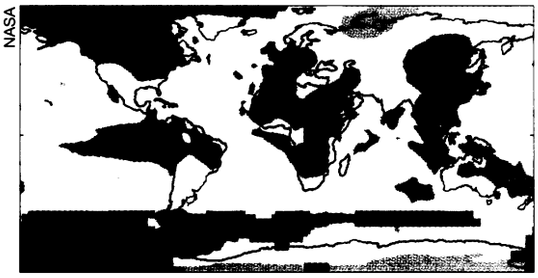
# Earth's temperature shot skyward in 1998

Global temperatures in 1998 shattered the record high mark, making last year the warmest since at least 1860, and possibly since the end of the last millennium. El Niño deserves part of the credit, say climate scientists, but some researchers also see signs that people are helping to push temperatures into uncharted territory.

The World Meteorological Organization (WMO) in Geneva announced last month that the mean surface temperature of the globe in 1998 reached 0.58°C above a baseline average for the period from 1961 through 1990. For climatologists, who worry about global changes in hundredths of a degree, last year's warmth stands out like a Himalayan peak.

"It's quite large. It represents several days' lengthening of the growing season," says David Parker of the United Kingdom Meteorological Office's Hadley Centre in Bracknell. The Hadley Centre and the University of East Anglia in Norwich supplied much of the analysis in the WMO statement, which includes data through mid-December. The British groups combine surface-temperature measurements made at more than 1,000 land meteorological stations with readings of sea-surface temperature from almost 2,000 ships and buoys.


NASA

*Red hues denote warm regions in 1998.*

A separate analysis, completed by NASA's Goddard Institute for Space Studies in New York, also has 1998 setting a temperature record by a wide margin, says James E. Hansen of the institute.

Climate researchers trace part of the heat to the El Niño ocean warming, which first started developing in mid-1997 in the Pacific. El Niño faded in May 1998, turning the tropical eastern Pacific cool, but temperatures remained elevated in many other ocean regions. In particular, the year brought "unprecedented warmth" to the Indian Ocean, according to WMO.

All the continents baked in 1998 except for northern parts of Europe and Asia. The southern United States faced extreme heat and drought during spring and summer. In central Russia, a June hot spell killed more than 100 people and fed large fires, WMO reports.

With El Niño now only a memory in the Pacific, Parker expects the globe to cool off in 1999, although probably not back to the 1961 to 1990 baseline. The globe has warmed markedly during the past decade, so much so that 7 of the 10 warmest years on record occurred after 1990. All of the top 10 postdate 1983.

The recent warmth amplifies concerns that greenhouse gases are turning up Earth's thermostat, according to some researchers. A United Nations consensus panel announced in 1995 that the balance of evidence suggests people are influencing climate. Now, says Parker, "the balance is tipping a bit further in that direction."

Greenhouse skeptics point out that the lower atmosphere up to 7 kilometers has not warmed over the last 20 years, since satellites started making measurements. These readings showed substantial warming in early 1998, but atmospheric temperatures later fell back to the 20-year average, says John Christy of the University of Alabama in Huntsville, who analyzes the satellite data.

Still, people are most concerned about Earth's surface, which has warmed by almost 0.7°C since the end of the 19th century, according to WMO. The hot spell of the past two decades may be unprecedented in the last 1,200 years, according to Jonathan T. Overpeck of the National Oceanic and Atmospheric Administration in Boulder, Colo., who discussed historical climate data last month at a meeting of the American Geophysical Union in San Francisco.

When Overpeck compiled work by scientists who have examined tree rings, glaciers, and sediments from lakes and oceans, he found no evidence for the existence of a global warm spell during the Medieval period—a time that climatologists once regarded as universally balmy. While Europe and Greenland were warm during this phase, South America, Antarctica, and Australia were not. Overall, he says, that time was not as warm as today. *—R. Monastersky*

# Sand piles harden as water makes links

Granular materials such as sands and powders behave in mysterious ways, for instance acting partly like solids and partly like liquids. They also play important roles in industries ranging from agriculture to drug manufacturing (SN: 9/20/97, p. 186).

A new study by French researchers finds that piles of undisturbed granular materials stick together more tightly as time passes. They also offer a new explanation for the phenomenon in these materials: Water from humid air slowly condenses into films bridging the spaces between grains. Surface tension then binds the grains together, increasing friction in the pile. The French team's experimental results match predictions based on this model.

"The more you wait, the more you create liquid bridges, and the more you have an adhesion force," says Lydéric Bocquet of the École Normale Superieure in Lyon. He and his colleagues there and at the Université Claude Bernard-Lyon I in Villeurbanne describe their findings in the Dec. 24/31, 1998 NATURE.

"I think it's neat. It's an interesting result," says Peter E. Schiffer of the University of Notre Dame in Indiana. The French data complement his own lab's finding that a few drops of moisture, in this case oil, will dramatically stiffen a liter of granular materials.

"If it's really what's happening, it's quite fascinating," says Jacob N. Israelachvili at the University of California, Santa Barbara. Water-bridge formation could be important in many areas, such as chemical and electric behavior of thin films, he adds. However, rather than building bridges that hold grains together, he suspects that the water might cause increased sintering—a type of chemical bonding.

Decades ago, scientists discovered that friction between solid objects in contact increases with time, a process called aging. To test if granular materials also age, the French researchers recently poured glass beads the size of fine sand grains into a drum and let them sit before turning the drum.

As the drum begins to rotate, the initially horizontal surface of the bead pile tilts toward the vertical until the pile collapses, much like a heap of clothes tumbling in a dryer. The team conducted tests at humidities from 5 to 55 percent and rest periods of 5 seconds to 2 hours. Under such conditions, "the [aging] effect is very clear," Bocquet says.

In unpublished experiments, the researchers have returned to solids, gauging friction by the steepness at which a test block begins to slide down an incline. The rate of increase of friction with contact time at 60 percent humidity was as much as five times the rate at 10 percent, he told SCIENCE NEWS. Moreover, tests on Teflon revealed no humidity effect, consistent with water's inability to cling to it.

Teflon shows some aging, however. That's not surprising, says Bocquet. Although it may have the largest influence, he never expected the water-bridge hypothesis to be the sole explanation for the aging effect. *—P. Weiss*