Dendrometer*

- Highly precise
- Widely applicable in different measurements (radius, diameter, circumference, stem length, fruit diameter)
- Extremely light (13 g), Less strain on plants
- No power consumption, and with our ulogger standing-alone can measure for up to 2 years
- Suitable for any outdoor conditions
- No calibration required, with a direct µm output
- Proven track record of more than 10 years in use under outdoor conditions
- Least maintenance requirements

Why we need dendrometer?

Changes occur in plant tissues as a result of growth and water content. Diurnal fluctuations reflect changes in tissue water content while seasonal dynamics are attributed to long-term increases due to growth. It has long been in the interest of plant scientists to design precise and appropriate instruments to monitor such changes in plants in a precise time scale and to correlate them with environmental changes for accurate interpretation of plant responses to the environment. Techniques are currently available for accurate monitoring of physical environmental parameters, but to obtain accurate corresponding data for plant responses has been difficult. Quantitative measurements such as yield, tree ring width, etc. are cumulative results of effects of various environmental factors integrated over a complete growth season, e.g. one year and therefore, lacks precision (i.e. which environmental factor, at what time and in what in-tensity it affects plant growth). To study relationships between environment and plants, there is need for precise, simul-taneous data on plant responses and environmental variables that influence these responses. Dendrometers are ideal tools for meeting such demands. The Ecomatik Dendrometers (patents pending) are highly precise instruments for continuous monitoring of radial and vertical changes of plant tissues e.g. stems, fruits, leaves etc..

The Ecomatik Dendrometers

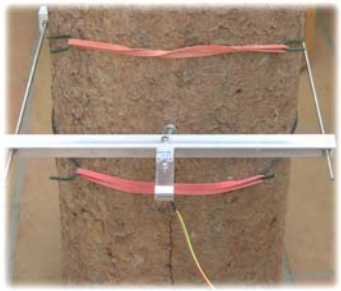
The Ecomatik Dendrometers are highly accurate and easy to use. They do not require any power supply and are easily automated. You only need a data reading device e.g. a data logger (for continuous data recording) or a simple voltmeter (for discrete data reading). No calibration is required. Except for the reset, which is done after 11 mm growth expanse (usually after many months or years), they are maintenance-free. The sensors are absolutely suitable for any outdoor conditions and in any season.

There are five Dendrometer types available, for measuring radius (DR), diameter of stem (DD), diameter of fruits (DF), circumference of stem and fruits (DC) and stem length (DV). One Dendrometer consists of a sensor and a frame, which fixes the sensor onto the plants.

* Patents Pending

Dendrometer

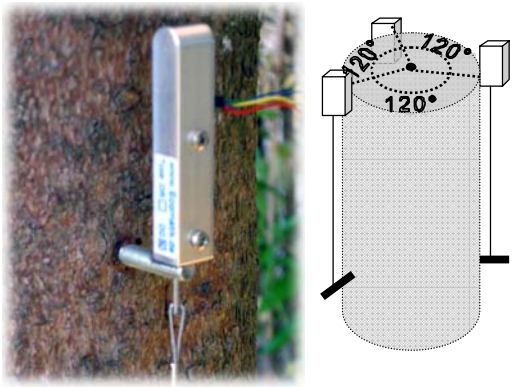
Type DR, for measuring changes in radius. Suitable for diameters>8 cm. The stem is injured by two screws.



Type DD, for measuring changes in diameter. Suitable for diameter 0- 20 cm (>20 cm on request). Due to a patented fixing technique no strain on plants at the measuring point.

Type DC, for measuring changes in circumference of stem and fruit. Suitable for diameter>2 cm, no injury to plant. Very light, a complete sensor without cable is only 16 g.

Type DF, for measuring changes in diameter of fruits, vegetables and cereals. Suitable for diameter<11 cm (>11 cm on request), The anti-move system ensures the centered position of the object, No injury, the frame can be reduced to meet any small size of plants.



Type DV, for measuring vertical variation of one section of plant stem. The data reflect important parameters of plant physiology:

(1)The variation of water content in the plant body and xylem water potential, respectively;

(2)The variation of plant orientation during growth.

If using three DV, the effects of water potential and of plant orientation can be separately detected.

Dendrometer

Examples of Measured Data

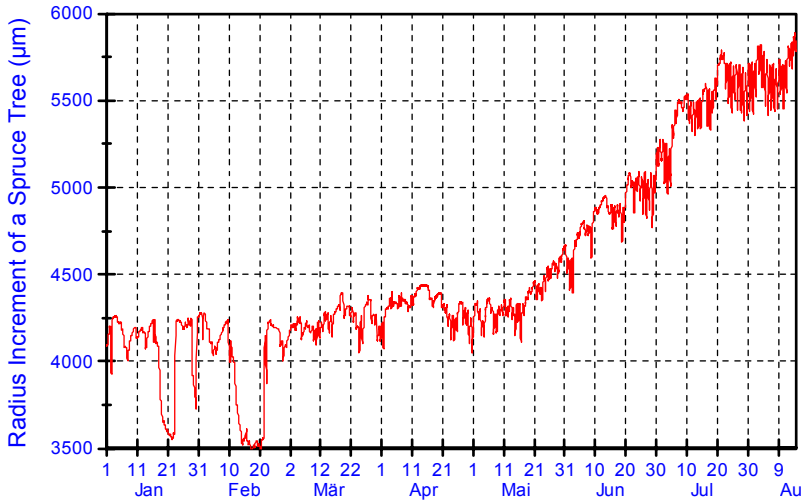


Fig.1 Radius dendrometer curve of a spruce tree

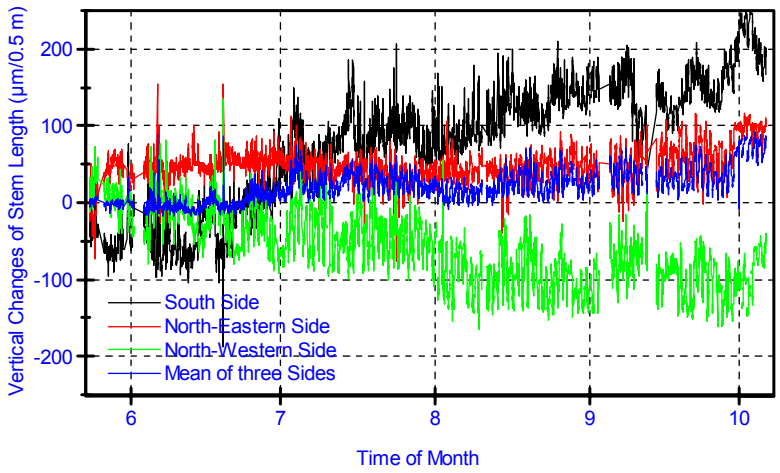


Fig. 2 Vertical changes of stem length of a Quercus suber tree. The tree is equipped with three vertical dendrometers at different sides (South, North-Western and North-Eastern). Because of competition pressure from South-Eastern the tree tends to South-Western direction.

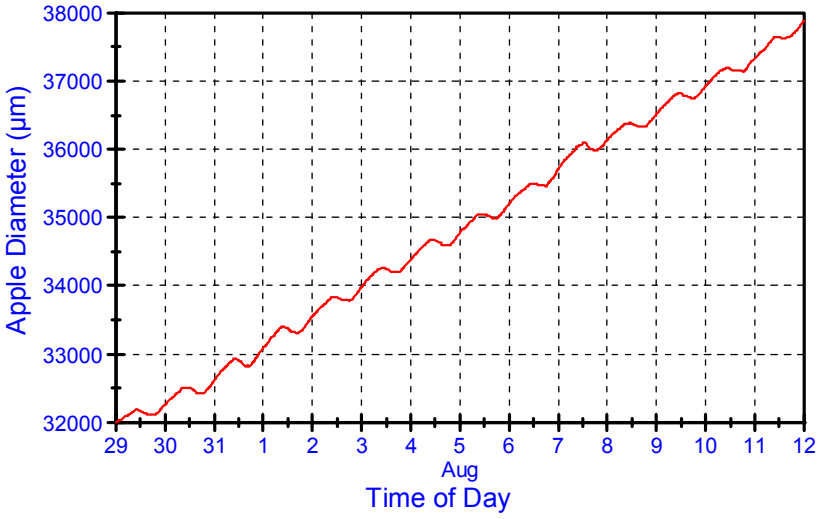


Fig. 3 Growth curve of a apple, measured with the fruit dendrometer

Dendrometer

Technical Specification and Ordering Information

Type	DD Diameter Dendrometer	DF Fruit Dendrometer	DR Radius Dendrometer	DC Circumference Dendrometer	DV Vertical Dendrometer
Frame					
Use area	For measuring stem diameter and leaf thickness	For measuring fruit diameter	For measuring stem radius	For measuring stem and fruit circumference	For measuring vertical variations of tree trunk, this is an indirect measure of xylem water potential in the tree body
Suitable for plant size	Diameter from 0 to 20 cm (>20 cm on request)	Diameter from 0 to 11 cm (>11 cm on request)	Diameter >8 cm.	Diameter from 2 to 32 cm (> 32 cm on request)	Diameter >8 cm
Plant injury	No	No	Injured by two screws (diameter=6 mm)	No	Injured by two screws (diameter=6 mm)
Temperature Coefficient	Very low	Very low	Very low	Temperature coefficient of the special wire cable <1.4×10^{-6}/K	
Material	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel
Size/weight	Frame: 27×24×1.5 cm, ca. 65 g	Frame: 18×15×1.5 cm, <52 g	Frame 14×15×1.5 cm, <60 g	Special wire cable <3 g	Special wire cable <3 g

Sensor	
Measurement Range	11 mm without reset, continuously extendable by resetting the frames/wire cable
Accuracy	<5 µm (measuring with two channels), with ulogger <7 µm
Resolution	Depending on data logger used, i.e. if use 12 bits logger <5 µm, if use ulogger, 7 µm
Linearity	±0.5%
Output signal	0 – 50 000 ohm
Power supply	No power supply required
Temperature Coefficient	2 single-ended channels measurement <0.1 µm/°C
	1 single-ended Channel measurement <0.04 %/°C
Environment	Outdoor condition: -30 to 40 °C air temperature, 0 to 100% relative air humidity
Weight of sensor	13 g without cable and frame
Cable length	2 m standard, extendable up to 100 m
Collection of data	Continuously with data logger (see next page, dendrometer data logger), discontinuously with a voltmeter

Dendrometer

Papers related to Ecomatik Dendrometers

Otieno DO, Kurz-Besson C, Liu J, Schmidt MWT, Vale-Lobodo R, David TS, Siegwolf R, Pereira JS and Tenhunen JD:Seasonal Variations in Soil and Plant Water Status in a *Quercus suber* L. Stand: Roots as Determinants of Tree Productivity and Survival in the Mediterranean-type Ecosystem. Plant and Soil, 283, 119-135, 2006

Otieno DO: Coordinated Tree Response to Drought – Vulnerablility and Sustainable Production: Hypothesees on Arid Ecosystem Adjustments to Limitation in Water Resources. Doctroal Thesis, University Bayreuth, Germany, 2004

Braeuning, A., Burchardt, I. (2006): Detection of growth dynamics in tree species of a tropical mountain rain forest in southern Ecuador, TRACE- Tree Rings in Archaeology, Climatology and Ecology, Vol. 4: Proceedings of the DEDROSYMPOSIUM 2005, Fribourg 127-131

Beeck C, Pude, R., Baab, G. und M. M.Blanke: Wie wirken Grünschnitt-Kompost und Miscanthusmulch auf die Bodenfeuchte, das Bodenleben sowie vegetatives und generatives Wachstum junger Apfelbäume? Erwerbs-Obstbau, im Druck, 2006

Liu J.C., Firsching B.M., Payer H.D. (1995): Untersuchungen zur Wirkung von Stoffeinträgen, Trockenheit, Ernährung und Ozon auf die Fichtenerkrankung am Wank in den Kalkalpen. GSF-Bericht 18/95, 236 S.

Liu J.C. (1995): Eine Methode zur Messung des vom Wassereffekt bereinigten Dickenzuwachses. Forstliche Forschungsberichte München, 153, 40-44.

Liu J.C., Häberle K.H., Loris K. (1994): Untersuchungen zum Einfluß des Matrix-potentials auf Stammdickenänderungen von Fichten (Picea abies (L.) Karst.). Pflanzenern. Bodenk., 158, 231-234.