MET6480: Advanced Topics in Physical Meteorology

Fall 2019

Instructor:	Yana Bebieva	**Time:**	MW 3.35 – 4.50
Email:	ybebieva@fsu.edu	**Place:**	305 LOV

Office Hours: After class or by appointment.

Textbooks: Xuhui Lee, *Fundamentals of Boundary-Layer Meteorology*, Springer, 2018. Supplementary: Roland B. Stull, *An Introduction to Boundary Layer Meteorology*, Kluwer Academic Publishers, 1988.

Course description and objectives: This course is primarily designed for upper-level undergraduate or graduate students. The course develops a foundation in boundary-layer meteorology by examining the dynamics and thermodynamics of the lower atmosphere. Students will establish a solid conceptual understanding of the fundamental equations used to describe boundary layer phenomena with the focus on grasping the physical meaning of the equations. Students will learn about measurement techniques and modern modeling needs and capabilities in the field. Throughout the course, students will master a scientific approach to solving problems in areas such as turbulence generation and destruction, canopy flow, and tracer diffusion. The skills gained during the course could be applied later in students' own research projects.

Prerequisites: Working knowledge of multi-variable calculus, partial differential equations (however, we will use simplified sets of equations), and basic physics. Previous knowledge of fluid mechanics and thermodynamics is helpful.

Grading Policy: Homework assignments (40%), quizzes (5%), Mid-term exam (closed book, 20%), report and class presentation on applications of the course material to students' own research projects at the end of the semester (35%). Homework solutions will be discussed immediately after assignments are completed, while the problems are still fresh in mind. For this reason, homework is due at the beginning of class on the date due, and no late work will be accepted. Arrangements must be made with the instructor for the making up of missed classes/deadlines/exams.

Grading scale ("pt" means points):

Grade	Range	Grade	Range
A	93 - 100 pt	C	73 - 76 pt
A-	90 - 92 pt	C-	70 - 72 pt
B+	87 - 89 pt	D+	67 - 69 pt
B	83 - 86 pt	D	63 - 66 pt
B-	80 - 82 pt	D-	60 - 62 pt
C+	77 - 79 pt	F	<60 pt

Important Dates:

Midterm Exam ..... October 14, 2019
Class Presentations ..... December 5, 2019

Course Website: Canvas.

Course Policy: Please do not use electronic devices (including cell phones, tablets, or computers) for communication during class and exam times.

University Attendance Policy: Arrangements should be made with the instructor for the making up of missed classes/deadlines/exams. Excused absences include documented illness, deaths in the family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. These absences will be accommodated in a way that does not arbitrarily penalize students who have a valid excuse. Consideration will also be given to students whose dependent children experience serious illness (Please refer to the Academic Regulations and Procedures,
https://registrar.fsu.edu/bulletin/undergraduate/information/academic_regulations/).

Academic Honor Policy: Academic Honor Policy: The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to "...be honest and truthful and...[to] strive for personal and institutional integrity at Florida State University." (Florida State University Academic Honor Policy, found at http://fda.fsu.edu/Academics/Academic-Honor-Policy). Collaborative learning (i.e., working together on assignments and/or the final project) is encouraged, however, all parts of homework solutions/project paper must be written individually. Students should be certain that they can reproduce any part the work that they turn in.

Americans With Disabilities Act: Students with disabilities needing academic accommodation should:
(1) register with and provide documentation to the Student Disability Resource Center;
(2) bring a letter to the instructor indicating the need for accommodation and what type.

Please note that instructors are not allowed to provide classroom accommodation to a student until appropriate verification from the Student Disability Resource Center has been provided. This syllabus and other class materials are available in alternative format upon request. For more information about services available to FSU students with disabilities, contact :

Student Disability Resource Center,
874 Traditions Way,
108 Student Services Building,
Florida State University,
Tallahassee, FL 32306-4167,
(850) 644-9566 (voice),
(850) 644-8504 (TDD),
sdrc@admin.fsu.edu
http://www.disabilitycenter.fsu.edu/.

Tentative Course Outline

Week	Dates	Topics
1	8/26	**Fundamental Equations:** Conservation equations. The ideal gas law. The surface energy balance.
	8/28 QZ[1]	**Governing Equations for Mean Quantities:** Reynolds decomposition. The mean equations for velocity, mixing ratio, and potential temperature. Simplified 1D equations.
2	9/2	*Labor Day.*
	9/4	The closure Problem. Quantifying Eddy Fluxes.
3	9/9 HW[2]	**Generation and Maintenance of Atmospheric Turbulence:** Energy transfer. Budgets of mean flow kinetic energy. Budget of the turbulent kinetic energy.
	9/11	Air stability.
4	9/16 QZ	**Flow in Plant Canopies:** Canopy morphology & volume average. The Mean momentum equations.
	9/18	Analytical wind profile in the canopy. Budgets of mean flow and TKE. Shear instability and transition to turbulence.
5	9/23 HW	**Balance of Forces in the Atmospheric Boundary Layer:** Atmospheric layers. Balance of forces in neutral and convective conditions.
	9/25	Balance of forces in stable conditions.
6	9/30 QZ	**Tracer Diffusion in the Lower Boundary Layer:** Basic Constrains. Point-Source diffusion in homogeneous turbulence.
	10/2	Gaussian plume model for elevated sources in the boundary layer. Diffusion from ground-level sources.
7	10/7	Diffusion in plant canopies. Footprint theory.
	10/9 HW	Course review
8	10/14	**Midterm Exam**
	10/16	**Principle of Eddy Covariance:** The canopy source term. The concept of net ecosystem exchange.
9	10/21	The chamber method. The eddy covariance control volume. Eddy covariance in advection-free conditions.
	10/23	Vertical advection. Horizontal advection. Practical consideration.
10	10/28 QZ	**Density Effects on Flux Measurements:** Density effects. Density corrections to eddy covariance fluxes.
	10/30	Density effects on flux-gradient relation. Density corrections to chamber fluxes.
11	11/4 HW	**Energy Balance, Evaporation, and Surface Temperature:** Resistance analogy for leaf-scale fluxes. Canopy energy balance and the big-leaf model.
	11/6	One-source model in remote sensing applications. Two-source model of evaporation.
12	11/11	*Veterans Day*
	11/13	Improved representations of surface-air exchange. One-source model of surface temperature.
13	11/18 QZ	**Budgets of Heat, Water Vapor, and Trace Gases in the Atmospheric Boundary Layer:** The slab approximation of the convective boundary layer. Boundary-layer growth and entrainment.
	11/20	Boundary-layer growth and entrainment (cont'd).
14	11/25	Heat budget in the convective boundary layer. Carbon dioxide budget in the convective boundary layer.
	11/27	*Thanksgiving Day Holiday*
15	12/2	Water vapor budget in the convective boundary layer. Trace gases in the nighttime stable boundary layer. The equilibrium boundary layer.
	12/5	**Class presentations**

[1] Quiz.

[2] Homework assignment is due on this date. Please turn it in at the start of class.