Atmospheric Dynamics II. Theory of Atmospheric Flows

METR 3123

Spring 2006 Syllabus

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Time and place: Mon, Wed, Fri 11:30 p.m. - 12:20 a.m., SEC, Room N202A; Wed 3:30 - 4:20 p.m. (help and exercise session), SEC, Room N202A.

Office hours: by appointment only.

Prerequisites: grade of C or better in METR 3113, 3213 and MATH 3113 or 3413.

Required textbook: Holton, J. R., 2004: *An Introduction to Dynamic Meteorolog*y, 4th edition, Academic Press, 535 pp.

Proposed grading: Two intermediate tests (February, April): 20% each. Best score of two surprise quizzes: 20%. Final exam (May): 40%. Grade cutoffs: ≥85%: A; ≥70%: B; ≥50%: C; ≥30%: D; <30%: F.

General information

The course focuses on fundamentals of atmospheric dynamics with emphasis on basic conservation laws for mass, momentum, and heat, and their mathematical formulation and application. It addresses the notions of circulation and vorticity and considers principal features of the atmospheric planetary boundary layer dynamics. It is assumed that students who take the class have mastered fundamentals of classical physics, have a thorough knowledge of elementary calculus, and know basics of vector calculus.

Course outline

I. Introduction. Atmospheric continuum. Meteorological variables. Scales of atmospheric motion. Fundamental forces. Structure of the static atmosphere. Pressure and geopotential. Density/temperature stratification in the atmosphere. Buoyancy.

II. Basic conservation laws. Conservation of momentum. Equations of motion and their approximations. Spherical coordinates. Conservation of mass; the continuity equation. Conservation of energy. First law of thermodynamics. Thermodynamic energy equation.

III. Applications of the basis equations. Basic equations in isobaric coordinates. Horizontal balance of forces. Geostrophic and cyclostrophic flows. Trajectories and streamlines. Thermal wind. Barotropic and baroclinic atmospheres. Horizontal divergence and vertical motion.

IV. Circulation and vorticity. Circulation theorem. Vorticity and potential vorticity. Vorticity equation in different coordinate systems. Barotropic and baroclinic potential vorticity equations.

V. Planetary boundary layer. Boundary layer concept. Atmospheric turbulence. Reynolds averaging. Boussinesq approximation. Turbulence kinetic energy. Planetary boundary layer momentum equations. Flux-gradient theory. Ekman layer. Secondary circulations.

Note: *Any student in this course who has a disability that may prevent him or her from fully demonstrating his or her abilities should contact Dr. E. Fedorovich personally to discuss accommodations necessary to ensure full participation and facilitate educational opportunities.*