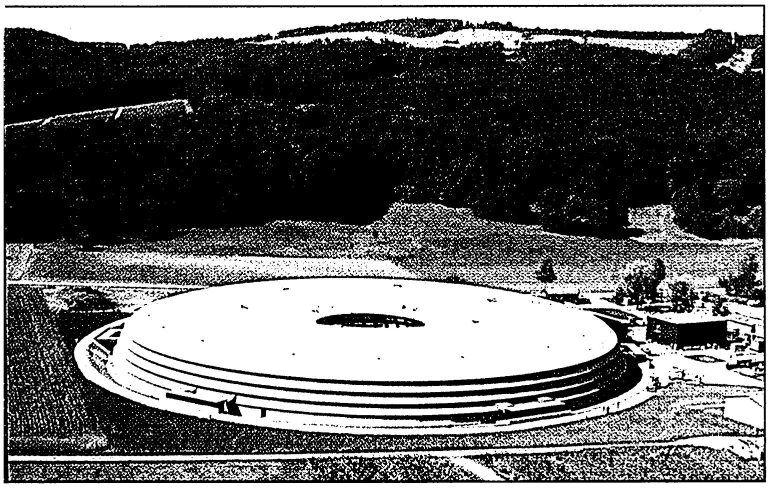
SYNCHROTRON RADIATION

Swiss Source Shows Small Is Powerful

VILLIGEN, SWITZERLAND—This week Swiss researchers will proudly unveil the Swiss Light Source (SLS), a modestly sized synchrotron that punches well above its weight. Based here at the Paul Scherrer Institute, the SLS produces high-energy, or "hard," x-ray beams comparable to much bigger sources such as the European Synchrotron Radiation Facility (ESRF) and the U.S. Advanced Photon Source. Such beams are essential for unraveling the structure of complex biological molecules and a host of other applications.

Local researchers are looking forward to having such a machine on their home patch. Tim Richmond and his colleagues at the Swiss Federal Institute of Technology in Zürich rely on x-rays to elucidate the mechanisms underlying gene expression. In earlier work teasing out the atomic structure of the nucleosome—the DNA packaging apparatus—Richmond's group had to travel to Grenoble, France, to use the ESRF. Now, they have a state-of-the-art facility just down the road. "It's the difference between being able to conceive of doing a large project and not being able to," Richmond says, "and doing it on a reasonable time scale."



Ready to roll. The Swiss Light Source will soon welcome researchers from across the globe.

CREDIT: SLS

Synchrotron light was discovered in the 1940s in early particle accelerators. When physicists bent a beam of fast-moving particles, they found that some of the energy was shed as light. The laserlike light soon proved useful in other branches of physics as well as materials science and, more recently, biology.

In the SLS, a beam of electrons is boosted to close to the speed of light in a circular accelerator and then transferred to an outer storage ring, where magnets keep the particles circulating at constant energy for between 10 and 30 hours. As the electrons round each bend, they emit light of varying wavelengths that is tapped off along beamlines to experimental stations.

As researchers get more skilled at using synchrotron radiation, they are demanding higher energies and more intensity (more photons per second). This usually means bigger machines. For example, the ESRF, which came online in the early 1990s, is 844 meters in circumference and produces an electron beam with an energy of 6 giga–electron volts (GeV). The ESRF uses specialized magnetic devices known as undulators and wigglers to manipulate the electron beam and customize the x-rays to researchers' needs.

For the SLS, project leader Albin Wrulich says, designers used a few "tricks" to get similar performance out of the new machine, pushing current undulator technology to the limit to increase x-ray intensity and the range of wavelengths available. As a result, although the SLS is just 288 meters around and has a 2.4-GeV electron beam, it produces x-rays of almost the same intensity as the ESRF's and, at $89 million, cost less than a third as much.

After its 19 October inauguration, engineers will continue to fine-tune the SLS before it is opened to the research community in January 2002. For Richmond, who hopes to show people what DNA looks like in higher cells through x-ray crystallography and to relate that structure to its function, the SLS is the perfect tool. All he needs now, he says, is a crystal. **–GISELLE WEISS**

Giselle Weiss is a writer in Allschwil, Switzerland.

WEATHER FORECASTING

Getting a Handle on The North's 'El Niño'

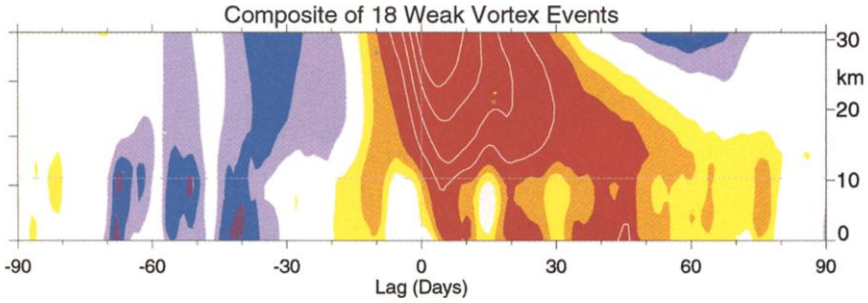
The lowermost layer of Earth's atmosphere—the troposphere, the place where all the people live—is a forecaster's nightmare. Weather patterns are capable of jumping without respite or warning from one mode of operation to another. This volatility is especially dramatic in winter. Frigid winds and powerful storms might first range far south of their usual haunts then retreat farther northward than usual, seemingly unpredictably, producing a midwinter respite. Only El Niño had seemed able to lock the weather into one regime or another long enough for forecasters to anticipate prolonged periods of extreme winter weather weeks or months ahead. Now forecasters have the prospect of another, unlikely steadying influence on the weather: the wispy stratosphere overlying the troposphere.

On page 581 of this issue of *Science*, meteorologists Mark P. Baldwin and Timothy J. Dunkerton of Northwest Research Associates in Bellevue, Washington, report that despite its reputation as a lightweight, the stratosphere at times reaches down through the troposphere to push Northern Hemisphere weather toward one extreme regime or the other for a couple of months at a time. That could give forecasters an edge in long-range predictions at middle and high latitudes comparable to that provided by El Niño at some latitudes. And it clearly shows that "there's no brick wall up there" sealing off tropospheric weather from the rest of the atmosphere, says meteorologist Marvin Geller of the State University of New York, Stony Brook. "To understand weather or climate, it's good to look at how the whole atmosphere is behaving."

Atmospheric scientists had long identified higher latitude weather oscillations in the stratosphere and troposphere, but until now they hadn't established a downward connection between the two. In the stratosphere, a polar vortex of high-speed winds that swirls around the North Pole in a ring 10 kilometers or more above Canada, Scandinavia, and Siberia waxes and wanes, sometimes abruptly. At the surface, the North Atlantic Oscillation (NAO)—a wobbly seesaw of varying atmospheric pressure that spans from Iceland to Lisbon—swings from one extreme to the other, redirecting winds around the North Atlantic and switching regional weather between cold and stormy and mild and fair (*Science*, 7 February 1997, p. 754).

In 1998, meteorologists David Thompson of Colorado State University in Fort Collins and John M. Wallace of the University of Washington, Seattle, expanded the NAO concept to encompass the entire higher latitudes and called it the Arctic Oscillation (AO). The tropospheric AO works much as the polar vortex does in the stratosphere. The AO involves the prevailing westerly winds that oscillate in strength and position to shift weather patterns around the hemisphere (*Science*, 9 April 1999, p. 241). When the shifts persist long enough, climate changes.

Thompson and Wallace's work prompted Baldwin and Dunkerton, who are stratosphere specialists, to look higher in the atmosphere for AO connections. To their surprise, they found downward links as well as upward ones. A switch from a strong stratospheric vortex to a weak one, say, would move down through the stratosphere, entering the tropo-



Weather from above. A weakening stratospheric vortex (red) can alter circulation down to the surface, bringing storms and cold weather farther south than usual.

sphere and reaching the surface as a weakening and diversion of the AO's westerly winds. Because it took a few weeks for a switch to get from the vortex to the AO, predicting a switch a week or two ahead looked possible.

Baldwin and Dunkerton have now taken a more detailed look at 42 years of vortex and AO wintertime behavior and found that the connection can be a persistent one. Once a major switch reaches the lower stratosphere, the vortex remains unusually weak or strong for an average of 60 days, which should let forecasters predict extremes in the underlying AO and the accompanying likelihood of weather extremes out as far as a month or two. Forecasters might, for example, warn that cold air outbreaks from the Arctic into midlatitudes would be three to four times more likely across Europe, Asia, and North America.

In separate, as-yet-unpublished analyses, Thompson, Baldwin, and Wallace find that major vortex and AO shifts affect surface temperatures about as much as El Niño does. In central Europe and most of North America, surface temperatures average 0.5° to 2°C cooler in the 60 days following the onset of an extremely weak vortex than in the same period following the onset of a strong vortex. The difference is 1.5° to 4°C for the high Eurasian Arctic. That compares with temperature differences between El Niño and its opposite, La Niña, of 1° to 3.5°C in higher latitudes. "The El Niño analogy is a good one," says Baldwin. "The magnitude of these [switches] could be very useful."

Researchers are generally impressed. The Baldwin and Dunkerton "analysis is very careful and very complete," says stratosphere meteorologist Karin Labitzke of the Free University Berlin. Predicting weather based on the work will be harder, as Baldwin and Dunkerton point out, because switches in the stratosphere and the AO sometimes occur independently, and no one understands the mechanics of the stratosphere-troposphere linkage when it does happen. Forecasters' computer models "must be able to predict where and when the effects of this interaction [between stratosphere and troposphere] will be manifested," says Edward O'Lenic, a long-range forecaster at the National Weather Service's Climate Prediction Center in Camp Springs, Maryland. "This is a tall order and a challenge for modelers, but the payoff could be great."

Modelers are already trying to sort out how the stratosphere can influence the weather. The stratosphere might gain leverage on the troposphere through great globe-girdling atmospheric waves that rise into the stratosphere during winter. How the stratosphere and troposphere communicate will be of interest not only to long-range forecasters, but to climatologists as well. The same linkage may well be operating when volcanic debris, an inconstant sun, ozone depletion, or greenhouse gases alter stratospheric climate. Perhaps more than one forecasting nightmare could be eased by understanding stratospheric harbingers.

–RICHARD A. KERR

SOURCE: M. BALDWIN AND T. DUNKERTON/NWRA

VOLCANOLOGY

Vesuvius: A Threat Subsiding?

NAPLES, ITALY—People living in the shadow of Vesuvius, the volcano that so famously buried the Roman town of Pompeii, may be able to sleep a bit easier. New satellite data, some experts say, suggest that the small earthquakes that shake the region almost daily are not harbingers of an imminent eruption. Rather, they occur because the central part of the volcano's crater is sinking at a rate of several millimeters per year.

About 1 million Neapolitans might have to be evacuated if Vesuvius awakes from its 57-year-long slumber. Scientists and civil defense experts are bitterly divided over the adequacy of evacuation plans. There is no way of knowing when Vesuvius might erupt again, but rising magma beneath active volcanoes can produce tremors before an eruption.

To aid the debate, Riccardo Lanari and his colleagues at the Research Institute for Electromagnetism and Electronic Components in

ScienceScope

Special Breed A Japanese government committee charged with either privatizing or abolishing some 163 special public corporations (*Science*, 7 September, p. 1743) has let those doing research off the hook. Many of the public works agencies have drawn criticism from economic reformers because they are seen as inefficient. But in a 5 October report, the committee says that it is "impossible" to alter the status of research organs such as the Institute of Physical and Chemical Research (RIKEN), the Japan Marine Science and Technology Center, and the Japan Atomic Energy Research Institute because they fulfill national policy objectives and are too dependent on government funding. "Unlike many of the other special corporations, the research labs have no sources of income," says Shun-ichi Kobayashi, RIKEN's president.

Even so, there may be changes afoot. The committee wants to consolidate seven research funders, including the Japan Society for the Promotion of Science and the New Energy and Industrial Technology Development Organization, into one entity. Researchers strongly prefer to have multiple funding sources. And Kobayashi says he's heard that RIKEN's accelerator physics group, which operates its own particle accelerators, could be merged into the High Energy Accelerator Research Organization (KEK) in Tsukuba. The report gives few details on such changes, however, and Kobayashi laments that "we only know what we read in the newspapers."

Technology Czar? The White House is rumored to have chosen one of two top deputies to science adviser John Marburger as part of a reorganization of his office. Richard Russell, a longtime congressional aide who has been serving as staff director of the White House Office of Science and Technology Policy since last spring, will become OSTP's head of technology, Washington insiders say. Russell, who earned a bachelor's degree in biology from Yale University in 1988, worked for the Republican-led House Science Committee from 1996 to 2000. He is closely linked to efforts to kill the Department of Commerce's Advanced Technology Program, which funnels R&D funds to tech companies.

Russell may be part of a slimmed-down senior staff split between science and technology. Sources say that White House planners may eliminate two existing senior posts, overseeing the environment and national security–international affairs.

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