SOLAR PHYSICS

Chasing Shadows on the Sun

Solar astronomers Charles Lindsey and Douglas Braun are seeing the sun in a whole new light—and finding some strange shadows. When they examined measurements of seismic motions at the sun's surface, taken by other researchers during the 24-hour days at the South Pole, they found extensive streaks of suppressed wave motion, the longest reaching from well down in the southern hemisphere far to the north. They are convinced that the streaks are shadowlike impressions of features thousands of kilometers below the surface. The findings, published in the 20 June *Astrophysical Journal*, "would be a breakthrough" if borne out, says California Institute of Technology solar physicist Norman Murray, offering researchers their most detailed look yet at structures in the solar interior.

Murray suspects the structures are magnetic but admits he's guessing. "We don't know what these things are," he says, adding that he's looking forward to confirmation from other experiments. "I don't think anyone expected what we are seeing," says Lindsey, who works at the Solar Physics Research Corporation in Tucson, Arizona. Then again, he adds, no one has ever looked below the surface of the sun in such detail.

Braun, of the University of Hawaii, explains that he and Lindsey, together with Yuhong Fan of Hawaii and Stuart Jefferies of the University of Delaware, did so by using a variant of helioseismology—monitoring vibrations of the sun's surface to study its interior. Researchers see these vibrations by watching for rhythmic changes in surface brightness or subtle Doppler shifts in the wavelengths of light from the surface. But helioseismology traditionally traces very large scale oscillations, which yield information about conditions inside the sun averaged over large areas. To examine interior structure in more detail, the group made maps showing how small regions of the sun's surface vibrate at various frequencies over intervals of 25 to 50 hours, taking advantage of the endless polar days. "We get one little feature here, and one there," says Lindsey. The traditional, "global" helioseismology is like listening to the solar interior, says Lindsey, while their "local" helioseismology is more like looking into the sun.

What a good look revealed was strange, long lines stretching between magnetically active sunspot regions spaced 500,000 kilometers apart on the sun's surface. The sunspot connection suggests to Lindsey, Braun, and Murray that the features are actually tubes of magnetic field, known as flux tubes. But that interpretation raises a puzzle, says Murray. Because the features don't show up in magnetograms, spectral images that can trace the magnetic field at the surface of the sun, Lindsey and Braun think that they run below the surface, at depths of several thousand kilometers. Yet, Murray says, flux tubes should naturally float up to the surface.

In exchange for leaving solar physicists with one puzzle, however, Lindsey and Braun's technique holds out hope of solving some others. Lindsey offers an example: By using the technique to monitor magnetic structure within the sun, researchers might learn more about what causes the sun to flare up and break out in sunspots every 11 years.

–Faye Flam

METEOROLOGY

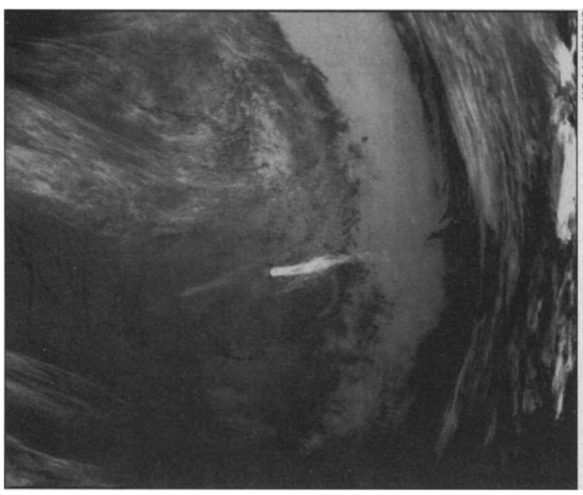
U.S.-Russian Team Solves Arctic Mystery

In a strikingly successful example of post-cold war scientific cooperation, U.S. and Russian researchers have revealed the true nature of plume-like streams of clouds streaking away from a remote island in the eastern Siberian Sea. For a decade, some researchers had speculated that the clouds, seen in satellite images, were plumes driven by methane gas bursting from beneath the sea floor, but a joint U.S.-Russian airborne expedition has penetrated a "plume" and found no methane. The mysterious plumes seem to be just odd clouds.

"It would have been very exciting to find methane gushing from the sea," says atmospheric scientist Anthony Hansen of the Lawrence Berkeley Laboratory, who flew on the plume mission, "but perhaps the more important result is that we found we could work very well with the Russians." And the mission was a heck of a bargain to boot.

Until the joint mission this spring, the plumes of Bennett Island, 1800 kilometers northwest of the Bering Strait, were shrouded in a veil of secrecy. U.S. scientists watched via satellite, but the Soviet military excluded Westerners from the area to protect a nearby facility from which U.S. submarine activity in the Arctic was monitored. So the hypothesis that the plume was driven by methane that had been trapped in permafrost flooded by the rising sea couldn't be tested.

In March, though, Hansen and Russell Schnell of the National Oceanic and Atmospheric Administration (NOAA) in Boulder decided to see whether the Russians would lift the veil. Just 6 weeks later, Hansen found himself in hot pursuit of plumes. Two keys to the whirlwind project, according to Schnell, were the right contact in Moscow and the direct delivery of funds to Russian scientists. Visas for the area were obtained through the head of a meteorological institute in Moscow, a friend of top officials in the area. And the whole operation—12 staff people, logistics, and 100 hours of flight time—was bought with about $25,000 in much-coveted hard currency. That was perhaps a tenth as much as the mission would have cost in the West, says Schnell.



NOAA/NESDIS

A mystery plume. As seen by satellite last May, Bennett Island sports a plume cloud.

Contrary to the previous experience of U.S. Arctic researchers, the attitude of the Russians in Siberia was "Point us the way, give us some dollars, and stand back," says Schnell. Thanks to that attitude, the mission was able to catch one "plume" before it faded. There was no elevated concentration of methane, and no plume rising from the surface. A cloud was simply forming at an altitude of 3 kilometers and blowing downwind. "We believe the Bennett Island plume is a meteorological phenomenon," says Hansen. Under the right conditions, it appears, wind blowing over the glacier-capped island kicks up a cloud on its lee side, as many mountains do. This 1-kilometer-high island just seems particularly adept at cloud making, says Schnell, perhaps because of its airfoil-like shape and orientation. To test that theory, Schnell predicted when the next plume should appear, based on weather forecasts. He was off by only 3 hours. So much for submarine bursts of methane, but at least prospects for research in the Russian Arctic look good.

–Richard A. Kerr