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**the ottawa PZT observations – 1956-70, their
comparison with BIH values by graphical,
spectral and fourier analyses**

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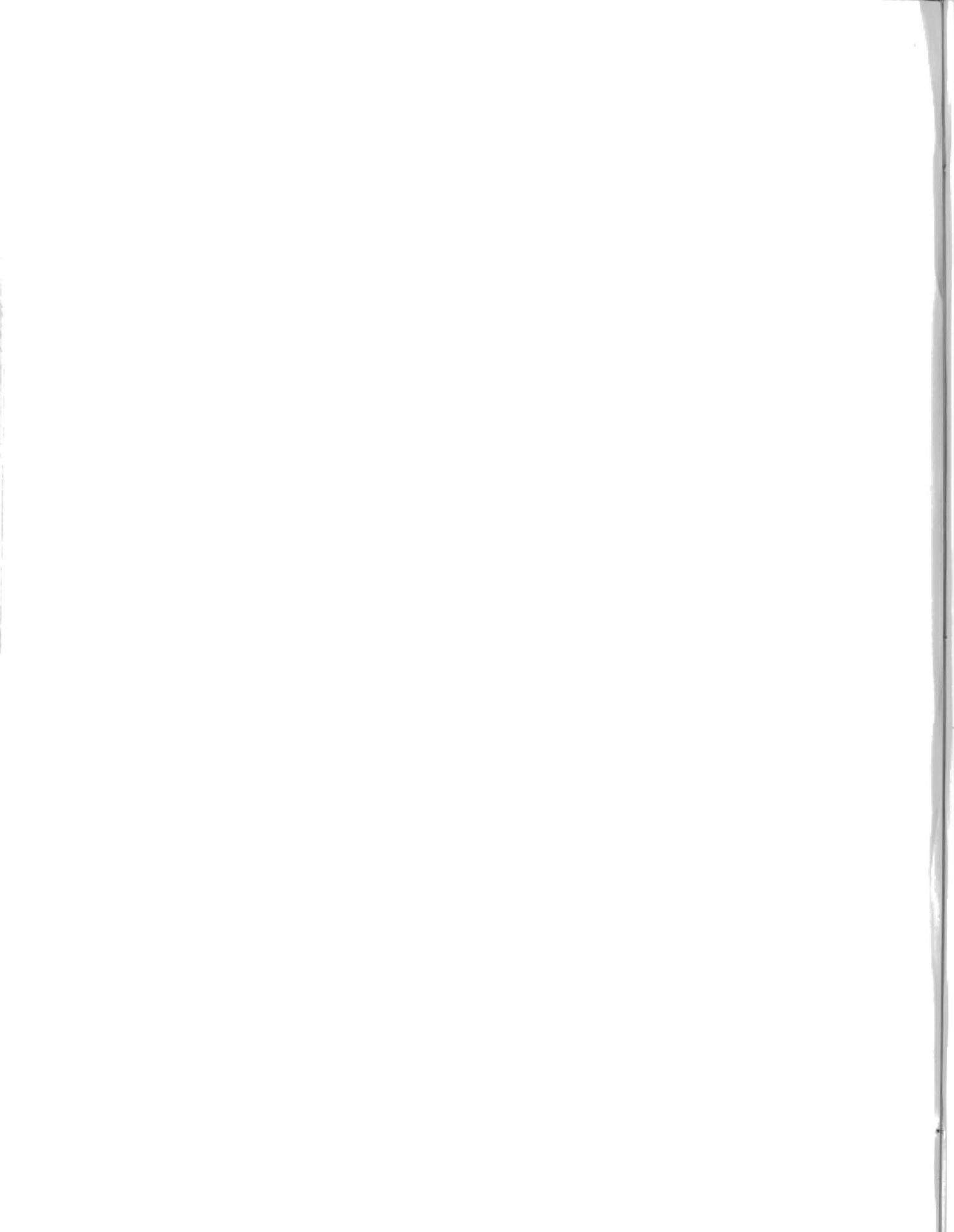
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the ottawa PZT observations – 1956-70, their comparison with BIH values by graphical, spectral and fourier analyses

E. G. WOOLSEY

Abstract. Results of measurements of latitude and time made with the Ottawa Photographic Zenith Tube (PZT) from 1956 to 1970 are given. The observations, on magnetic tape, are available to recognized scientific organizations at nominal cost.

The observations are shown to produce values of the variation in latitude and longitude with a probable error of ".01. They were compared to the published results of the Bureau International de l'Heure. The residuals so formed were subjected to a spectral analysis and it is demonstrated that the PZT was not capable of detecting secular motions of 10 cm or less. No motion was found for Ottawa.

The star catalogue is published to contribute to the knowledge of stellar positions.

Résumé. La présente publication donne les résultats de mesures de la latitude et du temps effectuées à l'aide de la lunette photographique zénithale d'Ottawa (PZT) de 1956 à 1970. Les observations, enregistrées sur bande magnétique, sont disponibles et seront communiquées aux organismes scientifiques reconnus, pour un coût nominal.

Les observations sont données de manière à indiquer les valeurs de la variation de latitude et de longitude avec une erreur possible de ".01. Elles ont été comparées aux résultats publiés par le Bureau International de l'Heure. Les données résiduelles ainsi obtenues ont été soumises à une analyse spectrale et il a été démontré que la lunette (PZT) ne peut détecter des mouvements séculaires de 10 cm ou moins. Aucun mouvement n'a été décelé pour Ottawa.

Le catalogue des étoiles est publié comme contribution à la connaissance de la position des étoiles.

Introduction

The PZT (Photographic Zenith Tube) is basically a fixed telescope that observes stars within 15 minutes of arc of the zenith. The light from a star passes through the lens, is reflected by a dish of mercury which establishes the vertical and is brought to focus on a photographic plate placed at just a sufficient distance below the lens to allow room for the plate holder. Each star is photographed four times during transit; the plate is driven to produce point images and is rotated 180° between each exposure. Each exposure is accurately timed.

The photographic plates are measured in two coordinates. Since we know the positions of the stars, in one coordinate we are able to record the latitude in relation to our star catalogue and, in the other coordinate, record the difference between observed and calculated times of transit of the star over our meridian. Clock comparisons are made daily (in our case with WWV and CHU).

These measures are used to determine the position of the pole and the rate of rotation of the earth. In order to do this we must adopt a coordinate system (x, y) for the position of the pole. By international agreement x is measured as the displacement of the pole toward Greenwich, and y the displacement of the pole toward 90° west of Greenwich. The origin adopted is the Conventional International Origin (CIO). Both x and y are measured in seconds of arc.

Our measures become:

$$\phi = \phi_0 + x \cos \lambda_0 + y \sin \lambda_0$$

$$\Delta T = (-x \sin \lambda_0 + y \cos \lambda_0) \tan \phi + t$$

where ϕ is our observed latitude and ΔT our observed difference in time, in seconds of mean solar time; ϕ_0 and λ_0 are our adopted latitude and west longitude. The values to be determined are x and y for the position of the pole and t the time correction measured in seconds of mean

time in respect to our reference clock. Thus at any instant we have two equations and three unknowns. It is only by introducing results from other stations that a solution can be found.

Such a solution is regularly carried out by the BIH (Bureau International de l'Heure) using observations from many stations around the world. When the observations from any individual station are compared to the values published by the BIH (Guinot, 1967-70), the major part of the observed variations in latitude and time correspond to the variations in x , y and t of the BIH and therefore must be features of the earth as a whole. There are, however, small residuals at each station that appear to be periodic and a phenomenon of that station. The study of both these types of variation reveals properties of the earth.

History

This article deals with results only. No effort will be made to describe the instrument in technical detail, which has already been done by Thomson (1955).

The Ottawa PZT was brought into operation in 1952. During the early years it was mounted in the transit annex of the Dominion Observatory, which was a stone, brick and concrete addition on the west side of the main building. In 1960 it was moved about 100 metres southeast to its own light, insulated building. At the end of January 1968 the 10-inch (25-cm) PZT was replaced with a new 8-inch (20-cm) instrument. The former was moved to Calgary to be on the same latitude as the Herstmonceux PZT of the Royal Greenwich Observatory. Finally, in January 1970 the Ottawa PZT was moved to a new site 16 kilometres due west. This is the terminal point of this report.

The Ottawa PZT plates from the years 1956 to 1960 inclusive were previously remeasured. The observations in latitude were published in *Time & Latitude Bulletin*, A45, of the Dominion Observatory, (Tanner, 1967), from which the following notes have been extracted.

"The principal changes within the period which still may effect the results are:

- (1) From 1956 to 1959 inclusive, observations consisted of two, two-hour groups from a 160-star catalogue, centred near 2200 hours local time; from 1960 onwards observations were made from dusk to dawn.
- (2) The instrument was moved in the period May 7 to May 25, 1960, to the new observing hut 1".252 south and 0^s275 east of its earlier location. The 0^s275 was allowed for in the calculation of time so there is no apparent discontinuity in this coordinate.
- (3) From 1962 onwards the catalogue consists of 80 stars in eight, three-hour groups.

"It has not been considered profitable to rework the 1952-1955 results for three reasons; the larger scatter, the smaller number of stars in common with the current catalogue, and the lack of an atomic standard of time comparison."

Star catalogue

The star catalogues are essentially on the FK4 basis with an epoch of observation about 1962. The positions were amended in 1966 by R.W. Tanner of this Branch, and incorporate the PZT observations to that date. They are relatively free from error and any adjustments made in the future will have little effect on the results being considered.

In order to have a permanent record, and to assist astronomers forming star catalogues, the catalogues employed for the two periods are published in Appendix A. The 160-star catalogue was used from 1956 to 1961 and the 80-star catalogue from 1962 to 1970.

The star catalogues require little explanation since they follow current

practice. The star number is made up of two parts, the hundreds define the group, the tens and units the number of the star within the group. The photographic magnitude and spectral class have been copied from the other publications, principally the *Henry Draper Catalogue*. The right ascension and declination are presented for the year 1950 and the proper motions are centennial. The BD number is given to provide identification of the star and cross-reference to other star catalogues.

Preparation of data

Since observations were available on punched cards, it was only necessary to bring them to a uniform basis and decide how to collect and present them in the most usable form for future investigations. The latitude is given directly and presents no problem.

In the time coordinate the readings are the difference between observed and calculated time of transit of a star recorded as differences with the time broadcast by WWV. In the past, time was related to the mean rotation of the earth; with the advent of atomic clocks time was maintained by adopting a constant annual rate and applying step corrections to keep radio transmitted time within 0.1 sec. of mean solar time. The annual rate was changed several times in the period considered. An obvious uniform time is atomic time and the most easily available atomic time was A1 (the U.S. Naval Observatory atomic standard) for which they had already published comparisons with WWV. Our observations are published as $\Delta T = \text{UTO} - \text{A1}$, the difference between our observed time of transit and the time of the atomic standard A1.

The other adjustment required to bring the observations to a uniform basis was to correct the earlier years for the change in aberration adopted in 1968.

The observations were collected by star groups and comparisons with the original summaries were made to insure that the values were free from errors. Our raw results are available on magnetic tape to recognized scientific organizations at a nominal cost. The tape gives:

Ottawa date of observation — year, month, day.

Julian day to two decimals.

Star group number.

Observed time minus atomic time 'A1'.

Observed latitude — seconds of latitude, omitting the 45°23'.

Number of stars observed.

Our night or reference number.

Preparation of summary values

Rather than publish our raw data, which would be of use to few investigators, summary values have been derived at intervals of one-twentieth of a year and ten-day intervals. The use of summary values reduces the night-to-night dispersion and provides values that can be compared directly with those published by the BIH.

The information on the raw data tape is similar to that sent to the BIH; the observations are arranged as average of star groups. These star groups originated in the star catalogue and contained about ten stars balanced north and south of the zenith. Unfortunately, it is the exception rather than the rule that complete groups are observed. Also, each night's work is on one plate, and the plate constants are derived from the mean of all stars observed. It therefore seemed preferable to use the average of all stars observed on one night as an observation.

In order to reduce night-to-night dispersion, the nights were grouped to form summary values. The grouping of nights was done in such a manner as to produce values at one-twentieth of a year and at ten-day intervals to facilitate comparisons with the published BIH (1968) values. Two different numerical methods were used, one for the one-twentieth of a year and the second for the ten-day intervals. Both schemes appear to represent our observations equally well.

The summary values are listed in Appendix B, giving time of observation in Besselian years from 1900 for the .05 year values and in Julian days for the ten-day smoothed values. The latitude, (ϕ), is in seconds only; the 45°23' has

been omitted. The time coordinate is observed minus atomic time A1 and is called 'UTO-A1'.

Values at one-twentieth of a year

The method of combining observations as suggested by Jeffreys (1960, 1961) was used to calculate the values for each twentieth of a year. The night values were weighted one for all nights with ten or more observations, one-half for all nights with five to nine stars, and zero for all nights with less than five stars observed. The various nights were divided into ten groups per year to yield values near .05, .10, etc., parts of a Besselian year. Care was taken to ensure that each group had a weight of at least ten, thus each group included a minimum of 10 nights on which observations were successfully carried out. To form values for the exact periods, the three term Lagrange interpolation formula for unequal intervals was used.

A second solution was made by grouping half the nights from each set to form a new series of ten groups per year. The average of the solutions has been adopted as the value at one-twentieth of a year.

This solution lent itself to the calculation of standard deviations. The standard deviations for each star were obtained on each night (as part of the routine calculations) from differences between the observed values and the mean value for the night. The standard deviations for each night and each summary value were obtained using the least-square solution of Jeffreys' formula. The averages of these errors are the values quoted in Table I.

In order to ensure that these standard deviations were indeed correct, a standard deviation for each night was determined from the differences between the observed value and a value for the night determined by straight line interpolation between the two adjacent summary values. This gave standard deviations in latitude and time respectively of $^{\circ}.090$ and $^{\circ}0^{\circ}165$ for 1956 to 1959 and $^{\circ}.050$ and $^{\circ}0045$ for 1962 to 1967. These standard deviations are not significantly different from those of the first solution.

Table I. Standard deviations

Epoch	Each Lat.	star Time	Each Lat.	night Time	Each summary values Lat.	Time
1956-59	$^{\circ}.15$	$^{\circ}021$	$^{\circ}.088$	$^{\circ}0162$	$^{\circ}.027$	$^{\circ}0062$
1962-67	$^{\circ}.11$	$^{\circ}013$	$^{\circ}.051$	$^{\circ}0045$	$^{\circ}.015$	$^{\circ}0013$

The standard deviation for a summary value was checked by comparing the two solutions. The root mean sum of the differences was the same as before.

There is a considerable improvement of the results with the change of location in 1960. In order to indicate the reliability of the results the standard deviations using a representative period for each site are as shown in Table I.

These are considered internal standard deviations since they are formed by comparing results among themselves.

The method of weighting and combining observations is somewhat arbitrary but the considerations leading to the method adopted may be of interest. From our experience, it should never be assumed (without investigation) that precision increases with the square root of the number of observations; there appears to be a limiting accuracy which cannot be improved significantly merely by increasing the number of observations.

Markowitz (1960) has pointed out that "On account of systematic effects no great increase in precision is gained by observing a large number of stars in any one night ... the weight of an observation with 16 stars is about 1.5 times as great as one with 6 stars."

We concur with his reasoning but have solved the problem by graphic means. We graphed the root mean square of residuals formed by subtracting our night values from the curve of best fit through the night values against the number of observations as ordinate. We found that after a certain number of observations the curve becomes a horizontal line.

Examining our night corrections in this manner we found that when ten stars were observed, we were approaching the values $^{\circ}.05$ and $^{\circ}005$, which was about 90 per cent of the limit. There was no justification for a more elaborate weight-

ing scheme than a simple one, two ratio (1. and .5).

The summary values became asymptotic at about $^{\circ}.015$ and $^{\circ}0015$, but the value was not approached until 18 or 20 nights were combined. The minimum number of ten nights was set rather by the number of nights available.

Ten-day smoothed values

The ten-day smoothed values were calculated by a less sophisticated method. The earlier years were adjusted for the move in 1960 by subtracting $1^{\circ}.252$ from the latitude. Running means for ten successive plates were formed. Values for the ten-day Julian dates were interpolated linearly from two adjacent values. The final listing was formed from these ten-day values by parabolic smoothing in groups of five.

Both methods produce comparable values and are in good agreement except at the beginning of 1968 where there is a period of thirty days with no observations, then four days observing followed by a gap of nine days. Neither method can be expected to bridge gaps so large.

Description of observations

Very little can be said about the observations until they are compared to the BIH. However, they have been graphed to give a visual representation to the reader. Figure 1 shows our readings in latitude and time.

As already stated the main part of each variation is common to all stations and these graphs resemble those in other publications.

In the lower or latitude curve the beat period of about six years between the Chandler and annual terms is obvious and during this period the amplitude of the Chandler term appears to be decreasing.

It is not practical to graph the time coordinate in the same manner. The large rate difference between observed and

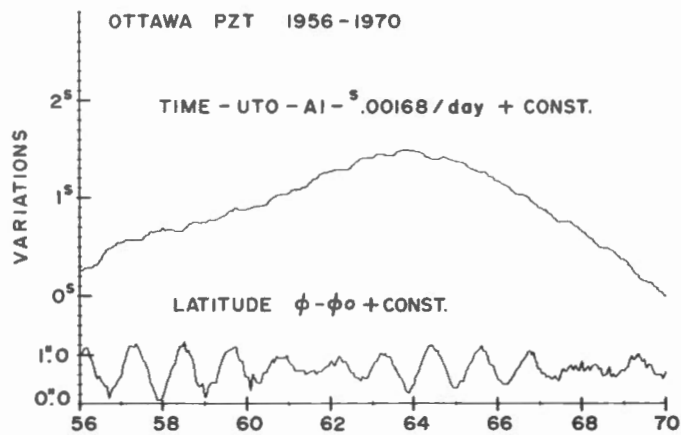


Figure 1.

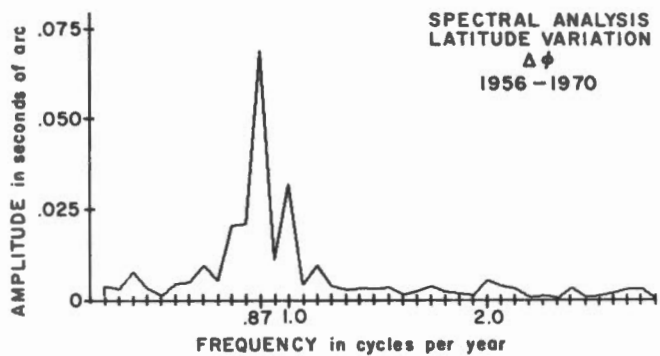


Figure 2.

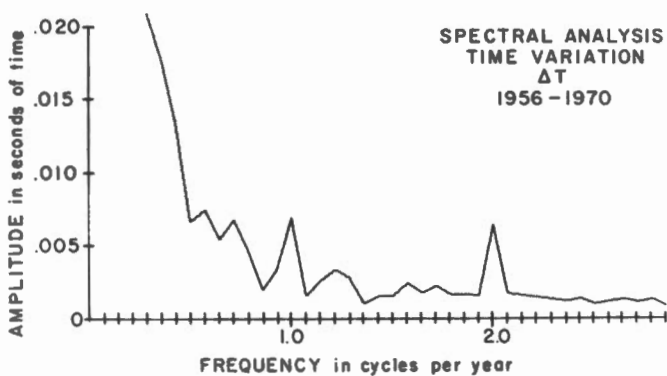


Figure 3.

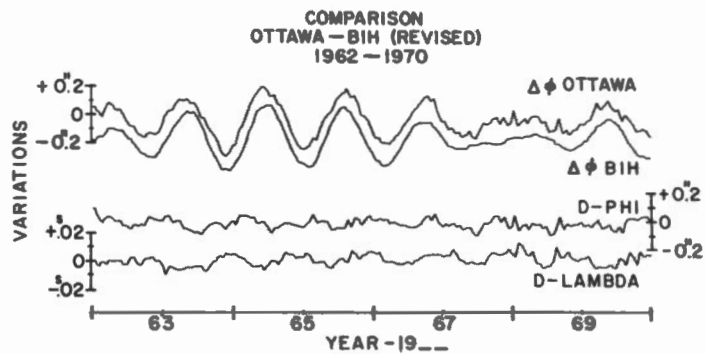


Figure 4.

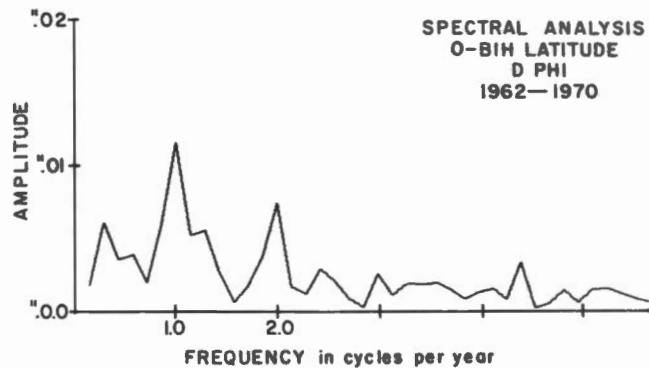


Figure 5.

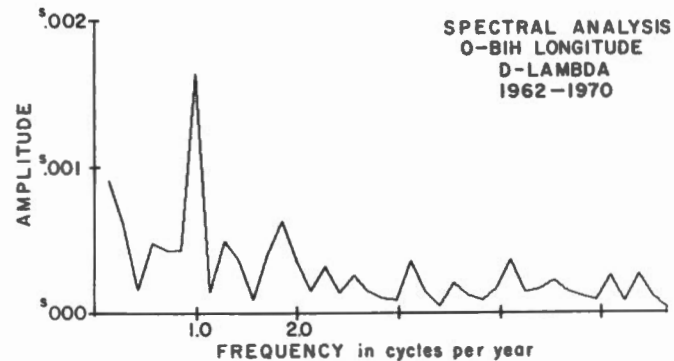


Figure 6.

atomic time would require the scale to be greatly reduced and thus obscure variations. By subtracting an average rate for the period, of $^{\circ}00168$ per day, the changes in rate are more easily seen and the graph draws attention to the fact that the rate of rotation of the earth is far from constant. This graph is similar to that shown by Markowitz (1969). Even with this method of showing the time, scale has been reduced by a factor of 10, that is, each division of the time graph is approximately equal to ten in latitude. The graph draws attention to the significant change in the rate of rotation of the earth (more than 100 parts in 10^{10} i.e. more than a millisecond per day) that occurred in the short period 1964-1966.

A spectral analysis may show better what is actually happening. Figure 2 shows the amplitude in latitude plotted against frequency.

Table II.

Frequency cycles per year	Period in days	Power ($^{\circ}01$) ²
.73	511	5
.75	465	5
.87	426	49
1.00	365	11
2.00	183	.3

The principal features are:

1. A few long terms that may be related to the short period examined (i.e. frequencies .73 and .75).
2. A large Chandler term. The values given in Table II confirm other findings, that the power of the Chandler term is about four times the annual term.
3. An annual term, and a semi-annual term barely distinguishable from the noise.
4. Amplitude of the noise level is taken as a little over $^{\circ}003$ or 10 cm.
5. The value of Q , the figure of merit (cf. electronic circuits), was calculated for the Chandler term as greater than 5. A much longer period would have to be studied to improve this value.

The spectral analysis of the time coordinate is given in Figure 3.

The principal features are:

1. Long-term variations had amplitudes too large to be included in the graph.
2. They are due to the major changes in the rate of rotation of the earth (the cause of which is still unknown). This can be more effectively studied by employing the BIH values, and has been adequately done by Markowitz (1969).
3. The period is too short to show any two- or four-year variations as suggested by some writers.
4. The annual and semi-annual terms of amplitude $^{\circ}0070$ and $^{\circ}0065$ dominate the rest of the spectrum.
5. The noise level is about four times as large as that found in latitude.
6. The scale used in the time graph is 1/4 that used to show variations in latitude.

Comparison with BIH

As stated in the introduction the BIH has solved equations similar to

$$\Delta\phi = \phi - \phi_0 = x \cos \lambda_0 + y \sin \lambda_0$$

$$\Delta T = (-x \sin \lambda_0 + y \cos \lambda_0) \tan \phi + t$$

by assigning latitude, longitudes, and weights to the various stations around the world. In their solution differences in time are expressed with respect to another uniform time, UTC, rather than atomic time. UTC is the coordinated universal time approximating the rotation of the earth and is essentially the same as WWV. It is maintained at a constant rate for the short periods required by their calculations but is not uniform over the longer period used in this report. Their method of calculation is described in detail in their annual reports (Guinot, 1967-70) and it suffices to say it provides the best reference to which we may compare our results (The International Latitude Service (ILS) and International Polar Motion Service (IPMS) only publish values of x and y). The BIH report provides values of x , y and UT1 and UT2-UTC, and comparisons of UTC with various atomic times. From their tables we are able to calculate our value for t , the correction to atomic A1 at any instant.

Comparison of our observations with the BIH are given in Appendix C under the headings of D-PHI and D-LAMBDA, the values being given in the sense observed minus computed. The latitude differences (D-PHI) were formed by adopting a latitude of $45^{\circ}23'37''$ (as a convenience to give decimals of a second only), so that the D-PHI values are observed corrections to this adopted latitude. The interpretation of the D-LAMBDA term is not as obvious. Our observed time values were based on an adopted west longitude of $5^{\text{h}}2^{\text{m}}51^{\text{s}}.94$, which entered directly into the calculation. If we had chosen a slightly smaller longitude, our recorded observed time would be increased by exactly the same amount. Thus the differences (D-LAMBDA) are observed corrections to our adopted longitude. The values used in the comparisons are the values for each twentieth of a year compared to the BIH unsmoothed values on the 1968 system which are only available back to 1962.

As expressed in the introduction "When the observations from any individual station are compared to the BIH... there are small residuals at each station that appear to be periodic and a phenomenon of that station." These residuals will now be examined by graph, spectral analysis and analytical solution.

Figure 4 provides a picture of these observations. The upper two graphs show the similarity of our latitude observations to those calculated for Ottawa using the BIH published values of x and y . The upper graph is $\Delta\phi = (\phi - \phi_0)$ Ottawa and the lower one $\Delta\phi = x \cos \lambda_0 + y \sin \lambda_0$. The time coordinate has been omitted because the scale required would mask all differences. The two lower graphs show D-PHI and D-LAMBDA, the variations in latitude and longitude of Ottawa compared to the BIH. At a latitude near 45° , $^{\circ}01$ is nearly equal to $^{\circ}001$ so that the variations are essentially on the same scale. There is no significance to the spacing of the graphs which have been designed to show variations with time. We will now proceed to examine these latter two curves.

The spectral analysis of D-PHI and

D-LAMBDA are given in Figure 5 and Figure 6. They have been graphed to essentially the same scale so that variations in latitude and longitude may be compared in amplitude and frequency. In order to have enough observations the ten-day smoothed values were used.

The noticeable features are:

1. In latitude there is an annual term of amplitude ".012 and a semi-annual term of amplitude ".007 and the noise level has remained unchanged at ".003 or 10 cm.
2. In longitude there is an annual term of amplitude °0016 and no semi-annual term. The amplitude of the noise level is about °0004, i.e. near 10 cm.
3. The large reduction in the noise when our results are compared to the BIH shows that this was a feature of the earth as a whole. It was very encouraging to find our error in determining longitude is again the same order as that for latitude.

The small annual and semi-annual terms as shown by the spectral analysis suggest that we submit our results to a Fourier analysis. This is precisely the practice followed by the BIH. Although the semi-annual term is not present in the D-LAMBDA, there appears no harm in

following the BIH and treating both coordinates in the same manner.

The analytical solutions for each year are given in Table III. There is a year-to-year variation but on the average in latitude the amplitude of the annual term is double the semi-annual, and in longitude the annual term is predominant.

The constant terms from the analytical solutions provide corrections to our adopted latitude and longitude. Therefore, we can say the observed mean values (1962-70) for the latitude and longitude of Ottawa in the BIH (1968) system are:

Latitude 45°23' 37".132
Longitude 5^h02^m 51^s.9525

The BIH adopted values: 45°23' 37.121 and 5^h 2^m 51.950 were based on our observations made in 1967. Our calculated values for the same period are: 45° 23' 37.122 and 5^h 2^m 51.9506. The difference is considered negligible and is probably due to the method of grouping.

An analysis of the variation of the constant terms *a* and *a'* (Table III) with time should yield the secular motion or continental drift of Ottawa (or an error in the proper motions of our star catalogue). Our solutions give:

Secular variation of
latitude -".11 ±".46 per century
longitude -°042 ±°060 per century

As would be expected for so short a period, the motion can hardly be called significant.

According to Munk and MacDonald (1960), the local variation described by the variations in D-PHI and D-LAMBDA after the removal of the corrections to the adopted latitude and longitude is "related to wind, pressure, and other meteorological variables." The verification of this is beyond the scope of this report.

The standard deviations obtained by comparing ($\phi - \phi_0$) Ottawa - $\Delta\phi$ BIH without adjustment for the annual terms yields values of ".036 and °0038 for latitude and longitude respectively. However, when these annual variations are applied, the standard deviations reduce to ".022 and °0019 which are one and half times the calculated internal values of ".015 and °0013. It is hoped that these differences can be reduced when local effects are studied.

Although the published values for the variation in latitude by the IPMS (Yumi, 1962-68) have not been adjusted for the new aberrational constant, it is interesting to compare our results. In order to avoid our values at the beginning of 1968, only six years, 1962 to 1967, were used. The Ottawa values are not adjusted for any annual term.

Table III. Comparison with BIH revised Fourier analysis

D-PHI						D-LAMBDA				
$\Delta = a + b \sin 2\pi\theta + c \cos 2\pi\theta + d \sin 4\pi\theta + e \cos 4\pi\theta$						$\Delta = a' \pm b' \sin 2\pi\theta \pm c' \cos 2\pi\theta \pm d' \sin 4\pi\theta \pm e' \cos 4\pi\theta$				
θ is in decimals of a Besselian year						θ is in decimals of a Besselian year				
Year	<i>a</i>	<i>b</i>	Units ".001			<i>a'</i>	<i>b'</i>	Units °0001		
			<i>c</i>	<i>d</i>	<i>e</i>			<i>c'</i>	<i>d'</i>	<i>e'</i>
1962	148	7	35	- 1	- 8	137	7	5	4	9
1963	117	- 6	41	24	1	159	39	-16	28	14
1964	133	25	20	15	-17	129	36	-25	17	0
1965	138	- 9	28	10	-11	117	36	-23	0	-11
1966	142	-12	20	5	-19	118	29	-25	- 1	- 1
1967	122	-34	13	18	-21	106	25	-34	- 9	5
1968	119	- 7	19	- 6	- 8	104	4	-32	-44	7
1969	137	-30	21	- 1	-22	132	40	-17	3	-10
8 years	132	- 8	25	8	-13	125	27	-20	- 3	1
Mean errors <i>a</i> ± 5						Mean errors <i>a'</i> ± 5				
<i>b, c, d, e</i> ± 7						<i>b', c', d', e'</i> ± 7				

The CIO origin was chosen to make the pole of the BIH and IPMS coincide on the average for the years 1964-1966. The Ottawa observations appear to favour the BIH position of the pole. No case is made for the standard deviations since all differences are known to contain systematic terms.

Table IV.

	Average	Standard
	deviation	deviation
$\Delta\phi(\text{BIH}) - \Delta\phi(\text{IPMS})$	"004	"028
$\phi - \phi_0 (\text{OTTAWA}) - \Delta\phi(\text{BIH})$	"001	"034
$\phi - \phi_0 (\text{OTTAWA}) - \Delta\phi(\text{IPMS})$	"005	"028

Apparent secular change in latitude

The secular change of latitude was investigated by averaging the latitudes at one-twentieth of a year over a period of six years. This should remove most of the annual and Chandler terms. The values for the earlier years were adjusted by

subtracting $1''.252$. In Table V the decimals of a second only are listed along with their differences from the mean.

The solution gives the secular drift in latitude as $0''.08 \pm 0''.13$ per century. This table was formed on the assumption that the Chandler term has a period of exactly 1.2 years, which is not exactly true; the small uncertainty was obtained by assuming each six-year period as independent, which is also not exactly true. The value is about equal and opposite in sign to that obtained by comparing Ottawa with the BIH for the years 1962 to 1970. The only conclusion is that there is no evidence of secular drift.

Conclusion

The Ottawa PZT has produced results of high order, by determining the variation in latitude and longitude with a probable error of $''01$. This instrument has now been moved to Calgary and is

Table V.

Period	Average latitude	Difference from mean
1956 to 1961 inclusive	.357	-.007
1957 1962	.364	.000
1958 1963	.361	-.003
1959 1964	.366	.002
1960 1965	.368	.004
1961 1966	.369	.005
1962 1967	.364	.000
1963 1968	.361	-.003
1964 1969	.369	.005

observing the same list of stars as Herstmonceux. We expect the Calgary results to duplicate the accuracy of Ottawa 1962-1967.

The results were examined and no secular motion of Ottawa was determined. The analysis shows that the Ottawa PZT cannot detect variations or motions of 10 cm or less. Although observations can be investigated for weather, tidal effects or corrections to the star catalogue, the noise level inherent in the observations makes it unlikely that any improvement will be made in the final results.

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OTTAWA PZT CATALOGUE 80 STARS IN 8 GROUPS

NO	MAG	SP	RA 1950	PM	DEC 1950	PM	BD NO
101	8.3	K0	22 59 17.438	+0.26	45 14 27.72	+02.1	44 4307
102	7.7	K0	23 08 31.452	-0.75	45 14 40.47	-27.5	44 4347
103	6.3	B9P	23 15 34.807	+0.24	45 12 56.46	-00.9	44 4373
104	8.7	K0	23 26 03.189	+0.02	45 25 03.86	-00.4	44 4424
105	8.1	A2	23 36 53.550	-0.06	45 26 34.76	-00.9	44 4464
106	8.4	F0	00 13 06.819	+0.15	45 15 58.75	-01.1	44 50
107	7.5	F5	00 17 53.264	+0.59	45 13 54.48	-00.6	44 62
108	7.4	F5	00 58 27.340	+0.96	45 11 00.60	-01.5	44 215
109	8.4	K2	01 16 06.745	-0.02	45 26 35.63	+01.8	44 279
110	8.5	K0	01 25 43.133	+0.58	45 22 31.21	+00.3	44 312
201	8.1	A5	01 54 49.045	-0.14	45 21 22.59	+00.7	44 392
202	8.4	A0	02 19 32.511	-0.07	45 16 56.77	+00.4	44 473
203	7.8	G5	02 21 50.218	-0.23	45 25 22.39	-07.8	44 483
204	8.3	F8	02 38 28.567	+0.86	45 16 54.33	-03.0	44 558
205	8.0	F8	02 41 28.822	-0.18	45 23 21.23	-04.4	44 569
206	7.5	H8	03 18 04.408	-0.06	45 12 28.61	+01.0	44 677
207	7.2	H8	03 22 11.257	-0.01	45 20 25.39	+00.2	44 695
208	8.4	K0	03 50 29.504	+0.03	45 21 53.86	-02.9	45 836
209	8.3	G5	04 07 34.442	+0.16	45 16 24.54	-04.0	45 887
210	7.6	A0	04 17 17.985	+0.22	45 20 46.01	-02.8	45 921
301	7.8	A0	04 44 15.199	+0.07	45 24 05.58	-03.3	45 987
302	7.5	H9	04 57 39.232	-0.09	45 22 25.23	-00.8	45 1023
303	8.5	A0	05 21 38.178	+0.04	45 11 04.07	+00.2	45 1115
304	8.3	G5	05 29 03.048	+0.11	45 27 22.43	-01.9	45 1132
305	8.0	F3	05 45 02.924	-0.02	45 13 17.65	-02.2	45 1178
306	7.4	A0	05 57 36.672	-0.02	45 09 35.81	-01.1	45 1225
307	7.4	A2	06 00 51.730	+0.04	45 35 24.79	-05.5	45 1235
308	7.8	A0	06 04 37.163	-0.07	45 33 44.46	-02.0	45 1248
309	8.7	K0	07 07 13.727	-0.12	45 19 48.00	-00.8	45 1394
310	7.5	K0	07 11 59.681	-0.08	45 29 52.45	-02.9	45 1408
401	8.3	K0	07 40 45.666	0.00	45 29 20.85	-02.9	45 1476
402	8.3	K0	08 08 24.269	+0.31	45 21 32.48	-00.4	45 1550
403	7.8	F0	08 30 49.208	-0.28	45 22 07.77	-02.3	45 1601
404	8.2	F5	08 40 29.395	-0.23	45 38 07.02	-05.2	45 1624
405	7.1	K0	08 48 48.223	-0.11	45 30 06.29	-03.4	45 1649
406	7.4	K0	09 18 06.177	-0.07	45 35 00.26	-03.0	45 1708
407	7.7	K0	09 43 31.098	+0.48	45 20 51.76	-13.0	45 1762
408	8.1	F2	09 47 19.985	-0.78	45 19 08.45	-09.1	45 1769
409	7.2	K0	09 54 48.110	+0.05	45 39 12.71	-03.4	46 1566
410	7.8	K0	10 25 36.216	-0.19	45 28 05.74	-02.3	45 1832

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OTTAWA PZT CATALOGUE 80 STARS IN 8 GROUPS

NO	MAG	SP	RA 1950	PM	DEC 1950	PM	BD NO
501	9.2	K0	10 49 38.791	-0.71	45 33 11.54	-03.6	46 1671
502	7.8	K0	10 56 08.877	-0.48	45 27 58.78	-03.7	45 1879
503	8.4	G0	11 12 20.111	-0.48	45 20 05.54	-06.1	45 1903
504	8.2	A2	11 19 05.622	-0.56	45 36 23.76	-01.5	46 1717
505	8.1	MB	11 25 06.823	-0.07	45 27 38.85	-02.3	45 1924
506	7.5	F2	11 37 09.720	+0.15	45 26 01.66	-01.4	45 1952
507	7.8	A3	12 29 13.744	-0.26	45 30 05.68	-01.4	46 1791
508	7.5	F2	12 36 10.645	-1.35	45 29 31.93	-03.8	46 1805
509	6.7	K0	13 03 37.467	-0.18	45 32 07.59	+02.5	46 1847
510	9.0	F5	13 17 05.553	-1.38	45 21 45.35	-03.4	45 2104
601	8.4	F5	13 33 51.762	-0.44	45 16 12.86	-01.8	45 2120
602	8.8	F5	13 46 33.442	-0.35	45 25 06.48	+01.0	45 2131
603	8.4	G5	14 39 16.606	-1.10	45 37 44.50	-19.2	46 1981
604	7.1	F0	14 42 38.338	+0.52	45 23 47.74	-02.0	45 2214
605	8.0	F5	14 52 37.590	-0.62	45 30 00.78	+05.4	45 2233
606	7.4	K2	15 22 23.836	-0.16	45 26 48.66	-00.3	45 2284
607	8.2	F0	15 37 32.744	+0.27	45 16 42.39	+01.4	45 2317
608	9.0	G5	15 42 27.953	-0.41	45 28 18.99	+03.1	45 2325
609	8.2	K0	16 06 25.425	-0.03	45 30 41.78	+00.9	45 2374
610	8.4	G5	16 23 47.715	-0.64	45 29 27.16	+01.7	45 2404
701	7.9	K2	17 10 12.145	-0.01	45 23 01.21	-01.2	45 2504
702	7.3	B3	17 12 00.269	-0.12	45 25 45.49	-01.1	45 2509
703	6.9	F0	17 18 23.795	-0.36	45 21 24.36	+08.6	45 2521
704	7.9	G0	17 36 37.733	+0.02	45 35 02.75	+04.7	45 2573
705	8.6	G5	17 53 14.164	+0.41	45 33 39.90	+02.2	45 2620
706	8.2	A0	17 53 17.771	-0.07	45 13 27.28	+00.4	45 2621
707	6.2	B9	17 57 26.447	-0.07	45 28 40.95	+02.5	45 2635
708	7.7	B9	17 59 41.018	-0.11	45 21 00.40	+01.4	45 2643
709	6.9	G0	18 14 06.184	-0.81	45 11 34.49	-11.2	45 2684
710	7.3	F0	18 47 08.243	+0.26	45 12 10.34	08.5	45 2777
801	8.4	K0	19 52 12.069	-0.09	45 20 19.21	+00.1	45 3001
802	7.7	A2	20 00 11.300	+0.28	45 20 10.19	+02.3	45 3038
803	8.1	K2	20 14 58.124	+0.03	45 11 00.79	+01.6	44 3414
804	7.2	F5	20 18 11.258	+0.18	45 12 19.84	-02.0	44 3429
805	6.3	B3	20 37 41.827	-0.03	45 29 21.48	+00.2	45 3233
806	7.7	K5	20 45 37.771	-0.02	45 23 43.18	-01.8	45 3275
807	7.7	G0	21 05 05.640	-0.08	45 28 25.57	-01.0	45 3410
808	6.7	A0	21 09 27.750	-0.08	45 28 07.49	-00.6	45 3438
809	6.8	B5	21 28 08.531	-0.02	45 16 26.73	-00.5	44 3840
810	7.0	MC	21 34 08.259	+0.59	45 09 00.09	+00.9	44 3877

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OTTAWA PZT CATALOGUE 160 STARS IN 12 GROUPS

NO	MAG	SP	RA 1950	PM	DEC 1950	PM	BD NO
101	8.0	F0	00 13 06.819	+0.15	45 15 58.75	-01.1	44 50
102	7.0	F5	00 17 53.264	+0.59	45 13 54.48	-00.6	44 62
103	8.5	MA	00 34 53.232	+0.12	45 19 45.53	+01.5	45 128
104	7.8	A3	00 43 40.231	-0.21	45 09 12.94	+00.5	44 162
105	8.8	A5	00 49 56.700	-0.35	45 10 13.18	-01.7	44 186
106	6.2	K0	00 54 49.201	+0.07	45 34 10.05	-00.5	45 237
107	7.0	F5	00 58 27.340	+0.96	45 11 00.60	-01.5	44 215
108	8.7	F8	01 07 03.176	+0.54	45 28 53.63	-01.5	44 252
109	7.5	K2	01 16 06.745	-0.02	45 26 35.63	+01.8	44 279
110	8.1	K0	01 25 43.133	+0.58	45 22 31.21	+00.3	44 312
111	6.3	A0	01 35 30.437	-0.16	45 08 45.40	+00.8	44 341
112	8.1	A5	01 54 49.045	-0.14	45 21 22.59	+00.7	44 392
113	8.1	A3	02 00 00.257	+0.04	45 32 14.69	-00.5	45 523
201	8.8	A0	02 19 32.511	-0.07	45 16 56.77	+00.4	44 473
202	7.6	G5	02 21 50.218	-0.23	45 25 22.39	-07.8	44 483
203	7.3	G5	02 27 10.353	+0.05	45 12 36.31	-00.8	44 512
204	8.4	F8	02 38 28.567	+0.86	45 16 54.33	-03.0	44 558
205	8.1	F8	02 41 28.822	-0.18	45 23 21.23	-04.4	44 569
206	8.6	K2	03 00 17.963	-0.19	45 33 01.83	-01.7	45 721
207	6.4	MA	03 12 40.017	+0.28	45 09 45.02	-03.0	44 648
208	7.5	H8	03 18 04.408	-0.06	45 12 28.61	+01.0	44 677
209	7.6	H8	03 22 11.257	-0.01	45 20 25.39	+00.2	44 695
210	8.1	K2	03 31 35.567	-0.13	45 16 59.78	-00.1	44 744
211	8.1	K0	03 48 07.130	-0.10	45 18 15.14	+00.3	45 828
212	7.9	K0	03 50 29.504	+0.03	45 21 53.86	-02.9	45 836
213	8.6	A0	03 56 23.122	+0.14	45 33 25.26	-01.2	45 858
301	7.8	G5	04 07 34.442	+0.16	45 16 24.54	-04.0	45 887
302	7.6	A0	04 17 17.985	+0.22	45 20 46.01	-02.8	45 921
303	7.7	B9	04 30 27.468	0.00	45 31 54.87	-01.0	45 955
304	7.7	A0	04 44 15.199	+0.07	45 24 05.58	-03.3	45 987
305	7.8	B9	04 57 39.232	-0.09	45 22 25.23	-00.8	45 1023
306	8.5	A0	05 21 38.178	+0.04	45 11 04.07	+00.2	45 1115
307	7.8	F8	05 28 57.611	-0.06	45 30 07.03	-03.5	45 1131
308	7.9	G5	05 29 03.048	+0.11	45 27 22.43	-01.9	45 1132
309	8.1	G5	05 35 20.203	+0.70	45 25 18.24	-10.8	45 1150
310	8.0	F3	05 45 02.924	-0.02	45 13 17.65	-02.2	45 1178
311	6.6	A0	05 55 42.894	-0.01	45 37 00.50	-01.6	45 1216
312	7.6	A0	05 57 36.672	-0.02	45 09 35.81	-01.1	45 1225
313	7.2	A2	06 00 51.730	+0.04	45 35 24.79	-05.5	45 1235

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OTTAWA PZ1 CATALOGUE 160 STARS IN 12 GROUPS

NO	MAG	SP	RA 1950	PM	DEC 1950	PM	BD NO
401	7.3	A0	06 04 37.163	-0.07	45 33 44.46	-02.0	45 1248
402	7.4	K0	06 18 03.542	+0.05	45 38 07.59	-01.5	45 1289
403	8.0	K5	06 20 52.448	+0.13	45 11 41.50	+00.3	45 1296
404	8.7	G5	06 40 22.174	+0.09	45 24 50.05	-03.2	45 1346
405	9.0	A2	06 50 50.710	-0.12	45 14 51.16	-04.1	45 1363
406	8.9	A0	06 59 55.120	-0.02	45 30 01.47	-00.7	45 1380
407	7.8	K0	07 07 13.727	-0.12	45 19 48.00	-00.8	45 1394
408	6.7	K0	07 11 59.681	-0.08	45 29 52.45	-02.9	45 1408
409	7.6	F2	07 14 24.115	-0.08	45 13 13.09	-06.9	45 1415
410	8.1	G5	07 27 57.558	-0.08	45 13 06.75	-02.3	45 1441
411	7.6	K0	07 40 45.666	0.00	45 29 20.85	-02.9	45 1476
412	8.0	K2	07 46 59.001	+0.09	45 28 04.63	-01.0	45 1496
413	8.1	A3	07 53 21.591	-0.19	45 35 03.40	-01.1	45 1509
501	7.8	K0	08 08 24.269	+0.31	45 21 32.48	-00.4	45 1550
502	8.1	K0	08 19 05.887	-0.37	45 30 45.09	-07.3	45 1568
503	7.8	F0	08 30 49.208	-0.28	45 22 07.77	-02.3	45 1601
504	8.1	G5	08 37 33.122	0.00	45 19 40.22	+01.5	45 1613
505	8.1	F5	08 40 29.395	-0.23	45 38 07.02	-05.2	45 1624
506	6.1	K0	08 48 48.223	-0.11	45 30 06.29	-03.4	45 1649
507	8.4	G5	09 03 59.561	-0.58	45 22 41.90	-04.9	45 1680
508	6.6	K0	09 18 06.177	-0.07	45 35 00.26	-03.0	45 1708
509	6.8	K0	09 43 31.098	+0.48	45 20 51.76	-13.0	45 1762
510	8.0	F2	09 47 19.985	-0.78	45 19 08.45	-09.1	45 1769
511	8.7	G5	09 52 36.884	+0.16	45 25 08.06	-00.9	45 1778
512	6.5	K0	09 54 48.110	+0.05	45 39 12.71	-03.4	45 1566
513	7.5	F2	10 04 02.073	-0.07	45 18 15.91	-00.6	45 1798
601	7.8	K2	10 11 08.518	-0.09	45 20 07.72	+00.4	45 1811
602	7.4	F5	10 13 27.840	-0.13	45 17 34.24	+02.3	45 1814
603	7.8	G5	10 14 27.401	-0.63	45 16 09.23	-02.0	45 1819
604	6.5	K0	10 25 36.216	-0.19	45 28 05.74	-02.3	45 1832
605	8.4	K5	10 32 46.110	-0.22	45 30 56.13	+01.6	46 1643
606	8.0	K0	10 49 38.791	-0.71	45 33 11.54	-03.6	46 1671
607	7.0	K0	10 56 08.877	-0.48	45 27 58.78	-03.7	45 1879
608	9.0	G5	11 01 40.650	+0.09	45 25 37.76	-02.6	45 1890
609	7.5	G0	11 12 20.111	-0.48	45 20 05.54	-06.1	45 1903
610	7.9	A2	11 19 05.622	-0.56	45 36 23.76	-01.5	46 1717
611	*	MB	11 25 06.823	-0.07	45 27 38.85	-02.3	45 1924
612	8.4	G0	11 36 07.336	-5.62	45 23 06.63	+01.4	45 1947
613	7.9	F2	11 37 09.720	+0.15	45 26 01.66	-01.4	45 1952

* 611, MAG 6.5 TO 7.3

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OTTAWA PZT CATALOGUE 160 STARS IN 12 GROUPS

NO	MAG	SP	RA 1950	PM	DEC 1950	PM	BD NO
701	8.8	F8	12 08 12.935	+0.30	45 27 13.91	-06.5	45 2001
702	7.7	A3	12 29 13.744	-0.26	45 30 05.68	-01.4	46 1791
703	8.0	F0	12 35 10.360	+0.15	45 31 41.96	+01.2	46 1802
704	7.1	F2	12 36 10.645	-1.35	45 29 31.93	-03.8	46 1805
705	6.7	K0	13 03 37.467	-0.18	45 32 07.59	+02.5	46 1847
706	8.6	F5	13 12 12.560	-0.02	45 26 41.46	-01.0	45 2096
707	8.7	F5	13 17 05.553	-1.38	45 21 45.35	-03.4	45 2104
708	8.3	F5	13 33 51.762	-0.44	45 16 12.86	-01.8	45 2120
709	8.0	K2	13 38 14.810	+0.03	45 14 24.05	-01.1	45 2124
710	8.9	F5	13 41 17.137	+0.06	45 35 46.83	-01.8	46 1894
711	8.6	F5	13 46 33.442	-0.35	45 25 06.48	+01.0	45 2131
712	8.6	F8	13 55 33.197	-0.08	45 23 55.73	+00.1	45 2140
713	6.1	K0	13 59 10.965	+0.17	45 31 36.54	-00.8	45 2148
801	9.1	G5	14 22 45.835	-1.45	45 22 22.42	+03.4	45 2178
802	8.4	F8	14 35 54.203	-0.07	45 32 45.40	-01.7	45 2203
803	7.7	G5	14 39 16.606	-1.10	45 37 44.50	-19.2	46 1981
804	6.8	F0	14 42 38.338	+0.52	45 23 47.74	-02.0	45 2214
805	8.5	F8	14 49 57.387	-0.68	45 22 33.50	+06.8	45 2230
806	7.9	F5	14 52 37.590	-0.62	45 30 00.78	+05.4	45 2233
807	8.7	G5	15 10 23.099	-0.86	45 20 56.51	+15.4	45 2266
808	7.9	K0	15 16 56.988	-0.39	45 11 52.82	+00.9	45 2277
809	6.2	K2	15 22 23.836	-0.16	45 26 48.66	-00.3	45 2284
810	8.8	K2	15 34 00.418	+0.15	45 36 45.90	-02.1	45 2307
811	7.9	F0	15 37 32.744	+0.27	45 16 42.39	+01.4	45 2317
812	8.0	G5	15 42 27.953	-0.41	45 28 18.99	+03.1	45 2325
813	8.7	F2	15 58 07.352	-0.27	45 35 35.49	-00.5	45 2355
901	7.4	K0	16 06 25.425	-0.03	45 30 41.78	+00.9	45 2374
902	7.4	G5	16 23 47.715	-0.64	45 29 27.16	+01.7	45 2404
903	8.4	G5	16 43 41.730	-0.28	45 11 37.83	-00.5	45 2446
904	8.4	G0	16 47 27.468	-0.33	45 17 12.85	-00.7	45 2453
905	6.9	K2	17 10 12.145	-0.01	45 23 01.21	-01.2	45 2504
906	7.4	B3	17 12 00.269	-0.12	45 25 45.49	-01.1	45 2509
907	6.6	F0	17 18 23.795	-0.36	45 21 24.36	+08.6	45 2521
908	8.3	K0	17 23 11.751	-0.06	45 23 44.14	+01.3	45 2531
909	7.3	G0	17 36 37.733	+0.02	45 35 02.75	+04.7	45 2573
910	8.2	G5	17 53 14.164	+0.41	45 33 39.90	+02.2	45 2620
911	8.0	A0	17 53 17.771	-0.07	45 13 27.28	+00.4	45 2621
912	6.2	B9	17 57 26.447	-0.07	45 28 40.95	+02.5	45 2635
913	5.9	K2	17 58 30.393	-0.05	45 30 09.87	-03.0	45 2638
914	7.4	B9	17 59 41.018	-0.11	45 21 00.40	+01.4	45 2643

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OTTAWA PZT CATALOGUE 160 STARS IN 12 GROUPS

NO	MAG	SP	RA 1950	PM	DEC 1950	PM	BI) NO
1001	8.5	F0	18 08 22.099	+0.02	45 36 21.48	-01.8	45 2667
1002	6.3	G0	18 14 06.184	-0.81	45 11 34.49	-11.2	45 2684
1003	7.9	A0	18 16 45.251	-0.01	45 08 07.24	+00.8	45 2690
1004	8.1	A0	18 21 37.358	0.00	45 11 34.56	+03.0	45 2704
1005	8.5	K0	18 29 41.225	+0.33	45 25 10.42	+00.2	45 2731
1006	8.0	F0	18 35 47.805	-0.10	45 37 38.61	+01.1	45 2747
1007	6.8	F0	18 47 08.243	+0.26	45 12 10.34	+08.5	45 2777
1008	8.9	F5	19 02 16.826	+0.18	45 31 58.28	-00.9	45 2824
1009	7.3	A0	19 13 56.282	+0.10	45 14 48.09	-01.0	45 2865
1010	8.6	K	19 18 55.970	-0.07	45 29 58.90	+00.6	45 2877
1011	7.5	K0	19 44 44.962	-0.04	45 36 45.24	-00.8	45 2971
1012	7.8	K0	19 52 12.069	-0.09	45 20 19.21	+00.1	45 3001
1013	7.5	A2	20 00 11.300	+0.28	45 20 10.19	+02.3	45 3038
1014	8.1	G5	20 06 32.283	-0.12	45 23 48.25	-03.3	45 3066
1101	7.5	K2	20 14 58.124	+0.03	45 11 00.79	+01.6	44 3414
1102	7.0	F5	20 18 11.258	+0.18	45 12 19.84	-02.0	44 3429
1103	7.3	B9	20 27 09.446	0.00	45 33 04.86	-00.5	45 3191
1104	6.5	B3	20 37 41.827	-0.03	45 29 21.48	+00.2	45 3233
1105	6.7	K5	20 45 37.771	-0.02	45 23 43.18	-01.8	45 3275
1106	7.5	A0	20 46 42.881	+0.04	45 15 58.32	+00.1	44 3590
1107	8.2	G7	20 51 47.539	+0.14	45 11 36.86	+00.1	44 3622
1108	7.3	G0	21 05 05.640	-0.08	45 28 25.57	-01.0	45 3410
1109	6.7	A0	21 09 27.750	-0.08	45 28 07.49	-00.6	45 3438
1110	7.6	B9	21 14 09.125	-0.03	45 31 20.27	-00.7	45 3476
1111	8.5	G0	21 26 15.499	-0.01	45 21 34.44	-03.7	44 3825
1112	7.0	B5	21 28 08.531	-0.02	45 16 26.73	-00.5	44 3840
1113	*	MC	21 34 08.259	0.59	45 09 00.09	00.9	44 3877
1114	6.5	MB	21 40 13.484	-0.07	45 32 13.60	-01.7	45 3637
1201	6.5	G5	22 06 39.422	-0.56	45 29 45.59	05.1	45 3813
1202	7.3	A2	22 24 54.875	-0.25	45 32 03.82	-01.5	45 3941
1203	8.2	K2	22 27 45.273	-0.05	45 29 17.24	00.5	45 3958
1204	7.9	K0	22 35 36.991	-0.19	45 08 52.98	00.5	44 4183
1205	7.1	F8	22 36 02.557	-1.05	45 34 11.50	-16.9	45 4002
1206	8.3	K2	22 41 01.671	0.06	45 15 57.76	1.7	44 4209
1207	8.1	K0	22 50 58.151	-0.02	45 25 37.18	0.1	44 4263
1208	8.4	F8	22 53 55.366	-0.16	45 31 29.35	-03.7	45 4094
1209	7.9	K0	22 59 17.438	0.26	45 14 27.72	2.1	44 4307
1210	8.8	F5	23 01 58.620	0.17	45 12 42.42	0.8	44 4320
1211	7.1	K0	23 08 31.452	-0.75	45 14 40.47	-27.5	44 4347
1212	6.3	B9	23 15 34.807	0.24	45 12 56.46	-00.9	44 4373
1213	7.9	K0	23 26 03.189	0.02	45 25 03.86	-00.4	44 4424
1214	7.8	A2	23 36 53.550	-0.06	45 26 34.76	-00.9	44 4464

* 1113, MAG 5.0 TO 6.7

APPENDIX B
OTTAWA PZT OBSERVATIONS 1956 TO 1970
VALUES AT 1/20 YEAR

EPOCH	LATITUDE	UTO-A1	EPOCH	LATITUDE	UTO-A1
56.05	38.768	.7958	58.55	38.777	-0.3096
56.10	38.820	.7910	58.60	38.792	-0.3044
56.15	38.831	.7634	58.65	38.742	-0.3283
56.20	38.821	.7330	58.70	38.718	-0.3440
56.25	38.722	.7032	58.75	38.645	-0.3684
56.30	38.692	.6786	58.80	38.473	-0.4031
56.35	38.630	.6700	58.85	38.429	-0.4511
56.40	38.503	.6497	58.90	38.450	-0.4696
56.45	38.536	.6367	58.95	38.459	-0.4922
56.50	38.500	.6307	59.00	38.320	-0.5329
56.55	38.464	.6394	59.05	38.361	-0.5498
56.60	38.425	.6451	59.10	38.444	-0.5624
56.65	38.433	.6378	59.15	38.478	-0.6023
56.70	38.309	.6352	59.20	38.465	-0.6376
56.75	38.401	.5993	59.25	38.469	-0.6573
56.80	38.428	.5882	59.30	38.551	-0.6791
56.85	38.447	.5590	59.35	38.625	-0.6951
56.90	38.488	.5610	59.40	38.680	-0.7140
56.95	38.516	.5145	59.45	38.741	-0.7393
57.00	38.541	.5001	59.50	38.790	-0.7478
57.05	38.646	.4757	59.55	38.792	-0.7638
57.10	38.737	.4665	59.60	38.812	-0.7686
57.15	38.820	.4356	59.65	38.812	-0.8168
57.20	38.851	.3950	59.70	38.836	-0.8208
57.25	38.838	.3614	59.75	38.838	-0.8426
57.30	38.827	.3298	59.80	38.732	-0.8914
57.35	38.869	.2967	59.85	38.687	-0.9192
57.40	38.808	.2671	59.90	38.683	-0.9533
57.45	38.763	.2479	59.95	38.540	-0.9825
57.50	38.704	.2228	60.00	38.528	-1.0108
57.55	38.673	.2190	60.05	38.529	-1.0373
57.60	38.638	.2086	60.10	38.386	-1.0559
57.65	38.582	.1764	60.15	38.554	-1.0791
57.70	38.467	.1750	60.20	38.482	-1.1014
57.75	38.405	.1371	60.25	38.464	-1.1347
57.80	38.355	.1179	60.30	38.468	-1.1647
57.85	38.301	.0909	60.35	37.232	-1.1862
57.90	38.284	.0565	60.40	37.326	-1.2140
57.95	38.298	.0390	60.45	37.325	-1.2402
58.00	38.341	.0277	60.50	37.345	-1.2583

APPENDIX B
OTTAWA PZT OBSERVATIONS 1956 TO 1970
VALUES AT 1/20 YEAR

EPOCH	LATITUDE	UTO-A1	EPOCH	LATITUDE	UTO-A1
58.05	38.388	-0.0244	60.55	37.394	-1.2645
58.10	38.474	-0.0457	60.60	37.451	-1.2677
58.15	38.551	-0.0782	60.65	37.427	-1.2852
58.20	38.612	-0.1151	60.70	37.484	-1.2986
58.25	38.649	-0.1513	60.75	37.462	-1.3235
58.30	38.690	-0.1929	60.80	37.471	-1.3488
58.35	38.776	-0.2219	60.85	37.465	-1.3760
58.40	38.836	-0.2499	60.90	37.481	-1.4074
58.45	38.845	-0.2719	60.95	37.497	-1.4356
58.50	38.882	-0.2875	61.00	37.427	-1.4571
61.05	37.409	-1.4667	63.55	37.367	-2.6277
61.10	37.387	-1.4938	63.60	37.318	-2.6402
61.15	37.348	-1.5127	63.65	37.279	-2.6552
61.20	37.336	-1.5423	63.70	37.240	-2.6781
61.25	37.348	-1.5727	63.75	37.187	-2.7044
61.30	37.337	-1.5977	63.80	37.129	-2.7370
61.35	37.342	-1.6187	63.85	37.103	-2.7721
61.40	37.301	-1.6469	63.90	37.130	-2.8063
61.45	37.314	-1.6611	63.95	37.183	-2.8388
61.50	37.330	-1.6712	64.00	37.192	-2.8751
61.55	37.330	-1.6766	64.05	37.293	-2.9115
61.60	37.349	-1.6894	64.10	37.332	-2.9466
61.65	37.304	-1.7072	64.15	37.403	-2.9866
61.70	37.330	-1.7181	64.20	37.459	-3.0287
61.75	37.323	-1.7341	64.25	37.519	-3.0731
61.80	37.341	-1.7539	64.30	37.556	-3.1157
61.85	37.364	-1.7736	64.35	37.593	-3.1586
61.90	37.386	-1.8015	64.40	37.603	-3.2048
61.95	37.399	-1.8257	64.45	37.576	-3.2408
62.00	37.449	-1.8521	64.50	37.533	-3.2658
62.05	37.417	-1.8790	64.55	37.544	-3.2913
62.10	37.385	-1.8984	64.60	37.486	-3.3171
62.15	37.448	-1.9263	64.65	37.463	-3.3396
62.20	37.486	-1.9544	64.70	37.410	-3.3636
62.25	37.465	-1.9859	64.75	37.343	-3.4025
62.30	37.428	-2.0167	64.80	37.280	-3.4435
62.35	37.435	-2.0489	64.85	37.226	-3.4836
62.40	37.400	-2.0791	64.90	37.176	-3.5220
62.45	37.349	-2.0998	64.95	37.159	-3.5605
62.50	37.317	-2.1073	65.00	37.164	-3.5930

APPENDIX B
OTTAWA PZT OBSERVATIONS 1956 TO 1970
VALUES AT 1/20 YEAR

EPOCH	LATITUDE	UTO-A1	EPOCH	LATITUDE	UTO-A1
62.55	37.312	-2.1179	65.05	37.185	-3.6270
62.60	37.269	-2.1319	65.10	37.238	-3.6647
62.65	37.250	-2.1440	65.15	37.221	-3.7029
62.70	37.234	-2.1574	65.20	37.284	-3.7442
62.75	37.273	-2.1799	65.25	37.354	-3.7932
62.80	37.267	-2.2025	65.30	37.394	-3.8422
62.85	37.254	-2.2340	65.35	37.421	-3.8864
62.90	37.277	-2.2630	65.40	37.450	-3.9263
62.95	37.333	-2.2939	65.45	37.519	-3.9662
63.00	37.397	-2.3237	65.50	37.543	-4.0019
63.05	37.432	-2.3390	65.55	37.565	-4.0395
63.10	37.439	-2.3618	65.60	37.592	-4.0731
63.15	37.481	-2.3853	65.65	37.533	-4.0999
63.20	37.512	-2.4156	65.70	37.535	-4.1408
63.25	37.496	-2.4492	65.75	37.486	-4.1888
63.30	37.513	-2.4853	65.80	37.402	-4.2346
63.35	37.486	-2.5228	65.85	37.388	-4.2800
63.40	37.482	-2.5572	65.90	37.363	-4.3248
63.45	37.454	-2.5865	65.95	37.292	-4.3700
63.50	37.385	-2.6108	66.00	37.242	-4.4120
66.05	37.235	-4.4503	68.05	37.330	-6.1874
66.10	37.202	-4.4977	68.10	37.356	-6.2368
66.15	37.206	-4.5399	68.15	37.383	-6.2919
66.20	37.194	-4.5800	68.20	37.348	-6.3391
66.25	37.226	-4.6291	68.25	37.397	-6.3835
66.30	37.254	-4.6785	68.30	37.400	-6.4460
66.35	37.283	-4.7304	68.35	37.391	-6.4979
66.40	37.323	-4.7779	68.40	37.353	-6.5468
66.45	37.354	-4.8179	68.45	37.361	-6.5895
66.50	37.387	-4.8543	68.50	37.289	-6.6279
66.55	37.438	-4.8839	68.55	37.296	-6.6586
66.60	37.459	-4.9174	68.60	37.301	-6.6847
66.65	37.489	-4.9555	68.65	37.380	-6.7312
66.70	37.526	-4.9999	68.70	37.276	-6.7727
66.75	37.543	-5.0478	68.75	37.303	-6.8139
66.80	37.503	-5.1020	68.80	37.270	-6.8619
66.85	37.520	-5.1554	68.85	37.295	-6.9131
66.90	37.422	-5.2066	68.90	37.312	-6.9620
66.95	37.356	-5.2516	68.95	37.349	-7.0077
67.00	37.356	-5.2926	69.00	37.334	-7.0541

APPENDIX B
OTTAWA PZT OBSERVATIONS 1956 TO 1970
VALUES AT 1/20 YEAR

EPOCH	LATITUDE	UTO-A1	EPOCH	LATITUDE	UTO-A1
67.05	37.302	-5.3354	69.05	37.364	-7.0973
67.10	37.310	-5.3724	69.10	37.378	-7.1479
67.15	37.276	-5.4212	69.15	37.440	-7.2016
67.20	37.281	-5.4712	69.20	37.496	-7.2581
67.25	37.253	-5.5211	69.25	37.448	-7.3167
67.30	37.266	-5.5718	69.30	37.477	-7.3771
67.35	37.289	-5.6233	69.35	37.512	-7.4326
67.40	37.251	-5.6712	69.40	37.467	-7.4885
67.45	37.234	-5.7111	69.45	37.436	-7.5385
67.50	37.296	-5.7437	69.50	37.450	-7.5736
67.55	37.350	-5.7745	69.55	37.368	-7.6127
67.60	37.334	-5.8007	69.60	37.409	-7.6517
67.65	37.353	-5.8326	69.65	37.383	-7.6820
67.70	37.385	-5.8678	69.70	37.348	-7.7294
67.75	37.390	-5.9091	69.75	37.299	-7.7811
67.80	37.340	-5.9546	69.80	37.294	-7.8265
67.85	37.393	-6.0023	69.85	37.307	-7.8820
67.90	37.337	-6.0511	69.90	37.295	-7.9299
67.95	37.351	-6.1014	69.95	37.255	-7.9804
68.00	37.442	-6.1515	70.00	37.321	-8.0356

APPENDIX B
 OTTAWA PZT OBSERVATIONS 1956 TO 1970
 10 DAY SMOOTHED VALUES

JULIAN DAY	LATITUDE	UTO-A1	JULIAN DAY	LATITUDE	UTO-A1
2435509.5	38.822	.7910	2436009.5	38.742	.2390
2435519.5	38.834	.7782	2436019.5	38.712	.2284
2435529.5	38.835	.7597	2436029.5	38.695	.2206
2435539.5	38.832	.7450	2436039.5	38.669	.2181
2435549.5	38.803	.7280	2436049.5	38.645	.2163
2435559.5	38.771	.7109	2436059.5	38.619	.2073
2435569.5	38.741	.6940	2436069.5	38.605	.1894
2435579.5	38.723	.6808	2436079.5	38.563	.1775
2435589.5	38.689	.6743	2436089.5	38.512	.1706
2435599.5	38.641	.6702	2436099.5	38.452	.1628
2435609.5	38.574	.6664	2436109.5	38.412	.1465
2435619.5	38.523	.6547	2436119.5	38.388	.1340
2435629.5	38.521	.6430	2436129.5	38.364	.1217
2435639.5	38.532	.6366	2436139.5	38.321	.1103
2435649.5	38.518	.6342	2436149.5	38.291	.0938
2435659.5	38.493	.6346	2436159.5	38.288	.0804
2435669.5	38.473	.6351	2436169.5	38.285	.0663
2435679.5	38.446	.6402	2436179.5	38.288	.0565
2435689.5	38.432	.6455	2436189.5	38.325	.0428
2435699.5	38.438	.6465	2436199.5	38.371	.0280
2435709.5	38.431	.6426	2436209.5	38.407	.0091
2435719.5	38.375	.6378	2436219.5	38.420	-0.0101
2435729.5	38.343	.6318	2436229.5	38.434	-0.0283
2435739.5	38.362	.6160	2436239.5	38.448	-0.0444
2435749.5	38.399	.6043	2436249.5	38.487	-0.0612
2435759.5	38.418	.5894	2436259.5	38.533	-0.0792
2435769.5	38.420	.5759	2436269.5	38.566	-0.0975
2435779.5	38.440	.5648	2436279.5	38.590	-0.1142
2435789.5	38.459	.5625	2436289.5	38.621	-0.1333
2435799.5	38.476	.5552	2436299.5	38.654	-0.1572
2435809.5	38.490	.5427	2436309.5	38.679	-0.1830
2435819.5	38.507	.5272	2436319.5	38.708	-0.2019
2435829.5	38.523	.5111	2436329.5	38.752	-0.2162
2435839.5	38.551	.4984	2436339.5	38.804	-0.2299
2435849.5	38.584	.4864	2436349.5	38.833	-0.2450
2435859.5	38.633	.4730	2436359.5	38.846	-0.2599
2435869.5	38.686	.4621	2436369.5	38.853	-0.2722
2435879.5	38.746	.4560	2436379.5	38.856	-0.2802
2435889.5	38.793	.4453	2436389.5	38.823	-0.2896
2435899.5	38.828	.4250	2436399.5	38.796	-0.3003

APPENDIX B
OTTAWA PZT OBSERVATIONS 1956 TO 1970
10 DAY SMOOTHED VALUES

JULIAN DAY	LATITUDE	UTO-A1	JULIAN DAY	LATITUDE	UTO-A1
2435909.5	38.843	.4018	2436409.5	38.782	-0.3072
2435919.5	38.840	.3810	2436419.5	38.785	-0.3070
2435929.5	38.851	.3647	2436429.5	38.784	-0.3084
2435939.5	38.846	.3476	2436439.5	38.758	-0.3206
2435949.5	38.841	.3296	2436449.5	38.712	-0.3384
2435959.5	38.850	.3097	2436459.5	38.670	-0.3507
2435969.5	38.870	.2930	2436469.5	38.652	-0.3554
2435979.5	38.854	.2767	2436479.5	38.601	-0.3652
2435989.5	38.807	.2627	2436489.5	38.534	-0.3830
2435999.5	38.772	.2493	2436499.5	38.480	-0.4097
2436509.5	38.455	-0.4345	2437009.5	38.489	-1.1041
2436519.5	38.450	-0.4534	2437019.5	38.469	-1.1223
2436529.5	38.454	-0.4598	2437029.5	38.460	-1.1413
2436539.5	38.461	-0.4668	2437039.5	38.463	-1.1572
2436549.5	38.456	-0.4824	2437049.5	38.465	-1.1695
2436559.5	38.416	-0.5082	2437059.5	38.489	-1.1828
2436569.5	38.382	-0.5297	2437069.5	38.519	-1.1967
2436579.5	38.365	-0.5443	2437079.5	37.305	-1.2120
2436589.5	38.392	-0.5506	2437089.5	37.320	-1.2262
2436599.5	38.419	-0.5570	2437099.5	37.332	-1.2380
2436609.5	38.444	-0.5673	2437109.5	37.342	-1.2466
2436619.5	38.467	-0.5876	2437119.5	37.366	-1.2530
2436629.5	38.488	-0.6118	2437129.5	37.388	-1.2584
2436639.5	38.469	-0.6316	2437139.5	37.411	-1.2623
2436649.5	38.447	-0.6452	2437149.5	37.437	-1.2661
2436659.5	38.470	-0.6559	2437159.5	37.449	-1.2726
2436669.5	38.519	-0.6676	2437169.5	37.439	-1.2825
2436679.5	38.555	-0.6805	2437179.5	37.446	-1.2908
2436689.5	38.580	-0.6896	2437189.5	37.464	-1.2988
2436699.5	38.618	-0.6960	2437199.5	37.478	-1.3094
2436709.5	38.650	-0.7049	2437209.5	37.470	-1.3238
2436719.5	38.688	-0.7202	2437219.5	37.471	-1.3382
2436729.5	38.718	-0.7333	2437229.5	37.467	-1.3521
2436739.5	38.750	-0.7403	2437239.5	37.465	-1.3669
2436749.5	38.778	-0.7462	2437249.5	37.470	-1.3829
2436759.5	38.789	-0.7533	2437259.5	37.483	-1.3991
2436769.5	38.807	-0.7582	2437269.5	37.491	-1.4145
2436779.5	38.814	-0.7617	2437279.5	37.483	-1.4307
2436789.5	38.817	-0.7752	2437289.5	37.469	-1.4448
2436799.5	38.798	-0.7959	2437299.5	37.450	-1.4536

APPENDIX B
OTTAWA PZT OBSERVATIONS 1956 TO 1970
10 DAY SMOOTHED VALUES

JULIAN DAY	LATITUDE	UTO-A1	JULIAN DAY	LATITUDE	UTO-A1
2436809.5	38.797	-0.8116	2437309.5	37.432	-1.4595
2436819.5	38.815	-0.8195	2437319.5	37.414	-1.4698
2436829.5	38.837	-0.8286	2437329.5	37.396	-1.4827
2436839.5	38.820	-0.8442	2437339.5	37.374	-1.4946
2436849.5	38.774	-0.8631	2437349.5	37.360	-1.5059
2436859.5	38.728	-0.8844	2437359.5	37.348	-1.5209
2436869.5	38.712	-0.9023	2437369.5	37.340	-1.5366
2436879.5	38.701	-0.9196	2437379.5	37.342	-1.5527
2436889.5	38.576	-0.9355	2437389.5	37.346	-1.5684
2436899.5	38.632	-0.9531	2437399.5	37.343	-1.5837
2436909.5	38.588	-0.9705	2437409.5	37.337	-1.5959
2436919.5	38.545	-0.9871	2437419.5	37.338	-1.6079
2436929.5	38.526	-1.0021	2437429.5	37.334	-1.6207
2436939.5	38.525	-1.0174	2437439.5	37.327	-1.6346
2436949.5	38.521	-1.0318	2437449.5	37.320	-1.6458
2436959.5	38.485	-1.0435	2437459.5	37.314	-1.6553
2436969.5	38.459	-1.0536	2437469.5	37.311	-1.6636
2436979.5	38.471	-1.0642	2437479.5	37.324	-1.6699
2436989.5	38.505	-1.0768	2437489.5	37.334	-1.6729
2436999.5	38.510	-1.0894	2437499.5	37.329	-1.6763
2437509.5	37.332	-1.6819	2438009.5	37.319	-2.2874
2437519.5	37.337	-1.6894	2438019.5	37.354	-2.3050
2437529.5	37.327	-1.6990	2438029.5	37.381	-2.3208
2437539.5	37.306	-1.7086	2438039.5	37.405	-2.3315
2437549.5	37.315	-1.7149	2438049.5	37.422	-2.3403
2437559.5	37.324	-1.7202	2438059.5	37.434	-2.3514
2437569.5	37.320	-1.7291	2438069.5	37.446	-2.3651
2437579.5	37.320	-1.7401	2438079.5	37.467	-2.3779
2437589.5	37.335	-1.7509	2438089.5	37.492	-2.3917
2437599.5	37.350	-1.7616	2438099.5	37.505	-2.4069
2437609.5	37.358	-1.7732	2438109.5	37.507	-2.4250
2437619.5	37.371	-1.7866	2438119.5	37.509	-2.4440
2437629.5	37.384	-1.8011	2438129.5	37.513	-2.4638
2437639.5	37.390	-1.8155	2438139.5	37.509	-2.4835
2437649.5	37.399	-1.8290	2438149.5	37.496	-2.5040
2437659.5	37.426	-1.8434	2438159.5	37.486	-2.5249
2437669.5	37.443	-1.8585	2438169.5	37.485	-2.5436
2437679.5	37.426	-1.8723	2438179.5	37.477	-2.5609
2437689.5	37.397	-1.8842	2438189.5	37.457	-2.5767
2437699.5	37.388	-1.8954	2438199.5	37.435	-2.5915

APPENDIX B
 OTTAWA PZT OBSERVATIONS 1956 TO 1970
 10 DAY SMOOTHED VALUES

JULIAN DAY	LATITUDE	UTO-A1	JULIAN DAY	LATITUDE	UTO-A1
2437709.5	37.409	-1.9089	2438209.5	37.410	-2.6050
2437719.5	37.445	-1.9244	2438219.5	37.383	-2.6166
2437729.5	37.480	-1.9403	2438229.5	37.361	-2.6261
2437739.5	37.486	-1.9556	2438239.5	37.343	-2.6330
2437749.5	37.473	-1.9722	2438249.5	37.321	-2.6401
2437759.5	37.455	-1.9897	2438259.5	37.294	-2.6477
2437769.5	37.440	-2.0072	2438269.5	37.267	-2.6570
2437779.5	37.436	-2.0241	2438279.5	37.251	-2.6684
2437789.5	37.431	-2.0412	2438289.5	37.229	-2.6816
2437799.5	37.414	-2.0578	2438299.5	37.202	-2.6963
2437809.5	37.395	-2.0736	2438309.5	37.171	-2.7119
2437819.5	37.374	-2.0877	2438319.5	37.139	-2.7298
2437829.5	37.356	-2.0982	2438329.5	37.110	-2.7490
2437839.5	37.334	-2.1051	2438339.5	37.112	-2.7689
2437849.5	37.321	-2.1093	2438349.5	37.138	-2.7874
2437859.5	37.320	-2.1138	2438359.5	37.151	-2.8053
2437869.5	37.308	-2.1204	2438369.5	37.158	-2.8240
2437879.5	37.289	-2.1277	2438379.5	37.174	-2.8420
2437889.5	37.268	-2.1349	2438389.5	37.182	-2.8611
2437899.5	37.249	-2.1418	2438399.5	37.205	-2.8805
2437909.5	37.231	-2.1485	2438409.5	37.252	-2.9011
2437919.5	37.236	-2.1569	2438419.5	37.306	-2.9209
2437929.5	37.255	-2.1675	2438429.5	37.328	-2.9412
2437939.5	37.269	-2.1791	2438439.5	37.358	-2.9616
2437949.5	37.273	-2.1909	2438449.5	37.392	-2.9827
2437959.5	37.266	-2.2054	2438459.5	37.424	-3.0051
2437969.5	37.257	-2.2221	2438469.5	37.456	-3.0292
2437979.5	37.257	-2.2388	2438479.5	37.490	-3.0537
2437989.5	37.268	-2.2550	2438489.5	37.521	-3.0775
2437999.5	37.288	-2.2706	2438499.5	37.541	-3.1007
2438509.5	37.564	-3.1239	2439009.5	37.542	-4.1245
2438519.5	37.583	-3.1476	2439019.5	37.538	-4.1484
2438529.5	37.598	-3.1723	2439029.5	37.508	-4.1735
2438539.5	37.600	-3.1972	2439039.5	37.462	-4.1988
2438549.5	37.596	-3.2199	2439049.5	37.425	-4.2235
2438559.5	37.574	-3.2387	2439059.5	37.394	-4.2487
2438569.5	37.549	-3.2535	2439069.5	37.379	-4.2746
2438579.5	37.535	-3.2660	2439079.5	37.360	-4.2998
2438589.5	37.547	-3.2803	2439089.5	37.340	-4.3239
2438599.5	37.534	-3.2955	2439099.5	37.324	-4.3478

APPENDIX B
 OTTAWA PZT OBSERVATIONS 1956 TO 1970
 10 DAY SMOOTHED VALUES

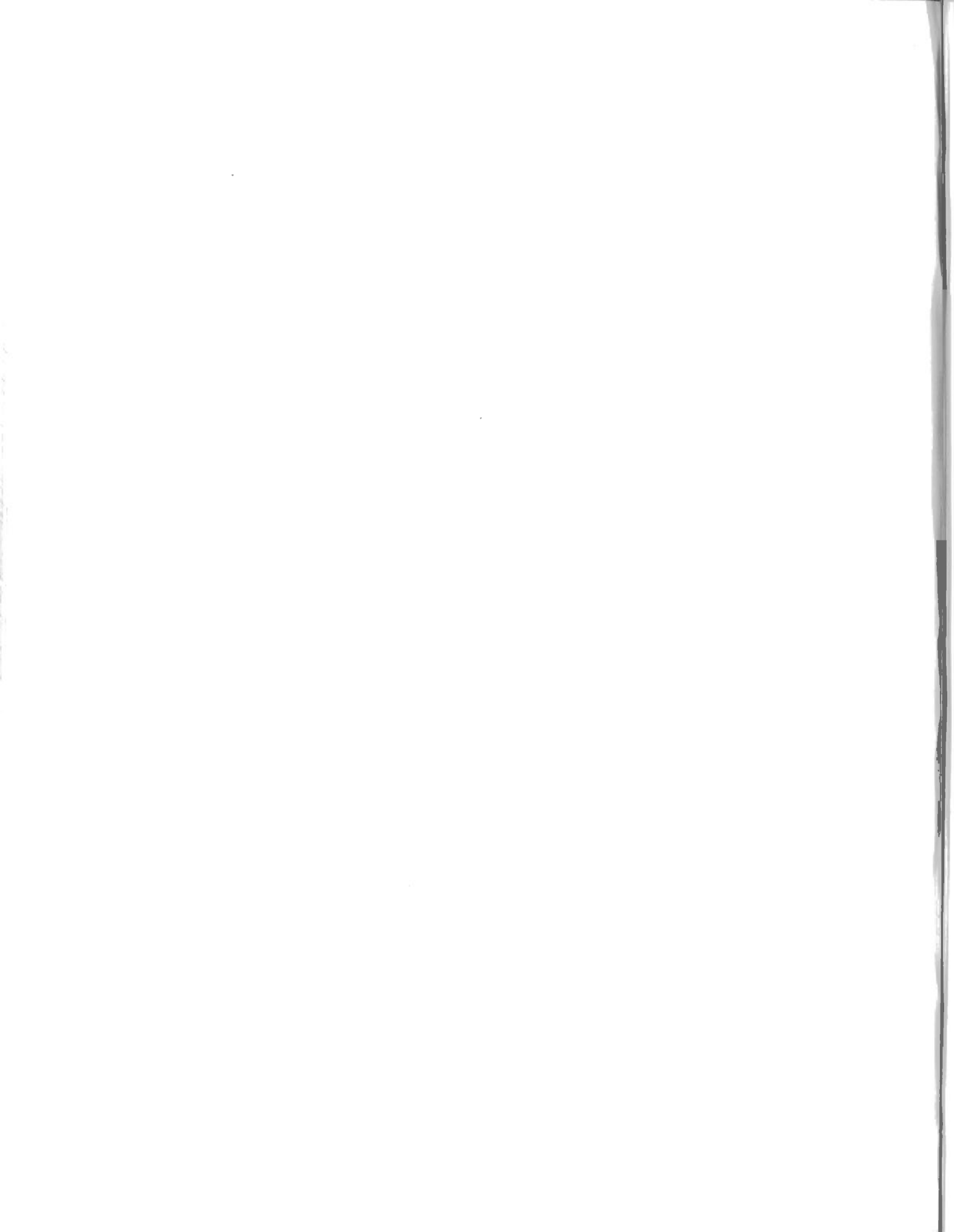
JULIAN DAY	LATITUDE	UTO-A1	JULIAN DAY	LATITUDE	UTO-A1
2438609.5	37.509	-3.3099	2439109.5	37.299	-4.3721
2438619.5	37.489	-3.3225	2439119.5	37.276	-4.3958
2438629.5	37.475	-3.3347	2439129.5	37.258	-4.4181
2438639.5	37.439	-3.3466	2439139.5	37.245	-4.4399
2438649.5	37.406	-3.3607	2439149.5	37.223	-4.4621
2438659.5	37.389	-3.3791	2439159.5	37.210	-4.4873
2438669.5	37.356	-3.4002	2439169.5	37.209	-4.5127
2438679.5	37.306	-3.4222	2439179.5	37.205	-4.5357
2438689.5	37.274	-3.4455	2439189.5	37.198	-4.5569
2438699.5	37.252	-3.4682	2439199.5	37.191	-4.5798
2438709.5	37.217	-3.4897	2439209.5	37.204	-4.6054
2438719.5	37.188	-3.5109	2439219.5	37.231	-4.6325
2438729.5	37.168	-3.5323	2439229.5	37.243	-4.6606
2438739.5	37.151	-3.5526	2439239.5	37.256	-4.6884
2438749.5	37.154	-3.5722	2439249.5	37.267	-4.7161
2438759.5	37.167	-3.5893	2439259.5	37.297	-4.7431
2438769.5	37.173	-3.6066	2439269.5	37.312	-4.7692
2438779.5	37.194	-3.6264	2439279.5	37.329	-4.7934
2438789.5	37.228	-3.6474	2439289.5	37.343	-4.8147
2438799.5	37.236	-3.6676	2439299.5	37.351	-4.8349
2438809.5	37.227	-3.6882	2439309.5	37.372	-4.8538
2438819.5	37.242	-3.7089	2439319.5	37.405	-4.8713
2438829.5	37.278	-3.7312	2439329.5	37.436	-4.8877
2438839.5	37.313	-3.7560	2439339.5	37.451	-4.9057
2438849.5	37.342	-3.7839	2439349.5	37.474	-4.9257
2438859.5	37.368	-3.8115	2439359.5	37.494	-4.9467
2438869.5	37.389	-3.8377	2439369.5	37.503	-4.9680
2438879.5	37.405	-3.8620	2439379.5	37.514	-4.9917
2438889.5	37.419	-3.8856	2439389.5	37.542	-5.0172
2438899.5	37.436	-3.9086	2439399.5	37.535	-5.0458
2438909.5	37.460	-3.9297	2439409.5	37.511	-5.0750
2438919.5	37.494	-3.9514	2439419.5	37.504	-5.1047
2438929.5	37.525	-3.9731	2439429.5	37.516	-5.1333
2438939.5	37.539	-3.9932	2439439.5	37.501	-5.1629
2438949.5	37.543	-4.0126	2439449.5	37.456	-5.1904
2438959.5	37.550	-4.0344	2439459.5	37.408	-5.2161
2438969.5	37.574	-4.0563	2439469.5	37.373	-5.2407
2438979.5	37.593	-4.0713	2439479.5	37.358	-5.2650
2438989.5	37.573	-4.0844	2439489.5	37.348	-5.2884
2438999.5	37.547	-4.1018	2439499.5	37.329	-5.3109

APPENDIX B
OTTAWA PZT OBSERVATIONS 1956 TO 1970
10 DAY SMOOTHED VALUES

JULIAN DAY	LATITUDE	UTO-A1	JULIAN DAY	LATITUDE	UTO-A1
2439509.5	37.314	-5.3333	2440009.5	37.362	-6.5615
2439519.5	37.307	-5.3553	2440019.5	37.355	-6.5851
2439529.5	37.298	-5.3785	2440029.5	37.329	-6.6074
2439539.5	37.277	-5.4034	2440039.5	37.295	-6.6280
2439549.5	37.268	-5.4297	2440049.5	37.299	-6.6457
2439559.5	37.267	-5.4565	2440059.5	37.307	-6.6600
2439569.5	37.271	-5.4834	2440069.5	37.309	-6.6742
2439579.5	37.261	-5.5108	2440079.5	37.313	-6.6931
2439589.5	37.255	-5.5382	2440089.5	37.337	-6.7175
2439599.5	37.262	-5.5665	2440099.5	37.335	-6.7424
2439609.5	37.279	-5.5944	2440109.5	37.305	-6.7655
2439619.5	37.290	-5.6218	2440119.5	37.298	-6.7872
2439629.5	37.276	-5.6486	2440129.5	37.292	-6.8103
2439639.5	37.249	-5.6739	2440139.5	37.282	-6.8354
2439649.5	37.235	-5.6965	2440149.5	37.272	-6.8627
2439659.5	37.254	-5.7167	2440159.5	37.286	-6.8903
2439669.5	37.285	-5.7349	2440169.5	37.290	-6.9185
2439679.5	37.313	-5.7521	2440179.5	37.295	-6.9451
2439689.5	37.331	-5.7682	2440189.5	37.311	-6.9710
2439699.5	37.339	-5.7829	2440199.5	37.325	-6.9962
2439709.5	37.340	-5.7977	2440209.5	37.327	-7.0217
2439719.5	37.341	-5.8153	2440219.5	37.328	-7.0465
2439729.5	37.343	-5.8345	2440229.5	37.334	-7.0709
2439739.5	37.360	-5.8531	2440239.5	37.348	-7.0952
2439749.5	37.388	-5.8724	2440249.5	37.373	-7.1211
2439759.5	37.401	-5.8942	2440259.5	37.393	-7.1495
2439769.5	37.389	-5.9180	2440269.5	37.415	-7.1788
2439779.5	37.376	-5.9422	2440279.5	37.444	-7.2078
2439789.5	37.378	-5.9669	2440289.5	37.477	-7.2379
2439799.5	37.384	-5.9937	2440299.5	37.468	-7.2705
2439809.5	37.367	-6.0218	2440309.5	37.443	-7.3030
2439819.5	37.338	-6.0495	2440319.5	37.441	-7.3355
2439829.5	37.334	-6.0763	2440329.5	37.462	-7.3683
2439839.5	37.364	-6.1027	2440339.5	37.491	-7.4006
2439849.5	37.389	-6.1288	2440349.5	37.506	-7.4302
2439859.5	37.394	-6.1541	2440359.5	37.498	-7.4607
2439869.5	37.393	-6.1798	2440369.5	37.466	-7.4915
2439879.5	37.398	-6.2054	2440379.5	37.460	-7.5187
2439889.5	37.391	-6.2308	2440389.5	37.461	-7.5409
2439899.5	37.383	-6.2569	2440399.5	37.457	-7.5617

APPENDIX B
 OTTAWA PZT OBSERVATIONS 1956 TO 1970
 10 DAY SMOOTHED VALUES

JULIAN DAY	LATITUDE	UTO-A1	JULIAN DAY	LATITUDE	UTO-A1
2439909.5	37.372	-6.2830	2440409.5	37.425	-7.5833
2439919.5	37.356	-6.3092	2440419.5	37.401	-7.6045
2439929.5	37.356	-6.3378	2440429.5	37.393	-7.6259
2439939.5	37.371	-6.3625	2440439.5	37.409	-7.6459
2439949.5	37.384	-6.3869	2440449.5	37.401	-7.6634
2439959.5	37.343	-6.4169	2440459.5	37.381	-7.6820
2439969.5	37.409	-6.4522	2440469.5	37.353	-7.7054
2439979.5	37.414	-6.4831	2440479.5	37.340	-7.7334
2439989.5	37.396	-6.5105	2440489.5	37.322	-7.7615
2439999.5	37.371	-6.5373	2440499.5	37.308	-7.7876
2440509.5	37.289	-7.8130	2440549.5	37.298	-7.9258
2440519.5	37.284	-7.8403	2440559.5	37.289	-7.9536
2440529.5	37.293	-7.8697	2440569.5	37.273	-7.9801
2440539.5	37.298	-7.8980	2440579.5	37.278	-8.0085



APPENDIX C
COMPARISON WITH RIH REVISED
VALUES AT 1/20 YEAR 1962 - 1970

EPOCH	D-PHI	D-LAMBDA	EPOCH	D-PHI	D-LAMBDA
62.00	.235	.0139	64.50	.064	.0128
62.05	.173	.0169	64.55	.106	.0138
62.10	.139	.0138	64.60	.103	.0154
62.15	.178	.0158	64.65	.122	.0119
62.20	.186	.0129	64.70	.134	.0068
62.25	.163	.0136	64.75	.131	.0087
62.30	.140	.0129	64.80	.122	.0083
62.35	.150	.0133	64.85	.117	.0112
62.40	.118	.0154	64.90	.111	.0102
62.45	.107	.0154	64.95	.102	.0103
62.50	.093	.0111	65.00	.123	.0074
62.55	.123	.0110	65.05	.152	.0097
62.60	.109	.0155	65.10	.196	.0142
62.65	.121	.0162	65.15	.138	.0144
62.70	.117	.0118	65.20	.150	.0140
62.75	.177	.0118	65.25	.149	.0136
62.80	.168	.0103	65.30	.141	.0178
62.85	.155	.0128	65.35	.093	.0183
62.90	.150	.0139	65.40	.087	.0155
62.95	.152	.0161	65.45	.106	.0132
63.00	.186	.0227	65.50	.095	.0112
63.05	.185	.0171	65.55	.101	.0134
63.10	.139	.0183	65.60	.158	.0144
63.15	.147	.0194	65.65	.111	.0064
63.20	.152	.0196	65.70	.174	.0085
63.25	.098	.0189	65.75	.158	.0114
63.30	.092	.0179	65.80	.122	.0099
63.35	.077	.0180	65.85	.162	.0081
63.40	.060	.0169	65.90	.190	.0063
63.45	.073	.0169	65.95	.156	.0067
63.50	.053	.0173	66.00	.149	.0082
63.55	.088	.0213	66.05	.168	.0067
63.60	.111	.0190	66.10	.159	.0130
63.65	.132	.0147	66.15	.162	.0145
63.70	.135	.0130	66.20	.137	.0135
63.75	.132	.0097	66.25	.146	.0146
63.80	.117	.0109	66.30	.129	.0156
63.85	.089	.0085	66.35	.119	.0157
63.90	.128	.0093	66.40	.123	.0150
63.95	.153	.0084	66.45	.110	.0138

APPENDIX C
 COMPARISON WITH BIH REVISED
 VALUES AT 1/20 YEAR 1962 - 1970

EPOCH	D-PHI	D-LAMBDA	EPOCH	D-PHI	D-LAMBDA
64.00	.126	.0092	66.50	.103	.0160
64.05	.187	.0108	66.55	.109	.0133
64.10	.180	.0114	66.60	.119	.0124
64.15	.183	.0143	66.65	.139	.0106
64.20	.169	.0156	66.70	.177	.0091
64.25	.174	.0179	66.75	.190	.0087
64.30	.132	.0167	66.80	.155	.0082
64.35	.141	.0162	66.85	.205	.0091
64.40	.146	.0199	66.90	.135	.0085
64.45	.104	.0165	66.95	.108	.0102
67.00	.132	.0091	68.50	.053	.0164
67.05	.116	.0098	68.55	.065	.0126
67.10	.136	.0051	68.60	.100	.0029
67.15	.111	.0092	68.65	.186	.0106
67.20	.120	.0121	68.70	.097	.0106
67.25	.091	.0139	68.75	.138	.0065
67.30	.103	.0154	68.80	.115	.0103
67.35	.101	.0134	68.85	.130	.0125
67.40	.062	.0150	68.90	.131	.0132
67.45	.042	.0157	68.95	.152	.0111
67.50	.093	.0141	69.00	.118	.0112
67.55	.139	.0156	69.05	.131	.0098
67.60	.132	.0113	69.10	.109	.0147
67.65	.148	.0074	69.15	.141	.0186
67.70	.189	.0075	69.20	.166	.0168
67.75	.192	.0088	69.25	.103	.0176
67.80	.140	.0081	69.30	.112	.0179
67.85	.180	.0074	69.35	.127	.0155
67.90	.103	.0052	69.40	.092	.0171
67.95	.109	.0082	69.45	.078	.0184
68.00	.195	.0102	69.50	.116	.0112
68.05	.080	.0002	69.55	.069	.0125
68.10	.114	.0022	69.60	.155	.0154
68.15	.129	.0084	69.65	.176	.0072
68.20	.091	.0097	69.70	.174	.0100
68.25	.135	.0065	69.75	.163	.0155
68.30	.123	.0145	69.80	.175	.0064
68.35	.127	.0154	69.85	.192	.0098
68.40	.102	.0181	69.90	.191	.0083
68.45	.114	.0169	69.95	.150	.0092

APPENDIX C
COMPARISON WITH BIH REVISED
10 DAY SMOOTHED VALUES 1962-1970

JULIAN DAY	D-PHI	D-LAMBDA	JULIAN DAY	D-PHI	D-LAMBDA
2437669.5	.223	.0153	2438169.5	.070	.0179
2437679.5	.191	.0164	2438179.5	.068	.0167
2437689.5	.153	.0158	2438189.5	.062	.0159
2437699.5	.139	.0146	2438199.5	.062	.0158
2437709.5	.151	.0148	2438209.5	.064	.0164
2437719.5	.177	.0151	2438219.5	.066	.0185
2437729.5	.198	.0150	2438229.5	.078	.0207
2437739.5	.190	.0133	2438239.5	.094	.0211
2437749.5	.172	.0128	2438249.5	.109	.0202
2437759.5	.155	.0134	2438259.5	.116	.0170
2437769.5	.146	.0135	2438269.5	.119	.0145
2437779.5	.148	.0125	2438279.5	.128	.0133
2437789.5	.147	.0123	2438289.5	.134	.0122
2437799.5	.135	.0125	2438299.5	.135	.0110
2437809.5	.124	.0129	2438309.5	.128	.0096
2437819.5	.115	.0141	2438319.5	.117	.0096
2437829.5	.110	.0147	2438329.5	.097	.0089
2437839.5	.101	.0146	2438339.5	.102	.0083
2437849.5	.102	.0127	2438349.5	.126	.0083
2437859.5	.117	.0112	2438359.5	.134	.0089
2437869.5	.122	.0122	2438369.5	.135	.0087
2437879.5	.121	.0140	2438379.5	.140	.0076
2437889.5	.116	.0157	2438389.5	.129	.0080
2437899.5	.113	.0161	2438399.5	.131	.0084
2437909.5	.108	.0152	2438409.5	.156	.0096
2437919.5	.123	.0140	2438419.5	.187	.0102
2437929.5	.151	.0129	2438429.5	.182	.0118
2437939.5	.171	.0115	2438439.5	.180	.0127
2437949.5	.177	.0100	2438449.5	.177	.0135
2437959.5	.169	.0107	2438459.5	.170	.0138
2437969.5	.156	.0119	2438469.5	.164	.0155
2437979.5	.150	.0126	2438479.5	.162	.0170
2437989.5	.148	.0136	2438489.5	.159	.0174
2437999.5	.148	.0141	2438499.5	.145	.0166
2438009.5	.150	.0148	2438509.5	.139	.0158
2438019.5	.163	.0177	2438519.5	.137	.0159
2438029.5	.169	.0213	2438529.5	.142	.0168
2438039.5	.174	.0205	2438539.5	.141	.0187
2438049.5	.171	.0184	2438549.5	.136	.0190
2438059.5	.159	.0178	2438559.5	.109	.0170

APPENDIX C
COMPARISON WITH RIH REVISED
10 DAY SMOOTHED VALUES 1962-1970

JULIAN DAY	D-PHI	D-LAMBDA	JULIAN DAY	D-PHI	D-LAMBDA
2438069.5	.143	.0193	2438569.5	.081	.0141
2438079.5	.143	.0202	2438579.5	.071	.0123
2438089.5	.153	.0203	2438589.5	.096	.0134
2438099.5	.151	.0187	2438599.5	.106	.0152
2438109.5	.135	.0189	2438609.5	.109	.0162
2438119.5	.118	.0190	2438619.5	.114	.0151
2438129.5	.105	.0189	2438629.5	.125	.0136
2438139.5	.091	.0180	2438639.5	.118	.0101
2438149.5	.078	.0180	2438649.5	.120	.0076
2438159.5	.071	.0187	2438659.5	.140	.0072
2438669.5	.143	.0069	2439169.5	.167	.0144
2438679.5	.124	.0068	2439179.5	.161	.0155
2438689.5	.121	.0079	2439189.5	.149	.0146
2438699.5	.124	.0103	2439199.5	.133	.0140
2438709.5	.115	.0110	2439209.5	.133	.0137
2438719.5	.111	.0106	2439219.5	.145	.0140
2438729.5	.109	.0103	2439229.5	.137	.0151
2438739.5	.096	.0101	2439239.5	.126	.0160
2438749.5	.104	.0096	2439249.5	.114	.0158
2438759.5	.123	.0077	2439259.5	.124	.0152
2438769.5	.135	.0070	2439269.5	.117	.0149
2438779.5	.160	.0091	2439279.5	.112	.0147
2438789.5	.191	.0125	2439289.5	.102	.0140
2438799.5	.188	.0139	2439299.5	.087	.0146
2438809.5	.159	.0148	2439309.5	.087	.0153
2438819.5	.148	.0140	2439319.5	.097	.0155
2438829.5	.157	.0133	2439329.5	.108	.0143
2438839.5	.164	.0134	2439339.5	.113	.0140
2438849.5	.161	.0143	2439349.5	.131	.0135
2438859.5	.152	.0147	2439359.5	.146	.0128
2438869.5	.138	.0162	2439369.5	.153	.0108
2438879.5	.117	.0168	2439379.5	.163	.0091
2438889.5	.094	.0171	2439389.5	.191	.0083
2438899.5	.079	.0165	2439399.5	.184	.0094
2438909.5	.083	.0135	2439409.5	.161	.0096
2438919.5	.095	.0122	2439419.5	.158	.0099
2438929.5	.107	.0120	2439429.5	.182	.0093
2438939.5	.101	.0115	2439439.5	.185	.0101
2438949.5	.093	.0116	2439449.5	.160	.0092
2438959.5	.106	.0148	2439459.5	.131	.0081

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COMPARISON WITH BIH REVISED
10 DAY SMOOTHED VALUES 1962-1970

JULIAN DAY	D-PHI	D-LAMBDA	JULIAN DAY	D-PHI	D-LAMBDA
2438969.5	.125	.0183	2439469.5	.115	.0097
2438979.5	.157	.0145	2439479.5	.117	.0100
2438989.5	.152	.0084	2439489.5	.124	.0104
2438999.5	.143	.0060	2439499.5	.125	.0102
2439009.5	.159	.0080	2439509.5	.132	.0099
2439019.5	.179	.0100	2439519.5	.129	.0092
2439029.5	.171	.0105	2439529.5	.125	.0090
2439039.5	.147	.0105	2439539.5	.109	.0098
2439049.5	.134	.0096	2439549.5	.104	.0109
2439059.5	.130	.0093	2439559.5	.106	.0118
2439069.5	.145	.0092	2439569.5	.110	.0124
2439079.5	.156	.0079	2439579.5	.100	.0134
2439089.5	.166	.0057	2439589.5	.092	.0142
2439099.5	.174	.0052	2439599.5	.097	.0151
2439109.5	.170	.0063	2439609.5	.108	.0143
2439119.5	.167	.0089	2439619.5	.108	.0130
2439129.5	.169	.0100	2439629.5	.088	.0134
2439139.5	.174	.0089	2439639.5	.059	.0148
2439149.5	.166	.0083	2439649.5	.043	.0154
2439159.5	.163	.0109	2439659.5	.060	.0153
2439669.5	.087	.0149	2440129.5	.144	.0057
2439679.5	.108	.0150	2440139.5	.139	.0048
2439689.5	.122	.0150	2440149.5	.141	.0067
2439699.5	.127	.0136	2440159.5	.163	.0094
2439709.5	.133	.0112	2440169.5	.173	.0120
2439719.5	.138	.0101	2440179.5	.177	.0124
2439729.5	.138	.0095	2440189.5	.185	.0127
2439739.5	.158	.0093	2440199.5	.178	.0129
2439749.5	.192	.0088	2440209.5	.155	.0133
2439759.5	.205	.0092	2440219.5	.134	.0135
2439769.5	.191	.0094	2440229.5	.118	.0138
2439779.5	.176	.0082	2440239.5	.109	.0131
2439789.5	.176	.0065	2440249.5	.115	.0129
2439799.5	.177	.0065	2440259.5	.120	.0140
2439809.5	.148	.0072	2440269.5	.128	.0145
2439819.5	.104	.0069	2440279.5	.141	.0129
2439829.5	.093	.0073	2440289.5	.162	.0112
2439839.5	.119	.0083	2440299.5	.137	.0124
2439849.5	.134	.0099	2440309.5	.100	.0140
2439859.5	.133	.0103	2440319.5	.088	.0152

APPENDIX C
COMPARISON WITH BIH REVISED
10 DAY SMOOTHED VALUES 1962-1970

JULIAN DAY	D-PHI	D-LAMBDA	JULIAN DAY	D-PHI	D-LAMBDA
2439869.5	.136	.0105	2440329.5	.102	.0155
2439879.5	.134	.0102	2440339.5	.126	.0153
2439889.5	.125	.0095	2440349.5	.139	.0140
2439899.5	.119	.0091	2440359.5	.133	.0154
2439909.5	.111	.0082	2440369.5	.105	.0180
2439919.5	.100	.0066	2440379.5	.105	.0175
2439929.5	.101	.0090	2440389.5	.115	.0136
2439939.5	.119	.0092	2440399.5	.121	.0104
2439949.5	.135	.0095	2440409.5	.101	.0105
2439959.5	.143	.0080	2440419.5	.100	.0112
2439969.5	.156	.0129	2440429.5	.122	.0123
2439979.5	.159	.0173	2440439.5	.173	.0124
2439989.5	.147	.0198	2440449.5	.200	.0100
2439999.5	.133	.0210	2440459.5	.209	.0075
2440009.5	.137	.0196	2440469.5	.208	.0081
2440019.5	.140	.0173	2440479.5	.209	.0108
2440029.5	.122	.0184	2440489.5	.198	.0109
2440039.5	.096	.0212	2440499.5	.191	.0090
2440049.5	.106	.0193	2440509.5	.177	.0068
2440059.5	.119	.0138	2440519.5	.176	.0061
2440069.5	.126	.0080	2440529.5	.189	.0066
2440079.5	.133	.0063	2440539.5	.199	.0068
2440089.5	.162	.0092	2440549.5	.200	.0076
2440099.5	.165	.0114	2440559.5	.189	.0083
2440109.5	.141	.0109	2440569.5	.170	.0077
2440119.5	.143	.0081	2440579.5	.173	.0084