Impact of climate anomalies on the functionality of beech trees in a mixed forest in the Italian south-eastern Alps

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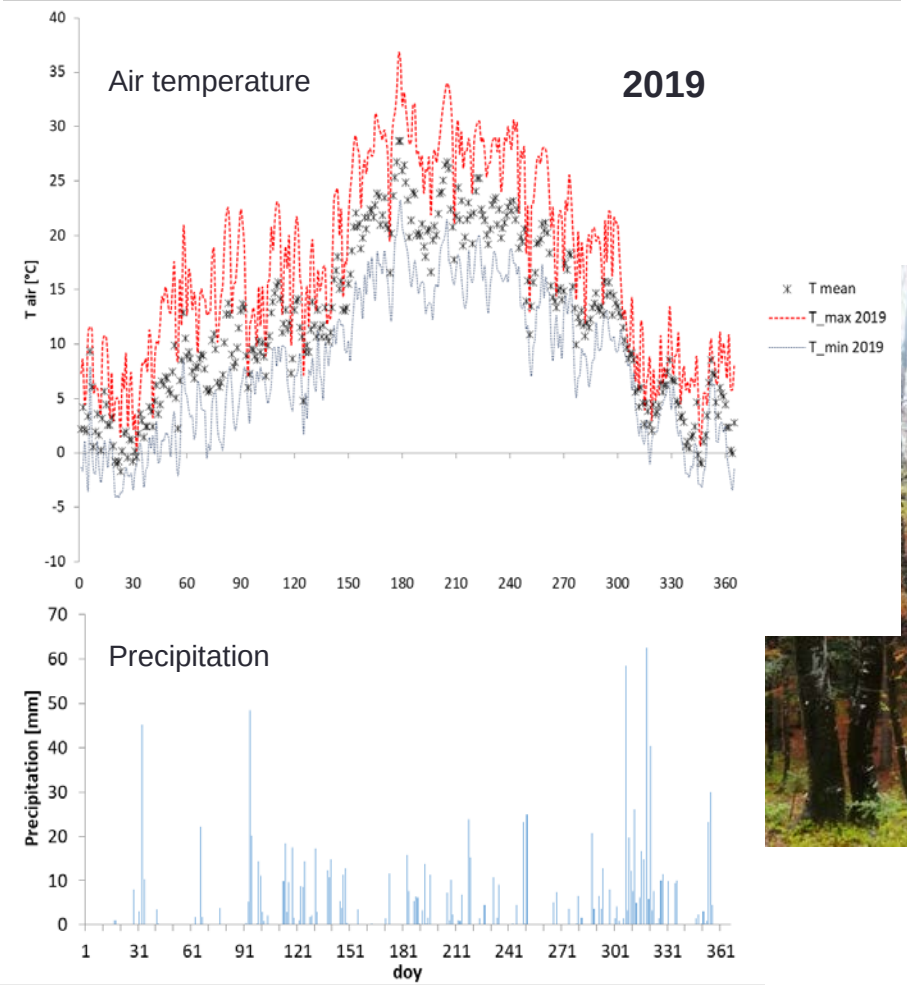
Cembra forest site – Trentino, Italy
1250 m a.s.l (46.20 N, 11.21 E)

Uneven aged mixed alpine forest

(*Abies alba, **Fagus sylvatica*** and *Picea abies as dominant species*)

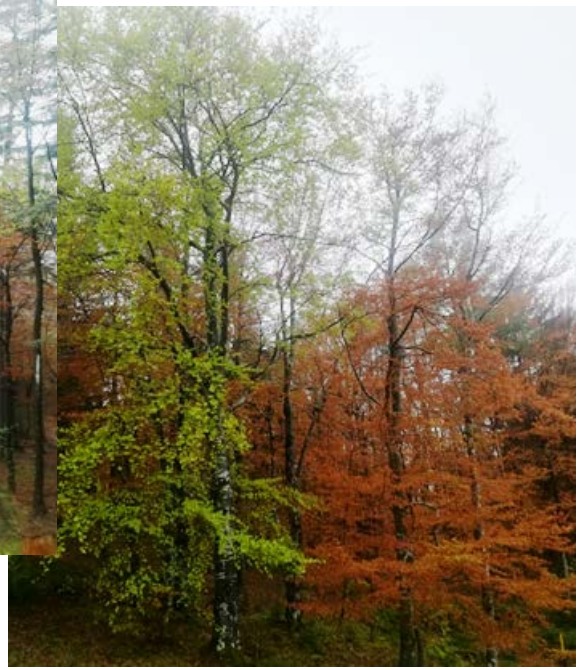
Late frost damage in spring 2019

Data: Cembra weather station (550 m a.s.l)



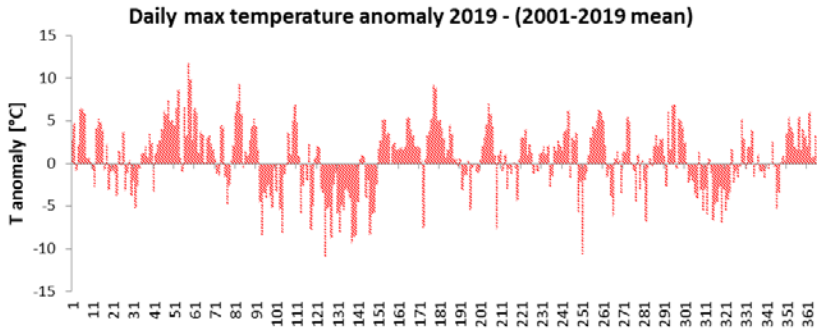
Cold and wet late spring with frost events in early May 2019 (doy 124-130)

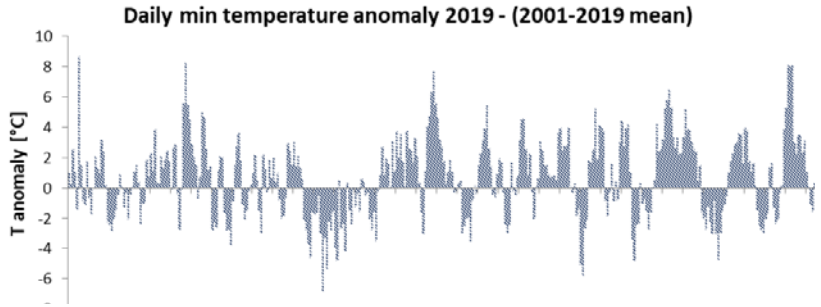
Beech (Fagus sylvatica L.) trees were damaged with different severity, depending on the distinct phenological stage of the leaf out.
Damage level at tree level ranged from null (intact green leaves) to total (completely burnt leaves).

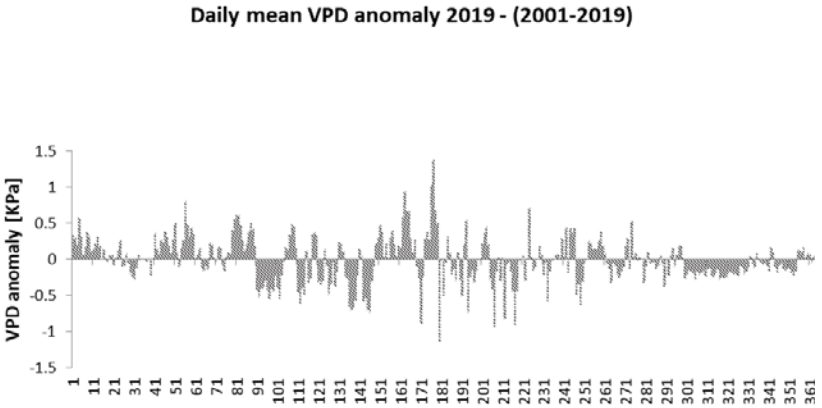


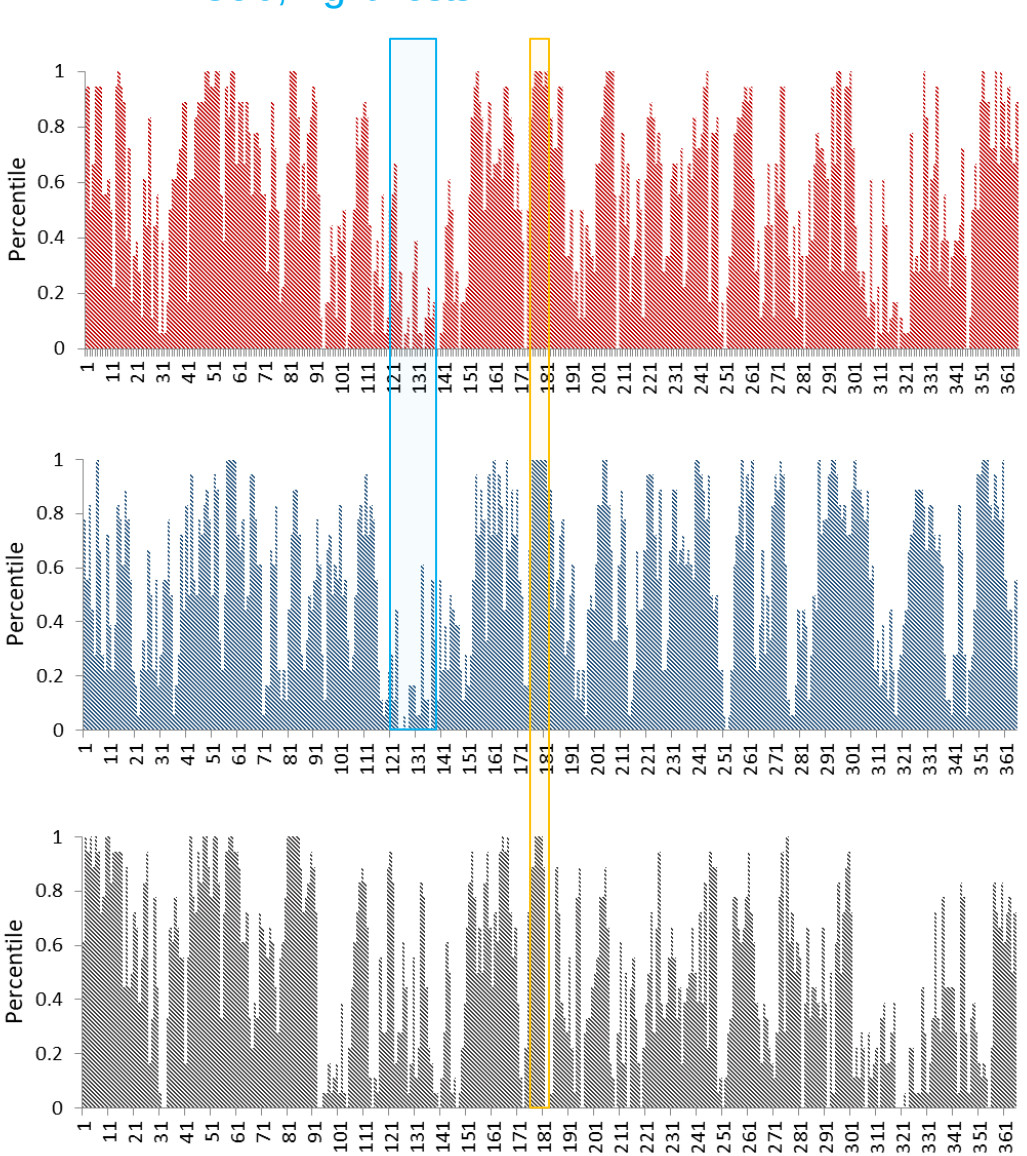
Climate anomalies 2019

Data: Cembra weather station (550 m a.s.l)









Tree functionality monitoring

Established in early June 2019 to evaluate the **effect of the frost induced impairment** and **assess forest resiliency**

1. **Tree stem radial growth** : measured using band dendrometers with readings taken every 10 days on average.

2. **Sap flow density (J): monitored by heat dissipation probes of Tree-Talker***, a multifunctional device for monitoring trees biological and physical features based on the Internet of Things (IoT) technology. Data collected at hourly frequency and J calculated according to Granier (1985) methodological approach

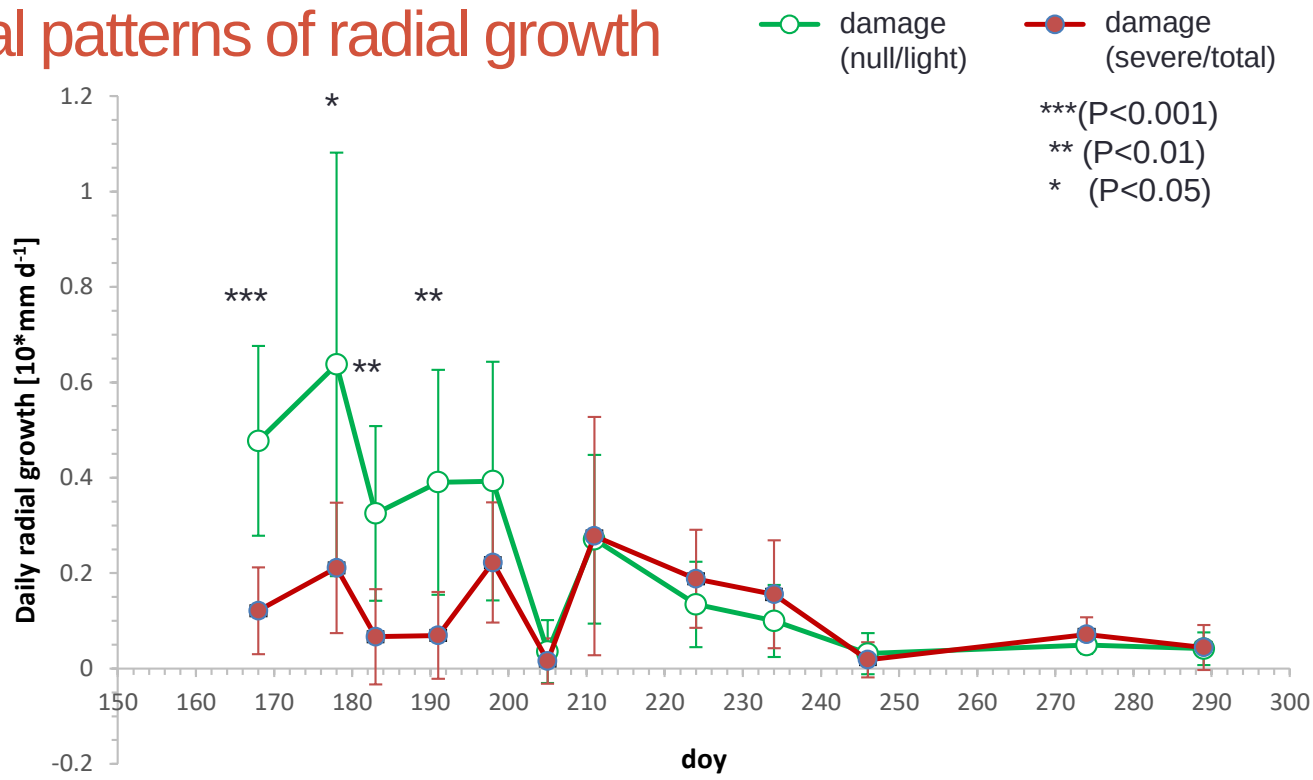
**Valentini et al. (2019). New tree monitoring systems: from Industry 4.0 to Nature 4.0. Annals of Silvicultural Research, 43, 2,84-88.*

Tree stem cumulated radial growth

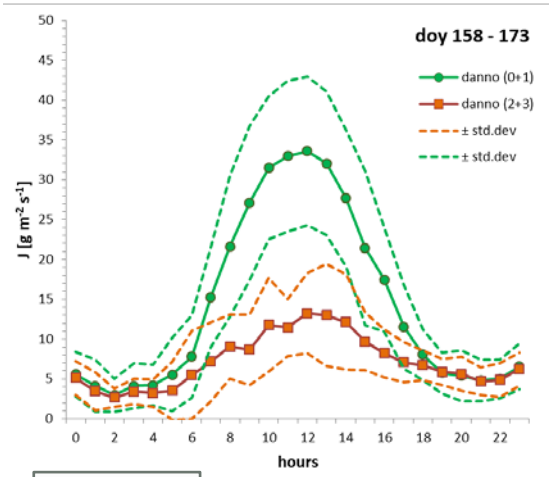
Damage level	Seasonal growth [mm]	SEM [mm]
(0-1)	**0.263**	**0.0274**
(2-3)	**0.146**	**0.0254**

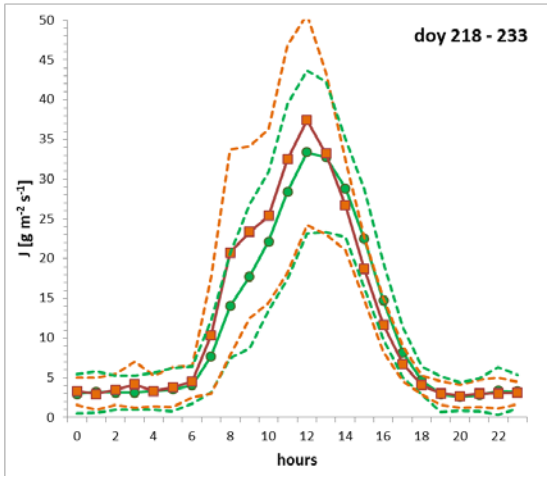
Source of Variation	DF	SS	MS	F	P
damage	1	0.0576	0.0576	9.935	**0.009**
plot	2	0.0166	0.00828	1.428	0.281
damage x plot	2	0.00214	0.00107	0.185	0.834
residual	11	0.0638	0.00580		
total	16	0.139	0.00870		

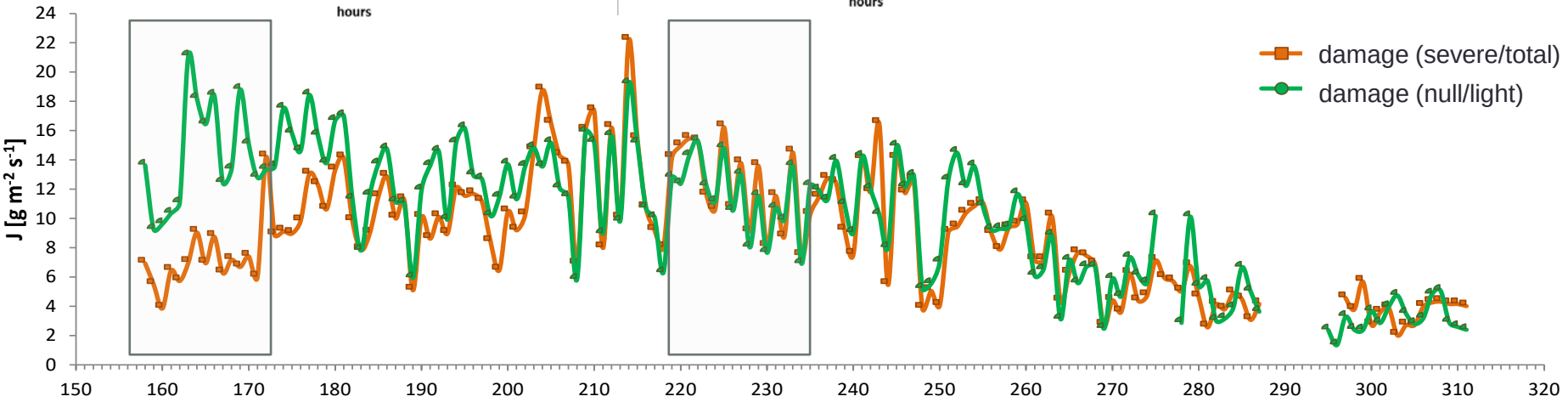
Temporal patterns of radial growth

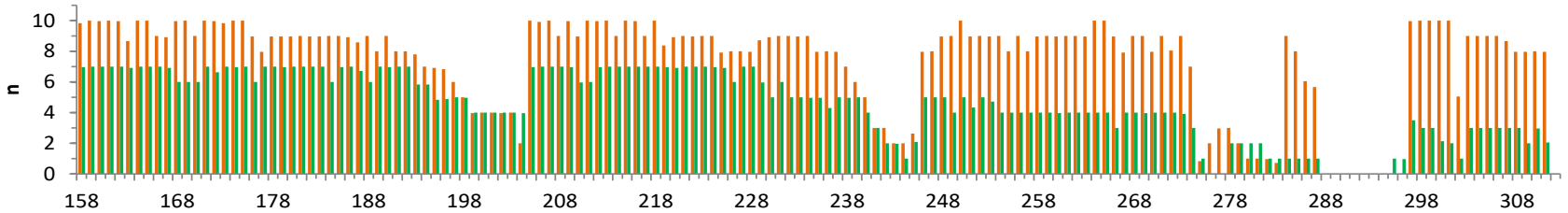


Sapflow density (J)









Conclusions and take home message

A severe frost event in late spring 2019 caused highly differentiated leaf damage during the leaf out phase on beech trees in an alpine forest.

Damaged trees showed:

1. Reduced radial growth (-45%) at seasonal level (June-October) yet with similar growth intensity after mid July, in comparison with undamaged individuals.
2. Reduced sap flow density rates up to -60% at the beginning of the monitoring period in June 2019, with total recovery after 3 weeks (doy 180)
3. A good level of resilience but monitoring should now focus on carry over effects.

Importance of evaluating the impact of climate anomalies on carbon uptake and transpiration in a climate change predicament with increasing frequency of extreme events in the alpine region, including frosts and heat-waves.