Earth Sciences

Sea surface may follow solar tune

Can the solar cycle—a minute waxing and waning of the sun's energy output — affect the frequency of monsoons in India, droughts in the U.S. Midwest or frigid weather at the North Pole? Since the last century, many scientists have faced ridicule for proposing such relationships. But in the last two years, several researchers have won a respectful audience by finding new statistical links between the solar cycle and weather here on Earth (SN: 5/14/88, p. 310). Using a similar approach, an oceanographer has now identified an intriguing correlation between the solar cycle and ocean temperatures.

Tim P. Barnett of the Scripps Institution of Oceanography in La Jolla, Calif., examined sea-surface temperatures in the tropics, going back to the late 1800s. In analyzing these data, he concentrated on quasi-biennial variations — any temperature changes that went through a cycle lasting approximately two years. Other researchers who recently found statistically strong relationships between the solar cycle and weather have analyzed their data according to a quasi-biennial oscillation in atmospheric winds.

When Barnett filtered out all temperature variations except those with periods of 20 to 30 months, he found the strength of these quasi-biennial variations did not remain constant. They appeared to go through an 11-year cycle: Every 11 years, the tropical oceans experienced strong temperature swings with a period of about two years.

Eleven years corresponds to the average length of the solar cycle, so Barnett compared the quasi-biennial temperature variations with the historical record of solar cycles. To his surprise, he discovered the two have swung nearly in unison through six cycles from the 1920s to the present. The largest swings occurred when the solar energy output reached its 11-year low point. "The agreement appears remarkable," Barnett reports in the August GEOPHYSICAL RESEARCH LETTERS.

Despite the correlation, Barnett says he remains extremely skeptical. If he looks farther back in time, the match between solar cycle and ocean temperatures dies out between 1900 and 1920. Such a mismatch need not kill the proposed connection; it might just reflect a period when the solar cycle was too weak to exert much control over sea temperatures. The biggest problem, says Barnett, is that no one has discovered a physical mechanism by which minute changes in the sun can drive large shifts on Earth. Until scientists do, the match between solar cycle and weather remains no more than an interesting bit of statistics.

Escape from jaws of microburst

On July 8, three airliners descending toward Denver's Stapleton airport avoided what might have been a grave disaster, thanks to a prototype wind-shear alert system that detected signs of a microburst — a wind pattern that has claimed hundreds of lives in aircraft crashes. Microbursts develop when vertical currents of air plunge toward the ground and then spread outward in a flow resembling the spray pattern that forms when water from a faucet hits the bottom of a sink. When a plane flies through a microburst, it hits a headwind and then a strong tailwind—a treacherous wind shear that can rob the plane of precious lift (SN: 3/21/87, p.185).

Most U.S. airports have set up a system of six wind-speed gauges to detect wind shear. But at Stapleton, scientists are testing improved detection tools, including a 16-gauge system and a Doppler radar. Though the radar was not operating on July 8, the gauges picked up a wind shear of 35 knots over the runway, which intensified to a 95-knot shear within 2 minutes. This was the strongest microburst ever detected with instruments, says John McCarthy of the National Center for Atmospheric Research in Boulder, Colo.

Physics

European Z° factory LEPs ahead

On Aug. 13, just one month after beginning operation, the Large Electron-Positron collider (LEP) at the European Laboratory for Particles Physics (CERN) in Geneva produced its first Z° particles. The five particles, detected over a period of four hours during the collider's initial experimental run, represent the start of a research program that should eventually yield a million Z° particles a year. Data from such a large batch will enable physicists to pinpoint the Z°'s key properties, such as its mass, and to test the theory linking two fundamental forces, the electromagnetic force and the weak nuclear force. Data from the Stanford (Calif.) Linear Collider and Fermilab in Batavia, Ill., have already provided improved estimates of the particle's mass (SN: 7/29/89, p.69).

LEP has four huge detectors, situated at different points along the 27-kilometer ring where beams of electrons and positrons, speeding in opposite directions, cross and their particles smash together. Although all the detectors are designed to catch the sprays of charged fragments generated by the decay of collision-created Z° particles, each detector has its own strengths and specific experimental goals. The Omni Purpose Apparatus for LEP (OPAL), a general-purpose detector based on proven technologies, was the first to detect a Z°. But within two days, the remaining three detectors — ALEPH, DELPHI and L3—also spotted their quarry. LEP should be operating at full capacity by October.

A lifetime for neutrons in a bottle

At a time when scientists can routinely measure such fundamental physical constants as the elementary charge to a precision better than 1 part per million, it's somewhat surprising to find that they still haven't established the neutron's lifetime to a similar degree of accuracy.

When not bound up in an atomic nucleus, the neutron is unstable, decaying into a proton, electron and neutrino. Experimental results accumulated over 40 years put the neutron's half-life — the time it takes for half the neutrons in a sample to decay—at 891.6 seconds, with an uncertainty of plus or minus 5.1 seconds. The large uncertainty demonstrates the difficulty of making the measurement. However, because of the important role the neutron lifetime plays in many cosmological and astrophysical theories, efforts to measure it more accurately continue.

The latest measurement of the neutron's lifetime, reported in the Aug. 7 PHYSICAL REVIEW LETTERS, is important not because of any significant improvement in accuracy but because of the technique used to make the measurement. Instead of trying to determine the number of neutrons present in a neutron beam while counting the charged decay products, an international team of researchers took a more direct approach by tracking the number of slow-moving, "ultracold" neutrons confined in a glass bottle coated with a special oil that both seals the container and reflects neutrons. Using this technique, the researchers obtained a neutron half-life of 887.6 seconds, with an uncertainty of plus or minus 3 seconds.

One major source of error in the measurement is the effect of gravity. While confined, the neutrons collide frequently with the oil-coated walls and gradually lose energy. The increasingly slow-moving neutrons tend to settle to the bottle's bottom, somewhat biasing neutron counts taken at different times. The researchers have found ways to correct for this problem and are now tackling other possible sources of error. "The method has the potential to reach still higher precision," they conclude. Even at its present state of development, the new technique of using stored, ultracold neutrons to measure neutron lifetimes gives results as good as those obtained with the most refined versions of earlier methods.