SUDDEN WARMINGS

Surprise Answer in the Lab

Sudden warmings are the most drastic large scale phenomena the atmosphere undergoes. Although they occur at high levels, they are apparently connected with surface weather, often resulting in a condition known as blocking that switches the worldwide circulation pattern to very much north-south rather than the more usual east-west. In the United States, this pattern often results in severe cold waves dipping far down into the South.

Until now, the cause of these warmings had been attributed by some to the streams of sun particles loosed by solar flares (SNL: 2/27/54).

But the atmosphere itself contains enough energy to account for the sudden warmings, without any input from streams of extra particles, researchers now find.

Confirming evidence that the high atmosphere can undergo temperature changes as great as 50 degrees C. comes from a computer programmed to make experimental forecasts of circumpolar air flow patterns at nine levels, from the surface to 20 kilometers.

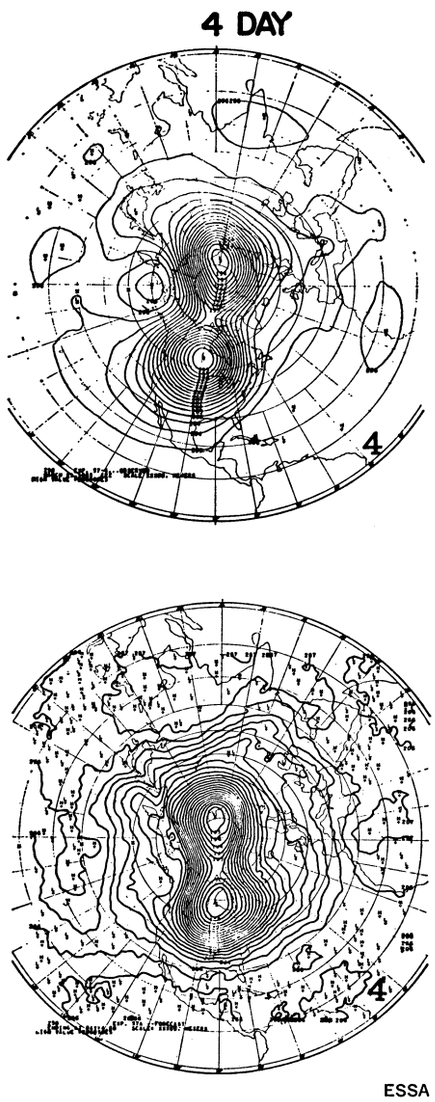
As far as meteorologists know, there have been six such sudden warmings, the first in 1952. Others probably occurred previously but only scattered soundings were then being taken at the extremely high altitudes where they are detected. All those studied occurred between mid-January and early March.

The self-contained nature of the sudden warmings was first found while using a computer at ESSA's Geophysical Fluid Dynamics Laboratory in Washington. It is programmed to predict what meteorologists call the general circulation, the planet-wide pattern of atmospheric motion averaged over a period of time, usually a month, season or year. Although the computer program contains such factors as heat transfer and atmospheric condensation, it does not include any imput for a sudden flow of solar energy from a corpuscular stream.

Nevertheless, a sudden warming was predicted by the computer. These calculations were then checked by the same computer, using a different set of equations that predict the circumpolar air flow patterns. Although the pattern is circular at the start, within a few days it becomes elongated and eventually becomes so unstable that it divides in two.

The two computer calculations show that no outside influence is required to account for sudden warmings and, therefore, that the model of the atmosphere being used to make experimental forecasts of the general circulation actually reflects physical reality even for previously puzzling events.

Dr. Kikuro Miyakoda of the Laboratory believes that the energy for the warming comes from the instability that causes the breakdown of the polar night vortex, which is a large-scale cyclonic circulation at high altitudes centered over the polar regions.



ESSA

Patterns, actual (top) and computed.

THE ELECTRIC MIND

Short Reactions Stay Unconscious

From the way humans behave, it is clear they have some kind of unconscious mental processes. A man can drive without making conscious traffic decisions, or shut out a conversation and still nod his head at the proper time; he can react according to experiences long forgotten, and even perhaps perceive things that are below his threshold of sensation.

From the way the brain behaves, it is now apparent that these unconscious processes do have a neurological basis.

According to work done at the University of California Medical Center in San Francisco, an unfelt sensation can nevertheless provoke a brain response. Moreover, the response is different from those that follow sensations that are actually felt.

Dr. Benjamin Libet, a physiologist who led the San Francisco team, says the evidence may help provide a physical basis for both subliminal perception and the unconscious thought processes.

In eight years Dr. Libet, with neurosurgeon Bertram Feinstein, experimented on more than 100 persons undergoing brain surgery for Parkinson's disease and cerebral palsy. Since the skulls had to be open and the patients unanesthetized for surgery, Dr. Libet was able to work directly with the sensory cortex to pick up signals sent from skin nerves.

Most of the patients were very willing to cooperate, to his surprise. He simply asked each patient to give him a half hour or so before surgery for the experiment, explaining that it was harmless, although of no help in the ailment.

Once the patient had agreed, Dr. Libet placed a flat plate a few centimeters long over the sensory cortex and matched it with a metal disk on the corresponding nerve area of the skin. Both plates had electrical contact points so that impulses could be sent either way.

Dr. Libet then tested the patient to find his threshold for sensory perception. Although the threshold varies widely among individuals, most patients could not feel an impulse below the one milliampere range. Yet their brains would react with a short, highly localized responses.

On the other hand, when the sensation was felt, this first primary response was followed by a series of complicated waves, says Dr. Libet. Instead of being localized in the sensory cortex, these afterwaves extended beyond to other brain areas and lasted half a second or longer.

Dr. Libet theorizes that conscious experience requires a minimum of at least half a second of brain activity. At shorter durations, the experience will most likely be unconscious, he says.

Dr. Libet's theory is backed further by the action of the brain under direct stimulation. A single, quite strong electrical impulse shot directly into the sensory cortex elicited no sensation in the patient, says Dr. Libet. But repeated impulses at low levels did.

The single impulse could be as much as 20 times stronger and still the patient would say he didn't feel anything, even while his brain was showing a large primary reaction.

The patient, however, did show some reaction to the single impulse—his muscle twitched. In other words, direct

sharp stimulation to a brain area devoted to sensory perception drew out, not a sensation, but a motor response.

Dr. Libet believes the results may explain how persons unconsciously make split-second reactions to danger, yet not realize what has happened until a second or so later.

It is also possible that unconscious experiences are laid down as reflex memories, says Dr. Libet. People could then respond later on the basis of experience of which they were unaware.

Dr. Libet points out that much intellectual activity, even at high levels of complexity, appears to proceed in the brain without conscious experience. Then, not infrequently, an idea springs into the conscious mind and comes under its more deliberate scrutiny.

If it is true that conscious experience requires the brain to continue reacting for as long as half a second, that would impose a certain ponderousness on thinking processes, says Dr. Libet.

But if, in contrast, only short reactions are needed for unconscious experiences, they might provide the kind of quick-acting, marginal thinking that facilitates complex integration in the mind.

"We were not trying to prove or disprove the existence of an unconscious process, we accepted it," says Dr. Libet. From all the evidence, this looks like its physiological basis.

Dr. Libet plans to publish a report of his work in SCIENCE of Dec. 22.

MOON MODEL

Scientists Now Certain of the Maria

Scientists are a cautious breed, and on a subject as publicity-prone as the moon they tend to be downright gunshy. When the Surveyor 5 robot spacecraft analyzed a patch of moon and sent a detailed description back to earth (SN: 10/14), most of the investigators steadfastly refused to admit that they had learned about anything but the tiny area directly beneath Surveyor's feet.

Now the researchers have changed their tune. The relatively smooth lunar maria, or seas, which cover from a fourth to a third of the moon's near side, are essentially the same all over, says Dr. Leonard D. Jaffe of the Jet Propulsion Laboratory in California, which runs the Surveyor flights. The other members of the team echo his confidence.

The turnabout was due to Surveyor 6, the fourth successful probe in the series, which landed on the moon Nov. 9, some 450 miles from Surveyor 5. Equipped with the same kind of automatic chemical analyzer that enabled its predecessor to count the percentages of atoms of different elements in the lunar rock, No. 6 produced a startlingly similar picture. The amounts of aluminum, magnesium and sodium were exactly the same, while oxygen, the most common element, varied only minutely from 58 percent at Surveyor 5's site to 57 percent beneath Surveyor 6. Silicon, the second most abundant element, matched to within experimental error.

Before the Surveyor program, Dr. Jaffe points out, scientific opinion about the moon ranged far and wide. Now there is a good deal of fairly well established knowledge, at least about the maria, where the manned Apollo landings will take place:

- Researchers used to argue over whether the mare rock was acidic or basic, and whether it contained iron deposited by meteorites. Now it is agreed to be basic, much like some earthly basalt, and to have only traces of meteoritic iron.
- Was the surface bare rock, or a porous honeycomb, or was it covered with a layer of coarse or fine particles? The Surveyors have shown that there is indeed a carpet of very fine particles, most of them only one-thousandth of an inch in diameter, almost too small for the spacecraft cameras to see.
- The most pressing differences of opinion were those directly related to manned landing. Would the surface support a man, let alone an Apollo spacecraft? Estimates of its strength covered a million-to-one range, from less than a sixth of an ounce per square inch to some five tons. Radar beams reflected from the moon had indicated solid resistance, but for all anyone knew, the solid layer might have been at the bottom of a mile of powdery dust. Some engineers were visualizing special snowshoes for astronauts, to keep them from disappearing beneath a fluffy surface. Fortunately, it is now known, the surface is easily strong enough, capable of bearing up to eight pounds per square inch after sinking down only an inch or two.

The next direct information from the maria may not be received until astronauts (or cosmonauts) land there, although there is one Surveyor left to go. Surveyor 7, which could be launched as early as Jan. 7, will instead be aimed at a target so inhospitable that the National Aeronautics and Space Administration wouldn't dream of landing men on it.

Located about 18 miles north of the rim of the crater Tycho, the site is a forbidding badlands of rocks, gullies, potholes and ridges. It was picked because it was so geologically different from the maria and also because Tycho is one of the moon's newest major surface features, so that its original appearance would be less worn down by the meteorites that constantly bombard the moon.

It is possible that the area around Tycho will show distinct chemical differences from the maria—higher acidity, more silicon, less iron and calcium —just as do earth's maria (the largely basaltic ocean floor) and highlands (the more acidic continents).

In addition, the 53-mile-wide Tycho may, as it was formed, have thrown out lunar material from as far as 12 miles below the surface, offering a ready-made excavation far down into the moon's crust.

To get the most out of its assignment, Surveyor 7 will have everything its predecessors had, and more. There will be TV, of course, and a chemical analyzer, plus magnets to look for iron, as well as a remote-control scoop like the one with which Surveyor 3 dug troughs and crushed rocks. A knob will be mounted atop the analyzer, so that the scoop can pick it up and set it down in different locations. In addition, there will be several mirrors: One set will enable the TV camera to take pictures looking underneath the spacecraft; another will be photographed only while reflecting the clear sky of space, to show any traces of dust that may be kicked up by Surveyor's activities; a third set will let the camera take stereo pictures without the need for the hazardous hop that was carried out by Surveyor 6. Despite the more elaborate instrumentation, Surveyor 7's payload will only weigh 22 pounds more than that of No. 6.

For the spacecraft to reach its target, a circle only 12.4 miles across, every step of the flight to the moon will have to be letter-perfect. "The scientific gain is worth the risk," says Surveyor program manager Benjamin Milwitzky, "but only if the spacecraft is going to be right on target." If even the slightest thing goes wrong, such as a tiny error in a midcourse correction, the destination will be changed to a safer one, a crater called Fra Mauro.

Almost 700 miles north of Tycho, Fra Mauro is about the same size, but the surrounding terrain is less hazardous for landing a spacecraft. Fra Mauro is also of interest, since it may contain material ejected from deep in the lunar crust during the formation of Mare Imbrium. Such material is likely to be chemically different from the rest of the surface, since the elements would probably have distributed themselves partly by weight during its volcanic past.