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30 July 1962

Lunar Synodical Period and Widespread Precipitation

Abstract. Precipitation activity over broad areas appears to be closely associated with the monthly lunisolar cycle. Indexes of precipitation in the continental United States over a continuous 50-year period, and 91-year daily histories of individual stations, reveal that heavy rains occur most frequently in the first and third weeks of the synodical month.

Although an effect of the moon on weather has been suggested by many investigators (*1*), no acceptable physical explanation has been offered for any of the effects that have been claimed or suspected. Such complicating factors as seasonal and geographical variations might easily obscure any hypothecated influence. The statistical evidence presented has been quite unsatisfactory because of the scarcity of data or its lack of representativeness. Also, valid tests of significance to distinguish the observed fluctuations from chance have not usually been applied except by van der Bijl (*2*) and Mauchly (*3*). The latter reported a possible relationship between precipitation activity and the moon's phases, noting a significant tendency for less precipitation to fall at selected cities on approximately the second and third days prior to new moon.

In pursuit of the questions raised by these previous studies and in connection with an explorative investigation into possible links between other astronomical factors and weather parameters, a comprehensive plan was devised to cope with the matter. The results that were achieved from following through with this research program, free of most of the limitations of its antecedents, are quite surprising and positive.

Data highly representative of the chronology of heavy precipitation in the continental United States are furnished by Weather Bureau records of the dates and places of maximum 24-hour precipitation per calendar month (*4*). A total of 16,057 maximum precipitation records, representing 6710 individual dates, are provided for the 1544 weather stations which continuously operated over the 50 years 1900–1949. It is reasonable to assume that these data are fairly representative of the occurrence of excessive widespread precipitation in the U.S. during that half-century.

The angular difference between the apparent longitudes of the moon and sun at Greenwich noon is expressed as hundredths of the synodical month of 29.53 days (*5*). When their longitudes coincide, at the event of new moon, the "synodic decimal" is 0.00, and when the lineup called full moon takes place, the decimal becomes 0.50. Quadrature aspects, which mark the phases popularly known as first and last quarters, are expressed as 0.25 and 0.75, respectively. The synodic decimal advances about 0.03 per day. A ten-unit moving total of a distribution within successive classes, each 0.01 in width, therefore equates roughly to a 3-day moving total.

The tabulation of synodic decimals for each storm date was performed in two parts, the precipitation history being separated into 25-year halves, for 1900–1924 (with 7856 cases), and for 1925–1949 (with 8201 cases). Treatment of the first 25-year series was completed without prior knowledge of the comparable outcome that resulted from handling the second series in the same way. Figure 1 shows a similarity between the abnormal distributions, which should behave normally and independently if no lunisolar influence were at work, that is quite pronounced. Correlation between the two curves is 0.805, while harmonics fitted to the series account for highly significant percentages of the variance.

The quantitative nature of the indicated lunation effect is clear from a separate plotting of the 185 dates which registered as precipitation maxima at ten or more stations. The amplitude of the diphasic 29.53-day cycle is remarkable, since the dates of the most extreme widespread rainfalls in the U.S. history are 3 times more frequent during the cyclic peak periods than during the cyclic trough periods.

That this effect is not due to an unsuspected bias introduced into the processing of the data is evident from a randomized test. The correlation between curves when the 185 "wettest days" are divided into two 25-year series is 0.63, whereas the correlation after scrambling (pairing off storm dates with the synodic decimals for randomly selected dates within the same period) is −0.03.

Other investigative approaches, in which different sorts of basic data

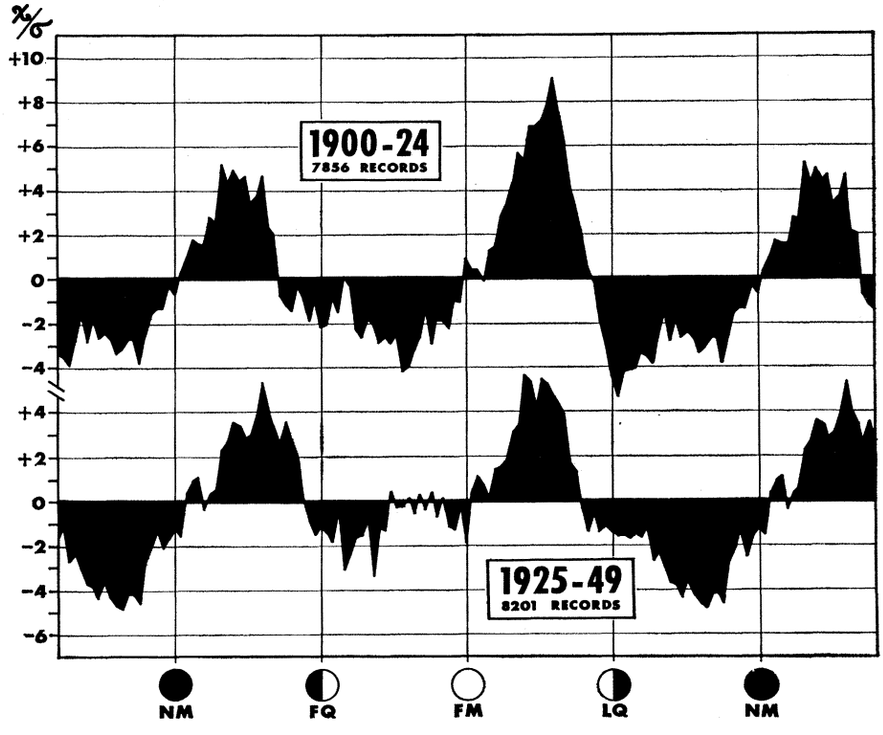

Fig. 1. Deviations (in terms of standard measure) of ten-unit moving totals of synodic decimals for 16,057 record dates of maximum 24-hour precipitation at 1544 U.S. stations, 1900–1949, treated in separate 25-year series for correlative comparison.

were used, lead to the same marked differences. For example, analyses of the precipitation records of single stations verify the reality and persistence of the lunisolar effect (or some closely related cycle of unknown cause). Distributions of the synodic decimals for the 1000 dates of heaviest rainfall, throughout full 91-year histories of such stations as New York City, Washington, Boston, and Toronto, clearly exhibit the same lunar-month pattern of fluctuation.

In pursuit of the vital question whether this lunar effect is globally discernible, we communicated with E. G. Bowen in the hope of arousing interest in similar work with data from the Southern Hemisphere. The unexpected outcome from this inquiry led to the accompanying report (*6*).

In summary, it can be stated that when dates of excessive precipitation are plotted in terms of the angular difference between the moon and sun, a pronounced departure from normal expectancy becomes conspicuous. There is a marked tendency for extreme precipitation in North America to be recorded near the middle of the first and third weeks of the synodical month, especially on the third to fifth days after the configurations of both new and full moon. The second and fourth quarters of the lunation cycle are correspondingly deficient in heavy precipitation, the low point falling about 3 days previous to the date of an alignment of the earth-moon-sun system. There is a demonstrable persistence of this lunisolar effect in U.S. weather records throughout the history of official meteorological observation (*7*).

These results should not be interpreted to mean that the position of the moon can be used as a reliable predictor of day-to-day rainfall. Rather, their immediate import is for atmospheric research. There is no assurance that the unknown mechanisms responsible for the effects presented here can be easily discovered; but to the extent that a search stimulates additional basic research, the prospects for a better understanding of the physical processes of the atmosphere are enhanced (*8*).

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Lunar Component in Precipitation Data

The influence of the moon in producing tides in the upper atmosphere and the appearance of a lunar component in daily temperature in certain parts of the world are comparatively well known, but the effects are extremely small and difficult to detect. The possibility of a large effect on rainfall first came to our notice in 1960 with the chance reading of a paper by Rodés (*1*). Rodés showed what appeared to be a connection between rainfall in the Spanish peninsula and both the declination and the position of apogee and perigee of lunar motion. An investigation was therefore made of the rainfall data in our possession, and it was apparent that it contained a strong lunar component. However, it was also clear that this was connected with the phase of the moon rather than with the parameters used by Rodés.

At this point a decision was taken not to publish the data immediately, but to reserve it for a later date. The reason for doing so was that our work on singularities in rainfall was still being treated with disbelief in meteorological circles, and to suggest a lunar effect on rainfall would simply not have met with the right response.

We were not surprised therefore when we received a communication from Bradley, Woodbury, and Brier (*2*) indicating a pronounced lunar effect in U.S. rainfall. The effect is matched by similar effects in the Southern Hemisphere. A curve showing the heaviest falls of the month for 50 stations in New Zealand, plotted in the same way as the U.S. data are plotted, is given in Fig. 1. It shows variations of a magnitude comparable with those in the U.S. and closely related in phase.

It should not be assumed from this that a lunar component will be found in all rainfall records. It is already apparent that there are distinct variations

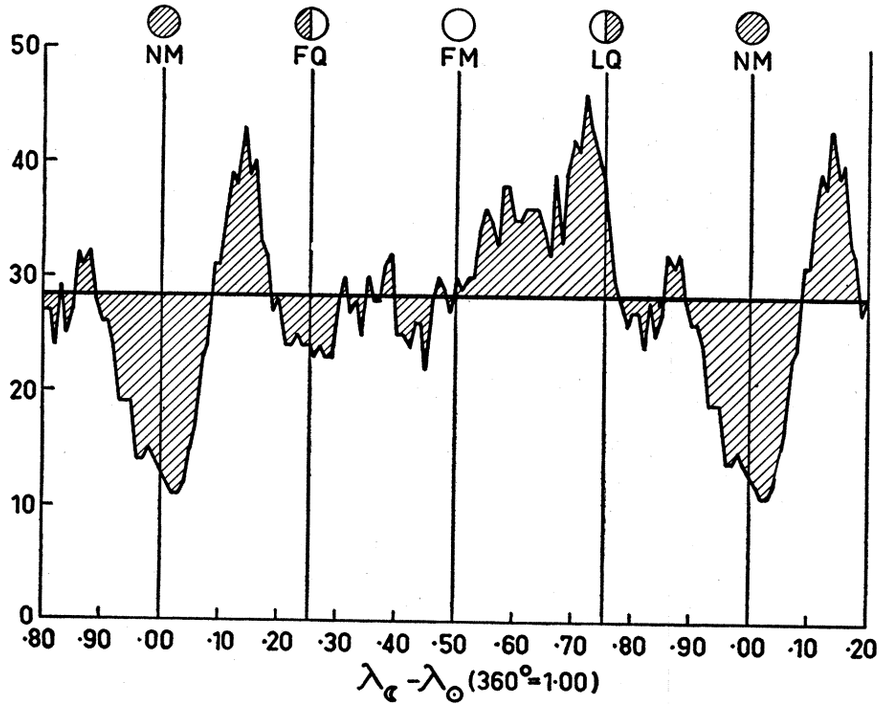

Fig. 1. Ten-unit moving totals of the heaviest falls of the month, for 50 New Zealand stations for the years 1901–1925, plotted against the synodic decimal.