

ATMS211 Climate and Climate Change

Mid-Term 1 Review

Note: The following is a summary of the material covered in class to date. Only broad concepts/themes are listed. You will need to consult your textbook, homework, and lecture notes for details.

Weather vs. Climate

Timescales; Predictability
Factors controlling climate

Quinn and Popper Articles

Quinn
-Model; theory; postulate
-Basic postulate of Science
Popper
-Questions of origin vs. Questions of validity

Earth as a Coupled System

The Climate System: 4 main components
Forcing vs. Perturbation
Daisyworld: Simple two component system
Feedback loops
-Positive feedback: unstable equilibrium
-Negative feedback: stable equilibrium
Systems diagrams
How do daisies control temperature?

Planetary Energy Balance

Planetary albedo; effective radiating temperature; outgoing longwave radiation
 $E_{IN} = E_{OUT}$; under what conditions?
Earth-Sun geometry
Greenhouse gases / greenhouse effect
Feedback factor (f)
Means of heat transfer
Energy fluxes: top of atmosphere, within atmosphere, between atmosphere and surface
Net radiation at top of atmosphere: incoming minus outgoing

Atmospheric Radiation

Electromagnetic Radiation
-Shortwave → visible (emitted by Sun; why?)
-Longwave → infrared (emitted by the Earth; why?)
Stefan-Boltzmann Law (amount of total emitted energy)
Wien's Displacement Law (wavelength of emitted energy)

Interaction of SW and LW radiation within the atmosphere
Distribution of incoming solar radiation on the planet; spherical geometry

Atmospheric Composition and Structure

Main atmospheric gases
Lapse Rate
Thermal structure
Water Vapor; saturation vapor pressure
Cloud formation (moist air, lifting, cooling, saturation, condensation)

Climate sensitivity: $\Delta T_s = \lambda \Delta F$

Forcing, response, climate sensitivity and feedback factor
Cloud forcing (SW vs. LW effects; characteristics of clouds that warm / cool planet)
Feedbacks

- Ice - albedo feedback
- Water vapor feedback
- Cloud feedback

Atmospheric Circulation

Fundamental cause and fundamental purpose of circulation
Planetary energy distribution
Seasonal variations (Sun-Earth distance, obliquity)
Understand the why's, where's, and how's of these circulations
Tropical circulation

- Hadley Circulation
 - Mechanism (surface heating, convection (where?), subsidence (where?), surface low/high (where?), ITCZ, surface wind pattern, Coriolis effect)
- Monsoon Circulation
 - Ocean/land thermal properties
 - Sea breeze and land breeze

Extra-tropical circulations

- Mechanism (colliding cold and warm air – fronts and jets)
- Heat transport

Hydrological Cycle

- Reservoirs (ocean, land, atmosphere)
- Exchange between reservoirs
- Residence time (burden/sink)
- Importance of water for climate