Climate Change - IPCC 2014 Report

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Module 1: Introduction: The Integrated Science of Climate Change

Learning Objectives

By the end of this section, you will be able to:

- **Identify** the core structure and scope of the IPCC Fifth Assessment Report (AR5).
- **Evaluate** the components of climate risk, including the interplay between hazards, exposure, and vulnerability.
- **Analyze** the standardized language used to communicate scientific uncertainty and confidence in technical findings.

Executive Summary: The AR5 Synthesis Report provides a comprehensive integration of physical science, impacts, and mitigation strategies. Central to the report is a risk-management framework that accounts for uncertain outcomes and utilizes a rigorous, standardized language to communicate levels of scientific confidence and probability.

Overview of the Synthesis Report

The Synthesis Report (SYR) distills knowledge across the three IPCC Working Groups and two Special Reports to provide a holistic view of climate change. This report emphasizes new results since the 2007 Fourth Assessment Report (AR4).

The "Longer Report" is structured into four primary topics:

- **Topic 1: Observed Changes and their Causes:** Focuses on observational evidence and human contributions to the changing climate.
- **Topic 2: Future Climate Changes, Risks and Impacts:** Assesses projections and resultant risks for ecosystems and societies.
- **Topic 3: Future Pathways for Adaptation, Mitigation and Sustainable Development:** Considers these as complementary strategies for risk management.
- **Topic 4: Adaptation and Mitigation:** Details individual options, policy approaches, and integrated responses.

Box Introduction.1 | Risk and the Management of an Uncertain Future

Climate change exposes economic sectors and ecosystems to **Risk**, defined as the potential for consequences when something of value is at stake and the outcome is uncertain.

The Risk Framework

Risks arise from the interaction of three distinct components:

- **Hazard:** Events or trends related to climate change (e.g., severe storms, multi-century sea level rise).
- **Vulnerability:** The predisposition or susceptibility to be adversely affected (e.g., lack of resilient infrastructure).
- **Exposure:** The presence of people, livelihoods, species, or assets in places that could be adversely affected.

Risk Assessment Principles

- **Probability vs. Magnitude:** High risk can result from high-probability events or **low-probability/high-consequence** outcomes (the "tail" of the distribution).
- **Policy Relevance:** Low-confidence outcomes are policy-relevant if the consequences are severe, such as a sea level rise exceeding one meter or the potential for the Amazon forest to amplify climate change.
- **Management Tools:** Effective risk management does not always require precise quantification; qualitative values, ethical goals, and cultural factors are critical for effective governance.

Box Introduction.2 | Communicating the Degree of Certainty in Assessment Findings

A critical feature of the IPCC report is the standardized communication of scientific uncertainty.

Evaluating Confidence

Confidence is a qualitative measure based on:

1. **Evidence:** The type, amount, quality, and consistency of data, models, or expert judgment (**Limited, Medium, or Robust**).
2. **Agreement:** The degree of consensus within the scientific community (**Low, Medium, or High**).

Quantifying Likelihood

When outcomes can be described probabilistically, specific terms are used to indicate the assessed likelihood:

💡 **Design Tip:** Professional Engineers should note that unless otherwise indicated, findings assigned a likelihood term are associated with **high or very high confidence**.

Checkpoint Quiz

1. **In the context of climate risk, a "Hazard" is defined by which of the following?**
   a) The susceptibility of an asset to harm.
   b) A climate-related event or trend ranging from brief storms to slow sea level rise.
   c) The presence of assets in a location at risk.
   d) The ethical value assigned to a specific outcome.

Answer: (b). Hazards represent the physical events or trends triggered by climate change, distinct from vulnerability (susceptibility) and exposure (presence of assets).

2. **A finding based on multiple independent lines of evidence with high consensus would be assigned which qualitative qualifier?**
   a) Robust evidence / Low agreement.
   b) High confidence.
   c) Exceptionally likely.
   d) Virtually certain.

Answer: (b). Confidence is the synthesis of evidence and agreement; strong evidence and high agreement result in a high level of confidence.

3. **Why are low-probability/high-consequence outcomes (tail outcomes) included in IPCC risk assessments?**
   a) Because they are virtually certain to occur by 2100.
   b) Because they represent the only scenarios with robust evidence.
   c) Because the severity of their impact makes them significant for policy and engineering judgment.
   d) Because they have the highest degree of scientific agreement.

Answer: (c). High risk can be driven by the magnitude of consequences even if the probability of occurrence is low, making these scenarios critical for robust risk management.

Module 2: Topic 1 – Observed Changes and their Causes

Learning Objectives

By the end of this section, you will be able to:

- **Evaluate** the observational evidence across the atmosphere, ocean, and cryosphere that confirms the warming of the climate system.
- **Analyze** the relationship between anthropogenic GHG emissions, economic growth, and population as drivers of historical climate change.
- **Identify** the cascading impacts of climate change on natural and human systems and the factors influencing regional vulnerability.

Executive Summary: Human influence on the climate system is clear, with recent anthropogenic emissions of greenhouse gases being the highest in history. Warming is unequivocal, evidenced by atmospheric and oceanic heating, diminishing snow and ice, and rising sea levels. These changes have triggered widespread, cascading impacts across global ecosystems and human societies, exacerbated by socio-economic inequalities.

Observed changes in the climate system

Warming of the climate system is **unequivocal**, and since the 1950s, many of the observed changes are unprecedented over decades to millennia.

Atmosphere

- **Surface Warming:** Each of the last three decades has been successively warmer than any preceding decade since 1850.
- **Regional Trends:** For the period 1901 to 2012, almost the entire globe has experienced surface warming.
- **Variability:** Trends based on short records (e.g., 1998–2012) are sensitive to natural variability and do not generally reflect long-term trends.
- **Precipitation:** Mid-latitude land areas of the Northern Hemisphere have seen a likely increase in precipitation since 1901.

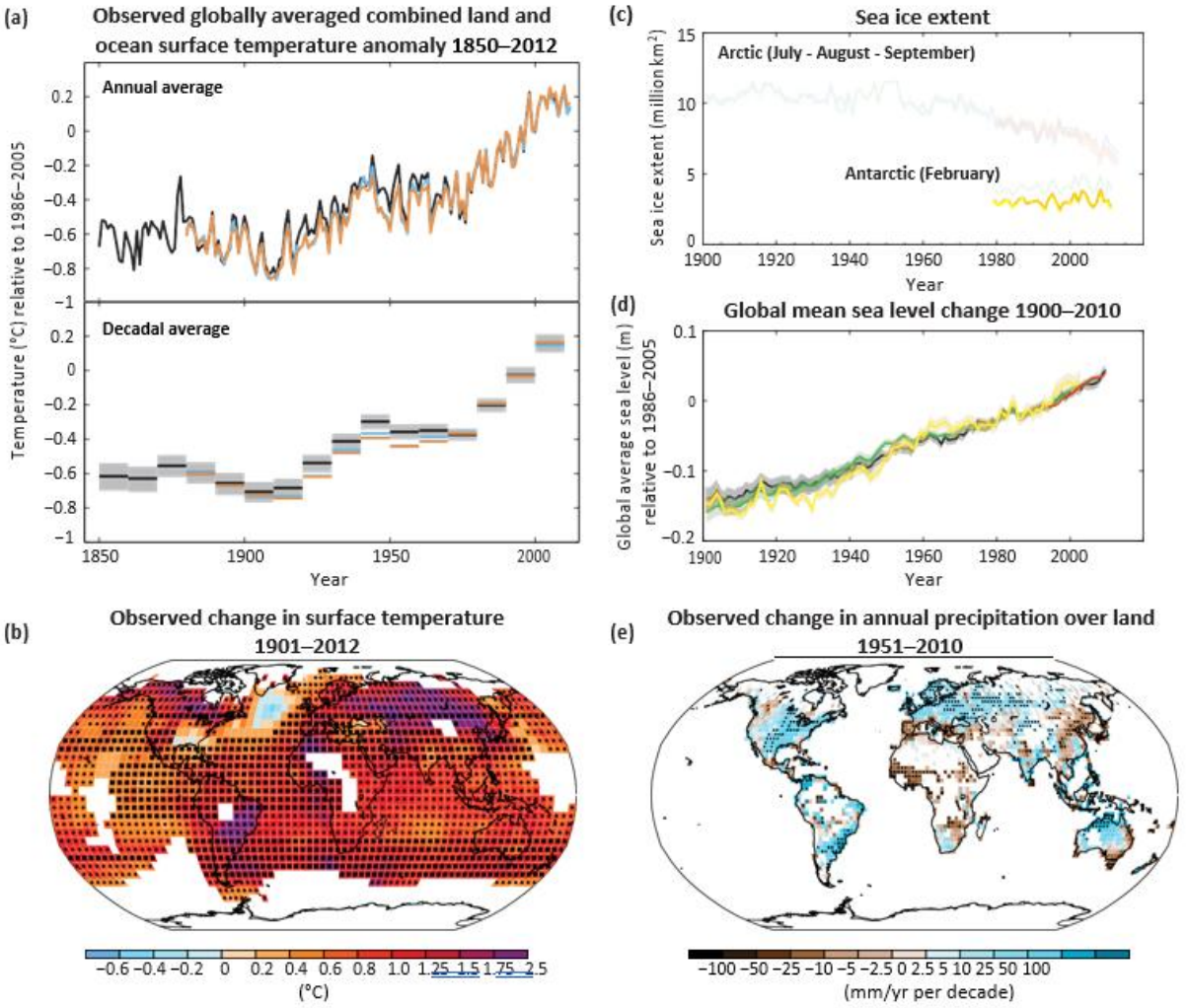

Figure 1.1 | Multiple observed indicators of a changing global climate system. (a) Observed globally averaged combined land and ocean surface temperature anomalies (relative to the mean of 1986 to 2005 period, as annual and decadal averages) with an estimate of decadal mean uncertainty included for one data set (grey shading). (b) Map of the observed surface temperature change, from 1901 to 2012, derived from temperature trends determined by linear regression from one data set (orange line in Panel a). (c) Arctic (July to September average) and Antarctic (February) sea ice extent. (d) Global mean sea level relative to the 1986–2005 mean of the longest running data set, and with all datasets aligned to have the same value in 1993, the first year of satellite altimetry data. (e) Map of observed precipitation change, from 1951 to 2010.

Ocean

- **Energy Storage:** Ocean warming accounts for more than **90% of the energy accumulated** between 1971 and 2010 (high confidence).
- **Acidification:** Oceanic uptake of CO2 has resulted in a pH decrease of 0.1 since the industrial era, a **26% increase in acidity**.
- **Salinity:** High-salinity regions have become more saline, while low-salinity regions have become fresher since the 1950s.

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