the oncology department at the University of Tokyo's Institute of Medical Science, says she would be interested in the new career path. "It would be very attractive to be able to work on what you want to work on, even if the position has a limited term," says Ohsugi, who is studying proteins involved in spermatogenesis.

Many details must be worked out before Ohsugi and her peers can apply for a position, however. Ohsugi wonders how a superpostdoc would affect the government's promise to forgive most, if not all, of her graduate school loans if she joins a national university faculty. It's also not clear if superpostdocs would have access to existing equipment. And Okamoto notes that Japan's pension schemes heavily penalize those who change jobs.

There is also the question of how the new positions would be attached to existing institutes and who would pay for them. Arai says institutes would want money to cover the indirect costs of supporting a new researcher. Introducing fixed-term employment at national universities and labs might also require amendments to public servant employment laws.

The committee's recommendations will be passed along to the Council for Science and Technology, the nation's highest science advisory body, which is reviewing the results of a 5-year plan adopted in 1996 to boost the nation's scientific prowess. Any decision on a new career track is likely to be part of a broader set of R&D policies.

–DENNIS NORMILE

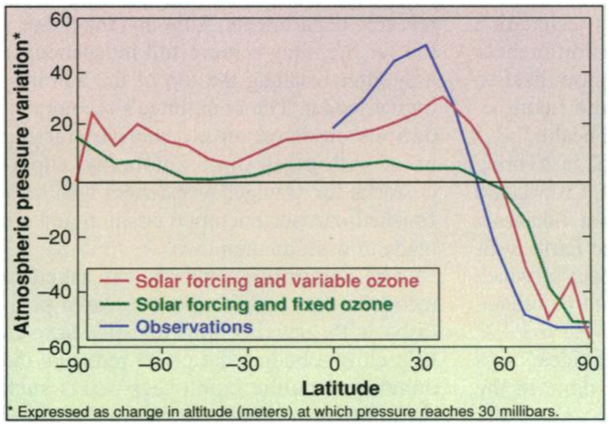
[redacted]

Link Between Sunspots, Stratosphere Buoyed

Everything from the stock market to climate has been linked to the 11-year cycle of sunspots—dark splotches on the sun's surface that mark an increase in solar activity. Almost all such correlations fall apart soon enough, but one has held up: For more than four sunspot cycles, the "weather" in the stratosphere has varied in time with solar activity, with atmospheric pressure peaking in a mid-latitude ring and plummeting over the North Pole at solar maximum. Yet solar output changes so little over the sunspot cycle that it's hard to see how the cycle could affect any earthly activities, even in the wispy stratosphere. Now on page 305 of this issue, a group of climate modelers presents the most promising mechanism yet for amplifying the effects of the solar cycle—and they suggest that sunspots' effects may even work their way down to the surface.

The mysterious amplifier, say modelers Drew Shindell of NASA's Goddard Institute for Space Studies (GISS) in New York City and his colleagues, is the stratosphere's much lamented ozone. By including ozone and its ability to absorb the sun's ultraviolet radiation in their computer model, Shindell and colleagues were able to mimic the high-latitude seesaw of pressure seen in the real stratosphere at altitudes of 25 kilometers. Their model runs also produced subtle climate change at the surface, including a few tenths of a degree warming of Northern Hemisphere high latitudes.

The stratospheric effect seems reasonable enough, says modeler Jerry D. Mahlman of the Geophysical Fluid Dynamics Laboratory in Princeton, New Jersey, who regards the mechanism as the first plausible means of linking sunspots and Earth's atmosphere. But "there's some skepticism" of a trickledown effect stretching all the way to the surface, says theoretician Lorenzo Polvani of Columbia University. Meteorologists have long doubted that the vanishingly thin stratosphere can affect the massive, turbulent lower atmosphere, called the troposphere. And although researchers back in 1987 reported that surface climate does vary in step with solar cycles, that correlation didn't hold up for long.



Ozone makes the match. Allowing ozone to vary with sunspots causes a model to react (red) like the real atmosphere (blue).

But a different correlation has lasted. More than a decade ago, meteorologists first reported that when sunspots hit their peak, a ring of relatively high pressure encircles a cap of low pressure over the North Pole in the winter stratosphere (*Science*, 11 May 1990, p. 684). When the sun's output falls, the pressure pattern reverses. Yet the sunspot cycle alters the sun's total output by only 0.1%, too little for any direct effect on Earth's climate. What could be causing the connection?

Modeling studies had already suggested that the answer might involve ozone. Ozone warms the stratosphere by absorbing ultraviolet light, and the sun's UV output rises and falls significantly during the sunspot cycle, varying 10 times more than does its total output at all wavelengths. Because the north polar region is cloaked in darkness during the winter, the UV-induced warming is limited to lower latitudes. That geographical disparity can drive circulation in the stratosphere, raising atmospheric pressure there and so boosting the westerly stratospheric winds that blow around the pole at 30 to 50 degrees north. And in a positive feedback that could amplify this effect, the increased UV light at solar maximum creates more stratospheric ozone from oxygen, triggering more stratospheric warming and perhaps a greater pressure difference.

Although this scenario is not new (*Science*, 4 August 1995, p. 633), earlier models left out the upper half of the stratosphere, and hence part of the ozone layer, to save computing time. Shindell and colleagues are the first to include a complete stratosphere as well as a chemical simulation that can produce more or less ozone depending on the amount of ultraviolet light. In their model, the 1% extra UV light at the solar maximum produced the characteristic stratospheric high-pressure ring and low pressure over the pole. A similar sort of pattern is seen in the Arctic Oscillation, a hemisphere-wide driver of northern climate (see p. 241).

Shindell even sees changes down at the surface. In his model, the stratosphere doesn't strong-arm the muscular troposphere but rather uses the troposphere's power against itself, creating a weak and indirect link between sunspots and surface climate. The GISS researchers found that at solar maximum, the mid-latitude, high-pressure ring deflects atmospheric waves that propagate up from the troposphere and carry energy from place to place in the atmosphere. The deflection of these waves back into the troposphere alters circulation in such a way as to produce a high-pressure ridge at 40°N that intensifies winds at the surface and redirects storms into Canada and northern Eurasia. The net result is to warm the high latitudes by a few tenths of a degree.

Even for researchers who find Shindell's sun-stratosphere connection reasonable, the step from the stratosphere to the surface is a stretch. "I'm skeptical about the models," says Polvani. "Other groups have similar models, and they haven't been able to reproduce those results." Indeed, the tropospheric changes are nearly lost in the noise, and this GISS model has been criticized as "rather crude" (*Science*, 10 April 1998, p. 202).

SOURCE: SHINDELL ET AL.

Still, the idea that the stratosphere may influence the troposphere is "picking up momentum," says meteorologist Marvin Geller of the State University of New York, Stony Brook. If the history of sun-climate relations is any guide, it's got a long way to go.

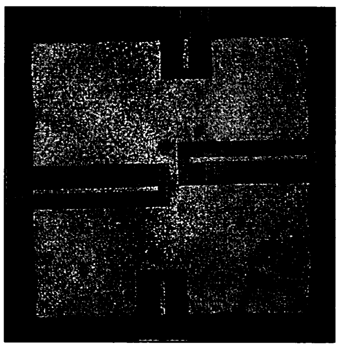
–RICHARD A. KERR

ACOUSTICS

Miniaturizing the Mike, In Silicon

The microphone is being reincarnated in silicon. At a recent meeting* in Berlin, several groups reported progress in converting the standard elements of a microphone—a vibrating membrane that picks up the sound and circuits that convert the vibration into an electrical signal—into structures on a silicon chip. Silicon microphones may not yet be as sensitive as conventional microphones, but they will be robust and cheap. "You can make thousands of them on a wafer," says physicist Gerhard Sessler of the Technical University of Darmstadt in Germany. "It is the coming thing," adds acoustic engineer Allan Pierce of Boston University in Massachusetts.

Most silicon microphones still rely on vibrating membranes to capture sound, but these membranes are micromachined from silicon and measure just 1 millimeter or so on a side and a micrometer thick. In the type of silicon mike that is closest to commercial production, known as a condenser microphone, the membrane is positioned next to a charged electrode. Together, the electrode and membrane form a capacitor, a structure that can store charge. Its capacitance, or ability to hold charge, depends on the distance between electrode and membrane. As the membrane vibrates in response to sound, the distance changes and so does the capacitance, creating an electrical signal in a circuit connected to the device.



Talk to me. Vibrations of a millimeter-square silicon membrane (orange) stimulate an electrical signal via four piezoresistors (dark orange).

In a variation on this theme, the field-effect microphone, the membrane is given an electric charge and positioned near a semiconductor channel that separates two contacts. The channel's ability to carry current varies in an electric field; as the membrane vibrates, it subjects the channel to a varying electric field, modulating the amount of current flowing through it.

In early prototypes of condenser and field-effect microphones, the membrane was etched out of one chip and the other part of the device was built on another, and the two were pressed together. At the meeting, Sessler reported a new technique for creating the whole device on a single chip. "On the chip you deposit a so-called 'sacrificial layer' … and on top of that layer you deposit the membrane," he says. Chemically etching away the sacrificial layer leaves a free-floating membrane anchored to the chip at its edges.

Other presentations described microphones in which piezoelectric and piezoresistive materials are deposited on top of the silicon membrane. These materials generate a current or a change in resistance, respectively, in response to changes in pressure. The result is a varying electrical signal as the membrane flexes in response to sound waves.

A few microphone designs presented at the meeting translate the vibration into an optical signal rather than an electronic one. The advantage of these designs, explains Sessler, is that optical signals don't interfere with each other via magnetic fields, so large numbers of optical mikes can be packed close together. The optical output can also travel long distances through optical fibers without degrading. "You don't have to preamplify directly at the microphone," says Sessler.

In one such device, developed by Sessler's group, the vibration of the membrane deforms an optical waveguide, altering its ability to transmit light. Two other designs pick up vibrations by bouncing a laser off a silicon membrane and recording variations in the reflected signal—a scaled-down version of a Cold War eavesdropping technique that picks up conversations that are taking place inside a room by playing a laser beam off a window. Pierce and his team at Boston have created small portable arrays of over 10,000 tiny microphones of this design connected to a small display device. The result is an acoustic imaging system, which can reconstruct the shape of objects by detecting differences in the arrival time of reflected sound pulses. The team is now developing an "artificial eye" for use underwater that would send out ultrasound pulses and detect reflected waves to distinguish objects as small as 1 millimeter.

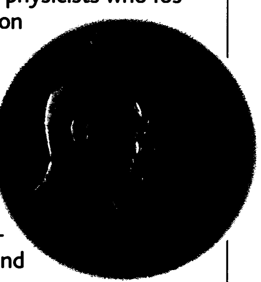
One of the new designs even shuns the traditional membrane. Jörg Sennheiser of Sennheiser Electronic Corp. in Wedemark,

* The Joint 137th Meeting of the Acoustical Society of America and the 2nd Convention of the European Acoustics Association Integrating the 25th German Acoustics DAGA Conference, Berlin, 14–19 March.

CREDITS: (TOP TO BOTTOM) SAM KITTNER; GERHARD SESSLER/TECHNICAL UNIVERSITY OF DARMSTADT

ScienceScope

Too Hot to Handle Cowed by a heated dispute, the French Physical Society (SFP) announced last week that it will no longer sponsor an award named after the late Lebanese physicist Rammal Rammal. The medal honors talented physicists who foster scientific cooperation among Mediterranean countries. But SFP officers last month nullified a jury vote that had tapped Israeli physicist Daniel Amit for the 1998 prize. Their decision came after Lebanese officials and academics protested the selection, even though Amit is an outspoken critic of Israel's occupation of southern Lebanon (*Science*, 5 March, p. 1422).



On 31 March the SFP's executive board went further, voting to sever its ties to the medal altogether. Despite the "generous aim" of a prize it has sponsored since 1993, the SFP is "incapable of handling" the type of controversy that dogged last year's pick, the board stated. The medal's originator, French physicist Gérard Toulouse, says he's consulting with Rammal's family about how to continue the prize. Toulouse says he would have preferred a more courageous stand from SFP leaders: "Any sensible member of the scientific community would have felt that the SFP [officers] should resign and the Rammal medal should stay."

Ready to Fuse Physicists are gearing up for another attempt to tame the wild horse of the energy frontier. In February, researchers produced "first plasma" at the National Spherical Torus Experiment (NSTX), a $24 million facility at the Princeton Plasma Physics Laboratory in New Jersey that will explore how to sustain the sun-hot plasma needed to fuse hydrogen atoms. Magnetic fields in the device are supposed to shape the plasma into a spherical torus—a sphere with a hole through its center.

Princeton researchers are now analyzing results from the test run in preparation for the machine's first full-scale research campaign, due to begin in July. A team from 14 U.S. institutions and Japan, Russia, and Great Britain will focus on "discovering whether the machine works the way the theoretical calculations said it would," says NSTX project director Masayuiki Ono. It could take a year, he says, "to bring it to full capability."

Contributors: David Malakoff, Jocelyn Kaiser, Michael Balter