Atmospheric Turbulence

(METR 6103)

Spring 2008 Syllabus

General information: Turbulence is a common state of atmospheric flow motion. Class will cover both fundamental and meteorological aspects of turbulence as a physical phenomenon. Students will be introduced to the basic properties of atmospheric turbulent flows and learn to use a variety of theoretical and numerical tools of turbulence description, analysis, modeling, and simulation, including direct numerical simulation and large eddy simulation. Turbulence parameterizations commonly applied in atmospheric numerical models will be overviewed and recommendations regarding optimal parameterization schemes for particular atmospheric problems will be provided. The course will be organized as a series of classroom exercises (lectures) in conjunction with individual (independent-study type) projects. Students' performance will be evaluated based on the project results presented in two written reports and two class talks.

Time and place: Mon, Wed, Fri, 1:00 - 1:50 pm.; Room NWC 5930.

Instructor: Dr. Evgeni Fedorovich (http://weather.ou.edu/~fedorovi/fedorovich.html)
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Prerequisites: METR 5113 and/or 5103, MATH 3113, 3123, or permission of instructor.

Textbook: Pope, S. B., 2000: *Turbulent Flows*, Cambridge University Press, 771 pp.

Recommended additional texts: Tennekes, H., and J. L. Lumley, 1972: *A First Course in Turbulence*, The MIT Press, 300 pp; Garratt, J. R., 1992: *The Atmospheric Boundary Layer*, Cambridge University Press, 316 pp.

Proposed grading of the course project: Literature review report (March): 30%; Presentation on the state of the art in the selected topic area (March): 20%; Course project report (May): 30%; Presentation of the project (April/May): 20%.

Course outline:

Part I. *Fundamentals.* Nature of turbulent flows. Equations of fluid motion. Statistical description of turbulence. Scales of turbulent motion and turbulence spectra. Specific features of atmospheric turbulence.

Part II. *Turbulent flow types.* Free shear flows. Wall flows. Atmospheric turbulent flows.

Part III. *Turbulence modeling and simulation.* Overview of approaches. Direct numerical simulation. Turbulent-viscosity models. Reynolds-stress and related models. Large eddy simulation.

Part IV. *Atmospheric applications of turbulence theory*. Turbulence in the atmospheric boundary and surface layers. Similarity and scaling techniques. Monin-Obukhov similarity theory. Turbulence parameterizations and closures used in mesoscale atmospheric models. Mellor-Yamada hierarchy of turbulence closures. Large eddy simulation of atmospheric boundary layer flows.

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 your educational opportunities.*