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Technical Note

No. 206-3

THE NORMAL PHASE VARIATIONS OF THE 18 KC/S SIGNALS FROM NBA OBSERVED AT BOULDER, COLORADO, U. S. A.

A. H. BRADY, A. C. MURPHY, AND D. D. CROMBIE

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The Normal Phase Variations of the 18 Kc/s Signals
from NBA Observed at Boulder, Colorado, U.S.A.

A. H. Brady, A. C. Murphy, and D. D. Crombie

Observations of the normal phase variations of the 18 kc/s signals radiated from the Canal Zone and received in Boulder, Colorado, U.S.A., are given in the form of monthly averages and standard deviations at five minute intervals. The relations between the diurnal phase variations and the diurnal variation in the length of sunlit path are shown. The calculated mean diurnal change in effective height of reflection is 18 km. Values of the short term phase differences are also given.

1. Introduction

This is the third of a series of reports, each of which summarizes the normal behavior of the phase of signals from various VLF transmitters as observed at particular receiving sites. This report deals with the reception at Boulder, Colorado, of 18 kc/s transmissions of NBA in the Canal Zone, a path length of 4260 km.

The earlier two reports in this series deal with the reception of NBA at Frankfurt, Germany [Brady et al., 1963], and Maui in the Hawaiian Islands [Brady et al., 1964].

It is the purpose of these reports merely to present the reduced phase data, with a minimum of discussion. The data in these reports will be used in subsequent papers, each of which will deal with a specific aspect of the data on all the paths.

2. Data Analyses

All the phase data used in these reports have been taken, reduced, and presented in a uniform manner as described in the first of the series [Brady et al., 1963]. Thus tables 1-12 contain monthly phase averages (AVER) at 5 minute intervals, standard deviations (SDV), and the number of observations (NO) used in obtaining these quantities (A fuller description of these tables is given in the first note of this series).

3. Diurnal Phase Variations

The monthly mean diurnal phase changes and standard deviations for 1962, taken from tables 1-12, are plotted in figures 1 and 2, while corresponding curves for 1961 are given in figures 3 and 4 for comparison. Ground sunrise (SR) and sunset (SS) at each end of the path are marked on the curves of diurnal phase variation. The agreement in magnitude and shape of the mean diurnal variations each month for the two years is considered to be good. The average diurnal phase change for 1961 is 186° , and for 1962 it is 189° . According to the mode theory of VLF propagation [Wait, 1959, 1962], a phase change of this magnitude corresponds to a change in the effective height of the ionosphere along the whole path of 18 km (assuming that the ionosphere is sharply bounded and that the mean of the daytime and nighttime heights is 80 km).

3.1 Seasonal Variation in Diurnal Phase Change

The mean diurnal phase change for each month is listed in table 13. Fourier analysis of these monthly means suggests that there may be small periodic variations having periods of 6 and 12 months. The apparent 6 month component has an amplitude of about 7° and a maximum between February and March. The apparent 12 month component also has an amplitude of about 7° but a maximum in December. Because of the scatter in the monthly means, these periodic components are probably not significant. However, if they should prove to be significant, they each represent peak-to-peak variations in the diurnal height change of about 1.3 km.

3.2 Variation of Phase with Amount of Illuminated Path

The monthly average phase variation shown in figures 1-4 shows typical superficial dependence on the length of path which is in daylight [Crombie et al., 1958; Pierce, 1957]. A more detailed examination of this relationship is given by plotting the diurnal phase changes at sunrise and sunset, together with variation in the length of illuminated path (at appropriate heights) at these times. This has been done in figures 5 and 6, which show the sunrise and sunset variations for March and June for 1961 and 1962, and in figures 7 and 8, which are for September and December in 1961 and 1962. The figures have been drawn so that the full diurnal phase variation fits the full "percent darkness" scale in each case.

It is clear from the figures that the variations shown for each month are very similar for both years.

The calculations of the length of illuminated path were made in the way described by Brady and Crombie [1964]. It is assumed in these

calculations that the screening height of the earth's atmosphere is 30 km. Sunrise or sunset at the heights of 0 and 80 km are thus equivalent to solar zenith angles of 90° and 97° .

3.3 Sunrise

Figures 5-8 show that the smoothed morning phase change follows closely the length of illuminated path. In June and September for both years the sunrise phase change started when the zenith angle of the sun was 97° . During March, however, greater variability was shown: In 1961 the phase change commenced earlier, while in 1962 it occurred later. During December in both years oscillatory phase variations [Crombie, 1964] occurred. They were particularly marked in 1961.

3.4 Sunset

Figures 5-8 also show that the dependence of the sunset phase change on the length of illuminated path is much weaker than at sunrise. In particular, the figures show quite clearly that during approximately 2 hours before ground sunset at the eastern end of the path there is a small phase retardation, typically, 10% of the total diurnal phase change. Then at ground sunset there is a further major phase retardation which follows quite closely the variation in the length of illuminated path. This portion is about 60% of the total phase change. The final stage commences when about 70% of the whole path has become dark. The rate of change of phase then becomes much less and in some cases it takes as long as 4 hours after ground sunset for the nighttime phase value to be finally attained.

4. Phase Stability

It was pointed out in the first paper of this series that both day-to-day phase stabilities and the phase variations over periods of time up to an hour or so were of interest. Typical values for the NBA-Frankfurt path were given in that paper.

The day-to-day standard deviations of phase observed at Boulder are given at 5 minute intervals for each month of 1962 in tables 1-12, and are also plotted in figures 1-4. During the hours when the path is completely daylit, the day-to-day standard deviations have a value of about 6° without any seasonal trend being apparent. When the path is dark, the day-to-day standard deviations vary between about 17° and 26° , again without a perceptible seasonal variation. For this path, a change in phase of 1° corresponds to a calculated change in the effective height of the ionosphere of 0.096 km. Thus the observed phase differences noted above are equivalent to height changes of about

0.6 km during the day if it is assumed that the fluctuations are entirely due to the ionosphere. The nighttime values range between 1.6 and 2.5 km.

The method of obtaining the short term phase variations has been described in the first of this series [Brady et al., 1963]. Table 14 contains the rms phase differences calculated in this way for intervals of 10-90 minutes (T). The data are given for both daytime and nighttime conditions during February, April, June, August, October, and December of 1962. As noted in the other papers of this series, the rms phase differences increase as the time interval T increases, particularly when T is small. Again, as for the observations of NBA at Frankfurt and Maui there is a general tendency for the magnitude of the daytime phase fluctuations to be less than when the path is dark. The observations at Boulder during April and October, however, are not in accordance with this. During April the daytime fluctuations consistently exceeded the nighttime fluctuations by 40% when T=10 minutes, and 100% when T approached 90 minutes. During October, on the other hand, the daytime fluctuations exceeded the nighttime fluctuations only when T exceeded 50 minutes, approximately.

5. Acknowledgment

The observations at Boulder have been obtained by Messrs. F. K. Steele and A. H. Diede. The U. S. Frequency Standard, maintained by the Radio Standards Laboratory, was used as a phase reference. The work reported here was supported by the Advanced Research Projects Agency, Washington, D. C., under Order No. 183.

6. References

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NBA (18kc/s, BALBOA, PANAMA) TO BOULDER, COLORADO
 AVERAGE PHASE FOR JANUARY-MARCH AND OCTOBER-DECEMBER 1962

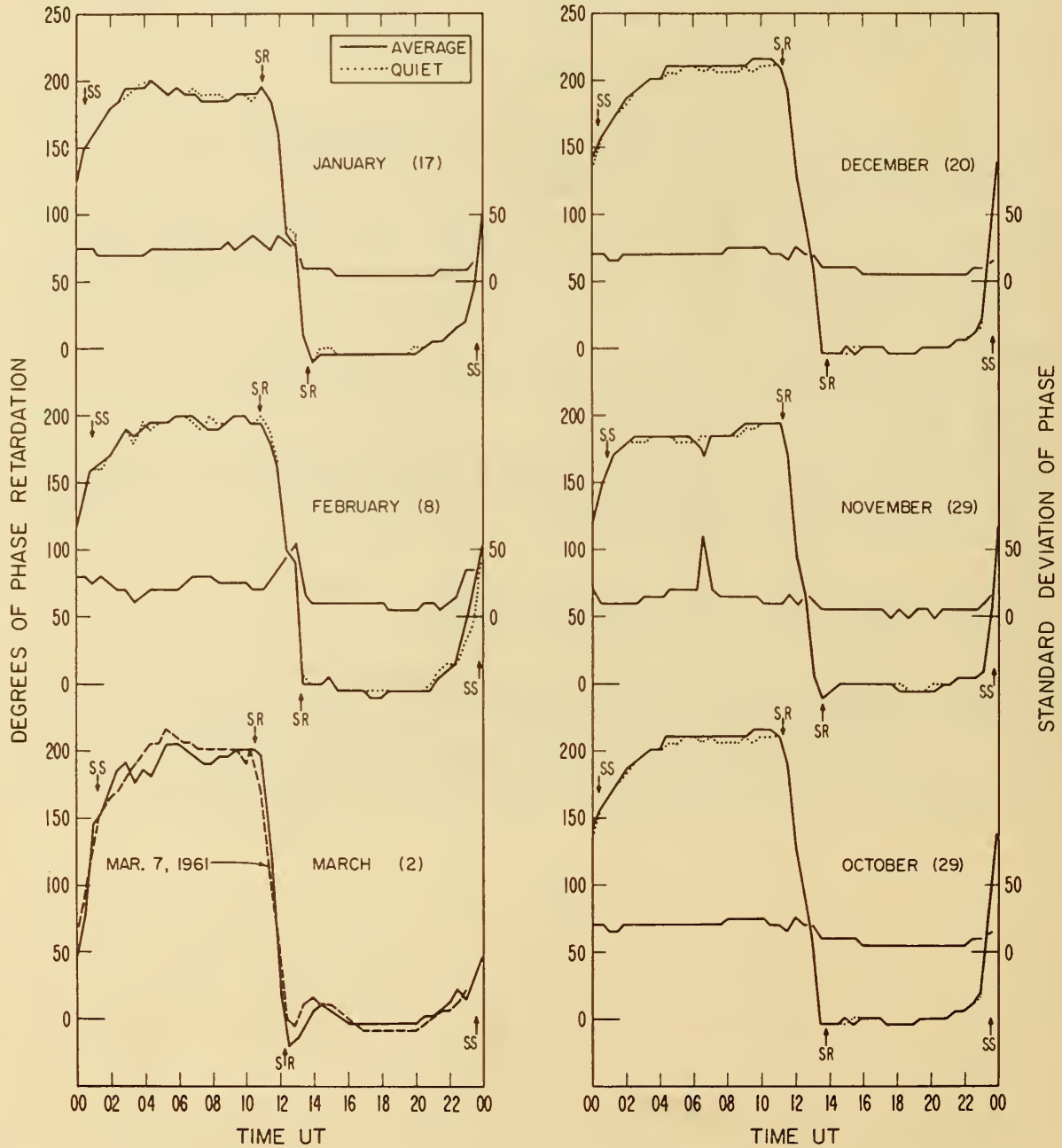


Fig. 1. Mean phase variations and standard deviations in degrees for January-March and October-December 1962. (Note: The dotted curve for March 1961 is superimposed on the March 1962 curve because only two days of observations were available in 1962), Sunrise and sunset at each end of the path are denoted by SR and SS on the mean phase curves.

NBA (18 kc/s, BALBOA, PANAMA) TO BOULDER, COLORADO
 AVERAGE PHASE FOR APRIL-JUNE AND JULY-SEPTEMBER 1962

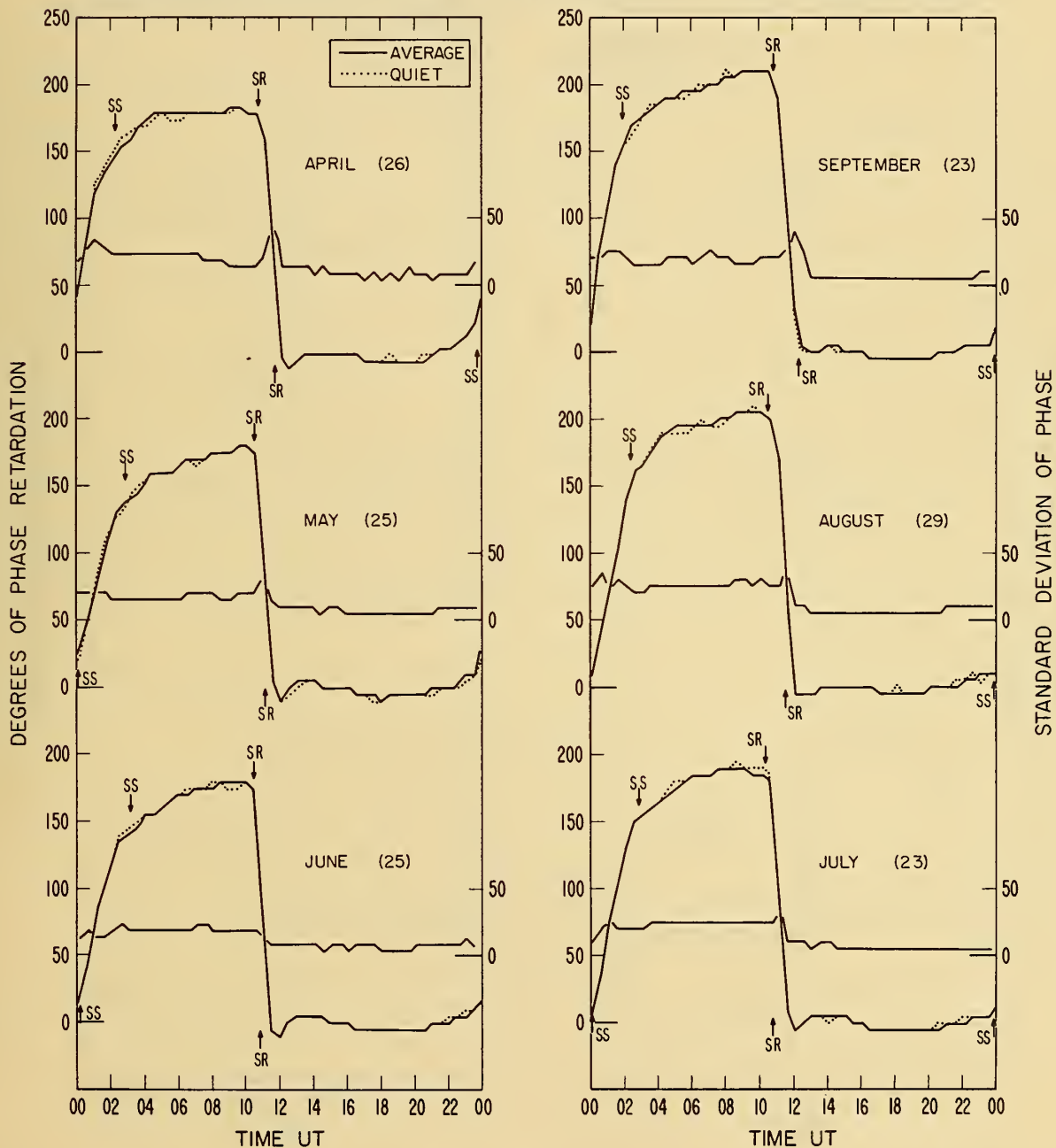


Fig. 2. Mean phase variations and standard deviations in degrees for April-June and July-September 1962. Sunrise and sunset at each end of the path are denoted by SR and SS on the mean phase curves.

NBA (18kc/s BALBOA, PANAMA) TO BOULDER, COLORADO
 AVERAGE PHASE FOR JANUARY-MARCH AND OCTOBER-DECEMBER 1961

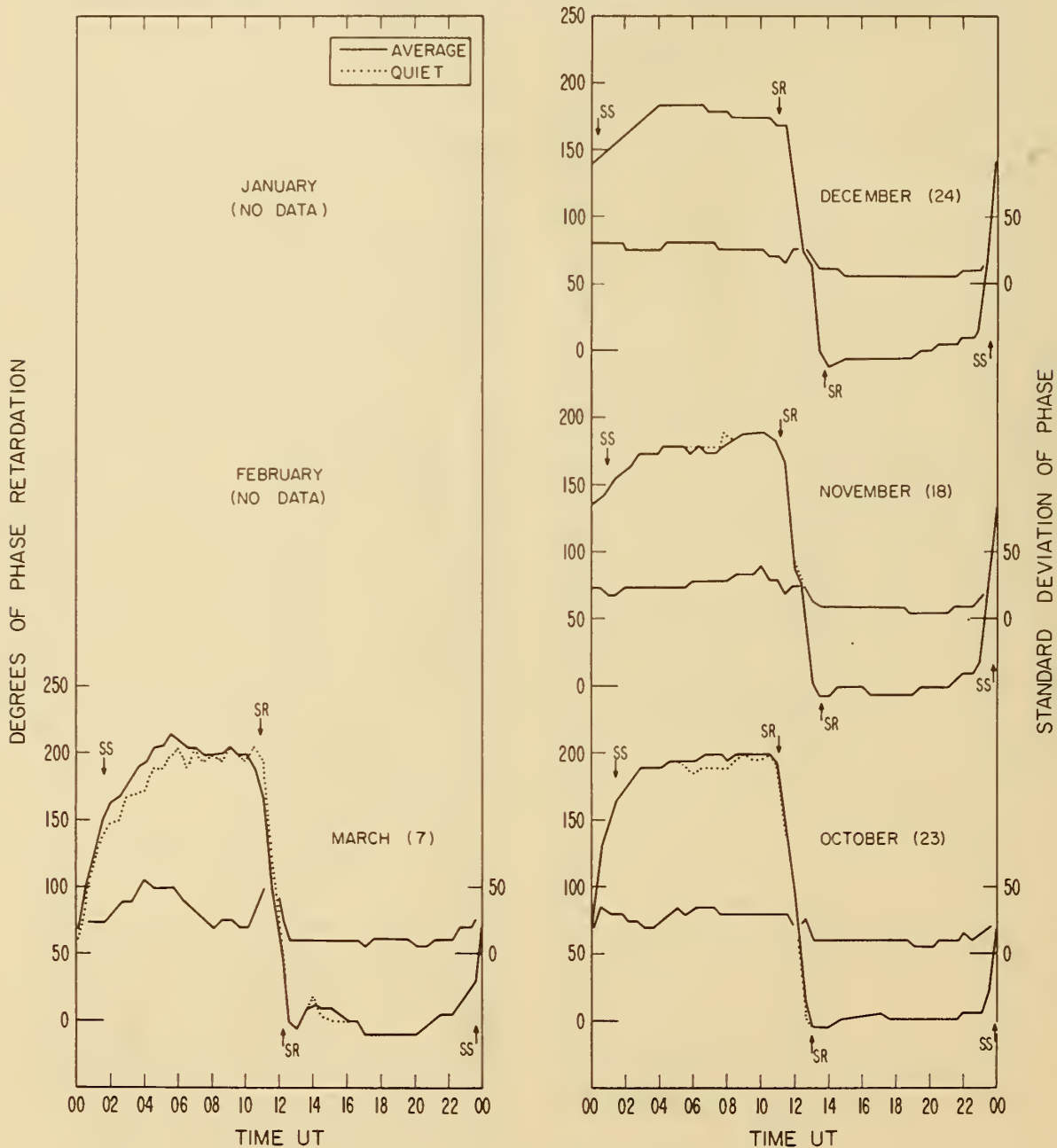


Fig. 3. Mean phase variations and standard deviations in degrees for January-March and October-December 1961. Sunrise and sunset at each end of the path are denoted by SR and SS on the mean phase curves.

NBA (18kc/s, BALBOA, PANAMA) TO BOULDER, COLORADO
 AVERAGE PHASE FOR APRIL-JUNE AND JULY-SEPTEMBER 1961

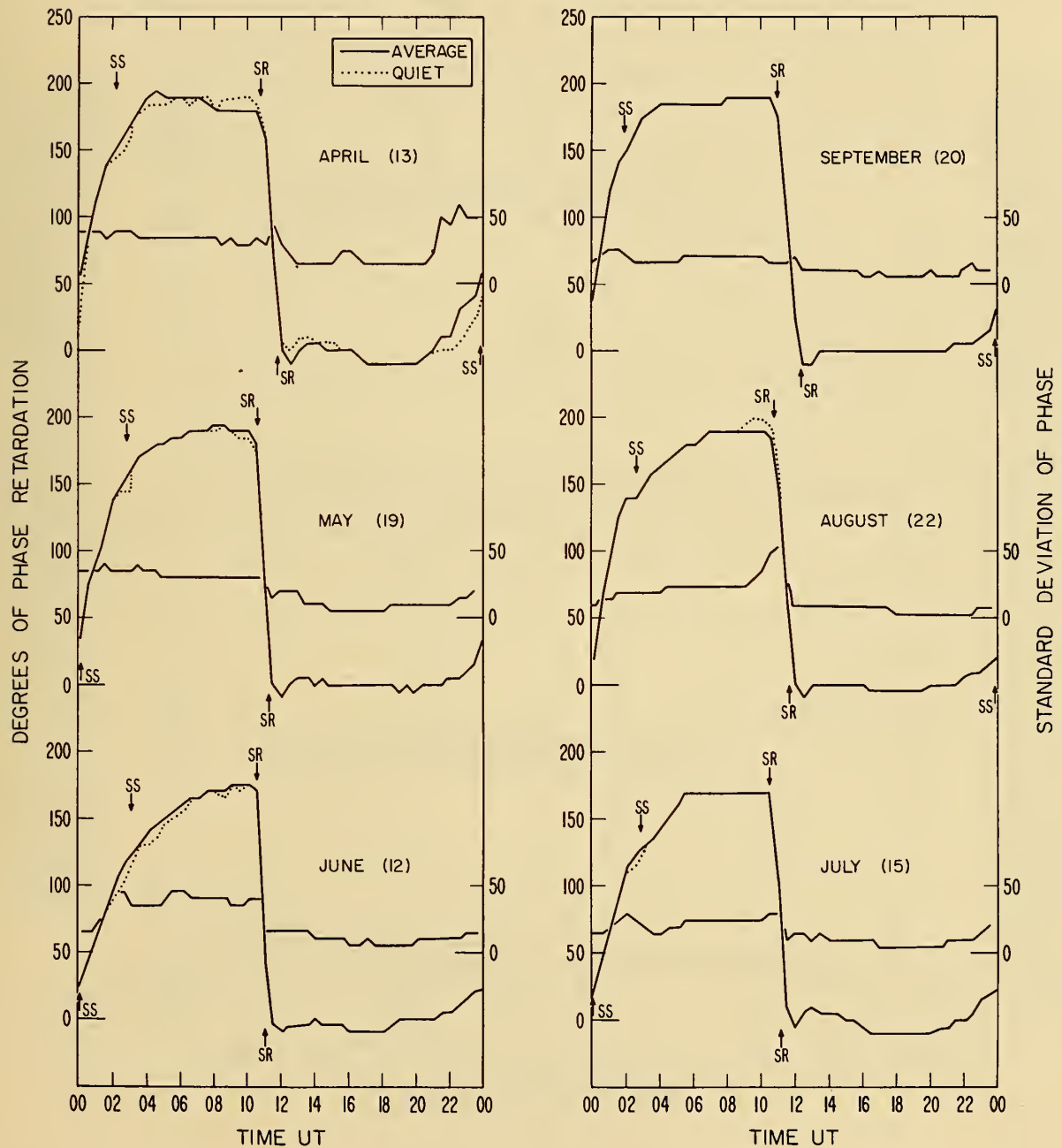


Fig. 4. Mean phase variations and standard deviations for April-June and July-September 1961. Sunrise and sunset at each end of the path are denoted by SR and SS on the mean phase curves.



Fig. 5. Diurnal phase variation (dotted) and percentage of darkness (solid lines) on path for March and June 1961. (Note: The ordinate also gives the percentage of the diurnal phase variation which has occurred).

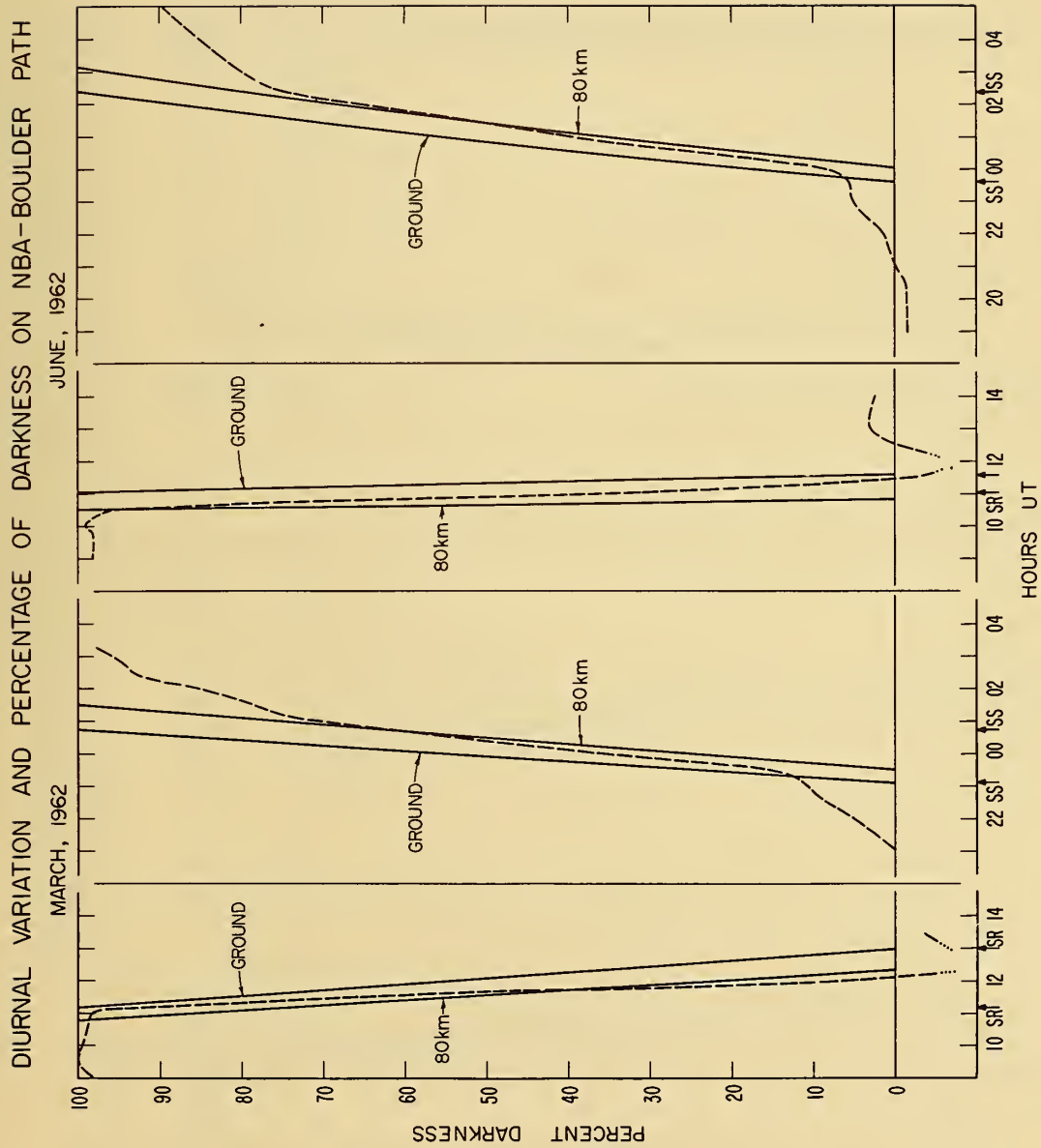


Fig. 6. Diurnal phase variation (dotted) and percentage of darkness (solid lines) on path for March and June 1962. (Note: The ordinate also gives the percentage of the diurnal phase variation which has occurred).

DIURNAL VARIATION AND PERCENTAGE OF DARKNESS ON NBA-BOULDER PATH

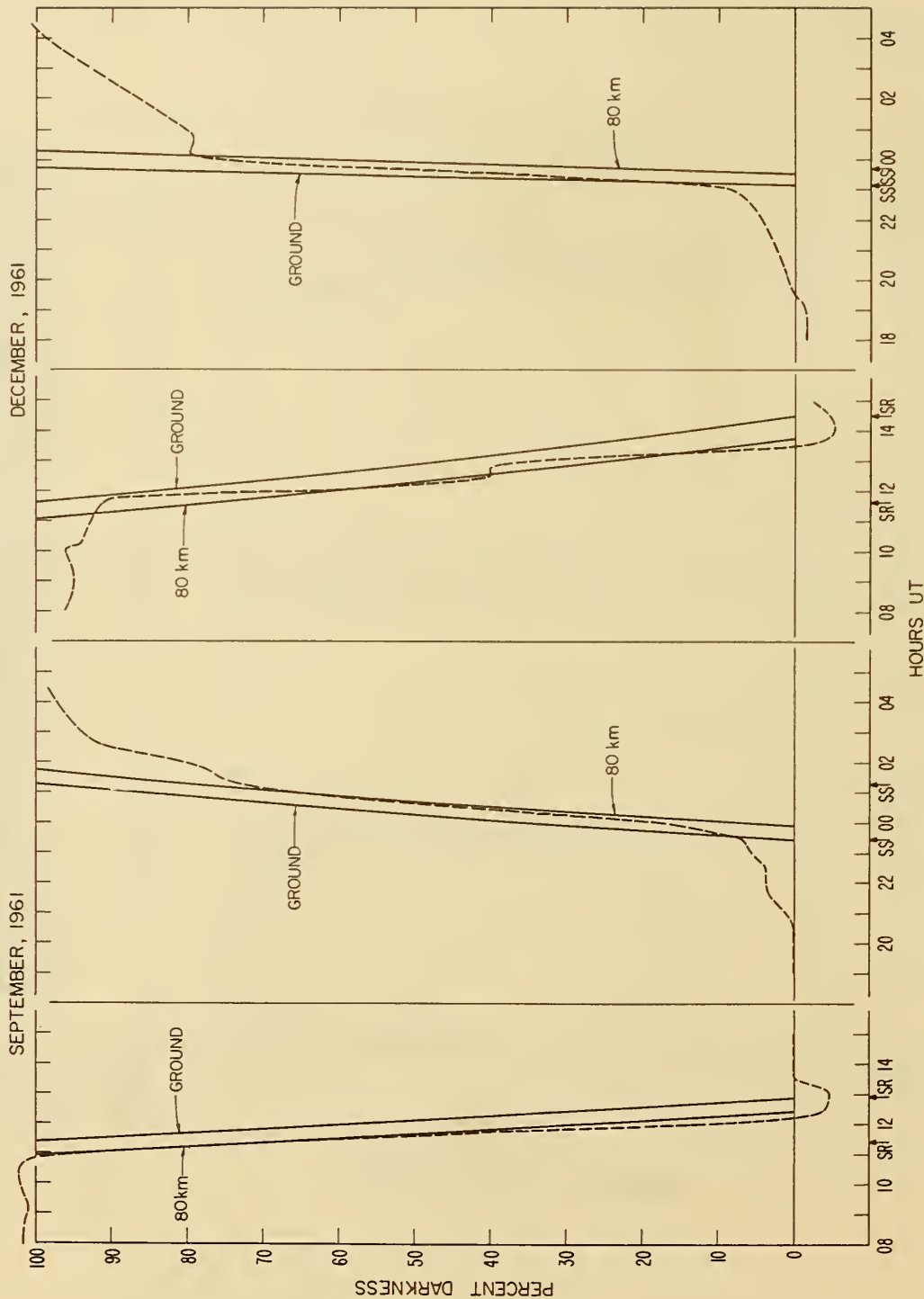


Fig. 7. Diurnal phase variation (dotted) and percentage of darkness (solid lines) on path for September and December 1961. (Note: The ordinate also gives the percentage of the diurnal phase variation which has occurred).

DIURNAL VARIATION AND PERCENTAGE OF DARKNESS ON NBA - BOULDER PATH

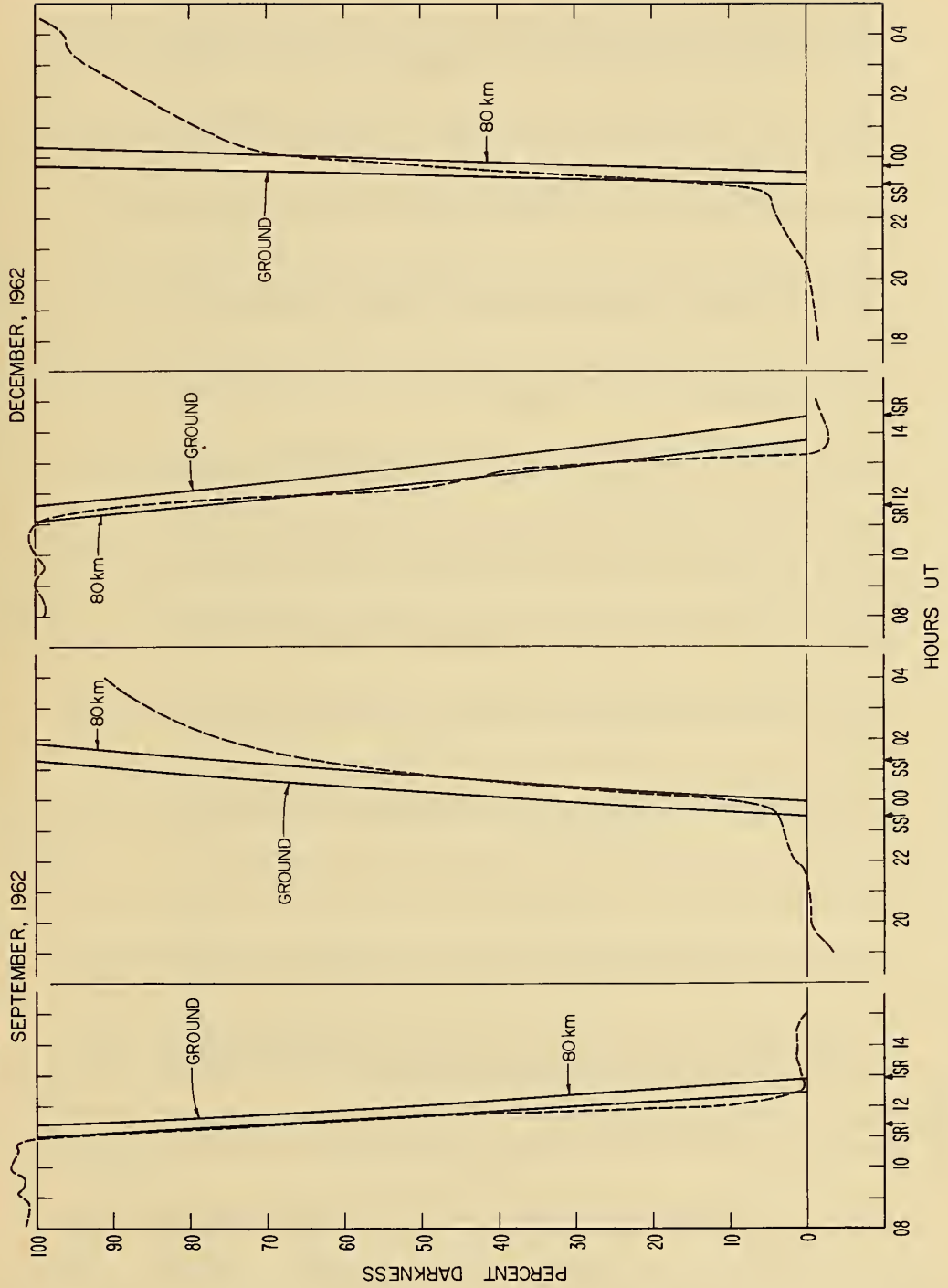


Fig. 8. Diurnal phase variation (dotted) and percentage of darkness (solid lines) on path for September and December 1962. (Note: The ordinate also gives the percentage of the diurnal phase variation which has occurred).

MONTHLY AVERAGE ON PATH 2 1 FOR MONTH 1 1962

UT	AVR	SDV	NO	QAV	NO	+5	MIN	+10	MIN	+15	MIN	+20	MIN	+25	MIN
00	622.	24.	18	624.	10	636.	10	638.	17	643.	17	647.	17	650.	17
01	652.	23.	19	656.	12	656.	12	656.	19	666.	19	677.	19	679.	19
02	672.	21.	18	671.	10	683.	10	683.	18	684.	18	685.	18	688.	18
03	688.	22.	17	686.	11	689.	11	689.	16	695.	16	697.	16	699.	16
04	696.	20.	17	696.	11	697.	11	697.	17	699.	17	700.	17	700.	17
05	700.	23.	16	702.	14	701.	14	701.	16	699.	16	699.	16	699.	16
06	695.	25.	16	695.	19	695.	19	695.	16	699.	16	699.	16	699.	16
07	690.	27.	16	696.	10	694.	10	694.	16	689.	16	689.	16	687.	16
08	690.	27.	16	690.	9	693.	9	693.	16	690.	16	689.	16	685.	16
09	687.	26.	16	694.	10	685.	10	685.	16	686.	16	688.	16	686.	16
10	687.	24.	16	691.	12	690.	12	690.	16	687.	16	693.	16	690.	16
11	693.	24.	15	689.	11	685.	11	685.	16	688.	16	688.	16	685.	16
12	684.	30.	16	689.	11	696.	11	696.	16	691.	16	691.	16	687.	16
13	685.	30.	16	687.	12	684.	12	684.	16	689.	16	689.	16	686.	16
14	497.	12.	15	498.	10	497.	10	497.	16	495.	16	497.	16	497.	16
15	497.	9.	17	497.	13	497.	13	497.	17	497.	17	497.	17	497.	17
16	496.	6.	18	497.	13	497.	13	497.	18	497.	18	497.	18	497.	18
17	495.	6.	18	496.	13	495.	13	495.	18	493.	18	493.	18	494.	18
18	495.	5.	17	494.	14	494.	14	494.	17	493.	17	493.	17	494.	17
19	496.	4.	17	496.	14	495.	14	495.	17	496.	17	496.	17	497.	17
20	498.	5.	16	497.	12	497.	12	497.	16	497.	16	497.	16	496.	16
21	502.	5.	17	502.	13	499.	13	499.	17	499.	17	499.	17	501.	17
22	508.	8.	17	504.	15	503.	15	503.	17	503.	17	503.	17	506.	17
23	513.	9.	18	507.	13	508.	13	508.	18	509.	18	509.	18	513.	18
24	520.	9.	18	511.	14	512.	14	512.	18	512.	18	512.	18	510.	18
25	548.	13.	17	520.	11	522.	11	522.	17	516.	17	517.	17	518.	17
				553.	11	568.	11	568.	17	557.	17	559.	17	548.	17

Table 1

MONTHLY AVERAGE ON PATH 2 1 FOR MONTH 2 1962

UT	AVER	SDV	NO	QAV	NO	+ 5	+10	+15	+20	+25	MIN
00	606.	29.	9	647.	5	27.	28.	29.	26.	26.	637.
01	645.	28.	9	659.	5	28.	29.	29.	26.	26.	658.
02	659.	26.	8	661.	6	28.	29.	26.	26.	26.	659.
03	672.	24.	9	672.	6	29.	29.	26.	26.	26.	672.
04	679.	24.	9	680.	6	29.	29.	26.	26.	26.	679.
05	682.	20.	9	684.	6	11.	15.	15.	11.	11.	682.
06	683.	12.	9	689.	6	11.	15.	15.	11.	11.	683.
07	693.	17.	9	692.	6	17.	22.	22.	17.	17.	692.
08	694.	19.	10	694.	6	18.	22.	22.	18.	18.	694.
09	697.	18.	10	696.	6	18.	22.	22.	18.	18.	696.
10	698.	18.	10	697.	6	18.	22.	22.	18.	18.	698.
11	701.	18.	10	700.	6	20.	25.	25.	20.	20.	700.
12	707.	30.	10	707.	6	30.	37.	37.	29.	29.	707.
13	709.	35.	10	709.	6	30.	37.	37.	29.	29.	709.
14	702.	35.	8	693.	6	27.	32.	32.	25.	25.	693.
15	707.	35.	8	695.	6	27.	32.	32.	25.	25.	695.
16	708.	35.	8	698.	6	23.	28.	28.	22.	22.	698.
17	709.	35.	8	699.	6	23.	28.	28.	22.	22.	699.
18	709.	35.	8	701.	6	23.	28.	28.	22.	22.	701.
19	709.	35.	8	703.	6	23.	28.	28.	22.	22.	703.
20	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
21	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
22	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
23	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
24	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
25	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
26	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
27	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
28	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
29	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
30	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
31	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
32	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
33	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
34	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
35	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
36	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
37	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
38	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
39	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
40	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
41	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
42	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
43	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
44	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
45	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
46	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
47	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
48	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
49	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
50	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
51	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
52	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
53	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
54	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
55	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
56	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
57	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
58	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
59	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.
60	709.	35.	8	704.	6	23.	28.	28.	22.	22.	704.

Table 2

MONTHLY AVERAGE ON PATH 2 1 FOR MONTH 3 1962

UT	AVER	SDV	NO	QAV	NO	+ 5	MIN	+ 10	MIN	+ 15	MIN	+ 20	MIN	+ 25	MIN
00	545	-0	1	545	1	-0	585	-0	585	-0	591	-0	598	-0	597
01	545	-0	1	575	1	-0	613	-0	613	-0	620	-0	627	-0	627
02	636	-0	1	643	1	-0	659	-0	659	-0	664	-0	666	-0	666
03	652	-0	1	671	1	-0	681	-0	681	-0	683	-0	685	-0	685
04	655	-0	1	682	1	-0	689	-0	689	-0	696	-0	690	-0	690
05	683	21	2	674	2	19	680	16	680	12	685	14	684	11	684
06	696	11	2	683	2	15	686	13	686	11	688	19	690	7	690
07	704	5	2	696	2	2	708	7	708	3	703	5	705	-2	705
08	701	4	2	704	2	0	701	1	701	1	709	7	700	5	700
09	697	3	2	701	2	8	699	6	699	7	698	2	699	2	698
10	692	8	2	692	2	6	692	7	692	4	697	3	697	3	697
11	695	3	2	693	2	6	696	6	696	2	695	5	696	2	696
12	697	3	2	697	2	3	700	2	700	2	700	3	701	3	701
13	700	2	2	699	2	3	700	4	700	2	703	3	704	5	704
14	698	2	2	698	2	3	696	3	696	2	698	1	696	1	697
15	697	2	2	697	2	2	696	3	696	1	675	13	690	18	697
16	520	3	7	520	7	3	503	8	503	8	494	4	481	7	482
17	478	5	4	478	4	5	479	5	479	3	480	8	481	5	482
18	483	4	4	483	4	4	487	4	487	5	489	3	491	3	492
19	507	9	9	507	9	11	496	13	496	12	496	10	497	10	502
20	507	10	2	509	2	17	511	17	511	16	510	15	508	14	508
21	507	12	2	507	2	11	509	11	509	10	508	10	508	9	508
22	499	3	3	499	3	3	499	3	499	3	499	3	498	3	498
23	497	3	3	497	3	3	497	3	497	3	497	3	497	3	497
24	496	3	3	496	3	2	496	2	496	2	495	2	495	2	495
25	495	2	2	495	2	2	495	2	495	2	495	2	495	2	495
26	494	2	2	494	2	2	494	2	494	2	494	2	494	2	494
27	494	2	2	494	2	2	494	2	494	2	494	2	494	2	494
28	493	2	2	493	2	2	493	2	493	2	493	2	493	2	493
29	500	2	2	500	2	2	501	2	501	2	502	2	502	2	502
30	505	6	4	505	4	5	512	5	512	4	507	5	509	6	508
31	516	11	4	520	4	2	523	3	523	3	514	4	518	4	517
32	514	11	4	514	4	2	523	3	523	3	520	4	518	4	517
33	514	11	4	514	4	2	523	3	523	3	520	4	518	4	517
34	514	11	4	514	4	2	523	3	523	3	520	4	518	4	517
35	514	11	4	514	4	2	523	3	523	3	520	4	518	4	517

Table 3

UT	MONTHLY AVERAGE	SDV	ON PATH	2	1	FOR MONTH	4	1962	+5 MIN	+10 MIN	+15 MIN	MIN	+20 MIN	MIN	+25 MIN	MIN
00	544	18.27	GAV	NO	551.	21.	557.	27.	21.	25.	25.	58.	573.	17.	581.	17.
01	587.	30.27	585	18	592.	25	599.	31	566.	27	25	60.	614.	17	617.	17
02	637.	35.23	624	17	639.	30	646.	37	629.	25	22	66.	644.	17	647.	17
03	656.	32.23	649	16	657.	28	665.	35	644.	22	24	69.	653.	17	657.	17
04	672.	25.26	665	15	677.	23	683.	29	664.	24	25	72.	661.	16	667.	16
05	676.	24.26	669	14	697.	20	698.	26	697.	18	16	75.	679.	15	691.	15
06	681.	23.26	678	13	677.	19	678.	25	679.	17	16	80.	681.	14	692.	14
07	679.	25.26	681	12	691.	21	681.	23	681.	16	15	81.	679.	13	697.	13
08	681.	20.26	679	11	679.	20	679.	22	676.	16	16	80.	680.	12	696.	12
09	684.	17.26	681	10	681.	20	680.	22	681.	14	15	81.	681.	11	697.	11
10	682.	14.26	683	9	682.	19	684.	20	683.	14	15	82.	684.	10	697.	10
11	659.	24.26	683	8	683.	18	683.	18	683.	17	17	83.	683.	9	682.	9
12	492.	13.25	683	7	683.	18	683.	18	685.	18	18	83.	684.	8	682.	8
13	501.	15.25	683	6	683.	18	683.	18	685.	18	18	83.	684.	7	682.	7
14	495.	17.26	683	5	683.	18	683.	18	683.	17	17	83.	683.	6	682.	6
15	501.	10.22	683	4	683.	18	683.	18	683.	17	17	83.	683.	5	682.	5
16	500.	15.22	683	3	683.	18	683.	18	683.	17	17	83.	683.	4	682.	4
17	496.	17.24	683	2	683.	18	683.	18	683.	17	17	83.	683.	3	682.	3
18	495.	12.24	683	1	683.	18	683.	18	683.	17	17	83.	683.	2	682.	2
19	497.	9.24	683	0	683.	18	683.	18	683.	17	17	83.	683.	1	682.	1
20	499.	7.24	683	0	683.	18	683.	18	683.	17	17	83.	683.	0	682.	0
21	501.	11.24	683	0	683.	18	683.	18	683.	17	17	83.	683.	0	682.	0
22	507.	9.27	683	0	683.	18	683.	18	683.	17	17	83.	683.	0	682.	0
23	512.	11.27	683	0	683.	18	683.	18	683.	17	17	83.	683.	0	682.	0

Table 4

MONTHLY AVERAGE ON PATH 2 1 FOR MONTH 5 1962

UT	AVER	SDV	NO	QAV	NO	+ 5	MIN	18	532	+10	MIN	520	17	536	+15	MIN	534	18	541	+20	MIN	549	18	547	+25	MIN	548	15
00	523	18	26	521	17	18	26	534	18	18	26	520	17	536	18	26	534	18	541	18	26	549	18	547	17	548	15	
01	520	18	26	520	17	19	26	535	18	19	26	521	17	537	18	26	535	18	542	18	26	550	18	545	17	549	15	
02	508	18	26	504	17	13	26	526	18	14	26	517	17	532	18	26	526	18	537	18	26	547	18	543	17	549	15	
03	633	18	26	627	17	13	26	634	18	15	26	636	17	640	18	26	634	18	643	18	26	653	18	638	17	643	15	
04	654	18	26	648	17	16	26	649	18	16	26	653	17	651	18	26	642	17	653	18	26	665	18	645	17	654	15	
05	662	18	26	659	17	15	26	660	18	15	26	658	18	660	18	26	658	18	661	18	26	671	18	658	17	665	15	
06	666	18	26	662	17	16	26	664	18	16	26	665	18	664	18	26	666	18	664	18	26	678	18	664	17	666	15	
07	668	18	26	669	17	17	26	669	18	17	26	669	17	669	18	26	669	18	669	18	26	679	18	669	17	669	15	
08	670	18	26	669	17	19	26	672	18	19	26	668	16	673	18	26	671	17	676	18	26	682	18	674	17	677	15	
09	674	18	25	674	17	18	24	675	18	18	24	676	17	677	18	24	676	17	677	18	24	682	18	677	17	677	15	
10	680	18	24	679	17	18	24	680	18	18	24	679	17	680	18	24	679	17	680	18	24	687	18	680	17	680	15	
11	675	18	25	677	17	18	25	679	18	17	25	677	17	679	18	25	676	17	679	18	25	687	18	679	17	680	15	
12	676	18	25	675	17	19	25	675	18	19	25	675	18	675	18	25	675	18	675	18	25	687	18	675	17	680	15	
13	674	18	25	677	17	11	25	677	18	11	25	677	17	677	18	25	677	17	677	18	25	693	18	677	17	680	15	
14	676	18	25	677	17	11	25	677	18	11	25	677	17	677	18	25	677	17	677	18	25	693	18	677	17	680	15	
15	676	18	25	677	17	11	25	677	18	11	25	677	17	677	18	25	677	17	677	18	25	693	18	677	17	680	15	
16	676	18	25	677	17	11	25	677	18	11	25	677	17	677	18	25	677	17	677	18	25	693	18	677	17	680	15	
17	676	18	25	677	17	11	25	677	18	11	25	677	17	677	18	25	677	17	677	18	25	693	18	677	17	680	15	
18	676	18	25	677	17	11	25	677	18	11	25	677	17	677	18	25	677	17	677	18	25	693	18	677	17	680	15	
19	676	18	25	677	17	11	25	677	18	11	25	677	17	677	18	25	677	17	677	18	25	693	18	677	17	680	15	
20	676	18	25	677	17	11	25	677	18	11	25	677	17	677	18	25	677	17	677	18	25	693	18	677	17	680	15	
21	676	18	25	677	17	11	25	677	18	11	25	677	17	677	18	25	677	17	677	18	25	693	18	677	17	680	15	
22	676	18	25	677	17	11	25	677	18	11	25	677	17	677	18	25	677	17	677	18	25	693	18	677	17	680	15	
23	676	18	25	677	17	11	25	677	18	11	25	677	17	677	18	25	677	17	677	18	25	693	18	677	17	680	15	

Table 5

MONTHLY AVERAGE ON PATH	SDV	NO	QAV	NO	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
01	515	14	27	516	16	25	524	18	23	16	65	19	24	18	27	19	25	536	17
02	537	19	27	547	18	25	584	19	25	15	65	18	25	18	27	18	25	571	17
03	593	17	25	599	22	25	631	22	25	19	65	21	25	21	25	20	25	633	18
04	617	21	25	643	22	26	640	22	26	20	65	22	26	20	26	19	26	642	18
05	641	19	26	649	20	26	651	20	26	19	65	21	26	19	26	20	26	652	19
06	658	18	26	664	22	26	669	22	26	21	66	22	26	21	26	20	26	667	20
07	666	20	26	691	22	25	670	22	25	21	66	22	25	21	25	21	25	670	19
08	670	22	25	674	22	25	671	22	25	23	66	22	25	23	25	22	25	672	18
09	673	23	26	676	22	26	675	22	26	23	66	22	26	23	26	22	26	680	18
10	679	22	26	679	22	26	680	22	26	22	67	22	26	22	26	22	26	680	17
11	679	21	25	681	22	25	678	22	25	21	67	22	25	21	25	21	25	677	18
12	675	22	23	677	21	23	676	21	23	21	67	21	23	21	23	21	23	674	18
13	558	19	23	555	18	23	631	18	23	18	63	18	23	18	23	18	23	501	18
14	495	8	24	490	8	23	492	8	23	8	54	8	23	8	23	8	23	498	18
15	500	8	24	502	9	22	503	9	22	9	54	9	22	9	22	9	22	505	18
16	504	8	22	506	9	22	506	9	22	8	56	9	22	8	22	8	22	506	18
17	505	6	23	504	8	22	504	8	22	8	56	8	22	8	22	8	22	506	18
18	504	8	23	500	7	24	503	8	24	8	54	8	23	8	23	8	23	503	18
19	502	6	23	500	6	23	500	6	23	8	54	6	23	8	23	8	23	502	18
20	499	8	24	499	7	24	499	7	24	7	54	7	24	7	24	7	24	497	18
21	497	8	24	495	8	24	495	8	24	8	54	8	24	8	24	8	24	495	18
22	495	8	22	495	6	22	496	6	22	6	54	6	22	6	22	6	22	498	18
23	497	6	22	497	6	22	497	6	22	8	54	6	22	8	22	8	22	498	18
24	498	8	24	499	8	24	499	8	24	8	54	8	24	8	24	8	24	502	18
25	501	10	26	504	10	26	502	10	26	10	54	10	26	10	26	10	26	506	18
26	507	11	26	509	11	26	508	11	26	12	54	11	26	12	26	12	26	510	18
27	510	11	26	511	11	26	512	11	26	12	54	11	26	12	26	12	26	511	18

Table 6

MONTHLY AVERAGE ON PATH 2 1 FOR MONTH 7 1962

UT	AVER	SDV	NO	QAV	NO	5	10	15	20	25	MIN
00	512.	12.	22	516.	12.	22	12.	13.	19.	20.	520.
01	534.	21.	24	553.	23.	24	27.	26.	26.	24.	570.
02	601.	20.	24	583.	23.	24	23.	22.	23.	21.	594.
03	654.	21.	24	610.	22.	23	21.	22.	20.	19.	625.
04	666.	23.	24	642.	18.	22	18.	18.	19.	13.	646.
05	678.	27.	24	652.	21.	24	21.	21.	22.	23.	655.
06	684.	25.	24	662.	25.	23	25.	25.	25.	25.	661.
07	686.	24.	24	669.	26.	24	26.	26.	26.	26.	673.
08	689.	25.	24	670.	26.	23	26.	26.	26.	26.	680.
09	689.	26.	23	675.	27.	24	27.	27.	27.	27.	684.
10	686.	26.	23	679.	27.	24	27.	27.	27.	27.	684.
11	682.	26.	23	683.	27.	24	27.	27.	27.	27.	686.
12	511.	18.	23	686.	25.	24	25.	25.	25.	25.	689.
13	504.	8.	23	687.	25.	24	25.	25.	25.	25.	691.
14	504.	8.	23	688.	26.	23	26.	26.	26.	26.	692.
15	503.	6.	23	690.	29.	23	29.	29.	29.	29.	695.
16	499.	6.	22	691.	20.	22	20.	21.	21.	18.	699.
17	495.	5.	22	692.	9.	23	9.	8.	7.	7.	7.
18	495.	5.	22	694.	8.	23	8.	8.	7.	7.	7.
19	496.	5.	22	695.	7.	23	7.	7.	7.	7.	7.
20	498.	5.	22	696.	8.	22	8.	8.	8.	8.	8.
21	499.	5.	22	697.	9.	22	9.	9.	9.	9.	9.
22	503.	5.	23	698.	5.	23	5.	5.	5.	5.	5.
23	504.	5.	23	699.	5.	23	5.	5.	5.	5.	5.
	508.	7.	24	700.	6.	24	6.	6.	6.	6.	6.
				701.	5.	24	5.	5.	5.	5.	5.
				702.	5.	24	5.	5.	5.	5.	5.
				703.	5.	24	5.	5.	5.	5.	5.
				704.	5.	24	5.	5.	5.	5.	5.
				705.	5.	24	5.	5.	5.	5.	5.
				706.	5.	24	5.	5.	5.	5.	5.
				707.	5.	24	5.	5.	5.	5.	5.
				708.	5.	24	5.	5.	5.	5.	5.
				709.	5.	24	5.	5.	5.	5.	5.
				710.	5.	24	5.	5.	5.	5.	5.
				711.	5.	24	5.	5.	5.	5.	5.
				712.	5.	24	5.	5.	5.	5.	5.
				713.	5.	24	5.	5.	5.	5.	5.
				714.	5.	24	5.	5.	5.	5.	5.
				715.	5.	24	5.	5.	5.	5.	5.
				716.	5.	24	5.	5.	5.	5.	5.
				717.	5.	24	5.	5.	5.	5.	5.
				718.	5.	24	5.	5.	5.	5.	5.
				719.	5.	24	5.	5.	5.	5.	5.
				720.	5.	24	5.	5.	5.	5.	5.

Table 7

MONTHLY AVERAGE ON PATH 2 1 FOR MONTH 8 1962

UT	AVER	SDV	NO	QAV	NO	5	10	15	20	25	MIN
00	515	25	19	517	23	26	30	32	34	37	514
01	547	34	20	547	24	29	32	35	38	39	540
02	570	37	21	570	25	30	33	36	39	40	570
03	603	39	22	603	26	31	34	37	40	41	603
04	636	42	23	636	27	32	35	38	41	42	636
05	669	45	24	669	28	33	36	39	42	43	669
06	702	48	25	702	29	34	37	40	43	44	702
07	735	51	26	735	30	35	38	41	44	45	735
08	768	54	27	768	31	36	39	42	45	46	768
09	801	57	28	801	32	37	40	43	46	47	801
10	834	60	29	834	33	38	41	44	47	48	834
11	867	63	30	867	34	39	42	45	48	49	867
12	900	66	31	900	35	40	43	46	49	50	900
13	933	69	32	933	36	41	44	47	50	51	933
14	966	72	33	966	37	42	45	48	51	52	966
15	999	75	34	999	38	43	46	49	52	53	999
16	1032	78	35	1032	39	44	47	50	53	54	1032
17	1065	81	36	1065	40	45	48	51	54	55	1065
18	1098	84	37	1098	41	46	49	52	55	56	1098
19	1131	87	38	1131	42	47	50	53	56	57	1131
20	1164	90	39	1164	43	48	51	54	57	58	1164
21	1197	93	40	1197	44	49	52	55	58	59	1197
22	1230	96	41	1230	45	50	53	56	59	60	1230
23	1263	99	42	1263	46	51	54	57	60	61	1263

Table 8

MONTHLY AVERAGE ON PATH 2 1 FOR MONTH 9 1962

UT	AVER	SDV	NO	QAV	NO	+ 5	MIN	+10	MIN	+15	MIN	+20	MIN	+25	MIN
00	520.	18.22	533.	521.15	534.15	15.22	548.15	21.22	548.15	20.22	552.15	15.22	561.15	21.22	568.
01	574.	22.22	579.	579.16	585.16	22.22	592.17	27.22	592.17	22.22	598.18	22.22	607.18	25.22	641.
02	639.	24.23	641.	640.18	646.18	23.23	646.18	17.23	646.18	23.23	648.19	23.23	652.19	18.23	653.
03	656.	18.23	658.	656.14	661.14	17.23	662.15	16.23	662.15	23.23	663.16	23.23	665.16	16.23	666.
04	678.	17.23	677.	678.15	678.15	16.23	678.16	16.23	678.16	23.23	679.17	23.23	680.17	16.23	681.
05	687.	17.23	687.	687.15	688.15	16.23	687.16	16.23	687.16	23.23	688.17	23.23	689.17	17.23	689.
06	690.	18.23	692.	689.15	691.15	17.23	692.16	19.23	692.16	23.23	693.17	23.23	694.17	19.23	693.
07	695.	19.23	696.	695.14	696.14	19.23	696.15	18.23	696.15	23.23	697.16	23.23	698.16	18.23	698.
08	698.	18.23	697.	698.15	697.15	18.23	698.16	19.23	698.16	23.23	699.17	23.23	700.17	20.23	699.
09	702.	23.23	703.	700.15	701.15	17.23	704.15	17.23	704.15	23.23	705.16	23.23	706.16	19.23	702.
10	701.	19.23	708.	709.16	708.16	19.23	709.17	15.23	709.17	23.23	710.18	23.23	711.18	16.23	708.
11	709.	16.23	709.	710.16	711.16	20.23	710.17	19.23	710.17	23.23	711.18	23.23	712.18	19.23	710.
12	710.	18.23	709.	712.17	711.17	19.23	713.17	20.23	713.17	23.23	714.18	23.23	715.18	20.23	711.
13	628.	20.23	687.	696.20	686.20	25.23	673.14	27.23	673.14	23.23	677.15	23.23	681.16	22.23	702.
14	536.	2.23	525.	526.20	518.20	33.23	511.12	35.23	511.12	23.23	507.11	23.23	509.11	24.23	545.
15	503.	6.23	502.	502.16	502.16	6.23	503.13	7.23	503.13	20.23	500.12	23.23	501.12	6.23	501.
16	503.	7.20	503.	503.13	503.13	7.20	503.13	7.20	503.13	20.23	504.14	20.23	504.14	7.20	502.
17	503.	7.20	503.	503.12	503.12	7.20	503.13	7.20	503.13	20.23	504.14	20.23	504.14	7.20	503.
18	499.	7.20	499.	501.16	501.16	7.20	502.11	6.20	502.11	19.23	501.10	22.23	501.10	6.20	500.
19	499.	7.19	499.	500.15	500.15	6.19	500.14	6.19	500.14	19.23	499.13	22.23	499.13	6.19	499.
20	499.	6.19	497.	497.15	497.15	6.19	496.14	6.19	496.14	19.23	496.13	22.23	496.13	6.19	498.
21	499.	6.19	497.	496.15	496.15	6.19	496.14	6.19	496.14	19.23	496.13	22.23	496.13	6.19	495.
22	499.	5.20	497.	497.13	497.13	5.20	495.12	5.20	495.12	19.23	495.11	22.23	495.11	5.20	495.
23	501.	6.19	499.	499.13	499.13	6.19	498.12	6.19	498.12	23.23	498.11	23.23	498.11	6.19	499.
24	501.	7.23	501.	501.16	501.16	7.23	502.17	7.23	502.17	23.23	500.16	23.23	500.16	7.23	500.
25	503.	7.23	503.	504.18	503.18	7.23	505.19	7.23	505.19	23.23	504.18	23.23	504.18	7.23	502.
26	506.	8.23	506.	505.18	505.18	8.23	505.17	9.23	505.17	23.23	505.16	23.23	505.16	8.23	505.
27	507.	11.23	508.	508.17	508.17	11.23	510.17	12.23	510.17	23.23	506.16	23.23	506.16	11.23	506.
28	508.	11.23	508.	508.16	508.16	11.23	510.17	12.23	510.17	23.23	506.16	23.23	506.16	11.23	507.

Table 9

MONTHLY AVERAGE ON PATH 2 1 FOR MONTH 10 1962

UT	AVER	SDV	NO	GAV	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO													
00	579.	19.	29	578.	25	590.	601.	18.	29	587.	23	617.	20.	29	609.	19.	29	613.	21	623.	19.	29	642.	23	617.	20.	29	609.	19.	29	613.	21	623.	19.	29	642.	23	617.	20.	29			
01	630.	20.	29	636.	24	645.	650.	19.	29	657.	21	678.	20.	29	642.	23	658.	20.	29	674.	24	645.	23	678.	24	674.	24	658.	25	678.	24	674.	24	658.	25	678.	24	674.	24	658.	25	678.	24
02	652.	18.	29	667.	24	678.	684.	18.	29	687.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
03	676.	18.	29	686.	24	695.	685.	19.	29	689.	24	699.	19.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
04	684.	19.	29	687.	24	695.	685.	19.	29	689.	24	699.	19.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
05	686.	19.	29	688.	24	695.	685.	19.	29	689.	24	699.	19.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
06	687.	19.	29	690.	24	695.	685.	19.	29	690.	24	695.	19.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
07	687.	19.	29	690.	24	695.	685.	19.	29	690.	24	695.	19.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
08	691.	21.	29	692.	24	695.	685.	21.	29	693.	24	695.	21.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
09	695.	21.	29	697.	24	695.	685.	21.	29	694.	24	695.	21.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
10	696.	22.	29	698.	24	695.	685.	22.	29	696.	24	695.	22.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
11	690.	22.	29	695.	24	695.	685.	22.	29	693.	24	695.	22.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
12	633.	16.	29	695.	24	695.	685.	16.	29	695.	24	695.	16.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
13	510.	14.	29	586.	20	504.	504.	14.	29	580.	19	552.	14.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
14	494.	5.	27	495.	21	493.	493.	5.	27	494.	21	493.	5.	27	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
15	499.	7.	27	495.	22	497.	497.	7.	27	498.	22	498.	7.	27	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
16	500.	5.	26	500.	20	500.	500.	5.	26	500.	20	500.	5.	26	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
17	497.	4.	26	498.	18	499.	499.	4.	26	498.	18	499.	4.	26	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
18	497.	3.	26	497.	15	497.	497.	3.	26	497.	15	497.	3.	26	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
19	498.	3.	26	498.	20	498.	498.	3.	26	498.	20	498.	3.	26	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
20	500.	3.	26	500.	20	500.	500.	3.	26	500.	20	500.	3.	26	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
21	502.	3.	26	502.	19	502.	502.	3.	26	501.	20	502.	3.	26	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
22	505.	3.	26	504.	19	504.	504.	3.	26	504.	19	505.	3.	26	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
23	509.	1.	4.	508.	17	510.	510.	1.	4.	507.	19	511.	1.	4.	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	688.	24	692.	24	722.	22	688.	24	700.	18.	29	662.	22	
	522.			524.		529.	529.			533.		541.																															

Table 10

MONTHLY AVERAGE ON PATH 2 1 FOR MONTH 11 1962

UT	AVER	SDV	NO	QAV	NO	QAV	NO	+5	MIN	+10	MIN	+15	MIN	+20	MIN	+25	MIN
00	623	1	27	629	17	634	18	19	27	18	17	17	17	14	14	13	18
01	651	1	28	649	17	655	18	19	28	19	19	19	19	14	14	10	20
02	675	1	28	666	17	677	18	19	28	20	20	20	20	11	11	10	20
03	681	1	28	674	17	686	18	19	28	21	21	21	21	12	12	11	19
04	681	1	29	679	19	685	19	20	29	21	21	21	21	14	14	14	19
05	681	1	29	682	17	686	18	19	29	21	21	21	21	15	15	15	19
06	681	1	29	683	19	686	19	20	29	21	21	21	21	16	16	17	19
07	681	1	29	687	18	686	18	19	29	21	21	21	21	17	17	18	18
08	681	1	29	682	16	684	16	17	29	21	21	21	21	18	18	18	18
09	681	1	29	680	18	684	18	19	29	21	21	21	21	18	18	19	18
10	681	1	29	679	17	683	17	18	29	21	21	21	21	19	19	19	18
11	681	1	29	684	16	684	16	17	29	21	21	21	21	20	20	20	18
12	681	1	29	681	18	686	18	19	29	21	21	21	21	20	20	20	19
13	681	1	29	687	19	688	19	20	29	21	21	21	21	21	21	21	19
14	681	1	29	684	18	688	18	19	29	21	21	21	21	21	21	21	17
15	681	1	29	687	18	688	18	19	29	21	21	21	21	21	21	21	16
16	681	1	29	684	17	686	17	18	29	21	21	21	21	21	21	21	15
17	681	1	29	682	15	686	15	16	29	21	21	21	21	21	21	21	17
18	681	1	29	680	14	686	14	15	29	21	21	21	21	21	21	21	16
19	681	1	29	681	16	686	16	17	29	21	21	21	21	21	21	21	17
20	681	1	29	681	16	686	16	17	29	21	21	21	21	21	21	21	17
21	681	1	29	681	16	686	16	17	29	21	21	21	21	21	21	21	17
22	681	1	29	681	16	686	16	17	29	21	21	21	21	21	21	21	17
23	681	1	29	681	16	686	16	17	29	21	21	21	21	21	21	21	17

Table 11

MONTHLY AVERAGE ON PATH 2 1 FOR MONTH 12 1962

UT	AVER	SDV	NO	QAV	NO	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
00	639.	19.	17	637.	10	643.	646.	18.	17	51.	10	651.	653.	18.	17	51.	10	651.	653.	18.	17
01	656.	17.	18	667.	13	669.	671.	17.	17	66.	13	682.	684.	18.	17	66.	13	682.	684.	18.	17
02	678.	16.	18	683.	14	684.	688.	16.	18	67.	14	699.	700.	19.	19	67.	14	699.	700.	19.	19
03	691.	19.	18	691.	13	692.	698.	19.	18	69.	13	705.	705.	19.	19	69.	13	705.	705.	19.	19
04	700.	20.	18	702.	12	704.	705.	20.	18	70.	12	710.	710.	20.	20	70.	12	710.	710.	20.	20
05	709.	20.	18	707.	13	711.	711.	20.	18	70.	13	713.	713.	20.	20	70.	13	713.	713.	20.	20
06	712.	21.	18	707.	14	711.	711.	21.	18	70.	14	713.	713.	21.	21	70.	14	713.	713.	21.	21
07	713.	22.	18	708.	15	711.	711.	22.	18	70.	15	712.	712.	22.	22	70.	15	712.	712.	22.	22
08	711.	22.	19	707.	13	711.	711.	22.	19	70.	13	711.	711.	22.	22	70.	13	711.	711.	22.	22
09	710.	22.	20	707.	13	711.	711.	22.	20	70.	13	711.	711.	22.	22	70.	13	711.	711.	22.	22
10	711.	24.	20	708.	12	711.	711.	24.	20	70.	12	711.	711.	24.	24	70.	12	711.	711.	24.	24
11	713.	24.	20	710.	14	713.	713.	24.	20	71.	14	714.	714.	24.	24	71.	14	714.	714.	24.	24
12	692.	22.	20	712.	13	714.	714.	22.	20	71.	13	715.	715.	22.	22	71.	13	715.	715.	22.	22
13	588.	16.	20	693.	12	689.	686.	16.	20	68.	12	707.	682.	18.	17	68.	12	707.	682.	18.	17
14	495.	20.	20	595.	14	587.	585.	20.	20	58.	14	589.	582.	19.	18	58.	14	589.	582.	19.	18
15	498.	10.	17	495.	15	493.	495.	10.	17	49.	15	494.	495.	10.	10	49.	15	494.	495.	10.	10
16	498.	10.	16	495.	14	498.	497.	10.	16	49.	14	495.	495.	11.	11	49.	14	495.	495.	11.	11
17	498.	5.	16	499.	13	498.	499.	5.	16	49.	13	499.	499.	5.	5	49.	13	499.	499.	5.	5
18	497.	5.	16	497.	12	497.	497.	5.	16	49.	12	497.	497.	5.	5	49.	12	497.	497.	5.	5
19	498.	4.	17	498.	13	497.	497.	4.	17	49.	13	497.	497.	4.	4	49.	13	497.	497.	4.	4
20	499.	4.	17	498.	12	498.	498.	4.	17	49.	12	498.	498.	4.	4	49.	12	498.	498.	4.	4
21	501.	5.	17	500.	12	499.	499.	5.	17	49.	12	499.	499.	5.	5	49.	12	499.	499.	5.	5
22	507.	7.	18	502.	15	504.	505.	7.	18	50.	15	506.	505.	6.	6	50.	15	506.	505.	6.	6
23	519.	8.	15	518.	14	517.	518.	8.	15	51.	14	512.	512.	8.	8	51.	14	512.	512.	8.	8
		12.	16		10		601.	12.	16		10		615.	17.	17		10		615.	17.	17

Table 12

Table 13

Monthly mean diurnal phase change
(NBA-Boulder path)

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
1961	-	-	205	185	190	170	170	190	185	195	187	180	degrees
1962	195	195	195	180	170	170	185	190	200	190	185	210	degrees

Table 14

RMS phase difference between observations separated by time T (NBA-Boulder path).

1962 Month	Time of Day	T										minutes
		10	20	30	40	50	60	70	80	90	degrees	
Feb.	Night	9.6	13.5	15.1	17.4	19.3	21.2	23.3	23.8	23.6	23.6	degrees
"	Day	2.1	2.5	3.4	3.9	4.4	4.7	4.9	5.1	5.2	5.2	"
April	Night	4.9	6.2	6.8	8.4	9.0	9.4	10.3	11.1	11.8	11.8	"
"	Day	6.6	10.4	13.7	16.6	18.0	18.6	19.2	19.6	19.0	19.0	"
June	Night	5.6	8.4	10.9	13.2	15.8	18.6	20.7	23.5	26.4	26.4	"
"	Day	3.4	5.4	6.8	8.5	9.7	11.1	11.9	12.5	12.4	12.4	"
Aug.	Night	6.9	9.3	12.0	14.7	17.0	18.6	20.1	21.9	24.0	24.0	"
"	Day	3.6	4.5	4.5	5.1	6.2	6.1	7.1	7.9	8.5	8.5	"
Oct.	Night	5.0	6.4	6.8	7.7	6.1	5.5	6.3	7.8	7.6	7.6	"
"	Day	2.7	3.8	4.9	5.2	7.2	8.4	9.6	10.7	11.5	11.5	"
Dec.	Night	3.4	4.2	5.2	5.9	6.6	7.2	8.0	8.7	9.5	9.5	"
"	Day	2.5	3.5	3.8	4.5	5.3	5.8	6.1	6.3	6.4	6.4	"



