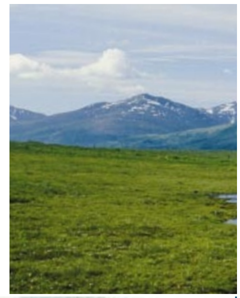
Too hot to handle



Alaska is warming up more than anywhere else on Earth. Climate researchers are now turning to regional models to find out why — and how to deal with it. John Whitfield went north to investigate.

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The vast forests that cover southern Alaska should be evergreen. But not these days. Hop in a tiny plane — which Alaskans seem to do as often as a New Yorker hails a cab — and you'll see patches of brown stretching for miles into the wilderness. This is the work of the spruce bark beetle, which over the past 15 years has killed more trees in Alaska than any other insect in North America's recorded history. In the Kenai Peninsula on Alaska's southern coast, some 40 million spruce have perished across an area twice the size of Yellowstone National Park. The beetle's population rocketed thanks to changes in the weather, argues Ed Berg, an ecologist with the Kenai National Wildlife Refuge. "We had a really long run of warm summers," he says.

The beetle boom is one of the more dramatic changes that locals and scientists alike attribute to global warming. But it's just one in a long list. Farther down the coast in Prince William Sound, boats pick their way through increased numbers of icebergs calving off the Columbia Glacier. The glacier has retreated 12 kilometres over the past 20 years, and some say it could collapse completely in another ten. Alaska's notorious mosquitoes, so big they're jokingly referred to as the state bird, have spread north to irritate the few residents who used to escape their attentions. Even the plants are changing. The spongy tundra, usually covered in grass and moss, is slowly being invaded by woody shrubs[1].

This summer saw the biggest melt yet in Alaska's sea ice, and winter in the interior was unprecedentedly mild — for the Arctic. "I've lived here since 1968, and last winter was the first one that didn't drop below −40 °C," says Gunter Weller, director of the Center for Global Change and Arctic System Research at the University of Alaska, Fairbanks.

Small change, big difference

Temperatures have changed more in Alaska over the past 30 years than they have anywhere else on Earth: winters have warmed by a startling 2–3 °C, compared with a global average of 1 °C. That's guaranteed to have dramatic effects in an Arctic landscape, where even small temperature changes can make the difference between freezing and melting. In Fairbanks, a city built on permafrost, the annual mean temperature is just −2 °C. If it pops above zero, residents can say goodbye to the frozen ground beneath their feet, along with the free iceboxes in their basements. The impacts on wildlife, and the people who depend on it for their livelihoods, will be huge.

Determining the effects of climate change on a local level has become one of the major priorities of the Intergovernmental Panel for Climate Change[2]. And to do that, the panel needs regional models. Unlike the first generation of climate models, which covered the whole globe and divided it into chunks 50–200 kilometres a side, small-scale, regional models now look at sections just a few kilometres across. This helps to refine the picture of climate change and lets models take account of elements of topography such as mountain ranges, peninsulas and even cracks in sea ice.

Such models are particularly crucial for places such as Alaska, as global-scale simulations are notoriously inaccurate at the poles[3]. Arctic clouds, for example, are not like their counterparts at lower latitudes: their droplets may be mostly ice rather than liquid water, for example. The gaps in our knowledge about arctic clouds puts some rainfall predictions off by as much as 100%. And no one can agree on how to deal with the reflectance of the Sun's energy by ice and snow, known as albedo. "Small differences in the value of ice albedo can produce large differences in model outputs," says climate researcher Filippo Giorgi of the Abdus Salam International Center for Theoretical Physics in Trieste, Italy.

Polar confusion

Inaccuracies in modelling other parts of the global climate can also accumulate up at the poles: an error in describing the winds that carry heat from the tropics to the poles, for example, could increase with every degree of latitude. "The Arctic could be a dumping ground for errors elsewhere," says atmospheric scientist Judy Curry of the Georgia Institute of Technology in Atlanta.

It is also hard to tell how much of Alaska's climate change is due to global warming and how much to natural climate cycles. The Pacific Decadal Oscillation — an El Niño-like fluctuation of temperatures between the north and tropical Pacific that takes place over 20–30 years — flipped Alaska into a warming phase in the 1970s. The North Atlantic Oscillation has also contributed to warmer winters in Alaska since the late 1960s[4]. But at the same time it has been associated with a 2–3 °C cooling just across the continent in Greenland. There seems to be a 60-year see-saw in

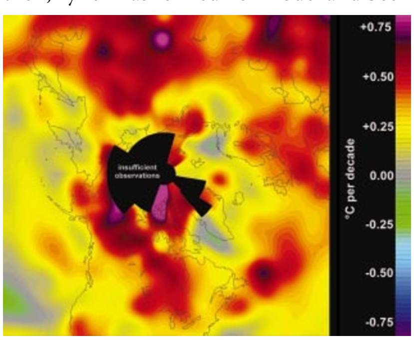
C. OTT/SPL

A tiny rise in Alaska's average temperature has let beetles wreak havoc in the forests (bottom left) and turned permafrost into marsh (left). Early spring thaws spell bad news for wildlife and trap Inuit hunters out on the snow (below).

C. RAINIER/CORBIS

temperatures between the east and west of this part of the Arctic: when one side heats up, the other cools down. In a few years, this could flip again and reverse Alaska's recent warming trend. No one yet knows.

So it is perhaps not surprising that Alaska was one of the first places to attract the serious attention of regional modellers. Back in 1993, Amanda Lynch of the University of Colorado, Boulder, created the world's first detailed regional model to take into account such interactions as those between ice and air and water, and she did it for Alaska[5]. Since then, Lynch has refined her model and been joined by a host of teams aiming to pin down Alaska's climate.



J. WALSH & W. CHAPMAN

Heating up: Alaska is a hotspot in this plot of air temperature change from 1973 to 2002.

In 2000, groups from the United States, Canada, Germany and Sweden, all with their own regional models, teamed up to run the Arctic Regional Climate Model Intercomparison Project (ARC-MIP). It isn't a beauty contest, says Curry, who serves as the project's coordinator. "The goal isn't to identify the best model, it's to improve all models," she says. The main difference between participants is how they deal with the interface where air meets sea or land: some have very complex treatments of how vegetation or sea ice influence the flow of gas and water into and out of the atmosphere. Others are less complex, treating sea ice as a simple barrier.

The first trial set for ARC-MIP's models has been to reproduce the results from one of the best climate data sets for the poorly surveyed Arctic — measurements collected by an icebreaker that was frozen into Arctic sea ice from October 1997 to October 1998. Those first ARC-MIP results should be submitted to journals around the end of this year, says Curry. The project is far from over, but so far it looks as if the simpler models are performing more accurately: complexity may just create more opportunities for things to go wrong.

Those model results can't come soon enough for the people of Alaska. In the far north, the area covered by sea ice is shrinking at a rate of about 3% per decade[6] — bad news for the seals and polar bears that depend on the ice environment, and for the subsistence hunters who depend on the animals. Winter is the prime hunting season, as snowmobiles can cover distances much more quickly than any vehicle on the tundra of summer. But the date when the snow melts has become less predictable, forcing communities to invest in expensive contingency plans such as helicopter rescue for stranded hunting parties.

Slip sliding away

The inhabitants of Barrow, the northernmost town in the United States, stand to lose more than their meals. The retreat of sea ice has exposed the land to the sea for more of the year, which has meant more erosion of the coast. Other symptoms of climate change exacerbate the erosion: more storms, melting permafrost — which makes the ground softer — and higher sea levels. Several other Alaskan communities are faced with having the ground washed out from under them, too. There are even plans to dismantle and move two villages on the northwest coast, Shishmaref and Kivalina, at a cost of more than $100 million — over $100,000 per resident.

Lynch and her colleagues have plotted the course of erosion in Barrow and the efficacy of attempts to stop it, such as building concrete walls or reinforcing beaches with sand. They have concluded that costly sea defences have done little to stem erosion. But they have also found that some areas of Barrow's coastline are actually gaining new land from the sea. When new buildings are required, says Lynch, the best response to the threat of erosion would be to focus construction in these places. Better prediction of future erosion will be the big challenge for her group over the next few years, she says.

As the ARC-MIP models are improved, they will help to refine global models, in preparation for a time when there is enough computer power to give global models the same resolution as local ones. Alaska should help to inform the global picture in other ways, too. Whether Alaska's current bout of warming slows down or even reverses, the dramatic effects of a few degrees of warming seen there should put us all on alert. "What you see here is an indicator of what can be expected in the rest of the world," says Weller. For much of the planet, that means dead trees, mosquitoes and a lot of slush. ■

John Whitfield works in *Nature*'s news syndication team.

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