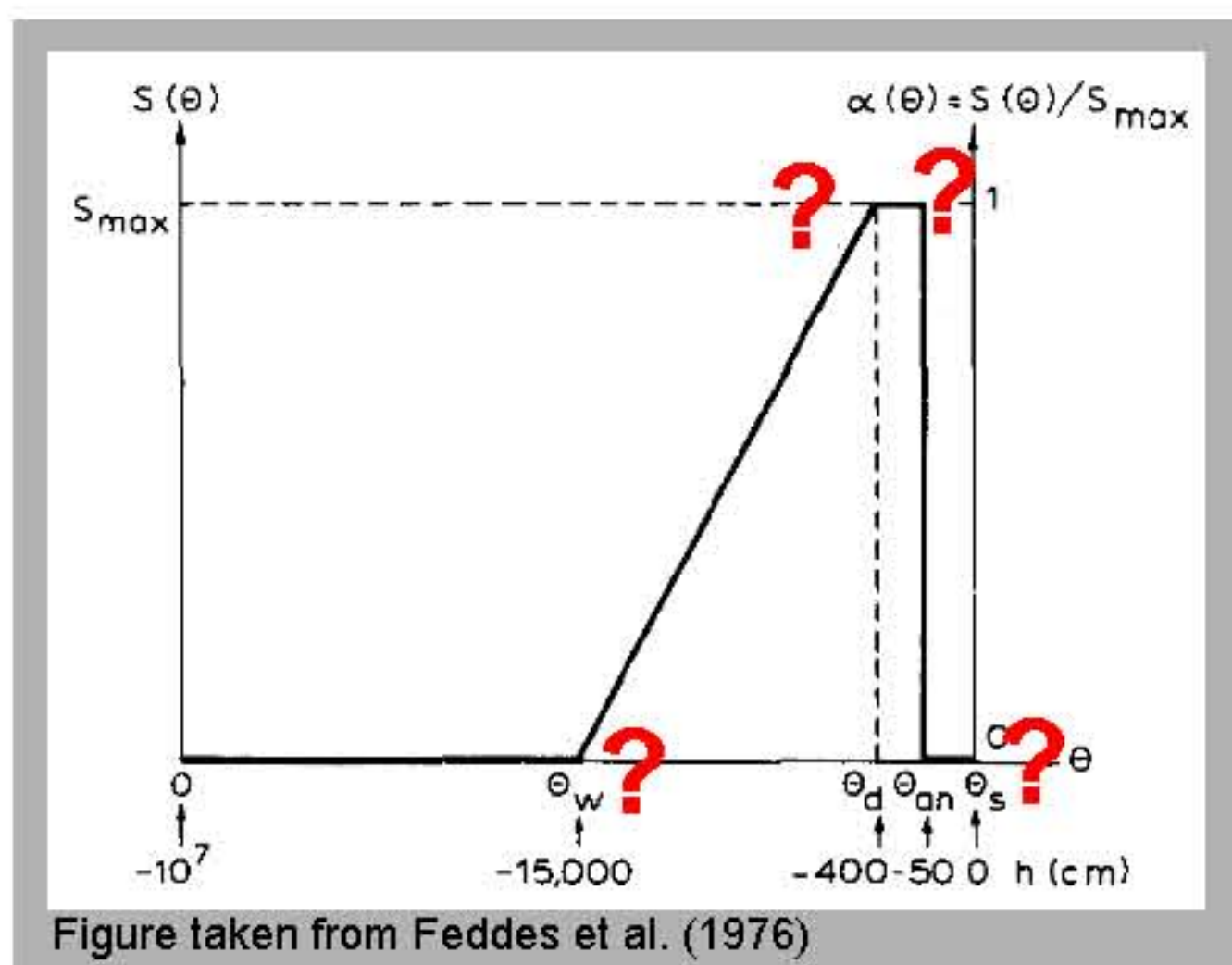


Problem

- Beech is a highly drought sensitive tree species.
- Water stress for beech can be assessed using soil water flow models.
- In many models, (semi)-empirical equations are used for estimating the potential evapotranspiration (ETP).
- Reduction functions, e.g. the very popular one of Feddes et al. (1976), reduce ETP depending on the water supply in the soil.



Few measurements on shape and parameters of Feddes' function for trees !

Large uncertainty in soil water modeling when applying literature values !

Research questions

Can the Feddes function be parameterized based on pF meter measurements?
Are the Feddes parameters site dependent?

Materials & Methods

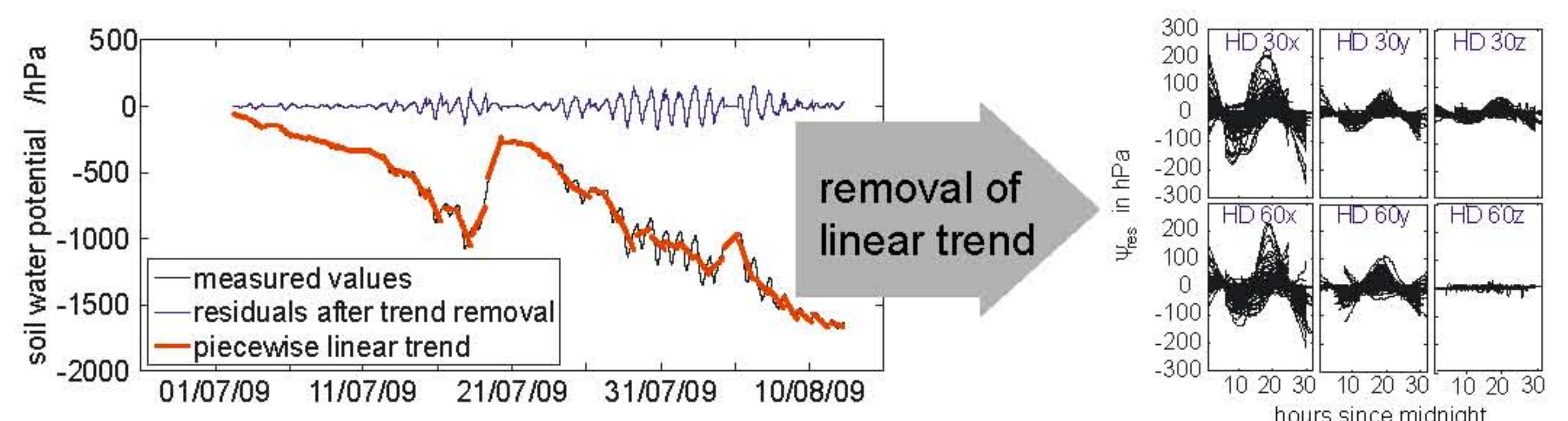
- 4 sites in Baden-Württemberg/Germany (HD, OC, CO, ES)
- 3 crown strata per site (crown center [x] and periphery [y], crown gap [z])
- 2 depths per measuring location (30 cm, 60 cm)

Continuous measurements (every 30 min):

- soil water potential down to permanent wilting point with pF meters
- soil water content
- stem diameter
- precipitation, air temperature/humidity, global radiation

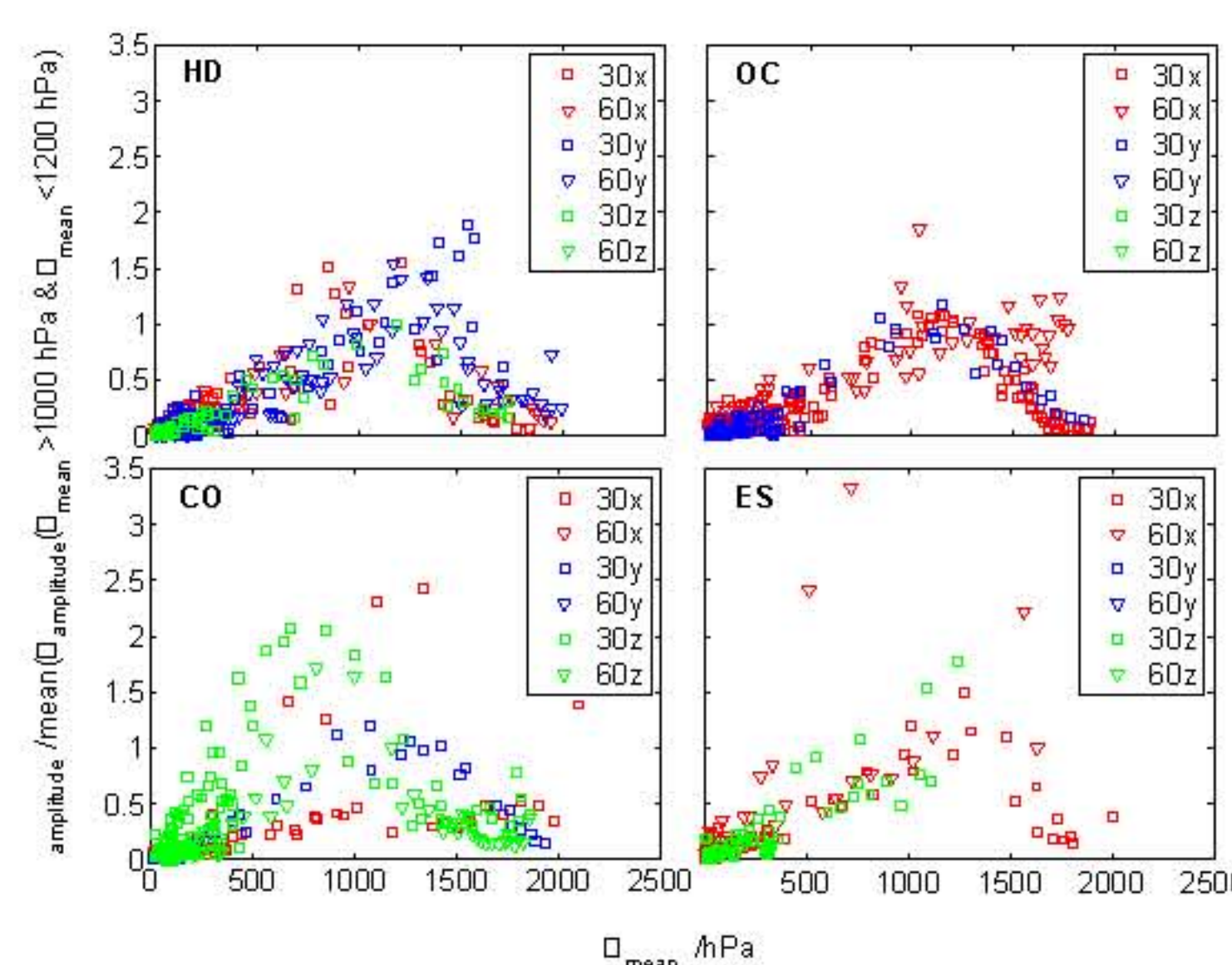
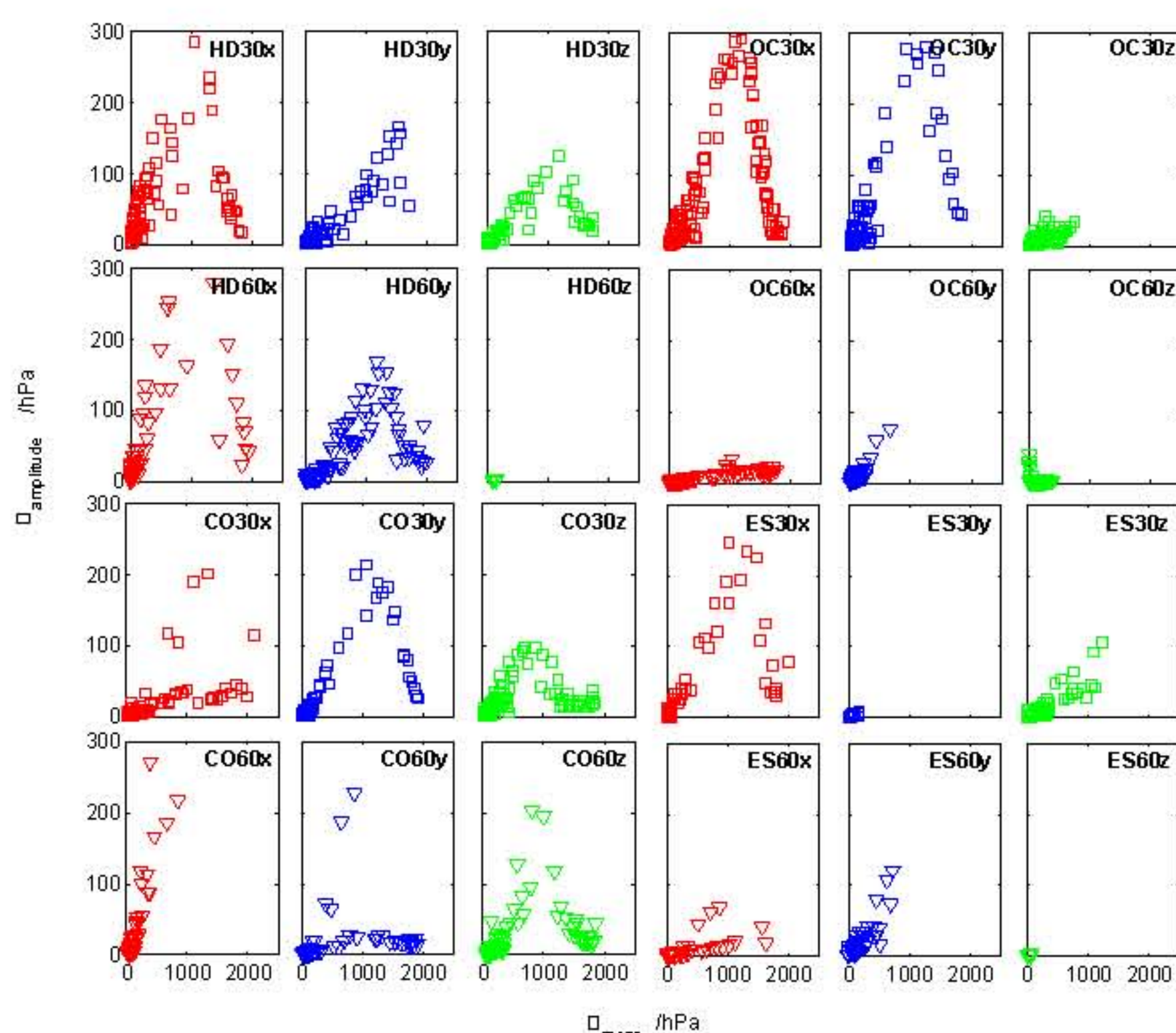


Identification of daily fluctuations in pF meter readings:

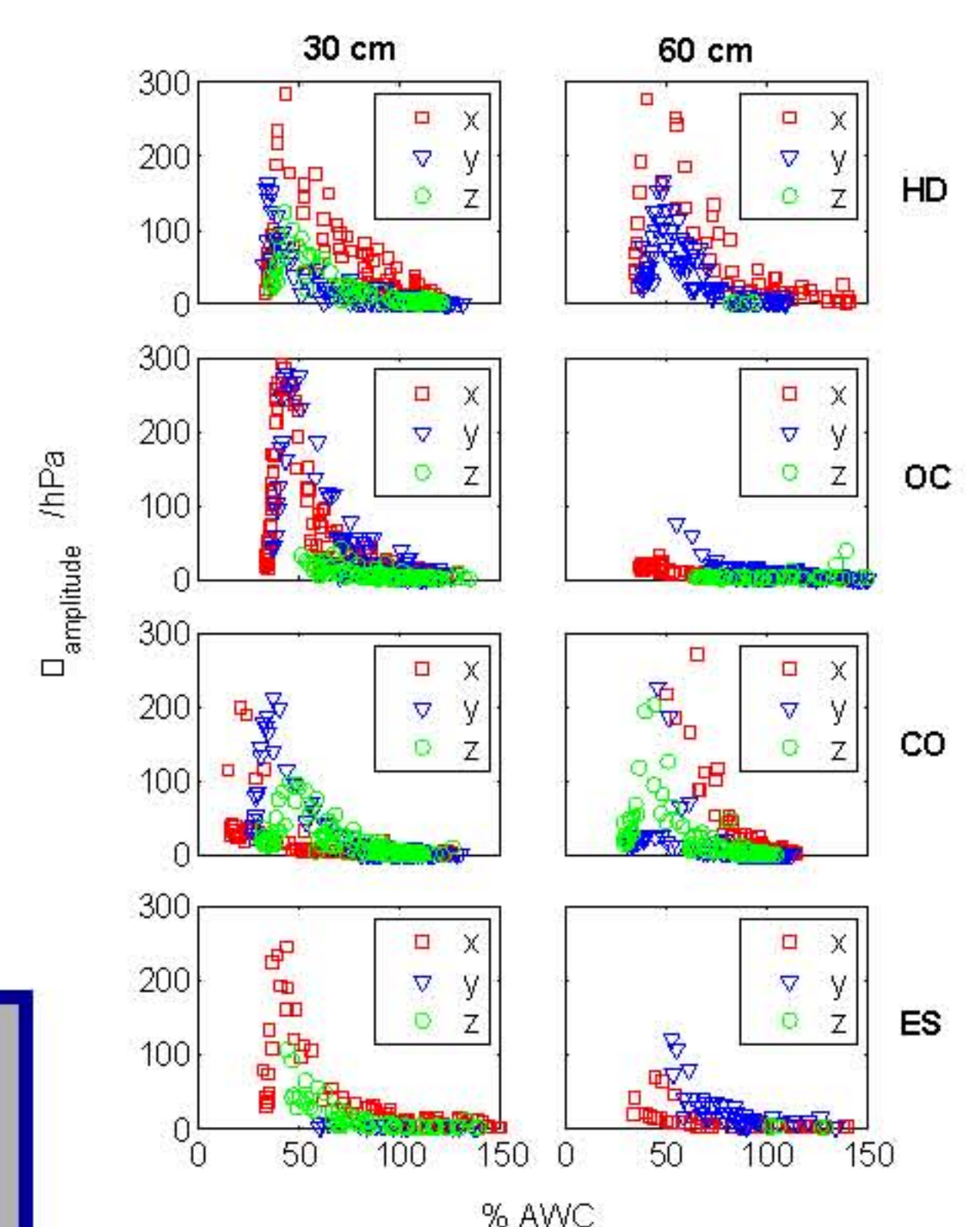


Results: Feddes' Parameters

- close relationship between daily amplitudes ($\psi_{\text{amplitude}}$) and daily mean (ψ_{mean}) of soil water potential ψ for days without rain
- ψ amplitudes high in crown centers and peripheries, low in crown gaps
- amplitudes in 60 cm lower than in 30 cm
- only small variation between sites



Maximum ψ amplitudes at 35 to 50 % of the soil's available water capacity (AWC).
Nearly no daily fluctuations at a depletion of the soil's AWC by more than 65 to 75 %.



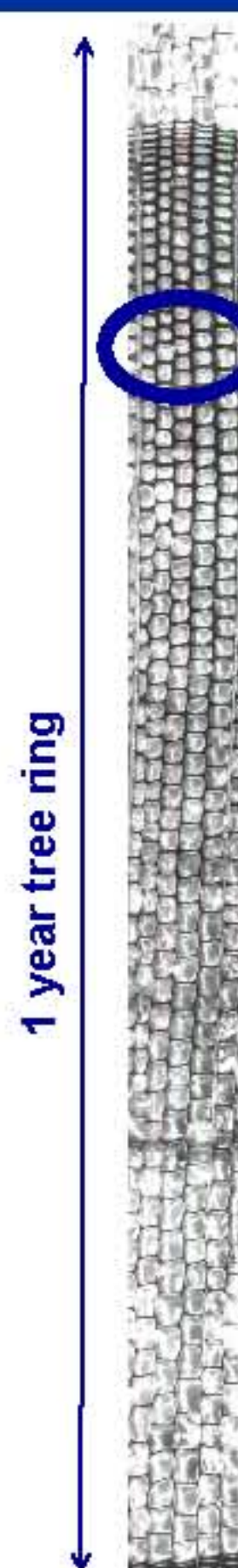
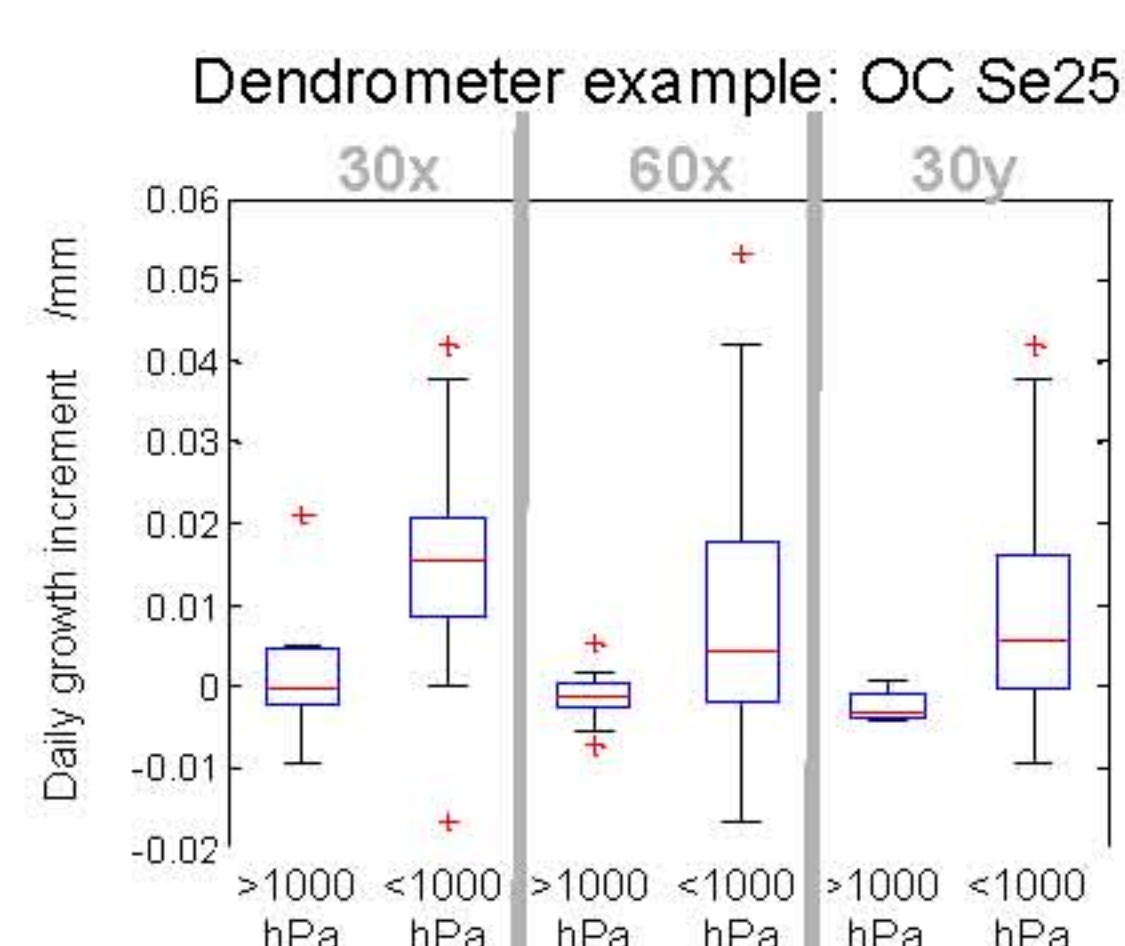
- In comparison with Feddes' function, our results suggest a more bell-shaped curve of the $\text{ETA}(\psi)$ function.
- The ψ values corresponding to maximum ψ amplitudes (Feddes' h_{an} and h_{d}) and to cessation of daily ψ fluctuations (Feddes' h_{w}) are similar for the various sites and crown strata.

Maximum ψ amplitudes at a ψ range between 900 and 1200 hPa.
Nearly no daily fluctuations for $\psi > 2000$ hPa.

Results: Effects on Radial Tree Growth

- The soil water status influences daily fluctuations in stem perimeter and daily growth increment.

Daily growth increments are lower when mean daily ψ falls below the optimum value (Feddes' h_{an} and h_{d}).



- Soil water status at the time of tracheid formation determines tracheid size of spruce.
- The critical values derived from the daily ψ amplitudes can explain the number and the size of sequences of individual cells along tree rings.

Tracheid diameters are reduced when the matric potential falls below critical values.

