Plant, Cell & Environment
MS# 03-001 **Ref#** 2

Title: Effects of Stand Age and Tree Species on Transpiration and Canopy Stomatal Conductance of Boreal Forests

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Quality of the Science		Importance of the Science		Quality of Presentation	
Experimentally and/or theoretically excellent reliable data, no flaws	☐	Research of major significance on topic of central importance; highly novel	☐	well presented	☐
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Comments for the authors (type in space below; add pages as necessary.

GENERAL APPRECIATION

The manuscript presents experimental data obtained in a chronosequence of mixed boreal forest stands in support of a stomatal model based on the assumption of water potential homeostasis in woody plants. Interpretation of data is focussed on the model already developed in a previous paper appeared in PCE (Oren et al 1999) which basically relates the stomatal sensitivity to the air saturation water vapour deficit with the maximal stomatal conductance and explains this as a consequence of the homeostasis of leaf water potential in trees. The manuscript aims at evaluating this theory among four different boreal tree species across a range of stand ages. I do not think the experimental data presented by the authors do actually contribute significantly to further testing this model and the main reason is simply that the data shown do not provide a convincing evidence that a daily minimum leaf water potential values is maintained among ages or not. The data on transpiration and stomatal response to water vapour saturation deficit although measured carefully and analysed properly have not been interpreted critically and alternate explanations of the stomatal behaviour and water relations observed have not been analysed.

DETAILED COMMENTS

p3
- *rapid CO_2 uptake* do not imply high transpiration rate.
- What does mean *the identity of the cells ?*
- If Ψ_L is kept constant how could changes in Ψ_L be the signal which regulates transpiration ?
- Eq 1. g (acceleration of gravity) not defined

p4
- Original equation in Jarvis's paper relates g_s to Ψ_L, not θ
- I do not follow the reasoning of $\Delta Gs/\Delta D$ being proportional to Gsmax as an implication of Gs being inversely proportional to D. I think the proportionality of $\Delta Gs/\Delta D$ to Gsmax derives from eq 3 instead.

p6

decline

p7

Bond- Lamberty Wang Gower 's 2002 paper do not refer to SLA. , ref Bond lamberty et al. should be 2003 not 2002. Relationships between DBH and height as used and mentionned p7 are not documented.

p8
- EL not Ec
- explain how Wi is calculated.

p9 .
- Assumptions made on Js and Wi are related to the calculation of E_L not the weighted average Js. Remove and and place them in p10 for introducing eq 5.
- replace *daily* by 24-hour

p10

The unit used for E_L mm.d-1 is confusing and should be replaced. mm is not a conventional mass or flow unit. It is generally used as a short cut for the transpiration or evaporation per unit ground area as mm = kg (H_2O) . m-2 (ground area). The author uses instead mm as mm3 (xylem sap). mm-2 (leaf area). Either mol(H_2O).m-2 (leaf area) or kg (H_2O) . m-2 (leaf area) must be used. Adding to this confusion, E_L unit is not kept consistent throughout the manuscript : see Fig 2 &3 vs Fig 4

p14
- I do not understand why boundary line analysis provide the *best* (what is it ?) *of the measured conditions .*
- Error or uncertainy on A_S / A_L must be given, results not acceptable as they are.
- Retaining only the highest range of Gs values for caracterising gs response to D after is questionable. It may not necessary provide a different response than when considering the entire range of values. If this is actually the case then the analysis of Gs response should not be restricted to highest values.

p15

What is an *exponential saturation ?*

P18.

I don’t agree with the authors that data from fig 5 support the assumption that Populus tremuloides, Pinus banksiana and Betula papyrifera regulated *their minimum water potential*.
- Betula is not shown in Fig 5,
- Populus showed minimum values from ~ -1.6 to -2.2 among three stands

- Pinus from ~ -.3 to -.6 MPa a 100% variation between two stands.

I am also sceptical regarding the interpretation of Picea mariana behaviour since this species keeps its water potential above -1.6 MPa well above the vulnerability threshold of most coniferous species – I am not aware of the particular value for P mariana. It may well be the case that no regulation is observed because the water potential values are well above the cavitation threshold due e.g. to the relatively low values of water vapour pressure saturation deficit. When compared with Populus which the authors consider as a regulating *isohydric* species while showing Ψ_L values below -2.2 MPa which might be close from the vulnerability threshold (see Blake et al. 1996), P mariana does not appear therefore to be unregulated.

On the top of that, Picea mariana might be suppressed in the 20 y stand where it accounts for a marginal sapwood area and is half-high as the other species.

Information on the vulnerability to cavitation of the species considered in the manuscript is essential here and should have been provided. Leaf shedding might be a regulation process of the tree water status in Populus which should be discussed here.

P20

- I cannot find anything regarding the fine root/ foliage ratio in the references cited (Bond-Lamberty et al. 2002, Wang in press ,so not available).
- Dang et al are refered as a study showing that P mariana does not regulate Ψ_L but they found actually that "Field measurements on in situ branches on warm sunny days showed that both conifer species (P mariana and P banksiana) maintained PSI above the corresponding threshold" .

Another point in the discussion which is not clear to me is the following. Boreal trees experience very low temperature and sapwood may freeze during winter. They should therefore has a cavitation repair capacity either in restoring new vessels or tracheids or filling the embolised conductive units. If so why postulate that they must avoid cavitation and embolism ? Following this line, why juvenile wood should explain the particular case of Picea mariana ? This latter species has also a low needle boundary layer conductance and might be partly decoupled from atmospheric VPD which makes the stomatal control of transpiration less effective than in Pinus banksiana or Populus whose foliage is less packed. This point should also be discussed thoroughly as it was in the parent paper by Oren et al. Furthermore, recent ideas on hydraulic architecture of trees tend to show that most vulnerable part of the conductive system are the end vessels and tracheids within petioles, leaf mesophyll or needles, eventually twigs but not wood.

P21 ,

L4. This sentence implies that the whole tree hydraulic architecture might be summarised by the only ratio As:Al which is oversimplifying. Main resistances to water flow resides in the root-soil interface and terminal parts of the water pathway such as leaf vein and petioles respectively.

p 22

Ewers et al paper does not provide a generic conclusion as claimed but refer to a fetilisation -irrigation experiment which has little to offer for interpreting the present results.

p23

- First sentence is incomprehensible.

- Consider also the hyseresis between D and Q0 and he social status of the species in each stand.
- The time constant of stomatal response to D and Q0 have not been considered in the explanation of hysteresis though they might differ among species and ages considered and contribute to the pattern observed (see eg. Rayment et al Tree Physiol, 20 (11), 713-723). As far as water storage might play a role for explaining the hysteresis observed it should be remembered that the time delay between xylem sap flux and transpiration due to water storage flux is not constant along the day but generally decreases until midday and increases then.
- Social status and shading of trees in the 20y old trees should be evoked at least for Picea mariana.

P25
The last paragraph is irrelevant and goes beyond the experimenal data provided here.

FIG 1; Choose symbols which can be discriminated when superposed.
FIG 2. one example plot of annual course of Dz & Q_0 would suffice but E plots must be enlarged and made clearer
FIG 3 G, linearity not seen clearly, *Y* axis scale should be 0-1
Fig 4. use symbols not hidden when superposed.(G & H).

Since those plots aimed at analysing the hysteresis between E and D or Q0 , I suggest further to calculate a sapwood volume and water storage capacity per unit leaf area for each stand and relate them. Then use the trunk sapwood volume instead of age for differentiating the plots.

Fig 5. Figure letters A, B, C lack.