ATS602: Atmospheric Dynamics (Spring 2011)

Introduction

ATS602, the second semester of Atmospheric Dynamics, is based on the course notes available over the web and on the highly recommended texts listed below. The course notes (in PDF format) are available at the Schubert Research Group Web Site under ”Teaching” with the user ID and password given in class. The complete list of chapters is given below. Chapters 1–10 contain material from ATS601. Selected chapters after Chapter 10 are covered in ATS602.

Outline

Grading

Homework	30%	
Midterm Exam	35%	(Thursday, March 10)
Final Exam	35%	(Wednesday, May 11, 9:40pm – 11:40pm)

Instructors

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Highly Recommended Texts

Gill, A. E., 1982: Atmosphere-Ocean Dynamics, Academic Press, 662 pages.

Holton, J. R., 2004: An Introduction to Dynamic Meteorology, Fourth Edition, Academic Press, 535 pages.

Pedlosky, J., 2003: Waves in the Ocean and Atmosphere, Springer-Verlag, 260 pages.

Salmon, R., 1998: Lectures on Geophysical Fluid Dynamics, Oxford University Press, 378 pages.

Vallis, G. K., 2006: Atmospheric and Oceanic Fluid Dynamics, Cambridge University Press, 750 pages.

An excellent introduction to dynamic meteorology can be found in Holton's textbook. The book is written at the senior undergraduate level, so all the material in it should be mastered by every atmospheric science graduate student. Gill's book is more of a graduate-level text and includes considerable oceanography. It focuses on linear theory and has an extensive discussion of fundamental fluid dynamics before the earth's rotation is introduced about a third of the way through the book (page 189). Salmon's book contains excellent discussions of many topics, such as two-dimensional turbulence, quasi-geostrophic turbulence, and semi-geostrophic theory. The newest and best text on AOFD is by Vallis. It is divided into four parts: Part I—Fundamentals; Part II—Instabilities, Wave-Mean Flow Interaction and Turbulence; Part III—Large-Scale Atmospheric Circulation; Part IV—Large-Scale Oceanic Circulation. Parts II and III are of most relevance to ATS602. Much of the material contained in Part IV is covered in Prof. Ito's oceanography course (ATS610). Although much of ATS602 is based on course notes, we shall make frequent reference to these four books. Other books which you should find useful are listed below.

Additional Recommended Texts

Andrews, D. G., J. R. Holton, and C. B. Leovy, 1987: Middle Atmosphere Dynamics, Academic Press, 489 pages.

Baines, P. G., 1995: Topographic Effects in Stratified Flows, Cambridge University Press, 482 pages.

Batchelor, G. K., 1967: Fluid Dynamics, Cambridge University Press, 615 pages.

Charney, J. G., 1973: Planetary Fluid Dynamics, in Dynamic Meteorology, P. Morel, Editor. D Reidel, Boston, pages 99–351.

Cushman-Roisin, B., 1994: Introduction to Geophysical Fluid Dynamics, Prentice-Hall, 320 pages.

Drazin, P. G., and W. H. Reid, 1981: Hydrodynamic Stability, Cambridge University Press, 527 pages.

Dutton, J. A., 1976: The Ceaseless Wind, McGraw-Hill, 579 pages.

Eliassen, A., and E. Kleinschmidt, Jr., 1957: Dynamic Meteorology, Handbuch der Physik, Volume 48, 154 pages.

Green, J., 1999: Atmospheric Dynamics, Cambridge University Press, 213 pages.

Greenspan, H. P., 1968: The Theory of Rotating Fluids, Cambridge University Press, 327 pages.

Haltiner, G. J., and R. T. Williams, 1980: Numerical Prediction and Dynamic Meteorology, John Wiley and Sons, 477 pages.

James, I. N., 1994: Introduction to Circulating Atmospheres, Cambridge University Press, 422 pages.

Kundu, P. K., and I. M. Cohen, 2004: Fluid Mechanics, Third Edition. Elsevier Academic Press, 759 pages.

Lamb, H., 1932: Hydrodynamics, Cambridge University Press and Dover Publications, 738 pages.

Landau, L. D., and E. M. Lifshitz, 1959: Fluid Mechanics, Pergamon Press.

LeBlond, P. H., and L. A. Mysak, 1978: Waves in the Ocean, Elsevier Scientific Publishing Company.

Lighthill, M. J., 1978: Waves in Fluids, Cambridge University Press, 504 pages.

Lighthill, M. J., 1986: An Informal Introduction to Theoretical Fluid Mechanics, Oxford University Press, 260 pages.

Lindzen, R. S., 1990: Dynamics in Atmospheric Physics, Cambridge University Press, 310 pages.

Pedlosky, J., 1987: Geophysical Fluid Dynamics, Second Edition, Springer-Verlag, 710 pages.

Schey, H. M., 1997: Div, Grad, Curl, and All That: An Informal Text on Vector Calculus, Third Edition. Norton Publishing, 163 pages.

Tritton, D. J., 1988: Physical Fluid Dynamics, Oxford Science Publications, Second Edition.

Turner, J. S., 1973: Buoyancy Effects in Fluids, Cambridge University Press, 368 pages.

Although it does not contain much geophysical fluid dynamics, Batchelor's book is a classic for fundamental fluid dynamics concepts. Other excellent books on fundamental fluid mechanics are by Lamb, Landau and Lifshitz, Tritton, and Kundu and Cohen. Another classic for meteorologists is Eliassen and Kleinschmidt, especially the first three chapters (written by Eliassen). Pedlosky's book offers a rigorous and thorough treatment of many topics, including quasi-geostrophic theory and baroclinic instability. Cushman-Roisin's book is more at the level of senior undergraduates; it is enjoyable reading, with each chapter having a short biographical sketch of an important contributor to geophysical fluid dynamics. Although the Andrews et al. book primarily concerns the dynamics of the stratosphere and mesosphere, it contains excellent discussions of wave, mean-flow interaction, Eliassen-Palm fluxes, and wave activity relations, all of which are applicable to tropospheric motions. Drazin and Reid's book concentrates on hydrodynamic stability problems and is recommended (especially its section 22) for use in conjunction with Chapter 18 of the course notes. Greenspan's book has a good discussion of Ekman layers and the spin-up problem encountered in laboratory rotating fluids. Lindzen's book and Green's book are not comprehensive treatments but contain unique perspectives on selected research topics to which the authors have made fundamental contributions. For mountain wave theory and general gravity wave theory the books by Baines and by LeBlond and Mysak are useful. Turner's book concentrates on buoyancy effects in fluids; it contains good discussions of buoyant plumes and bubbles, and should be used in conjunction with Chapter 23 of the notes. Many of problems we study in dynamics are closely related to problems in numerical weather prediction, as discussed in Haltiner and Williams' book. Finally, if you need to refresh your knowledge of vector calculus (we will make frequent use gradient, divergence, and curl), the short paperback book by Schey is very good.