Dynamic Meteorology : ATSC 404

January 3, 2008

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.

Instructors

Susan Allen, 2-2828, sallen@eos.ubc.ca, Rm 253 EOS South
Neil Balmforth, 2-9835, nbalmforth@eos.ubc.ca, Rm 357 EOS South

If you wish to see us, please make an appointment either after class or by phone or e-mail to save you waiting outside the door or not finding us in.

Teaching Assistant

Megan Wolfe, 2-3911, mwolfe@eos.ubc.ca, Rm 309 EOS East

Prerequisites

One of PHYS 312, MATH 316 and one of EOSC 250, MATH 217, MATH 317.

Meeting Times

Lectures are Monday, Wednesday, Friday 1 p.m. in Room 101 of Earth and Ocean Sciences Main.

Text (required):

J. R. Holton, An Introduction to Dynamic Meteorology, Fourth Edition, Academic Press, 2004.

Course Structure

The material lends itself to a standard lecture format but with the reasonable size class we should have time to answer a few questions/comments each lecture. If we don't have time or you prefer not to ask during class please feel free to ask after class or come to see us in our offices.

Comments on anything to do with the course: content, textbooks, lecture style *etc.,* are welcome. Please come to see one of us and we can discuss it. There will be a formal course evaluation at the end of the term but if you tell us earlier we 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 4 analytical assignments and one computer assignment.

The assignments are expected on time and either neatly hand written or "typed". 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 $(0.9)^{(\text{number of days or part days late})}$.

Grades

- Math Assignment 5%
- Math Quiz 5%
- Assignments 25%
- Mid-term Test 25%
- Final Exam 40%

Topics

[...] indicates the corresponding sections in Holton, 4th edition.
SEA : Dr. Allen instructing
NJB : Dr. Balmforth instructing

Math Review (1 hr) SEA

Ch.1 Introduction (2.5 hr) SEA

- Pressure gradient force [1.4.1]
- Viscous force [1.4.3]
- Hydrostatic balance [1.6.1]
- Pressure as vertical coordinate [1.6.2]
- Rotating frame of reference [2.1.1, 2.2]

Ch.2 Basic Conservation Laws (5 hr) SEA

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

Ch.3 Elementary Applications of Basic Equations (4.5 hr) SEA

- 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 (3.5 hr) SEA

- Vorticity[4.2]
- Scale analysis of the vorticity equation [4.4.3]
- Potential vorticity [4.3]
- Vorticity Equation [4.4]

Ch.5 Planetary boundary Layer (3 hr) NJB

- Eddy viscosity [pp.115-116]
- Ekman layer [5.3.4]
- Secondary circulations and spin-down [5.4]

Ch.6 Quasi-Geostrophic (QG) Analysis (1.5 hr) NJB

- QG approximation [6.2]
- QG vorticity equation [6.2.2]

Ch.7 Waves (5 hrs.) NJB

- Basic concepts
- Dispersion and group velocity [7.2.2]
- Shallow water gravity waves [7.3.2]
- Internal gravity waves in atm. [7.4]
- Rossby waves [7.7]
- Topographic Rossby waves

Ch.8 Baroclinic Instability (2.5 hr) NJB

- Hydrodynamic instability [8.1]
- Baroclinic instability in a 2-layer model [8.2]

Ch.9 Mesoscale Circulation (1.5 hr) SEA

- Fronts (and frontogenesis) [9.2.1]
- Convective storms [9.6]

Ch.10 General Circulation (1 hr) SEA

- The global picture
- Laboratory simulation of general circulation [10.7]
- Annular modes [10.6.2]

Ch.11 Tropical Dynamics (2.5 hr) SEA

- Equatorial wave theory [11.4]
- El Nino-Southern Oscillation (incl. ENSO effects at higher latitudes) [11.1.5, 11.1.6]

Ch.12 Numerical Modelling and Prediction (2 hr) SEA

- Historical background [13.1]
- Finite differences [13.3.1]
- Barotropic vorticity equation in finite differences [13.4]
- Comments

Dates

Date	Event
Jan 7	First Class
Jan 11	Math Assignment Due
Jan 16	Math Quiz
Jan 21	Last day to withdraw from course without a 'W' appearing on transcript
Feb 1	Assignment 1 Due
Feb 13	Assignment 2 Due
Feb 15	Last day to withdraw from course
Feb 18, 20, 22	Mid-term break (no classes)
Feb 27	Mid-term Test
Feb 29	Assignment 3 Due
Mar 21	Good Friday (no class)
Mar 24	Easter Monday (no class)
Mar 26	Assigment 4 Due
Apr 3	Computational Assignment Due
Apr 11	Last class
Apr 15-29	Official Examination Period (exam will occur during this period). This 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.