



Temperature signal in chestnut earlywood vessel size: is there an ecophysiological explanation?

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Viterbo Italy

Session Dendroclimatology

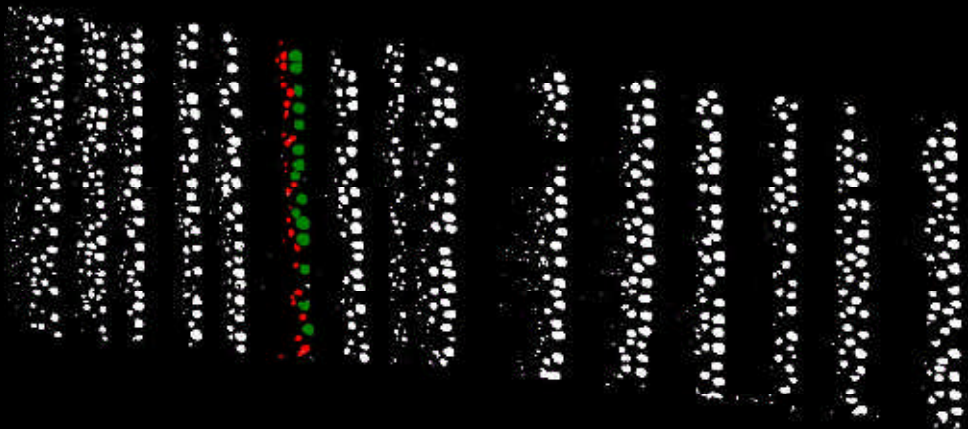
Saturday October 1st, 9:15 - 9:30

Many features

Number, Size, Shape, ...

Intra-annual scale

Spring, summer, fall



Castanea sativa Mill.



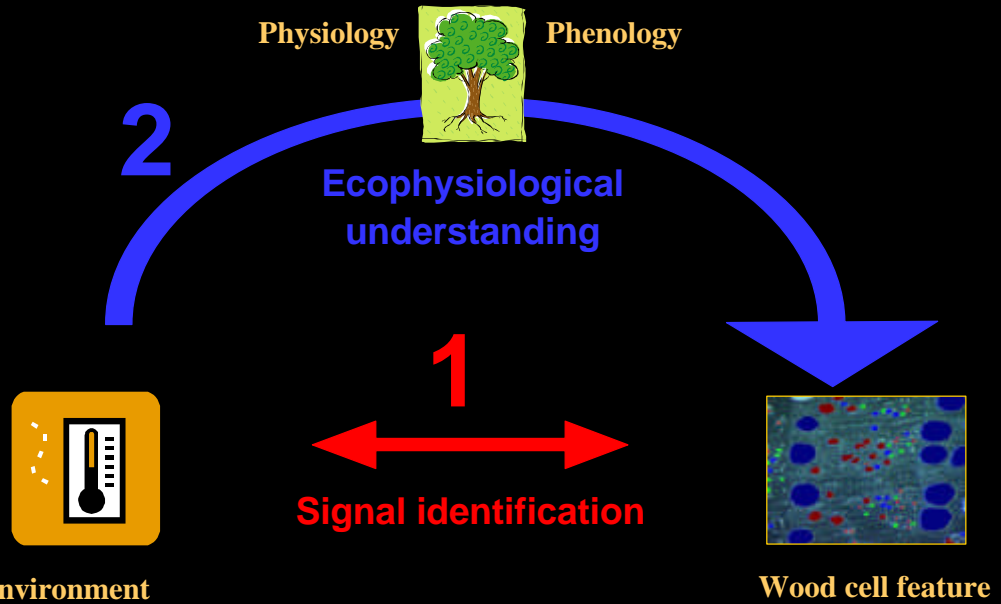
What you can see here is a magnified image of a chestnut wood cross-section. So, when looking at the wood in such a way, we can observe that beyond the most commonly used ring width there are a lot of other anatomical features stocked in the wood which might also contain an environmental signal. [\[CLICK\]](#)

- For example, for each single ring, you can measure the number, the size, the shape of all earlywood vessels; [\[CLICK\]](#)
- Or even you can perform analyses only by focusing to vessels built to a specific period within the growing season;

These potentialities of using these anatomical features as high resolution proxies are increasing the interest of the dendro-community on the topic of wood cell formation and anatomy.

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Fundamentals for proper use of proxies



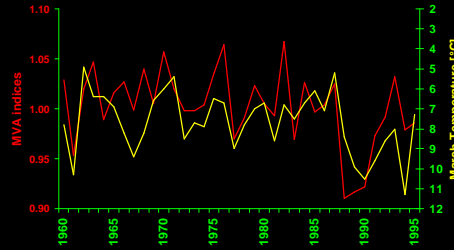
However, any feature can be properly used as a proxy only when 2 conditions are contemporaneously accomplished: [\[CLICK\]](#)

- Of course, first we have to identify which feature bear which signal and with which strength. [\[CLICK\]](#)
- But a good relationship might not always be enough if the recording mechanism behind that hasn't been explained. To understand how the tree respond to the environmental factor and how this will affect the wood cell formation will avoid a misuse of the proxy and supply a sound basis for scientific work. [\[NEXT\]](#)

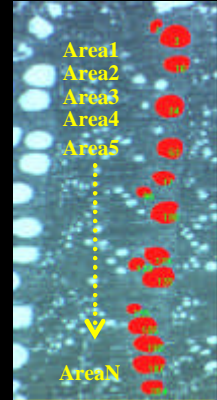
1. Vessel size correlates with March temperature

Fonti & García-González (2004). New Phytologist 163:77-86

T
March



$$r = - 0.63$$



Mean vessel area

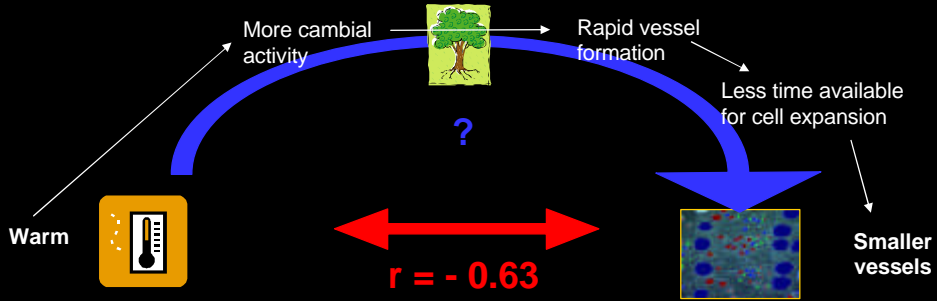
Background

As regard to the earlywood vessel of chestnut wood, a recent study has showed that the size of the vessels are quite good and negatively correlated with the mean temperature of March.

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2. What is the ecophysiological interpretation?



Initial hypothesis:

Size of vessels records temperature occurring **DURING** vessel formation, because temperature directly affects the rate of the process

Objective:

- To confirm previous findings
- To verify if vessels are built during March
- To verify whether a time shift in vessel formation corresponds to a comparable shift in the recorded temperature signal

Objective

The physiological interpretation of this relationship is however still missing. [\[CLICK\]](#)

The initial hypothesis we formulated so far is that the size of vessels simply record the temperature occurring at time vessels are formed, since temperature directly affect the process of vessel expansion: [\[CLICK\]](#)

... so a warm March means more cambial activity, rapid vessel formation, less time available for vessel expansion and therefore smaller vessels [\[CLICK\]](#)

The work presented here attempts to collect further piece of evidence supporting that hypotheses. Therefore, our specific objectives were:

-First, to confirm previous findings, which mean to confirm the existence of the negative relationship between vessel size and March temperature

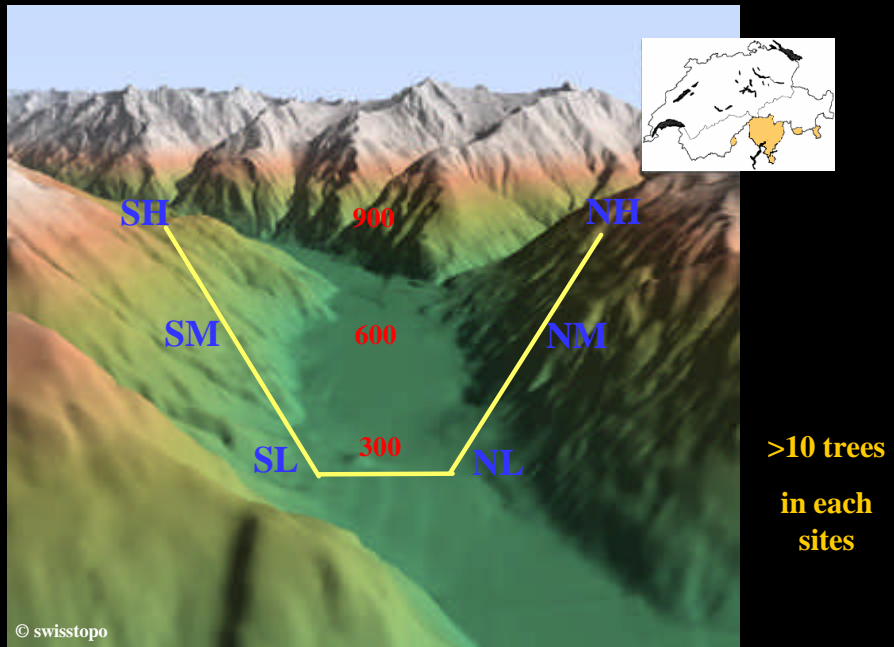
-Second, to verify if vessels are really build in March?

-Third, to verify a time shift in vessel formation correspond a comparable shift in the recorded temperature signal

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Altitudinal gradient



Sites and tree selection

To obtain a shift in timing of vessels formation we used an altitudinal gradient. [\[CLICK\]](#)

For this study 6 observations sites have been set along the lateral slopes of a East-West oriented valley from the Southern part of the Swiss Alps. [\[CLICK\]](#) The sites have been selected on three different elevation between the low valley and the maximal altitudinal range for the species, [\[CLICK\]](#) and located on both the south facing and north facing slope. [\[CLICK\]](#)

At least 10 chestnut trees were selected in each observation site.

Please note the "nick name" given to the sites. The first letter indicate the Aspect S= South, N=North; second letter indicate the altitudinal position L=Low, M=Middle and H=High)

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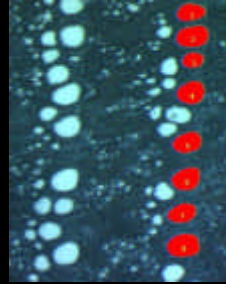
Survey

Past

Present and in situ

Earlywood vessels size chronologies

1 cm wide wood cores
first row of vessels
site chronologies



Temperature

Grono weather station (< 10 km)

Temperature

hourly data

Phenology

weekly observations

Wood formation

weekly observations
(punching cores)



Methods

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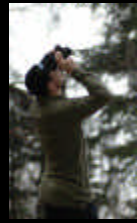
Survey was shared into 2 phases:

The first look was focused on quantifying the differences among sites as regard to Temperature, phenology and wood formation during this spring. [\[CLICK\]](#)

Afterwards we also took a look towards the past. We build 40 years long vessels size chronologies (from 1965 to 2004) for each site and related to Temperature data from a close weather station. [\[CLICK\]](#)

For doing this only vessels belonging to the first row have been into account, in order to consider only the first vessels build in the season.

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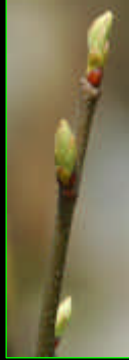
Spring phenophases



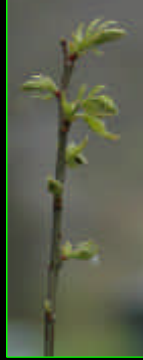
Bud dormancy



Bud swelling



Bud break



Leaf unfolding



Complete sprout elongation and male catkins appear



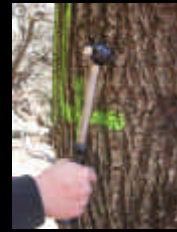
Beginning of flowering



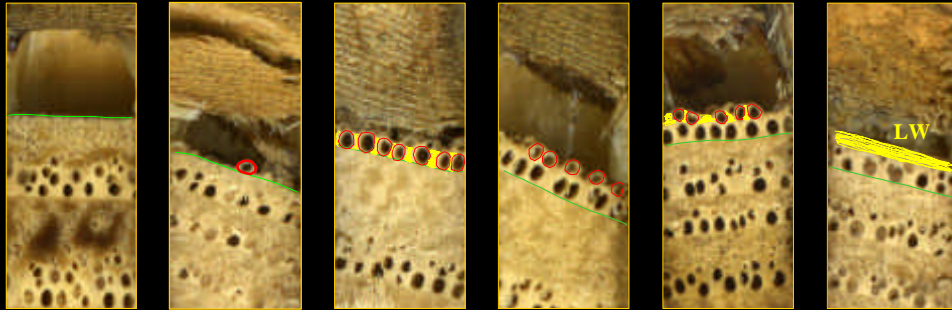
Methods

On this slide you have a visual summary of the different spring phenophases that we have recorded. Observations have been performed weekly. [\[CLICK\]](#)

Timely site differences in phenology have been based on timing of leaf unfolding. [\[NEXT\]](#)



Wood formation phases



No new cells

1st earlywood vessels appear

1st row complete

2nd row earlywood vessels

2st row complete

Latewood formation begins

Methods

On this slide instead you have a visual summary of the different wood formation phases that we also have recorded. Observations have been also performed weekly by using a punching corer. [\[CLICK\]](#)

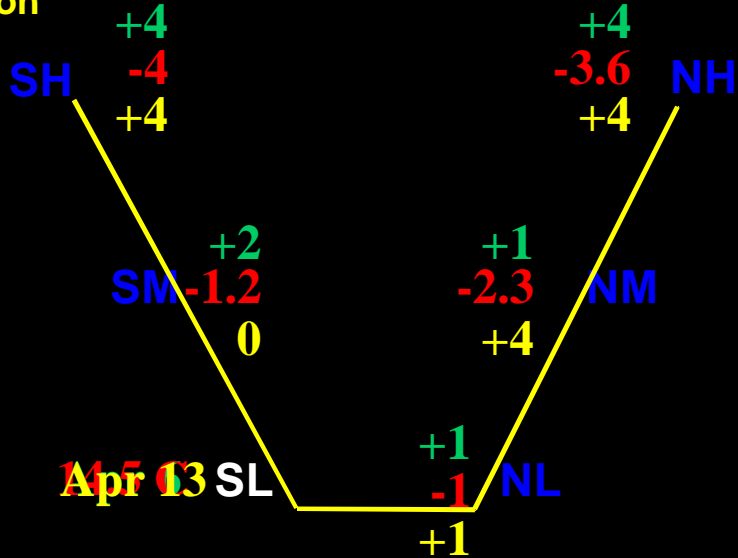
Timely sites differences of wood formation were based on the timing the first earlywood vessels appear. [\[NEXT\]](#)



Summary of sites differences

Wood formation

[weeks] March to May 05



Results

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With this slide I intend summarize the sites differences observed. Here again the schema which summarizes sites location. SL (south aspect and low elevation) was taken as the reference site. [\[CLICK\]](#)

So if we look at the temperature, the average temperature for the period March to May in SL of was 14.5 C. [\[CLICK\]](#) ... and this are the differences observed. So for example SH is on average 4 degrees colder than SL, SM 1.2 degree and so on. These differences were constant all along the period. [\[CLICK\]](#)

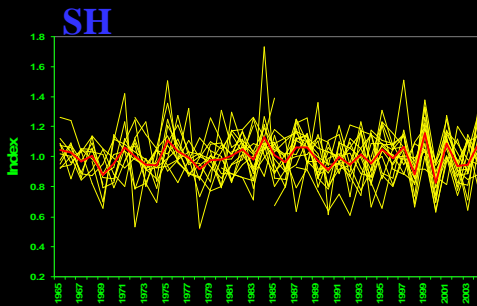
Now if we consider the timing of leaf unfolding we have observed that this earliest start in SL, on April 6th. High elevation sites have a lag of 4 weeks. [\[CLICK\]](#)

And finally looking at timing of earlywood vessel formation, we observe that this are earliest produced middle of April, so clearly after March, and also in this case we observe that there is a lag of about a months between sites due to elevation differences.

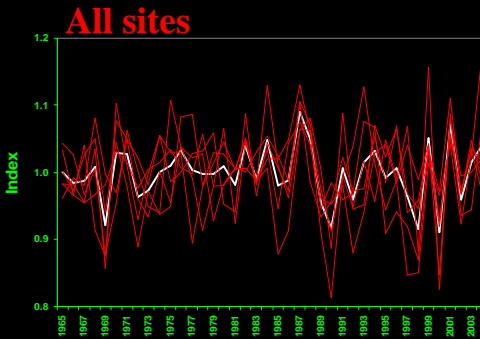
Except for the middle elevation sites, differences are quite consistent.

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Vessel size chronologies



Mean correlation = 0.17



Mean correlation = 0.46

Results

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Here I just want to show you some chronologies: first an example of a site (SH): yellow lines refers to the single tree and the red one is the average. [\[CLICK\]](#)

And here the 6 site chronologies (in red) and the composite of all (in white). [\[CLICK\]](#)

And here very little data just to show you how low the mean correlation between trees from the same site are, but how this value improve as soon as we consider all the site chronologies [\[NEXT\]](#)

Monthly correlations

Site	February	March	April
SH	-0.05	-0.32	+ 0.41
SM	-0.10	-0.11	+0.25
SL	-0.25	-0.27	+0.14
NL	-0.16	-0.24	-0.04
NM	-0.37	-0.38	+0.10
NH	-0.31	-0.16	+0.20
Composite	-0.31		+0.27

Red value = significant ($p < 0.01$)

Results

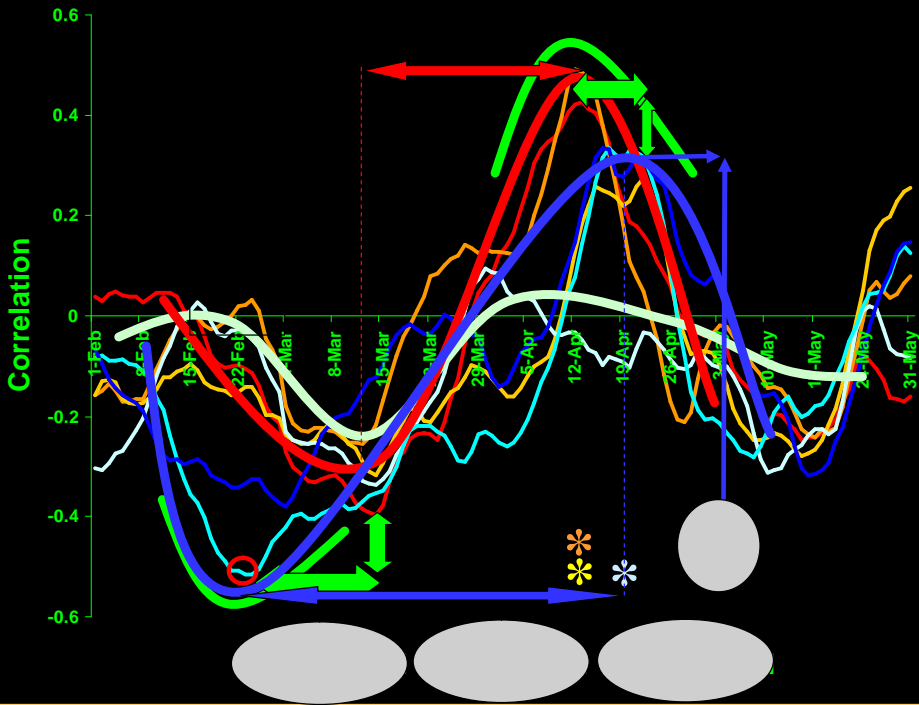
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This table summarize the correlation value of single site chronologies to early spring monthly Temperature. The negative value observed for March confirm previous result, even if correlation value are lower than those found previously.

In order to better evaluate a shifting in the Temperature signal among sites, we needed to reduce the window for temperature to a 2 weeks time-span and lagging it from day to day from February to May.

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Correlations with T on a 14-days moving window



Results

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So we did it for each single sites and results are shown in this graph. Asterisk indicate the timing when first earlywood vessels are formed.

After a first quick look, we can observe that: [\[CLICK\]](#)

-We have a negative correlation in February-March, but also a good correlation in April. The whole April monthly correlation was not as strong as it is here; [\[CLICK\]](#)

-timing of first vessel formation is from synchronous to a 2-3 weeks shifted as regard as the positive April correlation pick [\[CLICK\]](#)

-Sites curves little differ in timing and intensity of maximal negative and positive correlation: however the lag in site specific signal pick is not is not of the same amount of those observed in timing vessel formation [\[CLICK\]](#);

-Low elevation sites seems to have lower correlation with Temperature (less sensitive to temperature) [\[CLICK\]](#);

-South middle and high elevation have the higher positive correlations [\[CLICK\]](#)

-North middle and partially high elevation have the higher negative correlations [\[CLICK\]](#)

-The switch from maximum negative to maximum positive correlation



Conclusions

- Negative correlation to T March, but **ALSO** positive with T April
 - Vessels are build earliest at mid-April, which is **after** the observed Temperature signals
 - Differences in timing of recorded temperature signal between sites **are not the same** as the time lag observed in vessel formation
- Temperature directly affects vessel expansion:
REJECTED

Conclusions

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Summarizing the results, we have found that: [CLICK]

- Earlywood vessel size negatively correlate with March temperature but also positively with April [CLICK]

- Vessels are build earliest ad middle April and anyway after the Temperature signals observed [CLICK]

- Time shift in vessel formation is not reflected in signal [CLICK]

The result obtained lead us to conclude that there is no a direct influence of temperature on vessels expansion refuting therefore our initial hypothesis [NEXT]