UK UNLIMITED

ATOMIC WEAPONS ESTABLISHMENT

AWE Report O 2/94

Analysis of Short-period Seismograms from Explosions at the Novaya Zemlya Test Site in Russia

P D Marshall
Mrs D Porter*
J B Young
Mrs P A Peachell

Recommended for issue by:

A Douglas, Group Leader, Seismic Detection

Approved by:

H P S Powell, MSED

*Serco Ltd
Serco House
Hayes Road
Southall
UB2 5NJ

CONTENTS

SUMMARY

P and PcP recorded at four medium aperture seismometer arrays from explosions at Novaya Zemlya (Russia) are analysed. Five seismograms are produced for each P and PcP recording: the short period sum; the short period filtered in the bands 0.5-4 Hz and 1-4 Hz; the broad band; and the broad band corrected for the effects of anelastic attenuation. Each seismogram used in the analysis is illustrated. The estimates made include: the array magnitude m_b; the arrival time of the free surface reflection; ψ_∞ (the steady level of the explosion source reduced displacement potential); the seismic moment M_o; the broad band pulse rise-time, fall-time and duration; and the root mean square (RMS) amplitude in various time windows of the P and PcP codas. The variation in the estimates with maximum-likelihood magnitude (m_b^{ML}) is investigated; m_b^{ML} being estimated using ISC data. The main conclusions are:

(i) the relationship between $\log_{10} \psi_\infty$ and m_b^{ML} is

$$\log_{10}\psi_\infty = (1.05 \pm 0.08)\, m_b^{ML} - (2.08 \pm 0.45);$$

(ii) the rise time of the P pulse scales as $(\text{yield})^{1/10}$;

(iii) the relationship between $\log_{10}M_o$ and m_b^{ML} is

$$\log_{10}M_o = (1.15 \pm 0.18)\, m_b^{ML} + (8.92 \pm 1.05);$$

(iv) the apparent pP-P times differ from station to station whereas the pPcP-PcP times consistently lie in the range 0.4-0.5 s indicating a depth of firing of around 1000 m;

(v) RMS amplitude is a reliable estimator of relative source size.

1. INTRODUCTION

Within the area of the former USSR several sites were used extensively for underground nuclear testing. These include the principal test site near Semipalatinsk in East Kazakhstan used apparently for nuclear weapon development, and a test site in the North Caspian Sea area used to develop peaceful nuclear explosion technology for creating underground storage cavities in salt and for decoupling experiments. The third major test site is at Novaya Zemlya (NZ) in the Arctic circle. This remote area was originally used for atmospheric tests of large nuclear explosions presumably to avoid radioactive contamination of populated areas. Between 1966 and 1976 some very large explosions were detonated underground at NZ to avoid presumably the risk of seismic damage that might have occurred if they had been conducted near Semipalatinsk.

The underground explosions at NZ have been fired at two separate sites (figure 1) referred to in this report as the northern NZ (NNZ) and the southern NZ (SNZ) sites. Most of the explosions have been at the NNZ site which is near the Matochkin Shar Strait, which divides NZ into two islands. Only four underground explosions appear to have been fired at the SNZ site which lies near the southern tip of the southern island of NZ.

Short period (SP) P from large underground explosions is generally well recorded at teleseismic distances, particularly by the medium aperture seismometer arrays in Scotland, Canada, India and Australia. Analyses of the seismograms from explosions at East Kazakhstan and North Caspian Sea recorded at these arrays have been published [1,2]. Similar analyses have also been published for explosions at non-USSR test-sites such as the Nevada Test site in the USA, and the French test sites in Hoggar, Algeria and the Tuamotu Archipelago in the South Pacific [3,4,5,6]. The purpose of this report is to present the results of the analysis of P seismograms from underground explosions at NZ (table 1) recorded at the four arrays (table 2).

The recordings for each explosion have been processed to produce not only the SP array sum but also a broad band (BB) record and a BB record corrected for attenuation. A number of measurements, most related to source size, are made on the data including: the seismic magnitude; ψ_∞; the moment M_0; the source-pulse rise and fall times and duration; and the arrival times of the free surface reflections. ψ_∞ is the steady level of the explosion source reduced displacement potential. Root mean square (RMS) estimates are made of the amplitude in selected time-windows of the P wave and its coda. Pre-signal noise estimates in the six seconds preceding the onset are also made. In addition to an analysis of the P wave, the wave reflected at the core-mantle boundary (PcP) is analysed in a similar manner. In general PcP is a simple arrival with little or no coda.

The report is a catalogue of processed array seismograms and the measurements made. Analyses of the measurements are also given. Ideally any analysis of P waves from explosions would be discussed in terms of the yield of the explosion. However, no yields of explosions at NZ have yet been published. Some information is available from an official Russian source but this has not been used here because the uncertainties in the yields are too large (Fisk et al [7]). As a result the measurements are investigated here as a function of the maximum-likelihood magnitude (m_b^{ML}) derived from International Seismological Centre (ISC) Bulletin data using the method described by Lilwall & Marshall [8].

2. GEOLOGY OF NOVAYA ZEMLYA

Novaya Zemlya is a continuation of the Ural mountain chain which does not reach a particularly large elevation. The peak elevation is about 1000 m. The northernmost of the islands is covered with ice. The region is seismically stable indicating that uplift along faults which occurred in the Quaternary period has stopped. The southern portion of the Urals' fold belt is contiguous with the Russian Platform to the west and with portions of the central Asian fold belts to the east. In its northern portion it is contiguous with the Barents median massif in the west and with portions of other fold belts beneath the West Siberian cover which consists of several thousand metres of horizontal sediments. The crustal thickness is some 40 km.

Most of the underground explosions appear to be in shales and limestones of Cambrian age, the oldest rocks in NZ (figure 2). Ordovician and Silurian rocks are extensive and are mainly limestones, greywacke-type sandstones, and shales. Devonian rocks are present but differ in the east and west. The western Devonian is limestones and more rarely sandstones and shales. The eastern Devonian is mainly shales and sandstones. The volcanic rocks of Devonian age which are extensive in the main Ural belt are virtually absent in NZ. The Carboniferous is mainly limestones and the Permian, extensive in NZ, is a varied succession of sandstones, silts and clays, and some coal-bearing strata.

3. PROCESSING AND ANALYSIS METHODS

The methods used to process the P and PcP data are virtually identical to those used by Lyman et al [3], Marshall et al [2] and Douglas et al [6] in their studies of array recordings of the P waves from underground explosions. However, for completeness the methods are described briefly here.

The SP seismograms are from the arrays at Eskdalemuir, Scotland (EKA), Yellowknife, Canada (YKA), Warramunga, Australia (WRA) and Gauribidanur, India (GBA). The location of the arrays relative to NZ is shown in figure 3. All of the data available in the archives of the AWE seismological centre Blacknest have been used. Most of the data are taken from master tapes of edited digitised analogue recordings; some of the more recent explosions were directly recorded on digital tapes. The dates at which digital recording commenced at the arrays is given in table 2. The sampling interval of all signals processed is 0.05 s. The quality of the data is good even though much of it has been stored on analogue magnetic tapes for many years. Details of the analogue recording systems are given by Mowat & Burch [9]. Some data are taken from experimental BB systems and strong motion (SM) seismometers for which not all the calibration details are known. Nevertheless, the seismograms from these systems are presented because they are often the only data for a particular explosion. A list of available data is given in table 3. Some PcP data are missing because insufficient lengths of recordings were transcribed onto master tapes for archiving.

WRA at 106.0° is in the core shadow for the NZ test-sites which makes detection of P waves from small explosions difficult. The waves that are seen are diffracted arrivals and tend to be relatively complex waveforms. For the large explosions the signal-to-noise ratio (SNR) is very good but data for the small explosions are unavailable.

Deconvolved BB records are obtained for each explosion by passing the SP seismogram through a filter with a response as a function of frequency ω of $|a_2(\omega)|/a_1(\omega)$, where $a_1(\omega)$ is the SP instrument response and $a_2(\omega)$ the BB response. The frequency response of the SP recording system of one array (YKA) and the BB response are shown in figure 4. The SP responses of the other arrays differ slightly from that shown but these differences have been taken into account in the processing. Phase shifts due to the BB instrument are removed by using $|a_2(\omega)|$ rather than $a_2(\omega)$. The resultant seismograms are termed "phaseless seismograms" (Stewart & Douglas [10]). To reduce the noise on the BB seismograms they are passed through a Wiener filter (Douglas & Young [11]); the filter being designed using the spectrum of the noise ahead of the signal and an assumed theoretical signal spectrum. The application of the Wiener filter produces a least squares estimate of the BB displacement, ie, the ground displacement at the recording site.

To produce estimates of the ground displacement at the source, corrections are made for the effects of anelastic attenuation over the path between the source and the receiver by passing the BB seismograms through a filter with a response $[b(\omega)]^{-1}$, where $b(\omega)$ is the response, as a function of frequency, of an attenuation operator. The operator used is that of Carpenter [11] in which $|b(\omega)|$ is $\exp(-\omega t^*/2)$ and the phase spectrum is specified using Futterman's theory [12]. t^* is the ratio of travel time to Q, the specific quality factor.

The value of t^* used in the processing is 0.15 s at all arrays except for WRA where a value 0.30 s is used to try and compensate for some of the effects of diffraction around the outer core. The effect of diffraction is equivalent to a low pass filter and is thus similar to the effect of attenuation. The value for t^* of 0.15 s is the same as that used by Bache et al [14], Douglas [15] and Stewart [1] for explosions on the Russian Platform. The same value has been used for processing PcP; since PcP spends considerably less time in the attenuating upper mantle than the P a larger value of t^* is not warranted.

The rise-time, τ_{rise}, fall-time, τ_{fall}, duration and area of the P and PcP pulses (which are used to determine ψ_∞ and M_0) are all parameters related to the size of the source and are measured on the BB seismogram. The rise time is measured by dividing peak pulse amplitude by the maximum gradient of the leading edge of the P pulse (Stewart [16]). The fall time is determined in a similar way. The pulse duration (T_D) is taken as the time when the seismogram returns to the same amplitude level as its onset. However, if the SNR is low or the pulse is perturbed by secondary arrivals the duration is taken as the time from the onset to the apparent onset of the secondary arrival. H_0, the area under the P pulse, is measured by integrating the pulse for a time T_D beginning at the onset.

Douglas [15] shows that estimates of H_0 should not be affected by the amount of attenuation between the source and the receiver. However, in practice H_0 is measured on the BB seismogram corrected for anelastic attenuation. The P pulses on such seismograms are of shorter duration and thus are less perturbed by later or scattered arrivals than on uncorrected seismograms. Further, noise interference is minimised.

The value of ψ_∞ derived from the P-pulse area H_0, is defined as

$$\psi_\infty = [kG(\Delta)]^{-1}H_0$$

where $G(\Delta)$ is the geometrical spreading factor for P waves propagating to distance Δ, and k is the amplification effect of the free surface. However, this implies that

$$\rho_1 v_1 = \rho_0 v_0$$

where ρ_1 and v_1 are the density and P-wave speed respectively for the source material, and ρ_0 and v_0 the values for the recording station. If $\rho_1 v_1 \neq \rho_0 v_0$ then from Carpenter [17] a better estimator of the long term level is given by

$$\psi_\infty^{corr} = [2G(\Delta)]^{-1} \left[\frac{\rho_o v_o}{\rho_1 v_1}\right]^{1/2} H_o$$

taking k to be a factor of 2.

The relationship between ψ_∞^{corr} and M_o the moment is, following Aki et al [18]

$$M_o = 4\pi\rho_1 v_1^2 \psi_\infty^{corr}$$

Estimates of ψ_∞^{corr} have been made from H_o (and the area of the PcP pulse) using the tables of $G(\Delta)$ given by Carpenter [17]. The values of ρ_o and v_o at the arrays together with the assumed values of ρ_1 and v_1 are given in table 4.

The individual station measurements of τ_{rise} and τ_{fall}, duration and ψ_∞ for each explosion are combined to give a best estimates using the least squares matrix factorisation (LSMF) method described by Douglas [19]. It is assumed that the log of the measurements can be represented as the sum of a source effect, a receiver effect and an error term. The LSMF method is used to estimate the effects in the presence of the error.

The magnitude m_b at each array station and the RMS amplitude of selected time windows are determined from the SP P-wave seismograms. The m_b is calculated using the Gutenberg & Richter [20] formula

$$m_b = \log_{10}A/T + B(\Delta) + S,$$

where A is the amplitude and T the period of the P wave within the first few cycles after onset. $B(\Delta)$ is a correction for distance. Here the $B(\Delta)$ curve of Lilwall [21] is used. This curve is normalised to that of Gutenberg and Richter. S is a station correction determined by comparing the station magnitude with a network-average magnitude. The effect of T on the estimate of magnitude is investigated. Thus magnitude is determined from A, the amplitude corrected for the instrumental response at period T, and A_o, the amplitude measured on the seismogram taking no account of T. These magnitudes are compared to those derived using A/T.

An example of the output of the analysis procedure is given in figure 5 .

4. EPICENTRE LOCATION

The locations of the explosions at NZ have been estimated by the method of Joint Epicentre Determination (JED) (Douglas [22]). Lilwall & Marshall [8] used this procedure to locate NZ explosions which occurred between 1964 and 1983. Here the earlier work has been updated to include the explosions which have occurred between 1983 and 1990.

The method uses P and PKP arrival times taken from the ISC Bulletins to determine the locations relative to a fixed epicentre of one of the explosions. The method is most effective when all the epicentres are from a small area since any departure from the assumed travel-time curve can then be corrected for by a single term for each station. Thus, the NNZ and SNZ test-sites are treated separately.

To use JED at least one explosion epicentre must be restrained at each test site. Unfortunately the true location is not known for any of the explosions at NZ so the selection of one explosion epicentre to restrain must be determined from other evidence. The constrained epicentre used for the northern site is that of the explosion of 29 September 1976. This explosion was well recorded and lies near the centre of the cluster of explosion epicentres. However, the use of the ISC location (73.41°N 54.50°E) results in epicentres straddling the Matochkin Shar Strait. Such a situation is probably not realistic since this would require the setting up of command and control facilities for conducting nuclear tests on the north and south side of the Strait. The assumption has thus been made that the explosions all occurred in adits in the mountains immediately south of the Strait. For this reason the restrained location was chosen so that the epicentres lie beneath two mountain groups on the south of the Strait. The relocations are some 10-15 km east of those obtained by the ISC. In the absence of any topographic control on the location of the SNZ explosions their epicentres are estimated relative to the ISC epicentre for the explosion of 2 November 1974.

The arrival times are weighted to reduce the effect of gross errors. Gross errors can occur when for example, analysts misread the time code and report the wrong minute giving a P onset which is 1 minute out. Errors such as this are weighted out using the method of uniform reduction (Jeffreys [23]). For NNZ there is sufficient data to enable estimates to be made of the standard deviation of the time residuals for many of the stations and the readings are also weighted according to the standard deviation.. The final epicentres are given in table 1 and are shown in figures 6 and 7. The weighted standard deviation of the arrival time residuals is small (0.057 s) which together with the large number of readings results in very small 95% confidence regions (Appendix B) for most of the epicentres. The relative locations will reflect this but absolute locations are tied to the choice of co-ordinates for the restrained epicentre.

5. DESCRIPTION OF SEISMOGRAMS

Examination of the SP seismograms shows that the NNZ test-site can be divided into three areas. The areas are described here simply as NE, W and S and are shown in figure 8. The SP "average" seismograms at each station from each area is illustrated in figure 30. Whilst no single feature on the seismogram is common to all arrays, two array seismograms from the same explosion are sufficient to indicate a specific epicentral area. Figures 9-29 show the seismograms of the explosions at NNZ grouped by station and area. The trace at the top of the figure is the sum of the seismograms shown beneath. The purpose of the summation is to use, effectively, a source array to see whether there are any significant arrivals from reflectors in the source region. However, it would appear there are none. The summed seismogram is, effectively, the "average" seismogram for the particular region. Each of the figures includes an 'average' seismogram together with the individual BB and BB t* corrected seismogram for each explosion in the specific area.

Five of the explosions analysed are reported by Fisk et al [7] to be multiple explosions. The explosion at the SNZ test-site on 18 October 1975 was identified by Hurley [24] as a double explosion from the appearance of BB P at the four arrays. The appearance of the SP P seismograms from the disturbance at the NNZ test-site on 11 October 1980 led Stewart & Marshall [25] to identify this also as a double explosion. These identifications were later confirmed by Fisk et al [7] who, on evidence provided by the Russians, states that three of the early explosions were also double explosions. The double explosions are indicated in table 11. There is no observable evidence in the seismograms that these early explosions are in fact doubles. This suggests they were fired simultaneously and so close together that the two arrivals cannot be resolved on the seismogram.

At all stations the direction of first motion for both P and PcP is clearly positive; this is expected for an explosion source which has a radially symmetric radiation pattern. Buchbinder [26], however presents observations of PcP at distances of less than 32° which appear to show a dilatational first motion. However, Kogan [27] shows that the readings are in error and that no phase reversal is observed. The clear compressional pulses observed on the BB PcP waves recorded at EKA at an epicentral distance of 29.2° support the Kogan view.

The explosions at NZ are recorded at the four array stations with good SNRs resulting in excellent quality BB conversions. However, variations in the appearance of the seismograms from one array to another do occur.

5.1 Eskdalemuir

The P and PcP as recorded at EKA ($\Delta = 29.2°$ from NNZ) are shown in figures 9 to 11 and

21 to 23 respectively. The seismograms are simple at all three areas of the test-site, with those in the NE area being the simplest of all. The three NE explosions for which EKA data are available are all relatively small. The other explosions in this area were very large and the signal saturated the recording system. The seismograms from explosions in the W and S areas are a little more complex due to the presence of what appears to be the free surface reflection, pP, which is clearly observed on the BB recordings. There are no arrivals resulting from variations in wave speed within the upper mantle which give rise to triplication of the P travel time curve. This is in contrast to the extremely complex P seismograms recorded at GBA from explosions at the Chinese test-site in Xinjiang (Jones [28]) at a distance of 29.1° (figure 31).

The smallest explosion detected at EKA from NNZ is that of 9 October 1977 for which m_b^{ML}=4.36 although the array magnitude is 4.65. It is recorded with a SNR of about 6:1 on the 1-4 Hz filtered channel which indicates that explosions at NNZ with an m_b^{ML} of about 3¾ should be detected at EKA. The average station magnitude correction for NNZ explosions recorded at EKA is -0.41 ± 0.13.

PcP is a clear arrival on EKA seismograms. From an analysis of the amplitudes and periods of P and PcP it is found that on average the ratio of A/T for P and PcP is about 9 which means that the detection level for PcP from explosions is about m_b^{ML}4½. PcP has proved to be a useful phase in interpreting seismograms from double explosions.

The P and PcP seismograms of the double explosion of the 11 October 1980 are shown in figures 32 and 33 together with "average" seismograms from nearby explosions. This double explosion was spotted by Stewart & Marshall [25]. They observed that the P seismograms from the 11 October 1980 explosion are different, in detail, from seismograms normally recorded. However, the PcP seismograms are similar to those normally observed. Stewart & Marshall [25] demonstrate by a simple deconvolution of the seismograms, that the pulse shapes produced could be interpreted as being from two simultaneous explosions fired some 7 km apart. The spatial separation causes the appearance of the P seismograms to change with azimuth, but such variation is not observed in PcP because the steeply-descending wavefronts from each explosion are superpositioned. The observed P seismograms from the double explosion can thus be modelled as shown by Stewart & Marshall [25] using the observed PcP as the source function.

5.2 Yellowknife

The remarkable feature of the YKA P seismograms, (Δ = 44° from NNZ), is the complexity of the SP waveform; a surprising observation in view of the simple nature of the explosive source. The P seismograms at YKA are shown in figures 12 to 14 and those for PcP in figures 24 to 26. On first examination many of the PcP waveforms appear, for sources located in the W and NE areas, to be complex. However, this is due to the arrival of PP. Explosions in the S region generate PcP signals which are simple with no PP arrival visible. The difference in distance between the three regions to YKA is small and would not account for the absence of PP in seismograms from the explosions at the S test-site. The take-off angle in the source region is such that PP from the S area propagates through the region beneath the NE area and it is presumably here that the ray path is perturbed in such a way that PP is not observed at YKA. This observation is worthy of further study but this is beyond the scope of this report.

Complexity of P seismograms can be due to a number of different factors (Key [29], Douglas [30], Greenfield [31], Hudson [32], Douglas et al [33] and Douglas et al [34]). The reason for the complexity of the YKA P seismograms is not yet resolved although there have been a number of attempts to explain it (Greenfield [31], Douglas et al [33] and Douglas et al [34]). At present, our preferred explanation is that the direct P-wave has been reduced in amplitude by attenuation in passing through a region of low Q, whereas the scattered energy in the P coda has passed through only high Q material between the source and the receiver. PcP like the P coda has not passed through the low Q region and hence is a simple pulse-like arrival. This hypothesis requires that the P-wave magnitude computed from complex seismograms should be significantly lower than that computed from simple recordings of the same explosion. This is indeed true of the recordings of NZ explosions made at YKA. The average station magnitude at YKA is over half a magnitude lower than the m_b^{ML} (the correction is +0.55 ± 0.13). At YKA the amplitude of PcP is very similar to that of P, whereas at EKA and GBA P is 9 and 6 times larger respectively than PcP.

Further evidence of attenuation of P as the cause of the reduced amplitude is the broadening of the pulse and this is observed in the YKA P seismograms. However, an alternative explanation of the observed broadening is multipathing along the path between NZ and YKA. To test this hypothesis an EKA P seismogram is scaled and added to itself twice with delays of 0.3 and 0.8 s. A t* = 0.15 attenuation filter is also applied. The result is SP and BB seismograms (figure 34) which look like those of a NZ explosion recorded at YKA. A thorough examination of the cause of complexity at YKA is beyond the scope of this report but it is important that the cause be identified if an understanding of explosion generated P seismograms is to be achieved.

The smallest explosion at NZ for which P seismograms are available is that of 9 October 1977. The YKA magnitude is 3.98 whereas m_b^{ML} is 4.36. The SNR is only about 3 which indicates a detection capacity of a little under $m_b^{ML}4$ at YKA for NZ explosions. Given that PcP is recorded with a similar amplitude to P this magnitude represents the limit of detection for PcP too.

5.3 Gauribidanur

The P seismograms, recorded at GBA (figures 15 to 17) at a distance of 61° from NNZ, are simple and similar to those recorded at EKA. The PcP seismograms (figures 25 to 27) are also simple. For all of the NNZ explosions for which data are available at GBA the SNR is high. The station magnitude correction is -0.31 ± 0.21 which indicates that relative to m_b^{ML} the signals are larger than average although there is greater variation in the mean value than at the other array stations. The explosion of 9 October 1977 is recorded with a SNR of at least 10 which implies a detection capacity for NNZ explosions of about m_b^{ML} 3½ at GBA. However, for this explosion the GBA magnitude is 5.2 compared with the m_b^{ML} of 4.36 which means that this explosion is recorded with an unusually large amplitude.

Some PcP data are available although limited by an artifact of the automatic signal detector used at GBA. For a period of time the only data available from GBA is the beamed P signal which was of limited duration and included the PcP arrival but was not processed using the PcP velocity. Unfortunately the tapes of continuous data were not available to reprocess using the PcP velocity. However, the PcP data that are available suggests that the amplitude of PcP is about six times smaller than P.

5.4 Warramunga

At 106°, the distance of WRA from NNZ, the P waves are diffracted around the earth's outer core and the amplitudes are significantly reduced relative to amplitudes observed in the 30° to 90° range. Further, the diffraction preferentially attenuates high frequencies so that in general the signals recorded at distances of more than 90° should be of lower frequency than those observed between 30° and 90°. The WRA P seismograms (figures 18 to 20) are complex and, as expected for a diffracted arrival, the period of P is greater than observed on the SP seismograms at the other array stations. The lowest magnitude explosion for which WRA data are available is that of 11 October 1982 with a m_b^{ML} of 5.58. At WRA the amplitude of P is about 4 nms and is recorded with a SNR of about 3. The detection capacity of WRA is thus about $m_b^{ML}5\frac{1}{4}$.

The complexity of the P seismograms is assumed here to be due to discontinuities in wave speed at the core-mantle boundary (CMB). Within the P coda there are two or more discrete arrivals, the first arriving about 6 seconds after the onset. The low amplitude of the initial P-wave probably accounts for the clarity with which the arrivals are observed. Such arrivals have been associated with lateral variations in the"D" region which extends 200-300 km above the CMB. The evidence for this is provided by Vidale & Benz [35] who analysed recordings of the Chinese explosion of 21 May 1992 recorded at stations in Canada and the US in the distance range 85-103°. The arrival time, relative to the P onset, of the large amplitude secondary arrival at WRA is in excellent agreement with the observations of Vidale & Benz [35].

6. RESULTS

In this section the relationship between the observations made on the seismograms from the

NNZ site and m_b^{ML} is investigated. There is insufficient data from explosions at the SNZ site for the P waves from that site to be analysed. The little data that are available are given in Appendix C.

6.1 Array Magnitude and m_b^{ML}

It might be expected that the relationship between the array magnitudes and m_b^{ML} (see table 5 and figures in Appendix A) would not differ significantly from unity. However, for the three arrays EKA, YKA and GBA it seems probable that the slopes are less than 1. For WRA the best estimate of the slope is 1 but the uncertainty in the estimate is so large that the possibility that the true slope is less than 1 cannot be ruled out. One possible explanation of why the slopes of the lines relating m_b to m_b^{ML} are apparently less than unity at EKA, YKA and GBA is that at low m_b^{ML} the m_b estimates are biased high because those signals which by chance would have been recorded by the arrays with below average amplitudes lay below the detection threshold and so were not recorded. However, the smallest magnitude explosions recorded at each array have amplitudes well above the detection threshold so perhaps any bias is minimal.

Alternatively, the array m_b might be picking up evidence of a decrease in the corner frequency of the P pulse with yield which is not seen by m_b^{ML} because most stations that report amplitudes to the ISC have narrower band recording systems and may be on paths of lower Q from NZ than are the arrays.

Sufficient data are available to effectively calibrate PcP amplitudes to estimate an equivalent P wave magnitude. The PcP observations for each array are given in Appendix A in tables and as figures showing $\log_{10}A/T$ against m_b^{ML}. The factor to add to PcP $\log_{10}A/T$ values to determine an equivalent m_b^{ML} for each array is estimated to be

EKA	+4.31 ± 0.12
YKA	+4.34 ± 0.22
GBA	+4.32 ± 0.19

which is a remarkably consistent factor given the range of distance between EKA and GBA (29.2° and 61.2°). The station corrections for the P wave m_b are

EKA	-0.41 ± 0.13
YKA	+0.55 ± 0.13
GBA	-0.31 ± 0.21
WRA	-0.03 ± 0.31

which indicates that for NZ explosions EKA and GBA record above average amplitudes whereas YKA amplitudes are below average. This is in contrast to the amplitudes of PcP recorded at YKA which appear to be normal. Given the station magnitude corrections relative to m_b^{ML} for P and PcP at the array stations it is possible to use either or both phases to make an estimate of m_b^{ML} based on a single station reading.

Conventionally the $\log_{10}A/T$ of the P wave is used to determine m_b. To investigate whether this is the best estimator of source size, some other amplitude measurements have been analysed using unfiltered data and data filtered ½-4 Hz and 1-4 Hz; namely $\log_{10}A_o$ and $\log_{10}A$. The main conclusions that can be drawn from this analysis (summarised in table 5) are:

(i) with only one exception $\log_{10}A$ has the largest variance;

(ii) $\log_{10}A_o$ has the minimum variance in almost every example;

(iii) when $\log_{10}A/T$ is used the variance is only marginally greater than that observed for $\log_{10}A_o$ which suggests that any error introduced by the measurement of T is minimised by dividing by T;

(iv) the effect of the period of the P wave on the slope and intercept of the relationship between source estimator terms and m_b^{ML} is small.

A problem could arise in the measurement of the period T with for example, a complex P-wave seismogram resulting from multipathing on the path between the source and the receiver. If the arrival of two or more pulses resulted in an apparent period significantly different to the true period this would increase the variance of the observations.

6.2 ψ_∞ and m_b^{ML}

ψ_∞ measured on the BB t* corrected, P and PcP seismograms for each explosion are given in the tables in Appendix A. To provide the best estimate of the mean value of $\log_{10}\psi_\infty$ the data are analysed using the LSMF procedure. The source terms for the P and PcP data are summarised in table 11 and the station terms are given in table 12. If data from only one station or phase are available for a particular explosion the station corrections can be applied to improve the estimate of ψ_∞ for that explosion. ψ_∞ for WRA (Δ=106°) is not included because the geometric spreading factor G(Δ) is not accurately known. The relationship between m_b^{ML} and $\log_{10}\psi_\infty$ (figure 35) determined using the double-error regression procedure described by York [36] is

$$\log_{10}\psi_\infty = (1.05 \pm 0.08)m_b^{ML} - (2.08 \pm 0.45).$$

6.3 RMS Amplitudes and m_b^{ML}

The RMS amplitude of different time windows of P, PcP and their coda, in two different frequency bands, are shown as a function of m_b^{ML} in the figures in Appendix A. The slope, intercept and variance of the least squares line through the data points are summarised in tables 8 to 10.

If the criterion for the best estimate of relative source size is minimum variance then the RMS amplitudes are almost as good as measurements made using A_0 which, like RMS amplitude, is a measure of source size which does not depend on the period of the signal. The variance of the RMS measurements for P are all lower than those for PcP.

In both filter bands the minimum variance observed for RMS amplitudes at EKA and YKA are those which include the direct P, whereas at GBA and WRA it is the amplitudes that exclude P which have minimum variance. This observation is not explained by the complexity of P and its coda at the different array station but is probably related to the nature of the scattering between the source and receiver.

All of the measurements of RMS amplitude of P and its coda are larger than the RMS amplitude of the noise preceding the signal. This can be seen in the figures in Appendix A showing the relationship between RMS amplitudes and m_b^{ML}. [The noise levels are indicated by the asterisks on the graphs]. However, for observations made on PcP, only those made on the first 3 seconds have amplitudes significantly greater than the pre-signal noise. This is because the SNR is low for PcP from low magnitude sources and not because the phase arrives in the coda of the P wave since the PcP-P time varies from about 42 s at GBA to more than 3 minutes at EKA.

The RMS amplitude is a useful measure of relative source size but only at test-sites where a number of explosions have taken place. Relating of RMS amplitudes to yield requires the knowledge of at least one yield at the test site. It is very unlikely that procedures will be developed which will make it possible to predict the relationship between RMS amplitudes and yield for a particular test-site/station pair, or to use the relationship observed at one test-site and apply it to another.

6.4 Rise, Fall and Duration Times Relative to m_b^{ML}

There are a number of factors that affect the shape of the BB P-pulse and hence the rise and fall times and the duration of the observed pulse. One major factor is the arrival of any reflections from surfaces above the explosion. For example, the pP-P time may be so short that interference between the two arrivals results in a wrong measure of fall-time and duration. The rise-time is the measurement least likely to be affected by later arrivals and so should only be a function of yield and the medium in which the detonation occurred. The relationship between rise-time and yield is a measure of how the source function scales with yield.

For P waves the average slope of the line relating all the observations of rise and fall times and duration to m_b^{ML} is 0.09 ± 0.06 which shows that the observations scale roughly as $(\text{yield})^{1/10}$, assuming that m_b^{ML} and log yield are linearly related. This result is in agreement with similar measurements made on explosions at the East Kazakhstan test-site (Stewart [1]).

6.5 M_0 and m_b^{ML}

The individual array values of M_0 for each explosion are given in Appendix A. The least squares estimate of M_0 for each explosion (table 11) were determined using the LSMF method. The relationship between $\log_{10}M_0$ and m_b^{ML} determined using the York [36] procedure, is

$$\log_{10}M_0 = (1.15 \pm 0.18)m_b^{ML} + (8.92 \pm 1.05).$$

6.6 Estimates of pP Times from Explosions at NZ

The identification of pP has proved difficult for shallow focus explosions in which the pP-P times are very small. It is often possible to identify an arrival (A_{pP}) of opposite polarity to that of the direct P, which could be pP. However, such arrivals are usually much later than expected, given a knowledge of the wave speeds in the material above the explosion and the depth of firing.

For an explosion at shallow depth the pP-P times should be almost the same at all teleseismic recording stations. However, this has proved difficult to demonstrate. The arrival of the first clear negative pulse after P at a number of stations often produces a wide range of times for the arrival of A_{pP}. This is true for the explosions analysed here. This may be because the reflection did not occur directly above the shot point, or because S-P conversions at layers between the shot point and the free surface arrive shortly after the P to produce a complicated pulse which makes recognition of true pP difficult.

An analysis of A_{pPcP} from recordings at EKA, YKA and GBA indicates that the phase is very likely to be the free surface reflection in that its arrival time relative to PcP is consistent at the three arrays, being on average between 0.4 and 0.5 s. This is the same as the A_{pP}-P time measured at WRA which is around 0.5 s. If the P-wave speed in the overburden is assumed to be about 4.0 km.sec^{-1}, a reasonable assumption for the rocks found at NZ (Press [37]), then the estimated firing depth is around 1000 m which is close to the thickness of the overburden available with a horizontal adit at the NNZ test-site. Thus it would appear that the best estimates of the depth are obtained from an analysis of PcP rather than direct P.

The estimates of pP times are about half those determined by Burdick [38] and Burdick et al [39] who use intercorrelation and network spectral methods to determine pP-P times. It is difficult to accept the depth estimates that result from using Burdick's estimates of pP times and wave speeds in the overburden.

7. CONCLUSIONS

Although data from the two test-sites at NZ are available, only for the NNZ site is there sufficient data for a detailed analysis of the P and PcP from the explosions. In the absence of yield data the measurements made are analysed as a function of m_b^{ML} which is assumed to be a good indicator of the relative yield of the explosions. The main conclusions of the study are listed below.

(i) The relationship between $\log_{10}\psi_\infty$ and m_b^{ML} is

$$\log_{10}\psi_\infty = (1.05 \pm 0.08)m_b^{ML} - (2.08 \pm 0.45).$$

(ii) The results of the analysis of rise and fall times and durations indicate that the source scaling is roughly proportional to $(\text{yield})^{1/10}$ which is similar to that found for explosions at the East Kazakhstan test-site.

(iii) The relationship between $\log_{10}M_o$ and m_b^{ML} is

$$\log_{10}M_o = (1.15 \pm 0.18)m_b^{ML} + (8.92 \pm 1.05).$$

(iv) The apparent pP-P times differ from station to station whereas the pPcP-PcP times consistently lie in the range 0.4-0.5 s indicating a depth of firing of around 1000 m.

(v) The best estimate of source size is given by the P-wave amplitude (A_0) measured on the seismogram uncorrected for the instrumental response at period T. However, in terms of variance the RMS amplitudes are almost as good but only as a measure of relative source size. Such amplitudes are thus useful for test-sites where a number of explosions have occurred but an explosion of a known yield is required to calibrate the test site.

8. ACKNOWLEDGEMENTS

The authors would like to express their sincere appreciation to the staff at the EKA, YKA, GBA and WRA seismometer array stations without whose conscientious efforts to record the data the analysis reported here would not have been possible. The editing of the data and the subsequent processing was only possible with the help of the staff at Blacknest. Professor A Douglas kindly reviewed the manuscript and made many useful suggestions; his help is much appreciated by the authors.

REFERENCES

1 Stewart, R C. "P-wave seismograms from underground explosions at the Shagan River test site recorded at four arrays". AWE Report O 4/88, HMSO, London (1988).

2 Marshall, P D, Lilwall, R C, Stewart, R C & Marsden, I. "Seismometer array recordings of P-waves from explosions in the North Caspian Sea USSR area". AWE Report O 4/91, HMSO, London (1991).

3 Lyman, N S, Douglas, A, Marshall, P D & Young, J B. "P seismograms recorded at Eskdalemuir, Scotland from explosions in Nevada, USA". AWRE Report O 10/86, HMSO, London (1986).

4 Gillbanks, T G A, Marshall, P D & Stewart, R C. "P-wave seismograms recorded at Yellowknife Canada from underground explosions in Nevada, USA". AWE Report O 26/88, HMSO, London (1988).

5 Stimpson, I G. "Source parameters of explosions in granite at the French test site in Algeria". AWE Report O 11/88, HMSO, London (1988).

6 Douglas, A. "P seismograms from explosions in the S Pacific recorded at four arrays". AWE Report (To be published by HMSO) (1994).

7 Fisk, D, Alewine, III, R W, Gray, H L & McCarter, G D. "Multivariate seismic calibration for the Novaya Zemlya test-site". PL-TR-92-2251, Phillips Laboratory, Hanscom AFB, Ma, USA (1992).

8 Lilwall, R C & Marshall, P D. "Body wave magnitudes and locations of Soviet underground explosions at the Novaya Zemlya test site". AWRE Report O 17/86, HMSO, London (1986).

9 Mowat, W M H & Burch, R F. "Handbook for the stations which provide seismograms to the Blacknest seismological centre, United Kingdom". AWRE Blacknest Tech Report 44/47/29, Blacknest, Brimpton, RG7 4RS, UK (1977).

10 Stewart, R C & Douglas, A. "Seismograms from phaseless seismographs". Geophys J Roy astr Soc, **72**, 517-521 (1983).

11 Douglas, A & Young, J B. "The estimation of seismic body wave signals in the presence of oceanic microseisms". AWRE Report O 14/81, HMSO, London (1981).

12 Carpenter, E W. "Absorption of elastic waves - an operator for a constant Q mechanism". AWRE Report O 43/66, HMSO, London (1966).

13 Futterman, W. "Dispersive body waves". J Geophys Res, **67**, 5279-5291 (1961).

14 Bache, T C, Marshall, P D & Bache, L B. "Q for teleseismic P-waves from Central Asia". J Geophys Res, **90**, 3575-3587 (1985).

15 Douglas, A. "Differences in upper mantle attenuation between the Nevada and Shagan River test site: can the effects be seen in P-wave seismograms?" Bull Seism Soc Am, **77**, 270-276 (1987).

16 Stewart, R C. "Q and the rise and fall of a seismic pulse". Geophys J Roy astr Soc, **76**, 793-805 (1984).

17 Carpenter, E W. "A quantitative evaluation of teleseismic explosion records". Proc Roy Soc, A, 290, 396-407 (1966).

18 Aki, K, Bouchon, M & Reasenberg, P. "Seismic source function for an underground nuclear explosion". Bull Seism Soc Am, **76**, 131-148 (1968).

19 Douglas, A. "A special purpose least-squares programme". AWRE Report O 54/66, HMSO, London (1966).

20 Gutenberg, B & Richter, C. "Magnitude and Energy of Earthquakes". Annali Geofis, **9**, 1-15 (1956).

21 Lilwall, R C. "Empirical amplitude-distance/depth curves for short-period P waves in the distance range 20-180°". AWRE Report O 30/86, HMSO, London (1987).

22 Douglas, A. "Joint epicentre determination". Nature, **215**, 47-48 (1967).

23 Jeffreys, H. "The Theory of Probability". 3rd Edition, Oxford University Press (1961).

24 Hurley, R W. "Anomalous seismic signals from Novaya Zemlya". AWRE Report O 21/77, HMSO, London, (1977).

25 Stewart, R C & Marshall, P D. "Seismic P-waves from Novaya Zemlya explosions: seeing double!" Geophys J, **92**, 335-338 (1988).

26 Buchbinder, G G R. "Properties of the core-mantle boundary and observations of PcP". J Geophys Res, **73**, 5901-5923 (1968).

27 Kogan, S D. "A study of the dynamics of a longitudinal wave reflected from the earth's core". Izv. Akad. Nauk. SSSR, Fiz.Zemli, **6**, 3 (1972).

28 Jones, K. Personal communication.

29 Key, F A. "Some observations and analyses of signal generated noise". Geophys J R astr Soc, **15**, 377-392 (1968).

30 Douglas, A. "P-signal complexity and source radiation patterns" in VESIAC Report 7885-1-X, University of Michigan, USA (1967).

31 Greenfield, R J. "Short period P-wave generation by Rayleigh wave scattering at Novaya Zemlya". J Geophys Res, **76**, 7988-8002 (1971).

32 Hudson, J A. "Scattered surface waves from a surface obstacle". Geophys J R astr Soc, **13**, 441-458 (1967).

33 Douglas, A, Marshall, P D, Gibbs, P G, Young, J B & Blamey, C. "P signal complexity re-examined". Geophys J R astr Soc, **33**, 195-221 (1973).

34 Douglas, A, Marshall, P D & Corbishley, D J. "Absorption and the complexity of P signals". Nature, **233**, 50-51 (1971).

35 Vidale, J E & Benz, H M. "Seismological mapping of fine structure near the base of the Earth's mantle". Nature, **361**, 529-532 (1993).

36 York, D. "Least squares fitting of a straight line". Can Jour Phys, **44**, 1079-1086 (1966).

37 Press, F. "Seismic Velocities" in "Handbook of Physical Constants" Rev Ed S P Clark (Editor) Geol Soc Am Inc, Memoir 97, Page 203 (1966).

38 Burdick, L J. "Resolution of the pP paradox at Novaya Zemlya". PL-TR-91-2042. Phillips Laboratory, Hanscom AFB, Ma, USA (1991).

39 Burger, R W, Lay, T, Arvesen, C G & Burdick, L J. "Estimating seismic yield, pP parameters and tectonic characteristics at the Novaya Zemlya test site". WCCP-R-85-03 Woodward-Clyde Consultants, PO Box 93245, Pasadena, CA, USA (1985).

40 Daly, R A, Manger, G E & Clark, S P. "Density of rocks" in "Handbook of Physical Constants" Rev Ed S P Clark (Editor) Geol Soc Am Inc, Memoir 97, Page 23 (1966).

LIST OF TABLES

TABLE 1.

Epicentres, Origin Times and Magnitudes of the Novaya Zemlya Explosions

Date	Origin time	Latitude*	Longitude*	Area(km^2)	m_b^{ML}	N_A†
Epicentres for northern Novaya Zemlya explosions estimated relative to that of the 29 September 79						
640918	8: 0: 0.35±0.78	73.667N±11.1	54.533E± 2.8	43.5	4.19±0.15	6
641025	7:59:58.10±0.12	73.387N± 1.8	54.994E± 0.5	4.5	4.82±0.13	8
661027	5:57:58.09±0.06	73.387N± 1.1	54.845E± 0.4	1.8	6.49±0.05	53
671021	4:59:58.49±0.07	73.390N± 1.2	54.819E± 0.4	2.0	5.98±0.05	47
681107	10: 2: 5.49±0.06	73.387N± 1.1	54.867E± 0.3	1.7	6.13±0.04	65
691014	7: 0: 6.61±0.06	73.390N± 1.1	54.796E± 0.3	1.8	6.18±0.05	56
701014	5:59:57.57±0.06	73.304N± 1.0	55.036E± 0.3	1.5	6.79±0.05	57
710927	5:59:55.75±0.06	73.393N± 1.1	54.929E± 0.3	1.6	6.67±0.04	63
720828	5:59:56.87±0.06	73.388N± 1.0	54.856E± 0.3	1.5	6.49±0.04	69
730912	6:59:54.81±0.06	73.314N± 1.0	55.065E± 0.3	1.4	6.97±0.05	52
740829	9:59:56.15±0.06	73.397N± 1.0	54.914E± 0.3	1.5	6.58±0.05	63
750823	8:59:58.25±0.06	73.334N± 1.0	54.691E± 0.3	1.4	6.55±0.04	83
751021	11:59:58.03±0.06	73.307N± 1.0	55.019E± 0.3	1.4	6.60±0.04	68
760929	2:59:57.70±0.00	73.360N± 0.0	54.880E± 0.0	0.0	5.83±0.04	82
761020	7:59:58.07±0.07	73.398N± 1.3	54.821E± 0.4	2.3	4.98±0.06	39
770901	2:59:57.97±0.06	73.339N± 1.0	54.628E± 0.3	1.4	5.66±0.04	84
771009	10:59:58.12±0.13	73.409N± 1.8	54.936E± 0.6	4.8	4.36±0.08	28
780810	7:59:57.93±0.06	73.291N± 1.0	54.892E± 0.3	1.4	6.00±0.04	91
780927	2: 4:58.60±0.06	73.349N± 1.0	54.685E± 0.3	1.5	5.63±0.04	83
790924	3:29:58.75±0.06	73.343N± 1.0	54.681E± 0.3	1.4	5.77±0.03	104
791018	7: 9:58.75±0.06	73.316N± 1.0	54.825E± 0.3	1.5	5.79±0.04	91
801011	7: 9:57.47±0.06	73.336N± 1.1	54.949E± 0.3	1.5	5.76±0.04	80
811001	12:14:57.23±0.06	73.304N± 1.0	54.827E± 0.3	1.5	5.97±0.03	100
821011	7:14:58.63±0.06	73.339N± 1.1	54.617E± 0.3	1.6	5.58±0.04	87
830818	16: 9:58.90±0.06	73.354N± 1.0	54.983E± 0.3	1.5	5.91±0.04	96
830925	13: 9:58.22±0.06	73.328N± 1.0	54.550E± 0.3	1.5	5.77±0.03	105
841025	6:29:58.12±0.06	73.355N± 1.0	54.999E± 0.3	1.5	5.82±0.03	104
870802	2: 0: 0.20±0.06	73.326N± 1.0	54.611E± 0.3	1.4	5.82±0.03	99
880507	22:49:58.34±0.06	73.314N± 1.0	54.562E± 0.3	1.4	5.58±0.04	92
881204	5:19:53.30±0.06	73.366N± 1.0	55.010E± 0.3	1.4	5.89±0.03	94
901024	14:57:58.45±0.06	73.331N± 1.0	54.766E± 0.3	1.4	0.00±0.00	0
Epicentres for southern Novaya Zemlya explosions estimated relative to that of the 2 November 1974						
730927	7: 0: 1.12±0.08	70.731N± 1.4	53.836E± 0.5	3.3	5.89±0.05	53
731027	7: 0: 0.61±0.07	70.780N± 1.3	54.035E± 0.4	2.6	6.98±0.04	58
741102	5: 0: 0.00±0.00	70.810N± 0.0	53.910E± 0.0	0.0	6.81±0.04	71
751018	8:59:59.40±0.07	70.816N± 1.3	53.753E± 0.4	2.6	6.75±0.04	65

* Confidence limits in kilometres

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

TABLE 2.

The Arrays

Station	Code	Location	Element Spacing (km)	Date Operational	Digital Recording	To Novaya Zemlya (North)		
						Δ°	BB°	Az°
Eskdalemuir Scotland	EKA	55°19′59″N 3°09′33″W	0.9	17 May 1962	14 Nov 1983	29.16	30.1	263.7
Yellowknife Canada	YKA	62°29′34″N 114°36′17″W	2.5	26 Nov 1962		44.23	4.4	353.0
Gauribidanur India	GBA	13°36′15″N 77°26′10″E	2.5	1 Feb 1966	4 Mar 1979	61.15	352.7	154.7
Warramunga Australia	WRA	19°56′39″S 134°20′27″E	2.5	1 Mar 1966	7 Jun 1977	106.00	342.8	105.8

TABLE 3.

Availability of Array Data for Novaya Zemlya Explosions

(a) Northern test-site

	Date	EKA		YKA		GBA		WRA
		P	PcP	P	PcP	P	PcP	P
1	641025	*	-	*	-	-	-	-
2	661027(D)	0	*	0	0	0	0	*
3	671021(D)	0	*	*	*	S	*	*
4	681107	S	*	*	*	*	*	*
5	691014(D)	S	*	0	*	*	-	*
6	701014	0	*	-	-	0	*	*
7	710927	0	*	-	-	0	0	*
8	720828	0	*	-	-	-	-	-
9	730912	0	*	-	-	-	-	-
10	740829	*	*	S	S	-	-	-
11	750823	0	*	-	-	-	-	-
12	751021	*	*	-	-	*	-	*
13	760929	*	*	*	*	S	*	-
14	761020	*	-	*	*	*	-	-
15	770901	*	*	*	*	-	-	*
16	771009	*	-	*	*	*	-	-
17	780810	*	*	*	*	*	*	-
18	780927	*	*	*	*	*	-	-
19	790924	-	-	*	*	-	-	*
20	791018	*	-	*	*	-	*	*
21	801011(D)	*	*	*	*	*	*	*
22	811001	*	*	*	*	*	-	*
23	821011	*	-	*	*	*	-	*
24	830818	*	*	*	*	*	-	-
25	830925	*	*	*	*	*	*	-
26	841025	*	*	*	*	*	-	*
27	870802	*	*	*	*	*	-	*
28	880507	*	-	*	*	*	-	*
29	881208	*	*	*	*	*	*	-

(b) Southern test-site

1	730927	*	*	*	*	-	-	-
2	731027	0	*	-	-	-	-	*
3	741102	S	S	S	S	*	*	-
4	751018(D)	0	*	0	-	0	-	*

*	Data available and included in the analysis
0	Overloaded data
-	Data files unavailable
S	Strong motion channel available; calibration uncertain therefore not used in analysis.
(D)	Double explosion

TABLE 4.

P-wave Speed and Density for the Array Stations and Novaya Zemlya Source Region

Array	Density (ρ_o) (kg m^{-3})	P wave speed (v_o) (km s^{-1})	$\left[\frac{\rho_o v_o}{\rho_1 v_1}\right]^{1/2}$
EKA	1800	6.14	1.31
YKA	2670	5.64	1.23
GBA	2800	5.60	1.25
WRA	2800	5.60	1.25

The P-wave speed (v_1) and density (ρ_1) in the Novaya Zemlya source region is assumed to be 4.0 km s^{-1} [ref 40] and 2500 kg m^{-3} [ref 37] respectively. ρ_o and v_o are taken from [ref 2].

TABLE 5.

Summary of the Analysis of P-wave Measurements Tabulated and Presented in Graphical Form in Appendix A.
(S indicates slope of the least squares line, I the intercept and σ^2 the variance. DOF gives the degrees of freedom.)

Station	$\log_{10} \psi_\infty$			Rise-time sec			Fall-times sec			Duration sec		
	S	I	σ^2	S	I	σ^2	S	I	σ^2	S	I	σ^2
EKA	0.96	-1.63	0.0158	0.01	-0.85	0.0023	0.16	-1.73	0.0047	0.09	-0.80	0.0017
YKA	1.21	-3.17	0.0393	0.11	-1.21	0.0046	0.15	-1.43	0.0133	0.20	-1.15	0.0044
GBA	0.64	0.37	0.0368	0.13	-1.46	0.0054	0.06	-1.17	0.0102	0.16	-1.13	0.0067
WRA	1.26	-4.19	0.0702	0.07	-0.99	0.0067	0.03	-0.88	0.0056	0.08	-0.55	0.0032

Station	Period sec			Station magnitude			(0.5-4) Hz period sec			(0.5-4) Hz magnitude		
	S	I	σ^2	S	I	σ^2	S	I	σ^2	S	I	σ^2
EKA	0.05	-0.54	0.0014	0.79	1.60	0.0063	0.04	-0.47	0.0011	0.84	1.29	0.0076
YKA	0.08	-0.59	0.0026	0.84	0.36	0.0127	0.04	-0.43	0.0199	0.80	0.70	0.0110
GBA	-0.05	0.12	0.0045	0.59	2.64	0.0118	0.04	-0.41	0.0163	0.69	2.09	0.0076
WRA	-	-0.02	0.0010	1.00	0.03	0.1063	-0.03	0.12	0.0014	1.03	-0.16	0.1196

Station	(1-4) Hz period sec			(1-4) Hz magnitude			station magnitude ($\log_{10}A$)			station magnitude ($\log A_o$)		
	S	I	σ^2	S	I	σ^2	S	I	σ^2	S	I	σ^2
EKA	0.06	-0.61	0.0007	0.83	1.31	0.0068	0.83	1.06	0.0090	0.79	1.69	0.0063
YKA	0.05	-0.56	0.0023	0.80	0.64	0.0131	0.91	-0.23	0.0189	0.82	0.57	0.0109
GBA	-0.01	-0.16	0.0014	0.65	2.21	0.0095	0.53	2.76	0.0200	0.59	2.69	0.0108
WRA	-0.01	-0.05	0.0062	1.05	-0.50	0.1249	1.00	0.01	0.1188	1.00	.04	.0990

TABLE 5. (continued)

Station	(0.5-4) Hz station m ($\log_{10}A$)			(0.5-4) Hz station m ($\log_{10}A_o$)			(1-4) Hz station m ($\log_{10}A$)			(1-4) Hz station m ($\log_{10}A_o$)		
	S	I	σ^2	S	I	σ^2	S	I	σ^2	S	I	σ^2
EKA	0.88	0.82	0.0066	0.84	1.38	0.0075	0.89	0.70	0.0070	0.83	1.40	0.0067
YKA	0.85	0.27	0.0374	0.82	0.64	0.0105	0.85	0.08	0.0147	0.80	0.74	0.0130
GBA	0.73	1.68	0.0360	0.64	2.43	0.0085	0.63	2.05	0.0123	0.64	2.34	0.0085
WRA	1.01	-0.04	0.1267	1.06	-0.29	0.1165	1.05	-0.54	0.1476	1.08	-0.62	0.1208

Station	pP-P (s)			DOF
	S	I	σ^2	
EKA	0.35	-2.18	0.0126	12
YKA	0.17	-1.01	0.0032	18
GBA	0.09	-0.82	0.0189	12
WRA	-0.02	-0.15	0.0009	14

TABLE 6.

Summary of the Analysis of P RMS Amplitudes in Different Windows, Filtered in the band 0.5-4 Hz.
(S indicates slope of the least squares line, I the intercept and σ^2 the variance. DOF gives the degrees of freedom.)

Station	RMS (0-3)s			RMS (0-6)s			RMS (0-9)s			RMS (0-15)s		
	S	I	σ^2	S	I	σ^2	S	I	σ^2	S	I	σ^2
EKA	0.88	-2.98	0.0069	0.86	-2.99	0.0072	0.86	-3.02	0.0072	0.85	-3.06	0.0075
YKA	0.84	-3.47	0.0100	0.77	-3.18	0.0117	0.75	-3.07	0.0109	0.72	-3.02	0.0102
GBA	0.64	-1.77	0.0105	0.65	-1.92	0.0087	0.64	-1.96	0.0084	0.63	-2.01	0.0077
WRA	1.04	-5.47	0.1233	0.98	-5.23	0.1087	0.95	-5.09	0.1021	0.90	-4.85	0.0983

Station	RMS (3-9)s			RMS (3-15)s			RMS (9-18)s					
	S	I	σ^2	S	I	σ^2	S	I	σ^2			
EKA	0.75	-2.79	0.0141	0.75	-2.84	0.0139	0.72	-2.80	0.0195			
YKA	0.66	-2.72	0.0169	0.65	-2.72	0.0136	0.60	-2.59	0.0117			
GBA	0.63	-2.02	0.0052	0.59	-2.07	0.0051	0.51	-2.00	0.0161			
WRA	0.76	-4.13	0.0771	0.70	-3.77	0.0747	0.57	-3.11	0.0644			

TABLE 7.

Summary of the Analysis of P RMS Amplitudes in Different Windows, filtered in the Band 1-4 Hz.
(S indicates slope of the least squares line, I the intercept and σ^2 the variance. DOF gives the degrees of freedom)

Station	RMS (0-3)s			RMS (0-6)s			RMS (0-9)s			RMS (0-15)s		
	S	I	σ^2	S	I	σ^2	S	I	σ^2	S	I	σ^2
EKA	0.88	-3.01	0.0066	0.86	-3.03	0.0069	0.86	-3.10	0.0069	0.86	-3.16	0.0071
YKA	0.83	-3.49	0.0126	0.77	-3.21	0.0142	0.76	-3.19	0.127	0.73	-3.15	0.0112
GBA	0.64	-1.83	0.0107	0.65	-2.00	0.0089	0.64	-2.04	0.0088	0.64	-2.12	0.0080
WRA	1.06	-5.83	0.1257	0.99	-5.45	0.1168	0.94	-5.16	0.1060	0.86	-4.74	0.1008

Station	RMS (3-9)s			RMS (3-15)s			RMS (9-18)s					
	S	I	σ^2	S	I	σ^2	S	I	σ^2			
EKA	0.79	-3.02	0.0140	0.78	-3.08	0.0135	0.77	-3.13	0.0200			
YKA	0.68	-2.88	0.0185	0.67	-2.88	0.0138	0.63	-2.81	0.0101			
GBA	0.65	-2.36	0.0084	0.62	-2.31	0.0072	0.51	-2.00	0.0161			
WRA	0.78	-4.28	0.0910	0.68	-3.77	0.0859	0.51	-2.81	0.0677			

Table 8.

Summary of the Analysis of PcP Measurements.
S indicates slope of the least squares line, I the intercept and σ^2 the variance. DOF gives the degrees of freedom

Station	$Log_{10}\psi_\infty$			Rise-time sec			Fall-time sec			Duration sec		
	S	I	σ^2	S	I	σ^2	S	I	σ^2	S	I	σ^2
EKA	0.96	-1.37	0.0247	0.03	-0.77	0.0052	-0.08	-1.15	0.0071	-0.05	-0.39	0.0040
YKA	1.42	-4.45	0.0442	0.08	-1.31	0.0041	0.22	-2.07	0.0048	0.14	-1.12	0.0034
GBA	1.29	-3.35	0.1128	0.00	-0.64	0.0041	-0.36	1.38	0.0111	-0.19	0.94	0.0053

Station	Period sec			$Log_{10}A/T$			(0.5-4) Hz period sec			(0.5-4) Hz $Log_{10}A/T$		
	S	I	σ^2	S	I	σ^2	S	I	σ^2	S	I	σ^2
EKA	0.08	-0.63	0.0016	0.88	-3.55	0.0129	0.05	-0.44	0.0034	0.96	-4.05	0.0191
YKA	0.04	-0.54	0.0079	1.26	-5.83	0.0405	-0.24	1.10	0.0096	0.86	-3.48	0.0365
GBA	0.07	-0.59	0.0026	1.88	-9.50	0.0283	0.17	-1.14	0.0010	1.94	-9.88	0.0233

Station	(1-4) Hz period sec			(1-4) Hz $Log_{10}A/T$			$Log_{10}A$			$Log_{10}A_o$		
	S	I	σ^2	S	I	σ^2	S	I	σ^2	S	I	σ^2
EKA	0.15	-1.12	0.0044	0.89	-3.75	0.0288	0.96	-4.18	0.0133	0.86	-3.36	0.0134
YKA	-0.10	0.29	0.0042	1.01	-4.41	0.0364	1.30	-6.37	0.0317	1.26	-5.75	0.0407
GBA	0.17	-1.16	0.0003	1.78	-9.05	0.0191	1.95	-10.09	0.0357	1.87	-9.38	0.0260

TABLE 8 (continued)

Station	(0.5-4) Hz $Log_{10}A$			(0.5-4) Hz $Log_{10}A_o$			(1-4) Hz $Log_{10}A$			(1-4) Hz $Log_{10}A_o$		
	S	I	σ^2	S	I	σ^2	S	I	σ^2	S	I	σ^2
EKA	-1.00	-4.49	0.0132	0.94	-3.89	0.0219	1.04	-4.88	0.0364	0.88	-3.64	0.0306
YKA	0.63	-2.38	0.0335	0.97	-4.04	0.0407	0.91	-4.12	0.0314	1.03	-4.43	0.0358
GBA	2.11	-11.02	0.0252	1.90	-9.56	0.0225	1.95	-10.21	0.0228	1.75	-8.80	0.0178

Station	pP-P (s)			DOF								
	S	I	σ^2									
EKA	0.00	-0.39	0.0008	20								
YKA	0.10	-0.74	0.0050	17								
GBA	-0.44	2.30	0.0150	5								

TABLE 9.

Summary of the Analysis of PcP RMS Amplitudes in Different Windows, filtered in the Band 0.5-4 Hz.
(S indicates slope of the least squares line, I the intercept and σ^2 the variance. DOF gives the degrees of freedom.)

Station	RMS (0-3)s			RMS (0-6)s			RMS (0-9)s			RMS (0-15)s		
	S	I	σ^2	S	I	σ^2	S	I	σ^2	S	I	σ^2
EKA	0.95	-4.03	0.0143	0.90	-4.14	0.0115	0.86	-3.97	0.0105	0.82	-3.78	0.0110
YKA	0.95	-4.28	0.0349	0.85	-3.80	0.0335	0.80	-3.60	0.0300	0.77	-3.51	0.0248
GBA	1.92	-10.04	0.0212	1.89	-9.98	0.0224	1.88	-10.01	0.0213	1.88	-10.11	0.0198

Station	RMS (3-9)s			RMS (3-15)s			RMS (9-18)s					
	S	I	σ^2	S	I	σ^2	S	I	σ^2			
EKA	0.73	-3.46	0.0170	0.69	-3.26	0.0169	0.66	-3.11	0.0205			
YKA	0.61	-2.73	0.0233	0.61	-2.79	0.0215	0.60	-2.96	0.0943			
GBA	1.60	-8.65	0.0259	1.69	-9.28	0.0171	1.78	-9.89	0.0098			

TABLE 10.

Summary of the Analysis of PcP RMS Amplitudes in Different Windows, Filtered in the band 1-4 Hz.
(S indicates slope of the least squares line, I the intercept and σ^2 the variance. DOF gives the degrees of freedom)

Station	RMS (0-3)s			RMS (0-6)s			RMS (0-9)s			RMS (0-15)s		
	S	I	σ^2	S	I	σ^2	S	I	σ^2	S	I	σ^2
EKA	0.91	-4.20	0.0229	0.87	-4.05	0.0185	0.84	-3.94	0.0160	0.82	-3.90	0.0147
YKA	0.97	-4.48	0.0316	0.89	-4.14	0.0296	0.84	-3.92	0.0288	0.81	-3.84	0.0260
GBA	1.76	-9.19	0.0196	1.73	-9.16	0.0190	1.74	-9.30	0.0191	1.76	-9.47	0.0186

Station	RMS (3-9)s			RMS (3-15)s			RMS (9-18)s					
	S	I	σ^2	S	I	σ^2	S	I	σ^2			
EKA	0.71	-3.49	0.0163	0.72	0.3.56	0.0146	0.73	-3.72	0.0192			
YKA	0.63	-2.99	0.0217	0.63	-3.02	0.0162	0.63	-3.28	0.1616			
GBA	1.57	-8.62	0.0219	1.70	-9.43	0.0184	1.81	-10.19	0.0176			

Table 11.

m_b^{ML}, Array m_b, $\log_{10}\psi_\infty$ and $\log_{10}M_o$ for Explosions at Novaya Zemlya

	Date	m_b^{ML}	Array m_b	$\mathrm{Log}_{10}\psi_\infty$	$\mathrm{Log}_{10}M_o$	Area
1	641025	4.82	5.15	3.03	14.72	NE
2	661027(D)	6.49	6.42	4.86	16.55	NE
3	671021(D)	5.98	5.92	4.04	15.74	NE
4	681107	6.13	6.24	4.38	16.08	NE
5	691014(D)	6.18	6.23	4.45	16.15	NE
6	701014	6.79	6.55	4.81	16.50	S
7	710927	6.67	6.64	4.85	16.54	NE
8	720828	6.49	6.56	4.95	16.64	NE
9	730912	6.97	6.82	5.13	16.82	S
10	740829	6.58	6.76	4.94	16.63	NE
11	750823	6.55	6.55	4.83	16.52	W
12	751021	6.60	6.44	4.64	16.33	S
13	760929	5.83	5.74	3.93	15.64	S
14	761020	4.98	4.97	3.02	14.73	NE
15	770901	5.66	5.68	3.68	15.38	W
16	771009	4.36	4.69	2.49	14.19	NE
17	780810	6.00	5.95	4.23	15.93	S
18	780927	5.63	5.64	3.87	15.58	W
19	790924	5.77	5.75	3.96	15.66	W
20	791018	5.79	5.78	4.08	15.78	S
21	801011(D)	5.77	5.88	4.11	15.81	S
22	811001	5.97	5.91	4.13	15.78	S
23	821011	5.58	5.48	3.72	15.43	S
24	830818	5.91	5.93	4.19	15.89	S
25	830925	5.77	5.75	4.00	15.70	W
26	841025	5.82	5.87	4.08	15.78	S
27	870802	5.82	5.75	4.14	15.84	W
28	880507	5.58	5.52	3.94	15.64	W
29	881204	5.89	5.92	4.12	15.82	S

Southern Test Site:		
1	730927	5.89
2	751018(D)	6.75
3	741102	6.81
4	731027	6.98

(D) Indicates double explosion

TABLE 12.

Station Corrections for $\log_{10} \psi_\infty$

Station	Phase	Correction	n	95% Confidence Limits
EKA	P	+0.054	14	±0.123
EKA	PcP	-0.274	22	±0.121
YKA	P	+0.208	20	±0.104
YKA	PcP	+0.192	19	±0.105
GBA	P	-0.027	13	±0.124
GBA	PcP	-0.153	7	±0.167

Captions to Figures

Figure 1 Location of the two test-sites at Novaya Zemlya.

Figure 2 The geology of Novaya Zemlya.

Figure 3 Location of the four medium-aperture arrays relative to Novaya Zemlya.

Figure 4 Relative amplitude response of the broad band and the YKA short period systems.

Figure 5 An example of the short period and broad band seismograms and observations for the NZ explosion on 20 Oct 1976 recorded at GBA. On the lower left the figure shows where the SP peak-to-peak amplitude is measured and its half-period. Underneath is the BB P-wave showing the rise-time, fall-time, duration and pP-P interval. The measured area pulse H_o, is shown by the filled area on the t* corrected BB seismogram. The box to the lower right gives details of the measurements made on the different seismograms.

Figure 6 Location of explosions at the Novaya Zemlya (Northern) test-site:

(a) ISC epicentres; (b) the JED locations.

Figure 7 Location of explosions at the Novaya Zemlya (Southern) test-site:

(a) ISC epicentres; (b) the JED locations.

Figure 8 Areas of NNZ based on the appearance of the seismograms.

Figure 9 P seismograms and their sum for explosions in the North-east area of the NNZ test site recorded at EKA.

Figure 10 P seismograms and their sum for explosions in the South area of the NNZ test site recorded at EKA.

Figure 11 P seismograms and their sum for explosions in the West area of the NNZ test site recorded at EKA.

Figure 12 P seismograms and their sum for explosions in the North-east area of the NNZ test site recorded at YKA.

Figure 13 P seismograms and their sum for explosions in the South area of the NNZ test site recorded at YKA.

Figure 14 P seismograms and their sum for explosions in the West area of the NNZ test site recorded at YKA.

Figure 15 P seismograms and their sum for explosions in the North-east area of the NNZ test site recorded at GBA.

Figure 16 P seismograms and their sum for explosions in the South area of the NNZ test site recorded at GBA.

Figure 17 P seismograms and their sum for explosions in the West area of the NNZ test site recorded at GBA.

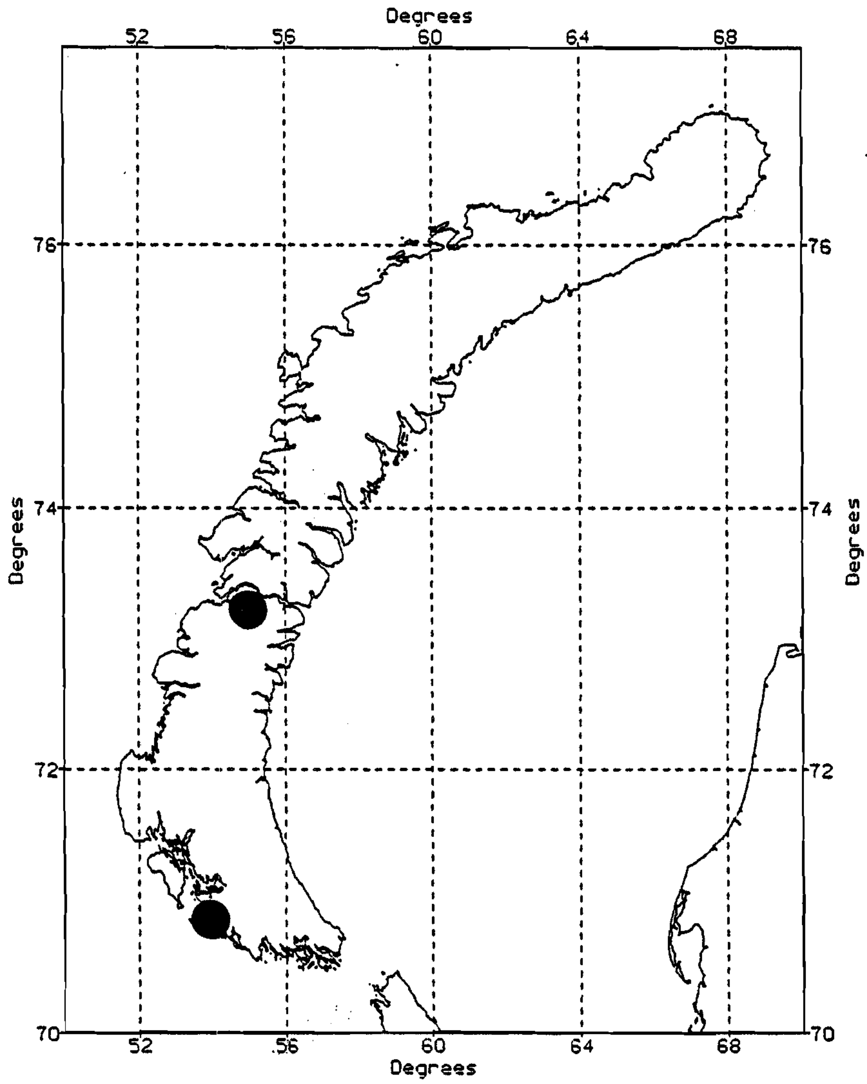


Figure 1 Location of the two test-sites at Novaya Zemlya.

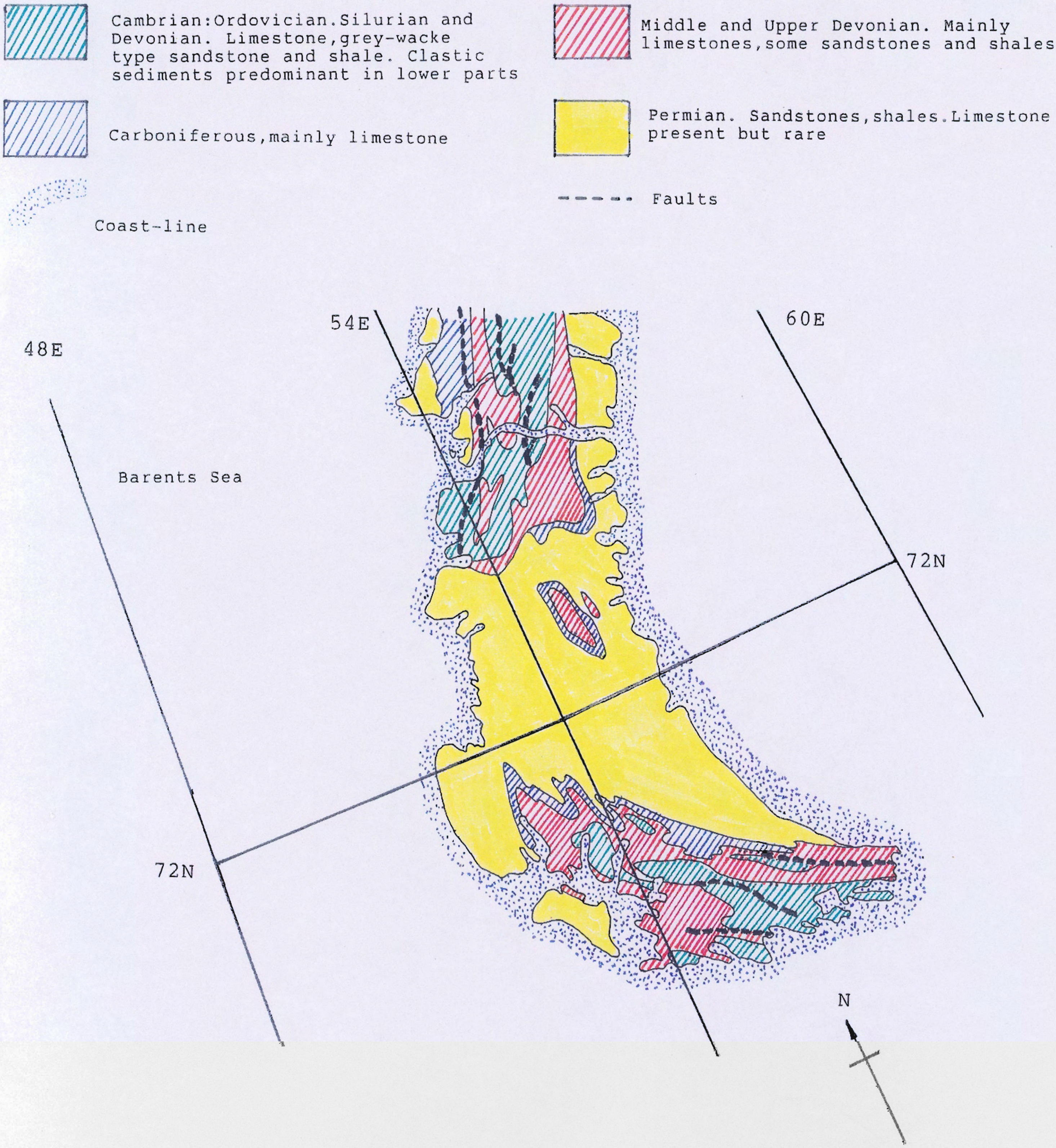


Figure 2 The geology of Novaya Zemlya.

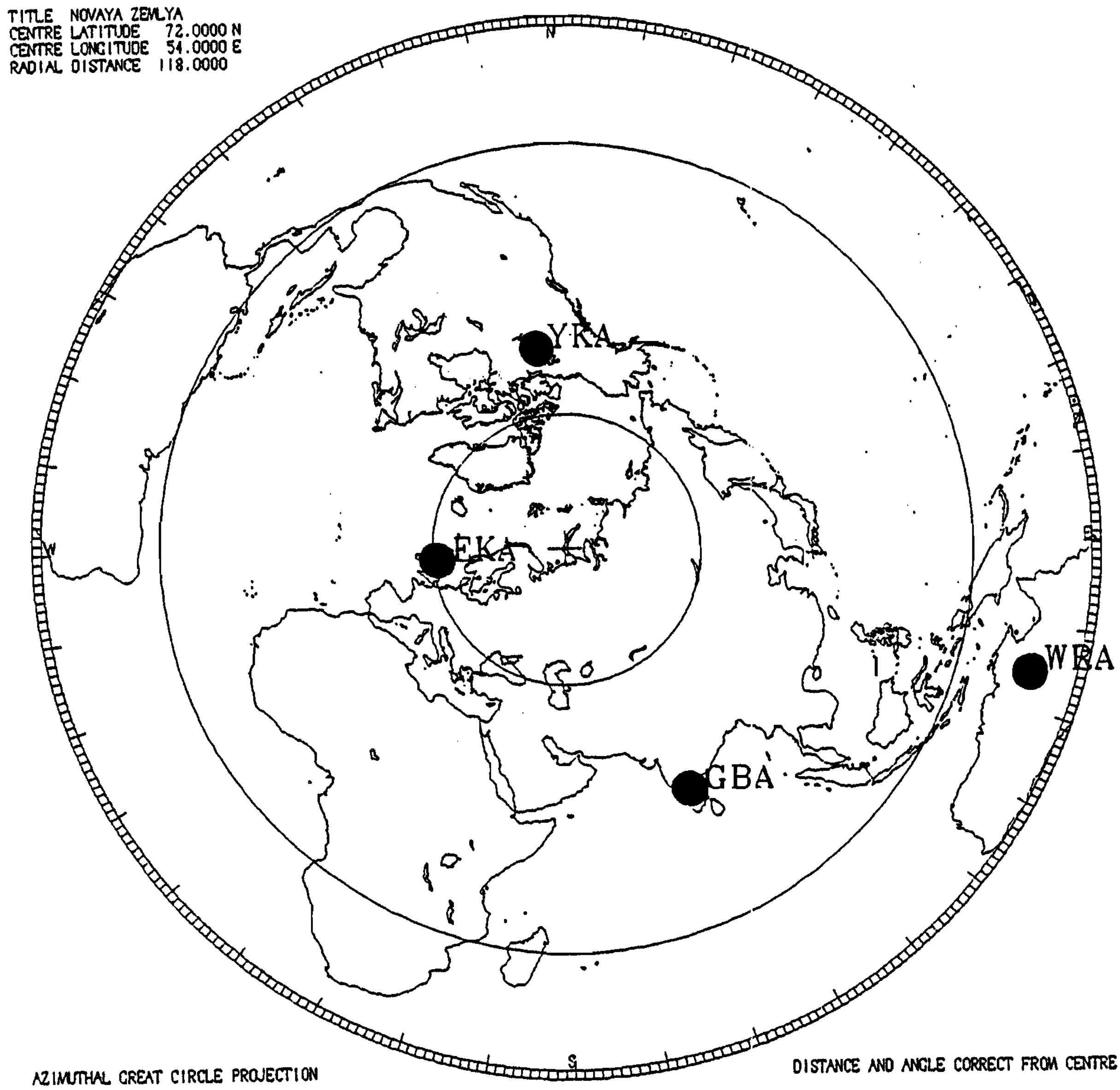


Figure 3 Location of the four medium-aperture arrays relative to Novaya Zemlya.

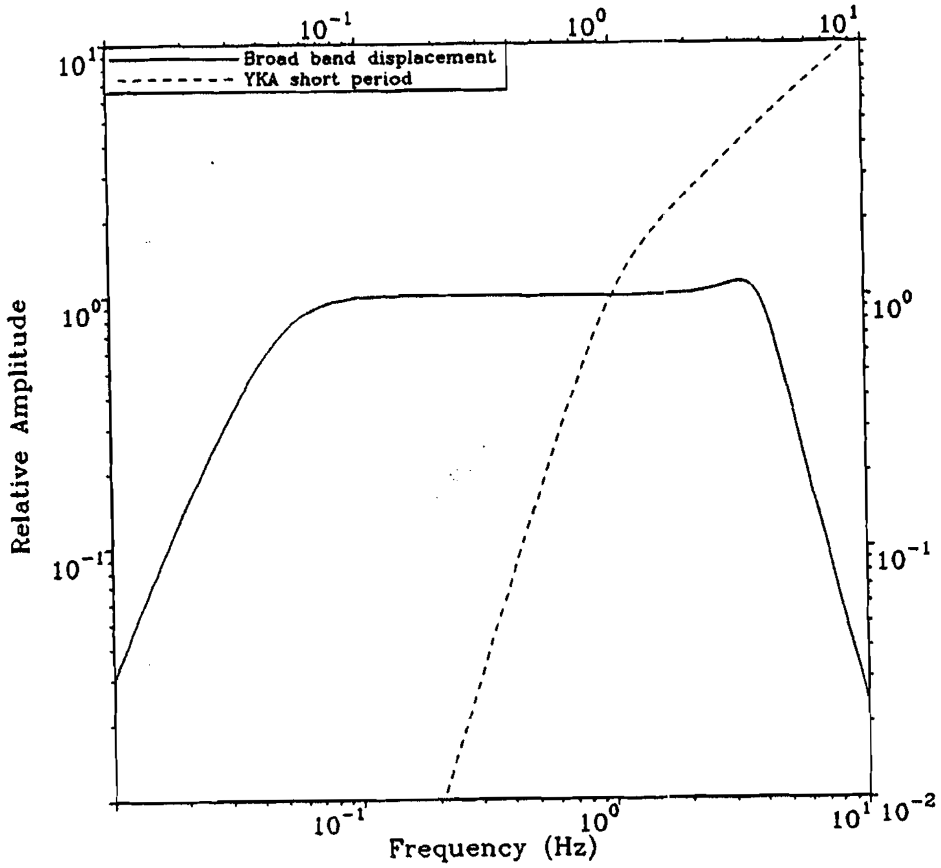


Figure 4 Relative amplitude response of the broad band and the YKA short period systems.

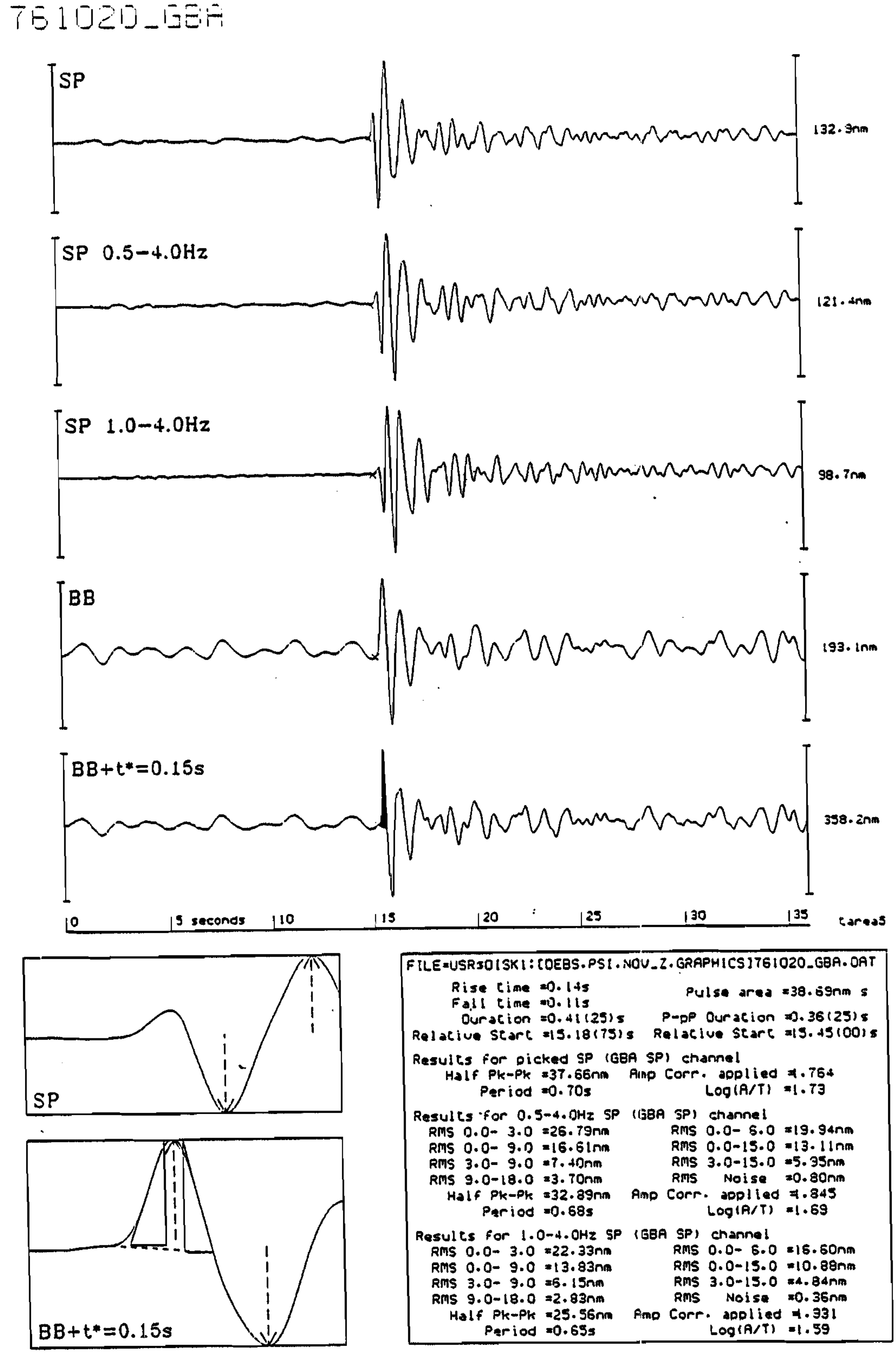


Figure 5 An example of the short period and broad band seismograms and observations for the NZ explosion on 20 Oct 1976 recorded at GBA. On the lower left the figure shows where the SP peak-to-peak amplitude is measured and its half-period. Underneath is the BB P-wave showing the rise-time, fall-time, duration and pP-P interval. The measured area pulse H_0, is shown by the filled area on the t* corrected BB seismogram. The box to the lower right gives details of the measurements made on the different seismograms.

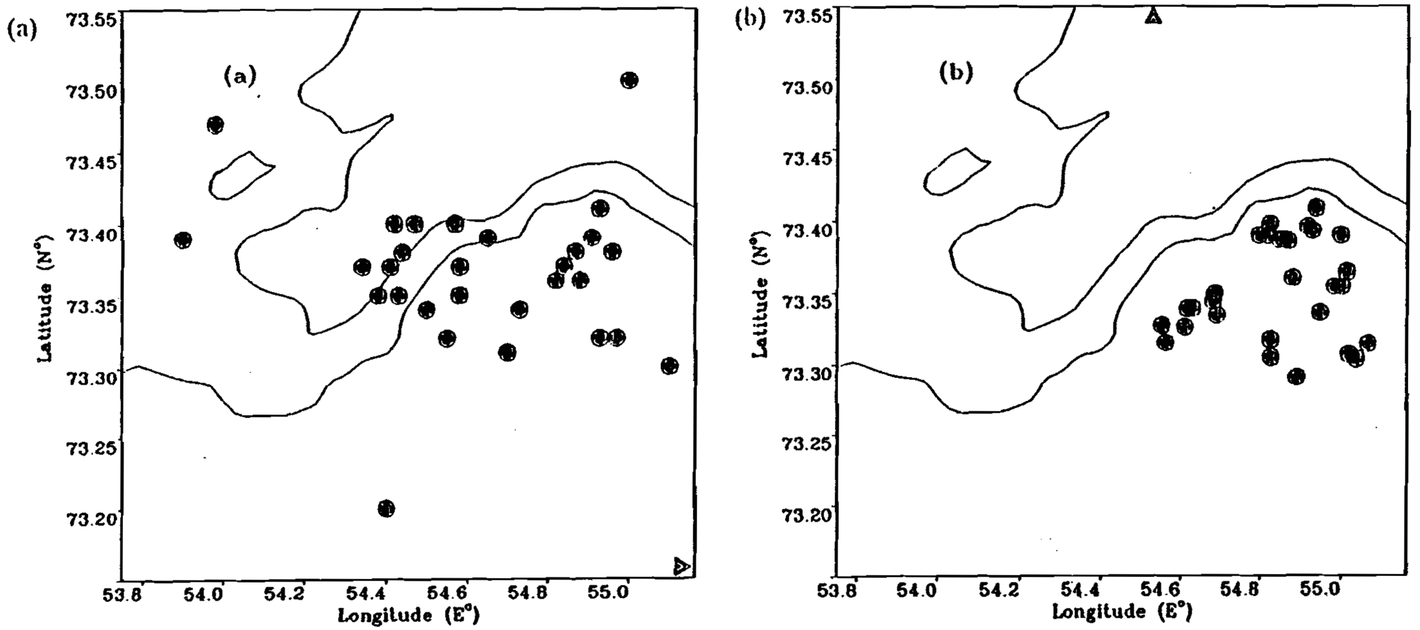


Figure 6 Location of explosions at the Novaya Zemlya (Northern) test-site:

(a) ISC epicentres; (b) the JED locations.

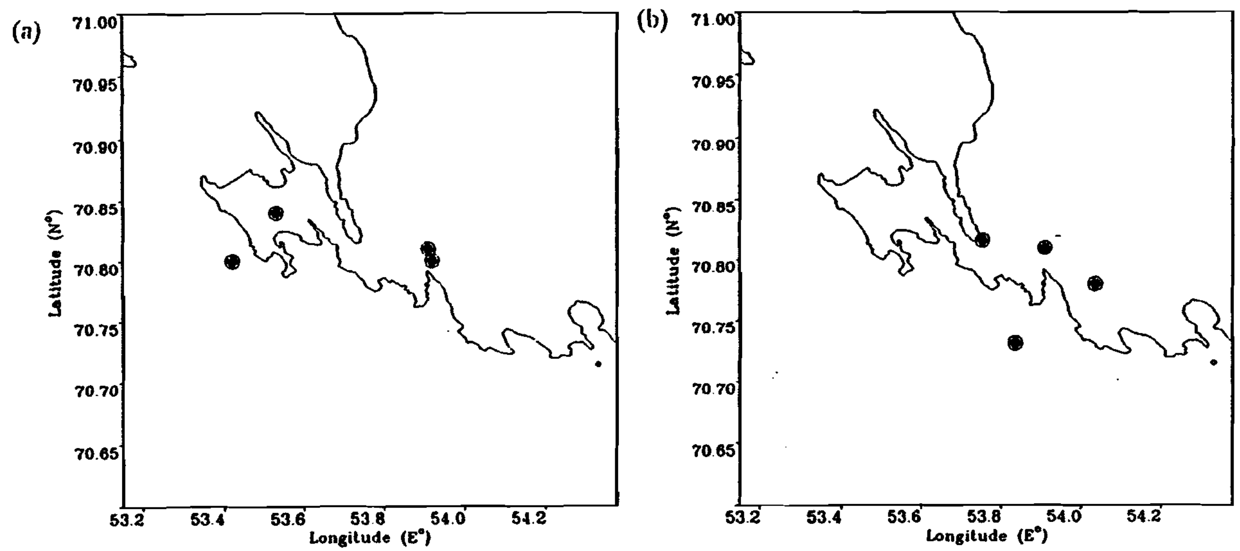


Figure 7 Location of explosions at the Novaya Zemlya (Southern) test-site:

(a) ISC epicentres; (b) the JED locations.

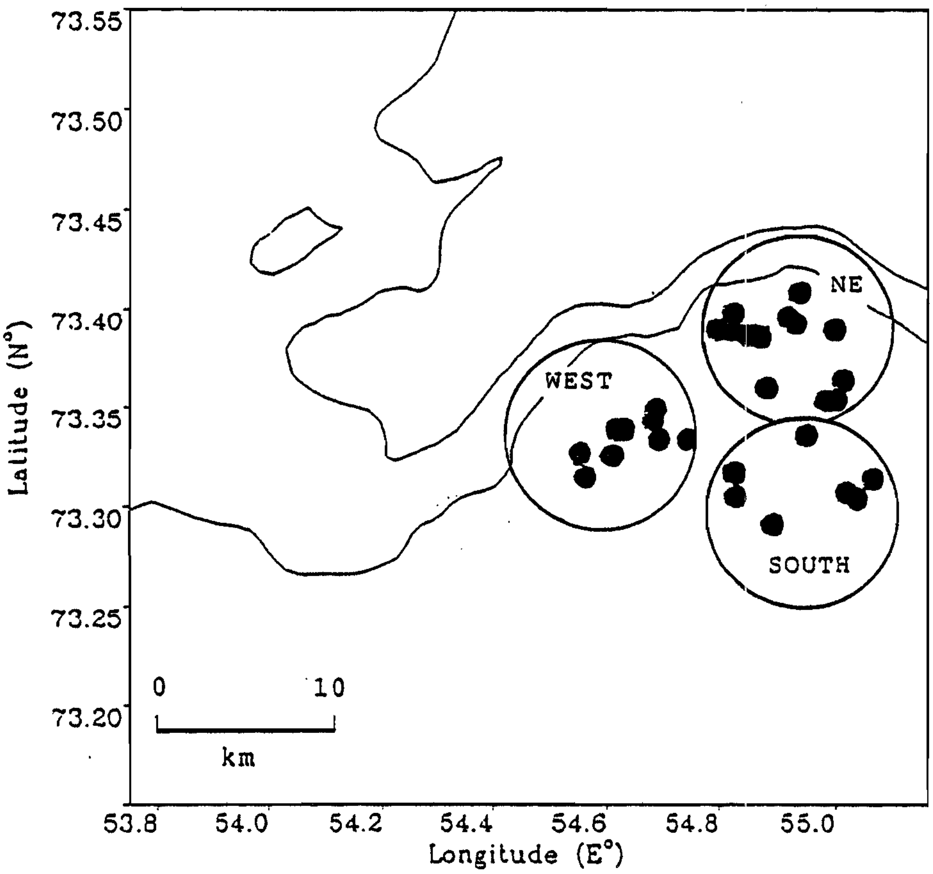


Figure 8 Areas of NNZ based on the appearance of the seismograms.

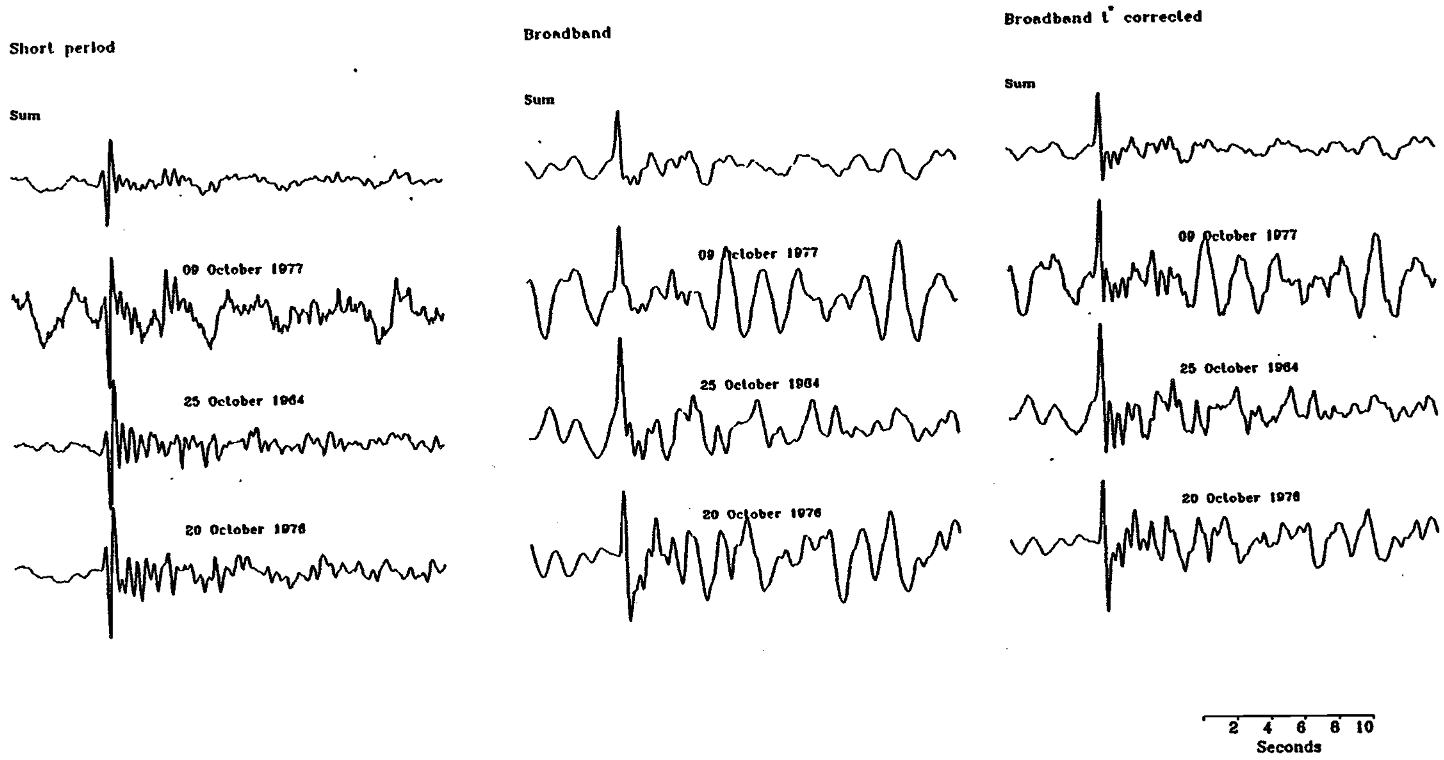


Figure 9 P seismograms and their sum for explosions in the North-east area of the NNZ test site recorded at EKA.

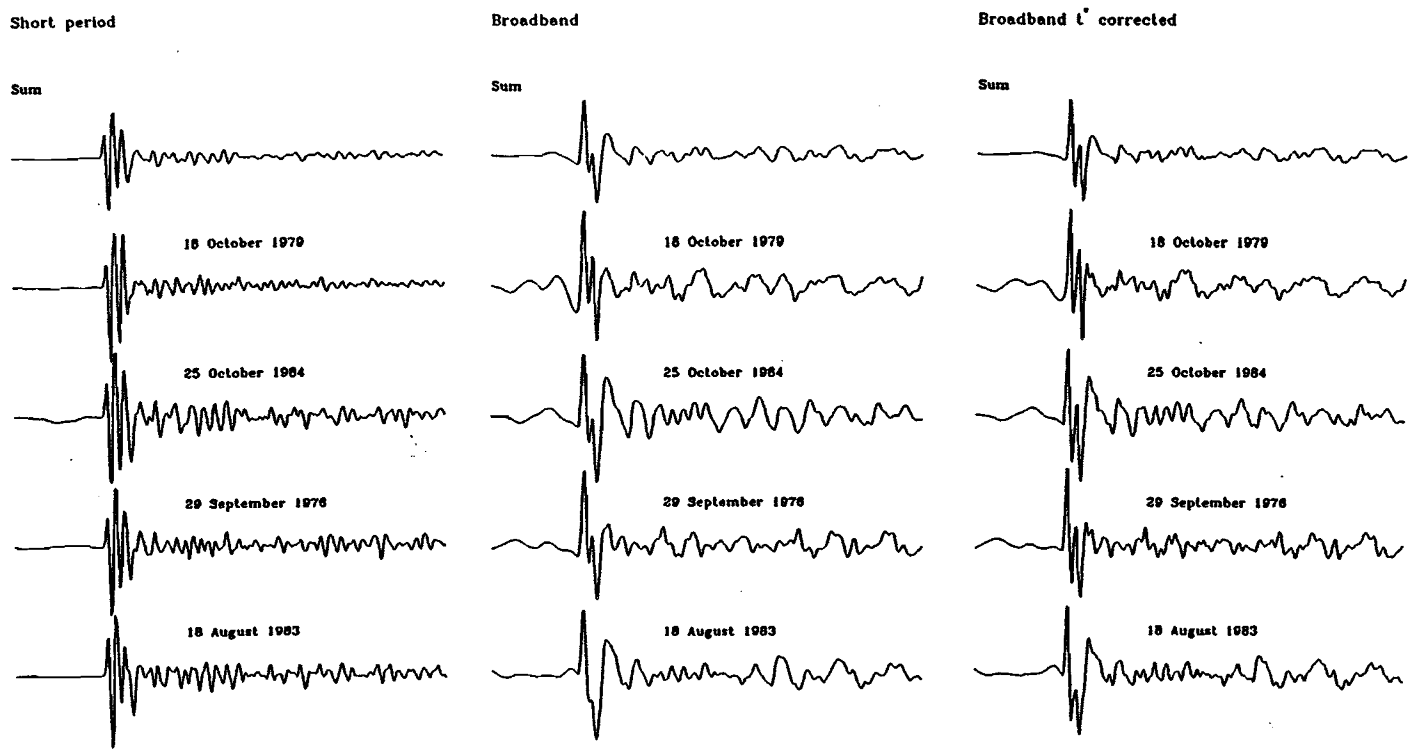


Figure 10 P seismograms and their sum for explosions in the South area of the NNZ test site recorded at EKA.

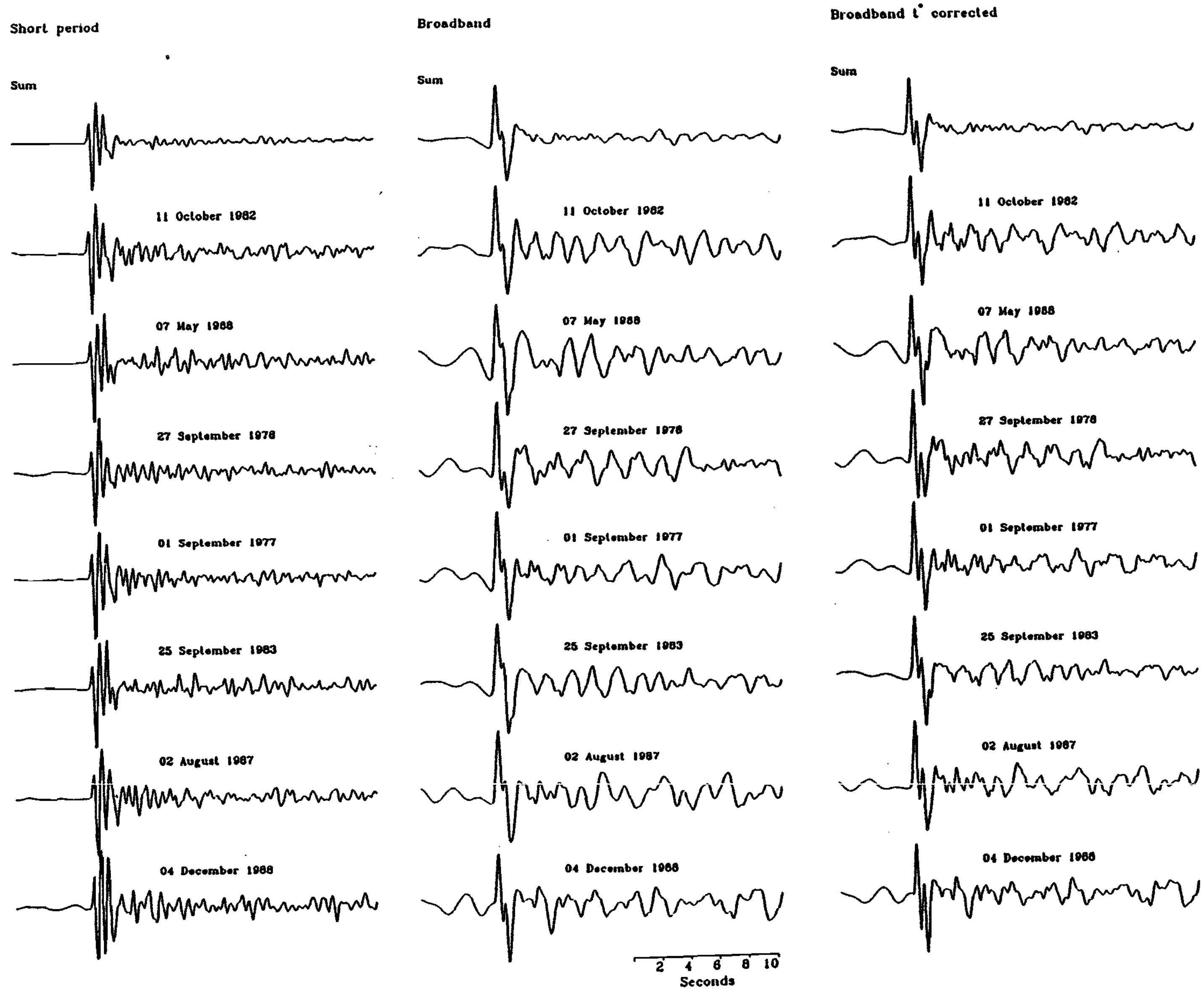


Figure 11 P seismograms and their sum for explosions in the West area of the NNZ test site recorded at EKA.

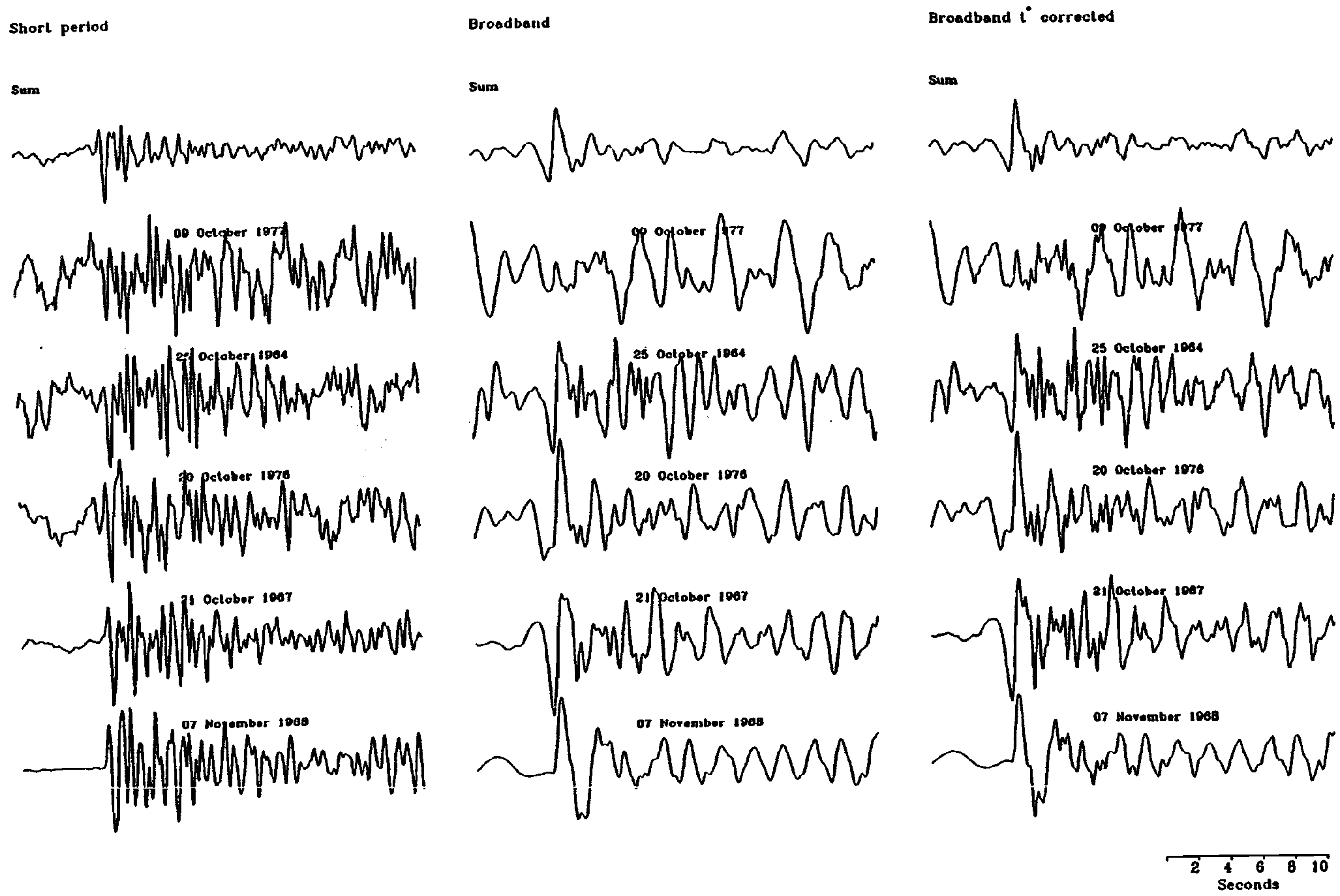


Figure 12 P seismograms and their sum for explosions in the North-east area of the NNZ test site recorded at YKA.

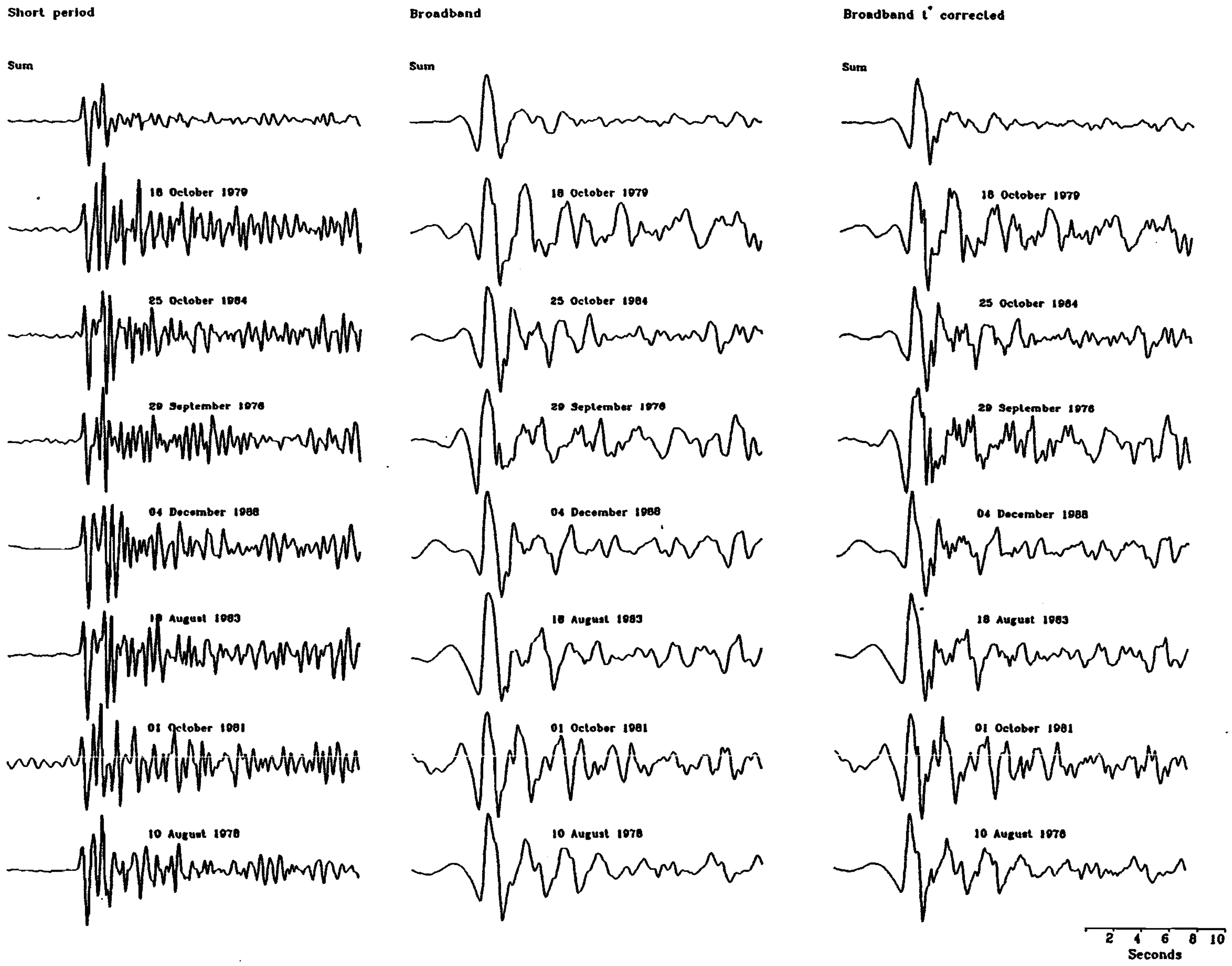


Figure 13 P seismograms and their sum for explosions in the South area of the NNZ test site recorded at YKA.

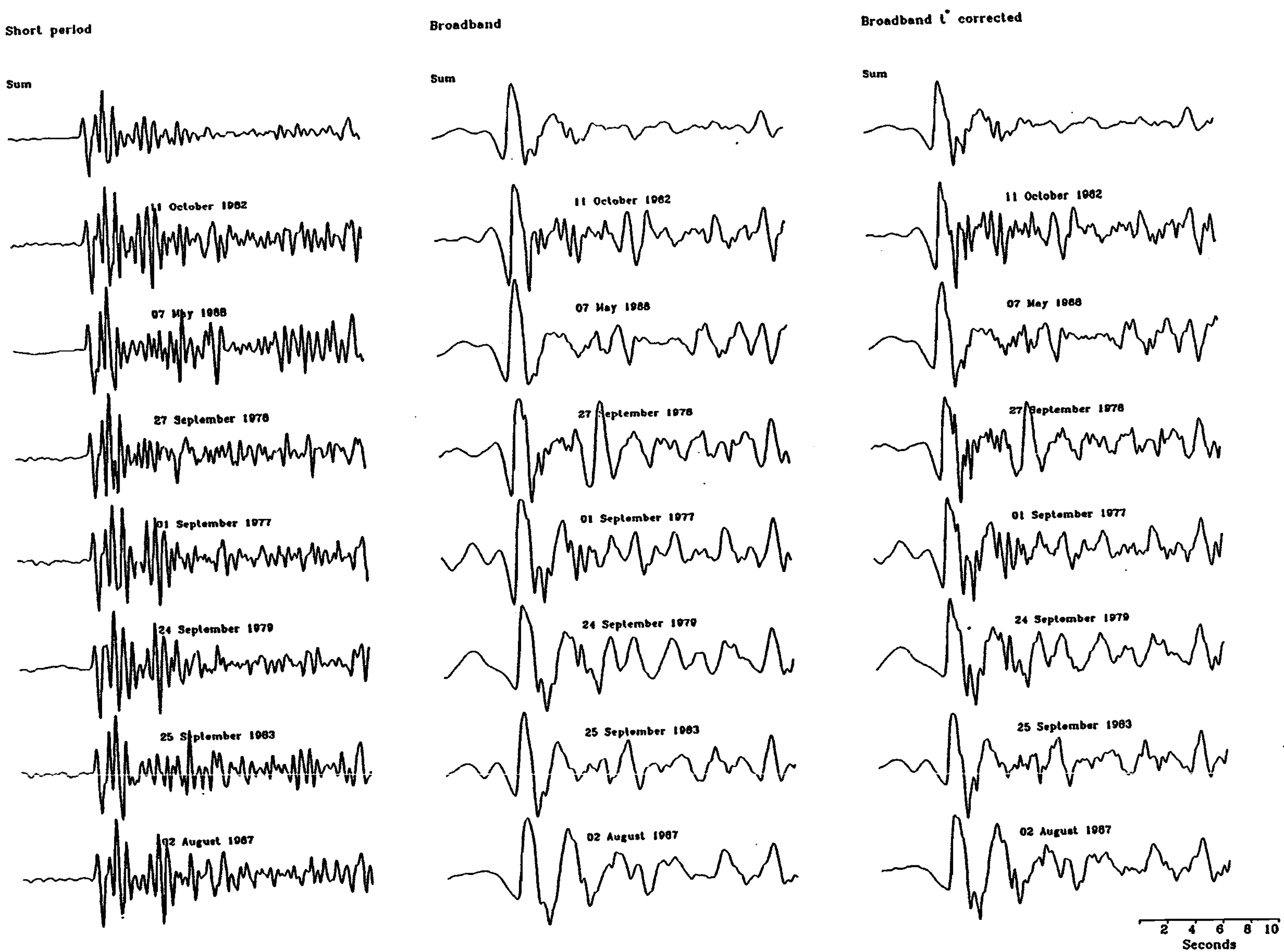


Figure 14 P seismograms and their sum for explosions in the West area of the NNZ test site recorded at YKA.

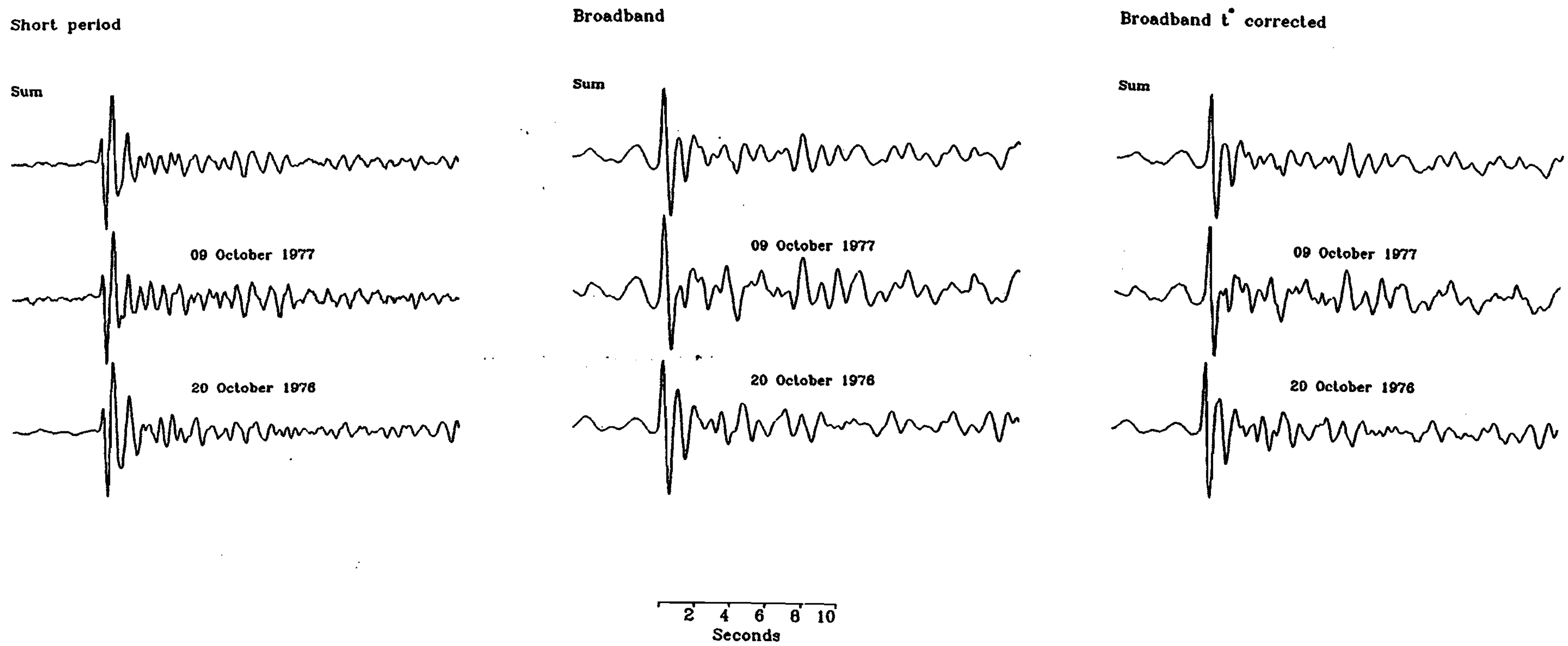


Figure 15 P seismograms and their sum for explosions in the North-east area of the NNZ test site recorded at GBA.

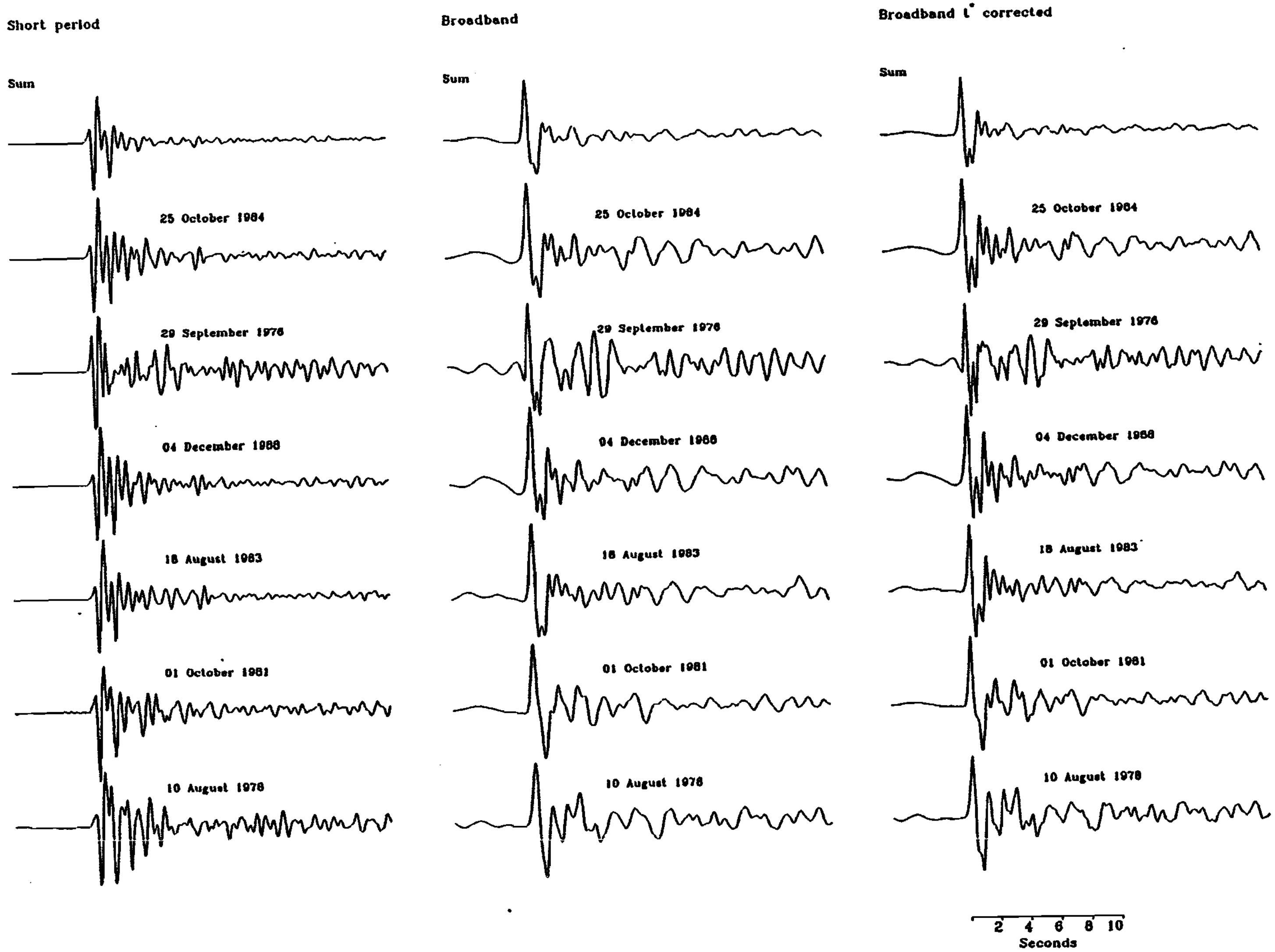


Figure 16 P seismograms and their sum for explosions in the South area of the NNZ test site recorded at GBA.

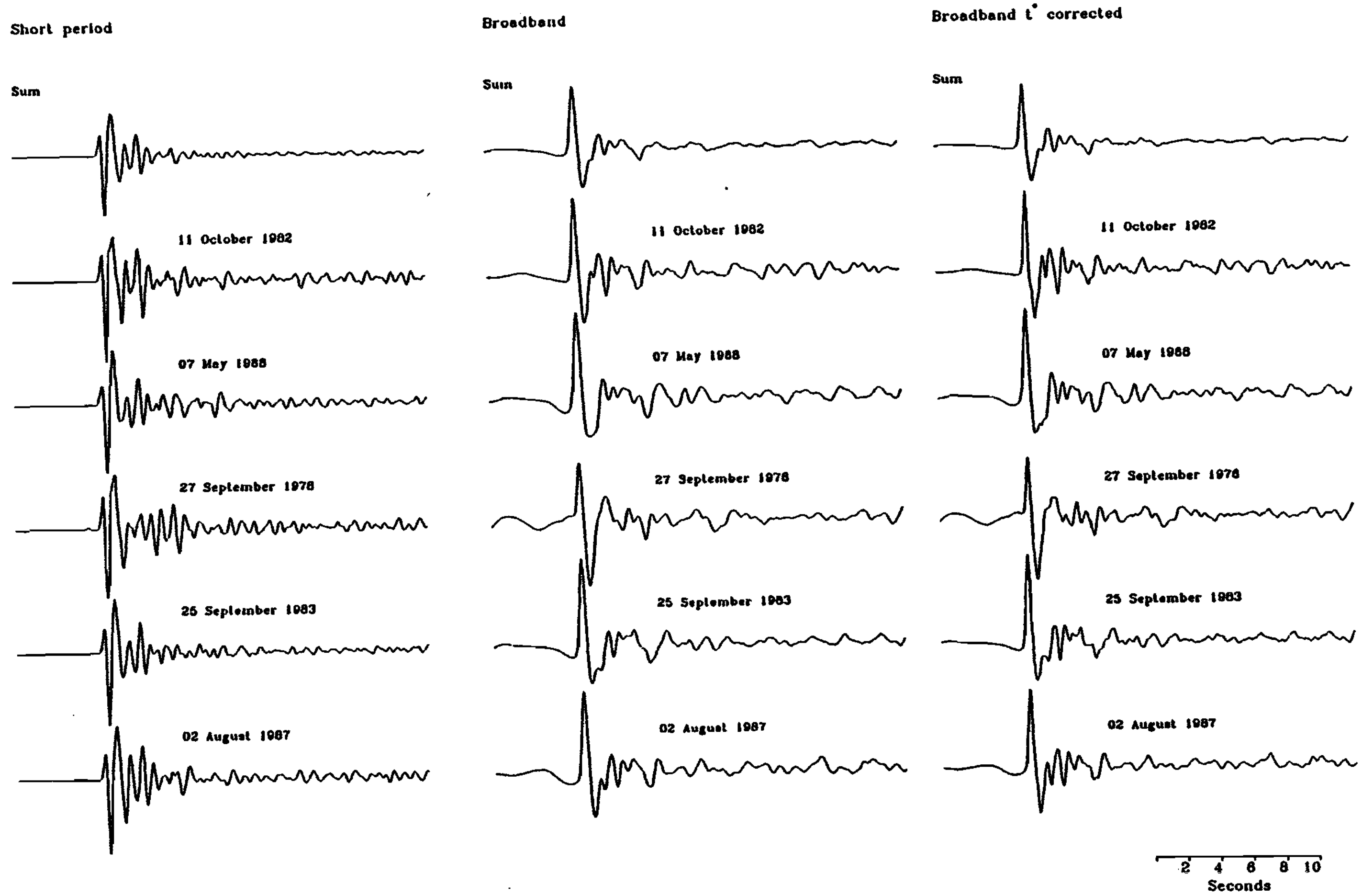


Figure 17 P seismograms and their sum for explosions in the West area of the NNZ test site recorded at GBA.

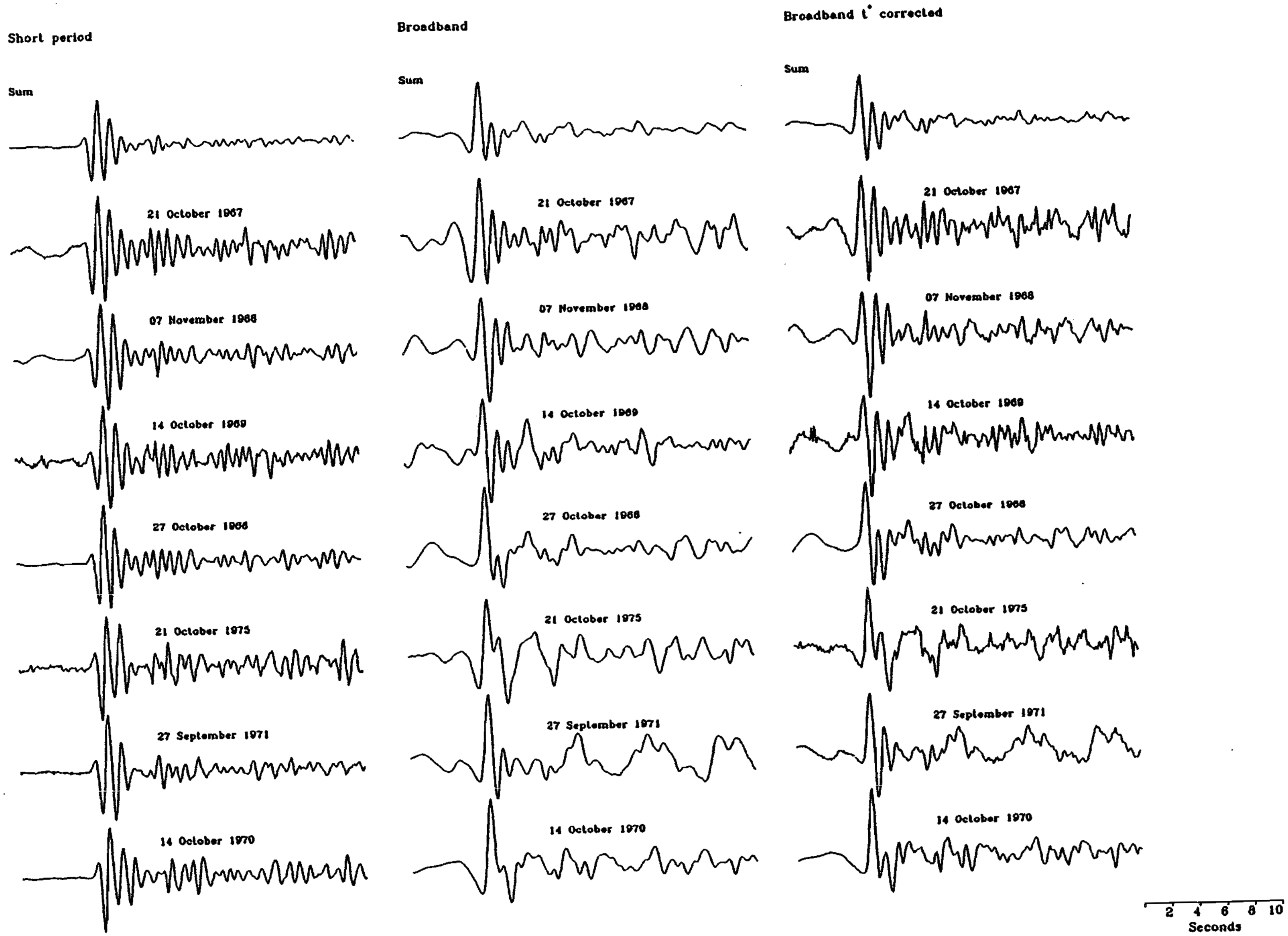


Figure 18 P seismograms and their sum for explosions in the North-east area of the NNZ test site recorded at WRA.

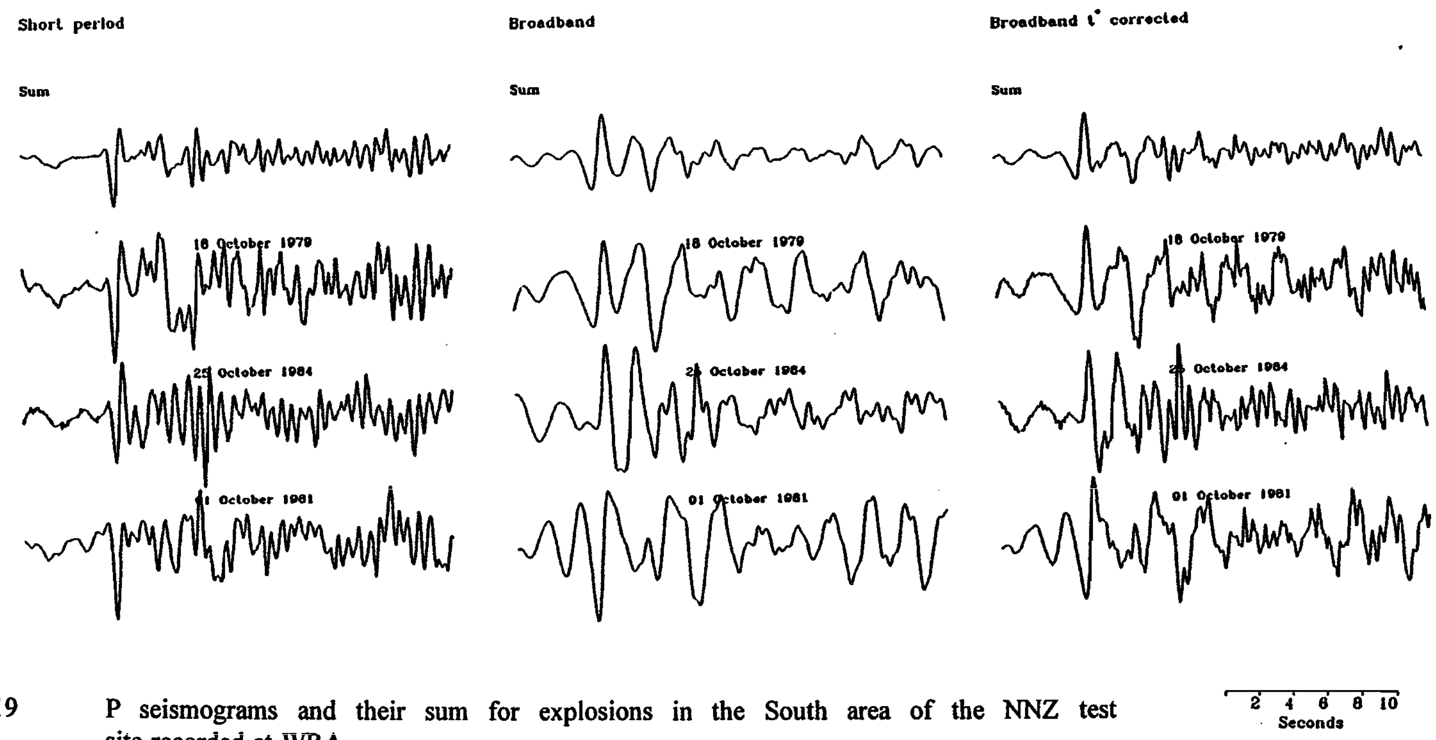


Figure 19 P seismograms and their sum for explosions in the South area of the NNZ test site recorded at WRA.

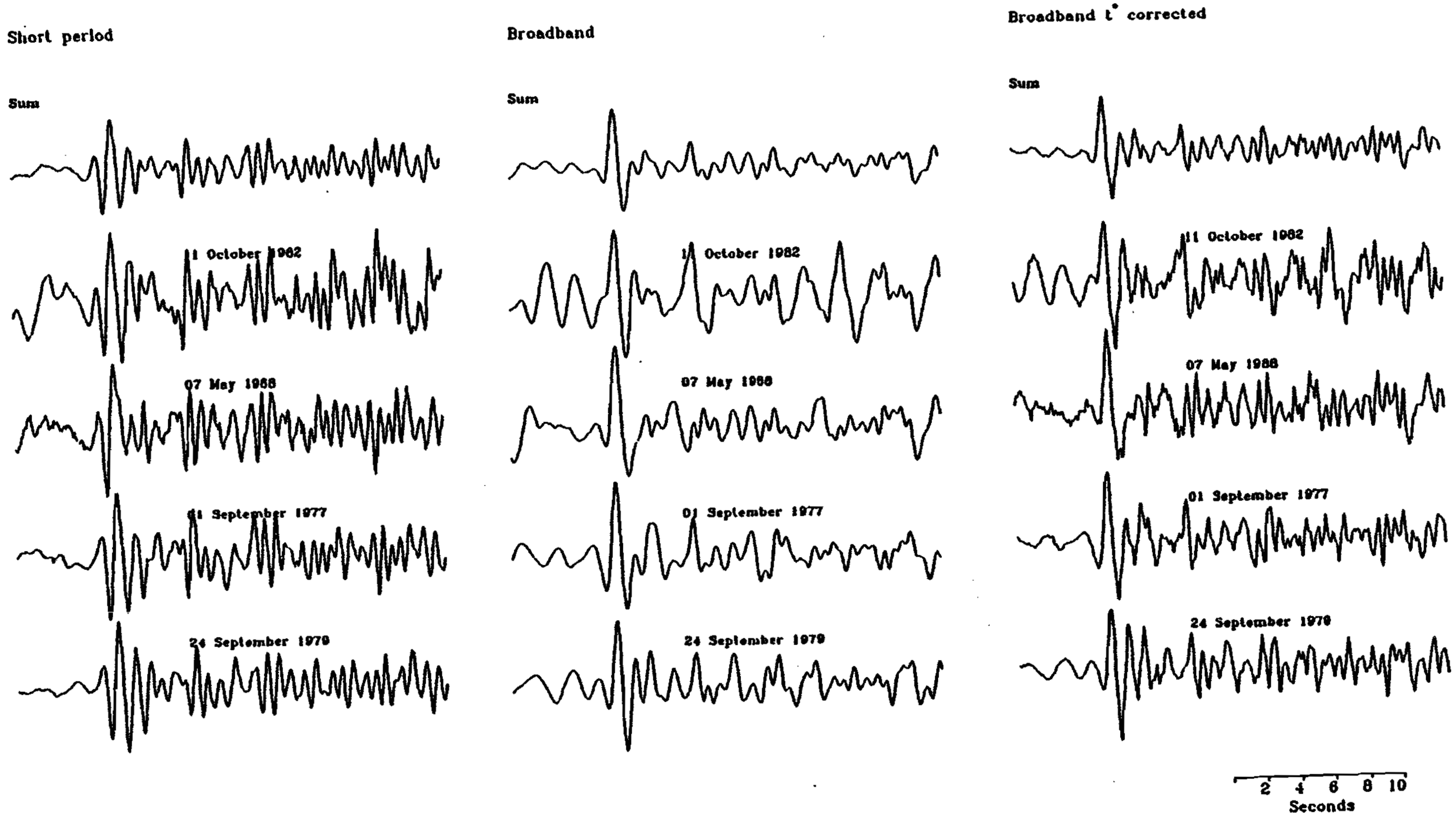


Figure 20 P seismograms and their sum for explosions in the West area of the NNZ test site recorded at WRA.

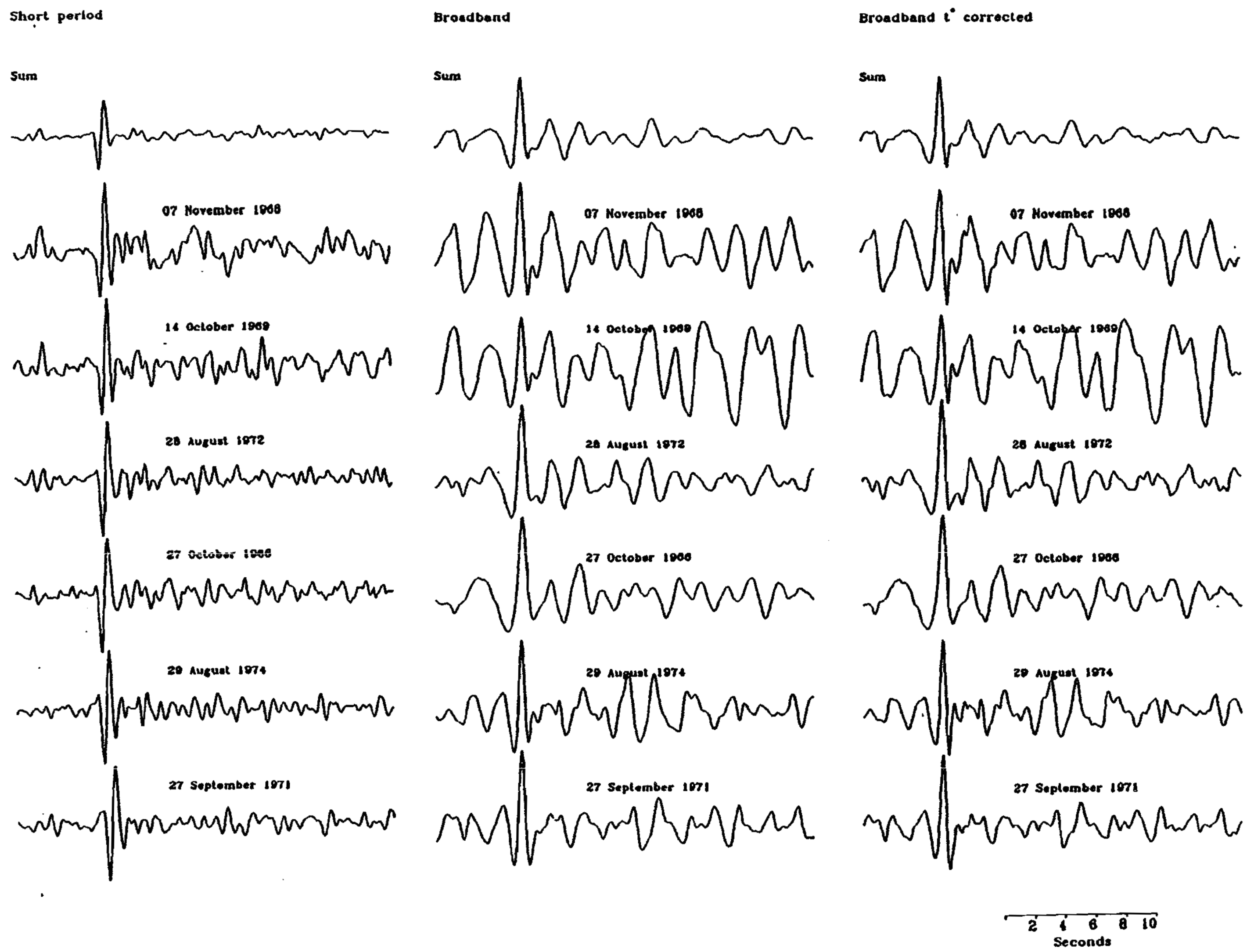


Figure 21 PcP seismograms and their sum for explosions in the North-east area of the NNZ test site recorded at EKA.

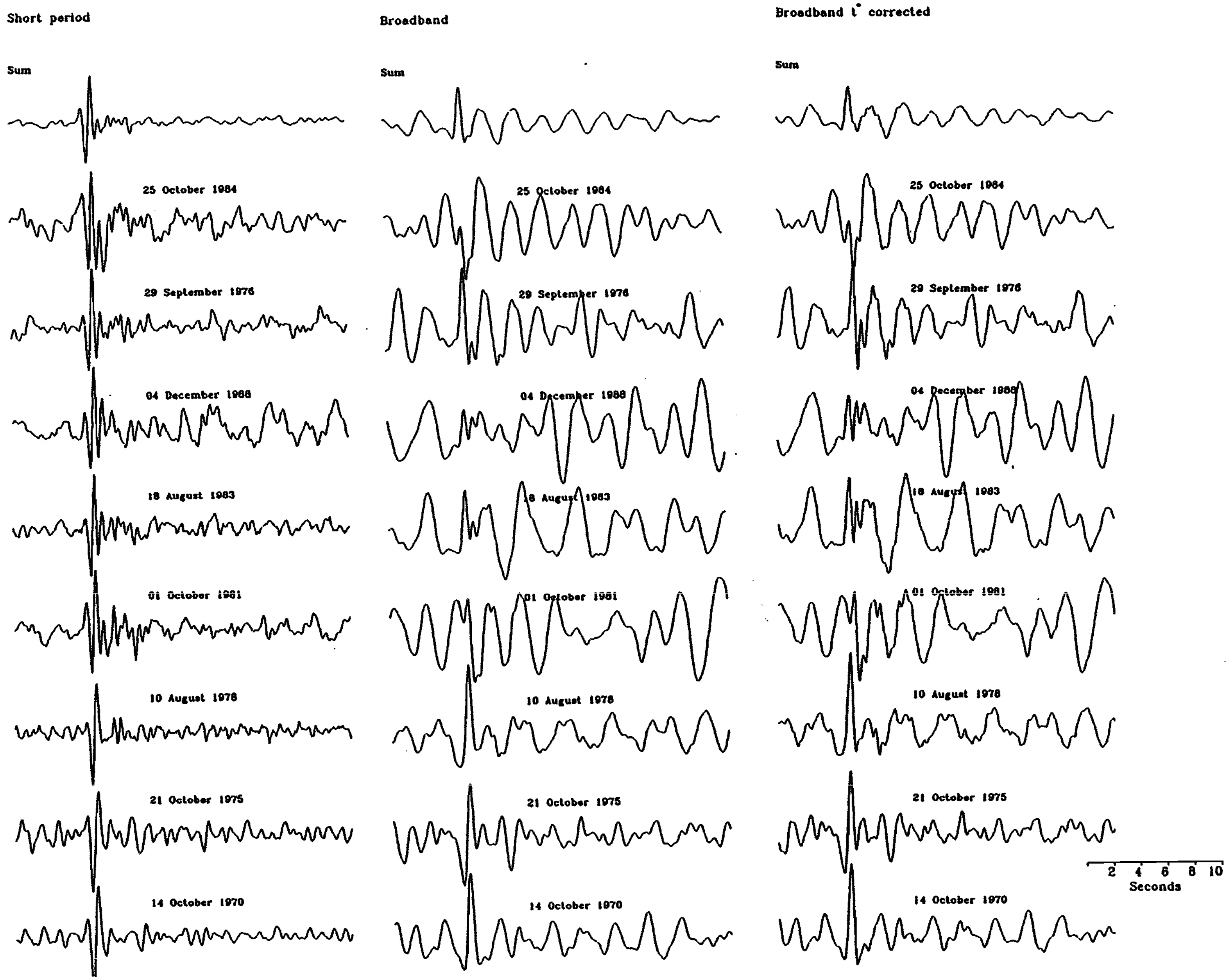


Figure 22 PcP seismograms and their sum for explosions in the South area of the NNZ test site recorded at EKA.

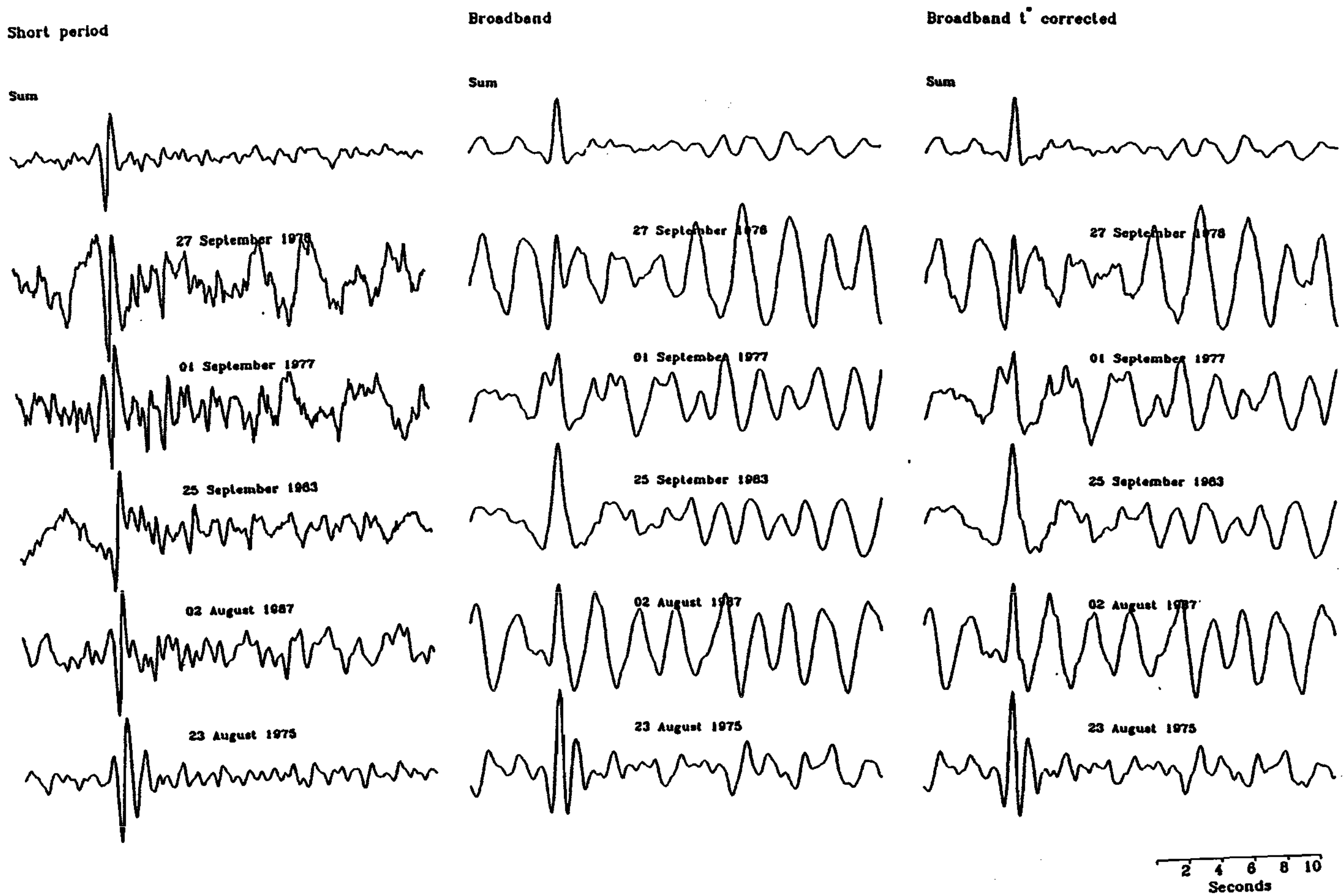


Figure 23 PcP seismograms and their sum for explosions in the West area of the NNZ test site recorded at EKA.

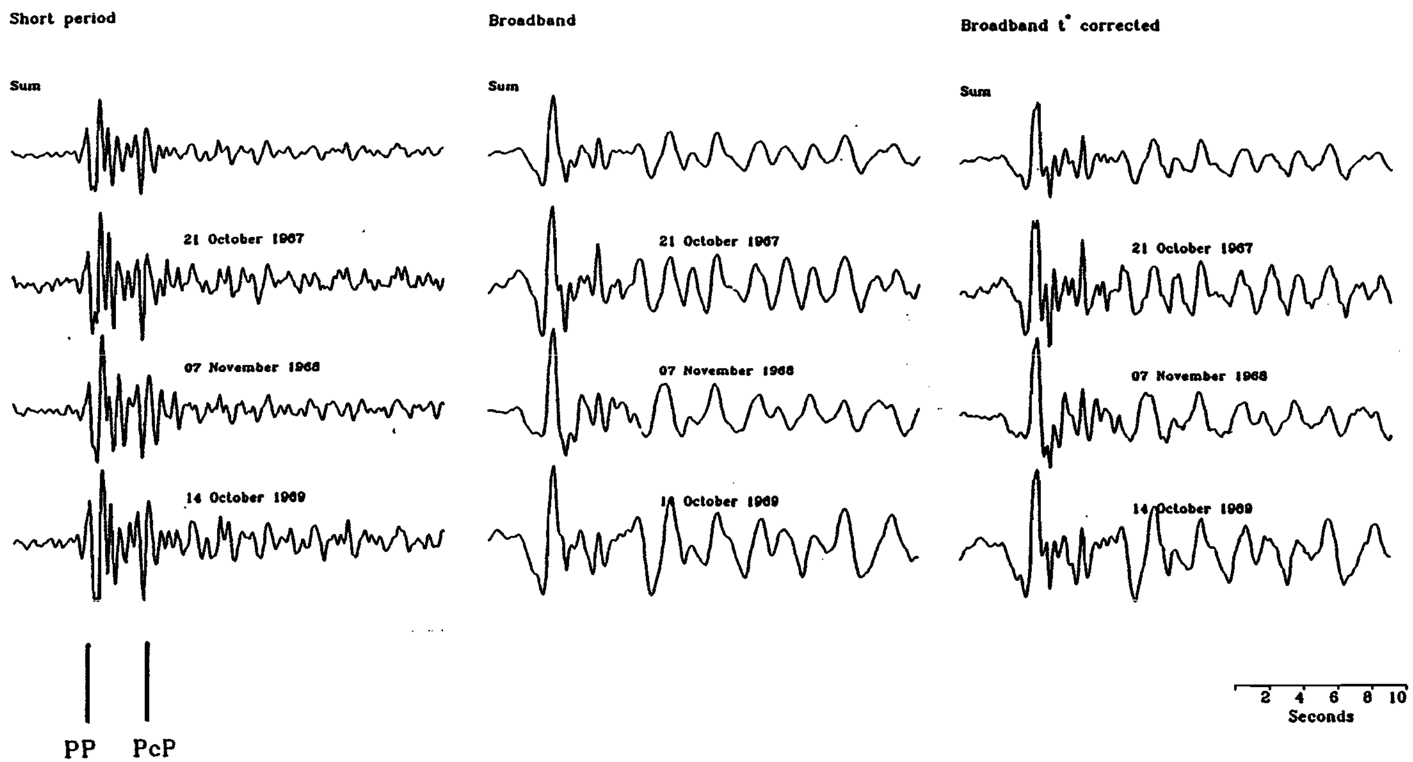


Figure 24 PcP seismograms and their sum for explosions in the North-east area of the NNZ test site recorded at YKA.

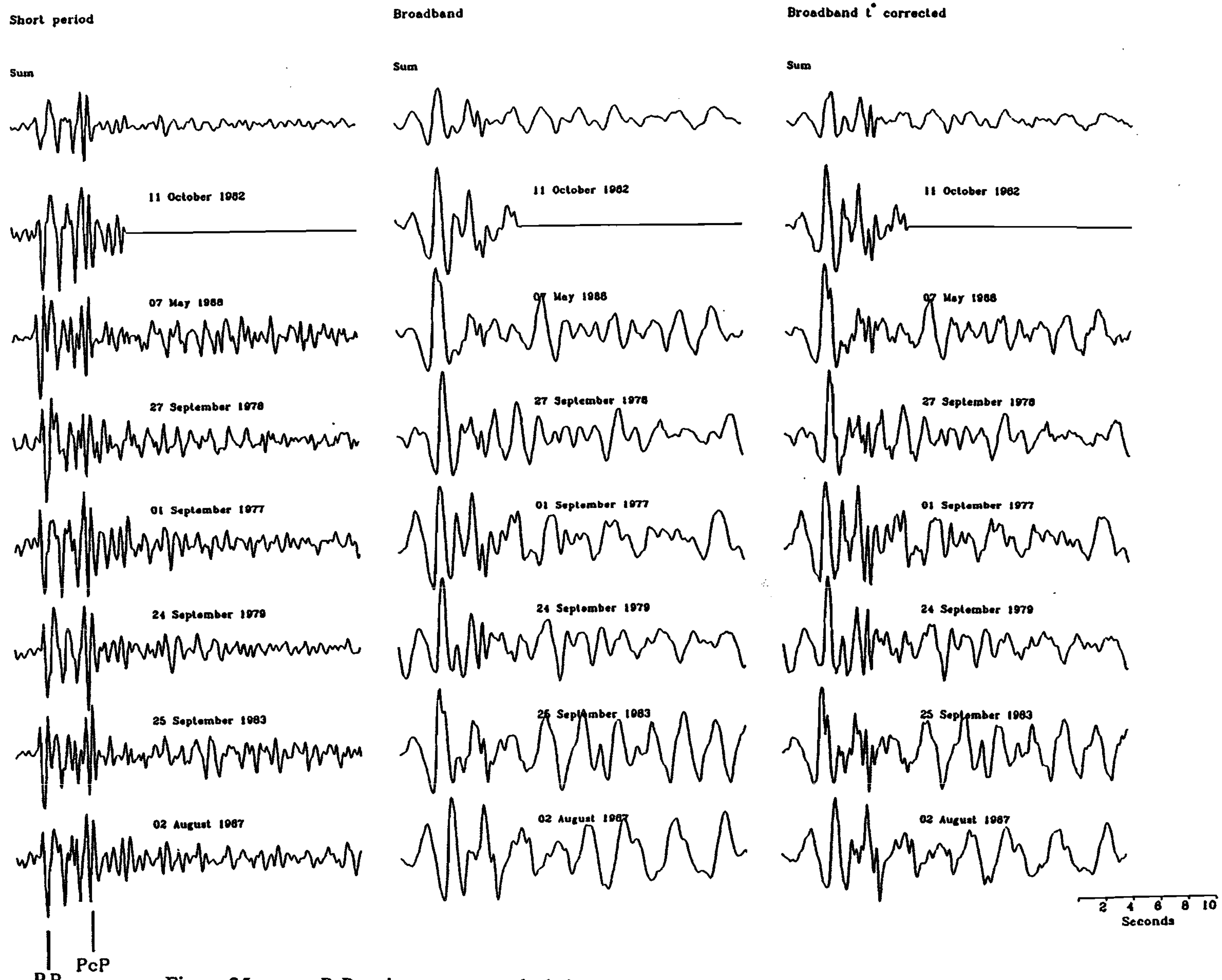


Figure 25 PcP seismograms and their sum for explosions in the West area of the NNZ test site recorded at YKA.

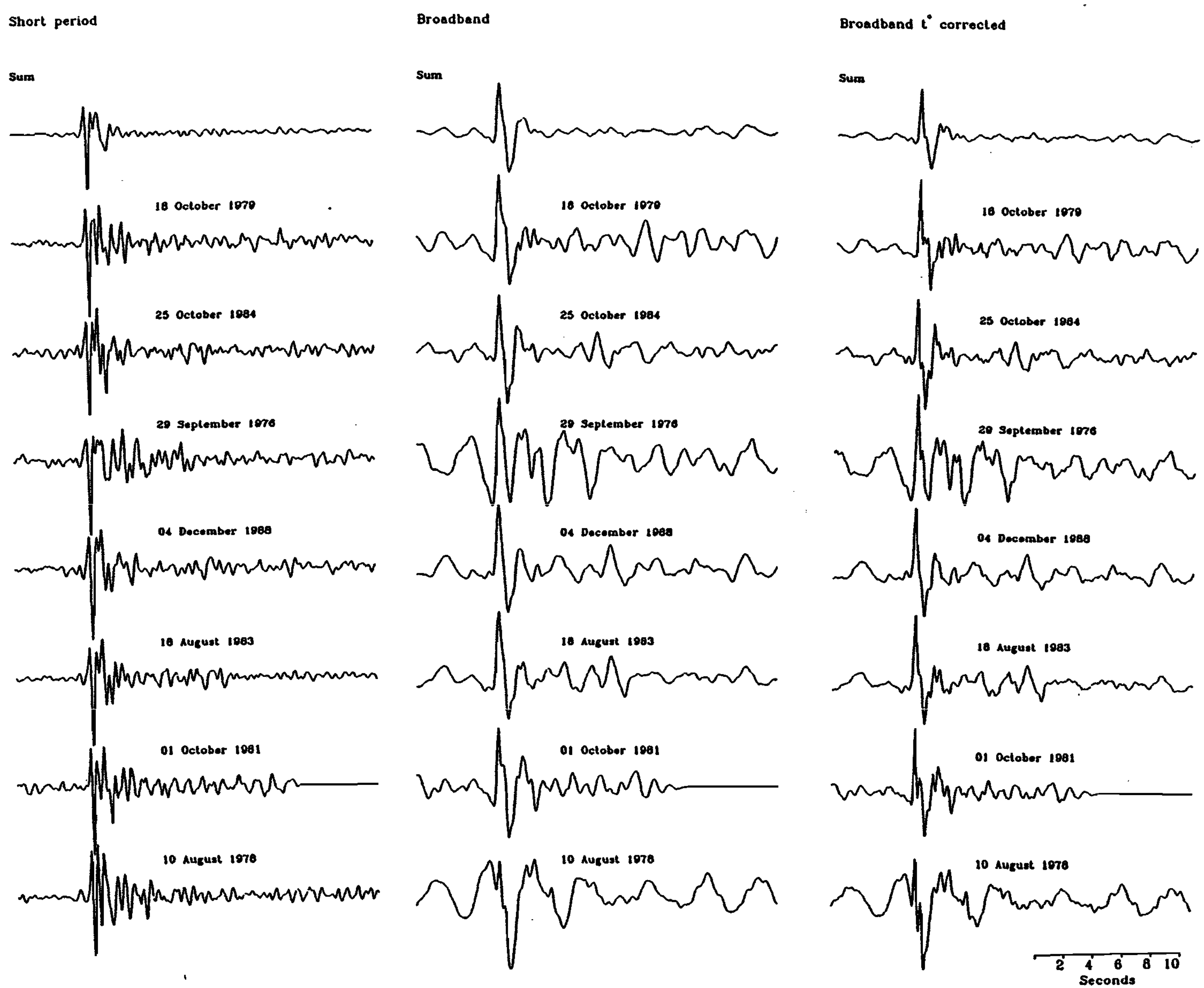


Figure 26 PcP seismograms and their sum for explosions in the South area of the NNZ test site recorded at YKA.

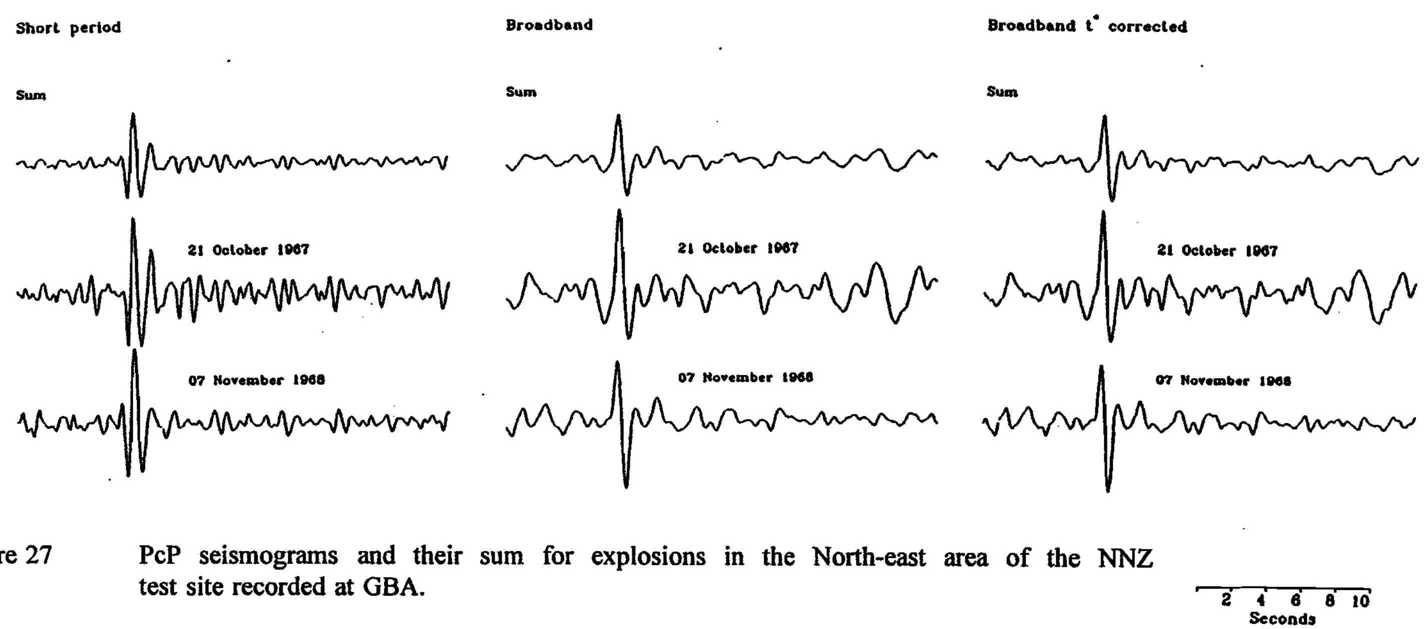


Figure 27 PcP seismograms and their sum for explosions in the North-east area of the NNZ test site recorded at GBA.

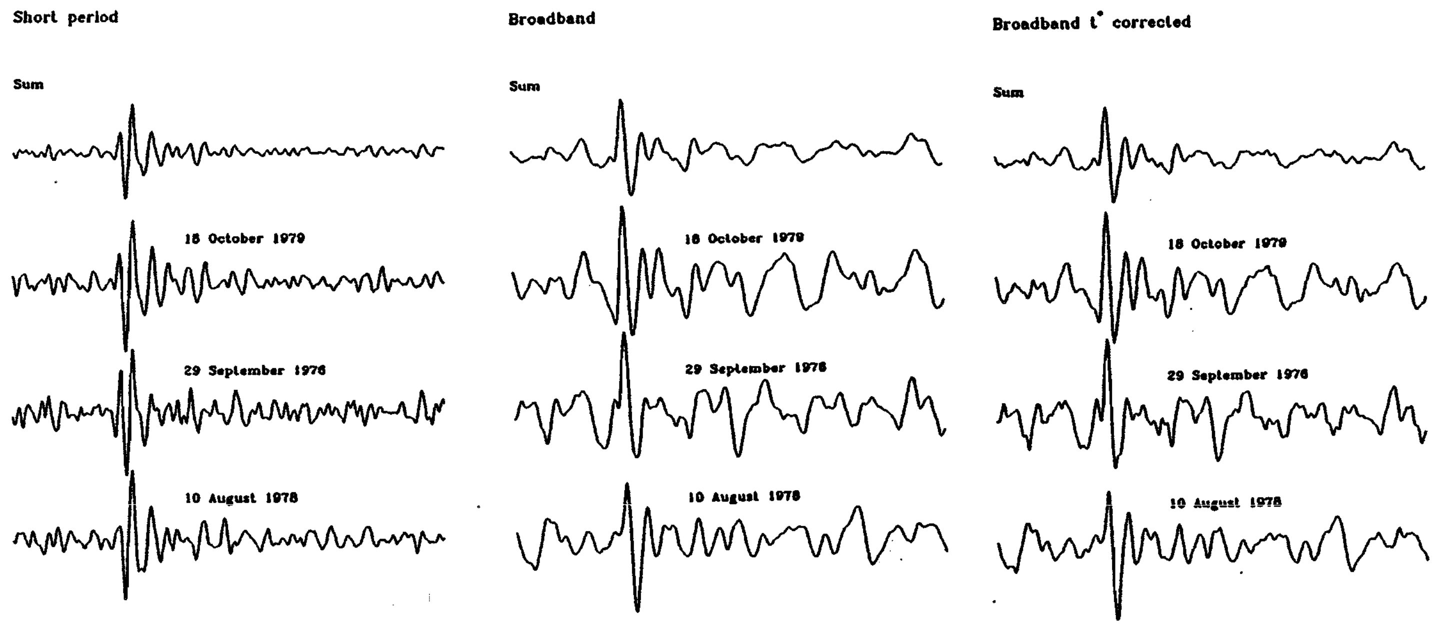


Figure 28 PcP seismograms and their sum for explosions in the South area of the NNZ test site recorded at GBA.

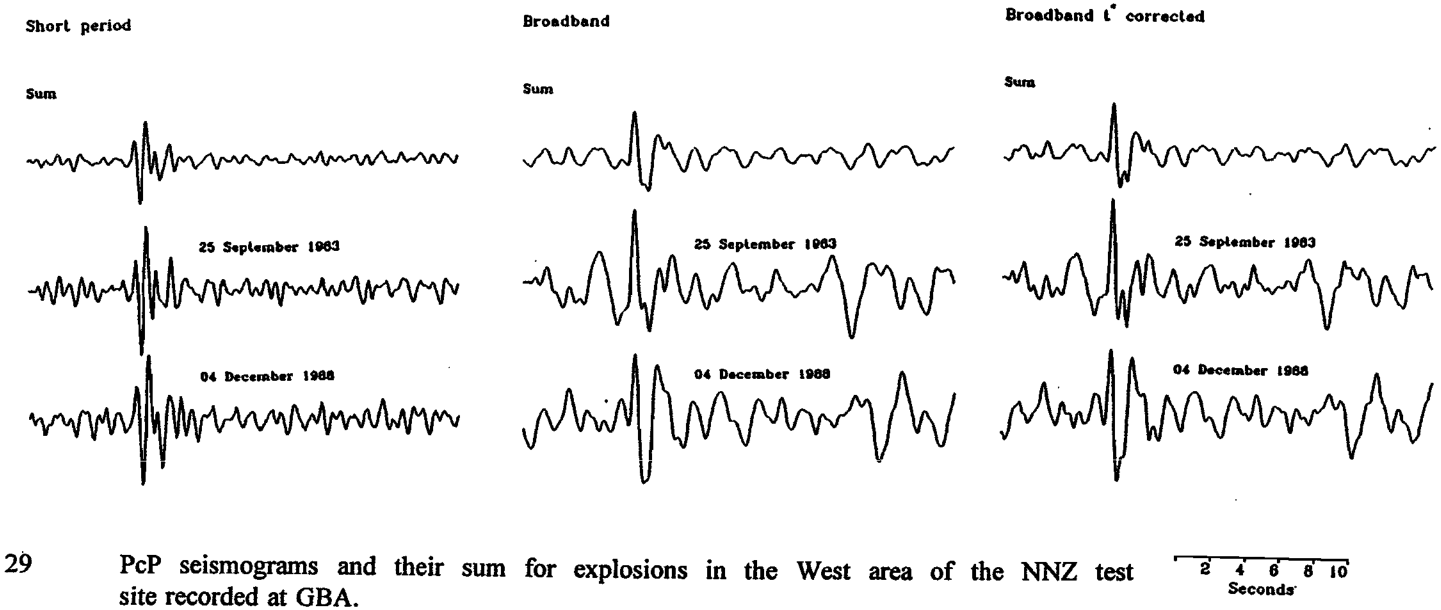


Figure 29 PcP seismograms and their sum for explosions in the West area of the NNZ test site recorded at GBA.

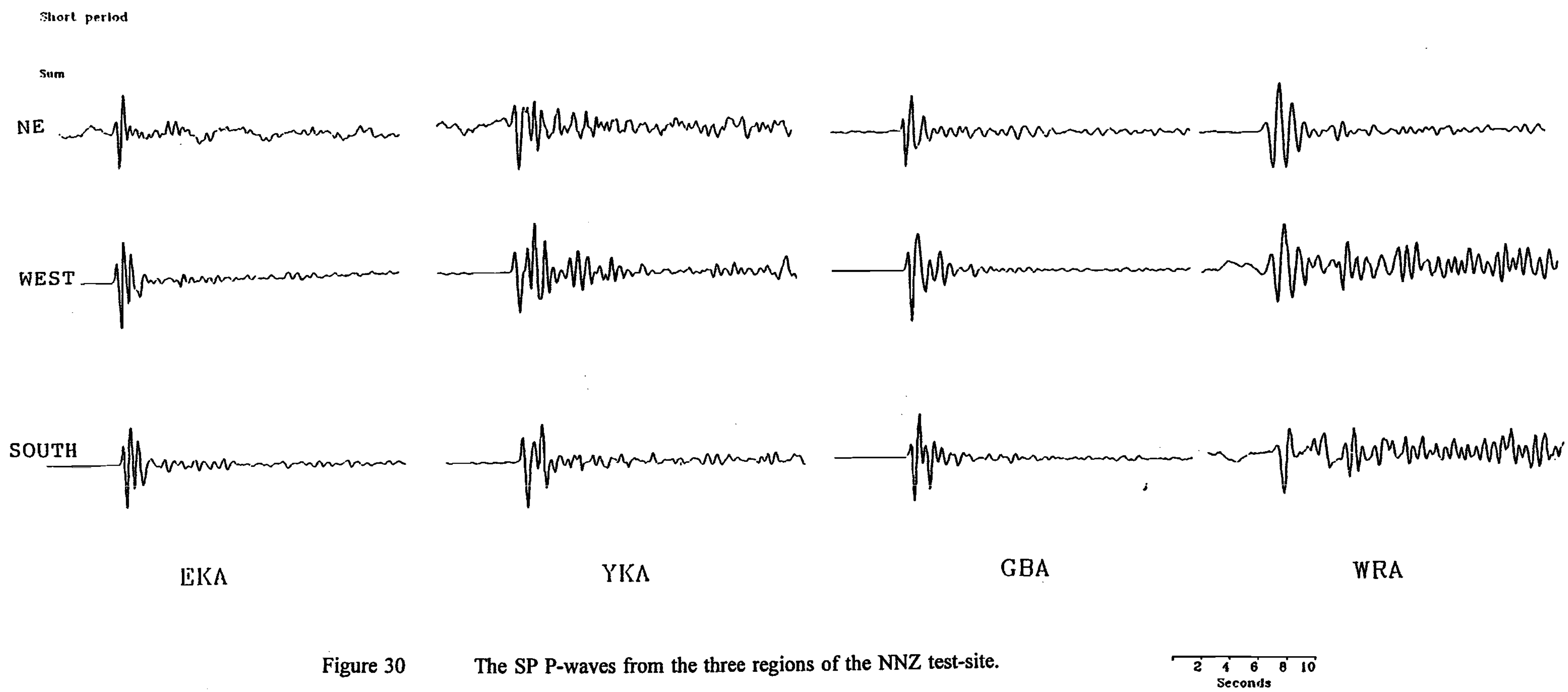
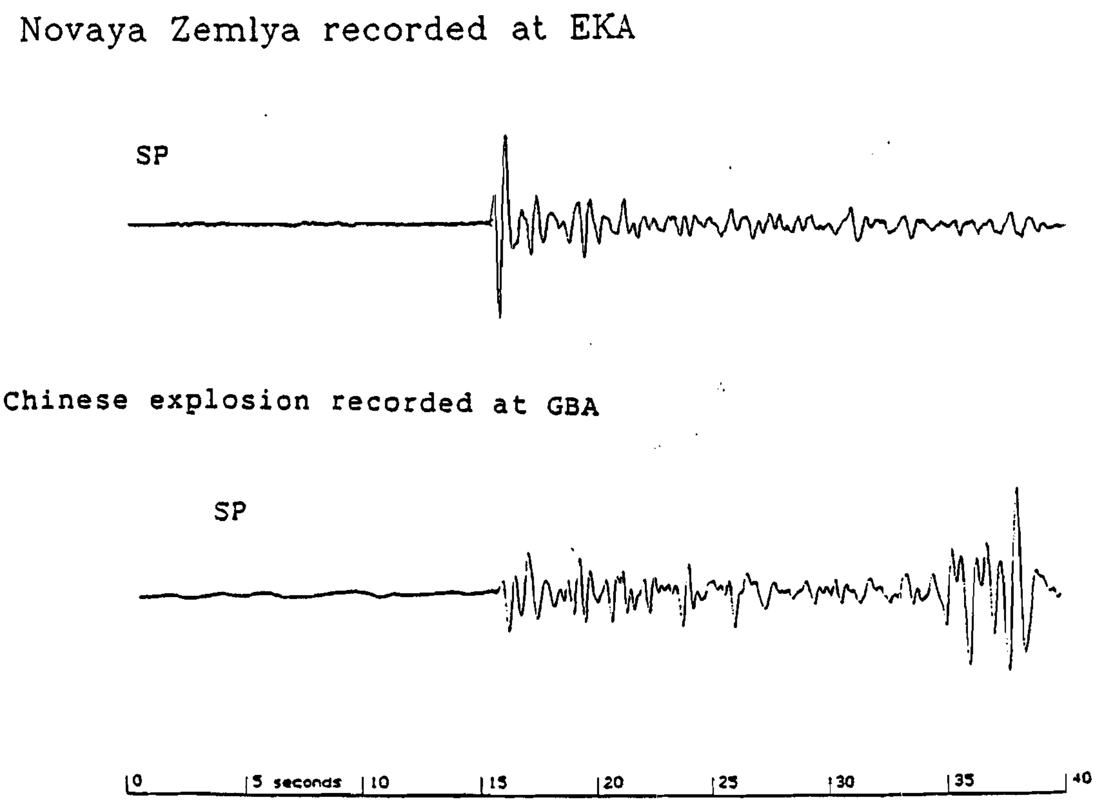


Figure 30 The SP P-waves from the three regions of the NNZ test-site.



Distance to GBA from Singer East: 3275 km

Distance to EKA from Novaya Zemlya: 3240 km

Figure 31 P waves from nuclear explosions recorded at distances of around 3250 kms:

(a) explosion at the NNZ site recorded at EKA;
(b) explosion at the Chinese test site recorded at GBA.

The complexity at GBA is presumably caused by variations in the upper mantle structure on the path between the Chinese test-site and GBA.

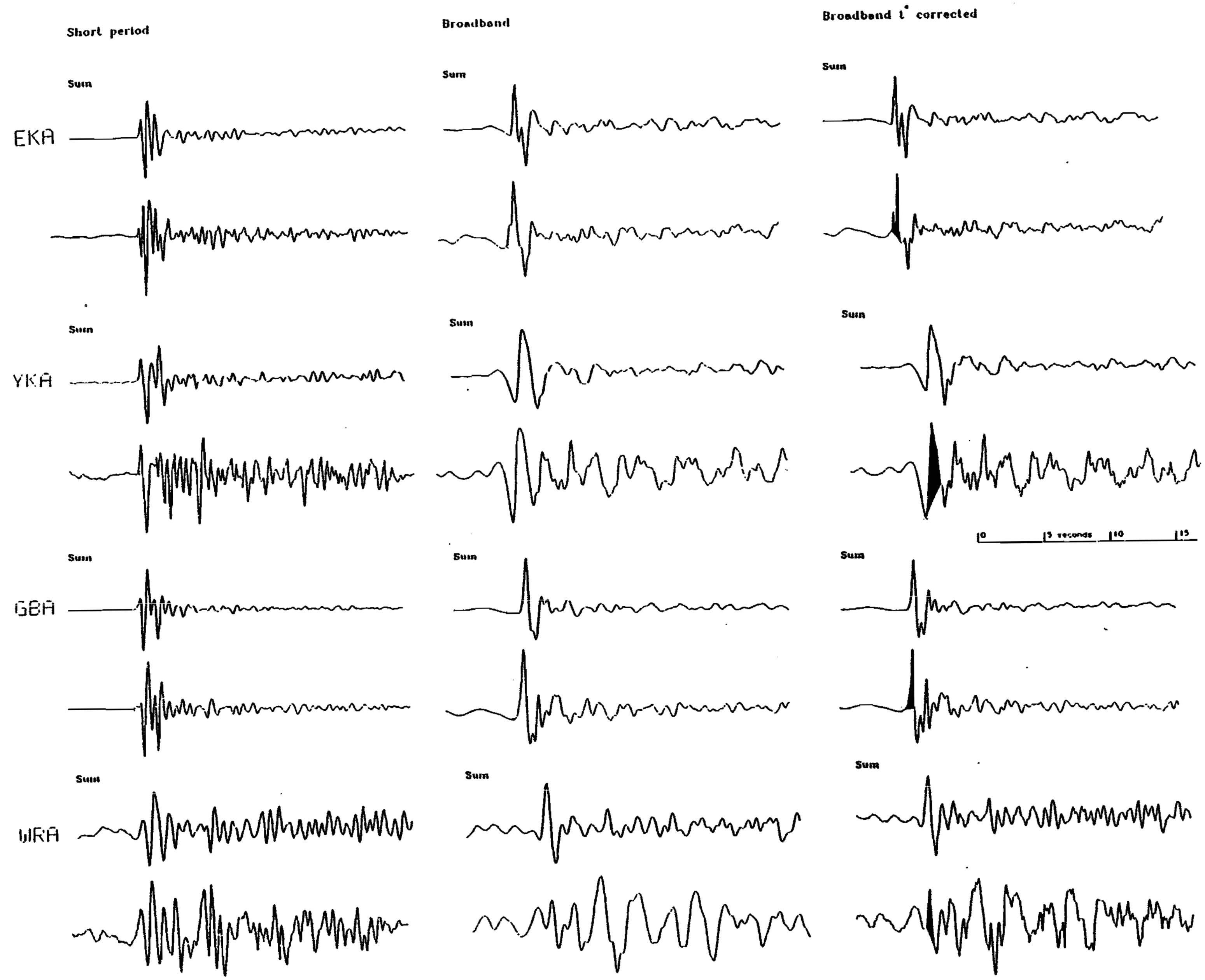


Figure 32 Double explosion (lower trace at each array) compared with the average P signal from the south area of the NNZ test-site.

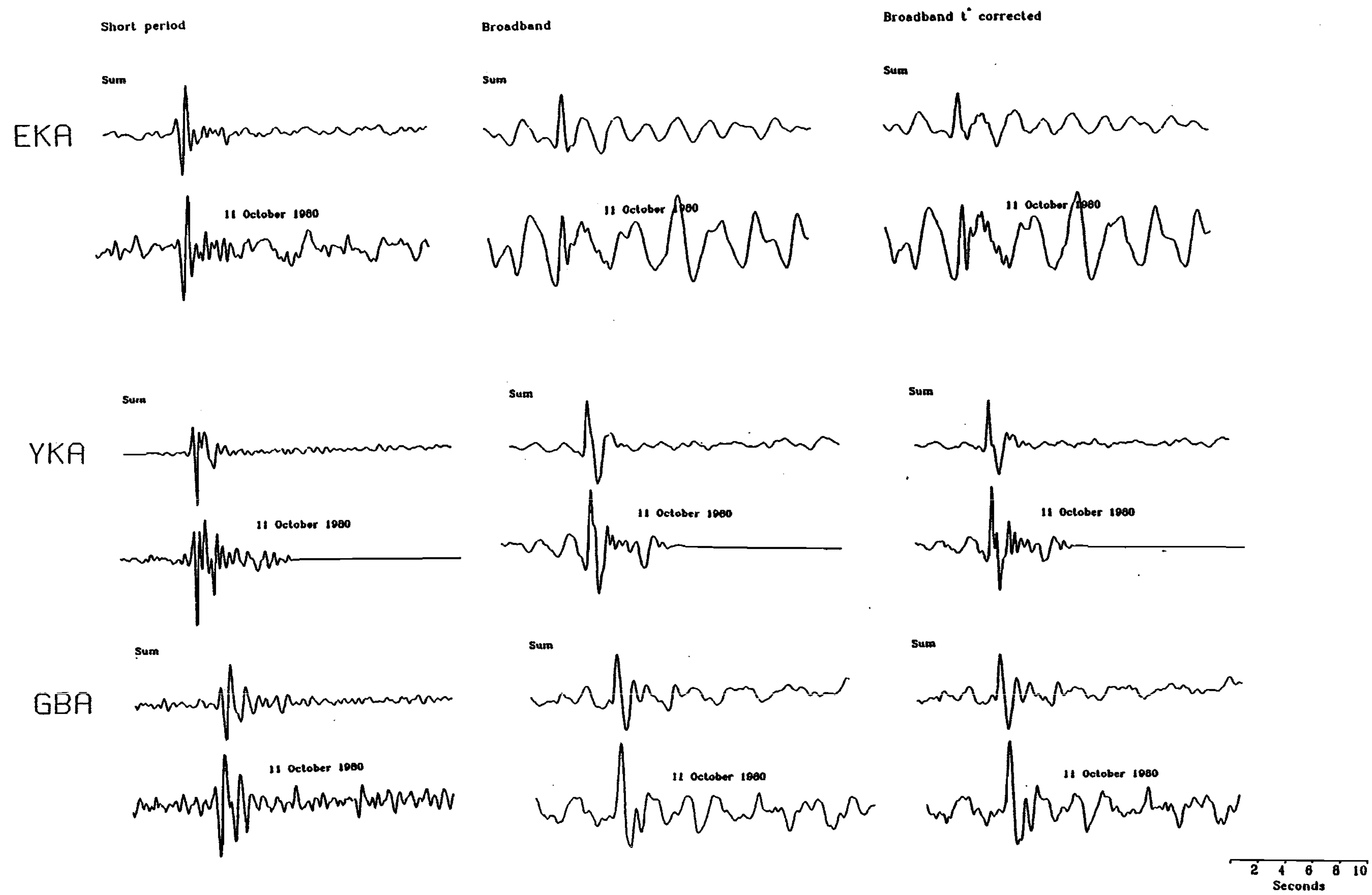


Figure 33 Double explosion (lower trace at each array) compared with the average PcP signal from the south area of the NNZ test-site.

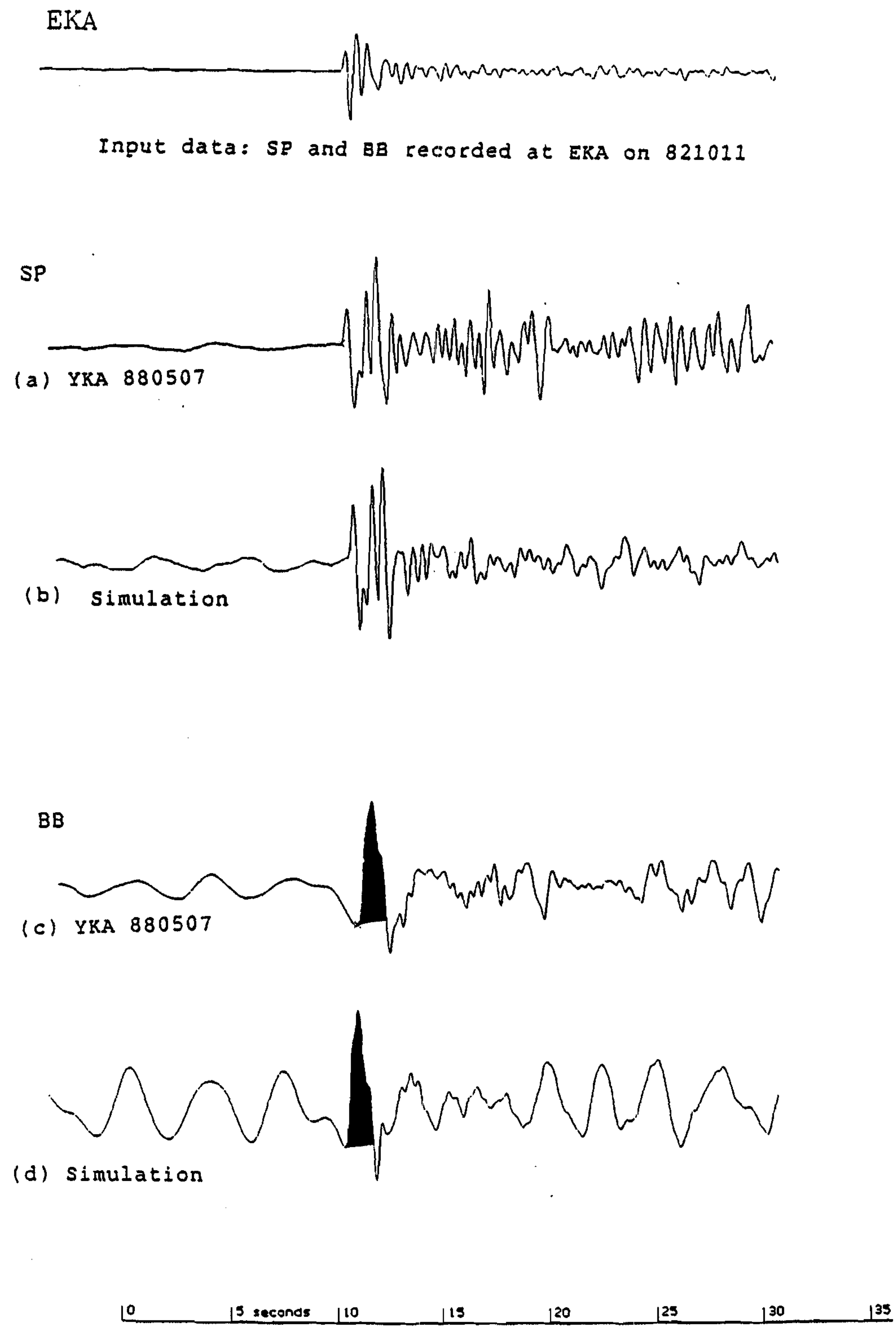


Figure 34 Simulation of the YKA P seismograms using a scaled and delayed EKA P signal.

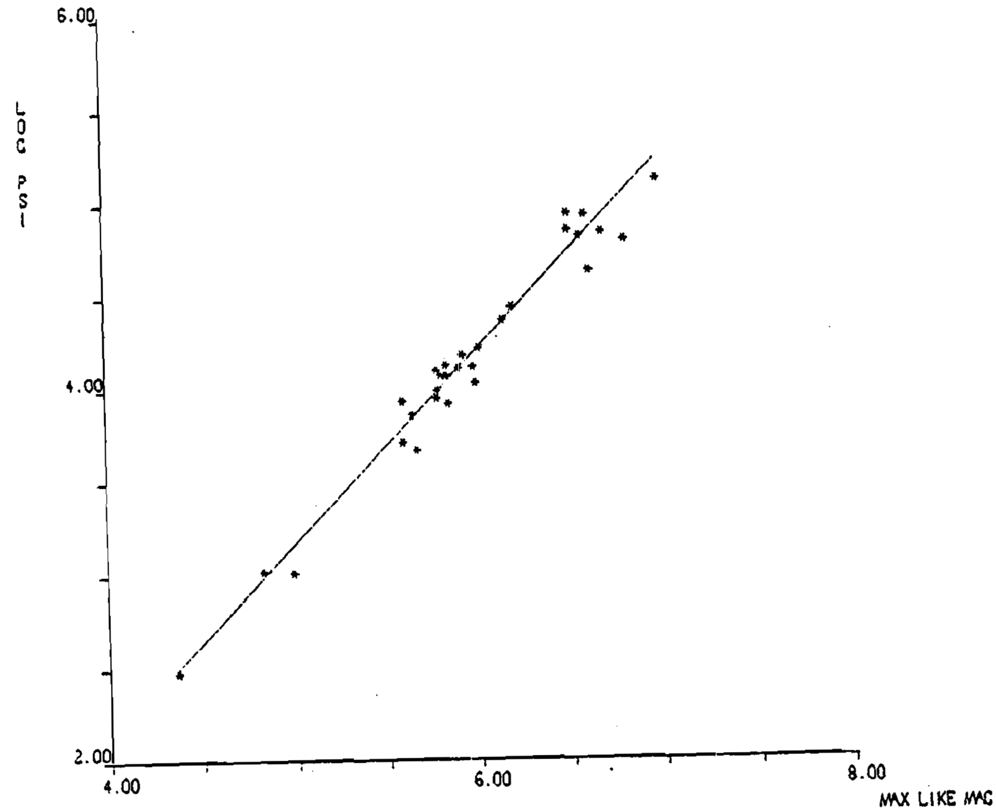


Figure 35 Logψ_∞ against maximum-likelihood magnitude for explosions at NZ.

APPENDIX A

GRAPHS AND TABLES OF INDIVIDUAL MEASUREMENTS MADE ON P AND PCP FROM EXPLOSIONS AT NOVAYA ZEMLYA

Table 1A Eskdalemuir array - Broad band and short period observations

Date	Ψ_∞ (m^3)	Moment (N m)	Duration (s)	Rise time (s)	Fall time (s)	pP-P time (s)	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	
641025	947.78	0.4764E+15	0.43	0.16	0.10	0.25	65.94	0.47	2.11	2.59	27
751021	0.00	0.0000E+00	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.00	27
760929	9815.83	0.4934E+16	0.49	0.15	0.18	0.76	401.10	0.55	1.82	2.25	27
761020	839.53	0.4220E+15	0.35	0.14	0.10	0.25	61.21	0.47	2.11	2.59	27
770901	8637.38	0.4342E+16	0.54	0.16	0.18	0.80	334.30	0.57	1.74	2.15	27
771009	507.92	0.2553E+15	0.43	0.14	0.13	0.21	27.19	0.45	2.22	2.72	27
780810	0.00	0.0000E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27
780927	5778.05	0.2904E+16	0.46	0.16	0.14	0.80	325.00	0.57	1.74	2.15	27
791018	4353.86	0.2188E+16	0.45	0.15	0.14	0.76	220.10	0.55	1.82	2.25	27
811001	0.00	0.0000E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27
821011	5280.18	0.2654E+16	0.50	0.16	0.16	0.77	218.80	0.55	1.82	2.25	27
830818	11108.47	0.5584E+16	0.56	0.13	0.20	0.74	388.40	0.50	2.00	2.47	27
830925	8564.30	0.4305E+16	0.56	0.18	0.16	0.77	326.20	0.55	1.82	2.25	27
841025	11615.47	0.5839E+16	0.56	0.14	0.19	0.80	396.90	0.52	1.90	2.36	27
870802	9948.29	0.5001E+16	0.54	0.17	0.18	0.81	369.80	0.57	1.74	2.13	35
880507	6335.30	0.3184E+16	0.54	0.17	0.15	0.75	255.10	0.52	1.90	2.33	35
881204	10268.02	0.5161E+16	0.49	0.13	0.18	0.76	380.40	0.43	2.35	2.79	35

B(Δ)=3.71 G(Δ)= 0.1435E-10s m^{-2} ρ_0=2800.0kg m^{-3} v_0=6140.0km s^{-1}
ρ_1=2500.0kg m^{-3} v_1=4000.0km s^{-1} K=0.76

Table 2A Eskdalemuir array - Observations in the 0.5-4.0Hz band

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
641025	58.73	0.55	1.82	2.25	21.68	16.22	13.90	11.28	7.39	6.44	4.70	1.92
751021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
760929	420.00	0.57	1.74	2.15	162.60	118.40	98.36	78.40	36.02	32.82	30.59	1.65
761020	55.62	0.57	1.74	2.15	21.55	16.36	13.99	11.19	7.84	6.36	4.38	1.68
770901	326.90	0.57	1.74	2.15	134.20	98.79	81.72	64.93	31.91	27.76	21.95	1.84
771009	24.79	0.45	2.22	2.72	8.16	6.63	5.62	4.67	3.75	3.26	2.97	2.16
780810	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	74.64	60.77	39.54	1.25
780927	306.00	0.55	1.82	2.25	114.20	84.39	70.52	55.96	30.58	25.55	19.74	2.00
791018	217.60	0.63	1.60	1.97	88.53	64.13	52.98	41.48	17.05	13.84	8.69	1.15
811001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	58.91	50.60	36.61	2.22
821011	202.40	0.57	1.74	2.15	82.47	61.01	50.86	40.70	21.90	19.24	15.14	1.88
830818	411.10	0.52	1.90	2.36	154.00	113.40	96.09	76.71	44.69	37.80	28.04	1.14
830925	307.50	0.52	1.90	2.36	128.60	92.62	78.10	63.53	29.72	30.20	26.12	2.02
841025	460.40	0.60	1.67	2.06	184.80	136.90	115.50	91.25	54.13	43.28	28.44	2.19
870802	368.50	0.57	1.74	2.13	146.70	109.50	91.12	72.32	41.16	34.01	23.98	1.59
880507	243.10	0.50	2.00	2.43	104.20	76.56	65.09	52.65	30.43	27.38	20.91	1.15
881204	465.80	0.52	1.90	2.33	186.10	139.40	115.90	92.07	53.00	43.97	35.32	5.79

Table 3A Eskdalemuir array - Observations in the 1.0-4.0Hz band

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
641025	56.21	0.47	2.11	2.59	20.59	15.24	12.88	10.33	6.06	5.23	3.71	0.84
751021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
760929	387.20	0.50	2.00	2.47	153.00	111.70	92.63	73.80	34.23	30.96	28.12	0.68
761020	52.96	0.47	2.11	2.59	20.06	15.02	12.79	10.14	6.64	5.29	3.31	0.78
770901	308.40	0.55	1.82	2.25	124.00	91.68	75.60	59.64	29.79	24.57	17.70	0.97
771009	23.43	0.43	2.35	2.87	7.53	6.09	5.03	4.12	3.11	2.66	2.23	1.11
780810	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	69.31	56.57	36.89	0.84
780927	276.10	0.57	1.74	2.15	107.00	79.15	66.04	52.16	28.60	23.20	17.60	0.89
791018	206.90	0.55	1.82	2.25	85.25	61.67	50.95	39.85	16.14	12.98	7.88	0.58
811001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55.84	46.91	32.61	0.64
821011	195.00	0.52	1.90	2.36	74.83	55.08	45.50	36.01	17.49	14.88	10.87	0.73
830818	374.40	0.52	1.90	2.36	141.50	103.30	87.99	70.05	40.06	33.60	24.80	0.47
830925	302.40	0.52	1.90	2.36	118.90	85.64	71.63	57.56	25.14	24.68	20.76	0.49
841025	415.20	0.52	1.90	2.36	172.20	125.80	106.60	83.82	47.10	37.00	22.82	0.73
870802	334.80	0.57	1.74	2.13	135.40	101.30	83.42	65.58	35.66	28.16	17.56	0.58
880507	236.60	0.55	1.82	2.23	96.13	70.36	59.08	47.21	24.81	21.82	16.50	0.50
881204	438.40	0.47	2.11	2.54	174.50	129.70	107.70	85.19	46.60	38.23	30.48	1.55

Table 4A Eskdalemuir array - Broad band and short period observations PcP

Date	ψ_∞ (m^3)	Moment (N m)	Duration (s)	Rise time (s)	Fall time (s)	pP-P time (s)	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	
641025	0.00	0.0000E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27
661027	135974.61	0.6835E+17	0.90	0.33	0.28	0.00	151.80	0.75	1.33	1.59	27
671021	11435.74	0.5748E+16	0.54	0.21	0.14	0.38	45.10	0.65	1.54	1.89	27
681107	44555.01	0.2240E+17	0.63	0.28	0.15	0.43	122.20	0.75	1.33	1.59	27
691014	60824.04	0.3057E+17	0.69	0.25	0.24	0.40	125.80	0.73	1.38	1.66	27
701014	119659.70	0.6015E+17	0.71	0.25	0.27	0.00	200.20	0.80	1.25	1.46	27
710927	132609.66	0.6666E+17	0.74	0.26	0.25	0.00	252.00	0.75	1.33	1.59	27
720828	164525.72	0.8270E+17	1.01	0.35	0.25	0.00	210.00	0.70	1.43	1.74	27
730912	252371.33	0.1269E+18	0.91	0.28	0.26	0.00	358.00	0.85	1.18	1.33	27
740829	162639.30	0.8175E+17	0.76	0.29	0.21	0.39	333.40	0.73	1.38	1.66	27
750823	125114.99	0.6289E+17	0.90	0.28	0.28	0.00	188.10	0.88	1.14	1.27	27
751021	81931.45	0.4118E+17	0.84	0.28	0.27	0.00	154.30	0.80	1.25	1.46	27
760929	26358.78	0.1325E+17	0.79	0.27	0.23	0.00	54.69	0.65	1.54	1.89	27
770901	9156.75	0.4603E+16	0.64	0.23	0.19	0.00	23.01	0.63	1.60	1.97	27
780810	32262.74	0.1622E+17	0.81	0.32	0.25	0.00	54.59	0.68	1.48	1.81	27
780927	17283.61	0.8688E+16	0.89	0.32	0.23	0.00	22.98	0.73	1.38	1.66	27
801011	24467.27	0.1230E+17	0.79	0.30	0.19	0.00	51.53	0.63	1.60	1.97	27
811001	24186.86	0.1216E+17	0.69	0.23	0.24	0.00	58.12	0.68	1.48	1.81	27
830818	28892.69	0.1452E+17	0.80	0.31	0.20	0.00	63.96	0.60	1.67	2.06	27
830925	26165.04	0.1315E+17	0.76	0.27	0.31	0.00	40.04	0.88	1.14	1.27	27
841025	15193.26	0.7637E+16	0.75	0.17	0.21	0.00	43.25	0.60	1.67	2.06	27
870802	24961.82	0.1255E+17	0.90	0.30	0.27	0.00	34.12	0.73	1.38	1.66	35
881204	21637.65	0.1088E+17	0.70	0.26	0.20	0.00	55.59	0.63	1.60	1.96	35

*

B(Δ)=0.00 G(Δ)= 0.1286E-11s m^{-2} ρ_0=2800.0kg m^{-3} υ_0=6140.0km s^{-1}

ρ=2500.0kg m^{-3} υ=4000.0km s^{-1} K=0.76

Table 5A Eskdalemuir array - Observations in the 0.5-4.0Hz band PcP

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
641025	2.49	0.85	1.18	1.33	1.33	1.38	1.62	1.85	1.75	1.96	1.95	2.55
661027	131.70	0.82	1.21	1.40	58.88	43.30	37.43	30.38	19.19	16.93	13.59	9.44
671021	47.68	0.65	1.54	1.89	17.59	13.38	13.16	10.80	10.25	8.28	5.42	4.08
681107	121.20	0.70	1.43	1.74	49.93	36.66	31.37	25.25	15.15	13.18	12.26	11.60
691014	128.40	0.70	1.43	1.74	49.64	37.17	31.92	27.51	17.22	18.17	17.67	11.48
701014	181.40	0.77	1.29	1.53	79.36	58.69	49.03	38.90	21.37	17.81	13.11	16.09
710927	240.10	0.77	1.29	1.53	101.70	73.42	62.07	49.97	24.59	23.11	23.22	19.26
720828	194.60	0.73	1.38	1.66	80.81	59.83	50.80	40.70	24.61	20.94	15.61	15.16
730912	334.60	0.95	1.05	1.10	164.50	124.80	103.20	82.84	49.28	42.57	32.25	32.36
740829	334.60	0.70	1.43	1.74	130.40	97.44	82.33	66.71	40.75	36.17	30.77	19.87
750823	183.10	0.93	1.08	1.16	86.98	63.03	52.12	41.59	17.09	16.47	16.23	13.82
751021	142.40	0.82	1.21	1.40	61.23	48.02	40.07	32.68	23.09	19.95	15.25	16.40
760929	56.71	0.60	1.67	2.06	20.56	15.40	12.74	10.44	5.65	5.52	4.85	3.59
770901	20.24	0.70	1.43	1.74	9.35	8.00	6.91	5.85	5.28	4.57	3.42	3.56
780810	49.95	0.70	1.43	1.74	20.00	14.66	12.14	9.78	4.59	4.43	4.03	4.00
780927	24.95	0.85	1.18	1.33	10.69	8.29	6.99	5.79	4.03	3.65	2.99	3.22
801011	52.53	0.63	1.60	1.97	19.06	14.06	11.65	9.37	4.66	4.35	3.93	4.11
811001	58.44	0.65	1.54	1.89	24.16	18.11	14.98	11.98	6.69	5.77	4.54	4.01
830818	66.39	0.57	1.74	2.15	23.62	17.33	14.34	11.67	5.43	5.54	5.43	4.58
830925	31.41	0.70	1.43	1.74	12.88	10.38	8.93	7.52	6.05	5.40	4.60	3.89
841025	48.79	0.60	1.67	2.06	19.36	14.31	11.93	9.76	5.10	5.04	5.07	5.04
870802	31.89	0.68	1.48	1.81	12.90	9.78	8.26	7.07	4.37	4.57	4.60	3.52
881204	55.98	0.60	1.67	2.05	21.97	16.50	14.30	11.97	8.08	7.64	7.09	4.80

Table 6A Eskdalemuir array - Observations in the 1.0-4.0Hz band PcP

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
641025	1.95	0.28	3.64	4.23	0.89	0.88	0.97	0.95	1.00	0.96	0.93	0.86
661027	86.92	0.65	1.54	1.89	38.44	28.88	24.65	19.91	13.13	11.22	8.09	7.18
671021	39.09	0.63	1.60	1.97	14.81	11.24	10.89	8.68	8.27	6.27	3.33	2.42
681107	93.39	0.65	1.54	1.89	39.39	29.10	24.61	19.74	11.53	9.96	9.17	8.23
691014	100.90	0.65	1.54	1.89	39.54	29.04	24.88	20.67	12.10	11.96	10.59	8.58
701014	125.90	0.70	1.43	1.74	56.97	41.91	34.97	27.78	14.54	12.38	9.50	9.34
710927	160.60	0.75	1.33	1.59	70.68	51.00	43.31	35.25	17.77	17.44	17.10	11.97
720828	134.90	0.70	1.43	1.74	57.39	43.22	37.05	29.67	20.31	16.64	11.56	11.62
730912	204.10	0.80	1.25	1.46	102.10	77.10	63.97	51.36	30.43	26.28	18.88	20.83
740829	257.60	0.73	1.38	1.66	104.60	78.70	66.34	53.62	33.59	29.28	24.33	13.84
750823	121.80	0.90	1.11	1.22	57.18	41.92	34.83	27.86	13.60	12.38	11.28	8.79
751021	95.66	0.75	1.33	1.59	43.86	32.44	27.21	22.36	12.19	12.00	11.41	9.75
760929	49.56	0.57	1.74	2.15	18.52	13.80	11.33	8.99	4.58	3.91	3.00	2.61
770901	17.04	0.65	1.54	1.89	6.86	6.04	5.19	4.25	4.11	3.29	2.01	2.46
780810	36.57	0.63	1.60	1.97	15.40	11.38	9.42	7.61	3.80	3.63	3.26	2.85
780927	16.10	0.82	1.21	1.40	7.26	5.75	4.92	4.05	3.17	2.70	2.02	1.62
801011	42.75	0.57	1.74	2.15	16.38	12.10	9.98	7.92	3.92	3.37	2.42	2.33
811001	50.18	0.60	1.67	2.06	20.61	15.56	12.80	10.15	5.77	4.76	3.28	2.22
830818	56.66	0.52	1.90	2.36	21.32	15.58	12.85	10.25	4.52	4.21	3.59	2.52
830925	23.06	0.65	1.54	1.89	9.61	7.96	6.83	5.57	4.87	3.97	2.69	2.02
841025	43.06	0.57	1.74	2.15	17.03	12.48	10.29	8.17	3.71	3.30	2.78	2.47
870802	24.46	0.63	1.60	1.96	9.74	7.66	6.45	5.39	3.88	3.54	2.78	2.18
881204	51.93	0.57	1.74	2.13	20.17	14.75	12.29	9.83	4.82	4.38	3.85	2.40

Table 7A Yellowknife array - Broad band and short period observations

Date	ψ_∞ (m^3)	Moment (N m)	Duration (s)	Rise time (s)	Fall time (s)	pP-P time (s)	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	
641025	645.81	0.3246E+15	0.71	0.24	0.16	0.00	12.56	0.57	1.74	2.19	23
671021	6301.56	0.3168E+16	1.04	0.23	0.20	1.00	59.25	0.60	1.67	2.09	23
681107	15091.59	0.7586E+16	1.04	0.23	0.31	1.02	94.44	1.00	1.00	1.00	23
760929	4787.38	0.2406E+16	0.98	0.25	0.19	0.66	36.76	0.63	1.60	2.00	23
761020	434.01	0.2182E+15	0.63	0.24	0.18	0.63	6.62	0.73	1.38	1.68	23
770901	4579.17	0.2302E+16	1.01	0.27	0.22	0.99	33.80	0.68	1.48	1.83	23
771009	102.60	0.5157E+14	0.49	0.14	0.19	0.00	2.35	0.55	1.82	2.29	23
780810	7797.08	0.3919E+16	0.95	0.28	0.29	1.02	71.65	0.88	1.14	1.28	23
780927	3848.28	0.1934E+16	0.93	0.24	0.18	1.00	27.50	0.63	1.60	2.00	23
790324	5102.57	0.2565E+16	1.01	0.29	0.31	1.05	35.29	0.68	1.48	1.83	23
791018	4916.61	0.2471E+16	0.90	0.26	0.23	1.01	32.19	0.68	1.48	1.83	23
801011	7624.77	0.3833E+16	1.23	0.34	0.41	1.01	38.49	0.80	1.25	1.47	23
811001	5663.29	0.2847E+16	0.89	0.28	0.20	0.91	43.04	0.70	1.43	1.75	23
821011	3070.73	0.1544E+16	0.95	0.26	0.23	1.01	21.56	0.68	1.48	1.83	23
830818	12822.83	0.6445E+16	1.24	0.30	0.38	1.09	48.61	0.73	1.38	1.68	23
830925	6036.64	0.3034E+16	1.06	0.30	0.19	0.88	28.11	0.68	1.48	1.83	23
841025	8543.76	0.4295E+16	1.05	0.24	0.34	0.98	48.90	0.63	1.60	2.00	23
870802	15436.21	0.7759E+16	1.33	0.30	0.25	1.00	39.97	0.70	1.43	1.75	23
880507	10884.33	0.5471E+16	1.33	0.36	0.26	0.76	23.31	0.68	1.48	1.83	23
881204	14991.08	0.7535E+16	1.26	0.29	0.44	1.04	65.84	0.73	1.38	1.68	23

*

B(Δ)=3.71 G(Δ)= 0.8546E-11s m^{-2} ρ_0=2670.0kg m^{-3} v_0=5640.0km s^{-1}
ρ_s=2500.0kg m^{-3} v_s=4000.0km s^{-1} K=0.81

Table 8A Yellowknife array - Observations in the 0.5-4.0Hz band

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
641025	14.89	0.43	2.35	2.95	7.21	7.56	6.96	6.00	6.83	5.66	4.12	2.25
671021	66.76	0.52	1.90	2.40	32.03	29.79	26.52	21.38	23.29	17.74	9.97	1.41
681107	110.20	0.90	1.11	1.22	51.24	46.54	41.04	34.05	34.84	28.16	18.79	0.70
760929	52.65	0.47	2.11	2.65	21.10	16.95	14.90	12.60	10.50	9.34	7.46	0.99
761020	7.48	1.15	0.87	0.74	3.63	3.26	2.95	2.53	2.54	2.17	1.62	1.00
770901	46.07	0.52	1.90	2.40	23.08	20.49	17.02	13.71	12.96	10.09	5.86	0.99
771009	2.78	0.45	2.22	2.80	1.24	1.36	1.36	1.22	1.41	1.22	1.02	0.53
780810	72.28	0.82	1.21	1.40	38.15	30.38	26.20	21.40	17.37	14.44	10.14	0.59
780927	43.78	1.08	0.93	0.86	20.55	15.33	13.18	10.76	7.03	6.25	5.77	0.79
790924	46.96	0.70	1.43	1.75	24.59	21.69	18.48	14.64	14.49	10.81	5.32	0.53
791018	45.69	0.57	1.74	2.19	24.00	20.54	17.92	15.09	13.92	11.87	8.30	0.83
801011	34.47	0.55	1.82	2.29	17.36	16.44	14.11	12.20	12.16	10.52	7.76	0.91
811001	51.24	0.57	1.74	2.19	28.07	24.02	22.24	18.37	18.65	14.99	10.28	2.81
821011	28.62	0.98	1.03	1.05	14.66	13.30	11.27	9.25	9.11	7.30	4.85	0.42
830818	55.04	0.50	2.00	2.52	26.08	21.42	18.28	14.97	12.70	10.49	7.50	0.50
830925	42.87	0.93	1.08	1.16	20.29	15.25	14.04	11.77	9.49	8.38	7.19	1.33
841025	69.94	0.50	2.00	2.52	28.47	22.85	19.38	15.86	12.58	10.57	8.62	2.20
870802	53.77	0.85	1.18	1.34	26.00	23.41	20.07	16.44	16.32	13.00	8.45	1.33
880507	34.11	0.93	1.08	1.16	15.73	11.80	11.00	9.75	7.61	7.54	7.55	0.20
881204	76.79	0.57	1.74	2.19	40.10	31.74	27.30	22.32	17.72	14.86	10.21	0.32

Table 9A Yellowknife array - Observations in the 1.0-4.0Hz band

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
641025	14.65	0.45	2.22	2.80	6.57	6.83	6.26	5.20	6.09	4.80	2.93	1.52
671021	60.78	0.47	2.11	2.65	28.04	26.75	23.44	18.88	20.76	15.78	8.50	0.92
681107	96.91	0.52	1.90	2.40	43.72	38.84	34.22	28.22	28.29	22.74	15.04	0.47
760929	48.15	0.43	2.35	2.95	18.84	15.34	13.59	11.42	9.99	8.61	6.44	0.76
761020	6.00	0.50	2.00	2.52	2.90	2.54	2.38	2.05	2.07	1.78	1.30	0.64
770901	43.34	0.52	1.90	2.40	20.26	18.67	15.56	12.44	12.57	9.53	4.89	0.71
771009	2.99	0.45	2.22	2.80	1.10	1.24	1.10	1.00	1.10	0.97	0.82	0.31
780810	64.73	0.65	1.54	1.91	31.42	24.76	21.60	17.83	14.37	12.28	8.89	0.48
780927	41.30	0.55	1.82	2.29	18.38	13.79	11.60	9.48	5.73	5.28	5.14	0.57
790924	42.30	0.55	1.82	2.29	21.69	19.86	16.79	13.24	13.70	10.08	4.49	0.35
791018	48.97	0.65	1.54	1.91	21.14	18.02	15.64	13.16	11.98	10.23	7.29	0.52
801011	33.08	0.55	1.82	2.29	13.57	13.75	11.85	10.22	10.89	9.19	6.50	0.55
811001	46.76	0.57	1.74	2.19	23.01	20.47	18.48	15.24	15.73	12.57	8.73	2.03
821011	27.54	0.47	2.11	2.65	12.83	12.08	10.28	8.27	8.73	6.67	3.89	0.29
830818	51.92	0.45	2.22	2.80	22.67	18.65	16.01	12.99	11.30	9.07	6.20	0.31
830925	33.10	0.50	2.00	2.52	16.56	12.70	11.88	9.91	8.64	7.35	6.35	0.78
841025	63.37	0.47	2.11	2.65	25.54	20.30	17.10	13.96	10.60	8.98	7.10	1.66
870802	43.71	0.55	1.82	2.29	22.21	20.82	17.87	14.37	15.24	11.61	6.29	1.00
880507	26.20	0.47	2.11	2.65	12.59	9.60	9.29	8.18	7.09	6.64	6.63	0.10
881204	72.48	0.55	1.82	2.29	34.95	28.19	24.27	19.63	16.51	13.28	8.40	0.20

Table 10A Yellowknife array - Broad band and short period observations PcP

Date	ψ_∞ (m^3)	Moment (N m)	Duration (s)	Rise time (s)	Fall time (s)	pP-P time (s)	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	
671021	8127.60	0.4085E+16	0.59	0.18	0.17	0.00	39.40	0.55	1.82	2.29	23
681107	13221.20	0.6646E+16	0.59	0.17	0.23	0.00	55.13	0.50	2.00	2.52	23
691014	15959.52	0.8022E+16	0.52	0.18	0.20	0.00	77.39	0.65	1.54	1.91	23
760929	9448.04	0.4749E+16	0.65	0.21	0.12	0.79	44.35	0.45	2.22	2.80	23
761020	447.54	0.2250E+15	0.38	0.13	0.10	0.56	2.71	0.38	2.67	3.33	23
770901	3417.02	0.1718E+16	0.41	0.13	0.14	0.00	28.67	0.52	1.90	2.40	23
771009	0.00	0.0000E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23
780810	11974.68	0.6019E+16	0.41	0.12	0.17	0.66	76.29	0.35	2.86	3.55	23
780927	2220.56	0.1116E+16	0.43	0.13	0.15	0.00	0.00	0.00	0.00	0.00	23
790924	6360.29	0.3197E+16	0.51	0.18	0.17	0.00	35.67	0.60	1.67	2.09	23
791018	10143.54	0.5099E+16	0.41	0.14	0.12	0.76	64.38	0.43	2.35	2.95	23
801011	12848.25	0.6458E+16	0.45	0.15	0.13	0.61	76.46	0.40	2.50	3.13	23
811001	9562.27	0.4807E+16	0.40	0.13	0.12	0.71	66.04	0.38	2.67	3.33	23
821011	1921.86	0.9660E+15	0.43	0.15	0.15	0.00	12.73	0.75	1.33	1.61	23
830818	15996.48	0.8041E+16	0.47	0.15	0.16	0.66	79.30	0.43	2.35	2.95	23
830925	3679.09	0.1849E+16	0.45	0.13	0.17	0.00	25.38	0.47	2.11	2.65	23
841025	13728.55	0.6901E+16	0.52	0.15	0.15	0.59	69.38	0.45	2.22	2.80	23
870802	4700.50	0.2363E+16	0.47	0.15	0.19	1.00	20.95	0.45	2.22	2.80	23
880507	2535.04	0.1274E+16	0.47	0.15	0.16	0.00	14.64	0.52	1.90	2.40	23
881204	20623.06	0.1037E+17	0.57	0.17	0.21	0.68	80.51	0.45	2.22	2.80	23

*
B(Δ)=0.00 G(Δ)= 0.1826E-11s m^{-2} ρ_0=2670.0kg m^{-3} v_0=5640.0km s^{-1}
ρ_1=2500.0kg m^{-3} v_1=4000.0km s^{-1} K=0.81

Table 11A Yellowknife array - Observations in the 0.5-4.0Hz band PcP

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
671021	40.70	0.50	2.00	2.52	15.76	11.94	10.85	8.90	7.23	6.07	4.51	11.80
681107	61.22	0.63	1.60	2.00	29.73	21.81	18.78	15.26	9.33	8.37	7.34	21.42
691014	76.72	0.60	1.67	2.09	31.90	25.69	23.15	19.66	17.18	15.13	11.79	24.34
760929	48.37	0.47	2.11	2.65	18.14	14.78	12.52	9.86	8.41	6.26	2.81	1.78
761020	4.05	1.27	0.78	0.57	1.80	1.73	1.78	1.67	1.76	1.64	1.27	0.83
770901	30.53	0.50	2.00	2.52	12.27	9.61	8.40	6.78	5.54	4.46	2.76	6.09
771009	2.55	1.02	0.98	0.95	1.10	1.25	1.25	1.09	1.32	1.09	0.75	0.74
780810	82.07	0.45	2.22	2.80	32.22	24.22	20.15	15.89	9.50	7.50	4.89	2.73
780927	14.45	0.50	2.00	2.52	6.33	5.21	4.80	4.07	3.81	3.27	2.31	5.12
790924	39.21	0.57	1.74	2.19	14.32	10.66	9.45	7.66	5.62	4.71	3.33	7.05
791018	68.25	0.43	2.35	2.95	25.16	18.61	15.42	12.35	6.34	5.68	4.74	1.93
801011	84.49	0.45	2.22	2.80	32.70	23.93	19.65	15.22	6.69	4.73	0.30	13.01
811001	70.32	0.43	2.35	2.95	25.19	18.93	15.90	12.88	7.86	6.98	4.92	3.85
821011	14.55	1.02	0.98	0.95	7.41	5.51	4.50	3.49	1.71	1.21	0.67	43.51
830818	87.83	0.50	2.00	2.52	34.19	24.98	20.92	16.57	8.47	7.15	5.04	2.53
830925	25.24	0.50	2.00	2.52	9.48	7.01	6.11	5.91	3.34	4.61	5.00	6.10
841025	75.44	0.45	2.22	2.80	30.44	22.16	18.75	14.79	7.99	6.45	4.47	3.33
870802	31.98	0.50	2.00	2.52	13.74	10.98	9.38	7.64	6.12	5.08	3.61	6.85
880507	16.70	0.52	1.90	2.40	6.25	4.83	4.41	4.25	3.11	3.58	3.63	4.93
881204	86.75	0.52	1.90	2.40	34.09	25.11	20.90	16.70	8.59	7.61	5.78	3.30

Table 12A Yellowknife array - Observations in the 1.0-4.0Hz band PcP

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
671021	35.39	0.50	2.00	2.52	14.12	10.51	9.09	7.31	4.91	4.11	3.19	10.16
681107	47.30	0.68	1.48	1.83	25.54	18.67	15.74	12.64	6.75	6.05	5.14	16.64
691014	63.27	0.60	1.67	2.09	27.38	21.41	18.42	15.35	11.58	10.35	8.03	19.93
760929	42.30	0.45	2.22	2.80	14.50	11.85	10.02	7.88	6.74	5.01	2.17	1.49
761020	3.20	0.55	1.82	2.29	1.50	1.48	1.38	1.20	1.31	1.11	0.76	0.57
770901	28.22	0.52	1.90	2.40	10.94	8.57	7.45	5.96	4.83	3.82	2.27	4.16
771009	1.60	0.88	1.14	1.28	0.87	0.84	0.88	0.79	0.89	0.77	0.56	0.51
780810	79.36	0.43	2.35	2.95	29.48	22.27	18.52	14.56	8.93	6.91	4.12	2.34
780927	13.12	0.55	1.82	2.29	5.89	4.49	3.99	3.29	2.57	2.20	1.63	3.72
790924	34.90	0.55	1.82	2.29	12.98	9.68	8.35	6.68	4.51	3.69	2.54	4.66
791018	55.80	0.40	2.50	3.13	23.08	17.24	14.22	11.24	6.09	4.97	3.49	1.55
801011	75.11	0.45	2.22	2.80	28.51	20.68	17.07	13.22	5.54	3.92	0.11	22.59
811001	59.94	0.47	2.11	2.65	22.45	17.04	14.17	11.23	7.02	5.62	3.07	2.82
821011	14.71	0.52	1.90	2.40	5.86	4.53	3.69	2.86	1.81	1.28	0.24	42.25
830818	75.31	0.47	2.11	2.65	29.12	20.99	17.63	13.95	6.49	5.60	4.14	2.22
830925	25.81	0.47	2.11	2.65	9.18	6.72	5.68	5.06	2.51	3.30	3.67	5.07
841025	67.09	0.45	2.22	2.80	25.61	18.53	15.48	12.23	5.63	4.81	3.93	2.85
870802	30.11	0.50	2.00	2.52	12.09	9.81	8.42	6.79	5.78	4.59	2.86	4.73
880507	16.96	0.47	2.11	2.65	6.02	4.47	3.85	3.56	2.03	2.60	2.89	4.06
881204	72.14	0.52	1.90	2.40	27.66	20.27	16.84	13.47	6.53	5.95	4.72	2.89

Table 13A Gauribidanur array - Broad band and short period observations

Date	ψ_g (m^3)	Moment (N m)	Duration (s)	Rise time (s)	Fall time (s)	pP-P time (s)	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	
751021	0.00	0.0000E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26
760929	5064.08	0.2545E+16	0.40	0.13	0.13	0.29	186.50	0.52	1.90	2.43	26
761020	2778.35	0.1397E+16	0.41	0.14	0.11	0.36	66.43	0.70	1.43	1.76	26
771009	1389.53	0.6985E+15	0.40	0.14	0.13	0.39	29.04	0.77	1.29	1.54	26
780810	19984.87	0.1005E+17	0.73	0.26	0.15	0.69	170.60	0.63	1.60	2.02	26
780927	18792.82	0.9446E+16	0.60	0.16	0.22	0.55	156.90	0.88	1.14	1.28	26
801011	9443.08	0.4747E+16	0.82	0.23	0.11	0.34	225.50	0.60	1.67	2.05	34
811001	14240.03	0.7158E+16	0.76	0.21	0.18	0.71	234.40	0.60	1.67	2.05	34
821011	9586.71	0.4819E+16	0.64	0.19	0.15	0.50	173.20	0.47	2.11	2.54	34
830818	9522.08	0.4786E+16	0.66	0.21	0.13	0.35	261.00	0.63	1.60	1.96	34
830925	19180.59	0.9641E+16	0.71	0.21	0.22	0.46	310.90	0.75	1.33	1.59	34
841025	8150.50	0.4097E+16	0.63	0.20	0.15	0.81	216.10	0.70	1.43	1.73	34
870802	18634.83	0.9367E+16	0.66	0.20	0.17	0.51	317.70	0.65	1.54	1.88	34
880507	12243.70	0.6154E+16	0.79	0.24	0.22	0.45	131.10	0.57	1.74	2.13	34
881204	11022.92	0.5541E+16	0.68	0.22	0.15	0.34	264.40	0.65	1.54	1.88	34

*
$B(\Delta)=3.81$ $G(\Delta)=$ $0.1393E-10s\ m^{-2}$ $\rho_0=2700.0kg\ m^{-3}$ $v_0=5670.0km\ s^{-1}$
$\rho_1=2500.0kg\ m^{-3}$ $v_1=4000.0km\ s^{-1}$ $K=0.81$

Table 14A Gauribidanur array - Observations in the 0.5-4.0Hz band

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
751021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
760929	210.10	0.52	1.90	2.43	76.35	61.46	51.62	42.26	32.90	27.85	21.17	0.34
761020	60.69	0.68	1.48	1.85	26.79	19.94	16.61	13.11	7.40	5.95	3.70	0.80
771009	23.34	0.63	1.60	2.02	10.27	7.72	6.60	5.44	3.54	3.26	2.58	0.55
780810	173.60	1.33	0.75	0.52	86.28	69.10	56.89	45.67	33.67	27.31	17.12	1.17
780927	156.30	0.55	1.82	2.32	70.27	55.63	45.99	36.09	26.54	19.82	8.50	1.08
801011	217.50	0.68	1.48	1.81	92.03	66.98	55.72	43.83	20.57	16.87	11.55	0.34
811001	209.50	0.50	2.00	2.43	95.08	72.71	61.08	47.97	32.81	24.82	12.34	1.01
821011	181.60	0.47	2.11	2.54	81.07	61.69	50.86	39.83	24.37	18.45	9.60	0.20
830818	245.30	0.63	1.60	1.96	103.30	76.26	63.76	49.64	27.68	20.36	8.01	0.61
830925	263.80	0.88	1.14	1.27	125.50	90.97	75.02	58.53	23.71	18.49	10.16	0.49
841025	202.40	0.60	1.67	2.05	88.16	66.64	55.23	43.05	26.26	19.33	8.28	0.30
870802	304.10	0.98	1.03	1.05	158.10	117.70	96.84	75.65	39.58	30.07	16.02	0.40
880507	159.00	0.85	1.18	1.33	71.82	53.53	44.65	34.98	20.27	15.49	7.57	0.52
881204	257.00	0.63	1.60	1.96	115.10	86.08	71.31	55.67	31.69	23.70	11.23	0.48

Table 15A Gauribidanur array - Observations in the 1.0-4.0Hz band

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
751021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
760929	199.20	0.50	2.00	2.56	70.74	54.72	45.40	36.99	24.27	21.42	17.08	0.22
761020	49.35	0.65	1.54	1.93	22.33	16.60	13.83	10.88	6.15	4.84	2.83	0.36
771009	20.56	0.57	1.74	2.21	8.89	6.65	5.65	4.57	2.91	2.54	1.86	0.43
780810	137.80	0.55	1.82	2.32	62.61	52.52	43.20	34.95	28.97	23.39	14.30	0.55
780927	120.50	0.55	1.82	2.32	52.80	43.88	36.39	28.64	24.35	18.12	7.37	0.69
801011	179.90	0.60	1.67	2.05	81.73	59.39	49.44	38.76	18.08	14.41	9.08	0.17
811001	197.40	0.55	1.82	2.23	80.83	61.92	51.31	40.31	26.14	19.95	10.12	0.93
821011	148.60	0.50	2.00	2.43	64.22	50.80	41.90	32.77	23.90	17.65	7.31	0.14
830818	208.30	0.63	1.60	1.96	92.61	68.20	57.01	44.33	24.23	17.68	6.24	0.31
830925	228.60	0.63	1.60	1.96	100.50	75.29	62.00	48.32	26.78	19.85	7.98	0.24
841025	177.90	0.57	1.74	2.13	79.08	59.97	49.74	38.71	24.17	17.59	6.08	0.22
870802	238.50	0.60	1.67	2.05	123.80	95.47	78.50	61.31	39.75	29.46	12.59	0.22
880507	127.50	0.65	1.54	1.88	55.90	42.84	35.61	27.92	18.45	13.91	6.19	0.33
881204	226.60	0.60	1.67	2.05	105.50	78.73	65.32	50.85	28.88	21.21	8.55	0.25

Table 16A Gauribidanur array - Broad band and short period observations PcP

Date	ψ_∞ (m^3)	Moment (N m)	Duration (s)	Rise time (s)	Fall time (s)	pP-P time (s)	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	
671021	26500.26	0.1332E+17	0.60	0.20	0.23	0.52	70.87	0.60	1.67	2.12	26
681107	38991.04	0.1960E+17	0.60	0.22	0.16	0.47	152.90	0.80	1.25	1.47	26
760929	6984.44	0.3511E+16	0.59	0.20	0.15	0.44	20.17	0.68	1.48	1.85	26
780810	28461.59	0.1431E+17	0.56	0.21	0.17	0.44	57.87	0.73	1.38	1.69	26
791018	46820.11	0.2353E+17	0.88	0.28	0.27	0.00	44.72	0.80	1.25	1.46	34
830925	10285.80	0.5170E+16	0.60	0.19	0.22	0.89	33.70	0.65	1.54	1.88	34
881204	7333.66	0.3686E+16	0.52	0.20	0.15	0.41	32.03	0.75	1.33	1.59	34

*

$B(\Delta)=0.00$ $G(\Delta)=$ $0.1523E-11s\ m^{-2}$ $\rho_0=2700.0kg\ m^{-3}$ $v_0=5670.0km\ s^{-1}$
$\rho_1=2500.0kg\ m^{-3}$ $v_1=4000.0km\ s^{-1}$ $K=0.81$

Table 17A Gauribidanur array - Observations in the 0.5-4.0Hz band PcP

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
671021	68.38	0.70	1.43	1.76	33.27	25.57	21.34	17.37	11.39	10.03	7.87	9.93
681107	153.10	0.82	1.21	1.40	69.42	50.30	41.81	33.36	14.57	13.65	11.68	15.83
760929	21.72	0.75	1.33	1.61	10.25	7.66	6.57	5.33	3.50	3.04	2.44	3.67
780810	53.23	0.80	1.25	1.47	25.50	18.87	15.98	12.78	7.61	6.45	4.88	5.67
791018	41.00	0.77	1.29	1.52	19.81	15.22	12.68	9.96	6.70	5.08	3.03	3.76
830925	31.49	0.65	1.54	1.88	13.44	9.95	8.31	6.68	3.63	3.25	2.91	3.56
881204	29.60	0.70	1.43	1.73	13.99	10.32	8.59	7.09	3.59	3.73	3.83	4.28

Table 18A Gauribidanur array - Observations in the 1.0-4.0Hz band PcP

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
671021	51.41	0.75	1.33	1.61	23.76	18.65	15.68	13.02	9.31	8.41	6.63	8.57
681107	112.30	0.77	1.29	1.54	50.12	36.00	30.16	24.29	10.42	10.45	9.72	13.28
760929	18.88	0.68	1.48	1.85	8.13	6.17	5.15	4.18	2.58	2.30	1.86	2.98
780810	38.83	0.73	1.38	1.69	17.14	13.05	10.98	8.72	5.83	4.64	3.16	4.82
791018	29.19	0.70	1.43	1.73	13.55	10.45	8.69	6.83	4.63	3.52	2.33	3.01
830925	27.04	0.68	1.48	1.81	11.88	8.69	7.27	5.84	2.93	2.70	2.27	2.92
881204	24.26	0.65	1.54	1.88	10.90	8.17	6.77	5.53	3.04	2.91	2.96	3.51

Table 19O Warramunga array - Broad band and ort period observations

Date	V_T (m^3)	Moment (N m)	Duration (s)	Rise time (s)	Fall time (s)	pP-P time (s)	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	
661027	24890.00	0.1251E+17	0.82	0.33	0.15	0.51	137.10	0.85	1.18	1.34	26
671021	2613.00	0.1313E+16	0.75	0.34	0.16	0.50	21.59	0.98	1.03	1.05	26
681107	4795.00	0.2410E+16	0.74	0.33	0.20	0.54	32.30	0.98	1.03	1.05	26
691014	6252.00	0.3148E+16	0.65	0.18	0.22	0.47	24.55	0.90	1.11	1.22	26
701014	44070.00	0.2215E+17	1.02	0.32	0.26	0.00	78.33	0.88	1.14	1.28	26
710927	10040.00	0.5047E+16	0.80	0.30	0.19	0.51	54.36	0.98	1.03	1.05	26
751021	5291.00	0.2660E+16	1.09	0.28	0.22	0.54	9.56	0.85	1.18	1.34	26
770901	1434.00	0.7208E+15	0.76	0.26	0.20	0.52	7.05	0.95	1.05	1.10	26
790924	1548.00	0.7781E+15	0.76	0.29	0.19	0.51	9.22	0.88	1.14	1.27	36
791018	828.00	0.4162E+15	0.91	0.31	0.13	0.00	3.71	0.85	1.18	1.34	36
801011	895.90	0.4503E+15	0.69	0.21	0.27	0.47	5.30	0.88	1.14	1.27	36
811001	804.50	0.4044E+15	0.79	0.33	0.18	0.00	4.05	0.77	1.29	1.53	36
821011	804.50	0.4044E+15	0.80	0.29	0.21	0.56	4.22	0.98	1.03	1.05	36
841025	637.00	0.3202E+15	0.69	0.25	0.16	0.50	4.30	0.82	1.21	1.40	36
870802	2191.00	0.1101E+16	0.95	0.30	0.23	0.57	8.95	0.98	1.03	1.05	35
880507	1050.00	0.5278E+15	0.74	0.20	0.17	0.60	5.30	0.88	1.14	1.27	36

B(Δ)=5.01 G(Δ)= 0.0000E+00s m^{-2} ρ_0=2600.0kg m^{-3} v_0=5600.0km s^{-1}
ρ_1=2500.0kg m^{-3} v_1=4000.0km s^{-1} K=0.00

Table 20O Warramunga array - Observations in the 0.5-4.0Hz band

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
661027	149.00	0.82	1.21	1.40	69.51	52.10	43.98	34.82	22.03	17.53	11.53	0.98
671021	24.40	0.88	1.14	1.28	11.64	9.10	7.87	6.38	5.02	4.18	2.75	0.52
681107	40.80	0.95	1.05	1.10	20.43	15.52	12.96	10.34	6.58	5.42	3.47	0.43
691014	30.11	0.93	1.08	1.16	14.97	11.34	9.55	7.89	4.98	4.68	3.94	0.97
701014	72.21	0.88	1.14	1.28	35.29	27.34	24.05	19.40	15.66	12.62	8.49	0.44
710927	59.37	0.95	1.05	1.10	29.02	21.30	17.79	14.13	7.33	6.25	4.56	0.36
751021	8.90	0.90	1.11	1.22	4.51	3.40	2.96	2.40	1.72	1.45	1.16	0.26
770901	6.45	1.05	0.95	0.90	3.55	2.83	2.48	2.23	1.72	1.75	1.72	0.22
790924	9.16	0.93	1.08	1.16	5.05	3.93	3.49	3.07	2.34	2.33	2.19	0.32
791018	3.30	0.85	1.18	1.34	1.48	1.35	1.24	1.12	1.11	1.01	0.92	0.30
801011	5.26	0.90	1.11	1.22	2.72	2.59	2.32	1.99	2.10	1.76	1.33	0.53
811001	4.15	0.82	1.21	1.40	1.75	1.64	1.49	1.28	1.34	1.14	1.06	0.35
821011	3.74	1.08	0.93	0.86	2.18	1.67	1.53	1.42	1.07	1.15	1.27	0.45
841025	4.17	0.82	1.21	1.40	1.78	1.87	1.89	1.58	1.93	1.52	1.00	0.26
870802	7.22	1.05	0.95	0.90	3.85	2.99	2.84	2.59	2.17	2.16	2.25	0.51
880507	4.36	0.88	1.14	1.27	2.10	1.81	1.65	1.52	1.37	1.33	1.31	0.37

Table 21O Warramunga array - Observations in the 1.0-4.0Hz band

Date	1/2 Pk-Pk (nm)	Period (s)	Frequency (Hz)	Gain	r.m.s. 0-3s (nm)	r.m.s. 0-6s (nm)	r.m.s. 0-9s (nm)	r.m.s. 0-15s (nm)	r.m.s. 3-9s (nm)	r.m.s. 3-15s (nm)	r.m.s. 9-18s (nm)	r.m.s. noise (nm)
661027	106.30	0.77	1.29	1.54	50.43	39.34	33.63	26.74	20.62	16.07	9.80	0.53
671021	16.14	0.82	1.21	1.40	7.92	6.77	6.04	4.95	4.82	3.86	2.31	0.25
681107	26.04	0.85	1.18	1.34	13.10	10.71	9.05	7.28	6.10	4.83	2.77	0.24
691014	19.57	0.88	1.14	1.28	9.86	8.15	7.07	5.94	5.13	4.44	3.32	0.61
701014	44.28	0.82	1.21	1.40	22.85	18.70	17.06	13.76	13.24	10.30	6.51	0.26
710927	35.68	0.93	1.09	1.16	17.72	13.54	11.44	9.15	6.28	5.11	3.42	0.31
751021	5.49	0.82	1.21	1.40	2.93	2.31	2.05	1.66	1.41	1.15	0.89	0.23
770901	3.35	1.05	0.95	0.90	2.05	1.78	1.53	1.60	1.37	1.47	1.59	0.12
790924	5.51	0.93	1.08	1.16	3.12	2.61	2.43	2.28	1.99	2.02	1.98	0.15
791018	2.06	0.65	1.54	1.91	0.89	0.82	0.86	0.80	0.84	0.78	0.76	0.13
801011	3.73	0.82	1.21	1.40	1.97	2.00	1.83	1.60	1.84	1.49	1.07	0.21
811001	2.68	0.65	1.54	1.91	1.15	1.08	1.07	0.97	1.02	0.91	0.94	0.13
821011	2.16	1.08	0.93	0.86	1.25	1.08	1.05	1.07	0.94	1.01	1.13	0.16
841025	3.09	0.73	1.38	1.68	1.34	1.50	1.61	1.37	1.74	1.38	0.94	0.10
870802	3.63	1.13	0.89	0.78	2.09	1.75	1.83	1.89	1.78	1.84	2.04	0.28
880507	2.68	0.63	1.60	2.00	1.28	1.25	1.21	1.18	1.17	1.16	1.20	0.21

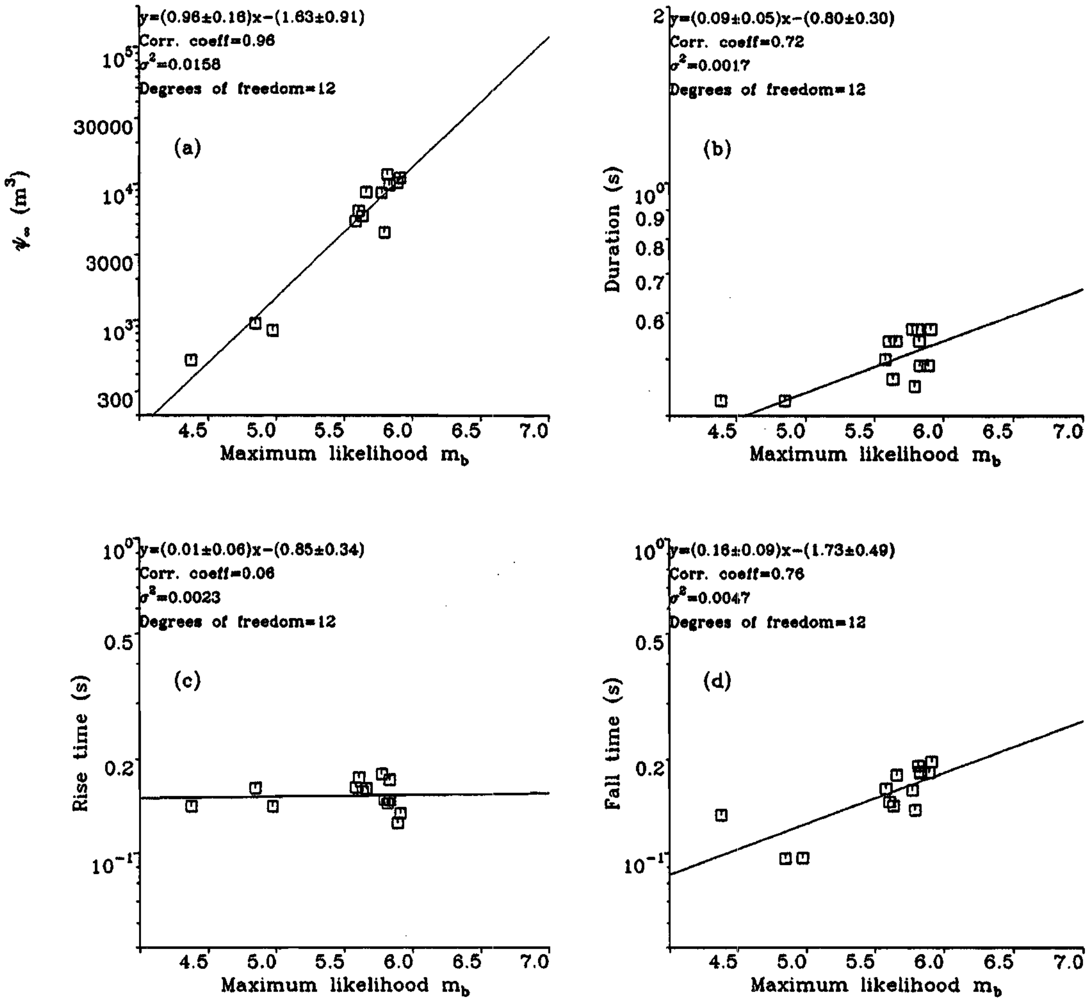


Figure 1 Novaya Zemlya at EKA

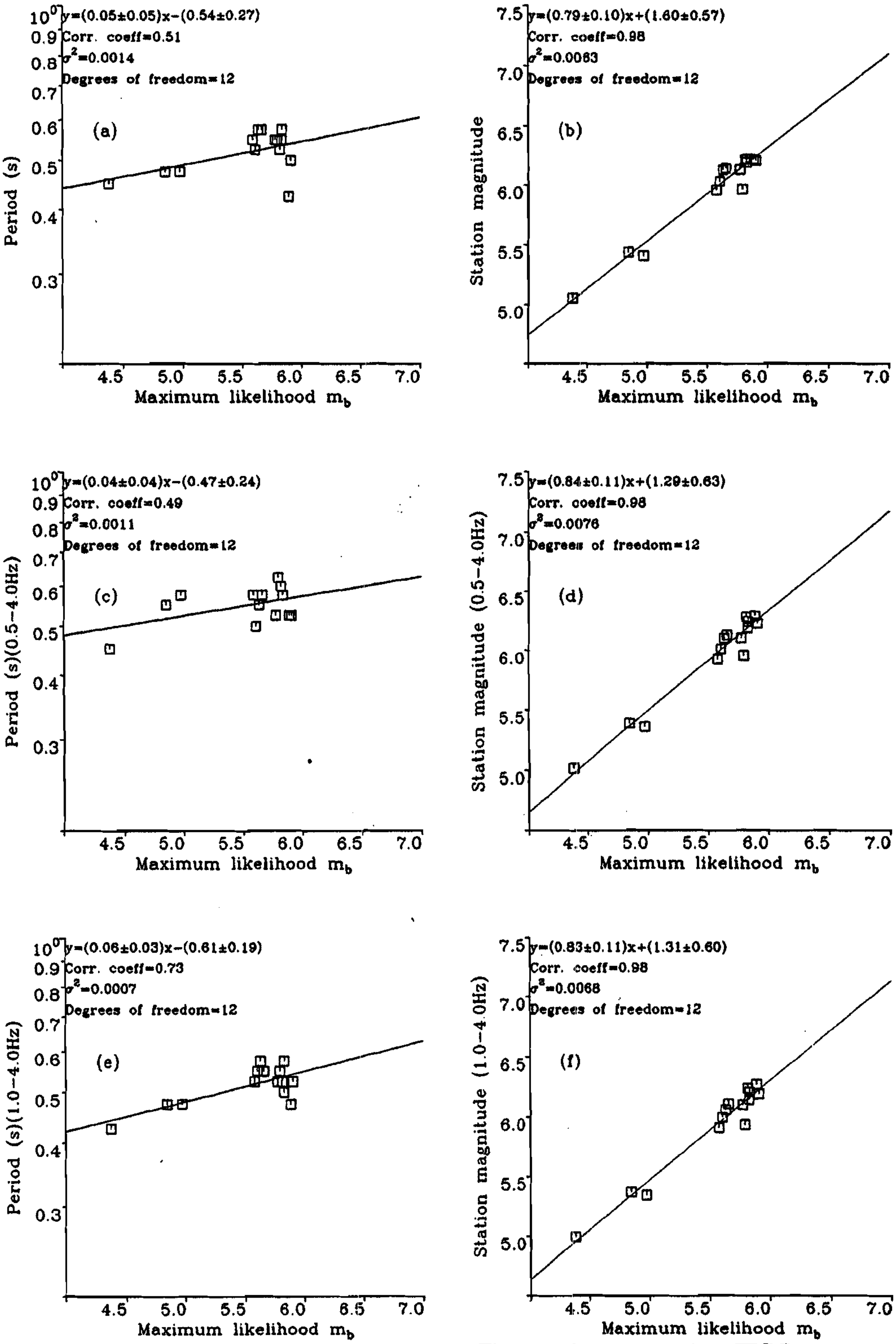


Figure 2 Novaya Zemlya at EKA

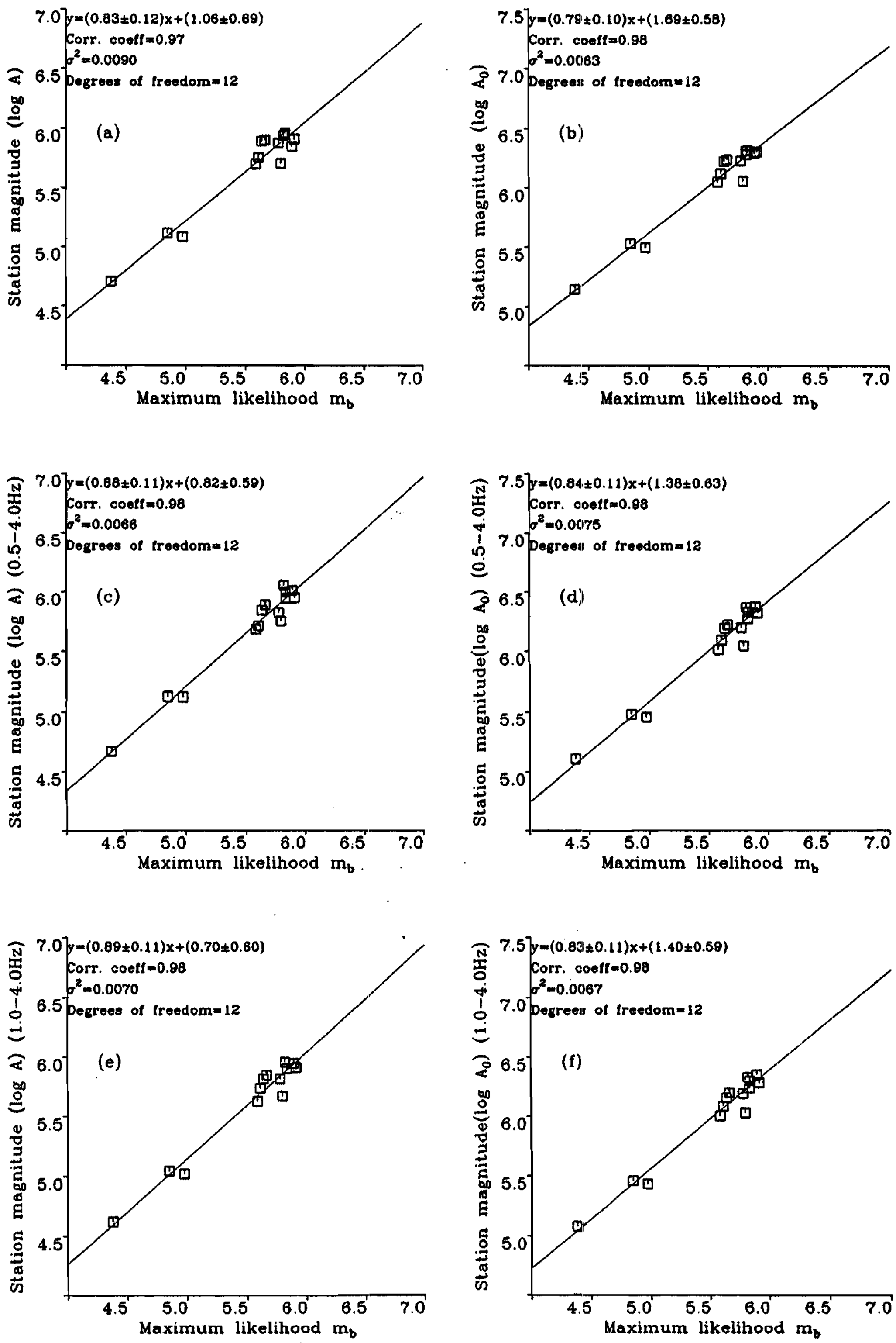


Figure 3 Novaya Zemlya at EKA

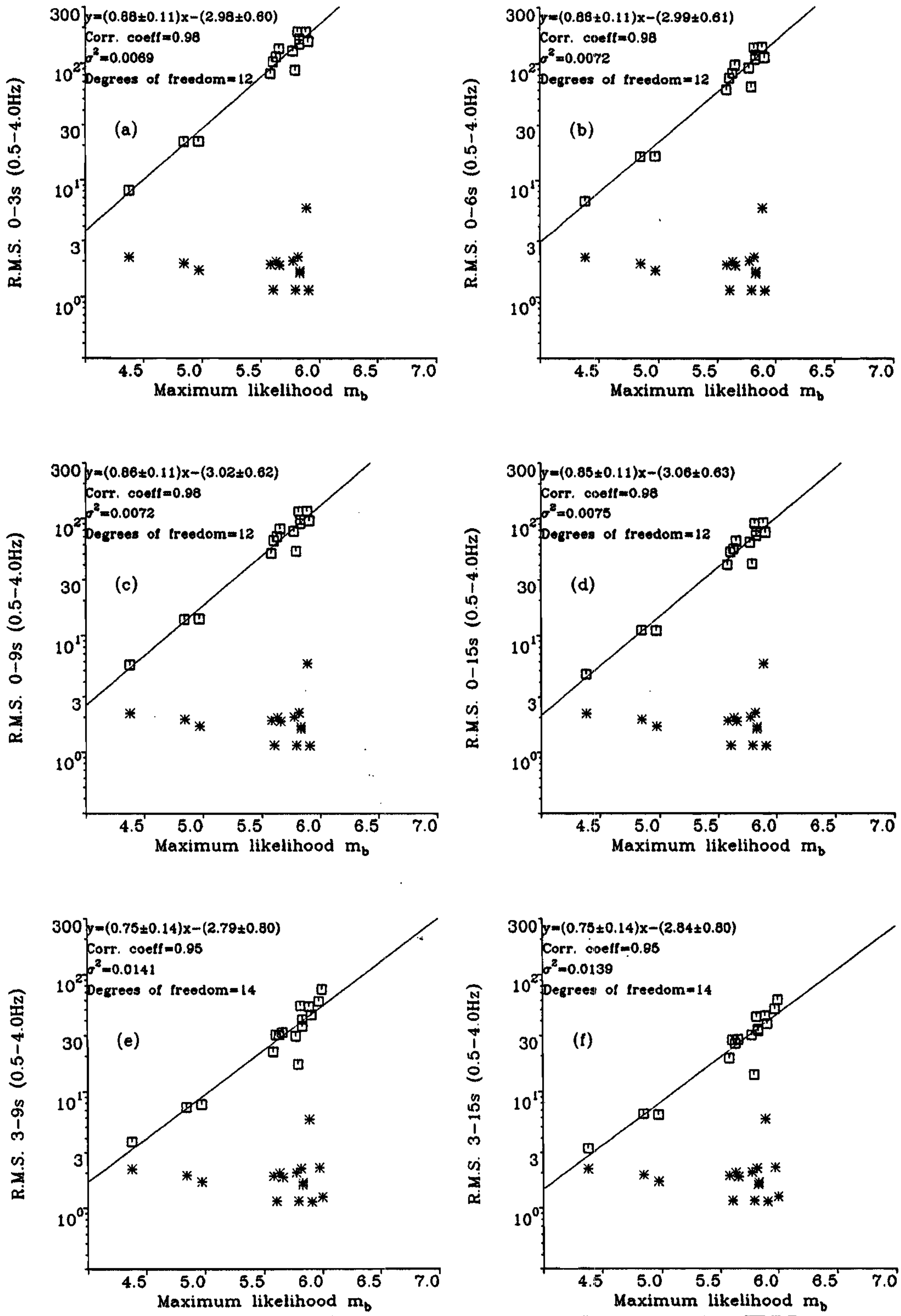


Figure 4 Novaya Zemlya at EKA

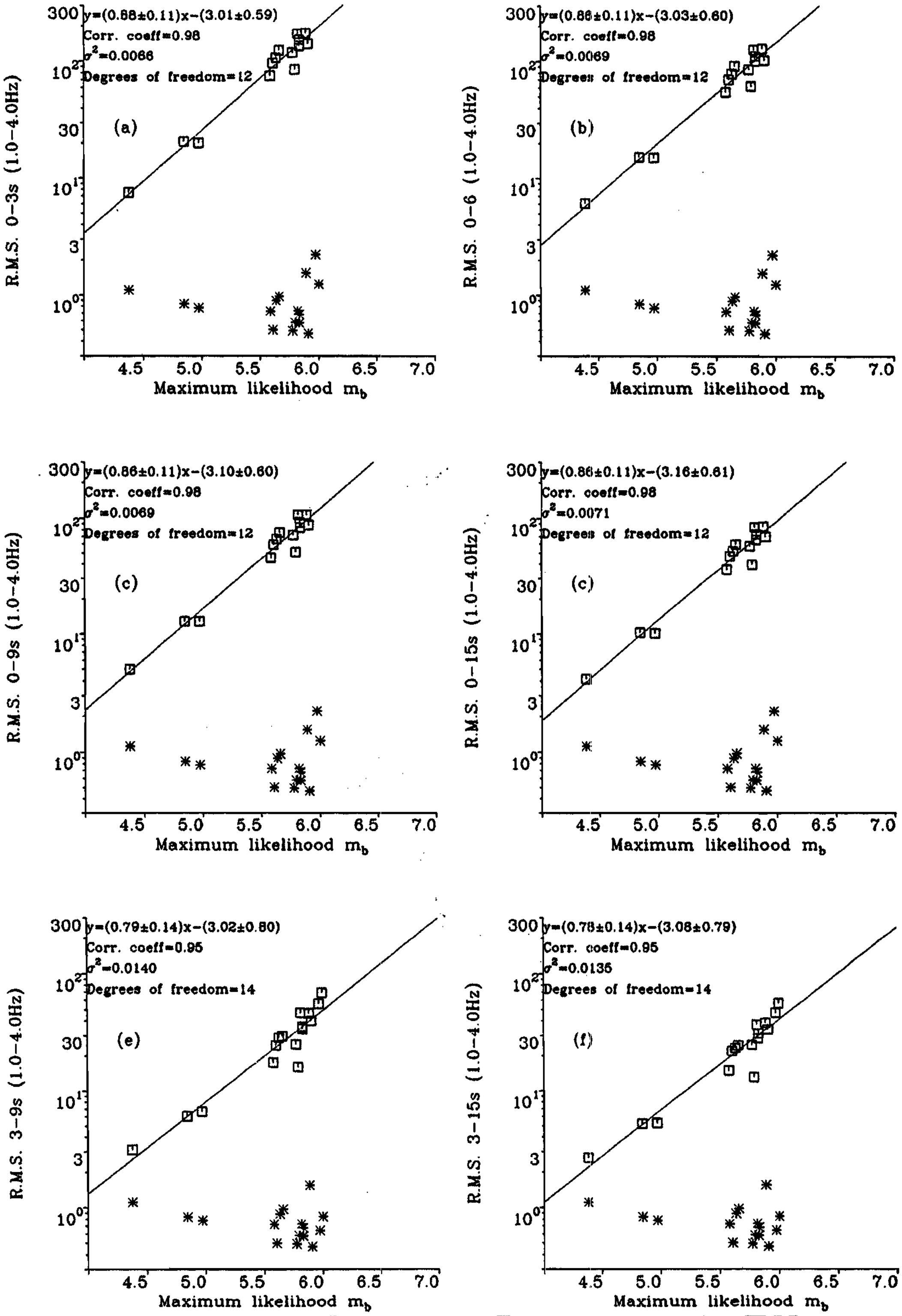


Figure 5 Novaya Zemlya at EKA

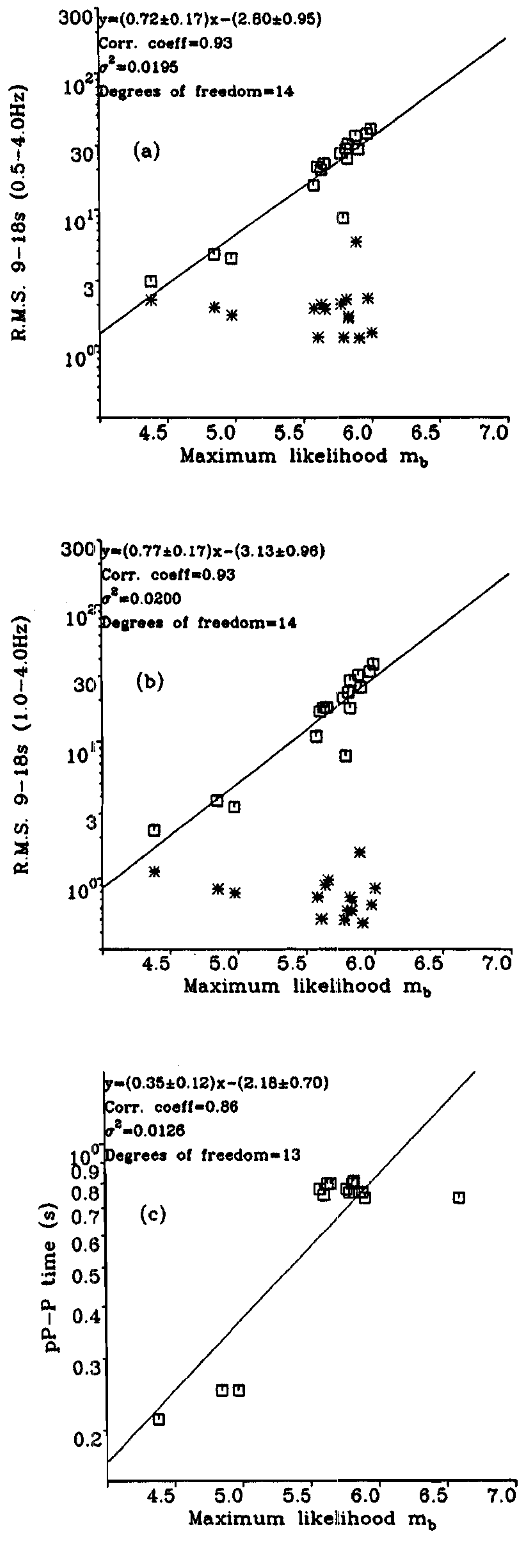


Figure 6 Novaya Zemlya at EKA

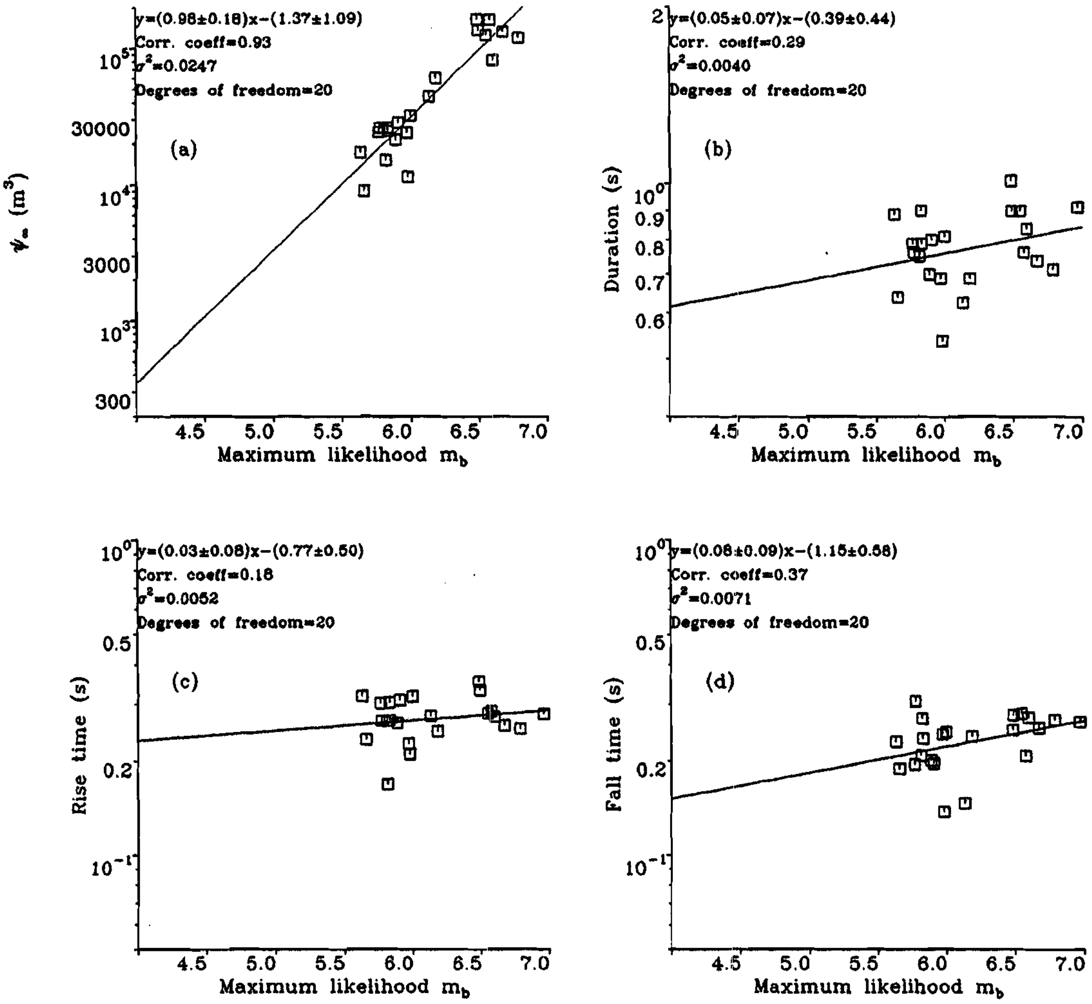


Figure 7 Novaya Zemlya at EKA PcP

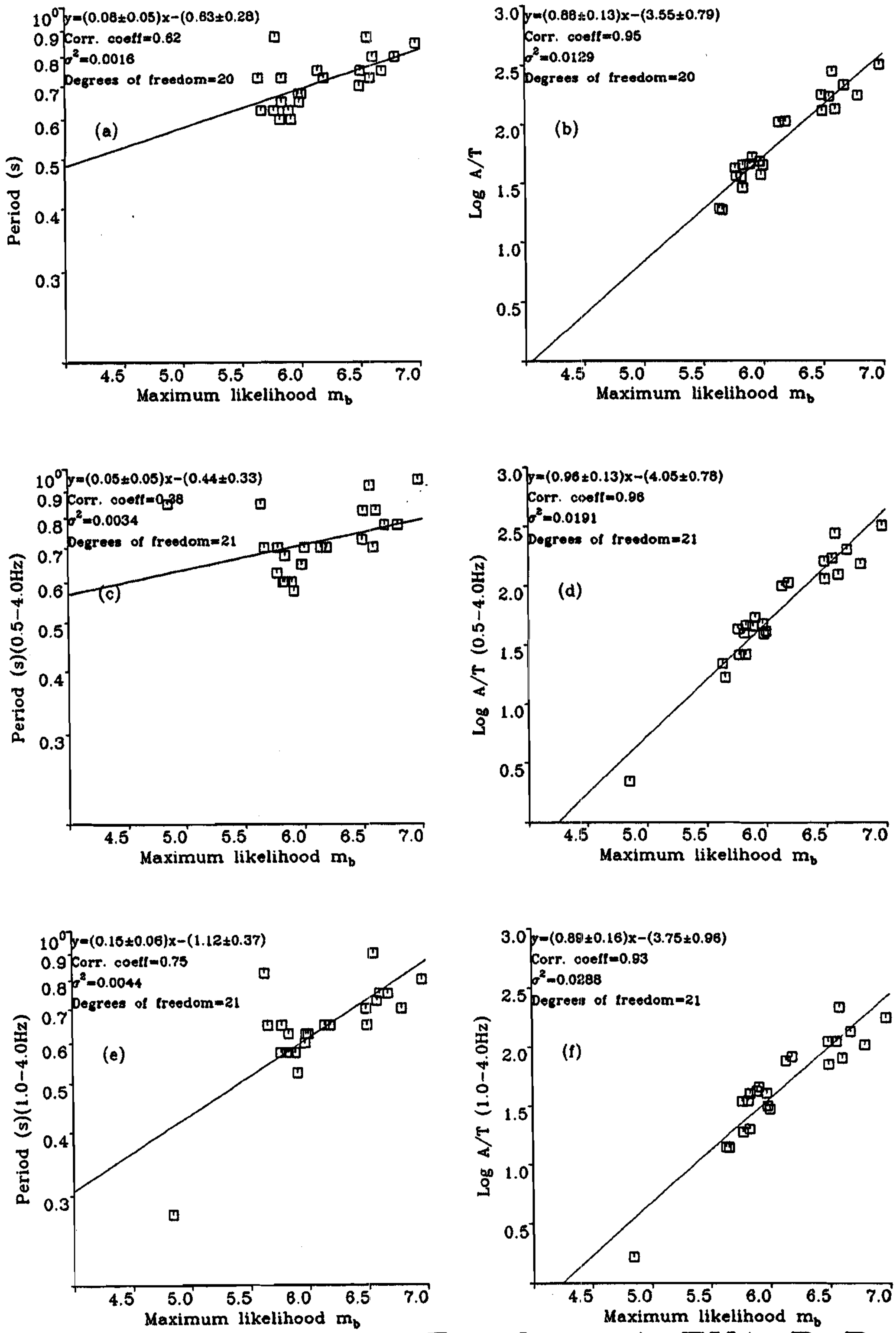


Figure 8 Novaya Zemlya at EKA PcP

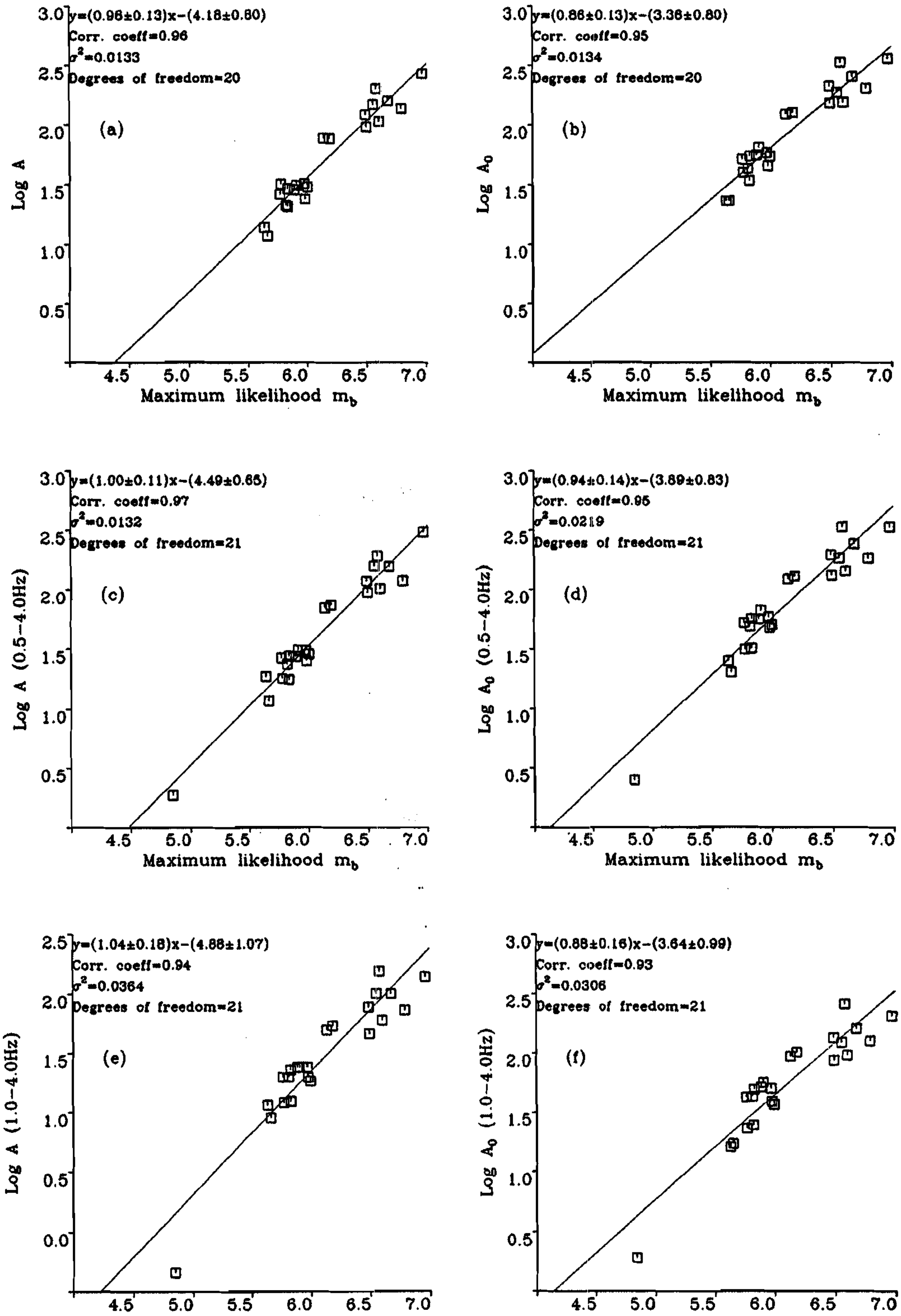


Figure 9 Novaya Zemlya at EKA PcP

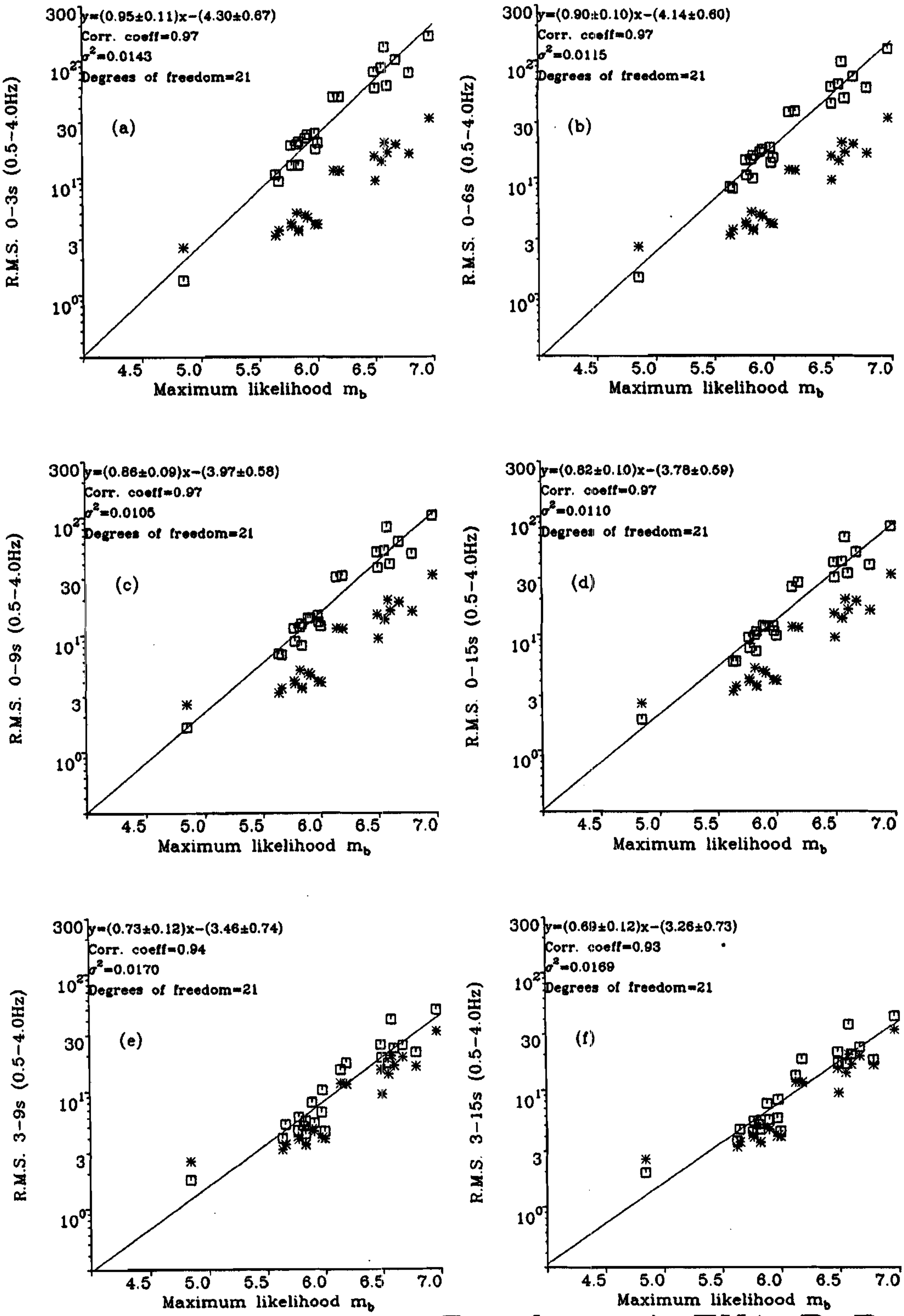


Figure 10 Novaya Zemlya at EKA PcP

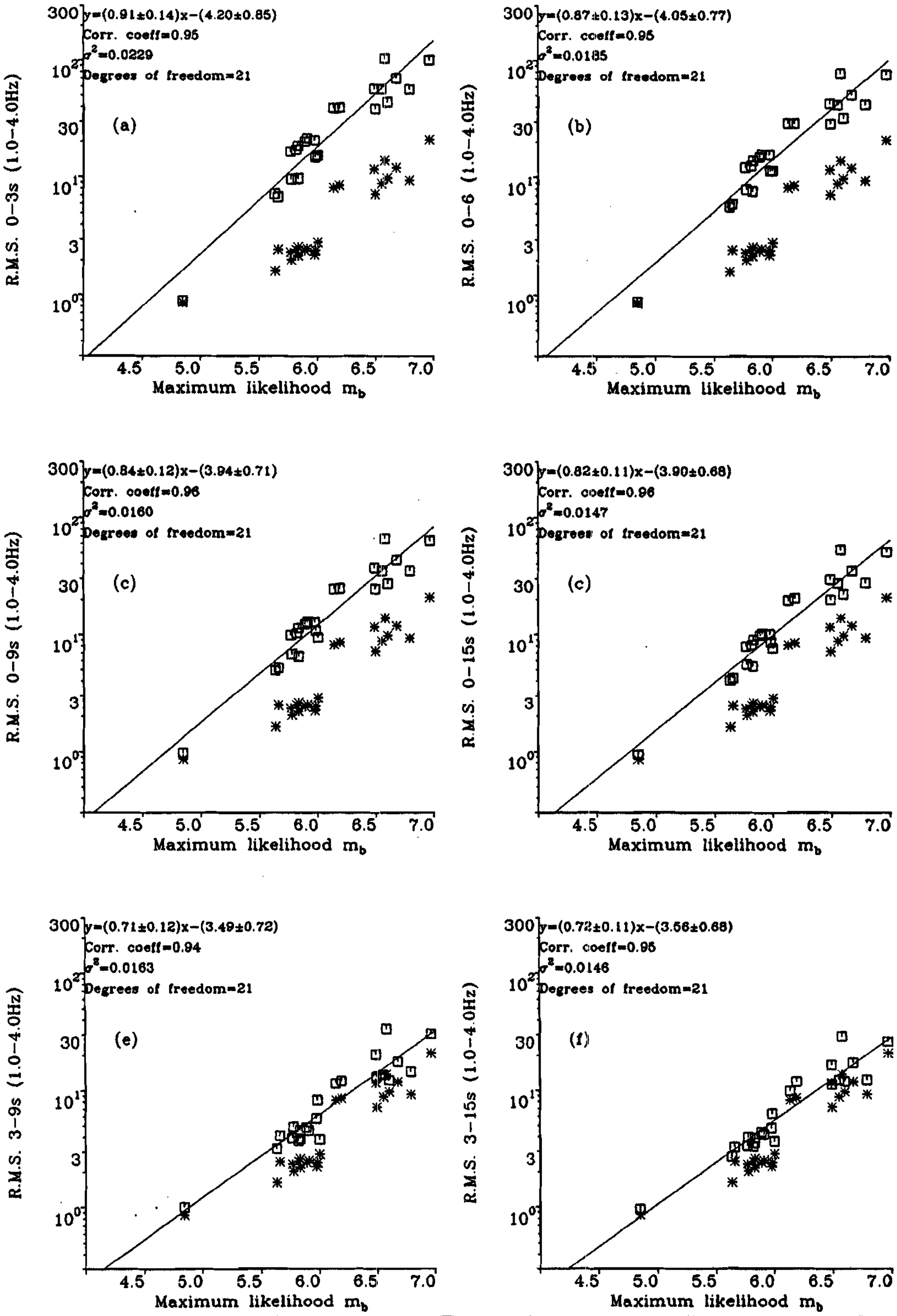


Figure 11 Novaya Zemlya at EKA PcP

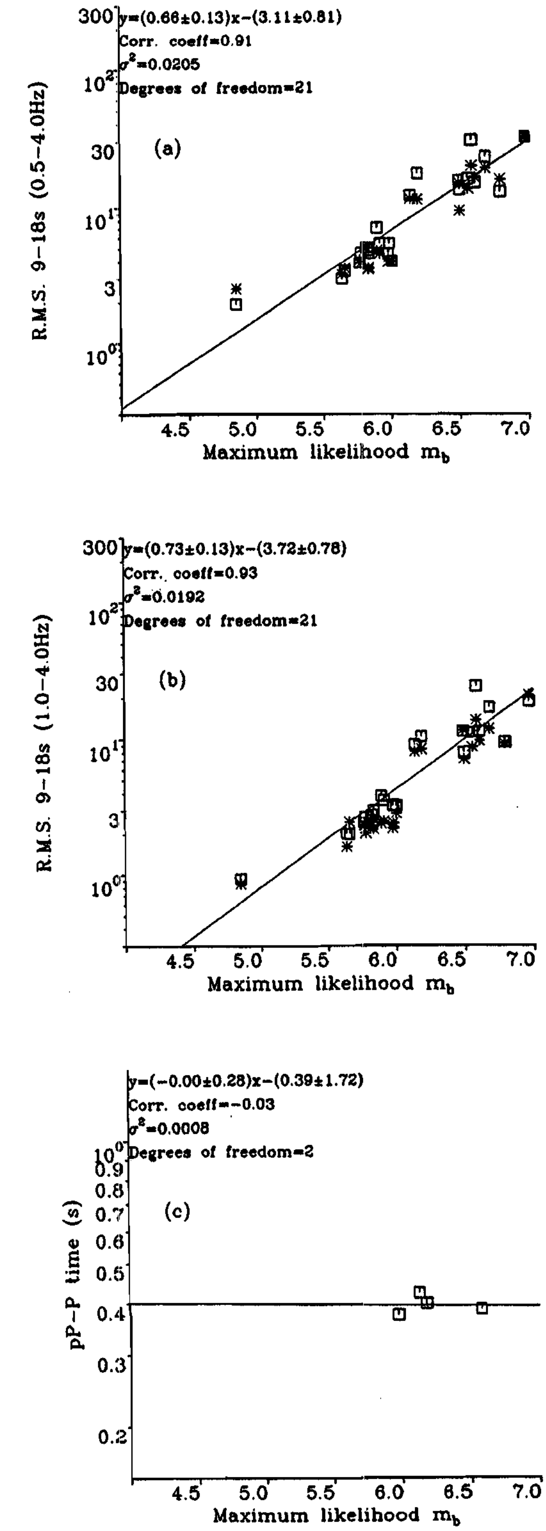


Figure 12 Novaya Zemlya at EKA PcP

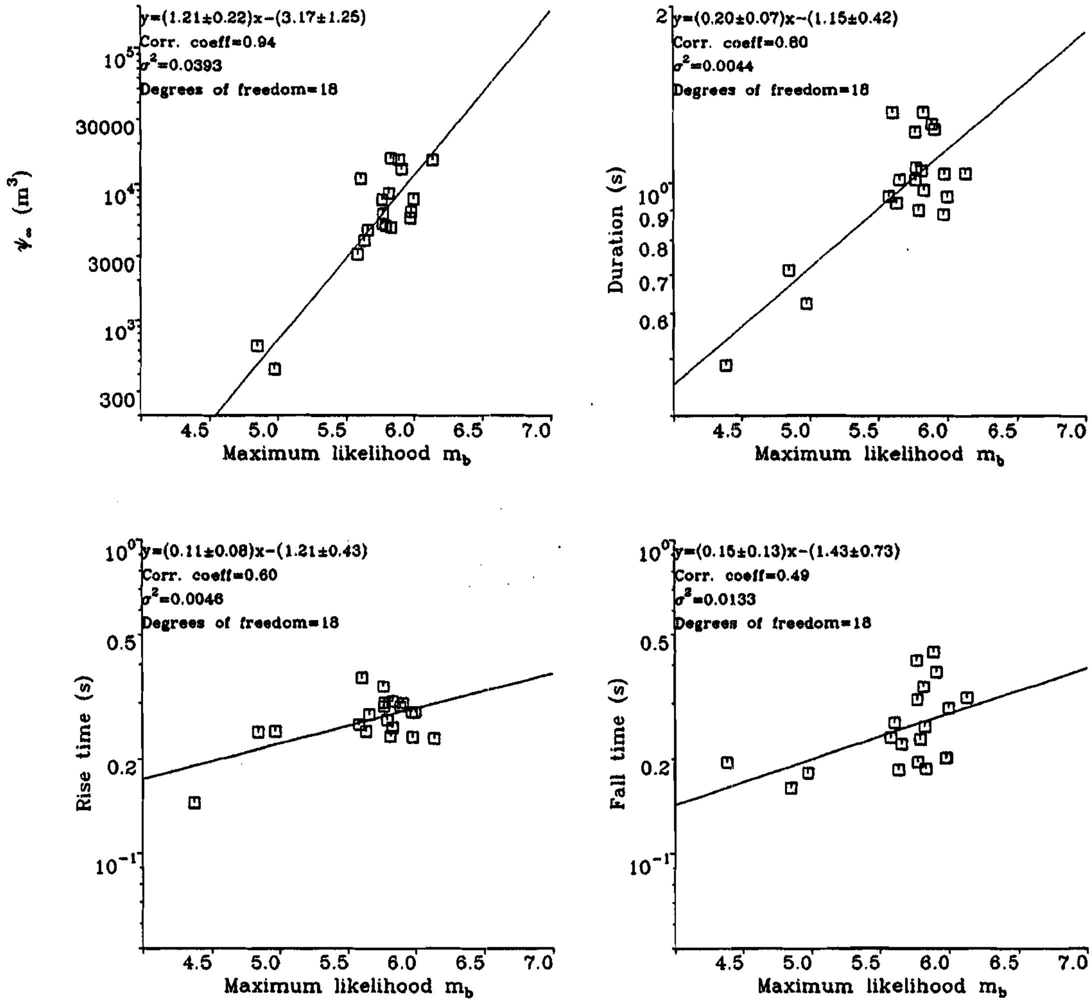


Figure 13 Novaya Zemlya at YKA

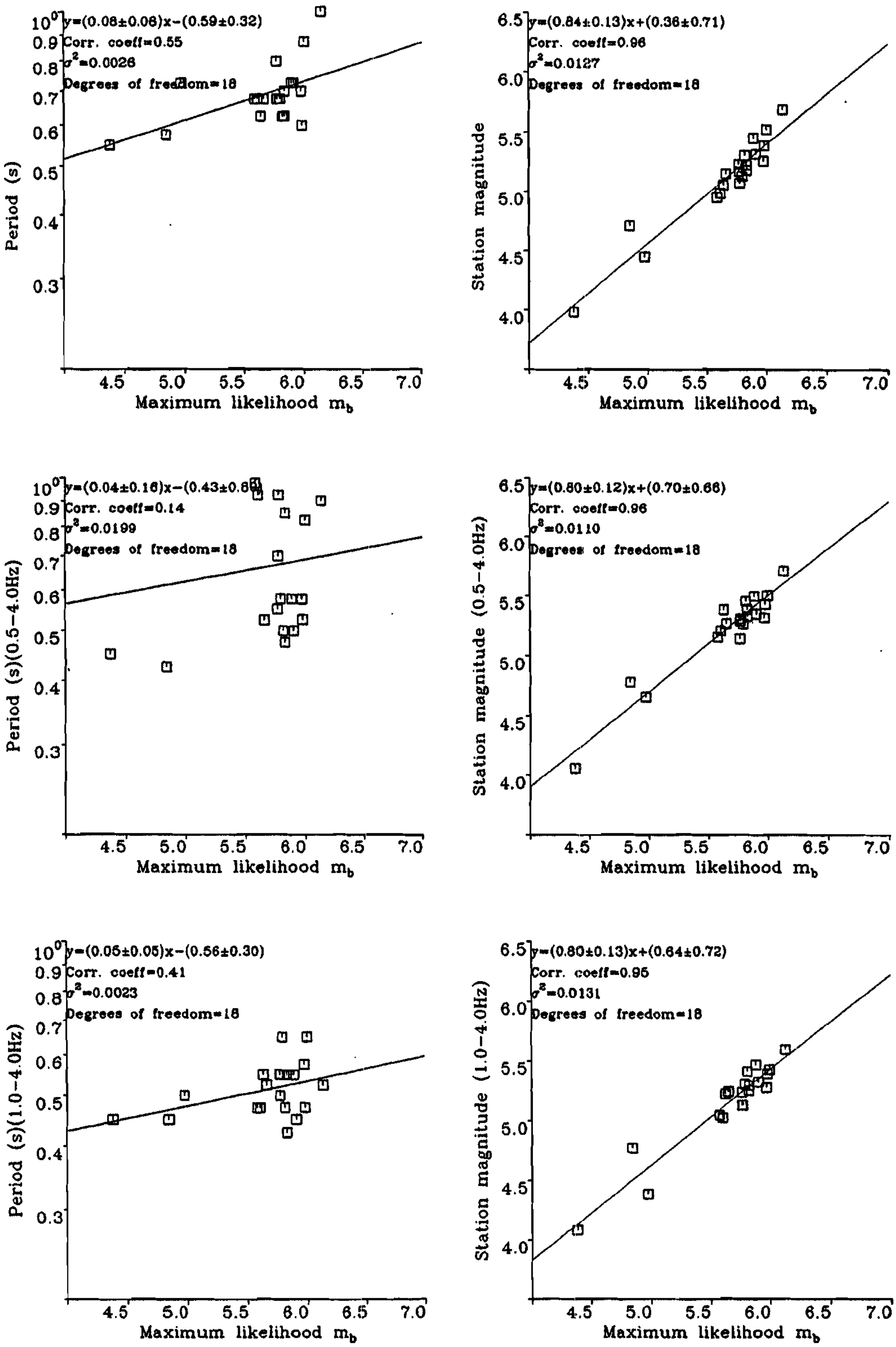


Figure 14 Novaya Zemlya at YKA

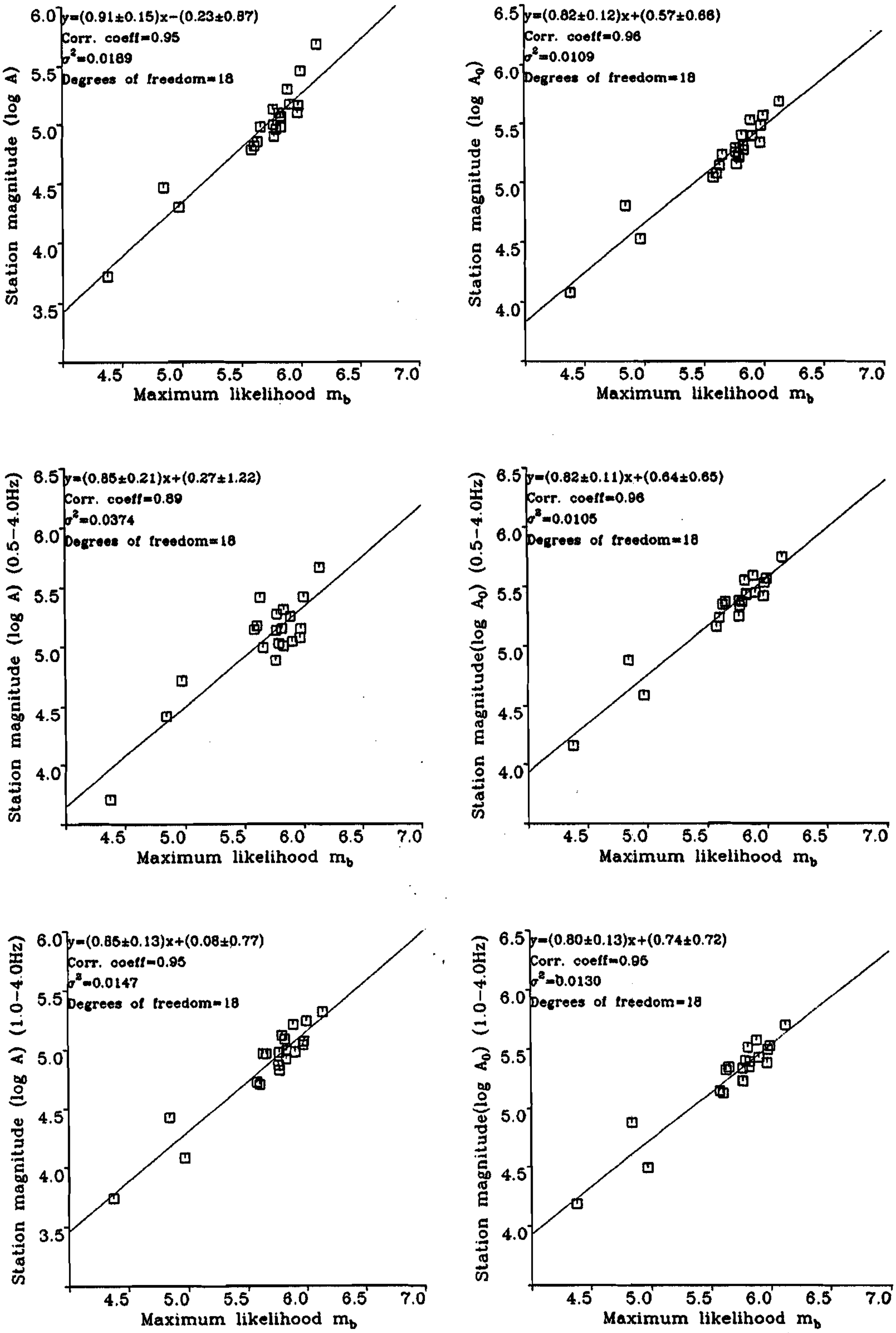


Figure 15 Novaya Zemlya at YKA

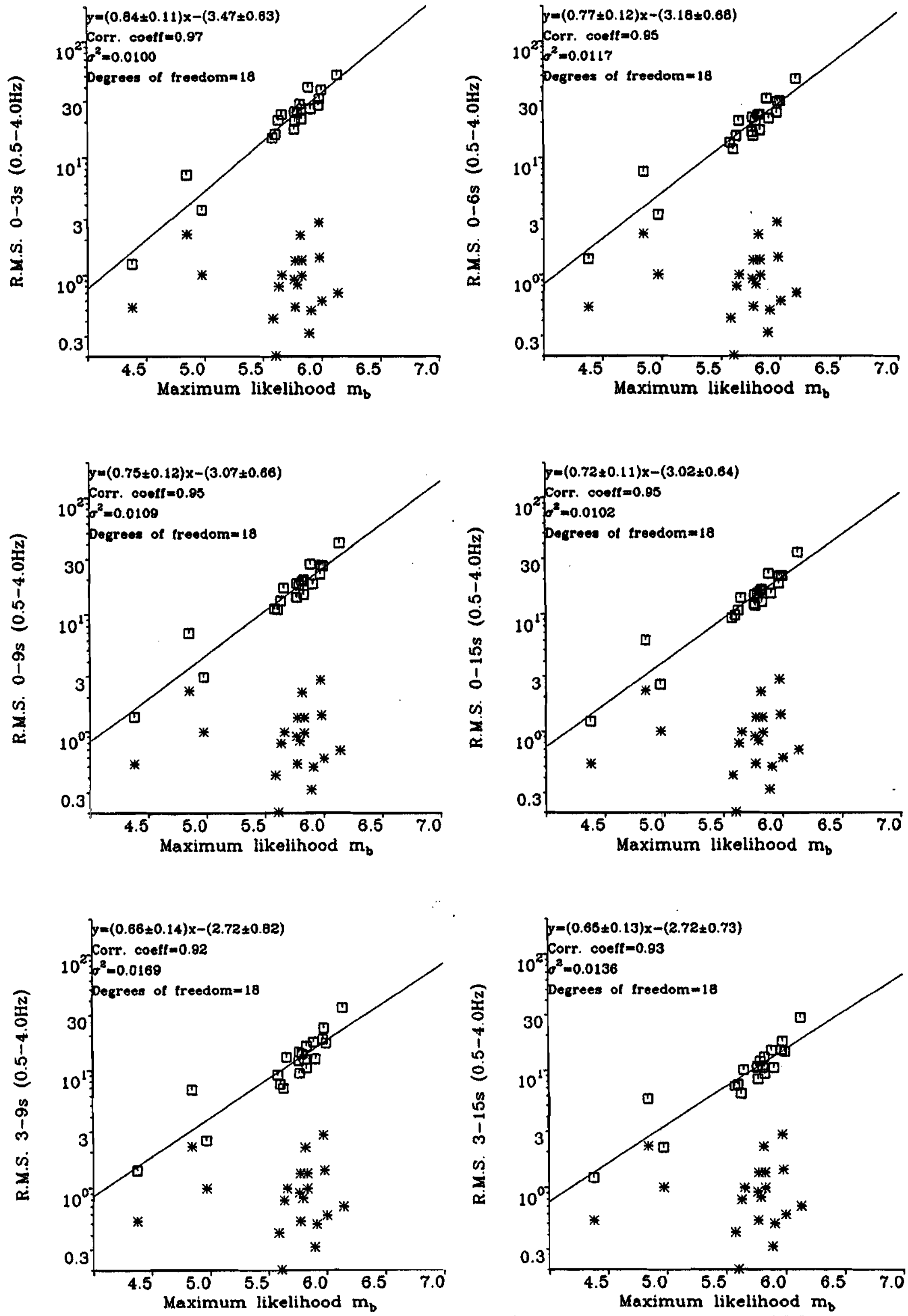


Figure 16 Novaya Zemlya at YKA

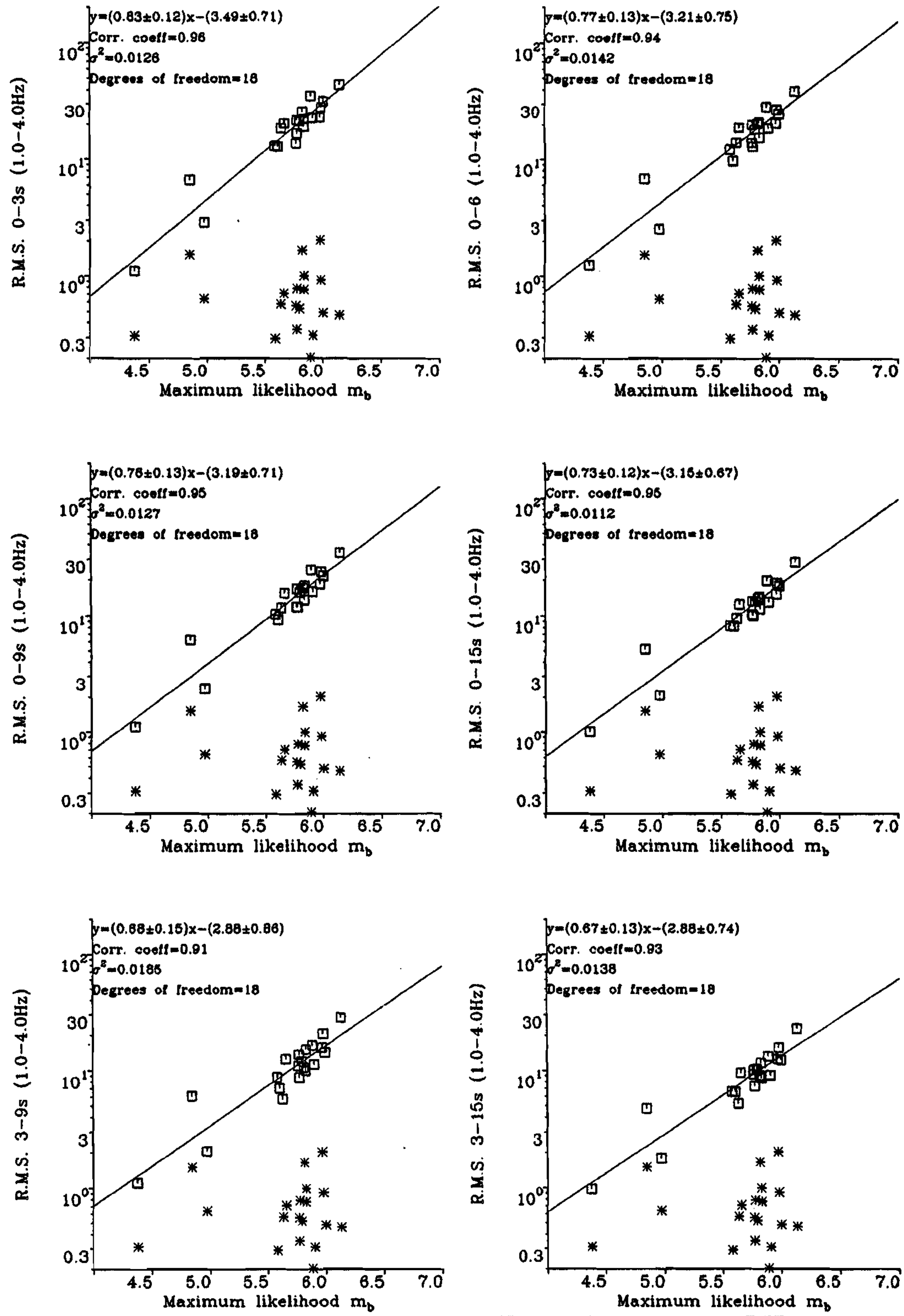


Figure 17 Novaya Zemlya at YKA

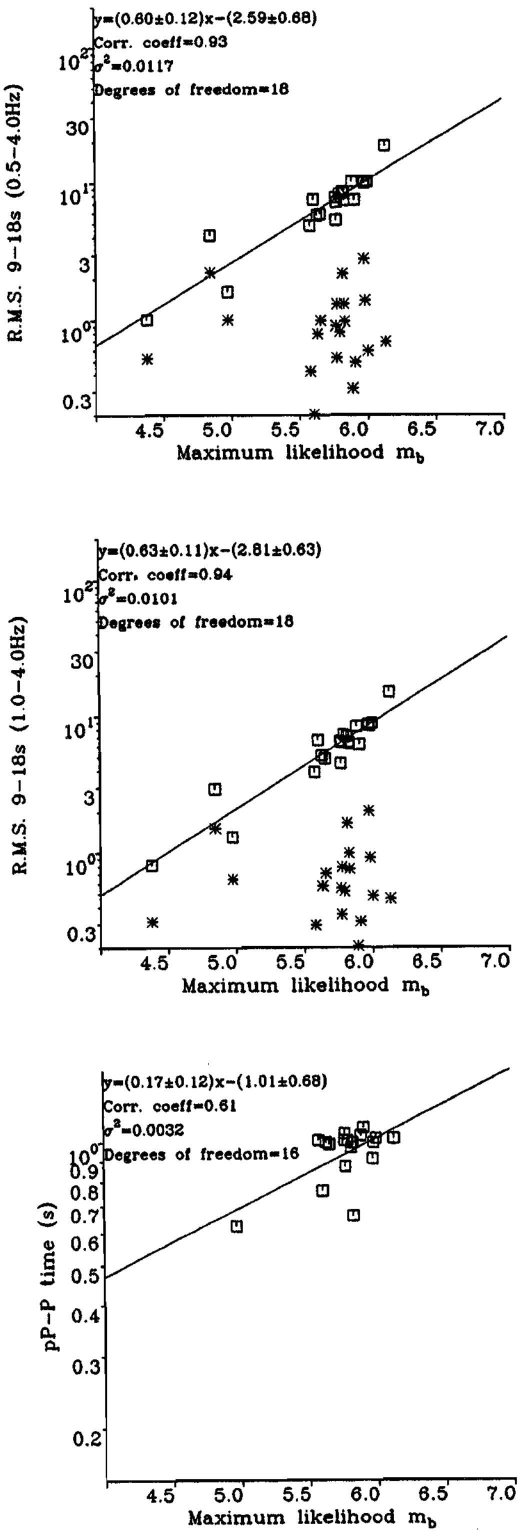


Figure 18 Novaya Zemlya at YKA

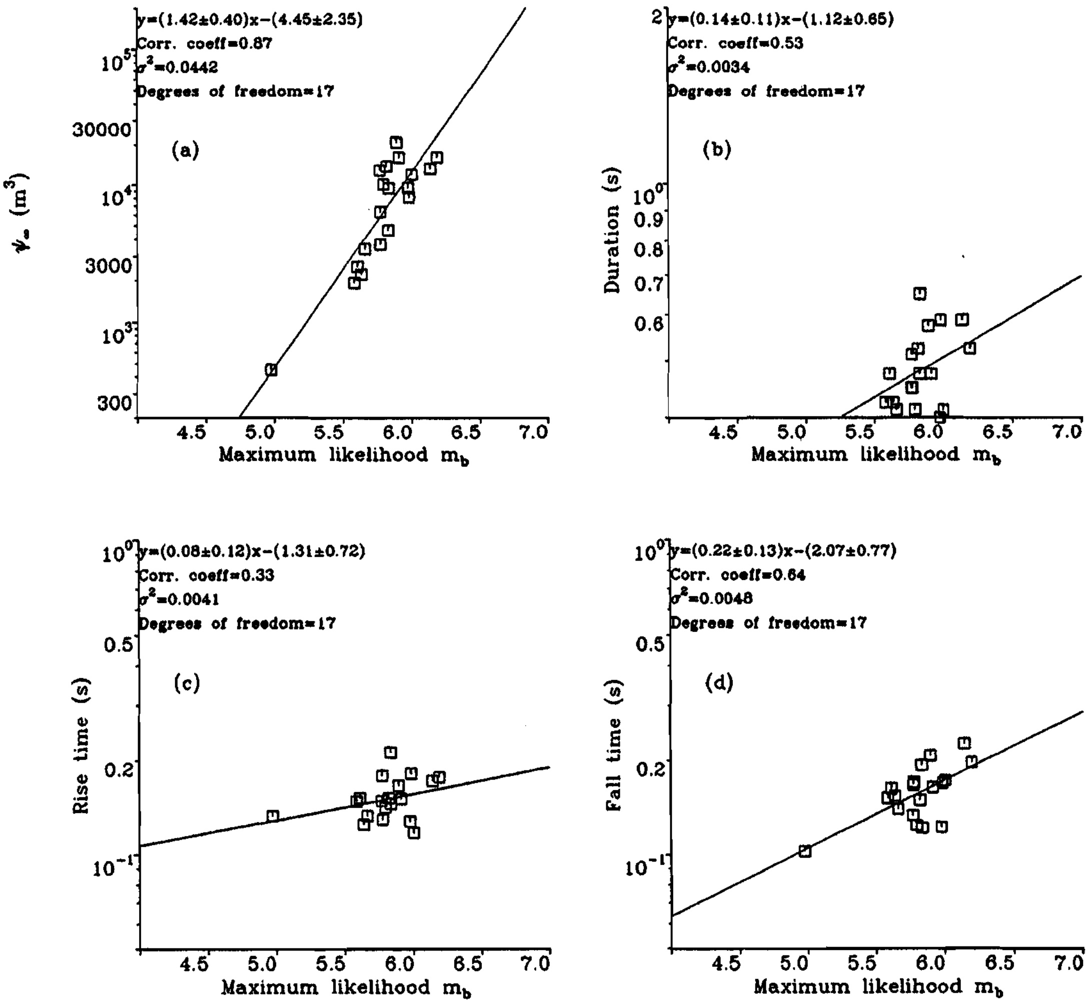


Figure 19 Novaya Zemlya at YKA PcP

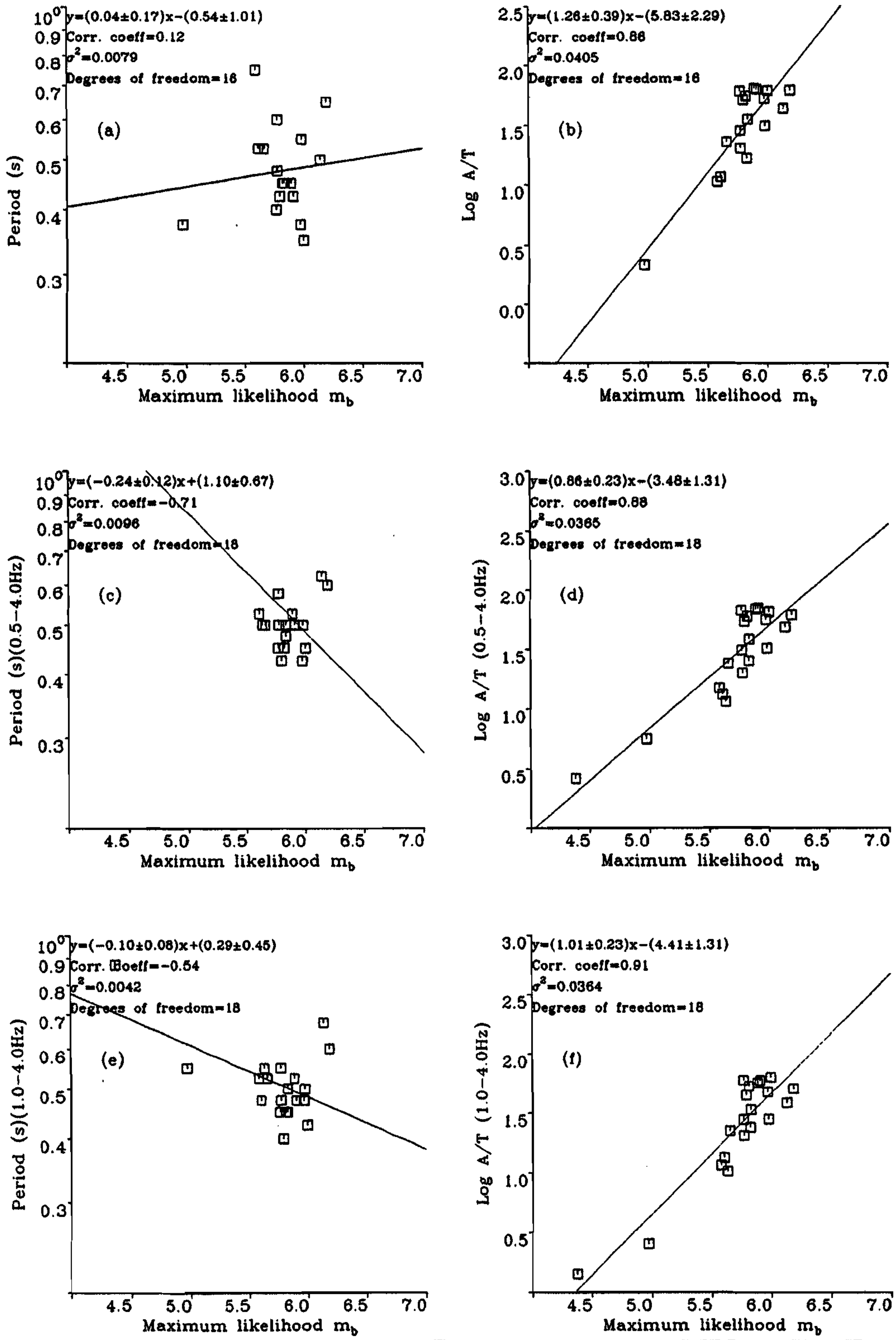


Figure 20 Novaya Zemlya at YKA PcP

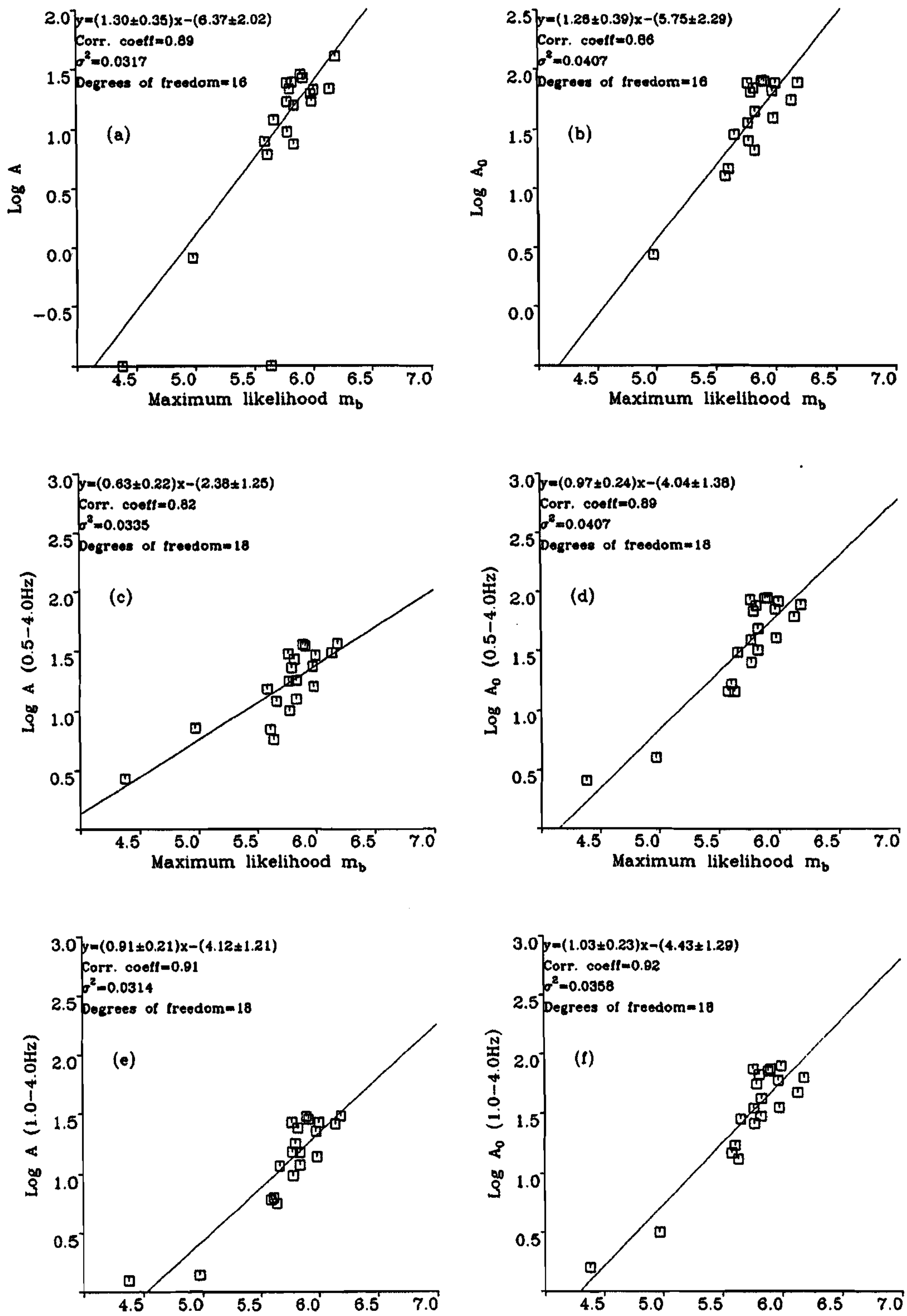


Figure 21 Novaya Zemlya at YKA PcP

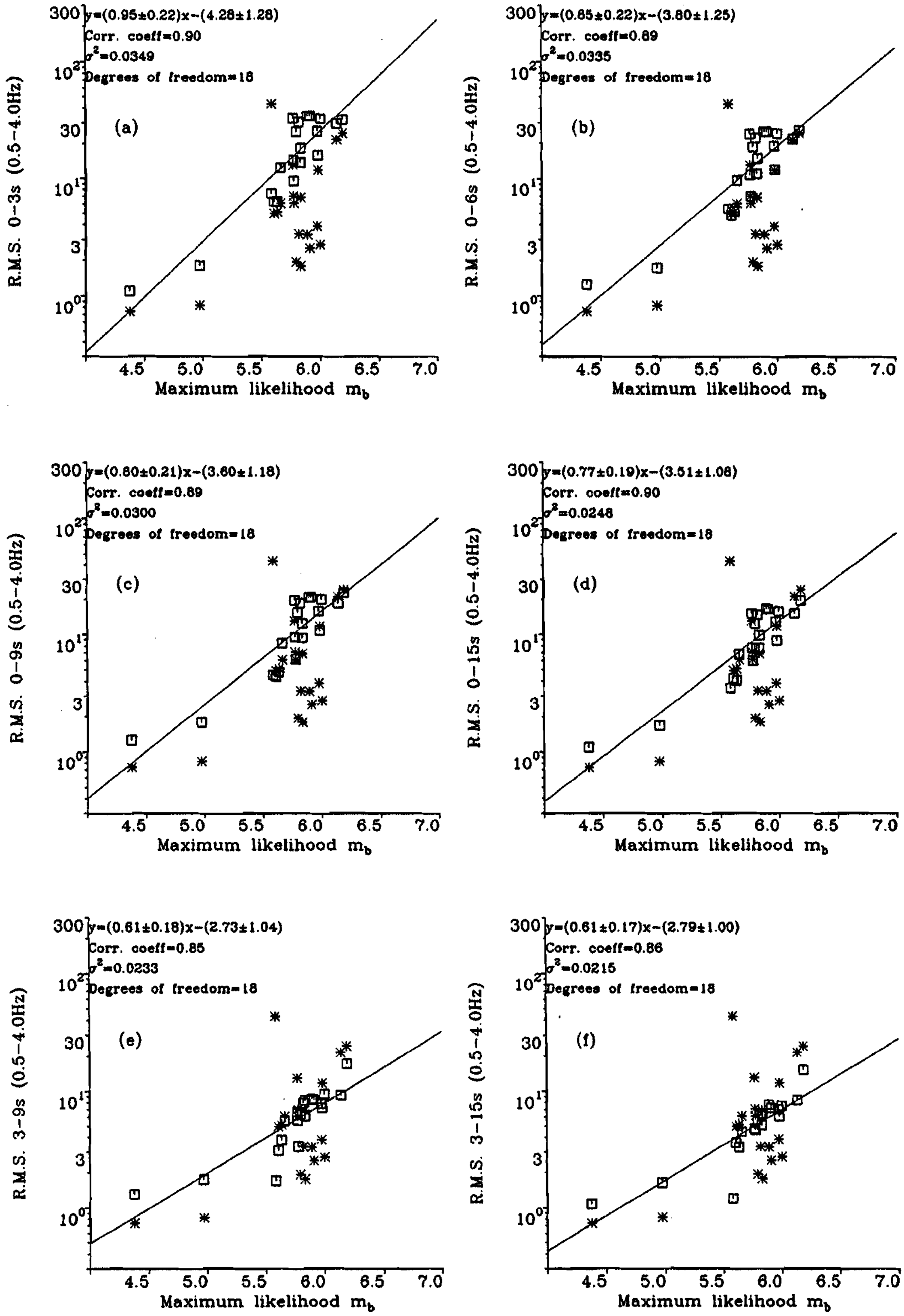


Figure 22 Novaya Zemlya at YKA PcP

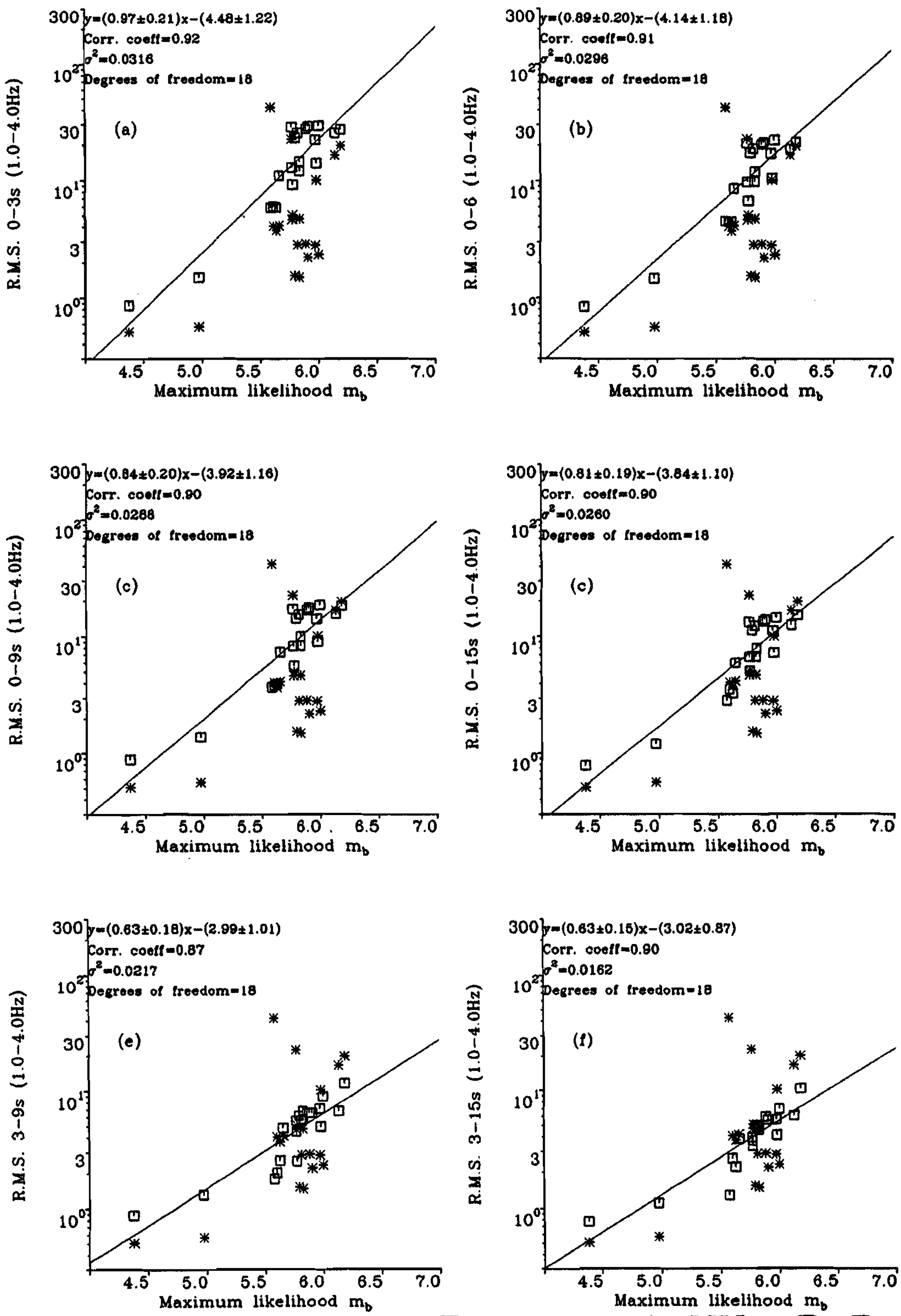


Figure 23 Novaya Zemlya at YKA PcP

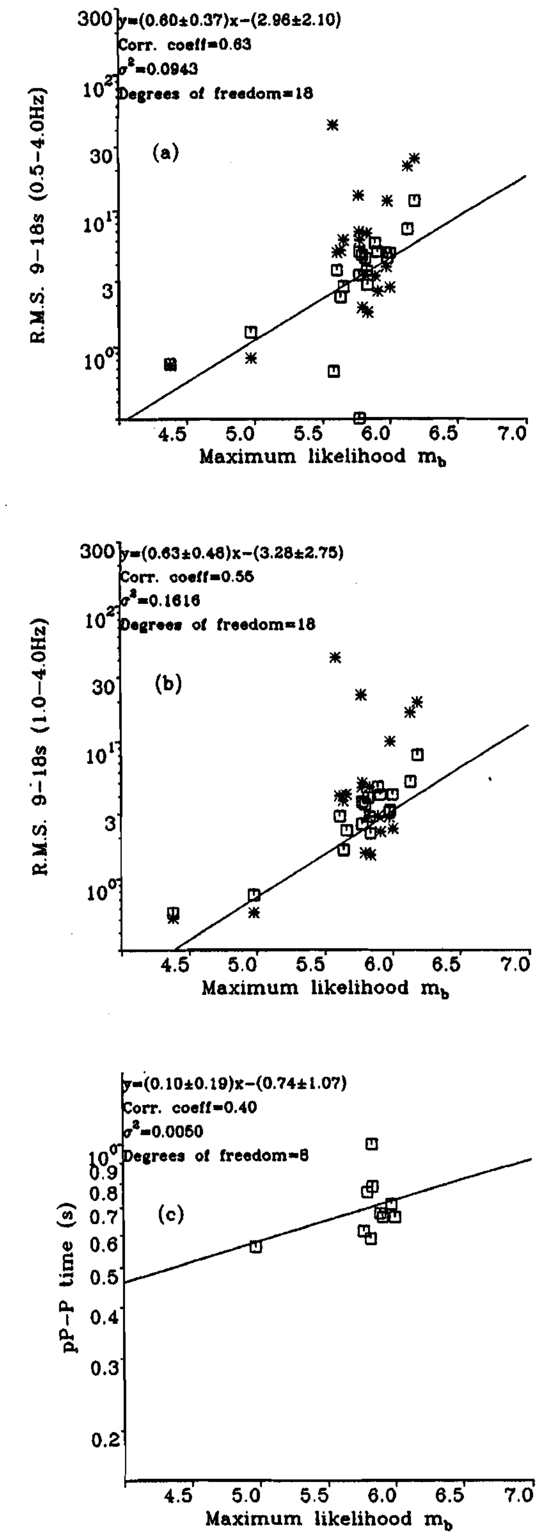


Figure 24 Novaya Zemlya at YKA PcP

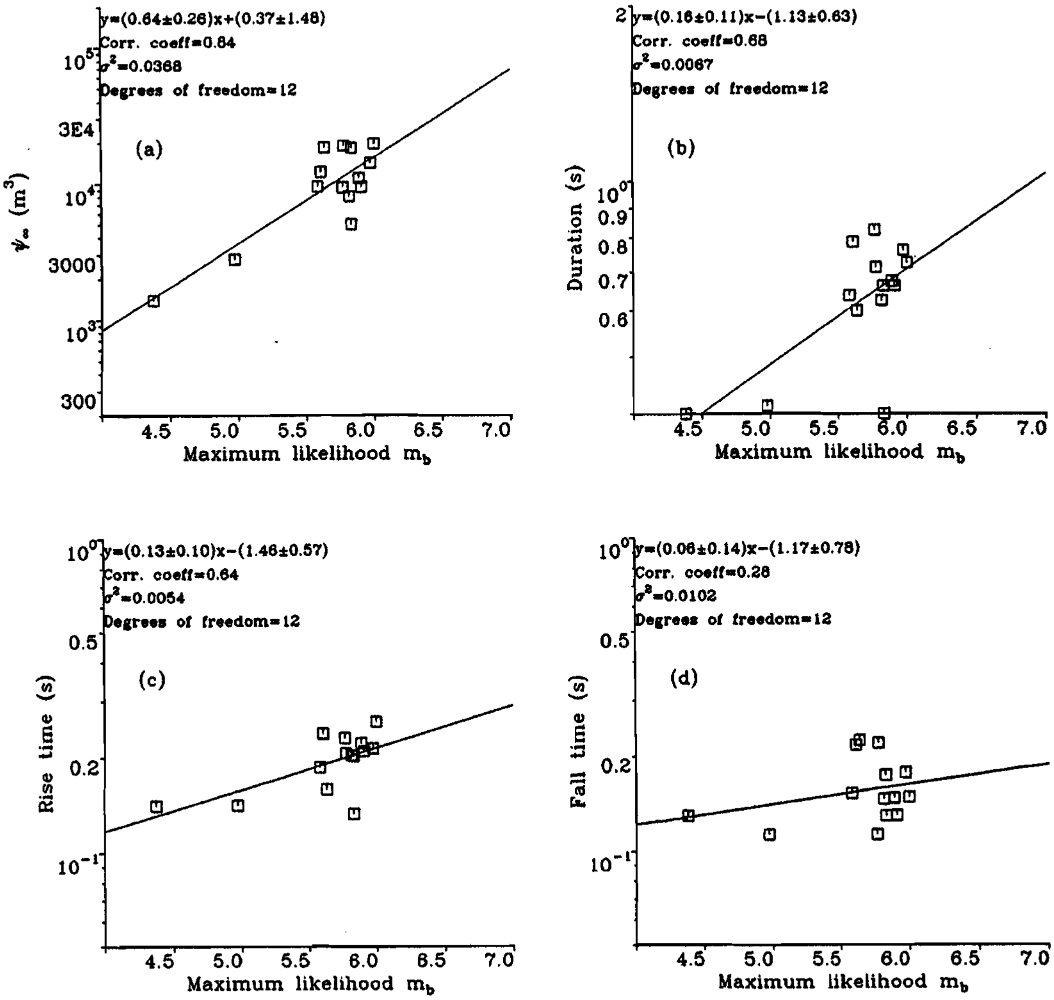


Figure 25 Novaya Zemlya at GBA

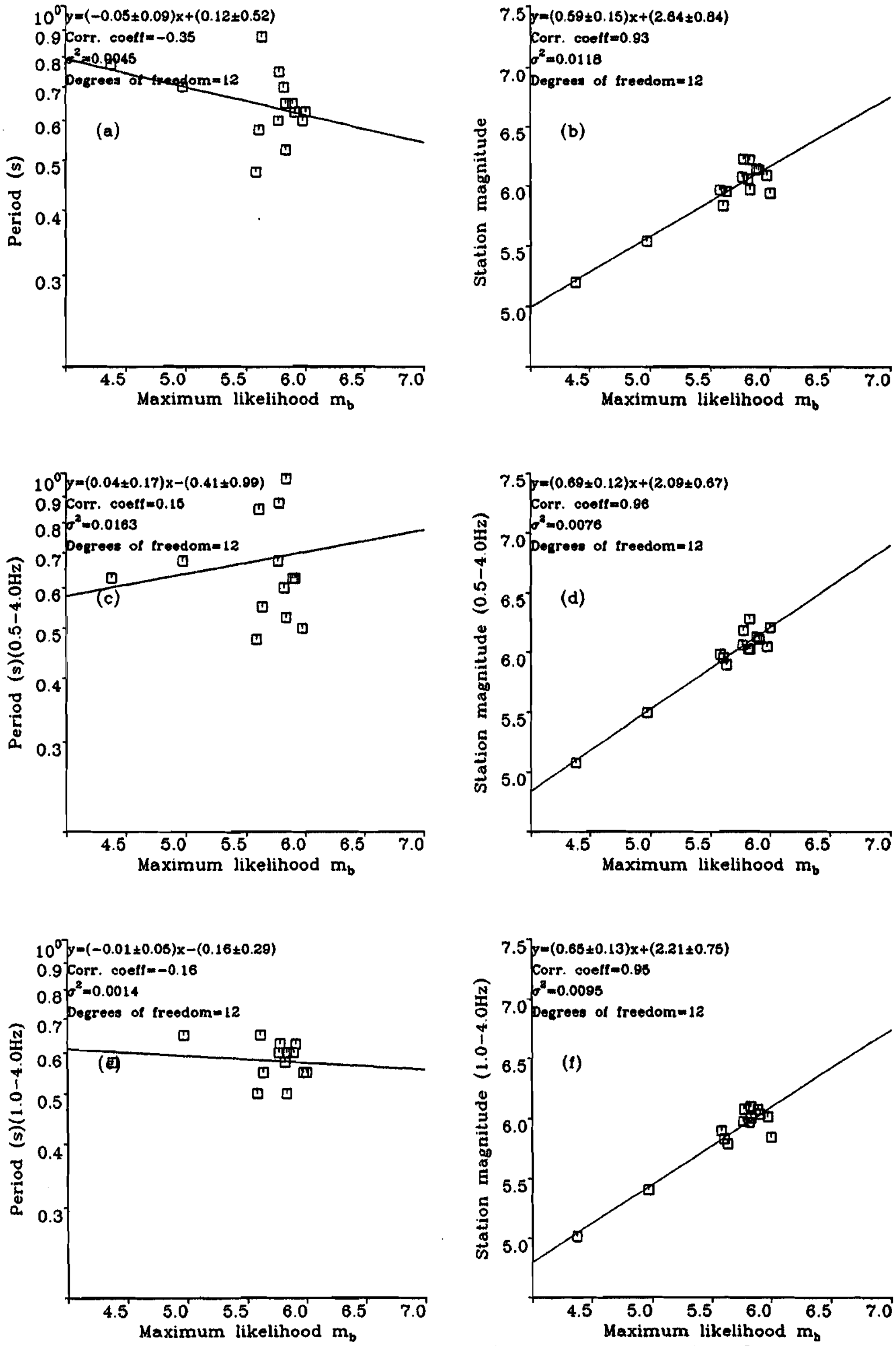


Figure 26 Novaya Zemlya at GBA

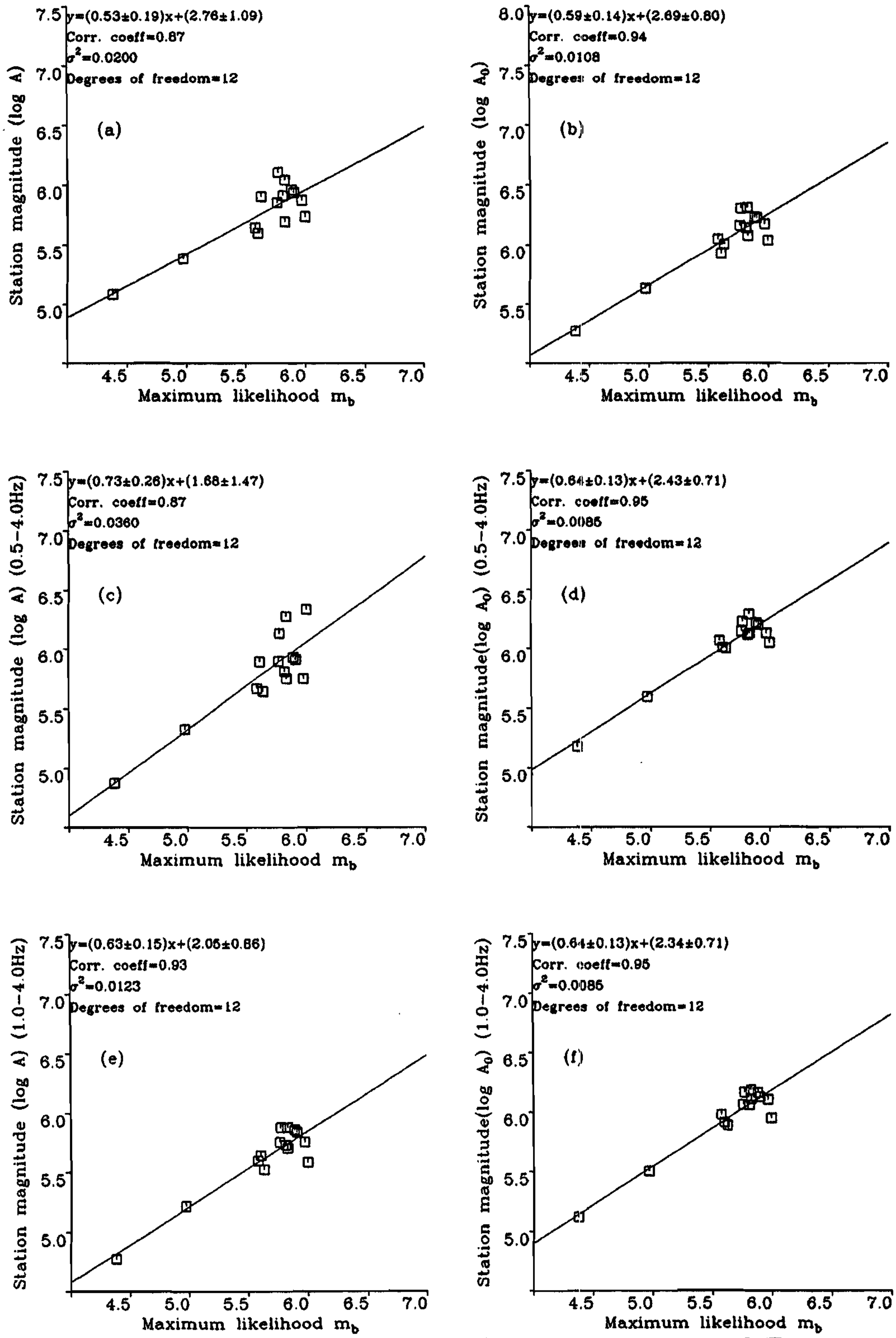


Figure 27 Novaya Zemlya at GBA

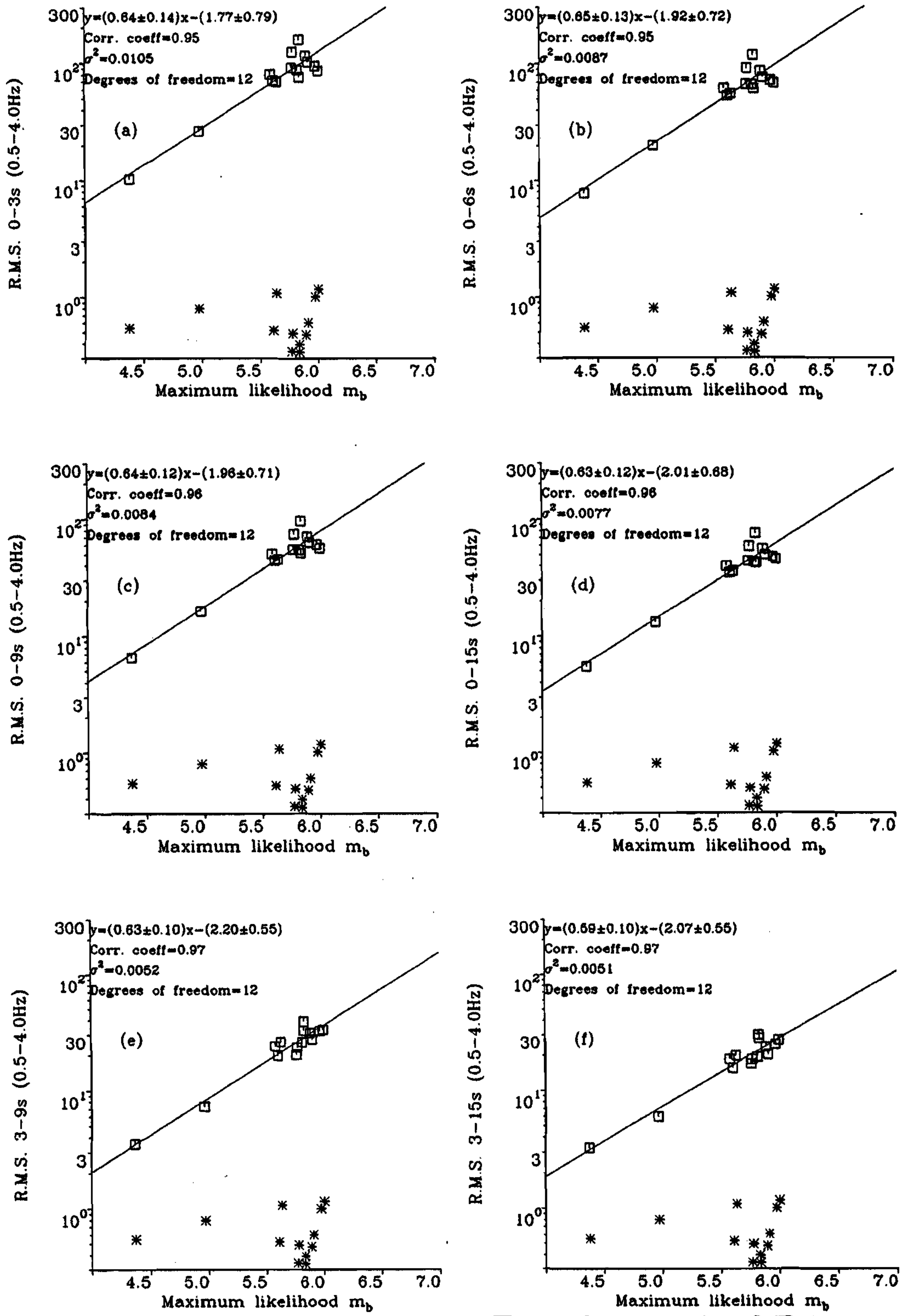


Figure 28 Novaya Zemlya at GBA

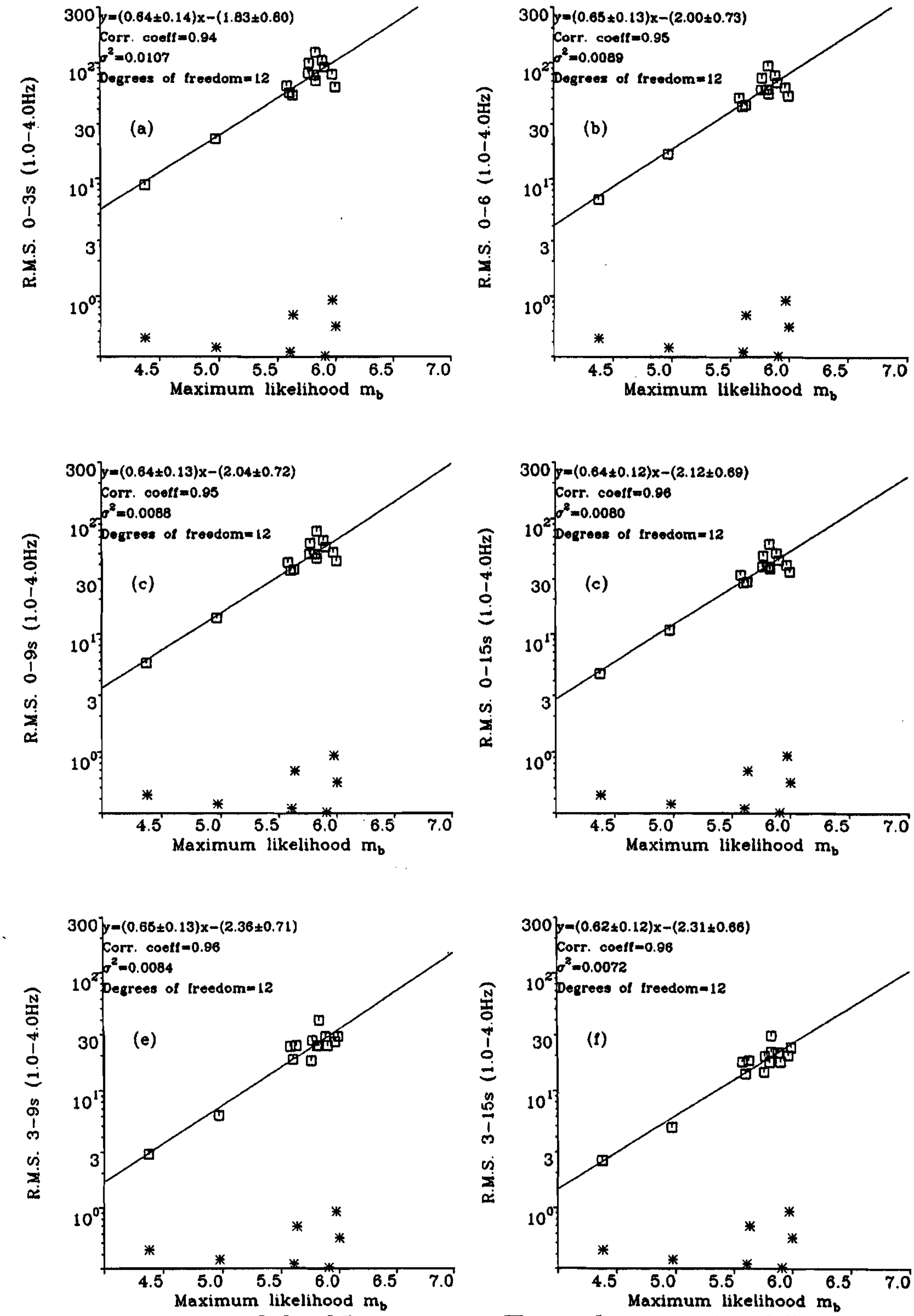


Figure 29 Novaya Zemlya at GBA

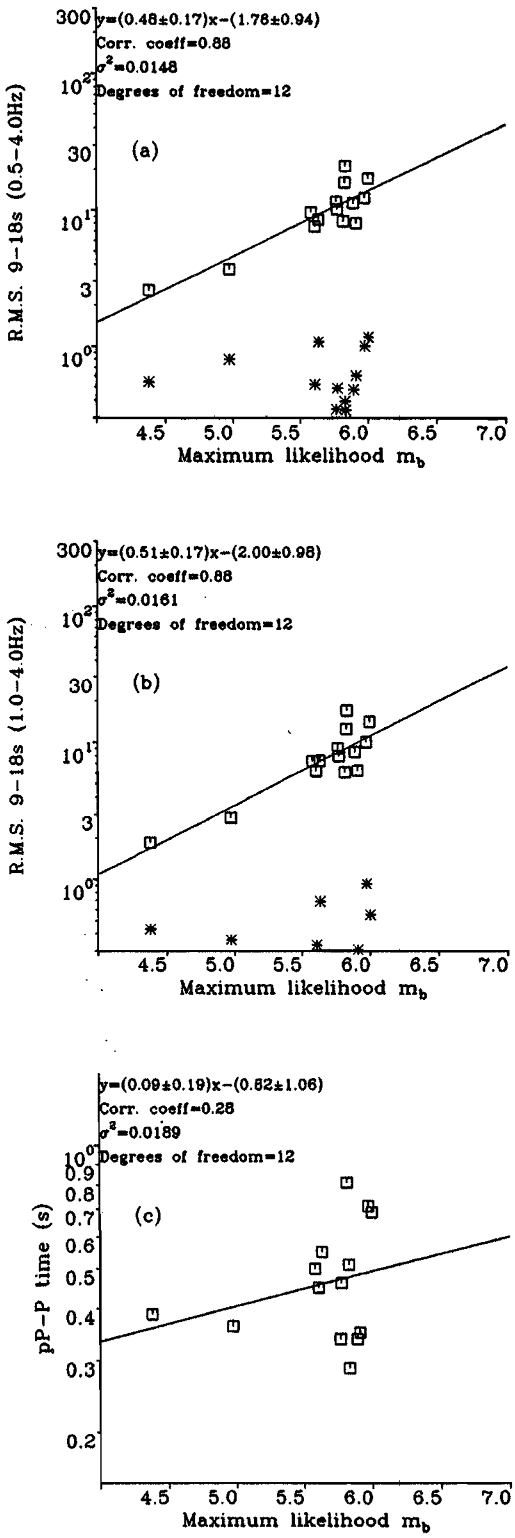


Figure 30 Novaya Zemlya at GBA

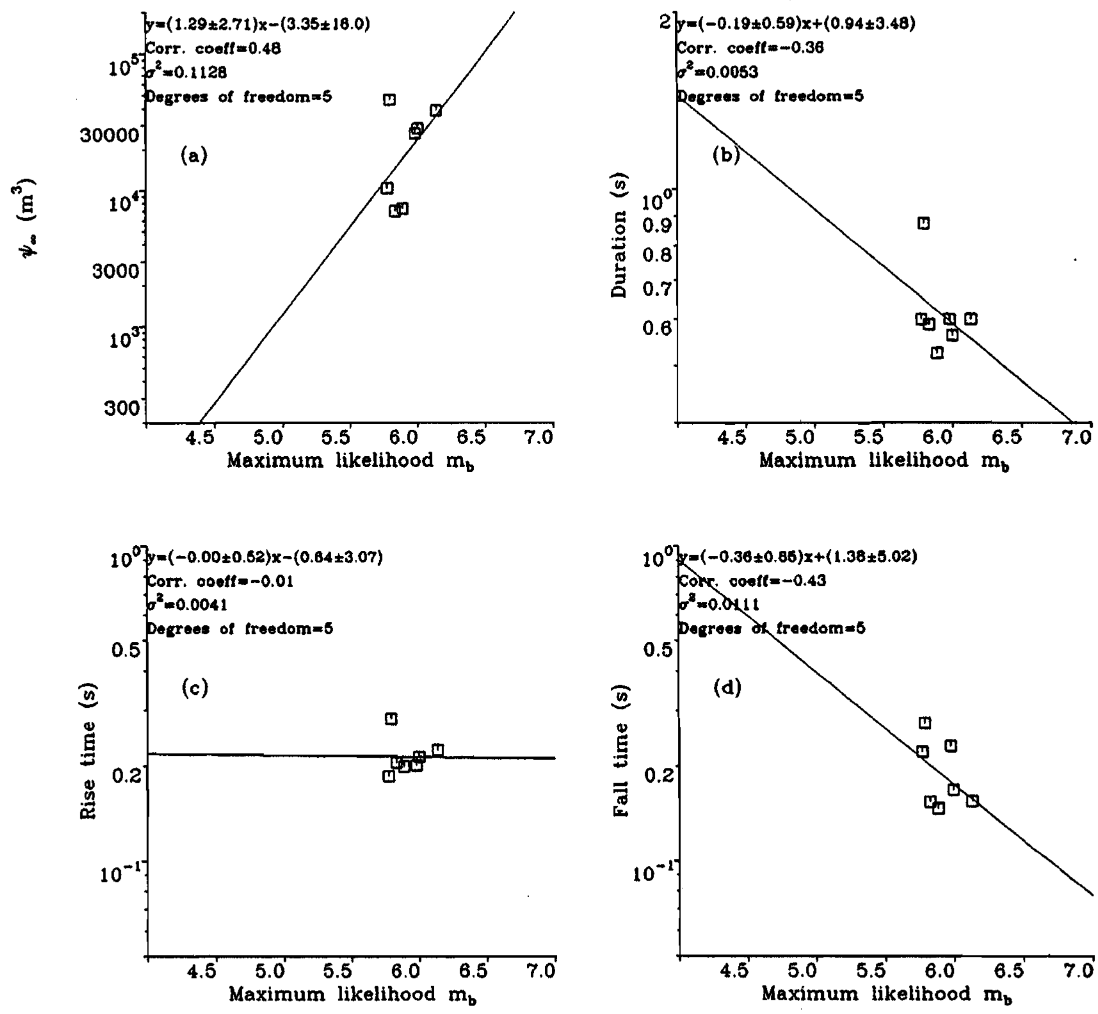


Figure 31 Novaya Zemlya at GBA PcP

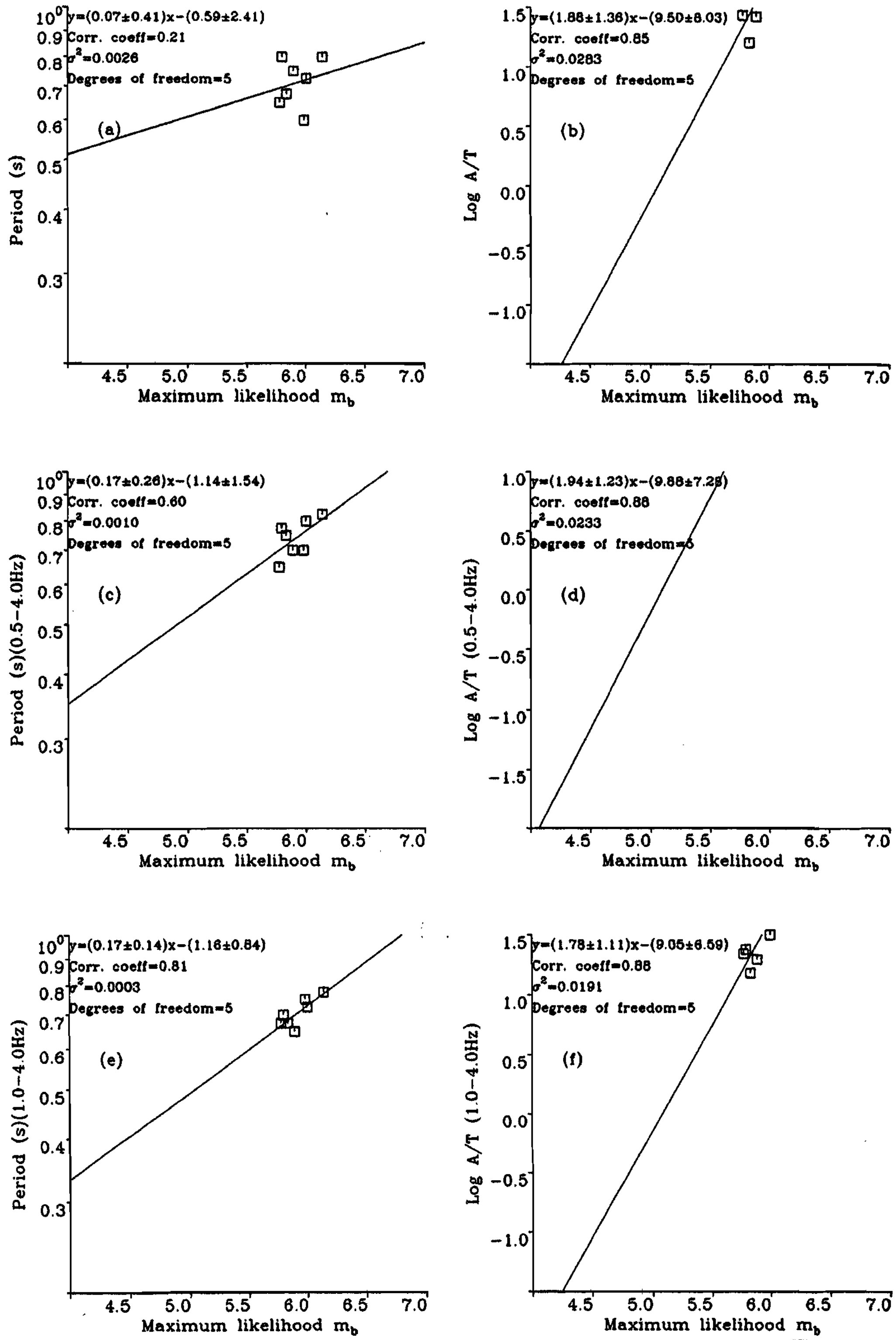


Figure 32 Novaya Zemlya at GBA PcP

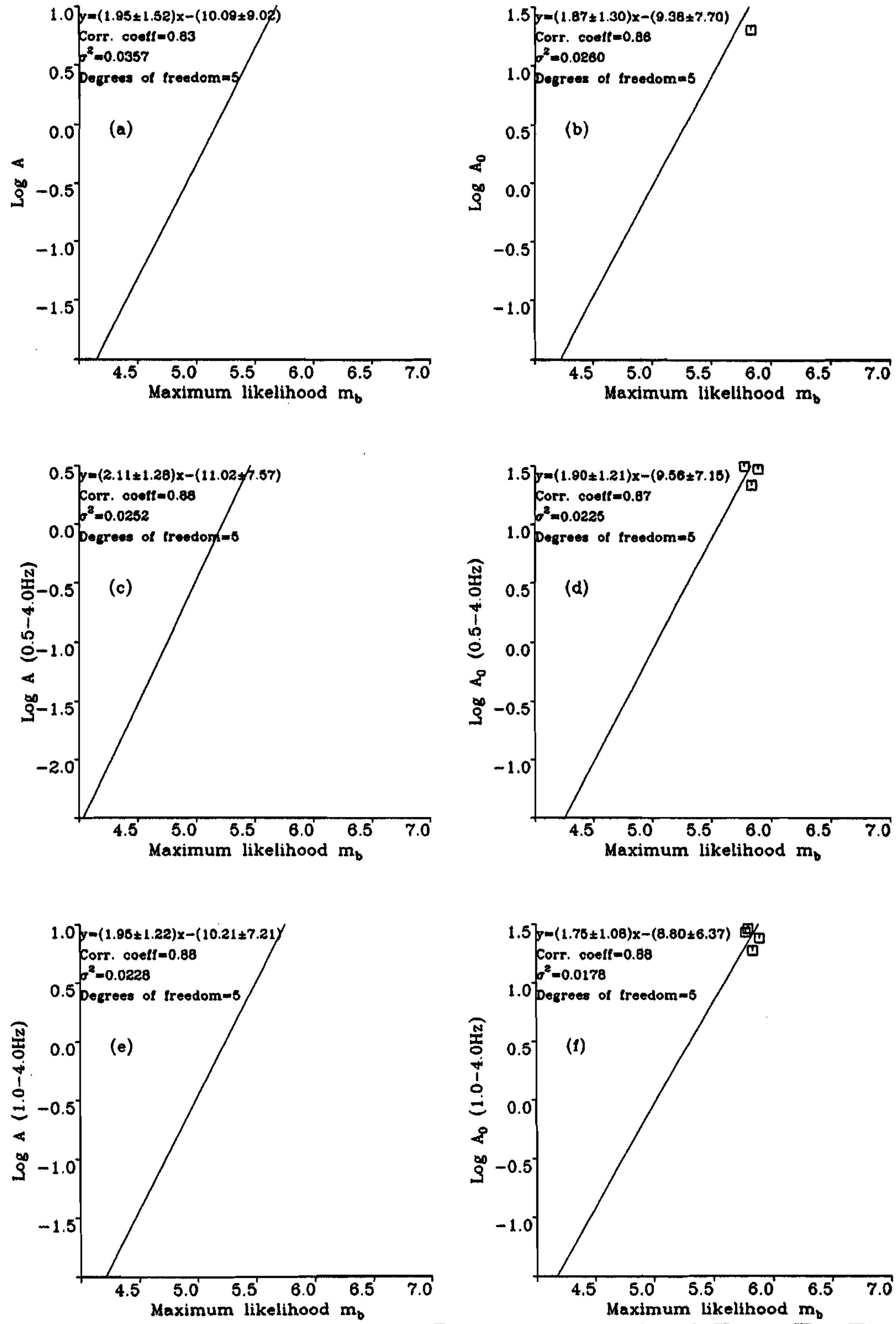


Figure 33 Novaya Zemlya at GBA PcP

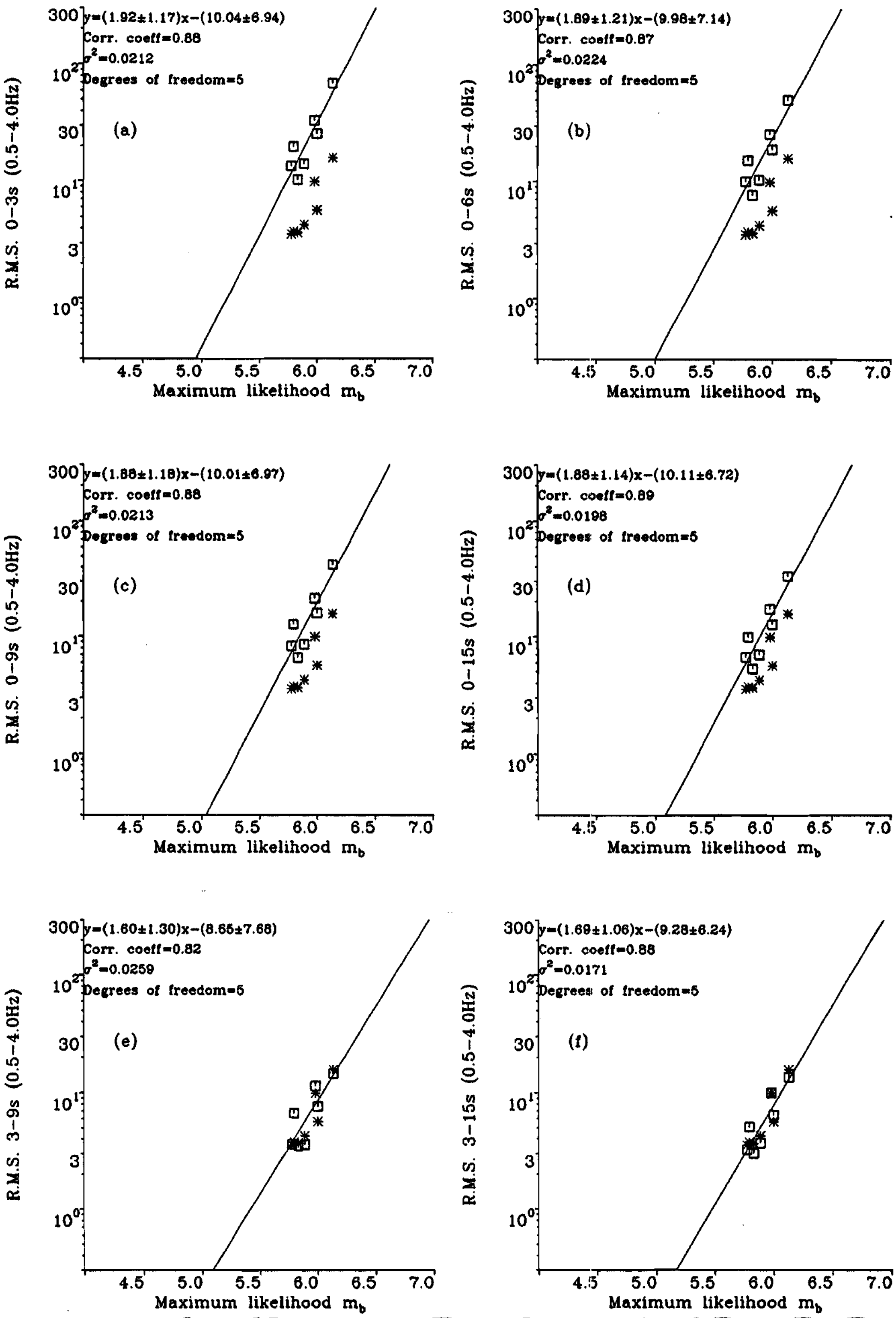


Figure 34 Novaya Zemlya at GBA PcP

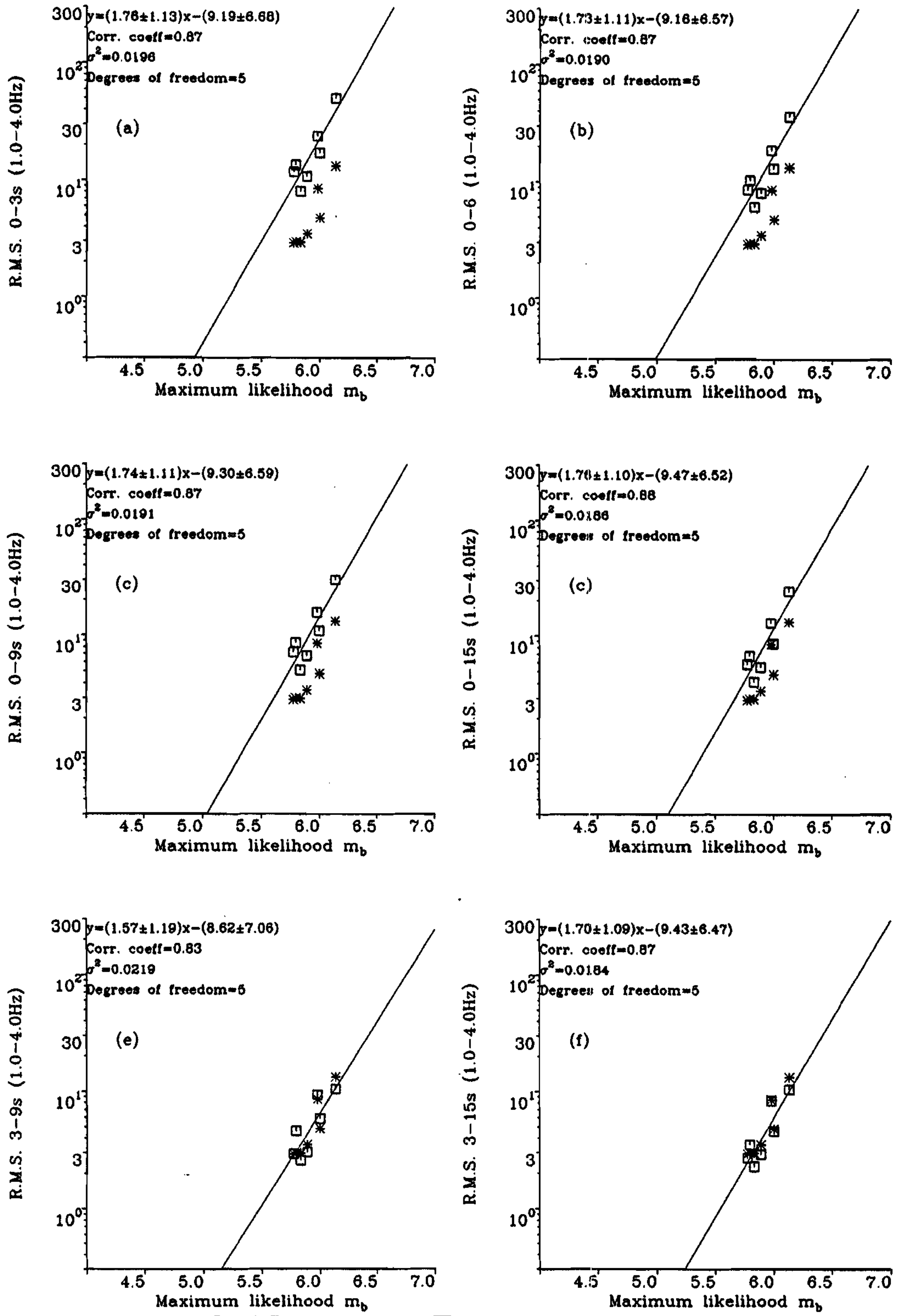


Figure 35 Novaya Zemlya at GBA PcP

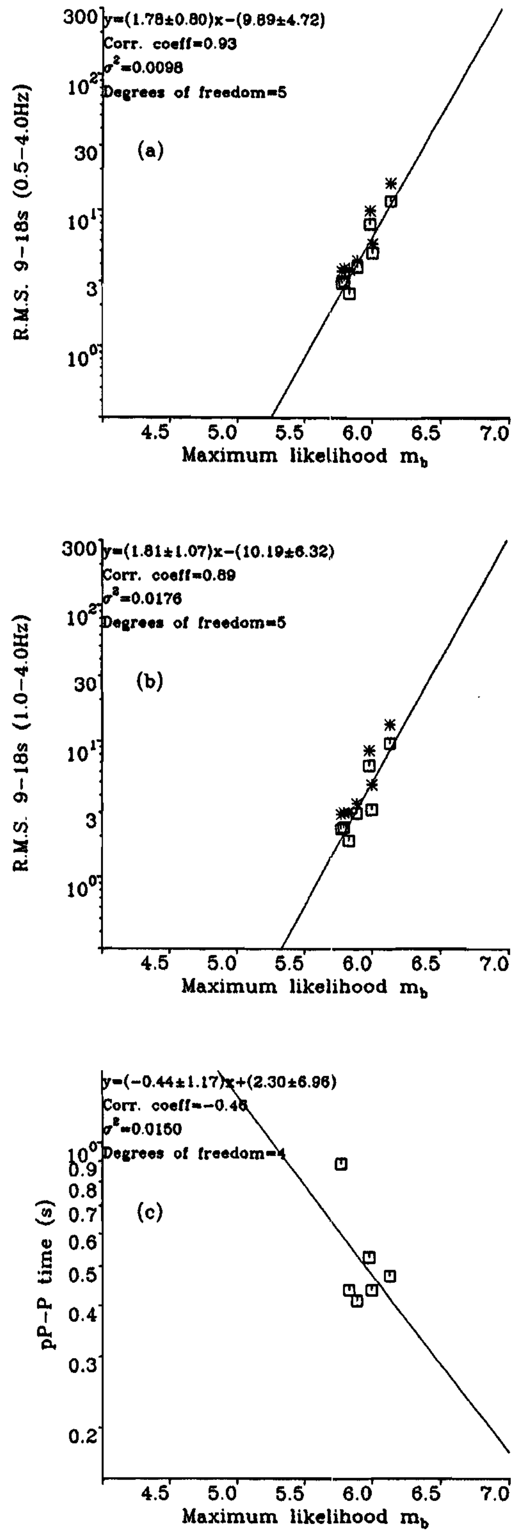


Figure 36 Novaya Zemlya at GBA PcP

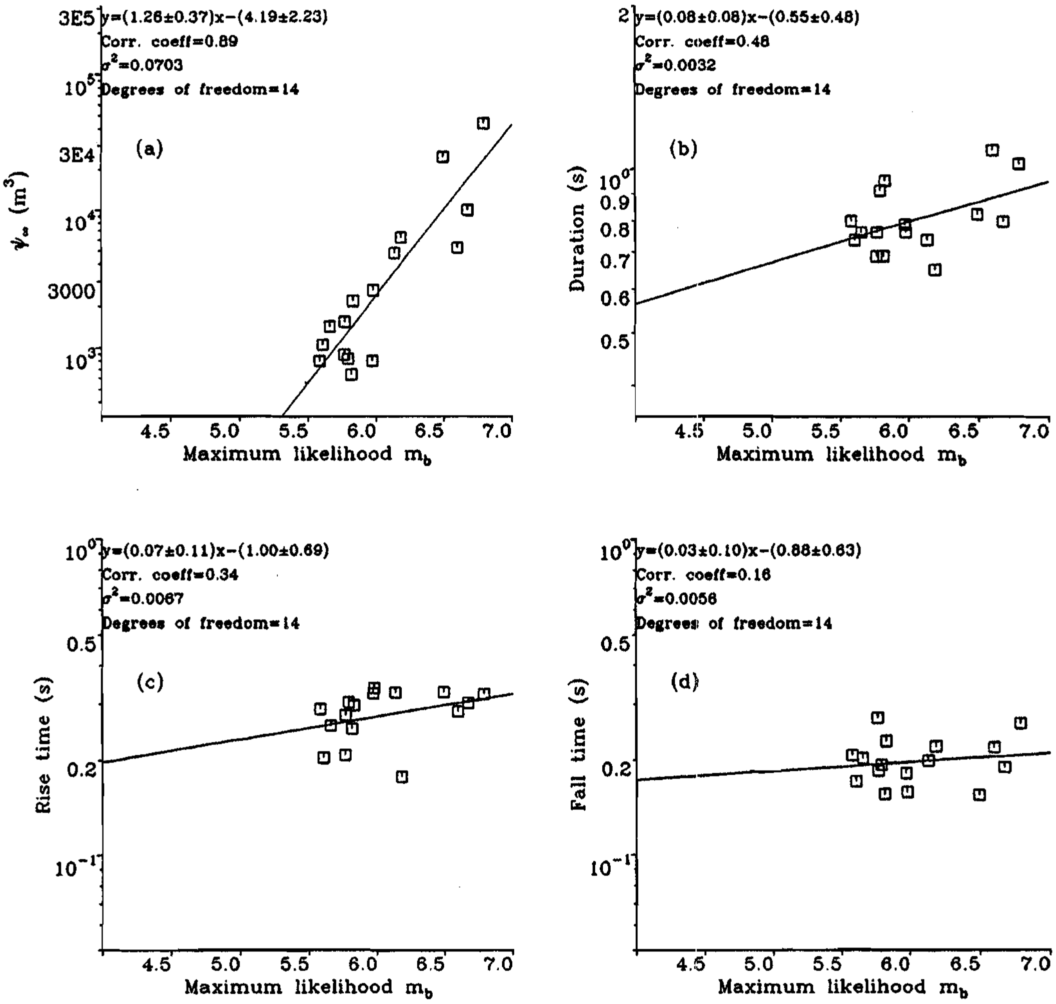


Figure 37 Novaya Zemlya at WRA

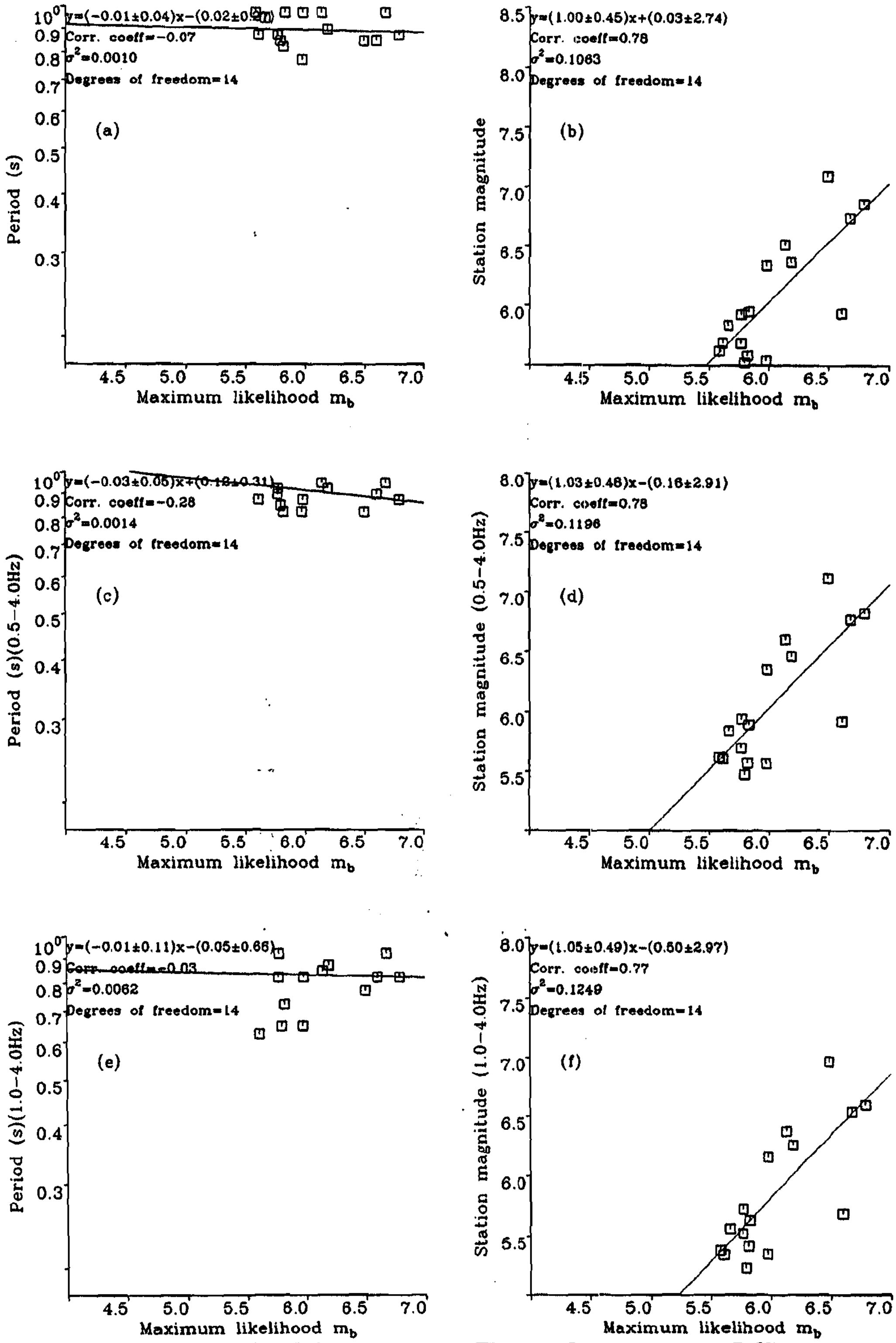


Figure 38 Novaya Zemlya at WRA

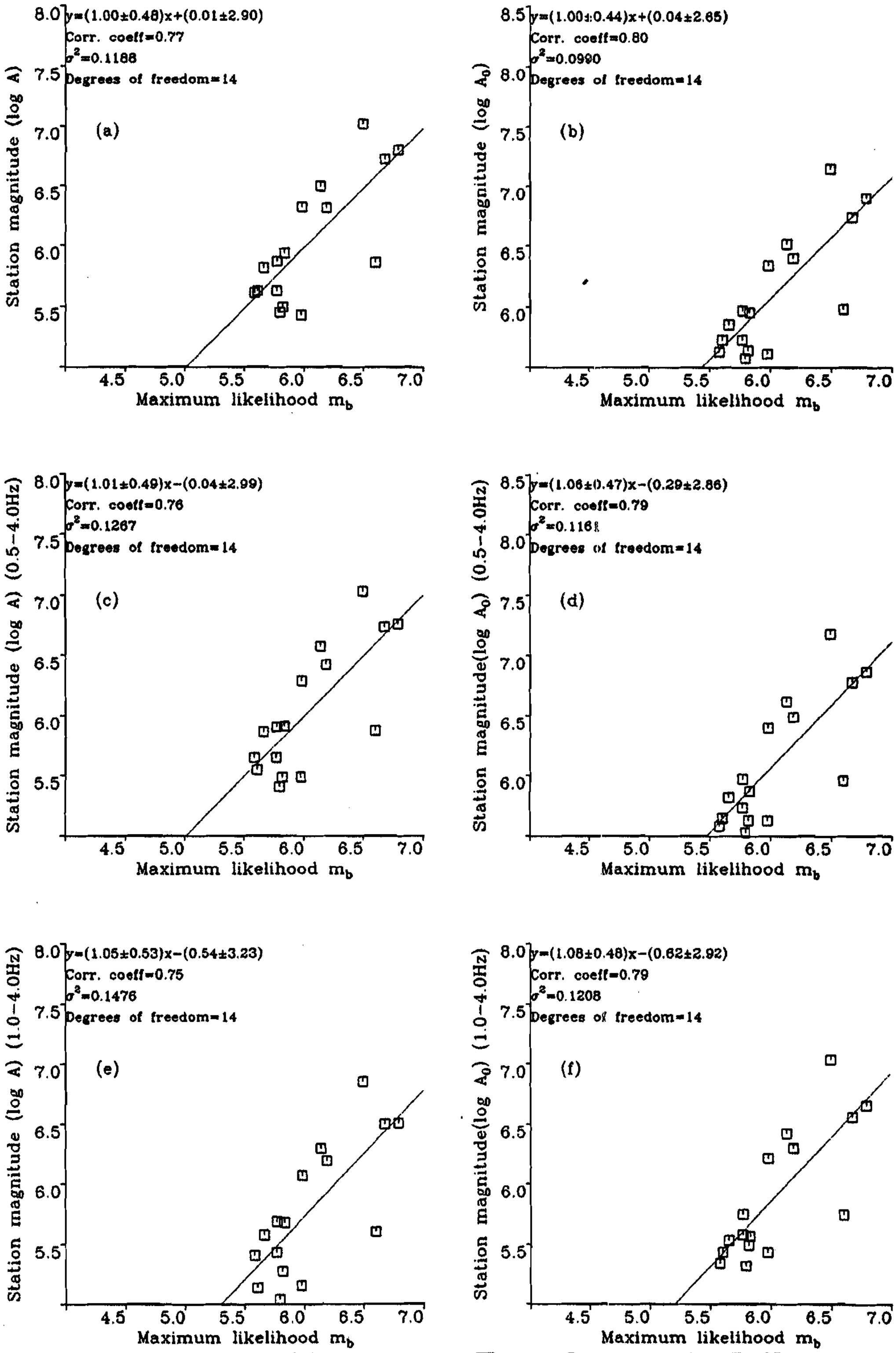


Figure 39 Novaya Zemlya at WRA

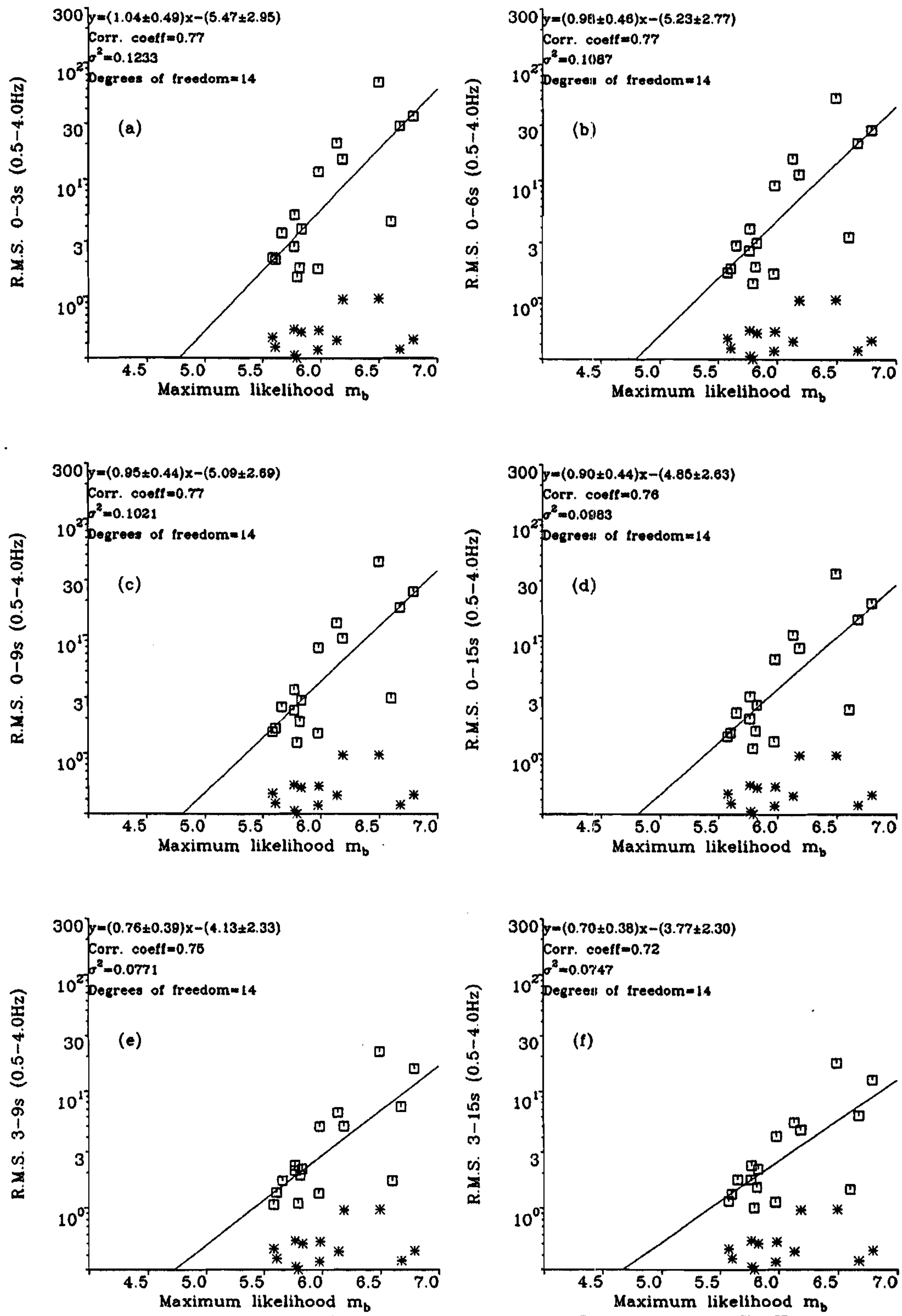


Figure 40 Novaya Zemlya at WRA

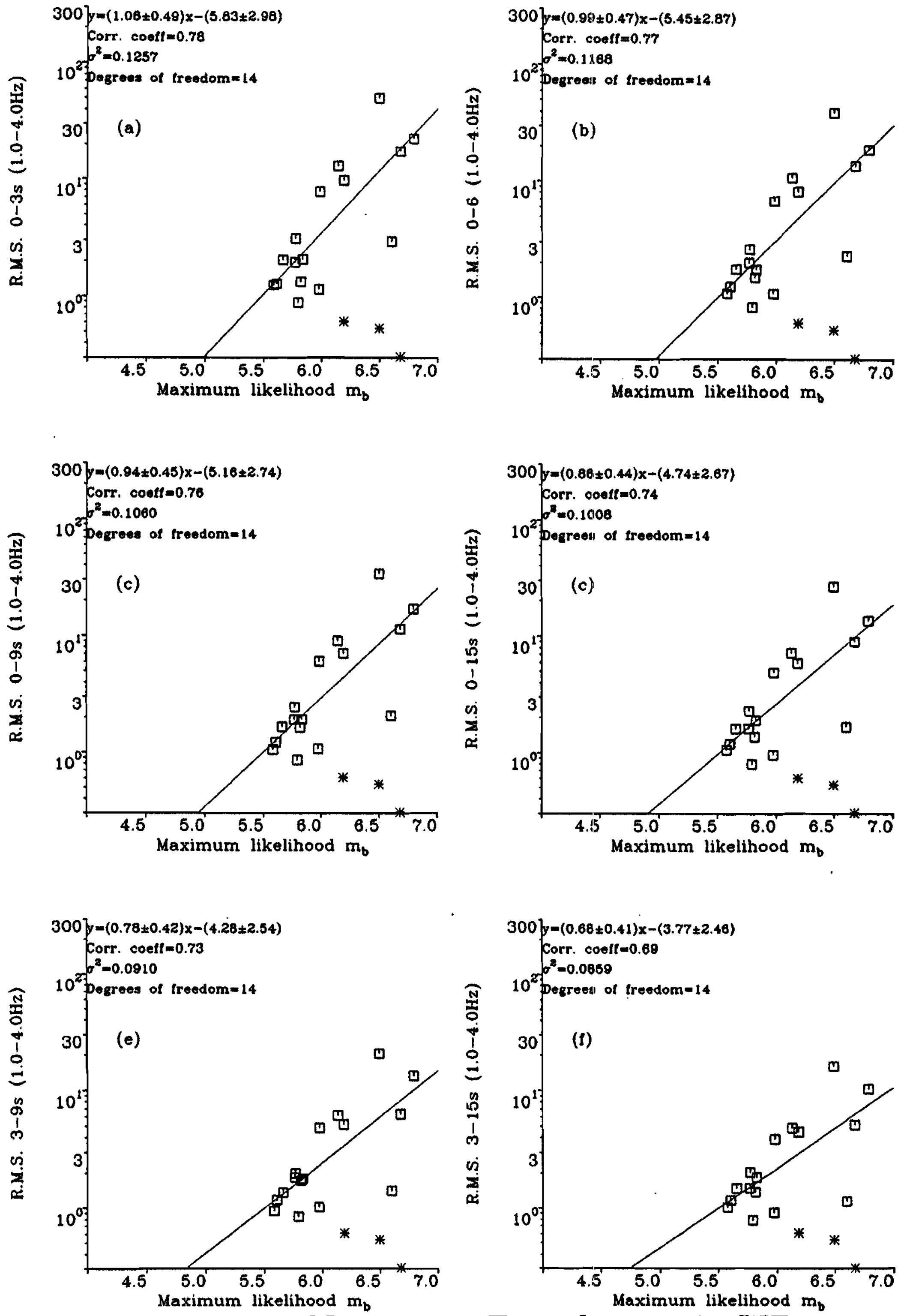


Figure 41 Novaya Zemlya at WRA

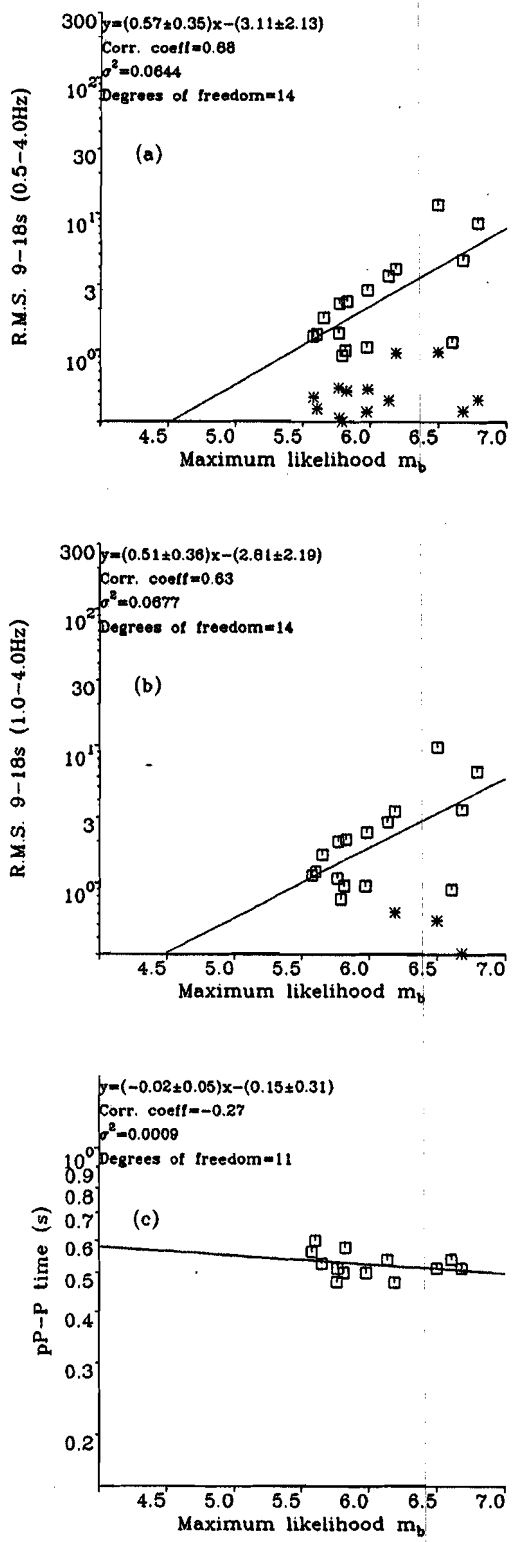


Figure 42 Novaya Zemlya at WRA

APPENDIX B

STATION TIME AND MAGNITUDE EFFECTS WITH 95% CONFIDENCE LIMITS

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
AAA	1.03±9.99	2	0.00±0.00	0	0.00±0.00	0	32	149
AAE	1.03±0.18	11	0.00±0.00	0	0.00±0.00	0	65	197
AAI	-1.36±0.49	2	0.00±0.00	0	0.00±0.00	0	89	107
AAM	-0.79±0.24	10	0.00±0.00	0	0.00±0.00	0	61	326
AAPN	0.41±0.48	2	0.00±0.00	0	0.00±0.00	0	46	252
AAS	8.19±1.11	2	0.00±0.00	0	0.00±0.00	0	154	260
ABA	-0.29±0.35	5	0.00±0.00	0	0.00±0.00	0	44	244
ABL	0.37±0.48	2	0.00±0.00	0	0.00±0.00	0	72	355
ABQ	0.25±0.48	2	-0.63±0.22	2	-0.31±0.22	2	71	344
ABU	-0.64±0.30	7	-0.08±0.21	6	-0.28±0.31	2	54	88
ACHM	1.00±0.39	3	0.00±0.00	0	0.00±0.00	0	46	252
ACI	0.34±0.40	3	0.00±0.00	0	0.00±0.00	0	39	231
ACL	-0.38±0.47	3	0.00±0.00	0	0.00±0.00	0	40	233
ACM	-0.72±0.48	2	0.00±0.00	0	0.00±0.00	0	61	328
ACO	-0.80±0.34	4	-0.49±0.33	1	0.00±0.00	0	69	338
ACU	1.38±0.39	3	0.00±0.00	0	0.00±0.00	0	44	249
ADE	-0.06±0.11	19	0.86±0.18	7	0.00±0.00	0	121	107
ADK	-0.82±0.16	24	0.31±0.12	9	0.18±0.22	2	50	39
AFC	1.02±0.34	4	0.00±0.00	0	0.00±0.00	0	46	251
AFI	1.38±0.70	6	0.05±0.32	1	0.00±0.00	0	115	51
AFR	1.46±0.69	6	-0.11±0.32	1	-0.09±0.31	1	122	28
AGM	0.00±0.00	0	-0.04±0.31	1	0.00±0.00	0	54	315
AGO	-0.63±0.39	3	0.00±0.00	0	0.00±0.00	0	36	249
AIA	-3.50±0.63	8	0.00±0.00	0	0.00±0.00	0	158	260
AJM	-0.96±0.42	4	0.00±0.00	0	0.00±0.00	0	48	156
AKSR	-0.78±0.48	2	0.00±0.00	0	0.00±0.00	0	51	206
AKU	1.88±0.14	25	0.79±0.13	13	0.00±0.00	0	25	290
ALA	0.83±9.99	2	0.00±0.00	0	0.00±0.00	0	70	352
ALB	-0.59±0.35	4	0.00±0.00	0	0.00±0.00	0	58	360
ALE	-0.62±0.11	27	-0.25±0.07	20	0.00±0.00	0	21	341
ALG	-0.73±0.39	3	0.00±0.00	0	0.00±0.00	0	44	244
ALI	1.21±0.31	7	0.00±0.00	0	0.00±0.00	0	44	249
ALM	0.02±0.36	4	0.00±0.00	0	0.00±0.00	0	46	250
ALOJ	0.73±0.39	3	0.00±0.00	0	0.00±0.00	0	46	252
ALP	-0.19±0.30	5	0.00±0.00	0	0.00±0.00	0	36	235
ALQ	-0.05±0.09	27	-0.63±0.07	20	-0.41±0.22	2	71	344
ALT	0.22±0.25	9	0.00±0.00	0	0.00±0.00	0	36	214
AMM	-0.53±0.48	2	0.00±0.00	0	0.00±0.00	0	61	350
ANG	0.98±0.34	5	0.22±0.15	5	0.36±0.31	1	81	300
ANM	1.11±0.28	6	0.00±0.00	0	0.00±0.00	0	40	26
ANMO	-0.07±0.39	3	0.00±0.00	0	0.00±0.00	0	71	344
ANN	-0.38±0.47	3	0.00±0.00	0	0.00±0.00	0	30	206
ANR	0.94±0.49	2	0.00±0.00	0	0.00±0.00	0	34	156
ANT	1.02±0.90	4	0.00±0.00	0	0.00±0.00	0	122	298
AN1	-0.70±0.28	6	0.00±0.00	0	0.00±0.00	0	63	326
AN10	-0.78±0.26	7	0.00±0.00	0	0.00±0.00	0	63	326
AN11	-0.89±0.24	8	0.00±0.00	0	0.00±0.00	0	63	326
AN12	-0.70±0.26	7	0.00±0.00	0	0.00±0.00	0	63	326
AN3	-0.77±0.28	6	0.00±0.00	0	0.00±0.00	0	63	326
AN4	-0.84±0.28	6	0.00±0.00	0	0.00±0.00	0	63	326
AN7	-0.78±0.34	4	0.00±0.00	0	0.00±0.00	0	63	326
AN8	-1.01±0.34	4	0.00±0.00	0	0.00±0.00	0	63	326
AN9	-0.74±0.31	5	0.00±0.00	0	0.00±0.00	0	63	326
AOI	0.06±0.48	2	0.00±0.00	0	0.00±0.00	0	35	236
APA	-5.28±0.41	3	0.00±0.00	0	0.00±0.00	0	9	242
APE	-0.39±0.48	2	0.00±0.00	0	0.00±0.00	0	39	218
APHE	0.60±0.39	3	0.00±0.00	0	0.00±0.00	0	46	252
APT	-0.21±0.35	4	0.03±0.18	3	0.00±0.00	0	60	316
AQU	0.61±0.13	16	0.00±0.00	0	0.00±0.00	0	37	235
ARC	0.68±0.48	2	0.00±0.00	0	0.00±0.00	0	66	359
ARE	1.33±0.53	10	-0.06±0.15	5	-0.10±0.19	3	116	301
ARG	0.33±0.24	9	0.00±0.00	0	0.00±0.00	0	39	215
ARH	-0.08±0.39	3	0.00±0.00	0	0.00±0.00	0	37	251
ARN	0.60±0.14	13	0.00±0.00	0	0.00±0.00	0	70	357
ARO	0.10±0.34	4	0.00±0.00	0	0.00±0.00	0	62	193
ARR	0.61±0.48	2	0.00±0.00	0	0.00±0.00	0	31	223
ART	0.47±0.48	3	0.00±0.00	0	0.00±0.00	0	62	194
ARU	-6.91±0.41	3	0.00±0.00	0	0.00±0.00	0	17	173
ARV	-0.10±0.34	4	0.00±0.00	0	0.00±0.00	0	36	237
ASH	1.73±0.49	2	0.00±0.00	0	0.00±0.00	0	36	175
ASK	-0.15±0.34	4	0.00±0.00	0	0.00±0.00	0	22	261
ASMO	0.93±0.39	3	0.00±0.00	0	0.00±0.00	0	46	252
ASS	0.09±0.31	5	0.00±0.00	0	0.00±0.00	0	36	237
ASU	-0.54±9.99	3	0.00±0.00	0	0.00±0.00	0	73	349
ATA	0.19±0.40	3	0.00±0.00	0	0.00±0.00	0	62	193
ATE	-0.70±0.48	3	0.00±0.00	0	0.00±0.00	0	40	252
ATEJ	0.69±0.39	3	0.00±0.00	0	0.00±0.00	0	46	252
ATH	-0.01±0.11	22	0.00±0.00	0	0.00±0.00	0	39	221
ATN	-2.01±0.39	4	0.00±0.00	0	0.00±0.00	0	40	231
ATX	-0.26±0.48	2	0.00±0.00	0	0.00±0.00	0	75	336

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	$\Delta°$	$\varphi°$
AURF	−0.67±0.39	3	0.00±0.00	0	0.00±0.00	0	37	243
AUTN	−0.22±0.41	3	0.00±0.00	0	0.00±0.00	0	36	243
AVE	0.41±0.11	22	0.00±0.00	0	0.00±0.00	0	51	254
AVF	−1.11±0.08	14	−0.10±0.09	12	0.00±0.00	0	35	250
AVY	−0.52±0.39	5	0.00±0.00	0	0.00±0.00	0	92	187
AYN	0.90±0.39	3	0.00±0.00	0	0.00±0.00	0	46	204
AZI	0.90±0.48	2	0.00±0.00	0	0.00±0.00	0	37	235
BAB	−0.32±0.39	4	0.00±0.00	0	0.00±0.00	0	52	247
BAC	−0.18±0.27	16	0.00±0.00	0	0.00±0.00	0	30	221
BAF	−0.52±0.24	8	0.00±0.00	0	0.00±0.00	0	33	246
BAG	−0.94±0.17	14	0.11±0.18	3	0.24±0.32	1	67	109
BAI	0.22±0.50	2	0.00±0.00	0	0.00±0.00	0	37	231
BAR	0.87±0.35	4	0.00±0.00	0	0.00±0.00	0	74	353
BAS	−0.61±0.34	7	0.00±0.00	0	0.00±0.00	0	33	246
BBS	−0.75±0.34	4	0.00±0.00	0	0.00±0.00	0	33	245
BBTK	0.87±0.39	3	0.00±0.00	0	0.00±0.00	0	35	210
BCAO	−0.71±0.48	2	0.00±0.00	0	0.00±0.00	0	72	218
BCI	0.30±0.48	2	0.00±0.00	0	0.00±0.00	0	35	227
BCK	0.56±0.16	16	0.00±0.00	0	0.00±0.00	0	38	212
BCN	1.10±0.24	8	0.00±0.00	0	0.00±0.00	0	71	351
BCR	−0.01±0.35	5	0.00±0.00	0	0.00±0.00	0	94	309
BCT	−0.38±0.38	4	0.00±0.00	0	0.00±0.00	0	60	317
BDB	−2.55±9.99	3	0.00±0.00	0	0.00±0.00	0	39	251
BDI	0.23±0.34	4	0.00±0.00	0	0.00±0.00	0	36	240
BDS	3.05±0.31	6	0.00±0.00	0	0.00±0.00	0	84	297
BDT	−0.87±0.29	10	−0.29±0.12	8	0.00±0.00	0	61	131
BDV	−0.62±0.39	3	0.00±0.00	0	0.00±0.00	0	35	229
BDW	−0.72±0.15	11	−0.64±0.12	7	0.00±0.00	0	64	347
BEE	−0.43±0.48	2	0.74±0.22	2	0.00±0.00	0	47	185
BEI	0.18±0.34	4	0.00±0.00	0	0.00±0.00	0	65	349
BEO	0.43±0.20	17	0.00±0.00	0	0.00±0.00	0	33	228
BER	−0.38±0.12	27	−0.04±0.31	1	0.00±0.00	0	23	262
BES	−0.91±0.33	5	0.00±0.00	0	0.00±0.00	0	34	247
BFD	−0.68±0.13	18	0.85±0.19	3	0.00±0.00	0	125	104
BFW	0.08±0.39	3	0.00±0.00	0	0.00±0.00	0	60	358
BGF	−0.57±0.30	5	0.53±0.18	3	0.00±0.00	0	35	250
BGG	−0.19±0.39	3	0.00±0.00	0	0.00±0.00	0	31	248
BGO	−0.78±0.39	4	0.00±0.00	0	0.00±0.00	0	62	326
BHA	0.27±0.32	7	−0.18±0.13	6	−0.51±0.31	1	89	206
BHG	0.45±0.12	14	0.09±0.17	4	0.00±0.00	0	32	239
BHJ	0.30±0.32	6	0.00±0.00	0	0.00±0.00	0	51	162
BHL	0.81±0.75	2	0.00±0.00	0	0.00±0.00	0	41	205
BHO	−0.36±0.31	5	−0.05±0.18	3	0.00±0.00	0	71	334
BHP	0.00±0.00	0	0.00±0.00	0	−0.27±0.33	1	93	315
BIR	0.60±0.28	8	0.00±0.00	0	0.00±0.00	0	30	220
BIZ	−0.76±0.48	2	0.00±0.00	0	0.00±0.00	0	29	222
BJI	0.67±0.17	10	−0.46±0.19	4	0.00±0.00	0	44	104
BKR	1.02±0.40	3	0.00±0.00	0	0.00±0.00	0	32	196
BKS	0.49±0.10	26	−0.26±0.08	19	−0.14±0.17	4	69	357
BLA	−0.44±0.13	18	0.22±0.11	10	0.00±0.00	0	66	322
BLC	−0.53±0.12	12	0.17±0.17	5	0.18±0.31	1	41	341
BLF	−0.14±0.39	3	0.00±0.00	0	0.00±0.00	0	104	206
BLR	0.63±0.41	3	0.00±0.00	0	0.00±0.00	0	43	14
BLS1	0.72±0.39	3	0.00±0.00	0	0.00±0.00	0	23	258
BLS2	0.37±0.48	2	0.00±0.00	0	0.00±0.00	0	23	258
BLY	0.28±0.34	4	0.00±0.00	0	0.00±0.00	0	33	232
BME	−0.69±9.99	3	0.00±0.00	0	0.00±0.00	0	53	252
BMN	0.71±0.10	14	−0.61±0.16	4	0.00±0.00	0	66	354
BMO	−0.50±0.09	11	−0.34±0.11	9	0.11±0.22	3	62	354
BMR	0.18±0.34	7	0.00±0.00	0	0.00±0.00	0	29	226
BNG	−0.75±0.13	19	0.65±0.22	2	0.00±0.00	0	72	219
BNH	−0.55±0.13	14	0.02±0.22	2	0.00±0.00	0	57	316
BNI	0.28±0.31	5	0.00±0.00	0	0.00±0.00	0	36	245
BNS	−0.36±0.09	20	0.30±0.10	14	0.32±0.19	4	30	248
BNT	0.07±0.35	4	0.00±0.00	0	0.00±0.00	0	35	216
BOB	0.09±0.39	3	0.00±0.00	0	0.00±0.00	0	35	241
BOC	−0.41±0.48	3	0.00±0.00	0	0.00±0.00	0	30	249
BOCO	1.54±0.28	6	0.00±0.00	0	0.00±0.00	0	96	309
BOD	−1.84±0.41	3	0.00±0.00	0	0.00±0.00	0	27	92
BOG	1.47±0.13	14	0.00±0.00	0	0.00±0.00	0	96	309
BOK	0.20±0.41	3	0.00±0.00	0	0.00±0.00	0	52	144
BOL	2.14±0.52	2	0.00±0.00	0	0.00±0.00	0	35	239
BOM	−1.61±9.99	3	0.00±0.00	0	0.00±0.00	0	55	159
BOZ	−0.39±0.34	4	0.02±0.20	3	0.00±0.00	0	61	349
BPT	−0.67±0.39	3	0.37±0.32	1	0.00±0.00	0	60	317
BRA	0.43±0.32	12	−0.22±0.19	3	−0.36±0.22	2	30	235
BRD	0.15±0.40	3	0.00±0.00	0	0.00±0.00	0	31	220
BRG	−0.38±0.10	23	0.23±0.07	20	0.38±0.22	2	28	240
BRK	0.32±0.31	5	0.00±0.00	0	0.00±0.00	0	69	357
BRL	0.58±0.34	5	0.00±0.00	0	0.00±0.00	0	27	243

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
BRN	0.22±0.16	14	0.00±0.00	0	0.00±0.00	0	27	243
BRS	0.18±0.12	23	0.51±0.32	1	0.00±0.00	0	118	91
BRT	-0.42±0.30	7	0.00±0.00	0	0.00±0.00	0	37	230
BRW	0.62±0.24	10	0.00±0.00	0	0.00±0.00	0	34	17
BRY	0.05±0.39	3	0.00±0.00	0	0.00±0.00	0	35	230
BRZ	0.87±1.10	2	0.00±0.00	0	0.00±0.00	0	140	85
BSF	-0.40±0.08	24	0.01±0.09	13	0.00±0.00	0	33	246
BSI	-3.62±0.40	4	0.00±0.00	0	0.00±0.00	0	72	137
BSL	1.08±0.48	2	0.00±0.00	0	0.00±0.00	0	36	239
BSS	0.04±0.34	4	0.00±0.00	0	0.00±0.00	0	38	233
BTO	0.54±0.37	4	0.00±0.00	0	0.00±0.00	0	42	110
BTY	0.10±0.39	3	0.00±0.00	0	0.00±0.00	0	70	353
BUB	-0.73±0.31	5	-0.26±0.17	4	0.23±0.31	1	33	245
BUC	-1.20±0.21	15	0.00±0.00	0	0.00±0.00	0	32	221
BUC1	0.60±0.64	4	0.00±0.00	0	0.00±0.00	0	32	221
BUD	0.63±0.15	15	-0.09±0.18	5	-1.12±0.23	2	30	232
BUH	-0.19±0.10	18	0.08±0.21	3	0.00±0.00	0	32	246
BUL	-0.53±0.11	28	0.19±0.07	26	0.06±0.18	4	95	205
BURJ	0.99±0.40	3	0.00±0.00	0	0.00±0.00	0	42	204
BUT	-0.40±0.15	12	0.00±0.00	0	0.00±0.00	0	61	350
BWA	0.06±1.10	2	0.00±0.00	0	0.00±0.00	0	124	98
BWO6	-0.46±0.40	3	0.00±0.00	0	0.00±0.00	0	64	347
BYA	0.00±0.00	0	-1.10±0.32	1	0.00±0.00	0	173	188
BY1	-4.39±1.10	2	0.00±0.00	0	0.00±0.00	0	173	189
BZS	-0.16±0.35	5	0.00±0.00	0	0.00±0.00	0	32	227
CAF	0.05±0.10	14	-0.36±0.11	8	0.00±0.00	0	37	250
CAL	3.20±0.50	2	0.00±0.00	0	0.00±0.00	0	54	141
CALN	-0.51±0.39	3	0.00±0.00	0	0.00±0.00	0	37	244
CAN	0.00±0.10	29	0.54±0.14	6	0.00±0.00	0	125	98
CAR	0.64±0.13	19	-0.02±0.08	16	-0.16±0.18	3	89	303
CBM	-1.00±0.14	11	-0.28±0.16	4	0.00±0.00	0	54	315
CBN	-0.58±0.48	2	0.00±0.00	0	0.00±0.00	0	64	320
CBZ	1.74±0.53	15	0.00±0.00	0	0.00±0.00	0	146	89
CCH	1.19±1.55	2	0.00±0.00	0	0.00±0.00	0	115	295
CDF	-0.21±0.09	21	-0.21±0.09	13	0.00±0.00	0	32	246
CDR	-0.17±0.09	12	0.00±0.00	0	0.00±0.00	0	37	245
CD2	0.57±0.35	4	0.00±0.00	0	0.00±0.00	0	49	121
CEI	2.57±0.48	5	0.00±0.00	0	0.00±0.00	0	29	227
CEN	0.51±0.55	11	0.00±0.00	0	0.00±0.00	0	129	293
CEY	-0.17±0.23	9	0.00±0.00	0	0.00±0.00	0	33	236
CFF	-0.56±0.48	2	0.00±0.00	0	0.00±0.00	0	36	249
CFR	-0.61±0.25	12	0.00±0.00	0	0.00±0.00	0	31	218
CFTV	0.03±0.39	3	0.00±0.00	0	0.00±0.00	0	57	258
CGN	0.69±9.99	3	0.00±0.00	0	0.00±0.00	0	32	221
CGP	-0.36±0.40	4	0.42±0.31	1	0.00±0.00	0	76	107
CHA	0.95±9.99	2	0.00±0.00	0	0.00±0.00	0	50	141
CHC	-0.26±0.43	3	0.00±0.00	0	0.00±0.00	0	67	321
CHG	-1.11±0.15	18	-0.34±0.12	9	0.00±0.00	0	60	130
CHI	-2.43±0.48	2	0.00±0.00	0	0.00±0.00	0	62	329
CHN	0.05±9.99	3	0.00±0.00	0	0.00±0.00	0	96	311
CHT	0.90±0.49	2	0.00±0.00	0	0.00±0.00	0	55	137
CHTO	-1.04±0.27	7	-0.27±0.14	5	0.00±0.00	0	60	130
CHZ	0.87±0.48	2	0.00±0.00	0	0.00±0.00	0	28	234
CIN	0.27±0.28	8	0.00±0.00	0	0.00±0.00	0	38	215
CIO	-0.47±0.48	2	0.00±0.00	0	0.00±0.00	0	36	236
CIR	-0.35±0.17	13	-0.59±0.09	13	-0.27±0.25	3	95	202
CIT	-0.06±0.41	3	0.00±0.00	0	0.00±0.00	0	32	99
CIZ	-3.17±1.10	4	0.00±0.00	0	0.00±0.00	0	142	68
CJR	0.22±0.28	8	0.00±0.00	0	0.00±0.00	0	30	225
CJR1	0.55±0.39	3	0.00±0.00	0	0.00±0.00	0	30	226
CKI	-0.59±0.39	3	0.00±0.00	0	0.00±0.00	0	36	242
CLC	0.47±0.30	7	0.00±0.00	0	0.00±0.00	0	71	353
CLE	0.03±0.23	10	-0.93±0.30	3	0.00±0.00	0	62	324
CLI	-1.09±0.28	6	0.00±0.00	0	0.00±0.00	0	30	220
CLK	0.37±0.16	14	-0.04±0.09	14	0.02±0.18	3	90	199
CLL	-0.78±0.09	29	-0.06±0.07	24	0.28±0.18	3	28	242
CLO	0.11±0.34	4	0.00±0.00	0	0.00±0.00	0	32	226
CMB	-0.26±0.34	4	0.00±0.00	0	0.00±0.00	0	69	356
CMC	0.48±0.35	5	0.38±0.22	2	0.00±0.00	0	39	354
CMP	1.94±0.17	19	0.00±0.00	0	0.00±0.00	0	31	222
CMS	-0.16±0.78	4	0.00±0.00	0	0.00±0.00	0	120	99
CNCB	2.31±0.78	5	0.00±0.00	0	0.00±0.00	0	115	297
CNG	-0.78±0.39	4	0.00±0.00	0	0.00±0.00	0	101	201
CNIL	1.57±0.40	3	0.00±0.00	0	0.00±0.00	0	47	254
CNN	0.00±0.00	0	-1.07±0.35	1	0.00±0.00	0	64	326
CNS	1.27±0.49	2	0.00±0.00	0	0.00±0.00	0	44	240
CN2	-0.15±0.32	5	0.00±0.00	0	0.00±0.00	0	43	93
COB	-2.13±0.98	11	0.00±0.00	0	0.00±0.00	0	137	78
COI	0.76±0.26	7	0.00±0.00	0	0.00±0.00	0	44	258
COL	1.55±0.10	25	-0.08±0.08	14	0.00±0.00	0	41	15

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
COM	0.87±0.34	5	0.00±0.00	0	0.00±0.00	0	88	329
CON	0.96±1.55	2	0.00±0.00	0	0.00±0.00	0	136	295
COO	0.50±0.15	11	0.00±0.00	0	0.00±0.00	0	121	93
COOL	-0.99±1.10	2	0.00±0.00	0	0.00±0.00	0	113	121
COP	0.33±0.09	29	0.69±0.09	21	0.48±0.30	1	25	247
COR	0.43±0.25	8	0.00±0.00	0	0.00±0.00	0	62	359
COZ	0.56±0.31	5	0.00±0.00	0	0.00±0.00	0	31	223
CPO	-1.72±0.12	15	0.04±0.10	10	0.10±0.18	3	68	326
CPP	0.48±0.96	3	0.00±0.00	0	0.00±0.00	0	126	296
CPX	-0.18±0.39	3	0.00±0.00	0	0.00±0.00	0	70	352
CRC	0.18±0.48	2	0.00±0.00	0	0.00±0.00	0	70	357
CRE	0.70±0.39	3	0.00±0.00	0	0.00±0.00	0	36	238
CRO	0.00±0.00	0	0.21±0.31	1	0.00±0.00	0	71	334
CRT	1.67±0.17	14	0.00±0.00	0	0.00±0.00	0	46	252
CRZ	1.50±0.79	5	0.00±0.00	0	0.00±0.00	0	131	74
CSI	1.62±0.48	2	0.00±0.00	0	0.00±0.00	0	38	231
CSS	0.08±0.37	4	0.00±0.00	0	0.00±0.00	0	40	208
CTFE	0.28±0.39	3	0.00±0.00	0	0.00±0.00	0	58	261
CTI	-0.18±0.24	8	0.00±0.00	0	0.00±0.00	0	34	240
CTT	-0.36±0.31	5	0.00±0.00	0	0.00±0.00	0	35	216
CUM	0.37±0.37	5	-0.42±0.23	2	-0.52±0.20	3	88	301
CVF	0.27±0.10	15	0.61±0.09	11	0.00±0.00	0	38	241
CVL	-0.10±0.48	2	0.00±0.00	0	0.00±0.00	0	64	320
CVO	-0.37±0.48	2	0.00±0.00	0	0.00±0.00	0	31	222
CVP	-0.37±0.52	2	0.00±0.00	0	0.00±0.00	0	67	107
CWC	0.66±0.48	2	0.00±0.00	0	0.00±0.00	0	70	354
CWF	-0.94±0.34	4	-0.17±0.19	3	0.00±0.00	0	31	259
CYA	0.46±1.10	2	0.00±0.00	0	0.00±0.00	0	126	291
CYP	-0.82±0.31	6	1.31±0.19	5	0.00±0.00	0	26	229
CZI	-0.42±0.39	3	0.00±0.00	0	0.00±0.00	0	39	231
DAC	0.99±0.48	3	0.00±0.00	0	0.00±0.00	0	71	354
DAF	0.04±0.40	3	0.00±0.00	0	0.00±0.00	0	62	194
DAG	-2.71±0.15	20	0.00±0.00	0	0.00±0.00	0	18	315
DAL	-0.28±0.48	4	-0.51±0.31	1	0.00±0.00	0	72	335
DAR	-1.81±0.35	4	0.11±0.31	1	0.00±0.00	0	98	107
DAU	0.47±0.48	2	0.00±0.00	0	0.00±0.00	0	66	348
DAV	0.00±0.34	6	-1.25±0.31	1	0.00±0.00	0	78	107
DBN	0.43±0.23	10	0.52±0.31	1	0.00±0.00	0	30	252
DBQ	-1.09±0.48	2	0.00±0.00	0	0.00±0.00	0	62	332
DCN	-0.23±0.07	13	0.52±0.15	7	0.00±0.00	0	32	266
DCU	0.52±0.39	3	0.00±0.00	0	0.00±0.00	0	66	349
DDI	0.90±0.17	14	0.00±0.00	0	0.00±0.00	0	45	151
DDK	-0.14±0.24	8	0.40±0.20	3	0.00±0.00	0	32	265
DDR	-1.01±0.12	20	0.00±0.00	0	0.00±0.00	0	54	84
DEV	-0.09±0.15	20	0.00±0.00	0	0.00±0.00	0	31	226
DHR	-0.01±0.48	2	0.00±0.00	0	0.00±0.00	0	47	186
DIM	-0.21±0.26	9	0.00±0.00	0	0.00±0.00	0	34	221
DIX	0.37±0.14	14	0.07±0.13	11	0.00±0.00	0	35	245
DKM	-0.37±0.30	5	0.36±0.15	4	0.00±0.00	0	32	265
DLE	-0.35±0.24	8	0.26±0.12	8	0.00±0.00	0	32	265
DL2	0.48±0.35	4	0.00±0.00	0	0.00±0.00	0	47	99
DMK	-0.28±0.12	18	0.00±0.00	0	0.00±0.00	0	34	217
DMN	1.17±0.32	5	0.51±0.37	1	0.00±0.00	0	49	143
DMU	-0.53±0.10	11	0.25±0.14	7	0.00±0.00	0	31	266
DOC	0.73±9.99	2	0.00±0.00	0	0.00±0.00	0	29	221
DOI	-1.89±0.39	3	0.00±0.00	0	0.00±0.00	0	36	244
DOM	1.07±0.39	4	0.27±0.22	2	0.00±0.00	0	83	299
DOU	-0.93±0.09	29	0.10±0.18	3	0.00±0.00	0	32	251
DPS	-0.06±0.48	2	0.00±0.00	0	0.00±0.00	0	38	233
DRA	0.95±0.34	7	0.00±0.00	0	0.00±0.00	0	32	223
DRB	0.35±0.39	3	0.00±0.00	0	0.00±0.00	0	36	216
DRV	-2.36±0.52	16	0.00±0.00	0	0.00±0.00	0	150	127
DSH	0.45±0.40	3	0.00±0.00	0	0.00±0.00	0	36	161
DSI	0.60±0.48	3	0.00±0.00	0	0.00±0.00	0	43	205
DST	0.00±0.24	8	0.00±0.00	0	0.00±0.00	0	36	215
DUG	0.22±0.10	20	-0.43±0.13	8	-0.16±0.31	1	66	350
DUI	0.14±0.23	9	0.00±0.00	0	0.00±0.00	0	37	234
DUR	-1.33±0.27	11	0.00±0.00	0	0.00±0.00	0	29	262
DZM	0.66±0.90	3	0.00±0.00	0	0.00±0.00	0	117	76
EAB	-0.66±0.08	14	-0.12±0.12	7	0.01±0.22	2	29	266
EALH	0.73±0.39	3	0.00±0.00	0	0.00±0.00	0	45	250
EAU	-0.46±0.09	13	0.46±0.12	8	0.11±0.22	2	29	265
EBAN	1.00±0.34	4	0.00±0.00	0	0.00±0.00	0	45	252
EBH	-0.52±0.10	17	0.04±0.11	8	0.03±0.22	2	28	265
EBL	-0.40±0.10	15	0.23±0.10	10	0.10±0.22	2	29	264
EBR	0.17±0.12	20	0.00±0.00	0	0.00±0.00	0	41	249
EBS	-0.69±0.48	2	0.00±0.00	0	0.00±0.00	0	61	341
ECB	-0.45±0.34	4	-0.02±0.23	2	0.00±0.00	0	33	265
ECH	-0.47±0.12	13	0.00±0.00	0	0.00±0.00	0	33	247
ECHE	0.73±0.39	3	0.00±0.00	0	0.00±0.00	0	43	250

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	$\Delta°$	$\varphi°$
ECP	-0.36±0.23	9	0.46±0.12	7	0.00±0.00	0	33	264
ECRI	0.86±0.34	4	0.00±0.00	0	0.00±0.00	0	40	253
ECT	-0.02±0.28	7	-0.28±0.33	1	0.00±0.00	0	60	317
EDC	0.17±0.14	16	0.00±0.00	0	0.00±0.00	0	35	217
EDI	-0.58±0.08	18	0.10±0.11	8	0.03±0.22	2	29	264
EDM	-0.43±0.09	25	0.32±0.08	18	0.16±0.18	3	54	351
EDU	-0.47±0.09	14	0.15±0.12	7	0.18±0.31	1	28	265
EGL	-0.49±0.13	14	0.54±0.11	8	0.00±0.22	2	29	264
EHOR	0.61±0.34	4	0.00±0.00	0	0.00±0.00	0	46	254
EIL	-0.79±0.18	13	0.00±0.00	0	0.00±0.00	0	45	205
EKA	-0.29±0.09	29	0.40±0.07	23	0.14±0.18	3	29	264
ELC	-1.25±0.28	6	0.00±0.00	0	0.00±0.00	0	67	329
ELL	0.85±0.15	15	0.00±0.00	0	0.00±0.00	0	39	213
ELO	-0.59±0.11	11	-0.14±0.12	7	0.11±0.31	1	28	266
ELY	0.81±0.48	2	0.00±0.00	0	0.00±0.00	0	68	351
EMM	-0.94±0.30	5	-0.11±0.32	1	0.00±0.00	0	56	313
EMS	0.26±0.34	4	0.07±0.31	1	0.00±0.00	0	35	245
ENIJ	0.14±0.34	4	0.00±0.00	0	0.00±0.00	0	46	250
ENN	-0.79±0.23	9	0.57±0.14	7	0.00±0.00	0	31	250
EPF	-0.33±0.09	16	0.19±0.09	12	0.00±0.00	0	39	250
EPLA	0.78±0.34	4	0.00±0.00	0	0.00±0.00	0	44	256
EPRU	1.15±0.39	3	0.00±0.00	0	0.00±0.00	0	46	253
ERC	0.06±0.23	9	0.00±0.00	0	0.00±0.00	0	41	234
ERE	0.63±0.48	3	0.00±0.00	0	0.00±0.00	0	34	194
EROQ	0.04±0.34	4	0.00±0.00	0	0.00±0.00	0	41	249
ERUA	0.99±0.39	3	0.00±0.00	0	0.00±0.00	0	42	258
ERZ	0.68±0.43	3	0.00±0.00	0	0.00±0.00	0	34	199
ESA	-0.78±0.31	6	0.00±0.00	0	0.00±0.00	0	101	87
ESEL	0.04±0.48	2	0.00±0.00	0	0.00±0.00	0	42	246
ESK	-0.24±0.10	26	0.47±0.08	18	1.24±0.31	2	29	264
ESY	-0.51±0.39	3	0.00±0.00	0	0.00±0.00	0	28	264
ETA	-0.63±0.28	6	0.29±0.23	2	0.00±0.00	0	32	264
ETER	0.37±0.48	2	0.00±0.00	0	0.00±0.00	0	39	247
ETOR	0.57±0.39	3	0.00±0.00	0	0.00±0.00	0	42	252
EUR	0.53±0.11	27	0.28±0.16	14	0.00±0.00	0	67	352
EVAL	0.53±0.34	4	0.00±0.00	0	0.00±0.00	0	46	255
EVIA	0.93±0.34	4	0.00±0.00	0	0.00±0.00	0	44	251
EZN	-0.31±0.13	17	0.00±0.00	0	0.00±0.00	0	36	218
FAI	0.17±0.48	2	0.00±0.00	0	0.00±0.00	0	41	233
FAM	0.26±0.48	2	0.00±0.00	0	0.00±0.00	0	40	207
FAR	2.65±0.73	2	0.00±0.00	0	0.00±0.00	0	47	256
FAV	-1.05±0.23	12	0.30±0.30	1	0.00±0.00	0	69	334
FBA	1.49±0.14	12	-0.18±0.15	5	0.00±0.00	0	41	14
FBC	-1.33±0.28	8	-0.06±0.22	2	0.00±0.00	0	38	323
FCC	-1.10±0.17	16	-0.37±0.16	4	0.00±0.00	0	47	338
FEL	-0.31±0.39	3	-0.29±0.31	1	0.00±0.00	0	33	245
FFC	-0.98±0.10	22	0.20±0.09	11	0.22±0.30	1	51	343
FGG	0.31±9.99	2	0.00±0.00	0	0.00±0.00	0	37	232
FGU	-0.40±0.34	4	0.00±0.00	0	0.00±0.00	0	66	347
FG2	-0.14±0.48	2	0.00±0.00	0	0.00±0.00	0	37	233
FG4	0.32±0.48	2	0.00±0.00	0	0.00±0.00	0	37	232
FHC	0.64±0.13	19	0.00±0.00	0	0.00±0.00	0	66	359
FIN	-1.41±0.48	2	0.00±0.00	0	0.00±0.00	0	36	242
FIR	0.61±0.17	17	0.00±0.00	0	0.00±0.00	0	36	239
FKO	-0.56±0.48	2	0.00±0.00	0	0.00±0.00	0	70	336
FLN	-0.85±0.09	27	0.28±0.08	16	0.00±0.00	0	34	255
FLO	-1.52±0.48	2	0.34±0.30	1	0.00±0.00	0	66	331
FLR	-0.17±0.28	6	0.00±0.00	0	0.00±0.00	0	60	315
FOC	0.04±0.40	8	0.00±0.00	0	0.00±0.00	0	30	220
FOUF	0.62±0.40	3	0.00±0.00	0	0.00±0.00	0	36	244
FRB	-0.89±0.13	16	-0.06±0.10	10	0.00±0.00	0	38	323
FRF	-0.49±0.23	9	0.21±0.12	7	0.00±0.00	0	37	244
FRI	0.13±0.10	20	0.00±0.00	0	0.00±0.00	0	70	355
FRR	-0.58±0.48	2	0.00±0.00	0	0.00±0.00	0	92	187
FRU	0.27±0.40	3	0.00±0.00	0	0.00±0.00	0	32	152
FSJ	0.19±0.12	14	-0.05±0.12	7	-0.16±0.32	1	53	360
FUQ	0.58±0.48	2	0.00±0.00	0	0.00±0.00	0	95	309
FUR	0.08±0.10	26	-0.05±0.08	20	-0.26±0.22	2	32	241
FVI	0.57±0.34	4	0.00±0.00	0	0.00±0.00	0	33	239
FVM	-1.56±0.13	17	-0.42±0.17	5	0.00±0.00	0	66	331
FYU	1.78±0.39	5	0.00±0.00	0	0.00±0.00	0	40	13
GAP	0.32±0.12	10	0.00±0.00	0	0.00±0.00	0	32	241
GAR	0.44±0.50	2	0.00±0.00	0	0.00±0.00	0	35	159
GBA	-0.88±0.13	26	0.23±0.10	17	0.00±0.00	0	61	155
GBO	-1.10±0.34	4	0.00±0.00	0	0.00±0.00	0	69	334
GBR	0.69±0.48	2	0.00±0.00	0	0.00±0.00	0	63	194
GBTN	-1.15±0.48	2	0.00±0.00	0	0.00±0.00	0	68	325
GCA	0.03±0.14	14	0.00±0.00	0	0.00±0.00	0	70	349
GCC	0.10±0.48	2	0.00±0.00	0	0.00±0.00	0	70	357
GDH	-1.26±0.12	17	-0.49±0.09	14	-0.13±0.18	4	30	318

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
GEN	-0.71±0.34	7	0.00±0.00	0	0.00±0.00	0	36	242
GEO	-0.63±0.39	3	-0.02±0.22	2	0.00±0.00	0	63	320
GET	0.10±0.48	2	0.00±0.00	0	0.00±0.00	0	36	217
GIB	-0.78±0.17	14	0.00±0.00	0	0.00±0.00	0	41	232
GIL	1.64±0.12	12	-0.21±0.12	7	0.00±0.00	0	41	14
GKN	0.60±0.49	2	0.00±0.00	0	0.00±0.00	0	48	144
GLA	1.16±0.16	14	0.00±0.00	0	0.00±0.00	0	74	351
GLD	0.05±0.25	9	-0.36±0.17	4	0.00±0.00	0	66	343
GLP	-0.32±0.39	5	0.00±0.00	0	0.00±0.00	0	35	214
GMA	0.70±0.23	9	0.00±0.00	0	0.00±0.00	0	39	23
GMB	-1.04±0.48	2	0.00±0.00	0	0.00±0.00	0	40	231
GMW	-0.07±0.28	6	0.00±0.00	0	0.00±0.00	0	59	358
GNZ	-1.03±0.78	10	0.00±0.00	0	0.00±0.00	0	136	71
GOA	-1.08±0.40	3	0.00±0.00	0	0.00±0.00	0	59	159
GOL	-0.26±0.10	22	-0.54±0.09	16	-0.57±0.18	3	66	343
GPA	-0.06±0.15	13	0.00±0.00	0	0.00±0.00	0	35	213
GRC	-1.11±0.28	7	0.00±0.00	0	0.00±0.00	0	35	250
GRE	0.02±0.25	9	-0.36±0.14	9	-0.23±0.18	3	86	299
GRF	0.36±0.07	26	0.32±0.08	18	0.53±0.30	1	30	243
GRFO	-0.03±0.48	2	0.00±0.00	0	0.00±0.00	0	30	243
GRO	0.17±0.48	2	0.00±0.00	0	0.00±0.00	0	30	193
GRR	-1.15±0.08	27	-0.10±0.08	16	-0.19±0.31	1	35	255
GRS	0.16±0.48	2	0.00±0.00	0	0.00±0.00	0	34	192
GSC	0.95±0.29	6	0.00±0.00	0	0.00±0.00	0	72	353
GSP	2.16±1.61	2	0.00±0.00	0	0.00±0.00	0	139	82
GTA	0.77±0.32	5	0.00±0.00	0	0.00±0.00	0	40	122
GUA	-2.72±0.27	7	-0.40±0.17	4	-0.66±0.20	3	77	86
GUD	0.62±0.30	5	0.00±0.00	0	0.00±0.00	0	43	254
GUMO	-2.22±0.48	3	0.00±0.00	0	0.00±0.00	0	77	86
GWC	-1.08±0.26	7	0.31±0.23	3	0.00±0.00	0	48	325
GWF	-0.33±0.23	9	0.00±0.00	0	0.00±0.00	0	32	246
GYA	-0.34±0.36	4	0.00±0.00	0	0.00±0.00	0	54	120
GZR	0.33±0.26	9	0.00±0.00	0	0.00±0.00	0	32	226
HAD	0.13±0.34	4	0.00±0.00	0	0.00±0.00	0	51	250
HAL	-1.24±0.34	4	0.00±0.00	0	0.00±0.00	0	55	310
HAM	0.09±0.27	11	0.00±0.00	0	0.00±0.00	0	27	248
HAU	-0.34±0.09	24	-0.14±0.08	15	0.00±0.00	0	33	247
HCC	0.62±0.48	2	0.00±0.00	0	0.00±0.00	0	70	357
HCY	-0.86±0.39	3	0.00±0.00	0	0.00±0.00	0	35	230
HDM	-0.13±0.28	6	-0.04±0.23	2	0.00±0.00	0	60	316
HEE	-0.47±0.15	12	0.00±0.00	0	0.00±0.00	0	31	250
HEI	-0.28±0.39	3	0.00±0.00	0	0.00±0.00	0	31	245
HEN	4.61±0.49	3	0.00±0.00	0	0.00±0.00	0	62	107
HFS	-3.02±0.12	25	0.99±0.08	17	0.00±0.00	0	20	251
HHC	0.92±0.41	3	0.00±0.00	0	0.00±0.00	0	42	108
HHM	-0.86±0.28	8	0.00±0.00	0	0.00±0.00	0	58	351
HKC	-0.14±0.25	11	0.00±0.00	0	0.00±0.00	0	60	114
HKL	1.37±0.48	2	0.00±0.00	0	0.00±0.00	0	84	29
HKT	0.13±0.28	6	0.00±0.00	0	0.00±0.00	0	75	334
HLG	-0.06±0.31	5	0.00±0.00	0	0.00±0.00	0	27	251
HLW	0.62±0.23	10	0.00±0.00	0	0.00±0.00	0	45	209
HNH	0.04±0.39	3	0.00±0.00	0	0.00±0.00	0	58	317
HNME	-0.68±0.48	2	0.00±0.00	0	0.00±0.00	0	55	314
HOF	-0.17±0.11	17	0.11±0.12	11	0.67±0.18	3	30	242
HOK	-0.54±0.48	2	0.00±0.00	0	0.00±0.00	0	30	248
HON	1.11±0.25	8	0.00±0.00	0	0.00±0.00	0	83	31
HPK	-0.36±0.34	5	0.00±0.00	0	0.00±0.00	0	30	261
HQL	0.41±0.39	3	0.00±0.00	0	0.00±0.00	0	45	204
HRI	0.91±0.34	4	0.00±0.00	0	0.00±0.00	0	41	205
HRT	0.00±0.25	8	0.00±0.00	0	0.00±0.00	0	35	214
HSS	-0.97±0.38	4	0.00±0.00	0	0.00±0.00	0	48	78
HUA	1.99±0.79	8	0.00±0.00	0	0.00±0.00	0	112	306
HVAR	-1.08±0.39	3	0.00±0.00	0	0.00±0.00	0	35	232
HVO	0.75±0.34	4	0.00±0.00	0	0.00±0.00	0	85	29
HYA	-0.81±0.34	4	0.00±0.00	0	0.00±0.00	0	22	261
HYB	-1.45±0.12	27	0.36±0.07	24	-0.36±0.23	3	58	153
IAS	-1.49±0.15	19	0.00±0.00	0	0.00±0.00	0	29	220
IFR	-1.59±0.12	19	0.00±0.00	0	0.00±0.00	0	50	252
ILG	0.00±0.00	0	0.23±0.30	1	0.00±0.00	0	21	325
ILT	-0.08±0.40	3	0.00±0.00	0	0.00±0.00	0	35	32
IMA	0.48±0.11	17	0.06±0.31	1	0.00±0.00	0	40	18
IMW	0.19±9.99	2	0.00±0.00	0	0.00±0.00	0	63	348
INK	-0.43±0.13	19	-0.10±0.10	9	-0.24±0.31	1	38	5
INR	1.49±0.49	3	0.00±0.00	0	0.00±0.00	0	51	134
IN1	-1.52±0.40	3	0.00±0.00	0	0.00±0.00	0	63	327
IN2	-1.43±0.48	2	0.00±0.00	0	0.00±0.00	0	64	328
IN3	-1.56±0.48	2	0.00±0.00	0	0.00±0.00	0	65	327
IN4	-1.57±0.39	3	0.00±0.00	0	0.00±0.00	0	64	326
IPM	-0.57±0.19	12	0.18±0.13	11	0.00±0.00	0	74	131
IRK	-1.15±0.51	2	0.00±0.00	0	0.00±0.00	0	29	108

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
IR1	1.71±0.48	2	0.00±0.00	0	0.00±0.00	0	38	186
IR2	1.95±0.40	3	0.00±0.00	0	0.00±0.00	0	38	185
IR7	1.58±0.48	2	0.00±0.00	0	0.00±0.00	0	38	186
ISA	-0.09±0.25	8	0.00±0.00	0	0.00±0.00	0	71	354
ISK	-0.16±0.12	26	0.00±0.00	0	0.00±0.00	0	35	215
ISO	-1.05±0.25	8	0.00±0.00	0	0.00±0.00	0	36	244
ISR	0.59±0.26	9	0.00±0.00	0	0.00±0.00	0	31	220
ISSF	-0.76±0.48	2	0.00±0.00	0	0.00±0.00	0	40	252
IST	-0.12±0.14	17	0.00±0.00	0	0.00±0.00	0	35	216
ITM	-0.81±0.47	2	0.00±0.00	0	0.00±0.00	0	40	223
IVA	0.33±0.39	3	0.00±0.00	0	0.00±0.00	0	35	228
IZM	-0.43±0.14	14	0.00±0.00	0	0.00±0.00	0	37	217
JAN	0.16±0.25	9	0.00±0.00	0	0.00±0.00	0	38	225
JARJ	0.80±0.44	3	0.00±0.00	0	0.00±0.00	0	42	204
JAS	0.17±0.08	21	-0.70±0.23	2	0.00±0.00	0	69	356
JAY	-1.18±0.27	9	0.28±0.35	1	0.00±0.00	0	91	95
JCT	-0.18±0.19	10	-0.28±0.12	7	0.00±0.00	0	75	338
JER	0.68±0.15	17	0.00±0.00	0	0.00±0.00	0	43	205
JMB	0.06±0.39	6	0.00±0.00	0	0.00±0.00	0	34	219
JMI	1.31±0.40	3	0.00±0.00	0	0.00±0.00	0	19	294
JNE	2.33±9.99	2	0.00±0.00	0	0.00±0.00	0	19	294
JNW	0.91±0.44	3	0.00±0.00	0	0.00±0.00	0	19	294
JOS	-0.36±0.18	14	-0.06±0.14	5	-1.34±0.35	1	29	231
JSC	-0.62±0.30	5	0.00±0.00	0	0.00±0.00	0	69	322
KAD	-0.86±0.32	6	0.00±0.00	0	0.00±0.00	0	57	158
KAR	2.54±0.48	7	0.00±0.00	0	0.00±0.00	0	49	165
KAS	0.57±0.13	20	0.00±0.00	0	0.00±0.00	0	34	209
KAT	2.61±0.43	3	0.00±0.00	0	0.00±0.00	0	34	178
KAV	-0.64±0.48	2	0.00±0.00	0	0.00±0.00	0	94	85
KBA	1.05±0.28	7	0.40±0.14	5	0.00±0.00	0	32	238
KBC	0.60±0.48	2	0.00±0.00	0	0.00±0.00	0	74	228
KBL	0.20±0.24	12	0.00±0.00	0	0.00±0.00	0	39	162
KBN	-0.75±0.48	2	0.00±0.00	0	0.00±0.00	0	37	226
KBS	-5.52±0.15	25	0.00±0.00	0	0.00±0.00	0	11	318
KCT	-0.26±0.40	3	0.00±0.00	0	0.00±0.00	0	36	216
KDC	-0.20±0.11	23	0.00±0.00	0	0.00±0.00	0	48	19
KDS	-0.40±0.39	4	0.00±0.00	0	0.00±0.00	0	71	251
KDZ	0.48±0.15	18	0.00±0.00	0	0.00±0.00	0	35	220
KEB	1.01±0.40	3	0.00±0.00	0	0.00±0.00	0	35	202
KEP	-4.88±1.55	2	0.00±0.00	0	0.00±0.00	0	141	250
KER	1.23±0.19	16	0.00±0.00	0	0.00±0.00	0	39	190
KES	0.01±0.39	3	0.00±0.00	0	0.00±0.00	0	51	250
KEV	-3.97±0.10	30	0.00±0.00	0	0.00±0.00	0	9	261
KEW	-0.30±0.48	2	0.00±0.00	0	0.00±0.00	0	32	257
KFNJ	0.49±0.40	3	0.00±0.00	0	0.00±0.00	0	43	205
KGM	0.00±0.17	11	0.02±0.19	4	0.00±0.00	0	77	130
KHC	0.26±0.08	29	-0.05±0.07	22	-0.16±0.15	4	30	239
KHI	1.58±0.15	11	0.00±0.00	0	0.00±0.00	0	39	175
KHT	-0.40±0.40	3	0.00±0.00	0	0.00±0.00	0	64	131
KIC	-0.72±0.09	22	0.00±0.00	0	0.00±0.00	0	75	242
KIM	-0.44±0.34	4	0.00±0.00	0	0.00±0.00	0	104	207
KIP	0.75±0.13	10	0.01±0.23	2	0.00±0.00	0	83	31
KIR	-5.41±0.10	29	0.00±0.00	0	0.00±0.00	0	13	262
KIS	-1.53±9.99	2	0.00±0.00	0	0.00±0.00	0	29	218
KJF	-6.12±0.13	20	0.00±0.00	0	0.00±0.00	0	13	241
KJN	-6.39±0.33	6	0.00±0.00	0	0.00±0.00	0	13	241
KKB	-0.43±0.48	2	0.00±0.00	0	0.00±0.00	0	35	223
KKM	0.11±0.43	5	-0.27±0.40	1	0.00±0.00	0	76	116
KKN	0.99±0.32	5	0.00±0.00	0	0.00±0.00	0	48	143
KKR	-9.38±9.99	2	0.00±0.00	0	0.00±0.00	0	45	153
KLG	-0.79±0.59	8	0.50±0.18	4	0.00±0.00	0	113	121
KLL	-0.63±0.34	4	0.00±0.00	0	0.00±0.00	0	31	249
KMI	-0.86±0.26	8	0.00±0.00	0	0.00±0.00	0	55	124
KMR	0.27±0.10	10	0.00±0.00	0	0.00±0.00	0	31	238
KMSA	-0.24±0.48	2	0.00±0.00	0	0.00±0.00	0	53	192
KMU	-0.89±0.19	13	-0.28±0.15	4	-0.11±0.22	2	50	77
KMY	0.26±0.50	3	0.00±0.00	0	0.00±0.00	0	24	260
KNA	-1.72±0.31	5	0.23±0.24	2	0.42±0.32	1	100	110
KNT	-0.34±0.30	5	0.00±0.00	0	0.00±0.00	0	36	223
KOA	-1.72±0.49	2	0.00±0.00	0	0.00±0.00	0	99	82
KOO	-0.30±0.13	25	-0.05±0.10	17	0.03±0.31	1	64	155
KOGH	-0.56±0.48	2	0.00±0.00	0	0.00±0.00	0	75	238
KOI	0.69±0.34	7	0.00±0.00	0	0.00±0.00	0	51	132
KON	-1.10±0.10	23	-0.39±0.31	1	-0.07±0.30	1	22	256
KONO	-0.87±0.34	4	0.00±0.00	0	0.00±0.00	0	22	255
KOT	-0.09±0.48	2	0.00±0.00	0	0.00±0.00	0	45	209
KOU	0.53±0.19	13	0.00±0.00	0	0.00±0.00	0	115	78
KPH	0.41±0.34	4	0.00±0.00	0	0.00±0.00	0	83	31
KPK	-0.54±0.39	3	0.00±0.00	0	0.00±0.00	0	67	357
KRA	-0.51±0.11	28	0.67±0.10	23	-0.23±0.22	3	28	232

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
KRI	-0.83±0.27	8	-0.38±0.13	6	0.00±0.00	0	91	204
KRK	-3.62±0.35	5	0.00±0.00	0	0.00±0.00	0	9	257
KRL	0.21±0.14	10	0.23±0.21	3	0.00±0.00	0	32	246
KRP	0.76±0.52	21	0.06±0.38	1	0.00±0.00	0	135	73
KRR	0.22±0.16	12	-0.28±0.09	12	-0.41±0.15	4	91	204
KRV	-0.17±0.49	2	0.00±0.00	0	0.00±0.00	0	33	192
KSA	0.62±0.26	10	0.00±0.00	0	0.00±0.00	0	41	205
KSH	1.22±0.35	4	0.00±0.00	0	0.00±0.00	0	35	151
KSP	-0.23±0.23	9	0.39±0.11	8	0.00±0.00	0	28	237
KSU	0.23±0.32	5	0.00±0.00	0	0.00±0.00	0	62	194
KTG	1.08±0.17	18	-0.26±0.10	15	-0.48±0.18	4	23	301
KUG	-1.19±0.49	3	0.00±0.00	0	0.00±0.00	0	94	113
KUK	-0.53±0.31	6	0.00±0.00	0	0.00±0.00	0	75	238
KUL	-0.03±0.42	3	0.00±0.00	0	0.00±0.00	0	36	160
KVG	-0.47±0.48	2	0.00±0.00	0	0.00±0.00	0	94	85
KVN	0.16±0.34	4	0.00±0.00	0	0.00±0.00	0	68	354
KVT	0.57±0.14	15	0.00±0.00	0	0.00±0.00	0	34	206
KYS	-0.08±0.15	14	0.00±0.00	0	0.00±0.00	0	55	83
KZN	-0.31±0.15	10	0.00±0.00	0	0.00±0.00	0	37	224
LAH	-0.35±0.39	4	0.00±0.00	0	0.00±0.00	0	43	156
LAO	-0.15±0.23	9	-0.04±0.14	7	-0.03±0.31	3	60	345
LAR	-0.38±0.34	5	0.00±0.00	0	0.00±0.00	0	65	344
LAT	-1.64±0.28	9	0.00±0.00	0	0.00±0.00	0	97	90
LAW	-1.17±0.40	3	0.00±0.00	0	0.00±0.00	0	66	335
LBF	-1.12±0.09	23	-0.16±0.08	15	0.00±0.00	0	35	249
LBFM	0.12±0.39	3	0.00±0.00	0	0.00±0.00	0	66	357
LCG	3.33±0.48	2	0.00±0.00	0	0.00±0.00	0	84	338
LCI	-0.24±0.28	6	0.00±0.00	0	0.00±0.00	0	37	229
LDF	-1.10±0.26	7	0.00±0.13	6	0.00±0.00	0	34	255
LDM	-0.71±0.23	10	0.00±0.00	0	0.00±0.00	0	58	352
LD1	-0.08±0.39	3	0.00±0.00	0	0.00±0.00	0	59	345
LD3	-0.16±0.34	4	-0.17±0.31	1	0.00±0.00	0	60	345
LEE	1.13±0.39	3	0.00±0.00	0	0.00±0.00	0	69	350
LEGH	-0.80±0.39	3	0.00±0.00	0	0.00±0.00	0	75	238
LEM	-2.52±0.31	9	-0.53±0.38	1	0.00±0.00	0	86	128
LEN	1.24±0.48	2	0.00±0.00	0	0.00±0.00	0	33	196
LFF	0.03±0.08	22	0.21±0.09	13	0.00±0.00	0	37	251
LFK	-0.39±0.48	2	0.00±0.00	0	0.00±0.00	0	40	208
LF1	-0.42±0.48	2	-0.05±0.22	2	0.00±0.00	0	59	344
LGN	-0.16±0.48	3	0.00±0.00	0	0.00±0.00	0	90	308
LGP	0.04±0.49	2	0.00±0.00	0	0.00±0.00	0	71	107
LGR	1.53±0.29	6	0.00±0.00	0	0.00±0.00	0	41	253
LHC	-0.40±0.12	19	0.56±0.13	12	0.14±0.31	1	56	332
LHE	0.39±0.39	3	0.00±0.00	0	0.00±0.00	0	40	251
LHN	-2.77±0.48	2	0.00±0.00	0	0.00±0.00	0	20	256
LHS	-0.58±0.48	2	0.00±0.00	0	0.00±0.00	0	68	321
LIC	-0.73±0.23	9	0.00±0.00	0	0.00±0.00	0	76	242
LIS	0.22±0.13	19	0.00±0.00	0	0.00±0.00	0	46	258
LIT	0.09±0.31	5	0.00±0.00	0	0.00±0.00	0	37	223
LJU	0.60±0.10	23	0.29±0.12	7	0.29±0.22	2	33	236
LLA	0.71±0.31	5	0.00±0.00	0	0.00±0.00	0	70	356
LLI	-0.21±0.39	3	0.00±0.00	0	0.00±0.00	0	40	232
LLS	-0.16±0.23	9	-0.14±0.13	7	0.00±0.00	0	33	243
LMG	-2.04±0.40	3	0.00±0.00	0	0.00±0.00	0	99	90
LMR	-0.53±0.09	20	-0.17±0.09	12	0.00±0.00	0	37	244
LNS	0.09±0.35	5	0.00±0.00	0	0.00±0.00	0	35	245
LNV	0.45±1.11	6	0.00±0.00	0	0.00±0.00	0	132	295
LOE	-2.43±0.49	2	0.00±0.00	0	0.00±0.00	0	62	128
LOF	-6.06±0.41	3	0.00±0.00	0	0.00±0.00	0	14	269
LOM	0.29±9.99	2	0.00±0.00	0	0.00±0.00	0	74	236
LOMF	-0.47±0.39	3	0.00±0.00	0	0.00±0.00	0	34	246
LON	-0.36±0.10	19	-0.16±0.09	13	0.00±0.22	2	60	357
LOR	-1.09±0.07	29	0.44±0.07	19	0.57±0.31	1	34	249
LPB	1.12±0.15	22	-0.05±0.24	2	0.07±0.31	1	115	297
LPF	-1.08±0.09	21	-0.10±0.08	16	0.00±0.00	0	35	255
LPG	0.56±0.34	4	-0.14±0.19	3	0.00±0.00	0	35	245
LPO	0.08±0.08	22	-0.21±0.08	15	0.00±0.00	0	38	251
LPS	0.93±0.23	10	0.05±0.15	5	-0.21±0.22	2	90	325
LRG	-0.31±0.09	23	0.11±0.08	16	0.46±0.31	1	37	244
LRM	-0.42±0.28	6	0.00±0.00	0	0.00±0.00	0	61	350
LSA	2.76±0.49	3	0.00±0.00	0	0.00±0.00	0	48	136
LSD	0.52±0.48	2	0.00±0.00	0	0.00±0.00	0	35	244
LSF	-0.77±0.07	23	0.45±0.09	13	0.00±0.00	0	36	251
LSM	-0.11±0.48	2	0.00±0.00	0	0.00±0.00	0	70	353
LUB	-0.27±0.23	9	0.00±0.00	0	0.00±0.00	0	72	340
LUG	-0.76±0.89	6	0.00±0.00	0	0.00±0.00	0	111	73
LUX	-0.27±0.49	4	0.00±0.00	0	0.00±0.00	0	32	249
LVN	2.62±9.99	2	0.00±0.00	0	0.00±0.00	0	71	351
LWI	0.83±0.12	13	0.00±0.00	0	0.00±0.00	0	77	207
LZH	0.99±0.29	7	-0.44±0.17	4	0.00±0.00	0	44	119

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
MADF	-0.88±0.39	3	0.00±0.00	0	0.00±0.00	0	39	252
MAF	-0.54±0.34	4	-0.09±0.22	2	0.00±0.00	0	36	250
MAIO	1.33±0.26	7	0.05±0.15	4	0.00±0.00	0	37	174
MAL	0.57±0.16	11	0.00±0.00	0	0.00±0.00	0	46	252
MAN	-0.23±0.36	6	0.00±0.00	0	0.00±0.00	0	69	109
MAO	-0.16±0.30	5	0.00±0.00	0	0.00±0.00	0	37	238
MASJ	0.94±0.48	2	0.00±0.00	0	0.00±0.00	0	43	204
MAT	-1.03±0.12	29	-0.42±0.12	7	0.00±0.00	0	54	84
MAW	-7.95±0.13	26	0.58±0.22	2	0.00±0.00	0	141	175
MBC	-0.14±0.10	27	0.59±0.10	15	-0.23±0.31	1	31	357
MBH	-0.04±0.41	3	0.00±0.00	0	0.00±0.00	0	45	205
MBO	0.54±0.28	9	0.00±0.00	0	0.00±0.00	0	71	257
MBT	-1.56±0.40	3	0.00±0.00	0	0.00±0.00	0	103	120
MCC	-0.17±0.34	4	0.00±0.00	0	0.00±0.00	0	55	355
MCQ	-0.67±0.14	16	0.00±0.00	0	0.00±0.00	0	145	100
MCT	0.24±0.39	3	0.00±0.00	0	0.00±0.00	0	41	233
MCV	-0.25±0.48	2	0.00±0.00	0	0.00±0.00	0	70	352
MCW	-1.06±0.31	5	0.00±0.00	0	0.00±0.00	0	58	358
MDB	1.02±0.48	3	0.00±0.00	0	0.00±0.00	0	31	224
MDC	0.02±0.39	3	0.00±0.00	0	0.00±0.00	0	69	357
MDI	-0.69±0.34	4	0.00±0.00	0	0.00±0.00	0	34	242
MDJ	0.17±0.36	4	0.00±0.00	0	0.00±0.00	0	44	88
MDR	-0.20±0.40	4	0.00±0.00	0	0.00±0.00	0	62	152
MDZ	1.51±0.78	7	0.00±0.00	0	0.00±0.00	0	131	293
MED	-1.71±0.40	3	0.00±0.00	0	0.00±0.00	0	74	134
MEI	-1.46±0.48	2	0.00±0.00	0	0.00±0.00	0	41	231
MEM	-0.84±0.23	14	0.00±0.00	0	0.00±0.00	0	31	249
MEO	-0.16±0.39	3	0.00±0.00	0	0.00±0.00	0	71	337
MES	-2.16±0.23	10	0.00±0.00	0	0.00±0.00	0	40	231
MEU	-1.30±0.34	4	0.00±0.00	0	0.00±0.00	0	41	231
MFF	-0.56±0.07	20	0.07±0.08	14	0.00±0.00	0	36	253
MFS	1.21±0.48	2	0.00±0.00	0	0.00±0.00	0	71	354
MFT	-0.38±0.39	3	0.00±0.00	0	0.00±0.00	0	35	217
MGD	0.47±0.49	2	0.00±0.00	0	0.00±0.00	0	35	59
MGN	0.96±0.26	11	0.00±0.00	0	0.00±0.00	0	34	212
MGR	0.34±0.34	4	0.00±0.00	0	0.00±0.00	0	38	232
MHC	0.55±0.08	27	0.31±0.31	2	0.00±0.00	0	70	357
MHI	1.37±0.30	7	0.23±0.16	4	0.00±0.00	0	37	174
MHK	-0.76±0.39	3	0.00±0.00	0	0.00±0.00	0	66	336
MID	1.22±0.26	7	0.00±0.00	0	0.00±0.00	0	47	15
MII	-0.65±0.48	2	0.00±0.00	0	0.00±0.00	0	29	223
MIM	-0.81±0.10	15	-0.11±0.16	4	0.00±0.00	0	56	315
MIN	-0.27±0.09	28	0.00±0.00	0	0.00±0.00	0	67	357
MIR	-6.23±1.10	3	0.00±0.00	0	0.00±0.00	0	142	156
MIZ	-0.54±0.27	7	0.00±0.00	0	0.00±0.00	0	52	80
MJZ	-9.90±0.69	10	0.00±0.00	0	0.00±0.00	0	139	82
MKL	0.51±0.48	2	0.00±0.00	0	0.00±0.00	0	62	193
MKRJ	0.51±0.40	3	0.00±0.00	0	0.00±0.00	0	43	205
MKS	-1.36±0.33	6	0.00±0.00	0	0.00±0.00	0	88	116
MLR	0.68±0.14	20	0.00±0.00	0	0.00±0.00	0	31	221
MLS	0.31±0.23	10	0.00±0.00	0	0.00±0.00	0	39	250
MMA	0.99±0.34	4	0.00±0.00	0	0.00±0.00	0	73	349
MMB	0.23±0.40	3	0.00±0.00	0	0.00±0.00	0	35	222
MME	1.03±0.34	4	0.00±0.00	0	0.00±0.00	0	35	240
MMK	0.60±0.24	8	0.33±0.13	6	0.00±0.00	0	34	244
MMN	1.57±0.51	2	0.00±0.00	0	0.00±0.00	0	38	231
MNA	0.09±0.31	5	0.00±0.00	0	0.00±0.00	0	68	354
MNE	-5.27±9.99	2	0.00±0.00	0	0.00±0.00	0	41	231
MNG	-6.60±0.96	19	-0.16±0.31	1	0.00±0.00	0	137	74
MNI	-0.77±0.31	6	0.00±0.00	0	0.00±0.00	0	83	109
MNK	-6.97±0.44	3	0.00±0.00	0	0.00±0.00	0	23	225
MNL	0.84±0.40	4	0.00±0.00	0	0.00±0.00	0	41	156
MNO	0.14±0.34	4	0.00±0.00	0	0.00±0.00	0	40	232
MNS	-0.43±0.14	10	0.00±0.00	0	0.00±0.00	0	37	236
MNT	-1.16±0.11	20	0.00±0.09	15	0.00±0.16	4	56	319
MNV	0.08±0.23	11	0.00±0.00	0	0.00±0.00	0	68	354
MNW	1.26±1.10	5	0.00±0.00	0	0.00±0.00	0	140	86
MNY	-0.31±0.24	9	0.00±0.00	0	0.00±0.00	0	36	246
MOA	-0.14±0.10	18	0.00±0.00	0	0.00±0.00	0	31	238
MOF	-0.46±0.34	4	0.00±0.00	0	0.00±0.00	0	33	246
MOK	0.30±0.39	3	0.00±0.00	0	0.00±0.00	0	83	31
MOL	-2.47±0.48	3	0.00±0.00	0	0.00±0.00	0	20	262
MOM	-0.43±0.38	5	0.00±0.00	0	0.00±0.00	0	93	88
MOMI	1.17±0.48	2	0.00±0.00	0	0.00±0.00	0	47	254
MOO	0.29±0.70	5	0.00±0.00	0	0.00±0.00	0	131	103
MOS	-5.59±0.43	3	0.00±0.00	0	0.00±0.00	0	19	211
MOT	0.11±0.26	7	0.00±0.00	0	0.00±0.00	0	75	341
MOX	-0.61±0.10	29	-0.19±0.07	23	-0.07±0.15	4	29	243
MOY	1.58±0.41	3	0.00±0.00	0	0.00±0.00	0	29	113
MRG	0.16±0.26	9	0.00±0.00	0	0.00±0.00	0	63	322

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
MRWA	0.39±0.90	3	0.00±0.00	0	0.00±0.00	0	110	125
MSH	1.53±0.25	9	0.00±0.00	0	0.00±0.00	0	37	174
MSI	-1.71±0.34	5	0.00±0.00	0	0.00±0.00	0	40	231
MSL	1.30±0.27	7	0.00±0.00	0	0.00±0.00	0	38	196
MSO	-0.69±0.13	12	-0.17±0.10	9	0.09±0.31	2	60	351
MSU	1.07±0.48	2	0.00±0.00	0	0.00±0.00	0	68	349
MSZ	-10.45±0.57	14	0.00±0.00	0	0.00±0.00	0	139	85
MTA	-0.20±0.40	3	0.00±0.00	0	0.00±0.00	0	32	194
MTD	-0.52±0.15	14	-0.53±0.10	13	-0.38±0.16	4	91	202
MTE	1.11±0.30	6	0.00±0.00	0	0.00±0.00	0	44	257
MTN	-1.99±0.29	7	0.00±0.00	0	0.00±0.00	0	98	107
MUD	-0.11±0.31	5	0.38±0.22	2	0.00±0.00	0	25	252
MUN	-0.82±0.12	15	0.82±0.14	5	0.47±0.22	2	113	126
MVIF	-0.24±0.39	3	0.00±0.00	0	0.00±0.00	0	37	243
MWC	0.57±0.28	6	0.00±0.00	0	0.00±0.00	0	73	354
MWI	0.73±0.35	6	0.29±0.13	6	0.18±0.31	1	82	301
MZF	-0.64±0.11	12	-0.08±0.10	10	0.00±0.00	0	36	250
MZO	-1.46±0.48	2	0.00±0.00	0	0.00±0.00	0	69	334
NAI	2.04±0.18	16	-0.08±0.14	14	0.00±0.00	0	75	199
NAO	-3.47±0.26	9	0.45±0.22	4	0.00±0.00	0	21	256
NAV	-1.21±0.48	3	0.00±0.00	0	0.00±0.00	0	66	322
NBO	0.00±0.00	0	-0.14±0.31	1	0.00±0.00	0	20	256
NB2	-3.45±0.23	11	0.53±0.11	9	0.00±0.00	0	20	256
NC3	-1.01±9.99	2	0.00±0.00	0	0.00±0.00	0	20	256
NDF	1.80±1.12	3	0.00±0.00	0	0.00±0.00	0	116	64
NDI	0.54±0.13	26	0.18±0.10	16	-0.63±0.25	2	46	152
NEC	-0.54±0.48	2	0.00±0.00	0	0.00±0.00	0	34	246
NEL	0.82±0.48	2	0.00±0.00	0	0.00±0.00	0	71	351
NEW	-0.14±0.12	24	-0.11±0.08	16	0.44±0.30	2	59	354
NHB	-0.52±0.48	2	0.00±0.00	0	0.00±0.00	0	63	320
NIA	0.94±1.10	2	0.00±0.00	0	0.00±0.00	0	124	77
NIE	0.35±0.13	25	0.21±0.13	12	-0.48±0.31	1	28	231
NIK	-1.40±0.29	6	0.00±0.00	0	0.00±0.00	0	50	33
NIL	0.39±0.40	4	0.00±0.00	0	0.00±0.00	0	41	157
NJ2	-0.22±0.32	5	0.00±0.00	0	0.00±0.00	0	52	105
NKM	0.04±0.34	4	0.00±0.00	0	0.00±0.00	0	48	253
NKY	-0.04±0.48	2	0.00±0.00	0	0.00±0.00	0	35	229
NLG	-1.75±0.40	3	0.00±0.00	0	0.00±0.00	0	58	152
NNT	-0.44±0.40	6	0.00±0.00	0	0.00±0.00	0	66	131
NOH	0.82±0.48	2	0.00±0.00	0	0.00±0.00	0	44	205
NOR	-1.77±0.28	7	0.00±0.00	0	0.00±0.00	0	16	330
NOU	1.04±0.15	14	0.00±0.00	0	0.00±0.00	0	117	76
NOV	-0.99±0.39	4	0.00±0.00	0	0.00±0.00	0	40	232
NPA	0.91±0.35	4	0.00±0.00	0	0.00±0.00	0	89	195
NPL	0.63±0.39	3	0.00±0.00	0	0.00±0.00	0	38	234
NPS	-2.36±0.33	8	0.00±0.00	0	0.00±0.00	0	41	218
NRAO	-2.71±0.40	3	0.00±0.00	0	0.00±0.00	0	20	255
NRI	-3.63±0.50	3	0.00±0.00	0	0.00±0.00	0	11	94
NRR	0.58±0.48	2	0.00±0.00	0	0.00±0.00	0	67	356
NSS	-5.42±0.48	2	0.00±0.00	0	0.00±0.00	0	17	262
NST	-0.63±0.32	5	0.00±0.00	0	0.00±0.00	0	63	130
NTI	-0.01±0.26	7	0.00±0.00	0	0.00±0.00	0	58	354
NUE	1.82±1.55	2	0.00±0.00	0	0.00±0.00	0	120	51
NUR	-6.53±0.11	31	0.00±0.00	0	0.00±0.00	0	17	237
NWAO	-0.87±0.59	7	0.00±0.00	0	0.00±0.00	0	114	125
NYC	-0.23±0.48	2	0.00±0.00	0	0.00±0.00	0	70	352
NYM	-0.15±0.48	2	0.00±0.00	0	0.00±0.00	0	69	352
NYR	-0.07±0.48	2	0.00±0.00	0	0.00±0.00	0	70	352
OBN	-4.18±0.48	3	0.00±0.00	0	0.00±0.00	0	20	212
OBO	0.48±0.31	5	0.00±0.00	0	0.00±0.00	0	62	193
OCO	-0.64±0.31	5	0.00±0.00	0	0.00±0.00	0	70	336
ODB	0.29±9.99	4	0.00±0.00	0	0.00±0.00	0	30	220
ODD1	0.33±0.49	2	0.00±0.00	0	0.00±0.00	0	23	259
OFD	-0.77±0.48	2	0.00±0.00	0	0.00±0.00	0	45	246
OGA	0.83±0.10	14	0.05±0.12	7	0.00±0.00	0	33	241
OGE	-0.46±0.48	2	0.00±0.00	0	0.00±0.00	0	39	251
OHR	-0.69±0.13	14	0.00±0.00	0	0.00±0.00	0	36	226
OIC	-0.25±0.27	11	-0.46±0.12	7	-0.17±0.22	3	55	88
OII	-1.44±0.40	3	0.00±0.00	0	0.00±0.00	0	40	231
OIS	-0.69±0.32	5	-0.20±0.22	2	0.00±0.00	0	55	88
OJEN	1.86±0.39	3	0.00±0.00	0	0.00±0.00	0	47	253
OLC	0.31±0.48	2	0.00±0.00	0	0.00±0.00	0	69	358
OLY	-1.04±0.39	3	0.00±0.00	0	0.00±0.00	0	69	331
OPA	0.76±0.34	4	0.00±0.00	0	0.00±0.00	0	83	31
ORI	0.95±0.25	8	0.00±0.00	0	0.00±0.00	0	38	231
ORO	-0.58±0.30	6	0.00±0.00	0	0.00±0.00	0	35	244
ORT	-1.07±0.11	15	0.00±0.00	0	0.00±0.00	0	68	325
ORV	-0.92±0.12	14	0.00±0.00	0	0.00±0.00	0	67	357
ORX	-0.91±0.48	2	0.00±0.00	0	0.00±0.00	0	35	244
OSS	0.55±0.30	5	0.00±0.00	0	0.00±0.00	0	33	242

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
OTT	-1.12±0.10	24	0.14±0.07	22	-0.08±0.17	4	57	320
OUA	0.05±1.10	3	0.00±0.00	0	0.00±0.00	0	116	75
OUL	-7.12±0.34	4	0.00±0.00	0	0.00±0.00	0	13	246
OVO	0.48±0.30	5	0.00±0.00	0	0.00±0.00	0	38	234
OXM	-0.96±9.99	2	0.00±0.00	0	0.00±0.00	0	86	336
OYM	-1.07±0.13	12	0.00±0.00	0	0.00±0.00	0	55	84
PAD	-0.58±0.39	3	0.00±0.00	0	0.00±0.00	0	34	239
PAE	1.43±0.60	7	-0.10±0.23	2	0.16±0.31	1	123	28
PAIG	-0.06±0.48	2	0.00±0.00	0	0.00±0.00	0	37	221
PAL	-1.38±9.99	2	0.00±0.00	0	0.00±0.00	0	61	317
PAS	0.10±0.15	16	0.00±0.00	0	0.00±0.00	0	73	354
PBA	1.03±9.99	2	0.00±0.00	0	0.00±0.00	0	65	139
PBJ	-1.66±9.99	3	0.00±0.00	0	0.00±0.00	0	88	332
PCA	1.23±0.39	3	0.00±0.00	0	0.00±0.00	0	46	10
PCC	0.00±0.35	4	0.00±0.00	0	0.00±0.00	0	69	358
PCI	2.29±9.99	2	-1.72±0.41	1	0.00±0.00	0	84	114
PCN	0.94±0.39	3	0.00±0.00	0	0.00±0.00	0	35	241
PCO	-0.68±0.39	3	0.00±0.00	0	0.00±0.00	0	69	336
PCT	-0.82±0.35	6	-0.70±0.16	5	0.00±0.00	0	64	129
PDA	0.88±0.39	4	0.00±0.00	0	0.00±0.00	0	52	274
PEC	0.26±0.34	4	0.00±0.00	0	0.00±0.00	0	73	353
PEL	0.12±0.65	7	0.00±0.00	0	0.00±0.00	0	131	295
PET	-0.26±0.40	3	0.00±0.00	0	0.00±0.00	0	44	58
PGB	-0.19±9.99	2	0.00±0.00	0	0.00±0.00	0	34	222
PGC	-0.60±0.23	10	0.03±0.27	2	0.00±0.00	0	58	359
PGD	0.90±0.34	4	0.00±0.00	0	0.00±0.00	0	36	238
PGP	-1.42±0.49	3	0.00±0.00	0	0.00±0.00	0	70	109
PHC	-0.53±0.13	14	-0.35±0.17	5	0.06±0.18	3	56	2
PII	-0.20±0.48	2	0.00±0.00	0	0.00±0.00	0	36	239
PIM	-1.14±0.48	2	0.00±0.00	0	0.00±0.00	0	87	338
PJD	2.08±0.49	2	0.00±0.00	0	0.00±0.00	0	41	14
PJG	-2.03±0.40	4	0.00±0.00	0	0.00±0.00	0	77	86
PKI	0.92±0.32	5	0.61±0.19	4	0.00±0.00	0	49	143
PLAT	1.63±0.48	2	0.00±0.00	0	0.00±0.00	0	47	253
PLD	-0.77±0.34	4	0.00±0.00	0	0.00±0.00	0	34	222
PLDF	-0.66±0.34	4	0.00±0.00	0	0.00±0.00	0	36	249
PLE	0.64±0.48	2	0.00±0.00	0	0.00±0.00	0	34	228
PLG	-0.07±0.19	10	0.00±0.00	0	0.00±0.00	0	36	222
PLI	-0.54±0.48	2	0.00±0.00	0	0.00±0.00	0	40	232
PLM	0.97±0.28	6	0.00±0.00	0	0.00±0.00	0	73	353
PLP	-1.62±0.35	5	-0.06±0.23	2	0.00±0.00	0	74	106
PLV	-0.17±0.49	2	0.00±0.00	0	0.00±0.00	0	60	122
PMA	0.51±0.34	4	0.00±0.00	0	0.00±0.00	0	49	26
PME	-0.20±0.48	2	0.00±0.00	0	0.00±0.00	0	44	16
PMG	-1.51±0.14	14	0.37±0.10	9	0.23±0.18	3	100	91
PMO	1.64±0.59	7	0.02±0.23	2	-0.03±0.31	1	120	26
PMR	-0.25±0.11	23	-0.17±0.08	19	-0.05±0.18	3	44	16
PNI	-1.33±0.39	3	0.00±0.00	0	0.00±0.00	0	36	244
PNJ	-0.52±0.40	3	0.00±0.00	0	0.00±0.00	0	61	318
PNL	0.79±0.32	5	0.00±0.00	0	0.00±0.00	0	47	10
PNS	0.90±0.90	5	-0.08±0.22	2	0.00±0.00	0	115	298
PNT	-0.75±0.12	25	-0.38±0.09	14	-0.06±0.22	2	58	356
POO	-0.69±0.14	22	-0.29±0.14	6	-0.20±0.30	1	56	158
POW	-0.87±0.34	4	0.00±0.00	0	0.00±0.00	0	68	331
PPCY	-0.92±0.39	3	0.00±0.00	0	0.00±0.00	0	40	209
PPE	-0.66±0.34	4	0.00±0.00	0	0.00±0.00	0	30	220
PPI	-2.02±0.24	11	-0.29±0.25	2	0.00±0.00	0	79	133
PPN	1.27±0.63	9	-0.32±0.20	3	-0.12±0.31	1	123	28
PPR	0.54±0.27	8	0.01±0.21	5	0.00±0.00	0	73	112
PPT	1.63±0.17	11	-0.16±0.19	3	0.15±0.31	1	123	28
PRA	0.34±0.15	19	0.34±0.09	14	0.40±0.23	2	29	239
PRE	-0.41±0.26	8	-0.14±0.14	7	0.04±0.22	3	100	204
PRG	-2.61±9.99	4	0.00±0.00	0	0.00±0.00	0	36	237
PRI	1.14±0.08	27	0.00±0.00	0	0.00±0.00	0	71	356
PRK	0.07±0.14	13	0.00±0.00	0	0.00±0.00	0	37	219
PRM	-0.80±0.13	12	0.00±0.00	0	0.00±0.00	0	69	323
PRN	0.93±0.48	2	0.00±0.00	0	0.00±0.00	0	69	352
PRO	0.79±0.50	2	0.00±0.00	0	0.00±0.00	0	35	237
PRS	0.31±0.31	6	0.00±0.00	0	0.00±0.00	0	71	357
PRT	1.20±0.30	11	0.00±0.00	0	0.00±0.00	0	36	239
PRU	0.27±0.09	30	0.26±0.07	24	-0.06±0.30	1	29	239
PRY	-0.43±0.48	3	0.00±0.00	0	0.00±0.00	0	102	205
PRZ	1.29±0.45	3	0.00±0.00	0	0.00±0.00	0	33	147
PSH	0.00±0.31	6	0.00±0.00	0	0.00±0.00	0	40	159
PSI	-1.88±0.16	12	-0.28±0.23	2	0.00±0.00	0	75	134
PSN	1.18±0.31	6	0.00±0.00	0	0.00±0.00	0	32	218
PSO	1.09±0.39	4	0.00±0.00	0	0.00±0.00	0	100	311
PSZ	0.30±0.25	10	0.00±0.00	0	0.00±0.00	0	30	231
PTH	0.62±0.40	3	0.00±0.00	0	0.00±0.00	0	46	149
PTJ	0.23±0.39	3	0.00±0.00	0	0.00±0.00	0	33	235

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
PTL	0.23±0.34	5	0.00±0.00	0	0.00±0.00	0	38	221
PTN	-0.60±0.31	5	0.00±0.00	0	0.00±0.00	0	58	320
PTO	0.72±0.10	19	-0.23±0.33	1	0.00±0.00	0	44	259
PTS	0.34±0.48	2	0.00±0.00	0	0.00±0.00	0	42	234
PTT	-0.85±0.49	3	0.00±0.00	0	0.00±0.00	0	29	222
PUK	-1.55±0.50	2	0.00±0.00	0	0.00±0.00	0	35	227
PUL	-6.81±0.40	3	0.00±0.00	0	0.00±0.00	0	17	227
PVL	0.84±0.28	19	0.00±0.00	0	0.00±0.00	0	33	221
PVY	0.16±0.39	3	0.00±0.00	0	0.00±0.00	0	35	228
PWLA	-1.03±0.48	2	0.00±0.00	0	0.00±0.00	0	69	328
PYA	-1.04±0.49	2	0.00±0.00	0	0.00±0.00	0	30	197
PYM	-0.04±0.23	9	0.00±0.00	0	0.00±0.00	0	36	249
PZI	-1.85±0.48	2	0.00±0.00	0	0.00±0.00	0	41	231
PZZ	-1.43±0.48	2	0.00±0.00	0	0.00±0.00	0	36	244
QASM	0.63±0.40	3	0.00±0.00	0	0.00±0.00	0	48	194
QCP	-0.29±0.35	6	0.00±0.00	0	0.00±0.00	0	69	109
QIZ	-0.20±0.40	3	0.00±0.00	0	0.00±0.00	0	62	119
QMB	-0.32±0.31	5	0.00±0.00	0	0.00±0.00	0	30	261
QUE	1.03±0.17	14	-0.49±0.31	1	0.00±0.00	0	44	165
QUI	-3.06±9.99	5	0.00±0.00	0	0.00±0.00	0	102	312
QZH	-1.58±0.40	3	0.00±0.00	0	0.00±0.00	0	59	108
QZO	-0.91±0.48	2	0.00±0.00	0	0.00±0.00	0	71	337
RAB	-1.37±0.35	5	0.00±0.00	0	0.00±0.00	0	96	84
RAC	-0.04±0.31	7	0.00±0.00	0	0.00±0.00	0	28	234
RAM	2.09±0.68	2	0.00±0.00	0	0.00±0.00	0	36	198
RAO	0.18±1.10	2	0.00±0.00	0	0.00±0.00	0	128	62
RAR	0.35±0.57	8	0.00±0.00	0	0.00±0.00	0	124	40
RBA	-0.74±0.31	5	0.00±0.00	0	0.00±0.00	0	50	254
RBL	0.32±0.39	3	0.00±0.00	0	0.00±0.00	0	33	238
RBZ	-0.60±0.34	5	0.00±0.00	0	0.00±0.00	0	50	254
RCI	-1.37±0.40	5	0.00±0.00	0	0.00±0.00	0	40	231
RDP	0.42±0.34	5	0.00±0.00	0	0.00±0.00	0	37	236
RES	-1.12±0.15	19	-0.54±0.08	14	-0.31±0.22	2	31	345
REY	1.29±0.24	12	0.00±0.00	0	0.00±0.00	0	27	291
RGS	-5.36±0.48	2	0.00±0.00	0	0.00±0.00	0	19	260
RHO	2.29±0.48	3	0.00±0.00	0	0.00±0.00	0	39	215
RHP	-0.05±1.55	4	0.00±0.00	0	0.00±0.00	0	139	82
RIV	0.30±0.56	8	0.51±0.12	7	0.24±0.31	1	124	95
RJF	-0.66±0.09	18	0.03±0.08	15	0.00±0.00	0	37	251
RKG	-0.90±0.90	3	0.00±0.00	0	0.00±0.00	0	115	126
RKT	1.05±0.69	5	0.00±0.00	0	0.00±0.00	0	129	12
RLO	-1.46±0.24	8	0.00±0.00	0	0.00±0.00	0	69	334
RMP	0.08±0.12	22	0.00±0.00	0	0.00±0.00	0	37	236
RMQ	0.23±1.09	3	0.00±0.00	0	0.00±0.00	0	116	94
RMU	0.07±0.40	3	0.00±0.00	0	0.00±0.00	0	69	348
RMW	-0.70±0.35	4	0.00±0.00	0	0.00±0.00	0	59	357
ROB	-1.11±0.13	10	0.00±0.00	0	0.00±0.00	0	36	243
ROC	0.24±0.51	2	0.00±0.00	0	0.00±0.00	0	59	321
ROF	-0.36±0.39	3	0.00±0.00	0	0.00±0.00	0	33	246
ROI	1.16±0.40	3	0.00±0.00	0	0.00±0.00	0	38	230
ROL	-0.26±0.48	3	-0.30±0.30	1	0.00±0.00	0	67	332
ROM	1.47±9.99	2	0.00±0.00	0	0.00±0.00	0	37	236
RRL	0.45±0.48	2	0.00±0.00	0	0.00±0.00	0	36	244
RRO	-1.85±0.61	2	0.00±0.00	0	0.00±0.00	0	70	337
RSCP	-1.99±0.34	4	0.00±0.00	0	0.00±0.00	0	68	326
RSL	-0.25±0.26	9	0.00±0.00	0	0.00±0.00	0	35	245
RSM	0.39±0.48	3	0.00±0.00	0	0.00±0.00	0	35	237
RSNT	-0.59±0.39	3	0.00±0.00	0	0.00±0.00	0	44	353
RSNY	-0.81±0.34	5	0.06±0.31	1	0.00±0.00	0	57	319
RSON	-0.69±0.34	5	0.21±0.22	2	0.00±0.00	0	54	336
RSP	-0.77±0.48	2	0.00±0.00	0	0.00±0.00	0	35	244
RSSD	-0.49±0.35	4	0.22±0.31	1	0.00±0.00	0	62	343
RUV	1.51±0.71	5	-0.04±0.24	2	0.00±0.00	0	120	25
RVR	-0.02±0.32	5	0.00±0.00	0	0.00±0.00	0	73	353
RXF	-0.44±0.26	7	0.00±0.00	0	0.00±0.00	0	58	352
RYD	0.31±0.34	4	0.00±0.00	0	0.00±0.00	0	49	190
RZN	0.31±0.48	2	0.00±0.00	0	0.00±0.00	0	35	221
SAC	0.28±0.48	2	0.00±0.00	0	0.00±0.00	0	69	358
SAL	-0.46±0.12	13	0.00±0.00	0	0.00±0.00	0	34	241
SALJ	0.48±0.48	2	0.00±0.00	0	0.00±0.00	0	43	205
SAM	0.43±0.49	3	0.00±0.00	0	0.00±0.00	0	34	163
SAN	0.36±0.71	8	0.00±0.00	0	0.00±0.00	0	132	294
SAO	0.17±0.09	20	0.00±0.00	0	0.00±0.00	0	70	357
SAOF	-1.04±0.39	3	0.00±0.00	0	0.00±0.00	0	36	243
SAP	-1.27±0.35	4	0.00±0.00	0	0.00±0.00	0	48	78
SAR	1.39±0.67	2	0.00±0.00	0	0.00±0.00	0	34	230
SAV	0.71±0.19	15	0.00±0.00	0	0.00±0.00	0	130	102
SAX	0.23±0.26	7	-0.17±0.16	4	0.00±0.00	0	33	243
SBA	-2.07±0.13	22	0.00±0.00	0	0.00±0.00	0	163	137
SBB	0.38±0.26	7	0.00±0.00	0	0.00±0.00	0	72	354

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
SBF	-0.57±0.34	4	0.00±0.00	0	0.00±0.00	0	37	243
SCB	-0.56±9.99	2	0.00±0.00	0	0.00±0.00	0	59	323
SCG	1.19±0.39	3	0.00±0.00	0	0.00±0.00	0	82	300
SCH	-1.05±0.12	22	-0.16±0.09	16	0.08±0.22	2	46	317
SCM	0.48±0.49	2	0.00±0.00	0	0.00±0.00	0	44	15
SCO	1.51±0.32	7	-0.23±0.14	5	0.00±0.00	0	22	301
SCP	-0.01±0.48	2	0.00±0.00	0	0.00±0.00	0	62	321
SDB	-0.04±0.24	8	0.00±0.00	0	0.00±0.00	0	92	220
SDI	-0.24±0.30	5	0.00±0.00	0	0.00±0.00	0	37	234
SDN	-0.88±0.35	4	0.00±0.00	0	0.00±0.00	0	49	26
SDV	1.08±0.16	10	0.12±0.22	3	0.00±0.00	0	91	307
SEA	0.65±0.56	2	0.00±0.00	0	0.00±0.00	0	59	358
SEO	0.63±9.99	3	0.00±0.00	0	0.00±0.00	0	49	94
SES	-1.25±0.12	20	-0.45±0.18	4	0.00±0.00	0	56	349
SET	0.05±0.39	3	0.00±0.00	0	0.00±0.00	0	44	242
SFA	-1.03±0.24	8	-0.12±0.18	3	-0.26±0.26	2	54	317
SFF	0.69±1.55	2	0.00±0.00	0	0.00±0.00	0	129	103
SFI	0.69±0.39	3	0.00±0.00	0	0.00±0.00	0	35	238
SFS	1.15±0.48	2	0.00±0.00	0	0.00±0.00	0	47	254
SGG	0.53±0.48	2	0.00±0.00	0	0.00±0.00	0	37	234
SGH	0.41±0.35	4	0.00±0.00	0	0.00±0.00	0	62	193
SGO	0.31±0.24	8	0.00±0.00	0	0.00±0.00	0	38	232
SGR	-1.04±0.28	6	0.00±0.00	0	0.00±0.00	0	35	255
SGS	-0.24±0.48	2	0.00±0.00	0	0.00±0.00	0	70	321
SHBJ	0.76±0.48	2	0.00±0.00	0	0.00±0.00	0	42	202
SHD	1.38±0.27	7	0.00±0.00	0	0.00±0.00	0	37	180
SHGH	-0.85±0.48	2	0.00±0.00	0	0.00±0.00	0	75	238
SHI	1.29±0.12	19	0.00±0.00	0	0.00±0.00	0	44	183
SHK	-2.44±0.16	14	-0.66±0.12	7	-0.26±0.22	3	54	90
SHL	-0.27±0.13	22	-0.07±0.22	2	0.00±0.00	0	52	136
SHW	0.76±0.49	2	0.00±0.00	0	0.00±0.00	0	61	358
SIC	-1.31±0.39	3	0.00±0.00	0	0.00±0.00	0	51	315
SID	1.62±0.34	5	0.00±0.00	0	0.00±0.00	0	26	288
SIO	-0.67±0.24	8	0.00±0.00	0	0.00±0.00	0	69	335
SIT	0.85±0.10	23	-0.39±0.33	1	0.00±0.00	0	50	7
SJG	0.19±0.17	12	-0.48±0.13	6	-0.39±0.22	2	81	305
SKA	-6.09±0.40	3	0.00±0.00	0	0.00±0.00	0	18	259
SKI	0.14±0.27	7	0.01±0.16	4	0.21±0.22	2	81	301
SKO	-0.79±0.10	23	-0.08±0.23	2	0.00±0.00	0	35	225
SLC	-0.58±0.26	7	0.00±0.00	0	0.00±0.00	0	66	349
SLD	0.86±0.28	6	0.00±0.00	0	0.00±0.00	0	70	357
SLE	-0.68±0.24	8	0.07±0.18	4	0.00±0.00	0	33	244
SLL	-3.61±0.39	3	0.00±0.00	0	0.00±0.00	0	20	252
SLY	0.94±0.48	2	0.00±0.00	0	0.00±0.00	0	38	193
SMF	-1.08±0.08	16	0.08±0.09	13	0.00±0.00	0	35	249
SMY	-0.79±0.29	7	0.00±0.00	0	0.00±0.00	0	48	46
SNA	-3.05±0.15	15	-0.14±0.30	1	0.00±0.00	0	148	213
SNF	-0.89±0.34	4	0.00±0.00	0	0.00±0.00	0	31	251
SNG	-0.27±0.15	14	0.00±0.00	0	0.00±0.00	0	71	131
SNY	-0.08±0.35	4	0.00±0.00	0	0.00±0.00	0	44	95
SOBI	-1.64±9.99	3	0.00±0.00	0	0.00±0.00	0	100	273
SOD	-5.89±0.11	31	0.00±0.00	0	0.00±0.00	0	11	252
SOF	0.38±0.26	9	0.00±0.00	0	0.00±0.00	0	34	224
SOH	-0.21±0.48	2	0.00±0.00	0	0.00±0.00	0	36	222
SOI	-0.99±0.48	2	0.00±0.00	0	0.00±0.00	0	40	230
SOP	0.38±0.25	14	0.07±0.31	1	-1.12±0.32	1	31	235
SPA	-2.14±0.15	22	-0.05±0.09	15	0.25±0.22	2	163	180
SPC	0.26±0.23	15	0.00±0.00	0	0.00±0.00	0	29	231
SPF	-0.53±0.13	11	0.07±0.13	6	0.00±0.00	0	37	244
SRI	0.89±0.29	6	0.00±0.00	0	0.00±0.00	0	37	188
SRN	-0.13±0.49	2	0.00±0.00	0	0.00±0.00	0	37	226
SRO	0.10±0.20	19	0.00±0.00	0	0.00±0.00	0	30	233
SRQ	0.99±0.48	2	0.00±0.00	0	0.00±0.00	0	47	253
SRS	-0.26±0.48	2	0.00±0.00	0	0.00±0.00	0	36	223
SRY	-1.12±0.16	14	0.00±0.00	0	0.00±0.00	0	55	84
SSB	-0.45±0.24	9	0.00±0.00	0	0.00±0.00	0	36	248
SSC	-1.07±0.10	20	-0.06±0.10	11	-0.04±0.31	1	34	255
SSE	-1.16±0.26	9	-0.73±0.18	4	0.00±0.00	0	54	103
SSF	-0.96±0.08	27	0.34±0.08	17	0.00±0.00	0	35	250
SSR	0.12±0.24	10	0.00±0.00	0	0.00±0.00	0	32	227
STB	-0.74±0.39	3	0.00±0.00	0	0.00±0.00	0	31	249
STC	0.95±0.34	4	0.00±0.00	0	0.00±0.00	0	70	357
STJ	-1.02±0.16	15	-0.43±0.19	3	0.00±0.00	0	50	303
STK	-0.65±0.13	15	0.00±0.00	0	0.00±0.00	0	119	103
STR	0.23±0.12	17	0.00±0.00	0	0.00±0.00	0	32	246
STS	0.71±0.28	9	0.00±0.00	0	0.00±0.00	0	42	260
STU	-0.48±0.11	23	0.00±0.08	17	0.51±0.18	3	32	244
STV	-2.21±0.33	5	0.00±0.00	0	0.00±0.00	0	36	243
SUD	-1.13±0.39	3	0.18±0.22	2	0.00±0.00	0	57	325
SUE	-0.86±0.34	4	0.00±0.00	0	0.00±0.00	0	22	263

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
SUF	-6.33±0.11	10	0.00±0.00	0	0.00±0.00	0	15	239
SVE	-4.98±0.50	3	0.00±0.00	0	0.00±0.00	0	17	169
SVT	1.32±0.45	5	-0.05±0.18	5	0.76±0.22	3	85	299
SVV	1.07±0.48	2	0.00±0.00	0	0.00±0.00	0	85	299
SVW	1.29±0.24	9	0.00±0.00	0	0.00±0.00	0	44	21
SYO	-4.42±0.15	15	0.00±0.00	0	0.00±0.00	0	142	189
SYP	0.82±0.39	3	0.00±0.00	0	0.00±0.00	0	72	356
TAB	1.63±0.14	22	0.00±0.00	0	0.00±0.00	0	36	192
TAC	1.91±0.36	6	0.00±0.00	0	0.00±0.00	0	86	336
TAF	0.12±0.25	11	0.00±0.00	0	0.00±0.00	0	48	249
TAM	-0.32±0.34	10	0.00±0.00	0	0.00±0.00	0	57	237
TAN	-0.24±0.28	7	0.12±0.19	3	0.00±0.00	0	92	187
TAS	-0.04±0.40	3	0.00±0.00	0	0.00±0.00	0	33	160
TAU	0.15±0.13	24	0.00±0.00	0	0.00±0.00	0	131	103
TBR	-0.45±0.34	4	0.00±0.00	0	0.00±0.00	0	61	318
TBT	-0.07±9.99	2	0.00±0.00	0	0.00±0.00	0	58	262
TBY	-2.22±0.48	2	0.00±0.00	0	0.00±0.00	0	21	252
TBZ	-0.13±0.46	4	0.00±0.00	0	0.00±0.00	0	33	201
TCE	0.99±0.48	2	0.00±0.00	0	0.00±0.00	0	87	298
TCF	-0.65±0.08	25	0.05±0.08	16	0.00±0.00	0	36	250
TDD	0.25±0.48	2	0.00±0.00	0	0.00±0.00	0	62	193
TDJ	-0.40±0.48	2	0.00±0.00	0	0.00±0.00	0	62	193
TDS	0.88±0.39	3	0.00±0.00	0	0.00±0.00	0	38	231
TEC	0.85±0.50	2	0.00±0.00	0	0.00±0.00	0	47	248
TEH	2.08±0.18	21	0.00±0.00	0	0.00±0.00	0	38	185
TEN	0.40±0.39	4	0.00±0.00	0	0.00±0.00	0	58	261
TET	0.39±0.19	12	0.00±0.00	0	0.00±0.00	0	90	201
TFO	1.23±0.28	6	-0.34±0.16	5	0.00±0.00	0	72	348
TGI	1.57±0.25	8	0.00±0.00	0	0.00±0.00	0	40	175
THT	-2.58±9.99	2	0.00±0.00	0	0.00±0.00	0	123	28
TIA	0.69±0.32	5	0.00±0.00	0	0.00±0.00	0	48	105
TIC	-1.05±0.34	4	0.00±0.00	0	0.00±0.00	0	75	243
TIK	-0.31±0.49	2	0.00±0.00	0	0.00±0.00	0	21	58
TIM	1.20±0.33	6	0.00±0.00	0	0.00±0.00	0	32	228
TIO	0.56±0.18	10	0.00±0.00	0	0.00±0.00	0	53	253
TIR	-0.29±0.16	15	0.00±0.00	0	0.00±0.00	0	36	227
TIY	1.17±0.35	4	0.00±0.00	0	0.00±0.00	0	45	109
TJC	-0.52±0.31	5	0.00±0.00	0	0.00±0.00	0	69	343
TKL	-1.02±0.26	7	0.00±0.00	0	0.00±0.00	0	68	324
TLB	-0.81±0.28	8	0.00±0.00	0	0.00±0.00	0	31	218
TLG	0.36±0.41	3	0.00±0.00	0	0.00±0.00	0	32	148
TLL	0.68±0.88	5	0.00±0.00	0	0.00±0.00	0	129	296
TLS	0.20±0.51	3	0.00±0.00	0	0.00±0.00	0	96	87
TMA	-0.31±0.26	7	-0.01±0.15	5	0.00±0.00	0	34	243
TMT	-0.04±0.39	3	-0.07±0.22	2	0.00±0.00	0	60	317
TNG	-2.85±0.43	3	0.00±0.00	0	0.00±0.00	0	86	129
TNN	2.17±0.49	2	0.00±0.00	0	0.00±0.00	0	40	17
TNO	-0.09±0.52	2	0.00±0.00	0	0.00±0.00	0	36	244
TNP	0.03±0.19	11	0.00±0.00	0	0.00±0.00	0	69	353
TNR	-0.46±9.99	2	0.00±0.00	0	0.00±0.00	0	31	224
TNS	-0.03±0.12	14	0.00±0.00	0	0.00±0.00	0	30	246
TOA	1.30±0.23	9	0.00±0.00	0	0.00±0.00	0	44	14
TOL	0.64±0.12	23	0.61±0.12	19	0.18±0.15	4	43	253
TOO	0.10±0.11	25	0.48±0.14	7	0.00±0.00	0	126	102
TOUF	-0.36±0.40	3	0.00±0.00	0	0.00±0.00	0	37	243
TOV	1.63±0.28	6	-0.04±0.34	1	0.00±0.00	0	90	306
TPC	1.09±0.31	5	0.00±0.00	0	0.00±0.00	0	73	352
TPH	0.02±0.48	2	0.00±0.00	0	0.00±0.00	0	69	353
TPM	-1.48±0.48	4	0.00±0.00	0	0.00±0.00	0	86	336
TPP	2.44±0.34	4	0.00±0.00	0	0.00±0.00	0	87	298
TPT	1.65±0.52	9	0.00±0.19	3	0.19±0.31	1	120	26
TRD	0.62±0.68	2	0.00±0.00	0	0.00±0.00	0	66	156
TRI	-0.40±0.11	22	0.00±0.00	0	0.00±0.00	0	33	237
TRM	-0.64±0.48	2	0.00±0.00	0	0.00±0.00	0	57	315
TRN	1.48±0.10	19	0.23±0.08	15	0.19±0.15	4	87	298
TRO	-5.53±0.12	23	0.00±0.00	0	0.00±0.00	0	12	270
TRR	0.55±0.70	7	0.00±0.00	0	0.00±0.00	0	130	103
TRT	-1.29±0.34	4	0.10±0.20	3	0.00±0.00	0	89	123
TRZ	-0.10±1.10	2	0.00±0.00	0	0.00±0.00	0	136	73
TSK	-1.59±0.15	18	-0.48±0.14	8	0.00±0.00	0	54	83
TTA	1.10±0.23	9	0.00±0.00	0	0.00±0.00	0	42	20
TTG	-0.41±0.29	6	0.00±0.00	0	0.00±0.00	0	35	228
TTN	2.32±0.51	5	0.00±0.00	0	0.00±0.00	0	62	106
TUC	1.15±0.10	21	-0.32±0.09	13	-0.04±0.30	1	74	348
TUL	-0.83±0.09	28	0.09±0.07	22	0.02±0.16	4	69	335
TUM	0.34±0.35	4	0.00±0.00	0	0.00±0.00	0	60	358
TVO	1.95±0.60	7	0.09±0.24	2	0.00±0.00	0	123	28
UAV	1.51±0.39	6	-0.12±0.23	2	0.12±0.31	2	92	307
UBO	0.00±0.28	7	-0.18±0.13	6	0.00±0.00	0	66	347
UCC	-0.41±0.13	23	0.00±0.00	0	0.00±0.00	0	31	251

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
UCT	-0.16±0.30	5	-0.25±0.16	4	0.00±0.00	0	60	316
UDD	-3.66±0.48	3	0.00±0.00	0	0.00±0.00	0	20	251
UDI	-0.31±0.40	4	0.00±0.00	0	0.00±0.00	0	33	238
UER	0.29±0.49	2	0.00±0.00	0	0.00±0.00	0	27	121
UKI	0.88±0.34	4	0.00±0.00	0	0.00±0.00	0	68	359
UKR	-0.25±0.41	3	0.00±0.00	0	0.00±0.00	0	26	134
ULC	-0.70±0.48	2	0.00±0.00	0	0.00±0.00	0	36	228
UME	-7.18±0.11	27	0.00±0.00	0	0.00±0.00	0	16	251
UNM	0.94±0.32	5	0.00±0.00	0	0.00±0.00	0	86	336
UPP	-3.70±0.11	31	0.00±0.00	0	0.00±0.00	0	19	246
URS	-0.12±0.50	2	0.00±0.00	0	0.00±0.00	0	55	90
UZH	-0.94±0.39	3	0.00±0.00	0	0.00±0.00	0	29	228
VAG	-0.52±0.39	3	0.00±0.00	0	0.00±0.00	0	38	222
VAH	1.54±0.64	7	-0.20±0.23	2	0.00±0.31	1	120	26
VAI	-0.45±0.30	5	0.00±0.00	0	0.00±0.00	0	34	243
VAL	-0.44±0.11	23	0.31±0.08	21	0.08±0.16	4	34	268
VAM	-2.32±0.16	14	0.00±0.00	0	0.00±0.00	0	41	219
VAN	0.29±0.54	2	0.00±0.00	0	0.00±0.00	0	36	176
VAR	-1.12±0.21	12	0.00±0.00	0	0.00±0.00	0	50	146
VAY	-0.65±0.13	14	0.00±0.00	0	0.00±0.00	0	36	224
VBY	0.10±0.34	4	0.00±0.00	0	0.00±0.00	0	33	235
VDL	0.81±0.26	7	0.43±0.18	3	0.00±0.00	0	34	242
VFI	-0.21±0.39	3	0.00±0.00	0	0.00±0.00	0	38	223
VGB	-0.14±0.39	3	0.00±0.00	0	0.00±0.00	0	61	356
VGL	0.14±0.48	2	0.00±0.00	0	0.00±0.00	0	37	223
VGI	0.72±0.39	3	0.00±0.00	0	0.00±0.00	0	35	242
VHM	1.76±0.46	4	0.00±0.00	0	0.00±0.00	0	88	333
VIC	-1.03±0.29	9	-0.53±0.31	1	0.17±0.31	1	58	359
VIE	0.18±0.13	19	0.12±0.12	8	-0.14±0.22	2	30	236
VIS	-1.08±0.49	2	0.00±0.00	0	0.00±0.00	0	58	148
VITF	-0.16±0.34	4	0.00±0.00	0	0.00±0.00	0	33	248
VKA	0.14±0.10	25	0.29±0.16	4	0.00±0.00	0	30	235
VLS	-0.30±0.13	18	0.00±0.00	0	0.00±0.00	0	39	225
VMA	0.19±0.39	3	0.00±0.00	0	0.00±0.00	0	38	222
VNE	0.01±0.39	3	0.00±0.00	0	0.00±0.00	0	37	222
VOU	-0.42±0.28	6	0.00±0.00	0	0.00±0.00	0	35	247
VOY	-0.16±0.34	4	0.00±0.00	0	0.00±0.00	0	33	237
VPA	-0.32±0.39	3	0.00±0.00	0	0.00±0.00	0	38	223
VPL	-0.63±0.34	4	0.00±0.00	0	0.00±0.00	0	40	232
VRI	-0.52±0.17	22	0.00±0.00	0	0.00±0.00	0	30	221
VSI	0.23±0.39	3	0.00±0.00	0	0.00±0.00	0	38	222
VSK	-0.01±0.39	3	0.00±0.00	0	0.00±0.00	0	38	222
VTH	-0.39±0.39	3	0.00±0.00	0	0.00±0.00	0	38	222
VTS	-0.99±0.31	5	0.00±0.00	0	0.00±0.00	0	34	224
VVI	-0.29±0.39	3	0.00±0.00	0	0.00±0.00	0	33	239
VVO	-0.60±0.39	3	0.00±0.00	0	0.00±0.00	0	70	335
WAB	-0.37±0.27	8	0.00±0.00	0	0.00±0.00	0	95	93
WAM	0.58±0.13	10	0.00±0.00	0	0.00±0.00	0	125	98
WAR	1.09±0.44	7	0.00±0.00	0	0.00±0.00	0	26	233
WCN	0.46±0.39	3	0.00±0.00	0	0.00±0.00	0	68	356
WDC	-0.80±0.09	21	0.00±0.00	0	0.00±0.00	0	66	358
WEL	-1.22±0.61	11	0.00±0.00	0	0.00±0.00	0	137	76
WES	-0.50±0.13	11	0.83±0.25	2	0.00±0.00	0	59	316
WET	0.24±0.12	15	-0.04±0.12	7	0.00±0.00	0	30	240
WHN	-0.34±0.39	5	0.00±0.00	0	0.00±0.00	0	52	110
WIN	0.29±0.28	7	-0.06±0.20	5	0.22±0.22	3	99	215
WIT	0.32±0.11	25	0.00±0.00	0	0.00±0.00	0	29	251
WKR	0.73±0.48	2	0.00±0.00	0	0.00±0.00	0	71	356
WKU	-0.12±0.41	3	0.00±0.00	0	0.00±0.00	0	55	88
WLF	-0.26±0.39	4	0.00±0.00	0	0.00±0.00	0	32	249
WLS	-0.21±0.08	17	0.00±0.00	0	0.00±0.00	0	32	246
WMO	-0.10±0.40	3	-0.15±0.19	3	0.00±0.00	0	71	337
WMQ	0.67±0.32	5	0.00±0.00	0	0.00±0.00	0	33	134
WOL	-0.88±0.15	10	0.30±0.12	7	0.00±0.00	0	32	258
WRM	1.70±0.50	2	0.00±0.00	0	0.00±0.00	0	32	250
WRS	-0.32±0.29	7	0.00±0.00	0	0.00±0.00	0	40	159
WSC	-0.61±0.31	5	0.00±0.00	0	0.00±0.00	0	63	320
WTS	-0.06±0.11	15	0.57±0.12	7	0.00±0.00	0	29	250
WTZ	-1.75±0.67	8	0.00±0.00	0	0.00±0.00	0	135	72
XAN	0.44±0.35	4	0.00±0.00	0	0.00±0.00	0	48	115
YAK	-2.36±9.99	2	0.00±0.00	0	0.00±0.00	0	28	73
YER	0.77±0.19	12	0.00±0.00	0	0.00±0.00	0	39	215
YKA	0.24±0.14	17	0.00±0.00	0	0.00±0.00	0	44	353
YKC	-0.75±0.12	22	-0.56±0.09	13	-0.49±0.22	2	44	353
YKM	-0.39±0.28	6	0.00±0.00	0	0.00±0.00	0	58	353
YLV	-0.52±0.35	4	0.00±0.00	0	0.00±0.00	0	35	215
YOU	-0.04±0.09	13	0.00±0.00	0	0.00±0.00	0	123	98
YRH	0.00±0.00	0	-0.05±0.33	1	0.00±0.00	0	32	263
YSS	0.56±0.40	3	0.00±0.00	0	0.00±0.00	0	45	75
YYI	0.84±0.43	3	0.00±0.00	0	0.00±0.00	0	51	133

Station time and magnitude effects with 95% confidence limits

Station	Time term(s)	N_T^*	N Nov Zemlya amp. term	N_1^*	S Nov Zemlya amp. term	N_2^*	Δ°	φ°
ZAG	0.35±0.18	15	0.00±0.00	0	0.00±0.00	0	33	235
ZAK	0.90±0.41	3	0.00±0.00	0	0.00±0.00	0	31	111
ZGN	-0.44±0.48	2	0.00±0.00	0	0.00±0.00	0	43	236
ZLA	-0.37±0.34	4	0.14±0.19	3	0.00±0.00	0	33	244
ZLP	1.26±1.13	2	-0.29±0.32	1	0.00±0.00	0	115	297
ZOBO	0.73±0.16	10	-0.25±0.21	3	0.00±0.00	0	115	297
ZST	0.38±0.16	14	0.00±0.00	0	0.00±0.00	0	30	234
ZUL	-0.82±0.12	15	-0.32±0.10	14	-0.01±0.31	1	33	245

* 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.

Available from

HER MAJESTY'S STATIONERY OFFICE

49 High Holborn, London W.C.1
71 Lothian Road, Edinburgh EH3 9AZ
9-12 Princess Street, Manchester M60 8AS
Southey House, Wine Street, Bristol BS1 2BQ
258 Broad Street, Birmingham B1 2HE
80 Chichester Street, Belfast BT1 4JY
or through a bookseller.

ISBN-0-85518205-9

Printed in England