Syllabus
Atmospheric Physics
(Physics 6200)
Fall Semester 2014

Instructor
Prof. Jens Oberheide, 102B Kinard Lab, Dept. of Physics and Astronomy, Clemson University, Tel. 864-656-5163, Email: joberhe@g.clemson.edu

Class Hours
MWF 9:05 – 9:55, 223 Kinard. If I am late for class and do not have a substitute, I do not expect students to wait more than 15 minutes.

Office Hours
MWF 1:30 – 2:30; Th 10:00 – 12:00. Students are encouraged to come any time on an as needed basis. I have an open door policy!

Prerequisite
MATH 1080; and PHYS 2080 or PHYS 2210.

Required Text
An Introduction to Atmospheric Physics (Second Edition) by David G. Andrews; Cambridge University Press, ISBN 978-0-521-69318-9, 2010, 237 pages; List Price US$ 75; it is important that you have the 2nd edition.

Further Reading
An Introduction to Atmospheric Physics (Second Edition) by Robert G. Fleagle and Joost A. Businger; International Geophysics Series, Vol. 25; ISBN 978-0-122-603556, 1980, 432 pages; List Price US $86; an older but good textbook that digs deeper into the theory.

Introduction to Theoretical Meteorology by Seymour L. Hess; Krieger Publishing Company, Malabar, Florida; ISBN 978-0-882-758572, 2002 (reprint edition from 1959), 362 pages; around $80; a classic textbook.

The physics of atmospheres (Third Edition) by John Houghton; Cambridge University Press, ISBN 978-0-521-011228, 2002, 312 pages; List Price $80; also a classic textbook

Note: The class will follow the book by Andrews. I will supplement it with material from the books above where appropriate.

Course Outline
The course is taught along with PHYS 4200. The latter is intended as an introductory class for third- or fourth year undergraduates studying atmospheric physics as part of a physics degree. It is also useful for undergraduate students of applied mathematics, physical chemistry and engineering who have an interest in the atmosphere. For the

PHYS 6200 class, I expect a generally deeper understanding of the material and the ability to attack more advanced problems in atmospheric physics. The graduate students taking the PHYS 6200 class will therefore be assigned specific projects that will be an important part of their performance evaluation. See below for details.

The emphasis of the course is on the underlying physics including atmospheric thermodynamics, radiative transfer, atmospheric fluid dynamics and elementary atmospheric chemistry. For details see the table of contents in the book by Andrews. The course will cover the whole book. Atmospheric applications are developed mainly through selected in-class examples and through homework problems. While the course will mainly address the troposphere, stratosphere, and mesosphere, that is, the region between the ground and about 90 km altitude, some topics will be expanded to include the thermosphere and the atmospheres of the Earth-like planets Mars and Venus. Some atmospheric measuring techniques, while not the focus of the course, will also be introduced as appropriate.

Learning Outcomes

1. Be able to apply basic thermodynamic concepts, Newton's laws, conservation laws and basic electrodynamics to explain the structure and general circulation of the atmosphere.
2. Demonstrate a quantitative understanding of the relationships among physical variables describing atmospheric structure and dynamics, such as temperature, pressure, density and winds through application of algebra and simple calculus to their governing equations.
3. Be able to apply the principles of energy transfer by electromagnetic radiation and basic molecular spectroscopy to determine heating and cooling rates in the atmosphere. This includes obtaining and applying the radiative transfer equation.
4. From basic fluid dynamics, obtain the Navier-Stokes equation on a rotating sphere in various coordinates, approximations and simplifications and apply it to general problems in atmospheric dynamics including vorticity, waves, and instability.
5. Apply the thermodynamical, radiative and dynamical concepts above to explain the chemical structure of the stratosphere, including the ozone hole and catalytic cylcles.
6. Be able to apply the key concepts above to physically explain climate change.
7. Recognize standard remote-sensing and in-situ measuring techniques and be able to discuss their strengths and weaknesses for attacking specific questions in atmospheric physics.

Projects

Each student will be assigned one project related to a special topic. There will be 3-4 weeks of time to study the subject including further reading of more advanced textbooks and contemporary scientific literature and to turn in a comprehensive write-up of at least 7 but not more than 15 pages. The write-up will be graded and counts 50% of the homework grade. Projects will be assigned after the midterm break.

Exams

There will be one mid-term and one final exam.

Homework
Homework is important to develop atmospheric applications based on the physical concepts discussed in class, and to obtain a broader perspective of the subject. It will be assigned on a weekly or bi-weekly basis at the discretion of the instructor. Homework is due on the date assigned. Late homework will not be accepted without a good excuse.

Course Grades and Weights
- 40% Homework (20% from project, 20% from other homework)
- 30% Mid-term exam
- 30% Final exam

A: 85-100; B: 70-85; C: 55-70; D: 40-55; F: 0-40

Attendance Policy
Attendance is required for all classes. It is the responsibility of the student to be aware of what is announced in class, including changes to homework assignments. Also see the general statement on attendance in the Graduate Announcements. The instructor will make suitable accommodations for students who have business related travel.

Class Web Page
The course web site can be accessed via Blackboard. Course announcements, assignments, instructional material etc. can be found there.

Academic Integrity Policy
The Clemson University statement on academic integrity applies, as posted in the Graduate Announcements. In addition, students may discuss homework problems with other students, but only in general terms. **Copying homework solutions from the web is strictly forbidden!**

Disability Access Statement
Students with disabilities requesting accommodations should make an appointment with Dr. Arlene Stewart (656-6848), Director of Disability Services, to discuss specific needs within the first month of classes. Students should present a Faculty Accommodation Letter from Student Disability Services when they meet with instructors. Accommodations are not retroactive and new Faculty Accommodation Letters must be presented each semester.

Title IX Statement
Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. This policy is

located at http://www.clemson.edu/campus-life/campus-services/access/title-ix/. Mr. Jerry Knighton is the Clemson University Title IX Coordinator. He also is the Director of Access and Equity. His office is located at 111 Holtzendorff Hall, 864.656.3181 (voice) or 864.565.0899 (TDD).