dust spewing into space, along with the flares that had inspired Cameron's scenario. The jets, Shu and others have suggested, indicate powerful winds, whipped up by the strong magnetic fields of young stars. Because a newborn star is likely to be spinning rapidly, Shu explains, its field lines would be whirling like the blades of an egg beater, flinging the ionized gases of the disk outward. The winds might blow some of the material entirely out of the disk, creating the jets.

Other clumps of disk material, however, might be lofted out of the disk for just a few days, like dust balls caught by a slight breeze. Shu, Shang, Lee, and Glassgold calculated that at the radius of the disk's inner edge, that would be enough time for the heat of the sun to melt the dust before it settled back into the cooler disk and congealed. Flares, meanwhile, bombarded the molten material with particles, leaving it laden with radioactive isotopes. Later, at a more active point in the sun's magnetic cycle, much stronger winds might sweep up the CAIs and fling them far out into the disk, sorting them by size along the way—just as earthly winds carry dust farther than sand.

As for the chondrules, Shu and his colleagues argue that they formed without ever leaving the disk when especially fierce flares melted these smaller clumps of material for a few hours. Later, they too rode the wind farther out into the disk.

Shu points out that traces of ancient magnetism locked into the chondrules when they solidified suggest that they formed in the powerful magnetic field found close to a young star. The theory also received an unexpected boost during Clayton's session, when MacPherson reported that he, Kevin McKeegan of the University of California, Los Angeles, and others had found that CAIs and related inclusions all have a consistent ratio of oxygen isotopes. This, says MacPherson, suggests they all were forged in the same location in the early solar system, then "dispersed to the different regions of the asteroid belt where we find them."

Still, MacPherson and others, including Cameron and Gerald Wasserburg of the California Institute of Technology (Caltech), say it is far from clear that solar flares can explain the complex patterns of radioactive residues found in chondrites. "The sources of these isotopic anomalies are almost certainly from outside the solar system," says Wasserburg. But others think the new model will overcome such objections. "It could be a synthesis that solves a decades-old problem," says Eric Feigelson, an x-ray astronomer at Pennsylvania State University. "It smells right to me."

–James Glanz

ECOLOGY

Is Warming Trend Harming Penguins?

One might think that penguins would be pretty resistant to shifts in their environment, living as they do in the coldest, iciest place on Earth. But scientists have found that even these tough birds have their sensitivities. A few good years for krill, penguins' main food, can push up penguin populations; the buzz of activity around research stations can nudge their numbers downward. Now ecologists are suggesting that the 4° to 5°C midwinter warming of the western Antarctic Peninsula climate observed over the last 5 decades is taking a toll on Adélie penguins.

Ecologists had already proposed that a decrease in sea ice cover due to the warming might be responsible for a recent decline in penguin numbers. Now, ecologist William Fraser of Montana State University in Bozeman says he may have discovered a new way in which climate change could be affecting penguins. Fraser, who described his latest work last week at a seminar on Capitol Hill sponsored by the U.S. Global Change Research Program, argues that more snow on some islands near Palmer Station on the Antarctic peninsula may be making it harder for the birds to breed. Because a warmer atmosphere holds more moisture and could be causing heavier snowfall, Fraser thinks the Adélie decline could be a "canary in the coal mine"—a sign that warming is affecting Antarctic ecosystems.

DONNA PATTERSON

Bird's-nest soup. An Adélie penguin trying to hatch an egg in icy water.

The warming may be just a natural fluctuation, not necessarily an early indicator of greenhouse warming. Still, other scientists find the idea intriguing. Gerald Kooyman of Scripps Institution of Oceanography in La Jolla, California, who studies Emperor penguins, cautions that Fraser's study area is "a pretty local area of Antarctica," but says, "[Fraser] has a really interesting point about a warming trend and the effect of snowfall patterns."

Fraser, who has studied penguins on the five islands near Palmer Station for more than 2 decades, has been trying to understand why Adélie populations have plummeted from about 15,200 breeding pairs in 1975 to 9200 today. Five years ago, he and colleagues published a paper in *Polar Biology* suggesting that a gradual reduction in sea ice in the western Antarctic Peninsula was playing a role: In the mid-1900s, heavy sea ice formed in three or four of every 5 years, but it is now seen just once or twice every 5 years. And while less sea ice seems to have helped out chinstrap penguins, which prefer open water, Adélies, which feed near ice edges, appear to be getting squeezed.

But "just as we were beginning to feel pretty smug" that sea ice changes accounted for the trends, Fraser says, he and his colleagues noticed an odd geographical pattern to Adélie rookeries. On Litchfield Island, where the number of breeding pairs dropped 43% between 1975 and 1992, the thriving nesting colonies were concentrated on the island's northeast side. The abandoned rookeries, by contrast, were on the southwest side of the island's rocky middle ridge, where more snow accumulates as storms sweep over the islands. The same pattern turned up on nearby islands, the researchers found.

So Fraser and his co-workers have taken a closer look at the nesting Adélies, and they have observed that birds laying eggs in snowy depressions at the edges of colonies seem to lose more eggs and chicks to snow and slush. "If you're not breeding in the right place, you're in trouble," Fraser says. He adds that once the colonies begin shrinking, the penguins are less able to fend off predatory birds called brown skuas, which steal chicks and eggs.

He thinks that retreating sea ice probably is the main driving force behind the drop in Adélie populations, but "superimposed on that," he says, may be the effects of more snowfall in early spring when the birds begin breeding. He cautions that 5 years' worth of observations of snowfall and rookeries isn't a whole lot of data. Because there are no long-term snowfall records for the region, he can't be certain yet that snowfall in the regions has truly increased over the past 2 decades. But more snowfall has been documented in other parts of Antarctica, notes Fraser.

Others agree that it may be a while before scientists are sure why the Adélies are dwindling. Some factor that has increased populations of competitors for habitat, such as elephant seals, also could be taking a toll on the birds, says Steve Emslie of Western State College in Gunnison, Colorado. "If you don't look at all those confounding variables before you point a finger at any particular cause, you're going to get in a lot of trouble," Emslie says. Still, says Kooyman, "These kind of things are an alert for us to start looking more closely at things that we might otherwise overlook."

–Jocelyn Kaiser