

"They say it is observed in the Low Countries (I know not in what part) that every five and thirty years the same kind and suit of weather comes about again . . . ; they call it Prime . . . computing backwards, I have found some concurrence."

—Francis Bacon

10 *Why Does It Rain on January 23?*

It has been said that the mark of an educated man is his resistance to new ideas. This characterization is not made disparagingly. The educated man knows so much that he knows why a new idea won't work. You'll never hear him say, "Why don't they try it?" or "Why don't they do it this way?" These questions are usually asked by people who would not ask if they knew more.

But sometimes educated people know too much. I recall a story from World War I. The German zeppelins were striking terror in the hearts of the people of London, and the British bullets, instead of destroying them, were going right through the tough airship skins. What was needed was a bullet that would ignite on contact with the balloons, and British scientists applied various explosives to the bullets to achieve the desired results. Every attempt produced failure.

One day an old man came to the war office and said he had the solution. He told the harried military experts to put a dab of

dynamite on the nose of their bullets. The dynamite, he said, would ignite the silk covers of the balloons.

Of course, no one paid any attention to him; everyone knew that dynamite is relatively nonexplosive. It was unthinkable that it would explode upon contact with silk. But the old man persisted. Finally, to end their annoyance, one of the experts went with the old man to his back yard. The test was made. A bullet with dynamite on it, fired through a piece of silk, *did* set the fabric on fire.

The answer was simple. Dynamite is nitroglycerine and a filler. In the process of being fired, the filler fell back and left a few drops of pure nitroglycerine on the bullet's nose. When this hit the taut silk it exploded.

The problem was solved—in spite of the educated men at the war office. In this case they knew too much.

Something of the sort may be happening with regard to using cycle knowledge as an aid to weather forecasting. Although largely ignored by many, the possibility of cycles in weather has occupied the attention of some of the most eminent meteorologists, who have felt that long-range weather prediction is possible only through an understanding and application of cycles.

Broadway and the Barometer

Whether you call it atmosphere or just plain air, there are approximately 5 quadrillion tons of the stuff clinging to our earth. Here, on the surface, we're at the bottom of the pile and the air pressure at sea level is about 14.7 pounds per square inch, or one ton per square foot.

Air pressure is measured by a barometer and recorded as inches of mercury; 29.91 inches of mercury equals 14.7 pounds per square inch, and so on, up and down the scale. Usually a falling barometer indicates that a storm is coming and a rising barometer that good weather is on the way.

Since 1873 barometric pressure at New York City has moved in a cyclic pattern that has averaged 7.6 years. The precision with which this strange cycle has repeated can be seen in Figure 40. The

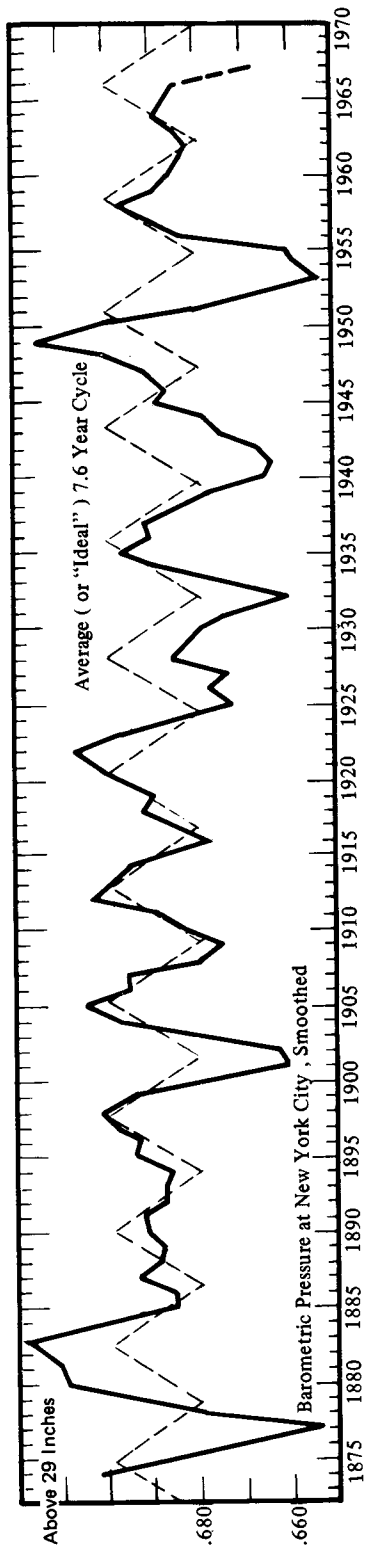


Fig. 40. The 7.6-Year Cycle in New York's Barometric Pressure, 1874-1967

actual barometric pressure has been smoothed by a three-year moving average, shown by the solid line.

Significantly, of the twenty-four turning points shown in the chart, a total of twelve came within half a year of ideal timing and in only one instance was a turning point more than two years from the ideal. A Bartels test of significance was performed in order to rate the behavior of this cycle better. This test showed that such a performance could have resulted by chance *no more than one time in forty-eight*. Adding to its credibility is the fact that the cycle continued to perform in the ideal pattern after it was discovered in 1953; in fact, its behavior has been dramatically precise through 1968.

What does it all mean, you may ask. Why do we study repetitive behavior in barometric pressure at New York City? These are logical questions. First, there is the most obvious answer—we study it because it is there. Secondly, such work may be invaluable in future long-range forecasts. A third reason is that it may be possible that this cycle found in nature may tend to influence other things in seemingly unrelated areas.

For example, cycles of this length have been found in other natural-science series. Douglass and Abbot both reported cycles of this length in tree-ring growth; Alter and Lane both found similar lengths as minor cycles in the behavior of sunspots; Abbot discovered a 7.58-year cycle in solar radiation and one of 7.66 years in the average mean temperature in Berlin. Another barometric-pressure study was performed by Clayton, who found a 7.54-year cycle at five widely separated weather stations throughout the world.

Also, cycles of this approximate length have been reported in pig-iron prices, steel prices, stock prices, sales of a public-utility company, and revenue freight ton-miles.

Could it be that changes in pressure influence man, and man in turn, reflects this influence in many ways? Long lists of reactions to a falling barometer in both animals and humans have been compiled. Generally the symptoms are restlessness, irritability, an increase in traffic and industrial accidents, forgetfulness, and sleeplessness.

One study by two biostatisticians, Digon and Bock, of the Pennsylvania Department of Health, shows that suicides tend to increase dramatically whenever barometric pressure changes by 0.35 inches or more, and there was also some indication that a falling barometer was more dangerous than a rising one. The two scientists did not offer any possible explanation for the apparent fact that changes in barometric pressure may trigger acts of self-destructive violence.

Whether or not there is any cause-and-effect relationship between the barometric-pressure cycle and any psychological or economic behavior will require long periods of extensive observations at various latitudes. But what a fascinating subject for someone to pursue! Does barometric pressure at places other than New York City have a 7.6-year cycle? Is the behavior worldwide? As the amount of air surrounding our planet is fixed, one would imagine that a 7.6-year cycle in pressure in one part of the world would have to be offset by an upside-down 7.6-year cycle in some other part of the world. Is there such an upside-down 7.6-year cycle, and if so, where? Also, in these other parts of the world do economic affairs also have an upside-down 7.6-year cycle? No one knows, but it is extremely important to find out if we are to understand the rhythmic forces to which we as human beings are subject.

The Rhythm of the Rain

The weatherman and his public image have shown great progress since 1870 when the U.S. Signal Corps initiated our first national weather service. Each evening as we watch our favorite television prognosticator give his or her odds on rain occurring in the next five days it is difficult to realize that until the late Henry Wallace was Secretary of Agriculture (1933-1940) there were no government forecasts made for more than twenty-four hours into the future.

Concerned with the obvious effect of weather on crops, Wallace suggested that the Weather Bureau attempt forty-eight-hour forecasts. Now, with advanced computers, radar, and the Tiros satel-

lites monitoring the move of every cloud formation, it is possible to make fairly accurate general weather predictions almost two weeks in advance—and when meteorologists accept Einstein's famous premise that "God does not play dice with the universe" and recognize that there are rhythmic behavior patterns in climatology, they may be able to predict weather several years into the future!

Yet many of them continue to work with their heads in the sand—or the clouds. Show them the following graph (Figure 41), and they will tell you that the obvious 4.33-year cycle in Philadelphia precipitation since 1820 is mere coincidence.

This cycle, if real, is a small factor in total precipitation, probably accounting for only slightly more than a one-inch change in a year. Yet if the cycle is significant, if it is one of the reasons for changes in levels of precipitation, then it is another important clue to helping us unravel our puzzle.

As a further check on our Philadelphia figures the precipitation figures from nearby New York City and Baltimore were both investigated. Each produced the same 4.33-year cycle. Of the three cities the Baltimore cycle is most pronounced (Figure 42). This cycle could occur by chance only once in 400 times.

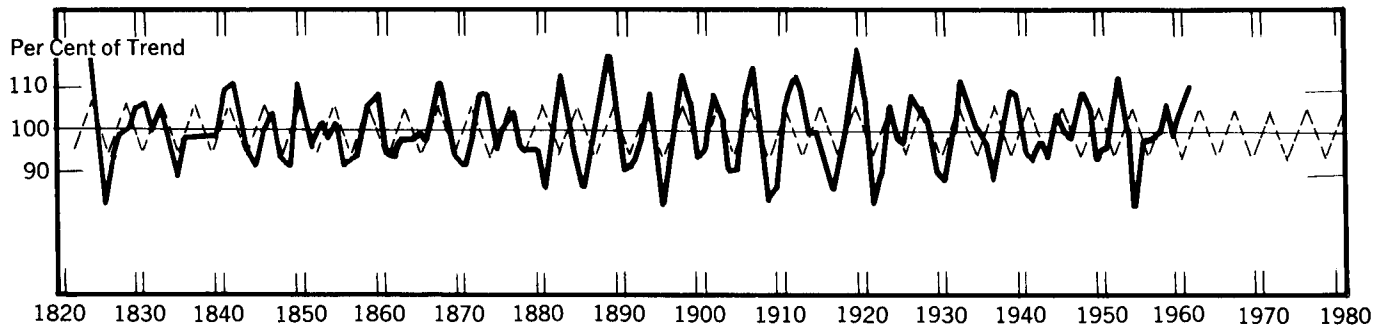


Fig. 41. The 4.33-Year Cycle in Philadelphia's Precipitation, 1820-1960

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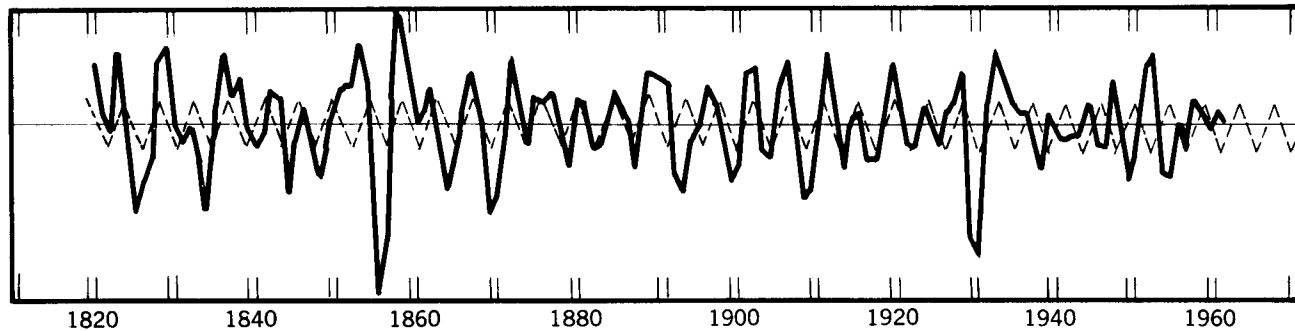


Fig. 42. The 4.33-Year Cycle in Baltimore's Precipitation, 1820-1960

Why Does It Rain on January 23?

A heavy rainfall usually descends on Brisbane, Australia, on January 23. Dr. E. G. Bowen, Chief of the Radiophysics Division of the Commonwealth Scientific and Industrial Research Organization in Australia, reported that on certain days, such as January 23, it rained in Brisbane and that this has occurred so often that it could hardly be chance.

Later the U.S. Weather Bureau corroborated Dr. Bowen's findings concerning a recurring pattern of high and low rainfall on the same calendar days. Dr. Bowen suggested that since certain meteoric showers recur at regular dates, the entrance of meteoric dust into the earth's atmosphere may have been the culprit, but there is still no proof as to the exact cause of this yearly shower.

The 100-Year Cycle

The late Professor Raymond H. Wheeler, while at the University of Kansas, engaged in an immense project to summarize, in an organized fashion, all of recorded history. The compilation of the 2,500 years of records from which Wheeler derived so many brilliant hypotheses took 20 years and at one time occupied as many as 200 people. You will meet him again when we consider the cycles in war.

As Wheeler's work progressed, he noticed a marked correspondence between the historical record of human events and the weather at the time the events occurred. Wheeler's chief interest was in the relation and reaction of man to his environment and, of course, weather and climate are a major element in our environment.

Professor Wheeler discovered many cycles during the course of his work but he felt the most important one to be a climate cycle of about 100 years' duration. To this 100-year cycle of weather change he tied the record of human events and concluded that the two factors, weather and human events, were intimately related.

Wheeler's 100-year cycle is divided into four phases (see Figure 43).

This cycle averages 100 years, although it may run as short as

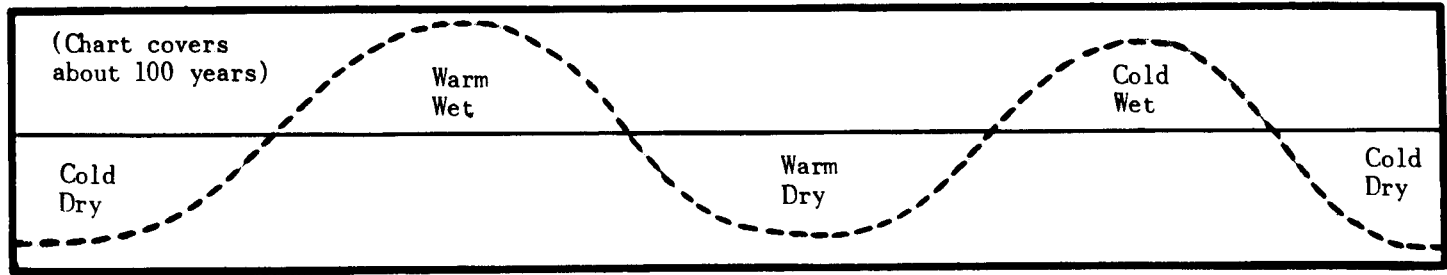


Fig. 43. Wheeler's Phases in Climate

seventy years and as long as 120 years. Also, the four phases are not precisely equal in duration. In general, the cycle has a warm and a cold phase, with each of these having a wet and a dry period. These expressions are only intended to describe world conditions in general and not the weather conditions for specific geographic locations at specific times.

Wheeler noted that the general character of the climate over a period of years can be seen in historical cycles. Because people are certainly affected by the character of the weather, similar events have occurred throughout history during the same phases of the 100-year climate cycle.

COLD-DRY

The cold-dry period, according to Wheeler, is a time of general individualism, with weak governments, migrations, and other mob actions such as race riots. Class struggles and civil wars ranging from palace intrigues to revolutions occur during the general anarchy of the cold-dry period. People are cosmopolitan and Epicurean, borrowing culture and living by superficial and skeptical philosophies. (In 1949 Wheeler indicated that we were passing through a cold-wet period and heading into this ugly cold-dry era. Draw your own conclusions.)

As this phase nears an end and fades into the next phase, leadership emerges and societies become stabilized; new governments develop and nationalistic spirit revives. Wars take the form of expansion and imperialism.

In the transition from the cold to the warm era, human energies operate at a high level (just as in the spring of the year). Learning is revived, genius appears, industrial revolutions occur, crops are good, and times are prosperous.

WARM-WET

The warm-wet period sees the climax of the trends started in the previous transition, with achievement becoming organized, and the emphasis put on cooperation and integration of views and effort rather than individual accomplishment. Interest in the state rather than the individual develops and governments become more rigid and centralized.

WARM-DRY

As the weather changes from a general warm-wet phase to warm-dry phase, the rigid governments of the previous period become despotic, police states emerge and personal freedom declines. Behavior patterns are introverted. In art, surrealistic and impressionistic patterns develop, and in business, aggressiveness and self-confidence decline with subsequent depressions and the collapse of economic systems.

During the transition to the next cold period, according to Wheeler, wars reflect the culmination of the decadence of the previous period and become the cruelest type of struggle with entire populations slaughtered or enslaved. (This period saw the beginning of World War II.) However, as the temperature falls and rainfall increases, activity increases, crops are again good, and general revival begins.

COLD-WET

The cold-wet phase sees the reemergence of individualistic philosophy, with decentralizing trends in government and business. It is a period of emancipation and natural behavior; art is straightforward and simple; scholarship follows mechanistic lines. These trends continue and grow until they reach a climax of general anarchy during the cold-dry period to follow.

If we are now into the cold-dry period, we can eagerly look forward to the golden age of the warm-wet period coming up next. And the sooner the better!

Our Shuddering Earth

Lake Hebgen, twelve miles west of Yellowstone Park, is a favorite watering hole and resting place for waterfowl and other bird life.

At noon on August 16, 1959, every bird began to leave the area and by nightfall not a bird was to be seen on the lake. This event was so unusual that it aroused both local and national scientific interest. At midnight the first shocks of Yellowstone's frightening earthquake began just west of the park.

What mysterious force caused the birds to abandon the area twelve hours before the first earth tremors? Dr. John Aldrich of the Department of the Interior searched all available literature on the subject but failed to find any record of similar behavior in the past. Although birds are known to be acutely sensitive to changes of atmospheric pressure, one wonders from what source came the early warning of impending disaster. How did the birds know that Lake Hebgen soon would not be a safe resting place?

More than a million earthquakes occur annually throughout the world and are registered on sensitive seismographs with ratings in intensity from 1 to 10. Earthquakes originate miles beneath the surface of the earth, splitting tremendous masses of rock along rupture planes called "faults." They recur in the same well-defined areas year after year, especially along the Pacific coast, the western mountain region of the United States, and a large part of Canada.

That they occur in the same area time after time is common knowledge. But there is growing evidence that their behavior has a rhythmic pattern, and increased research and knowledge into possible earthquake cycles may save the world countless lives and billions of dollars in property damage.

Dr. Charles Davison, of England, studied records of earthquakes in the northern hemisphere for the years 1305 to 1899. During this 581-year period there were fifty-three peaks of earthquake abundance at an average of 10.96 years apart.

Davison found a close association between earthquakes and sunspots, as you can see in Figure 44.

He noted that earthquakes and sunspots both fluctuate in a cycle about eleven years long and that the ideal time of *most* quakes is about the same as the ideal time of *most* sunspots. Also, the irregularities of the eleven-year earthquake cycle seem to be similar to the irregularities of the eleven-year sunspot cycle. Perhaps there is some association between earthquakes and sunspots. What is it? When we discover it, will it throw light on the way cycles operate and the cause of cycles in other things?

The sun and its fascinating behavior are closely related to our weather in many ways. We will take a long look at these meteorological "coincidences" later.

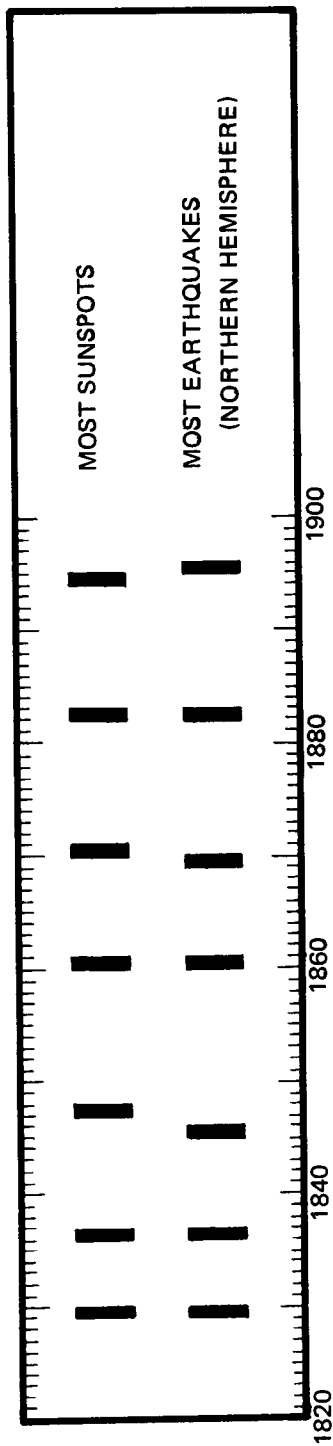


Fig. 44. Earthquakes and Sunspots, 1829-1896

Note that the first cycle is short for both sunspots and earthquakes, the next cycle is average for both, the third is long for both, and so on (after Davison). Is there some association between earthquakes and sunspots, and when we discover it, will we have another important clue as to how cycles operate?

Many other cycles have been discovered in earthquakes. In Japan, where the earth trembles several times a day, the great seismologist Omori discovered an increase in numbers every 2.75 years. Stanford University's president, following the California earthquake of 1906, concluded that earthquakes in the Portola rift appeared to have a thirty-to-forty-year cycle, and a former Weather Bureau meteorologist, W. C. Clough, working with 1,700 years of data, alleged the existence of a thirty-seven-year cycle in the behavior of Chinese earthquakes. I tested his theory, refined the cycle length to thirty-five years, and discovered an additional significant cycle that measured 17.66 years.

Volcanos spew their "fire and brimstone" on land and man with little warning. Most famous perhaps is Vesuvius, which erupted in A.D. 79 and buried the metropolis of Pompeii under twenty feet of pumice stone and ash. Vesuvius still belches approximately every thirty seconds.

Although volcanos are scattered throughout the world, the majority are in the Pacific Ocean area. Unfortunately, accurate records for their eruption are available only for this century so that any study of their cycles is extremely limited. Yet the volcanologist Giuseppe Imbo stated that eruptions of Vesuvius occur at intervals approximately fourteen to seventeen years apart, although he too claimed that there were not sufficient data to make firm predictions.

However, T. A. Jaggar, who was one of the world's outstanding authorities on volcanic activity and lived on the edge of the crater of the volcano Kilauea in Hawaii, had marked success with his predictions. In January 1929 he successfully predicted the eruption of Kilauea. In 1945 he repeated his forecast, and again Kilauea erupted. The striking features of the Kilauea pattern, according to Jaggar, were a long cycle of 134 years, another of approximately 33 years, and a minor cycle of approximately 11 years. The 11-year cycle, he noted, showed a tendency to correspond to the minimum period of spots on the sun.

California's Lassen Peak is the most recently active peak in the conterminous United States and it shows evidence of a sixty-five-year cycle. A major eruption occurred in the period from 1914 to 1917, and according to the geologist H. A. Harkness, an earlier eruption took place in the winter of 1850-1851. Other geologists

corroborate his dating and allege that there is good reason to believe that sixty-five years earlier another outbreak occurred.

Based on this brief evidence, if the cycle continues, there should be a very hot year near Lassen Peak around 1980.

The Billion-Dollar Basin

The Great Lakes are the largest inland body of fresh water in the world, encompassing in a "basin" approximately 295,000 square miles of land and water. The five lakes forming this great natural wonder exhibit the same behavior that one notices in most other phenomena in nature. Their lake levels go up and down in cycles, creating havoc with shipping, fishing, beach resorts, and the manufacture of electric power.

In 1964, when the water level of the Great Lakes had reached its lowest point in history, a congressional hearing was called and Senator Philip Hart's opening remarks contained an analogy pertinent to our inquiry: "The Basin is the heart of the Midcontinent . . . in fact, the heart of the American continent. It is a heart which beats in direct ratio to the strength and capacity and continued availability of that water."

Colonel S. W. Pinnell, of the Army Corps of Engineers, testified during the hearings. He explained that the water levels in the Great Lakes depend primarily on such natural processes as precipitation, runoff, and evaporation. If there is a major variation in these normal processes, there is a corresponding change in the net amounts of water supplied to the lakes, and this results in consequent periods of abnormally high or low water.

The major economic effects of low water level on commerce and power were also explained. Colonel Pinnell said that a major portion of commercial shipping on the Great Lakes is affected by the low levels of Lakes Michigan and Huron. From an analysis of major items of lake traffic into or out of United States harbors during 1964, when water levels were about one foot too low, he noted that the loss in commercial shipping was estimated at about \$7 million. Also, reductions in power generation occur because when levels are low the outflow from the lakes is low. During the first half of 1964 the output of the state generating plant at Niagara was about $1\frac{1}{4}$ billion kilowatt-hours less than average.

Colonel Harry A. Musham, of Chicago, has been forecasting *future* levels of Lakes Michigan and Huron for many years with considerable success. In 1941 he predicted that Lake Michigan would reach maximum levels in 1951 and 1952. It did. In 1943 he predicted that lake levels would decline in 1963, *twenty years later*. They did—to a point that brought about the aforementioned congressional investigation.

Musham's forecasts, which he arrived at after studying data on the levels in Lakes Michigan and Huron, are based on a cycle that he says may be about 22.75 years long. Michigan and Huron have the same water level, and changes in their levels are generally indicative of changes in the other Great Lakes. Musham extends his relationship beyond the Great Lakes, saying, "What happens in Lake Michigan is an index of what is happening, fresh water-wise, throughout the world's bread basket regions. Like all other landlocked reservoirs, the lake is fed by rain. Studies show that Great Lakes' peak levels are always preceded by bountiful world-wide precipitation."

A comprehensive scanning of the data for Lake Huron and Lake Michigan recently made at the Foundation tends to confirm Musham's work and suggests a number of cycles in these figures. The post-1964 upturn in lake levels predicted by these cycles has indeed come about.

A complete understanding of the cycles in the levels of the Great Lakes would contribute greatly to the ability of hydrologists to forecast future lake levels. The saving that would result from this knowledge when applied to the stabilization of lake levels, minimizing damage done to shore installations, controlling harbor depths, and many other areas is incalculable.

Since precipitation is so closely related to lake levels, increased knowledge could also aid in making more accurate long-range weather forecasts, with subsequent reductions in agricultural losses. The importance of knowing in advance the basic climate pattern—wet or dry, hot or cold—for a large area of the country does not need stating.

But it does need to be pointed out that the problem of long-range weather forecasting, even with recent advances in equipment and techniques, is far from being solved, and the possibility of cycles being a large part of the solution should not be overlooked.