

## EAS 8803: Thermodynamics of Atmospheres and Oceans

Instructor: J. Curry

Textbook: Thermodynamics of Atmospheres and Oceans, Curry and Webster

The subject matter of the course matches closely the material in the text *Thermodynamics of Atmospheres and Oceans*. Students are expected to read the assigned material before class. Less than half of the class time is used for lecturing, and no attempt is made in the lectures to go over all of this material in detail. I use a "collaborative learning" approach to teaching that integrates conceptual and operational knowledge, where students working in teams use class time for quizzes, problem-solving, discussions, and web-based explorations.

Grading:

Homework/Quizzes	25%
Exam I	25%
Exam II	25%
Term Paper	25%

Course Outline:

- 1 Composition, Structure, and State
  - 1.1 Composition of the Atmosphere
  - 1.2 Composition of the Ocean
  - 1.3 Kinetic-Molecular Model of the Ideal Gas
  - 1.4 Equation of State for Air
  - 1.5 Equation of State for Seawater
  - 1.6 Compressibility and Expansion Coefficients
  - 1.7 Hydrostatic Equilibrium
- 2 First and Second Laws of Thermodynamics
  - 2.1 Work, Heat and the First Law
  - 2.2 Applications of the First Law to Ideal Gases
  - 2.3 Entropy and the Second Law
  - 2.4 Equilibrium and the Combined First and Second Laws
  - 2.5 Calculation of Thermodynamic Relations
  - 2.6 Heat Capacity
  - 2.7 Dry Adiabatic Processes in the Atmosphere
  - 2.8 Adiabatic Processes in the Ocean
- 3 Transfer Processes
  - 3.1 Time-dependent Thermodynamics
  - 3.2 Radiant Energy
  - 3.3 Radiative Transfer
  - 3.4 Diffusive Transfer Processes
  - 3.5 Turbulent Transport
  - 3.6 Time-dependent Equations for the Ocean and Atmosphere

- 4 Thermodynamics of Water
  - 4.1 Molecular Structure and Properties of Water
  - 4.2 Thermodynamic Degrees of Freedom
  - 4.3 Phase Equilibria
  - 4.4 Atmospheric Humidity Variables
  - 4.5 Colligative Properties of Water Solutions
  - 4.6 Simple Eutectics
- 5 Nucleation and Diffusional Growth
  - 5.1 Surface Tension
  - 5.2 Nucleation of the Liquid Phase
  - 5.3 Nucleation of the Ice Phase
  - 5.4 Diffusional Growth of Cloud Drops
  - 5.5 Ice Crystal Morphology and Growth
- 6 Moist Thermodynamic Processes in the Atmosphere
  - 6.1 Applications of the Combined First and Second Laws
  - 6.2 Isobaric Cooling
  - 6.3 Cooling and Moistening by Evaporation of Water
  - 6.4 Saturation by Adiabatic, Isobaric Mixing
  - 6.5 Saturated Adiabatic Cooling
  - 6.6 The Ice Phase
  - 6.7 Conserved Moist Thermodynamic Variables
  - 6.8 Thermodynamic Diagrams
- 7 Static Stability of the Atmosphere and Ocean
  - 7.1 Stability Criteria
  - 7.2 Stability of a Saturated Atmosphere
  - 7.3 Processes Producing Changes in Stability
- 8 Cloud Characteristics and Processes
  - 8.1 Cloud Classification and Characteristics
  - 8.2 Precipitation Processes
  - 8.3 Radiative Transfer in a Cloudy Atmosphere
  - 8.4 Fogs, Stratus, and Stratocumulus Clouds
  - 8.5 Cumuliform Clouds
- 9 Ocean Surface Exchanges of Heat and Freshwater
  - 9.1 Surface Energy Budget
  - 9.2 Surface Salinity Budget
  - 9.3 Surface Buoyancy Flux
  - 9.4 Air Mass and Upper Water Mass Modification
- 10 Sea Ice, Snow and Glaciers
  - 10.1 Large-scale Morphology of Sea Ice
  - 10.2 Ice Thickness Distribution
  - 10.3 Evolution of the Salinity Profile in Sea Ice
  - 10.4 Thermal Properties of Sea Ice
  - 10.5 Optical Properties of Sea Ice and Snow
  - 10.6 Growth and Decay of Sea Ice

- 10.7 Metamorphosis of Surface Snow
- 10.8 Glaciers

11 Thermohaline Processes in the Ocean

- 11.1 Radiative Transfer in the Ocean
- 11.2 Ocean Surface Layer
- 11.3 Surface Density Changes and the Ocean Mixed Layer
- 11.4 Deep Water Formation
- 11.5 Global Thermohaline Circulations

12 Global Energy Balances

- 12.1 Planetary Radiation Balance
- 12.2 Global Heat Engine
- 12.3 Global Hydrologic Cycle
- 12.4 Planetary Energy Balances
- 12.5 Water on the Terrestrial Planets