Course outline: Climatic Environments / GEOG 321 / 001

General information

Term and year: Winter 2024

Course pre-requisite(s): GEOG 203 or ATOC 210

Course schedule (class day(s) and time): Tuesdays & Thursdays from 8:35am – 9:55am in BH 306

Number of credits: 3

Instructor information

Name and title: Dr. Sara Helen Knox

E-mail: sara.knox@mcgill.ca

Office location / office hours: BH 619 (or via Zoom) / Tuesdays 10-11am

Communication plan: During my office hours, my door (Zoom room) is always open. If the office hour does not work with your schedule, please let me know & I will try to work out a time to meet with you. I welcome you to contact me outside of class and office hours. I aim to respond to emails within 48 hours (and ***primarily during work hours*** – M-F from 9am to 5pm ET).

Course overview

The earth-atmosphere system, radiation and energy balances. Surface-atmosphere exchange of energy, mass and momentum and related atmospheric processes on a local and regional scale. Introduction to measurement theory and practice in micrometeorology.

Learning outcomes

By 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 radiation and energy budgets and surface microclimates.
- understand the basics of turbulence, dispersion and local wind systems in the atmospheric boundary layer and how they are controlled by surface processes.
- provide examples of key physical, biological and chemical processes that control trace gas, water and energy fluxes between the land surface and the atmosphere,
- provide examples of how surface-atmosphere interactions respond to environmental change, and how this can create climate feedbacks.
- know the principles of basic instrumentation, methods and data-analysis (including the use of the R programming language) used for today's monitoring and modelling of weather and climate in the atmospheric boundary layer.
- analyze and interpret data from measurement systems that are used to monitor near-surface climate and surface radiation, energy, and greenhouse gas balances.
- explain how the principles of micrometeorology have practical applications to society.

Instructional methods

The course consists of two 1.5 hour lectures each week and one lab visits covering 32 topics, directed readings, assignments, study questions, a midterm during the semester and a final during the exam period.

Lectures will be held **in-person**. While I *strongly* encourage you to attend in person as best as you are able, all lectures will also be recorded and made available to you after class. Note that if you do not attend lecture, you will not receive participation marks for that day, however, each student can miss up to **three** lectures without it impacting their participation grade. If you miss more than 3 lectures, contact me regarding your absences and we can assess potential accommodations.

Communication guidelines

Communication Method	How and When to Use It
Announcements	New announcements will be posted regularly to keep you informed of logistics and any important course updates. Please make sure to check frequently.
Email	While I encourage you to post course content related questions in the Discussion Forums (see below), for private communication, use email. Please put the course ID {GEOG 321} on the subject line. Emails are typically answered within 24-36 hours during ***regular business hours (M-F 9am-5pm)***. When addressing me in your email, you can refer to me as either Sara, Dr. Knox or Prof. Knox. Remember that email is a formal and public method of communication. Do not write anything that you do not want on the permanent, public record.
Course Logistics Q & A Forum	Use this forum to ask logistical questions about the course or report any problems you encounter. Your classmates may have the same question. Students are encouraged to respond to questions and help each other! The TAs and I will check this Forum every few days.
Other Discussion Forums	Discussion Forums are available for any questions related to assignments and study questions as well as the lecture material. As noted above, your classmates may have the same question. Students are encouraged to respond to questions and help each other!

Expectations for student participation

You will receive **Participation** marks (5% of your grade) for answering Slido questions during lectures. Note that you do not need to have the correct answer to receive full marks, you just need to submit an answer **to all multiple-choice questions** during the lecture. You are also strongly encouraged to engage in all discussion questions on Slido. Details on joining Slido can be found here.

Required course materials

The readings are posted on the course website (https://geog321.github.io/). They consist of draft chapters from the textbook '*Boundary Layer Climates*' by T. R. Oke and a few other sources.

Course content

Note: All dates and topics are still subject to change. Please make sure to regularly check the website for updates to the schedule.

Week	Date	Description	Course materials	Assignments
1	04-Jan	**1** Introduction and course overview **2** Energy and mass balances (intro.)	Reading Package Lectures 1-2	
2	09-Jan	**2** Energy and mass balances (cont.) **3** Surface energy balance	Reading Package Lectures 1-2 & 3	
3	11-Jan	**Tutorial**: Intro to R		
4	16-Jan	**4** Radiation geometry and 'sun-paths' **5** Shortwave radiative transfer (intro.)	Reading Package Lectures 4-5	
5	18-Jan	**5** Shortwave radiative transfer (intro.) **6** Shortwave reflection and albedo	Reading Package Lectures 4-5 & 6	Assignment 1 handed out
6	23-Jan	**7** Longwave radiation and emissivity		
7	25-Jan	**8** Net all-wave radiation **9** Virtual field site visit (Radiation instrumentation)	Reading Package Lecture 9	
8	30-Jan	**10** Soil thermal properties **11** Soil heat transfer (intro.)	Reading Package Lectures 10-12	
9	01-Feb	**11** Soil heat transfer (cont.) **12** Modelling subsurface temperatures	Reading Package Lectures 10-12	Assignment 1 due
10	06-Feb	**13** Radiation and heat transfer in water, snow and ice **14** Radiation in complex terrain	Reading Package Lectures 13 & 14	Assignment 2 handed out
11	08-Feb	**15** Laminar and turbulent flow **16** Production of atmospheric turbulence (intro.)	Reading Package Lectures 15 & 16-17	
12	13-Feb	**16** Production of atmospheric turbulence (cont.) **17** Dissipation of atmospheric turbulence	Reading Package Lectures 16-17	
13	15-Feb	**18** Turbulence statistically approached	Reading Package Lectures 18	
14	20-Feb **(recorded lecture)**	**19** Momentum transfer	Reading Package Lectures 19-20	Assignment 2 due
15	22-Feb **(recorded lecture)**	**20** Velocity profile laws	Reading Package Lectures 19-20	
16	27-Feb	**21** Flux-gradient relations Midterm review	Reading Package Lectures 21-26	
17	29-Feb	**Midterm Examination**		
18	05-Mar	*Winter Reading Break*		Assignment 3 handed out
19	07-Mar	*Winter Reading Break*		

20	12-Mar	**22** Eddy covariance **23** Dynamic stability (intro.)	Reading Package Lectures 21-26	
21	14-Mar	**23** Dynamic stability (cont.) **24** Turbulent exchange in non-neutral situations	Reading Package Lectures 21-26	
22	19-Mar	**25** Lab visit (Eddy covariance system, trace gas measurements)	Reading Package Lectures 21-26	Assignment 3 due
23	21-Mar	**26** Convective and stable boundary layers **27** Surface heterogeneity and advection	Reading Package Lectures 21-26 & 27	
24	26-Mar	**28** Flow in complex orography **29** The water cycle at land-atmosphere interfaces (intro.)	Reading Package Lectures 28 & 29-31	Assignment 4 handed out
25	28-Mar	**29** The water cycle at land-atmosphere interfaces (cont.) **30** Plant-atmosphere interactions	Reading Package Lectures 29-31	
26	02-Apr	**31** Measuring and modeling evapotranspiration	Reading Package Lectures 29-31	
27	04-Apr	**32** Land atmosphere interactions in a changing global climate		
28	09-Apr	Final class: Review/evaluation/exam instructions		Assignment 4 due

Evaluation

Participation	5%
Self-study questions	5%
Written assignments (best 3 of 4)	40%
Mid-term exam	20%
Final exam	30%

As noted above, you will receive **Participation** marks for answering Slido questions during lectures. Note that you do not need to have the correct answer to receive full marks, you just need to submit an answer **to all multiple-choice questions** during the lecture. You are also strongly encouraged to engage in all discussion questions on Slido.

Assignments will be handed **on myCourses** on the due date. All assignments are required to be labelled with course number, student number, student name and assignment number. Late assignments will be penalized 10% of the actual marks achieved for each (partial) day past **11:59 pm** on the due date. Late assignments will not be accepted once graded assignments have been returned to the class (which results in a grade of 0%). Note that you are not required to use **R** (or other programming languages) for assignments, however, it is encouraged, and I will provide support and resources to help you with that (see Coding resources on the course website). Your assignment grade will be based on **your top three assignments**. Each assignment is worth 13.33% of your final grade.

Collaboration on homework is encouraged. However, you should think about the problems yourself before discussing them with others. **Also, write-ups must be done independently.** (In practice, this means that it is OK for other people to explain their solutions to you, but you must not be looking at other people's solutions as you write your own.)

Self-study questions are assigned regularly throughout the semester (10 in total). These are a great opportunity for you to apply some of the concepts covered in class and will help prepare you for assignments and exams. It is also a helpful way for you to **learn R** if that is of interest to you. Note that while solutions to the self-study questions are available to you, you are required to upload your own answers to these questions on myCourses (either as a word document, pdf, or html file). To help you keep up with the course material, you will have 3 days to upload your answers to myCourses (note that they are due at **11:59pm PT** on that day). **You only need to complete 8/10 to receive full marks for the self-study questions (5% of your total grade)**. Note that late study questions will receive a grade of zero. All self-study questions and their due dates are already posted under Assignments.

The **mid-term exam** will be a closed-book, in-person exam on **Thursday, February 29th** during class. More details on the mid-term exam can be found on the course website.

The **final exam** will be held during the final exam period. It will also be a closed-book, in-person exam. The duration of the final is 3 hours (180 minutes). Additional details on the final exam will be posted on the course website.

Note: Illness and extenuating circumstances can happen and may be legitimate reasons for extensions on assignments or postponement of exams. If there are reasons you are unable to meet a deadline be sure to discuss with me well in advance if possible. You must be prepared to provide confirmation of illness.

McGill policy statements

- Language of submission
  "In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French written work that is to be graded. This does not apply to courses in which acquiring proficiency in a language is one of the objectives." (Approved by Senate on 21 January 2009)

  « Conformément à la *Charte des droits de l'étudiant* de l'Université McGill, chaque étudiant a le droit de soumettre en français ou en anglais tout travail écrit devant être noté, sauf dans le cas des cours dont l'un des objets est la maîtrise d'une langue. » (Énoncé approuvé par le Sénat le 21 janvier 2009)

- Academic integrity
  "McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures" (Approved by Senate on 29 January 2003) (See McGill's guide to academic honesty for more information).

Additional statements

- Artificial Intelligence (AI) Tools: Artificial intelligence (AI) language models, such as ChatGPT, may be used for any assignment with appropriate citation. Examples of citing AI language models are available at: libguides.umn.edu/chatgpt. AI tools can be helpful, especially with coding in my experience, but you will likely find that they are of limited use for other aspects of your assignments. You are responsible for fact checking statements composed by AI language models.
- Copyright: © Instructor-generated course materials (e.g., handouts, notes, summaries, exam questions) are protected by law and may not be copied or distributed in any form or in any medium without explicit permission of the instructor. Note that copyright infringements can be subject to follow-up by the University under the Code of Student Conduct and Disciplinary Procedures.
- Extraordinary circumstances: In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.
- Inclusive learning environment: As the instructor of this course, I endeavor to provide an inclusive learning environment. However, if you experience barriers to learning in this course, do not hesitate to discuss them with me and/or Student Accessibility and Achievement.
- Pronouns: Please email me if you would like me to refer to you by a different name than the name indicated in your student record or to inform me of your pronouns.
- Respect: The University is committed to maintaining teaching and learning spaces that are respectful and inclusive for all. To this end, offensive, violent, or harmful language arising in course contexts may be cause for disciplinary action.
- Wellness: Many students may face mental health challenges that can impact not only their academic success but also their ability to thrive in our campus community. Please reach out for support when you need it; wellness resources are available on campus, off campus, and online.
- Workload management skills: If you are feeling overwhelmed by your academic work and/or would like to further develop your time and workload management skills, don't hesitate to seek support from Student Services.