ATMOSPHERIC SCIENCES 340:

INTRODUCTION TO THERMODYNAMICS AND CLOUD PROCESSES

SPRING QUARTER 2007

GENERAL INFORMATION

Class Meets:	M, Tu, W, Th, F, 11:30 a.m. – 12:20 p.m.
Place:	Room ATG 310C
Instructor:	Professor Mark T. Stoelinga Room 508 ATG Telephone: 206-543-6235
Office Hours:	Monday and Wednesday 12:30 p.m. – 2:00 p.m.
Required Textbook:	*Atmospheric Sciences: An Introductory Survey, Second Edition* by J. M. Wallace and P. V. Hobbs. Academic Press, 2006.
Purpose of Course:	1) To review the basic concepts of thermodynamics and to apply these to the atmosphere. 2) To provide an introduction to the physical processes leading to the formation of clouds and precipitation.
Grading:	1) 1/5 (20%): class participation. This includes: participation during lectures (asking insightful questions and answering questions posed to the class); participation during Tuesday problem solving sessions (volunteering to come up to the board to solve homework problems, and providing assistance if solicited); and attending office hours for help on problem solving. 2) 1/5 (20%):.**first mid-term exam**, held on **Wednesday, 18 April**. 3) 1/5 (20%): **second mid-term exam**, held on **Wednesday, 9 May**. 4) 2/5 (40%): **final exam**, held at **2:30-4:20 p.m.** on **Wednesday, 6 June 2007**, in our normal room (**ATG 310C**). The exams are closed-book, with basic formulas given.
Instruction Ends:	Friday, 1 June 2007

Syllabus

Monday	26-Mar-07	Course information. Introduction to course. Thermodynamic terms and definitions.
Tuesday	27-Mar-07	Boyle's and Charles' Laws. The ideal gas equation. Molecular weight.
Wednesday	28-Mar-07	First Law. Joule's Law. Heat capacity.
Thursday	29-Mar-07	Equipartition of energy. Pressure-volume diagram for an ideal gas. Isothermal and adiabatic processes.
Friday	30-Mar-07	Cyclic and reversible processes. Carnot's ideal heat engine. Engine efficiency. Carnot engine for an ideal gas.
Monday	31-Mar-07	Second Law and Carnot's theorems. Entropy.
Tuesday	3-Apr-07	*Problem Solving.*
Wednesday	4-Apr-07	Clausius-Clapeyron equation. Partial pressure and Dalton's Law.
Thursday	5-Apr-07	Composition of dry air. Apparent molecular weight. Ideal gas equation for dry air.
Friday	6-Apr-07	Hypsometric equation. Scale height. Thickness.
Monday	9-Apr-07	Reduction of pressure to sea level. Altimeters.
Tuesday	10-Apr-07	*Problem Solving.*
Wednesday	11-Apr-07	Concept of an air parcel. First law for dry air. Dry static energy. Dry adiabatic lapse rate.
Thursday	12-Apr-07	Static stability for dry air parcel displacements. Inversions. Gravity waves.
Friday	13-Apr-07	Mirages.
Monday	16-Apr-07	Potential temperature.
Tuesday	17-Apr-07	*Problem Solving.*
Wednesday	18-Apr-07	FIRST MID-TERM EXAM
Thursday	19-Apr-07	Meteorological thermodynamic diagrams.
Friday	20-Apr-07	Measures of water vapor in the air. Ideal gas equation for pure water vapor and for moist air. Virtual temperature. Hypsometric equation for moist air.
Monday	23-Apr-07	Saturated air. Saturation vapor pressure. Saturation mixing ratio. Relative humidity. Dewpoint. Lifted condensation level.
Tuesday	24-Apr-07	*Problem Solving.*
Wednesday	25-Apr-07	Moist adiabatic processes. Saturated adiabatic vs. pseudoadiabatic processes. Latent heat and the First Law for saturated parcel displacements. The moist adiabatic lapse rate.
Thursday	26-Apr-07	Adiabatic liquid water content. Equivalent potential temperature.
Friday	27-Apr-07	Wet-bulb temperature. Normand's Rule. Wet-bulb potential temperature.

Monday	30-Apr-07	Static stability for moist parcel displacements. Conditional instability. Layer lifting and convective instability.
Tuesday	1-May-07	*Problem Solving.*
Wednesday	2-May-07	Parcel method for assessing possibility of deep convection. Level of free convection. Convective available potential energy (CAPE). Convective inhibition.
Thursday	3-May-07	Examples of using the skew-T.
Friday	4-May-07	More examples of using the skew-T.
Monday	7-May-07	Cloud formation processes. Cloud nomenclature.
Tuesday	8-May-07	*Problem Solving.*
Wednesday	9-May-07	SECOND MID-TERM EXAM
Thursday	10-May-07	Homogeneous nucleation of cloud droplets. Kelvin's equation.
Friday	11-May-07	Atmospheric aerosol. Heterogeneous nucleation of droplets.
Monday	14-May-07	Köhler curves. CN and CCN
Tuesday	15-May-07	*Problem Solving.*
Wednesday	16-May-07	Effects of aerosol concentrations on clouds.
Thursday	17-May-07	Growth of droplets by condensation.
Friday	18-May-07	Onset of precipitation: transition from condensational to collisional growth. Growth of drops by collisions and collection.
Monday	21-May-07	Ice in clouds. Ice nucleation. Ice enhancement.
Tuesday	22-May-07	*Problem Solving.*
Wednesday	23-May-07	Growth of ice particles from the vapor phase. Ice particle habits.
Thursday	24-May-07	Growth of ice particles by riming and aggregation. Continuous collection equation for riming and aggregation.
Friday	25-May-07	Thunderstorms.
Monday	28-May-07	UW HOLIDAY: Memorial Day (no class)
Tuesday	29-May-07	*Problem Solving.*
Wednesday	30-May-07	Artificial cloud seeding.
Thursday	31-May-07	*Problem Solving.*
Friday	1-Jun-07	Review and Student Evaluations