ENGR(GEOG) 4161/6161 Environmental Microclimatology
The University of Georgia
Fall Semester 2006

Professor: David Emory Stooksbury
Office: 603 Driftmier Engineering Center
Phone: 583-0156 (3-0156 on campus)
E-mail: stooks@engr.uga.edu

UGA Bulletin Course Description
An introduction to the interactions between the biosphere and atmosphere. Energy, moisture, and carbon exchange in the soil-plant-atmosphere continuum with applications to managed and natural environments. The impact of weather and climate on humans and domesticated animals. Elementary turbulent exchange theory will be introduced.
Offered fall semester every even-numbered year.

Credits: 4 hours.

Weekly Class Meeting Pattern: Tu/Th lecture and Tu 3 hours lab/discussion per week.

Level: Undergraduate/Graduate

Undergraduate Prerequisite: (MATH 2500 or MATH 2700) and PHYS 1211-1211L and [(BIOL 1103 and BIOL 1103L) or (BIOL 1104 and BIOL 1104L) or BIOL 1107-1107L or (BTNY 1210 and BTNY 1210L) or (BTNY 1220 and BTNY 1220L)]

Undergraduate Prerequisite or Corequisite: None

Courses that Require this Course as a Prerequisite: None. Course may fulfill the climatology course requirement for the undergraduate and the graduate certificates in atmospheric sciences.

Texts:
An Introduction to Boundary Layer Meteorology (1988) by Roland B. Stull
Floods, Famines, and Emperors by Brian M. Fagan
Dive into Python by Pilgrim

References: None

Topic Outline

Week 1: August 14 - 18 Mean Boundary Layer Characteristics

Stull pp.1-27
boundary-layer definition
wind and flow

turbulent transport
Taylor's hypothesis
virtual potential temperature
boundary layer depth and structure
micrometeorology
significance of the boundary layer

Homework

Exercise 1 (Stull pp. 26-27): 1.1, 1.7, 1.8, 1.10 and 1.11

Homework is due at the beginning of class 22 August

Week 2: August 21 - 25 Application of the Governing Equations to Turbulent Flow

Tuesday Discussion: Fagan: Preface pp. xi - xviii; Chapter 1 (The Great Visitation) and Chapter 2 (Guano Happens) pp. 2-37 (Two page typed summary due at the beginning of class)

Stull pp. 76 - 87

methodology
basic governing equations
simplification, approximations, and scaling arguments

Laboratory: Mathematical and Conceptual Tools

Before laboratory read Stull pp.29-45

the significance of turbulence and its spectrum
the spectral gap
mean and turbulent parts
basic statistical methods
- the mean
- rules of averaging
- Reynold's averaging
- variance
- standard deviation
- turbulence intensity
- covariance
- correlation

Laboratory Exercise 1 (Stull pp. 70-71): 2.2, 2.3, 2.4, 2.5, and 2.6

Homework

Exercise 2 (Stull pp. 111-112): 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, and 3.7

Homework is due at the beginning of class 29 August

Week 3: August 28 - September 1 Prognostic Equations for Turbulent Fluxes and Variances

Tuesday Discussion: Fagan: Chapter 3 (ENSO) and Chapter 4 (The North Atlantic Oscillation) pp. 39-70 (Two page typed summary due at the beginning of class)

Stull pp. 87-114

equations for mean variables in a turbulent flow
summary of equations, with simplification

Laboratory: Turbulence and Flux

Before laboratory read Stull pp. 45-56

turbulence kinetic energy (TKE)
kinematic flux
eddy flux
turbulent flux profiles

Laboratory Exercise 2 (Stull pp. 71-73): 2.7, 2.10, 2.11, 2.14, 2.15, 2.16, and 2.17

Homework

Exercise 3 (Stull pp. 112-113): 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, and 3.15

Homework is due at the beginning of class 5 September

Week 4: September 4 - 8 Turbulence Kinetic Energy

Tuesday Discussion: Fagan: Chapter 5 (A Time of Warming) and Chapter 6 (Pharaohs in Crisis) pp. 71-117 (Two page typed summary due at the beginning of class)

Stull pp. 115-134

prognostic equations for the turbulent departures
free convection scaling variables
prognostic equations for variances

Laboratory:

Before laboratory read Stull pp 57-69

summation notation
comparison with vector notation
stress
- -pressure
- -Reynolds
- -viscous

friction velocity

Laboratory Exercise 3 (Stull pp. 73-74): 2.23, 2.24, 2.25, 2.26, 2.27, and 2.28

Homework

Exercise 4 (Stull pp. 113-114): 3.17, 3.18, 3.19, 3.23, 3.26

Homework is due at the beginning of class 12 September

Week 5: September 11 - 15 Stability and Scaling

Tuesday Discussion: Fagan: Chapter 7 (The Moche Lords) and Chapter 8 (The Classical Maya Collapse) pp. 119-158 (Two page typed summary due at the beginning of class)

Stull pp. 169 - 196

prognostic equations for turbulent fluxes
TKE budget derivation
contributions to the TKE budget
mean kinetic energy and interaction with turbulence
stability concepts
Richardson number
Obukhov length
dimensionless gradients
miscellaneous scaling parameters
combined stability tables

Laboratory:

Before laboratory read Stull pp. 295-302

autocorrelation
structure function

Week 6: September 18 - 22 Turbulence Closure Techniques

Tuesday Discussion: Fagan: Chapter 9 (The Ancient Ones) and Chapter 10 (The Little Ice Age) pp. 159-201 (Two page typed summary due at the beginning of class)

Stull pp. 197 -220

The Closure Problem
parameterization rules
local closure - zero and half order
local closure - first order
local closure - one-and-a-half-order

Laboratory: Discrete Fourier Transform

Before laboratory read Stull pp. 303-310

Discrete Fourier Transform

Week 7: September 25 - 29 Turbulence Closure Techniques

Tuesday Discussion: Fagan: Chapter 11("Drought Follows the Plow") and Chapter 12 (El Ninos that Shook the World) pp. 203-241 (Two page typed summary due at the beginning of class)

Stull pp. 220 - 250

local closure - second order
local closure - third order
nonlocal closure - transilient turbulence theory
nonlocal closure - spectral diffusivity theory

Laboratory: Fast Fourier Transform

Before laboratory read Stull pp. 310-312

Fast Fourier Transform

<u>Week 8: October 2 - 6 Boundary Conditions and External Forcing</u>

Midterm is Wednesday October 4

Stull pp. 251 - 294

effective surface turbulent flux
heat budget at the surface
radiation budget
fluxes at interfaces
partitioning of flux into sensible and latent portions
flux to and from the ground

Lab/Discussion: Literature Presentation I

<u>Week 9: October 9 - 13 Similarity Theory</u>

Take Home Exam I: Due back on October 21.

Midpoint Withdrawal Deadline is Monday October 9

Stull pp. 347 - 404

Buckingham Pi dimensional analysis methods
scaling variables
similarity relationship list
log wind profile
Rossby-number similarity and profile matching
spectral similarity
similarity scaling domains

<u>Week 10: October 16 - 20 Measurement and Simulation Techniques</u>

Tuesday Discussion: Fagan: Chapter 13(The Fate of Civilizations) pp. 243-260 (Two page

typed summary due at the beginning of class)

Stull pp. 405 - 440

sensor and measurement categories
instruments
field experiments
simulation methods
analysis methods

Laboratory: Energy Spectrum
Before laboratory read Stull pp. 312-318

Energy Spectrum

Week 11: October 23 - 27 Convective Mixed Layer

Fall Break is Thursday-Friday October 26 – 27

Stull pp. 441 - 498

unstable surface layer
mixed layer
entrainment zone
entrainment velocity and its parameterization
subsidence and advection

Laboratory: Spectral Characteristics
Before laboratory read Stull pp. 318-329

Spectral Characteristics

Week 12: October 30 - November 3 Stable Boundary Layer

Stull pp. 499 - 544

mean characteristics
processes
evolution
other depth models
low level nocturnal jets
buoyancy (gravity) waves
terrain slope and drainage winds

Lab/Discussion: Literature Presentation II
Week 13: November 6 - 10 Boundary Layer Clouds

Stull pp. 545 -586

thermodynamics

radiation
cloud entrainment mechanisms
fair-weather cumulus
stratocumulus
fog

Laboratory: Spectra of Two Variables and Periodgram
Before laboratory read Stull pp. 329-336
spectra of two variables
periodgram

Week 14: November 13 - 17 Geographic Effects

Stull pp. 587 - 618
geographically generated local winds
geographically modified flow
urban heat island

Laboratory: More Spectral Analysis
Before laboratory read Stull pp. 336-343
nonlocal spectra
spectral decomposition of the TKE equation

Week 15: November 20 - 21 Microclimatology of Plant Canopies

Thanksgiving Holiday is Wednesday-Friday November 22-24

Week 16: November 27 - December 1 Microclimatology of Forests and Animals

Lab: Students' Final Projects Presentations

Week 17: December 4 - 8
Classes End on Wednesday December 6; For the Fall Semester 2006, the University will operate a Friday class schedule on Wednesday, Dec. 6 and a Thursday class schedule on Tuesday, Dec. 5.

Course Learning Objectives Matrix

Course Learning Objectives	Course Assessment Methods*	Extent of Coverage of Program Outcomes**

		(ABET Criterion 3)
Upon successful completion of this course, the student will be able to:		
1. Students will be able to demonstrate an understanding of the soil-plant-atmosphere continuum.	A, B, C	a - xxx b - x h - xxx
2. Students will be able to demonstrate an understanding of the microclimate impacts managed and natural ecosystems.	A, B, C, D	a - xxx b - x d - x h - xxx e - xxx
3. Students will be able to demonstrate the use of climate information in management decisions involving managed and natural ecosystems.	A, B, C, D	a - xxx d - x g - xxx h - xxx e - xxx

* Course Assessment Methods: A - Homework; B - Hourly Exams; C - Final Exam; D - Computer based project; E - Student Evaluation

** Extent of Coverage: x - some, xx - moderate, xxx - extensive

ABET EC-2000 Criterion 3 Program Outcomes

a) an ability to apply knowledge of mathematics, science, and engineering
b) an ability to design and conduct experiments, as well as to analyze and interpret data
d) an ability to function on multi-disciplinary teams
g) an ability to communicate effectively
h) the broad educational necessary to understand the impact of engineering solutions in a global and societal context
j) a knowledge of contemporary issues

Overall Course Contribution to Program Outcomes

This course is designed with to audiences in mind. The first audience is ecological engineering students wile the second audience is students in the applied life sciences (agriculture, forestry, ecology, etc). Both of these audiences need an understanding of the linkages within the soil-plant-atmosphere continuum and how these systems impact each other.

Method of Grading

Midterm take home exam	15%
Final take home exam	15%
Final Project	30%
Weekly Write-ups	10%
Literature Presentation I	10%
Literature Presentation II	10%
Participation	10%

Revision

15 August 2006

Additional Information

Academic Honesty
The University of Georgia seeks to promote and ensure academic honesty and personal integrity among students and other members of the University Community. A policy on academic honesty has been developed to serve these goals. All members of the academic community are responsible for knowing the policy and procedures on academic honesty. The document for academic honesty may be found at the web site for The University of Georgia Office of Senior Vice President for Academic Affairs and Provost.

Engineering Professional Policy
Engineers make great contributions to society. Engineering is a very satisfying profession that provides many rewards but is demanding and requires hard work. The engineering profession is governed by a code of ethics. Engineering faculty at UGA expect students to act in a professional manner at all times and develop the work ethics required for a successful engineering career. Engineering students at UGA are responsible for maintaining the highest standards of professionalism and professional practice.

Departmental Grading Policy Regarding Communication Skills
Thirty percent of the grade on all written assignments (lab reports and papers) and oral presentations will be based on quality of communication. Spelling, grammar, punctuation, and clarity of writing are evidence of written communication quality. Enunciation, voice projection, clarity and logical order of the presentation and effective use of visual aids are evidence of oral communication quality.

Homework
Homework is due at the beginning of class on the dates indicated. Late homework will not be accepted. Students are responsible for all the material covered in class and the appropriate sections of the textbooks.

Discussion Write-ups
Two page typed (10 or 12 point with one inch margins) discussion write-ups are due at the beginning of Tuesday 's lecture. Each write-up should include a summary of Fagan's main points and *your* thoughts on his points.

Literature Presentations
Each student will be required to give two literature presentations during the semester. The presenter will be responsible for choosing the research problem, finding the appropriate literature (4-7 articles for undergraduates, 7-10 for graduates), presenting the findings using PowerPoint, and leading a class discussion on the research problem.

Final Project Presentation
Students will give a PowerPoint presentation appropriate for a college educated (non-science) audience about the topic covered in their project. This presentation will be given the last week of

classes.

The instructor reserves the right to modify this syllabus as he deems necessary.

Final Take Home Exam is Due on Tuesday 12 December 2006 at 3:30 pm