# Are periodic tangential band of vessels a new anatomical marker of floods in diffuse-porous tree rings?

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## 1- INTRODUCTION

- **Spring floods are an important component of the hydrological cycle and uncertainties remain regarding the impacts of current and future climate changes on boreal flood regime and in a context of hydroelectricity production.**
- **Flood rings in riparian ring-porous species (Fig. 1a) have been widely used to single out major flood events (St George and Nielson 2000; Kames et al. 2016).**
- **More recently, continuous measurement of earlywood vessel cross-sectional area has proved useful to reconstruct year-to-year variations in spring flow (Kames et al. 2016; Nolin et al. EGU 2020 abstract).**
- **In contrast to ring-porous species, no prevalent anatomical features related to flooding have been identified in diffuse-porous species and studies looking at diffuse-porous species are rare (see Meko et al. 2020).**
- **Preliminary observations of diffuse-porous species growing on the floodplain of Lake Duparquet revealed the presence of tree rings with periodic tangential bands of vessels (PTBV) that may correspond to major flood years (Fig. 1b to 1e).**

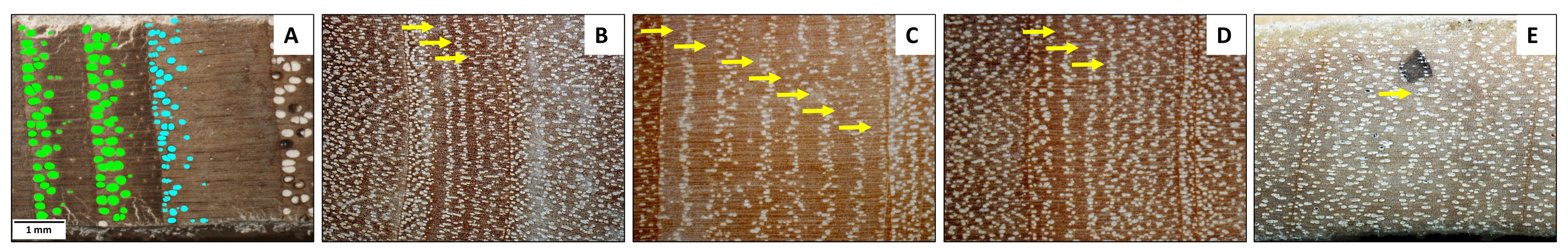


**Figure 1: Flood ring of 1960 in *Fraxinus nigra* (A, pale blue), periodic tangential band of vessels formed in 1957 (B: code23), in 1979 (C: code 17 and D: code 23) in flooded *Populus tremuloides* (yellow arrows) and single PTBV formed in 1980 (E: code 21) in control *P. tremuloides* (yellow arrow). Scale is same for all images.**

## 2- OBJECTIVES

- **Compare the ability of two observers to identify complex anatomical features in tree rings.**
- **Compare flood-ring distribution in *Fraxinus nigra* to that of PTBV in *Populus tremuloides* (and *P. balsamifera*) in trees exposed and not exposed to flooding.**
- **Identify hydroclimatic variables behind the formation of these tree-ring features.**

## 3- METHODS

- **Paired sampling of *F. nigra* and *P. tremuloides* (*P. balsamifera*) was used in both flooded and control sites along Lake Duparquet, northwestern Quebec.**
- **Elevation of each sampled core to the base of the tree as well as the elevation between the tree base and the water level were measured.**
- **Flood-ring intensity (1 and 2) was quantified and PTBV identified using a numerical code associated with position within a tree ring (1 to 3) and the number of bands (see code in Fig 1).**
- **Distribution of tree-ring features was compared between observers.**
- **Frequency distributions were compared to monthly hydroclimate variables i.e., Harricana river discharge, Rutgers snow cover (1966-2017; Estilow et al. 2015), maximum temperature and total precipitation (CRU TS 4.03; Harris et al. 2020).**

## 4- RESULTS

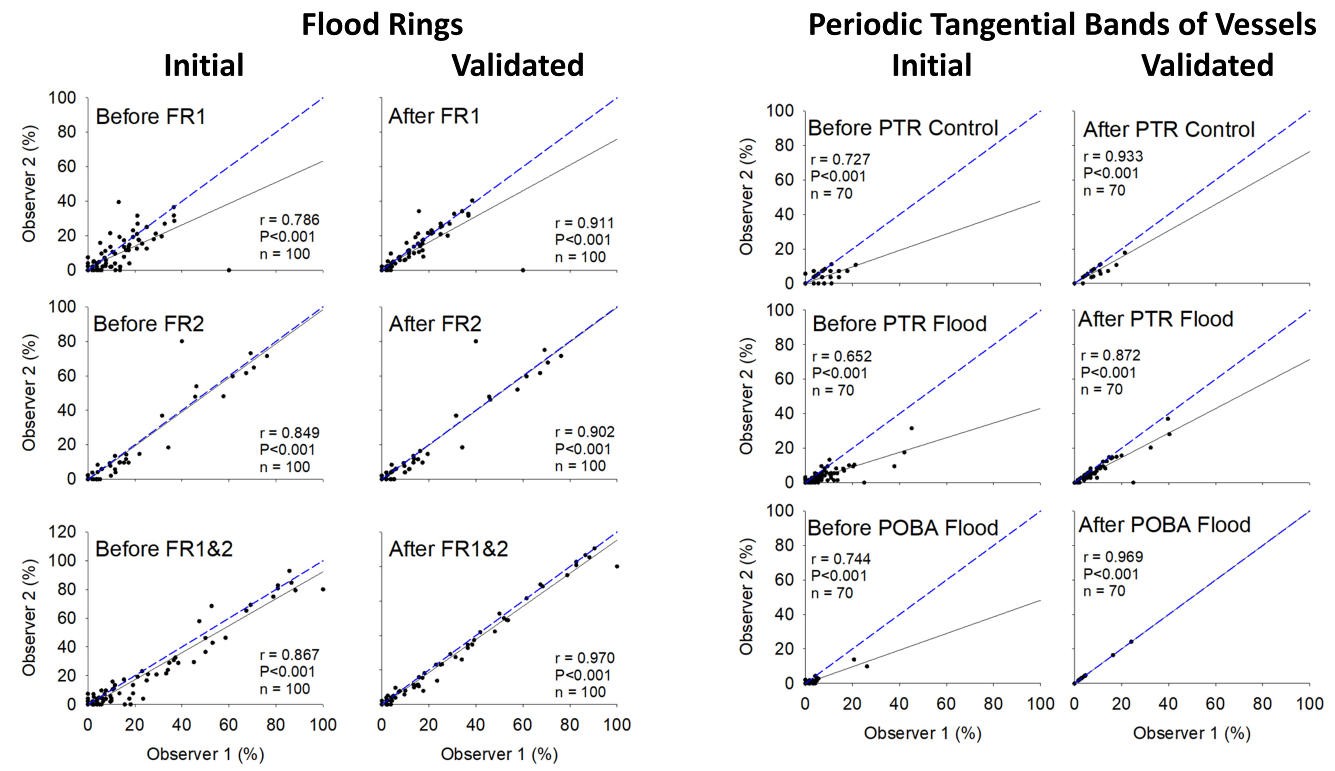


**Figure 2: Flood ring relative frequency compiled by two observers (FR1: low intensity; FR2 high intensity; FR1&2: pooled) and periodic tangential bands of vessels pooled compilations for control and flood *P. tremuloides* (PTR) and flooded *P. balsamifera* (POBA). The one-to-one relationship is indicated by the dashed blue line.**

1. **Initial observations made by two observers were positively correlated and similarities were greatest when identifying flood rings compared to PTBV. Dissimilarities decreased after validating each other.**

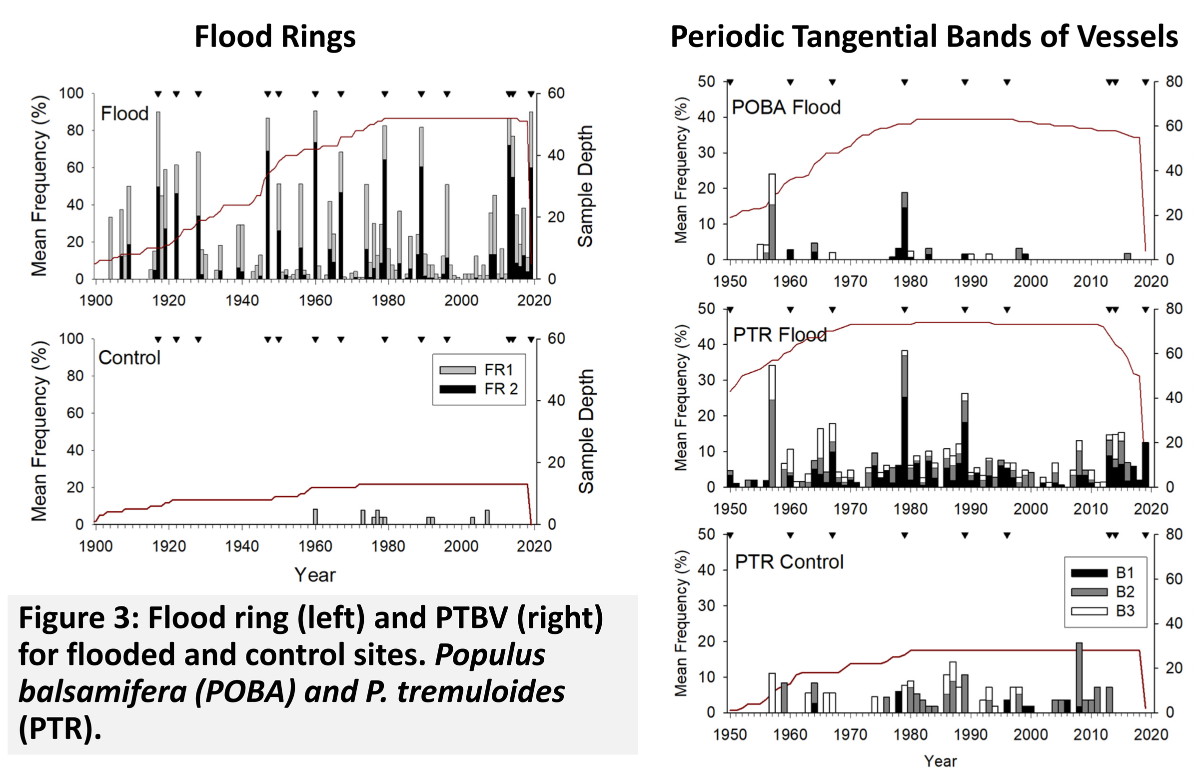


**Figure 3: Flood ring (left) and PTBV (right) for flooded and control sites. *Populus balsamifera (POBA) and P. tremuloides* (PTR).**

2. **Flood rings were almost inexistent in control compared to flooded sites (Fig. 3).**
3. **Flood rings were more abundant than PBTV in flooded sites and both (especially flood rings) corresponded to major flood events (see ∇, Fig. 3).**
4. **PTBV were observed in both flooded and control sites (except for *P. balsamifera*).**
5. **In control *P. tremuloides*, early PTBV (B1) were rare compared to that in flooded sites (Fig. 3).**

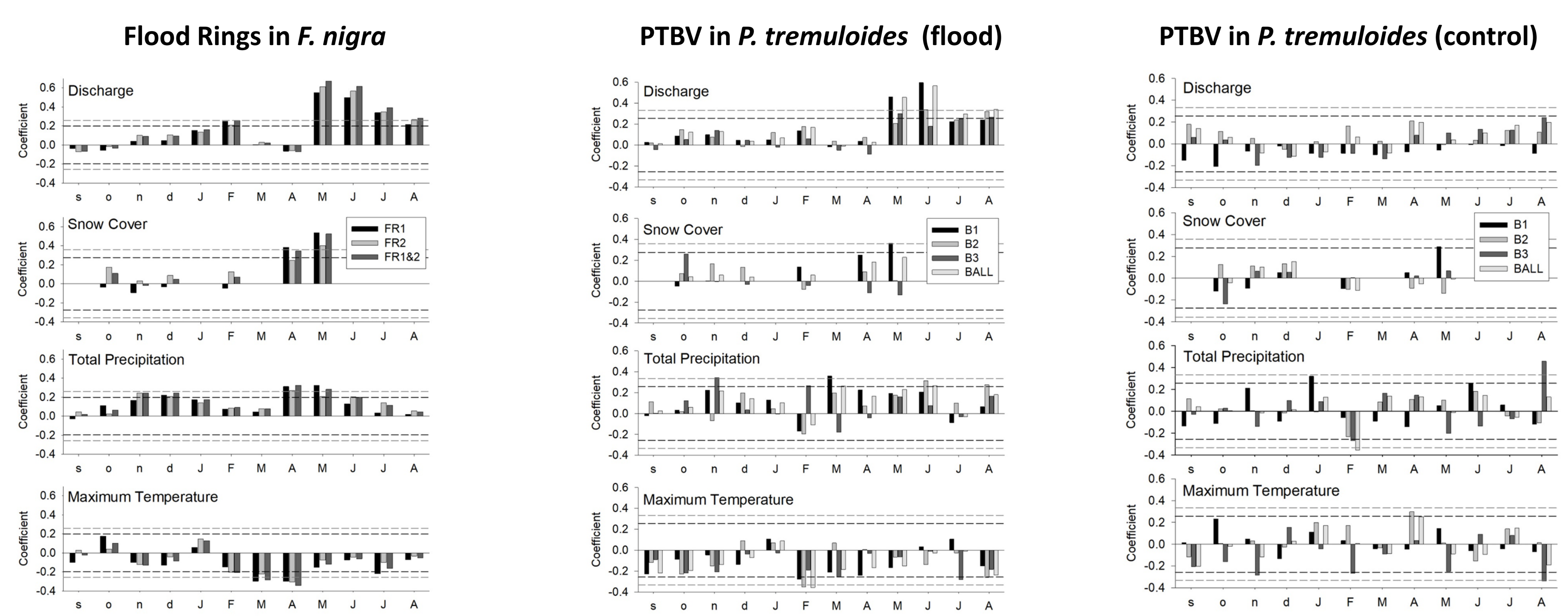


**Figure 4: Pearson correlation between flood-ring (left panel), PTBV in flooded *P. tremuloides* (middle panel), control *P. tremuloides* (left panel) distributions and four hydroclimatic factors. Dashed lines indicate p-value of 0.05 and 0.01 respectively.**

## 4- RESULTS

6. **Flood rings were strongly correlated with May-June discharge (+), April-May snow cover (+), precipitation (+) and April Tmax (-) (Fig. 4).**
7. **In flooded *P. tremuloides*, early occurring PTBV were also correlated with May-June discharge (+) and May snow cover (+) whereas correlation with control were less clear.**
8. **Both flood rings and PTBV in *P. tremuloides* shared similar field correlations with February-March maximum temperature (-) and with snow cover (+; Fig.5)**

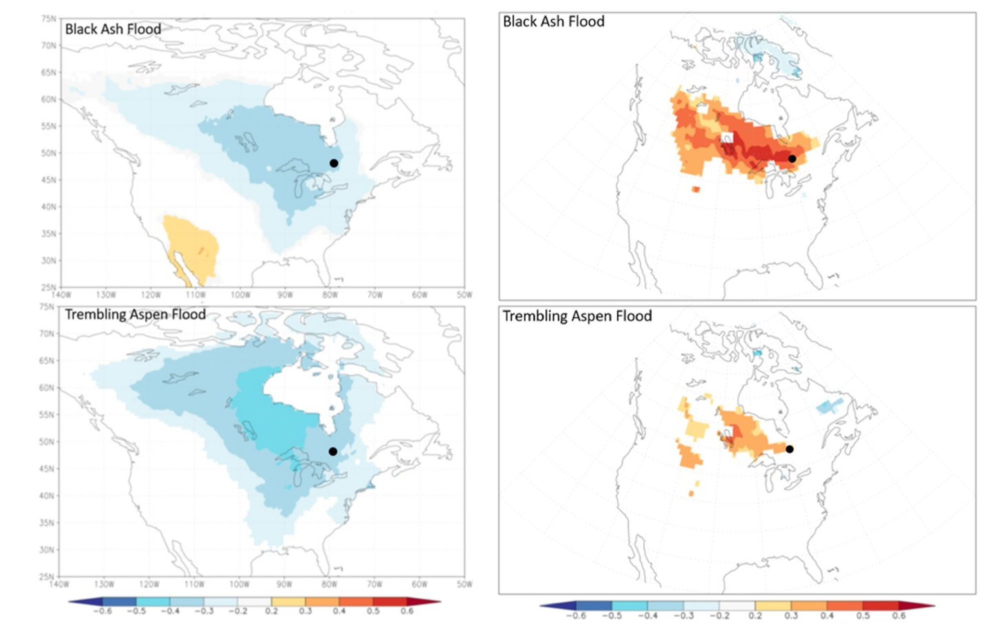


**Figure 5: Field correlation between mean February-March maximum temperature and the occurrence of flood rings in flooded *F. nigra* (upper left) and of PTBV in *P. tremuloides* (lower left). The right panel represents the field correlations with mean of April and May snow cover from 1966 to 2018. The black dot marks the location of the sample site. Maps were obtained using the KNMI Climate Explorer webpage (http://climexp.knmi.nl/).**

## 5- DISCUSSION

- **Visual identification of tree-ring features is time consuming and training importance increases with complexity of features.**
  - **both observers were fairly comparable when identifying flood rings in *F. nigra*. Variability increased with the more complex PTBV features and systematic validation made the data more robust.**
- **Flood rings were almost exclusively found in the flooded zone (exceptional 1960 flood observed in control) and were clearly associated with condition leading to maximum spring flood.**
- **In *P. balsamifera*, PTVB were solely observed in the flooded zone. In contrast PTVB in *P. tremuloides* were observed both in the control and in the flooded zone.**
  - **early formed PTBV showed potential in identifying major flood years. Later occurring PTBV could relate to precipitation pulse during the growing season.**
  - **need to better understand why some trees are recording PTVB and others not (i.e., core height? tree status?)**
- **Preliminary results also suggest that the number of band may decrease with stem height as indicated by same tree sampled at 20cm (Fig 1c) and at 50cm (Fig 1d).**

## 6- ACKNOWLEDGEMENT

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