Plant Water Relations Techniques - FOR 6345C, Section 019B – Spring 2012 Syllabus

Instructors: Dr. Tim Martin (359 N-Z, 846-0866, tamartin@ufl.edu), Dr. Carlos Gonzalez (352W N-Z, 846-0851, cgonzabe@ufl.edu)

Class Meetings: Wednesdays, periods 4-6 (10:40 – 1:40), 219 Newins-Ziegler Hall

Office Hours: After class on Wednesdays, 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 ecophysiologist

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
Class Project	30
Annotated Bibliography	20

Participation - Students are expected to attend all class meetings, participate in lab activities, and contribute to course discussion.
Annotated Bibliography – Choose a water relations technique that is of interest to you or that is important for your research – it can be a technique we learned in class or some other. Create an annotated bibliography of at least 15 peer-reviewed papers that have used this technique. For each paper, provide a paragraph or two which describes how the technique was used and how the technique contributed to the goals of the paper. The bibliography (by hard copy or e-mail) is due at the beginning of class on March 28. ***No late bibliographies will be accepted.***
Final Project – During the last two class meetings, we will conduct a field exercise in which we apply a number of the techniques learned in class. The class will be broken into small "teams", each of which will be responsible for a set of measurements. The data will be collated and distributed to the class. Each student will independently analyze and report the data from all measurements. The project (by hard copy or e-mail) is due by 5:00 p.m. on April 30. ***No late projects will be accepted.***

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Final grades will be assigned as:

90-93.3% A-	93.4-96.6 A	96.7-100 A+
80-83.3% B-	83.4-86.6 B	86.7-89.9 B+
70-73.3% C-	73.4-76.6 C	76.7-79.9 C+
60-63.3% D-	63.4-66.6 D	66.7-69.9 D+

Less than 60%= E (Fail)

Tentative Course Schedule

Date	Topic	Date	Topic
Jan. 11	Course introduction; syllabus; discussion of student expectations and needs; review of plant water relations concepts [Martin]	Mar. 7	**UF Spring Break – No Class**
Jan. 18	Plant water potential measurements [Gonzalez]	Mar. 14	Soil water relations [Martin/Gonzalez]
Jan. 25	Pressure-volume curves for determining water potential components [Martin/Gonzalez]	Mar. 21	Thermocouple theory; thermocouple circuits and construction [Martin]
Feb. 1	Introduction to gas exchange measurements; theory and configuration of gas exchange systems; introduction to LiCor 6400 photosynthesis system [Martin]	Mar. 28	Introduction to dataloggers; multiplexers; sensor hookup; programming [Martin] **Annotated Bibliography Due by beginning of class** **No Late Bibliographies Accepted**
Feb. 8	LiCor 6400 tutorial; stomatal conductance measurements; calculation of gas-phase limitations to photosynthesis [Martin]	April 4	Introduction to xylem sap flow measurements; heat pulse velocity; tissue heat balance; heat dissipation [Gonzalez]
Feb. 15	Xylem hydraulics – theory; xylem hydraulic conductivity [Gonzalez]	April 11	Construction of heat dissipation sap flow probes and power supplies [Gonzalez]
Feb. 22	Xylem vulnerability to cavitation [Gonzalez]	April 18	Field day – applications of water relations techniques to quantify soil-plant-atmosphere water transport [Martin/Gonzalez]
Feb. 29	Field Tour: Austin Cary Memorial Forset eddy covariance site [Rosvel Bracho]	April 25	Field day / data analysis help [Martin/Gonzalez]
		April 30	**Final Project Due 5:00 p.m.** **No Late Projects Accepted**

Partial Reading List

Useful texts

Kirkham, M.B. 2004. Principles of Soil and Plant Water Relations. Academic Press. [similar to Kramer and Boyer, better coverage of more recent techniques]

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. 2008. Plant physiological ecology. Springer. [comprehensive ecophysiology text]

Pallardy, S.G. 2008. Physiology of woody plants, Third 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]

Slavik, B. 1974. Methods of studying plant water relations. Springer. [good coverage of water relations theory]

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 Forestieres 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 Forestieres 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.

Wullschleger, 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.

Wullschleger, 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.