Physical Geography Chapter 8
Global Climates

Based mostly on temperature and precipitation

Empirical Classification – based on statistical parameters and physical characteristics.

Genetic classification – based on causes of climate variation.

Köeppen System – German botanist

1. Utilizes Temperature and Precipitation
2. Reflect Vegetation Lines
3. Affects life

Limitations:
1. Considered only average monthly temperature and precipitation
2. Ignored local climate conditions: wind, cloud cover, precipitation, intensity, humidity, daily T extremes

Simplified Köeppen

Based on Annual Range of Temperatures	T & P
A: Humid- Tropical	BW, BS: Arid, Semi-arid
C: Humid Mesothermal (mild winter)	
D: Humid Microthermal (severe winter)	H: Highland Climate
E: Polar Climates	

Appendix C

Climograph – display of temperature and precipitation ranges

Thornthwaite System

As a farmer interested in growing a specific crop, the Köeppen system correctly identifies vegetation types, but does not provide a farmer with information concerning the amounts and timing of annual soil moisture surpluses and deficits. (Soil Scientists like this one)

Based on PE – Potential Evapotransporation
(Theoretical value that increases with increasing temperature, winds and length of daylight and decreases with increasing humidity)

AE – Actual Evapotranspiration – reflects actual water use by plants

Thus, measurements of AE relative to PE and available soil moisture are the determining factors for most vegetation and crop growth.

Three Climate Zones (Based on PE valves)
1. Low – latitude climates: PE > 130 cm (51 inches)
2. Middle – Latitude: 130 cm >PE> 525 cm (20.5 inch)
3. High Latitude Climates – PE less than 52.5 cm

Climate zones may be subdivided based on how long and by how much AE is below PE

Two classes don't fit well: Tropical wet and dry regions, Mediterranean Climates

Used mostly in U.S. – trying to adapt it to elsewhere

Scale and Climate
Macro → Meso → Micro
Sahara Coastal Slope of a hill
So Cal

Microclimate Affects:
Regions North of the Tropic of Cancer
1. South facing slopes tend to be drier and warmer because they receive more direct sunlight (Slope Aspect)
2. Humans – large reservoir construction
3. Urban Heat Island- tend to be warmer

Past Climates – Paleoclimatology
Ice Ages

Pleistocene Epoch – Until 1960s – 4 major cool period
Gunz → Mindel →Riss→ Würm
Nebraskan→Kansan→Illinoian→Wisconsinan

Glaciers tend to destroy previous evidence Last one – 8-30k

Varves-seasonal lake sediments
- showed last deglaciation = 13k

Two Major Discoveries – Technology Based
1. Radiometric Dating Technioves – glaciation peaked at 18 k
   - ice covered NY, Boston, Indiana, Des Moines
2. Climate change is also recovered in deep sea sedimentary core record DSPP
   - more than four - numerous

How do we know?
Deep sea mud contains forams (Foramonifera)

- build tiny shells for protein – composed of $CaC0_3$
- different species live (or thrive) in a different surface water temperatures

Oxygen Isotope Analysis
$^{16}0$, $^{18}0$ ratios
Modern seawater has a fixed ratio of these isotopes

Given: When water evaporates more $^{16}0$ evaporates
During an ice age, evaporated water is stored in the ice sheets of Antarctica and Greenland, rather than returned to oceans – This changes the ratio.
Analysis of the Oxygen isotope ratios recorded in the forams reveal a record of sea level changes that reflect the growth and decline of ice sheets. (Figure 8.6)

Stages – Fig 8.6

- warm intervals – odd numbers OIS- Oxygen Isotope Stage
- cold intervals - even numbers

Holocene Epoch: things have been stable

- 7000 BP- Altithermal

Rates of Climate Change
Reflected in ice cores of Antarctica and Greenland
Climate change occurs rapidly – Positive feedback Mechanism

- ice albedo

Causes of Climate Change
Five Categories:

1. Astronomical variations in the Earth's orbit
2. Changes in the output of Solar Energy and/or the transparency of outer space
3. Changes in atmospheric gases or dust
4. Changes in land masses that affect albedo and ocean circulation
5. Changes in land masses that affect albedo and oceanic circulation

Milankovitch Cycles – 1924 (Astronomical Variations)

1. Eccentricity – variation in the shape of the orbit
   (100 k cycle) O to ⬭ to O
2. Obliquity – changes in tilt from 22-24.5º
   (41k)
3. Precession – determines time of year Perihelion occurs
   (21K)

Obliquity appears to be the most important
Eccentncity has been most dominant
Next 23k –full on ice age condition

Solar Output
sunspot cycle – more sunspots – more solar energy
11 yr cycle – unsure
Dendro- Tree Ring- supports evidence of cycle
many cycles – 2, 2.2, 5.5, 20 to 23, 50, 100 yr cycles

Changes in Earth's Atmosphere
Primary Villain – Volcanoes
All of the coldest years – after a large eruption
Tambora- 1815/16
Krakatoa – 1883

Atmospheric Gases
$C0_2$- Green house Gas
No $C0_2$- 16ºC would be below freezing

Ice cores also showed increases in $C0_2$ (positive feedback loop)
Warm water hold less (releases more, increases $C0_2$)

Other Greenhouse gases- Methane, CFCs, N_20

Changes in the Ocean
Heinrich events – major influx of freshwater
- slows deep water circulation
- warms up Northern Hemisphere

ENSO?

Changes in Land Masses
Glacial Periods- polar continents
Barriers- Atmospheric – Himalayas
Panama – Atlantic/ Pacific mixing

Future Climates
Little Ice Age – 1197 – 1309 AD
- Had inpacts on circulation – Anasazi moved
  Santorini –1450 BC
  GCM: General Circulation Models