Sap flow resumption in oaks saplings during spring

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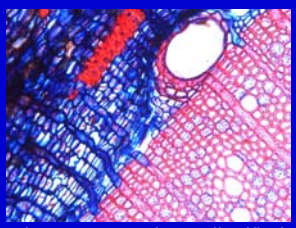
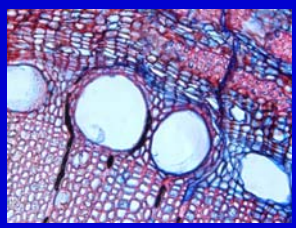
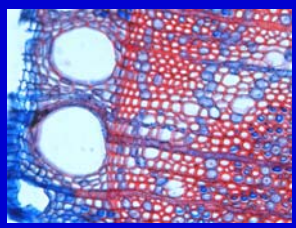
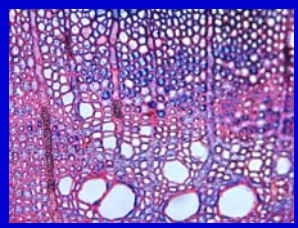
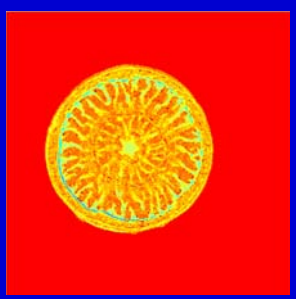
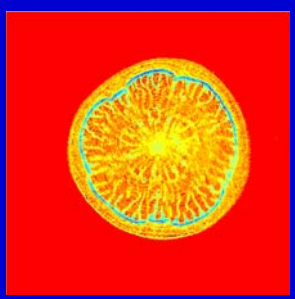
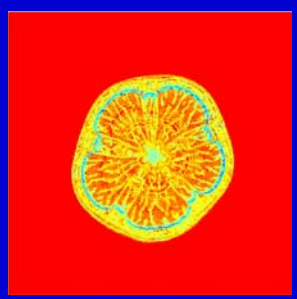
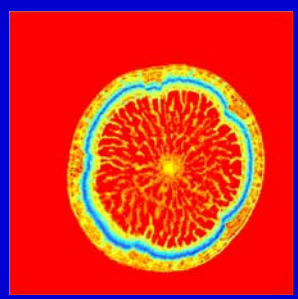
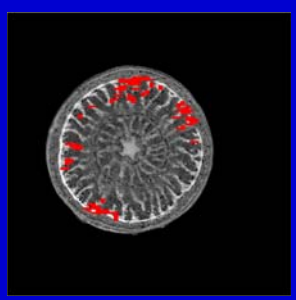
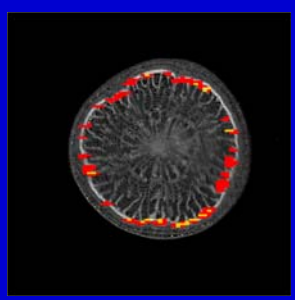
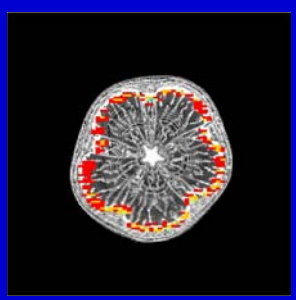
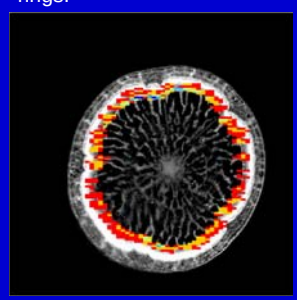
Nuclear Magnetic Resonance imaging (NMRI), a method for non-invasive observation of water state in wood stem (at 50cm stem height), and wood anatomical observations of vessels formation were combined to assess the re-hydration and flow in three-year-old pedunculate oaks (*Quercus robur L.*) during 4 pheno-phases of leaf development.

Pheno phase				
				
	Bud swelling (29-04-2009)	**Internodes start growing** (03-05-2009)	**Leaves fully developed** (22-05-2009)	**Bud swelling of 2nd flush** (01-07-2009)
Earlywood (EW) vessel formation				
	First EW vessels are lignified but most of the circumference is without vessels.	First row of EW vessels is almost complete but not all are yet lignified.	First row of EW vessels lignified; second row of EW vessels not yet fully lignified.	All EW vessels are lignified and latewood is present.
Water content (% per pixel: 0 - 10, 10 - 20, 20 - 30, 30 - 40, 40 - 50, 50 - 60, 60 - 70, 70 - 80, 80 - 90, 90 - 100)				
	Highest amount of water in the cambium layer and in adjacent IW- vessels.	More water in the cambium layer, including the layer with cell development.	Water content in older rings is decreasing.	Highest amount of water in the layer with cell development but almost no water in the previous rings.
Xylem flow (mm^3/s: 0,000 - 0,003, 0,003 - 0,006, 0,006 - 0,009, 0,009 - 0,012, 0,012 - 0,015)				
	Slow flow in single lignified vessels and in LW vessels of the previous year.	Water transport in lignified vessels. No longer flow in LW vessels of the previous year.	Significant increase in water transport.	Highest amount of water transport.

2 * 2 * 0.3 cm (256*256 pixels)

2 * 2 * 0.3 cm (64*128 pixels) plotted on water content (256*256 pixels)

Summary of the observation:

- The begin of earlywood-vessels formation is irregularly distributed around the circumference of the tree.
- The non-simultaneous vessel formation leads to equally inhomogeneous patterns in water content and initiation of sap flow.
- Sap flow resumption started in newly formed earlywood vessels already during bud swelling, but only with low intensity.
- There is no flow in previous rings, except during bud swelling.
- By fully developed leaves– about three weeks after bud swelling and when earlywood vessels are all lignified - water flow increases significantly.

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