Plugging holes with stratospheric winds

In spite of its seemingly wispy nature, the atmosphere that enshrouds the globe can alter the rotation rate of the earth. Scientists have long been able to detect the atmosphere's part in speeding up and slowing down the planet.

But in matching the circulation patterns of the atmosphere — principally the troposphere, the layer closest to the ground — with changes in the rotation rate, researchers have uncovered some discrepancies. And to explain these, they have suggested a number of causes ranging from the redistribution of groundwater to changes in sea level.

Now, in the Aug. 20 JOURNAL OF GEOPHYSICAL RESEARCH, Richard Rosen and David Salstein of Atmospheric and Environmental Research, Inc., in Cambridge, Mass., show that most of the discrepancies can be accounted for by including data from the stratosphere, the layer just above the troposphere. After incorporating newly available stratospheric wind data, the meteorologists conclude that "tropospheric plus stratospheric winds can fully account for seasonal, nontidal changes in the length of day [or rotation rate] without invoking other geophysical processes."

Getting to the core of climate cycles

At the coldest inhabited spot on the planet, Soviet engineers have drilled 2,083 meters into the ice, obtaining the first continuous ice record of the drastic swings in climate over the last 150,000 years. The high-quality core they have extracted from the Vostok station in East Antarctica extends from the present interglacial, or warming, period through about 100,000 years of glacial cooling, then on through the previous interglacial episode and into the tail end of another glaciation.

Soviet and French researchers collaborating in the analysis of the core present some of their initial geochemical results in two papers in the Aug. 15 NATURE. In one paper, Claude Lorius of the Laboratory of Glaciology and Environmental Geophysics in St. Martin d'Héres, France, and his co-workers measured the changes in the abundance of the oxygen-18 isotope as a function of depth in the ice sheet. The oxygen-18, they believe, is linked to the temperature of East Antarctica, with increases of the isotope reflecting a warmer climate. And since temperature is thought to affect the accumulation rate of the ice, oxygen-18 measurements enabled them to date the ice as well.

The measurements revealed three relatively cold periods within the last glacial episode. The researchers found that the last interglacial period was warmer, perhaps by 3°C, than the present period. They calculate temperature differences of about 10°C between glacial and interglacial times.

One very striking feature of the oxygen-18 profile is how clearly it follows a 40,000-year cycle in insolation, the amount of solar radiation that reaches the earth's surface. This strongly supports the idea that periodic variations in insolation — brought on by cyclic changes in the earth's orbit — contribute to local climate shifts. The oxygen-18 results are also consistent with other studies that estimated changes in carbon dioxide levels — another factor linked to climate. But the results do not agree with oxygen-18 studies of deep-sea cores, indicating to the researchers that the Antarctic climate and the global ice volume, which the deep-sea cores are thought to reflect, have not evolved in the same way. In particular, they say, "The last interglacial appears to be about twice as long in the Antarctic temperature record as in the ice-volume record."

The oxygen-18 ice data also correlate very well with measurements of beryllium-10 discussed in the second NATURE paper, written by F. Yiou at the René Bernas Laboratory in Orsay, France, and colleagues. These researchers link beryllium levels to the precipitation rate, which, they conclude, was two times lower during the last glaciation than in the interglacial periods.

Deep-sea currents driven by wind

Two researchers recently confirmed what oceanographers have suspected for 40 years — that long-term cycles of wind can drive deep ocean currents. The surprise, though, was not in the confirmation of the old theory but in the reassuring finding that present methods for mapping the wind are accurate enough for scientists to construct meaningful dynamic models of wind and ocean currents, Chester Koblinsky of NASA Goddard Space Flight Center in Greenbelt, Md., told SCIENCE NEWS.

Koblinsky and Pearn Niiler of Scripps Institution of Oceanography in La Jolla, Calif., compared ocean currents, measured with a moored current meter, with 10- to 100-day wind cycles in the North Pacific derived from previously collected data. They found that ocean currents 150 to 4,000 meters below the surface are directly related to surface wind shear forces, they report in the Aug. 23 SCIENCE.

This phenomenon probably applies to the midlatitudes of the eastern ocean basins, wherever winds are very intense, says Koblinsky. But powerful western boundary currents, such as the Gulf Stream and the Pacific's Kurishio, would tend to overwhelm the effects of the wind, he says.

Maps of global wind patterns are presently constructed from the four-times-daily reports of merchant vessels all over the world and from satellite photos of clouds. Because ships mostly confine themselves to a few major routes in the northern hemisphere and avoid storms, these data have long been considered of dubious value, says Koblinsky. "It's really comforting to the oceanographic community to know that the measurements are good enough," he says.

Good enough, that is, to model the ocean for studies of the earth's climate and weather, he says. "The ocean is the missing link for climate," says Koblinsky.

On another front, NASA is planning to begin measuring global wind patterns from space in about five years, according to Koblinsky. Because of the newly demonstrated usefulness of present wind measurements, he and his colleagues are impatient to get the much more accurate and complete global wind measurements from space for their models.

Bald cypress gaining on bristlecone

Scientists have reconstructed the climate of the Mississippi Valley for the past 450 years using old bald cypress trees from Arkansas swamps, according to a report in the Aug. 8 NATURE. This "paleoclimate reconstruction" is some 150 years longer than any previous reconstruction using tree rings in eastern North America, and it is the first to use swamp trees, says David W. Stahle of the University of Arkansas in Fayetteville.

The reconstruction, which was calibrated and verified against modern climate records, showed smaller fluctuations in moisture between 1650 and 1840 than before or after. The researchers also noted that probably the worst drought in Arkansas in the last 450 years occurred between 1549 and 1577.

Because tree rings from trees in wet places tend not to reflect the effects of droughts or wet periods very well, researchers have traditionally used dry-adapted conifers on very dry sites, says Stahle. The most famous examples of this are the ancient bristlecone pines of the dry western mountains, which have provided tree ring data going back 5,000 years.

The East has no such long-lived dry-adapted trees. But tree ring widths of the bald cypress reflect climate changes very well — an unusual trait in a swamp species, says Stahle. Furthermore, individual bald cypress trees live more than 1,000 years — probably making the species the longest-lived species in the East, he says. When a bald cypress does die, it tends to fall over into the swamp, where it is preserved and eventually fossilized, perhaps making it possible, he says, to extend tree-ring-based climate reconstructions of the East back about 5,000 years.