

UNIVERSITY OF TWENTE.

*Changes in thermal infrared spectra
caused by temperature and water
stress*

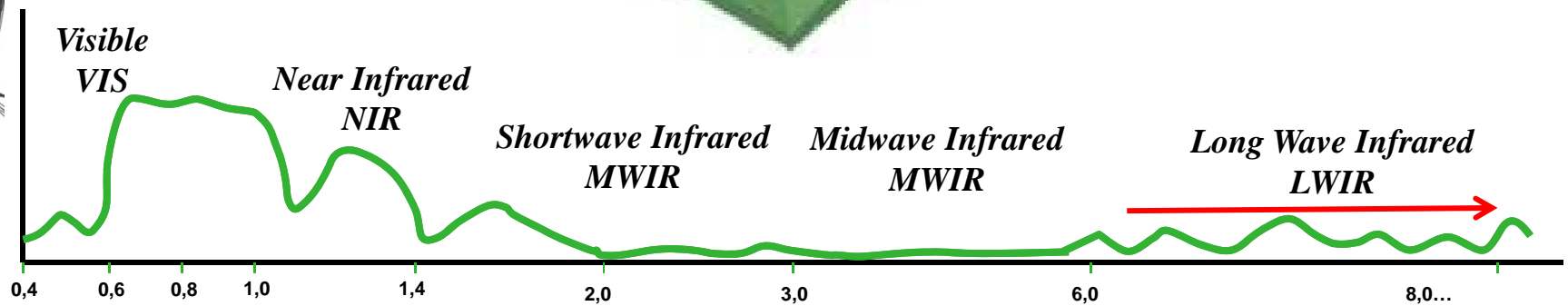
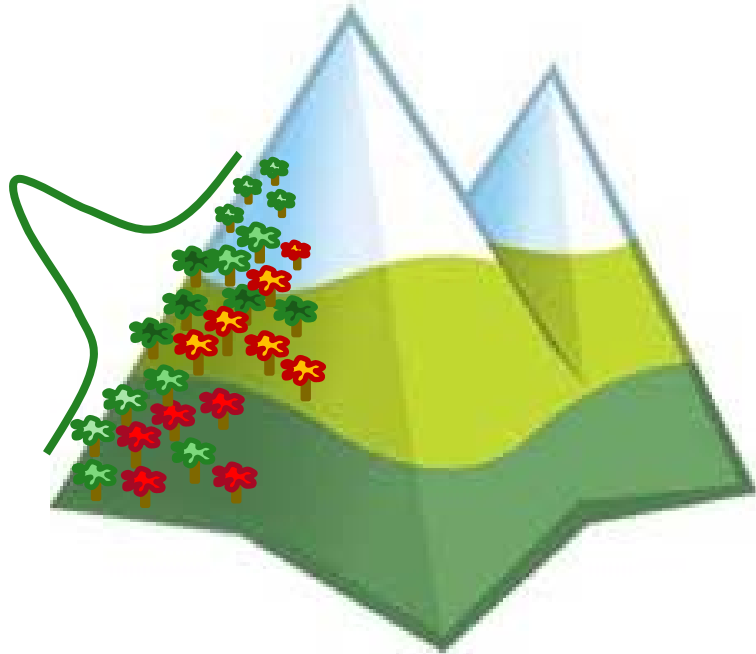
Maria Fernanda Buitrago Acevedo
Thomas Groen
Chris Hecker
Andrew Skidmore
Department of Natural Resources



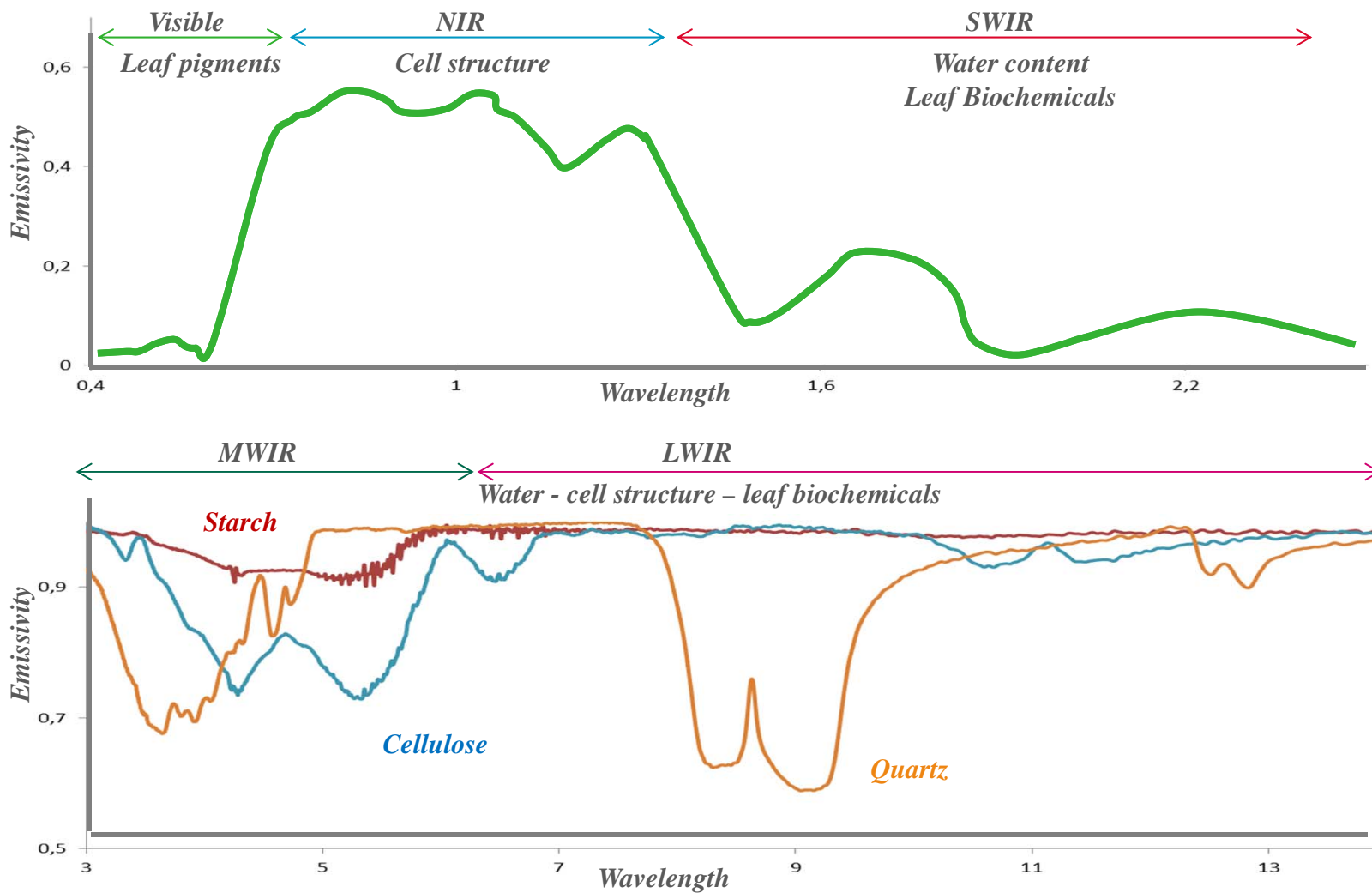
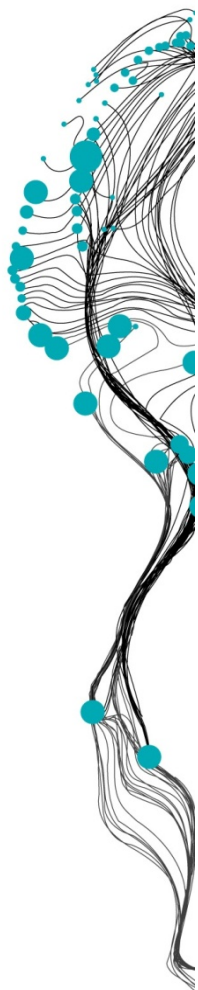
FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

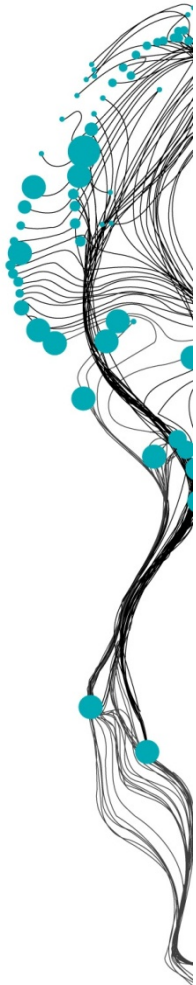
Context of this research

Spectral response of Alpine vegetation in Thermal Infrared



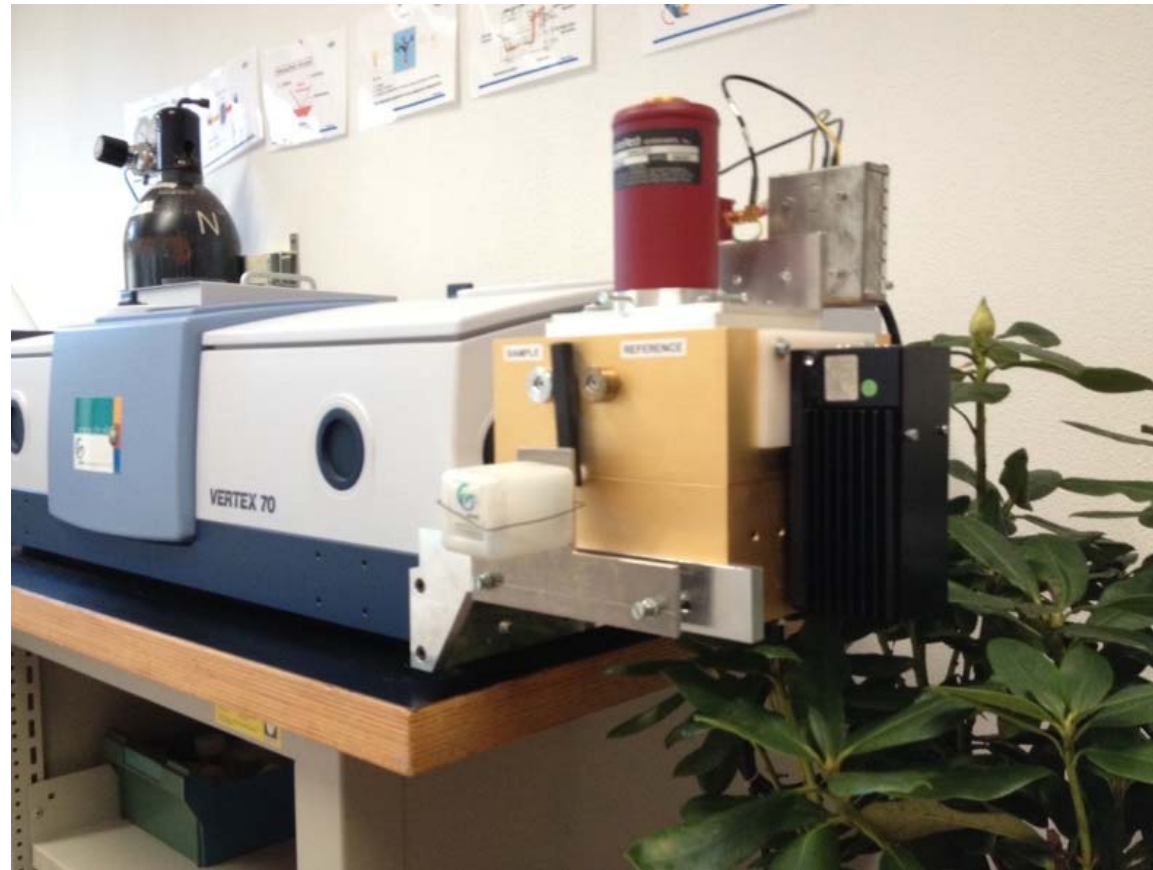
Why emissivity in plants

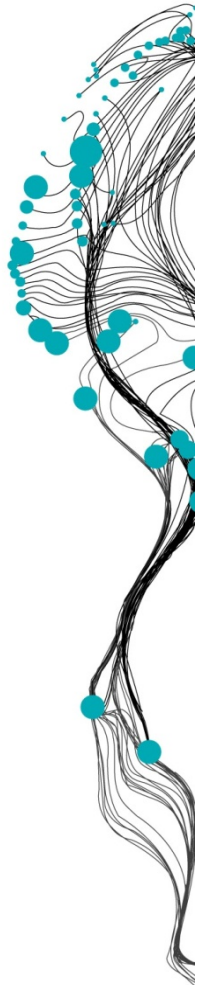




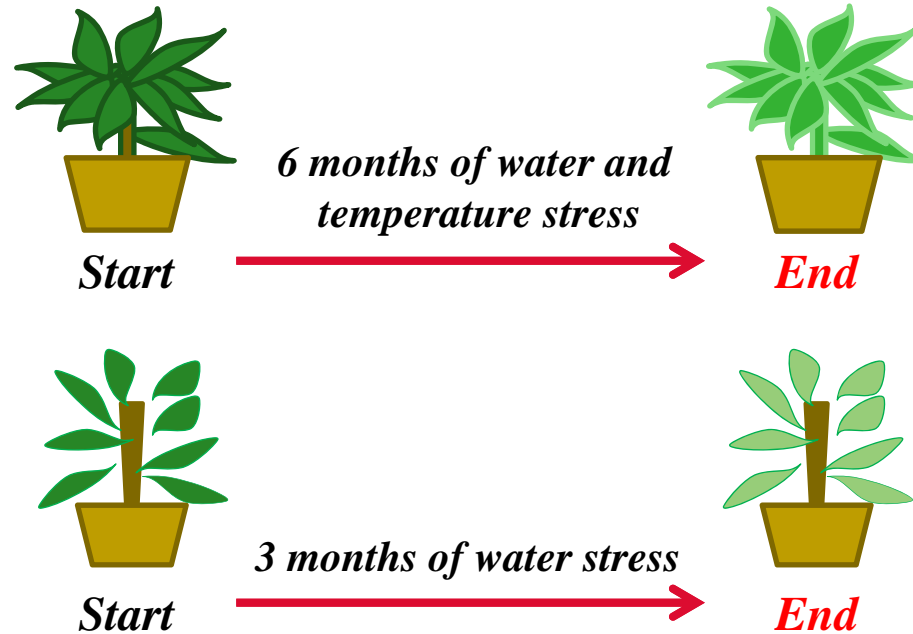
FTIR Spectrometer (laboratory)

Bruker Vertex 70 and integrating sphere





Experiment:

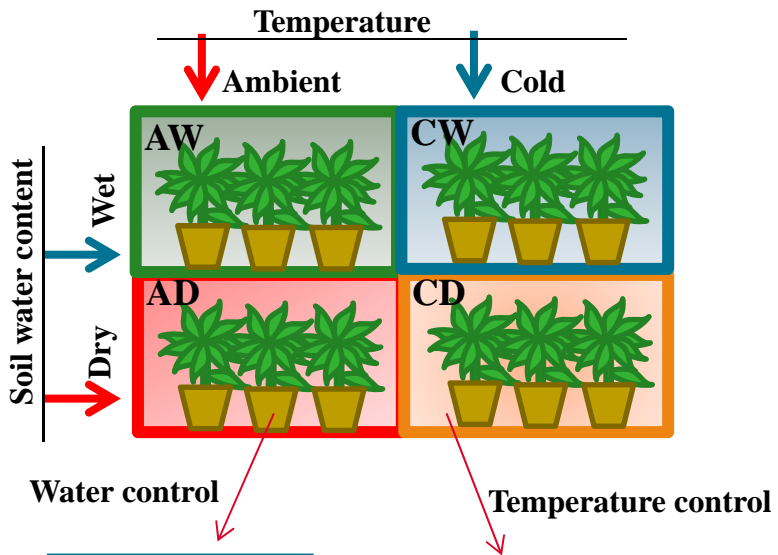


Measurements:

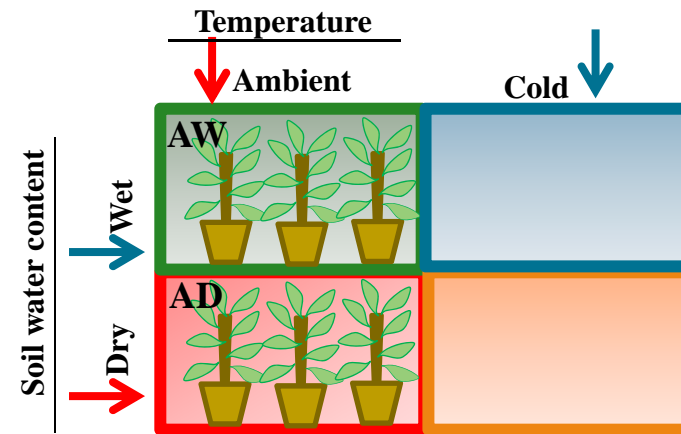
- *Leaf Water Content: $LWC = 100 * (W_w - W_d) / W_w$*
- *Microstructure: Leaf thickness and cuticle thickness*
- *TIR spectra*

Experiment:

Rhododendron (sp.)



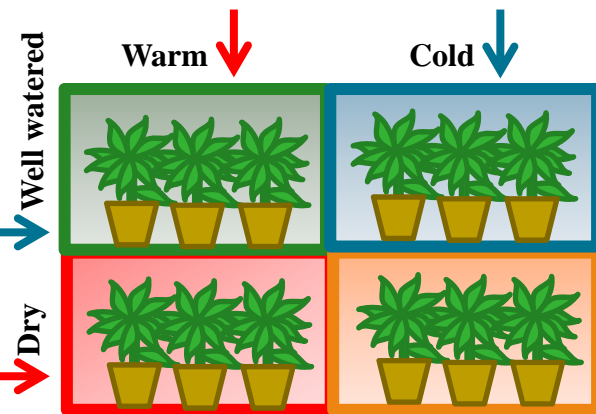
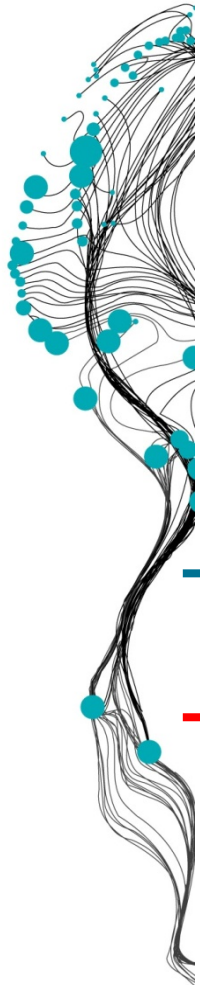
Beech (*Fagus sylvatica*)



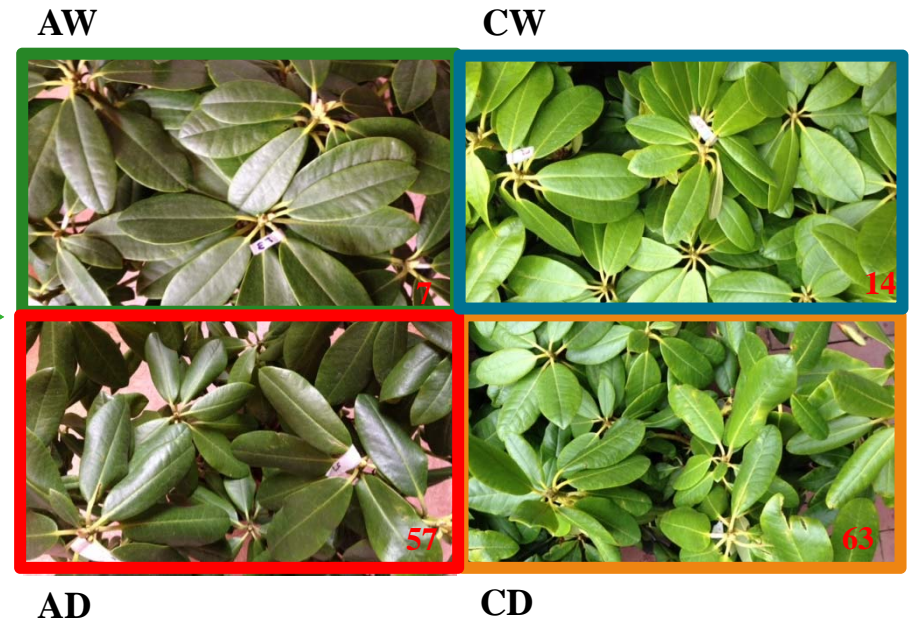
Tracking the same leaves



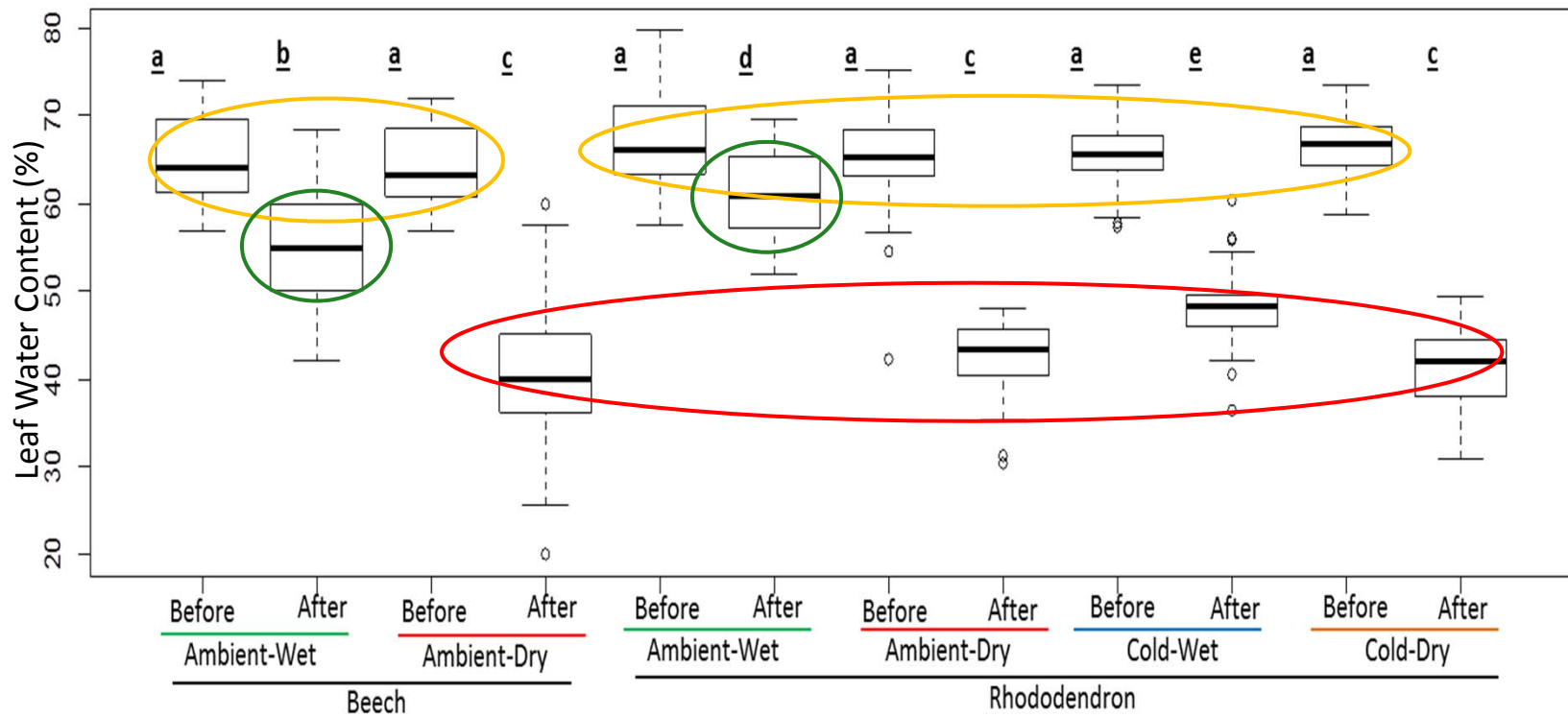
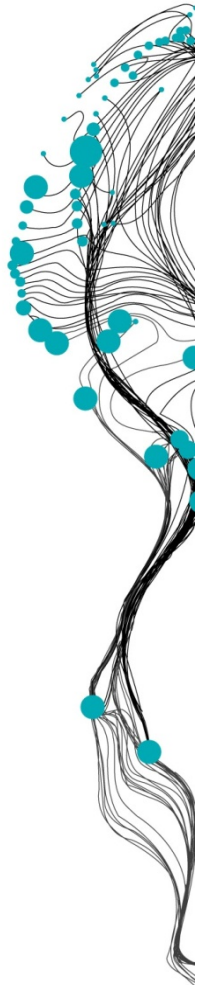
Visual results:

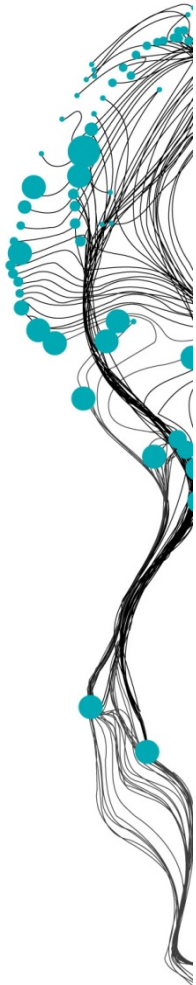


Results

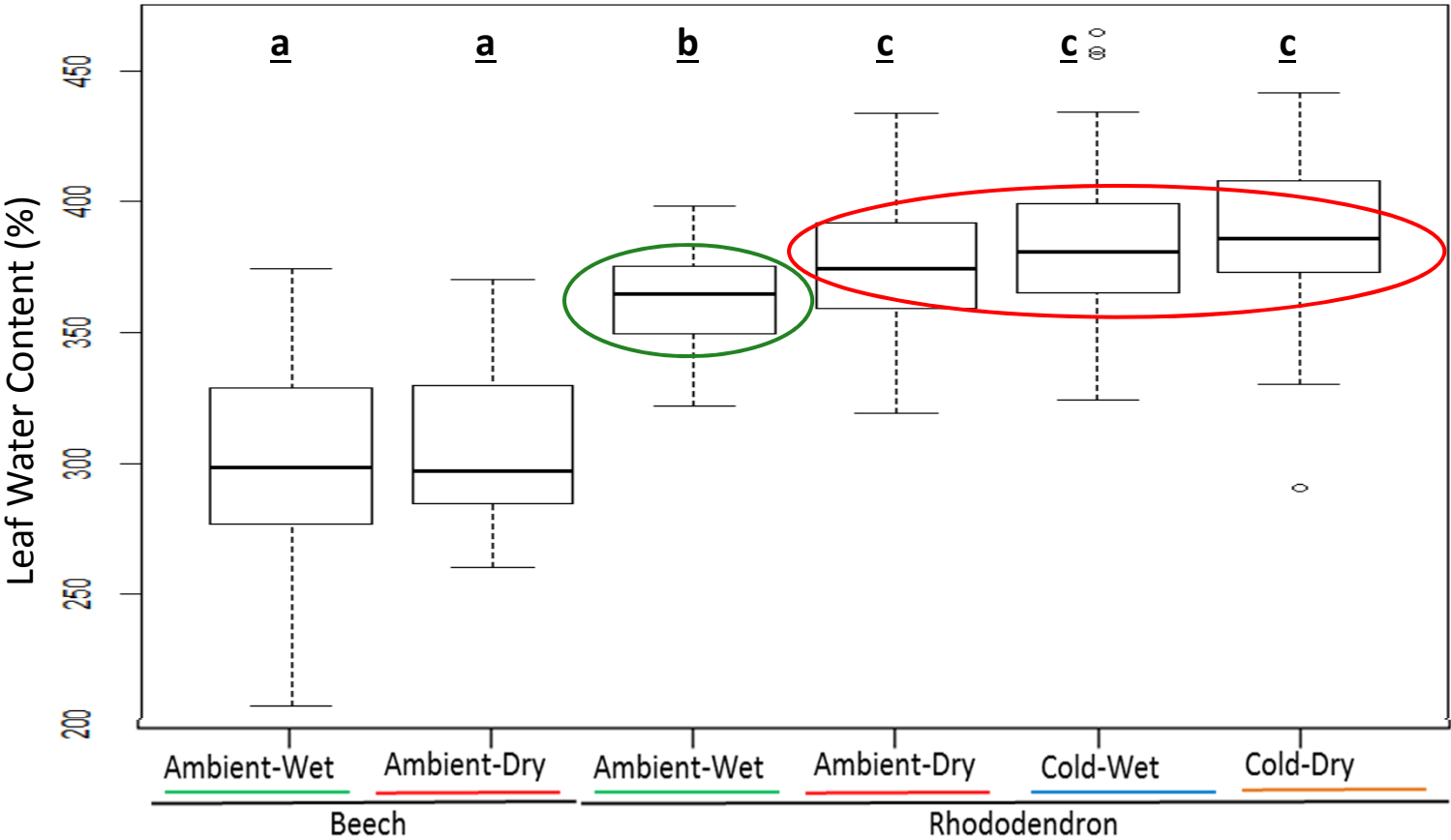


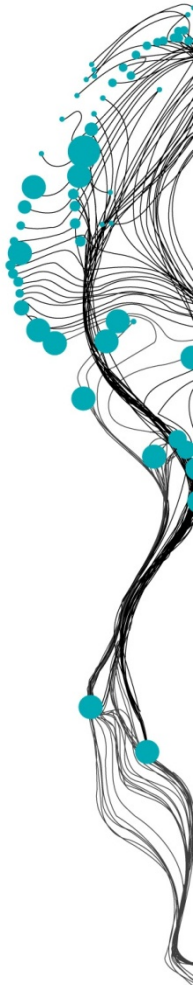
Results: Leaf Water Content (LWC)



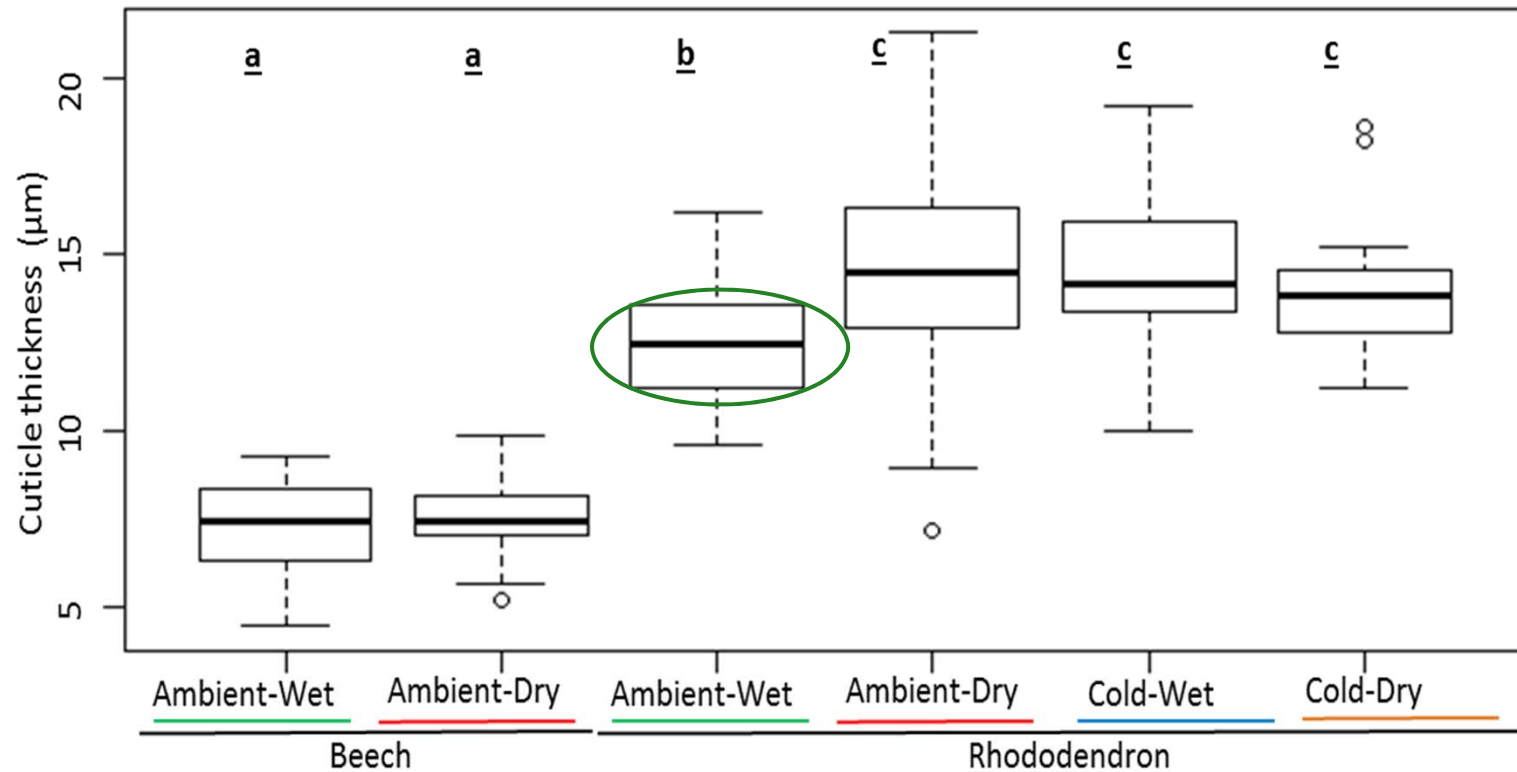


Results: Leaf thickness



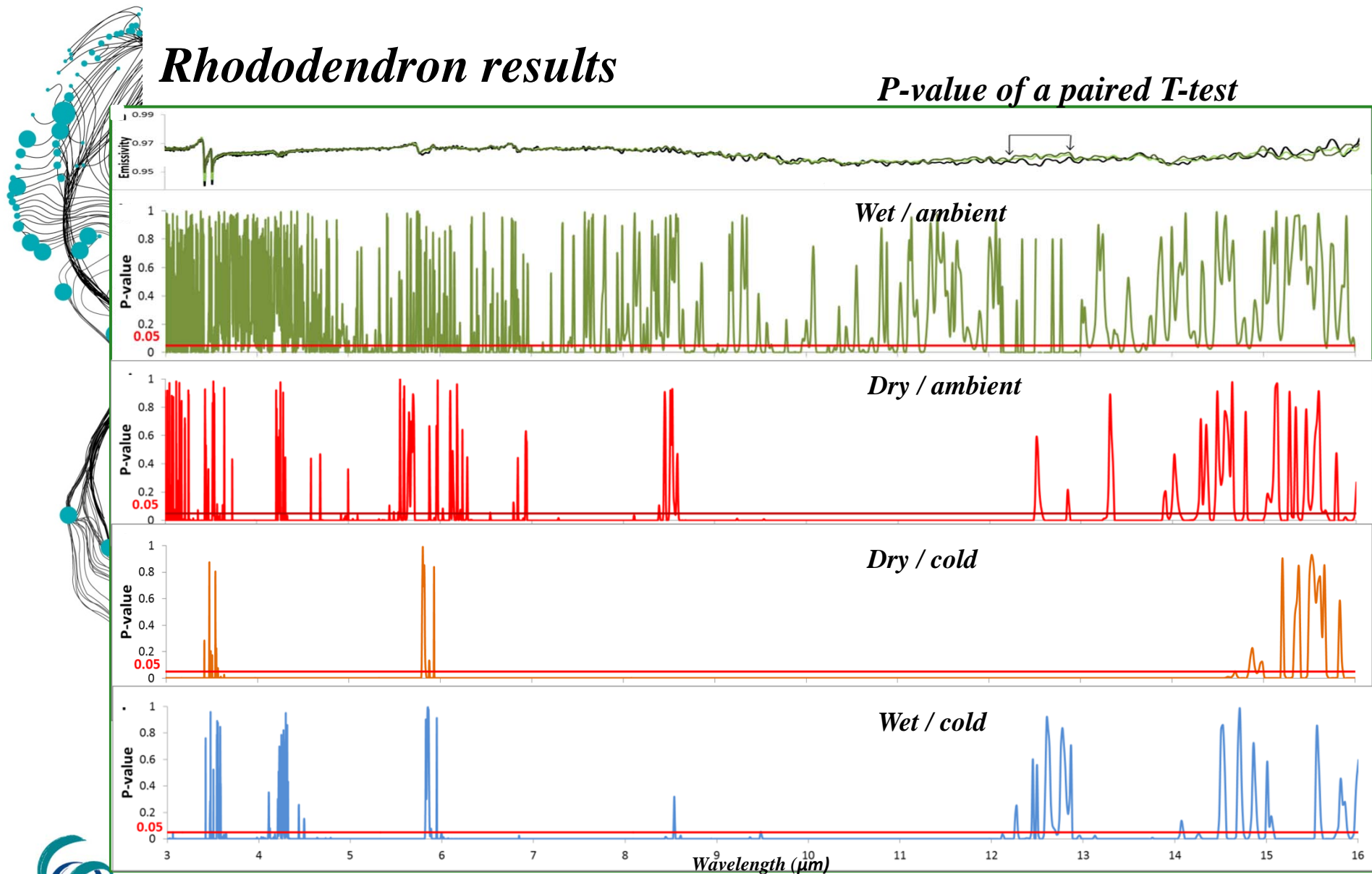


Results: Cuticle thickness



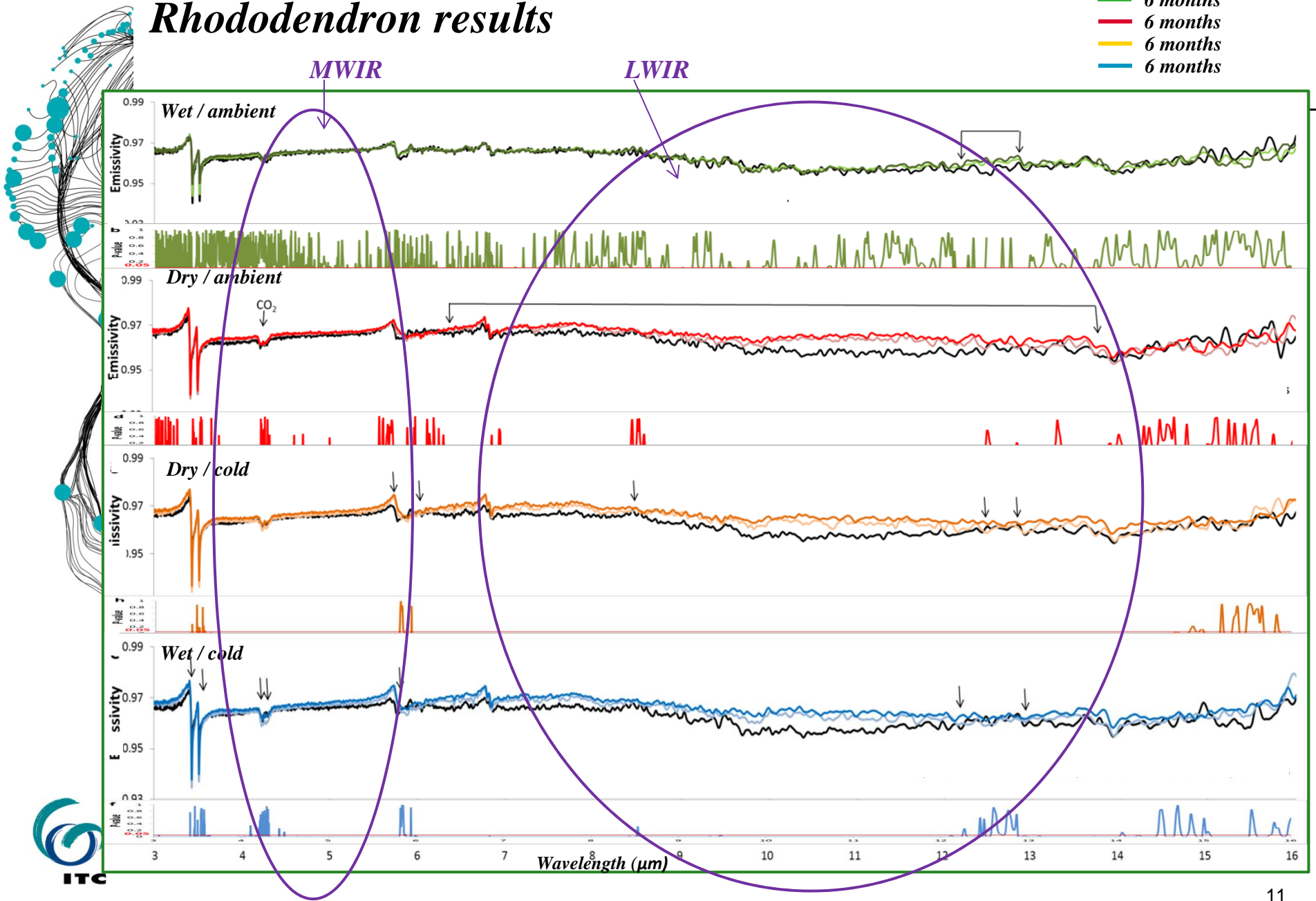
Rhododendron results

P-value of a paired T-test

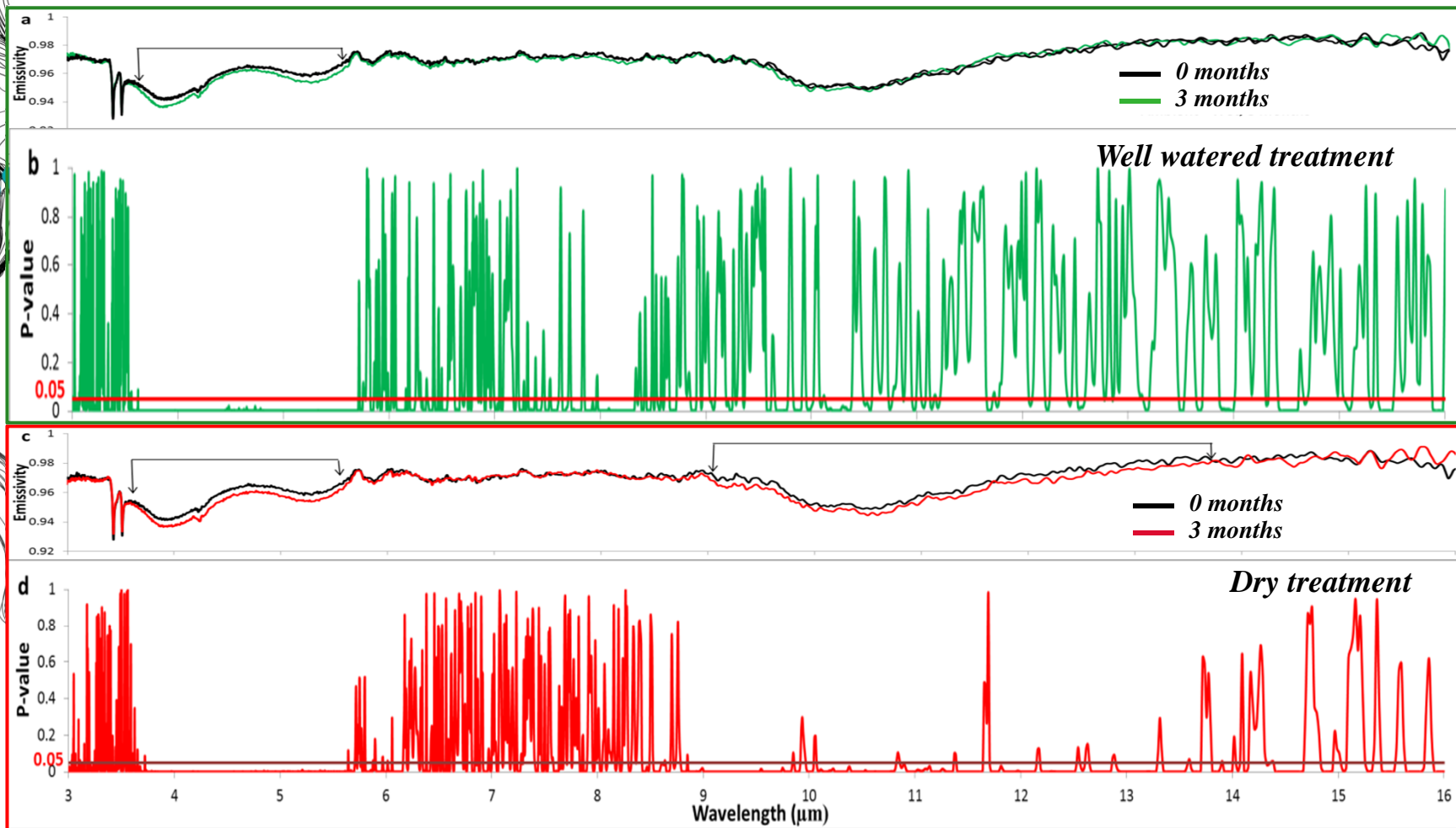


Rhododendron results

- 0 months
- 6 months
- 6 months
- 6 months
- 6 months

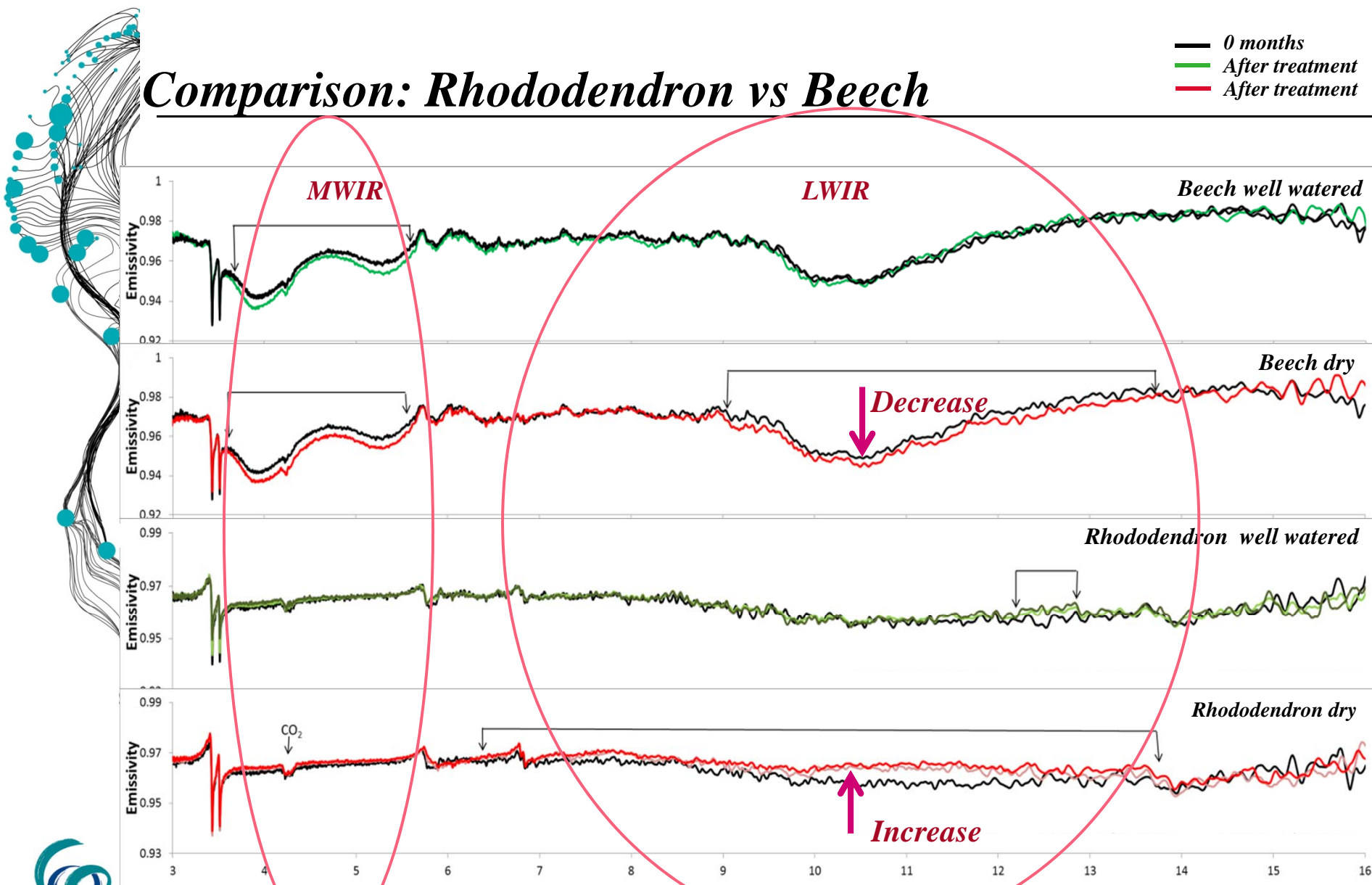


Results beech (*F. sylvatica*)

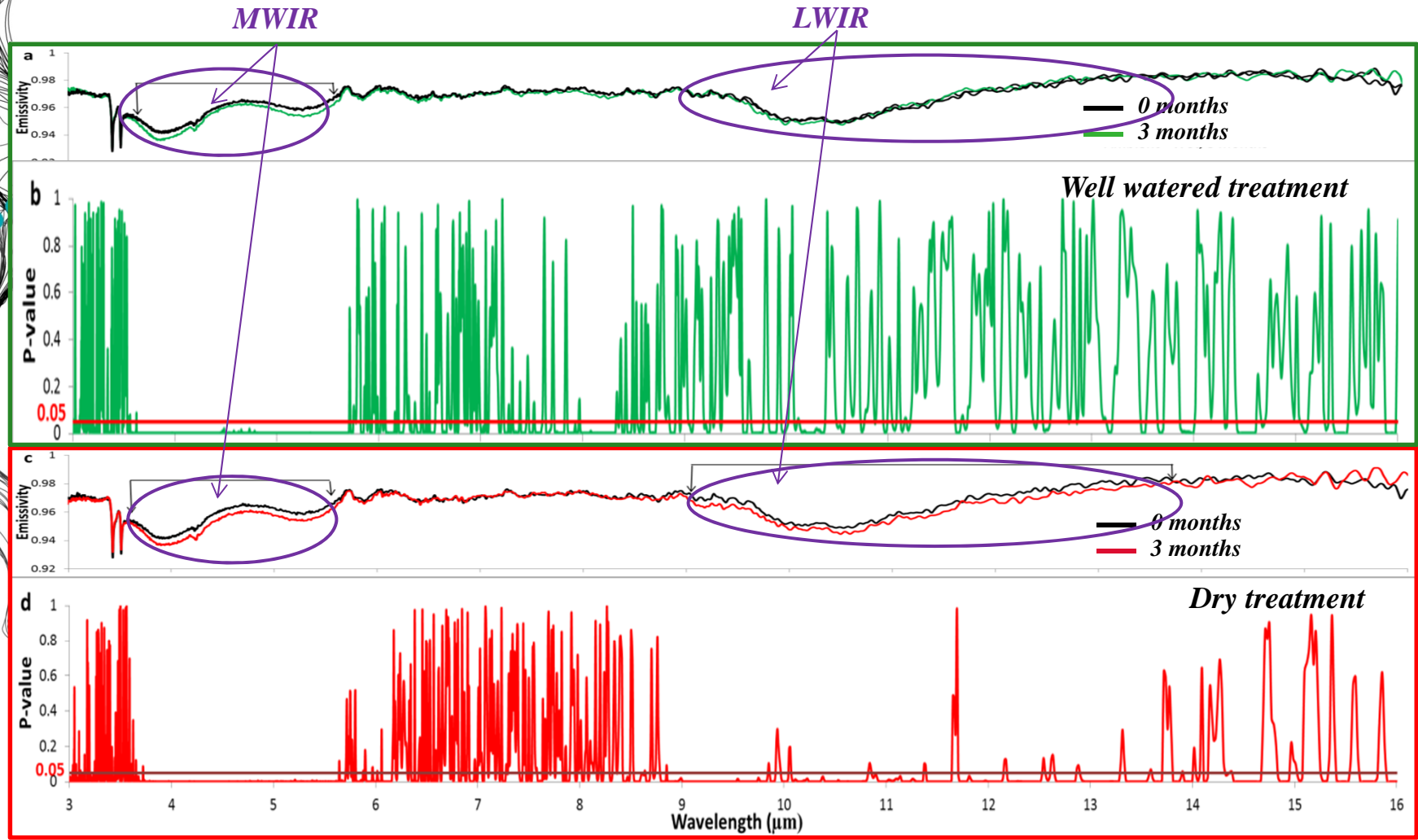


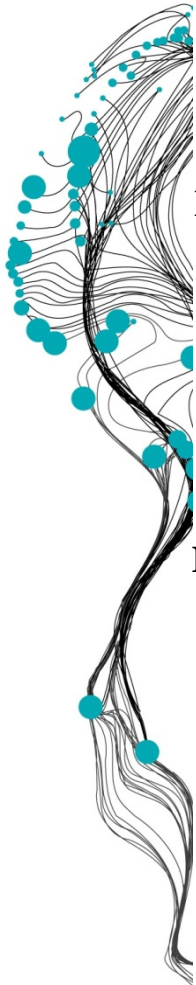
Comparison: Rhododendron vs Beech

- 0 months
- After treatment
- After treatment



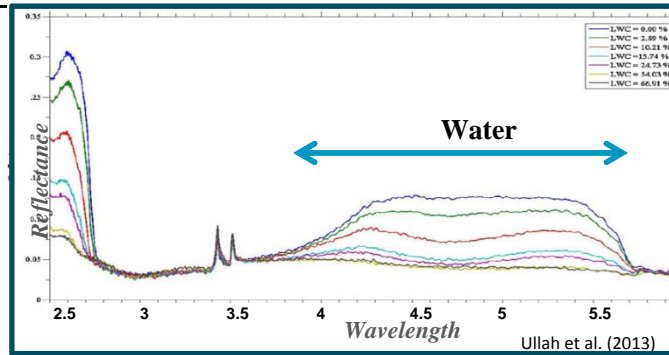
Results beech (*F. sylvatica*)





Possible causes:

MWIR and changes in LWC:



LWIR: Changes generated by cuticle and cuticular waxes

F. sylvatica

Smooth, sunken nervationes.

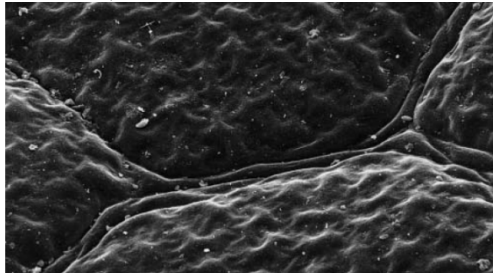


Photo from: Barthlott & Neinhuis (1997)



Photo from: Gulz, Prasad & Muller (1992)

Rhododendron sp.

Striated cuticle

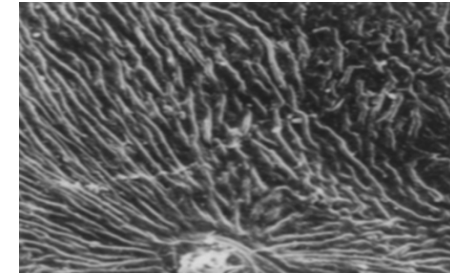


Photo from: Hardin & Gensel (1982)

Smooth surface, few crystals.

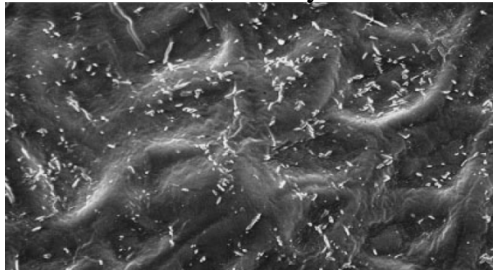


Photo from: Barthlott & Neinhuis (1998)



Photo from: Gulz, Prasad & Muller (1992)

Rugous cuticle and scales

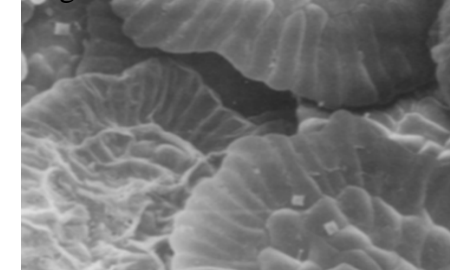


Photo from: Hardin & Gensel (1982)



Conclusions:

- Stress change the TIR spectral behavior of plants.
- Cold and dry stress have similar responses (visual, LWC, cuticle and leaf thickness)
- Dry treatment cause changes in the 4-6 μm region (MWIR), related with changes in LWC.
- TIR spectra shows differences between species in the range 7-12.5 μm (LWIR), probably related with biochemistry and microstructure of the leaf, especially complexity of the cuticle.