Climate Variability and Climate Change

1. Definitions
   • The Climate System; Natural and Forced Variability

2. Natural Variability
   • North Atlantic Oscillation, El Nino/Southern Oscillation

3. Forced Change (natural)
   • Volcanic Eruptions (scattering particles)
   • Changes in the Solar Luminosity

4. Forced Change (human)
   • Burning of fossil fuels (increasing GH gases)
   • Burning of biomass (scattering particles)
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1. Definitions: The Climate System

• **The Climate system**
  – What is included: the coupled atmosphere, ocean, land surface, and sea ice system
  – What usually isn’t included:
    • things that don’t have much effect on the “climate system”
    • things that change on very long (geologic) time scales are usually considered external to the climate system
      – Examples: changes in location of continents and oceans, changes in land topography)

• **Natural Variability**
  – Variations in climate that are due to *internal* interactions between the atmosphere, ocean, land surface and sea ice.
    • Examples: year-to-year differences in storminess in the Pacific Northwest, drought, the El Nino/Southern Oscillation (ENSO) phenomenon, the North Atlantic Oscillation, etc.
1. Definitions:
Agents of Climate Change: Forcing

Climate can change due to *external forcing*

- **Natural Forcing**
  - Examples:
    - Volcanoes (scattering particles $\alpha$)
    - changes in the Earth’s orbit
    - changes in the solar luminosity ($L_o$)

- **Human Forcing**
  - Examples:
    - emissions of greenhouse gases ($\varepsilon$)
    - aerosols (tiny particles $\alpha$)
    - land use changed (albedo $\alpha$, etc)