Water Balance of Selected Sites and Tree Species – Retrospect of 20 Years of Monitoring in the Federal State of Brandenburg (Germany)

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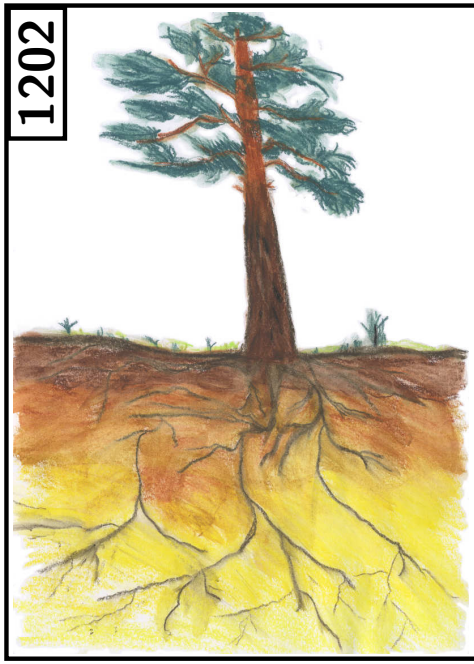
European forests in a changing environment: Air pollution, climate change and forest management

7th ICP Forests Scientific Conference 21–23 May 2018 – Riga/Latvia

Survey Sites – Soils, Stands and Ground Vegetation

1202

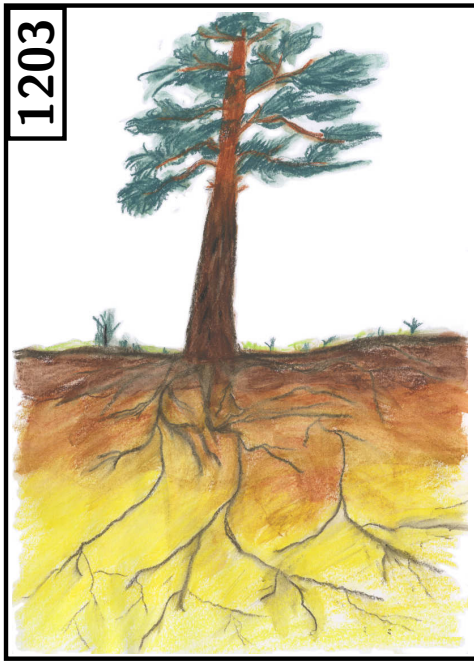


Scots pine with deciduous understorey
LAI(W/S) = 3,2/5,2
RSC = 229 s m^{-1}

Grasses + dwarf shrubs ⇒dwarf shrubs
LAI(W/S) = 1/2,
RSC = 150...340...400 s m^{-1}

Lamellic Arenosol, Mor
Medium sand with loamy sand lamellae
$SWHC_{100}$ = 105 mm,

1203

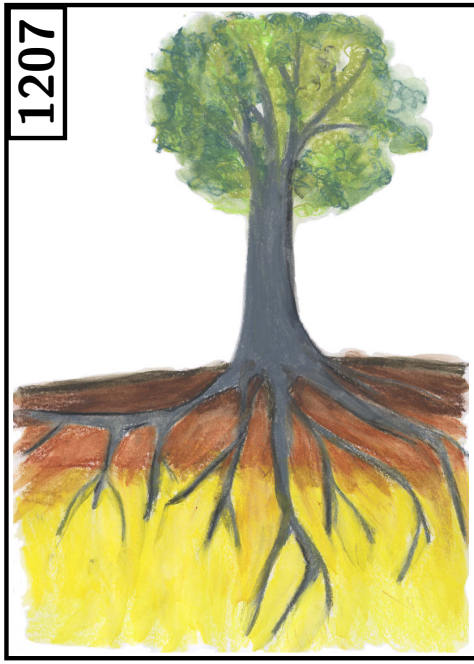


Scots pine
LAI(W/S) = 2,2/2,8
RSC = 229 s m^{-1}

Grasses⇒ grasses + dwarft shrubs
LAI(W/S) = 1/2
RSC = 104...212...314 s m^{-1}

Albic Podzol, Mor
Fine sand,
$SWHC_{100}$ = 79 mm,

1207

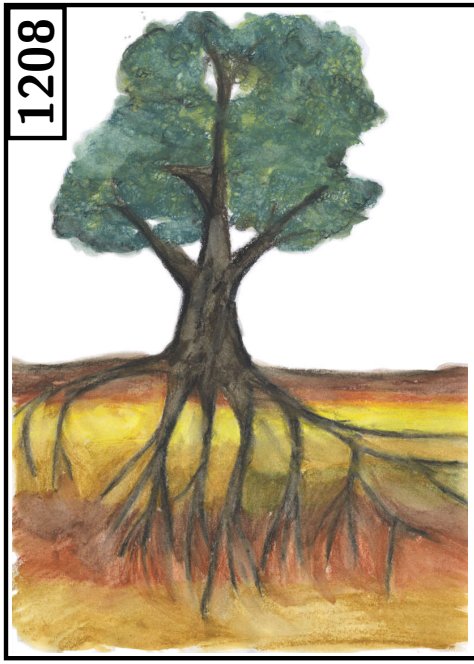


European beech
LAI(W/S) = 0/5,3
RSC = 215 s m^{-1}

Sparse
Evaporation only

Haplic Arenosol, Moder
Coarse sand,
$SWHC_{100}$ = 65 mm,

1208



Sessile oak
LAI(W/S) = 0/3,8
RSC = 263 s m^{-1}

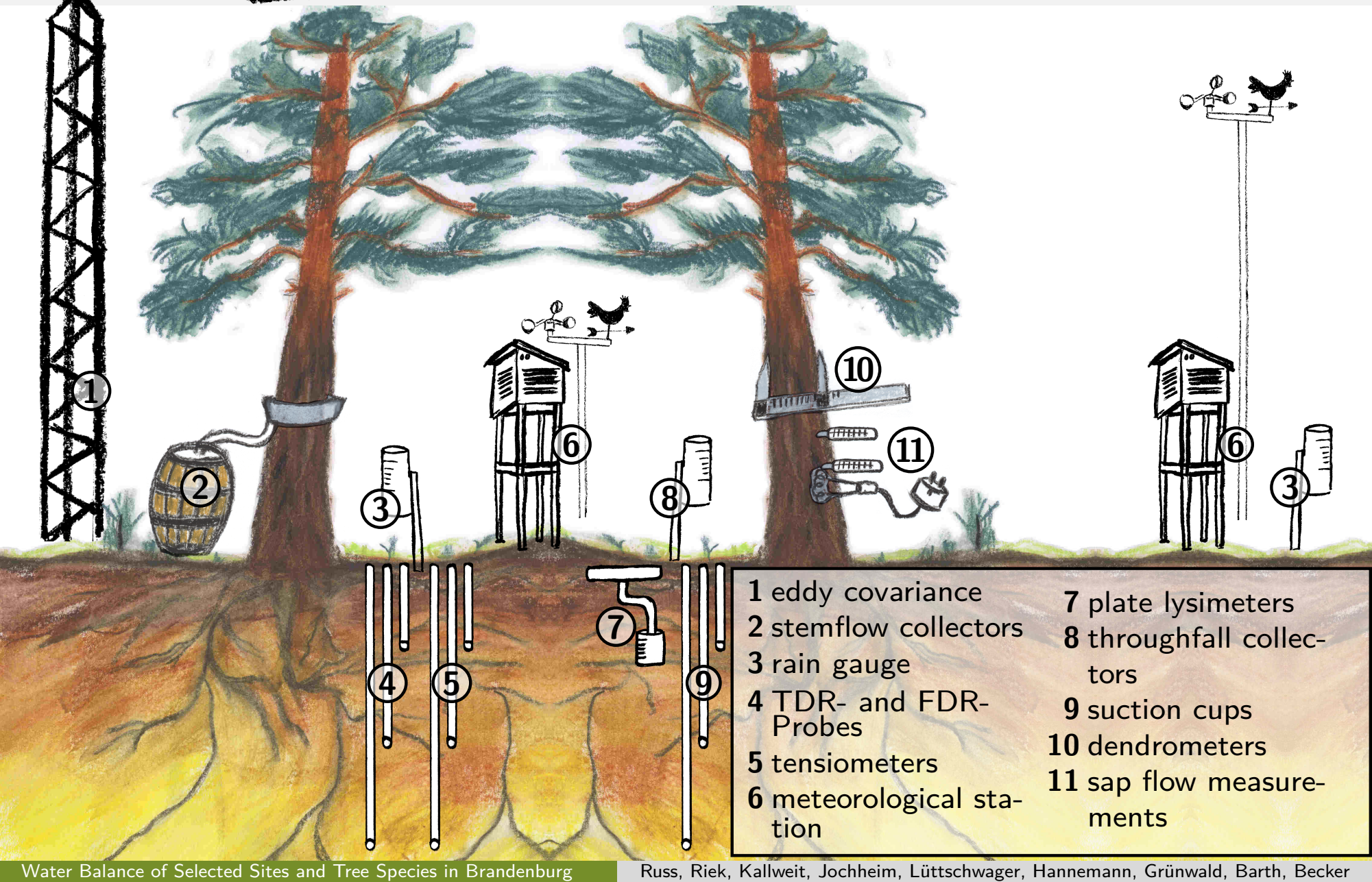
Sparse
Evaporation only

Albic Luvisol, Moder
Sandy loam above loam
$SWHC_{100}$ = 84 mm,

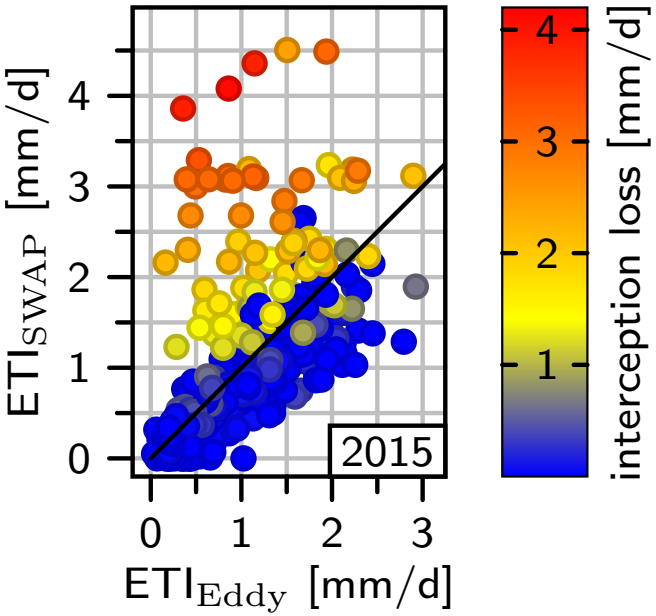
Water Balance Modelling Using SWAP 3.2.36

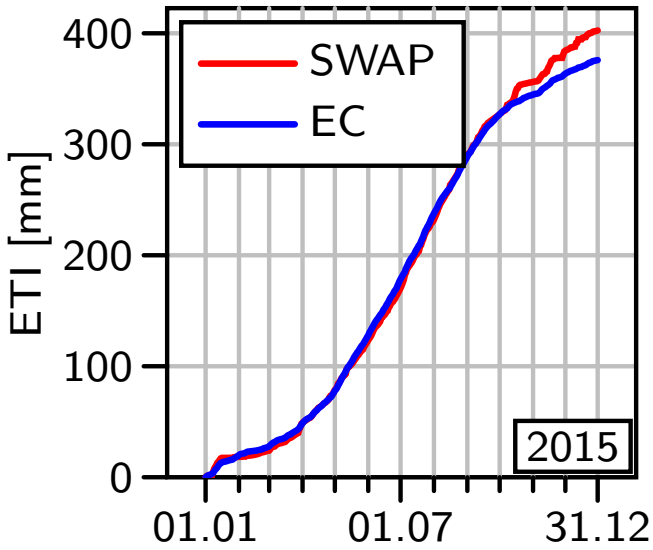
- Water balance model **SWAP 3.2.36** (Van Dam, 2000; Kroes et al., 2009)
  - One-dimensional model, Richards' equation
  - Penman-Montheith equation (pot. evapotranspiration)
  - Interception losses: Gash et al. (1995) (stand) and Braden (1985) (ground vegetation)
  - Root water uptake / act. transpiration Feddes et al. (1978, 2001)
  - Van Genuchten (1980) and Mualem (1976) equations for description of soil hydraulic properties (Hysteresis according to Scott et al. (1983))

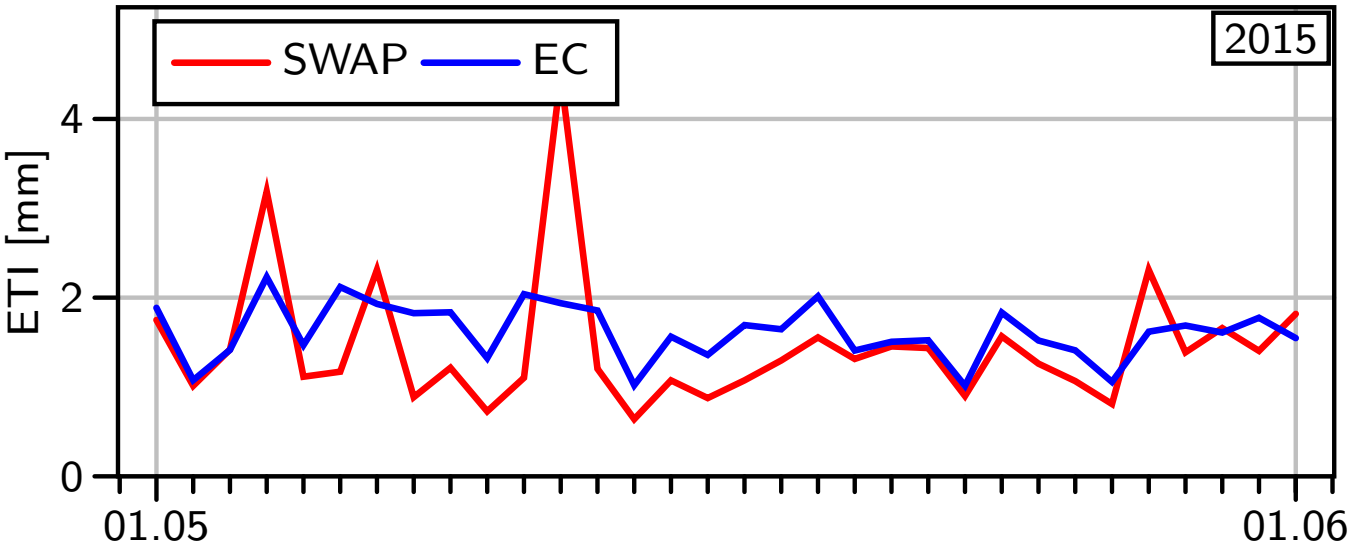
Schematic Measurement Setup

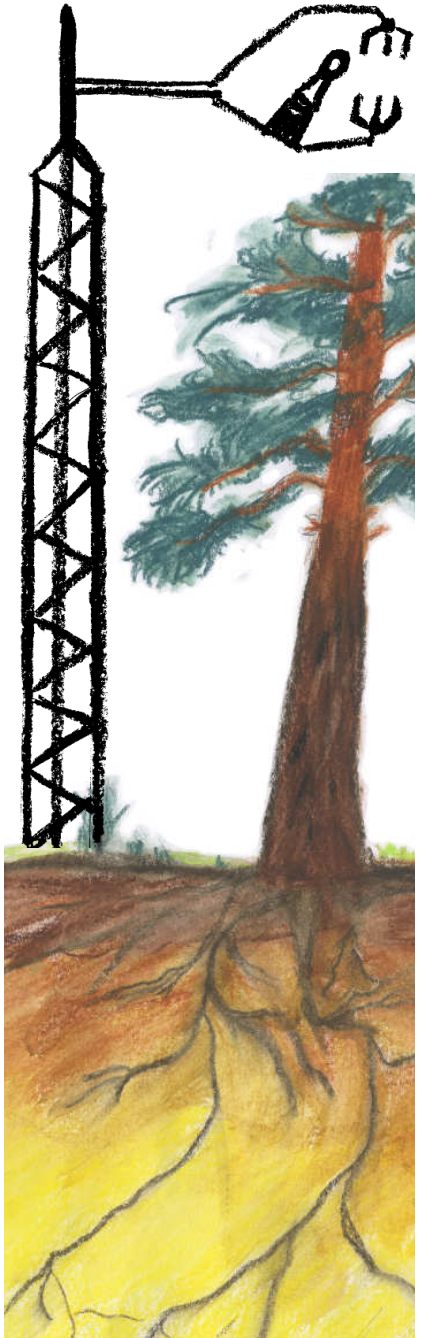


Eddy Covariance Method – 1203 (Scots Pine)

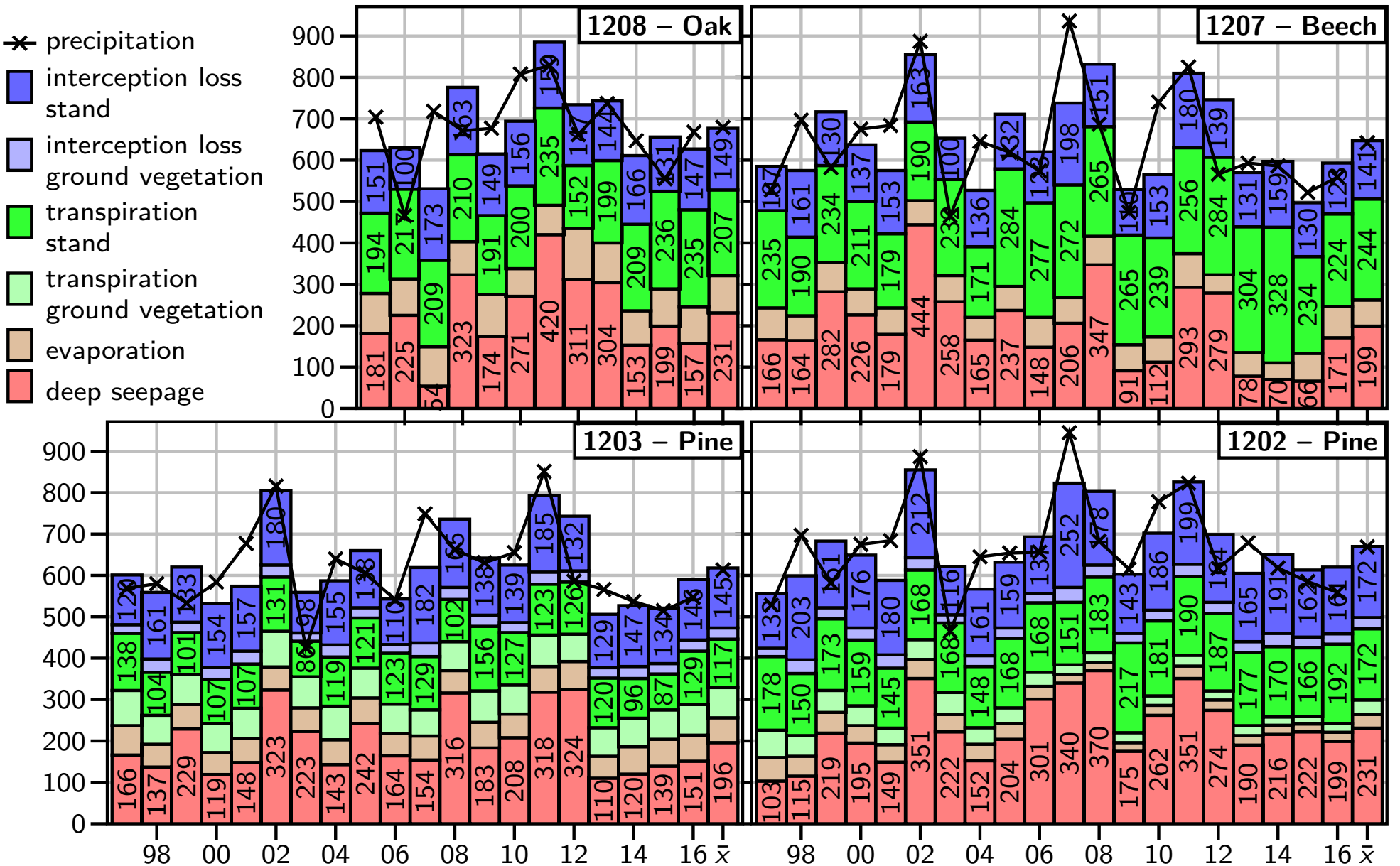




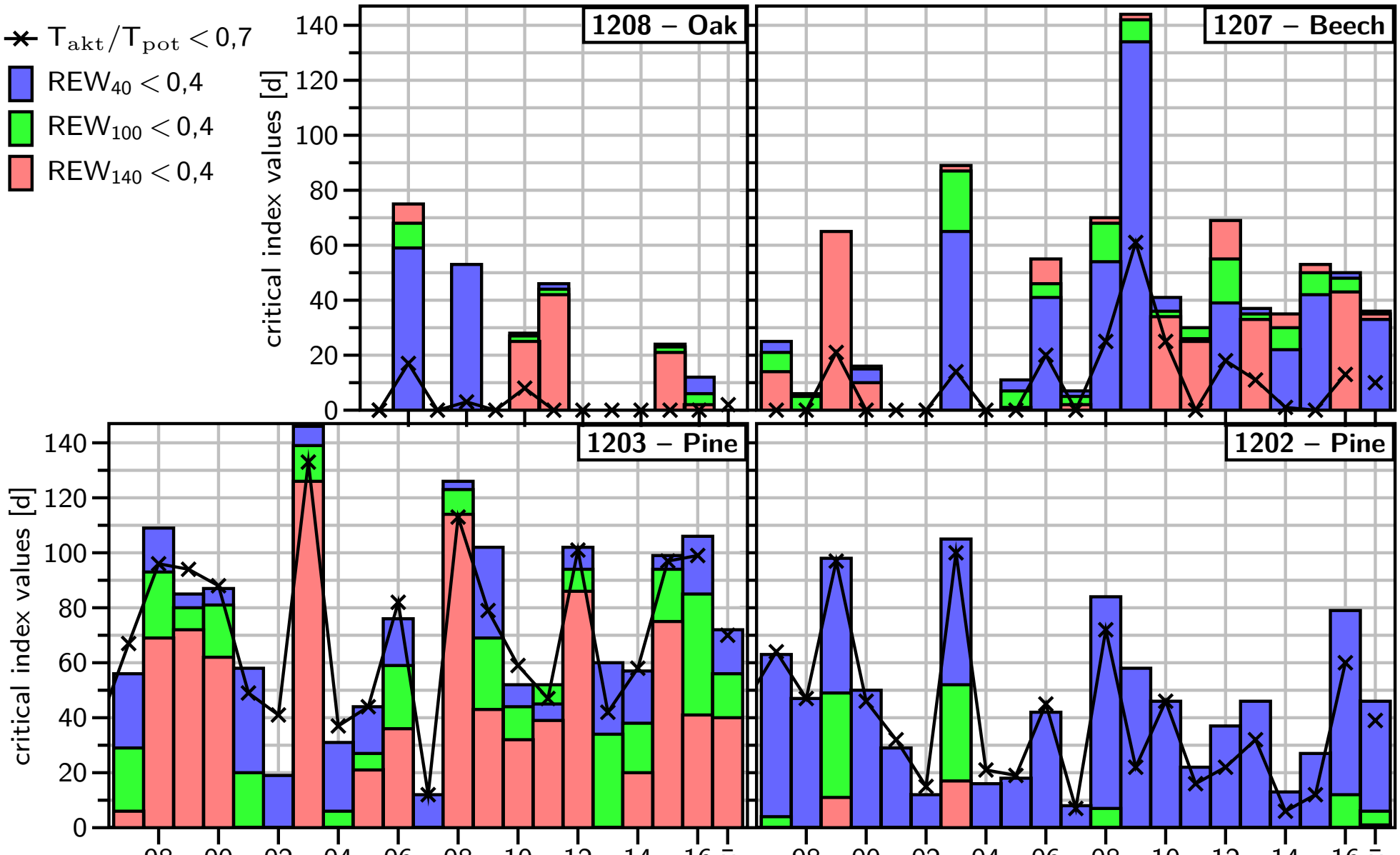




Water Balance Components – Annual Sums [mm]



Number of Drought Days



Stress Indicators Derived from Dendrometer Measurements

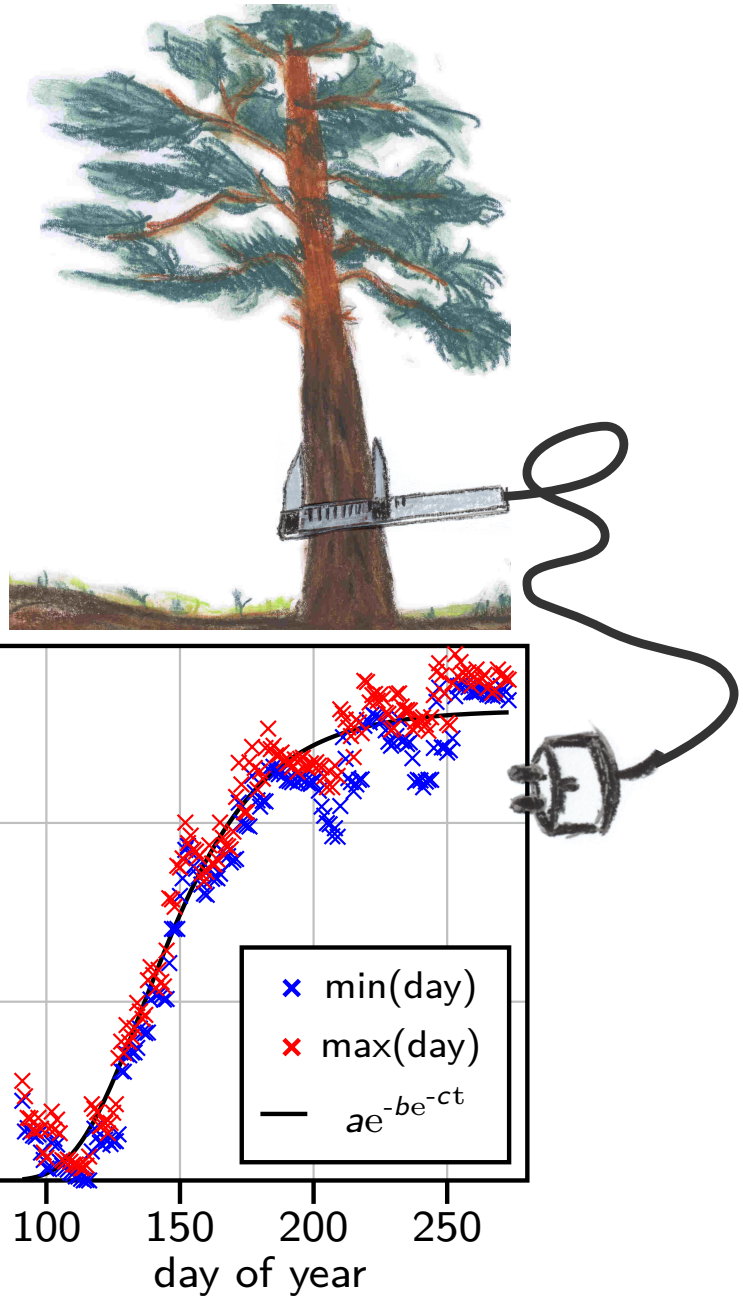
Method of v. Wilpert (1990):

Diurnal fluctuations ($\Delta_d(\varnothing)$, MDS)

- Optimal water supply => low fluctuation (small water deficits in the tree).
- Moderate drought (and high atmospheric demand) => high fluctuation (water deficits developed during the day are compensated overnight)
- Severe drought => low fluctuation (water deficits can't be compensated overnight)

Medium-term fluctuations ($\Delta_m(\varnothing)$)

- Smoothed (11-day running mean) residuals of the Gompertz curve
- Medium-term filling and emptying of the trunk reservoir => adaptation to varying levels of water supply
- Peaks at the beginning of the growing season result from a swelling phase at the start of cambial growth



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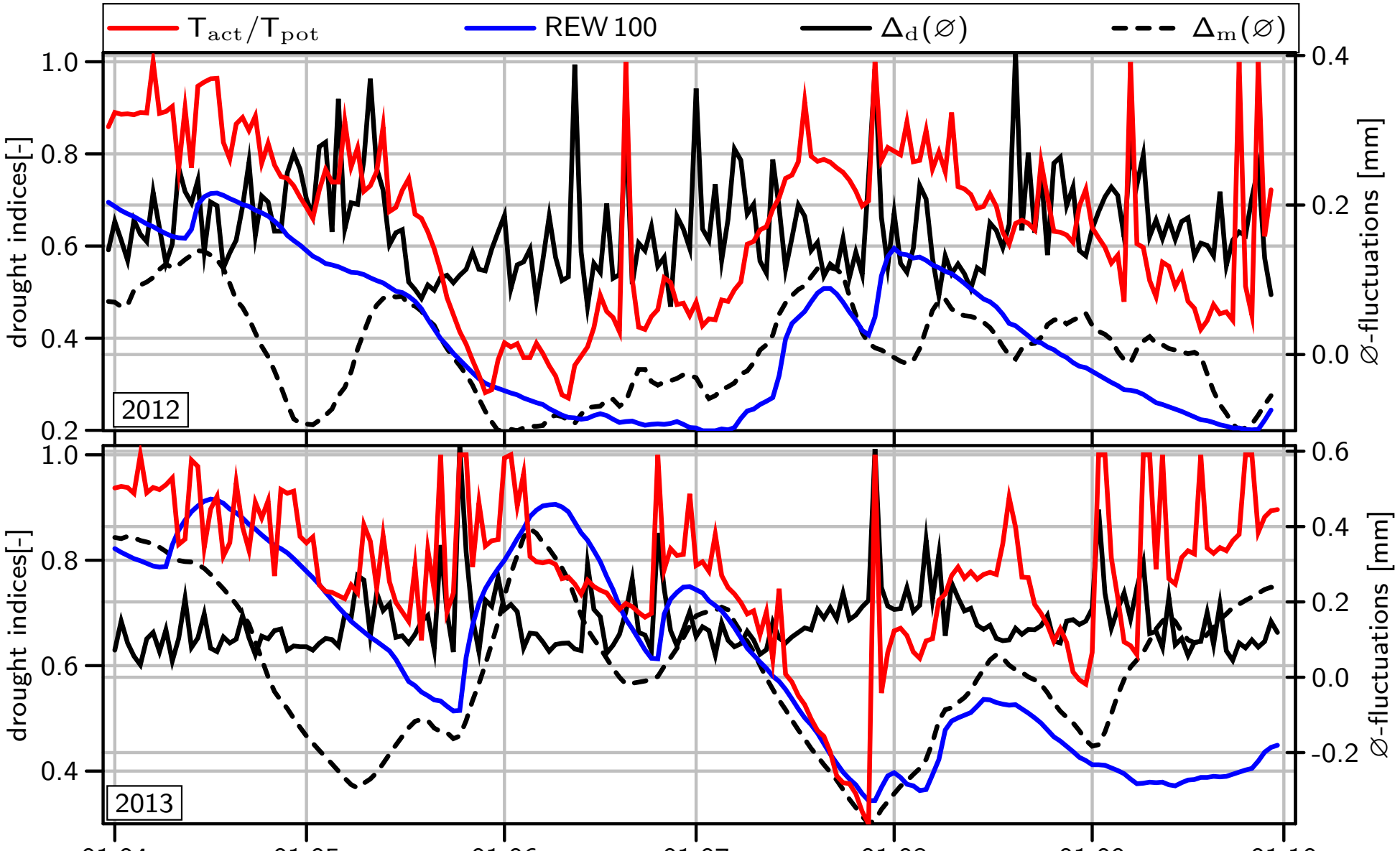

Conclusions

1. High soil water storage capacity reduces the risk of drought stress during dry periods
2. Compared to the variability of meteorology, the effects of tree species on water balance are relatively small and uncertain
3. The monitoring of drought responses with dendrometers looks promising

Thanks for your attention!

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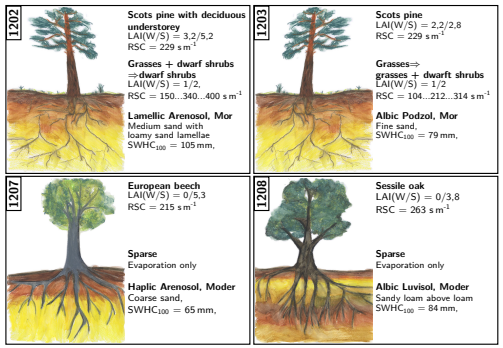

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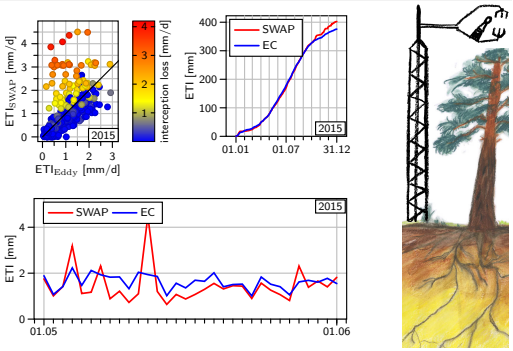

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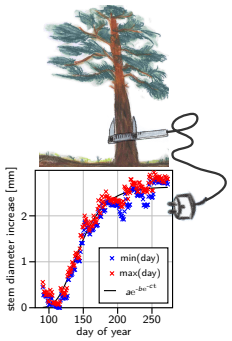

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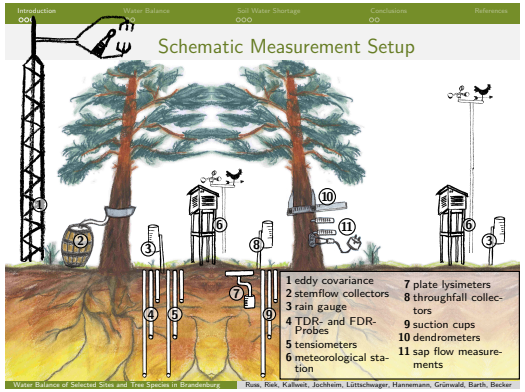

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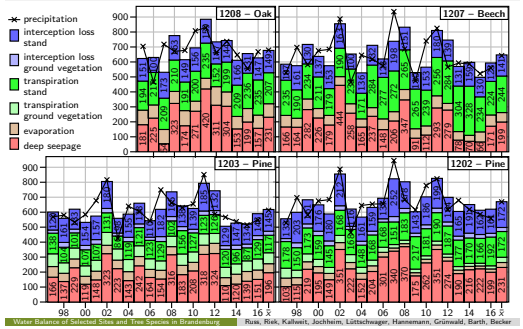

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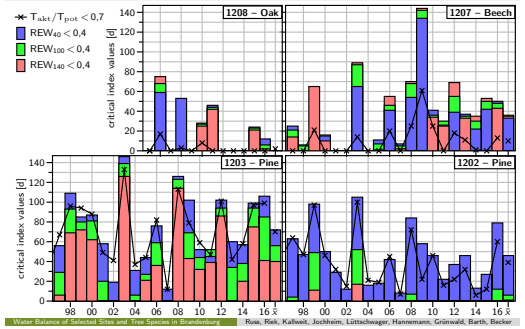

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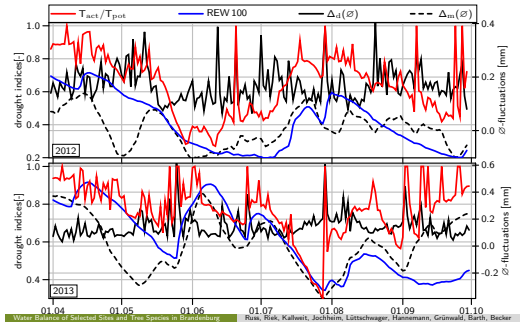

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References I

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