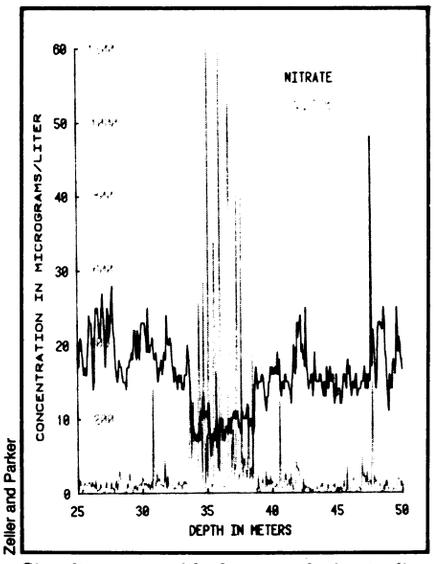
. . . Solar weather

nitrate analysis has, at worst, a resolution of two years — that is, the timing of an event can be pinpointed to within two years. "And there is no indication that we lose this resolution in older ice," says Zeller. "We may be able to go back 30,000 to 40,000 years."

Satisfied that their nitrate measurements correlate well with recent variations in solar activity as determined from sunspot activity, the researchers began to look for other implications. Several recent findings support the possibility of a link between solar variability and climate. One of the most convincing is that when a graph indicating nitrate concentration found in Antarctic snow (plotted as a function of depth) is aligned with a timetable, significant benchmark variations are apparent at a section of the ice cores correlating to a period of history called the Maunder Minimum or the Little Ice Age (1645 to 1715). A time when little to no sunspot activity was reported by astronomers and extremely cold, dry conditions prevailed throughout the world, the Maunder Minimum is also marked by a dramatic drop in nitrate accumulation. From an annual average of about 23 parts per billion, nitrate concentrations fall during this period to about 10 and sometimes 6 parts per billion.

Simultaneously, and quite curiously, on the graph there appears a series of pulses of high sodium concentration in the cores. Under normal conditions, little sodium is found in the bulk of Antarctic snow, despite the proximity to the Southern Ocean, a major source of the element. This is because the global atmospheric circulation forms a vortex at the poles, which tends to inhibit the incursion of large oceanic air masses over the continent. In addition, the South Pole rises more than 9,000 feet above sea level and lies about 800 miles from the ocean. Thus, the sharp spikes of sodium concentration, sometimes registering more than 50 times the usual amount, captured the curiosity of solar chronologers Zeller and Parker.



Simultaneous with decreased nitrate (i.e., decreased solar activity) in the Maunder Minimum, sodium concentration rose. This indicates that global circulation may have changed and allowed winds to sweep sodium from the ocean to the continent.

"Conditions must have been drastically altered for a period of about 50 years," Zeller explains. "There seems to have been a change in the circulation patterns of the planet, a breakdown of the vortex, and the incursion of giant salt storms sweeping over the interior of the South Pole."

The nitrate calendar reveals other possible clues in the solar-weather connection. Based on preliminary results, the researchers believe that the nitrate record may indicate cyclic swings in solar activity. Depending on the timing of the cycle, this sort of regular swing in solar activity may be linked to the apparent regularity of ice ages, says Zeller. With only 3,500 years' worth of ice cores analyzed so far, the researchers expect further studies of cores that extend back 12,000 years to provide a better view of the long-term cycle of solar activity. To that end, they plan to establish a permanent nitrate analysis laboratory and to double their current core record during the scientific research season in Antarctica this year.

As to what extent these alterations in circulation patterns were driven by changes in the sun's activities, "We're just not sure yet," Zeller says, "but the propinquity of the drop in nitrates to the pulses of sodium increase certainly intimates a link between the sun's activities and the world's atmospheric circulation patterns."

Although their results certainly have important bearing on paleoclimatic research, "The object of our work is not climatic studies," Zeller says. "What we are attempting to do is to provide a more finite mechanism, a higher resolution mechanism, that can give us year-by-year information about solar and climatic variations of yesterday. This in turn may give us insight into what to expect for tomorrow." □

Suzanne Olson is a Los Angeles-based science writer.

BOOKS

BOOKS is an editorial service for readers' information. To order any book listed or any U.S. book in print please remit retail price, plus 50¢ handling charge for each book to **Book Order Service,** Science News, 1719 N Street, N.W., Washington, D.C. 20036. All books sent postpaid. Domestic orders only.

ANNUAL REVIEW OF ASTRONOMY AND ASTROPHYSICS Vol. 18 — Geoffrey Burbidge et al., Eds. The lead article, "On Some Trends in the Development of Astrophysics," is by V. A. Ambartsumian, Academy of Sciences of Armenian SSR, USSR. Annual Reviews, 1980, 591 p., illus., $20.

A CENTURY OF DNA: A History of the Discovery of the Structure and Function of the Genetic Substance — Franklin H. Portugal and Jack S. Cohen. Tells one of the most fascinating stories in modern science — that of DNA, from its discovery in 1869 to the solution of the genetic code in the 1960s. Written for the general reader with high school training in chemistry and biology, as well as for the professional scientist and science historian. Originally published in hardback in 1977. MIT Pr, 1980, 384 p., illus., paper, $6.95.

ENGINES: The Search for Power—John Day. Covers the various types of power units from the earliest use of wind and water through the precursors of the fuel-powered engines of the 17th and 18th centuries and from the types that came into practical use in the 19th and 20th centuries to the space shuttle engine. Beautifully illustrated with color, black and white photographs and diagrams showing how the engines operate. St Martin, 1980, 256 p., color/b&w illus., $27.50.

EVOLUTION OF THE VERTEBRATES: A History of the Backboned Animals through Time — Edwin H. Colbert. Presents a general review of vertebrate evolution and shows how animals with backbones developed through more than 400 million years of earth history. Included in this edition is discussion of past continental relationships based on plate tectonics and its effect on the evolution and distribution of tetrapods. Wiley, 3rd ed., 1980, 510 p., illus., $25.

THE FOREST — Roger Caras. Describes an eagle's three-week stay in a northwestern American wilderness, looking at the forest as a total system. Tells in charming language of the plants, from the smallest to the stately Douglas fir, and of the animals and their struggles to survive. Originally published in hardback in 1979. HM, 1980, 178 p., illus. with drawings by Norman Arlott, paper, $4.95.

FROM X-RAYS TO QUARKS: Modern Physicists and Their Discoveries — Emilio Segrè. This eminent scientist attempts to show not only the main discoveries but also the way they were reached, the personalities of the leading physicists and the errors committed before the right path was found. Originally published in Italian. W H Freeman, 1980, 337 p., illus., $20, paper, $9.95.

GALAPAGOS: Islands Lost in Time — Tui De Roy Moore, Introduction by Peter Matthiessen. Exquisite photography makes the world of the Galapagos Islands come alive for the reader. The photographer/author grew up and still lives in this fascinating archipelago, where for more than 10 years she has concentrated on capturing on film the most unusual and revealing aspects of the islands and their wildlife. The text tells of the formation of the Galapagos, the evolution of wildlife, the coming of humans to the islands, growing up there and the author's love for the life she found around her. Viking Pr, 1980, 71 p. plus 299 color photographs, $25.

MATHEMATICS TODAY: Twelve Informal Essays — Lynn Arthur Steen, Ed. These essays by outstanding mathematicians are intended to convey to the nonmathematician something of the nature, development and use of mathematical concepts, particularly those that have found application in current scientific research. Originally published in hardback in 1979. Vintage (Random), 1980, 367 p., illus., paper, $4.95.

THE UNDERGROUND HOUSE BOOK — Stu Campbell. Underground homes offer remarkable energy savings, minimal maintenance and revolutionary possibilities for siting. This book is a blend of theory with technical material, including drawings, tables and floor plans, as well as first-hand experiences of underground home architects, builders and dwellers. Garden Way Pub, 1980, 210 p., illus., paper, $9.95.