

ATOC 521 – Cloud Physics

Course Outline, Winter 2025

Department of Atmospheric & Oceanic Sciences, McGill University

Lectures / course schedule

When: January 7 – April 10, 2025
Tuesdays and Thursdays, 08:35 – 09:55 h (EST/EDT)

Where: Burnside Hall, room 708

Notes: Winter break: week of March 3 ([see key dates](#)); no class;
Make-up days: none this term

Course credit: 3 credit points

Instructor

Prof. Andreas Zuend

Office: Burnside Hall, room 944

Phone: 514-398-3760

Email: andreas.zuend@mcgill.ca

Office hours: ask me before/after class or make an appointment (send an email);
Also: consider using the [“Discussions” tool on myCourses](#) to ask course-related questions and get responses from the TA / Prof. / other students.

Teaching assistant

Meng-Tze Lee

Office: Burnside Hall, room 825

Email: meng-tze.lee@mail.mcgill.ca

Office Hours: Wednesdays from 4:00 to 5:00 PM (or by email appointment)

Website / myCourses

All relevant materials (assignments, announcements, lecture slides, etc.) will be posted on the [myCourses page for ATOC 521](#). Special announcements may also be made in class.

Textbook

A Short Course in Cloud Physics (3rd edition) by R. R. Rogers and M. K. Yau,
ISBN: 0-08-034863-7 available as [ebook](#) via the McGill library; (also available in print at McGill bookstore, the library or from previous students).

This book is *highly recommended but not mandatory* for this course. Relevant information from the selected chapters will also be provided on the lecture slides and/or related handouts. However, the book offers practice problems at the end of each chapter – and it covers some additional details on selected topics not discussed in class.

Course contents

This course provides a detailed survey of the basic physical processes involved in the formation of warm (liquid), cold (ice) and mixed-phase clouds. Material to be covered: most of Chapters 1 – 9 of the textbook. Topics include: the thermodynamics of dry and moist air, mixing of air parcels, how air reaches water saturation leading to condensation, microphysics of the formation and growth of cloud droplets and ice crystals, atmospheric aerosols related to cloud formation, initiation of precipitation, rain and snow.

A tentative listing of the course topics and lecture schedule is provided in Table 1:

Table 1: Tentative lecture schedule

Week	Date	Topics & Remarks
1	Tuesday, January 07, 2025	Course introduction; cloud classification
1	Thursday, January 09, 2025	Chapter 1: Thermodynamics of dry air
2	Tuesday, January 14, 2025	Chapter 1: Thermodynamics of dry air
2	Thursday, January 16, 2025	Chapter 2a: Thermodynamics of moist air; + assignment #1 posted
3	Tuesday, January 21, 2025	Chapter 2a,b: Thermodynamics of moist air
3	Thursday, January 23, 2025	Chapter 2b: Thermodynamics of saturated air; + assignment #1 due
4	Tuesday, January 28, 2025	Chapter 2c: Thermodynamics of saturated air & mixing
4	Thursday, January 30, 2025	Chapter 2c & 3a: Buoyancy and atmospheric stability
5	Tuesday, February 04, 2025	Chapter 3a,b: Atmospheric stability
5	Thursday, February 06, 2025	Chapter 3b & 4a: Instability; Convection; + assignment #2 posted
6	Tuesday, February 11, 2025	Chapter 4a, 4b: Convection and mixing
6	Thursday, February 13, 2025	Chapter 4b, 4c: Convection, bubbles, plumes; + assignment #2 due
7	Tuesday, February 18, 2025	Chapter 5: Cloud observations 1
7	Thursday, February 20, 2025	Chapter 5: Cloud observations 2
8	Tuesday, February 25, 2025	<i>Midterm exam during class</i>
8	Thursday, February 27, 2025	Chapter 6a: Cloud droplet formation
	Tuesday, March 04, 2025	<i>Study-break, no class</i>
	Thursday, March 06, 2025	<i>Study-break, no class</i>
9	Tuesday, March 11, 2025	Chapter 6a,b: Droplet formation, nucleation; + assignment #3 posted
9	Thursday, March 13, 2025	Chapter 6b,c: Koehler theory; Atmospheric aerosols 1
10	Tuesday, March 18, 2025	Chapter 6c,d: Atmospheric aerosols 2 & aerosol–cloud–climate interactions; + assignment 3 due
10	Thursday, March 20, 2025	Chapter 6d & 7a: Droplet growth
11	Tuesday, March 25, 2025	Chapter 7a,b: Growth of droplet populations
11	Thursday, March 27, 2025	Chapter 7b & 8a: Warm rain initiation; + assignment #4 posted
12	Tuesday, April 01, 2025	Chapter 8a: Warm rain initiation
12	Thursday, April 03, 2025	Chapter 8b: Stochastic collection and growth; + assignment #4 due
13	Tuesday, April 08, 2025	Chapter 9: Ice crystal formation and growth 1
13	Thursday, April 10, 2025	Chapter 9: Ice crystal formation and growth 2

Mode of course content delivery

This course will be taught in form of in-person classes, which will include regular lectures, in-class problem solving, midterm and final exams.

- The classes will take place regularly in the form of interactive ~80 min lectures (see schedule above), usually with a 5 min break in the middle.
- Lecture slides will be made available on myCourses prior to each class.

Prerequisites

(apply to undergraduates only): ATOC 315, MATH 314, and MATH 315, or permission of the instructor.

Means of Assessment & Evaluation

Table 2:

Assessment item	Weight*	Description	Due Date	Considerations and Late Penalties
Midterm Exam	25%	In-class, 80 min, closed-book, but allowing 2 crib sheets. Qualitative short-answer questions and quantitative (calculation) problems.	February 25, 2025	Make-up exam to be held roughly two weeks later for students with a valid reason for missing the assessment.
Final Exam	45%	3 h; closed-book, but allowing 4 crib sheets. Qualitative short-answer questions about physical concepts and quantitative (calculation) problems.	<i>To be scheduled</i> during the final exam period.	Missed final exams are handled by Service Point. Inform also instructor.
Homework assignments (4)	4 x 7.5% (30% total)	Derivations and applications of theory and physical concepts.	One roughly every 3 weeks; see Table 1.	Late assignments receive a 10% penalty per day late.

* Indicated percentage weights refer to the contribution of an item to the final (overall) course grade.

Additional information on assessments:

- There will be four (4) graded homework assignments. Please submit these *by the due date as instructed on the assignment*. These assignments are a *mandatory* part of the course. They are highly beneficial for internalizing and applying discussed concepts and equations. Tentative assignment due dates are listed in Table 1.
- Assessments in this course are governed by the [Policy on Assessment of Student Learning \(PASL\)](#), which provides a set of common principles to guide the assessment of students’ learning. Also see [Faculty of Science-specific rules](#) on the implementation of PASL.
- The grading of assignments and exams follows the General Science Grading Rubric (appendix 1) at www.mcgill.ca/science/staff/advisor-instructor/policy-assessment-student-learning-addenda, primarily scoring based on category column 2: “Correct application of concepts”. Achievable point totals for each problem/question or block of questions (e.g. in case of a, b, c,... components of a problem) will be indicated on assignments and exams. For a given problem, the achieved grading rubric score will be accounted for in proportion to the indicated total points achievable.
- Legally mandated academic accommodations are handled by Student Accessibility and Achievement. For more information see <https://www.mcgill.ca/access-achieve/>. If you have a disability or health condition requiring special accommodation, please contact the instructor to arrange a time to discuss your situation. Prior to doing so, it would be helpful if you familiarize yourself with the services offered by the Student Accessibility & Achievement office.

- Academic considerations for assessments that are missed or late for valid reasons will be provided at the instructor's discretion. As per the new Quebec guidelines, medical notes are not required for absences of less than 5 days. **Note that repeated, similar requests for academic considerations in this course are unlikely to be granted.**
- If a student is not able to complete an assignment or exam within the given time frame based on a valid reason (e.g. illness), the instructor should be informed as soon as possible, such that an extension, exam deferral, or another adequate measure can be considered.
- The final exam date will be announced once it is known (final exam period: April 14–30).
- The midterm and final exams will consist of a combination of qualitative questions (physical concepts) and quantitative problems related to the course contents discussed.
- Details on covered material for exams, allowed formula sheets and tools, will be announced during class in advance of the exams. The final exam will cover material for the *entire* course.
- Unless otherwise specified, no work intended for extra credit will be accepted.
- In the case of a failing grade (D or lower for undergraduate, below B- for graduate students), there will be a **supplemental exam** offered during the supplemental exam period **worth 70 %** of the course grade (the remaining 30 % from graded homework assignments). See further information on [eligibility rules for deferred and supplemental exams](#).

General rules and regulations

- 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)
- 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).
- In the event of extraordinary circumstances beyond the University's control, the content and/or assessment tasks in this course are subject to change and students will be advised of the change.