

# Introduction to Climate Change

## Introduction to Climate Change – Study Notes

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### 1. What Is Climate Change?

- **Definition:** Long-term alteration of temperature, precipitation, wind patterns, and other aspects of the Earth's climate system.
  - **Key Distinction:**
    - *Weather* = short-term atmospheric conditions.
    - *Climate* = average weather over decades to millennia.
  - **Primary Driver (Current Era):** Human activities that increase concentrations of greenhouse gases (GHGs) in the atmosphere.
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### 2. The Science Behind It

| Component                | Role in Climate System                                     | How It Affects Climate                                                          |
|--------------------------|------------------------------------------------------------|---------------------------------------------------------------------------------|
| <b>Solar Radiation</b>   | Primary energy source                                      | Variations can cause natural climate fluctuations (e.g., solar cycles).         |
| <b>Atmospheric Gases</b> | Trap outgoing infrared radiation (greenhouse effect).      | More GHGs → stronger greenhouse effect → warming.                               |
| <b>Aerosols</b>          | Scatter/absorb sunlight; act as cloud condensation nuclei. | Can cool (sulfate aerosols) or warm (black carbon).                             |
| <b>Albedo</b>            | Reflectivity of Earth's surface (ice, snow, vegetation).   | Loss of bright surfaces (melting ice) reduces albedo → more absorption of heat. |
| <b>Ocean Circulation</b> | Stores and transports heat.                                | Changes can amplify or dampen warming (e.g., El Niño).                          |

#### 2.1 Greenhouse Gases (GHGs)

| Gas                               | Main Sources                                             | Global Warming Potential (100-yr) |
|-----------------------------------|----------------------------------------------------------|-----------------------------------|
| Carbon Dioxide (CO <sub>2</sub> ) | Fossil-fuel combustion, cement production, deforestation | 1 (reference)                     |

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| Gas                                              | Main Sources                                                     | Global Warming Potential<br>(100-yr) |
|--------------------------------------------------|------------------------------------------------------------------|--------------------------------------|
| Methane (CH <sub>4</sub> )                       | Agriculture (livestock, rice), fossil fuel extraction, landfills | ~28-36                               |
| Nitrous Oxide (N <sub>2</sub> O)                 | Fertilizer use, industrial processes                             | ~298                                 |
| Fluorinated gases (HFCs, PFCs, SF <sub>6</sub> ) | Refrigeration, electronics, metal production                     | 1,000-23,000                         |

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## 3. Evidence of Climate Change

### 1. Temperature Records

- Global surface temperature has risen ~1.1°C above pre-industrial levels (1850–1900 baseline).
- Last decade = warmest on record.

### 2. Melting Cryosphere

- Arctic sea ice extent ↓ ~13% per decade.
- Greenland and Antarctic ice sheets losing mass → sea level rise.

### 3. Sea Level Rise

- Global average sea level ↑ ~20cm since 1900; rate accelerating to ~3.4mm/yr<sup>1</sup> (1993–2023).

### 4. Ocean Changes

- Surface ocean warming → heat content ↑ 93% of excess energy.
- Ocean acidification: pH down ~0.1 (30% increase in acidity) since 1850.

### 5. Extreme Weather

- Increased frequency/intensity of heatwaves, heavy precipitation events, and droughts.
  - Attribution studies link many of these trends to anthropogenic warming.
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## 4. Impacts

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| Sector          | Observed / Projected Impacts                                                                            |
|-----------------|---------------------------------------------------------------------------------------------------------|
| Human Health    | Heat-related mortality, spread of vector-borne diseases, respiratory problems from air quality decline. |
| Agriculture     | Shifts in growing zones, crop yield variability, increased irrigation demand.                           |
| Water Resources | Glacial melt altering river flows, heightened flood                                                     |