

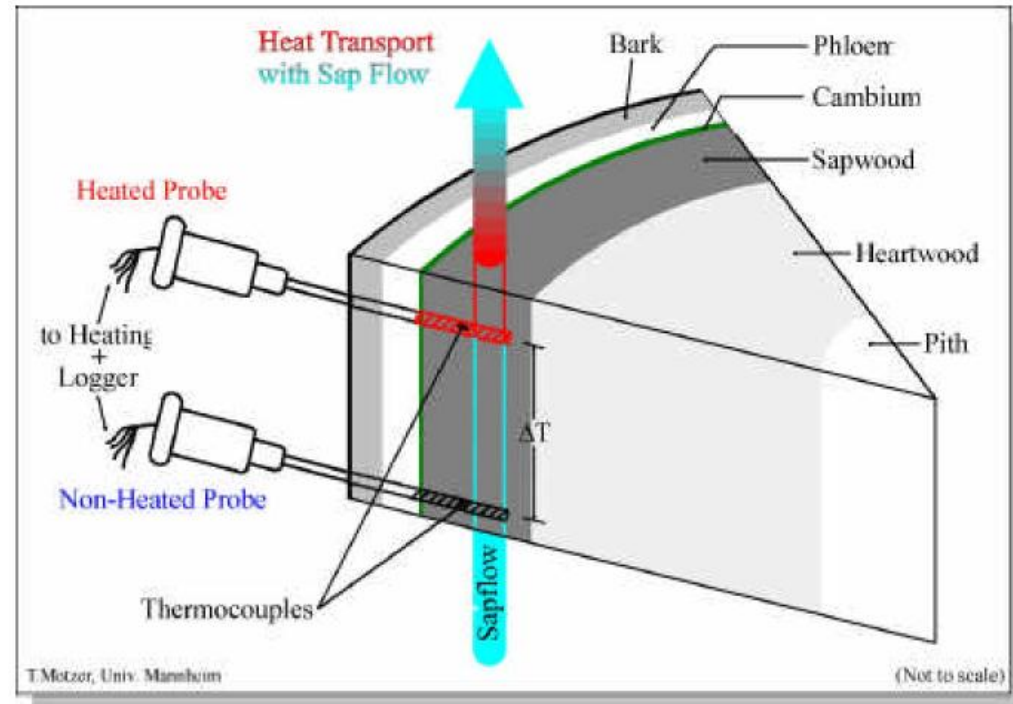
Hydrological Measurements

Miriam Coenders

5. Sap Flow Measurement



Sap flow measurements

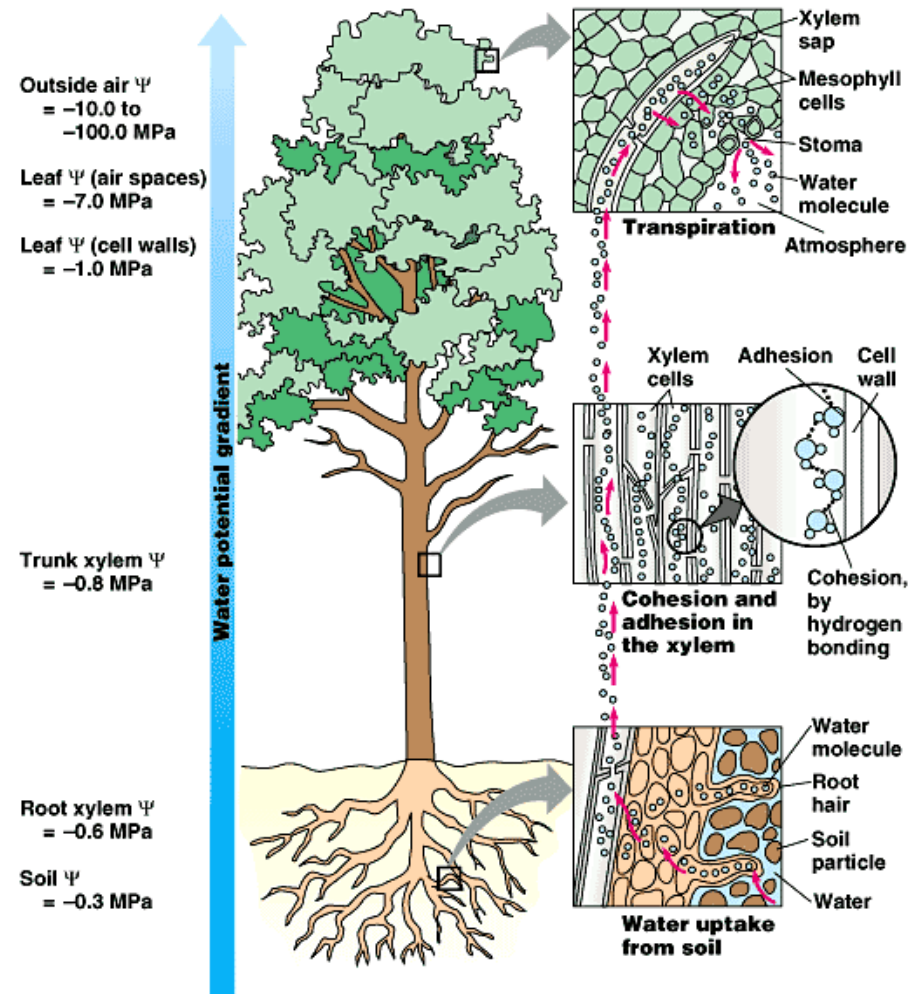


Jan Friesen

February 22, 2013

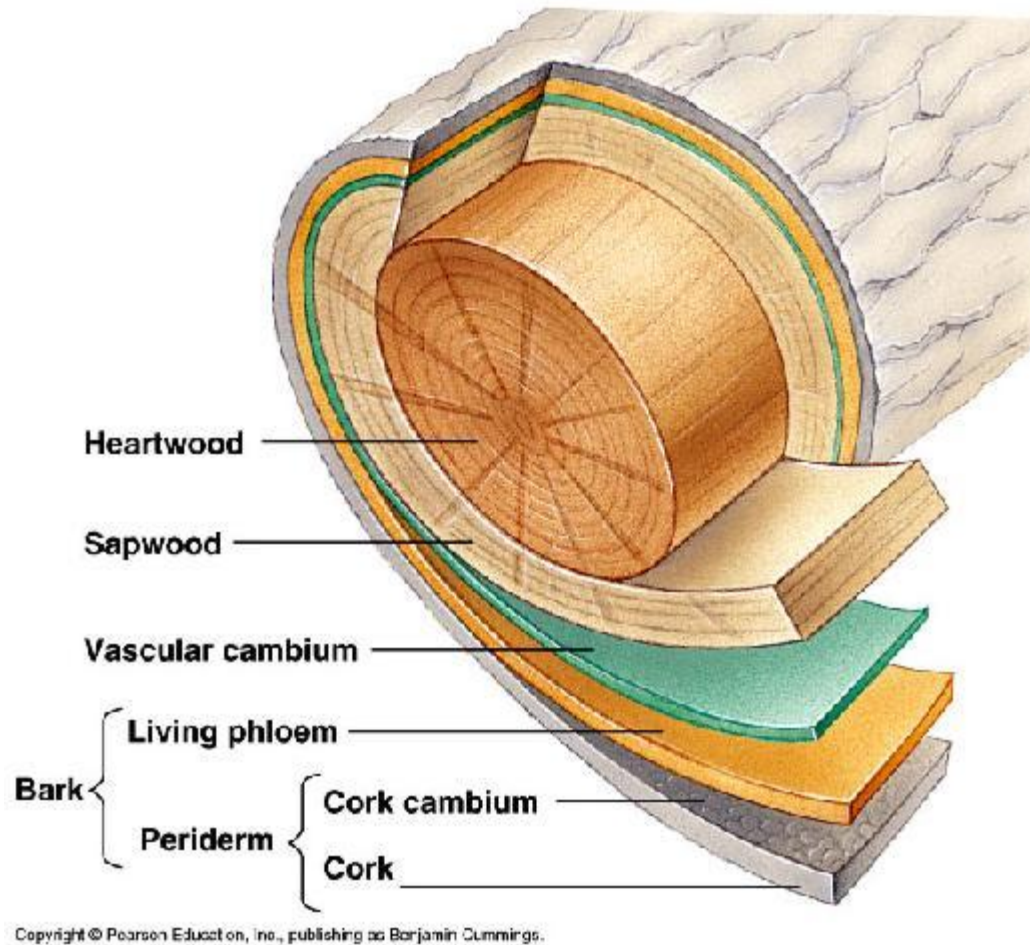
Vegetation water relations

Transpiration:
Process by which water
from plants is evaporated
into the atmosphere

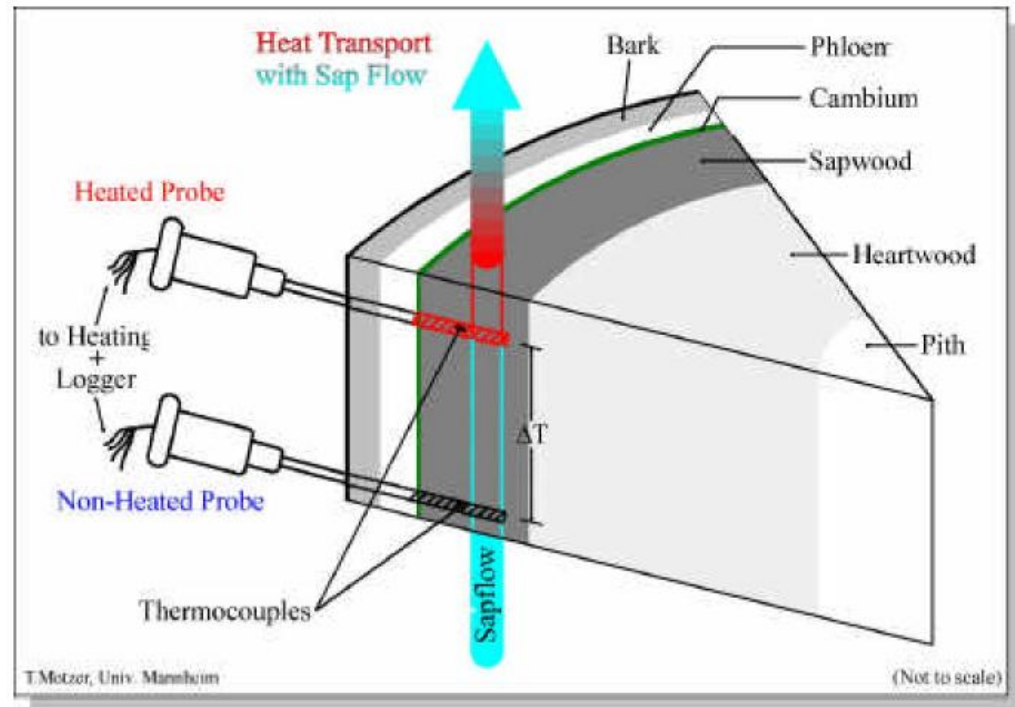


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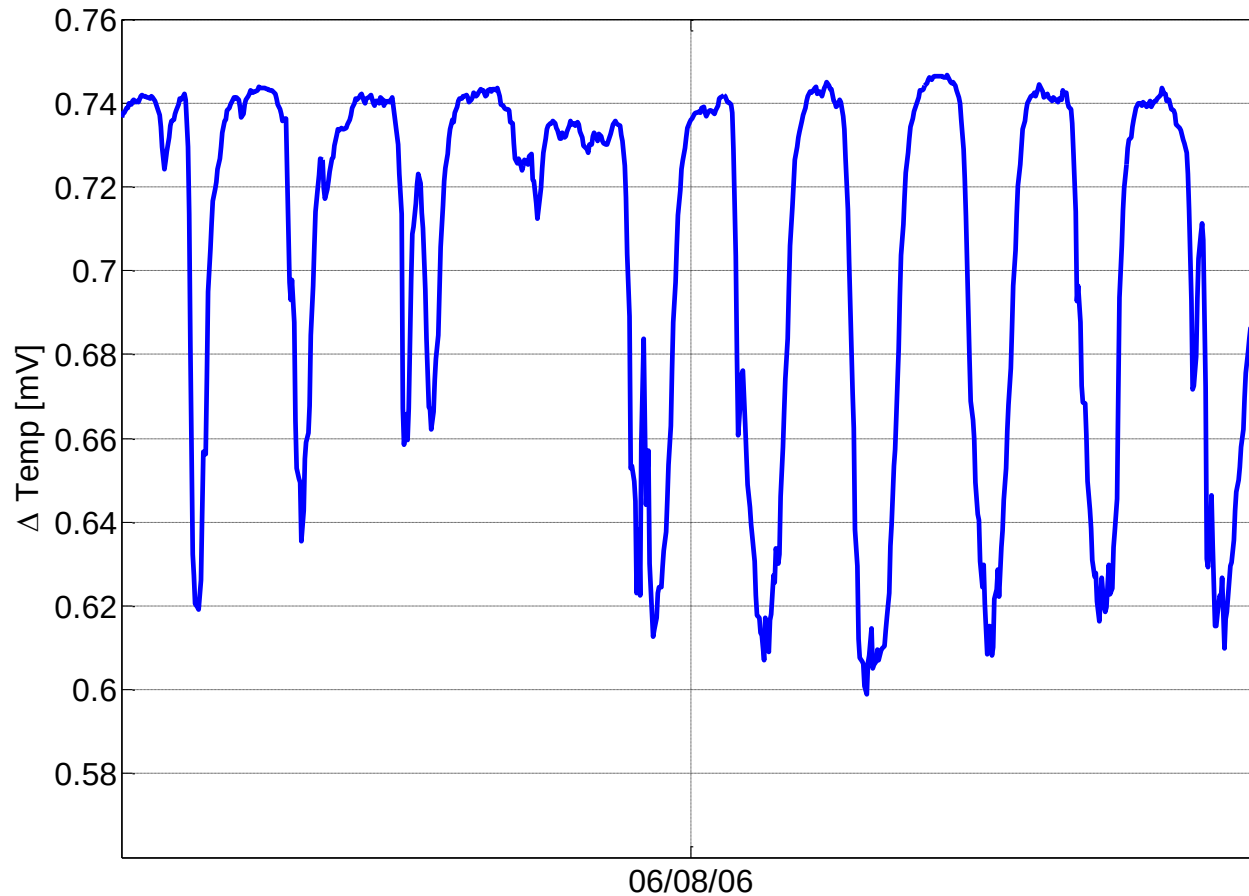
Sapwood



Heat flow technique



Raw temperature signal

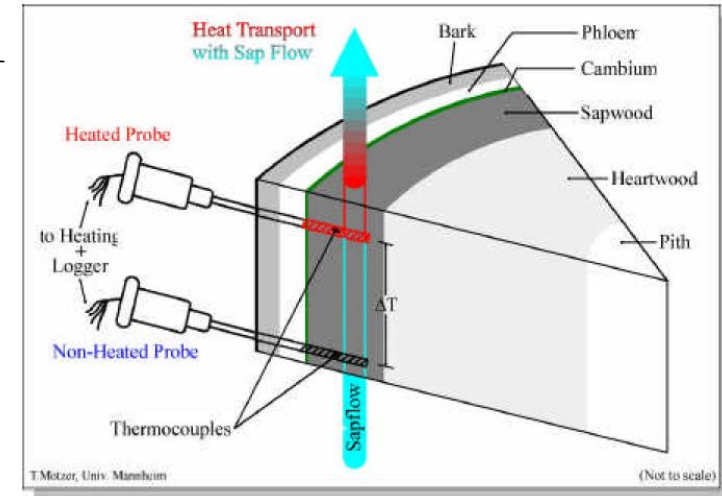


Heat flow technique

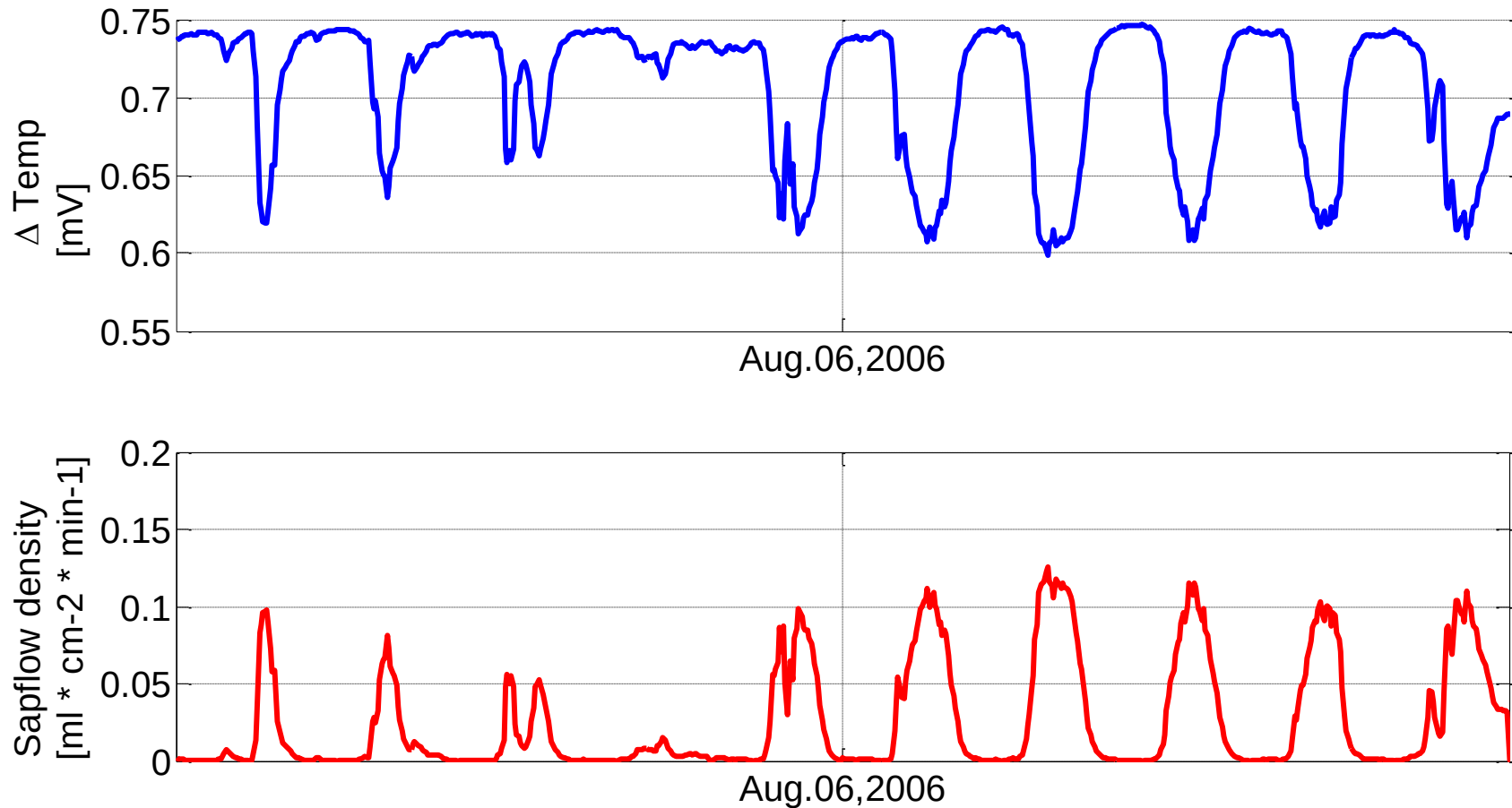
$$u = 0.714 \cdot \left(\left(\frac{\Delta T_{night}}{\Delta T_{actual}} \right) - 1 \right)^{1.231}$$

ΔT_{night} : temperature difference during low flow period at night

ΔT_{actual} : actual temperature difference



Raw signal to sapflow density

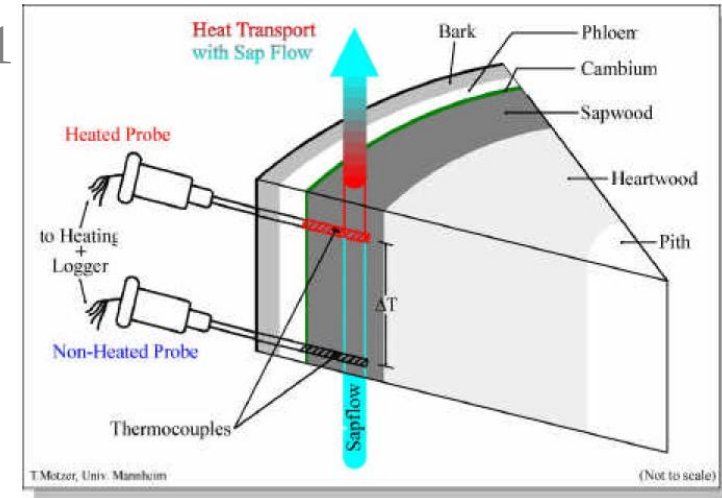


Heat flow technique

$$u = 0.714 \cdot \left(\left(\frac{\Delta T_{night}}{\Delta T_{actual}} \right) - 1 \right)^{1.231}$$

$$F = u \cdot SA$$

SA: sapwood area



Sapwood area

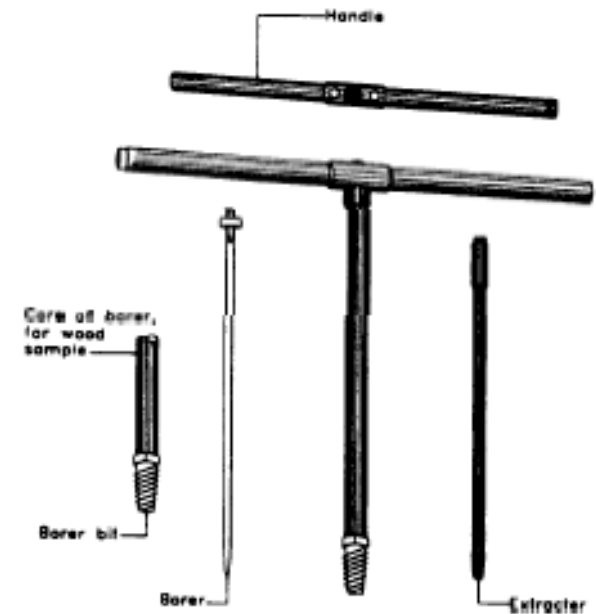


Figure 4-5. The increment borer

Sapwood area

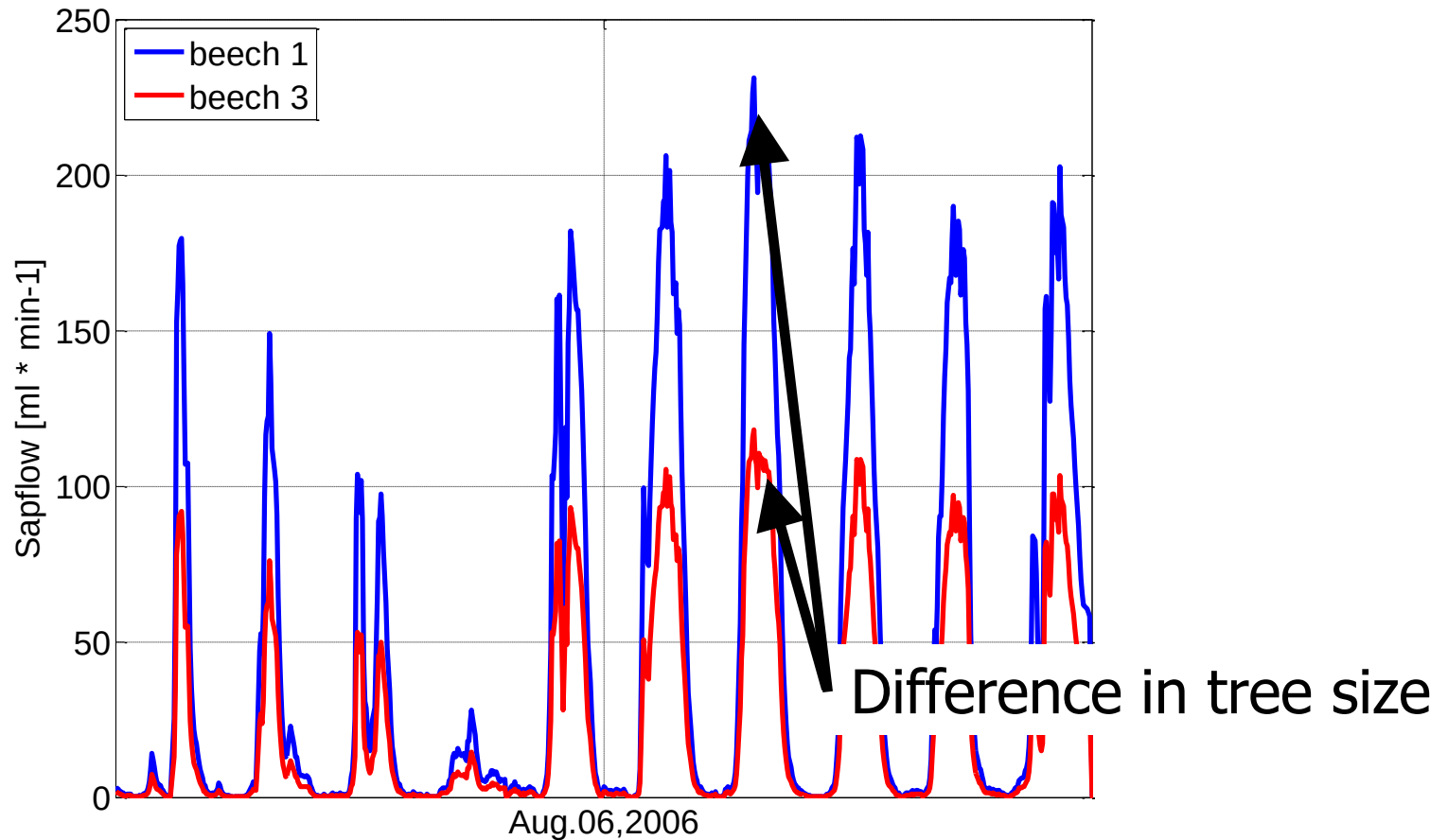


Source Unknown

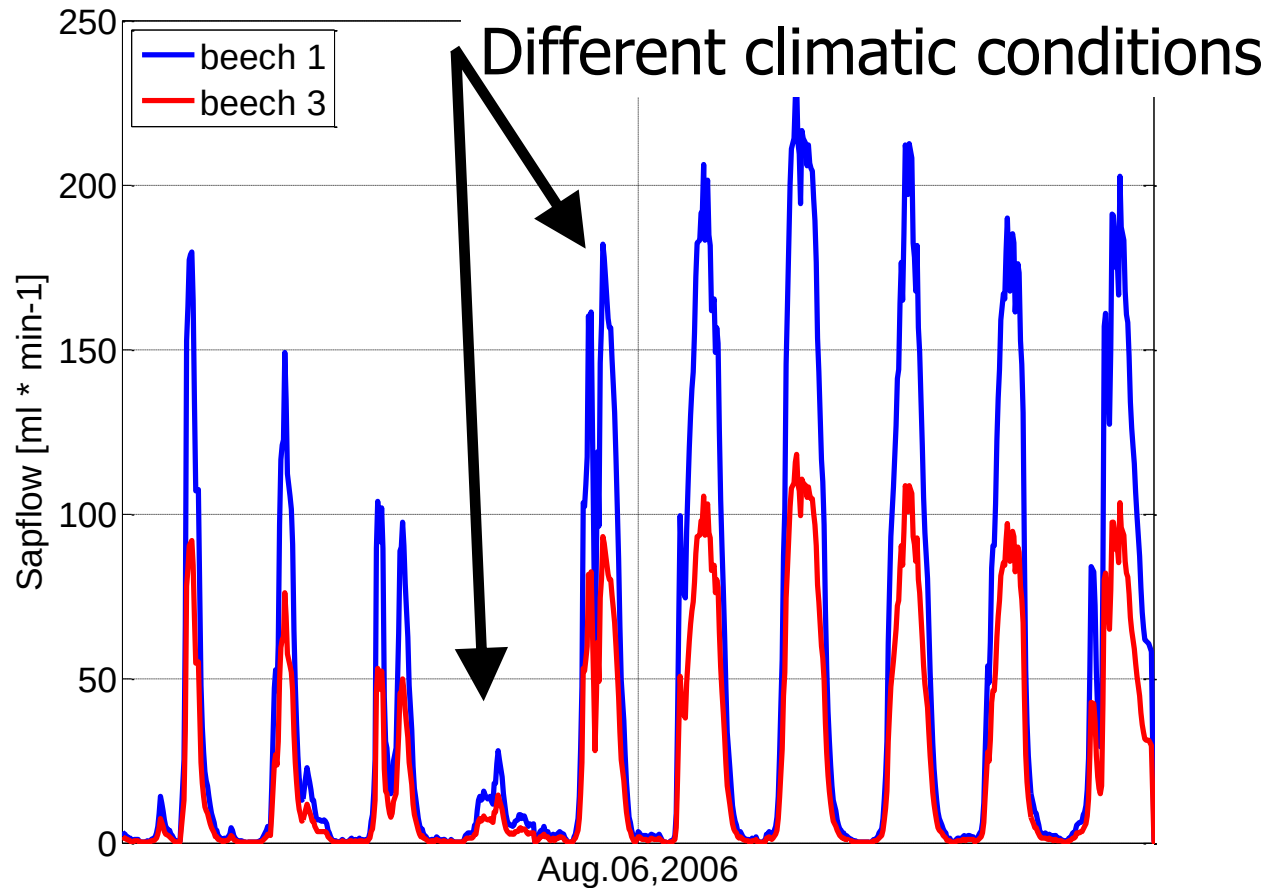


Source Unknown

Sapflow density to whole-tree flow



Sapflow density to whole-tree flow



Scaling from tree to catchment

- Differences in tree species
- Differences in tree size
- Differences in tree density

Differences between tree species

Plant species	Height (m)	Age (yrs)	Leaf area (m ² , both sides)	Foliage mass (kg dry matter)	Leaf number	Transpired water (l per tree)		Region
						Maximum per day	Average per year or season	
<i>Betula pendula</i>	12	28	115	4.6		140		Denmark
<i>Populus canadensis</i>	13	18	135	5.4		128		Denmark
<i>Quercus petraea</i>	12	25	90	3.5		73		Denmark
<i>Fraxinus excelsior</i>	15	27	60	2.4		47		Denmark
<i>Alnus incana</i>	11	19	116	3.7		47		Denmark
<i>Fagus sylvatica</i>	12	27	100	2.8		32		Denmark
<i>Picea abies</i>	13	33		10.9		27		Denmark
<i>Betula pendula</i>	15	21		3.0			5307	Southwest Germany
<i>Fagus sylvatica</i>	14	21		2.3			3801	Southwest Germany
<i>Pinus sylvestris</i>	15	21		4.4			3037	Southwest Germany
<i>Pseudotsuga menziesii</i>	15	21		6.1			2368	Southwest Germany
<i>Pseudotsuga menziesii</i>	28	45	400			65	23,760	USA (Washington)
<i>Salix alba</i>	3.5		10		25,000	9.1	800	Southwest Germany
<i>Alnus glutinosa</i>	2.5		8		2500	3.7	350	Southwest Germany
<i>Fraxinus excelsior</i>	3		7		500	3.6	340	Southwest Germany
<i>Acer platanoides</i>	2.5		6		900		160	Southwest Germany
<i>Acer pseudoplatanus</i>	2.5		3		300		130	Southwest Germany
<i>Elaeis guineensis</i>	5	11	4		32	30	23,300	Zaire

Source: Larcher, 1980

Differences in tree density



Google Earth



Google Earth

Sapflow measurements

- Sapflow is a measure of transpiration
- Sapflow data show
 - Response of transpiration to climatic change
 - Response of transpiration to changes in soil water
- Easy to measure fluxes
- Difficult
 - to quantify total flow and
 - to upscale to spatial units