

ATMS 501 Fundamentals of Physics and Chemistry of the Atmosphere

Syllabus

1. Introduction to the atmosphere. Terms of reference: variables, units, relation between mass and pressure. Vertical structure of the atmosphere: pressure / density, composition, incoming solar radiation, temperature. Atmospheric motions. Distribution of rainfall.
2. The Earth system. Overview of the oceans, the cryosphere, the terrestrial biosphere and the crust and mantle. The hydrologic cycle and the carbon cycle; the inventory of oxygen. A brief overview of the history of the Earth, with emphasis on climate.
3. Atmospheric thermodynamics Gas laws. The hydrostatic equation and its applications. The First Law of Thermodynamics. Latent heats and enthalpy. Adiabatic processes in the atmosphere. Thermodynamics of moist air. The concept of static stability. The Second Law of Thermodynamics, heat engines, entropy.
4. Radiative Transfer. The spectrum of radiation. Quantitative description of radiation. Blackbody radiation laws. Absorptivity and emissivity. Absorption, emission and scattering of radiation by particles and gases. Radiative transfer in planetary atmospheres. Remote sensing. Radiation balance at the top of the atmosphere.
5. Atmospheric chemistry. Important tropospheric trace gases and aerosols, with emphasis on their sources and sinks, residence times, chemical transformations, and transport. Role of reaction rates in determining equilibrium concentrations. Urban and regional air pollution. The nitrogen, and sulfur cycles. Stratospheric chemistry with emphasis on the ozone layer.
6. Cloud physics. Nucleation of water vapor condensation. Cloud liquid water content and entrainment. The microstructure of warm clouds. Growth of cloud droplets in warm clouds. The microphysics of cold clouds. Artificial modification of clouds and precipitation.
7. Boundary layer processes. Physical and statistical description of turbulence and turbulent fluxes. The surface energy balance. Bulk aerodynamic formulae for the fluxes at the Earth's surface. Vertical structure and evolution of the boundary layer over land and sea. Role of low clouds. Regional boundary layer phenomena.
8. Climate The global energy balance at the top of the atmosphere and at the earth's surface. Radiative-convective equilibrium. Role of boundary layer processes and clouds. The diurnal and seasonal cycles. Observed climatic variability and change. Natural and anthropogenic forcings of the climate system, Climate feedbacks. Greenhouse warming.

Class Format Daily lectures/ discussions. Assigned homework problems. Weekly hour quizzes (Fridays) based on material discussed in class that week. Final exam. Course grade based 60% on cumulative point score on weekly quizzes and 40% on final exam.

Textbook

J.M. Wallace and P.V. Hobbs, 2006: *Atmospheric Science: An Introductory Survey, Second Edition*. Academic Press 483pp.

Textbook Companion Website: <http://books.elsevier.com/companions/defaultindividual.asp?isbn=9780127329512>

Contains answers to most of the exercises and supplementary materials such as the skew $T \ln p$ chart.