ATM 317
Dynamic Meteorology II

ATM 317: Dynamic Meteorology II
Spring 2019

Professor: **Andrea Lopez Lang**
ES 323
alang@albany.edu
518-442-4558
Office Hours: Tuesday and Thursday, 10:30 – 11:30 am
Or by appointment

Teaching Assistant: Daniel Reese
ES 332
dreese@albany.edu
Office Hours: Monday and Wednesday, 12:30-1:30 pm
Or by appointment

Location: BB 217   **Course Number:** 1135
Time: Monday, Wednesday & Friday   **Credits:** 3
10:25-11:20 am   **Prerequisite:** ATM 316

Web: http://www.atmos.albany.edu/facstaff/andrea/courses/atm317.html
The course page will be updated with suggested readings, copies of homework assignments, and in-class handouts. Please bookmark this page for the semester.

Accessibility:
If you have a documented disability and may require some accommodation or modification in procedures, class activity, instruction, etc., please see me early in the semester. If you need forms or information, please visit the Disability Resource Center;
http://www.albany.edu/disability/index.shtml

Academic Integrity:
It is every student's responsibility to become familiar with the standards of academic integrity at the University. Claims of ignorance, of unintentional error, or of academic or personal pressures are not sufficient reasons for violations of academic integrity. Please see the current Undergraduate Bulletin or University Libraries for more information on academic integrity.
http://www.albany.edu/undergraduate_bulletin/regulations.html

Please turn off your cell phone before you get to class. All electronic devices, including cell phones, must be put away before class begins and in no way will they be tolerated during exams. You will be asked to leave the classroom for distracting use of electronic devices.

UAlbany
ATM 317

Dynamic Meteorology II

Course Information

ATM 317: Dynamic Meteorology II

Lecture: Mon/Wed/Fri 10:25-11:20 AM - Business Building 217
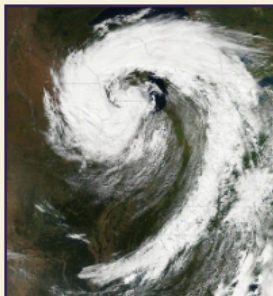
Professor: *Andrea Lopez Lang*
Email: *alang@albany.edu*
Office Hours: *Tu/Th 10:30-11:30 AM, Earth Science 323*

TA: *Daniel Reese*
Email: *dresse@albany.edu*
**Office Hours**:*M/W 12:30-1:30 PM, Earth Science 332*

Welcome to ATM 317, Dynamic Meteorology II.
From the course webpage you have access to information that will help you study, stay up to date, and succeed in this course.

- **Printable Syllabus** with tentative schedule.
- **Handouts** - Past homeworks, in-class assignments and handouts
- **Notes** - Lecture topics and suggested reading

Current Weather Prediction Center (WPC) Maps
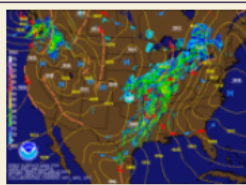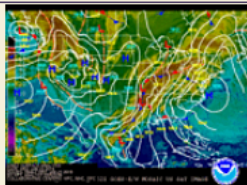
Please email the the instructor if there is anything else you would like to see added to this page.

Apps   NWS   WxC   weather   NWS EDD   btangy   UAmail   https://iridl.ldeo.c...   AES   MyPage   WRF   RAP   NCDC Climate Ra...   Other Bookmarks

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Dynamic Meteorology II

Course Info
Course Home
Calendar/Notes
Assignments
Syllabus

Weather Links
DAES page
NWS
DAES WX
WPC
RAP

Information for current ATM undergraduate students
DAES Majors

ATM 317: Lectures, Reading, and Tentative Schedule

Section 1: Circulation, Vorticity, and PV

Week	Dates	Topic	Reading	HW
1	Jan 23-25	Review: Kinematic Flows, Equations of motion, force balances	Martin Ch 1.4 Martin 4	
2	28 Jan -1 Feb	Thickness and Thermal Winds	Martin 4 Holton 3	
3	February 4-8	Circulation & Vortcity	Martin 5.1-5.2	
4	February 11-15	Vortcity & Quiz 1	Martin 5.2-5.3	
5	February 18-22	Vorticity equations	Martin 5.1-5.2 Holton 4.1-4.4	
6	25 Feb- 1 March	PV and PV equations	Martin 5.2-5.3 Holton 4.2-4.4	

Section 2: Intro to the Quasigeostrophic System

Week	Dates	Topic	Reading	HW
7	March 4-8	Wave strucutre of the atmosphere	Martin 8.2	
8	March 11-15	Exam 1 and Sutcliffe (1939)	Martin 6.1-6.2	
- - -	March 18-22	Spring Break!	- - - -	- - -
9	March 25-29	Sutcliffe Development Theorem and QG assumptions	Martin 6.2-6.3 and 5.4 Holton 6.2-6.3	
10	Apr 1-5	QG omega equation and Trenberth form	Martin 6.2-6.3 Holton 6.4	
11	April 8-12	Deformation terms & QG assumptions	Martin 6.3 Holton 6.4	
12	April 15-19	Quiz 2 and Vector form of omega	Martin 6.4 Holton 6.4	
13	April 22-26	Secondary circulations and Q-vector	Martin 6.4 Holton 6.4	

Course Description:
An application of the governing equations to describe and understand synoptic to planetary scale phenomena, including vertical motion, jet streaks, and the frontal cyclone; introduction to the concepts of vorticity and potential vorticity.

Course Topics *(Tentative)*:
1. Review (Kinematic properties of flows, balanced flows)
2. Thermal Wind
3. Circulation
4. Vorticity
5. Potential vorticity
6. Vorticity equation
7. Structure of extratropical circulations
8. Quasi-geostrophic approximations and the ageostrophic wind
9. Quasi-geostrophic omega equation
10. Ageostrophic circulations
11. The **Q**-vector *
12. Quasi-geostrophic height tendency*
    * Topics introduced if time allows

Texts:
Mid-latitude Atmospheric Dynamics by J. E. Martin (Required)
An Introduction to Dynamic Meteorology by J. R. Holton (Recommended)

Grading: A-E
       Homework (5-6): 35%
       In class assignments and presentations: 10%
       Quizzes (2): 20%
       Midterm (*Wed, 22 March 2018*): 15%
       Final (*Wed. 15 May 2019 at 3:30 pm*): 20%

I know you have a life outside of class, therefore I give everyone one free late day to be used on one assignment. *Once you have used your late day, a late assignment will incur a 10% deduction per day. If solutions have been discussed in class, you can no longer turn in your late assignment and you will receive a zero on that assignment.*

I will come to class prepared to lecture but I encourage you to start a conversation and ask questions in class if you do not understand something. If you have a question, chances are someone else has the same question, go ahead and speak up. The classroom should be an open and inviting environment so that everyone feels free to participate and discuss the material. Everyone in the classroom is responsible for creating this type of environment; I ask you to leave your distractions at the door and participate as a community of learners.

Tentative Schedule

ATM 317: Spring 2019

	M	W	F		M	W	F
January	21	23	25	**March**	18	20	22
	No Class	First Day of Class Review	Review & Kinematic flows		*Spring Break*		
	28	30	1		25	27	29
	Review & Kinematic flow	Review & Eq. of Motion	Force Balances		Sutcliffe Development Theorem	Applying Sutcliffe Dev. Theorem	Revisit QG assumptions
February	4	6	8	**April**	1	3	5
	Thickness and Thermal Wind	Interpreting Thermal Wind	What is Circulation?		*QG omega equations*	Trenberth form of Omega eq	The QG Assumptions
	11	13	15		8	10	12
	Kelvin's Circulation Theorem	Bjerknes Circulation Theorem	**Quiz 1**		Deformation terms	Geostrophic Paradox	Geostrophic Adjustment
	18	20	22		15	17	19
	Circulation vs. vorticity	Vorticity in Natural Coords	Vorticity Equation		**Quiz 2**	Vector form of forcing	Natural Coordinate form of Q
	25	27	1		22	24	26
	The Vorticity eq terms	Potential Vorticity	PV Conservation Using PV		*Holiday*	Q vector form QG Omega Eq	Applications of the Q-vector
March	4	6	8	**May**	29	1	3
	Hydrodynamic Instability	Eddy Kinetic Energy	Diagnosing Vertical Motion		Q-vector and Cyclogenesis	Q-vector and Frontogenesis	Bring it all together
	11	13	15		6	8	10
	Sutcliff Form	**Midterm**	Sutcliffe & Omega		Last week exercise	Last week exercise	

Wednesday, May 15

Final Exam
3:30 – 5:30 pm

A Brief History of the Field of Meteorology

SYNOPTIC:

Derived from the Greek word syn ("together") and opsis ("view")

Describes observations that give a broad point of view

Breakthroughs in mid 1800s

- Espy (1830s) → "Thermal Theory of Cyclones"
  Storm → clouds → latent heating → heat engine model
- Redfield (1831) → Cyclonic circulations
  Vortical structures around cyclones
- Loomis (1841) → currents in cyclones
  Combination of kinematic flows

Espy   Redfield

Loomis

FIGURE 9. Diagrams of surface winds in cyclones: No. 1, according to Espy; No. 2, according to Redfield; Nos. 3 and 4, according to Loomis' own investigations, from Loomis, "On two storms which were experienced throughout the United States in the month of February, 1842," *Trans. Am. Phil. Soc.*, **9** (1846). Loomis' analyses of the wind patterns in two storms clearly indicate the confluence of two different currents and distinct boundaries between these currents.

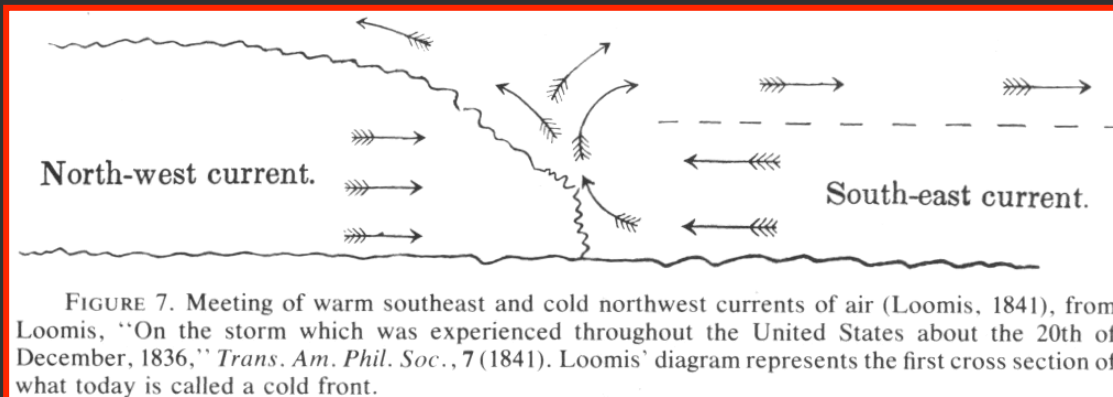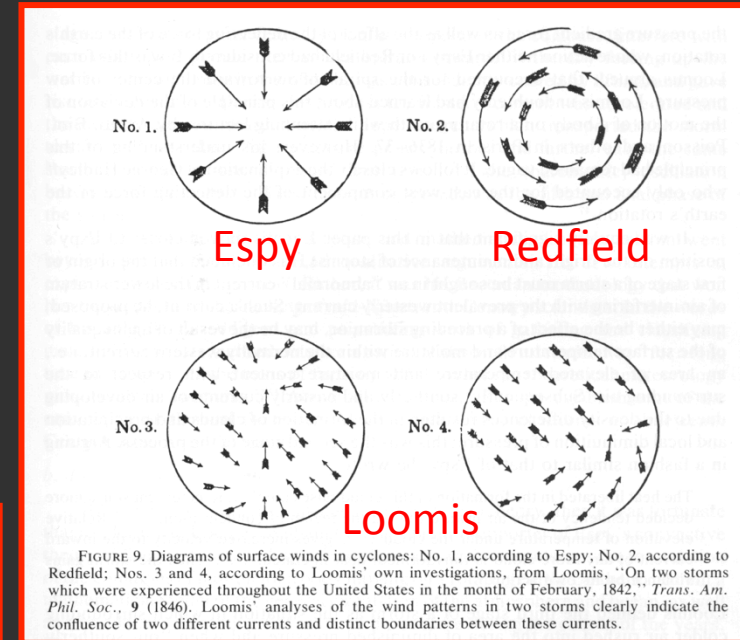North-west current.   South-east current.

FIGURE 7. Meeting of warm southeast and cold northwest currents of air (Loomis, 1841), from Loomis, "On the storm which was experienced throughout the United States about the 20th of December, 1836," *Trans. Am. Phil. Soc.*, **7** (1841). Loomis' diagram represents the first cross section of what today is called a cold front.

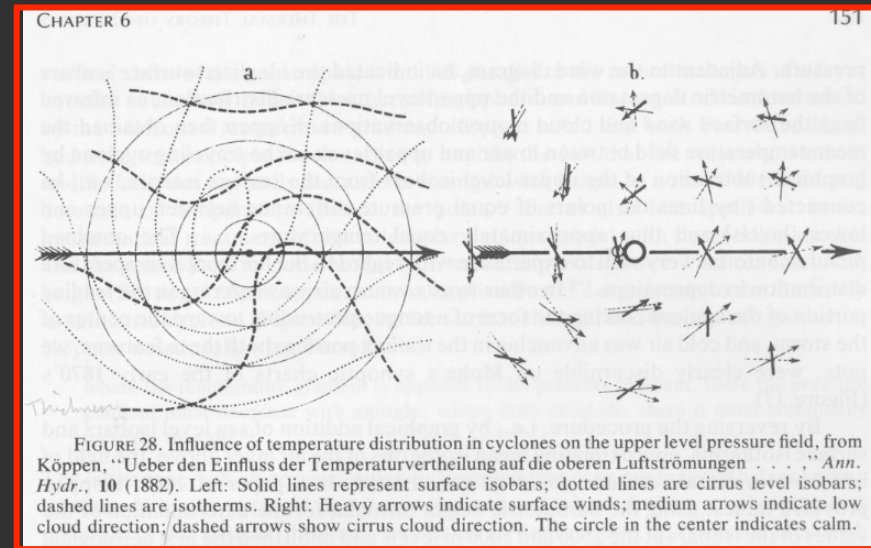# A Brief History of the Field of Meteorology

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- Loomis (1841) → currents in cyclones
  Combination of kinematic flows
- Koppen (1882) → thermal structure
  Vertical tilt and vertical structures of cyclones

Modern meteorology
- 1ˢᵗ Law of Thermodynamics
  → Conservation of Energy
  - Ferrel derived thermal wind

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FIGURE 28. Influence of temperature distribution in cyclones on the upper level pressure field, from Köppen, "Ueber den Einfluss der Temperaturvertheilung auf die oberen Luftströmungen . . . ," *Ann. Hydr.*, **10** (1882). Left: Solid lines represent surface isobars; dotted lines are cirrus level isobars; dashed lines are isotherms. Right: Heavy arrows indicate surface winds; medium arrows indicate low cloud direction; dashed arrows show cirrus cloud direction. The circle in the center indicates calm.

A Brief History of the Field of Meteorology

Vilhelm Bjerknes

Father of Modern of Meteorology

- Father (*Carl Anton Bjerknes*) was a professor of mathematics and physics

- Worked with *Heinrich Hertz* (*namesake of the unit of frequency*) on the existence of EM waves and instruments that transmit/receive radio pulses

- 1895 – Professor at the University of Stockholm

   Combination of fluid dynamics and thermodynamics

   - Developed primitive equations (*still used today!!!!*)

- 1904 – Theory → *Primitive equations* could be used to predict atmospheric motion!

- 1917 – Founded Bergen Geophysical Institute at the University of Bergen, Norway.

   - Developed **Norwegian Cyclone Model** *(with son Jacob, Halvor Solberg and Tor Bergeron)*

Prof. Vilhelm Bjerknes