



SUPPLEMENT
TO THE
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Major Palmer's Report on the Longitude of various places in New Zealand.

Colonial Secretary's Office,
Wellington, 30th March, 1876.

THE following Report by Major Palmer, on the telegraphic differences of longitude between various points in the Colony, is published for general information.

CHARLES C. BOWEN,
(in the absence of the Colonial Secretary).

No. 1.

The AGENT-GENERAL to the Hon. the COLONIAL SECRETARY,
7, Westminster Chambers, Victoria Street, Westminster, S.W.,
21st September, 1875.

SIR,—

I have the honor to forward, at the request of Major Palmer, R.E., a letter addressed to you enclosing for the information of the Government a memorandum on the telegraphic differences of longitude between various points in the colony. I now transmit the original of these papers; but I have had a careful copy made of them, which has been revised by Major Palmer, and which I will send as duplicate by the outgoing Southampton mail.

I have, &c.,
I. E. FEATHERSTON,
Agent-General.

The Hon. the Colonial Secretary, Wellington.

Enclosure in No. 1.

Major PALMER, R.E., to the Hon. the COLONIAL SECRETARY,
Southborough, Tunbridge Wells, 31st August, 1875.

SIR,—

I have the honor to forward, for the information of the New Zealand Government, a memorandum on the telegraphic differences of longitude between various points in the colony, determined under my superintendence in the months of November, December, and January last, in accordance with your request. Also, a note on absolute longitude and on the latitude of Burnham Observatory.

I am unable to include in this memorandum the results for difference of longitude between Burnham and Rockside (Dunedin), because Mr. McKerrow, the Observer at that station, has not yet sent me the details of his observations, though I have more than once requested him to do so. But I am prepared to reduce his work as soon as I receive it, and to send you a supplementary memorandum on the subject.

I have, &c.,
H. S. PALMER,
Major R.E.

The Hon. the Colonial Secretary, Wellington.

MEMORANDUM

On Determinations, by Galvanic Signals, of Differences of Longitude between Burnham Observatory and other Stations in New Zealand, 1874-75. Also, a Note on Absolute Longitude and Latitude.

1. The stations included in the operations about to be described were,—

The transit-pier at the transit of Venus Observatory, Burnham
 " " " " " " Queenstown.
 " " " " " " Government Observatory, Wellington.
 " " " " " " Mr. Heale's temporary Observatory, Auckland.

I will designate these four points by the letters B, Q, W, A, respectively.

2. The Observers who took part in the work were Lieutenants Crawford, R.N., and Darwin, R.E.; Mr. T. Heale, Inspector of Surveys; Major Palmer, R.E.; and Professor C. H. F. Peters, Chief of the American Transit of Venus party at Queenstown. These observers will severally be distinguished by the letters C, D, H, P, PE.

3. The method pursued was as follows:—Reciprocal galvanic signals were exchanged between two stations (Burnham being one of them) whose difference of longitude was required, on nights when local time was accurately determined at both by transits of Greenwich clock stars. A sidereal clock or chronometer was used at one station, a mean solar chronometer—compared with the sidereal standard before and after signalling*—at the other. At the sending station an ordinary key was used for signalling, the operator tapping his key precisely at every tenth second of his clock or chronometer with an additional tap at the fifth second of each minute as a means of identification. This was continued for seven minutes. At the receiving station the signals were sounded on a Morse instrument, and the Observer noted† and wrote down the instant of reception of each signal, to the nearest tenth of a second by his clock or chronometer. When one set had thus been sent, the direction of the signals was changed; the station which had at first received now sent. Each station of a pair thus sent and received a set of signals on each night of observation. For the determination of difference of longitude from any set of signals, the mean of all the times of transmission from the sending station (omitting the fifth-second signals), reduced to true sidereal time at place, was used, for comparison with the mean of all the times of reception of the same signals at the receiving station, reduced to true sidereal time there. The difference of these sidereal times gave one value for the difference of longitude. The signals were exchanged when practicable at about the middle time of the star observations, so that the times of transmission might coincide pretty closely with that for which the mean clock error was found by observation, thus avoiding the necessity of trusting the clock-rate for more than a very short interval.

4. The determinations of local sidereal time depend almost entirely‡ on the right ascensions of Greenwich clock-stars as derived from Greenwich Catalogues, and on the places of southern circum-polar stars furnished in Stone's and Ellery's Catalogues. Strict methods of reduction were adhered to in every case. I myself drew up the instructions and tables for use at W and A.

5. The sources of constant errors in the determinations of difference of longitude, apart from accidental errors of observation, are the following:—

- (1.) Wave and armature time on the telegraph line; which, however, may be considered as eliminated by sending the signals both ways.
- (2.) The personal equations of the observers in observing transit of stars; unknown.
- (3.) The personal equations in tapping the key in coincidence with the clock beats; unknown.
- (4.) The personal equations in receiving signals by ear; unknown.
- (5.) The different qualities of the transit instruments at the several stations.
- (6.) In the case of Q, the difference in the mode of recording transits and time-signals from that practised at B, Q having used a chonograph for both these purposes.

6. Signals were exchanged on four nights between B and Q; on four nights between B and W; and on three nights between B and A. The results, subject to small errors of the kinds enumerated above, are as follows:—

7. Queenstown.

Date.	Operators.	Resulting Diff. of Longitude.	Time, determination by.
		M. s.	
Nov. 25	PE at Q sends to P at B ...	Q west of B	14 32.25
	P at B sends to PE at Q ...	"	14 32.25
Nov. 27	PE at Q sends to P at B ...	"	14 32.63
	P at B sends to PE at Q ...	"	14 32.64
Nov. 30	PE at Q sends to P at B ...	"	14 32.81
	P at B sends to PE at Q ...	"	14 32.85
Dec. 2	PE at Q sends to P at B ...	"	14 32.97
	P at B sends to PE at Q ...	"	14 32.94

Mean difference of longitude Q west of B ... 14 32.67

The second result on 27th November is the mean of two sets, in which the decimals of seconds were 61s. and 67s.

* Except at W, where the mean solar chronometer was itself made the standard.

† Except at Q, where the signals were recorded automatically on a chonograph.

‡ Q only used a few stars not in the list of Greenwich clock-stars, and did not directly use the Greenwich Catalogues. But the right ascensions used were in every case sensibly the same as those derivable from the Greenwich Catalogues.

8. *Wellington.*

Date.	Operators.	Resulting Diff. of Longitude.	Time, determination by.
1874.		M. S.	
Dec. 26	P at W sends to D at B ...	W east of B 9 52.96	} P at W; D at B
	D at B sends to P at W ...	" " 9 52.96	
Dec. 27	P at W sends to C at B ...	" " 9 52.59	} P at W; C at B
	C at B sends to P at W ...	" " 9 52.50	
1875.			
Jan. 11	P at B sends to D at W ...	" " 9 51.89	} P at B; D at W
	D at W. sends to P at B ...	" " 9 51.80	
Jan. 13 ^a	P at B sends to D at W ...	" " 9 52.16	} P at B; D at W
	D at W sends to P at B ...	" " 9 52.08	

Mean difference of longitude W east of B 9 52.37

The discordances in this case are considerably greater than the others. I attribute this to the character of the instruments used at W. In the first place, the transit instrument had no micrometer; consequently the observations spread over a long time. I was occupied nearly two hours one night with the transit of a single circumpolar star. This necessitated a certain amount of reliance on the steadiness of rate of the chronometer employed—viz., Molyneux No. 2082; but the performance of this chronometer was bad, its rate being unsteady and very large, between 20 sec. and 30 sec. daily, and it is likely that errors of some consequence were thus introduced.

The first result on 13th January is the mean of two sets, in which the decimals of seconds were ^s.10 and ^s.23. On 26th December three clock-stars only were observed at W, instead of the usual number, six at least; but the observations were good, and full weight has therefore been given to the night's work.

9. *Auckland.*

Date.	Operators.	Resulting Diff. of Longitude.	Time, determination by.
1874.		M. S.	
Dec. 26	H at A sends to D at B ...	A east of B 9 52.75	} H at A; D at B
	D at B sends to H at A ...	" " 9 52.61	
Dec. 29	H at A sends to P at B ...	" " 9 52.32	} H at A; P at B
	P at B sends to H at A ...	" " 9 52.05	
1875.			
Jan. 5	H at A sends to P at B ...	" " 9 52.37	} H at A; P at B
	P at B sends to H at A ...	" " 9 52.06	

Mean difference of longitude A east of B... .. 9 52.36

It is necessary to remark that as Mr. Heale has not sent me his reductions for examination, I cannot vouch for their accuracy; but the results give no reason to suppose that they are otherwise than correct. The time observations at A were taken with a small (two-feet) portable transit instrument by Troughton and Simms, kindly lent me by Messrs. Coates and Co., of Christchurch.

Note on the Longitude of Wellington Observatory and the Latitude of Burnham.

10. Although the extra meridional observations of the moon for longitude, taken at Burnham with the altazimuth in November and December last, have not yet been reduced, an *approximate* longitude has been worked out from the observed meridional transits of the moon. According to this approximate determination, the longitude of the transit-pier at Burnham appears to be 11h. 29m. 12s. 44 east of Greenwich. The errors of the moon's tabular right ascensions have been taken into account in this reduction; but the result remains affected by the personal equations of the observers, both as regards transits of stars and transits of the moon, which have not yet been ascertained. Though the determination, therefore, can only be regarded as approximate, it may nevertheless be interesting to compare it with those previously arrived at by others, and given in the documents enumerated in the foot-note.*

1. The approximate absolute longitude of the transit-pier at Burnham	H. M. S.
obtained as above by ourselves is	11 29 12.44 E.
Wellington Observatory transit-pier east of the Burnham transit-pier	
by galvanic signals	9 52.37

Palmer's approximate longitude of Wellington Observatory ... 11 39 4.81 E.

2. Adopting the longitude of Melbourne Observatory as fundamental, and equal to 9h. 39m. 54s. 80; and the telegraphic difference of longitude from Melbourne to Sydney Observatory as +24m. 55s. 81, we get 10h. 4m. 50s. 61 as the longitude of Sydney Observatory. The chronometric difference from Fort Macquarie (Sydney), to Pipitea Point (Wellington), determined by Captain Stokes, R.N., is +1h. 34m. 15s. 53. Hence we have,—

	H. M. S.
Longitude of Sydney Observatory...	10 4 50.61 E.
Correction to Fort Macquarie ...	+2.63
Pipitea Point, East of Fort Macquarie ...	+1 34 15.53
Correction to Wellington Observatory ...	-2.88

Stokes's longitude of Wellington Observatory ... 11 39 5.89 E.

* Parliamentary Paper, 1871, G. No. 23. Supplement to the *New Zealand Gazette* No. 12, 1871. Report by Dr. Hector to the Colonial Secretary, 9th September, 1874, enclosing Memorandum on Longitude by Captain Nares, R.N.

3. The chronometric difference between Garden Island (Sydney) Observing Station and the Cathedral, Wellington, determined by Captain Nares, of H.M.S. Challenger, is +1h. 34m. 15s. 47. Hence we have,—

	H.	M.	S.
Longitude of Sydney Observatory ...	10	4	50.61 E.
Correction to Garden Island Station ...			+5.73
Cathedral, Wellington, East of Garden Island	+1	34	15.47
Correction to Wellington Observatory ...			-2.01

Nares's longitude of Wellington Observatory 11 39 9.80 E.

This differs nearly four seconds from Stokes's result, but Captain Nares admits that in all probability Stokes's is the more trustworthy of the two, as in the Challenger's case twenty-one days elapsed between the time observations at Sydney and those at New Zealand, while the interval in Stokes's case was probably much shorter.

4. Separate determination of absolute longitude by transits of the moon which were made in 1869-70-71 at Rockside, Dunedin, by Messrs. Thomson and McKerrow, and at the Hutt, Wellington, by Mr. Jackson, were combined in 1871, by determining telegraphically the difference of longitude between those points, with the following mean result:—

	H.	M.	S.
Longitude of Hutt Observatory ...	11	39	50.72 E.
Correction to Wellington Observatory ...			-35.41

Thomson and Jackson's longitude of Wellington Observatory ... 11 39 15.31 E.

But the errors of the moon's tabular place were not taken into account in this determination. The average of these errors for the days in which the moon was observed at Rockside and the Hutt was about +0s.25, which would probably cause an error of between +6s. and +7s. in the resulting longitude. Therefore Messrs. Thomson's and Jackson's corrected longitude of the observatory may be taken approximately as 11h. 39m. 9s. E.

5. The chart longitude of Pipitea Point, in which New Zealand mean time (*i.e.*, the time in longitude 11h. 30m. E) is at present founded, is 11h. 39m. 11s. 53 E, so that we have,—

	H.	M.	S.
Chart longitude of Pipitea Point ...	11	39	11.53 E.
Correction to Wellington Observatory ...			-2.88

Present adopted longitude of Wellington Observatory ... 11 39 8.65 E.

11. Recapitulating these five results, we have for the longitude of Wellington Observatory, as variously determined,—

	H.	M.	S.
1. Palmer's absolute longitude, approximate only	11	39	4.81 E.
2. Stokes's chronometric, depending on Melbourne ...	11	39	5.89 „
3. Nares's chronometric, depending on Melbourne ...	11	39	9.80 „
4. Thomson and Jackson's, approximate absolute... ..	11	39	9.00 „
5. Present adopted longitude for New Zealand mean time	11	39	8.65 „

The mean of these is 11h. 39m. 7.63s., or within about one second of that at present adopted as the standard for colonial time. I therefore should not recommend that any immediate change of that standard be made. It will be soon enough to alter it once for all when the whole of the Burnham observations have been correctly reduced and communicated to the Colonial Government, and when, by means of the projected submarine cable, a telegraphic longitude-difference shall have been obtained between New Zealand and the Sydney or Melbourne Observatory.

Latitude of Burnham.

12. The latitude of the transit-pier at Burnham, as derived from fifty-three circummeridional observations of north and south stars, is 43° 36' 48".4 south.

H. S. PALMER,
Major R.E.,
August 31, 1875.

The Hon. the Colonial Secretary, New Zealand.