Established IPCC in 1998

Includes over 2,000 scientists from 154 countries - nominated for participation in the panel by their own governments.

“The major activity of the IPCC is to prepare in regular intervals comprehensive and up-to-date assessments of policy-relevant scientific, technical and socio-economic information relevant for the understanding of human induced climate change, potential impacts of climate change and options for mitigation and adaptation.”

“It bases its assessment mainly on peer reviewed and published scientific/technical literature.”
The **First Assessment Report** completed in 1990 - Provided the overall policy framework for addressing the climate change issue. Played an important role in establishing the *Intergovernmental Negotiating Committee for a UN Framework Convention on Climate Change (UNFCCC)* by the UN General Assembly (1994).

**Second Assessment Report** in 1995 - Provided key input to the negotiations, which led to the adoption of the Kyoto Protocol to the *UNFCCC* in 1997.

**Third Assessment Report** *(TAR)* in 2001- “Climate Change 2001” Submitted to the 7th Conference of the Parties to the UNFCCC and Parties agreed that it should be used routinely as a useful reference for providing information for deliberations on agenda items of the Conference of the Parties.
Fourth Assessment Report (AR4): "Climate Change 2007"
Released Feb, April, May 2007

• 2500+ scientific reviewers
• 800+ contributing authors
• 450+ lead authors
• 130+ countries
• 6 years
• 4 volumes

Working Group I Report "The Physical Science Basis"
Working Group II Report "Impacts, Adaptation and Vulnerability"
Working Group III Report "Mitigation of Climate Change"
Synthesis Full Report
“The clarity and completeness of the IPCC’s global warming findings permanently relegates skeptics to the fringe.”

First report to link actual data on how natural systems are responding to the amount of warming they have experienced.

“For the first time we are no longer arm-waving with models, Authors compiled more than 29,000 data sets, on everything from glaciers to the timing of spring foliage, and compared the trends with the amount of regional warming observed in each area since 1970. In more than 90% of cases, the changes in natural systems were consistent with predictions of how they would behave in a warming world.” Martin Parry, co-chair of the IPCC's Working Group II.
1. Global atmospheric concentrations of CO₂ (from fossil fuel and land use change), CH₄ (from agriculture), N₂O (from agriculture), have increased markedly since 1750 and now far exceed pre industrial values.

<table>
<thead>
<tr>
<th></th>
<th>CO₂</th>
<th>CH₄</th>
<th>N₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preindustrial</td>
<td>280ppm</td>
<td>715ppb</td>
<td>270ppb</td>
</tr>
<tr>
<td>2005</td>
<td>379ppm</td>
<td>1774ppb</td>
<td>319ppb</td>
</tr>
</tbody>
</table>

2005 values exceed by far the natural variations in the last 650,000 yrs.
2. There is now very high confidence that the global average net effect of human activities since 1750 has been one of warming, with a radiative forcing of +1.6 W/m².

CO₂ + CH₄ + N₂O = + 2.3

CO₂ forcing increased by 20% in the last 10 yrs – largest in the last 200 yrs.

Ozone = +0.35
Halocarbons = +0.35
Albedo changes = -0.2
Aerosols = -0.5 direct
-0.7 indirect
3. Warming of the climate system is **unequivocal** as is now evident from Observations.

11 of the last 12 yrs are the warmest on record.

100 yr linear trend of 0.74°C (larger than reported in TAR)

Ocean temps have increased to depths of 3000m – absorbing 80% of the added heat.

Glaciers and snow cover has declined.

Losses from ice sheets of Greenland and Antarctica.

Sea level rise of 1.8mm/yr – 1961-2003
3.1mm/yr – 1993-2003

Total 20th cent rise = 0.17m
4. Numerous long-term changes in climate have been observed on continental, regional, and ocean basin scales.

- Arctic temps increased at twice the global average rate in the past 100 yrs.
- Arctic sea ice has shrunk by 2.7% per decade with decreases in summer of 7.4% per decade.
- Perma frost temps have increased by up to 3°C.
- Area covered by permafrost has decreased by 7% in northern hemisphere (spring 15%).
- Precipitation trends (1900 – 2005): increased in eastern N and S America, central Asia; decreased in Mediterranean, S Africa S Asia.
- Ocean salinity has decreased at mid- and high-latitudes and increased at low-latitudes.
- Mid-latitude westerly winds have strengthened.
- Droughts in tropics and subtropics have become more intense and longer.
- Heavy precipitation events more frequent of over most land areas.
- Extreme temperature trends: cold days, nights and frost less frequent; hot days, nights and heat waves more frequent.
- Cyclone activity in N Atlantic increased in intensity.
Observed changes are consistent with

✓ expected responses to forcings

✗ inconsistent with alternative explanations
A Paleoclimatic Perspective

Paleoclimate information supports the interpretation that the warmth of the last half century is unusual in at least the previous 1300 years.

The last time the polar regions were significantly warmer than present for an extended period (about 125,000 years ago) due to differences in earth’s orbit, reductions in polar ice volume led to 4 to 6 m of sea level rise.
Projections of Future Changes in Climate

Warming of 0.1 °C/dec for next 20 yr even if emissions held at 2000 levels due to slow response of oceans.

For low scenario (B1): 0.2 °C/dec

For high scenario (A1FI): 4.0°C/dec

"Approximately twenty to thirty percent of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5-2.5 degrees Celsius,"

‘Impacts, Adaptation and Vulnerability'
PROJECTIONS OF FUTURE CHANGES IN CLIMATE

• Warming and sea level rise would continue for centuries due to the timescales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilized.

• Temperatures in excess of 1.9 to 4.6°C warmer than pre-industrial will be sustained for millennia…with the eventual melt of the Greenland ice sheet. Would raise sea level by 7 m comparable to that of 125,000 years ago.
AFRICA is one of the most vulnerable continents to climate variability.

By 2020, 75-250 million people projected to be exposed to increase of water stress.

Agricultural production and access to food supplies severely compromised. Suitable growing area, length of growing season, and yield decreased.

Decrease in fisheries resources in large lakes due to rising water temperatures.

Sea level rise to affect highly populated coastal areas.

Mangroves and coral reefs become further degraded.
ASIA also to experience greater water stress.

Glacier melt in the Himalayas to increase flooding and rock avalanches followed by decreased river flows as glaciers recede.

Freshwater availability decreased in large river basins. Compounded by increased demands could affect more than a billion people by 2050.

Increased flooding in heavily populated mega delta coastal regions.

Crop yield increase 20% in E and SE, decrease 30% in central and S by 2050.

Morbidity and mortality to increase due to water borne diseases in E, S and SE.
Australia and New Zealand are expected to experience increased water security problems by 2030.

Agriculture and forestry decline in S and E due to increased drought and fire by 2030.

 Longer growing season in New Zealand close to major rivers.

Increased coastal development at risk from sea level rise, more intense storms, and coastal flooding by 2050.

Significant loss of biodiversity by 2020 – Great Barrier Reef, Queensland Wet Tropics, Kakadu wetlands, sub-Antarctic islands.
European impacts will depend on area.

Increases in inland flash flooding.

Frequent coastal flooding and increased erosion.

Extensive species loss (up to 60%) in mountain areas and reduced winter tourism.

Increased high temps, drought, heat waves, and wildfires in S and central Europe.

Reduced demand for heating, increased crop yields and forest growth initially in N Europe.
Latin America set to lose its tropical forests.

Gradual replacement of tropical forest by savanna in Amazonia.

Significant biodiversity loss through species extinction.

Salinisation and desertification of agricultural land

Soybean yields increase. Some crops and livestock decrease.

Increase flooding in low lying areas

Shifts in location of SE Pacific fish stocks.
North America also to experience water stress especially in the west.

Decreased snow pack, increased winter flooding, and reduced summer flows in west.

Increased pests, diseases, and fires.

Increased yields in agriculture by 5-20% with regional variability.

Increased heat waves especially in urban areas.

Increased vulnerability in coastal regions from sea level rise and increase in storm intensity.
Polar Regions to melt.

Reduction in Thickness and extent of glaciers, and ice sheets.

Changes in natural ecosystems, barriers to species invasion reduced.

Reduced heating costs.

Traditional ways of life threatened.
Small Islands are especially vulnerable to sea level rise and extreme events.

Deterioration of coastline conditions effects local resources and reduce tourism.

Reduction of water resources insufficient to meet demand.

Invasion by non-native species.
<table>
<thead>
<tr>
<th>WATER</th>
<th>ECOSYSTEMS</th>
<th>FOOD</th>
<th>COASTS</th>
<th>HEALTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased water availability in moist tropics and high latitudes</td>
<td>Up to 30% of species at risk of extinction</td>
<td>Tendencies for cereal productivity to decrease in low latitudes</td>
<td>Increased damage from floods and storms</td>
<td>Increasing burden from malnutrition, diarrhoeal, cardio-respiratory, and infectious diseases</td>
</tr>
<tr>
<td>Decreasing water availability and increasing drought in mid-latitudes and semi-arid low latitudes</td>
<td>Most corals bleached</td>
<td>Tendencies for some cereal productivity to increase at mid- to high latitudes</td>
<td></td>
<td>Increased morbidity and mortality from heat waves, floods, and droughts</td>
</tr>
<tr>
<td>Hundreds of millions of people exposed to increased water stress</td>
<td>Widespread coral mortality</td>
<td>Cereal productivity to decrease in low latitudes</td>
<td>About 30% of global coastal wetlands lost</td>
<td>Changed distribution of some disease vectors</td>
</tr>
</tbody>
</table>

Global mean annual temperature change relative to 1980-1999 (°C)

Significant is defined here as more than 40%.

Based on average rate of sea level rise of 4.2 mm/year from 2000 to 2080.
Mitigation can be achieved by deployment of a portfolio of technologies that are currently available and those that are expected to be commercialized.

**Energy efficiency**—improved distribution, fuel efficient vehicles, shift from road to rail transport, efficient electrical appliances, improved land management and cultivation practices, improved insulation.

**Low carbon energy sources**—nuclear power, renewables, biofuels, geothermal, solar, hydropower, wind.

**CO$_2$ capture and storage**—reforestation, material recycling.

“Geoengineering options …………remain largely speculative and unproven and with the risks of unknown side effects.”
"Mitigation of Climate Change"

Changes in lifestyle and behavior
Focus on resource conservation instead of consumption
New energy infrastructure investments
Urban planning
Financial incentives
Investments in research
Reduction of deforestation

“It is often more cost effective to invest in increased energy efficiency than increased energy supply.”
Co-Benefits of Mitigation

Substantial health benefits
Air pollution abatement
Reduced pressure on natural ecosystems
Increased energy security
Increased agricultural production
Improved indoor air quality
Summary of Major Findings include the Following:

**Pollution Will Skyrocket Unless Governments Act**
Global emissions are projected to rise by 25-90% over 2000 levels by 2030, unless policies are adopted to reduce emissions.

**Still Possible to Avoid Dangerous Global Warming**
To prevent dangerous global warming, emissions would need to peak no later than 2015 and then decline by 50% by 2050, thereby limiting the global average temperature increase to about 2°C over pre-industrial levels. The U.S. must reduce its emissions by at least 80% by 2050 to meet the global target.

**Action Cheaper than Inaction**
Stabilizing greenhouse gas concentrations at relatively safe levels will cost less than 3% of expected economic growth by 2030 (less than 0.12% per year). The former chief economist of the World Bank, Sir Nicholas Stern, has put the price of unmitigated warming at as high as 20% of global GDP by 2100.

**Vast Potential for Energy Efficiency**
Energy efficiency in vehicles and buildings could significantly reduce global warming emissions “with net economic benefit” and with “large co-benefits,” but “many barriers exist against tapping this potential.” The co-benefits include improved energy security, job creation, lower costs, and reduced air pollution.
**Vast Potential for Renewable Energy**
Given costs relative to other supply options, renewable electricity…can have a 30-35% share of the total electricity supply in 2030.... “Renewable energy generally has a positive effect on energy security, employment, and on air quality.”

**Reducing Global Warming Pollution Can Improve Health**
“Near-term health co-benefits from reduced air pollution as a result of actions to reduce emissions can be substantial and may offset a substantial fraction of mitigation costs.”

**Voluntary Action Ineffective**
“The majority of [voluntary] agreements has not achieved significant emissions reductions beyond business as usual.”