

Atmospheric Dynamics I Syllabus

Department of Physics & Atmospheric Science PHYC/OCEA 4411/5411 Fall 2026

Dalhousie University operates in the unceded territories of the Mi'kmaw, Wolastoqey, and Peskotomuhkati Peoples. These sovereign nations hold inherent rights as the original peoples of these lands, and we each carry collective obligations under the Peace and Friendship Treaties. Section 35 of the Constitution Act, 1982, recognizes and affirms Aboriginal and Treaty rights in Canada.

We recognize that African Nova Scotians are a distinct people whose histories, legacies, and contributions have enriched the part of Mi'kma'ki known as Nova Scotia for over 400 years.

Course Instructor

Name	Email	Student Hours
Dr. Sean Hartery	sean.hartery@dal.ca	Tuesdays 10 AM – 1 PM or by appointment Dunn 210

1. Course Description

The basic laws of fluid dynamics are applied to studies of atmospheric motion, including the atmospheric boundary layer and synoptic scale weather disturbances (the familiar highs and lows on weather maps). Emphasis will be placed on the blend of mathematical theory and physical reasoning which leads to the best understanding of the dominant physical mechanisms.

1.1 Course Prerequisites

PHYC 2140.03 or [PHYC 2060.03](#) or permission of the instructor

1.2 Cross-Listing

[PHYC 4411.03](#), [OCEA 4411.03](#), [PHYC 5411.03](#), [OCEA 5411.03](#)

2. Student Resources

2.1 Student Hours

I will be available once per week in Dunn 209 (or virtually, by request) as indicated above. This is your opportunity to directly ask questions regarding lecture content and get assistance with assignments.

2.2 Discussion Boards

Outside of student hours and lectures, you can post questions regarding assignments, lecture content, or general course logistics to the Discussion boards on Brightspace. All students are encouraged to reply, but you can expect a reply from me within 24 - 48 hours.

2.3 Instructor Email

Please include the course code in the subject of your email and your banner number in the body. Ideally, keep emails to important course logistics (e.g. requesting an extension, making up a test, etc.). For questions regarding course content, you can always chat with me after class – and if it's a small question, just drop by my office. I don't answer emails after 6:00 PM.

3. Course Structure

The course will be delivered in-person. My lectures will largely consist of oral explanations supplemented by written derivations and example problems on the blackboard/whiteboard. Students are expected to take notes. Lectures will not be recorded by the instructor, but students may request permission to record lectures.

3.1 Lectures

Class Days: M, W
Class Times: 1005 – 1125
Classroom: 302
Building: Sir James Dunn Building
Campus: Studley
Schedule: See [Course Content](#)

3.2 Brightspace

Assignments and other course resources will be available via Brightspace. You can access the Brightspace page for this course by logging in with your Dalhousie netID and password at the following site: <https://dal.brightspace.com/d2l/home>

3.3 Announcements

Important announcements will be posted primarily on Brightspace and occasionally sent via e-mail. It is important that you check both Brightspace and your assigned Dalhousie e-mail account regularly.

4. Course Materials

4.1 Textbook (required)

The following textbook is required:
“Mid-Latitude Atmospheric Dynamics: A First Course”
Jonathan E. Martin

Where can I get the textbook?

Option 1: Campus bookstore. Physical and e-text available.

Option 2: I have a few copies which I can loan out for the semester. First come, first serve. A deposit of 20\$ is required.

4.2 Calculator (required)

A *non-programmable* scientific calculator is permitted for use during tests and exams.

About the Instructor

I started my academic career with a BSc in Physics at Dalhousie University, originally intending to pursue astronomy. In 2nd and 3rd year, I had the opportunity to work with an atmospheric lidar, and my focus shifted from the deep reaches of the universe to the ethereal clouds of our atmosphere. After leaving Dalhousie, I pursued a PhD in Physics at the University of Canterbury, studying aerosol-cloud interactions over the Southern Ocean, specifically the formation of mixed phase cloud. This provided the rare opportunity to conduct atmospheric research near Antarctica aboard the R/V Tangaroa. For my postdoc, I studied the filtration characteristics of novel materials for “N95” masks. Eventually, I accepted an instructor position at Augusta University in Georgia. I found great joy working with students as they explored the fundamental concepts of physics – particularly in the lab, where they could see simple electrical and mechanical principles at work. In 2023, I was given the opportunity to bring my love and passion for teaching physics back to Dalhousie – I hope that I get to share some of my joy of physics with you.

Outside of research and teaching, I enjoy biking, baking, playing guitar, drinking coffee, seeing live music, and hanging out with my partner and our two cats: Pebble & Pangea.



5. Course Content

While the following schedule is tentative, topics will proceed in the order below. With some exceptions, we will cover Chapters 1 – 5.3 in Martin.

Week	Lecture	Date	Topic	Reading(s)
1	NC	Mon, Sep 07	No Class	
	1	Wed, Sep 09	Introduction, Vector Review	
2	2	Mon, Sep 14	Eulerian & Lagrangian Perspectives	1.2, 1.4
	3	Wed, Sep 16	Pressure Gradient, Gravity, Geopotential	2.1.1, 2.1.2, 2.2.1
3	4	Mon, Sep 21	Geopotential Height, Friction	2.1.3, 2.2.2
	5	Wed, Sep 23	Coriolis	2.2.2, pp58-59
4	6	Mon, Sep 28	Scale Analysis	M3.1.1, pp59-60
	NC	Wed, Sep 30	Truth & Reconciliation	
5	7	Mon, Oct 05	Geostrophic Balance	pp61-65
	8	Wed, Oct 07	Conservation of Mass	pp65-68
6	NC	Mon, Oct 12	Thanksgiving	
	Q	Wed, Oct 14	Quiz 1	
7	9	Mon, Oct 19	Conservation of Energy	pp68-71
	10	Wed, Oct 21	Potential Temperature	pp71-72
8	11	Mon, Oct 26	Atmospheric Stability	pp72
	12	Wed, Oct 28	Pressure Coordinates	4.1
9	13	Mon, Nov 02	Vertical Velocity	
	14	Wed, Nov 04	Thermal Wind Balance	4.3
10	NC	Mon, Nov 09	Reading Week	
	NC	Wed, Nov 11		
11	15	Mon, Nov 16	Natural Coordinates	pp93-97
	Q	Wed, Nov 18	Quiz 2	
12	16	Mon, Nov 23	Balance Conditions	pp97-102
	17	Wed, Nov 25	Gradient Wind Balance	pp103-108
13	18	Mon, Nov 30	Circulation	pp115-120
	19	Wed, Dec 02	Vorticity	pp122-126
14	20	Mon, Dec 07	Potential Vorticity	pp128-130
	21	Tue, Dec 08	Vorticity Equation	M5.3
	P	Wed, Dec 09	Project Presentations	

6. Learning Objectives

Upon successful completion of PHYC4411/5511 OCEA4411/5511, a student will be able to:

Diagnose: thermal wind from geopotential thickness isopleths; geostrophic wind from geopotential height isopleths; warm and cold air advection from thickness & height maps.

Distinguish Between: subgeostrophic and supergeostrophic flow; baroclinic and barotropic conditions; fundamental and apparent forces;

Identify: the physical meaning and canonical name of terms in various differential equations; approximations or assumptions applied in the derivations of equations.

Apply: the primitive equations of motion to study various systems of interest by applying appropriate scaling arguments and convenient coordinate systems.

7. Assessments

You will automatically get the benefit of the grading method which leads to the highest final grade. Please note the differences between undergraduate (UG: PHYC4411/OCEA4411) and graduate grading schemes (G: PHYC5411/OCEA5411)

Assessment	UG Method 1	UG Method 2	G Method 1	G Method 2
Assignments	25%	25%	20%	20%
Participation	5%	5%	5%	5%
Quiz 1	15%	Best Quiz 22.5%	15%	Best Quiz 22.5%
Quiz 2	15%		15%	
Project	10%	10%	15%	15%
Final Exam	30%	37.5%	30%	37.5%

7.1 Assignments

Assignments are all weighted equally. Your lowest scoring assignment will be dropped when computing your final grade.

Assignment	Due Date
#1	Wed Sept 23
#2	Wed Oct 7
#3	Wed Oct 28
#4	Wed Nov 4
#5	Wed Nov 25
#6	Wed Dec 02

7.2 Participation

Students can earn participation grades in three ways:

1. Asking questions in class or in office hours.
2. Working on in-class activities.
3. Completing entries in the "Dynamics Glossary".

More information will be provided in class.

7.3 Quizzes

There will be two (2) in-person quizzes which will take place in lieu of lecture. The material covered by each quiz will be specified in lecture.

	Date
Quiz 1	Wed. Oct. 14 th
Quiz 2	Wed. Nov 18 th

7.4 Undergraduate Project

Students are expected to complete:

- Research Article Selection.** Select a peer-reviewed *research* article from a relevant academic journal (e.g. AMS, JGR, RMets) which is appropriately connected to the fundamental concepts presented in our course. In a short paragraph (<150 words), the student is expected to explain how the article connects to the course.
- Article Summary.** Provide a substantive summary of the research article, connecting the main points of the article to the fundamental concepts in our course. The summary will be submitted twice: first as a rough draft, and then as a final, revised draft.
- Oral Presentation.** Present the research article to the class in the form of an oral presentation with accompanying PowerPoint.

Project Component (weight)	Date
Research Article Selection (5%)	Fri. Oct 2 nd
First Draft of Summary (15%)	Fri. Nov 6 th
Final Draft of Summary (20%)	Wed Dec 9 th
Oral Presentation (60%)	Wed Dec 9 th

Students are encouraged to discuss their projects with the instructor throughout the semester.

7.5 Graduate Project

The graduate project is identical to the undergraduate project, except:

- The weighting of components is different (see table).
- The article summary must draw on two (2) additional sources, which provide supporting or contrasting information.
- While the rubric is similar, the expected level of quality required to meet a rubric criterion is raised (i.e. work that might be considered a 4/5 for an undergraduate would be considered 3/5 for a graduate student).

Project Component (weight)	Date
Research Article Selection (5%)	Fri. Oct 2 nd
First Draft of Summary (15%)	Fri. Nov 6 th
Final Draft of Summary (40%)	Wed Dec 9 th
Oral Presentation (40%)	Wed Dec 9 th

7.6 Final Exam

The final exam will be a cumulative test of all content featured in lectures, with an emphasis on the later, untested parts of the course. The final exam will take place during the formal exam period and is scheduled by the registrar. The date will be announced on Brightspace once scheduled by the Registrar.

7.7 Calculation of Final Grades

Undergraduate

Conversion of numerical grades to final letter grades follows the Dalhousie Grade Scale:

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A- (80-84)	B- (70-72)	C- (55-59)	

Please note that your final numerical grade is rounded (e.g. 89.5 → 90, 89.4 → 89) before conversion to letter grade as above.

Graduate

Number to letter conversion is the same for graduates as for undergraduates, except that any grade below B- is considered an F. For grades of F, see FGS calendar for implications on program continuation.

8. Course Policies on Missed or Late Academic Requirements

8.1 Assignments

If you require an extension on an assignment, please give me 24 hours' notice. I can normally grant extensions up to 3 days, but I can offer longer extensions in more serious cases (e.g. prolonged illness). If you *don't* request an extension, an assignment loses ten percentage points per day past due (e.g. an assignment grade of 87% would drop to 77% for one day past due, 67% two days, etc.). Assignments later than 5 days past the deadline will not be accepted.

8.2 Quizzes

If you know ahead of time that you are going to miss a quiz due to serious illness or personal emergency, please notify me ASAP and we will re-schedule – given my other teaching duties, this is likely to take place after 6 PM on a weekday. You must contact me and write the quiz within 48 hours of the in-class date.

If no plan is made, or you are unable to write the quiz within 48 hours of the in-class date, please submit a Student Declaration of Absence. You will be graded according to Method 2.

8.3 Project Deadlines

If you submit a project component within 48 hours of the due date, it will be considered “on time”. Anything past 48 hours must be agreed upon by prior request.

8.4 Final Exam

Students must take the exam on the scheduled date except under exceptional circumstances. If you are unable to take exam at the scheduled date for a valid medical, personal, or academic reason, you should contact the course lecturer as soon as possible. You may not use a Student Declaration of Absence for the final exam. For University-wide deadlines for payment of academic fees, course withdrawals, convocation, etc. please visit: https://www.dal.ca/academics/important_dates.html

8.5 Student Declaration of Absence

A student declaration of absence may only be used to excuse absence for one (1) quiz.

9. Course Policies related to Academic Integrity

All coursework submitted for grading must represent your work and your work alone. To be clear:

- × Students are not permitted to access or copy another student’s homework assignments, tests, or exams (including those of past students).
- × Students are not permitted to use any device which would enable cheating during a test or final exam.
- × Students are not permitted to use courseware like Chegg, Course Hero, Quizlet, or LLMs or broadly defined “AI” (including, but not limited to) ChatGPT to complete their homework assignments.
- × A student who supplies their coursework to another student (in the present semester and/or a future semester) also commits an act of plagiarism.

If a student commits a serious act of plagiarism or academic dishonesty, it may result in an automatic grade of F for the course. Continued offenses may result in expulsion from Dalhousie. For more information on Dalhousie University’s Academic Integrity policies, please consult:

https://www.dal.ca/dept/university_secretariat/academic-integrity.html

10. A Note About AI

I strongly recommend reading the following report on *cognitive offloading* by researchers at MIT: <https://www.media.mit.edu/publications/your-brain-on-chatgpt/> (Kosmyna et al., 2025). The findings are grim, showing that users who habitually use AI to perform tasks that require critical thinking gradually accrue a *cognitive deficit*: i.e., over time, researchers have found that an AI user’s critical thinking skills degrade. Ok, sure, but maybe you are just worried about your grade. Well... more recent research has shown that whatever increase in assignment grade is gained through AI is subsequently lost on tests and exams (Strömberg et al, 2026). As tests & exams make up a much larger portion of your grade (and are a better testament to your understanding), you would be shooting yourself in the foot to rely on AI for homework or whilst studying.

I hope that this course will provide you with the deep understanding of atmospheric dynamics that is necessary to be a meteorologist; but acquiring this understanding necessarily requires YOU to do the thinking.

Nataliya Kosmyna, Eugene Hauptmann, Ye Tong Yuan, Jessica Situ, Xian-Hao Liao, Ashly Vivian Beresnitzky, Iris Braunstein, and Pattie Maes. "Your brain on chatgpt: Accumulation of cognitive debt when using an ai assistant for essay writing task." arXiv preprint arXiv:2506.08872 (2025).

Strömberg, David and Lei, Victor and Wu, Yanhui, The Generative AI Learning Penalty: Evidence from Chinese Secondary Education (June 02, 2026). CEPR Discussion paper: DP21577, Available at SSRN: <https://ssrn.com/abstract=6977138> or <http://dx.doi.org/10.2139/ssrn.6977138>

11. Course Accessibility

Religious, Cultural, and Community Based Accommodations

Students are eligible for accommodations based on [protected characteristics](#) such as religion. If you have [religious, cultural, or community-significant observances](#) that conflict with course requirements, please reach out to me to collaboratively find alternatives for completing course requirements.

Academic Accommodations

To begin the process of requesting formal academic accommodations (e.g. extended time for writing tests, assignment extensions, etc.), contact the [Student Accessibility Centre](#).

Syllabus Appendix

Please use the following link to access Dalhousie's "Syllabus Appendix". The appendix has important resources, statements, policies, and guidelines geared towards supporting students. [Syllabus Appendix: Student Supports & University Statements, Policies, and Guidelines](#)