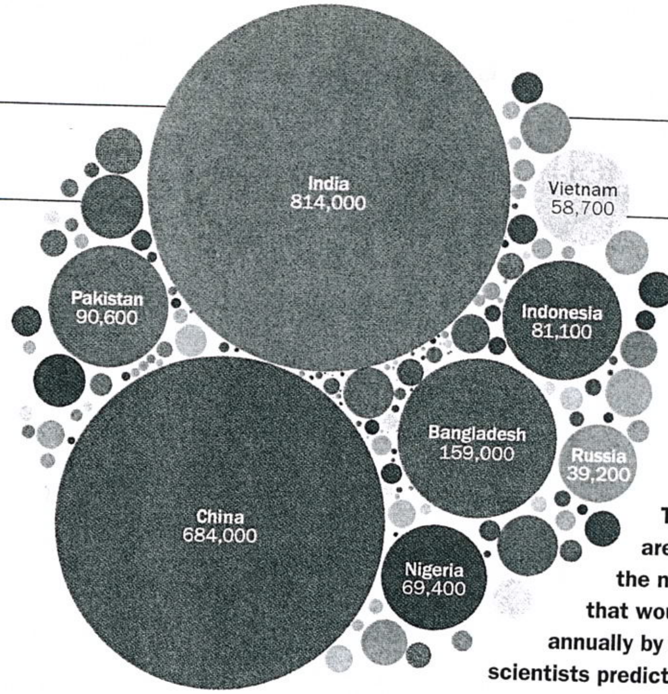
Environment

Controls offer climate quick fix

Cuts in soot, methane could slow warming temperatures

By Devin Powell



India and China would see the most deaths prevented by 14 measures reducing methane and soot. The circles at left are proportional to the number of deaths that would be prevented annually by country in 2030, scientists predict. SOURCE: D. SHINDELL

Carbon dioxide may be the top target in the long-term fight against global warming. But taking aim at methane and soot has a better chance of keeping the planet cooler in the short run, a new study finds.

Cutting emissions of these two pollutants would diminish warming by half a degree Celsius by 2050, researchers report in the Jan. 13 *Science*, potentially slowing sea level rise, glacial melting and other problems caused by rising temperatures.

"These are really the low-hanging fruit both for mitigating climate change and improving air quality," says study leader Drew Shindell, a climate scientist at the NASA Goddard Institute for Space Studies in New York City.

Shindell and his colleagues tested about 400 known pollution controls, selecting 14 interventions that had the greatest impact on warming in a computer simulation.

Seven of the proposed controls focus on methane. Implementing interventions already being used in some parts of the world can prevent methane from reaching the atmosphere by filtering it out of air rising from coal mines, livestock manure, landfills and other sources.

For soot, putting filters on cars that burn diesel, for instance, could trap these black flakes of carbon, which absorb sunlight and heat the atmosphere. Soot also darkens snow and glaciers, which hastens melting.

Piers Forster, a climate scientist at the University of Leeds in England, agrees that limiting methane emissions would affect climate. But he cautions that some sources of soot also give off other particles that reflect sunlight, cooling the planet.

"If you were to cut out these emissions, you might actually get a warming effect instead of a cooling effect," he says.

Recirculation degraded Gulf oil

Fueled by hydrocarbon plumes, bacteria feasted on crude

By Janet Raloff

A succession of hydrocarbon-noshing species of bacteria mushroomed throughout the months-long 2010 oil spill in the Gulf of Mexico because their movable feasts were repeatedly replenished, a new study finds. That explains the relatively speedy disappearance of giant plumes of subsea oil and gas that jetted from the wellhead and never surfaced.

Only about 15 percent of the BP crude floated up to form giant surface slicks, a second study reports. Natural gas constituents and dissolvable chemicals amounting to twice that mass remained near the seafloor, creating the roving, cloudlike hydrocarbon plumes on which the bacteria fed.

Both studies appeared online January 10 in the *Proceedings of the National Academy of Sciences*.

For the plume-degradation study, David Valentine of the University of California, Santa Barbara and his colleagues adapted a Navy computer program that predicted Gulf currents and incorporated information newly gleaned from the Gulf and lab studies. The program established which hydrocarbons were present, where plumes had been recorded and which Gulf bacteria had a propensity for eating plume compounds.

Then the researchers used the program to predict the bugs' feeding rates. Although bacteria should have depleted the available oxygen as they ate and reproduced, the computer program showed there would have been substantial water mixing, replenishing oxygen supplies.

Most parcels of the oiled water in which the bacteria were riding circled back to the seafloor wellhead multiple times, the Navy's current data indicate. This would have restocked the bacteria's hydrocarbon smorgasbord and further fueled mushrooming populations of these bugs.

"What happened in the deep plumes was far more complex than any of the initial papers had really acknowledged," says chemical oceanographer Benjamin Van Mooy of the Woods Hole Oceanographic Institution in Massachusetts.

Earth

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Glaciers like Greenland's Jakobshavn Isbrae (shown) are now expected to add less to sea level rise this century than worst-case scenarios predict.

Greenland ice flow stop-and-go

Motion suggests worst-case sea level predictions unlikely

By Devin Powell

Time-lapse snapshots showing Greenland's glaciers racing toward the sea in recent years have turned up some good news and some bad news.

As the island's glaciers disintegrate over coming decades, they won't raise the world's oceans as much as the most pessimistic forecasts had shown possible, researchers report in the May 4 *Science*.

"We're certainly looking at significant rises in sea level, but some of the worst-case scenarios that people have imagined don't seem likely," says glaciologist Twila Moon of the University of Washington in Seattle.

That's in contrast to the situation in some parts of Antarctica, where recent work suggests that researchers' worst fears may be realized (Page 5).

Moon's team used satellite measurements from 2000 to 2011 to clock the speeds of more than 200 of Greenland's outlet glaciers — flowing tongues of frozen water that carry ice away from the vast ice sheet that blankets most of the country. Where the glaciers extend offshore, they tend to fall apart and dump ice into the ocean.

Some of these icy conveyor belts have already been spotted moving — and thus melting — faster in recent years. The giant glacier Jakobshavn Isbrae, for instance, accelerated from 9.4 kilometers per year in 2000 to 12.6 kilometers per year in 2003. A 2008 study in *Science* estimated how much such acceleration might contribute to rising sea level. If every glacier could suddenly increase its speed tenfold, sea level would rise about half a meter by 2100, researchers found. A more realistic doubling of speed between 2000 and 2010, followed by leveling off, would contribute a smaller rise of about nine centimeters.

"We were trying to set some really firm upper limits on sea level rise using values that seemed within the realm of possibility," says glaciologist Tad Pfeffer of the University of Colorado Boulder, a coauthor of the 2008 study.

The new data show that glaciers as a whole haven't accelerated that much, or that uniformly, from winter to winter. On average, they moved about 30 percent faster at the end of the first decade of the 21st century than they did at the beginning.

Sea salinity has shifted since '50s

Warmer atmosphere may be cause of water cycle changes

By Devin Powell

More water moved into and out of the atmosphere in 2000 than in 1950, making saltier parts of the world's oceans saltier and fresher waters less salty, researchers report in the April 27 *Science*.

A warming planet may be to blame. Simulations in the new study suggest evaporation and rainfall got a 4 percent boost as surface temperatures rose half a degree Celsius. That boost is a bigger change than previous studies had suggested, but fits with the idea that a warmer atmosphere can hold more moisture.

"We see big broad patterns of change," says Paul Durack, an oceanographer at Lawrence Livermore National Laboratory in California.

Measuring such global changes in Earth's evaporation and rain cycle has never been easy. Rain gauges on land or at sea tend to be sparsely distributed, and the exact positions of such instruments decades ago isn't always known.

Ocean salinity provides a fairly stable, reliable way to measure how much water goes up and comes down, says William Ingram, an atmospheric physicist at the Met Office Hadley Centre in Exeter and the University of Oxford in England. Small fluctuations in evaporation and rainfall tend to get smoothed out over time, helping scientists to tease out long-term trends.

Durack's team analyzed 1.7 million salinity measurements made by ships during the second half of the 20th century. Other researchers had already seen patterns of change in these data, but Durack and his colleagues sharpened the picture. A network of autonomous buoys deployed in the 21st century helped to fill in gaps in the record, particularly at high latitudes where winter storms keep ships away.

Environment

"People may very well remember this as a year of extreme weather and climate." —JESSICA BLUNDEN

Recent extreme weather attributed to human-caused climate warming

Probability of some droughts, heat waves now much greater

By Janet Raloff

Texans sweltered through the hottest, driest spring and summer on record last year. Much of the blame can be attributed to a recurring climate pattern known as La Niña, which emerges every few years as surface waters chill in the eastern equatorial Pacific. But Earth's steadily warming climate contributed as well, a new analysis concludes.

Since the 1960s, the likelihood of Texas seeing extremely hot, dry weather in a La Niña year has mushroomed 20-fold due to human-induced global warming, David Rupp of Oregon State University in Corvallis and his colleagues calculate.

The researchers were one team among six international groups probing climate's link to extreme events in late 2010 through 2011. The collected findings appear July 10 in the *Bulletin of the American Meteorological Society*.

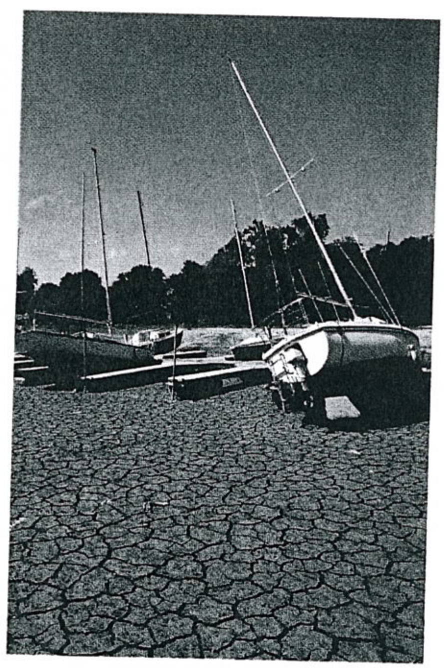
"People may very well remember this as a year of extreme weather and climate," says Jessica Blunden of the National Climatic Data Center and an editor of *State of the Climate in 2011*, a report published as a supplement to the July 10 *Bulletin of the American Meteorological Society*.

Severe food shortages gripped the Horn of Africa last year after drought left the land parched from winter 2010 through the following spring. La Niña played a role there, too. And computer analyses of global climate conditions since 1979 find that a recent warming of surface waters in the Indian and Pacific oceans has destabilized La Niña weather patterns. Chris Funk of the U.S. Geological Survey in Santa Barbara, Calif., concludes that this process probably intensified 2011's drought in East Africa.

Other teams pointed to global warming as a likely contributor to excessive heat in central Europe last summer and to unusually balmy temperatures in central England in November 2011. In the British case, that kind of heat could be expected to recur every 20 years now — a 62-fold increase over the 1960s.

Yet global warming can't be blamed for all monster weather. Unprecedented flooding that submerged large tracts of northern Thailand, including its capital, for up to two months last year resulted from rainfall at an intensity the region had encountered before. But water management practices and heavy industrialization of a floodplain slowed drainage last year.

These new analyses are pioneering efforts to get near real-time assessments of climate's role in extreme weather events, says climatologist Thomas Peterson of the National Climatic Data Center, in Asheville, N.C.



DAVID WOO/DALLAS MORNING NEWS/CORBIS

Benbrook Lake near Fort Worth, Texas, dried up last year during the state's warmest August on record. A new analysis links global warming with increases in extreme weather.

For years, he says, climate scientists have argued that although global warming can increase the frequency of extreme weather, they couldn't pin any particular event on human-caused climate change. That appears to be changing, Peterson and his colleagues argue.

Using a developing field known as "attribution science," researchers are beginning to apply massive computing capacity to explore how global temperatures, surface reflectivity and moisture patterns can affect the odds of localized extreme weather events.

In 2011, droughts beyond Africa and Texas brought billions of dollars in crop losses, Blunden says. The North Atlantic saw above-average hurricane activity (19 named storms, compared with an average of 12), and seven separate U.S. tornado outbreaks that each wreaked more than $1 billion in damage.

Polar regions racked up their own extremes, says Martin Jeffries of the University of Alaska Fairbanks. Barrow, Alaska, sustained a record 86 days in a row when the minimum air temperature failed to dip below freezing.

Understanding global warming's role in extreme events extends well beyond blaming rights. Peterson notes that water managers may need to change policies if evidence begins pointing to persistent changes in the recurrence rates and lengths of droughts or the frequency of heavy rains.

Right now, linking these events is difficult, usually works only for events lasting longer than a month and can take a year to complete. Peterson's team hopes to see the science mature to the point that assessments might be turned around more quickly and to tackle events lasting mere days. ■

Environment

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Record melt year for Greenland ice as heat waves sweep across Arctic

Globe's second-largest ice sheet may face slushy future

By Alexandra Witze

Greenland's ice is on the hot seat again.

A heat wave, possibly the most extreme in a century, washed over the frozen island in mid-July, melting around 97 percent of the surface ice temporarily. Slush even appeared at Greenland's highest, coldest spot.

Overall, more of Greenland's ice melted in June and July than in any previous year during the satellite era, says Marco Tedesco of the City University of New York.

Weather and climate patterns conspired this year to produce what Ohio State University glaciologist Jason Box calls a "one-two-three-four-five punch." Among other things, a strong warming trend shifted much of the upper snowpack closer to the melting point. When a dome of particularly warm air began moving over Greenland on July 8, things were primed for nearly all of the snow on top to thaw.

At the Summit Camp research station, more than 3,200 meters above sea level, the thermometer soared above freezing for several days straight. It was the first significant melt at the site since 1889, says Mary Albert, an ice expert at Dartmouth College.

At a second site 700 kilometers to the northwest, "it was wet and slushy, which made it really hard to walk around on the ice without falling knee-deep into the snow," says Dartmouth graduate student Kaitlin Keegan. Flags planted in the snow began to topple. Supply planes were unable to land on the once-solid runways.

Ice cores from that site show evidence of similar melt in 1946 (though to a lesser degree) and in 1889, says Dorthe Dahl-Jensen of the University of Copenhagen. "So it is rare indeed," she says.

Temperatures soared again during the last week of July, as a second warm air mass moved over the island. The air was warm and foggy, and the ice-block-throwing competition scheduled as part of the "Icelympics," polar scientists' companion to the London Games, had to be canceled because the blocks were melting.

"Nature could have caused this [year's] melt event by chance," says Richard Alley, a glaciologist at Penn State University. "But humans made it more likely with greenhouse gases."

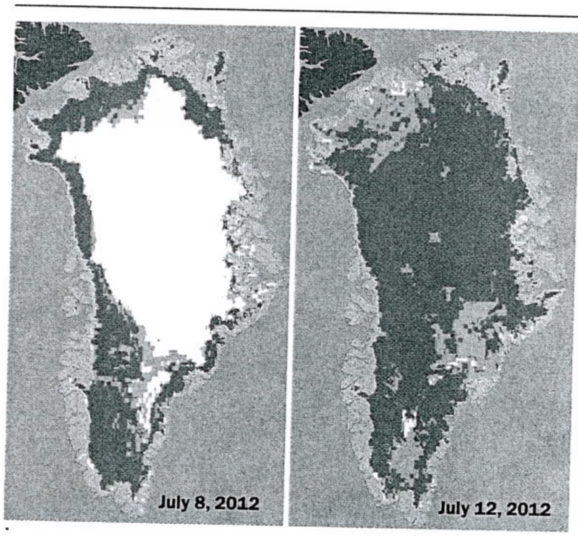
By measuring microwave energy coming off Greenland, satellites can see how much meltwater there is versus how much ice. During the peak of the July melt, Summit's uppermost snow contained about one-tenth as much melt as that seen in areas closer to the southwest coast, where melting has been most pronounced in recent years, Tedesco and his colleague Xavier Fettweis of the University of Liège in Belgium found.

Overall, Greenland has been losing close to 300 billion metric tons of ice yearly. At Summit Camp, meltwater refreezes in place, but at lower elevations it runs off into the oceans and contributes to sea level rise.

The two regions most sensitive to rising surface temperatures are southwestern and northwestern Greenland, Tedesco says. "Those are the two exposed nerves," he says. In the Southwest, raging meltwaters washed out a bridge in the town of Kangerlussuaq on July 11. In the Northwest, the Petermann Glacier broke off a massive chunk of ice on July 16, the second huge iceberg calving in two years.

But not all such headline-making events can be linked to surface warming, Kurt Kjaer of the University of Copenhagen and his colleagues write in the Aug. 3 *Science*.

Kjaer's team used old aerial photographs to study how surface elevation had changed in northwestern Greenland since the mid-1980s. Looking closely at glaciers along the northwest coast, the scientists found two periods in which more ice than usual flowed into the ocean. Roughly 26 billion metric tons were lost annually in short-lived speedups from 1985 to 1993, and again from 2005 to 2010, the researchers report. Neither of these two speedups were predictable, they say. "This finding challenges predictions about the future response of the Greenland ice sheet to increasing global temperatures," they write.



Big thaw The surface of the ice sheet that covers Greenland, an island three times the size of Texas, melted almost entirely in mid-July when a dome of warm air parked itself over the land mass. The first image shows satellite data from just before the heat wave. The second image shows the condition of the ice sheet a few days later, when an estimated 97 percent of the surface had thawed.

- No data
- Ice/snow free
- Probable melt
- Melt
- No melting

COLO E. DIGIROLAMO, SSAI/NASA GSFC, JESSE ALLEN, NASA EARTH OBSERVATORY