

GEOG 3311A – Micrometeorology Course Outline: Section 001 Fall 2024

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 5	October 14-20	December 6	December 7&8	December 9-22

September 13, 2024: Last day to add a second-term half course

September 30, 2024: National Day for Truth and Reconciliation (observed as a non-instructional day at Western).

October 14, 2024: Thanksgiving Holiday

November 30, 2024: Last day to drop a first term half course without penalty



Course Instructor	Contact Information	Office Hours
James Voogt	javoogt@uwo.ca	Mondays 1:00-2:00 or set up appointment via email

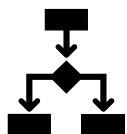
Teaching Assistant(s)	Contact Information	Office Hours
Mohammad Rokhafrouz	mrokhafr@uwo.ca	TBD – will be posted to OWL



- 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 Thursdays 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**

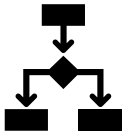
See also:

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 affect surface climates
- 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 the new OWL Brightspace learning environment: <https://westernu.brightspace.com/d2l/home>. Any changes will be indicated on the OWL site and discussed with the class.

Current versions of all popular browsers (e.g., Safari, Chrome, Edge, Firefox) are supported with OWL Brightspace; what is most important is that you update your browser frequently to ensure it is current. All JavaScript and cookies should be enabled."

If students need assistance, they can seek support on the OWL Brightspace Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be

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. Course Content and Schedule

Week	Dates	Topic	Lab
2	Sept 9 & 11	Course Introduction: Micrometeorology, Microclimatology and the Atmospheric Boundary Layer	Thermocouples Sign up for heat island traverse ¹
3	Sept 16 &-18	Measurement Source Areas. Radiation, Energy and Water Balance Concepts The G&E weather station - Intro to Assignment 1	Temperature and Humidity Review Visit to AECB roof
4	Sept 23 & 25	Radiation Budget: Shortwave Radiation	Radiation Budget Visit to TC green roof Choosing measurements for the green roof
5	Oct 2 Only! NO CLASS Sep 30 (National Day for T&R)	Radiation Budget: Longwave and net radiation	Oct 4 11:55 pm G&E Weather Station Report Due TC instrument setup²
6	Oct 7 & 9	Longwave Radiation & Surface Temperatures UHI traverse corrections	Radiation Budget Lab Due Oct 11 11:55 pm
	<i>Oct 14 & 16</i>	<i>Fall Reading Week</i>	
7	Oct 21 & 23	Soil Microclimates	Soil Microclimates

Week	Dates	Topic	Lab
8	Oct 28 & 30	Local scale circulations, winds near the surface	Nov 1 11:55 pm Soil microclimate lab due
9	Nov 4 & 6	Winds near the surface, atmospheric turbulence Dynamic stability	Nov 8 11:55 pm - UHI Traverse Report Due
10	Nov 11 & 13	Air pollution meteorology and the Gaussian Plume Model	Winds & GPM
11	Nov 18 & 20	Convective Transfer	Nov 22 11:55 pm Wind & GPM lab due
12	Nov 25 & 27	Energy balance analysis	
13	Dec 2 & 4	Climates of non-homogeneous terrain	Dec 4 11:55 Green roof energy balance report due

Colour codes: **Blue** – lab activity that is not marked; **Red** – lab activity that is submitted and marked; **Green** – field activity (dress appropriately!); **Black** – due date of report or lab

All assignments have a 72 hour flexible assignment window

Notes

1. Heat island traverses will occur at night, when weather conditions are suitable, ideally with pairs of students.
2. Because of limited lab/lecture time we may need a longer period for instrument setup – potential targets for this activity would be on a Friday, Saturday or Sunday

7. 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

8. Evaluation

Below is the evaluation breakdown for the course. The evaluation of the course is through lab reports and assignments. Both involve the same type of work but lab reports are shorter and more focused than reports. The course aims to build experience in collecting, analyzing and interpreting microclimate / micrometeorological data.

Assessment	Format	Weight (%)	Due Date
Lab Assignments (3)	Mixed (calculations, graphical analysis, written explanations / discussions)	30 (3 x 10%)	See lab schedule Due dates are Fridays at 11:55 pm. All due dates have a 72 hour flexibility window.
G&E Weather Station Report	Report (calculations, graphical analysis, written explanations / discussions)	20	Oct 4 11:55
Urban Heat Island Traverse (can be done in pairs)	Report (measurements, data analysis, graphical presentation, written explanations)	15	Nov 8 11:55 pm
Green roof energy balance	Report (measurements, data analysis, graphical presentation, written explanations)	20 (report) + 5 (assigned instrument ¹)	Dec 4 11:55 pm
Participation	Attendance at scheduled lectures, labs and field activities; Preparation for field work	10	



“Assigned Instrument”: students must be prepared to install their assigned instrument and to explain to the class its measurement source area and representativitys

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
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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](#).

General Information about missed work:

University policy on academic considerations are described [here](#). This policy requires that all requests for academic considerations must be accompanied by a self-attestation. Further information about academic considerations, and information about submitting this self-attestation with your academic consideration request may be found here.

Please note that any academic considerations granted in this course will be determined by the instructor, in consultation with the academic advisors in your Faculty of Registration, in accordance with information presented in this course outline.

Flexibility statements

Please note that because the submission deadline for the assessment of all labs and all reports already includes flexibility in the form of a 72 hour submission window, the instructor reserves the right to deny academic consideration for assignments which are submitted following the end of the period of flexibility.

When a student receives academic considerations or academic accommodations which overlap with the built-in flexibility of the assessment, the longest period of accommodation will determine the deadline.

Absence from Course Commitments

Students must familiarize themselves with the [Policy on Academic Consideration – Undergraduate Students in First Entry Programs](#)

Students missing course work for medical, compassionate or extenuating circumstances can request academic consideration by completing a request at the central academic consideration portal. Students are permitted one academic consideration request per course per term without supporting documentation. Note that supporting documentation is **always** required for academic consideration requests for examinations scheduled by the office of the registrar (e.g. December and April exams) and for practical laboratory and performance tests typically schedule during the last week of the term. Students should also note that the instructor may designate one assessment per course per term that requires supporting documentation. This designated assessment is described elsewhere in this document. Please note that any

academic considerations granted in this course will be determined by the instructor of this course, in consultation with the academic advisors in your Faculty of Registration, in accordance with information presented in this course outline. Supporting documentation for academic considerations for absences due to illness should use the Student Medical Certificate or, where that is not possible, equivalent documentation by a health care practitioner.

Course Assessments that Require Supporting Documentation

For this course the no assessment has been designated as requiring supporting documentation.

Academic Consideration for Course Components with Flexible Deadlines

This course employs flexible deadlines for assignments. The assignment deadlines can be found above in the course outline. For each assignment, students are expected to submit the assignment by the deadline listed. Should illness or extenuating circumstances arise, students are permitted to submit their assignment up to 72 hours past the deadline without academic penalty. Should students submit their assessment beyond 72 hours past the deadline, a late penalty of 10% per day will be subtracted from the assessed grade. As flexible deadlines are used in this course, requests for academic consideration will not be granted. If you have a long-term academic consideration or an accommodation for disability that allows greater flexibility than provided here, please reach out to your instructor at least one week prior to the posted deadline.

Accommodation for Religious Holidays

Students should review the policy for Accommodation for Religious Holidays. Where a student will be unable to write examinations and term tests due to a conflicting religious holiday, they should inform their instructors as soon as possible but not later than two weeks prior to writing the examination/term test. In the case of conflict with a midterm test, students should inform their instructor as soon as possible but not later than one week prior to the midterm.

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 lab assignments and reports.

12. 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.

13. 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.



14. 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.

15. 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.

16. 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.

17. Important Dates

September 5: Classes resume

September 13: Last day to add a first term half course

October 14: Thanksgiving Holiday – Department Office Closed

October 14-20: Fall Reading Week (No classes; Department Office open)

November 30: Last day to drop a first term half course or a full course without penalty

December 6: Classes end

December 7 and 8: Study days

December 9-22: 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 / Course Text:

I recommend Oke 1987 as an excellent, easy-to-read introduction to microclimates and some aspects of micrometeorology. That text has been around for a long time so there should be lots of used copies around.

There are a number of other relevant texts identified in the list below. The list includes a link to the on-line version where available (Western university computer or proxy connection likely required).

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

A01 - Arya, S.P. 2001 *Introduction to Micrometeorology*, 2nd Edition, Academic Press, San Diego. A 1st edition (1988) also exists and may be used.

F08 - Foken, T. 2008 *Micrometeorology*. Springer-Verlag Berlin Heidelberg. [On-line text](#)

H23 Hiscox, A. 2023. *Conceptual Boundary Layer Meteorology: The Air Near Here*. Academic Press. Available [on-line](#) from Science Direct (requires direct or proxy connection to Western University)

MU13 - Monteith, J.L. and M.H. Unsworth. 2013 *Principles of Environmental Physics: Plants, Animals and the Atmosphere*, (Earlier editions entitled *Principles of Environmental Physics*) are also available in hard copy and can be used.) [On-line text](#)

O87 – Oke, T.R. 1987 *Boundary Layer Climates*, Routledge.

O17 - Oke, T.R., G. Mills, A. Christen, J.A. Voogt 2017. *Urban Climates*, Cambridge University Press, London. Available [on-line](#) from Western Libraries

S12 - Shuttleworth, W.J. 2012. *Terrestrial Hydrometeorology*, Wiley-Blackwell, Oxford. Available [on-line](#) from Western Libraries.

CN98 - Campbell, G.S. and J.M. Norman. 1998. *An Introduction to Environmental Biophysics*, Springer-Verlag, New York. Stack 6 (S6) - Regular Loan ; QH505 .C34 1998

The following table provides relevant readings to course content that will help support the lecture and lab material.

Where an on-line version is available via Western Libraries that is included in the list below. Note that access to some on-line texts can be restricted to as few as a single user.

Course Readings

Here are readings from texts on the list above. Bolded readings are recommended.

<p>Week 2. Introduction O87: ix-xxiv, 3-8, 20-36, 395-399 A01: 1-8; O17: 156-159; Atmospheric (Planetary) Boundary Layer O87: 40-42, 61-63, 71-76 O17: 29-35; H23: Chapter 1 A01: 57-63, 75-83, 214-218</p>	<p>Week 3 Source Areas & Radiation, Energy and Water Balance Concepts O17: Section 3.1 O87: Chp 1 MU90: 232-252 A01: Chp 2</p>
<p>Week 4-6 Shortwave and Longwave Radiation O87: 8-16, Appdx A1 + radiation aspects of Chps 3, 4 MU13: Chp 5, Chp 6 O17 122-130 (Chp 5) A01: Chp 3</p>	<p>Weeks 7 Soil Microclimates O87: 42-51, 259 A01: Chp 4 MU13: Section 15.3.2 F08: 15-18, 212-217.</p>
<p>Week 8-9 Winds Near the Surface O87: 54-58, 75-76, 83-84, 139-140, 363-365 MU90: 298-303 O17: 99-105 A01: Chp 9 & 10 Local Scale Circulations O87: 167-182</p>	<p>Week 9 Atmospheric Turbulence O17: Section 4.1; H23: Chp 2 A01: Chp 8 S12: Chp 15 MU13: Chp 16 Dynamic Stability: See OWL</p>
<p>Week 10 Air Pollution and Gaussian Plume Model O87: 310-318, 322-338 See also OWL</p>	<p>Week 11 Convective Transfer O87: 59-71, Appendix A2 O17: 175-184 A01: Chp 11, 12 S12: Chp 19, 20 MU13: Chp 3, Chp 16</p>
<p>Week 13. Climate of Non-homogeneous Terrain O87: 34-36, Chp 5. O17: 109-121 A01: Chp 14</p>	

A note on readings and this course:

Readings should help deepen and broaden your understanding of course concepts. I will be looking for evidence that you have been engaged in readings as part of the evaluation of labs and (especially) reports. In the case of reports, readings may extend to other parts of the listed texts, or journal articles, that are aligned with the assignment objectives. Be sure to reference your sources appropriately!