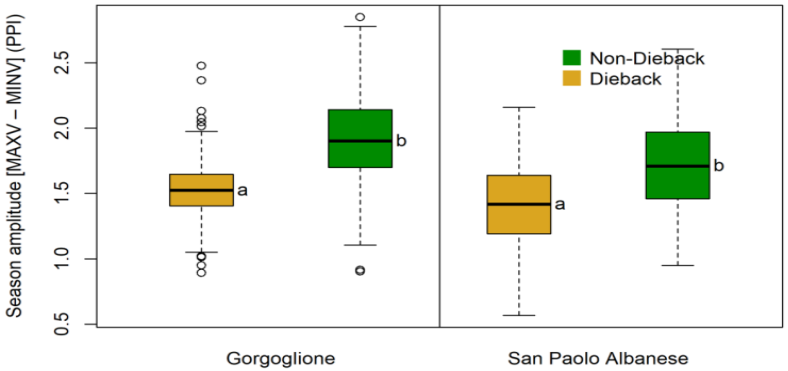


Boxplots refer to the **length of the season** (day) for **D** and **ND** stands for each site

Dieback stands exhibit a **longer growing season** compared to non-dieback stands, related to a **delay** in **leaf autumn senescence**

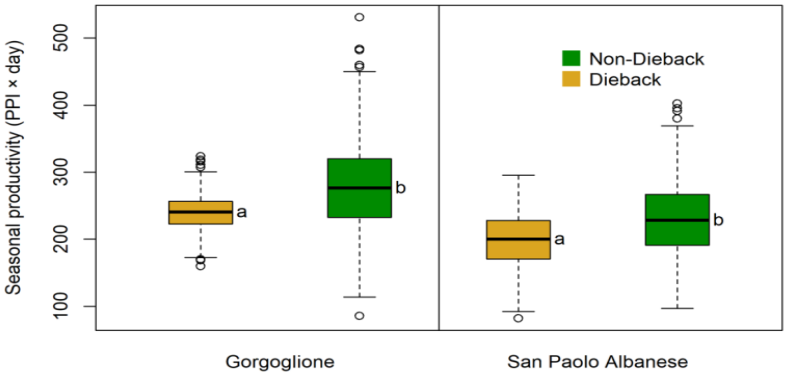
Phenological metrics evaluation

Season amplitude



Boxplots refer to the **season amplitude** [MAXV – MINV] (PPI) for **D** and **ND** stands for each site

Seasonal productivity

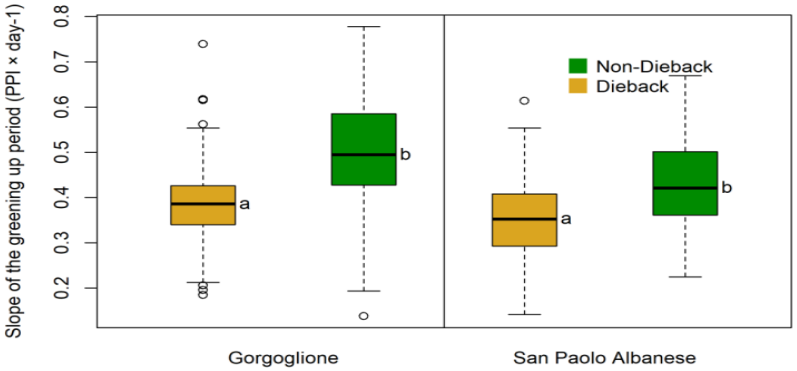


Boxplots refer to the **seasonal productivity** (PPI x day) for **D** and **ND** stands for each site

Non-dieback stands show **greater season amplitude** compared to diebacks, also reflected in **enhanced productivity**, either seasonal or total

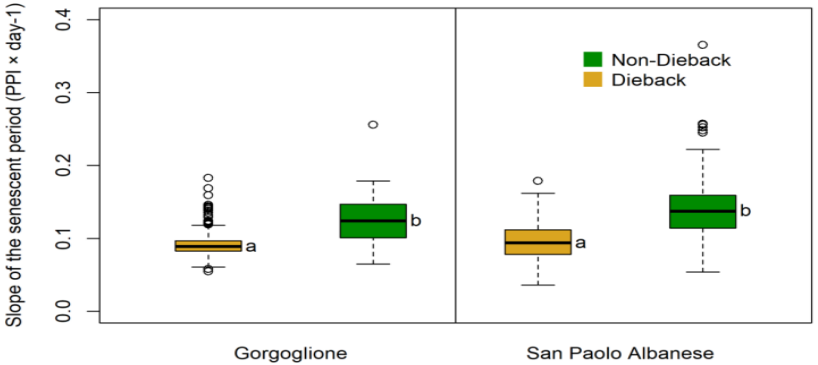
Phenological metrics evaluation

Slope of the greening up period



Boxplots refer to the **slope of the greening up period** (PPI x day-1) for **D** and **ND** stands for each site

Slope of the senescent period



Boxplots refer to the **slope of the senescent period** (PPI x day-1) for **D** and **ND** stands for each site

Non-dieback stands demostrate **higher positive (*greening period*)** and **negative slopes (*browning period*)** in comparison to dieback stands

Main findings

The employment of phenological proxies could provide a new insight on climate-vegetation interactions

The outcomes highlight how trees, showing clear symptoms of decline, may keep their vital activities by **changing their phenological performance**

Here is what we plan

Deriving **xylem phenology** and evaluating its connection with satellite-based estimates of canopy phenology

Work in progress …

Thanks for your attention

Contact us for more informations

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