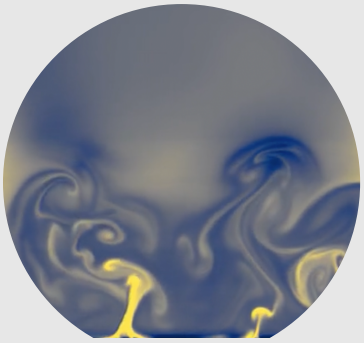

Boundary Layers & Turbulence

ESCI 448 (3 Credit Hours)

Instructor Info

- Dr. Greg Blumberg
- Office Hrs: Mon 1:00-2:00 PM, Tues 3:00-5:00 PM, Wed 1:00 PM-3:00 PM
- Caputo Hall, Room 409
- 717-871-7434
- http://wblumberg.github.io
- Greg.Blumberg@millersville.edu

Course Info

- Prereq: C- or higher in ESCI 342 and MATH 211.
- Monday & Friday
- Monday 5:00-6:15 PM, Friday 8:30-9:25 AM
- Caputo 402

Course Topics

Mean boundary layer characteristics; turbulence and its spectrum; governing equations to turbulent flow; prognostic equations for turbulent fluxes and variances; turbulence kinetic energy; turbulence closure schemes; similarity theory; simulation techniques; convective and stable boundary layers; boundary layer clouds.

Material

Recommended Text

Boundary Layer Meteorology, R. B. Stull

Other

Any required materials (e.g., book chapters, research papers) will be provided on D2L.

Grading Scheme

10%	Participation
30%	Classwork/Homework
30%	PBL Parameterization Project
30%	Kite Project

Grades will follow the standard scale:

Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
Minimum %	94	90	87	83	80	77	73	70	67	63	60	0

Curving is at the discretion of the professor.

These various assignments are here to help reinforce the material we're learning and let you know how well you have mastered the material. In my mind, a good class has regular questions or comments that contribute to the classroom discussion and demonstrate your thinking. The Classwork/Homework category will consist of various short assignments for you to implement the concepts and skills you've learned in this class, and will be occasionally graded on completion.

There will be *two semester group projects* that allow you to explore the PBL through modeling and observations. For the modeling project, you must run the WRF single column model and present to the class information on a specific PBL parameterization scheme. In the observation project, you will fly kites with your group around Lancaster and present an analysis of your observations.

Late Work & Absences Policy

Attendance in this class is important as the material will be relevant to your career at some point! You don't want to miss out on a key piece of information that could help you make a better decision! If you need to be absent from class, please let me know ahead of time.

With respect to homework/classwork, I am willing to let you miss one assignment - no questions asked. Occasionally unwelcome life events occur (e.g., health, family issues, etc.). Because I understand how difficult these times can be, I am happy to work with you to see that you are caught up.

Course Learning Objectives

By the end of this course, you should have an understanding of:

- typical characteristics of daytime and nighttime planetary boundary layer (PBL).
- characteristics of transitional boundary layers (evening transition, morning transition, heterogeneous surfaces).
- ways the governing equations are altered to account for turbulent motions (e.g., Reynolds-Averaged Navier-Stokes, Large Eddy Simulations, Direct Numerical Simulation).
- what encompasses the turbulence closure problem and ways to resolve it.
- how to operate single column models to study the evolution of the PBL.
- differences between local and non-local methods of closing the turbulence budget.
- similarity theory and its use in atmospheric boundary layer modeling.
- common boundary layer parameterization schemes used in numerical weather prediction models.
- surface layer parameterization schemes (Monin-Obukhov Similarity Theory, K-theory).
- land-surface influences and feedbacks on the PBL (also known as lower boundary conditions and surface forcings).
- how to use the eddy correlation method to calculate statistical moments of turbulence.
- PBL/mesoscale phenomena such as the urban heat island, sea/land/vegetation breezes.
- how various PBL wind structures are formed (e.g., Ekman pumping, nocturnal low-level jets, log-wind profile).
- common and state-of-the-art instrumentation for PBL monitoring.

JupyterHub and Python

I have worked with Dave Fitzgerald to set up a JupyterHub server for my classes. This is a website that you can log into and access Jupyter notebooks to write Python code with. There will be some components of this class where we will be using Python to do some data analysis. The website to access the JupyterHub will be provided in-class.

IMPACTS

This semester I am involved in the IMPACTS field project between January and February. Because I will have to participate in occasional deployments to launch weather balloons (as will others in this class, I imagine), we may have to hold our class virtually. I will send an email out and/or put a message up on D2L to let you know when this may happen.

Contacting Me

I'm invested in your success in this course. Professors like myself hold office hours so students can come by to talk about the course material or ask questions about the field of study we are involved in. If you cannot make it into my office, I also have a virtual meeting room through the Zoom software, which you need to use your university account to access. Please send me an email if you'd like to meet with me virtually!

Here is the link to my Zoom meeting room for Office Hours:

`https://millersville.zoom.us/j/94617438462`

Should you need to contact me over email regarding this class, you must follow the rules below. Doing so will be helpful for me in staying organized and allow me to reply to your request in a timely manner:

1. Put your course number and "ESCI" into your email subject line (e.g., "ESCI 109 - Lab 2 Questions").
2. Use your Millersville account email instead of your personal email.
3. Start and end with a proper greeting (e.g., "Good morning, Dr. Blumberg" "Sincerely, *Your Name*").
4. Check your grammar and punctuation!
5. Be kind and gracious.
6. Be clear about what it is you want to tell me. If you have run into an issue, let me know how you've tried to solve it first!

Diversity and Inclusion Statement

I consider this classroom to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability - and other visible and non-visible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

Accommodations for Students with Disabilities

If you have a documented physical or learning disability and want to use your special accommodations through the Learning Center, please let me know. Your accommodations may benefit other students in our class as well! Resources for obtaining these accommodations can be found at http://www.millersville.edu/learningservices/disabilityaccom.php.

ADA Program (Office of Learning Services) Americans With Disability Act | Millersville University (if you have a disability that requires accommodations under the Americans with Disabilities Act, please present your letter of accommodations and meet with me as soon as possible so that I can support your success in an informed manner. Accommodations cannot be granted retroactively. If you would like to know more about the Millersville University Office of Learning Services-please contact the office at 717-871-5554)

Millersville University Policies and Links

- Academic Honesty Policy link Governance Manual (millersville.edu); for additional information please see the following: What is Academic Integrity? | Millersville University
- Attendance Policy link: Class Attendance Policy | Millersville University
- Inclusion Statement: Millersville University Inclusion Statement | Millersville University
- Land Acknowledgement: Land Acknowledgement | Millersville University
- Policy on Delays and Cancellations link Policy on Delays & Cancellations | Millersville University
- Preferred Name FAQs link Preferred Name FAQs | Millersville University
- Privacy Rights under FERPA link Annual Notification of Student Rights Under FERPA | Millersville University
- Student Conduct and Community Standards Handbook link studentcodeofconduct.pdf (millersville.edu)
- Title IX Reporting Requirements and the Faculty member: Millersville University is committed to maintaining a safe education environment for all students. In compliance with Title IX of the Education Amendments of 1972 and guidance from the Office for Civil Rights, the University requires faculty members to report incidents of sexual violence shared by students to the University's Title IX Coordinator. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. Faculty members are obligated to report sexual violence or any other abuse of a students who was, or is, a child (under 18 years of age) when the abuse allegedly occurred to the person. Information about Title IX, resources and reporting can be found at: What is Title IX | Millersville University