Microclimatology: Boundary Layer Climatology (Geography 5921)
Spring 2026
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Office Hours: T & TR 11:00-1:00 p.m. (Beck), T & TR 4:00–5:00 p.m. (Quiring), and by appointment. Office hours are in person.

If you are not available during my regular office hours, please feel free to contact me to setup a meeting at a time that works for you.

Lectures: Tuesday and Thursday, 2:20 p.m. – 3:40 p.m., 070 Derby Hall

Required Materials:
Boundary Layer Climates, 2nd Edition (1987), Oke, ISBN-13: 9780415043199

Digital version of this textbook is freely available from OSU library and through Carmen.

Class Website: carmen.osu.edu

Course Objectives:

The **boundary layer** is the part of the atmosphere that is affected by interactions with the surface. This course covers the fundamentals (processes, spatial and temporal variations and methods for measuring and modeling) of atmosphere-surface interactions, including:
(1) radiation fluxes,
(2) turbulent heat, moisture, and momentum fluxes, and
(3) subsurface conductive fluxes.

The boundary layer is where humans, animals and plants live. Therefore, it is an important part of the atmosphere and it has a direct impact on the biosphere. Human activities both control, and are controlled by, boundary layer climates. For example, atmospheric pollutants are concentrated near the surface and diffuse into the atmosphere by turbulence. Land use/land cover regulates the daily and seasonal cycles of energy and moisture exchange between the surface and the atmosphere. Large-scale atmospheric motions are influenced by surface energy exchanges.

Students will gain the conceptual framework necessary to understand and quantify surface-atmosphere interactions. The course will also explore the various ways that anthropogenic activities influence these interactions (especially at local to regional scales).

The lectures will provide the theoretical background for the class. The homework assignments will give students the opportunity to apply these principles. The research project will provide the

students with an opportunity to explore in greater depth a topic that is of interest to them.

Learning Objectives:

As a result of taking this course you should know certain things (knowledge objectives) and be able to do certain things (skill objectives).

Knowledge objectives (Things you should know by the end of the course):

- Describe the processes that are responsible for energy, moisture and momentum exchange between the surface and the atmosphere
- Describe the spatial and temporal variations in each component of the surface energy and moisture budgets, and the physical processes that are responsible for these patterns
- Describe how each component of the surface energy and moisture budget are measured and modeled and the biases (errors) in each of the measuring and modeling techniques
- Evaluate how human activities influence moisture and energy fluxes in the boundary layer at local, regional and global scales
- Evaluate how human activities are influenced by moisture and energy fluxes in the boundary layer at local, regional and global scales
- Critically evaluate and identify sources of uncertainty measurements and models of surface energy and water exchanges

Skill objectives (Things you should be able to do by the end of the course):

- Calculate and interpret a surface energy budget
- Calculate and interpret a surface water budget
- Quantify the influence of atmospheric stability on energy, moisture and momentum fluxes
- Use Python to visualize data using maps and graphs
- Generate graphs and maps for your research paper and oral presentation
- Write a scientific research paper or literature review paper that develops an argument from multiple sources. This paper will conform to the standard for publication in a peer-reviewed journal
- Deliver a clear and concise oral presentation on the research that you completed during the semester

Grading:

Your grade will be calculated as follows:

Exercises	35%
Mid-term exam	20%
Research paper	20%
Oral presentation	5%
Final exam	20%

Exercises (35% each)

The exercises will require you to apply what you learn in this class. There will be 9 exercises assigned during the semester. The exercises will be assigned one week before they are due. These are individual assignments and each student must submit their own work. However, you may discuss the questions and work collaboratively. **There are no makeup assignments and late submissions are not accepted.**

Exams (20% each)
The two exams will be based on the material covered in the lectures, readings, and exercises. The final exam will be cumulative. They will involve short answer, application and problem solving (based on the exercises), and paragraph/essay questions.

- **Midterm Exam** (Thursday, March 12)
- **Final exam** (April 29, 2:00-3:45 pm)

Barring extraordinary circumstances, there will be no make-up exams. Written documentation will be required and verified before a make-up exam will be considered. Students must contact the instructor ***prior*** *to any exam to be considered for a make-up exam.*

Research Paper (20%)
The research paper will provide you with an opportunity to do an in-depth analysis on a topic related to boundary layer climates that is of interest to you. I am expecting you to either provide a review and synthesis of the relevant literature and/or to analyze data. The paper should be approximately 12 to 14 pages of text and should follow the style of *Journal of Applied Meteorology and Climatology*.

You are welcome to select any topic that relates to boundary layer climates. I have listed examples of a number of topics that would be appropriate:

- How does land use/land cover change influence the local and regional climate? It would be best to select a specific type of land cover change such as urbanization, deforestation, irrigated agriculture, etc.
- Urban heat islands or urban climates
- Air pollution
- Impact of aerosols on clouds, hurricanes, or …
- Select one component of surface-atmosphere interactions (ocean-atmosphere, land-atmosphere; sea ice-atmosphere) and examine how it will be influenced by climate change (or by other anthropogenic activities)
- How do land-atmosphere interactions influence/cause droughts?
- Impact of the land surface on hurricanes (i.e., brown ocean)
- How does atmospheric stability influence dispersion and transport of air pollution?
- How does urbanization influence precipitation patterns?
- How is tornadic frequency (or intensity or width) influenced by land surface characteristics (surface roughness, elevation, slope, etc.)?
- How do droughts influence the surface energy budget?

The research paper is due on Friday, April 24 (worth 20% of your final grade).

Oral Presentation (5%)
Each student will give a 6 to 8 minute presentation in class on April 21 or April 23 that summarizes the results of your research paper. I will distribute a grading rubric and discuss the requirements of the presentation in class.

The grading scale is:
A = 93 to 100%
A- = 90 to 92%
B+ = 87 to 89%
B = 83 to 86%
B- = 80 to 82%
C+ = 77 to 79%
C = 73 to 76%
C- = 70 to 72%
D+ = 67 to 69%
D = 63 to 66%
D- = 60 to 62%
E = <59%

Expectations of students

- Attend all classes, be on time, and actively participate in the class.
- You will be responsible for understanding all the material covered in lecture and that is part of the assignments.
- Complete all assignments.
- Read assigned material. Wider reading is encouraged.
- Submit assignments on time. **No late assignments will be accepted.**
- Some material that will be presented in class is not in the textbook, so make arrangements to get notes if you are absent.

Class Policies

No private conversations or other distracting behavior will be tolerated.
All cellphones must be silent during class. Please refrain from email/texting during class.

Ohio State's Academic Integrity Policy

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the university's *Code of Student Conduct*, and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the university's *Code of Student Conduct* and this syllabus may constitute "Academic Misconduct."

The Ohio State University's *Code of Student Conduct* (Section 3335-23-04) defines academic misconduct as: "Any activity that tends to compromise the academic integrity of the university or subvert the educational process." Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the university's *Code of Student Conduct* is never considered an excuse for academic misconduct, so I recommend that you review the *Code of Student Conduct* and, specifically, the sections dealing with academic misconduct.

If I suspect that a student has committed academic misconduct in this course, I am obligated by university rules to report my suspicions to the Committee on Academic Misconduct. If

COAM determines that you have violated the university's *Code of Student Conduct* (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the university.

If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.

Other sources of information on academic misconduct (integrity) to which you can refer include:

- The Committee on Academic Misconduct web pages (COAM Home)
- *Ten Suggestions for Preserving Academic Integrity (Ten Suggestions)*
- *Eight Cardinal Rules of Academic Integrity* (www.northwestern.edu/uacc/8cards.htm)

Copyright Disclaimer
The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Statement on Title IX
Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at *http://titleix.osu.edu* or by contacting the Ohio State Title IX Coordinator at *titleix@osu.edu*.

Statement on Religious Accommodations
Ohio State has had a longstanding practice of making reasonable academic accommodations for students' religious beliefs and practices in accordance with applicable law. In 2023, Ohio State updated its practice to align with new state legislation. Under this new provision, students must be in early communication with their instructors regarding any known accommodation requests for religious beliefs and practices, providing notice of specific dates for which they request alternative accommodations within 14 days after the first instructional day of the course. Instructors in turn shall not question the sincerity of a student's religious or spiritual belief system in reviewing such requests and shall keep requests for accommodations confidential.

With sufficient notice, instructors will provide students with reasonable alternative accommodations with regard to examinations and other academic requirements with respect to students' sincerely held religious beliefs and practices by allowing up to three absences each semester for the student to attend or participate in religious activities. Examples of religious accommodations can include, but are not limited to, rescheduling an exam, altering the time of a student's presentation, allowing make-up assignments to substitute for missed class work, or flexibility in due dates or research responsibilities. If concerns arise about a requested accommodation, instructors are to consult their tenure initiating unit head for assistance.

A student's request for time off shall be provided if the student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement and the student has notified their instructor, in writing during the first 14 days after the course begins, of the date of each absence. Although students are required to provide notice within the first 14 days

after a course begins, instructors are strongly encouraged to work with the student to provide a reasonable accommodation if a request is made outside the notice period. A student may not be penalized for an absence approved under this policy.

If students have questions or disputes related to academic accommodations, they should contact their course instructor, and then their department or college office. For questions or to report discrimination or harassment based on religion, individuals should contact the **Office of Institutional Equity**. (Policy: **Religious Holidays, Holy Days and Observances**).

Your Mental Health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available 24/7 by dialing 988 to reach the Suicide and Crisis Lifeline.

Accessibility accommodations for students with disabilities

Requesting Accommodations

The university strives to maintain a healthy and accessible environment to support student learning in and out of the classroom. If you anticipate or experience academic barriers based on your disability (including mental health, chronic, or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion.

If you are ill and need to miss class, including if you are staying home and away from others while experiencing symptoms of a viral infection or fever, please let me know immediately. In cases where illness interacts with an underlying medical condition, please consult with Student Life Disability Services to request reasonable accommodations. You can connect with them at **slds@osu.edu**; 614-292-3307; or **slds.osu.edu**.

Accessibility of course technology

This course requires use of Carmen (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor.

- CarmenCanvas accessibility
- CarmenZoom accessibility

Artificial Intelligence Policy

All students have important obligations under the Code of Student Conduct to complete all

academic and scholarly activities with fairness and honesty. Our professional students also have the responsibility to uphold the professional and ethical standards found in their respective academic honor codes. Specifically, students are not to use "unauthorized assistance in the laboratory, on field work, in scholarship or on a course assignment" unless such assistance has been authorized specifically by the course instructor. In addition, students are not to submit their work without acknowledging any word-for-word use and/or paraphrasing" of writing, ideas or other work that is not your own. These requirements apply to all students — undergraduate, graduate, and professional.

To maintain a culture of integrity and respect, these generative AI tools should not be used in the completion of course assignments unless an instructor for a given course specifically authorizes their use. Some instructors may approve of using generative AI tools in the academic setting for specific goals. However, these tools should be used only with the explicit and clear permission of each individual instructor, and then only in the ways allowed by the instructor. In accordance with this policy, in our course we will use (and not use) AI in the following ways: (1) **Coding/programming assistance.** It is permissible to use AI to help write code and debug code. This includes python code that is used for generating plots and analysis for the exercises. (2) **Literature search.** It is permissible to use AI to help find peer-reviewed journal articles for your research paper. (3) **Miscellaneous**. You can use AI to learn about course concepts, find resources or data, or other similar searches.

If you are not sure if a tool you wish to use is permitted for this course, please contact me to discuss it first.

Tentative Class Schedule

The following course schedule is a guide and it may change as the class evolves. ***The exam dates are fixed****.*

Date	**Lecture**
Jan. 13	Syllabus and Introduction to boundary layer climates
Jan. 15	Introduction to Python and Jupyter Notebook Exercise #1: Introduction to reading data and making graphs
Jan. 20	Importance of the atmospheric boundary layer; Radiation (pp. 4-17)
Jan. 22	Python: Syntax, Data Types and Mathematical Operators Exercise #2: Radiation
Jan. 27	Surface Radiation Balance (pp. 8-27) **(recorded lecture provided on Carmen)**
Jan. 29	Python: Numpy arrays and calculations **(recorded lecture provided on Carmen)** Exercise #3: Surface radiation budget
Feb. 3	Surface Radiation Balance (pp. 8-27)
Feb. 5	Python: Plotting and visualization with Matplotlib Exercise #4: Solar geometry
Feb. 10	Surface Energy Budget (pp. 33-76)
Feb. 12	Python: Flow control: interactive, conditional statements Exercise #5: Sensible heat
Feb. 17	Vertical Wind Profile (pp. 37-42; 54-59)
Feb. 19	Python: Mapping Exercise #6: Ground heat
Feb. 24	Ground Heat (pp. 42-48)
Feb. 26	Python: Input/output Exercise #7: Vertical wind profile
Mar. 3	Evaporation & Latent Heat (pp. 63-71)
Mar. 5	Python: MetPy Exercise #8: Surface energy budget
Mar. 10	Exam review
Mar. 12	**Midterm Exam**
Spring break (March 16 to 20)	
Mar. 24	Midterm Results & Research Projects
Mar. 26	Land cover change Exercise #9: Research paper outline
Mar. 31	Irrigation
Apr. 2	Urban boundary layer
Apr. 7	Boundary layer of hurricanes
Apr. 9	Air pollution & dispersion
Apr. 14	Land surface-atmosphere interactions
Apr. 16	Ice-atmosphere interactions
Apr. 21	Student presentations #1
Apr. 23	Student presentations #2
Apr. 29	**Final Exam (2:00 pm to 3:45 pm)**