

PCCRC DISTINGUISHED LECTURE

The Science of Global Climate Change

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Abstract

Significant advances in the scientific understanding of climate change now make it clear that there has been a change in climate that goes beyond the range of natural variability. As stated in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC): the warming of the climate system is unequivocal and it is very likely due to human activities.

There is an increasing body of evidence showing physically consistent changes in climate. These include increases in global average surface air temperature (Figure 1); atmospheric temperatures above the surface; surface and sub-surface ocean water temperature; widespread melting of snow; decreases in Arctic sea-ice extent and thickness; decreases in glacier and small ice cap extent and mass; and rising global mean sea level. The observed surface warming at global and continental scales is also consistent with reduced duration of freeze seasons; increased heat waves; increased atmospheric water vapor content and heavier precipitation events; changes in patterns of precipitation; increased drought; increases in intensity of hurricane activity, and changes in atmospheric winds. Moreover, these changes in physical variables are reflected in changes in ecosystems and human health.

Today's best climate models are now able to reproduce these observed major changes in climate, which makes them extremely useful tools for understanding and determining the changes in forcing that are responsible. The culprit is the astonishing rate at which greenhouse gas concentrations are increasing in the atmosphere, mostly from fossil fuel combustion. Greenhouse gas concentrations are higher now than at any time in at least the last 650,000 years. Atmospheric concentrations of carbon dioxide, the most important anthropogenic greenhouse gas, are nearly 38% higher than pre-industrial values, and over half of that increase has occurred since 1970 (Figure 1). Billions of additional tons of carbon will be added to the atmosphere through industrial activity in the decades ahead, and carbon dioxide concentrations are increasing at rates beyond the highest of the IPCC scenarios suggesting that changes in climate may be larger and more rapid than projected.

Global warming is, therefore, not just a threat for the future. It is already happening, endangering the health and welfare of the planet. There isn't one single solution: governments need to agree on and enforce emission targets; innovators need to develop low-carbon energy sources and improve efficiency; and individuals need to do their best to reduce their own carbon footprints.

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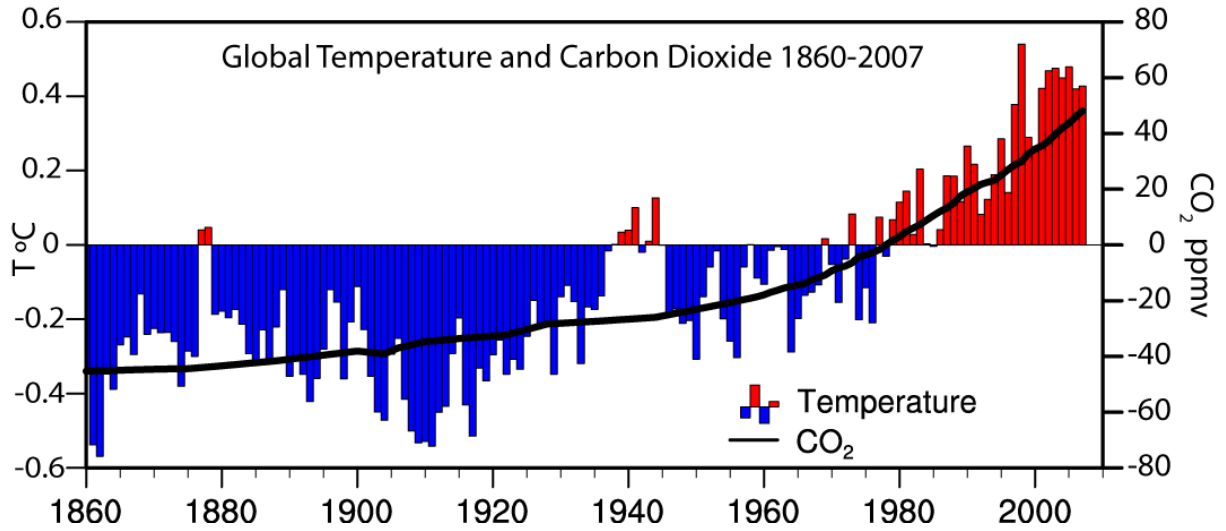


Figure 1. Estimated changes in annual global mean surface temperatures ($^{\circ}\text{C}$, color bars) and carbon dioxide concentrations (thick black line) over the past 148 years relative to 1961-1990 average values. Carbon dioxide concentrations since 1957 are from direct measurements at Mauna Loa, Hawaii, while earlier estimates are derived from ice core records. The scale for carbon dioxide concentrations is in parts per million (ppmv) relative to a mean of 333.7 ppmv, while the temperature anomalies are relative to a mean of 14°C .