The Alliance for Just Deliberation on Solar Geoengineering

Climate Science: An Overview

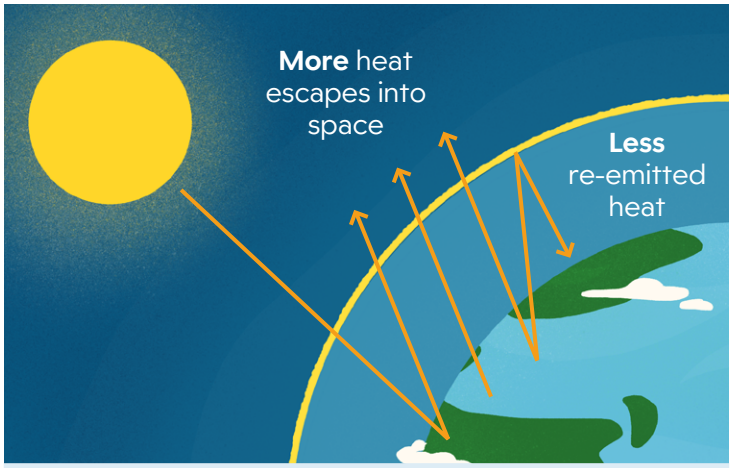
Climate science is the study of Earth's climate system, including the atmosphere, oceans, land, and the interactions between them. It explores how energy from the Sun drives weather and climate patterns, how ecosystems and the carbon cycle regulate atmospheric conditions, and how human activities impact these natural processes. By combining data from satellites, climate models, historical records, and ground observations, scientists aim to understand past, present, and future climate changes.

Understanding Climate Change

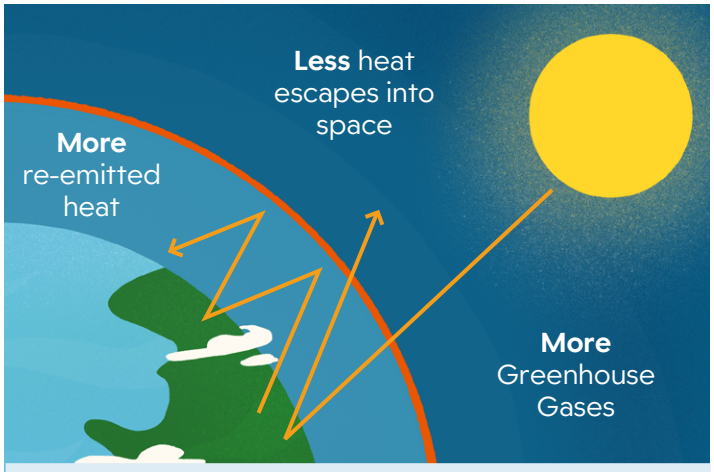
Climate change refers to long-term shifts in global temperature and weather patterns, historically influenced by natural factors like volcanic eruptions and solar cycles. However, the current rate of change is unprecedented and primarily driven by human activities. Since the Industrial Revolution, fossil fuel combustion, deforestation, and industrial processes have significantly increased greenhouse gas (GHG) emissions, intensifying the greenhouse effect and accelerating global warming. The rapid changes observed over the past century indicate that human activity is fundamentally altering the Earth's climate system.

The Greenhouse Effect

The greenhouse effect is a natural process where GHGs in Earth's atmosphere (such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)) trap heat from the Sun and keep the planet warm enough to sustain life. However, human activities have intensified this effect, leading to excessive heat being trapped and causing global warming.



Natural Greenhouse Effect



Human Enhanced Greenhouse Effect

How Do We Know Climate Change Is Happening?

1. Global Temperature Rise: According to the IPCC, "Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850-1900 in 2011-2020."

2. Melting Ice: Glaciers, ice sheets, and Arctic sea ice are rapidly shrinking, contributing to rising sea levels.

3. Sea Level Rise: Global sea levels rose approximately 20 cm between 1901 and 2018, threatening coastal communities.

4. Ocean Changes: Oceans absorb over 90% of excess heat and CO_2, leading to warming, acidification, and disrupted marine ecosystems.

5. Extreme Weather: The frequency and intensity of heatwaves, hurricanes, floods, and droughts are increasing worldwide.

Impacts of climate change across human systems and ecosystems





Ecosystems and biodiversity: Climate change disrupts ecosystems, endangers species, and accelerates habitat loss.

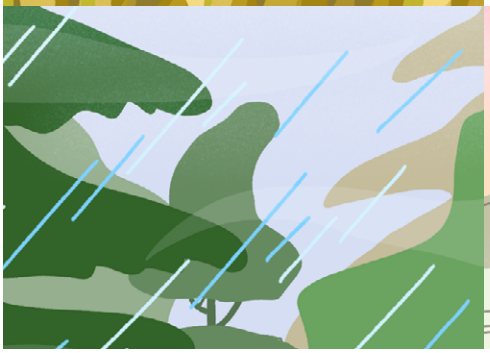
Food Security: Altered weather patterns affect crop yields, threatening food supplies, particularly in vulnerable regions.

Water Resources: Melting glaciers and changing rainfall patterns impact freshwater availability for millions of people.

Human Health: Rising temperatures contribute to heat-related illnesses, the spread of diseases, and air quality issues.

Economic Disruption: Infrastructure damage, resource scarcity, and extreme weather events strain economies globally.

With each incremental increase in global average temperatures, the risks of more intense and frequent climate impacts increases disproportionately across both land and ocean/coastal systems. Even low levels of global warming have higher risks associated with some of these systems, such as coastal reefs.







Addressing Climate Change

Efforts to combat climate change currently focus on these main areas:

1. Mitigation: Reducing GHG emissions by transitioning to renewable energy, improving energy efficiency, reforesting, and developing sustainable agricultural practices.
2. Adaptation: Reducing vulnerability to climate impacts through resilient infrastructure, improved water management, and disaster preparedness.
3. Carbon Dioxide Removal: Encompasses various methods designed to extract CO_2 from the atmosphere, including direct air capture with long-term storage, soil carbon sequestration, biomass-based carbon removal and storage, enhanced mineralization, ocean-based strategies, and afforestation/reforestation.

The Path Forward

Climate science provides the foundation for understanding the complexities of Earth's changing climate and its far-reaching impacts. A deep commitment to global collaboration, equitable action, and science-driven solutions is essential to address the challenges ahead and secure a sustainable future for all.