



Earlywood vessel selection influences the ecological signal

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Title page

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In the last few years there has been an increase of dendrochronological investigations aiming at the identification of environmental proxies in some wood cell anatomical features.

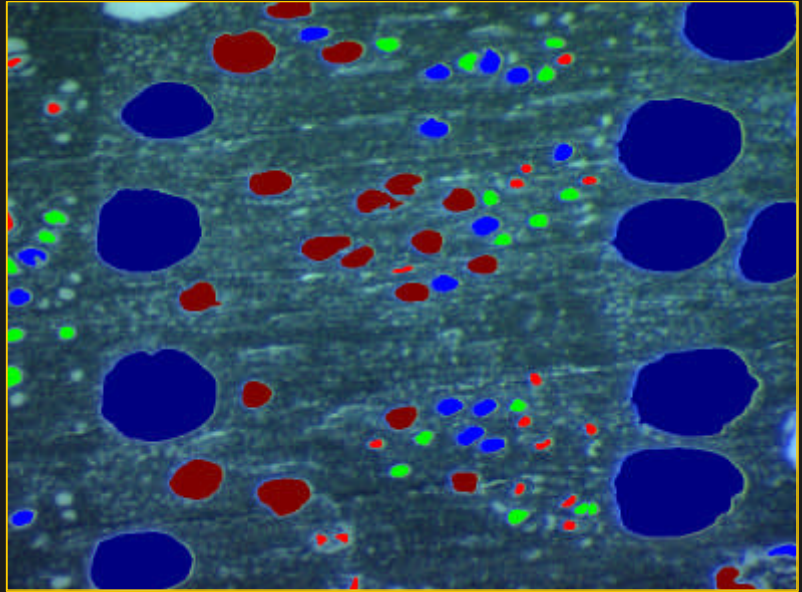
In particular several attempts have been performed by using tree ring series of earlywood vessel features of ring porous wood species, as oak and chestnut. And in some cases, some of them have also supplied positive results. However none of them has addressed the methodological question about how do we have to select the earlywood vessels in order to get the higher or stronger signal.

With this study, Ignacio Garcia Gonzalez (from Galicia in Spain) and myself did a first attempt in this sense.

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Cellular features

- Position
- Number
- Size
- Shape
- ...



Nowadays, such kind of images are very easily done. Good wood surface preparation combined with a microscope it allows you to collect good images with good detail of the wood cells characteristics.

With modern image analysis software it is then a "child's play" to quickly get a lot of measurements of these characteristics.

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Here you can see for example how the computer easily recognized the vessels on this chestnut wood cross-section.

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It is than possible to get a lot of cellular features as position, number, size, shape and so on can you can use to build chronologies and that can be used to relate with environmental parameters.

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New opportunities

- Different Signals
- High Resolution

Open questions

- Which features bear which signals?
- Which cells, within the ring, have to be considered in order to have the correct expression of the signal?

Objective

Investigate how the selection of the earlywood vessels can influence the expression of the signals they contain

Objective

These technical improvements open new opportunities in dendrochronology. A dendrochronologist can now, for example, simultaneously analyze several wood cell anatomical features, which might contain different signals, and all of this with a intra-annual resolution.

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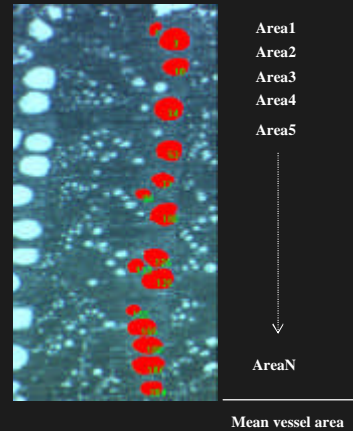
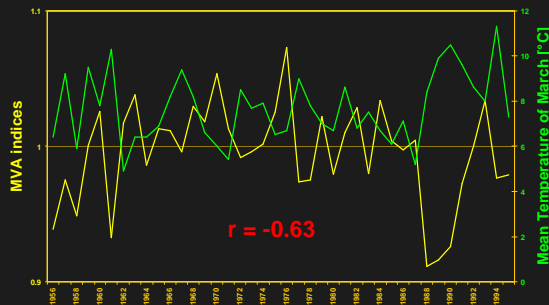
On the other hand, however, there are some new methodological question that have to be addressed. Of course it is important to find out which feature bear which signal, but it is also very important to be aware about which cells, whitin the rings, have to be considered in order to have the correct expression of the signal.

This presentation in particular focus on these second question. And in particular

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the objective of our research is to investigate how the selection of the earlywood vessels can influence the expression of the signals they contain

51 chestnut trees
3 sites
from 1956 to 1995
vessel > 0.01 mm²



Materials

This study was based on a previously used dataset that already proved that chestnut earlywood vessels bear an ecological signal.

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The feature we used was the mean earlywood vessel area (MVA) which consist in the mean area of all the earlywood vessels in a ring.

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The main results of this study was tha the size of the vessels is negatively correlated with the main temperature of March. The correlation between MVA and March temperature is showed in the graph. The correlation value observed was 0.63.

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This study was based on about 50 trees collected in three different sites from the Southern part of the Swiss Alps. The time span considered was 40 years and all vessel larger than 0.01 mm² were considered in the calculation.

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Analyses

Measuring data

Time series

Detrending

Chronology

Filtering !!!

Climatic Data
(T March)

Simple correlation r

Methods

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The analysis were performed following standard procedures. The vessels were measured and than for each ring we calculated the MVA. Then we build the time-series for each trees. And than the time series were detrended in order to only keep the year to year variability. And finally all detrended time series were merged together in order to get a unique MVA-chronology.

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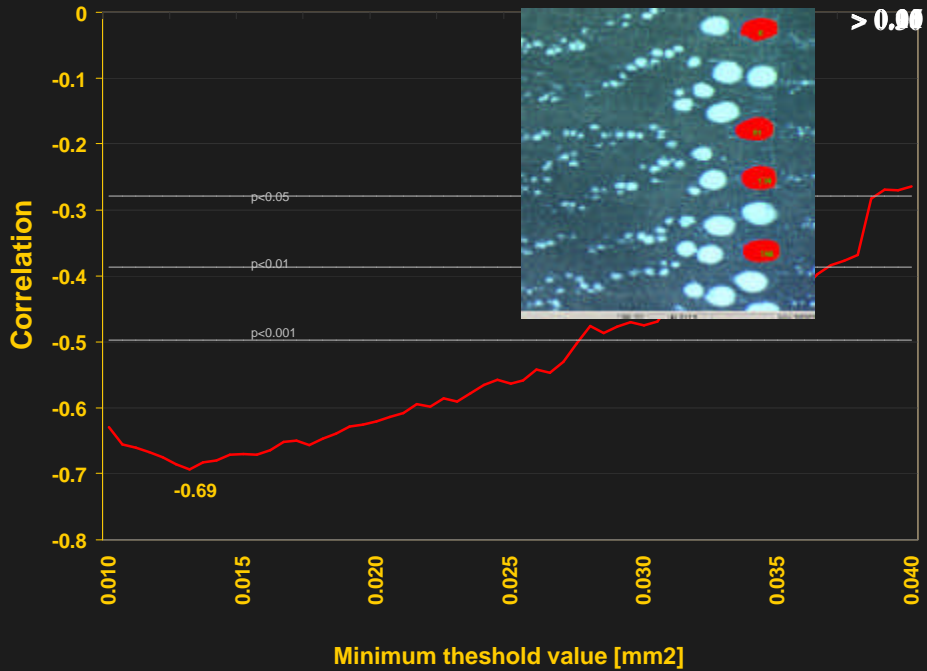
These latter has been than related with the climatic data, in this case the Temperature of March, in order to get the simple correlation value.

What we did with this new studies was to do exactly the same BUT applying a size filter on the vessels in order to see how the correlation value can be affected by the way we selected the earlywood vessels.

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Filter 1: Minimum threshold value



Results

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The first filtering we applied was based on the minimum threshold value, which means that all the vessels smaller than a given value were not considered in the calculations.

Then after each increase of the minimal threshold value (CLICKING 4 times) we recalculated the MVA and the new correlation value (i.e. between the new MVA Chronology and the Temperature of March), in order to the following graph

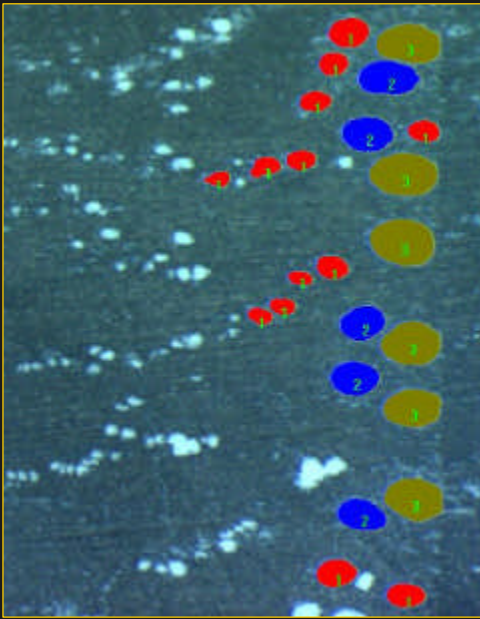
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On the Y-axes we have the correlation and on the X-axes there is the minimal threshold value we applied. In this graph we can therefore observe that, at the beginning, by increasing the minimal threshold value we have an improve of the correlation, but after a while, when keeping on increasing this minimal value, the correlation get worst till to become unsignificantly.

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Variability

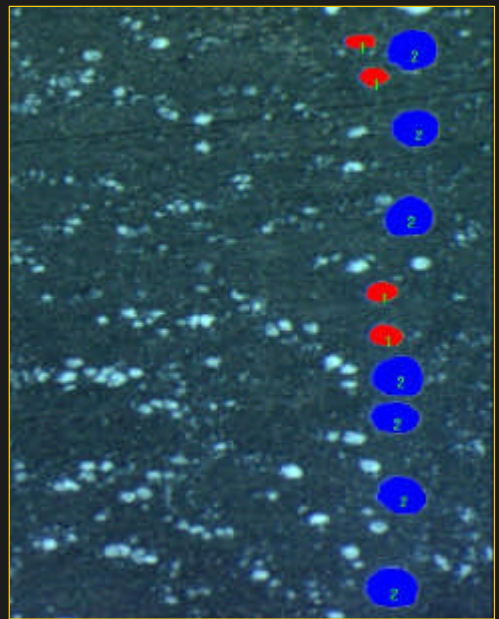
MVA = 0.042 mm²



MVA = 0.067 mm²

=

MVA = 0.042 mm²



MVA = 0.056 mm²

>

Results

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These two pictures can help us in understanding why we have these changes in the correlation values.

Here we can see 2 different annual rings with completely different patterns in earlywood vessels. The one on the left has many much more vessels and a large range in size than the one on the right.

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However if we calculate the MVA for both of the rings we can see that they have the same value. This means that they contain the same correlation. But this is not completely correct.

If we eliminate the smallest vessels (i.e. the red vessels) we can then observe that the MVA values change and that there finally are differences between the vessels.

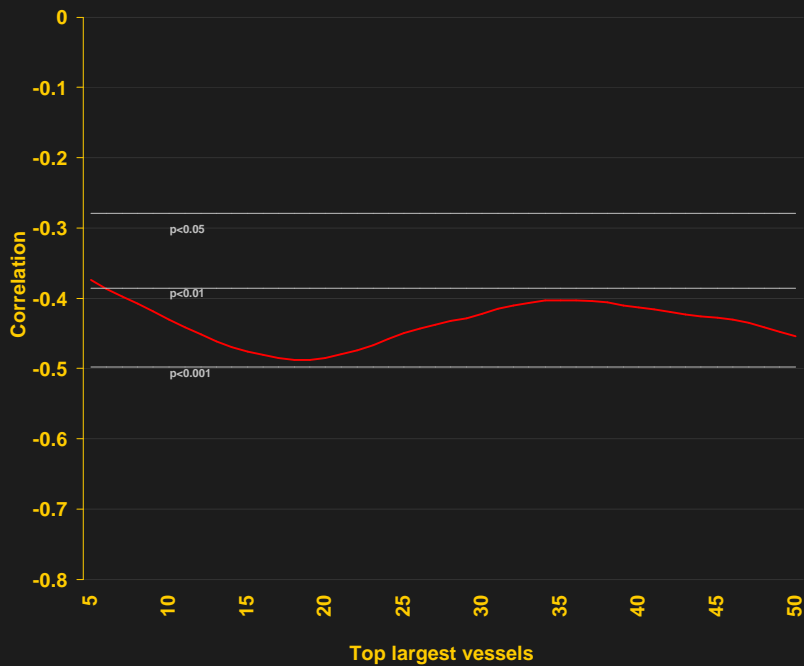
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But if we continue in eliminating the smallest vessels, (i.e. also the blue vessels), we can see that we will not have any vessel left on the right ring.

So in order to avoid these problems we also applied another filter, which was based on the top largest vessel in each ring. This means that we only considered first the 5 largest vessels, then the 10 largest one, and so on and so on.



Filter 2: Top largest vessels



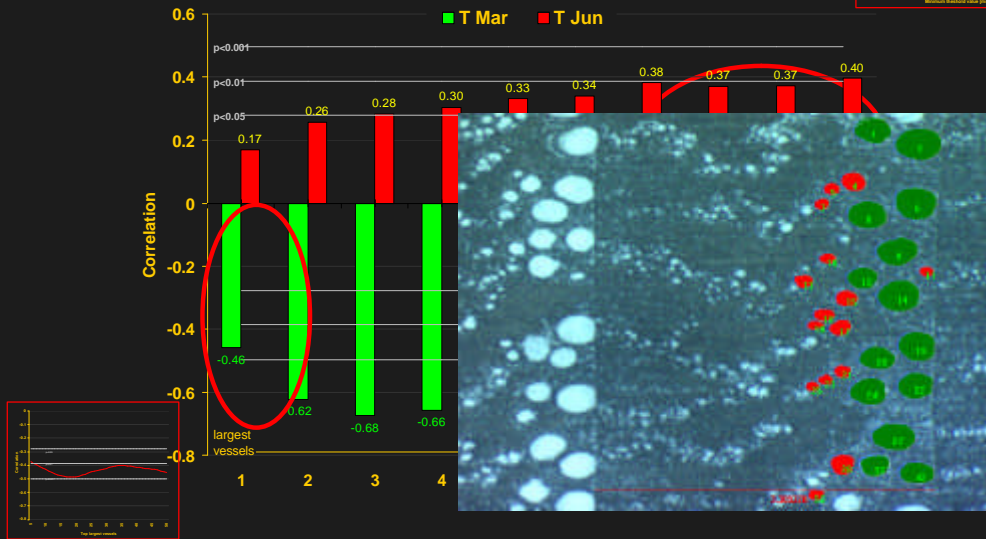
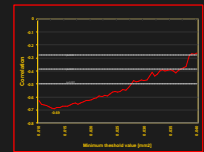
Results

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The results of these new filtering is shown in these new graph. Here we can observe that the correlation value are in general smaller and more constant than in the filtering we applied before.

So, these 2 filtering have shown us that the way we select the vessels (strongly) affect the correlation.

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Results

This Graph may explain us WHY!

Here we separated all vessels in each ring in 10 groups, BY SIZE. Than for each group we calculated the MVA Chronology and the new correlation with the Temperature of March (green bars) and the Temperature of June (red bars).

What we can see in that the Temperature of March is mainly captured by the largER vessels, but not by the largEST one.

We can also see that the smaller vessel tend to lose the Temperature of March signal while they gain the Temperature of June signal.

These observations might explain us the results observed with the 2 filtering applied.

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By eliminating the smallest vessels we are also depleting the vessels that contain another signal mixed in. Which might explain why the correlation than improve by increasing a little the minimal threshold value.

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The lower correlation values observed with the other filtering can be now explained with the fact that the largest vessels does not contain the March temperature signal very well.

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So all this once again, bit with an image. Here we can see that the larger, green vessels are those that contain the March temperature signal, whereas the smallest, red one, contain the June temperature signal. From these images we can also observe the importance that the position the vessels have. And this make me think about the correctness of selecting the earlywood vessels



Conclusions

- **To be careful in selecting earlywood vessels: wrong criteria can mask the signal**
- **Signal content has to be verified (by splitting the cells in subgroups) in order to deplete other signals/noises**
- **Earlywood vessels selection criteria might consider the position within the ring rather the size of cells.**

Conclusions

So, after what we have seen, these are the conclusions.

First: The expression of the signal can be influenced by the way the vessels are chosen. Therefore it is important to be careful in selecting the earlywood vessels. The choice of a wrong criteria might mask the signal we want to work with.

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Second: In order to avoid of selecting vessels containing different signals, it will be worthy to verify the signal content by dividing the wood cells in groups and calculate the signal content for each group separately. Other signals/noises can be therefore be identified and depleted.

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And finally: If I would have to repeat a study like this one, I would strongly reconsider to do a selection based on the position of the vessels within the ring rather than on the size of the vessels. This might not change the result substantially, but it has a better physiological meaning.

Thanks for your attention!!!!!!!!!!!!