The Moon Influences Western U.S. Drought

An 18.6-year cycle of Great Plains drought related to lunar tide turns up in the record previously used to support only a sun-weather relation

Cyclicity is the bugaboo of climate studies. Many cycles are reported, few are confirmed. The dubious reputation of most cyclicity studies makes the recent discovery of the moon's periodic influence on weather all the more startling. Although it is a subtle effect, the lunar cycle that influences drought in the American Great Plains, in combination with a previously reported solar influence, may on rare occasions wreak such widespread havoc as the Dust Bowl of the 1930's.

The evidence for the moon's effect on drought, as well as the sun's effect, first appeared in the record of varying tree-ring width in and near the Great Plains. In 1979 Murray Mitchell of the National Oceanic and Atmospheric Administration in Silver Spring, Maryland, and Charles Stockton and David Meko of the University of Arizona reported that the narrowing of tree rings during drought conditions revealed a tendency over their 360-year record toward an expansion of the area of drought about every 22 years. That is just the period of the sun's Hale sunspot cycle, during which the magnetic poles of the sun and its sunspots flip and return to their original orientation.

The apparent effect of the 22-year solar cycle on weather was not large. It accounted for only about 10 percent of the variance in the drought record. However sunspots reached out into the weather system, they could only increase or decrease the tendency toward drought, not control it. The effect during any one cycle, ranging from undetectable to seemingly catastrophic, was unpredictable. But it was the first such effect among the many reported to gain any wide acceptance.

Then two researchers somewhat outside the mainstream of climate research began saying that Mitchell, Stockton, and Meko did not have it right. Robert Currie, then with ARCO, argued that they were actually seeing the effects on the weather of the moon's 18.6-year cycle of changing declination, during which its maximum height in the sky varies by 20 of its diameters. There is no 22-year cycle, he says, but there is an 11-year cycle driven by the periodic growth and decline in the number of sunspots. P. R. Bell of the Institute for Energy Analysis in Oak Ridge, Tennessee, took a middle ground. Both the 22- and 18.6-year cycles are present in the tree-ring record of drought, he said.

Although he had a long-running interest in possible lunar effects on weather, Mitchell was doubtful of the lunar interpretation but he took another look. He found that all it took was to split the tree-ring record in half to make the 18.6-year cycle jump out at him in both halves. The problem apparently had been that around 1800, while maintaining the length of its period, the 18.6-year drought cycle shifted by about half a cycle, creating a tendency toward drought when wetter weather would have been expected and vice versa. Such a phase change might result from modulation of the 18.6-year cycle by an even longer cycle of some sort. Analysis of the complete record, including the phase change, yielded two side-band cycles, one having a period slightly longer and one slightly shorter than 18.6 years. The split cycle, having been proportionately reduced in strength, went unreported.

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The effect of the moon on weather has been further confirmed elsewhere. In a study of the Indian monsoon, William Campbell of Scott Air Force Base and his colleagues have shown that the moon can accelerate or retard the seasonal march of the monsoon rains up the Indian subcontinent. S. Hameed at the State University of New York at Stony Brook and his colleagues have reported detection of the lunar cycle in a 500-year record of flood and drought in northern China. And Currie has reported finding it in the variation of atmospheric pressure over Japan and in the record of drought in the mid-latitudes of South America.

Now that a lunar influence on weather is established as a respectable phenomenon, the periodic effects of the sun are again embroiled in controversy. Currie sees only an 11-year solar cycle, and Bell, Mitchell, and Glenn Brier and his colleagues at Colorado State University independently find the 22-year cycle but little or no evidence of an 11-year cycle. A large part of the problem is that everybody uses different mathematical techniques to extract the subtle periodic signals from the random climatic noise that nearly overwhelms them in the record.

Understanding how the moon or the sun physically affects precipitation over the Great Plains might help to resolve such mathematical questions. In the case of the moon, the effect must act through gravity-induced tides. The 18.6-year cycle of the moon's declination elicits varying tides in the atmosphere just as the apparent daily motions of the moon raise tides in the atmosphere and the ocean. How the relatively weak variations of the 18.6-year cycle gain the leverage to influence the vigorous motions of the atmosphere is not clear. Mitchell is thinking about the possible interaction of atmospheric tidal accelerations and motions due to Earth's rotation that yields motions over the central plains far larger than their simple sum. Currie favors a different resonant interaction, one between a tidally induced wave in the atmosphere and mountains, like the Rockies. In any case, unlike sun-weather relations, the tidal link of the moon-weather connection provides an obvious starting point.

Researchers now have a tool with which to probe the workings of the atmosphere. Whether it will also serve as a forecasting tool remains problematic. The drought of the 1930's was the most widespread since 1600. Drought struck about 20 years later in the 1950's, although it was less widespread and less persistent. But the late 1970's were no drier than the times between the two earlier periods of drought. The superposition of lunar and solar cycles, as nearly occurred in 1934, may intensify a period of drought, but there are obviously many more keys to understanding drought.

—RICHARD A. KERR

Additional Reading

R. G. Currie, *J. Geophys. Res.* **89**, 1295 (1984).