Environmental Biophysics
AGRONOMY/SOIL SCI/ATM OCN 532
Fall Semester 2016
Course Description
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Course Details

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MEETING TIME: **Tuesday and Thursdays 9:30-10:45 AM** in room 351 Moore Hall
OFFICE HOURS: By appointment or email – and I encourage you to please come see me!
PREREQUISITES: Intro calculus, Physics 103, Botany 130 & computer programming; or consent instructor
MY SCHEDULE: I anticipate being here each class day – no planned travel right now
REQUIRED TEXTBOOK: An Introduction to Environmental Biophysics (second edition, second printing or beyond, 2000). G.S. Campbell and J.M. Norman. Springer Verlag, N.Y. 1998. 286 pp. & additional readings that I will email to you
CREDIT HOURS: 3
CLASS SIZE: Typically limited to 30 students
COURSE WEBSITE (potential additional readings): login with your ID at - https://learnuw.wisc.edu/

Course Description

A quantitative approach to soil-plant-atmosphere interactions with particular emphasis on energy, water and carbon exchanges in agricultural and ecological systems. This includes a description of the physical microenvironments where organisms reside, a discussion of heat and mass transfer models, and applications to exchange processes between organisms and their surroundings. Equations and numerical models are used to provide a quantitative synthesis of information from plant physiology, soil physics and micrometeorology. Some discussion of measurements and instruments is included. Course is taught at the senior or graduate student level.

Expectations

Students are expected (1) to participate actively in course lectures and discussion and **not use cell phones for texting, etc. during lecture**; (2) complete all assigned readings prior to the course lectures; (3) complete one mid-term exam and one final exam (one or both could be take home format); and (4) complete all homework assignments throughout the semester. Other reading/lecture materials may be provided as needed on-line as PDFs (https://learnuw.wisc.edu; login with your UW ID) or emailed directly to you.

Grading

Participation 10%
Mid-term 25%
Final exam 25%
Assigned problem sets (~14 total) 40%

Environmental Biophysics Course Syllabus

(Note: things may change a bit as the course progresses)

Dates	Topic	Reading assignments for that class period	Homework Assignment
Tue Sep 6	**Introduction**: Microenvironments, conservation principles, continuity in the biosphere, models and units	Chapter 1	Problems Chapter 1 – on your own: 1.1, 1.2, 1.3, 1.4 (**not handed in or graded**)
Thu Sep 8	**Temperature:** Typical behavior of soil and air temperatures from seconds to years	Chapter 2, pp. 15-26	Problem set Chapter 2: **DUE 9/15**
Tue Sep 13	**Temperature:** Thermal time, growing degree-days and biological development	Chapter 2, pp. 26-34 *McMaster & Wilhelm, 1997*	
Thu Sep 15	**Water Vapor and other Gases:** Specifying the state of water in the atmosphere, saturation	Chapter 3	Problem set Chapter 3: **DUE 9/22**
Tue Sep 20	**Case study: Madison Urban Heat Island impacts on temperature, water vapor, GDDs, growing seasons** *Guest Lecture by Dr. Jason Schatz*	*Schatz and Kucharik, 2016* *Schatz and Kucharik, 2015*	
Thu Sep 22	**Liquid Water in Organisms and Their Environment:** water potential, water content, water flow between organisms and their environment, phase changes, moisture release curves for leaves and soils	Chapter 4	Problem set Chapter 4: **DUE 9/29**
Tue Sep 27	**Wind:** atmospheric turbulence, modeling wind speed, wind in vegetation	Chapter 5, pp. 63-74	Problem set Chapter 5: **DUE 10/4**
Thu Sep 29	**Heat and Mass Transport**: molar fluxes, resistances and conductances in series and parallel	Chapter 6	Problem set Chapter 6: **DUE 10/6**
Tue Oct 4	**Conductances for Heat and Mass Transport:** molecular diffusion in cells and small animals	Chapter 7, pp. 87-92	

Thu Oct 6	**Conductances for Heat and Mass Transport:** Transport in the atmosphere and above natural surfaces	Chapter 7, pp. 93-99	Problem set Chapter 7: **DUE 10/13**
Tue Oct 11	**Conductance for Heat and Mass Transport:** Convective transport from animals and leaves	Chapter 7, pp. 99-109	
Thu Oct 13	**Heat Flow in the Soil:** Thermal properties, soil temperature, and transport of heat	Chapter 8	Problem set Chapter 8: **DUE 10/20**
Tue Oct 18	**Water Flow in the Soil I:** Soil hydraulic properties, infiltration	Chapter 9, pp. 129-133	
Thu Oct 20	**Water Flow in the Soil:** Evaporation from the soil, redistribution	Chapter 9, pp. 133-139	Problem set Chapter 9: **DUE 10/27**
Tue Oct 25	**Water Flow in the Soil:** transpiration, plant available water	Chapter 9, pp. 139-144	
Thu Oct 27	**Case study on Soil Gas Fluxes:** Connection to the C and N cycles *Guest lecture by Adam von Haden*	Readings to be assigned	
Tue Nov 1	**Radiation Basics:** Electromagnetic spectrum, blackbody radiation, radiation attenuation	Chapter 10	**Take home EXAM:** *Material covered through October 27* **Due November 8**
Thu Nov 3	**Radiation Fluxes in Natural Environments:** Direct and diffuse solar radiation, clouds, sun angles, radiation balance, radiative properties of natural surfaces	Chapter 11, pp. 167-178	Problem set Chapter 10: **DUE 11/10**
Tue Nov 8	**Radiation Fluxes in Natural Environments:** View factors	Chapter 11, pp. 178-183	Problem set Chapter 11: **DUE 11/15**
Thu Nov 10	**Animals and Their Environment Part I:** energy budget concept, metabolism, effects of animal coats and tissues, and animal thermal responses	Chapter 12, pp. 185-194 Chapter 13, pp. 219-220	
Tue Nov 15	**Animals and Their Environment Part II**	Chapter 12, pp. 195-201	Problem set Chapter 12: **DUE 11/22**

Thu Nov 17	**Plants and Plant Communities:** leaf energy balance, leaf temperature	Chapter 14, pp. 223-229	
Tue Nov 22	**Plants and Plant Communities:** Canopy energy balance, transpiration, review of methods to calculate ET**,** canopy temperature *Guest lecture: Mallika Nocco*	Chapter 14, pp. 229-234	Problem set Chapter 14: **DUE 11/29**
Thu Nov 24	**No Class – THANKSGIVING**		
Tue Nov 29	**Plants and Plant Communities:** leaf photosynthesis, simple empirical photosynthesis models, biochemical models, stomatal conductance controls *Guest lecture: Mallika Nocco?*	Chapter 14, pp. 235-245	
Thu Dec 1	**Light Environment of Plant Canopies**: Light Interception, leaf area index, leaf angle distributions, exponential extinction	Chapter 15, pp. 247-254	Problem set: Leaf Energy balance spreadsheet model: **DUE 12/8**
Tue Dec 6	**Light Environment of Plant Canopies:** Diffuse and scattered radiation	Chapter 15, pp. 254-258	Problem set Chapter 15: **DUE 12/13**
Thu Dec 8	**Light Environment of Plant Canopies:** Canopy assimilation, radiation received by leaves, sunlit and shaded leaves, calculating canopy assimilation from leaf assimilation	Chapter 15, pp. 258-263	
Tue Dec 13	**Heterogeneous canopies and indirect Sensing of Canopy Architecture:** Estimating canopy structure; principles, theory, random vs. heterogeneous canopies; instrumentation used	Chapter 15, pp. 273-276	**Take home final exam sent out**
Thu Dec 15	**Putting it all together: Ecological Modeling approaches** *Guest Lecture: Melissa Motew* *Class evaluations*	*Readings to be determined*	
Wed Dec 21	**TAKE HOME FINAL EXAM DUE Dec 21 by 5 PM (originally scheduled for Dec. 17)**		