# Dynamic Meteorology : ATSC 404, spring term 2014

30 Dec 2013

### Calendar Entry
Dynamic principles governing atmospheric motions on a rotating planet. Simplified mathematical models of atmospheric flow based on scale analysis. Application to synoptic-scale and general circulation of the troposphere.

### Course Purpose
The students completing this course will be able to explain physically flow structures of the atmosphere. They will be able to apply standard dynamical techniques to calculate properties of these flows.

### Instructor
Valentina Radic
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If you wish to see me, please make an appointment either after class or by phone or e-mail to save you waiting outside the office or not finding me in.

### Teaching Assistant
Noel Fitzpatrick, Rm 309 EOS Main 310

### Meeting Times
Lectures are Monday, Wednesday, Friday 1 p.m. in Room 105 of Earth and Ocean Sciences Main (EOS Main)

### Textbook (required):
J.R. Holton & G. J. Hakim "An Introduction to Dynamic Meteorology", 5th edition, Academic Press, 2013. 532 pp

### Course Structure
The material lends itself to a standard lecture format but with the reasonable size class I (Valentina) should have time to answer a few questions/comments each lecture. If I do not have time or you prefer not to ask during class please feel free to ask after class or come to see me in my office. Comments on anything to do with the course: content, textbooks, lecture style etc., are welcome. Please come to see me and we can discuss it. There will be a formal course evaluation at the end of the term but if you tell me earlier I can start doing something about it for this term.

### Assignments
The assignments are an important part of the learning process in this course because the course is oriented to problem solving. As well as a first week mathematics review assignment, there will be 5 assignments mainly involving problem solving and/or Matlab exercises from the textbook (the Matab codes will be provided). If you are not familiar with Matlab you can learn Matlab on the fly while you take the course. Some useful Matlab tutorials can be found online, e.g.:

http://www.lynda.com/MATLAB-tutorials/Up-Running-MATLAB/124067-2.html?srchtrk=index:1%0Alinktypeid:2%0Aq:MatLab%0Apage:1%0As:relevance%0Asa:true%0Aproducttypeid:2

http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-094-introduction-to-matlab-january-iap-2010/

The assignments are expected on time and either neatly hand written (for the problem solving part) or "typed" (please save as PDF). Please include explanations as to what you are doing at each step. The assumptions you make to solve the problem are crucial and must be explicitly stated. Late assignments will be marked and then the mark will be multiplied by (0.9)^(number of days or part days late).

**Participation**

Student participation in class is strongly encouraged and can add to 10% of total mark. After every lecture, the students will be given a homework (to read a section in the textbook and/or to attempt to solve some related short problems). The homework is to be handed in, in person, at the following lecture. The homework will not be graded, but, in order to earn the participation mark, it should demonstrate an effort to solve the given problems (please include explanations as to what you are doing at each step). Each Monday after class the correct solutions to the homework problems from the previous week will be posted online.

**Grades**

- Participation (homework x 34): 10%
- Math assignment: 5%
- Math quiz: 5%
- Assignments (x 5): 25%
- Mid-term Test: 15%
- Final Exam: 40%

**Topics (provisional)**

[…] indicates the corresponding sections in Holton & Hakim, 5th edition.

Ch.1 Introduction

- Pressure gradient force [1.2.1]
- Viscous force [1.2.2]
- Hydrostatic balance [1.4.1]
- Pressure as vertical coordinate [1.4.2]
- Rotating frame of reference [2.1.1, 2.2]

Ch.2 Basic Conservation Laws

- Total differentiation [2.1]
- Momentum equation [2.2]
- Momentum equation in Cartesian coordinates
- Scale analysis of the momentum equation [2.4]
- Continuity equation [2.5]
- Thermodynamic energy equation [2.6]
- Thermodynamics of dry atmosphere [2.7]

Ch.3 Elementary Applications of Basic Equations
- Basic equations in isobaric coordinates [3.1]
- Balanced flow: Geostrophic flow, cyclostrophic flow, gradient wind [3.2]
- Trajectories and streamlines [3.3]
- Thermal wind [3.4]

Ch.4 Vorticity
- Vorticity[4.2]
- Scale analysis of the vorticity equation [4.3.3]
- Potential vorticity [4.4]
- Vorticity Equation [4.5, 4.5.1]

Ch.5 Atmospheric Oscillations
- Waves - basic concepts [5.2]
- Dispersion and group velocity [5.2.2]
- Shallow water gravity waves [5.3.2]
- Internal gravity waves in atmosphere [5.4]
- Rossby waves [5.7]
- Topographic Rossby waves [5.7.2]

Ch.6 Quasi-Geostrophic (QG) Analysis
- QG approximation [6.2]
- QG vorticity equation [6.3]

Ch.7 Baroclinic Instability
- Hydrodynamic instability [7.1]
- Baroclinic instability in a 2-layer model [7.2]

Ch.10 General Circulation
- The global picture [10.2, 10.3]
- Energy cycle [10.4]

Ch.9 Mesoscale Circulation
- Fronts (and frontogenesis) [9.2]
- Convective storms [9.6]

*If there is time left:*
Ch.11 Tropical Dynamics
- Equatorial wave theory [11.4]
- El Nino-Southern Oscillation (incl. ENSO effects at higher latitudes) [11.1.5, 11.1.6]

Ch.13 Numerical Modelling and Prediction
- Historical background [13.1]
- Finite differences [13.2.1]
- Barotropic vorticity equation in finite differences [13.3]

Calendar

| Date | | Event |
|---|---|---|
| Jan 06 | Mon | *First class* |
| Jan 10 | Fri | Math Assignment Due |
| Jan 15 | Wed | Math Quiz |
| Jan 20 | Mon | *Last day to withdraw from course without a 'W' appearing on transcript* |
| Jan 31 | Fri | Assignment 1 Due |
| Feb 10 | Mon | *Family day (no class)* |
| Feb 14 | Fri | Assignment 2 Due; *Last day to withdraw from course* |
| Feb 17-21 | Mon | *Mid-term break (no class)* |
| Feb 26 | Wed | Mid-term Test |
| Mar 07 | Fri | Assignment 3 Due |
| Mar 21 | Fri | Assignment 4 Due |
| Apr 04 | Fri | Assigmnent 5 Due |
| Apr 07 | Mon | *Last class* |
| Apr 12-30 | | Official Examination Period |

The examination period is set out in the Calendar and no work or vacation or travel arrangements should be made for this period. Note, examination period includes Saturdays.