PGEOG 130 - Spring 2008 Syllabus
Weather and Climate

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Office hours: Rm 1049 N Tue & Thu, 7:00 - 8:00 pm
Lecture hours: Rm 0714 W Tue & Thu, 5:35 - 6:50 pm
**Weather** = state of the atmosphere at a given time and place

**Climate** = generalization of weather (stereotyping)

Mean Percentage of Sunshine for November
Climate

• More than just ‘average weather’

• Extreme events & probability

• Sum of all statistical weather information describing a place or region

‘Climate is what you expect, Weather is what you get’

Elements of WAC (Basic Measurable Properties)

1. Temperature of Air
2. Humidity of Air
3. Cloud Cover (type and amount)
4. Precipitation (type and amount)
5. Air Pressure
6. Wind Speed and Direction
Chapter 1 Outline

I. Introduction/Overview
II. Weather and Climate
   A. Basic elements of weather and climate
   
III. Atmospheric Hazards: Assault by the Elements
Chapter 1 Outline

I. Introduction/Overview

II. Weather and Climate
   A. Basic elements of weather and climate

III. Atmospheric Hazards: Assault by the Elements

   hurricanes, tornados, hail, floods, mudslides, waves, blizzards, freezing rain, heat waves, cold spells, mid-latitude storms

Weather Related Events – Damage in $Billions
What is the worst weather disaster ever to affect the US?

Hurricane Katrina
Katrina was not only the most expensive national disaster in US history, leaving an insurance bill for the devastation in Louisiana, Mississippi and Alabama of some US$60bn ($94bn)….. Congress has allocated US$110bn ($172bn) for relief and reconstruction.
Chapter Outline

IV. The Atmosphere: A Part of the Earth System
   A. Earth’s four spheres
      1. Lithosphere
      2. Atmosphere
      3. Hydrosphere
      4. Biosphere

1. Lithosphere: Solid Earth
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2. Atmosphere: Gaseous Envelope

- 99% of Atm. Within 30km of Earths Surface
- Energetic: energy exchange between space and atmosphere and between the atmosphere and the surface of the earth.
3. Hydrosphere: All Water
   • Small reservoirs are important for weather and climate processes and geologic processes (reshaping the earth)

4. Biosphere: All Life on Earth
   • Extends from the ocean floor to a few km into the atmosphere
Chapter Outline

B. Earth System Science: Study of the interconnections between the four spheres

1. What is a system? Group of interconnected parts that make up a complex whole. Most natural systems transfer matter and energy from one region to another.

2. Feedback mechanisms

3. Earth as a system

1. What is a system? Most natural systems transfer matter and energy from one region to another.

- Closed System: matter does not enter or leave the system

- Open System: both matter and energy can enter and leave the system
2. Feedback Mechanisms:

- **Negative Feedback Mech.**: mechanisms that stabilize or maintain the system (resist change) (examples: clouds)

- **Positive Feedback Mech.**: mechanisms that enhance or promote change (examples: hurricanes, melting of glaciers)

3. Earth as a System

   2 Sources of Energy that drive the earth system
   - **Sun**: solar radiation drives weather and climate
   - **Earths Interior**: energy from formation and radioactive decay of elements
3. Earth as a system: **Subsystem Hydrologic Cycle**

![Diagram of the hydrologic cycle](image)

3. Earth as a system: **Subsystem Geologic Cycle**

![Diagram of the geologic cycle](image)
V. Composition of the Atmosphere:
Gas, Water Vapor, Particles

A. Major components

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Percent by Volume</th>
<th>Concentration in Parts Per Million (PPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N₂)</td>
<td>78.054</td>
<td>750.540</td>
</tr>
<tr>
<td>Oxygen (O₂)</td>
<td>20.946</td>
<td>209.460</td>
</tr>
<tr>
<td>Argon (Ar)</td>
<td>0.934</td>
<td>9.340</td>
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<tr>
<td>Carbon dioxide (CO₂)</td>
<td>0.037</td>
<td>370.0</td>
</tr>
<tr>
<td>Neon (Ne)</td>
<td>0.00183</td>
<td>18.2</td>
</tr>
<tr>
<td>Helium (He)</td>
<td>0.000524</td>
<td>5.24</td>
</tr>
<tr>
<td>Methane (CH₄)</td>
<td>0.00015</td>
<td>1.5</td>
</tr>
<tr>
<td>Krypton (Kr)</td>
<td>0.000114</td>
<td>1.14</td>
</tr>
<tr>
<td>Hydrogen (H₂)</td>
<td>0.00005</td>
<td>0.5</td>
</tr>
</tbody>
</table>

B. Carbon Dioxide
V. Composition of the Atmosphere:

C. Variable Components

1. Water Vapor
   0–4% by volume
   Absorbs energy from the sun and the surface of the earth
   Requires energy to change state (latent heat)

2. Aerosols: small solid and liquid particles suspended in the atmosphere (mainly lower atm.)
   Water droplet nuclei
   Reflect/absorb incoming solar radiation
   Colorful sunrises and sunsets
3. **Ozone** ($O_3$)

Concentrated in the Stratosphere

Filters Ultraviolet Radiation

![Diagram of ozone formation](image)

VI. **Ozone Depletion**: A Global Issue

**CFC**-Chloroflorocarbons (AC, refrigeration, aerosol sprays)

**Ozone Reduction** = increase in skin cancer, cataracts, disruption of ocean food web

![Diagram of chlorine and ozone](image)

Antarctic Ozone Hole
VI. Ozone Depletion: A Global Issue

Montreal Protocol

Complete phaseout of CFCs

Anticipated recovery second half of 21st Century

VII. Probing the Atmosphere

A. Radiosondes: Instrument package that measures pressure, temperature, and relative humidity. Uses radio transmitter to send data back to surface.
VII. Probing the Atmosphere
- Planes, Rockets
- **DOPLAR Radar and Satellites:**

VIII. Extent of the Atm.
- No sharp boundary between Atm. and Space
- Sea Level Pressure: 14.7 lbs/in² ~ 1000 mb
- 100 km very few gas molecules
- highly compressible
A. Thermal structure:
1. Troposphere
2. Stratosphere
3. Mesosphere
4. Thermosphere

1. Troposphere
12km = avg. thickness
16km = tropics
09km = poles

Temp. decrease with altitude

Environmental Lapse Rate = 6.5°C/km

Energetic Layer
2. **Stratosphere**

Zone of constant temp. above tropopause

Temp. increase with altitude (Ozone)

Stratopause = 50km above surface

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3. **Mesosphere**

Temp. decrease with altitude

Mesopause = coldest temperatures (-90°C)

Difficult to explore
4. Thermosphere

Temp. increase with altitude due to absorption of solar radiation by oxygen and nitrogen

Temp approach 1000°C

B. Vertical variations in composition

1. Homosphere: zone of homogeneous composition extends up to 80km (mesopause)

2. Heterosphere: zone of heterogeneous composition extends from mesopause through thermosphere

- Layered structure based on atomic weight

  Hydrogen  \((H)\)
  Helium  \((He)\)
  Oxygen  \((O)\)
  Nitrogen  \((N_2)\)
3. Ionosphere
- electrically charged layer 80-400km
- N₂ & O absorb short wave solar radiation
- release electrons; move as an electric current