

Evidence of intensifying climate change grows

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26 January 2011

As the world's governments dither on climate change, data continue to stream in on the alarming rate of warming. Global surface temperatures for 2010 matched record highs, with the past decade the hottest ever recorded. Arctic ice cover continued its precipitous decline in 2010, attaining the lowest measured extent for any December on record and third lowest in summer. And the amplifying effect of this snow and ice melt is larger than previously thought, according to new research.

"The 2010 data confirm the Earth's significant long-term warming trend," according to World Meteorological Organization chief Michel Jarraud. "The ten warmest years on record have all occurred since 1998."

Warming was most extreme this past year in two regions. The first covers most of Canada and Greenland, with mean temperatures for the year increasing by upwards of 3°C (5.4°F). The second region extends from northern Africa to the western portion of China, which saw increases between 1 and 3°C (1.8 and 5.4°F). Some areas experienced cooler than normal temperatures last year (e.g., northwest Europe and southeast United States), though these areas were smaller in size and the temperature changes were lower in magnitude.

Despite these regional variations, the most telling metric of climate change is the increase in global averages. Three major data sets of sea and land temperatures, when harmonized and corrected for localized conditions such as urban heat islands, show an increase of over 0.5 °C (just shy of 1°F) compared to the mean temperature for 1961-1990. When accounting for uncertainty of the measurements, 2010 temperatures matched 2005 and 1998 as the hottest since systematic measurements began in the mid-19th century.

A high number of extreme weather events were also experienced in 2010, including a severe heat wave in

Russia that contributed to devastating wildfires, and disastrous monsoon flooding in Pakistan that cost thousands of lives and left 7 million homeless. While no particular event can be directly tied to climate change, "It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent," according to the consensus view of climate scientists enunciated in the Intergovernmental Panel on Climate Change's most recent report. Already 2011 has followed accordingly, with severe floods in Sri Lanka, Brazil and Australia.

The changing climate is felt perhaps most intensely in the Arctic, where declining sea ice cover visually illustrates the dramatic warming in the region. This past year, both the Northwest Passage through northern Canada and Northeast Passage along the coast of Siberia were free of ice. The sea ice shrunk to the third smallest area on record in 2010, with all indications that the decline will continue. According to National Snow and Ice Data Center Director Mark Serreze, "We are still looking at a seasonally ice-free Arctic in 20 to 30 years." His colleague, Dr. James Maslanik, University of Colorado, explained that "the oldest and generally thickest ice (five years or older) has now disappeared almost entirely from the Arctic."

As with temperature, sea ice cover varies regionally. Antarctic sea ice coverage has even been well above average over the past several months, though it has returned closer to normal recently. However, in Antarctica the extent of sea ice tends to be highly variable, since most of it disappears during summer months, rather than remaining year round as in the Arctic.

Scientific understanding of melting ice and snow cover is still somewhat limited. In general, observations of sea ice decline do not match up well with climate models. The observed shrinking of ice has proceeded much faster than expected, surprising many experts.

However, research posted online last week in *Nature Geosciences* may go a long way in improving our understanding of feedback between ice cover and rising temperatures. Using three decades of satellite and field measurements, a team of scientists led by Mark Flanner of the University of Michigan was able to home in on the feedback of Arctic snow and ice.

In the climate system there are a few important types of feedbacks—including cloud formation, water vapor and snow/ice cover—which can either dampen or amplify an initial change. Areas of snow and ice have a cooling effect on the planet, since they reflect incoming sunlight back into space. When warming temperatures cause snow and ice cover to recede, less solar energy is reflected, and the amount of heat remaining in the atmosphere increases. This causes an amplifying feedback, as the added heat melts even larger areas of ice and snow.

The researchers found that melting snow and ice had reduced the overall cooling effect by twice as much as previously thought. The feedback is substantially larger than assumed by the dozen and a half climate models—a finding that should help improve modeled projections of climate change.

But even as scientific understanding improves, and as hard data rolls in on the rate of temperature rise and melting Arctic seas, world governments remain paralyzed. Two years of successive UN-sponsored climate negotiations, in which advocates hoped to reach a comprehensive agreement to follow the expiring Kyoto protocol, produced little more than promises to achieve self-imposed and insufficient national emission targets.

Achieving even modest targets is increasingly improbable for the world's largest emitters. In the United States, on the first day of the new Congress, lawmakers proposed three bills to block greenhouse gas regulation by the federal government. Currently the Obama administration has put forward proposals, essentially mandated by the courts, that require improved energy efficiency for new or upgraded power plants and other large emitters.

However, any constraint on profit is proving increasingly unacceptable. President Obama signaled a willingness to forsake environmental concerns in the face of right-wing opposition when he announced delays to pollution rules for industrial boilers and lower

smog levels this past December.

Meanwhile the attack on the scientific foundations of climate science is continuing. Republicans in the new Congress have proposed eliminating funding for vital climate research, including the US government's contribution to the Intergovernmental Panel on Climate Change. Rep. Darrell Issa, Republican of California, chairman of the House Oversight Committee, has made one of his chief goals "investigating" climate scientists who have already been exonerated numerous times. Rick Piltz of Climate Science Watch summed up the current state of affairs: "The war on climate science and scientists that's going on now makes the Bush administration look moderate."



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