The Heat Wave: What Happened?

Triple-digit temperatures continued to sizzle the southern and central United States and moved eastward last week, claiming more than 1,200 lives since the searing reign began June 22. With no immediate end in sight, the National Weather Service last week forecast more of the same at least until mid-August. For meteorologists, the unpredicted, protracted heat wave and associated drought has brought the additional discomfort of defeat, though in hindsight much is being learned.

The scene was set last May, according to Robert Livezey of the Long Range Prediction Group of the National Oceanic and Atmospheric Administration. At that time, he says, the predominate air flow over the United States at 10,000 feet was moving strongly eastward from the Pacific Ocean. These westerly winds were forced straight across the country in part by a very strong and stationary clockwise-circulating air mass (high) over south-central Canada.

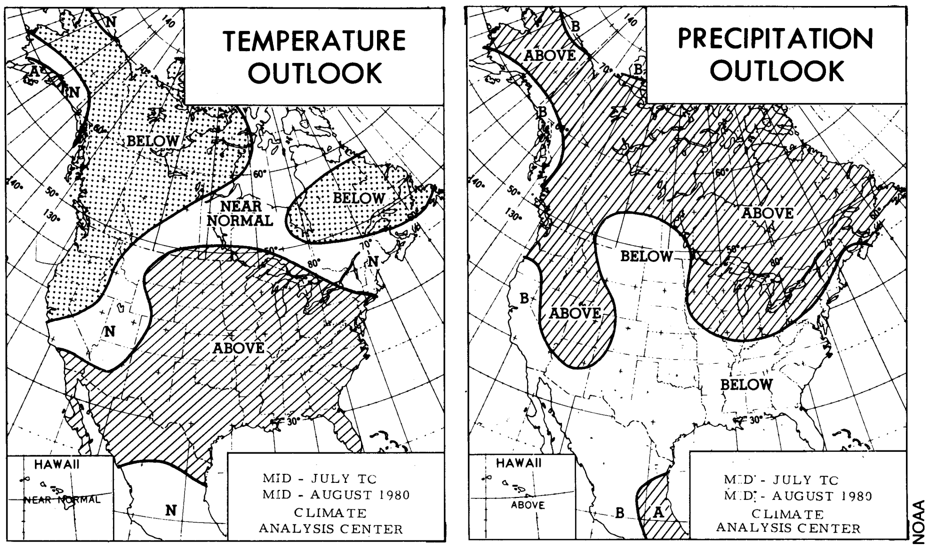
When the Canadian high began to break up, the system that had been maintaining the westerlies collapsed. As a result, a strong but previously suppressed high pressure system in the Pacific began to swell, says Livezey. In response, a series of alternating lows (counterclockwise-circulating air masses) and highs set up, including the very strong, stationary high — and its accompanying heat and dryness — that took up residence over the south-central United States.

The "wavy" alternating pattern of highs and lows, the position of the high over the south-central states and even the longevity of the entire pattern are not unusual, Livezey says. But the strength of the south-central U.S. high is rare: "We don't see an anomaly of this magnitude in the 33 years of data that we have," he says.

Just why the high pressure system is so strong and so persistent is unclear. In part, such a "blocking" high—so called because it is strong enough to deflect any smaller scale weather events such as fronts and storms — is maintained by the circulation system it creates. According to Jerome Namais of the Climate Research Group at Scripps Institution of Oceanography, the air within a high pressure system sinks very slowly — about 500 meters per day — which causes compression and drying of the air. This dehumidification essentially eliminates cloud-building, which increases heating of the air due to solar radiation. This expands the air column, which in turn amplifies the high pressure area.

"But the real causal mechanism is unclear," says Namais. Livezey agrees: "We don't know if the system sets up due to internal forcing [causes] or external forcing." Namais suggests, however, that the key may be an interaction between the sea and the air. The Pacific Ocean surface, cooled by last year's strong westerly winds, may have caused reduced air drag and allowed the clockwise-circulating air mass to slow and build.

"Realistically, no one could have forecast the extreme extent and strength" of the high over the south-central states, says Namais. But in hindsight, he says, had forecasters — who usually watch for longer-scale events — been watching the development of the rapidly growing Pacific high, they might have forecast the formation of the heat wave-producing high. What they're looking for now, says Livezey, is a weakening of the Pacific high that may signal a collapse of the entire system. □



Mid-July to mid-August thirty-day outlook offers no relief from heat, drought.

Beauty bottoms out: Fifth quark found

Pinning down the existence of a new variety of quark and making it available so its properties can be studied is one of the experimental milestones of particle physics these days. Theory proposes the existence of six varieties or "flavors" of quarks and six varieties of the particles called leptons as the basic constituents of all other forms of matter. Firmly establishing the existence and identity of the fifth quark in order of discovery is now reported accomplished by work done at the Cornell Electron Storage Ring (CESR) at Ithaca, N.Y. The reports caused a certain satisfaction at the 20th International Conference on High Energy Physics held this week at the University of Wisconsin in Madison.

Nature is not kind to those who would seek to identify and study quarks. Current theory decrees that quarks may not exist as free particles, but only as constituents, bound and confined inside the structures they make. Those structures are the particles seen in experiments such as protons, neutrons, mesons and hyperons of various kinds. In spite of one or two reported experimental exceptions nature seems to behave as theory expects.

The thing that would-be quark hunters have to do is to go and find particles in which the sought-after quark plays a role and try to study the quark in the relations and behavior of these particles. Three flavors of quark (named up, down and strange) were available for study in particles well known from the late 1950s and early '60s, but the three varieties of heavy or unstable quark, called charm, bottom or beauty and top or truth, can be found only in extremely heavy particles. Such particles could not be made experimentally at the energies available in those days.

The fourth flavor, charm, came over the horizon and began to have its identity established in 1974 with the discovery of the psi particles. The fifth flavor, bottom or beauty, requires work with the heaviest particles known to physics, the upsilon particles, whose masses lie around 10 billion electron-volts.

Upsilons were first discovered in 1977. Gradually it has become clear that there are at least four of them, designated upsilon, upsilon prime, upsilon double prime and upsilon triple prime. The CESR colliding beam apparatus is particularly adapted to work in the energy range that creates the upsilon masses, so it was turned to a study of them.

It had been assumed from their first discovery that the upsilons contained bottom quarks, namely that they were so-called "bottomonium," a series of structures built of a bottom quark and a bottom antiquark, each one with slightly more energy than the one below it in the series. That, however, had to be proved.

John Yoh of Columbia University, representing a collaboration of physicists from Columbia, the State University of New York at Stony Brook, the Max Planck Institute in Munich and Louisiana State University using the CUSB detector at CESR, reported evidence that the upsilons are structurally similar and related to each other. That was done by making upsilons in some quantity and studying how they decay radioactively. Evidence for a hierarchical relation among the upsilons is that the more massive upsilons do sometimes decay into less massive ones. This strengthens the belief that the upsilons are bottomonium.

Bottomonium is fascinating but it is still not the best way to study bottom quarks. Properties of the bottom quark in bottomonium are masked or partially canceled by the presence of its antiquark in the structure. To study bottom well requires what in the trade is called bare bottom or naked beauty, some particle in which a bottom quark is bound to another flavor and can manifest itself better. Edward H. Thorndike of the University of Rochester reported how that was accomplished by a collaboration from Vanderbilt University, Syracuse University, Rutgers University, the University of Rochester, Harvard University and Cornell University using the CLEO detector at CESR.

It started with a difference between the most massive upsilon, upsilon triple prime, and the others. The less massive upsilons have a signature that indicates that they will decay rather reluctantly. The signature of the upsilon triple prime indicates a readiness to decay. That indicated to the physicists that there was a "threshold" between the upsilon double prime and the upsilon triple prime, the mass value of something into which the upsilon triple prime could be expected to readily decay.

Observation was able to show that the upsilon triple prime falls apart into basically a bottom quark and a bottom antiquark. These partner with quarks from the surroundings, forming the so-called B mesons. The B mesons further decay, and in the final decay process yield a large number of the sort of particle theory expects bottom or beauty quarks to decay into. So Thorndike says, "We can conclude that naked beauty exists."

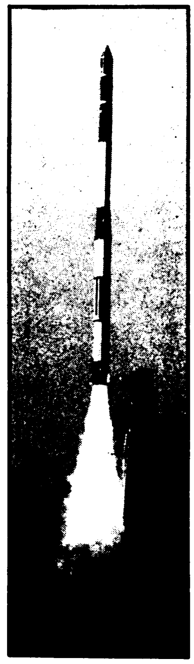
All of this is being taken rather smugly as a fine example of the way in which nature confirms theory. "The big surprise is that there are actually no surprises," says Thorndike. □

India joins the space-launch club

Not quite 23 years after the Soviet Union's momentous launching of Sputnik 1, 15 countries have had satellites of their own in space (Australia, Canada, China, Czechoslovakia, France, Great Britain, India, Indonesia, Italy, Japan, the Netherlands, Spain, West Germany, the United States and the USSR). Far fewer, however, have actually been able to put them there. For years, the United States and USSR launched everything that went into orbit, forming an exclusive club that was subsequently joined only by China, France (which is also the primary builder of the Ariane rocket for the European Space Agency), Great Britain and Japan — until last week. The newest member is India, which on July 18 sent a tiny test satellite into orbit aboard a four-stage, solid-propellant rocket launched from Sriharikota on the country's southeastern coast.

The 35-kilogram satellite, designed merely to report on the flight environment and the shape of its own elliptical orbit, was India's third. The previous two were launched by the Soviet Union, whose space links with the subcontinent also include the possibility of training some Indians as cosmonauts. The new rocket (whose maiden flight last August ended in failure) is not from Soviet designs, however, according to Indian officials, but evolved from India's own sounding-rocket research, which has been going on since the 1960s. (Japan's first orbital launching, by comparison, used a rocket based on a U.S. design, although a Japanese-designed rocket has since matched the feat.)

Satish Dhawan, chairman of India's policy-making Space Commission, also said on the day of the launching that the new rocket gives the country the capability of developing intermediate-range ballistic missiles, since "any country which can place a satellite in orbit can develop an IRBM." A four-stage rocket, depending for success on a series of properly executed firings, might be an unlikely choice for an IRBM, but last Friday's launching could be seen as relevant to an appropriate guidance system. In addition, officials report that Indian researchers are at work on liquid-propellant technology.


Shar Centre

The Indian Space Research Organization, meanwhile, is planning to launch a scientific satellite with the new rocket next year. A remote-sensing satellite for earth-resources studies is in the works for 1984 or 1985, although its projected 500-kilogram weight is about 10 times the payload capacity of at least the present version of the rocket. This could well mean that it will be orbited by a different vehicle entirely, such as ESA's Ariane, Indian officials acknowledge. It is possible, in fact, that an Ariane will launch India's next satellite before either of the above probes has flown. An Indian experimental communications satellite called Apple is due to ride an Ariane officially scheduled for November, although the recent failure of Ariane's second test flight may have delayed the flight into 1981. India's new rocket is thus not an automatic entree to orbit, at least for the time being, but the launch capability does put the country in exclusive company. □

Human tests of bacteria-produced insulin

It's another step forward in the attempt to harness bacteria to fulfill human needs. Eli Lilly and Co. has announced what it believes to be the first testing in humans of a product of the rapidly expanding recombinant DNA technology (SN: 3/29/80, p. 203). At a plant in England the pharmaceutical company has begun testing bacterially produced human insulin on eight nondiabetic healthy subjects. The first results of the tests, which began July 14, show bacterially made insulin to be approximately as effective in lowering blood sugar as naturally produced insulin. One subject who received 9.6 units of the insulin had a 36 percent drop in blood sugar. The bacterial product had already been shown effective in laboratory animals.

Facilities to produce insulin with bacterial techniques are already under construction both in Indianapolis, Lilly's U.S. headquarters, and near Liverpool, England. Lilly expects insulin production at the plants, which will cost more than $40 million, to begin in 1982, although "considerable" scientific work, including tests on diabetics, and government approvals must be gained before the insulin can be made commercially available.

The bacterially produced, or "biosynthetic," insulin is identical to that made by the human body (SN: 9/16/78, p. 195). The researchers expect that biosynthetic insulin will reduce the incidence of allergic reactions — a small proportion of diabetics are allergic to the insulin currently available from animal pancreas glands. In addition, the bacterially produced material would answer the concern that animal pancreas glands will be in short supply in about 20 years. □