EAS 100 – Planet Earth
Lecture Topics Brief Outlines

IV. Atmospheric Science Section

1. Introduction, Composition and Structure of the Atmosphere

Learning objectives: Understand the basic characteristics of the atmosphere – structure, especially the lower layer in which most weather phenomena exist; the composition of the atmosphere; and atmosphere properties – pressure, temperature, moisture content.

Reading: 310-316

Figures to study: Text, Figures 11.4, 11.7, 11.8

Topics:

Basic topics in atmospheric sciences: structure (layering: pressure, temperature and moisture) and composition of the atmosphere, solar radiation, atmospheric circulation, seasons, weather, climate, global warming, ozone "hole", pollution, acid rain

Earth's atmosphere

Composition: Nitrogen and Oxygen, minor constituents and important trace elements

Layering: by temperature, pressure, moisture content

Pressure decreases with altitude; in the lowest layer (the troposphere) temperature decreases with altitude; generally, moisture content decreases with altitude. The "top" of the atmosphere is a gradual transition into space.

2. Circulation of the Atmosphere, Weather Forecasting

Learning objectives: Understand atmospheric circulation (wind) on a global, regional and local scale. Circulation driven by uneven heating of the atmosphere by the Sun caused by spherical shape of the Earth (polar regions receive less heating) and the Earth's tilt which causes seasons and variations in the length of daylight hours.

Reading: Text, pages 316-325, 356-364, 392-400

Figures to study: Text, Figures 11.11, 11.12, 11.13, 11.14, 11.15, 11, 17, 11.18, 11.39, 11.40, 13.5, 13.6, 13.10, 13.11, 13.14, 13.15, 14.6, 14.7, 14.8, 14.9, 14.10

Topics:

Circulation: global, regional, local: Trade winds, global circulation pattern

Solar radiation

Most electromagnetic radiation (energy) from Sun is in visible, infrared and ultraviolet range of wavelengths.

Solar energy – amount of energy reaching Earth; energy transfer in the atmosphere

Reasons for seasons – Earth's tilt

Less direct angle (Sun's rays spread out over a wider area) in winter.

Shorter day in winter.

Primary influences on solar heating of atmosphere:

Solar constant (changing?)

Orbital effects (Milankovitch cycles) – eccentricity, change in tilt angle, orientation of spin axis

Tilt of the Earth's axis (causes seasons)

Rotation of the Earth – daily cycle of heating and cooling

Angle of the Sun's rays – latitude and seasonal effect

Coriolis effect – caused by Earth rotation; results in moving air (and other objects/mass) to deflect to the right in the northern hemisphere

Adiabatic heating and cooling (a thermodynamic effect – increase pressure (such as descending air) causes heating, decrease pressure (ascending air) causes cooling

Global Circulation Pattern: Combination of uneven solar heating (greater heating in equatorial regions, less near poles) and Coriolis effect causes convection (cells) of global air circulation – study Figures 13.13 and 13.14 in text

Secondary Influences on Solar Heating of the Atmosphere

Influence of oceans – Heat exchange; evaporation, clouds

Distribution of continents

Water cycle – Evaporation causes cooling; precipitation causes heating of air due to latent heat of vaporization (540 cal/g of water)

Energy Transfer in the Atmosphere

Radiation, conduction, convection (horizontal and vertical movements of air [wind]; convection is most efficient mechanism

Weather forecasting

Regional and local atmospheric circulation – high and low pressure areas (air masses or volumes) form due to uneven heating of atmosphere; high and low pressure areas move due to global circulation pattern (cells)

Circulation about highs (in northern hemisphere) is clockwise (air flows outward, expanding, and deflects to right by Coriolis effect)

Circulation about lows (in northern hemisphere) is counter-clockwise (air flows inward, lower pressure or “suction”, and deflects to right by Coriolis effect)

Circulation about lows commonly results in a front – a nearly linear boundary between relatively cold air and warmer air; front also separates areas of different moisture content (humidity) and wind direction

Fronts move due to global circulation pattern (movement of high and low pressure areas, generally west to east in the mid-latitude area of the conterminous US, and counter-clockwise circulation about the lows (also moves front generally to the east)

Fronts are also areas of rapid vertical movement of air creating strong temperature and humidity variations and severe weather

Weather forecasting approaches

3. Climate

Learning objectives: Understanding climate and climate change

Reading: Text, pages 310-311, 317-331

Figures to study: Text, Figures 11.20, 11.21, 11.24, 11.26, 11.28, 11.29

Topics:

Methods of climate study.

Causes of climate change – Astronomical effects (Milankovitch Cycles), Continental Drift, Solar "Constant", Volcanism, Greenhouse Gases.

Relationship of global circulation to climate zones – example of deserts at about 30^{o} N and 30^{o} S latitude.

Climate change in past million years.

4. Hurricanes, Tornadoes

Learning objectives: Understanding the development and effects of severe weather – hurricanes and tornadoes.

Reading: Text, pages 395-414

Figures to study: Text, Figures 14.5, 14.6, 14.7, 14.8, 14.9, 14.11, 14.12, 14.13, 14.16, 14.17, 14.18, 14.22, 14.23, 14.24, 14.25

Topics:

Where hurricanes form.

Energy for hurricanes – solar radiation, heat transfer from ocean waters, latent heat of condensation.

Huricane circulation – move with trade winds, circulation about the eye of the hurricane.

Damage and hazards from hurricanes.

Some famous hurricanes – Camille, Andrew, Hugo, Katrina.

Hurricane tracks and landfall.

Tornadoes – relationship to fronts and thunderstorms.

Locations and "seasons' for tornadoes.

Conditions for formation.

Tornado characteristics – Fujita intensity scale.

Examples of tornado occurrence and damage.

5. Greenhouse Effect, Atmospheric Pollution, Ozone Depletion, Acid Rain

Learning objectives: The greenhouse effect and a brief look at human influences on the atmosphere.

Reading: Text, pages 314-315, 325-331

Figures to study: Text, Figures 11.6, 11.23, 11.24, 11.25, 11.26, 11.28, 11.29, 11.30

Topics:

Greenhouse Effect – greenhouse gases, human contributions, heating of the atmosphere, CO_2 and methane in the atmosphere.

Ozone “layer” – CFC’s and Chlorine chain reaction in the stratosphere.

Effects of Ozone in the troposphere and the stratosphere.

Acid Rain – SO_2 and Nitrous oxide emission form acid rain.

Effects of Acid rain – aquatic life, forests, concrete and building stone.

Acid rain concentration (pH) in the U.S.

Atmospheric Science section selected PowerPoint slides (Some of the slides shown in class):
http://web.ics.purdue.edu/~braile/eas100/ATMSnotes.pdf