SHORTWAVE RADIO PROPAGATION CORRELATION WITH PLANETARY POSITIONS*

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Summary—An examination of shortwave radio propagation conditions over the North Atlantic for a five-year period, and the relative position of the planets in the solar system, discloses some very interesting correlations. As a result of such correlations, certain planetary relationships are deduced to have specific effect on radio propagation through their influence upon the sun. Further investigation is required to fully explore the effect of planet positions on radio propagation in order that the highly important field of radio weather forecasting may be properly developed.

Introduction

MANY investigators of solar activity in the past have conducted extensive studies of planetary phenomena in an effort to account for the maximum and minimum of the eleven-year sunspot cycle and also the shorter period variations in sunspot numbers which take place from month to month. The results of several of these investigators appear to indicate a connection between the interrelationship of the planets and the degree of spottedness of the solar surface. The works of Huntington,[1] Clayton,[2] and Sanford,[3] were found to be particularly applicable to the subject matter of this paper.

The results of their investigations suggested that a similar study relating planetary phenomena to radio disturbances over the North Atlantic might reveal information of value. Since June, 1948, the author has conducted research on this subject, and this paper presents the correlation that has been found between shortwave radio disturbances and certain planetary phenomena as described below.

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* Decimal Classification: R 113.216.

[1] E. Huntington, EARTH AND SUN, Yale University Press, New Haven, Connecticut, 1923.

[2] H. H. Clayton, SOLAR RELATIONS, Clayton Weather Service, Canton, Massachusetts, 1943.

[3] F. Sanford, INFLUENCE OF PLANETARY CONFIGURATIONS UPON THE FREQUENCY OF VISIBLE SUNSPOTS, Smithsonian Institution, Washington, D. C., 1936.

Motion of the Planets

The heliocentric interrelationship between Mercury, Venus, Earth, Mars, Jupiter and Saturn was extracted from the AMERICAN EPHEMERIS AND NAUTICAL ALMANAC published by the U. S. Naval Observatory in Washington, D. C. for the years 1942, 1944, 1947, 1948, and 1949. Dates when the heliocentric relationship of any two planets was 0°, 90°, 180° or 270° were recorded. At 0° an inner planet is in line on the same side of the sun with an outer planet; at 90° an inner planet is 90° *ahead* of an outer planet; at 180° an inner planet and an outer planet are in line on opposite sides of the sun; at 270° an inner planet is 90° *behind* an outer planet. These relations are hereinafter referred to as configurations.

In addition to plotting the positions of the various planets in this way, a record was made of the solar quadrants over which each configuration took place. The solar quadrants in this study are determined by the Earth-Sun relationship under which the Sun is divided into its four quadrants as follows: The first quadrant is the visible sector of the eastern hemisphere of the Sun as viewed from the Earth; the second quandrant is the invisible sector of the eastern hemisphere; the third quadrant is the invisible sector of the western hemisphere; and the fourth quadrant the visible sector of the western hemisphere.

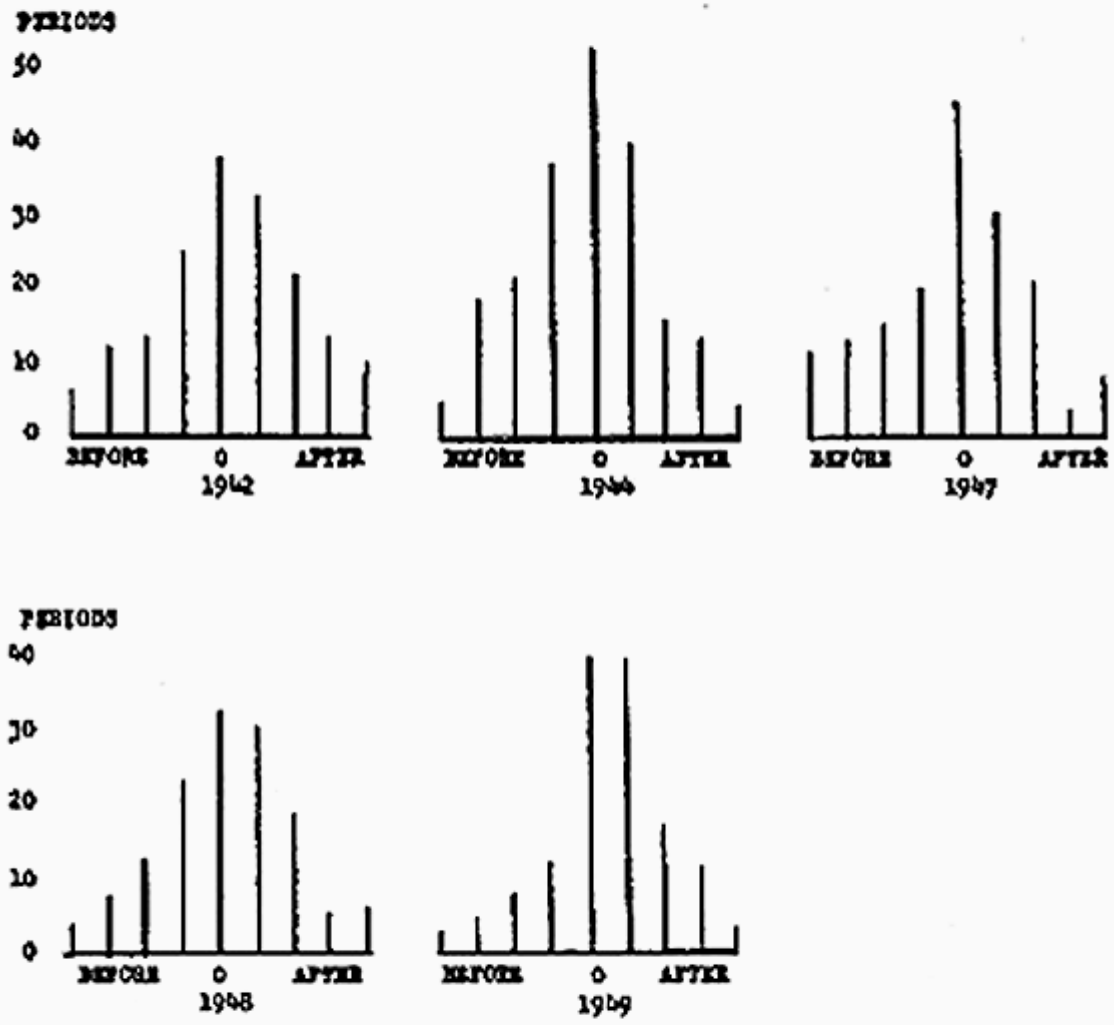
Every configuration of the type previously mentioned was calculated between Mercury and Venus, Mercury and Earth, Mercury and Mars, Mercury and Jupiter, and Mercury and Saturn. Following this the same method was used with Venus and its outer planets, Earth and its outer planets, Mars and its outer planets, and Jupiter and Saturn. The analysis shows that these configurations are quite random in time and vary from cases where only one configuration between two planets takes place in a 14-day period to cases in which five of these six planets are involved in a configuration with some other planet within a forty-eight hour period. Cases where an inner planet makes a configuration with two outer planets within a twenty-four hour period are quite numerous.

At perihelion, Mercury moves 6° 19′ per day and therefore will make more configurations per unit time at this point in its orbit than at aphelion, where its speed is reduced to 2° 44′ per day. The variation in orbit speed of the other planets is negligible for this particular study.

Method of Observation

Each technician at the RCA Communications, Inc. Receiving Station at Riverhead, Long Island, New York, maintains a log record

during his tour of duty which provides a record of conditions on shortwave signals over the North Atlantic during the midnight to 8:00 A.M. period, the 8:00 A.M. to 4:00 P.M. period and the 4:00 P.M. to midnight period. All of these eight-hour periods for the years 1942, 1944, 1947, 1948 and 1949 were correlated with existing planetary configurations and the results systematically recorded. The correlation between shortwave disturbances and planetary configurations is shown in Figure 1 for each of the years studied.



NUMBER OF 8-HOUR WATCH PERIODS RATED AS DISTURBED (POOR) BY RCAC RIVERHEAD COMPARED TO DAYS BEFORE AND DAYS AFTER (0) CONFIGURATION DAY. CONFIGURATION DAY DESIGNATED AS "0".

Fig. 1—Correlation between disturbed periods and day of configuration.

It can be readily seen from these graphs that disturbed conditions show good correlation with planetary configurations. This strongly indicates a relationship between North Atlantic shortwave signal behavior and planetary configurations. All configurations, however, are not accompanied by disturbed conditions. Analysis shows that some 0°, 90°, 180°, or 270° configurations between two planets can be nullified if one of them is close to 120° from another planet on the same day.

It is, however, definitely shown that each of the six planets studied is effective in some configurations.

There seems to be a "quadrant effect" in that planets over some solar quadrants show better correlation with disturbed conditions than when over other quadrants. The two most effective quadrants are shown in the study to be the first and third quadrants and the least effective the fourth quadrant. Good correlation exists with configurations of the 180° type wherein the inner planet is over the first quadrant and the outer planet over the third quadrant.

The results of a special study of Mercury when this planet was over the first quadrant and the outer planet was over the third quadrant is shown below. (The period of plus and minus one day from configuration day or a three-day period was considered in determining whether correlation was made with radio conditions.)

Planets	Number of Configurations of Above Type	Number of Configurations Disturbed
Mercury — Venus	4	4
Mercury — Mars	6	5
Mercury — Jupiter	5	3
Mercury — Saturn	4	3

The best correlation is found between shortwave disturbances and configurations of the multiple type. Analysis shows that the closer a configuration comes to being a multiple, the greater the likelihood of a disturbance. In a multiple configuration one fast inner planet will make a configuration with two slower outer planets while the two outer planets are themselves actually in configuration or close to a configuration. An example would be Mercury reaching a position where it was 90° behind Venus and 180° from Jupiter which places Venus 90° behind Jupiter. Configurations of this type, surprisingly, are quite common. Six examples are shown below.

(1)	February 7, 1944	Mercury — Venus	0°
	February 8, 1944	Mercury — Jupiter	90°
	February 8, 1944	Venus — Jupiter	90°
	(February 7th to 10th were severely disturbed)		
(2)	April 12, 1949	Mercury — Venus	0°
	April 12, 1949	Venus — Jupiter	90°
	April 12, 1949	Mercury — Jupiter	90°
	(April 11th to 13th were severely disturbed)		

(3)	January 23, 1947	Mercury — Earth	180°
	January 24, 1947	Mercury — Saturn	180°
	January 26, 1947	Earth — Saturn	0°
	(January 25th was severely disturbed)		
(4)	May 14, 1947	Earth — Jupiter	0°
	May 15, 1947	Mercury — Jupiter	180°
	May 15, 1947	Mercury — Earth	180°
	(May 13th to 17th were severely disturbed)		
(5)	February 22, 1948	Venus — Jupiter	180°
	February 23, 1948	Mercury — Venus	90°
	February 23, 1948	Mercury — Jupiter	270°
	(February 23rd to 25th were severely disturbed)		
(6)	April 18, 1948	Mercury — Venus	180°
	April 19, 1948	Mercury — Jupiter	90°
	April 21, 1948	Venus — Jupiter	270°
	(April 19th to 23rd were severely disturbed)		

The relationship between the positions of Jupiter and Saturn is very important in respect to multiple configurations and during those years when these two planets are separated by 0°, 90°, 180°, and 270°, there will be a greater number of multiple configurations since these planets move very slowly. Hence, the faster inner planets will make a double configuration in rapid time sequence every time one of them makes a contact with either Jupiter or Saturn. This is particularly so in the case of Mercury or Venus.

Correlation of Observations

The encouraging correlation found between ionospheric disturbances over the North Atlantic and configurations (particularly of the multiple type) for 1942, 1944, 1947, 1948, 1949, suggest the following deductions:

(1) That the most disturbed twelve-month periods will be those preceding and following configurations of the 0°, 90°, 180°, and 270° type between Saturn and Jupiter.

(2) That the most disturbed parts of the periods in (1) will be those in which Mars is close to a configuration of the 0°, 90°, 180°, and 270° type with either Saturn or Jupiter.

(3) That the most disturbed part of the periods in (2) will be weeks when Earth, Venus, or Mercury has a configuration of

the 0°, 90°, 180°, or 270° type with either Saturn, Jupiter, or Mars.

(4) That the most severe disturbances of all will come when the combined influence of Mars, Earth, Venus, and Mercury are such that all four will be arranged in positions where there will be a great concentration of planetary influence near the 0°, 90°, 180°, or 270° points of the Saturn-Jupiter team during the configurations mentioned in (1).

(5) That the least disturbed periods will be those preceding and following periods when Saturn and Jupiter are separated by 120°, the principal disturbances during these periods coming from configurations of the 0°, 90°, 180°, or 270° type that the inner planets Mars, Earth, Venus, and Mercury make among themselves, or as a multiple with either Saturn or Jupiter.

(6) That the least disturbed periods of all will be those when Saturn, Jupiter, and Mars are equally spaced by 120°, the principal disturbances during these periods coming from configurations that Earth, Venus, and Mercury make among themselves, or as multiples with Saturn, Jupiter, or Mars. Configurations of the multiple type are less frequent during an arrangement of 120° among these three slow outer planets.

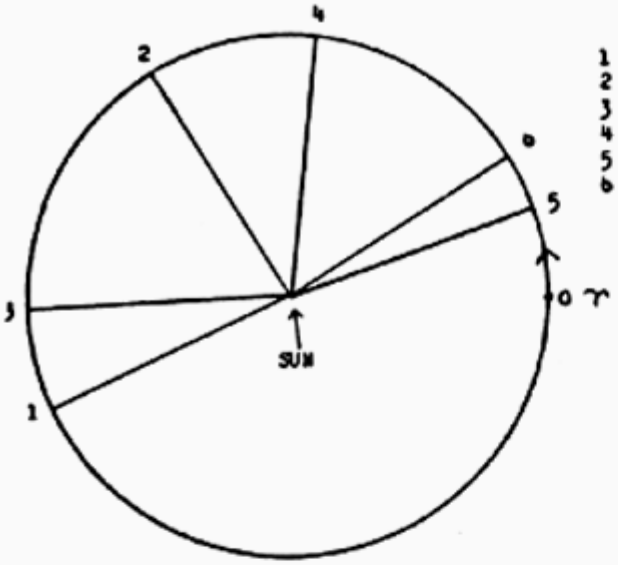
(7) That 60° relationships between planets will also tend to produce "least disturbed periods" since 60° is one half of 120°.

An exact arrangement of 120° as mentioned in (6) is rare but a very close approach to it occurred in 1934 when Jupiter was 120° behind Saturn on June 1st. During August, Mars came to the 120° position with both Jupiter and Saturn within a few days, while Jupiter and Saturn were 117° apart. Magnetic activity records show that the 1934 yearly average was the lowest recorded between 1930 and 1949.

Considerable scientific study has been devoted to the great magnetic storm and aurora of July 26th to 30th, 1946. Figure 5 shows the positions of the six planets as they were at zero Greenwich mean time July 27th, 1946. The space separation between the planets is given below.

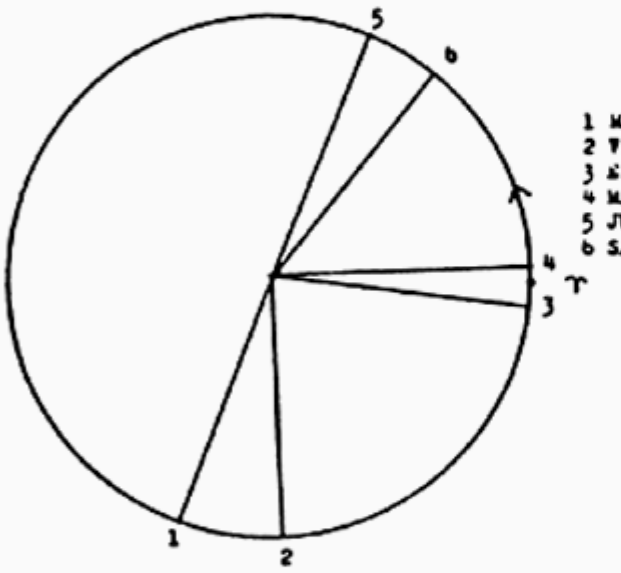
Jupiter—Saturn	91° 45′
Jupiter—Earth	92° 55′
Saturn —Earth	175° 20′
Mars —Mercury	89° 12′

The speed of Mercury carried it past the 90° point in relation to Mars a few hours after zero and into a multiple configuration with Saturn and Jupiter on July 30th.



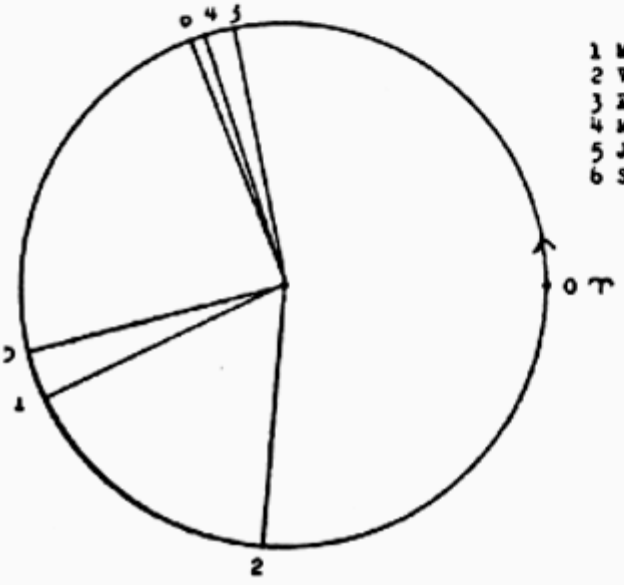
		°	'
1	MERCURY	205	43
2	VENUS	122	28
3	EARTH	163	12
4	MARS	83	59
5	JUPITER	20	06
6	SATURN	33	15

Fig. 2—Heliocentric longitude of planets during disturbances on March 24, 1940.



		°	'
1	MERCURY	250	21
2	VENUS	273	03
3	EARTH	354	40
4	MARS	2	58
5	JUPITER	69	10
6	SATURN	52	50

Fig. 3—Heliocentric longitude of planets during disturbances on September 18, 1941.

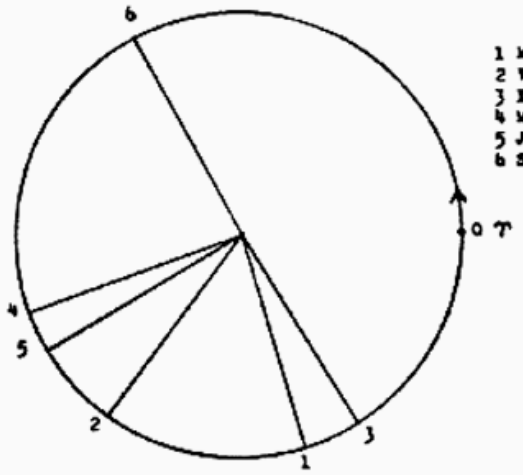


		°	'
1	MERCURY	204	57
2	VENUS	265	21
3	EARTH	102	01
4	MARS	108	09
5	JUPITER	194	56
6	SATURN	111	05

Fig. 4—Heliocentric longitude of planets during disturbances on January 3, 1946.

The heliocentric positions of the planets are shown in Figures 2, 3 and 4 for three other severe storms, March 23rd to 26th, 1940, September 18th to 20th, 1941 with aurora and January 3rd and 4th, 1946 with aurora.

Since 1946 a short term (24 hours) forecasting system has been under development at the Central Radio Office of RCA Communications, Inc. in New York City. An observatory, housing a six-inch refracting telescope, is maintained and daily solar observations, weather permitting, are made and correlated with existing radio conditions. From these solar observations, consisting of a study of the solar surface by eyepiece, and the mapping and classifying of all sunspots, a forecast for the following twenty-four hours is made. These forecasts when compared to actual radio conditions have been attaining an accuracy of around 80 per cent, as reported by RCA Communications, Inc., Riverhead, New York and Radio Suisse, Berne, Switzerland.



		°	'
1	MERCURY	288	45
2	VENUS	234	03
3	EARTH	303	21
4	MARS	199	33
5	JUPITER	210	26
6	SATURN	116	41

Fig. 5—Heliocentric longitude of planets during disturbances on July 27, 1946.

Conclusion

The research conducted at this Observatory since 1946 has quite definitely indicated that sunspots themselves are not the full answer to the problems that are manifest. There is very strong evidence that some other forces are at work in addition to the sunspots. The need of a new approach is indicated. The study of the planets as a new approach to propagation analysis has netted the encouraging results that are given in this paper and shows sufficient promise to warrant further and deeper study. A highly developed forecasting technique of this type would enable forecasting to be done several years ahead since advance planetary phenomena can be calculated with very great accuracy.

Acknowledgments

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