AOSC400: Physical Meteorology – Fall 2016

1. Course Information:

Instructor: **Dr. Menglin Jin**
Department: Department for Atmospheric and Oceanic Science
University of Maryland, College Park
Fall Semester 2016

Course Title:	**Physical Meteorology**
Course Code:	AOSC400
Section:	Sections 1
Class Hours & Location:	TBD
Office Hours:	noon-1:00 PM Tuesday and Wednesday
Office Location:	CSS 4437
Office Phone:	240-441-4048
Home page	www.at,os.umd.edu/~mjin
E-mail:	Mjin1@umd.edu
Preferred Contact: (Either through email or Phone)	Email

- In addition to the above posted office hours, I am available by email daily.

2. Course Description:

a. Course Overview and Description:

AOSC400 is a 3 credit lecture course that is designed to provide undergraduate students majoring in Atmospheric and Oceanic Science (AOSC) with advance knowledge on the thermodynamics, physical basis of clouds, clouds-aerosol interaction, and rainfall formation.

b. Prerequisites: (NEED TO CHECK DEPARTMENT?)

Completion of AOSC401 (Climate Dynamics and Earth Climate System) or equivalent dynamics course.

c. Required and recommended texts, readers, or other reading materials:

1988 *A Short Course in Cloud Physics* by Rogers and Yau (Required)
2006 Wallace and Hobbs Atmospheric Science (Recommended)

There is no one-covers-all text book for graduate level advanced meteorology. I recommend purchasing Rogers and Yau's *A Short Course in Cloud Physics* because of its concise explanations of basic concepts and simple equations that are easy to look up. You also need to read other books (as suggested in item d below) to catch up the background of Atmospheric Science and/or to get better understanding.

d. Other Reading materials:
Research articles will be assigned via the internet (ww www.atmos.umd.edu/~mjin) during the semester.

In additions, some parts of the following books/articles may be useful in our class:
1973 Iribarne and Godson Atmospheric Thermodynamics
1962 Fletcher The Physics of Rainclouds
1997 Hill Understanding Environmental Pollution
2000 Hobbs Basic Physical Chemistry for the Atmospheric Sciences
2000 Hobbs Introduction to Atmospheric Chemistry
1971 Mason The Physics of Clouds
1997 Pruppacher and Klett Microphysics of Clouds and Precipitation
1997 Turco Earth under Siege
1977 Twomey Atmospheric Aerosols

e. Student learning objectives for the course:

The student will be able to:

1. articulate a basic understanding of theory and facts of thermodynamics
2. describe the key microphysical processes in cloud formation and cloud-aerosol interaction,
3. understand the concepts of rain formation, and explain the important observations related to atmosphere electricity and rainfall events
4. explain various arguments in cloud-aerosol-rainfall relations

3. Grades

Course Requirements	**% of Grade**	**Points**
Homework	20	100
Midterm 1	15	100
Midterm 2	15	100
Class Participation	5	100
Final Exam	25	100
Research Project	20	100

Total	**100**	**600**

Homework:
As you can see from the above grade breakdown, homework is an important part of your grade. It is very difficult to learn the material in any class unless you spend a significant amount of time thinking about the subject matter and actually using the ideas. I try to design homework that accomplishes this. Homework is typically due 1 to 1.5 week(s) after the assigned date (although this may vary). I accept late homework without grade-reduction only if there are extenuating circumstances. Otherwise, I deduct 10 points (out of 100) for each day the homework is late.

Start on the homework assignments early and come see me if you are stuck. If you start on it early, it is not that hard. **Do not wait until the last minute.**

Exams:

No makeup exams will be given. If one exam is missed, then a zero will be given. If you must miss an exam, then see me in advance to possibly arrange it early.

The format of the exams will be similar to the homework and will consist mainly of problems or short answer questions. Obviously, cheating on the exam will not be tolerated and will result in a zero being given for that exam.

Class Participation:

While class participation is graded as 5%, you are expected to be prepared for class and to take active part in the class discussions. Use the class time to get your questions answered on the homework or concepts that you do not understand.

As a student, class participation is an important component of your education and I encourage that you take advantage of class time to ask questions no matter how "simple" you think they might be. Typically what you will find is that other students are also confused about exactly the same issue. I expect all graduate students to take a ***strong*** interest in their own education. Hence, I ***expect*** regular participation from all of you.

Research Project

2 students (TBD) are formed to one research group to discuss one research topic on cloud microphysics. The topic will be decided at the first part of course, with

guidance from the professor. A 8-page paper will be required from each research group at the end of class, and a 15-minute presentation will be given by each group to the class at the last part of semester.

a. Grading information:
Grading Percentage Breakdown

93% and above	A
92% - 90%	A-
89% - 88%	B+
87% - 83%	B
82% - 80%	B-
79% - 78%	C+
77% - 73%	C
72% - 70%	C-
69% - 68%	D+
67% - 63%	D
62% - 60%	D-
below 60%	**F**

b. Extra credit options, if available:

Certain extra credit assignments will be given.

c. Penalty (if any) for late or missed work:

Late work will be penalized 10% per day or part of a day late for any project.

4. AOSC400 List of Topics

Part 1: Thermodynamics

1. The Gas Laws
2. The Hydrostatic Equation
3. The First Law of Thermodynamics
4. Adiabatic Processes
5. Water Vapor in Air
6. The Second Law of Thermodynamics

Part 2: Radiation Balance

Part 3: CLOUD Macrophysics and Microphysics

Key observations of cloud features

Vertical stability and convection
Humidity of parcel in an updraft
    Condition for an increase in RH
RH vs time for parcel in an updraft with condensation
Drop growth equation
Surface tension
Effects of solute
Köhler curves
    Critical supersaturation
    Critical radius
Effects of latent heat

Nucleation and growth in an updraft
Rain formation by stochastic coagulation
Entrainment

Part 4: Atmospheric Aerosol

Sources and characteristics of atmospheric particles
Size distributions - linear and log (radius)
Cumulative distributions
Various integrals and examples
Inverse power (or Junge) distribution
Gaussian distribution
Short review of classical mechanics
Newton's laws of motion
Impulse - momentum theorem
Work - energy theorem
Small sphere falling in air
stopping distance terminal velocity
relaxation time mobility
Diffusion coefficient of particles
Langevin integral of equation of motion
Methods of measuring particle size distributions
Nuclepore filters
Electrical mobility analyzers
Particles in Curvilinear Flow
Equation of motion
Processes in filtration – diffusion and impaction
Collection efficiency
experimental data
Stokes number
Examples: aircraft icing
fog harvesting
Relative diffusion coefficient
Monodisperse coagulation equation
Polydisperse coagulation
Transport of mass through the size distribution
Removal processes

Part 5. Atmospheric Electricity， Optics, and Lightning

Overview of the global electric circuit
Fair weather electric fields and conductivity
Thunderstorms as electrical generators
Charge structure of a thunderstorm
Mechanisms of electrification
Inductive
Non-inductive
Lightning

Types and frequency
Flash densities and strike probabilities
Luminous phenomena
Physical properties of return strokes
Mechanisms of damage
Protection

Rainbows, halos, glories
Observations
Reasons related to water vapor and aerosols

Acoustics
Brief introduction

5. University, College, or Department Policy Information:

a) Academic integrity statement (from Office of Judicial Affairs):
Your own commitment to learning, as evidenced by your enrollment at San José State University and the University's Academic Integrity Policy requires you to be honest in all your academic course work. Faculty are required to report all infractions to the Office of Judicial Affairs.

b) Campus policy in compliance with the Americans with Disabilities Act:
If you need course adaptations or accommodations because of a disability, or if you need special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours.

c) Academic Honesty:
Faculty will make every reasonable effort to foster honest academic conduct in their courses. They will secure examinations and their answers so that students cannot have prior access to them and proctor examinations to prevent students from copying or exchanging information. They will be on the alert for plagiarism. Faculty will provide additional information, ideally on the green sheet, about other unacceptable procedures in class work and examinations. Students who are caught cheating will be reported to the Judicial Affairs Officer of the University.

6. Timetable

Note:
a. RY: A Short Course in Cloud Physics by R. R. Rogers and M. K. Yau

b. The schedule/activity may need to be changed during semester

The lecture schedule indicates the intended scope and timing of materials presented in the course. It is likely that we will deviate from this schedule over the semester.

Day	week	Lecture time	Lecture Title	Comment	HW assignment
8/25/16	W	Lecture 1	Introduction	1st day	
8/30	M	2	Thermodynamics: RY-chapter 1	RY chap. 1	HW1
9/1	W	3	Thermodynamics: RY chap. 2		
9/6	M	4	Thermodynamics: RY Chap. 3	Last day to drop	HW2
9/8	W	5	Thermodynamics: RY Chap 4		
9/13	M	6	No class	no class , labor day	
9/15	W	7	Atmos. Electricity (1)		HW4
9/20	M	8	Atmos. Electricity (2)		
9/22	W	9	Atmos. Electricity (3)		HW5
9/27	M	10	Atmospheric Electricity (4)		
9/29	W	11	Mid-term review, Homework Discussion		
10/4	M	12	Mid-term 1		
10/6	W	13	Cloud Observation (RY Chap. 5), research project discussion		HW6
10/11	M	14	Cloud Observation, cloud formation		
10/13	W	15	Cloud formation (RY chap. 6)		HW7
10/18	M	16	Warm and Cold Clouds		

10/20	W	17	Cloud growth (RY chap. 7)		HW8
10/25	M	18	Cloud Modeling (Guest Lecture)		
10/27	W	19	Mid-term 2		
11/1	M	20	Aerosol (1)		HW9
11/3	W	21	Aerosol (2)		
11/8	M	22	Research Project mini-report		
11/10	W	23	Video		
11/15	M	24	Cloud-aerosol interaction: Aerosol paper discussion (Twomey 1977)		HW10
11/17	W	25	Aerosol Observation		
11/22	M	26	Discussion on aerosol paper (Stevens and Feingold 2009)		
11/24	W	27	No Class	Thanksgiving	
11/29	M	28	Guest lecture by Lorraine Remer		
12/1	W	29	Student Research		
12/6	M	30	Student research		
12/8	W	31	Student research, final review	Last Day of Instruction	
12/13-17	Th	Final Exam Week			