Syllabus for METR 601

This course is the first of a two-course sequence presenting an introduction to central dynamical concepts and models in meteorology. It assumes no prior knowledge of fluid dynamics or meteorology, but does assume familiarity with undergraduate mathematics and elementary mechanics. Concurrent registration in 602 is assumed but not required.

Basic fluid dynamics.

- Preliminaries: Techniques of model construction and analysis; review of vector algebra and calculus.
- Kinematical concepts: Field representations; fields given by streamfunctions and velocity potentials; vorticity, divergence, circulation; Helmholtz decomposition; vortex patches and inversion problems
- Dynamical concepts and relations; parcels in continua; Lagrangian and Eulerian descriptions of motion; material derivatives; pressure, stress, and strain; equations describing changes in momentum, density, energy, vorticity, and circulation.
- Linear theory of sound waves: linearisation and its justification; travelling waves; speed of sound; the incompressibility assumption in meteorology.
- Coordinate systems: curvilinear, rotating, and meteorological.

Simple kinematic and dynamic models of atmospheric motions.

- Geostrophic, thermal, and gradient wind balances.
- Shallow water models: the hydrostatic approximation as a "long wave" approximation; f- and β-plane approximations; adjustment problems; modes of oscillation (Kelvin, Poincare, Rossby); potential vorticity.
- Stratified Boussinesq models; layer and level models (adjustment problems and modes); internal gravity waves (dispersion relations, vertical propagation, group velocity), the role of N^2.
- Quasi-geostrophic models: the Rossby number and the geostrophic approximation; barotropic β-plane models (divergent and non-divertent); potential vorticity equation and linear waves.

Many of the lectures will be based on material found in the text for the courses, Gill's Atmosphere-Ocean Dynamics. Students are expected to read relevant sections of the text. Other useful texts are:

Aris's Vectors, Tensors, and the Basic Equations of Fluid Mechanics,
Batchelor's An Introduction to Fluid Dynamics,
Holton's An Introduction to Dynamic Meteorology
Pedlosky's Geophysical Fluid Dynamics.

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