

# Separating transpiration and stem water storage in a large boreal tree using Heat Ratio Method



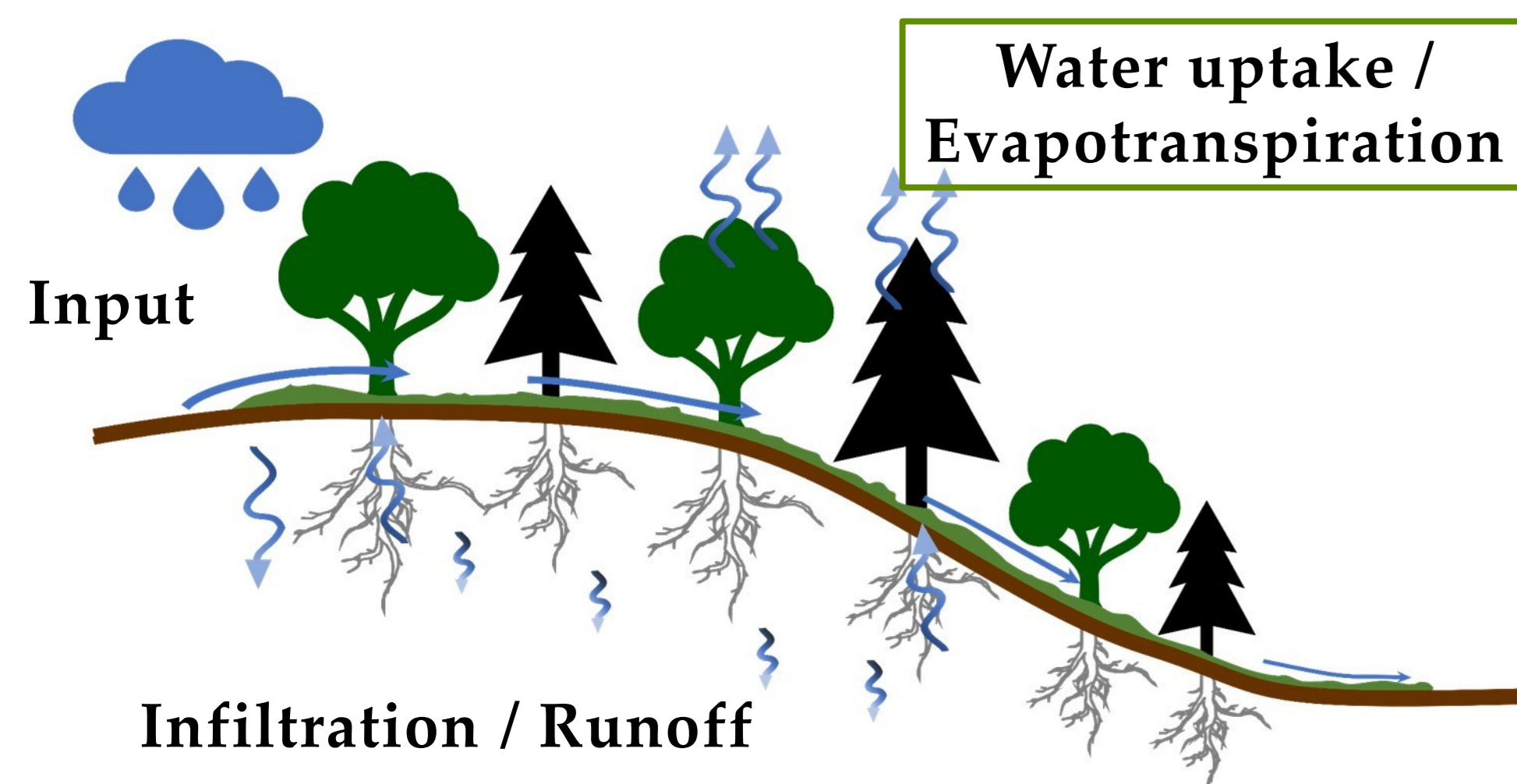
sap flow sensors  
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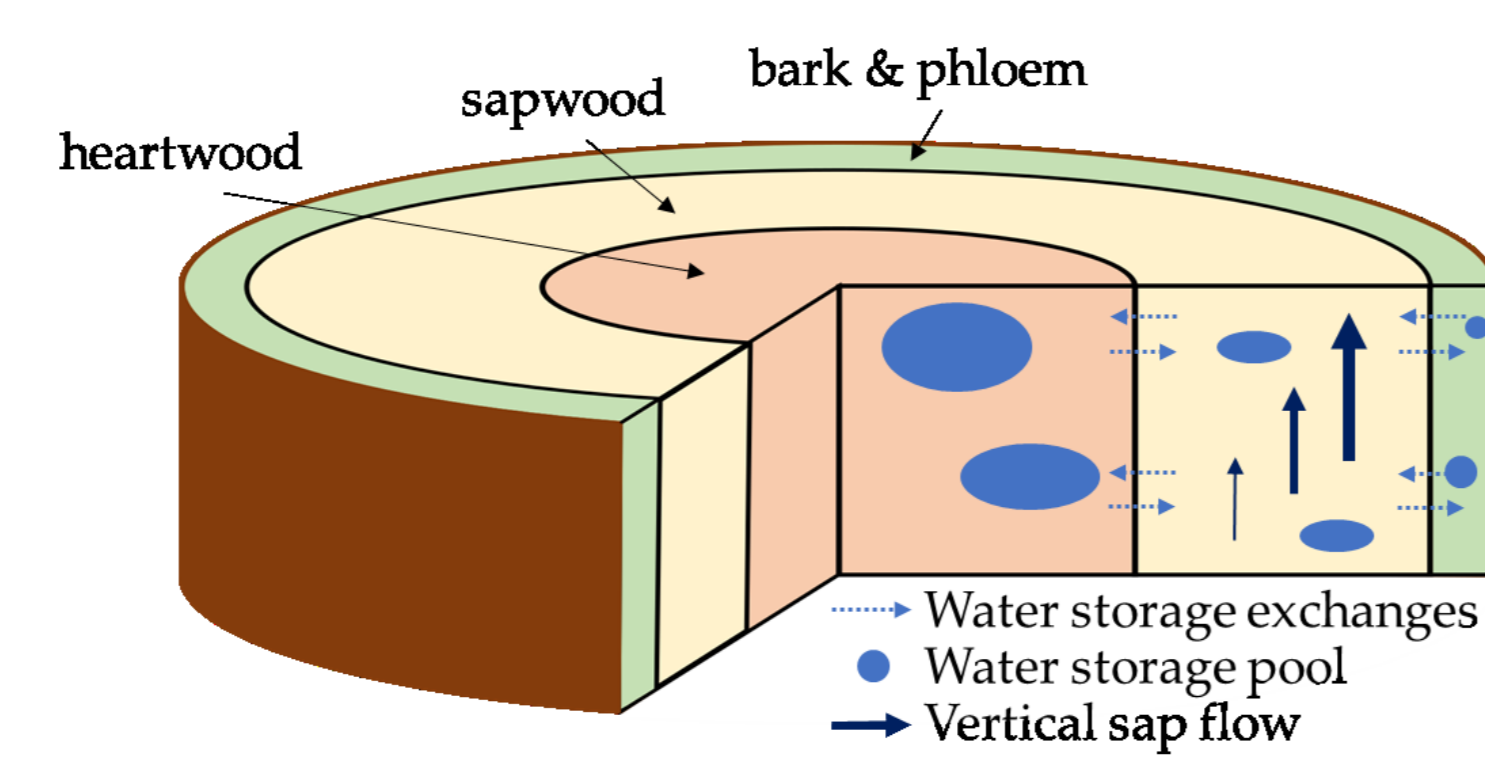


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## 1. Estimating forest water use



Trees play a major role in controlling the water fluxes of terrestrial ecosystems, thus obtaining accurate estimates of water use is crucial under current and future climatic conditions.



Lags between canopy and stem measurements of water fluxes highlight the importance of stem water storage as a significant water pool in forests.

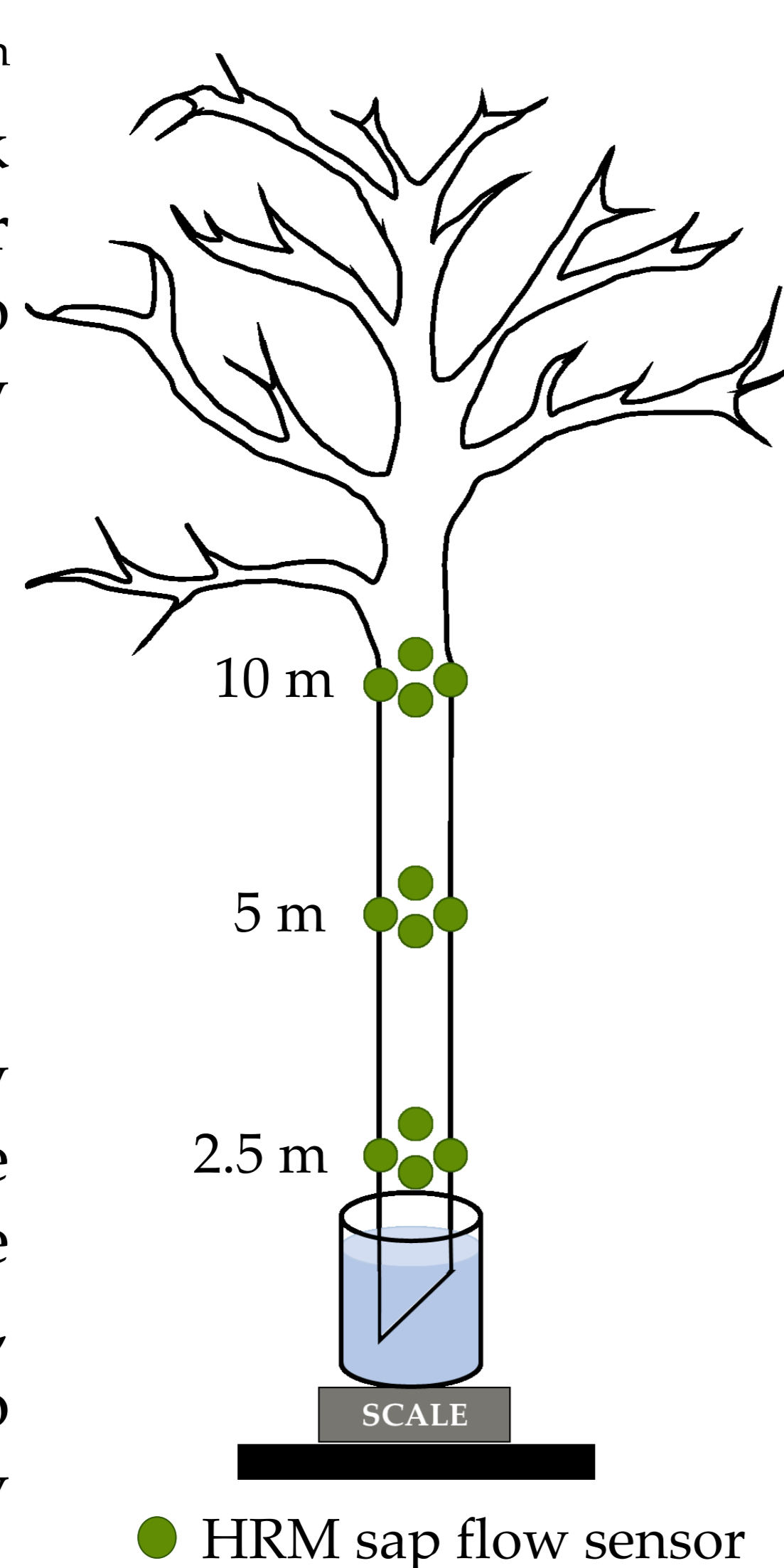
**Objective 1.** Are estimates of sap flow accurately matching gravimetric flow?

**Objective 2.** Can we identify the dynamics of stem water storage *versus* transpiration in hourly sap flow measurements?

## 2. Sap flow sensors & Cut-tree method

Heat Ratio Method sap flow sensors (ICT International Pty Ltd.) were installed on a 60 years old and 20 m tall aspen in July 2017 at 2.5, 5 and 10 m along the trunk across four cardinal directions.

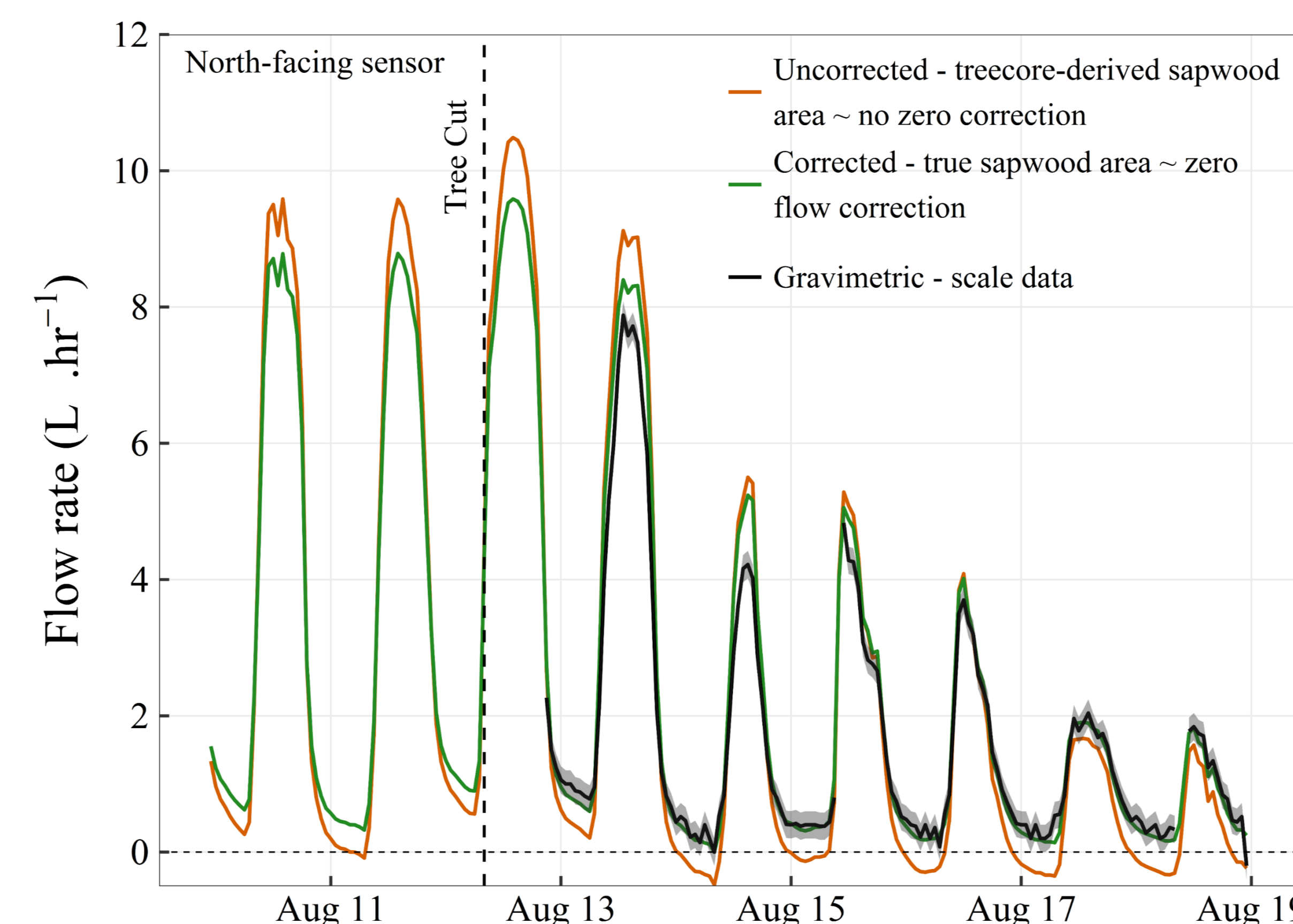
The tree was cut August 12<sup>th</sup> 2017 and the base of the trunk was suspended in a large water bucket resting on a scale to record water flow gravimetrically.



**Objective 1.** A zero flow correction and an appropriate sapwood area calculation were applied to estimate sap flow, which was then compared to gravimetric flow measured by the scale.

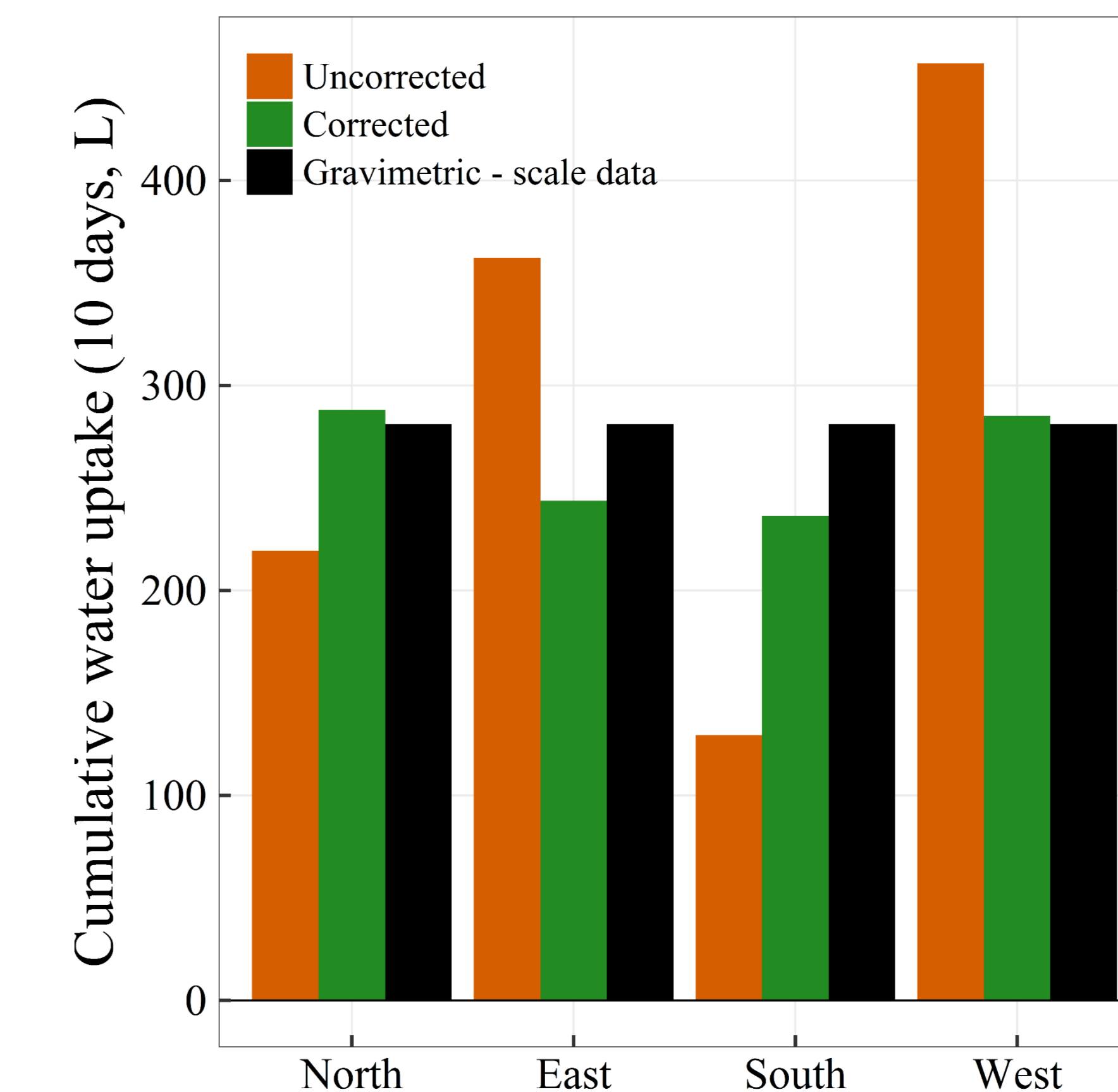
**Objective 2.** The influence of height location (2.5, 5 and 10 m trunk height) on measured sap flow across cardinal orientations was assessed and the relationship with VPD estimated.

## 3. Measured sap flow poorly matches with gravimetric flow without appropriate data corrections



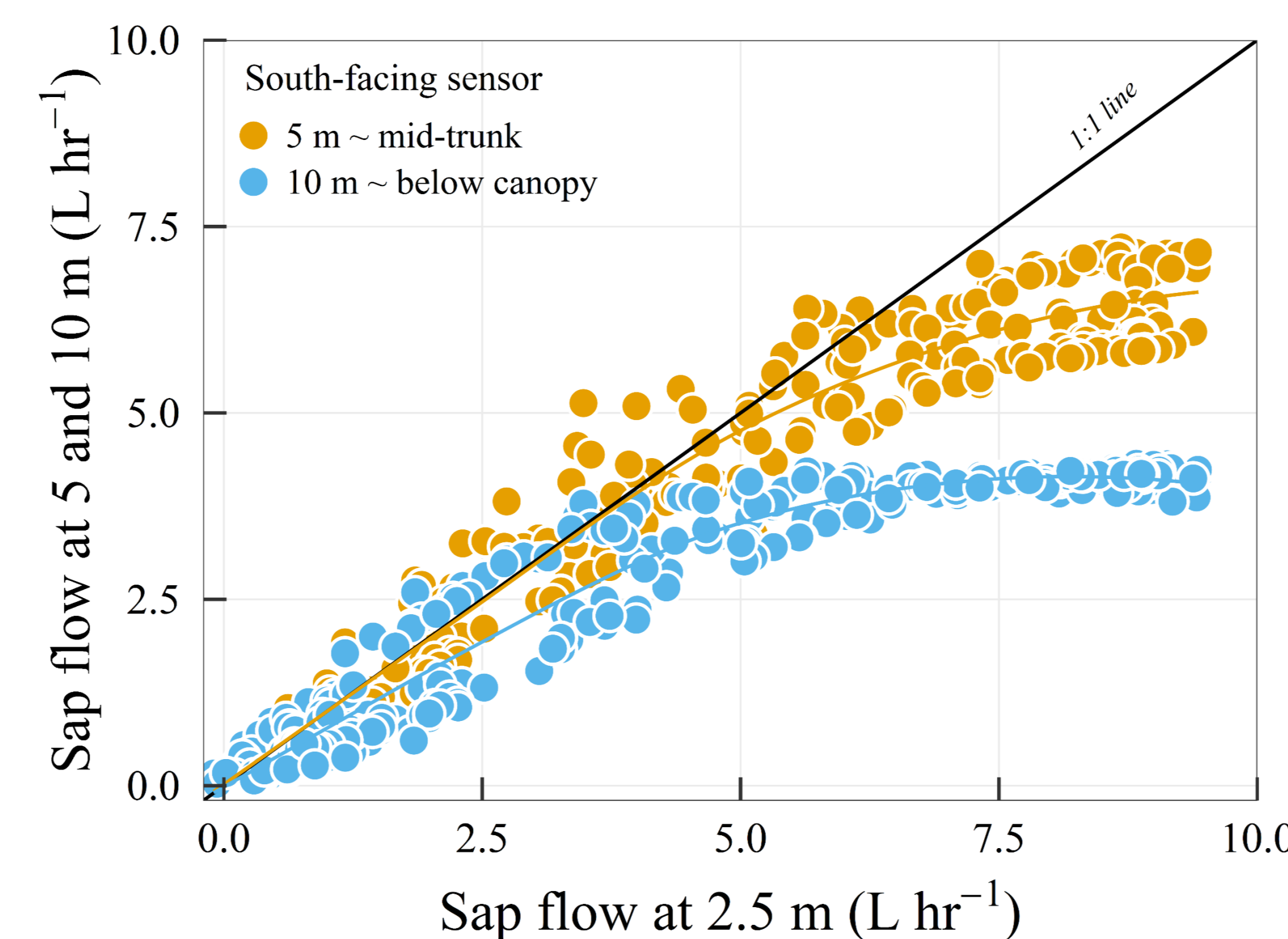
→ Proper sapwood area estimation and zero flow correction are necessary for improving the match with gravimetric flow.

→ Even after correction, sensors overestimate high flows during the day.

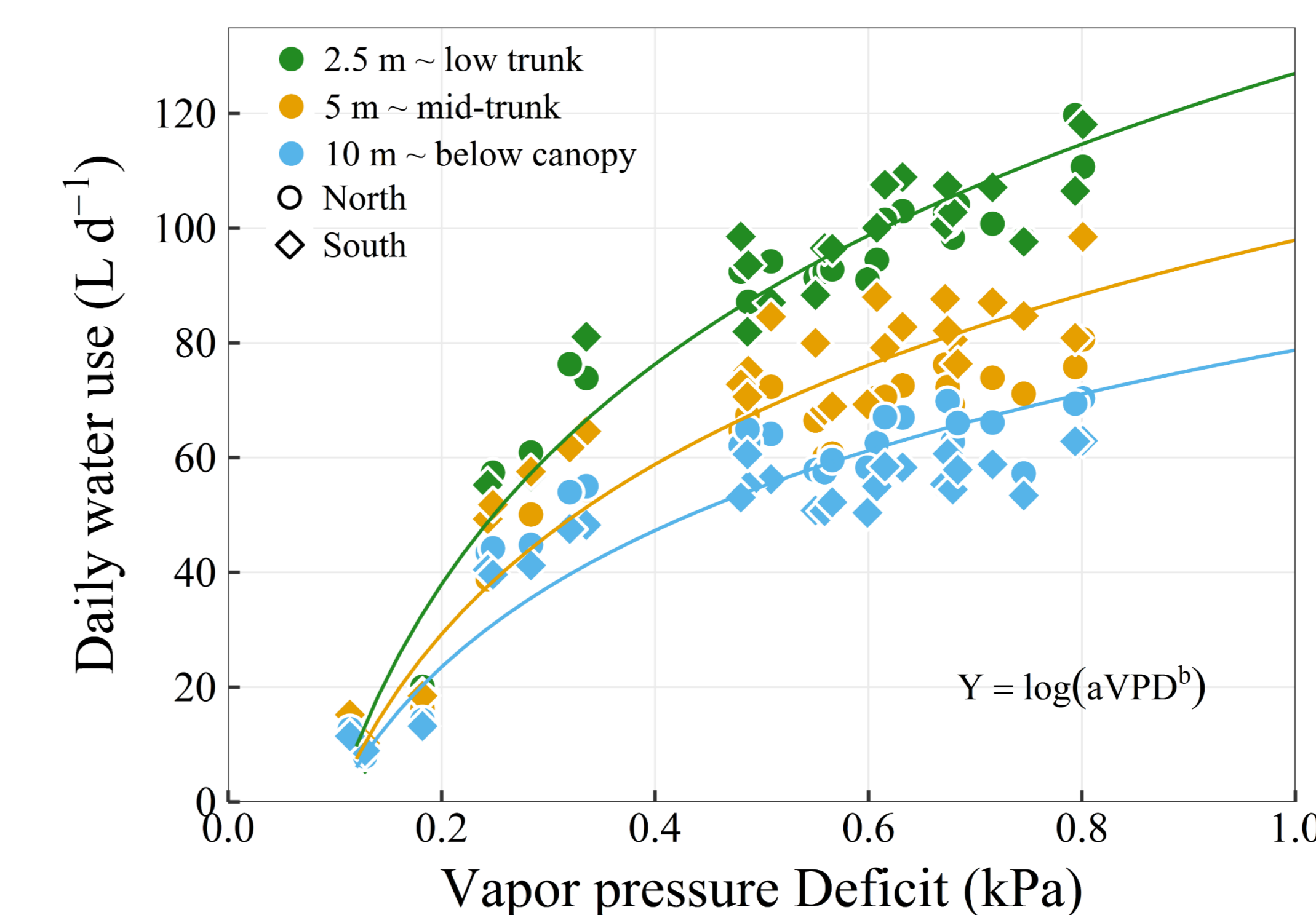


→ A relatively small over/under-estimation of hourly flow significantly impact the accuracy of the measured cumulative water uptake over only 10 days.

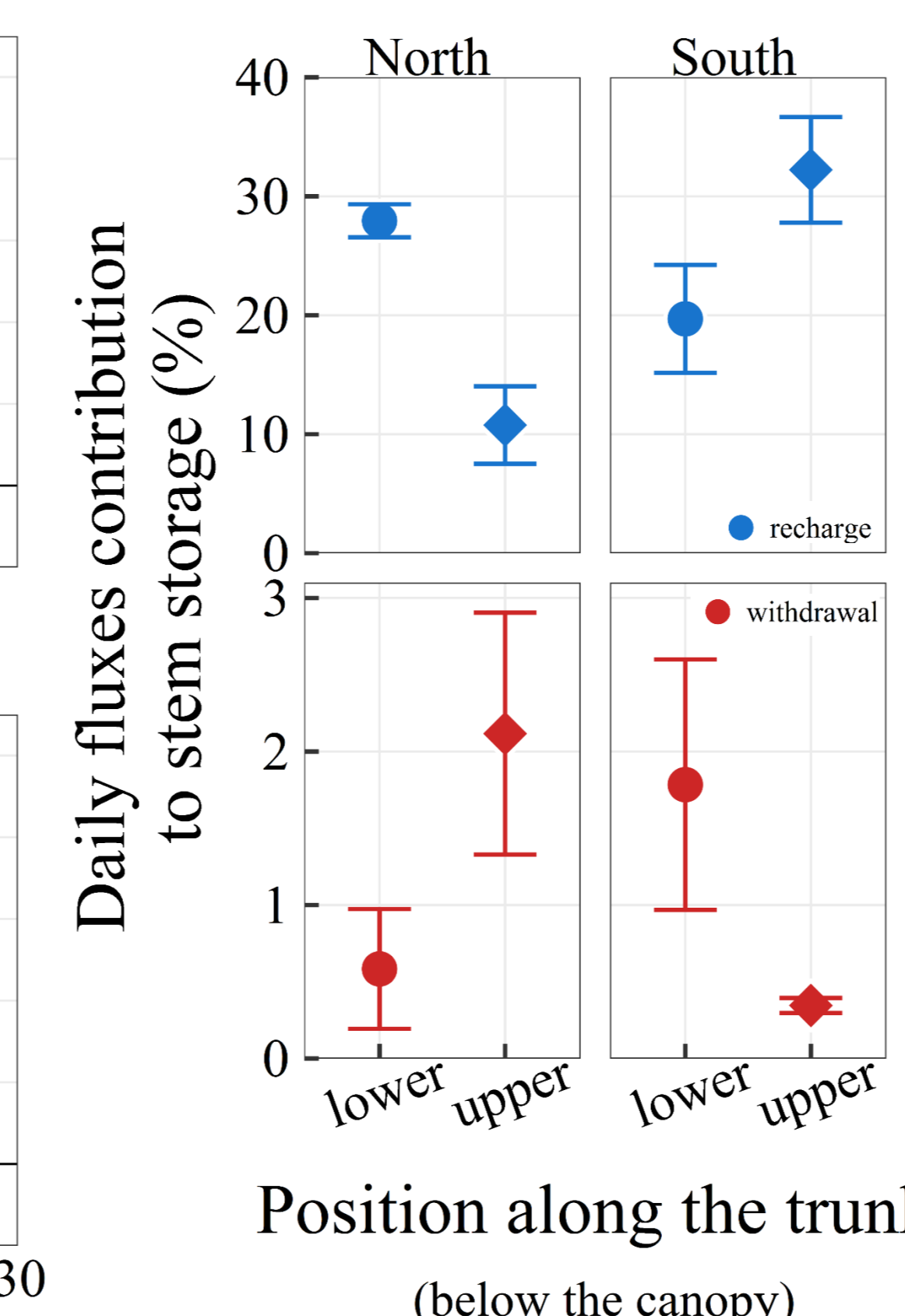
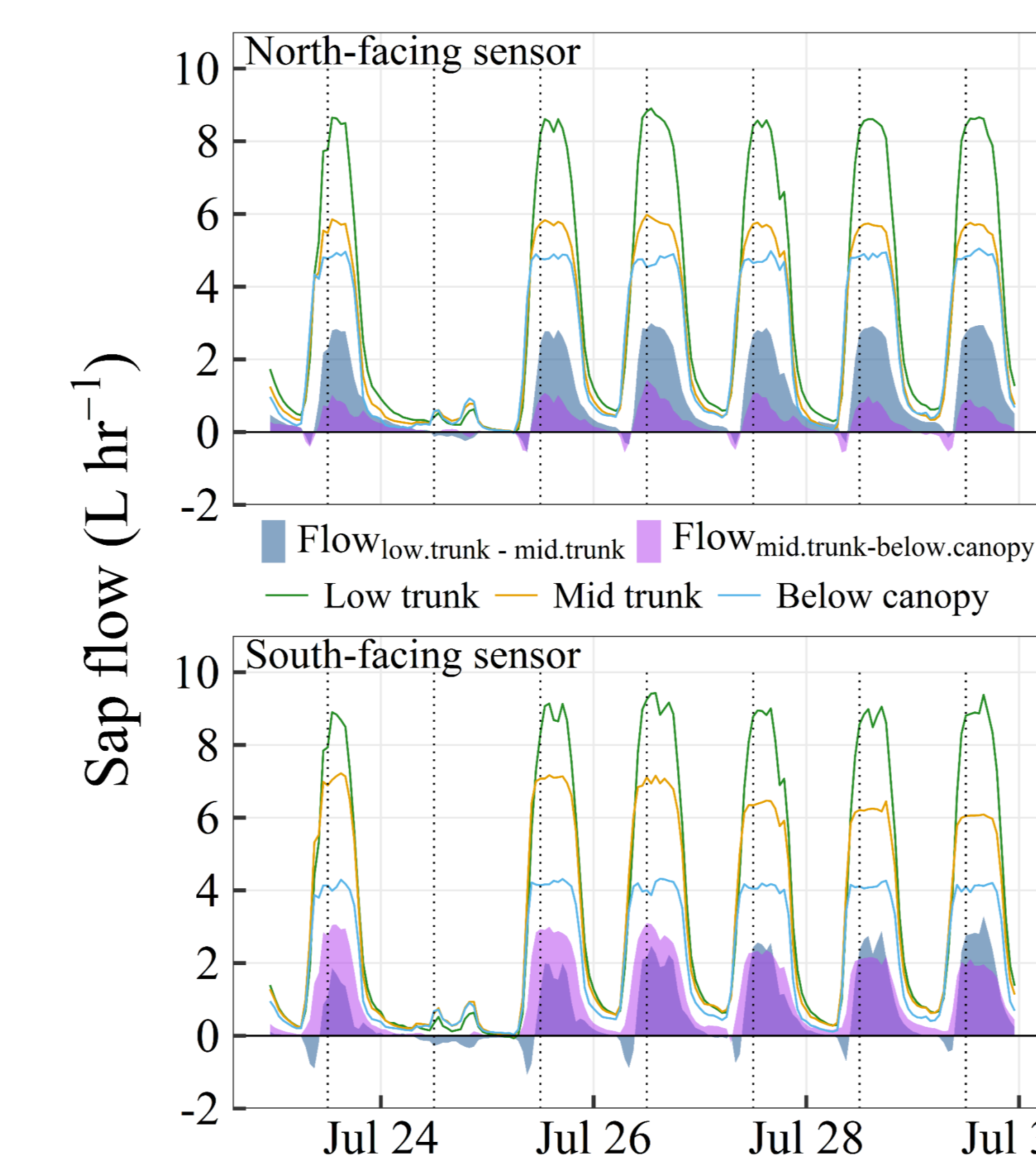
## 4. Stem water storage represents up to 45% of daily water use in this mature aspen trunk



→ Measured sap flow at 5 and 10 m along the trunk shows limited maximum flow compared to the sap flow measured at 2.5 m.



→ The placement of the sap flow sensor at different trunk heights will impact the parameter estimation for correlating sap flow with climatic variables such as vapor pressure deficit.



→ There is a large volume of water daily exchanged with the wood, with little withdrawal before the cut.

→ In temperate broadleaved trees, the trunk represents the largest reservoir of stored water, however, over the days show here, aspen doesn't seem to rely on stored water for early morning transpiration.

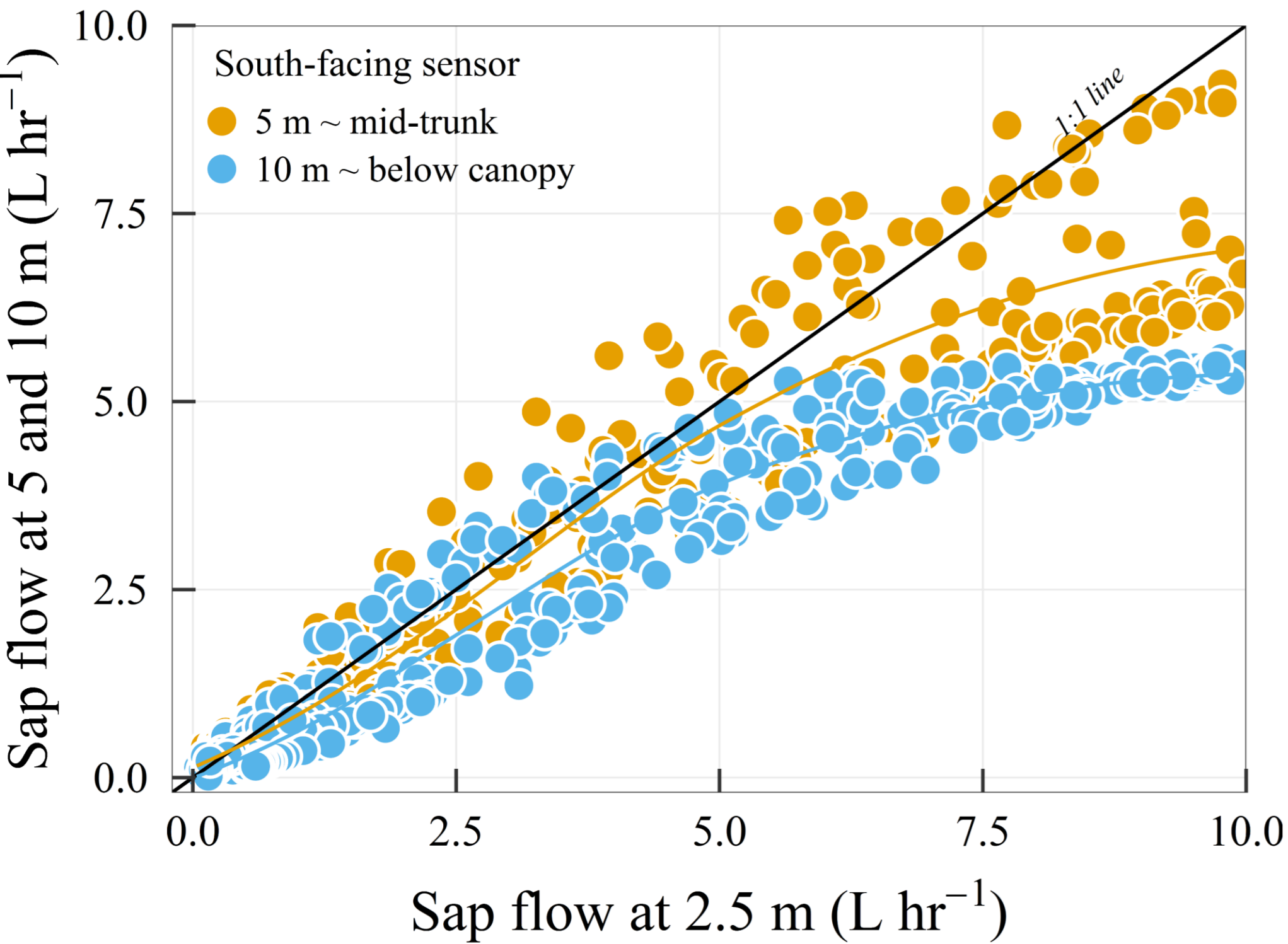
**Objective 1.** Data corrections (appropriate zero flow correction and correct extrapolation to the whole sapwood area) are crucial for the accuracy of the sensors at various time scales.

**Objective 2.** It appears that large volumes of water are exchanged laterally within the sapwood but little is withdrawn, which may indicate significant exchanges of water with the phloem and the heartwood which are currently not accounted for.

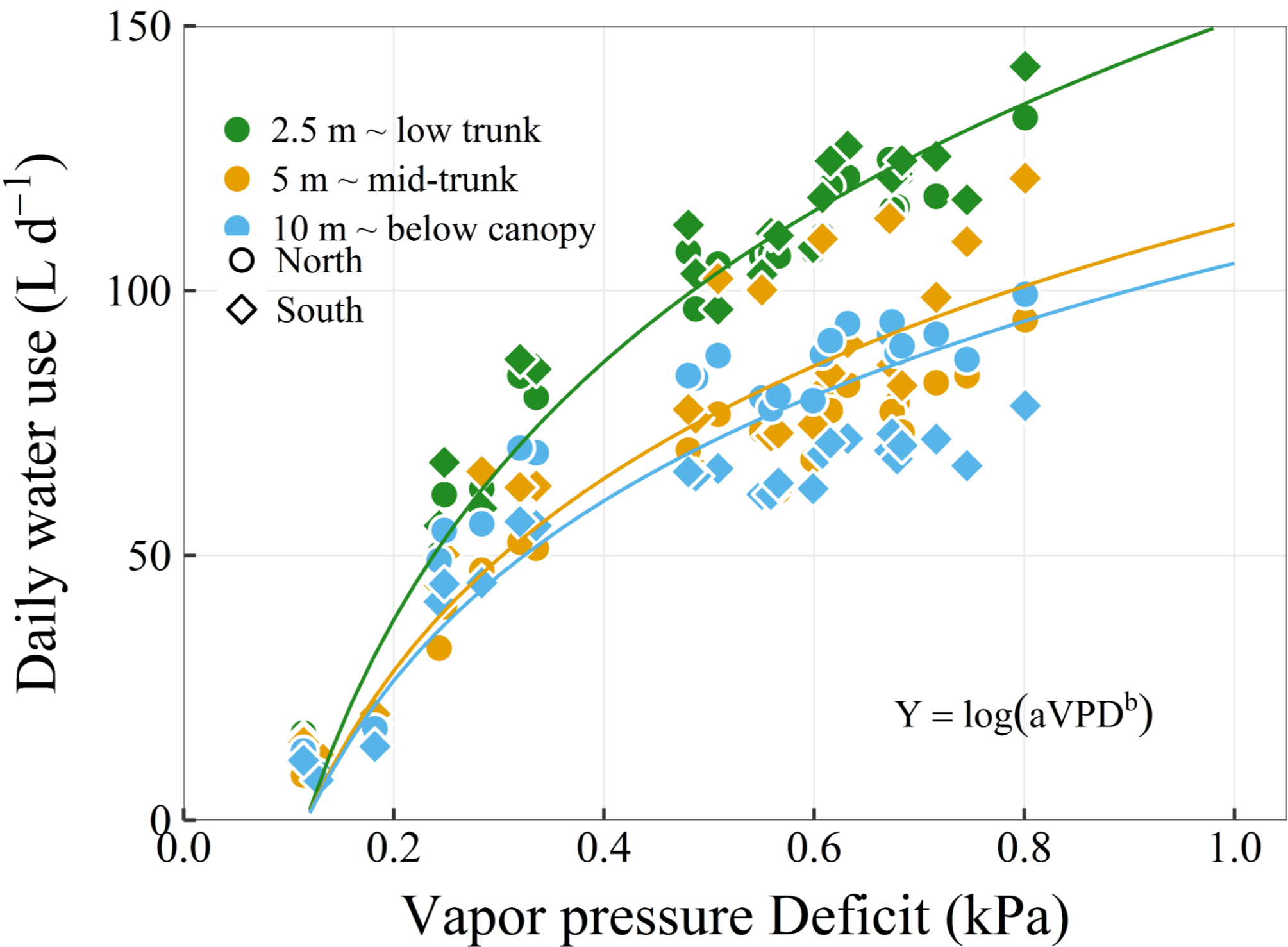
Thank you for field support to Iain Jamieson, Fran Leishman, Andy Fitzsimmons, Julie Zettl, and all members of the Landhäusser's lab and Newton Tran (ICT International Ltd.)



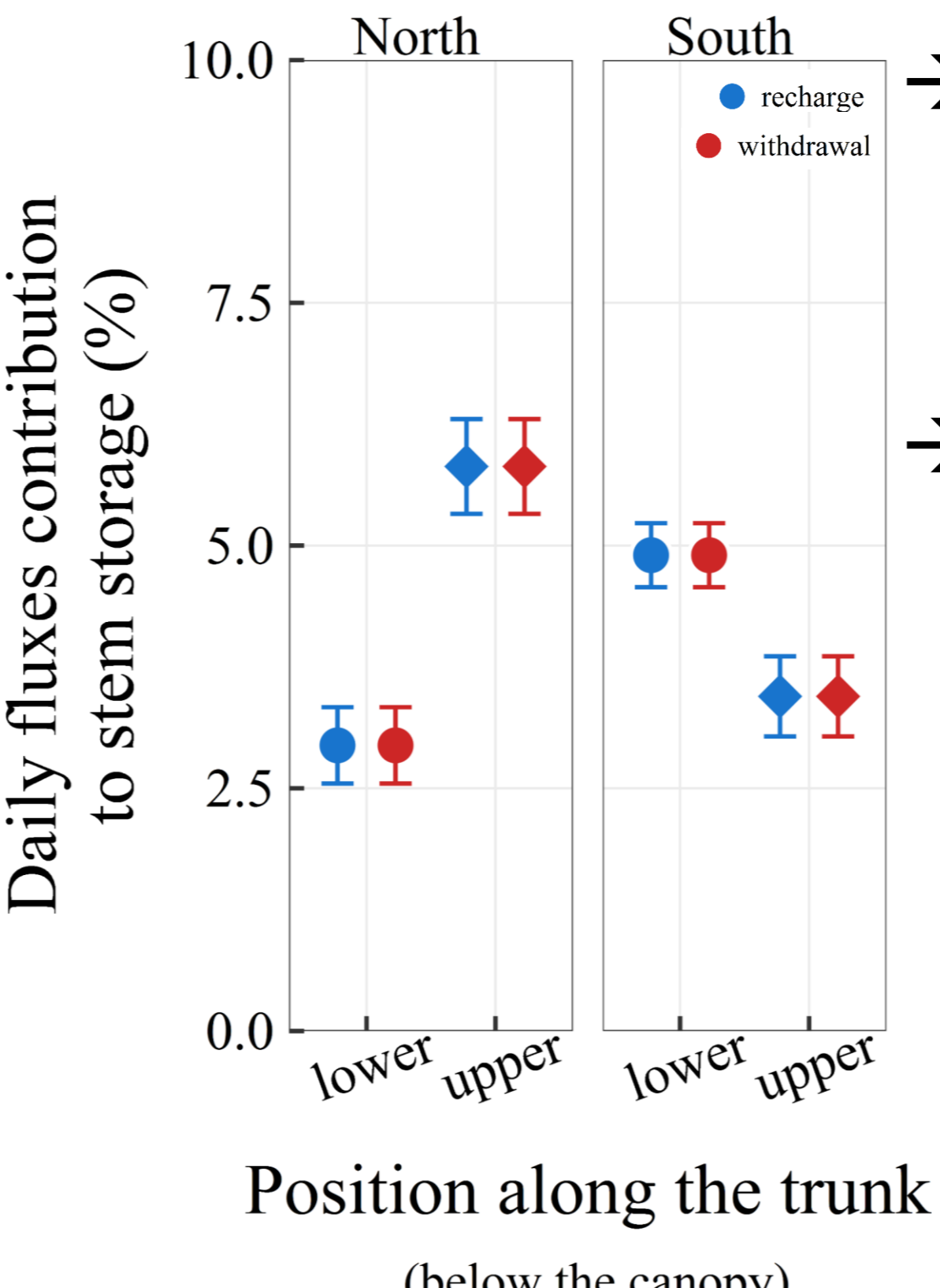
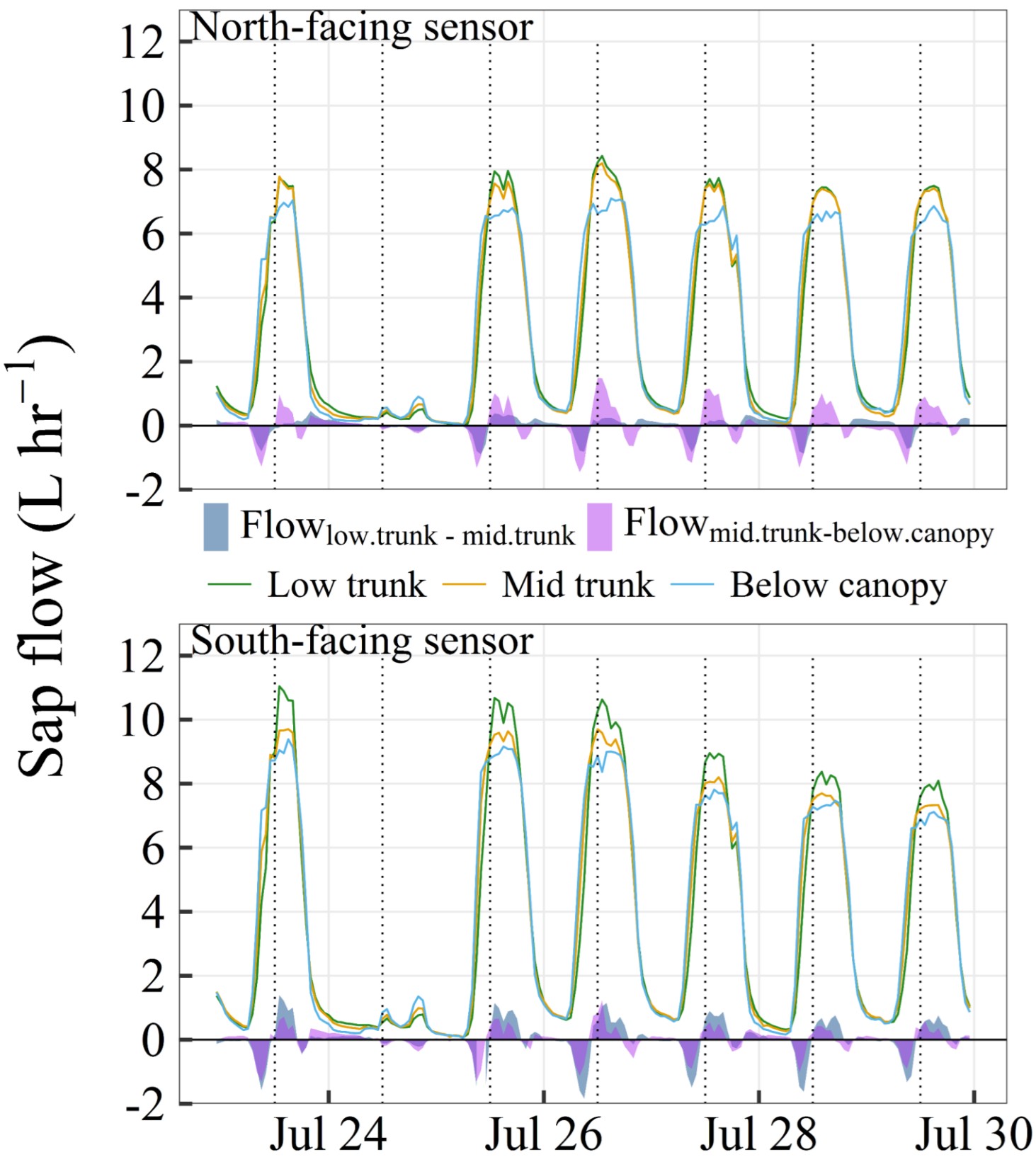
4. Stem water storage represents up to 20 % of daily water use in this mature aspen trunk



→ Measured sap flow at 5 and 10 m along the trunk shows limited maximum flow compared to the sap flow measured at 2.5 m.



→ The placement of the sap flow sensor at different trunk heights will impact the parameter estimation for correlating sap flow with climatic variables such as vapor pressure deficit.



→ There is a significant volume of water daily exchanged with the wood.  
 → In temperate broadleaved trees, the trunk represents the largest reservoir of stored water. From the low trunk to below the canopy, ~16% of daily water fluxes come from daily water storage in this aspen tree.

**Objective 1. Data corrections (appropriate zero flow correction and correct extrapolation to the whole sapwood area) are crucial for the accuracy of the sensors at various time scales.**

**Objective 2. It appears that ~16% of daily water fluxes come from internal water storage, which may come significant exchanges of water with the phloem and the heartwood which are currently not accounted for.**