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Body Wave Magnitudes and Locations of French Explosions in the South Pacific

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SUMMARY

Estimates are given of the magnitudes, epicentres and origin times of 76 explosions fired by France at the Tuamotu Archipelago in the South Pacific for which time and amplitude data are published in the bulletins of the International Seismological Centre (ISC). Most of the explosions took place at Mururoa but 5 seem to have been fired at the neighbouring island of Fangataufa; Mururoa and Fangataufa being about 50 km apart. The epicentres and origin times are estimated using the joint epicentre method. The epicentres are estimated relative to that of the explosion of the 25 July 1979. The epicentre of this explosion was chosen so that the pattern of epicentres in the vicinity of Mururoa fits centrally over the island.

The magnitudes are determined using a joint maximum-likelihood method. With this method allowance is made for the detection threshold of the stations reporting P amplitudes. If such allowance is not made the estimates will usually be biased high with the bias increasing as magnitude decreases. However, for the Tuamotu explosions systematic differences between the maximum-likelihood estimates of magnitude and the ISC estimates are small and are negligible above m_b 5.5.

The joint methods of epicentre and magnitude estimation also produce estimates of station time and magnitude effects. These effects are listed for up to 582 stations.

1. INTRODUCTION

Marshall et al [1] give estimates of the body wave magnitudes, epicentres and origin times of some of the explosions carried out by France at the Mururoa atoll in the Tuamotu Archipelago in the South Pacific. The explosions are those that occurred between 1975 and 1985 for which data on onset time and amplitude are published in the bulletins of the International Seismological Centre (ISC). In this report we give similar estimates for the 76 explosions that took place in the South Pacific between 1968 and 1989 and which are reported in the ISC bulletins. Five of the explosions (which took place in 1968-71) were fired in the atmosphere (Bolt [2]); the remainder appear to have been fired underground. Most of the explosions took place at Mururoa but as shown by the analysis presented here 5 (including 2 atmospheric explosions) appear to have been fired at the neighbouring island of Fangataufa; Mururoa and Fangataufa being about 50 km apart.

In computing the epicentres and origin times we follow Marshall et al [1] and use the method of Joint Epicentre Determination (JED) of Douglas [3]. To estimate the magnitude, the joint maximum-likelihood method of Lilwall[4] and Lilwall and Neary [5] is used. The method has an advantage over the least squares method used by Marshall et al [1] in that allowance is made for the detection (or reporting) thresholds of the stations. If such allowance is not made the estimates are biased high with the bias increasing as magnitude decreases.

2. EPICENTRE RELOCATIONS

The JED method was used to relocate the explosions using P & PKP arrival times taken from ISC bulletins. Arrival time readings were weighted to allow for gross errors and for variation between stations in the quality of the arrival time measurements. The effect of gross errors is reduced using the method of uniform reduction (Jeffreys [6]). The method assumes that the errors in the observations are essentially normally distributed but that the distribution is modified by the addition of a small uniform distribution due to gross errors. This modification to the distribution results in weights that progressively reduce the contribution of residuals as their deviation from the mode increases.

For stations that report sufficient explosions (here set at 10) the standard deviation of the residuals is calculated and used to weight the arrival times for the station. This technique permits the incorporation of a large body of PKP data which would normally be given zero weight because its variance is significantly greater than that of most P observations.

Two analyses were carried out, one using all the data, the other using only data for what appear to be the five explosions at Fangataufa. Consider first the analysis that uses data from all 76 explosions. To fix the overall location of the group, one of the epicentres was restrained to a predetermined value. The restrained epicentre chosen is that for the explosion on 25 July 1979, one of the largest and most widely recorded of the explosions. No true epicentre for the explosion has been published and so the location must be fixed using other evidence. The strategy used by Marshall et al[1] was to shift the restrained epicentre until the overall pattern fitted centrally over Mururoa island. The epicentre used by Marshall et al [1] (21.88S, 138.94W) gives for the data they used, the minimum deviation of the median location from the lagoon centre (taken as 21.83S, 138.91W). Confidence in the restrained location is gained by the fact that the ISC location (21.86S, 139.0W) is roughly 6 km WNW of the chosen position, a bias similar to that expected when station travel time corrections are not used (Lilwall & Underwood [7]). Here the epicentres have been determined relative to the same restrained epicentre as used by Marshall et al [1]. All depths are restrained to zero and the origin time of the 25 July 1979 explosion was restrained to the nearest exact minute (17:57:00). A total of 554 stations was used.

Figure 1(a) shows the ISC epicentres for all 76 explosions. Although the epicentres are clearly concentrated around Mururoa, many lie well out to sea and there is no obvious separate group of epicentres associated with Fangataufa. The JED results on the other hand (figure 1(b)) show clearly the separation of the epicentres into two groups: 5 in the vicinity of Fangataufa and most of the remainder on or near Mururoa. One other epicentre, that for the explosion of 27 October 1984 (at 22.064S, 138.477W which is SE of Mururoa) is somewhat closer to Fangataufa than to Mururoa and so may be another Fangataufa explosion. However, the uncertainty in the epicentral estimate is large, the confidence ellipse has semi-minor and semi-major axes of about 9 and 29 km respectively and the major axis is oriented NW-SE. Thus if the true epicentre is on one of the two islands it is more likely to be on Mururoa than Fangataufa. Consequently it is assumed here that the 27 October 1984 explosion was fired at Mururoa.

Figure 1(c) shows the results of the JED analysis of the five Fangataufa explosions. Here the epicentre of one of the explosions (that of 30 November 1988) has been restrained to the centre of the island (22.233S, 138.74W). Three of the epicentres (which are for the underground explosions) now form a very tight group which lie on or close to the island. The epicentres of the other two, which are atmospheric explosions, lie out to sea.

Table 1 gives the relocated epicentres, origin times and 95% confidence limits. In addition to the epicentres, the JED method gives estimates of the station time-terms. These are listed in table 2. Positive values, show that the signal was late relative to the time predicted from travel-time tables (here Jeffreys-Bullen) and conversely a negative value shows that the onset is early relative to the predicted time. If the time terms are to be used as corrections which when added to the observed time corrects for deviations from predicted times, then all the time terms should have their sign reversed.

3. MAGNITUDES

Given n explosions recorded at some or all of q stations, then it is usually assumed that m_{ij}, the magnitude of the ith explosion recorded at the jth station can be written:

$$m_{ij} = b_i + s_j + \varepsilon_{ij}$$

where b_i is the magnitude of explosion i, s_j is a station term and ε_{ij} is an error term. Following Gutenberg and Richter [8] the body wave magnitude at station j for explosion i is:

$$m_{ij} = \log A_{ij}/T_{ij} + B\ (\Delta_{ij})$$

where A_{ij} is the amplitude of the P wave, T_{ij} its predominant period, and $B(\Delta_{ij})$ the correction factor for the distance Δ_{ij} between explosion i and station j. Usually b_i and s_j are estimated by least squares (see for example Douglas [9]) with the assumption that:

$$\sum_{j=1}^{j=q} s_j = 0. \tag{1}$$

Such estimates are unbiased if the observed m_{ij} are sampled randomly from a normal distribution. In practice however, the distribution of m_{ij} will not be normal. Below average amplitudes will tend to be under-reported because at some stations the amplitude will be so small it will not be detected or if detected will not be measured and reported to data centres. Magnitudes estimated by least squares will thus tend to be biased high.

Lilwall [4] and Lilwall and Neary [5] following Christoffersson [10] shows that unbiased estimates of magnitude (and station effects) can be obtained (given estimates of station threshold and the variance of the threshold) by using maximum-likelihood methods, again with the assumption given in (1). Using Lilwall's method, maximum-likelihood estimates of body wave magnitude $\left(m_b^{ML}\right)$ have been determined for all the 76 explosions considered here.

From Christoffersson et al [10] the distribution of <u>observed</u> station magnitudes m_{ij} can be written as:

$$P\left(m_{ij_{obs}} \,|b_i, s_j, \sigma ..\right) = \frac{\phi\left(\dfrac{m_{ij}-G_j}{\gamma_j}\right)\theta\left(\dfrac{m_{ij}-s_j-b_i}{\sigma}\right)}{\phi\left(\dfrac{s_j+b_i-G_j}{\sqrt{(\sigma^2+\gamma_j^2)}}\right)} \tag{2}$$

$$\text{(3)} \quad \text{where } G_j = g_j + B(\Delta_{ij}).$$

θ is the normal density function of variance σ^2 representing the distribution of "uncensored" values of m_{ij}; ϕ the cumulative normal distribution; g_j the mean (50%) amplitude measurement threshold in terms of logA/T for station j; γ_j^2 the variance of the threshold assumed normally distributed about g_j. If the sources are close together equation 3 enables the main logA/T thresholds g_j to be expressed in terms of magnitude thresholds G_j.

Estimates of b_i,s_j and σ can be determined by maximising the likelihood function resulting from the product over the observed values of m_{ij} of terms given by equation 2.

$$L(b_i,s_j,\sigma) = \prod_{\substack{\text{observed} \\ m_{ij}}} P(m_{ij}|b_i,s_j \ldots) \tag{4}$$

Maximisation being subject to the constraint given by equation 1.

Ideally station thresholds and the variance of the thresholds would be determined once for each station and then used for all time. However, station thresholds do change with time. Possible reasons for this might be increased noise levels due to the growth of industry in the vicinity of the station and changes in reporting procedures with some stations deciding to measure amplitudes on smaller signals than they had in the past. Estimates of station thresholds and variance covering the period 1982-1989 have been combined with those of Lilwall and Neary [5] to cover the whole period 1964-1989. The threshold and variances are estimated from the overall distribution of log A/T submitted to the ISC for each station using the method of Kelly and Lacoss [11]. As with the travel times the effects of gross errors in the amplitudes is reduced using weighting based on the method of uniform reduction (Jeffreys [6]). Examination of the distributions of observed amplitudes away from the mode suggests that the frequency of gross errors is 0.01 times the peak frequency.

For the amplitude analysis the explosions have been divided into three groups: (i) Mururoa underground; (ii) Fangataufa underground; and (iii) atmospherics. The JED results suggest that station time-terms are roughly constant for all the epicentres in the region. Thus, fixing an epicentre at Mururoa does not introduce any obvious systematic bias into the epicentres of the Fangataufa explosions when the epicentres of the explosions at the two islands are estimated in the joint analysis. However, there does seem to be significant differences in the station magnitude effects for underground explosions at the two islands possibly due to variations in the near source effects (Douglas et al [12]). Because of these possible differences in station magnitude effects it seems sensible to analyse the amplitude data for underground explosions at each island separately. Also near-source effects for atmospheric explosions may be less variable than for underground explosions and may generate signals with low predominant frequencies. For these reasons the data from the atmospheric explosions has been analysed separately from those of the underground explosions.

Now, the station network for each of the three analyses is not constant and it is possible that this will result in systematic biases in the magnitudes estimated. There is no sure way of correcting for these possible biases. Here, we have simply assumed that the average station effect for the analysis that uses the largest number of stations (that of the Mururoa underground explosions with 68 explosions and 178 stations) sets the baseline. Then for the Fangataufa underground explosions the average s_j^F-s_j^M is computed; where s_j^F is the magnitude term for station j obtained from the analysis of the observations from the Fangataufa explosions and s_j^M the equivalent terms obtained from the analysis of the Mururoa observations; the average being formed from only those stations common to both the Fangataufa and Mururoa analyses. The average (0.043 magnitude units) is then subtracted from s_j^F and added to the magnitudes of the Fangataufa explosions. The magnitudes and station terms for the atmospheric explosions have been corrected in a similar way. For these explosions 0.039 magnitude units have been subtracted from the magnitudes and the same value added to the station terms.

The data used for each analysis are: (i) Mururoa underground explosions - 1860 amplitude readings from 68 explosions and 178 stations; (ii) Fangataufa explosions - 99 readings from 3 explosions and 54 stations; (iii) atmospheric explosions-55 readings from 5 explosions at 26 stations. The estimated magnitudes and station magnitude terms, corrected to a common baseline as described above, are given in tables 1 and 2 respectively. For the station magnitude terms positive values indicate above average amplitudes and negative values those with below average amplitudes.

Comparisons of station terms from the various analyses are displayed in figure 2. Figure 2(a) shows a comparison of the station magnitude terms with the time terms. Assuming that P wave speeds in the earth are negatively correlated with attenuation - the lower the wave speed the greater the attenuation - then this would be expected to show up as a negative correlation between the station magnitude and time terms. As figure 2(a) shows, if there is such a correlation it is weak. Figures 2(b) and 2(c) show respectively the station magnitude term for the Fangataufa underground explosions and the atmospheric explosions against the terms for the Mururoa underground explosions. It is clear that there is little correlation between the station magnitude terms which justifies the decision to analyse the three data sets separately.

The magnitude analyses described above were made using the distance-correction curve (B(Δ)) of Lilwall [13] which covers the range 20-180°. The advantage of using this curve, particularly for the Tuamotu explosions is that observations from many more stations can be included than with the standard Gutenberg curve which ends at 100°. However, comparison of magnitudes (m_b^{ML}) estimated using the data from 20-180° range with those estimated using data in the 20-100° range shows that with the larger range the magnitudes are 0.09 magnitude units larger than those obtained with stations only out to 100° (figure 3(a)). Conversely the station magnitude terms obtained using data at distances of 100° and less are 0.09 magnitude units larger than those obtained using data out to 180° (figure 2(d)). (Similar results are obtained using the Gutenberg curve to estimate the magnitudes for data in the 20-100° range.) This result may indicate that the B(Δ) curve of Lilwall is systematically too large at distances beyond 100°. Alternatively it may be that the amplitudes observed on ray paths between the Mururoa test site and stations at PKP distances are systematically above the world average. This remains to be investigated. Perhaps surprisingly however, comparison of the m_b^{ML} obtained here and those published by the ISC (which uses the Gutenberg curve) shows that any systematic difference between the two sets of magnitudes is small (figure 3(b)). As expected what differences there are, are greatest (≈0.1 magnitude units) at the lowest magnitudes and these differences decrease as magnitude increases. Above about m_b5.5 the differences are negligible.

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TABLES

Table 1: Epicentres, origin times and magnitudes for the Tuamotu explosions.

Table 2: Station time and amplitude terms with 95% confidence limits.

FIGURE CAPTIONS

Figure 1: Maps of Mururoa and Fangataufa and Estimated Epicentres.

(a) ISC epicentres.
(b) JED epicentres computed using data for all 76 explosions.
(c) JED epicentres computed using only data for the 5 Fangataufa explosions.

Figure 2: Comparisons of Station Terms

(a) Station magnitude terms against station time-terms for the Mururoa underground explosions.

(b) Station magnitude terms for the Fangataufa underground explosions against the magnitude terms for the Mururoa explosions.

(c) Station magnitude terms for the atmospheric explosions against the magnitude terms for the Mururoa underground explosions.

(d) Station magnitude terms for the Mururoa underground explosions derived using only data in the range 20-100° against those derived using data out to 180°.

Figure 3: (a) Maximum-likelihood magnitudes derived for the Mururoa underground explosions using only data in the range 20-100° against the magnitudes derived using data in the range 20-180°.

(b) ISC magnitudes against maximum-likelihood magnitudes. Also shown is the line $m_b^{ISC} = m_b^{ML}$ and the least squares line through the data.

TABLE 1.

Epicentres, Origin Times and Magnitudes of the Tuamotu Explosions

Date	Origin time	Latitude*	Longitude*	Area(km^2)	m_b^{ML}	N_A†
Epicentres estimated relative to th 25 July 79 Mururoa explosion						
680824	18:30: 0.60±0.21	22.185S± 5.3	138.688W± 7.1	156.7	4.95±0.08	18
680908	19: 0: 0.97±0.26	21.821S± 7.4	138.975W± 8.4	231.9	4.91±0.09	16
700530	17:59:59.94±0.22	22.270S± 6.1	138.637W± 6.0	158.3	4.44±0.15	6
700703	18:30: 0.25±0.26	21.953S± 6.5	138.917W± 6.3	187.8	4.65±0.13	7
710814	19: 0: 0.77±0.23	21.823S± 6.8	138.976W± 7.6	182.8	4.65±0.12	8
760711	0:30: 0.53±0.19	21.863S± 5.4	138.786W±10.0	216.6	4.93±0.09	16
770219	23:30: 0.43±0.20	21.840S± 5.7	138.848W± 7.2	162.6	5.02±0.09	16
770319	23: 0:59.89±0.09	21.887S± 2.8	138.920W± 2.6	32.2	5.92±0.05	50
770706	22:59:59.99±0.26	21.783S± 7.2	138.960W±16.0	461.8	4.81±0.14	6
771124	16:59:59.92±0.11	21.884S± 3.5	138.886W± 3.5	46.2	5.86±0.06	36
780322	17:30: 0.45±0.45	21.702S±13.0	138.934W±12.4	424.7	4.73±0.17	4
781130	17:31:59.98±0.09	21.868S± 2.8	138.950W± 2.7	31.6	5.86±0.05	54
781219	16:57: 1.49±0.21	21.768S± 6.4	138.943W± 7.0	170.4	5.01±0.09	15
790324	16:28: 0.40±0.16	21.806S± 4.6	138.933W± 5.8	111.9	4.93±0.08	19
790404	18: 7: 0.46±0.44	21.850S±12.5	138.702W±14.5	418.3	4.69±0.16	7
790618	23:27: 0.66±0.29	21.810S±11.0	138.809W±10.1	326.0	4.71±0.15	5
790629	18:56: 0.17±0.15	21.818S± 4.4	138.903W± 5.1	87.2	5.21±0.09	13
790725	17:57: 0.00±0.00	21.880S± 0.0	138.940W± 0.0	0.0	6.11±0.04	72
790728	19:56: 0.28±0.30	21.809S± 8.9	138.812W± 8.4	237.0	4.73±0.23	2
800323	19:37: 0.00±0.10	21.861S± 3.2	138.939W± 3.3	41.1	5.63±0.06	38
800401	19:31: 0.22±0.16	21.845S± 6.0	138.758W± 5.7	101.5	5.05±0.09	15
800404	18:33: 0.05±0.42	21.921S±13.9	138.799W±11.4	332.2	4.30±0.19	4
800616	18:27: 0.04±0.12	21.870S± 3.6	138.899W± 3.9	62.5	5.30±0.07	25
800706	17:27: 0.47±0.27	21.849S± 7.3	138.848W± 6.7	223.6	4.54±0.14	6
800719	23:47: 0.00±0.09	21.861S± 2.7	138.934W± 2.7	31.6	5.73±0.05	50
801203	17:33: 0.00±0.10	21.875S± 3.3	138.939W± 3.2	43.2	5.58±0.06	37
810328	17:23: 0.58±0.19	21.790S± 5.7	138.678W± 6.3	176.9	4.75±0.14	6
810410	17:57: 0.49±0.25	21.795S± 9.1	138.946W±10.6	322.0	4.76±0.10	12
810708	22:23: 0.30±0.15	21.791S± 4.6	139.046W± 5.0	94.8	5.14±0.09	15
810803	18:33: 0.03±0.13	21.842S± 4.0	138.903W± 4.7	81.3	5.09±0.06	29
811111	17: 7: 0.20±0.19	21.856S± 6.2	138.954W± 5.9	147.5	4.71±0.12	9
811205	16:58: 1.08±0.41	21.685S±13.2	138.933W±12.7	405.4	4.68±0.20	3
811208	16:47: 0.23±0.15	21.797S± 4.7	138.927W± 4.5	79.0	5.14±0.08	21
820320	17: 3: 0.18±0.22	21.846S± 5.4	138.868W± 6.1	148.8	4.96±0.10	14
820701	17: 2: 0.20±0.14	21.769S± 4.7	138.946W± 4.7	94.4	5.08±0.08	18
820725	18: 2: 0.00±0.10	21.836S± 3.0	138.896W± 3.1	39.8	5.60±0.05	40
830419	18:53: 0.17±0.09	21.819S± 2.7	138.872W± 2.7	32.2	5.70±0.05	58
830525	17:31: 0.12±0.08	21.861S± 2.6	138.917W± 2.5	29.3	5.87±0.04	63
830628	17:46: 0.24±0.10	21.767S± 3.1	138.871W± 3.4	44.5	5.32±0.06	36
830804	17:14: 0.20±0.14	21.835S± 4.0	138.829W± 4.5	84.9	5.13±0.08	21
831207	17:28: 0.28±0.24	21.829S± 7.3	138.928W± 9.4	225.7	4.89±0.12	11
840512	17:31: 0.04±0.09	21.863S± 2.6	138.901W± 2.7	30.7	5.57±0.05	48
840616	17:43:59.98±0.11	21.849S± 3.0	138.880W± 3.2	43.7	5.28±0.06	30
841027	17:16: 0.40±0.45	22.064S±18.2	138.477W±16.3	777.7	4.49±0.21	3
841102	20:45: 0.13±0.09	21.857S± 2.6	138.920W± 2.5	29.5	5.64±0.05	48
841206	17:29: 0.16±0.09	21.837S± 2.7	138.890W± 2.8	33.3	5.56±0.05	58
850430	17:29: 0.55±0.36	21.829S±10.3	138.952W±12.7	554.4	4.51±0.13	8
850508	20:28: 0.24±0.08	21.831S± 2.7	138.981W± 2.7	30.2	5.64±0.05	57
850603	17:30: 0.61±0.25	21.816S± 5.5	138.897W± 7.5	201.2	4.83±0.11	10
851026	16:35: 0.24±0.11	21.849S± 3.0	138.815W± 3.6	51.8	5.30±0.06	38
851124	16: 1: 0.66±0.19	21.802S± 5.8	138.781W± 4.9	107.9	4.55±0.10	13
851126	17:42: 0.06±0.09	21.856S± 2.6	138.899W± 2.6	30.2	5.76±0.04	59
860426	17: 2: 0.67±0.35	21.725S± 9.5	138.941W±12.0	469.0	4.45±0.19	5
860530	17:25: 0.11±0.09	21.862S± 2.7	138.949W± 2.7	31.9	5.58±0.05	49
861112	17: 2: 0.32±0.11	21.843S± 3.0	138.927W± 3.4	47.1	5.28±0.06	31
861210	17:15: 0.18±0.11	21.833S± 3.4	138.892W± 3.9	53.6	5.23±0.08	21
870505	16:58: 1.33±0.39	21.705S± 6.9	138.581W±10.0	318.1	4.55±0.22	4
870520	17: 5: 0.12±0.09	21.850S± 2.6	138.913W± 2.7	30.1	5.51±0.05	51
870606	18: 0: 0.71±0.32	21.769S± 6.5	138.874W± 9.8	311.6	4.40±0.21	5
870621	17:55: 0.12±0.11	21.865S± 3.9	138.891W± 4.9	70.8	5.10±0.06	33
871023	16:50: 0.31±0.09	21.845S± 2.7	138.907W± 2.8	33.2	5.54±0.05	50
871105	17:30: 0.36±0.09	21.791S± 2.8	138.874W± 3.0	36.3	5.36±0.05	43
871119	16:31: 0.16±0.09	21.845S± 2.6	138.941W± 2.6	30.4	5.74±0.05	53
880511	17: 0: 0.27±0.10	21.833S± 3.0	138.945W± 3.3	42.5	5.27±0.06	36
880525	17: 1: 0.14±0.09	21.845S± 2.8	138.961W± 3.0	35.3	5.50±0.05	41
880623	17:31: 0.29±0.10	21.846S± 3.2	138.911W± 3.7	50.9	5.18±0.06	34
881105	16:30: 0.40±0.10	21.793S± 3.0	138.987W± 3.2	42.0	5.30±0.07	24
881123	17: 1: 0.33±0.11	21.835S± 3.2	138.954W± 3.3	44.9	5.29±0.07	27
881130	17:54:59.98±0.09	22.194S± 2.7	138.737W± 3.0	36.0	5.58±0.05	34
890511	16:45: 0.52±0.12	21.812S± 3.7	138.884W± 3.8	64.7	5.16±0.07	23
890603	17:30: 0.20±0.11	21.842S± 3.4	138.922W± 3.6	55.3	5.16±0.06	29
890610	17:29:59.86±0.10	22.222S± 2.9	138.664W± 3.2	39.8	5.52±0.06	34
891024	16:30: 0.21±0.10	21.852S± 3.0	138.912W± 3.3	42.1	5.37±0.07	25
891031	16:57: 0.26±0.10	21.793S± 3.0	138.855W± 3.4	42.4	5.30±0.06	31
891120	17:29: 0.27±0.11	21.793S± 3.1	138.884W± 3.4	48.3	5.19±0.07	27
891127	16:59:59.83±0.09	22.228S± 2.7	138.721W± 2.9	35.8	5.59±0.06	31
Epicentres estimated relative to 30 Nov 88 Fangataufa explosion						
680824	18:30: 0.54±0.33	22.228S± 7.7	138.644W±10.5	348.4		
700530	17:59:59.90±0.36	22.309S± 9.5	138.606W± 8.7	365.6		
881130	17:55: 0.00±0.00	22.233S± 0.0	138.740W± 0.0	0.0		
890610	17:30: 0.07±0.15	22.217S± 4.2	138.721W± 4.7	80.4		
891127	16:59:59.96±0.15	22.251S± 3.7	138.722W± 4.2	71.9		

* Confidence limits in kilometres

† Number of stations used in computing m_b^{ML}

TABLE 2.

Station Time and Magnitude Effects with 95% Confidence Limits

Station	Time term(s)	N_T^e	Mururoa amp. term	N_1^e	Fangataufa amp. term	N_2^e	Atmospherics amp. term	N_3^e	Δ°	φ°
AAM	-1.28±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	82	38
ABH	-5.71±0.72	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	142	36
ABL	-0.60±0.31	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	59	19
ACO	-2.05±0.31	9	0.05±0.22	2	0.00±0.00	0	0.00±0.00	0	69	33
ADE	-2.31±0.38	6	1.16±0.30	2	0.00±0.00	0	0.00±0.00	0	72	239
ADK	-1.61±0.14	22	0.13±0.19	3	-0.03±0.24	2	0.00±0.00	0	81	337
AFI	-2.17±0.46	4	-1.01±0.33	1	0.00±0.00	0	0.00±0.00	0	32	279
AJM	4.43±0.62	14	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	285
ALP	3.86±1.02	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	42
ALQ	-1.46±0.11	63	-0.22±0.04	49	-0.29±0.17	3	-0.29±0.20	3	65	29
AMM	-0.66±0.51	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	72	19
ANM	-0.75±0.34	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	89	349
ANMO	-1.68±0.52	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	64	29
ANR	2.67±1.32	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	148	313
ANTO	1.38±0.88	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	161	20
AN1	-1.63±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	80	39
AN10	-1.69±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	80	39
AN11	-1.88±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	80	39
AN12	-1.59±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	81	39
AN4	-1.73±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	80	40
AN7	-1.56±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	81	39
AN8	-1.73±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	80	39
AN9	-1.54±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	80	39
APT	0.00±0.00	0	-0.09±0.32	1	0.00±0.00	0	0.00±0.00	0	88	44
AQU	4.72±0.15	19	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	42
ARE	-1.02±0.22	27	-0.29±0.19	3	0.00±0.00	0	0.00±0.00	0	63	98
ARN	-0.55±0.12	34	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	16
ARU	-3.61±1.28	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	344
ARV	3.54±0.15	20	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	148	41
ASP	-2.30±0.35	7	-0.52±0.21	3	0.00±0.00	0	0.00±0.00	0	79	249
ASPA	-2.64±0.15	26	-0.50±0.10	11	-0.16±0.19	3	0.00±0.00	0	79	249
ASS	2.91±0.16	19	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	148	42
ATB	-0.56±0.32	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	86	92
ATX	-1.76±0.53	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	65	39
AVE	0.43±1.02	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	136	64
AVF	-6.95±1.24	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	141	42
AZI	4.84±0.88	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	43
BAF	-5.72±1.01	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	142	38
BAL	-1.48±0.45	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	91	237
BAO	-0.96±0.17	20	-0.25±0.31	1	0.00±0.00	0	0.00±0.00	0	85	105
BAR	-1.00±0.38	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	58	22
BCAO	7.26±0.87	12	0.31±0.20	5	0.00±0.00	0	0.00±0.00	0	152	125
BCH	-0.43±0.16	13	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	59	18
BCT	-1.71±0.40	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	87	43
BDF	-0.88±0.49	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	85	105
BDI	0.40±0.19	14	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	42
BDT	0.79±0.59	10	0.22±0.16	6	0.00±0.00	0	0.00±0.00	0	126	276
BDW	-1.85±0.14	30	-0.35±0.08	18	0.00±0.00	0	0.00±0.00	0	70	23
BEO	0.51±0.23	21	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	152	32
BFD	-2.14±0.18	14	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	68	237
BFW	-1.63±0.31	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	69	12
BHG	0.36±0.11	39	0.28±0.08	16	0.17±0.31	1	0.00±0.00	0	146	34
BHO	-2.45±0.14	16	-0.16±0.12	7	0.00±0.00	0	0.00±0.00	0	70	38
BKS	-0.77±0.12	35	0.05±0.06	29	0.03±0.23	2	0.00±0.00	0	62	15
BLA	-1.28±0.15	22	0.03±0.10	14	0.00±0.00	0	0.00±0.00	0	81	44
BLC	0.00±0.00	0	-0.49±0.33	1	0.00±0.00	0	0.00±0.00	0	92	17
BLP	-0.38±0.41	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	59	18
BMA	-0.18±0.39	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	86	113
BMN	-0.99±0.12	43	-0.13±0.06	24	0.00±0.00	0	0.00±0.00	0	65	18
BMO	-1.58±0.41	5	0.00±0.00	0	0.00±0.00	0	-0.17±0.13	5	69	16
BMR	1.13±0.89	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	151	25
BMW	-1.55±0.18	11	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	70	11
BNG	1.00±0.15	55	0.34±0.07	25	1.18±0.30	2	0.00±0.00	0	152	125
BNH	-1.77±0.20	11	-0.13±0.22	2	0.00±0.00	0	0.00±0.00	0	90	41
BNI	-1.54±0.17	19	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	43
BOB	0.24±0.15	13	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	146	42
BOG	-0.52±0.46	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	69	76
BPT	0.00±0.00	0	0.04±0.31	1	0.00±0.00	0	0.00±0.00	0	87	44
BRA	4.34±1.02	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	30
BRG	-2.09±0.10	62	0.06±0.05	50	-0.08±0.17	3	0.00±0.00	0	144	30
BRK	-1.12±0.21	12	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	62	15
BRS	-2.25±0.24	22	-0.24±0.32	1	0.00±0.00	0	0.00±0.00	0	62	250
BRT	7.31±0.67	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	152	41
BRW	-0.93±0.45	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	94	354
BSF	-5.30±1.02	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	142	38
BSS	6.14±1.02	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	151	44
BUB	0.00±0.00	0	0.05±0.23	2	0.00±0.00	0	0.00±0.00	0	143	37
BUD	4.10±0.19	27	0.26±0.19	4	0.00±0.00	0	0.00±0.00	0	149	30
BUH	-4.48±0.78	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	143	36
BUL	0.36±0.23	12	-0.33±0.12	9	0.39±0.30	1	0.00±0.00	0	136	163

TABLE 2. cont.

Station	Time term(s)	N_T^*	Mururoa amp. term	N_1^*	Fangataufa amp. term	N_2^*	Atmospherics amp. term	N_3^*	$\Delta°$	$\varphi°$
BUT	-0.40±0.44	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	72	19
BWA	-4.86±0.39	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	64	241
BWO6	-1.92±0.18	17	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	70	22
BY2	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	-0.19±0.32	2	59	176
BZS	-0.10±0.61	16	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	151	29
CAN	-2.25±0.23	15	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	63	241
CAR	0.00±0.00	0	-0.40±0.36	1	0.00±0.00	0	0.00±0.00	0	78	73
CAW	-0.07±0.53	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	43	233
CBM	-2.50±0.44	4	0.20±0.25	2	0.00±0.00	0	0.00±0.00	0	93	40
CCH	0.26±0.26	14	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	68	100
CDF	-5.34±0.88	4	-0.01±0.36	1	0.00±0.00	0	0.00±0.00	0	142	38
CDR	-2.99±0.90	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	45
CD2	-0.31±1.05	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	124	293
CEN	-0.52±0.56	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	62	115
CEY	3.08±0.12	15	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	148	37
CFR	0.43±0.21	15	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	155	22
CHG	0.81±0.15	29	0.22±0.10	11	0.00±0.00	0	0.00±0.00	0	126	278
CHTO	0.75±0.15	21	0.16±0.09	11	0.38±0.31	1	0.00±0.00	0	126	278
CIO	3.48±0.79	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	148	41
CIR	0.00±0.00	0	-0.46±0.29	2	0.00±0.00	0	0.00±0.00	0	136	167
CJR	0.95±0.92	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	151	26
CKI	-0.91±0.17	17	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	43
CLC	-1.48±0.17	18	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	20
CLE	-2.33±0.57	4	-0.61±0.26	4	0.00±0.00	0	0.00±0.00	0	82	40
CLK	-3.39±1.76	3	-0.33±0.23	2	0.00±0.00	0	0.00±0.00	0	142	170
CLL	-2.64±0.11	53	-0.17±0.06	35	-0.01±0.19	3	0.00±0.00	0	144	30
CLO	6.55±1.02	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	152	29
CLX	-1.26±0.52	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	73	16
CMB	-1.09±0.12	18	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	62	16
CMP	1.81±0.88	14	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	153	26
CMS	-2.19±0.20	18	-0.10±0.34	1	0.00±0.00	0	0.00±0.00	0	67	244
CMT	-0.66±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	72	19
CNCB	0.76±0.19	23	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	66	99
CNS	2.86±0.79	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	57
COB	-1.45±0.22	13	-0.05±0.35	1	0.00±0.00	0	0.00±0.00	0	45	233
COL	-2.20±0.12	44	0.05±0.06	25	0.00±0.00	0	0.08±0.32	1	87	356
COM	-0.77±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	59	54
COZ	0.96±0.81	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	153	26
CRE	2.26±0.17	17	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	148	42
CRO	0.00±0.00	0	0.10±0.30	2	0.00±0.00	0	0.00±0.00	0	70	38
CTA	-1.81±0.14	60	0.23±0.06	29	0.36±0.18	3	0.00±0.00	0	69	256
CTAO	-1.63±0.17	13	0.15±0.18	3	0.00±0.00	0	0.00±0.00	0	69	256
CTI	0.92±0.13	32	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	146	38
CVF	1.09±1.01	3	-0.36±0.33	1	0.00±0.00	0	0.00±0.00	0	146	45
CWF	-0.27±1.03	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	135	36
CYP	0.42±0.23	27	1.37±0.30	1	0.00±0.00	0	0.00±0.00	0	147	21
DAG	-2.32±1.03	3	-0.45±0.21	3	0.00±0.00	0	0.00±0.00	0	118	13
DAU	-0.27±0.16	11	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	67	22
DCN	0.00±0.00	0	0.38±0.23	2	0.00±0.00	0	0.00±0.00	0	132	37
DDI	0.01±0.19	23	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	146	292
DDK	0.00±0.00	0	-0.02±0.36	1	0.00±0.00	0	0.00±0.00	0	132	37
DEV	1.09±0.75	15	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	152	27
DHN	-1.55±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	85	40
DIX	-2.08±0.16	23	0.24±0.11	20	0.00±0.00	0	0.00±0.00	0	144	40
DLE	0.00±0.00	0	0.16±0.35	1	0.00±0.00	0	0.00±0.00	0	132	37
DMN	-7.60±0.21	20	0.11±0.11	11	0.26±0.35	1	0.00±0.00	0	140	287
DMU	0.00±0.00	0	0.30±0.23	2	0.00±0.00	0	0.00±0.00	0	132	36
DOI	-1.31±0.23	13	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	43
DOU	0.64±0.13	37	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	140	37
DRV	-1.92±0.65	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	67	205
DSH	5.78±0.79	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	151	311
DUG	-0.74±0.15	20	-0.22±0.22	2	0.00±0.00	0	-0.30±0.22	2	66	22
DUI	5.88±0.13	24	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	150	43
DZM	-1.24±0.19	20	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	51	259
ECB	0.00±0.00	0	0.26±0.34	1	0.00±0.00	0	0.00±0.00	0	132	38
ECH	-5.00±0.74	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	142	38
ECP	0.00±0.00	0	0.18±0.24	2	0.00±0.00	0	0.00±0.00	0	133	38
ECT	-1.68±0.32	8	0.33±0.30	1	0.00±0.00	0	0.00±0.00	0	88	43
EDM	-1.69±0.09	56	0.51±0.06	33	0.00±0.00	0	0.00±0.00	0	78	15
EIL	1.16±0.73	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	171	35
ELC	-2.02±0.37	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	75	39
ELL	1.95±0.63	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	162	32
EMM	-1.85±0.19	10	0.39±0.14	5	0.00±0.00	0	0.00±0.00	0	93	43
EMS	-2.77±0.19	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	143	41
ENN	-2.20±1.30	29	0.22±0.10	18	-0.01±0.35	1	0.00±0.00	0	140	35
ENR	-2.28±0.80	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	44
EPF	-6.63±1.02	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	140	48
ERC	5.96±0.79	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	151	50
ETA	0.00±0.00	0	0.04±0.33	1	0.00±0.00	0	0.00±0.00	0	133	37
EUR	-1.00±0.11	44	0.26±0.10	27	-0.56±0.32	1	-0.33±0.16	4	65	19

TABLE 2. cont.

Station	Time term(s)	N_T^*	Mururoa amp. term	N_1^*	Fangataufa amp. term	N_2^*	Atmospherics amp. term	N_3^*	$\Delta°$	$\varphi°$
FBA	-2.26±0.11	37	-0.05±0.06	27	0.01±0.31	1	0.00±0.00	0	87	356
FBAS	-2.45±0.54	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	87	357
FCC	-3.20±0.45	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	88	22
FCH	-0.69±0.38	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	117
FEL	-4.18±0.60	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	143	38
FFC	-2.50±0.15	19	-0.73±0.09	15	-0.36±0.25	2	0.00±0.00	0	83	20
FHC	-0.89±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	64	12
FIN	-1.04±0.59	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	43
FIR	1.98±0.21	12	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	42
FRF	0.00±0.00	0	-0.08±0.33	1	0.00±0.00	0	0.00±0.00	0	144	45
FRI	-1.31±0.11	45	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	62	17
FRU	0.01±0.77	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	146	314
FUR	-1.12±0.11	27	-0.14±0.10	15	0.00±0.00	0	0.25±0.31	1	145	35
FVI	0.39±0.17	22	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	37
FVM	-2.10±0.11	42	0.06±0.09	16	-0.28±0.33	1	0.00±0.00	0	75	38
GAM	0.18±1.02	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	150	311
GAP	-0.46±0.12	17	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	36
GAR	-0.59±1.03	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	150	311
GAS	-0.64±0.52	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	63	14
GBA	-0.96±0.13	45	-0.82±0.07	35	-0.22±0.17	3	0.00±0.00	0	145	262
GBO	-2.60±0.32	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	71	36
GCA	-1.01±0.40	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	64	24
GCC	-0.99±0.13	25	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	15
GFM	-1.43±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	79	44
GIB	4.31±1.81	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	152	49
GIL	-2.02±0.38	6	0.04±0.15	4	0.00±0.00	0	0.00±0.00	0	87	356
GKN	-7.78±0.73	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	140	288
GLA	-0.90±0.12	42	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	60	23
GLD	-1.05±0.19	16	0.00±0.11	10	-0.16±0.24	2	0.00±0.00	0	69	27
GMA	-1.01±0.52	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	89	351
GMW	-1.81±0.40	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	71	12
GOL	-1.33±0.11	48	-0.22±0.07	30	-0.22±0.18	3	-0.21±0.22	2	69	27
GRC	-7.79±1.03	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	140	41
GRF	-2.34±0.09	56	0.31±0.09	12	0.00±0.00	0	0.00±0.00	0	144	33
GRFO	-2.47±1.04	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	33
GRS	0.09±1.76	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	162	347
GSC	-1.14±0.16	23	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	20
GTA	0.03±0.18	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	127	304
GUN	-7.29±0.63	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	139	288
GWF	-5.03±0.74	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	142	37
GYA	0.48±1.02	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	121	288
GZR	-0.18±1.27	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	152	28
HAU	-5.96±0.88	4	0.19±0.36	1	0.00±0.00	0	0.00±0.00	0	142	38
HBVT	-2.38±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	89	41
HDM	-1.70±0.51	3	0.17±0.18	3	0.00±0.00	0	0.00±0.00	0	88	44
HEE	-5.32±0.94	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	140	35
HFS	-8.76±0.79	15	-0.52±0.12	15	0.00±0.00	0	0.00±0.00	0	137	20
HKT	-1.71±0.51	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	66	40
HNH	-1.76±0.40	6	-0.01±0.23	2	0.00±0.00	0	0.00±0.00	0	89	42
HNME	-2.25±0.45	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	93	41
HOF	-3.08±0.13	26	-0.09±0.11	10	-0.33±0.38	1	0.00±0.00	0	143	32
HPI	-0.39±0.37	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	70	20
HUA	0.10±0.52	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	92
HVAR	5.10±0.89	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	151	39
HYB	-0.61±0.13	46	-0.32±0.07	29	-0.08±0.19	3	0.00±0.00	0	145	269
IAS	8.89±1.24	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	152	20
IFR	0.74±1.25	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	138	64
IKZ	3.78±1.03	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	165
ILT	-0.44±0.40	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	95	346
IMA	-1.81±0.13	26	-0.01±0.31	1	-0.75±0.34	1	0.00±0.00	0	89	354
IMI	-1.35±0.67	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	44
IMW	-1.09±0.37	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	70	21
INH	-0.92±0.54	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	48	263
INK	-2.60±0.14	35	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	90	2
IPM	0.57±1.03	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	120	263
ISA	-0.78±0.16	22	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	19
ISR	0.49±0.81	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	154	24
ITA	0.60±0.55	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	86	112
ITR	-1.73±0.34	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	96	102
JACH	-1.33±0.48	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	116
JAS	-1.01±0.11	31	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	62	16
JAS1	-1.05±0.31	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	62	17
JCT	-2.00±0.15	28	0.05±0.07	24	0.00±0.00	0	0.00±0.00	0	64	37
JER	2.16±1.08	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	169	27
JOS	3.74±0.24	25	0.09±0.11	11	0.00±0.00	0	-0.13±0.34	1	149	27
JSC	-1.56±0.34	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	78	46
KAAO	5.54±1.77	11	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	152	303
KAD	3.04±0.18	23	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	267
KBA	-0.05±0.14	30	-0.12±0.06	25	-0.12±0.18	3	0.00±0.00	0	147	35
KBL	0.84±0.61	15	0.00±0.00	0	0.00±0.00	0	1.15±0.20	2	152	303

TABLE 2. cont.

Station	Time term(s)	N_T^*	Mururoa amp. term	N_1^*	Fangataufa amp. term	N_2^*	Atmospherics amp. term	N_3^*	$\Delta°$	$\varphi°$
KBS	-0.35±1.01	3	0.27±0.33	1	0.00±0.00	0	0.00±0.00	0	121	6
KDC	-1.72±0.12	37	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	80	353
KDS	-0.07±1.03	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	128	91
KDZ	0.49±0.68	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	156	30
KEV	-1.13±0.21	22	-0.01±0.14	7	0.00±0.00	0	0.00±0.00	0	132	7
KHC	-0.56±0.09	76	-0.09±0.04	59	-0.16±0.17	3	-0.14±0.25	2	145	32
KHO	0.24±1.76	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	150	307
KIC	0.81±0.18	21	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	133	102
KIR	-1.08±0.17	12	0.23±0.27	3	0.00±0.00	0	0.00±0.00	0	132	10
KJF	-4.07±0.62	44	0.22±0.10	16	0.38±0.33	1	0.00±0.00	0	137	9
KKN	-7.72±0.24	21	0.32±0.16	6	0.00±0.00	0	0.00±0.00	0	140	288
KKR	11.88±1.29	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	291
KMR	1.50±0.16	16	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	146	33
KMZ	-4.44±1.22	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	141	155
KNA	-0.80±0.63	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	86	255
KOD	-1.83±0.23	18	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	143	257
KOU	-2.11±0.20	12	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	53	260
KPK	-0.80±0.52	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	63	15
KRA	0.53±0.13	67	0.43±0.06	29	0.30±0.31	1	0.38±0.21	3	148	26
KRO	10.20±1.03	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	315
KRI	-0.26±1.25	5	-0.55±0.21	4	0.00±0.00	0	0.00±0.00	0	140	163
KRP	-0.80±0.19	24	-0.26±0.18	4	0.00±0.00	0	0.00±0.00	0	42	237
KSH	1.46±0.60	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	309
KSP	-0.61±0.10	42	0.00±0.09	14	0.00±0.00	0	0.00±0.00	0	145	28
KTG	-1.41±1.01	4	-0.26±0.35	1	0.00±0.00	0	0.00±0.00	0	119	20
KUL	1.02±1.04	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	151	309
KVN	-0.99±0.12	17	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	64	18
KVT	1.91±1.76	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	160	11
LAO	-1.45±0.52	3	0.00±0.00	0	0.00±0.00	0	0.08±0.28	1	74	23
LAT	-1.57±0.52	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	73	270
LBFM	-1.16±0.37	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	65	14
LDM	-1.08±0.30	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	73	16
LD3	-1.40±0.30	9	-0.14±0.14	5	0.00±0.00	0	0.00±0.00	0	74	23
LFF	-7.24±1.74	4	0.12±0.36	1	0.00±0.00	0	0.00±0.00	0	140	45
LF3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	-0.23±0.21	2	73	23
LHC	-1.97±0.30	9	-0.29±0.37	1	0.00±0.00	0	0.00±0.00	0	83	31
LHD	-1.15±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	73	16
LHS	-1.37±0.45	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	79	46
LIC	0.74±1.08	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	133	102
LJU	2.74±0.13	54	0.56±0.25	2	0.00±0.00	0	0.78±0.23	2	148	36
LLA	-0.72±0.13	22	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	16
LLS	-1.23±0.14	18	0.47±0.10	15	0.00±0.00	0	0.00±0.00	0	144	38
LMG	-1.80±0.63	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	71	268
LMR	-1.63±0.90	4	-0.55±0.33	1	0.00±0.00	0	0.00±0.00	0	144	45
LNO	-3.10±0.45	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	70	36
LNV	-1.80±0.37	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	60	117
LON	-1.98±0.12	23	-0.13±0.15	4	0.00±0.00	0	0.00±0.00	0	70	12
LOR	-7.26±1.05	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	141	41
LPB	0.47±0.18	48	-0.17±0.07	23	0.20±0.22	2	0.00±0.00	0	66	99
LPS	-1.53±0.31	9	0.01±0.16	4	0.00±0.00	0	0.00±0.38	1	61	58
LRG	-1.24±1.10	3	-0.15±0.33	1	0.00±0.00	0	0.00±0.00	0	144	45
LRM	-0.55±0.10	37	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	72	19
LSD	-1.91±0.21	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	42
LSF	-7.63±1.76	3	0.06±0.36	1	0.00±0.00	0	0.00±0.00	0	140	43
LSZ	-6.88±1.03	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	141	160
LTX	-0.73±0.20	10	-0.17±0.13	6	0.00±0.00	0	0.00±0.00	0	61	35
LUB	-2.20±0.40	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	65	34
LUG	-1.10±0.65	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	51	267
LWI	3.24±1.26	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	153	152
LZH	-0.27±0.93	6	0.00±0.00	0	0.28±0.36	1	0.00±0.00	0	124	299
MAIO	1.40±0.60	17	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	159	316
MAT	-0.55±0.52	3	-0.32±0.25	2	0.00±0.00	0	0.00±0.00	0	97	306
MAW	-1.63±0.16	30	-0.01±0.31	4	0.00±0.00	0	0.00±0.00	0	89	188
MBC	-1.62±0.14	23	0.03±0.08	16	0.09±0.33	1	0.00±0.00	0	99	5
MBL	0.00±0.00	0	-0.89±0.34	1	0.00±0.00	0	0.00±0.00	0	92	246
MDG	-2.37±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	74	271
MDI	-1.14±0.14	17	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	39
MDZ	-0.59±0.37	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	62	117
MEM	0.04±0.20	16	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	141	35
MEO	-2.81±0.18	16	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	68	35
MFW	-1.21±0.45	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	70	15
MGR	6.07±0.67	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	152	45
MHC	-0.49±0.10	48	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	15
MHI	1.63±0.68	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	158	316
MHK	-1.52±0.63	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	73	33
MIM	-2.11±0.51	3	-0.28±0.32	1	0.00±0.00	0	0.00±0.00	0	92	42
MIN	-1.96±0.23	15	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	64	14
MIR	-1.88±0.39	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	84	198
MJZ	-0.33±0.38	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	47	230
MLR	0.62±0.13	45	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	154	25

TABLE 2. cont.

Station	Time term(s)	N_T°	Mururoa amp. term	N_1°	Fangataufa amp. term	N_2°	Atmospherics amp. term	N_3°	Δ°	φ°
MME	1.66±0.64	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	42
MMK	-1.16±0.16	14	0.48±0.09	12	0.00±0.00	0	0.00±0.00	0	144	40
MNA	-0.64±0.12	22	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	63	18
MNG	-0.31±0.21	12	-0.26±0.25	2	0.00±0.00	0	0.00±0.00	0	43	233
MNK	0.39±0.74	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	15
MNS	3.60±0.11	38	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	43
MNV	-0.92±0.17	12	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	63	18
MOA	0.62±0.13	43	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	146	33
MOS	0.78±0.87	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	146	4
MOT	-0.94±0.19	11	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	62	34
MOX	-3.44±0.10	44	0.05±0.07	24	0.00±0.21	3	0.00±0.00	0	143	32
MRG	-0.64±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	82	42
MSC	5.12±0.88	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	150	44
MSO	-0.96±0.15	23	0.14±0.08	16	0.00±0.00	0	0.00±0.00	0	72	18
MSU	-0.20±0.17	14	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	65	23
MSZ	-2.18±0.21	23	-0.32±0.34	1	0.00±0.00	0	0.00±0.00	0	49	229
MTD	-7.20±0.73	9	-0.30±0.13	7	0.00±0.00	0	0.00±0.00	0	140	166
MTN	-1.61±0.18	15	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	85	258
MWC	-0.68±0.15	24	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	59	20
MZF	-7.44±1.02	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	140	43
MZZ	0.48±0.84	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	159
NAI	5.25±1.76	5	-0.37±0.20	4	0.00±0.00	0	0.00±0.00	0	157	169
NAO	-0.64±0.67	8	-0.27±0.32	1	0.00±0.00	0	0.00±0.00	0	136	21
NB2	-0.86±0.17	30	-0.29±0.07	25	0.09±0.21	2	0.00±0.00	0	136	21
NDF	-1.36±0.57	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	41	268
NDI	1.32±0.11	63	0.15±0.06	38	-0.82±0.32	1	0.33±0.34	1	147	289
NEW	-1.56±0.11	49	-0.17±0.09	13	0.00±0.00	0	0.18±0.24	2	72	15
NIE	1.39±0.15	46	0.37±0.12	7	0.00±0.00	0	0.07±0.22	3	148	26
NIL	-0.84±1.76	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	300
NNA	-2.68±0.46	4	-0.66±0.26	2	0.00±0.00	0	0.00±0.00	0	60	91
NOP	-1.33±0.37	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	62	21
NOU	-1.36±0.23	12	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	50	259
NPA	-1.97±0.89	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	143	177
NRI	-1.94±0.74	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	125	342
NTI	-1.70±0.53	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	73	15
NUR	-4.44±0.20	51	0.36±0.09	20	0.34±0.33	1	0.00±0.00	0	140	13
NVL	-1.83±0.53	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	85	171
NWAO	-1.71±0.52	3	-0.32±0.32	1	0.00±0.00	0	0.00±0.00	0	89	235
OBN	0.46±0.73	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	5
OCO	-1.71±0.31	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	69	35
OGA	0.25±0.10	44	-0.07±0.07	23	0.00±0.00	0	0.00±0.00	0	145	37
OHR	0.82±0.18	26	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	154	38
OLY	-1.98±0.16	14	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	73	39
ORI	6.98±0.79	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	152	43
ORO	-1.89±0.16	25	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	41
ORT	-1.99±0.44	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	77	43
ORV	-1.40±0.12	32	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	64	15
ORX	-2.60±0.69	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	41
OSS	-0.25±0.13	15	0.30±0.09	11	0.00±0.00	0	0.00±0.00	0	145	38
OTT	-2.09±0.32	8	-0.28±0.33	1	0.00±0.00	0	0.00±0.00	0	88	39
OVO	6.14±1.02	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	151	44
OXM	0.05±2.06	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	56	46
PAS	-0.93±0.16	22	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	59	20
PBJ	-0.32±0.52	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	57	52
PCA	-1.22±0.40	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	82	359
PCC	-1.08±0.14	20	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	15
PCH	-1.48±0.48	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	117
PCN	1.99±0.93	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	41
PCP	-1.48±0.68	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	43
PDCR	-2.14±0.36	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	94	105
PEC	-1.12±0.34	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	59	21
PEL	-1.37±0.20	20	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	60	116
PGC	-1.57±0.22	12	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	72	11
PGD	2.59±0.18	13	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	41
PGE	-1.06±0.52	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	20
PHAM	-0.70±0.41	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	60	17
PHC	-1.61±0.40	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	73	8
PKI	-7.13±0.21	21	0.32±0.08	17	0.39±0.32	1	0.00±0.00	0	140	287
PLM	-1.14±0.17	26	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	59	21
PME	-1.67±0.19	10	0.14±0.12	7	0.00±0.00	0	0.00±0.00	0	84	355
PMG	-1.92±0.22	15	-0.20±0.14	6	0.00±0.00	0	0.00±0.00	0	72	267
PMR	-1.80±0.11	46	0.17±0.05	36	0.40±0.18	3	0.33±0.31	1	84	355
PNI	-2.64±0.88	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	42
PNL	-1.34±0.34	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	81	360
PNS	1.11±0.56	4	0.00±0.00	0	0.00±0.00	0	0.25±0.22	4	66	99
PNT	-1.65±0.12	40	-0.06±0.07	23	-0.20±0.31	1	0.00±0.00	0	73	13
POO	4.59±0.13	32	0.08±0.14	6	0.00±0.00	0	0.00±0.00	0	149	269
POW	-2.03±0.31	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	73	39
PPD	-1.08±0.65	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	80	110
PPE	0.82±1.02	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	153	21

TABLE 2. cont.

Station	Time term(s)	N_T^*	Mururoa amp. term	N_1^*	Fangataufa amp. term	N_2^*	Atmospherics amp. term	N_3^*	$\Delta°$	$\varphi°$
PPI	-0.17±0.72	6	0.43±0.25	2	0.00±0.00	0	0.00±0.00	0	118	257
PRA	-1.11±0.10	46	0.07±0.06	30	0.20±0.18	3	0.00±0.00	0	145	31
PRI	-0.32±0.11	51	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	17
PRIN	-1.37±0.63	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	86	44
PRM	-1.69±0.32	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	77	45
PRS	-0.79±0.12	27	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	16
PRT	1.65±0.89	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	41
PRU	-0.87±0.09	75	0.12±0.04	55	0.05±0.17	3	0.13±0.23	2	145	31
PSH	4.68±1.02	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	151	301
PSI	0.28±0.21	14	0.12±0.18	4	0.00±0.00	0	0.00±0.00	0	121	259
PSO	0.05±0.64	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	64	77
PSZ	4.03±0.63	11	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	29
PTH	-1.34±0.60	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	290
PTJ	0.35±0.19	14	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	35
PTZ	-2.59±1.02	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	142	164
PVL	0.73±0.62	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	155	28
PZZ	-1.47±0.18	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	43
QIS	-2.72±0.38	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	75	254
QUE	1.54±0.18	19	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	156	294
QZO	-3.19±0.38	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	68	34
RAB	-2.52±0.52	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	69	274
RAC	1.72±0.24	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	27
RAR	1.23±0.56	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	19	268
RBL	0.86±0.20	20	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	36
RDP	4.86±0.15	18	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	44
RES	-2.34±0.40	5	0.35±0.14	5	0.00±0.00	0	0.00±0.00	0	100	11
RFA	-1.33±0.55	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	62	119
RHP	-0.88±0.54	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	47	230
RIY	3.10±1.76	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	148	37
RJF	-7.50±1.24	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	140	45
RLO	-2.37±0.14	27	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	71	36
RMP	4.77±0.17	13	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	44
RMQ	-1.57±0.19	16	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	65	250
RMT	-0.38±0.52	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	63	14
RMW	-1.96±0.40	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	71	12
ROB	-1.46±0.15	22	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	43
ROCH	-0.86±0.68	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	60	116
RRL	-1.74±0.23	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	43
RPO	-3.52±0.63	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	69	35
RSCP	-2.37±0.34	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	76	42
RSNT	-1.41±0.16	14	0.32±0.22	2	0.00±0.00	0	0.00±0.00	0	86	11
RSNY	-2.07±0.17	23	0.17±0.18	3	0.00±0.00	0	0.00±0.00	0	89	40
RSON	-2.56±0.15	26	-0.04±0.09	15	-0.07±0.22	2	0.00±0.00	0	83	27
RSP	-2.10±0.63	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	42
RSSD	-1.87±0.19	17	-0.03±0.17	3	0.00±0.00	0	0.00±0.00	0	73	25
RUP	-5.64±0.79	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	142	36
RVR	-1.38±0.17	24	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	59	21
RXF	-1.21±0.32	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	74	16
SAL	0.60±0.11	43	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	146	40
SAM	6.00±0.89	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	152	314
SAN	-1.66±0.41	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	60	117
SAO	-1.13±0.12	40	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	16
SAV	-1.86±0.52	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	64	233
SAX	-1.26±0.14	14	0.08±0.09	13	0.00±0.00	0	0.00±0.00	0	144	38
SBA	-0.46±0.38	12	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	62	191
SBB	-1.35±0.15	31	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	60	20
SDI	4.69±0.13	21	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	150	43
SDN	-2.28±0.41	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	79	348
SDV	-2.03±0.19	11	0.22±0.12	8	0.00±0.00	0	0.00±0.00	0	74	73
SDW	-1.24±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	60	21
SEK	0.00±0.00	0	0.00±0.00	0	0.01±0.36	1	0.00±0.00	0	128	165
SES	-1.39±0.12	41	0.22±0.11	10	0.00±0.00	0	0.00±0.00	0	76	18
SET	2.35±0.91	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	146	57
SFI	2.99±0.73	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	41
SGG	5.51±0.67	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	150	43
SGO	5.94±0.14	19	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	151	44
SHI	0.70±1.02	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	167	309
SHL	0.25±0.61	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	134	285
SHW	-0.98±0.51	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	69	12
SIO	-2.16±0.15	22	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	70	36
SIT	-1.05±0.13	17	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	79	2
SJG	-3.10±0.51	4	-0.64±0.21	3	0.00±0.00	0	0.00±0.00	0	82	67
SKO	0.13±0.18	25	0.00±0.00	0	-0.40±0.39	1	0.00±0.00	0	154	36
SLA	-0.80±0.54	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	67	108
SLE	-3.30±0.25	14	0.27±0.11	10	0.00±0.00	0	0.00±0.00	0	143	37
SLL	-1.06±0.74	7	0.15±0.18	5	-0.49±0.34	1	0.00±0.00	0	137	20
SLR	0.00±0.00	0	0.00±0.00	0	0.42±0.33	1	0.00±0.00	0	131	165
SNA	-0.78±0.29	12	-0.09±0.21	3	0.00±0.00	0	0.00±0.00	0	83	166
SNF	0.45±0.14	17	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	140	36
SOB	-2.23±0.63	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	94	101

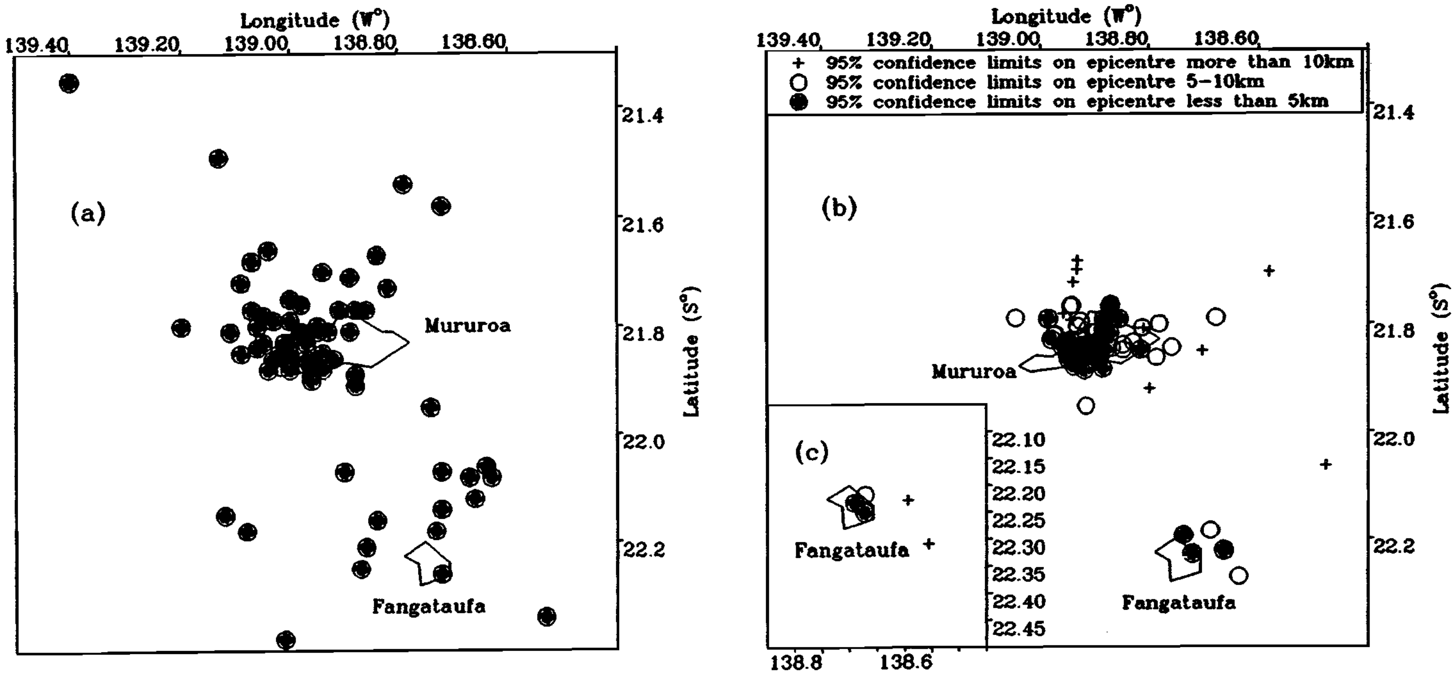
TABLE 2. cont.

Station	Time term(s)	N_T^*	Mururoa amp. term	N_1^*	Fangataufa amp. term	N_2^*	Atmospherics amp. term	N_3^*	Δ°	φ°
SOB1	-1.35±0.19	14	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	94	101
SOD	-1.52±0.16	36	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	134	8
SOI	6.76±0.88	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	153	47
SOP	0.09±0.19	29	0.35±0.16	8	0.00±0.00	0	0.00±0.00	0	148	32
SPA	-0.95±0.19	27	-0.76±0.08	19	-0.20±0.18	3	0.00±0.00	0	68	180
SPC	1.90±0.24	41	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	148	27
SRO	1.80±0.62	29	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	30
SSF	-6.89±1.16	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	141	41
SSR	0.56±0.19	13	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	152	30
STK	-2.12±0.17	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	70	243
STU	0.00±0.00	0	0.23±0.34	1	0.00±0.00	0	0.00±0.00	0	143	36
STV	-1.60±0.21	19	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	144	44
SUF	-9.70±0.16	32	-0.22±0.11	13	0.00±0.00	0	0.00±0.00	0	138	10
SVE	-3.98±1.76	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	143	343
SVW	-2.35±0.15	13	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	84	352
SYP	-0.53±0.19	14	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	59	18
TACH	-1.42±0.40	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	60	117
TAM	2.43±1.19	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	82
TAS	2.79±1.28	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	150	315
TAU	-1.77±0.19	19	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	64	232
TBR	-1.97±0.34	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	87	43
TCW	-1.10±0.64	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	44	233
TDS	4.95±1.76	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	153	45
TFO	-0.79±0.46	4	0.00±0.00	0	0.00±0.00	0	-0.46±0.21	2	62	26
TIC	0.81±1.08	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	133	102
TIR	-1.12±1.08	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	154	38
TKL	-2.12±0.32	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	77	43
TLB	0.76±1.05	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	155	22
TLL	-1.39±0.22	10	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	113
TMA	-1.17±0.14	18	0.47±0.09	12	0.00±0.00	0	0.00±0.00	0	144	40
TMT	0.00±0.00	0	-0.32±0.32	1	0.00±0.00	0	0.00±0.00	0	88	43
TNP	-1.09±0.13	17	-0.62±0.22	2	-0.94±0.23	2	0.00±0.00	0	63	19
TNS	-5.72±0.88	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	142	34
TOA	-1.19±0.18	12	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	84	356
TOO	-2.10±0.18	22	-0.12±0.19	4	0.00±0.00	0	0.00±0.00	0	66	237
TOV	-2.56±0.31	9	-0.18±0.21	3	0.00±0.00	0	0.00±0.00	0	75	73
TPC	-1.28±0.16	22	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	60	22
TPM	-0.92±0.45	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	56	47
TRI	2.49±0.11	45	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	148	37
TRN	0.00±0.00	0	0.01±0.31	1	0.00±0.00	0	0.00±0.00	0	83	76
TRO	-0.80±0.79	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	130	10
TSI	0.89±1.20	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	121	260
TTA	-1.48±0.13	30	0.12±0.12	7	0.00±0.00	0	0.00±0.00	0	86	352
TUC	-1.27±0.15	23	-0.13±0.19	3	0.00±0.00	0	-0.13±0.35	1	60	27
TUL	-2.23±0.11	46	0.08±0.05	44	-0.41±0.22	2	0.00±0.00	0	70	36
UAV	-1.06±0.45	4	0.14±0.20	3	0.00±0.00	0	0.00±0.00	0	73	73
UBO	-0.95±0.52	3	0.00±0.00	0	0.00±0.00	0	-0.05±0.17	3	68	24
UCC	1.23±0.61	15	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	139	36
UCT	0.00±0.00	0	0.13±0.22	2	0.00±0.00	0	0.00±0.00	0	88	43
UME	-0.65±0.63	12	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	136	13
UPP	-1.30±0.88	7	0.28±0.46	1	0.00±0.00	0	0.00±0.00	0	139	18
UZH	4.78±0.88	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	150	25
VAI	-1.60±0.11	24	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	40
VAN	-0.02±1.02	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	159	321
VAO	-0.63±0.23	12	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	83	112
VAY	0.79±0.12	23	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	155	35
VBY	4.08±0.18	16	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	36
VDL	-0.46±0.17	12	0.35±0.10	11	0.00±0.00	0	0.00±0.00	0	145	39
VG1	0.46±0.19	14	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	145	41
VHO	-1.30±0.35	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	57	50
VIC	0.00±0.00	0	0.01±0.31	1	0.00±0.00	0	0.00±0.00	0	71	11
VKA	1.07±0.16	34	0.15±0.14	6	0.29±0.23	2	0.00±0.00	0	147	31
VOY	0.27±0.18	24	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	147	37
VRI	0.24±0.19	29	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	154	23
VTS	1.02±0.72	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	154	32
VVO	-2.49±0.31	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	70	36
WAB	-0.93±0.41	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	76	270
WAM	-1.79±0.18	15	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	63	239
WARB	0.00±0.00	0	0.00±0.00	0	-1.10±0.34	1	0.00±0.00	0	84	244
WBN	-1.93±0.52	3	-0.67±0.33	1	0.00±0.00	0	0.00±0.00	0	84	244
WB2	-2.23±0.15	31	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	80	253
WB3	-2.51±0.41	5	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	80	253
WB5	-2.71±0.36	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	80	253
WCB	-2.20±0.34	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	80	253
WCN	-0.77±0.31	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	63	17
WDC	-1.50±0.10	53	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	64	14
WES	-1.75±0.34	7	1.37±0.19	3	0.00±0.00	0	0.00±0.00	0	89	43
WET	-1.23±0.10	43	-0.12±0.07	20	0.19±0.30	1	0.00±0.00	0	145	33
WIT	-0.48±1.76	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	139	32
WKTM	-0.84±0.52	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	61	19

TABLE 2. cont.

Station	Time term(s)	N_T^*	Mururoa amp. term	N_1^*	Fangataufa amp. term	N_2^*	Atmospherics amp. term	N_3^*	Δ°	φ°
WLF	-4.06±1.25	9	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	141	37
WLO	0.00±0.00	0	0.23±0.31	1	0.00±0.00	0	0.00±0.00	0	68	36
WLS	-5.20±0.88	4	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	142	37
WMO	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	-0.38±0.21	2	68	35
WMQ	-0.46±0.88	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	136	311
WOL	0.40±1.03	3	0.57±0.23	3	0.00±0.00	0	0.00±0.00	0	136	37
WRA	-2.11±0.14	53	-0.56±0.05	47	-0.30±0.22	2	0.00±0.00	0	80	253
WTS	-7.28±0.49	40	0.23±0.08	18	0.16±0.23	2	0.00±0.00	0	140	33
WTZ	-0.52±0.35	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	41	237
XAN	-0.69±1.05	3	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	120	297
YJA	0.29±0.40	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	67	106
YKA	-1.15±0.10	56	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	87	11
YKC	-1.85±0.10	53	0.30±0.05	40	-0.15±0.32	1	0.00±0.00	0	87	11
YKM	-1.23±0.36	6	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	73	16
YOU	-2.13±0.17	16	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	64	241
ZAG	4.27±0.82	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	149	35
ZAK	-1.14±0.64	8	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	125	317
ZGN	5.07±0.68	7	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	150	55
ZLA	-2.86±0.67	7	0.51±0.14	6	0.00±0.00	0	0.00±0.00	0	143	38
ZOBO	-0.14±0.17	47	0.00±0.08	20	0.20±0.18	3	0.00±0.00	0	66	99
ZST	0.71±0.13	49	0.00±0.00	0	0.00±0.00	0	0.00±0.00	0	148	31
ZUL	-3.47±0.16	18	0.21±0.09	15	0.00±0.00	0	0.00±0.00	0	143	38

* N_T is the number of arrival times used to estimate the time term.
N_1, N_2 and N_3 are the number of amplitude observations used to estimate the amplitude terms.

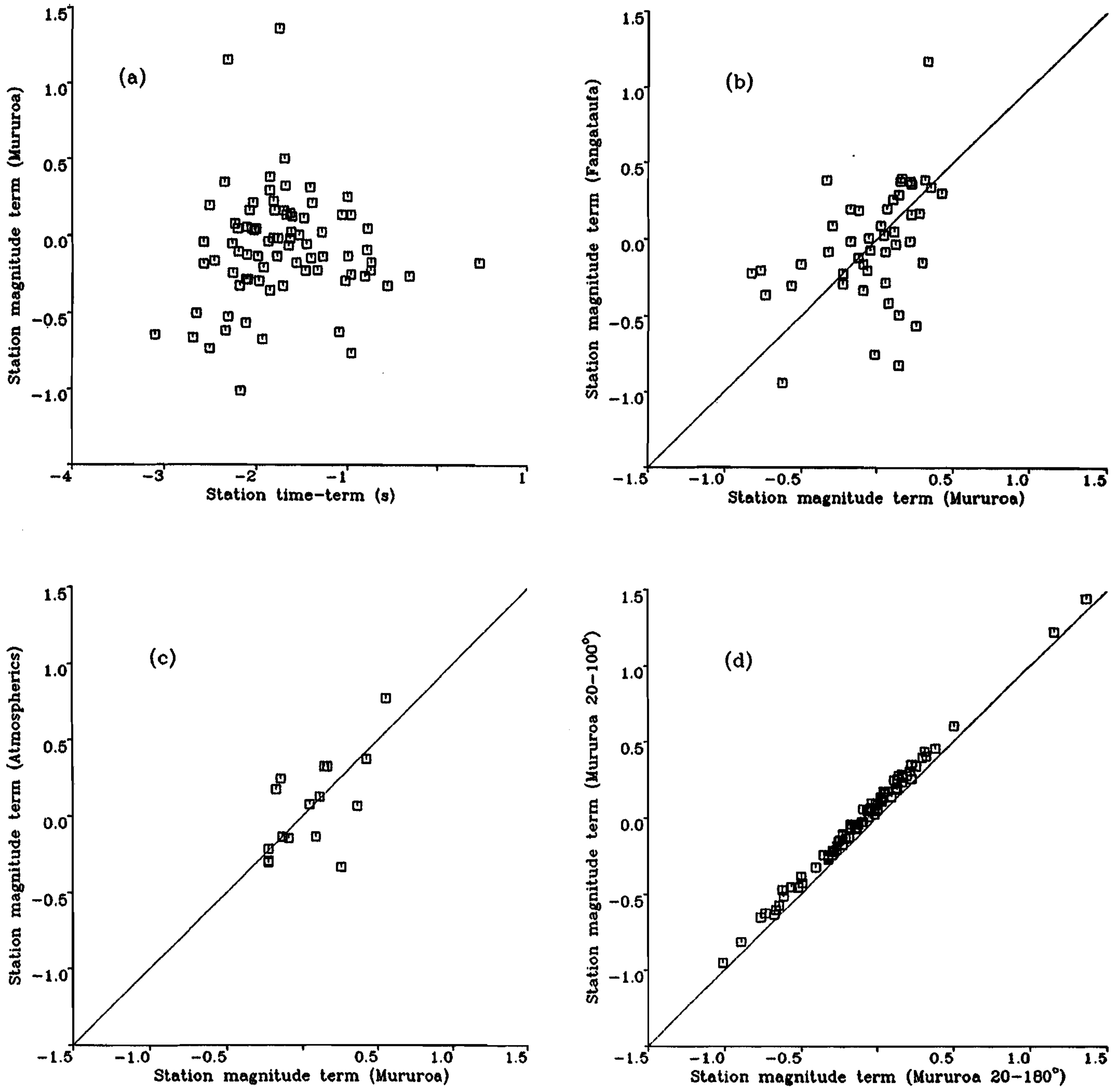


<u>**FIGURE 1. MAPS OF MURUROA AND FANGATAUFA AND ESTIMATED EPICENTRES.**</u>

a) **ISC epicentres.**

b) **JED epicentres computed using data for all 76 explosions.**

c) **JED epicentres computed using only data for the 5 Fangataufa explosions.**



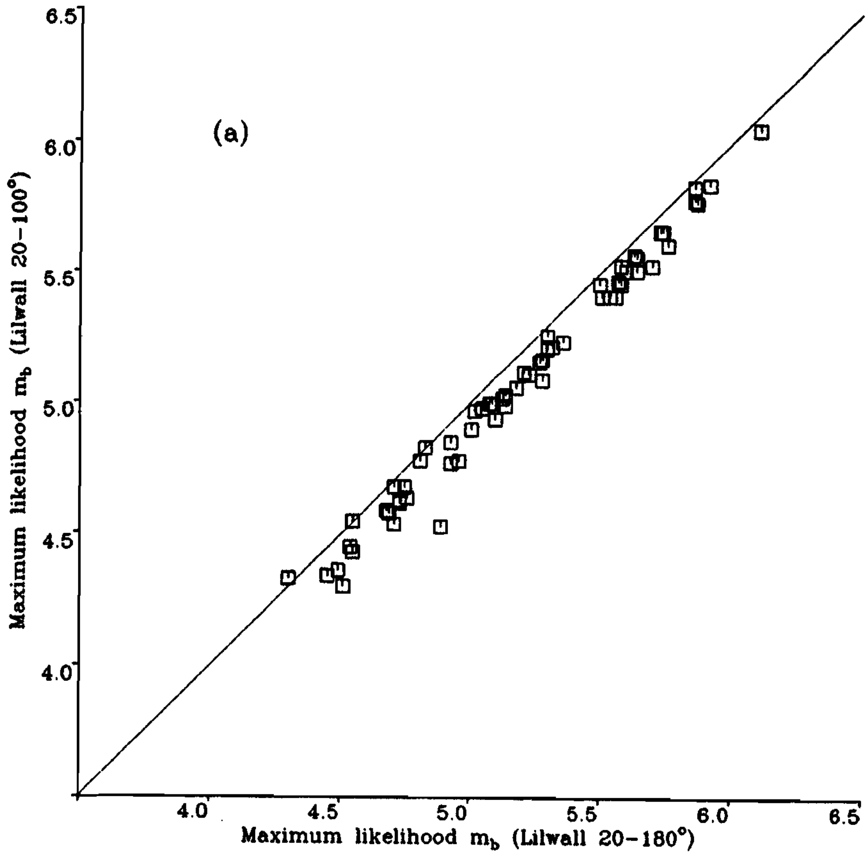
<u>FIGURE 2. COMPARISONS OF STATION TERMS</u>

a) Station Magnitude terms against station time-terms for the Mururoa underground explosions.

b) Station magnitude terms for the Fangataufa underground explosions against the magnitude terms for the Mururoa explosions.

c) Station magnitude terms for the atmospheric explosions against the the magnitude terms for the Mururoa underground explosions.

d) Station magnitude terms for the Mururoa underground explosions derived using only data in the range 20-100° against those derived using only data out to 180°.



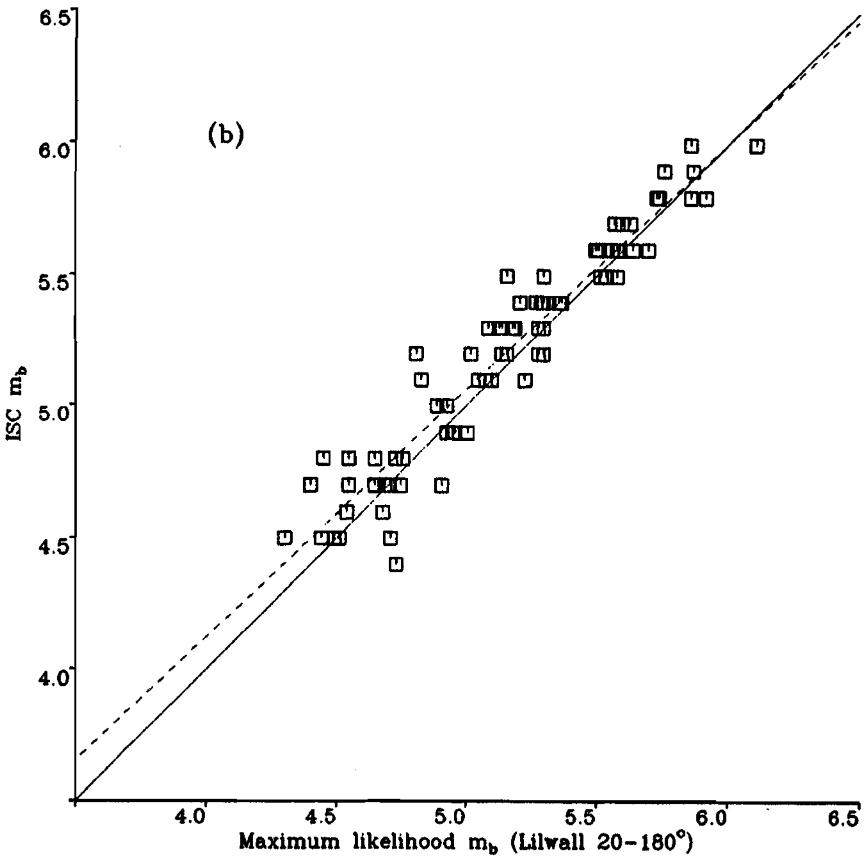


FIGURE 3.

a) Maximum-likelihood magnitudes derived for the Mururoa underground explosions using only data in the range 20-100° against the magnitudes derived using the data in the range 20-180.

b) ISC magnitudes against maximum-likelihood magnitudes. Also shown is the line $m_b^{ISC} = m_b^{ML}$ and the least squares line through the data.

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