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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

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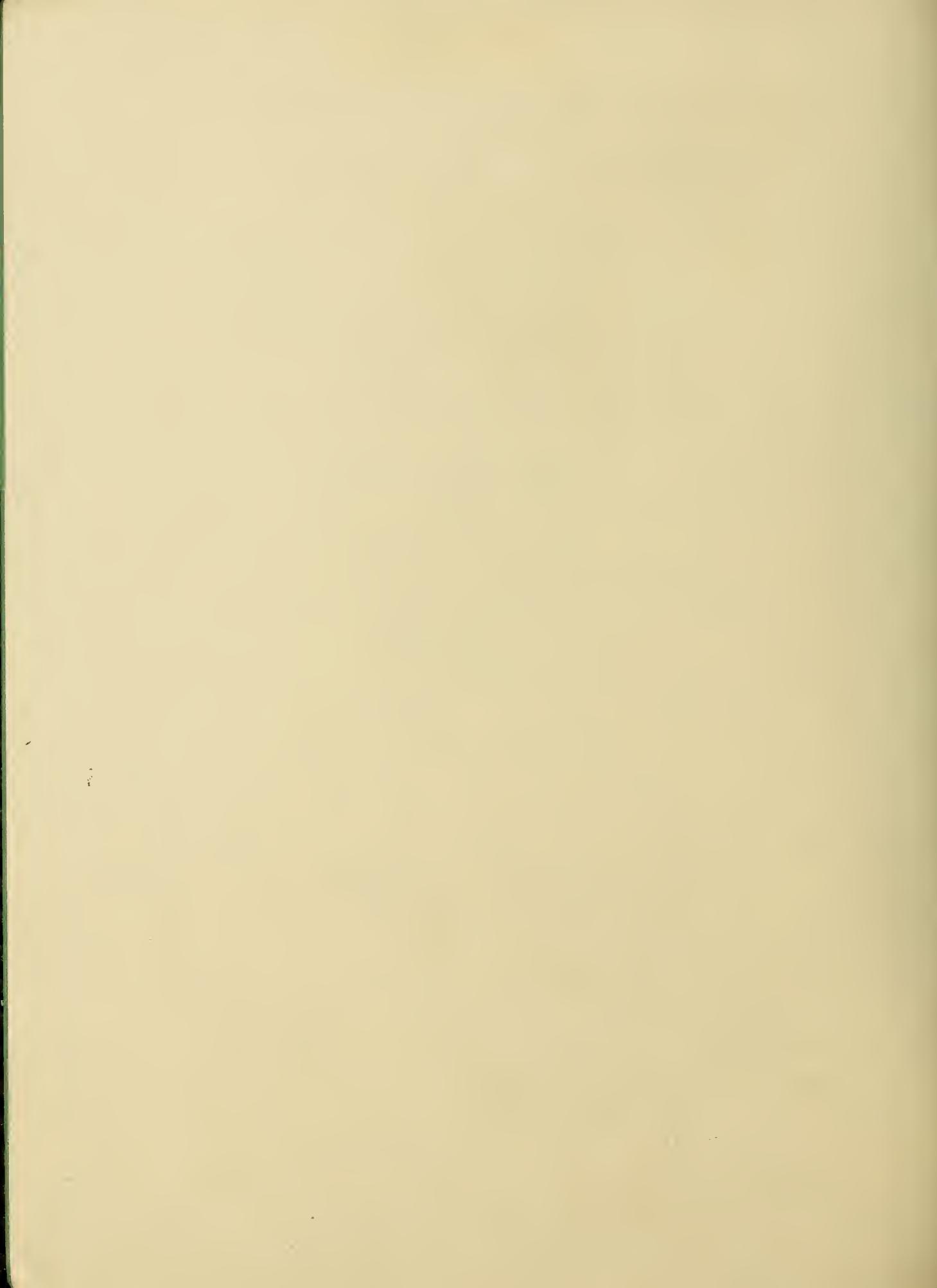
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THE NORMAL PHASE VARIATIONS OF THE 18 KC/S SIGNALS FROM NBA OBSERVED AT BOULDER, COLORADO, U. S. A.

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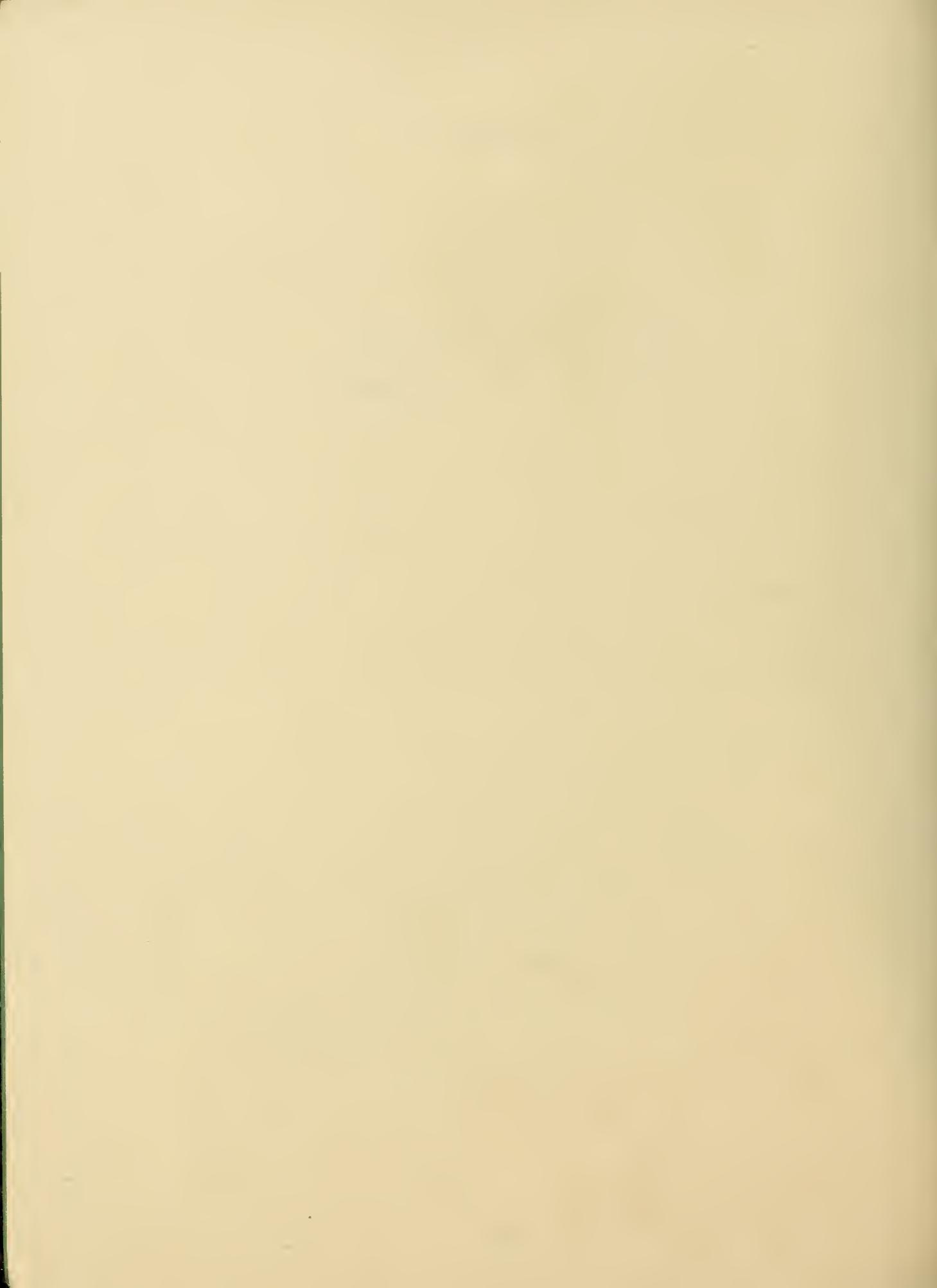
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The Normal Phase Variations of the 18 Kc/s Signals
from NBA Observed at Boulder, Colorado, U.S.A.

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 night-time 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

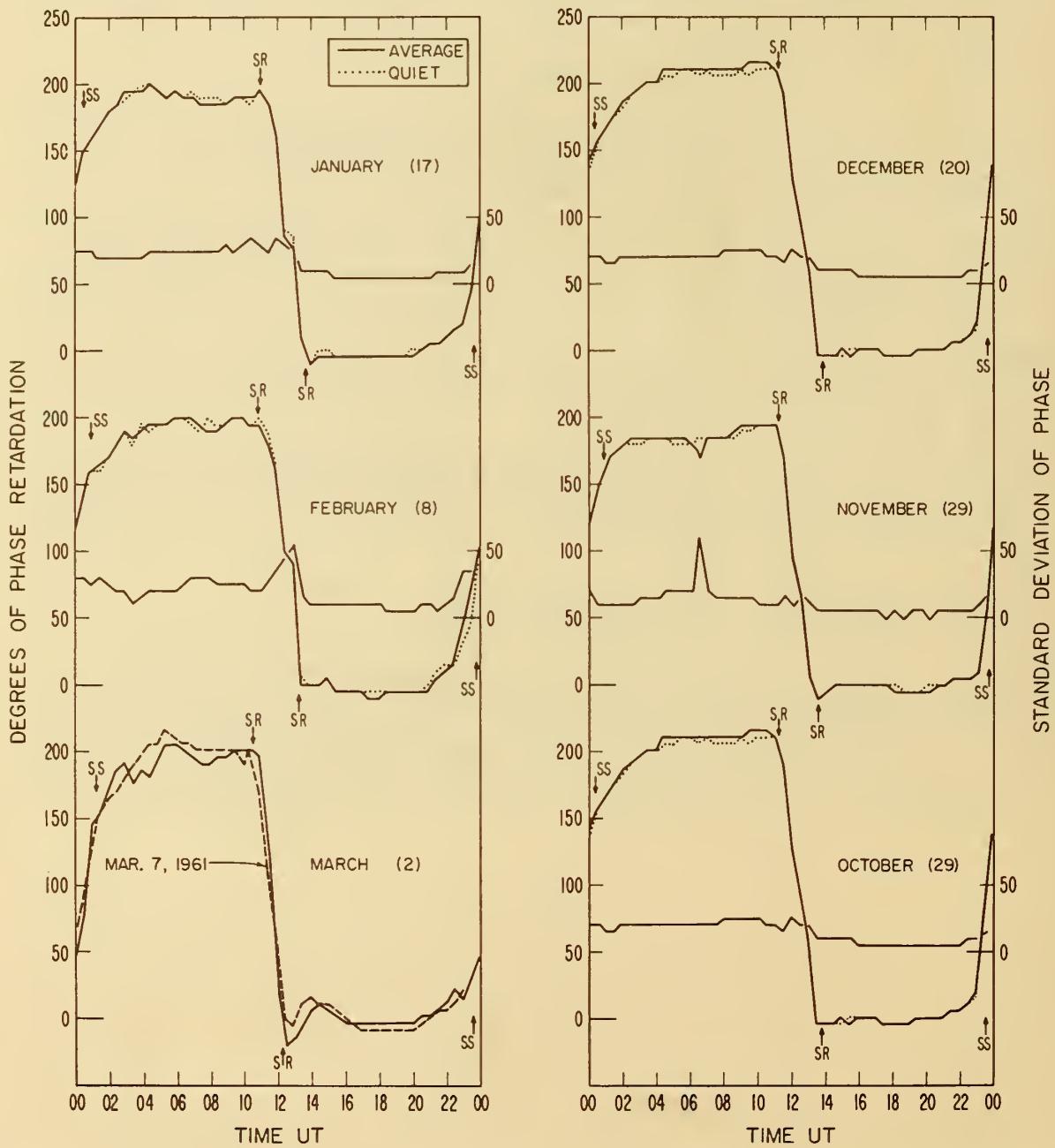


Fig. 1. Mean phase variations and standard deviations in degrees for January-March and October-December 1962. (Note: The dotted curve for March 1961 is superimposed on the March 1962 curve because only two days of observations were available in 1962). Sunrise and sunset at each end of the path are denoted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

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

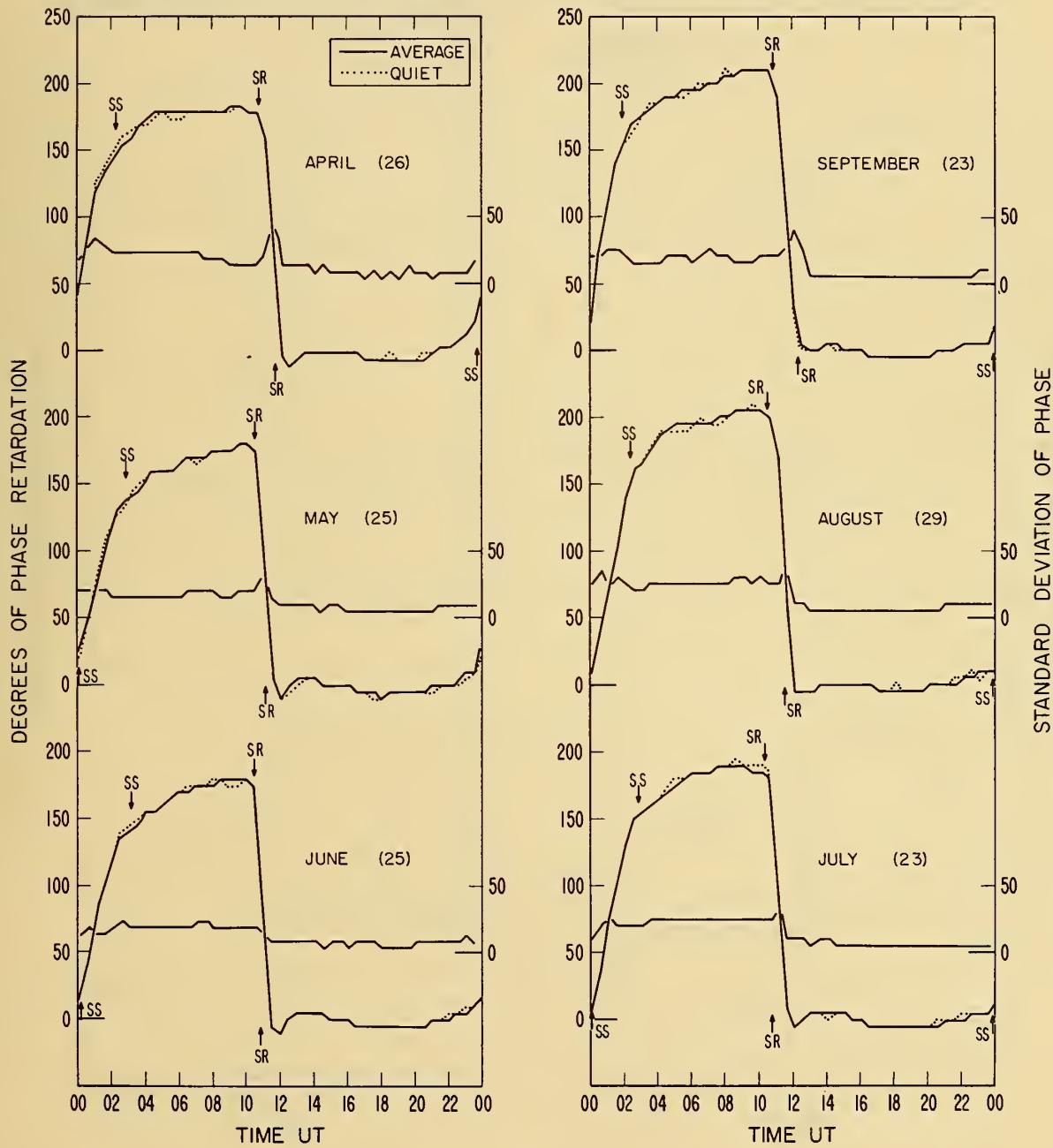


Fig. 2. Mean phase variations and standard deviations in degrees for April-June and July-September 1962. Sunrise and sunset at each end of the path are denoted by SR and SS on the mean phase curves.

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

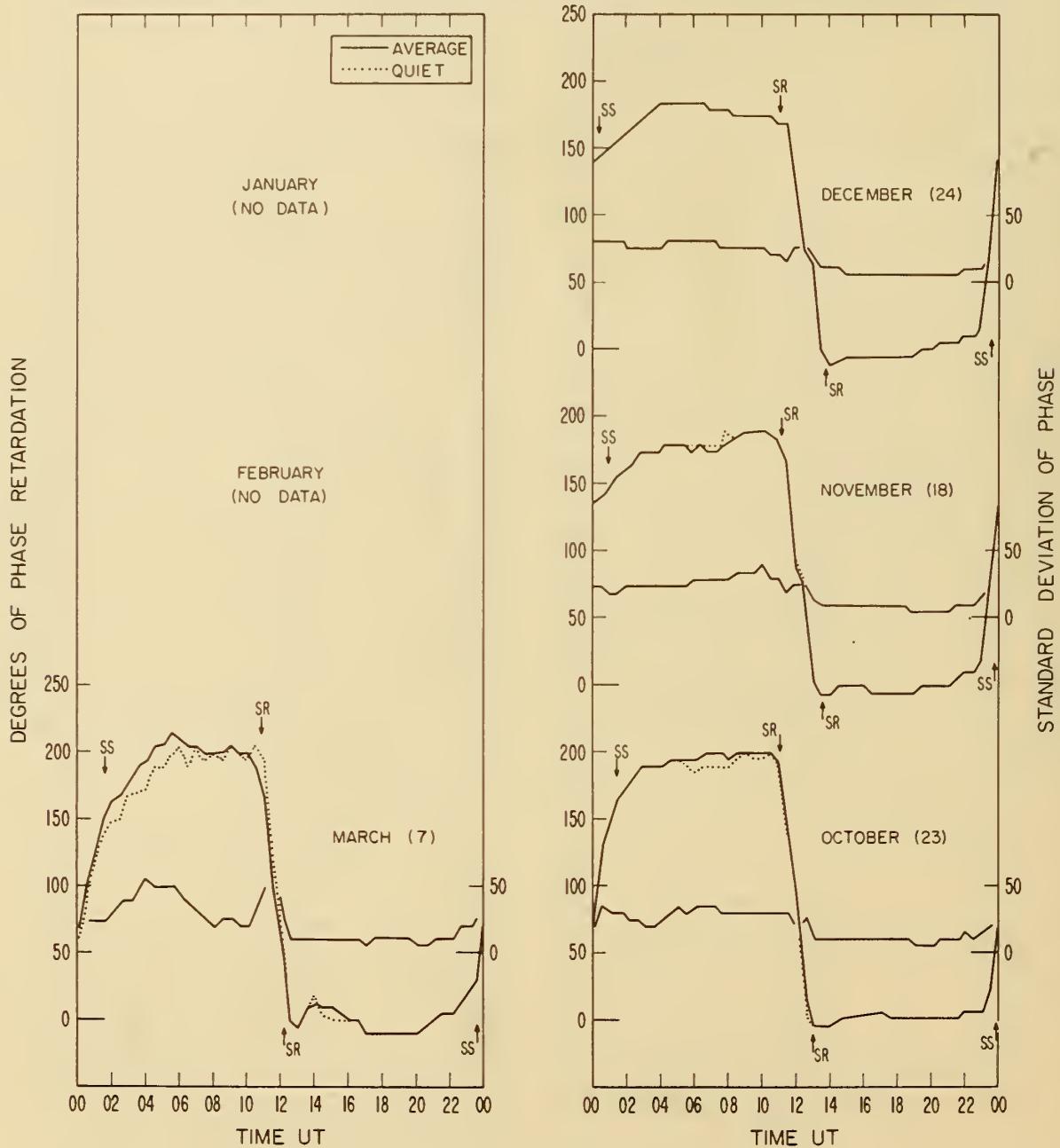


Fig. 3. Mean phase variations and standard deviations in degrees for January-March and October-December 1961. Sunrise and sunset at each end of the path are denoted by SR and SS on the mean phase curves.

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

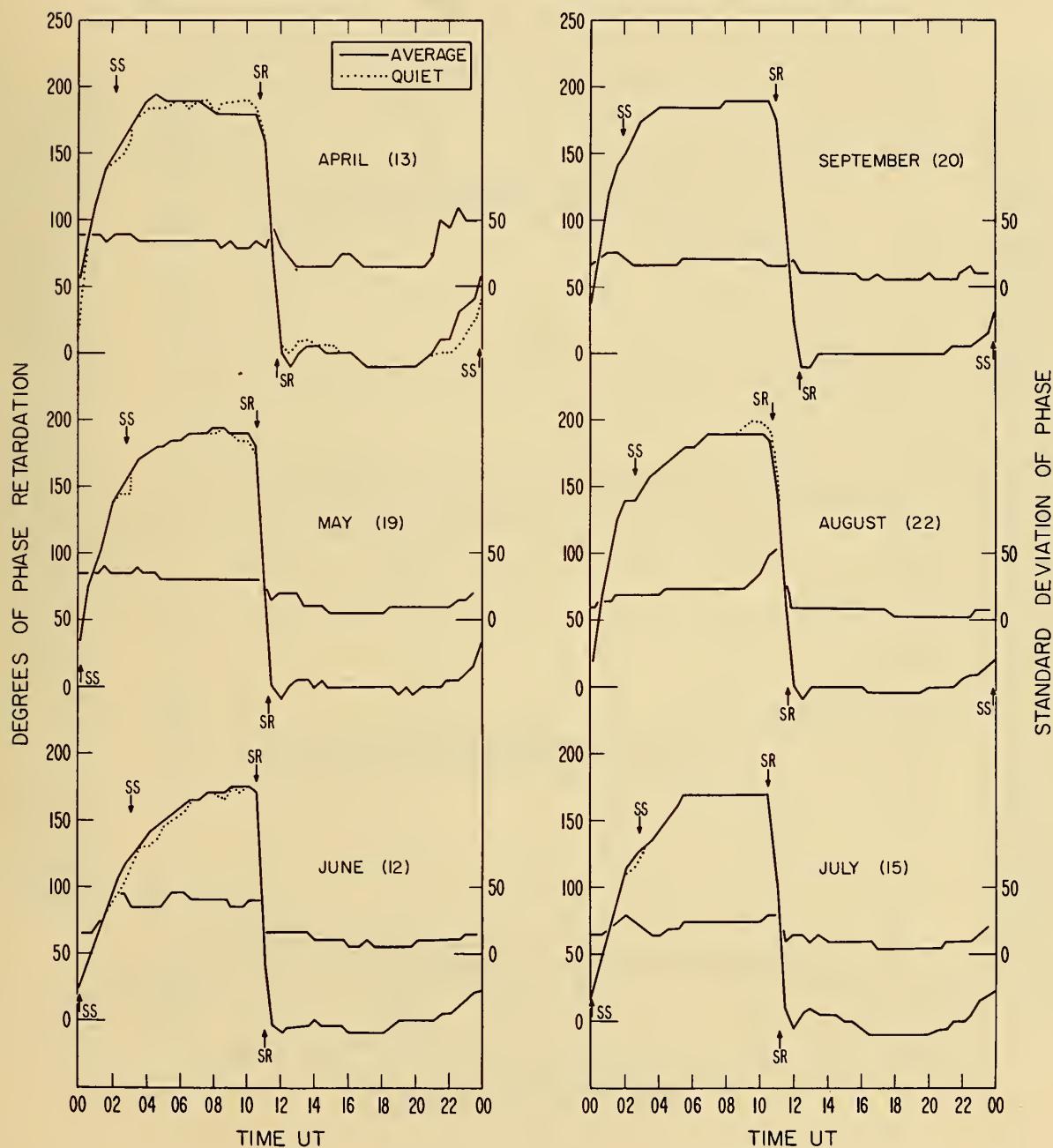


Fig. 4. Mean phase variations and standard deviations for April-June and July-September 1961. Sunrise and sunset at each end of the path are denoted by SR and SS on the mean phase curves.

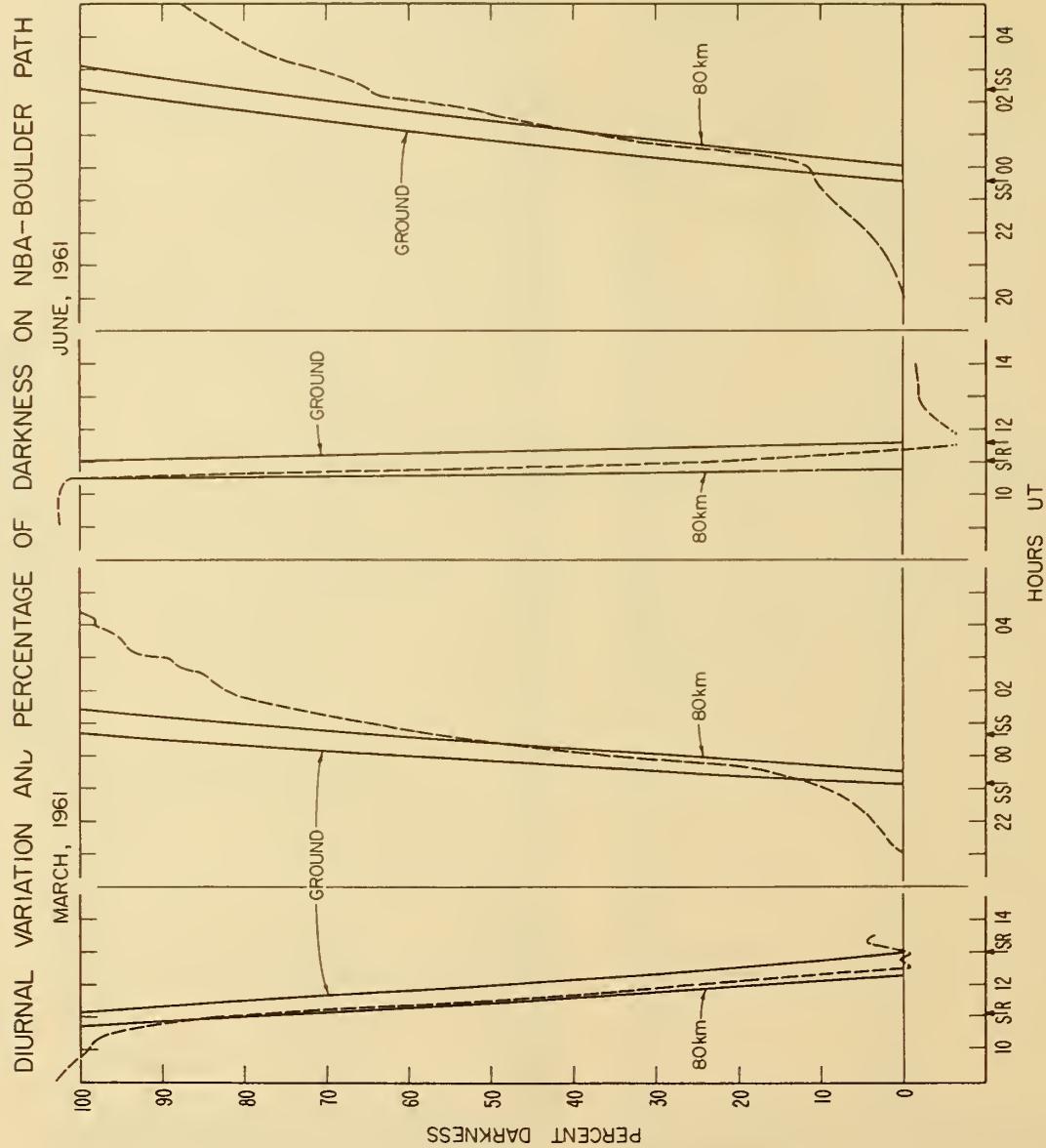


Fig. 5. Diurnal phase variation (solid lines) and percentage of darkness (dotted lines) on path for March and June 1961. (Note: The ordinate also gives the percentage of the diurnal phase variation which has occurred).

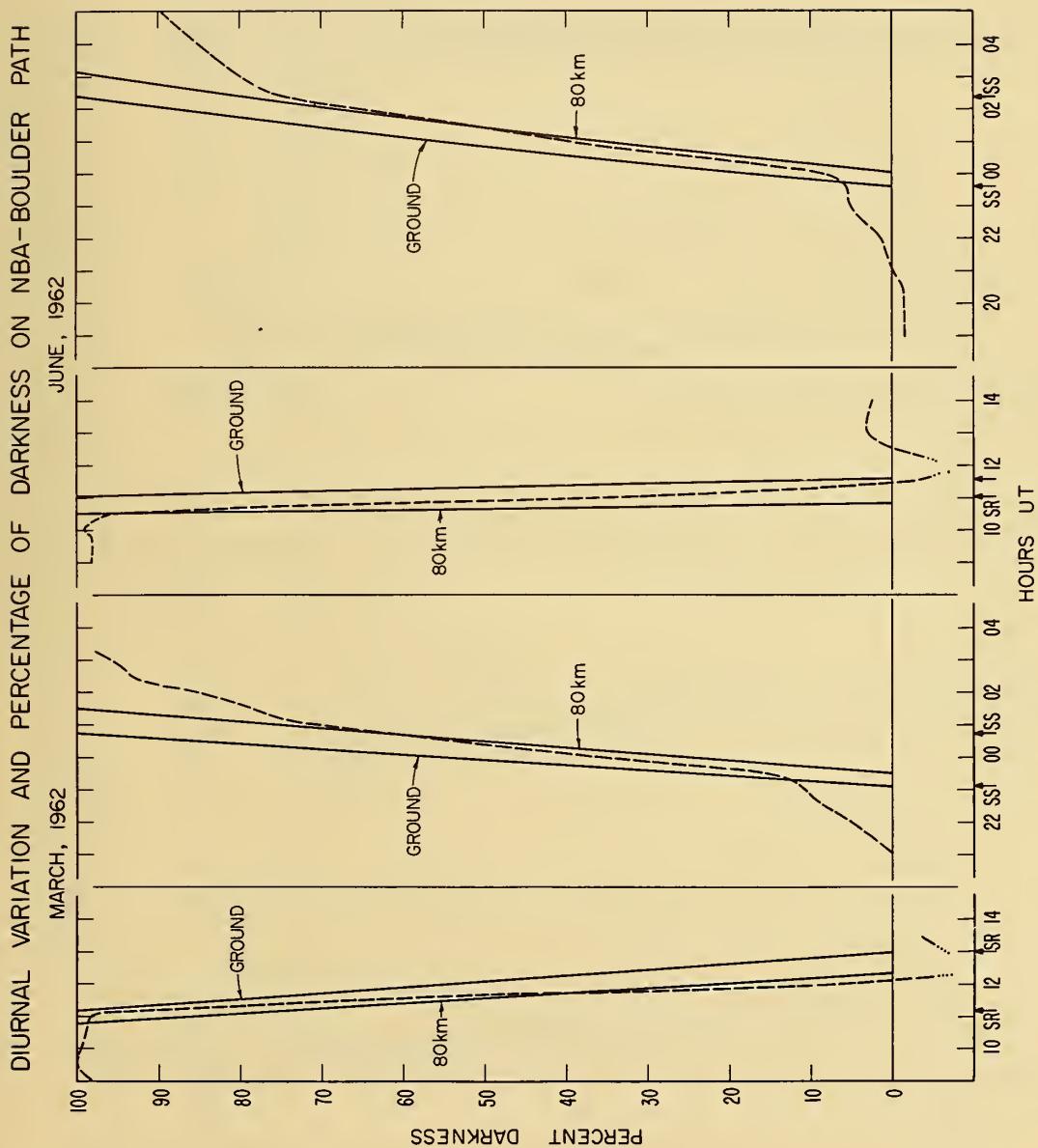


Fig. 6. Diurnal phase variation (dotted) and percentage of darkness (solid lines) on path for March and June 1962. (Note: The ordinate also gives the percentage of the diurnal phase variation which has occurred).

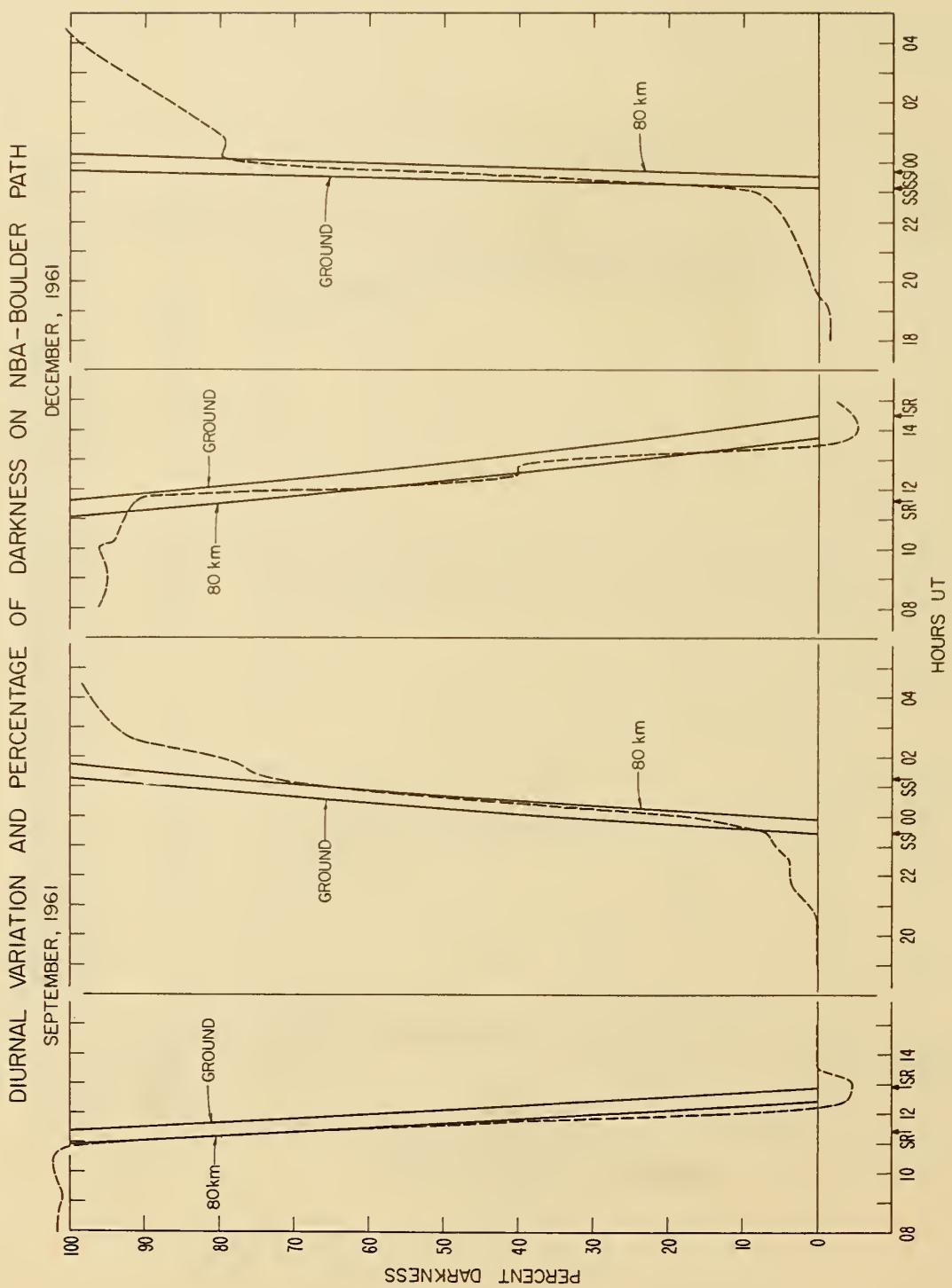


Fig. 7. Diurnal phase variation (dotted) and percentage of darkness (solid lines) on path for September and December 1961. (Note: The ordinate also gives the percentage of the diurnal phase variation which has occurred).

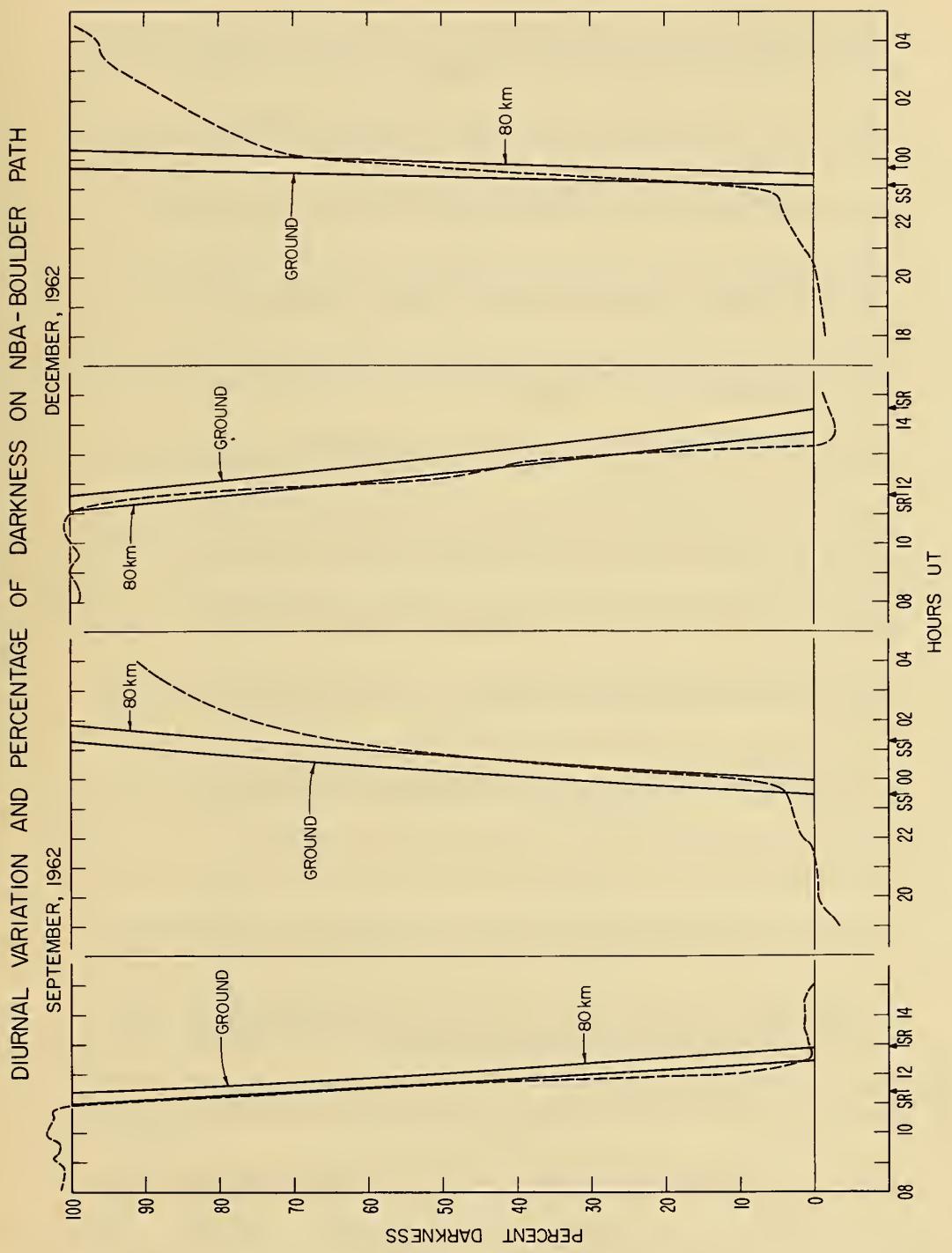


Fig. 8. Diurnal phase variation (dotted lines) and percentage of darkness (solid lines) on path for September and December 1962. (Note: The ordinate also gives the percentage of the diurnal phase variation which has occurred).

Table 1

Table 2

MONTHLY AVERAGE ON PATH	UT	AVER SDV NO	QAY NO	2 1 FOR MONTH 3 1962		
				5 MIN	+ 5 MIN	- 5 MIN
00	545.	-0. 1	565.	-0. 1	585.	-0. 1
01	575.	-0. 1	594.	-1. 1	613.	-1. 1
02	643.	-0. 1	651.	-0. 1	659.	-0. 1
03	656.	-0. 1	659.	-1. 1	662.	-1. 1
04	671.	-0. 1	676.	-0. 1	681.	-0. 1
05	687.	-0. 1	688.	-0. 1	689.	-0. 1
06	692.	-0. 1	694.	-1. 1	696.	-1. 1
07	674.	-2. 1	675.	-2. 1	685.	-2. 1
08	683.	-1. 2	685.	-1. 2	686.	-1. 2
09	690.	-1. 5	698.	-1. 5	698.	-1. 5
10	707.	-2. 2	707.	-2. 2	707.	-2. 2
11	704.	-4. 2	704.	-4. 2	703.	-4. 2
12	701.	-2. 1	700.	-2. 1	700.	-2. 1
13	697.	-3. 2	698.	-3. 2	698.	-3. 2
14	692.	-8. 2	692.	-8. 2	692.	-8. 2
15	693.	-7. 1	693.	-6. 1	694.	-5. 1
16	696.	-3. 2	696.	-3. 2	696.	-3. 2
17	697.	-2. 2	697.	-2. 2	697.	-2. 2
18	698.	-3. 2	698.	-3. 2	698.	-3. 2
19	699.	-2. 2	699.	-2. 2	699.	-2. 2
20	699.	-2. 2	699.	-2. 2	699.	-2. 2
21	699.	-2. 2	699.	-2. 2	699.	-2. 2
22	509.	-6. 2	509.	-6. 2	509.	-6. 2
23	520.	-2. 2	520.	-2. 2	520.	-2. 2
24	516.	-2. 2	516.	-2. 2	516.	-2. 2
25	544.	-2. 2	544.	-2. 2	544.	-2. 2
26	544.	-2. 2	544.	-2. 2	544.	-2. 2
27	551.	-2. 2	551.	-2. 2	551.	-2. 2
28	551.	-2. 2	551.	-2. 2	551.	-2. 2
29	551.	-2. 2	551.	-2. 2	551.	-2. 2
30	551.	-2. 2	551.	-2. 2	551.	-2. 2
31	551.	-2. 2	551.	-2. 2	551.	-2. 2

Table 3

MONTHLY AVERAGE ON PATH 2 FOR MONTH 4 1962									
UT	AVER	SDV	NO	QAV	NO	MIN	5 MIN	27 MIN	57 MIN
00	544.	22	551.	+ 5.27	550.21	557.	556.21	556.21	556.21
01	587.	17	562.	3.25	558.21	597.	593.17	593.17	593.17
02	621.	25	623.	3.23	640.15	626.	626.15	626.25	626.25
03	637.	23	643.	1.6	649.	642.	644.14	644.14	644.14
04	646.	6	648.	1.5	659.	642.	654.14	654.14	654.14
05	655.	2	658.	2.4	665.	2.4	664.14	664.14	664.14
06	667.	2	669.	1.8	664.	2.6	666.15	666.15	666.15
07	678.	1	679.	1.5	679.	2.6	678.14	678.14	678.14
08	680.	1	681.	1.6	681.	2.6	681.14	681.14	681.14
09	681.	1	682.	2.5	681.	2.5	681.14	681.14	681.14
10	683.	1	683.	1.8	683.	1.8	683.14	683.14	683.14
11	685.	1	685.	1.8	685.	1.8	685.14	685.14	685.14
12	687.	1	687.	1.5	687.	1.5	687.14	687.14	687.14
13	688.	1	688.	1.5	688.	1.5	688.14	688.14	688.14
14	689.	1	689.	1.5	689.	1.5	689.14	689.14	689.14
15	690.	1	690.	1.5	690.	1.5	690.14	690.14	690.14
16	698.	1	698.	1.5	698.	1.5	698.14	698.14	698.14
17	699.	1	699.	1.5	699.	1.5	699.14	699.14	699.14
18	700.	1	700.	1.5	700.	1.5	700.14	700.14	700.14
19	701.	1	701.	1.5	701.	1.5	701.14	701.14	701.14
20	702.	1	702.	1.5	702.	1.5	702.14	702.14	702.14
21	703.	1	703.	1.5	703.	1.5	703.14	703.14	703.14
22	704.	1	704.	1.5	704.	1.5	704.14	704.14	704.14
23	705.	1	705.	1.5	705.	1.5	705.14	705.14	705.14

UT	AVER	SDV	NO	QAV	NO	MIN	5 MIN	27 MIN	57 MIN
00	544.	22	551.	+ 5.27	550.21	557.	556.21	556.21	556.21
01	587.	17	562.	3.25	558.21	597.	593.17	593.17	593.17
02	621.	25	623.	3.23	640.15	626.	626.15	626.25	626.25
03	637.	23	643.	1.6	649.	642.	654.14	654.14	654.14
04	646.	6	648.	1.5	659.	642.	666.15	666.15	666.15
05	655.	2	658.	1.8	665.	2.6	664.14	664.14	664.14
06	667.	2	669.	1.8	664.	2.6	667.14	667.14	667.14
07	678.	1	679.	1.5	679.	2.6	680.14	680.14	680.14
08	680.	1	681.	1.6	680.	2.6	681.14	681.14	681.14
09	681.	1	682.	2.5	681.	2.5	681.14	681.14	681.14
10	683.	1	683.	1.8	683.	1.8	683.14	683.14	683.14
11	685.	1	685.	1.8	685.	1.8	685.14	685.14	685.14
12	687.	1	687.	1.5	687.	1.5	687.14	687.14	687.14
13	688.	1	688.	1.5	688.	1.5	688.14	688.14	688.14
14	689.	1	689.	1.5	689.	1.5	689.14	689.14	689.14
15	690.	1	690.	1.5	690.	1.5	690.14	690.14	690.14
16	698.	1	698.	1.5	698.	1.5	698.14	698.14	698.14
17	699.	1	699.	1.5	699.	1.5	699.14	699.14	699.14
18	700.	1	700.	1.5	700.	1.5	700.14	700.14	700.14
19	701.	1	701.	1.5	701.	1.5	701.14	701.14	701.14
20	702.	1	702.	1.5	702.	1.5	702.14	702.14	702.14
21	703.	1	703.	1.5	703.	1.5	703.14	703.14	703.14
22	704.	1	704.	1.5	704.	1.5	704.14	704.14	704.14
23	705.	1	705.	1.5	705.	1.5	705.14	705.14	705.14

Table 4

MONTHLY AVERAGE ON PATH 21 FOR MONTH 5 1962									
UT	AVER	SDV	NO	DAY NO	MIN	MIN	MIN	MIN	MIN
00	521	18	26	524	18	532.	529.	17	536.
01	522	18	26	524	17	561.	562.	20	566.
02	523	18	26	524	17	561.	562.	20	566.
03	524	17	641.	641.	643.	643.	19	643.	643.
04	525	15	656.	656.	657.	657.	18	658.	658.
05	526	15	656.	656.	657.	657.	18	658.	658.
06	527	17	659.	659.	660.	660.	19	661.	661.
07	528	17	662.	662.	663.	663.	19	664.	664.
08	529	17	663.	663.	664.	664.	19	665.	665.
09	530	17	664.	664.	665.	665.	19	666.	666.
10	531	17	665.	665.	666.	666.	19	667.	667.
11	532	17	666.	666.	667.	667.	19	668.	668.
12	533	17	667.	667.	668.	668.	19	669.	669.
13	534	18	668.	668.	669.	669.	18	670.	670.
14	535	18	669.	669.	670.	670.	18	671.	671.
15	536	18	671.	671.	672.	672.	18	673.	673.
16	537	18	673.	673.	674.	674.	17	675.	675.
17	538	18	675.	675.	676.	676.	17	677.	677.
18	539	18	677.	677.	678.	678.	17	679.	679.
19	540	18	679.	679.	680.	680.	17	681.	681.
20	541	18	681.	681.	682.	682.	17	683.	683.
21	542	18	683.	683.	684.	684.	17	685.	685.
22	543	18	685.	685.	686.	686.	17	687.	687.
23	544	18	687.	687.	688.	688.	17	689.	689.
24	545	18	689.	689.	690.	690.	17	691.	691.
25	546	18	691.	691.	692.	692.	17	693.	693.
26	547	18	693.	693.	694.	694.	17	695.	695.
27	548	18	695.	695.	696.	696.	17	697.	697.
28	549	18	697.	697.	698.	698.	17	699.	699.
29	550	18	699.	699.	700.	700.	17	701.	701.
30	551	18	701.	701.	702.	702.	17	703.	703.
31	552	18	703.	703.	704.	704.	17	705.	705.
01	553	18	705.	705.	706.	706.	17	707.	707.
02	554	18	707.	707.	708.	708.	17	709.	709.
03	555	18	709.	709.	710.	710.	17	711.	711.
04	556	18	711.	711.	712.	712.	17	713.	713.
05	557	18	713.	713.	714.	714.	17	715.	715.
06	558	18	715.	715.	716.	716.	17	717.	717.
07	559	18	717.	717.	718.	718.	17	719.	719.
08	560	18	719.	719.	720.	720.	17	721.	721.
09	561	18	721.	721.	722.	722.	17	723.	723.
10	562	18	723.	723.	724.	724.	17	725.	725.
11	563	18	725.	725.	726.	726.	17	727.	727.
12	564	18	727.	727.	728.	728.	17	729.	729.
13	565	18	729.	729.	730.	730.	17	731.	731.
14	566	18	731.	731.	732.	732.	17	733.	733.
15	567	18	733.	733.	734.	734.	17	735.	735.
16	568	18	735.	735.	736.	736.	17	737.	737.
17	569	18	737.	737.	738.	738.	17	739.	739.
18	570	18	739.	739.	740.	740.	17	741.	741.
19	571	18	741.	741.	742.	742.	17	743.	743.
20	572	18	743.	743.	744.	744.	17	745.	745.
21	573	18	745.	745.	746.	746.	17	747.	747.
22	574	18	747.	747.	748.	748.	17	749.	749.
23	575	18	749.	749.	750.	750.	17	751.	751.
24	576	18	751.	751.	752.	752.	17	753.	753.
25	577	18	753.	753.	754.	754.	17	755.	755.
26	578	18	755.	755.	756.	756.	17	757.	757.
27	579	18	757.	757.	758.	758.	17	759.	759.
28	580	18	759.	759.	760.	760.	17	761.	761.
29	581	18	761.	761.	762.	762.	17	763.	763.
30	582	18	763.	763.	764.	764.	17	765.	765.
31	583	18	765.	765.	766.	766.	17	767.	767.
01	584	18	767.	767.	768.	768.	17	769.	769.
02	585	18	769.	769.	770.	770.	17	771.	771.
03	586	18	771.	771.	772.	772.	17	773.	773.
04	587	18	773.	773.	774.	774.	17	775.	775.
05	588	18	775.	775.	776.	776.	17	777.	777.
06	589	18	777.	777.	778.	778.	17	779.	779.
07	590	18	779.	779.	780.	780.	17	781.	781.
08	591	18	781.	781.	782.	782.	17	783.	783.
09	592	18	783.	783.	784.	784.	17	785.	785.
10	593	18	785.	785.	786.	786.	17	787.	787.
11	594	18	787.	787.	788.	788.	17	789.	789.
12	595	18	789.	789.	790.	790.	17	791.	791.
13	596	18	791.	791.	792.	792.	17	793.	793.
14	597	18	793.	793.	794.	794.	17	795.	795.
15	598	18	795.	795.	796.	796.	17	797.	797.
16	599	18	797.	797.	798.	798.	17	799.	799.
17	600	18	799.	799.	800.	800.	17	801.	801.
18	601	18	801.	801.	802.	802.	17	803.	803.
19	602	18	803.	803.	804.	804.	17	805.	805.
20	603	18	805.	805.	806.	806.	17	807.	807.
21	604	18	807.	807.	808.	808.	17	809.	809.
22	605	18	809.	809.	810.	810.	17	811.	811.
23	606	18	811.	811.	812.	812.	17	813.	813.
24	607	18	813.	813.	814.	814.	17	815.	815.
25	608	18	815.	815.	816.	816.	17	817.	817.
26	609	18	817.	817.	818.	818.	17	819.	819.
27	610	18	819.	819.	820.	820.	17	821.	821.
28	611	18	821.	821.	822.	822.	17	823.	823.
29	612	18	823.	823.	824.	824.	17	825.	825.
30	613	18	825.	825.	826.	826.	17	827.	827.
31	614	18	827.	827.	828.	828.	17	829.	829.

MONTHLY AVERAGE ON PATH	2	1	FOR MONTH	6	1962
UT	AVR	SDV	NO		
00	51.9.	14.25	543.	517.	521.
01	51.9.	14.25	543.	517.	521.
02	51.7.	17.25	593.	548.	519.
03	51.6.	19.25	618.	577.	519.
04	51.6.	19.25	638.	607.	520.
05	51.6.	19.25	644.	670.	520.
06	51.6.	19.25	649.	674.	520.
07	51.6.	19.25	653.	677.	520.
08	51.6.	19.25	658.	676.	520.
09	51.6.	20.0	661.	676.	520.
10	51.6.	20.0	664.	679.	520.
11	51.6.	20.0	669.	682.	520.
12	51.6.	20.0	673.	687.	520.
13	51.6.	20.0	677.	691.	520.
14	51.6.	20.0	681.	695.	520.
15	51.6.	20.0	685.	709.	520.
16	51.6.	20.0	689.	723.	520.
17	51.6.	20.0	693.	737.	520.
18	51.6.	20.0	697.	751.	520.
19	51.6.	20.0	701.	765.	520.
20	51.6.	20.0	705.	779.	520.
21	51.6.	20.0	709.	793.	520.
22	51.6.	20.0	713.	807.	520.
23	51.6.	20.0	717.	821.	520.
24	51.6.	20.0	721.	835.	520.
25	51.6.	20.0	725.	849.	520.
26	51.6.	20.0	729.	863.	520.
27	51.6.	20.0	733.	877.	520.
28	51.6.	20.0	737.	891.	520.
29	51.6.	20.0	741.	905.	520.
30	51.6.	20.0	745.	919.	520.
31	51.6.	20.0	749.	933.	520.
00	51.6.	20.0	753.	947.	520.
01	51.6.	20.0	757.	961.	520.
02	51.6.	20.0	761.	975.	520.
03	51.6.	20.0	765.	989.	520.
04	51.6.	20.0	769.	1003.	520.
05	51.6.	20.0	773.	1017.	520.
06	51.6.	20.0	777.	1031.	520.
07	51.6.	20.0	781.	1045.	520.
08	51.6.	20.0	785.	1059.	520.
09	51.6.	20.0	789.	1073.	520.
10	51.6.	20.0	793.	1087.	520.
11	51.6.	20.0	797.	1101.	520.
12	51.6.	20.0	801.	1115.	520.
13	51.6.	20.0	805.	1129.	520.
14	51.6.	20.0	809.	1143.	520.
15	51.6.	20.0	813.	1157.	520.
16	51.6.	20.0	817.	1171.	520.
17	51.6.	20.0	821.	1185.	520.
18	51.6.	20.0	825.	1199.	520.
19	51.6.	20.0	829.	1213.	520.
20	51.6.	20.0	833.	1227.	520.
21	51.6.	20.0	837.	1241.	520.
22	51.6.	20.0	841.	1255.	520.
23	51.6.	20.0	845.	1269.	520.
24	51.6.	20.0	849.	1283.	520.
25	51.6.	20.0	853.	1297.	520.
26	51.6.	20.0	857.	1311.	520.
27	51.6.	20.0	861.	1325.	520.
28	51.6.	20.0	865.	1339.	520.
29	51.6.	20.0	869.	1353.	520.
30	51.6.	20.0	873.	1367.	520.
31	51.6.	20.0	877.	1381.	520.
00	51.6.	20.0	881.	1395.	520.
01	51.6.	20.0	885.	1409.	520.
02	51.6.	20.0	889.	1423.	520.
03	51.6.	20.0	893.	1437.	520.
04	51.6.	20.0	897.	1451.	520.
05	51.6.	20.0	901.	1465.	520.
06	51.6.	20.0	905.	1479.	520.
07	51.6.	20.0	909.	1493.	520.
08	51.6.	20.0	913.	1507.	520.
09	51.6.	20.0	917.	1521.	520.
10	51.6.	20.0	921.	1535.	520.
11	51.6.	20.0	925.	1549.	520.
12	51.6.	20.0	929.	1563.	520.
13	51.6.	20.0	933.	1577.	520.
14	51.6.	20.0	937.	1591.	520.
15	51.6.	20.0	941.	1605.	520.
16	51.6.	20.0	945.	1619.	520.
17	51.6.	20.0	949.	1633.	520.
18	51.6.	20.0	953.	1647.	520.
19	51.6.	20.0	957.	1661.	520.
20	51.6.	20.0	961.	1675.	520.
21	51.6.	20.0	965.	1689.	520.
22	51.6.	20.0	969.	1703.	520.
23	51.6.	20.0	973.	1717.	520.
24	51.6.	20.0	977.	1731.	520.
25	51.6.	20.0	981.	1745.	520.
26	51.6.	20.0	985.	1759.	520.
27	51.6.	20.0	989.	1773.	520.
28	51.6.	20.0	993.	1787.	520.
29	51.6.	20.0	997.	1801.	520.
30	51.6.	20.0	1001.	1815.	520.
31	51.6.	20.0	1005.	1829.	520.
00	51.6.	20.0	1009.	1843.	520.
01	51.6.	20.0	1013.	1857.	520.
02	51.6.	20.0	1017.	1871.	520.
03	51.6.	20.0	1021.	1885.	520.
04	51.6.	20.0	1025.	1899.	520.
05	51.6.	20.0	1029.	1913.	520.
06	51.6.	20.0	1033.	1927.	520.
07	51.6.	20.0	1037.	1941.	520.
08	51.6.	20.0	1041.	1955.	520.
09	51.6.	20.0	1045.	1969.	520.
10	51.6.	20.0	1049.	1983.	520.
11	51.6.	20.0	1053.	1997.	520.
12	51.6.	20.0	1057.	2011.	520.
13	51.6.	20.0	1061.	2025.	520.
14	51.6.	20.0	1065.	2039.	520.
15	51.6.	20.0	1069.	2053.	520.
16	51.6.	20.0	1073.	2067.	520.
17	51.6.	20.0	1077.	2081.	520.
18	51.6.	20.0	1081.	2095.	520.
19	51.6.	20.0	1085.	2109.	520.
20	51.6.	20.0	1089.	2123.	520.
21	51.6.	20.0	1093.	2137.	520.
22	51.6.	20.0	1097.	2151.	520.
23	51.6.	20.0	1101.	2165.	520.
24	51.6.	20.0	1105.	2179.	520.
25	51.6.	20.0	1109.	2193.	520.
26	51.6.	20.0	1113.	2207.	520.
27	51.6.	20.0	1117.	2221.	520.
28	51.6.	20.0	1121.	2235.	520.
29	51.6.	20.0	1125.	2249.	520.
30	51.6.	20.0	1129.	2263.	520.
31	51.6.	20.0	1133.	2277.	520.
00	51.6.	20.0	1137.	2291.	520.
01	51.6.	20.0	1141.	2305.	520.
02	51.6.	20.0	1145.	2319.	520.
03	51.6.	20.0	1149.	2333.	520.
04	51.6.	20.0	1153.	2347.	520.
05	51.6.	20.0	1157.	2361.	520.
06	51.6.	20.0	1161.	2375.	520.
07	51.6.	20.0	1165.	2389.	520.
08	51.6.	20.0	1169.	2403.	520.
09	51.6.	20.0	1173.	2417.	520.
10	51.6.	20.0	1177.	2431.	520.
11	51.6.	20.0	1181.	2445.	520.
12	51.6.	20.0	1185.	2459.	520.
13	51.6.	20.0	1189.	2473.	520.
14	51.6.	20.0	1193.	2487.	520.
15	51.6.	20.0	1197.	2501.	520.
16	51.6.	20.0	1201.	2515.	520.
17	51.6.	20.0	1205.	2529.	520.
18	51.6.	20.0	1209.	2543.	520.
19	51.6.	20.0	1213.	2557.	520.
20	51.6.	20.0	1217.	2571.	520.
21	51.6.	20.0	1221.	2585.	520.
22	51.6.	20.0	1225.	2609.	520.
23	51.6.	20.0	1229.	2623.	520.
24	51.6.	20.0	1233.	2637.	520.
25	51.6.	20.0	1237.	2651.	520.
26	51.6.	20.0	1241.	2665.	520.
27	51.6.	20.0	1245.	2679.	520.
28	51.6.	20.0	1249.	2693.	520.
29	51.6.	20.0	1253.	2707.	520.
30	51.6.	20.0	1257.	2721.	520.
31	51.6.	20.0	1261.	2735.	520.
00	51.6.	20.0	1265.	2749.	520.
01	51.6.	20.0	1269.	2763.	520.
02	51.6.	20.0	1273.	2777.	520.
03	51.6.	20.0	1277.	2791.	520.
04	51.6.	20.0	1281.	2805.	520.
05	51.6.	20.0	1285.	2819.	520.
06	51.6.	20.0	1289.	2833.	520.
07	51.6.	20.0	1293.	2847.	520.
08	51.6.	20.0	1297.	2861.	520.
09	51.6.	20.0	1301.	2875.	520.
10	51.6.	20.0	1305.	2889.	520.
11	51.6.	20.0	1309.	2903.	520.
12	51.6.	20.0	1313.	2917.	520.
13	51.6.	20.0	1317.	2931.	520.
14	51.6.	20.0	1321.	2945.	520.
15	51.6.	20.0	1325.	2959.	520.
16	51.6.	20.0	1329.	2973.	520.
17	51.6.	20.0	1333.	2987.	520.
18	51.6.	20.0	1337.	3001.	520.
19	51.6.	20.0	1341.	3015.	520.
20	51.6.	20.0	1345.	3029.	520.
21	51.6.	20.0	1349.	3043.	520.
22	51.6.	20.0	1353.	3057.	520.
23	51.6.	20.0	1357.	3071.	520.
24	51.6.	20.0	1361.	3085.	520.
25	51.6.	20.0	1365.	3099.	520.
26	51.6.	20.0	1369.	3113.	520.
27	51.6.	20.0	1373.	3127.	520.
28	51.6.	20.0	1377.	3141.	520.
29	51.6.	20.0	1381.	3155.	520.
30	51.6.	20.0	1385.	3169.	520.
31	51.6.	20.0	1389.	3183.	520.
00	51.6.	20.0	1393.	3197.	520.
01	51.6.	20.0	1397.	3211.	520.
02	51.6.	20.0	1401.	3225.	520.
03	51.6.	20.0	1405.	3239.	520.
04	51.6.	20.0	1409.	3253.	520.
05	51.6.	20.0	1413.	3267.	520.
06	51.6.	20.0	1417.	3281.	520.
07	51.6.	20.0	1421.	3295.	520.
08	51.6.	20.0	1425.	3309.	520.
09	51.6.	20.0	1429.	3323.	520.
10	51.6.	20.0	1433.	3337.	520.
11	51.6.	20.0	1437.	3351.	520.
12	51.6.	20.0	1441.	3365.	520.
13	51.6.	20.0	1445.	3379.	520.
14	51.6.	20.0	1449.	3393.	520.
15	51.6.	20.0	1453.	3407.	520.
16	51.6.	20.0	1457.	3421.	520.
17	51.6.	20.0	1461.	3435.	520.
18	51.6.	20.0	1465.	3449.	520.
19	51.6.	20.0	1469.	3463.	520.
20	51.6.	20.0	1473.	3477.	520.
21					

MONTHLY AVERAGE ON PATH	2	1	FOR MONTH	7	1962	UT AVER SDV NO		5 MIN		10 MIN		15 MIN		20 MIN		MIN		
						QAV	NO	12	11	10	9	8	7	6	5	4	3	2
00	512.	12	22	514.	12	22	514.	516.	515.	515.	517.	517.	524.	524.	524.	524.	524.	524.
01	534.	21	24	543.	21	24	543.	553.	553.	552.	552.	552.	570.	570.	570.	570.	570.	570.
02	601.	20	24	574.	17	605.	19	605.	19	605.	19	605.	19	605.	19	605.	19	605.
03	633.	21	24	653.	19	24	651.	651.	651.	651.	651.	651.	659.	659.	659.	659.	659.	659.
04	650.	19	24	655.	17	655.	17	655.	17	655.	17	655.	17	655.	17	655.	17	655.
05	681.	21	24	681.	17	681.	17	681.	17	681.	17	681.	17	681.	17	681.	17	681.
06	684.	25	24	685.	18	684.	18	685.	18	685.	18	685.	18	685.	18	685.	18	685.
07	686.	25	24	688.	16	686.	16	688.	16	688.	16	688.	16	688.	16	688.	16	688.
08	689.	25	24	688.	19	688.	19	689.	19	689.	19	689.	19	689.	19	689.	19	689.
09	691.	26	23	691.	18	690.	18	690.	18	690.	18	690.	18	690.	18	690.	18	690.
10	686.	26	23	689.	18	689.	18	689.	18	689.	18	689.	18	689.	18	689.	18	689.
11	682.	31	23	686.	16	686.	16	686.	16	686.	16	686.	16	686.	16	686.	16	686.
12	694.	25	23	694.	17	690.	17	690.	17	690.	17	690.	17	690.	17	690.	17	690.
13	689.	26	23	689.	18	687.	18	687.	18	687.	18	687.	18	687.	18	687.	18	687.
14	686.	26	23	689.	15	686.	15	689.	15	686.	15	686.	15	686.	15	686.	15	686.
15	682.	31	23	597.	14	584.	14	584.	14	584.	14	584.	14	584.	14	584.	14	584.
16	694.	25	23	694.	17	690.	17	690.	17	690.	17	690.	17	690.	17	690.	17	690.
17	686.	26	23	689.	15	686.	15	689.	15	686.	15	686.	15	686.	15	686.	15	686.
18	695.	24	24	695.	17	695.	17	695.	17	695.	17	695.	17	695.	17	695.	17	695.
19	696.	24	24	696.	17	696.	17	696.	17	696.	17	696.	17	696.	17	696.	17	696.
20	697.	24	24	697.	17	697.	17	697.	17	697.	17	697.	17	697.	17	697.	17	697.
21	698.	24	24	698.	17	698.	17	698.	17	698.	17	698.	17	698.	17	698.	17	698.
22	503.	5	24	503.	12	503.	12	503.	12	503.	12	503.	12	503.	12	503.	12	503.
23	507.	7	25	507.	19	506.	19	506.	19	506.	19	506.	19	506.	19	506.	19	506.

Table 7

Table 8

MONTHLY AVERAGE ON PATH 2 FOR MONTH 8 1962									
UT	AVER	SDV	NO	DAY NO	MIN	5 MIN	10 MIN	15 MIN	20 MIN
00	51.1	25.0	2.9	515.	+ 5.28	51.9	520.	524.	528.
01	54.4	34.0	2.24	550.	- 2.26	55.3	558.	563.	565.
02	57.5	26.0	2.28	581.	- 2.25	58.3	585.	586.	588.
03	60.1	29.6	2.29	604.	- 2.24	60.4	607.	610.	613.
04	67.7	23.7	2.29	664.	- 2.23	66.5	67.5	67.7	67.7
05	69.1	25.7	2.29	678.	- 2.23	68.0	68.8	69.2	69.5
06	69.5	24.5	2.29	688.	- 2.23	68.9	69.5	69.9	70.0
07	69.8	22.6	2.29	691.	- 2.23	69.2	69.9	70.1	70.3
08	70.0	23.7	2.29	693.	- 2.23	69.5	70.0	70.4	70.7
09	70.3	24.5	2.30	694.	- 2.23	69.7	70.5	70.9	71.3
10	70.7	24.7	2.30	695.	- 2.23	69.9	70.7	71.1	71.5
11	70.9	27.3	2.30	697.	- 2.23	70.1	70.9	71.3	71.7
12	70.9	27.7	2.30	702.	- 2.23	70.3	71.0	71.4	71.8
13	70.4	29.7	2.30	703.	- 2.23	70.6	71.3	71.7	72.1
14	70.2	27.3	2.30	704.	- 2.23	70.5	71.2	71.6	72.0
15	70.3	24.7	2.30	705.	- 2.23	70.6	71.3	71.7	72.1
16	70.3	29.7	2.30	706.	- 2.23	70.8	71.5	71.9	72.3
17	70.7	28.0	2.30	707.	- 2.23	70.9	71.6	72.0	72.4
18	70.7	29.7	2.30	708.	- 2.23	71.0	71.7	72.1	72.5
19	70.7	29.7	2.30	709.	- 2.23	71.0	71.7	72.1	72.5
20	70.9	29.7	2.30	710.	- 2.23	71.1	71.8	72.2	72.6
21	70.1	29.7	2.30	711.	- 2.23	71.3	71.8	72.2	72.6
22	70.2	29.7	2.30	712.	- 2.23	71.4	71.8	72.2	72.6
23	70.8	29.7	2.30	713.	- 2.23	71.8	72.2	72.6	73.0
24	52.0	23.7	2.30	692.	- 2.23	69.5	70.2	70.9	71.6
25	52.4	23.7	2.30	693.	- 2.23	69.6	70.3	71.0	71.7
26	52.6	23.7	2.30	694.	- 2.23	69.7	70.4	71.1	71.8
27	52.9	23.7	2.30	695.	- 2.23	69.8	70.5	71.2	71.9
28	53.2	23.7	2.30	696.	- 2.23	69.9	70.6	71.3	72.0
29	53.2	23.7	2.30	697.	- 2.23	70.0	70.7	71.4	72.1
30	53.2	23.7	2.30	698.	- 2.23	70.1	70.8	71.5	72.2
31	53.2	23.7	2.30	699.	- 2.23	70.2	70.9	71.6	72.3
32	53.2	23.7	2.30	700.	- 2.23	70.3	71.0	71.7	72.4
33	53.2	23.7	2.30	701.	- 2.23	70.4	71.1	71.8	72.5
34	53.2	23.7	2.30	702.	- 2.23	70.5	71.2	71.9	72.6
35	53.2	23.7	2.30	703.	- 2.23	70.6	71.3	72.0	72.7
36	53.2	23.7	2.30	704.	- 2.23	70.7	71.4	72.1	72.8
37	53.2	23.7	2.30	705.	- 2.23	70.8	71.5	72.2	72.9
38	53.2	23.7	2.30	706.	- 2.23	70.9	71.6	72.3	73.0
39	53.2	23.7	2.30	707.	- 2.23	71.0	71.7	72.4	73.1
40	53.2	23.7	2.30	708.	- 2.23	71.1	71.8	72.5	73.2
41	53.2	23.7	2.30	709.	- 2.23	71.2	71.9	72.6	73.3
42	53.2	23.7	2.30	710.	- 2.23	71.3	72.0	72.7	73.4
43	53.2	23.7	2.30	711.	- 2.23	71.4	72.1	72.8	73.5
44	53.2	23.7	2.30	712.	- 2.23	71.5	72.2	72.9	73.6
45	53.2	23.7	2.30	713.	- 2.23	71.6	72.3	73.0	73.7
46	53.2	23.7	2.30	714.	- 2.23	71.7	72.4	73.1	73.8
47	53.2	23.7	2.30	715.	- 2.23	71.8	72.5	73.2	73.9
48	53.2	23.7	2.30	716.	- 2.23	71.9	72.6	73.3	74.0
49	53.2	23.7	2.30	717.	- 2.23	72.0	72.7	73.4	74.1
50	53.2	23.7	2.30	718.	- 2.23	72.1	72.8	73.5	74.2
51	53.2	23.7	2.30	719.	- 2.23	72.2	72.9	73.6	74.3
52	53.2	23.7	2.30	720.	- 2.23	72.3	73.0	73.7	74.4
53	53.2	23.7	2.30	721.	- 2.23	72.4	73.1	73.8	74.5
54	53.2	23.7	2.30	722.	- 2.23	72.5	73.2	73.9	74.6
55	53.2	23.7	2.30	723.	- 2.23	72.6	73.3	74.0	74.7
56	53.2	23.7	2.30	724.	- 2.23	72.7	73.4	74.1	74.8
57	53.2	23.7	2.30	725.	- 2.23	72.8	73.5	74.2	74.9
58	53.2	23.7	2.30	726.	- 2.23	72.9	73.6	74.3	75.0
59	53.2	23.7	2.30	727.	- 2.23	73.0	73.7	74.4	75.1
60	53.2	23.7	2.30	728.	- 2.23	73.1	73.8	74.5	75.2
61	53.2	23.7	2.30	729.	- 2.23	73.2	73.9	74.6	75.3
62	53.2	23.7	2.30	730.	- 2.23	73.3	74.0	74.7	75.4
63	53.2	23.7	2.30	731.	- 2.23	73.4	74.1	74.8	75.5
64	53.2	23.7	2.30	732.	- 2.23	73.5	74.2	74.9	75.6
65	53.2	23.7	2.30	733.	- 2.23	73.6	74.3	75.0	75.7
66	53.2	23.7	2.30	734.	- 2.23	73.7	74.4	75.1	75.8
67	53.2	23.7	2.30	735.	- 2.23	73.8	74.5	75.2	75.9
68	53.2	23.7	2.30	736.	- 2.23	73.9	74.6	75.3	76.0
69	53.2	23.7	2.30	737.	- 2.23	74.0	74.7	75.4	76.1
70	53.2	23.7	2.30	738.	- 2.23	74.1	74.8	75.5	76.2
71	53.2	23.7	2.30	739.	- 2.23	74.2	74.9	75.6	76.3
72	53.2	23.7	2.30	740.	- 2.23	74.3	75.0	75.7	76.4
73	53.2	23.7	2.30	741.	- 2.23	74.4	75.1	75.8	76.5
74	53.2	23.7	2.30	742.	- 2.23	74.5	75.2	75.9	76.6
75	53.2	23.7	2.30	743.	- 2.23	74.6	75.3	76.0	76.7
76	53.2	23.7	2.30	744.	- 2.23	74.7	75.4	76.1	76.8
77	53.2	23.7	2.30	745.	- 2.23	74.8	75.5	76.2	76.9
78	53.2	23.7	2.30	746.	- 2.23	74.9	75.6	76.3	77.0
79	53.2	23.7	2.30	747.	- 2.23	75.0	75.7	76.4	77.1
80	53.2	23.7	2.30	748.	- 2.23	75.1	75.8	76.5	77.2
81	53.2	23.7	2.30	749.	- 2.23	75.2	75.9	76.6	77.3
82	53.2	23.7	2.30	750.	- 2.23	75.3	76.0	76.7	77.4
83	53.2	23.7	2.30	751.	- 2.23	75.4	76.1	76.8	77.5
84	53.2	23.7	2.30	752.	- 2.23	75.5	76.2	76.9	77.6
85	53.2	23.7	2.30	753.	- 2.23	75.6	76.3	77.0	77.7
86	53.2	23.7	2.30	754.	- 2.23	75.7	76.4	77.1	77.8
87	53.2	23.7	2.30	755.	- 2.23	75.8	76.5	77.2	77.9
88	53.2	23.7	2.30	756.	- 2.23	75.9	76.6	77.3	78.0
89	53.2	23.7	2.30	757.	- 2.23	76.0	76.7	77.4	78.1
90	53.2	23.7	2.30	758.	- 2.23	76.1	76.8	77.5	78.2
91	53.2	23.7	2.30	759.	- 2.23	76.2	76.9	77.6	78.3
92	53.2	23.7	2.30	760.	- 2.23	76.3	77.0	77.7	78.4
93	53.2	23.7	2.30	761.	- 2.23	76.4	77.1	77.8	78.5
94	53.2	23.7	2.30	762.	- 2.23	76.5	77.2	77.9	78.6
95	53.2	23.7	2.30	763.	- 2.23	76.6	77.3	78.0	78.7
96	53.2	23.7	2.30	764.	- 2.23	76.7	77.4	78.1	78.8
97	53.2	23.7	2.30	765.	- 2.23	76.8	77.5	78.2	78.9
98	53.2	23.7	2.30	766.	- 2.23	76.9	77.6	78.3	79.0
99	53.2	23.7	2.30	767.	- 2.23	77.0	77.7	78.4	79.1
100	53.2	23.7	2.30	768.	- 2.23	77.1	77.8	78.5	79.2
101	53.2	23.7	2.30	769.	- 2.23	77.2	77.9	78.6	79.3
102	53.2	23.7	2.30	770.	- 2.23	77.3	78.0	78.7	79.4
103	53.2	23.7	2.30	771.	- 2.23	77.4	78.1	78.8	79.5
104	53.2	23.7	2.30	772.	- 2.23	77.5	78.2	78.9	79.6
105	53.2	23.7	2.30	773.	- 2.23	77.6	78.3	79.0	79.7
106	53.2	23.7	2.30	774.	- 2.23	77.7	78.4	79.1	79.8
107	53.2	23.7	2.30	775.	- 2.23	77.8	78.5	79.2	79.9
108	53.2	23.7	2.30	776.	- 2.23	77.9	78.6	79.3	80.0
109	53.2	23.7	2.30	777.	- 2.23	78.0	78.7	79.4	80.1
110	53.2	23.7	2.30	778.	- 2.23	78.1	78.8	79.5	80.2
111	53.2	23.7	2.30	779.	- 2.23	78.2	78.9	79.6	80.3
112	53.2	23.7	2.30	780.	- 2.23	78.3	79.0	79.7	80.4
113	53.2	23.7	2.30	781.	- 2.23	78.4	79.1	79.8	80.5
114	53.2	23.7	2.30	782.	- 2.23	78.5	79.2	79.9	80.6
115	53.2	23.7	2.30	783.	- 2.23	78.6	79.3	80.0	80.7
116	53.2	23.7	2.30	784.	- 2.23	78.7	79.4	80.1	80.8
117	53.2	23.7	2.30	785.	- 2.23	78.8	79.5	80.2	80.9
118	53.2	23.7	2.30	786.	- 2.23	78.9	79.6	80.3	81.0
119	53.2	23.7	2.30	787.	- 2.23	79.0	79.7	80.4	81.1
120	53.2	23.7	2.30	788.	- 2.23	79.1	79.8	80.5	81.2
121	53.2	23.7	2.30	789.	- 2.23	79.2	79.9	80.6	81.3
122	53.2	23.7	2.30	790.	- 2.23	79.3	80.0	80.7	81.4
123	53.2	23.7	2.30	791.	- 2.23	79.4	80.1	80.8	81.5
124	53.2	23.7							

MONTHLY AVERAGE ON PATH	2 1 FOR MONTH	9 1962	MIN											
			SDV NO	DAV NO										
10	520.	533.	546.	548.15	554.	558.15	562.	564.15	568.	570.15	574.	576.15	580.	582.15
11	522.	557.15	584.	592.15	592.	598.15	592.	598.15	598.	602.15	602.	607.15	604.	610.15
12	522.	612.	624.	626.15	626.	627.15	626.	627.15	627.	628.15	627.	629.15	629.	630.15
1	522.	641.	656.	658.15	656.	660.15	656.	660.15	660.	662.15	662.	664.15	664.	667.15
2	522.	661.	674.	677.15	674.	683.15	674.	683.15	683.	687.15	687.	690.15	688.	692.15
3	522.	682.	687.	690.15	687.	691.	687.	691.	691.	692.	692.	693.	693.	694.15
4	522.	690.	692.	694.15	690.	695.	692.	695.	695.	696.	692.	696.	696.	697.15
5	522.	693.	695.	697.15	693.	696.	693.	696.	696.	697.	693.	697.	697.	698.15
6	522.	695.	697.	699.15	695.	700.	697.	700.	699.	702.	695.	702.	702.	703.15
7	522.	699.	702.	704.	702.	704.	702.	704.	702.	705.	702.	705.	705.	706.15
8	522.	707.	707.	708.	707.	708.	707.	708.	707.	709.	707.	709.	707.	709.15
9	522.	709.	710.	710.	709.	710.	710.	710.	710.	710.	710.	710.	710.	710.15
0	522.	711.	712.	712.	711.	712.	711.	712.	711.	712.	711.	712.	711.	712.15
1	522.	710.	713.	713.	710.	713.	710.	713.	710.	713.	710.	713.	710.	713.15
2	522.	714.	716.	716.	714.	717.	716.	717.	714.	717.	716.	717.	716.	717.15
3	522.	715.	717.	717.	715.	718.	717.	718.	715.	718.	717.	718.	717.	718.15
4	522.	716.	718.	718.	716.	719.	718.	719.	716.	719.	718.	719.	718.	719.15
5	522.	717.	719.	719.	717.	720.	719.	720.	717.	720.	719.	720.	719.	720.15
6	522.	718.	720.	720.	718.	721.	720.	721.	718.	721.	720.	721.	720.	721.15
7	522.	719.	721.	721.	719.	722.	721.	722.	719.	722.	721.	722.	721.	722.15
8	522.	720.	722.	722.	720.	723.	722.	723.	720.	723.	721.	723.	721.	723.15
9	522.	721.	723.	723.	721.	724.	723.	724.	721.	724.	722.	724.	722.	723.15
0	522.	722.	724.	724.	722.	725.	724.	725.	722.	725.	723.	725.	723.	724.15
1	522.	723.	725.	725.	723.	726.	725.	726.	723.	726.	724.	726.	724.	725.15
2	522.	724.	726.	726.	724.	727.	726.	727.	724.	727.	725.	727.	725.	726.15
3	522.	725.	727.	727.	725.	728.	727.	728.	725.	728.	726.	728.	726.	727.15
4	522.	726.	728.	728.	726.	729.	728.	729.	726.	729.	727.	729.	727.	728.15
5	522.	727.	729.	729.	727.	730.	729.	730.	727.	730.	728.	730.	728.	729.15
6	522.	728.	730.	730.	728.	731.	730.	731.	728.	731.	729.	731.	729.	730.15
7	522.	729.	731.	731.	729.	732.	731.	732.	729.	732.	730.	732.	730.	731.15
8	522.	730.	732.	732.	730.	733.	732.	733.	730.	733.	731.	733.	731.	732.15
9	522.	731.	733.	733.	731.	734.	733.	734.	731.	734.	732.	734.	732.	733.15
0	522.	732.	734.	734.	732.	735.	734.	735.	732.	735.	733.	735.	733.	734.15
1	522.	733.	735.	735.	733.	736.	735.	736.	733.	736.	734.	736.	734.	735.15
2	522.	734.	736.	736.	734.	737.	736.	737.	734.	737.	735.	737.	735.	736.15
3	522.	735.	737.	737.	735.	738.	737.	738.	735.	738.	736.	738.	736.	737.15
4	522.	736.	738.	738.	736.	739.	738.	739.	736.	739.	737.	739.	737.	738.15
5	522.	737.	739.	739.	737.	740.	739.	740.	737.	740.	738.	740.	738.	739.15
6	522.	738.	740.	740.	738.	741.	740.	741.	738.	741.	739.	741.	739.	740.15
7	522.	739.	741.	741.	739.	742.	741.	742.	739.	742.	740.	742.	740.	741.15
8	522.	740.	742.	742.	740.	743.	742.	743.	740.	743.	741.	743.	741.	742.15
9	522.	741.	743.	743.	741.	744.	743.	744.	741.	744.	742.	744.	742.	743.15
0	522.	742.	744.	744.	742.	745.	744.	745.	742.	745.	743.	745.	743.	744.15
1	522.	743.	745.	745.	743.	746.	745.	746.	743.	746.	744.	746.	744.	745.15
2	522.	744.	746.	746.	744.	747.	746.	747.	744.	747.	745.	747.	745.	746.15
3	522.	745.	747.	747.	745.	748.	747.	748.	745.	748.	746.	748.	746.	747.15
4	522.	746.	748.	748.	746.	749.	748.	749.	746.	749.	747.	749.	747.	748.15
5	522.	747.	749.	749.	747.	750.	749.	750.	747.	750.	748.	750.	748.	749.15
6	522.	748.	750.	750.	748.	751.	750.	751.	748.	751.	749.	751.	749.	750.15
7	522.	749.	751.	751.	749.	752.	751.	752.	749.	752.	750.	752.	750.	751.15
8	522.	750.	752.	752.	750.	753.	752.	753.	750.	753.	751.	753.	751.	752.15
9	522.	751.	753.	753.	751.	754.	753.	754.	751.	754.	752.	754.	752.	753.15
0	522.	752.	754.	754.	752.	755.	754.	755.	752.	755.	753.	755.	753.	754.15
1	522.	753.	755.	755.	753.	756.	755.	756.	753.	756.	754.	756.	754.	755.15
2	522.	754.	756.	756.	754.	757.	756.	757.	754.	757.	755.	757.	755.	756.15
3	522.	755.	757.	757.	755.	758.	757.	758.	755.	758.	756.	758.	756.	757.15
4	522.	756.	758.	758.	756.	759.	758.	759.	756.	759.	757.	759.	757.	758.15
5	522.	757.	759.	759.	757.	760.	759.	760.	757.	760.	758.	760.	758.	759.15
6	522.	758.	760.	760.	758.	761.	760.	761.	758.	761.	759.	761.	759.	760.15
7	522.	759.	761.	761.	759.	762.	761.	762.	759.	762.	760.	762.	760.	761.15
8	522.	760.	762.	762.	760.	763.	762.	763.	760.	763.	761.	763.	761.	762.15
9	522.	761.	763.	763.	761.	764.	763.	764.	761.	764.	762.	764.	762.	763.15
0	522.	762.	764.	764.	762.	765.	764.	765.	762.	765.	763.	765.	763.	764.15
1	522.	763.	765.	765.	763.	766.	765.	766.	763.	766.	764.	766.	764.	765.15
2	522.	764.	766.	766.	764.	767.	766.	767.	764.	767.	765.	767.	765.	766.15
3	522.	765.	767.	767.	765.	768.	767.	768.	765.	768.	766.	768.	766.	767.15
4	522.	766.	768.	768.	766.	769.	768.	769.	766.	769.	767.	769.	767.	768.15
5	522.	767.	769.	769.	767.	770.	769.	770.	767.	770.	768.	770.	768.	769.15
6	522.	768.	770.	770.	768.	771.	770.	771.	768.	771.	769.	771.	769.	770.15
7	522.	769.	771.	771.	769.	772.	771.	772.	769.	772.	770.	772.	770.	771.15
8	522.	770.	772.	772.	770.	773.	772.	773.	770.	773.	771.	773.	771.	772.15
9	522.	771.	773.	773.	771.	774.	773.	774.	771.	774.	772.	774.	772.	773.15
0	522.	772.	774.	774.	772.	775.	774.	775.	772.	775.	773.	775.	773.	774.15
1	522.	773.	775.	775.	773.	776.	775.	776.	773.	776.	774.	776.	774.	775.15
2	522.	774.	776.	776.	774.	777.	776.	777.	774.	777.	775.	777.	775.	776.15
3	522.	775.	777.	777.	775.	778.	777.	778.	775.	778.	776.	778.	776.	777.15
4	522.	776.	778.	778.	776.	779.	778.	779.	776.	779.	777.	779.	777.	778.15
5	522.	777.	779.	779.	777.	780.	779.	780.	777.	780.	778.	780.	778.	779.15
6	522.	778.	780.	780.	778.	781.	780.	781.	778.	781.	779.	781.	779.	780.15
7	522.	779.	781.	781.	779.	782.	781.	782.	779.	782.	780.	782.	780.	781.15
8	522.	780.	782.	782.	780.	783.	782.	783.	780.	783.	781.	783.	781.	782.15
9	522.	781.	783.	783.	781.	784.	783.	784.	781.	784.	782.	784.	782.	783.15
0	522.	782.	784.	784.	782.	785.	784.	785.	782.	785.	783.	785.	783.	784.15
1	522.	783.	785.	785.	783.	786.	785.	786.	783.	786.	784.	786.	784.	785.15
2	522.	784.	786.	786.	784.	787.	786.	787.	784.	787.	785.	787.	785.	786.15
3	522.	785.	787.	787.	785.	788.	787.	788.	785.	788.	786.	788.	786.	787.15
4	522.	786.	788.	788.	786.	789.	788.	789.	786.	789.	787.	789.	787.	788.15
5	522.	787.	789.	789.	787.	790.	789.	790.	787.	790.	788.	790.	788.	789.15
6	522.	788.	790.	790.	788.	791.	790.	791.	788.	791.	789.	791.	789.	790.15
7	522.	789.	791.	791.	789.	792.	791.	792.	789.	792.	790.	792.	790.	791.15
8	522.	790.	792.	792.	790.	793.	792.	793.	790.	793.	791.	793.	791.	792.15
9	522.	791.	793.	793.	791.	794.	793.	794.	791.	794.	792.	794.	792.	793.15
0	522.	792.	794.	794.	792.	795.	794.	795.	792.	795.	793.	795.	793	

Table 9

MONTHLY AVERAGE ON PATH 21 FOR MONTH 10 1962

UT	AVR	SDV	NO	DAV	NO	+ 5 MIN	NO	+ 10 MIN	NO	+ 15 MIN	NO	+ 20 MIN	NO	+ 25 MIN	NO
00	579.	18.29	578.25	590.	18.29	587.23	601.	19.29	598.23	609.	20.29	613.24	623.	21	622.21
01	652.	19.29	650.24	655.	20.29	659.24	661.	17.29	667.24	664.	20.29	665.23	665.	23	665.23
02	676.	18.29	667.24	668.	18.29	668.24	669.	20.29	672.24	672.	20.29	674.24	675.	24	675.24
03	685.	19.29	686.23	684.	19.29	687.23	685.	20.29	689.23	689.	21.29	690.21	685.	21	688.21
04	686.	20.29	687.24	685.	20.29	688.24	686.	20.29	688.24	688.	20.29	688.24	688.	24	689.24
05	687.	19.29	688.21	686.	18.29	687.21	687.	18.29	688.21	688.	18.29	689.20	689.	20	689.20
06	688.	19.29	689.20	686.	18.29	690.20	686.	18.29	690.20	691.	19	691.19	686.	19	689.19
07	688.	21.29	690.19	687.	20.29	691.19	687.	20.29	691.19	691.	20	691.20	690.	20	694.21
08	691.	19.29	689.19	691.	20.29	690.19	691.	20.29	690.19	691.	20	691.20	691.	20	697.21
09	697.	20.29	691.21	687.	18.29	691.21	687.	18.29	691.21	688.	20	691.20	691.	20	694.20
10	696.	19.29	690.20	686.	18.29	690.20	686.	18.29	690.20	691.	19	691.19	697.	18	695.18
11	690.	21.29	692.18	685.	22.29	693.18	689.	22.29	693.18	693.	20	693.20	693.	20	693.20
12	698.	19.29	693.20	691.	20.29	695.20	691.	20.29	695.20	692.	21	694.21	694.	21	695.21
13	696.	23.29	694.20	695.	22.29	695.20	695.	22.29	695.20	696.	22	697.22	697.	22	697.22
14	696.	22.29	695.18	695.	21.29	695.18	695.	21.29	695.18	696.	19	696.19	697.	19	697.19
15	690.	16.29	691.15	689.	15.29	691.15	689.	15.29	691.15	690.	14	690.14	690.	14	690.14
16	696.	14.29	692.14	695.	13.29	693.14	694.	13.29	694.14	695.	12	695.12	694.	12	695.12
17	697.	14.29	691.15	695.	13.29	693.15	694.	13.29	694.15	695.	12	695.12	696.	12	696.12
18	697.	14.29	691.15	695.	13.29	693.15	694.	13.29	694.15	695.	12	695.12	696.	12	696.12
19	698.	13.29	694.13	695.	12.29	693.13	694.	12.29	693.13	695.	11	695.11	696.	11	696.11
20	501.	3.27	499.22	497.	2.27	495.22	497.	2.27	495.22	498.	21	498.21	501.	20	501.20
21	502.	3.27	498.21	497.	2.27	494.21	497.	2.27	494.21	501.	21	501.21	502.	21	502.21
22	504.	3.27	497.21	501.	2.27	493.21	501.	2.27	493.21	503.	22	503.22	504.	22	504.22
23	509.	3.27	498.21	501.	2.27	494.21	501.	2.27	494.21	507.	22	507.22	519.	23	519.23

54.29

Table 10

Table 11

MONTHLY AVERAGE ON PATH 21 FOR MONTH 12 1962									
UT	AVR	SDV	NO	DAY	MIN	5 MIN	10 MIN	15 MIN	20 MIN
00	639.	1.7	637.	1.0	646.	1.7	645.	1.0	645.
01	656.	1.8	658.	1.2	661.	1.7	660.	1.2	655.
02	678.	1.6	674.	1.4	667.	1.8	667.	1.2	655.
03	691.	1.9	681.	1.3	686.	1.9	681.	1.2	676.
04	703.	2.0	690.	1.3	685.	1.9	681.	1.2	676.
05	709.	2.1	696.	1.3	689.	1.9	686.	1.2	676.
06	711.	2.2	702.	1.2	697.	1.9	692.	1.2	689.
07	711.	2.2	702.	1.2	700.	1.9	693.	1.2	689.
08	710.	2.1	704.	1.2	705.	1.9	698.	1.2	694.
09	709.	2.0	708.	1.2	710.	1.9	705.	1.2	699.
10	714.	2.2	714.	1.2	714.	1.9	715.	1.2	702.
11	713.	2.2	712.	1.2	712.	1.9	713.	1.2	702.
12	692.	2.6	692.	1.2	692.	1.9	692.	1.2	688.
13	588.	2.8	588.	1.2	587.	1.9	585.	1.2	580.
14	495.	1.0	495.	1.2	495.	1.9	495.	1.2	495.
15	498.	1.5	498.	1.2	498.	1.9	498.	1.2	498.
16	499.	1.6	499.	1.2	499.	1.9	499.	1.2	499.
17	498.	1.4	498.	1.2	498.	1.9	498.	1.2	498.
18	497.	1.4	497.	1.2	497.	1.9	497.	1.2	497.
19	498.	1.6	498.	1.2	498.	1.9	498.	1.2	498.
20	498.	1.7	498.	1.2	498.	1.9	499.	1.2	499.
21	501.	1.7	501.	1.2	499.	1.9	501.	1.2	499.
22	502.	1.7	502.	1.2	503.	1.9	504.	1.2	505.
23	509.	1.7	509.	1.2	507.	1.9	508.	1.2	506.

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	180	170	170	185	190	200	190	185	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	
Feb.	Night	9.6	13.5	15.1	17.4	19.3	21.2	23.3	23.8	23.6
"	Day	2.1	2.5	3.4	3.9	4.4	4.7	4.9	5.1	5.2
April	Night	4.9	6.2	6.8	8.4	9.0	9.4	10.3	11.1	"
"	Day	6.6	10.4	13.7	16.6	18.0	18.6	19.2	19.6	"
June	Night	5.6	8.4	10.9	13.2	15.8	18.6	20.7	23.5	26.4
"	Day	3.4	5.4	6.8	8.5	9.7	11.1	11.9	12.5	12.4
Aug.	Night	6.9	9.3	12.0	14.7	17.0	18.6	20.1	21.9	24.0
"	Day	3.6	4.5	4.5	5.1	6.2	6.1	7.1	7.9	8.5
Oct.	Night	5.0	6.4	6.8	7.7	6.1	5.5	6.3	7.8	7.6
"	Day	2.7	3.8	4.9	5.2	7.2	8.4	9.6	10.7	11.5
Dec.	Night	3.4	4.2	5.2	5.9	6.6	7.2	8.0	8.7	9.5
"	Day	2.5	3.5	3.8	4.5	5.3	5.8	6.1	6.3	6.4

