Shrinking ice cap, growing crisis

Impact of melting Arctic sea ice seen in drier California winters

By John D. Cox - Special To The Bee
Published 7:38 am PST Sunday, November 4, 2007

Forget the polar bears. If climate modelers are even half-right about how the Earth works, Californians may soon discover that the loss of Arctic sea ice hits a lot closer to home.

Sooner than anyone expected, the changing climate could aggravate a deepening water crisis, the consequence of a surprising planetary-scale rearrangement of weather circulation patterns that tightens the grip of drought across the American West. Water-supply planners who are accustomed to looking for the origins of West Coast climate variations in the surface temperatures of the tropical Pacific Ocean – home of El Niño and La Niña – may find themselves at the mercy of events where they least expect them.

The U.S.-Arctic link was discovered in 2004 by climate researchers at the University of California, Santa Cruz. Their computer simulations of shrinking sea ice showed that, outside of the Arctic itself, the most striking impact is the formation of a large, stubborn atmospheric feature off the West Coast that, like a boulder in a stream, deflects winter storms northward.

Weather changes in winter would leave California's water supply especially vulnerable. The state receives roughly 75 percent of its precipitation during the season and depends heavily on capturing the winter excess for use during its long, dry summers.

While their climate simulations were interesting when events in the Arctic seemed to be keeping pace with gradually warming temperatures, what happened this summer to the sea ice has given them more critical urgency. In September, at the end of the 2007 "melt season," the area covered by Arctic sea ice had shrunk 23 percent below the previous record set in 2005 and was 43 percent less than in 1979, when satellite measurements began.

"Every scientist I've talked to has used words like 'shocking,' " observed Oceanographer Marika Holland, a sea ice specialist at the National Center for Atmospheric Research in Boulder, Colo. "The changes that are happening in the Arctic are incredibly large and dramatic, and they're happening very rapidly."

Events in the Arctic had been moving along at a different pace in 2004 when UC Santa Cruz climate scientist Lisa C. Sloan and Jacob O. Sewall, then a graduate student, experimented with a climate model from the atmospheric research center to see how reduced sea ice effected regions outside of the polar region. When they ran the computer model with sea ice conditions as they were anticipated to exist in 2050, a curious signal emerged.

"The biggest change was over western North America in the wintertime," Sloan recalled, "That was a very surprising result." Along the West Coast, from southern British Columbia to Baja

California, winter precipitation dropped as much as 30 percent, and even as far inland as the Rocky Mountains it fell by 17 percent.

A climate that is changing rapidly seems to be full of surprises. Among the more disquieting is the fact that observations of real-world changes such as Arctic sea ice loss are coming on much faster than changes simulated by most computer models. The idea of gradual change is deeply rooted in the science of climate. It is no small issue, this question of pace, because the faster things happen the harder it is to adapt.

In this case, what just a few years ago appeared to be a problem that was 30 or 40 years in the future now looks like something on the near horizon, an imminent threat. Climate is by definition the statistics of long-term weather, and people who study it are not accustomed to thinking in terms of imminent threats. Sewall, now an assistant professor of geosciences at Virginia Tech, observes that it might be 30 years before researchers have the data to firmly establish the link between the northward shift of West Coast winter storm tracks and Arctic ice measurements, although by then, of course, the precipitation impacts would be very old news.

"But I expect, with the rate of sea ice change in the last five years, that if we continue on this trajectory, you're going to see these sorts of impacts happening in the next five years to 10 years," he said.

A period of 30 to 40 years sounds like somebody else's concern, maybe something to be passed on to another generation of taxpayers. In any case, it's enough time to build more water storage facilities or make other engineering fixes to a water distribution system that has fueled the state's agricultural and urban expansion since the 1950s.

A time scale of five to 10 years, on the other hand, poses a different problem for Californians. It is hardly time to do anything but find ways to conserve and to brace for more of the kind of cutbacks and price hikes already under way in water-short Southern California.

So how does it happen that the loss of sea ice around the North Pole – in the summer, for the most part – changes the tracks of storms during the winter thousands of miles away?

The bright white ice acts like a mirror that very effectively reflects incoming sunlight and its warm energy back into space. This keeps the underlying Arctic Ocean cold as well as the air above it. The cold air sinks. As the ice disappears, the relatively dark ocean absorbs the sunlight and its warmth and slowly gives up thermal energy to the overlying air. Rather than sinking cold air, a column of warm air rises into the atmosphere, like a bridge piling in a river, and that, says Sewall, "changes the whole atmospheric flow that you're seeing in the Northern Hemisphere."

"It's going to do some steering of where the storm tracks are going as they cross the Arctic, and that has influence downstream," he said. "It changes the planetary wave pattern." These changes to storm tracks also affect Britain and Western Europe, but the American West is so much more vulnerable than other regions because almost all its precipitation arrives in the single season of winter.

As the summer melt season in the Arctic has become longer and more intense, the extent of winter ice cover has declined as well, and scientists are beginning to think that a critical point may have been reached. The winter ice cover has begun returning to the Arctic Ocean, although recovery is slower than usual. In October, it was still smaller than in any October anyone had seen since 1979.

Record minimum ice packs were recorded in 2002, 2003, 2004 and again in 2005, Sewall said, "But 2005 was the first winter when the ice cover didn't just recover and come back. As of 2005, all of that ice didn't come back."

Moreover, in 2007, for the first time, scientists saw ice melt away from a zone of Arctic Ocean they thought of as permanent ice pack. "We've got a pretty significant area of water up there absorbing energy, so it would not be at all surprising to find that it takes longer for the ice to freeze up in the winter and that ice extent may not fully recover to the point where it was, say, in April 2007."

But maybe the scientists got it all wrong with their climate model in 2004. Call it what you will, it's not the real world: It's just a darn software program running on a darn computer. Why should we take it seriously? Do other models produce the same results – in the vernacular, are the findings "robust?" Sewall put these questions to the test in subsequent research in 2005.

First he tested the 2004 results by feeding the same data into an updated climate model from the atmospheric research center, a more sophisticated version with better physics and higher resolution, producing greater detail. Just about the same results emerged – 25 percent less annual precipitation over California and the Southwest, 8 percent more in Alaska and northern British Columbia.

The 2004 experiment was what climate researchers call a "sensitivity study" – a single climate parameter is manipulated, such as Arctic ice cover, to test the system's sensitivity to it. Next, Sewall tested the results on a model that behaves more like the real climate: Sea ice shrinks in response to heightened concentrations of greenhouse gases and warming temperatures. Again the West Coast lost winter precipitation.

Then Sewall analyzed results from six other climate system models, and all seven models reproduced the same general pattern of lower precipitation in the Southwest and higher precipitation in the far Northwest. The results from multiple models gave Sewall a better idea of the sensitivity of West Coast precipitation to Arctic ice loss. "It's the existence of open water that's having the impact on climate. The ice doesn't have to be totally gone. If half of an area has open water, then you're going to see some impact."

Still there is uncertainty. This is the cutting edge of climate research: Translating changes in long-term global temperature averages into terms that matter most to people – figuring out how temperatures and precipitation in different regions are affected on shorter time-scales. Sophisticated climate models running on some of the most powerful computers in the world are not very good at capturing events in this level of detail.

In the case of Arctic sea ice, says Holland, of the atmospheric research center, "Using the best that we can get, all of the models are conservative if you compare from 1955 to the present." While a few of the models capture the kind of losses sustained in the Arctic in recent summers, these abrupt changes are smoothed out in the averaging that climate scientists typically employ to create profiles of change in which they have high confidence. But the confidence comes at a price. "What you're essentially doing is averaging out the natural variability," Holland says.

To climate modelers intent on isolating the impact of heightened greenhouse gas concentrations, natural variability is just so much random local noise. The Earth doesn't draw these distinctions, of course. In the real climate system, everything is in play at once. Last summer, for instance, the natural variability of an area of stubborn high pressure over the Arctic accentuated the loss of ice cover.

Likewise, along the West Coast, the impact of Arctic ice loss on winter storms complicates a set of climate circumstances that already is complex and troublesome. On the heels of a winter that saw one of the lowest snowpacks on record, sea surface temperatures across the tropical Pacific Ocean – which naturally wax and wane – now happen to be in a cool La Niña state, raising the likelihood of another dry winter over the Southwest. Other climate modelers foresee a long-term trend of warmer storms bringing more rainfall and less snow to the Sierra Nevada, and earlier and less manageable spring run-off. Last May, a large group of climate researchers published results from 19 models that suggested the region already has entered a new, more arid climate state. Their study, published in the journal Science, noted: "Almost all models have a drying trend in the American Southwest, and they consistently become drier throughout the century."

Where does natural variation end and human-caused change begin? The question itself is an artifact of the way we tackle the devilishly difficult problem of figuring out how the Earth works. Probably the answer is that the sources of change, natural or human, can't be so clearly parsed out – they feed back on one another in negative and positive ways that surprise our best thinking on the subject. Perhaps the more immediate question is: If Arctic ice is disappearing so much faster than the best computer models projected – if they were too optimistic – what else have they got wrong?

Go to: Sacbee / Back to story