Climate/Space 321: Earth and Space System Dynamics
Winter 2025
Tu/Th 12:00pm to 1:30pm, CSRB 2246

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Students requiring accommodations or special assistance with course requirements should contact me as soon as possible (by the mid of January) to discuss appropriate academic accommodations for qualified students with disabilities.

COURSE OBJECTIVES

1. Understand the meanings of technical terms such as pressure, density, temperature and how they are related in atmospheres
2. Understand stability and instability of motions
3. Understand the meaning of vorticity in describing fluid motions
4. Can use proper mathematical notation to describe the motion of atmospheres
5. Can use calculus to compute atmospheric quantities
6. Can use mathematical software and computer program to draw figures, write equations and deduce meanings

WORKLOAD

1. **9** homework assignments
2. **1 scripting** or **1 15-minute** recitation presentation
3. Two exams, open script, close book

PROGRAMMING LANGUAGE

1. Python/Jupyter Notebook (required for homework)
2. LaTex/Overleaf (required for scripting)
3. Tutorials on how to write Python and LaTex code will be provided

COURSE MATERIALS

(1) Textbook:

- Fundamentals of Atmospheric Physics, Murry Salby
- Atmosphere, Ocean, and Climate Dynamics, John Marshall
- Atmosphere-Ocean dynamics, Adrian Gill
- An Introduction to Dynamic Meteorology, James Holton

(2) Scripts and recitation

- There will be **three** recitation sessions during the whole semester (see Course Schedule at the end of the syllabus).
- At the end of each lecture, one student will be chosen by random to summarize today's lecture in the form of **(1) a formal scripting in LaTeX** or **(2) in the form of a recitation.**
  - If you are chosen to summarize in the **form of a recitation**, you will present the material for 15 minutes to the whole class during a recitation session. You are only allowed to use whiteboard and marker for recitation (no digital forms allowed). Please email your handwritten/whiteboard/LaTeX version of the recitation/scripting to the IA after the recitation session. IA will typeset it in a formal LaTex script.
  - If you are chosen to summarize in the **form of a formal scripting**, you are required to submit a formal well-formatted LaTeX script. Please complete the LaTeX script in the shared Overleaf document in a week after receiving the scripting assignment
- Materials covered in the recitation session will be compiled in a shared LaTex script to be used in your exams.
- The formal shared LaTex script will be the **only** reference materials you can use in your exams.

(3) Online programming guides and AI

- Example programming guide in Python and LaTex will be provided as online resources.
- You are allowed to use AI to help you with your study/homework or your scripting tasks. But you cannot use AI during your exams.

COURSE EVALUATION

Component	Explanation	Weight	Grading Distribution
Attendance & Participation	If you are chosen at the end of the class but do not show up, you will lose all 10% of your grade. Starting from the second lecture.	10%	A+ 97% A 93% A- 90% B+ 87% B 83% B- 80% C+ 77% C 73% C- 70% D+ 67% D 63% D- 60%
10 Homework assignments	Each homework assignment is worth 20 points. 1 point off will be taken per late day without prior consent.	40%	
First exam (2/13)	Exams are conducted in classroom. You can only use the shared script for referencing.	20%	
Second exam (4/8)		20%	
recitation and scripting	Every student needs to do either a scripting or a recitation of a designated lecture material. If you are chosen to the scripting or recitation, you do not need to turn in this week's homework. You will automatically earn a full score for this homework.	10%	
TOTAL		**100%**	

COURSE SCHEDULE*

Week	Date	Topic		Assignments
Part I: Description of physical world: Unit, dimension and geometry				
1	Jan 9	Overview of the course		
2	Jan 14	Unit, dimension and scale	G. Maltese (recitation)	HW 1 out
	Jan 16	Review of geometry and physical concepts	G. Koontz (recitation)	
3	Jan 21	Review of mathematical concepts and vector calculus	J. Kirkey (scripting)	HW 1 due / HW2 out
Part II: Atmosphere in one dimension				
3	Jan 23	Pressure-density relation: Hydrostatic balance	J. Toogood # E. Geiss (recitation)	
4	Jan 28	Pressure-temperature relation: Thermodynamics (1)	N. Vandenbrink (recitation)	HW 2 due / HW 3 out
	Jan 30	Pressure-temperature relation: Thermodynamics (2)	Q. Garrow (recitation)	
Reading		Salby – Fundamentals of Atmospheric Physics Chapter 1, 1.1, 1.2 Chapter 2, 2.1, 2.2, 2.3, 2.4 Chapter 3, 3.1, 3.2 3.3, 3.6 Chapter 6, 6.1, 6.2, 6.3, 6.4		
5	Feb 4	Stability: atmospheric oscillation	(scripting)	HW 3 due / HW 4 out
	Feb 6	Instability: atmospheric convection	(scripting)	
6	Feb 11	Recitation #1 (5 presentations + 3 scripting)		HW 4 due
	Feb 13	**First Exam, in class, open script but close book**		
Part III: Atmosphere in motion				
7	Feb 18	Atmospheric process (1): diffusion		HW 5 out
	Feb 20	Atmospheric process (2): transport		
8	Feb 25	Equation of motion		HW 5 due / HW 6 out
	Feb 27	Laminar flow: Bernoulli's principle		
9	Mar 4	**Winter Break – no class**		
	Mar 6			
10	Mar 11	Turbulent flow: Reynold's stress		HW 6 due / HW 7 out
Part IV: Atmosphere under rotation				
10	Mar 13	Rotating reference frame: Coriolis force		
11	Mar 18	Motion under rotation: Taylor's theorem		HW 7 due / HW 8 out
	Mar 20	Geostrophic relation		
12	Mar 25	Density wind relation		HW 8 due / HW 9 out
	Mar 27	Vorticity and Kelvin's theorem		
13	Apr 1	Ekman transport		HW 9 due

	Apr 3	Recitation #2 (5 presentations + 5 scripting)		
14	Apr 8	**Second Exam, in class, open script but close book**		
Part V: Atmosphere on a sphere				
14	Apr 10	Orthogonal coordinate system		
15	Apr 15	Primitive equations		HW 10 out
	Apr 17	General circulation of atmospheres		
16	Apr 22	Recitation #3 (4 presentations)		HW 10 due

* **22** presentations + scripting are scheduled now. Current enrollment number is **26**.

* Schedule and other syllabus/course elements are subject to change at the discretion of the instructor. Changes will be announced within an appropriate time frame.