

GEOG 3311A – Micrometeorology Course Outline: Section 001 Fall 2023

1. Course Information

*Details about design and delivery of the course are listed below in Section 6



Classes Start	Fall Reading Week	Classes End	Study day(s)	Exam Period
September 7	October 30-November 5	December 8	December 9	December 10-22

September 15, 2023: Last day to add a second-term half course

October 9, 2023: Thanksgiving Holiday

November 13, 2023: Last day to drop a first term half course without penalty



Course Instructor	Contact Information	Office Hours
James Voogt	javoogt@uwo.ca	Mon. 2:00-3:00 or by appointment via email

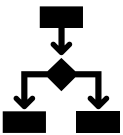
Teaching Assistant(s)	Contact Information	Office Hours
Ethan Cade	ecade@uwo.ca	TBD



- Office hours will be held in-person or via Zoom
- Students will be able to sign up for an appointment using email
- Students will be able to drop into session on Mon 2:00-3:00

2. Calendar Description

Principles of weather and climate at micro-, local, and meso-scales; processes associated with transfer of heat, mass, and momentum and resulting climates near the surface; local winds, fog, urban climates and air pollution.

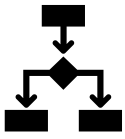


2 lecture + 2 lab hours, 0.5 course

Antirequisite(s): None

Prerequisite(s): One of Geography 2310A/B, Geography 2320A/B or Geography 2330A/B, or at least 3rd year standing in an Environmental Science or Earth Sciences program. (A 1000-1099 level course in Applied Mathematics, Mathematics, or Physics is also recommended).

Prerequisite checking is the student's responsibility



Senate Regulations state, “unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.”

3. Textbook



All resources (lectures, labs, assignments) will be posted in OWL

Recommended textbook: Oke, T.R. 1987. *Boundary Layer Climates*, **2nd Edition**

See also:

Oke et al. 2017. *Urban Climates*, Cambridge University Press. Available from Western Libraries (online)

4. Course Objectives and Format

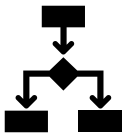
This course provides an introduction to the study of micrometeorology and microclimatology. It examines the processes that underly the behaviour of the atmosphere close to the surface; specifically the transfer of heat, mass and momentum and how these modify the microclimate. Presentations include theoretical and analytical examination of the processes that occur (i.e. we use equations and numbers in this course). Assignments require use of a computer spreadsheet and hand calculation using calculators. An introduction to micrometeorological instrumentation is also provided that includes the use of instruments and construction of thermocouples.

Micrometeorology and microclimatology are generally restricted to that portion of the atmosphere known as the planetary boundary layer, so this course does not examine weather per se, but does deal with some local to mesoscale atmospheric effects such as sea breezes and atmospheric conditions important to air pollution. Micro-meteorology and climatology have a number of important applications. These include the assessment (and potentially intentional changes to) urban climates (e.g. white roofs and green roofs), road and runway icing, human heat stress, and agricultural crop performance.

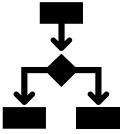
At the end of the course you should be able to:

- explain how the surface radiation and energy budget affects the surface climate
- describe important surface characteristics that affect surface energy budget and surface microclimates
- use numerical techniques to estimate surface energy budget terms
- understand and use basic instrumentation related to micrometeorology
- explain how the principles of the surface energy budget have practical application to society

All course material will be posted to OWL: <http://owl.uwo.ca>. Any changes will be indicated on the OWL site and discussed with the class.



Google Chrome or Mozilla Firefox are the preferred browsers to optimally use OWL; update your browsers frequently. Students interested in evaluating their internet speed, please click [here](#). [Using the right browser is important, especially when using different features integrated with OWL]



If students need assistance, they can seek support on the [OWL Help page](#). Alternatively, they can contact the [Western Technology Services Helpdesk](#). They can be contacted by phone at 519-661-3800 or ext. 83800.

5. Learning Outcomes

Upon successful completion of this course, students will be able to:

- Develop knowledge and critical understanding of the fundamental characteristics, processes, temporal changes and landscapes of social and biophysical systems and their interactions - in particular spatio-temporal variations of the near surface climate, especially as described through the surface radiation and energy balances.
- Relate specialized understanding of the geography of bio-physical systems to knowledge and practices in environmental and natural sciences
- Use the fundamental knowledge of the physical basis of near-surface climates to explain how microclimates can be expected to vary in space and time.
- Collect, analyze and interpret data from measurement systems that are used to monitor near-surface climate and surface radiation and energy balances.



6. Communication



- Students should check the OWL site every 24 – 48 hours
- For any other communication, the centrally administered **e-mail account** provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at his/her official university address is attended to in a timely manner. You can read about the privacy and security of the UWO email accounts [here](#).
- Emails will be monitored daily; students will receive a response within 1 business day
- Students should post all course-related content on the discussion forum so that everyone can access answers to questions
- The discussion forums will be monitored daily by instructors or teaching assistants

7. Course Content and Schedule

Week	Dates	Topic	Lab
1	Sept 11-15	Course Introduction: Micrometeorology, Microclimatology and the Atmospheric Boundary Layer	Temperature and Humidity Review
2	Sept 18-22	Measurement Source Areas. Radiation, Energy and Water Balance Concepts	The Geography and Environment weather station. Introduction to Assignment 1
3	Sept 25-29	Radiation Budget: Shortwave Radiation	
4	October 2-6	Radiation Budget: Shortwave Radiation	Radiation Budget Analysis Shortwave Assignment 1 Due Oct 6
5	October 9-13	Radiation Budget: Longwave and Net Radiation	Radiation Budget Analysis: Longwave
6	October 16-20	Surface Temperatures	Measures of Thermal Comfort Assignment 2 Due Oct 20
7	October 23-27	Soil Microclimates	Measuring and calculating subsurface heat flux
8	<i>October 30- Nov 3</i>	<i>Fall Study Break</i>	<i>N/A</i>
9	November 6-10	Winds near the surface	Logarithmic Wind Profile
10	November 13-17	Local scale circulations, atmospheric turbulence and dynamic stability	Assignment 3 Due Nov 17
11	November 20-24	Air Pollution Meteorology and the Gaussian Plume Model	Gaussian Plume Model
12	Nov 27- Dec 1	Convective Transfer	Energy Balance Analysis Assignment 4 Due Dec 1.
13	December 4-8	Climates of non-homogeneous terrain	Project Due Dec 6.



8. Evaluation

Below is the evaluation breakdown for the course. Two options are provided for students. The assignments are intended to provide preparation and practice for the final exam, which consists of a take home assignment that will use a real micrometeorological data set that will need to be analyzed and assessed using the techniques developed in the course.

An option project can be selected if students wish to de-weight assignments in favour of a project that aligns with their own interests.

Assessment	Format	Option 1	Option 2	Due Date
Assignments (4)	Mixed (calculations, graphical analysis, written explanations / discussions)	40	20	See lab schedule (Due dates are Fridays at 4 pm).
Project	Written		40	Dec. 1
Final Exam	Take home (written; analysis of a provided data set)	60	40	10 days from start of exam period

Students must pass the final exam in order to pass the course.

The evaluation methods described in the course outline are essential requirements for the course.



Students are responsible for material covered in the lectures as well as the assigned chapters/sections in the text.

- All assignments are due at 11:55 pm EST unless otherwise specified
- After an assessment is returned, students should wait 24 hours to digest feedback before contacting their evaluator; to ensure a timely response, reach out within 7 days

Click [here](#) for a detailed and comprehensive set of policies and regulations concerning examinations and grading. The table below outlines the University-wide grade descriptors.

A+	90-100	One could scarcely expect better from a student at this level
A	80-89	Superior work which is clearly above average
B	70-79	Good work, meeting all requirements, and eminently satisfactory
C	60-69	Competent work, meeting requirements
D	50-59	Fair work, minimally acceptable
F	below 50	Fail

Information about late or missed evaluations:

Non-medical absences that affect submission of assignments or the course project require prior approval of the instructor or approval by the Dean's office. Students seeking academic accommodation on medical grounds for any missed tests, exams, participation components and/or assignments worth less than 10% of their final grade must

contact the instructor. Should the number of requests by a student exceed two, then they are required to apply to the Academic Counselling office of their home Faculty and provide documentation.

Students seeking academic accommodation on medical grounds for any missed tests, exams, participation components and/or assignments worth 10% or more of their final grade must apply to the Academic Counselling office of their home Faculty and provide documentation. Academic accommodation cannot be granted by the instructor or department.

- Late assessments without illness self-reports will be subject to a late penalty 10%/day
- Late assessments with illness self-reports should be submitted within 24 hours of submission of the last illness self-report
- An assignment cannot be submitted after it has been returned to the class. When one assignment is missed, the weight will be transferred to the final grade; subsequent missed assignments will have their weight transferred to the final exam.

Grades will not be adjusted on the basis of need. It is important to monitor your performance in the course. Remember: *You* are responsible for your grades in this course.

9. Accommodation Policies

Students with disabilities work with Accessible Education (formerly SSD) which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The accommodation policy can be found here: [Academic Accommodation for Students with Disabilities](#).

Academic Consideration for Student Absence

The University recognizes that a student's ability to meet their academic responsibilities may, on occasion, be impaired by medical illness. Illness may be acute (short term), or it may be chronic (long term), or chronic with acute episodes. The University further recognizes that medical situations are deeply personal and respects the need for privacy and confidentiality in these matters. However, in order to ensure fairness and consistency for all students, academic accommodation for work representing 10% or more of the student's overall grade in the course shall be granted only in those cases where there is documentation indicating that the student was seriously affected by illness and could not reasonably be expected to meet their academic responsibilities.

[Policy on Academic Consideration for Medical Illness - Undergraduate Students](#)

[Student Medical Certificate \(SMC\)](#)

Religious Accommodation

Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the [Western Multicultural Calendar](#).

10. Make-up Examinations

Make-up examinations are not provided in this course.

11. Use of Electronic Devices

Students will need to use software (e.g. Excel) and/or calculators as a normal part of completing the assignments and take home exam.

12. How to Be Successful in this Class:

Students enrolled in this class should understand the level of autonomy and self-discipline required to be successful.

1. Invest in a planner or application to keep track of your courses. Populate all your deadlines at the start of the term and schedule time at the start of each week to get organized and manage your time.
2. Take notes as you go through the lesson material. Keeping handwritten notes or even notes on a regular Word document will help you learn more effectively.
3. Make use of the supplementary reading list, especially if you are having difficulties understanding the lecture and/or laboratory material.
4. Connect with others. Try forming a study group and try meeting on a weekly basis for study and peer support.
5. Do not be afraid to ask questions. If you are struggling with a topic, check the online discussion boards or contact your instructor(s) and or teaching assistant(s).
6. Reward yourself for successes. It seems easier to motivate ourselves knowing that there is something waiting for us at the end of the task.



13. Continuity of Education Plan (in-person class pivoting to online learning)

In the event of a COVID-19 resurgence during the course that necessitates the university to direct courses move away from face-to-face interaction, all remaining course content will be delivered entirely online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will **not** change. Any remaining assessments will also be conducted online as determined by the course instructor.

14. Academic Offences

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence.

15. Western's Commitment to Accessibility

The Department of Geography and Environment strives at all times to provide accessibility to all faculty, staff, students and visitors in a way that respects the dignity and independence of people with disabilities.

Please contact the course instructor if you require material in an alternate format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2147 for any specific question regarding an accommodation. Information regarding accommodation of exams is available on the Registrar's website.

More information about "Accessibility at Western" is available.

16. Mental Health

If you or someone you know is experiencing distress, there are several resources here at Western to assist you. Please visit Western's [Health and Wellness website](#) for more information on mental health resources.

17. Support Services

[Western's Support Services](#)
[Student Development Centre](#)

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at https://www.uwo.ca/health/student_support/survivor_support/get-help.html.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

18. Important Dates

- September 7: Classes resume
- September 15: Last day to add a first term half course
- October 9: Thanksgiving Holiday – Department Office Closed
- October 30-November 5: Fall Reading Week (No classes; Department Office open)
- November 13: Last day to drop a first term half course without penalty
- November 30: Last day to drop a full course without penalty
- December 8: Classes end
- December 9: Study day
- December 10-22: Examination Period

Program Learning Outcomes and Skills

Learning Outcomes

- ✓ Develop knowledge and critical understanding of the fundamental characteristics, processes, temporal changes and landscapes of social and biophysical systems and their interactions.
- ✓ Demonstrate informed awareness of geographical diversity through knowledge of different places and understanding of the processes that shape them spatially and over time.
- ✓ Relate specialized understanding of the geography of bio-physical systems to knowledge and practices in environmental and natural sciences
- ✓ Collect, analyze and interpret geographical and geo-spatial data in relation to social and biophysical systems
- ✓ Describe, explain, analyze and interpret a range of geographical phenomena outside the classroom by engagement with people, places and environments

- ✓ Analyze real-world problems and policy applications using geographical concepts, skills and understanding.
- ✓ Communicate geographic ideas and understanding effectively to a variety of audiences in writing, orally, and graphically

Geographical Skills

- ✓ Field and/or lab methods: including observation, data collection (of all kinds), mapping
- ✓ Geographical data: statistical concepts, analysis and inference; quantitative and qualitative analysis; numerical and/or mathematical analysis; calculations; programming; problem solving.
- ✓ Map, remote sensing images and geo-spatial data interpretation and analysis
- ✓ Spatial thinking, spatial analysis & spatial processes of human and/or environmental processes (e.g. cultural, social, political, economic, scientific)

Generic Skills

- ✓ Literature and secondary data sources: information search and retrieval, meta-analysis of published data, synthesis of information sources and literature, annotated bibliographies.
- ✓ Writing – education and practice in writing essays, reports, notebooks.
- ✓ Visual presentation and graphical design: graphical design and production of: maps, diagrams, presentations, posters, web-based media
- ✓ Project planning, management and design: time management, independent major project, research proposals.

Readings:

I recommend Oke 1987 as an excellent, easy-to-read introduction to microclimates and some aspects of micrometeorology. Considering that some other texts may be more easily available, the following table provides relevant readings to course content that will help support the lecture and lab material.

<p>Week 1. Introduction O87: ix-xxiv, 3-8, 20-36, 395-399 F08 1-8 A88: 1-7; S88: 9-23 CN98: 1-8 O17: 156-159 Atmospheric (Planetary) Boundary Layer O87: 40-42, 61-63, 71-76, 97-98, 310-313 A88: 57-63, 75-83, 214-218 S88: 441-456, 468-469, 473-477, 499-502, 520-522, 526-529, 534-536</p>	<p>Week 2 Source Areas & Surface Atmosphere Exchange Basics O17: Chp 2 MU90: 232-252</p>
<p>Week 3-6 Shortwave and Longwave Radiation O87: 8-16, Appdx A1 + radiation aspects of Chps 3, 4 O17 126-128, 156-159 MU90: 28-35, 50-57, 79-97, 82-86, 93-97 A88: 21-33 CN98: 147-165, 167-183, 224-231</p>	<p>Weeks 7 Soil Microclimates O87: 42-51, 259 A88: 37-46 MU90: 223-230 CN98: 23-26, 113-127 F08: 15-18, 212-217.</p>
<p>Week 9 Winds Near the Surface O87: 54-58, 75-76, 83-84, 139-140, 363-365 A88: 75-83, 131-133, 141-151 MU90: 112-117 O17: 99-105 CN98: 63-74</p>	<p>Week 10 Atmospheric Turbulence & Dynamic Stability S12: Chp 15 A88: Chp 8 O17: 79-82 Local Scale Circulations O87: 167-182</p>
<p>Week 11 Air Pollution and Gaussian Plume Model O87: 310-318, 322-338</p>	<p>Week 12 Convective Transfer O87: 59-71, Appendix A2 A88: 54-57, 74-75, 117-119, 157-167, 169-176, 189-194; Chp 11, 12 S12: Chp 19, 20 O17: 175-184 CN98: 77-85, 93-99</p>

Week 13. Climate of Non-homogeneous Terrain

O87: 34-36, Chp 5.

A88: 33-35, 223-235, 252-260

S88: 587-595, 601-609

Relevant texts and codes as used in the table of readings.

Codes: Letter - Author's Last Initial, Number - date of publication.

A88 - Arya, S.P. 1988. *Introduction to Micrometeorology*, 1st Edition, Academic Press, San Diego.
A 2nd edition (2001) also exists and may be used.

CN98 - Campbell, G.S. and J.M. Norman. 1998. *An Introduction to Environmental Biophysics*, Springer-Verlag, New York.

F08 - Foken, T. 2008 *Micrometeorology*. Springer-Verlag Berlin Heidelberg. On-line text (link will require UWO connection or proxy connection)

MU90 - Monteith, J.L. and M.H. Unsworth. 1990 *Principles of Environmental Physics*, 2nd ed., Elsevier: Amsterdam. (A 3rd edition, 2008 is also available and can be used)

O17 - Oke, T.R., G. Mills, A. Christen, J.A. Voogt 2017. *Urban Climates*, Cambridge University Press, London. Available online from Western Libraries

O87 - Oke (1987) *Boundary Layer Climates*, Routledge.

S12 - Shuttleworth, W.J. 2012. *Terrestrial Hydrometeorology*, Wiley-Blackwell, Oxford.

S88 - Stull, R.B. 1988. *An Introduction to Boundary Layer Meteorology*, Kluwer Academic, Dordrecht./