global climate change

planetary perspective

PROJECT OVERVIEW

FROM LEFT-RIGHT: Mandy Mobley, Ashley Ortmann, Melissa Discepolo, Professor Robert Miller, Alisha White, Matthew Santilli, Jenny Williams, Claire Bowman, Aaron Bowman, Louis Lacio, Angela Falk, Tim Hoskins, Artemiy Zheltov, Paul Kennedy, Professor Ray Huff.

study goals

For six weeks during Spring Semester 2007, the Clemson Architecture Center in Charleston (CAC.C) undertook a study of the potential impacts of global climate change on the urban design and preservation of the Charleston peninsula. Our goal was to accept current science at face value and study the design implications. We adopted a range of predictive models (one conservative and one more radical), identified key issues, and then developed design approaches that would address the issues and, hopefully, make the City a better place. Our intention was to identify problems and approaches that the City of Charleston should now begin to consider if it is to deal effectively with a significant impending problem.

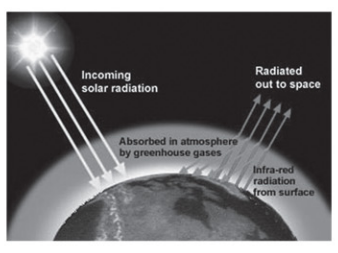
This study is limited to the Charleston peninsula. Although the range of social and ecological problems is broader than indicated, we focused strictly on matters of planning, urban design, and urban preservation. Finally, we sought to find positive possibilities in the new and seemingly negative conditions that await us.

scientific data

This work relies heavily on the 2007 findings of the Intergovernmental Panel on Climate Change (IPCC), an international body made up of scientists and politicians. It's 2007 reports, still being issued, represent the latest international consensus on global climate change with significantly improved statistical certainty over previous reports.

Our scientific advisor for this study was Dr. Greg Carbone, Ph.D., Associate Professor in the Department of Geography at the University of South Carolina.

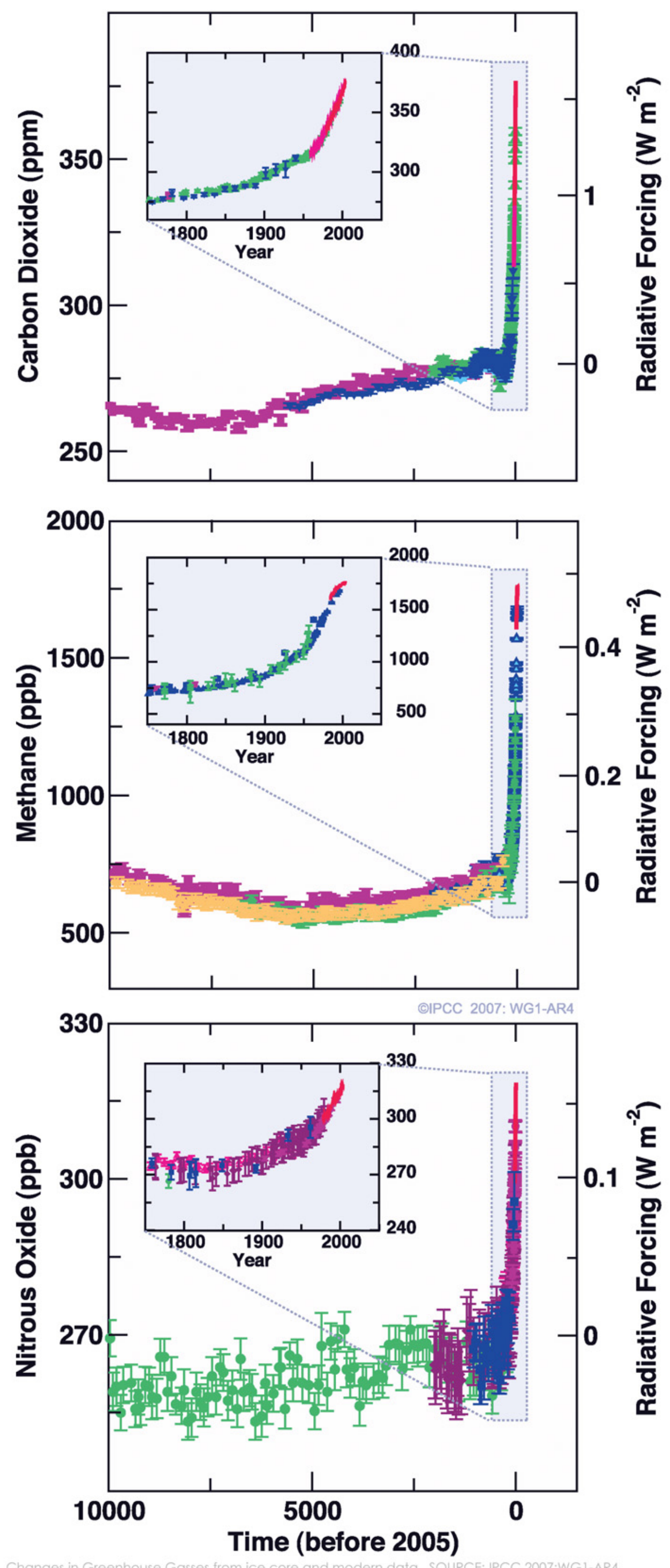
GREENHOUSE GASSES & GLOBAL WARMING



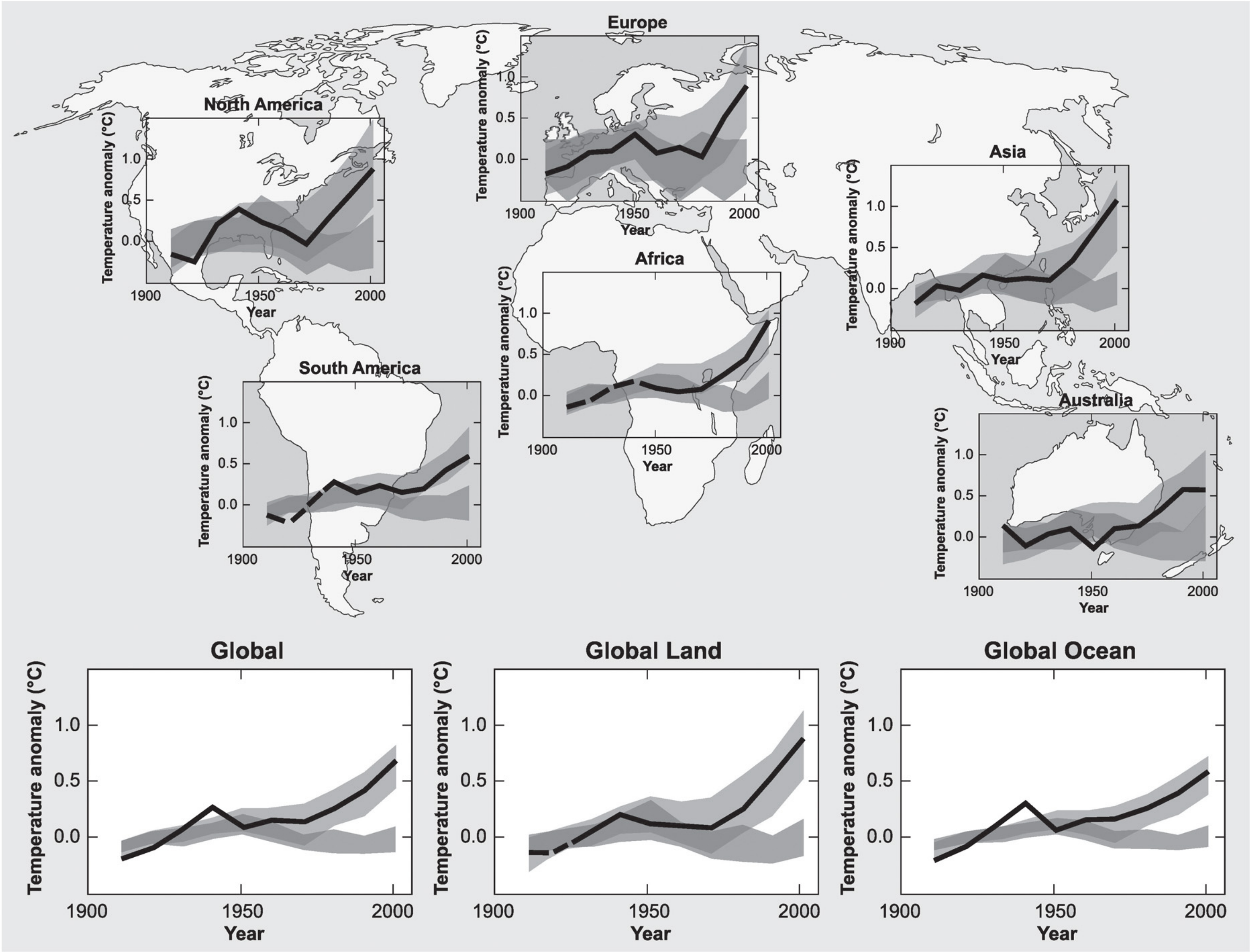
global warming

Most of the sun's heat is radiated back into space; some is absorbed within the atmosphere. The tendancy of the planet to stay warm due to atmospheric absorption, much like a greenhouse, is called "the greenhouse effect." Gasses that most dramatically contribute to this effect, the so-called "greenhouse gasses," are carbon dioxide, methane, and nitrous oxide.

It is critical to biological stability that the globlal climate system maintain a balance, roughly loosing as much heat as it gains. It has become clear in the past few decades that the earth's temperature range is no longer stable; it is increasing. Although the average global temperature is rising, climatological change will vary dramatically by region and involves much more than temperature. For this reason, the overall effects brought about by global warming are referred to as global climate change.



Changes in Greenhouse Gasses from ice core and modern data. SOURCE: IPCC 2007:WG1-AR4



Global & Continental Temperature Change: black graph line indicates actual data; gray graph bands indicate models for natural (dark gray) and natural + anthropogenic (light gray) forcings. SOURCE: IPCC 2007:WG1-AR4

greenhouse gas concentrations

From ice core samples, scientists can determine atmospheric composition from as long as 650,000 years ago. Carbon dioxide is the most important anthropogenic greenhouse gas, the concentration of which has ranged from 180 to 300 parts per million—until now. The pre-industrial level of carbon dioxide (280 ppm) rose to 379 ppm[3] in 2005, and the rate of increase is accellerating. The growth in concentration was larger during the last 10 years (1995–2005 average: 1.9 ppm per year) than it has been since we began keeping continuous direct atmospheric measurements (1960–2005 average: 1.4 ppm per year).

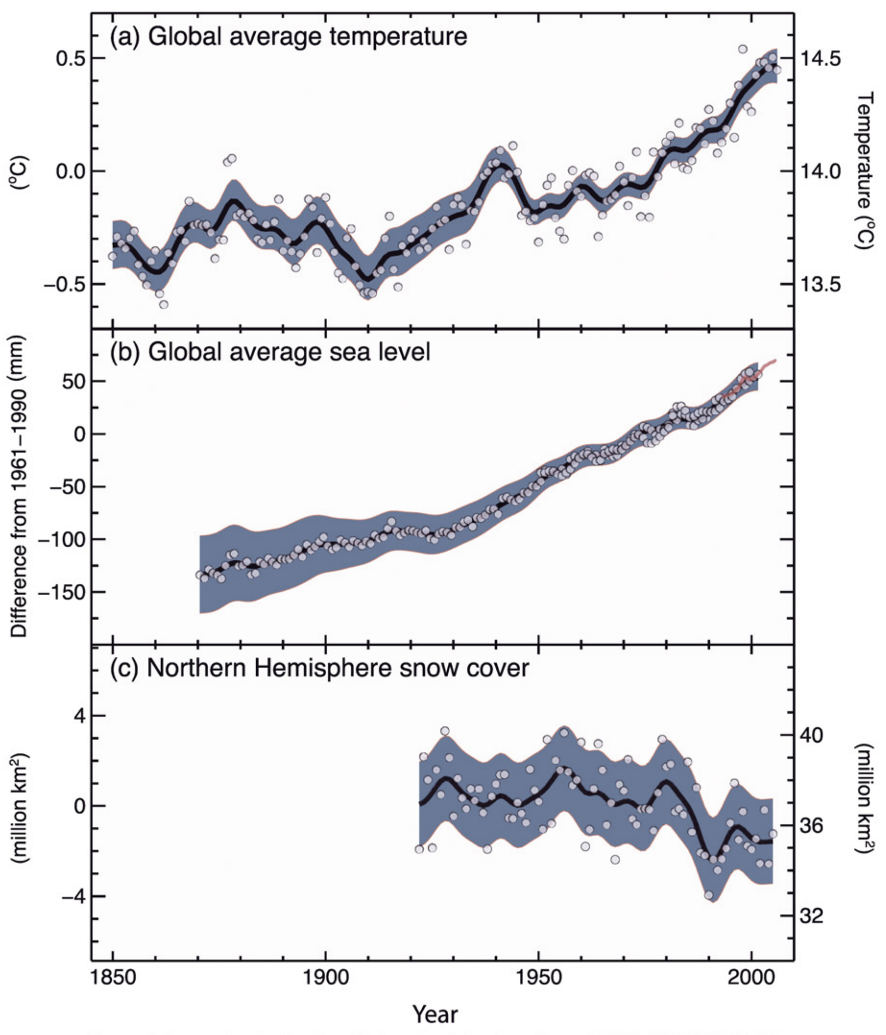
"Radiative Forcing" is a measure of the influence a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system (positive values indicating warming). It is thus an index of potential climate change. The combined Radiative forcing for greenhouse gasses is unprecedented in the last 10,000 years. The carbon dioxide radiative forcing increased by 20% from 1995 to 2005, the largest change for any decade in at least the last 200 years. Source: IPCC 2007: WG1-AR4.

global temperature increase

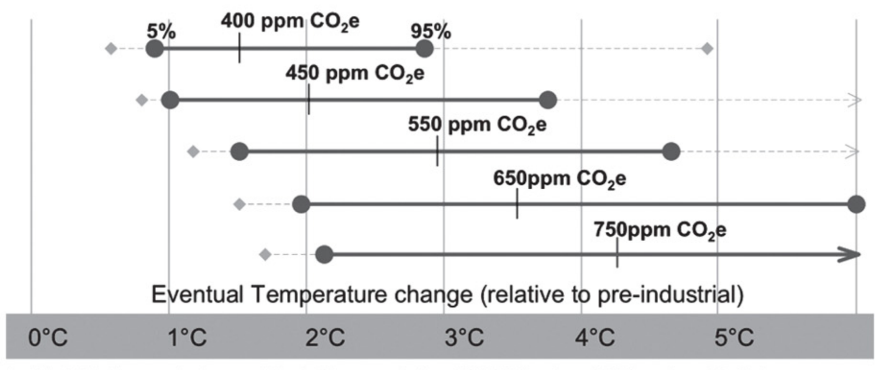
The warming of our climate system is unequivocal, evidenced by increases in global air and ocean temperatures, widespread melting of snow and ice, and rising global sea level. Eleven of the last twelve years (1995–2006) rank among the 12 warmest years in the instrumental record (since 1850). The warming trend of the last 50 years (0.13°C per decade) is nearly twice that of the last century. Observations since 1961 show that the average temperature of the global ocean has increased to depths of at least 3000 m and that the ocean has been absorbing more than 80% of the heat added to the climate system. Such warming causes seawater to expand, further contributing to sea level rise. Average arctic temperatures increased at almost twice the global average in the past 100 years.

Palaeoclimatic information shows that the warmth of the last half century is unusual in at least the previous 1,300 years. The last time the polar regions were significantly warmer than they are today (about 125,000 years ago), reductions in polar ice volume led to a 4 to 6 meter sea level rise. Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1,300 years. Source: IPCC 2007: WG1-AR4.

SEA LEVEL RISE



Changes in Temperature, Sea Level, and Northern Hemisphere Snow Cover. SOURCE: IPCC 2007:WG1-AR4

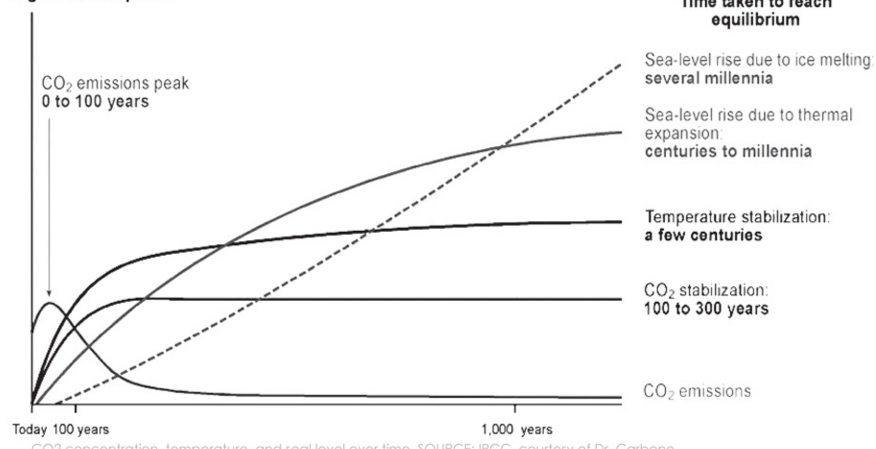


Predicted global temperate change relative to CO_2 concentrations. SOURCE: Stern Report, 2006; courtesy of Dr. Carbone.

current and future sea level rise

As greenhouse gasses increase, the average global temperature rises. Average global temperature, however, is misleading. Temperatures increase much more dramatically at the earth's poles (particularly the North Pole) than at the equator.

Mountain glaciers and snow cover have declined in both hemispheres. Widespread decreases in glaciers and ice caps have contributed to sea level rise. Global average sea level rose at an average rate of 1.8 mm per year from 1961 to 2003. The rate of increase from 1993 to 2003 was almost double that rate: about 3.1 mm per year. The total 20th-century rise is estimated to be 0.17 meters. SOURCE: IPCC 2007:WG1-AR4



CO2 concentration, temperature, and seal level over time. SOURCE: IPCC, courtesy of Dr. Carbone.

emission scenarios (SRES)

The IPPC developed four Emission Scenarios (IPCC Special Report on Emission Scenarios—SRES) for predicting future climate change. The A-series scenarios model an economically-prioritiezed value system that puts economic growth ahead of other concerns; the B-series scenarios model a world in which environmental values trump economic ones. Both are a mixture of economic and environmental values (neither models business as usual). The 1-series looks at global population organizations and the 2-series at more isolated local organizations. In all, IPCC looked at six scenario groups: A1B, A1FI, A1T, A2, B1 and B2. All are considered equally sound.

A1 The A1 scenario describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops three alternative directions of technological energy change. The three A1 groups are distinguished by their technological emphasis: fossil-intensive (A1FI), non-fossil energy sources (A1T), and a balance across all sources (A1B).

A2 The A2 scenario describes a heterogeneous world of selfreliance and preservation of local identities. Fertility patterns across regions converge slowly, which results in continuously increasing population. Economic development is regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.

B1 The B1 scenario describes a convergent world with the same global population as the A1 storyline, service and information economic structures being dominant, and reductions in material intensity along with the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.

B2 The B2 scenario describes a world in which local solutions to economic, social, and environmental sustainability dominate. It is a world with continuously increasing global population, at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented towards environmental protection and social equity, it focuses on local and regional levels. SOURCE: IPCC Special Report on Emission Scenarios, IPCC 2007:WG1-AR4

modeling

In the IPCC's first report of 1990, projections suggested global average temperature increases between about 0.15°C and 0.3°C per decade for 1990 to 2005. This can now be compared with the observed values of about 0.2°C per decade, strengthening confidence in near-term projections. A major advance in the assessment of climate change in the 2007 IPCC work is the large number of simulations and a broader range of models. Taken with observations, these provide a quantitative basis for estimating many aspects of future climate change.

In general, average global warming is likely to be in the range 2°C to 4.5°C over the next century, with a best estimate of about 3°C. These average global increases disguise the very much larger polar increases. Snow cover is projected to contract. Widespread increases in thaw depth are projected over most permafrost regions. Sea ice is projected to shrink in both the Arctic and Antarctic. In some projections, arctic late-summer sea ice disappears almost entirely by the latter part of the 21st century. SOURCE: IPCC 2007:WG1-AR4

lag time

Global warming and sea level rise will continue for centuries due to climate processes and feedbacks, even if greenhouse gas concentrations were suddenly stabilised. Both past and future anthropogenic carbon dioxide emissions will continue to contribute to warming and sea level rise for more than a millennium, due to the time it takes to naturally remove this gas from the atmosphere.

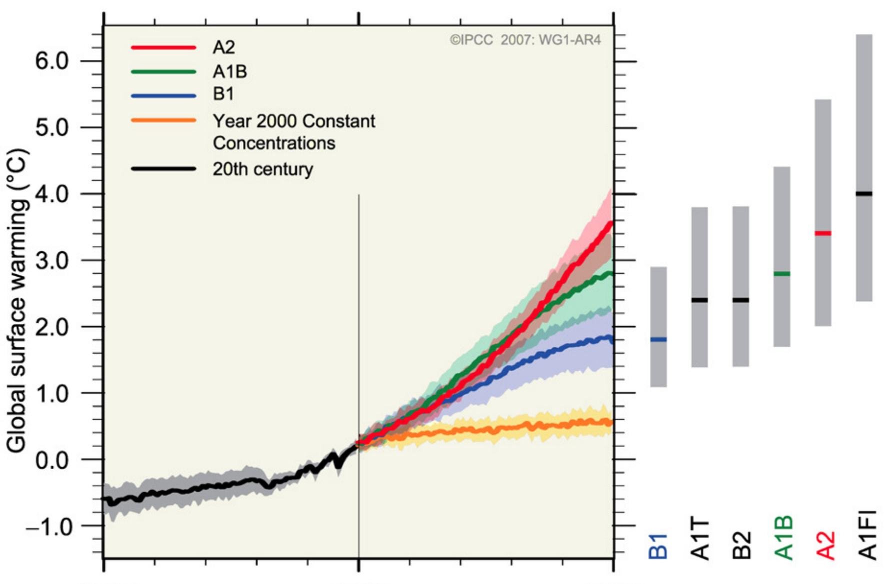
Models show that, even if all radiative forcing agents were held constant at year 2000 levels, a further warming trend would occur in the next two decades at a rate of about 0.1°C per decade. About twice as much warming (0.2°C per decade) can be expected if emissions are reduced to the range of the SRES scenarios (see below). Best-estimate projections indicate that warming until 2030 will be insensitive to human action and is likely to be at least twice as large as the corresponding natural variability during the 20th century—in other words, we have already sealed our fate for the next twenty years, at least. SOURCE: IPCC 2007:WG1-AR4

ice sheet uncertainty

The SRES models do not include uncertainties in climate-carbon cycle feedback nor do they include the full effects of changes in ice sheet flow, due to a lack of published literature. (The IPCC's credibility is paramount; they use no speculative data.) Because understanding of these processes is limited and there is no consensus on their magnitude, these factors have been neglected by IPCC modeling, making their projections more conservative. The projections do, however, include a contribution due to increased ice flow from Greenland and Antarctica but at rates observed for 1993 to 2003, which will most probably increase.

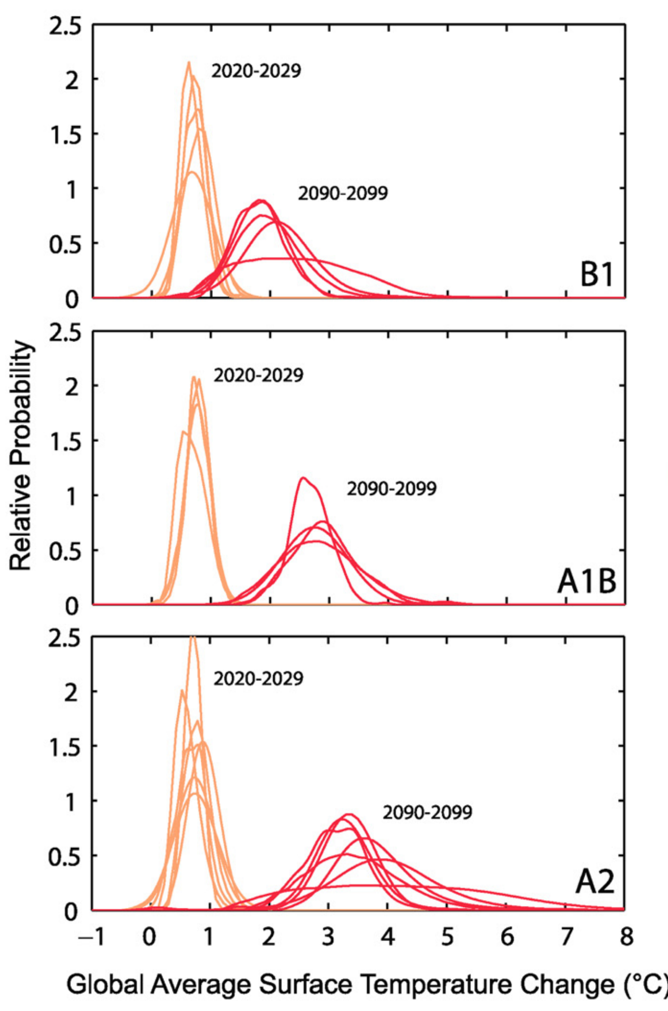
We know that the Greenland Ice Sheet is contracting and contribute to sea level rise. Current models suggest that the surface mass balance will become negative at a global average warming (relative to pre-industrial values) in excess of 1.9°C to 4.6°C—precisely what is forcast. If a negative surface mass balance were sustained for millennia, that would lead to virtually complete elimination of the Greenland Ice Sheet and a resulting contribution to sea level rise of about 7 meters (23'). The corresponding temperatures would be comparable to those inferred for the last interglacial period 125,000 years ago, when palaeoclimatic information suggests reductions of polar land ice and 4 to 6 meters of sea level rise. SOURCE: IPCC 2007:WG1-AR4

projections



Averages and Ranges for surface warming, by scenario. SOURCE: IPCC 2007:WG1-AR4

Of the six SRES scenarios, the best estimate for the low scenario (B1) is a 1.8°C temperature rise by 2100; the best estimate for the high scenario (A1FI) is 4.0°C. The orange line at bottom is a theoretical referent where concentrations held constant at year 2000 values. The grey bars at right indicate the likely range of statistical error with best estimate (solid line within each bar). SOURCE: IPCC 2007:WG1-AR4



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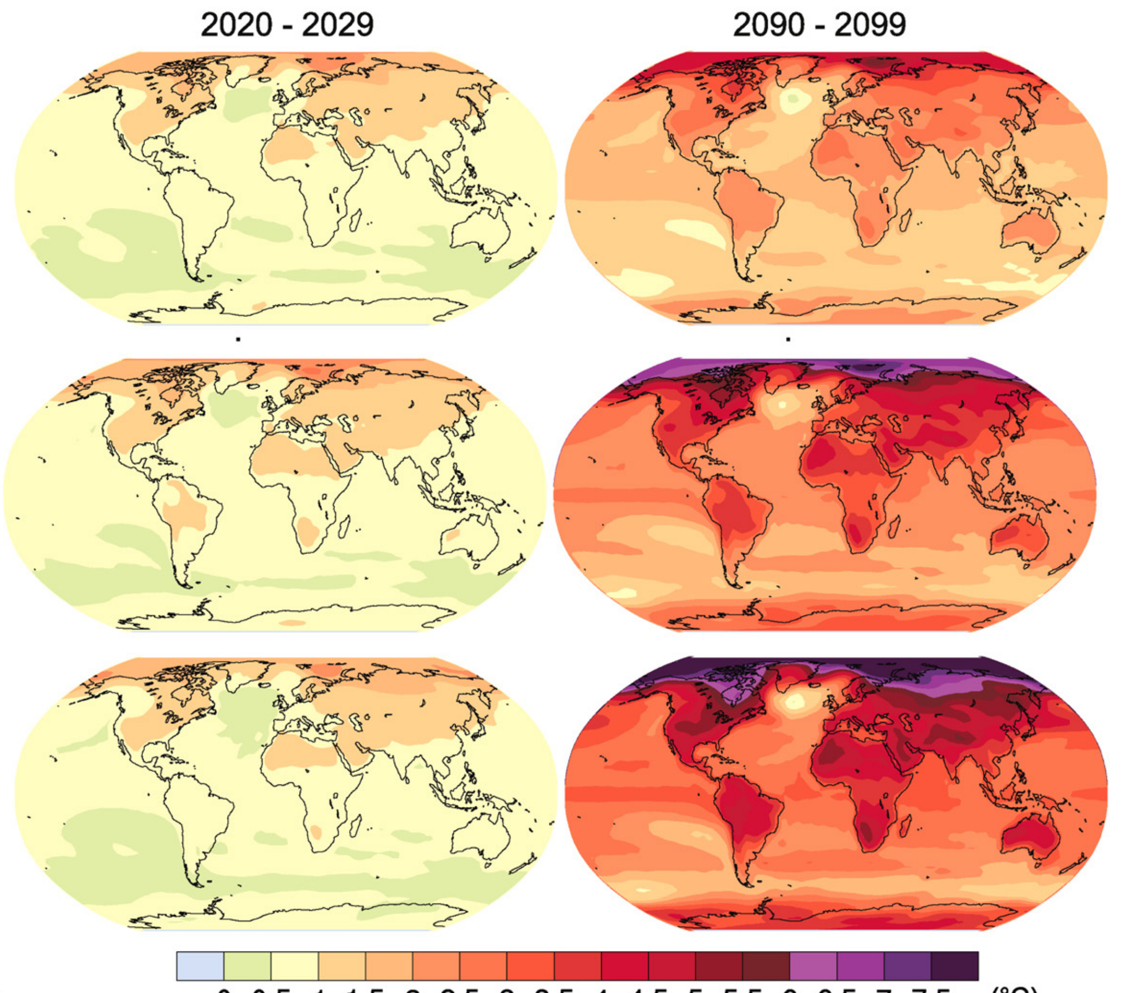

Projected surface temperature changes for the early and late 21st century relative to the period 1980–1999. The central and right panels show projections for the B1 (top), A1B (middle), and A2 (bottom) SRES scenarios averaged over the decades 2020– 2029 (centre) and 2090–2099 (right). The left panels show corresponding uncertainties from several different studies for the same periods. SOURCE: IPCC 2007:WG1-AR4