

Introduction to Climate Change

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Key concepts, causes, impacts, and responses

1. What Is Climate Change?

Term	Definition
Climate	Long-term (30-year+) average of temperature, precipitation, wind, etc., for a region.
Weather	Short-term atmospheric conditions (hours to days).
Climate Change	A statistically significant shift in climate patterns over decades to centuries, driven by natural processes and human activities.
Global Warming	The increase in Earth's average surface temperature, a major component of climate change.

2. Scientific Basis

2.1 The Greenhouse Effect

1. Solar radiation reaches Earth – some is reflected, most is absorbed and re-emitted as infrared (IR) radiation.
2. Greenhouse gases (GHGs) (CO₂, CH₄, N₂O, water vapor, etc.) absorb IR, trapping heat and warming the lower atmosphere.
3. Without GHGs, average surface temperature would be ~-18°C; with them it is ~+15°C.

2.2 Radiative Forcing

- **Positive forcing** – warming (e.g., increased CO₂).
- **Negative forcing** – cooling (e.g., volcanic aerosols).
- The Intergovernmental Panel on Climate Change (IPCC) quantifies forcing in **watts per square meter (W/m²)**.

2.3 Evidence of Change

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Indicator	Observation	Time Scale
Global mean surface temperature	↑↑↑↑1.2°C since pre-industrial (1850-1900)	1850-present
Ocean heat content	↑↑↑↑0.5°C in upper 200m	1950-present
Sea-level rise	↑↑↑↑20cm (1900-present)	1900-present
Glacial retreat	Majority of world's glaciers shrinking	20th-century-present
Arctic sea-ice extent	↓↓↓↓13% per decade (satellite era)	1979-present
Extreme weather frequency	More heatwaves, heavy precipitation events	Recent decades

3. Primary Drivers

Driver	Source	Approx. Share of Anthropogenic GHG Emissions
Carbon Dioxide (CO ₂)	Fossil-fuel combustion, cement production, land-use change	~75%
Methane (CH ₄)	Agriculture (livestock, rice), landfills, fossil-fuel extraction	~15%
Nitrous Oxide (N ₂ O)	Fertilizer use, industrial processes	~6%
Fluorinated gases (F-gases)	Refrigerants, electronics, fire-suppression	~4%

3.1 Natural vs. Anthropogenic

- **Natural variability** (solar cycles, volcanic eruptions, El Niño/La Niña) still influences climate but cannot explain the observed long-term warming trend.
 - **Anthropogenic forcing** (mainly CO₂) accounts for >95% of the warming since the mid-20th-century (IPCC AR6).
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4. Impacts

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4.1 Physical Environment

- **Temperature:** More frequent heat extremes, longer warm seasons.
- **Hydrology:** Altered precipitation patterns