Microclimatology: Microclimatological Measurements (Geography 5922)
Fall 2022
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Office Hours: TR 4:00–5:00 p.m. and by appointment. Office hours will be 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: Monday and Wednesday, 3:55 p.m. – 5:15 p.m., 070 Derby Hall

Course Materials:
Readings will be provided from the following textbooks via Carmen:
Meteorological Measurement Systems, 2001, Brock and Richardson, ISBN-13: 9780105134513.
An electronic version of this book is available through the OSU library:
https://app.knovel.com/kn/resources/kpMMS00003/toc

Boundary Layer Climates, 2nd Edition (1987), Oke, ISBN-13: 9780415043199
An electronic version of this book is available through the OSU library:
http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=74015

Other assigned readings (journal articles, sensor instruction manuals, etc.) will also be made available on Carmen.

Class Website: carmen.osu.edu

Course Objectives:
This course serves as an introduction to microclimatological instrumentation and fieldwork. We will learn about various environmental sensors: how they work, how they should be deployed, how to retrieve and process information from them, how to interpret the data they produce.

For each meteorological variable the lectures will provide an overview of:
a) Importance of the measurements. How are the measurements used?
b) Instruments and how they work. How are measurements made?
c) Application of knowledge through hands-on data collection with both basic and advanced instruments (in-class exercise)

The in-class exercises will give students the opportunity to apply these principles by making measurements in the field. The research project will provide the students to design an experiment and to collect data to answer a research question that is of interest to them.

We will cover the following meteorological variables this semester:
1) Air temperature (sling psychrometer; thermometer, thermistor)
2) Surface temperature (IR temperature)

3) Humidity (sling psychrometer; hygrometer)
4) Precipitation
5) Solar radiation
6) Soil moisture and soil temperature
7) Various other meteorological sensors
8) Dataloggers and datalogger programming

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 [Goal A: 1c, 1d]
- Describe the spatial and temporal variations in each component of the near-surface atmosphere, surface energy and moisture budgets [Goal A: 1a, 3a], and the physical processes that are responsible for these patterns [Goal A: 3d]
- Describe how each component of the surface energy and moisture budget are measured using sensors and the calibration, limitations, uncertainty/biases in the measurements and the standards observed for its deployment [Goal A: 2a, 2c]
- Evaluate how human activities influence moisture and energy fluxes in the boundary layer at local, regional and global scales [Goal A: 1e]
- Evaluate how human activities are influenced by moisture and energy fluxes in the boundary layer at local, regional and global scales [Goal A: 1e]
- Critically evaluate and identify sources of uncertainty in measurements of surface energy and water exchanges [Goal B: 3b]

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

- Measure and interpret meteorological variables and the surface energy budget [Goal B:3h]
- Deploy sensors in accordance with accepted observational standards and collect measurements using a data logger
- Quantify the influence of site characteristics on energy, moisture and momentum fluxes [Goal B: 3f]
- Use Python to visualize data using maps and graphs [Goal B: 3a]
- Generate graphs and maps for your group project and oral presentation [Goal C: 1g]
- Write a scientific report that answers a research question based on an analysis of data. This paper will conform to the standard for publication in a peer-reviewed journal [Goal C: 1i]
- Deliver a clear and concise oral presentation on the research that you completed during the semester [Goal C: 1d]

Grading:
Your grade will be calculated as follows:

Exercises (8)	35%
Quizzes (7)	15%
Group project	25%
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 8 exercises assigned during the semester. The exercises will be assigned one week before they are due. You need to be in class to make the measurements that are associated with the exercises. If you do not attend class, you will not have the data you need to complete the exercises. While we will be doing data collection in groups, the exercises are individual assignments and each student must submit their own work. However, you may discuss the questions and work collaboratively. Your exercises will be submitted on Carmen. **There are no makeup assignments and late submissions are not accepted.**

Exercise #1: Measuring air temperature using multiple methods; Due Sept. 7
Exercise #2: Measuring voltage; Due Sept. 21
Exercise #3: Automated measurement of air temperature and relative humidity; Due Sept. 28
Exercise #4: Measuring an atmospheric temperature profile at 1 m and 3 m; Due Oct. 5
Exercise #5: Measuring relative humidity and dewpoint temperature; Due Oct. 12
Exercise #6: Measuring the accuracy of a tipping bucket rain gauge; Due Oct. 19
Exercise #7: Measuring atmospheric profile; Due Oct. 26
Exercise #8: Measuring radiation; Due Nov. 2

Quizzes (15% each)
COMET MetEd is a collection of hundreds of training resources developed by and for the use of the geosciences community. Among the many resources which have been developed in the MetEd program are a series of lessons on meteorological sensors. You will be asked to complete 7 COMET modules from the "Instrumentation and Measurement of Atmospheric Parameters" course that cover: introduction to measurement, calibration and sensing, temperature, humidity, wind, radiation and precipitation.

After you complete each COMET lesson you will be asked if you want to take the quiz associated with the lesson. FOR EACH COMET LESSON YOU MUST TAKE THE QUIZ AND YOU MUST PASS IT (>70% score). Your quiz score will be emailed to me and will become part of your grade. The quizzes may be taken at any time, but they must be completed before the due date that is listed below. **No late submissions are not accepted.**

Lesson 1: Foundations of Meteorological Instrumentation and Measurements; Due Sept. 5
Lesson 2: Meteorological Instrument Performance Characteristics; Due Sept. 12
Lesson 3: Measurement of Atmospheric Temperature; Due Sept. 26
Lesson 4: Measurement of Atmospheric Humidity; Due Oct. 3
Lesson 5: Measurement of Surface Precipitation; Due Oct. 10
Lesson 6: Measurement of Wind; Due Oct. 17
Lesson 7: Measurement of Atmospheric Radiation; Due Oct. 24

Group Project (25%)
The group project will provide you with an opportunity to design and implement a field experiment to answer a research question related to micrometeorology. This project will be an opportunity to utilize the instruments and data collection skills that you have developed over the semester. This will be a group project. The class will be divided into groups of ~3 students. Each group will develop a research question, design a field experiment, collect data, analyze the data and write a project report that summarizes the research question, data and methods, and results of your analysis. Part of your grade for the group project will be based on peer assessment. This is to ensure

that each student contributes to the project. Project report is due on Monday, December 5 (worth 25% of your final grade).

Oral Presentation (5%)
Each group will give a 15-minute class presentation the results of your research project. The presentation should include a description of your research question, datasets and methods, results and conclusions. Presentations will be given in class on Monday, December 5 and Wednesday, December 7 (worth 5% of your final grade). I will distribute a grading rubric and discuss the requirements of the presentation in class.

Exam (20%)
The exam will be based on the material covered in the lectures, readings, COMET lessons and exercises. The final exam will be cumulative. It will involve short answer, application and problem solving, and paragraph/essay questions.

- **Final exam** (Monday, December 12, 6:00-7:45 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.*

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.
- Class exercises involves group work. You need to be in class to make the measurements that are associated with the exercises. If you do not attend class, you will not have the data you need to complete the exercises.
- 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

- Class lectures will not be recorded or broadcast on Zoom. In person attendance is required to successfully complete this class. If you miss class, you are responsible for getting lecture notes and any other materials that you missed from one of your classmates
- 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 it may change as the class evolves. ***The exam date is fixed****.*

Date	**Lecture**
Aug. 24	Syllabus and Introduction
Aug. 29	Importance of Meteorological Measurements & Principles of Measurement (error, uncertainty, bias, precision, calibration)
Aug. 31	**Exercise #1**: Measuring air temperature using multiple methods
Sep. 5	***No Class (Labor Day)***
Sep. 7	Discussion of Principles of Measurement
Sep. 12	Basics of Electricity
Sep. 14	**Exercise #2**: Measuring voltage
Sep. 19	Dataloggers and datalogger programming
Sep. 21	**Exercise #3**: Automated measurement of air temperature and relative humidity
Sep. 26	Air Temperature
Sep. 28	**Exercise #4**: Measuring an atmospheric temperature profile at 1 m and 3 m
Oct. 3	Humidity
Oct. 5	**Exercise #5**: Measuring relative humidity and dewpoint temperature
Oct. 10	Precipitation
Oct. 12	**Exercise #6**: Measuring the accuracy of a tipping bucket rain gauge
Oct. 17	Wind
Oct. 19	**Exercise #7**: Measuring atmospheric profile (**Waterman Farm**; full site characterization)
Oct. 24	Solar Radiation & Net Radiation
Oct. 26	**Exercise #8**: Measuring radiation
Oct. 31	Research Project Overview & Team Formation
Nov. 2	Group Working Session #1: Research Design
Nov. 7	Exposure and Instrument Siting (AASC Guidelines)
Nov. 9	Group Working Session #2: Instruments and Data Logger
Nov. 14	Data Quality Control and Quality Assurance
Nov. 16	Group Working Session #3: Data Collection and Analysis
Nov. 21	Other measurement systems: soil moisture & temperature, eddy covariance
Nov. 23	**No Class (Thanksgiving)**
Nov. 28	Other measurement systems: ceilometers, barometers, radiosondes, etc.
Nov. 30	Group Working Session #4: Analysis and Final Report
Dec. 5	Group presentations (part 1)
Dec. 7	Group presentations (part 2)
Dec. 12	**Final Exam (6:00 pm to 7:45 pm)**