Microclimatology: Boundary Layer Climatology (Geography 5921)
Spring 2020
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Office Hours: T 4:00–5:00 p.m., TR 4:00–5:00 p.m. and by appointment.
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, 11:10 a.m. – 12:30 p.m., Scott Lab N054

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

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 paper 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 how and why they vary over space and time
- 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
- Discuss how human activities influence moisture and energy fluxes in the boundary layer (anthropogenic influences)
- Discuss how human activities are influenced by moisture and energy fluxes in the boundary layer (anthropogenic impacts)

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

- Calculate how incoming shortwave radiation varies over time and space
- Calculate and interpret a surface energy budget
- Calculate and interpret a surface water budget
- Calculate and interpret the Bowen Ratio
- Quantify the influence of atmospheric stability on energy, moisture and momentum fluxes
- Perform library research.
- Write a literature review (synthesis of the literature).
- Evaluate the published research and the research of your peers.
- Write a scientific research paper that conforms to the accepted 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	30%
Mid-term exam	20%
Research paper	25% (20% for paper and 5% for presentation)
Article reviews	5%
Final exam	20%

Exercises (30% each)

The exercises will require you to apply what you learn in this class. There will be 8 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 5)
- **Final exam** (Monday, April 27, 10:00-11:45 am) will be cumulative. The final exam will be held in the same room as the lecture.

*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 (25%; 20% for paper and 5% for presentation)
The research paper will provide you with an opportunity to do an in-depth study 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*. The research paper is due on April 7 (worth 20% of your final grade). Each student will present a 5-minute summary of their research paper in class on April 9, 14 or 16 (worth 5% of your final grade). Alternatively, you may submit a 5-minute video that summarizes your research paper.

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)

Article Reviews (5%)
The second half of the course (after Spring Break) will focus on reading and discussing journal articles. You are expected to carefully and critically read all of the assigned journal articles. Before each class you are expected to read the assigned material and bring to class a summary with critique notes and discussion questions in response to the readings (up to about one page). These reviews will be graded and they will facilitate our in-class discussion.

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.

Statement on Academic Misconduct

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct at http://studentlife.osu.edu/csc/.

Disability Services

The University strives to make all learning experiences as accessible as possible. 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. You are also welcome to register with Student Life Disability Services to establish reasonable accommodations. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion.

SLDS contact information: slds@osu.edu; 614-292-3307; slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.

Tentative Class Schedule

The following course schedule is a guide, and likely will change as the class evolves. ***The exam dates are fixed****.*

Date	**Lecture**
Jan. 7	Syllabus and Introduction
Jan. 9	Importance of the atmospheric boundary layer; Radiation
Jan. 14	Radiation (pp. 4-17)
Jan. 16	Surface Radiation Balance (pp. 8-27) Exercise #1: Radiation
Jan. 21	Surface Radiation Balance (pp. 8-27)
Jan. 23	Solar Geometry (pp. 339-353) Exercise #2: Surface radiation budget
Jan. 28	Solar Geometry (pp. 339-353)
Jan. 30	Research Paper Assignment Exercise #3: Solar geometry
Feb. 4	Surface Energy Budget (pp. 33-76)
Feb. 6	Surface Energy Budget (pp. 33-76) Exercise #4: Sensible heat
Feb. 11	Vertical Wind Profile (pp. 37-42; 54-59)
Feb. 13	Vertical Wind Profile (pp. 37-42; 54-59) Exercise #5: Vertical wind profile
Feb. 18	Ground Heat (pp. 42-48)
Feb. 20	Ground Heat (pp. 42-48) Exercise #6: Ground heat
Feb. 25	Evaporation & Latent Heat (pp. 63-71)
Feb. 27	Evaporation & Latent Heat (pp. 63-71) Exercise #7: Surface energy budget
Mar. 3	Exam review
Mar. 5	**Midterm Exam**
Mar. 10	**Spring Break (NO CLASS)**
Mar. 12	**Spring Break (NO CLASS)**
Mar. 17	Land-atmosphere interactions: Soil moisture
Mar. 19	Land-atmosphere interactions: Vegetation feedbacks & deforestation Exercise #8: Research paper outline
Mar. 24	Land-atmosphere interactions: Urban microclimates
Mar. 26	Ice-atmosphere interactions: Arctic amplification
Mar. 31	Ocean-atmosphere interactions: Global teleconnections
Apr. 2	Ocean-atmosphere interactions: Boundary layer of hurricanes
Apr. 7	**Research paper due; NO CLASS (AAG Conference, Denver, CO)**
Apr. 9	Student presentations #1
Apr. 14	Student presentations #2
Apr. 16	Student presentations #3
April 27	**Final Exam (10:00 am to 11:45 am)**