scientists to estimate a worldwide total and make comparisons. The researchers used data from 1,545 northern and 656 southern weather stations, all of which have been recording since at least the mid 1920s. Observers have only recently begun recording precipitation over Antarctica, and the report includes no information from this continent.

Although the overall trend is toward more precipitation, many areas have become drier in recent years or experienced no overall change over the last century. South American stations, and to a lesser extent South Asian and Australian stations, report precipitation increases, but records from stations in southern Africa show no rise. Also, while the midlatitude regions on both sides of the equator have experienced more precipitation, the northern tropics have dried while the southern tropics have become wetter. The researchers say drought in Africa and the Caribbean accounts for recent dryness in the northern tropics.

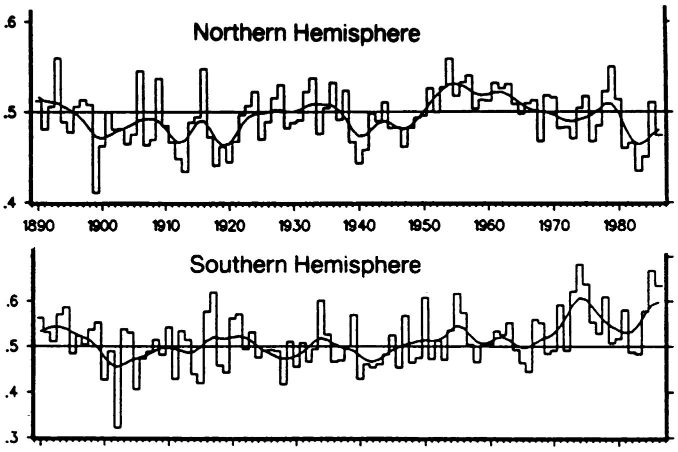
Diaz and his colleagues say the changes in precipitation loosely match what is expected to occur during a greenhouse warming — a general heating of Earth's climate due to increasing atmospheric concentrations of certain gases. But, he cautions, "at this point I would certainly not want to say that we are seeing any sort of greenhouse signal."

Part of the problem with identifying such a signal, he says, is that precipitation fluctuates radically from year to year and from decade to decade. During the years 1899-1920, for instance, precipitation levels over South America were much lower than the mean annual amounts during a reference period of 1921-1960. However, in the years since 1970 the same continent has experienced precipitation levels above the mean measurements for the reference period.

The researchers also say the record clearly shows large swings in precipitation caused by strong El Niño-Southern Oscillations. These seesaw shifts in the warm ocean water and high atmospheric pressures alter precipitation patterns across the Pacific and other areas.

If the expected climate warming has started to affect the levels of precipitation, this change would be superimposed on the large natural swings, making it difficult to detect the "fingerprint" of greenhouse warming in these historical records. "We have to be cautious when we try to ascribe a particular mechanism to the data," Diaz says.

The researchers also admit to other problems with the long-term precipitation records. Because certain portions of the continents have few or no weather stations, the researchers had to average the available measurements over large tracts of land. In many cases, a single station must cover hundreds or thousands of square kilometers. If such a station has measured a drop in precipitation, it is difficult to tell whether the entire area surrounding the station suffered a drought at that time or whether the rain simply shifted slightly, leaving the station drier than nearby areas.



Diaz et al./Journal of Geophysical Research

Graphs indicate annual variations in precipitation over land in the Northern Hemisphere and Southern Hemisphere as represented by a percentile based on mean values for 1921-1960. Boxes show actual yearly percentiles.

Moreover, the researchers say changes in instruments or procedures may have introduced large biases into the measurements.

Because of these and other caveats, some scientists are skeptical about using the historical precipitation records to test for climate change signals. Says Chester Ropelewski at the NOAA Climate Analysis Center in Camp Springs, Md., "We may have to write off the historical records."

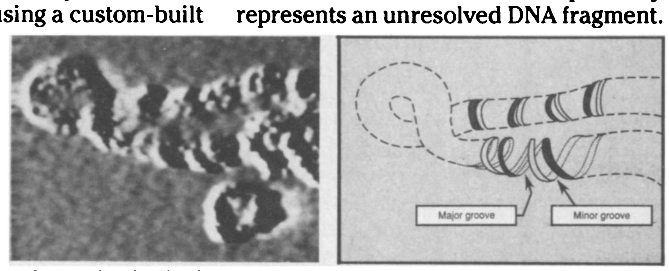
Yet the worldwide data for precipitation are among the most detailed of all weather records, and many experts say they will become quite important in the near future to those who work with climate models. Computer specialists are beginning to run detailed simulations of how greenhouse warming will slowly change the climate. According to computer modeler Michael Schlesinger at Oregon State University in Corvallis, matching these predictions against the historical records for precipitation and other variables will help determine how the climate is changing and whether greenhouse gases are at the root of the change. *— R. Monastersky*

Scanning the winding coils of naked DNA

When James D. Watson and Francis H.C. Crick first worked out the double-helical structure of DNA, they relied on data in the form of patterns of spots created by X-rays diffracted from crystallized DNA and captured on film. Now, 36 years later, a team of researchers using a custom-built scanning tunneling microscope has produced the first direct images of chemically unaltered, uncoated, pure DNA. Magnified 1 million times by the microscope, a typical double-stranded DNA molecule clearly shows its helical structure, and researchers can directly measure the spacing between coils.

"It was not obvious that we would succeed," says Miquel B. Salmeron of the Lawrence Berkeley (Calif.) Laboratory (LBL). "The previous experience of other laboratories was a little bit discouraging, but we tried it anyway." Salmeron and his collaborators at LBL and the Lawrence Livermore (Calif.) National Laboratory describe their results in the Jan. 20 Science.

The researchers looked at calf thymus DNA, deposited from a potassium chloride solution onto a graphite surface. They used their scanning tunneling microscope to trace out a kind of topographic map of the deposited molecules. In the image shown on the left, a looped DNA strand, stretching across an area 400 angstroms wide, rises about 20 angstroms above the surface. A circular feature seen below the strand probably represents an unresolved DNA fragment.



LBL/LLNL

The diagram on the right illustrates how the bumps can be interpreted as coils. Measurements show that the distance between adjacent coils varies from 27 to 63 angstroms.

"We have not yet pushed the instrument to its maximum potential," Salmeron says. The team plans to investigate whether its microscope can resolve differences among the four nucleotides that serve as the building blocks for a single DNA strand.

"DNA was the first molecule that we tried," Salmeron says. "Now we can imagine trying other biological molecules for which there is no other technique that we can utilize to study their structures." *— I. Peterson*