

Plant Water Relations Techniques - FOR 6345C, Section 3106 - Fall 2006 Syllabus

Instructor: Dr. Tim Martin (359 N-Z, 846-0866, tamartin@ufl.edu)

Class Meetings: Mondays, periods 2-5 (8:30-12:35), 219 Newins-Ziegler Hall

Office Hours: After class on Mondays, or by appointment; If my office door is open and I'm not meeting with someone, you are always welcome to drop in.

Course web site:
<http://www.sfrc.ufl.edu/class/FOR6345>

"Nothing tends so much to the advancement of knowledge as the application of a new instrument. The native intellectual powers of men in different times are not so much the causes of the different success of their labours, as the peculiar nature of the means and artificial resources in their possession."

- Sir Humphrey Davy, 19th Century English chemist, quoted in Thomas Hager's book *Force of Nature: The Life of Linus Pauling*, Simon and Schuster, New York, 1995.

"It's sometimes too easy to let the toys drive the science."

- paraphrased quote from Thomas Hinckley, 20th Century American tree ecophysiologicalist

Course description: This two credit course will focus on instruments and techniques used to quantify water balance and status in plants in the field. Emphasis will be placed on the theory, assumptions, advantages and shortcomings of various measurement techniques.

Objectives: To familiarize graduate students with some of the tools necessary to measure plant water relations parameters in the field. Emphasis will be on water potential measurements with Scholander pressure chambers, leaf gas exchange measurements with porometers and infrared gas analyzers, and xylem sap flux measurements with heat dissipation probes.

Text: Readings and handouts will be distributed throughout the semester in class. See Reading List at end of Syllabus

Course Grades:

Course evaluations will be based on the following items

Task	% of total course points
Participation	50
Problem sets	25
Final exam or Term Paper	25

Participation - Students are expected to attend all class meetings, participate in lab activities, and contribute to course discussion.

Problem sets - A number of problem sets will be assigned to help students master the assumptions and calculations necessary to utilize techniques. Some problem sets will be completed in association with lab exercises, while others will be completed outside of class time.

Final Exam or Term Paper - Students may choose to complete (a) a comprehensive final exam; or (b) a term paper reviewing the use of one or more water relations techniques in an area of interest to the student. Students will register their decision with the instructor, and if choosing the term paper, discuss the topic and expectations for coverage with the instructor.

Final grades will be assigned as: A (90-100 %), B+ (85-89 %), B (80-84 %), C+ (75-79 %), C (70-74 %), D+ (65-69 %), D (60-64 %), E (< 60 %).

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Tentative Course Schedule

Date	Topic	Date	Topic
Aug 28	Course introduction; syllabus; discussion of student expectations and needs	Oct 23	Xylem hydraulic conductivity and cavitation
Sep 4	No Class - Labor Day	Oct 30	Xylem hydraulic conductivity and cavitation (cont.)
Sep 11	Introduction to gas exchange measurements; theory and configuration of gas exchange systems; introduction to LiCor 6400 photosynthesis system	Nov 6	Introduction to dataloggers; multiplexers; sensor hookup; programming
Sep 18	LiCor 6400 tutorial; stomatal conductance measurements; calculation of gas-phase limitations to photosynthesis	Nov 13	Thermocouples: theory; thermocouple circuits; construction
Sep 25	Gas exchange (cont.)	Nov 20	Introduction to xylem sap flow measurements; heat pulse velocity; tissue heat balance; heat dissipation;
Oct 2	Introduction to pressure chamber; measurement of xylem pressure potential	Nov 27	Construction of heat dissipation sap flow probes and power supplies
Oct 9	Pressure-volume curves	Dec 4	Applications of sap flow tools: transpiration; crown conductance; hydraulic conductance; scaling issues
Oct 16	No Class - Martin Traveling		

Final Exam: "14E", 5:30-7:30 p.m., Thursday, December 14, 219 Newins-Ziegler

Partial Reading List

Useful texts

- Kramer, P.J., and J.S. Boyer. 1995. Water relations of plants and soils. 1995. Academic Press. [good detailed survey of the topic]
- Lambers, H., F.S. Chapin, and T.L. Pons. 1998. Plant physiological ecology. Springer. [comprehensive ecophysiology text]
- Kozlowski, T.T. and S.G. Pallardy. 1997. Physiology of woody plants, Second Edition. Academic Press. [undergraduate-focused text]
- Pearcy, R.W., J.R. Ehleringer, H.A. Mooney, and P. Rundel (Eds.). 1989. Plant physiological ecology: Field methods and instrumentation. Chapman and Hall. [commonly called "the pink book"; although a bit dated, provides an excellent overview of the principles behind many field methods and instruments]
- Tyree, M.T., and M.H. Zimmermann. 2002. Xylem structure and the ascent of sap. Springer. [highly readable, seminal overview of xylem structure and function]

Papers

- Ball, J. T. 1987. Calculations related to gas exchange. *In*: E. Zeiger, G. D. Farquhar, and I. R. Cowan (Eds.), Stomatal Function. pp.445-476.
- Boyer, J.S. 1995. Measuring the water status of plants and soils. Academic Press, San Diego. 178 p.
- Breda, N., H. Cochard, E. Dreyer, and A. Granier. 1993. Water transfer in a mature oak stand (*Quercus petraea*): seasonal evolution and effects of a severe drought. Canadian Journal of Forest Research 23:1136-1143.
- Cermak, J., M. Deml and M. Penka. 1973. A new method of sap flow rate determination in trees. Biologia Plantarum 15:171-178.
- Clearwater, M. J., F. C. Meinzer, J. L. Andrade, G. Goldstein, and N. M. Holbrook. 1999. Potential errors in measurement of nonuniform sap flow using heat dissipation probes. Tree Physiology 19:681-687.

- Daum, C.R. 1967. A method for determining water transport in trees. *Ecology* 48 425-431.
- Ewers, B.E. and R. Oren. 2000. Analyses of assumptions and errors in the calculation of stomatal conductance from sap flux measurements. *Tree Physiology* 20:579-589.
- Field, C.B., J.T. Ball and J.A. Berry. 1989. Photosynthesis: principles and field techniques. *In*: R.W. Pearcy, J.R. Ehleringer, H.A. Mooney and P. Rundel (Eds.), *Plant Physiological Ecology: Field Methods and Instrumentation*. Chapman and Hall, London. pp. 209-253.
- Goldstein, G., J.L. Andrade, F.C. Meinzer, N.M. Holbrook, J. Cavelier, P. Jackson, and A. Celis. 1998. Stem water storage and diurnal patterns of water use in tropical forest canopy trees. *Plant, Cell and Environment* 21:397-406.
- Granier, A. 1985. Une nouvelle méthode pour la mesure du flux de sève brute dans le tronc des arbres. *Annales des Sciences Forestières* 42:193-200.
- Granier, A. 1987. Mesure du flux de sève brute dans le tronc du Douglas par une nouvelle méthode thermique. *Annales des Sciences Forestières* 44:1-14.
- Grime, V.L., J.I.L. Morison, and L.P. Simmonds. 1995. Including the heat storage term in sap flow measurements with the stem heat balance method. *Agricultural and Forest Meteorology* 74:1-25.
- Hatton, T.J., E.A. Catchpole, and R.A. Vertessy. 1990. Integration of sapflow velocity to estimate plant water use. *Tree Physiology* 6:201-209.
- Sestak, Z., J. Catsky and P.G. Jarvis. 1971. *Plant Photosynthetic Production: Manual of Methods*. Junk, The Hague. 800 p.
- Granier, A. and D. Loustau. 1994. Measuring and modelling the transpiration of a maritime pine canopy from sap-flow data. *Agricultural and Forest Meteorology* 71:61-81.
- Hatton, T.J., S. Moore, and P. Reece. 1995. Estimating stand transpiration in a *Eucalyptus populnea* woodland with the heat pulse method: measurement errors and sampling strategies. *Tree Physiology* 15:219-227.
- Marshall, D.C. 1958. Measurement of sap flow in conifers by heat transport. *Plant Physiology* 33:385-396.
- Martin, T.A., K.J. Brown, J. Kucera, F.C. Meinzer, D.G. Sprugel, and T.M. Hinckley. 2001. Control of transpiration in a 220-year-old *Abies amabilis* forest. *Forest Ecology and Management* 152:211-224.
- Ritchie, G.A. and T.M. Hinckley. 1975. The pressure chamber as an instrument for ecological research. *Advances in Ecological Research* 9:165-254.
- Wullschlegel, S.D., F.C. Meinzer, and R.A. Vertessy. 1998. A review of whole-plant water use studies in trees. *Tree Physiology* 18:499-512.
- Wullschlegel, S.D. and A.W. King. 2000. Radial variation in sap velocity as a function of stem diameter and sapwood thickness in yellow-poplar trees. *Tree Physiology* 20:511-518.

UNIVERSITY OF FLORIDA POLICIES YOU NEED TO KNOW:

ACADEMIC HONESTY: As a result of completing the registration form at the University of Florida, every student has signed the following statement: I understand that the University of Florida expects its students to be honest in all their academic work. I agree to adhere to this commitment to academic honesty and understand that my failure to comply with this commitment may result in disciplinary action up to and including expulsion from the University.

UNIVERSITY SUPPORT SERVICES: Resources are available on-campus for students having personal problems or lacking clear career and academic goals which interfere with their academic performance. These resources include:

1. University Counseling Center, 301 Peabody Hall, 392-1575, personal and career counseling
2. Student Mental Health, Student Health Care Center, 392-1171, personal counseling
3. Sexual Assault Recovery Services (SARS), Student Health Care Center, 392-1161, sexual counseling
4. Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling

SOFTWARE USE: All faculty, staff and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against the University policies and rules, disciplinary action will be taken as appropriate.

ACCOMODATIONS FOR STUDENTS WITH DISABILITIES: Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation.