February 24, 2015
GEOL 1010-002 (Notes)

# Lecture 9 - Climatology

## *Geology in the News*

- Dating of remains in Oregon caves sheds new light on human migration into the Americas (timing/date)

## Climate Basics

- Why do we care?
  - ① Inter-disciplinary field (not just atmosphere); Earth only planet we can live on; studied by lots of scientists
    - ↳ know things ahead of time to plan accordingly
- Climate - average surface conditions on Earth through long-time scales
  - ① Min 10 years (lots of different fields to study/collect lots of data)
- Weather - average surface conditions on Earth through short-time scales
  - ① Days to weeks

## System Interactions

- Interactions among all these components are complicated to untangle
- Feedbacks - when you change one variable, it causes a series of changes to alter the variable again (replicate process)

## Positive Feedback

- Change in 2nd component (B) enhances the change in the 1st component (A)
  - ① When A ↑, B changes which causes A to ↑ again
    - Ex. ↑ temp → melt ice → ↑ temp more
- 'A' can decrease every time you come around cycle too
  - ① Ex. lower the temp = more ice forms = temp drops again
- Problem - Hard to break out of (need external factor to intervene to break cycle)
- Unbalance system (spiral out of control)

## Negative Feedback

- Change to 2nd component (B) offsets the initial change in the 1st component (A)
  1. When A ↑, B ↓
  2. When B ↓, A ↓
  3. When A ↓, B ↑
  4. When B ↑, A ↑ (back to 1)
- Creates a stabilizing see-saw effect (balance system)

## What Controls Climate

- Insolation - heat energy Earth receives from Sun (most abundant source - income solar radiation)
- Several things affect how much insolation Earth receives
  1. Variations in Isolation
     - Earth not always same distance from Sun

Less Insolation (Not Winter/Summer) { ° Aphelion - max distance from Sun
(a) 152 million km

More Insolation { ° Perihelion - min distance from Sun
(a) 147 million km

## Variations in Insolation

- Milankovich Cycles - 3 cycles of Earth's movement
  1. 1- Eccentricity - Shape of Earth's orbit as it goes around sun (shape not same with time)

100,000 yrs to go from max → min → max { - Eccentricity Maximum - Elliptical Form
- Eccentricity Minimum - Oval/Circular Form

* Little changes added up over time = big change
* Leads to Ice Ages (affects when glaciers get bigger or smaller)

*All 3 cycles have big impact on climate ONLY on long time scales

Back & Forth Motion (Horizontal)

② Obliquity (Tilt) - How Earth is tilted on its axis (angle of tilt changes with time)
- Min Tilt = 22 1/2° Mid Tilt = 23 1/2° Max Tilt = 24 1/2°
  - Significant enough to affect climate
  - Cycle takes roughly 41k yrs

Obliquity (Consequences)
- Why we have opposite seasons in the N and S hemispheres
- Seasonal Contrast - how different summers are vs. winters
  ① Low Obliquity Angle = low seasonal contrast
  ② High Obliquity Angle = high seasonal contrast

*Look At Diagram on Slide 15*

- Precession - 3D motion, wobbles as Earth rotates on its axis → causes what time of year you experience seasons
  ① Ex. Dredle wobbles on top when spun
  ② 1 Full Wobble = 22,000 years (one cycle) → Long Time Span LEADS To No Impact on Short Time Scale
  ③ Wobble - circular motion

The Atmosphere
- Albedo - how reflective are diff materials & surfaces
- Lose 30% of insolation as it first interacts with atmosphere
- Clouds highly reflective
  ① 20% insolation reflects off clouds

Atmospheric Gases
- Atmo- Composition
  ① Nitrogen - 78%
  ② Oxygen - 21%
  ≤ 1% { ③ Greenhouse Gases (GGs) - extremely good at preventing insolation from bouncing off surface of Earth
    - Keep insolation at surface trapped longer
    - Affects Earth's temp
    - GGs, like $CO_2$, measured in parts per million & trillion