Tree growth

Questions:

- Can pines recover from drought stress?
- What is the growth reaction of the different tissues of a tree to changes in the water availability?

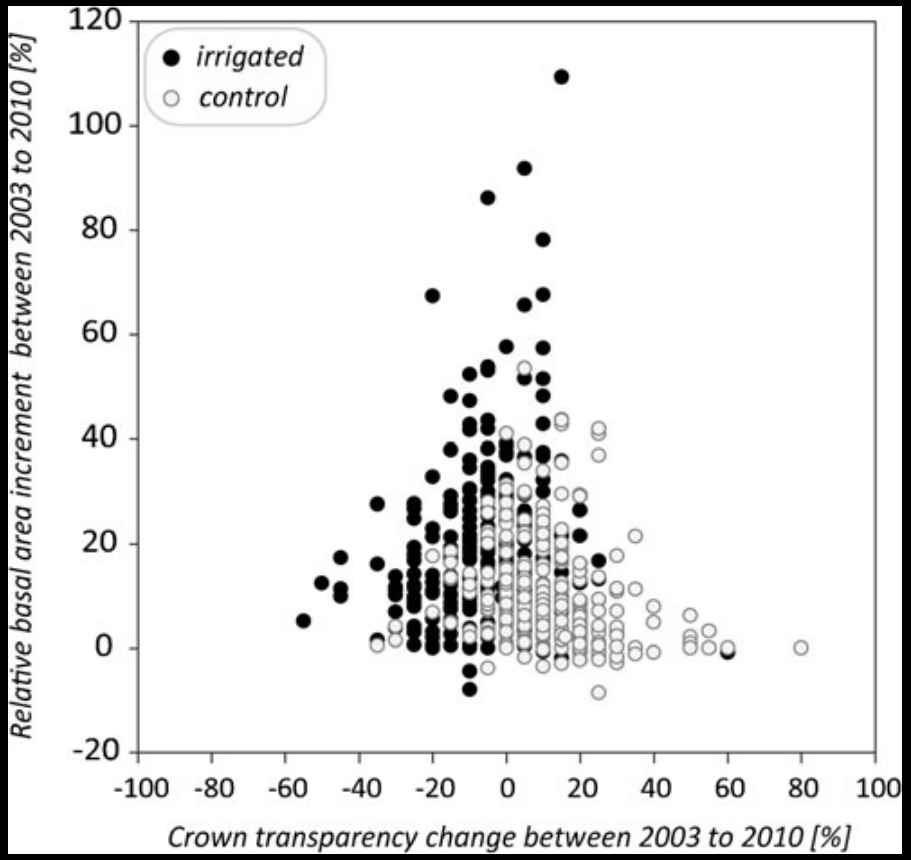
Measurements:

- Crown transparency estimation of 800 trees annually since 2003
- Annual radial growth of 13 trees (felled in 2006)
- Shoots and needle growth of 13 trees (felled in 2006)
- Intra-annual radial growth in 2005 of 6 trees (pinning technique)
- Intra annual diameter growth (band dendrometers)
- Stable isotopes 13C and 18O in wood (EW, LW) of 6 trees 1996-2005
- Resin flow in 2011 60 trees (A. Giuggiola)

A. Rigling, B. Eilmann, R. Siegwolf, M. Saurer, N. Buchmann, A. Giuggiola, M. Dobbertin†

Irrigation changed growth & crown transparency

Control	2009:	irrigated
+ 1.5 m^2/ha	Basal area increment	+ 4.5 m^2/ha
+ 1.0 cm	Height growth	+ 32.0 cm
- 11.2 %	Crown transparency	+ 4.9 %
- 0.14	LAI	+ 0.33
6.8 %	Mortality	2.5 %

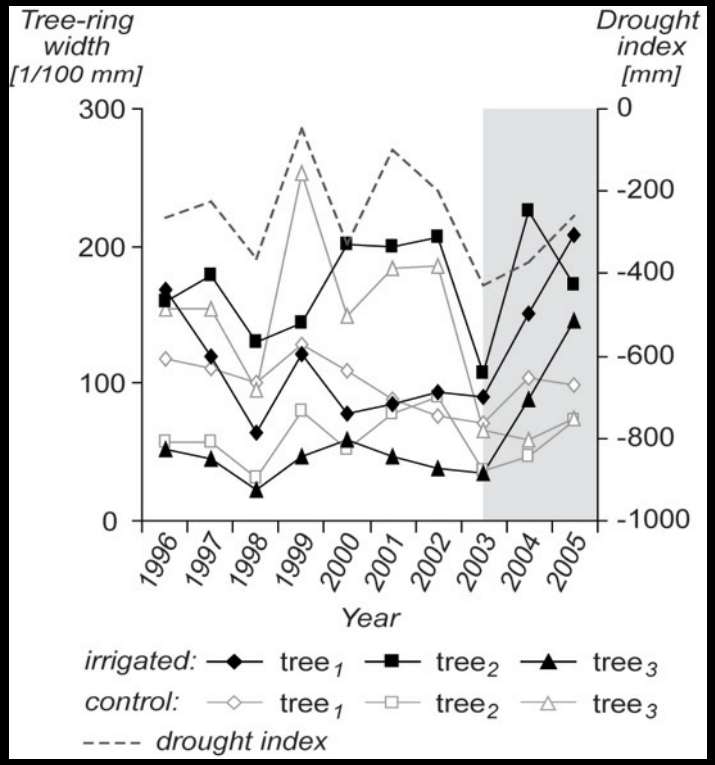


- After 7 (8) years of irrigation growth was significantly increased and crown transparency reduced and the pines recovered from drought 1996, 1998, 2003, 2004

(Dobbertin et al. 2010: Tree Physiology; Eilmann et al. 2013: Annales of Forest Sciences)

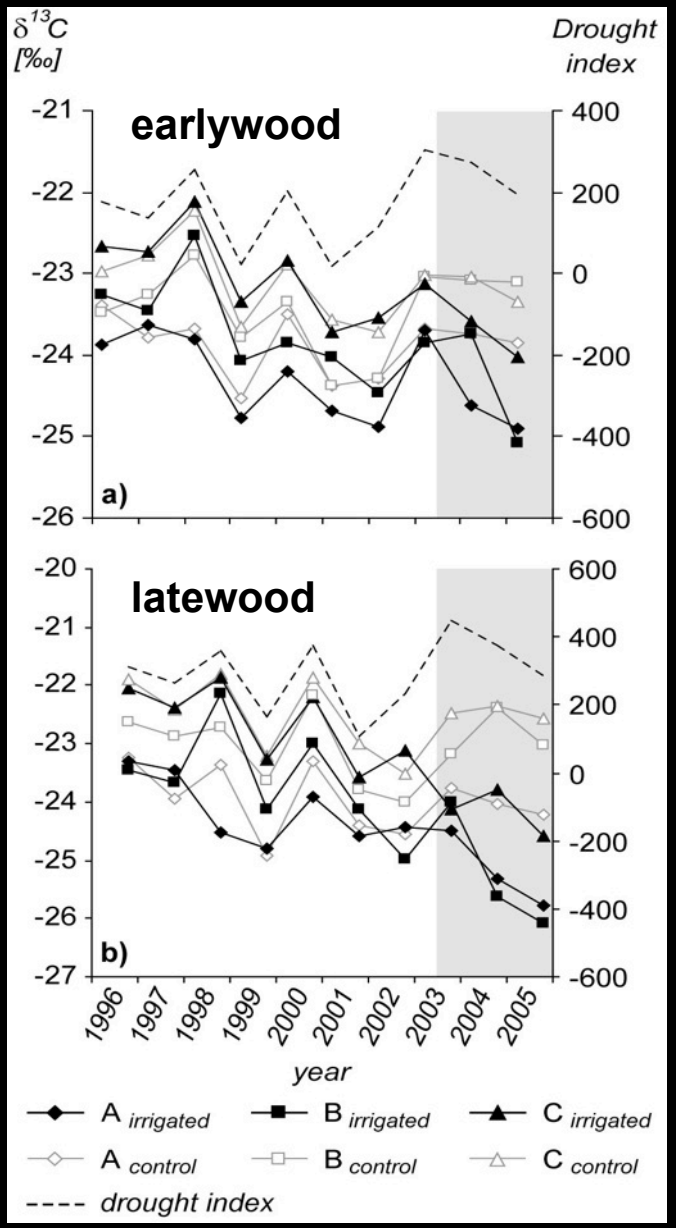
Radial growth & stable isotopes

Diameter growth



- Irrigation significantly increased diameter growth
- Growth reaction delay of 1year (after irrigation started)

δ^{13} C

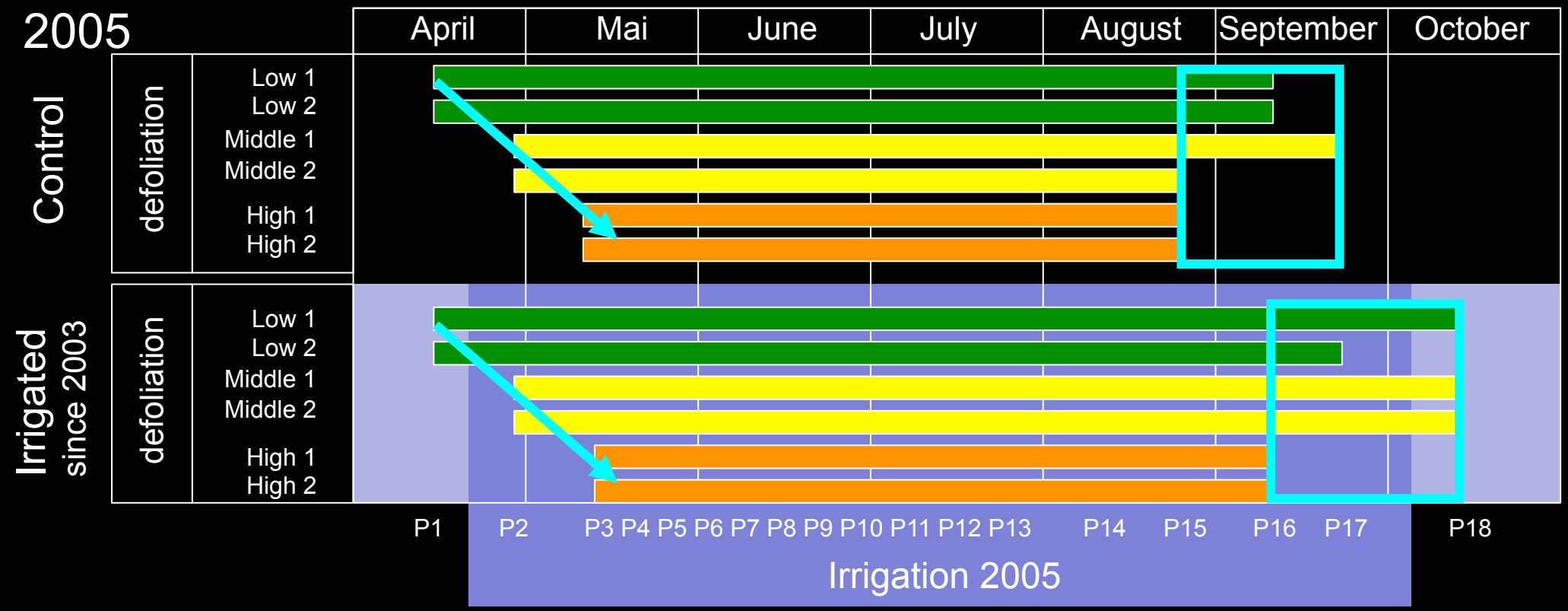


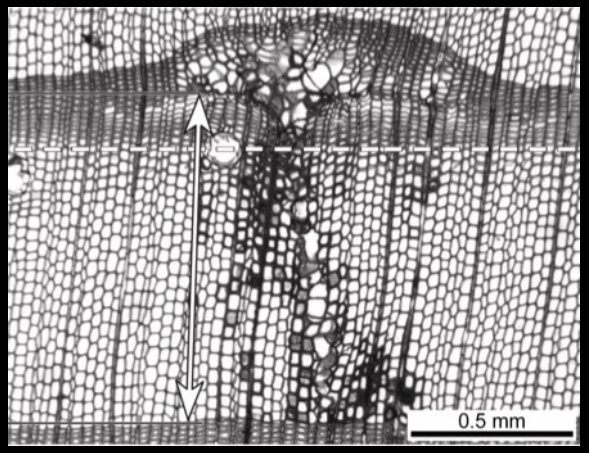
The stable isotope of Carbon, δ^{13} C, proxy for drought stress:

- dry conditions -> closed stomata -> less δ^{13} C fixed
- Latewood: Pines immediately react on irrigation with more opened stomata

(Eilmann et al. 2010: Plant, Cell & Environment)

Pinning - timing of wood formation





- Start of growing season delayed in non-vital trees
- drought leads to an earlier stop of the growing season by up to 5 weeks

(Eilmann et al. 2011: J. of Experimental Botany)

Outlook

- integrated growth analysis including roots, stems at different heights, branches, shoots needles, resin, cones and seeds to understand the spatio-temporal carbon allocation under different water supply
- Link to tree physiology
- Link to wood anatomy
- Link to other experiments reducing water consumption by management (thinning, shrub removal -> PhD Arnaud Giuggiola)