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IMPROVED BODY-WAVE MAGNITUDES OF ALEUTIAN EARTHQUAKES

ARTHUR C. TARR

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Survey

ROCKVILLE, MD. 20852

Prepared for
The U.S. Atomic Energy Commission
Nevada Operations Office
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ABSTRACT

Uncertainties in routine PDE m_b estimates of Aleutian earthquake magnitudes often reflect the effects of station-source region biases and station detection-threshold magnitudes. Examination of magnitude data from aftershocks of the February 27, 1970, Aleutian Trench earthquake indicates that magnitudes of small aftershocks were consistently underestimated, since these events were observed primarily by Western United States stations having negative biases. The same general pattern is observed elsewhere in the Aleutian arc. Quantitative estimates of the station-source region biases using over five years of short-period P amplitude data confirm these observations. Correction for the station-source region bias significantly reduces the dispersion of station magnitudes about the mean and, in some cases, shifts the mean by as much as 0.3 magnitude unit.

1.0 INTRODUCTION

The importance of frequency-of-occurrence statistics and estimates of energy release for Aleutian Islands earthquakes in the vicinity of Amchitka Island requires that the estimation of earthquake magnitude be done accurately and meaningfully. Magnitude estimation is at present subject to numerous complications which often conspire to give statistically imprecise values. Amelioration of these complications is possible by special analysis and techniques which, unfortunately, are often rendered impractical whenever large amounts of data must be processed rapidly. It is the purpose of this paper to summarize the difficulties encountered in magnitude determination, to describe the problem in the particular case of Aleutian earthquakes, and to describe one relatively simple approach toward solving at least a portion of the problem.

This study demonstrates the existence of significant effects which often bias magnitude estimates, especially those events in the lower magnitude ranges which are detected by only a few sensitive stations. Quantitative estimates of magnitude bias were computed for a suite of fifty stations and twenty source regions. The data source was a massive set of over 250,000 amplitude-period observations reported routinely to NOS since July 1, 1963. Significant improvement in the accuracy of event magnitude is realized with the correction of station magnitudes by the bias estimates. The aftershock series of the February 27, 1970, Aleutian Trench earthquake is used as an example to demonstrate the nature of the station-source region biasing problem.

1.1 Notation

The following notation is employed in this paper:

A	Ground amplitude
B_{ij}	Magnitude bias function
c_{ij}	Magnitude bias estimate
e_{ijk}	Error in observation y_{ijk}
h	Depth of focus
i	Station index ($i = 1, 2, 3 \dots I$)
j	Region index ($j = 1, 2, 3 \dots J$)

k	Event index, j^{th} region ($k = 1, 2, 3 \dots K_j$)
m_b	NOS body-wave magnitude
$\bar{m}_{jk}$	Mean (uncorrected) event magnitude ($= m_b$)
m_{jk}	Unbiased (corrected) event magnitude estimate
$Q(\Delta, h)$	NOS calibration function
$\bar{r}_{ij}$	Uncorrected magnitude residual ($= y_{ijk} - \bar{m}_{jk}$)
r_{ij}	Corrected magnitude residual ($= y_{ijk} - m_{jk}$)
s	Standard deviation estimate
T	Period
y_{ijk}	Station magnitude observation
α_i	Station bias function
β_j	Region bias function
γ_{ij}	Path bias function
Δ	Epicentral distance

1.2 Conventions

$\delta_{ijk}=1$	Observation exists
$=0$	Observation does not exist
$\delta_{.jk}$	Number of stations observing jk^{th} event
$\delta_{ij.}$	Number of events in j^{th} region observed by i^{th} station

1.3 Definitions

Magnitude as used in this paper is an event parameter commonly employed to rank earthquakes by measuring ground amplitude (A) and corresponding period (T) of compressional body waves, and use of the

$$\text{Magnitude} = \log (A/T) + Q(\Delta, h) \quad (1)$$

relationship in which it is assumed that the logarithmic term is representative of the energy contained in the compressional phase. $Q(\Delta, h)$ is an empirically determined calibration function which, in principle, compensates for the effects of geometrical spreading and mean attenuation (material absorption and scattering) of the wavefront. The body-wave magnitude (m_b) as computed by the National Ocean Survey and published in Preliminary Determination of Epicenters (PDE) and Earthquake Data Reports is defined as the (uncorrected) mean of station magnitudes determined by equation (1). The values of the calibration function are those of Gutenberg and Richter (1956), and the amplitudes are those corresponding to the maximum value attained in the first few cycles of the P phase as measured on short-period vertical instruments.

The magnitude of a particular event, when corrected for focal mechanism effects, should be the same for all stations observing it. In practice, this is not the case for m_b . The magnitude residual is defined as the station magnitude minus the mean magnitude, and thus is assumed to include the effects of biases, source mechanism, errors of measurement, and errors in the calibration function.

2.0 MAGNITUDE RESIDUALS

2.1 Source of Magnitude Residuals

Magnitude residuals arise from a number of sources, principal of which are errors of observation, station-source region bias, source mechanism effects, and differential attenuation.

Errors of observation are taken here to include (assumed) random errors of scaling the amplitude and period of the chosen cycle in the P wave packet, systematic errors owing to imperfect knowledge of the magnification curve of the seismograph system, and other nonrandom errors resulting from differences in conventions for scaling the amplitude and period. The first and third of these may be minimized by standardized scaling procedures and by careful measurement techniques. The second may be reduced by a precise calibration of the instrument and by periodic checks to assure constancy of the magnification curve.

Misidentification of phase type is a related source of observational error that is particularly important for epicentral distances less than 20° . Evernden (1967) has shown the necessity for distinguishing correctly between crustal P waves traveling at differing velocities and has demonstrated significant differences between the calibration curves appropriate to the Western United States and the Eastern United States. Clearly, the effects of failure to use the correct calibration curve will be minimized only when these regional differences are understood and recognized by those scaling seismograms.

The regional calibration function problem is really part of a larger problem, namely the heterogeneity of the whole Earth, and most particularly, the upper lithosphere. Gross structure in the epicentral region, local and upper crustal conditions under a particular station, and differential attenuation in the relatively homogeneous mantle may significantly influence magnitude determinations; for convenience, this effect is called herein the station-source region bias, to distinguish it from influences owing to source mechanism. A precise mathematical model for representing station-source biases is difficult to define, particularly under a station where a large number of variable quantities (layer thickness, density, P and S velocities, for example) are involved.

The situation in the focal region is not quite so uncertain since most earthquakes occur below the very heterogeneous surface crustal layers, but source mechanism effects tend to complicate the problem. Principal of the source mechanism effects is the energy radiation pattern which describes the spatial distribution of earthquake energy

as it leaves the focus; negative magnitude residuals are expected for stations which are close to null planes. Correction for the radiation pattern requires a knowledge of the event in question, and in particular, the focal mechanism solution.

Errors in the calibration function will not be considered in this paper since the effects of such errors will be included in estimates of the station-source region biases. Eventually, refinement of $Q(\Delta, h)$ must be attempted for the sake of a representative world-average attenuation function for estimation of magnitude when corrections are not known or cannot be applied.

2.2 Magnitude Bias Function Model

One general model has been proposed to represent magnitude bias, whereby a function B_{ij} completely represents all sources of attenuation of the wavefront between source and station, not already compensated for by the $Q(\Delta, h)$ function. B_{ij} includes the effects of the radiation pattern at the focus and complexities in the source function, the crustal transfer functions of the source region (if appropriate) and the station region, and anomalous zones of high or low material absorption through which passes the bundle of rays connecting events in a particular region to a station.

It would be desirable if B_{ij} could be separated into functions which were purely characteristic of station, source, and path effects, namely,

$$B_{ij} = \alpha_i + \beta_j + \gamma_{ij} \quad (2)$$

without any interaction between functions, and which would be independent of the earthquake itself. Bolt and Freedman (1968) have proposed a components of variance determination using this model. However, for the purposes of this study, a very simple form of (2) will be assumed:

$$B_{ij} = c_{ij} \quad (3)$$

where c_{ij} is a constant for each station-source region pair. The implications of this assumption are:

1. The characteristics of each earthquake (source mechanism, source function) in the j^{th} region are similar enough that variations among events are negligible.

2. Angular dependence in the crustal transfer function and differential attenuation along the path are constant within the limits imposed by the solid angle subtended by rays passing to the station from events in the j^{th} region.

3. Frequency dependence in the source function and crustal transfer function, as well as attenuation in the deep Earth, is negligible.

2.3 Two Solutions to the Problem of Station-Source Region Bias

It has been proposed above that one component of the error in magnitude determination lies in the station-source region bias term c_{ij} . It seems reasonable that the approach to better magnitude estimates is to determine the c_{ij} and apply them uniformly to a suite of new data. Some improvement in the dispersion of magnitude estimates about the mean should be expected even without instituting strict requirements on scaling and reporting procedures.

The simplest way to estimate the c_{ij} is to accumulate the magnitude residuals in the compartments of an $I \times J$ layout and call each c_{ij} the mean of the residuals in each compartment. The difficulty with this procedure is that the mean of the residuals is contaminated by the biases of the other stations in each suite of stations reporting magnitude estimates (see Appendix I, equation A6).

A somewhat better approach is to determine simultaneously the biases and the event magnitudes, requiring that the sum of the squared residuals be minimized. The following will outline the procedure according to a hypothetical model:

$$y_{ijk} = m_{jk} + c_{ij} + e_{ijk} \quad (4)$$

where y_{ijk} , m_{jk} , c_{ij} , and e_{ijk} are the observation, event magnitude, bias, and error, respectively, in the k^{th} event in the j^{th} region observed by the i^{th} station. The errors e_{ijk} are assumed to be distributed according to a distribution of zero mean and common variance for each event.

It is necessary to make an assumption to permit a unique solution of the normal equations; it should be clear that $c_{ij} + \epsilon$ and $m_{jk} - \epsilon$ (where ϵ is a constant) also satisfy the normal equations.

$$\sum_i c_{ij} = 0 \quad (\text{all } j = 1, 2, 3 \dots J) \quad (5)$$

$$\sum_j c_{ij} = 0 \quad (\text{all } i = 1, 2, 3 \dots I) \quad (6)$$

The first possibility states that the sum of the biases for a given region averages to zero for a large number of stations, whereas the second possibility states that the sum of the biases for a given station averages to zero for a large number of source regions. Since upper crustal conditions immediately beneath a station are more likely to produce anomalous attenuation properties, the first assumption is probably more nearly correct, and (5) will be temporarily adopted here as a working assumption.

The observational equations of the form (4) may be reduced in a least-squares sense, and are cast into a matrix formulation which is developed more fully in Appendix I. Solution is done region by region, the results $c_i(j)$ ($= c_{ij}$) then applied to compute new event magnitudes m_{jk} .

The interpretation of the solutions is deferred until after the characteristics of the magnitudes of Aleutian earthquakes are discussed in the next sections.

3.0 MAGNITUDES OF ALEUTIAN EARTHQUAKES

The following characteristics are observed in the computation of station magnitudes for Aleutian earthquakes:

1. Magnitudes tend to be underestimated by Western United States stations.
2. Magnitudes tend to be overestimated by European (particularly Scandinavian) and Asian stations.
3. The detection threshold magnitude for Aleutian events is higher for Scandinavian stations than for United States stations.

The reported (mean uncorrected) magnitude estimate is, therefore, influenced by the biases (suggested by the first two items above) of each of the stations reporting magnitude data. The suite of stations reporting a particular event is controlled, in part, by the third item. Thus, it is likely, for example, that Aleutian events whose true magnitude is less than the Scandinavian threshold magnitude will have mean magnitudes which are underestimated owing to a predominance of Western United States observations in the suite of data. Estimation of the magnitude of larger events detected by Scandinavian stations should be closer to the true magnitude owing to partial cancellation of negative Western United States biases by positive Scandinavian biases.

3.1 Magnitudes of Aftershocks Following the Aleutian Trench Earthquake of February 27, 1970

It will be useful to consider a series of shallow earthquakes occurring in a small zone under the south wall of the Aleutian Trench, a relatively quiet portion of the Aleutian arc, to demonstrate the points of the preceding section. The principal (and largest) earthquake of the series was a moderately strong event ($m_b = 6.0$; $m_s = 6.2$); all succeeding members of the series are considered to be aftershocks of this main shock. The largest aftershock ($m_b = 5.4$) occurred some 20 days after the main shock and, for all practical purposes, terminated the series, since only two earthquakes (both $m_b = 4.0$) were detected by the world network of stations in the next $3\frac{1}{2}$ months.* The small

*The 24 members of the aftershock series considered here are those which had magnitude data reported in PDE. Many smaller events were detected by the Aleutian Seismic Network (Engdahl, 1970).

aftershock source region insures that the effects of errors in the calibration function and differences in ray path are minimized in the comparisons which follow.

The mean magnitude of the main shock was estimated from 41 station magnitude values. The histogram of the magnitude residuals (fig. 1) demonstrates that the distribution of residuals is severely skewed. Several features of the histogram should be noted:

1. Alaskan residuals (COL, GIL) are strongly negative. These stations are about 22 degrees distant from the epicenter.
2. Western United States stations have residuals that are either strongly negative (EUR, DUG, NEW, GOL) or moderately positive (TUC, BMO, ALQ, JCT).
3. With the exception of GEO, Eastern United States residuals are strongly positive.
4. European residuals are generally positive (some strongly so), but one station (CLL) is strongly negative.
5. All Asian stations except MUN and PMG (which are near zero) are moderately positive.
6. Stations in Canada and Greenland have a mixture of positive and negative residuals. MBC and NP-, located at practically the same site, report magnitudes differing by 0.7 magnitude unit.

Examination of the 26 magnitude residuals from the principal aftershock yields similar evidence. The histogram of these residuals (fig. 2) indicates that the distribution contains at least two separate populations. The important features of this distribution are as follows:

1. Alaskan residuals (PMR, GIL) are strongly negative.
2. All Western United States residuals are negative, some strongly so. BMO is most negative.
3. European residuals, with the exception of MOX, are moderately to strongly positive.
4. Asian stations (SHL, POO) are strongly positive.

5. The Canadian and Greenland stations are mixed. One group (FCC, FBC, GWC) is strongly positive, GDH is moderately positive, ALE is strongly negative, and both MBC and NP- are near zero.

Examination of 20 other members of the aftershock series confirms that certain characteristics are consistent with features of the two distributions described above, namely:

1. Alaskan residuals (PMR, COL, GIL) are all strongly negative.
2. Western United States range from near zero to strongly negative (BMO is always most negative) with several exceptions. EUR and DUG fluctuate from near zero to strongly positive values.
3. The Scandinavian stations KJN and NUR are consistently positive, moderately to strongly so. LOR ranges from moderately negative to near zero.
4. NP-is consistently near zero.

When the lists of stations reporting magnitude observations for each event are ranked according to the magnitude residual, the relative position of most stations remains relatively constant. The most consistent stations are KJN and NUR which usually have strongly positive residuals, and BMO which has strongly negative residuals. Other consistent stations are GIL, NP-, EUR, and EDM. Somewhat inconsistent stations are LOR, DUG, and TFO. Consistent stations with limited data are NEW, SHL, COP, and FBC.

Greatest inconsistency occurs in the comparison of relative rank of the main shock with all other members of the series, while comparison of the principal aftershock with the smaller earthquakes shows a much greater degree of consistency. It seems reasonable to presume, therefore, that inconsistency arising from a comparison with the main shock is due to problems associated with the large size of the earthquake (complicated first motions and inadequate standardization of scaling conventions at all stations) more than other factors.

3.2 Results of Station-Source Region Bias Calculations

The values of station-source region magnitude biases are tabulated

in table 1 for region 7 (Andreanof Islands)* and a selected suite of fifty stations. The table quantitatively demonstrates the observational evidence discussed previously, that Aleutian earthquake magnitudes are biased significantly at individual stations and that stations with similar bias estimates tend to be found in large regional clusters. For example, it is clear that Western United States stations tend to have negative biases, while European stations have generally positive biases. The geographical distribution of region 7 magnitude biases is depicted in figure 3, and figure 4 depicts magnitude biases associated with station BMO. Appendix II is a tabulation of station-source region biases calculated for this study. A list of the fifty stations selected precedes each group of source regions.

Only very preliminary interpretation of the patterns of station-source magnitude biases is possible at this time. The consistency of the BMO bias values as one passes along the Aleutian, Kuril-Kamchatka, and Middle America tectonic arcs gives some measure of confidence in the results. If one were to exclude the anomalous positive values associated with regions between the Queen Charlotte Islands and the Gulf of California (all less than 20 degrees from BMO), the suggestion could be made that a constant negative station correction, associated with crustal conditions under BMO, might be separated from the set of bias values. The evaluation of this suggestion can only be made whenever biases for all regions within range of BMO are calculated.

The suggestion has been made that efficient propagation is possible for rays passing down the inclined seismic zone, and, hence, positive magnitude residuals might be expected for stations in the correct distance range. For the Aleutian arc, this requires about a 35 degrees departure angle (for surface focus) which is far too shallow for even the closest European station. It is possible, however, that considerable refraction may be taking place when the ray enters and leaves the slab of descending lithosphere; the answer awaits a detailed study of possible ray paths to Europe, perhaps by means of a ray-tracing study.

Table 2 lists the principal events occurring within the first three months of 1970 in region 7. The events are ranked according to the number of observing stations. In all cases, the standard deviation of the magnitude estimate, corrected for station-source region bias, is reduced. The improvement appears to be greater for

*The regionalization scheme employed in this paper is that of Flinn and Engdahl (1965).

smaller magnitude events, with factors of about 2 being typical. The relatively small reduction at large magnitudes seems to be due to the presence of several extreme values in the suites of event data.

Table 1

REGION 7 (Andreanof Islands)

1 JAN 1965 - 30 JUN 1970

STATION	BIAS		STATION	BIAS	
	ESTI-MATE	NO. OBS.		ESTI-MATE	NO. OBS.
● BMO	-.46	353	● UBO	+.01	401
● TFO	-.42	421	● BOZ	+.02	86
□ GIL	-.41	85	★ TSK	+.02	48
● ALQ	-.36	60	○ MBC	+.05	49
● LON	-.34	56	▲ GRF	+.07	19
□ COL	-.31	223	★ CPO	+.09	247
○ NOR	-.30	25	▲ KJN	+.09	81
● DUG	-.24	180	▲ STU	+.10	21
★ WMO	-.20	227	★ LAO	+.11	136
● EUR	-.18	300	○ ILG	+.22	31
● GOL	-.16	100	▲ BNS	+.23	19
● TUC	-.16	45	▲ COP	+.26	15
○ NP-	-.12	103	● NEW	+.27	62
● BKS	-.08	20	▲ NUR	+.29	55
★ JCT	-.05	15	★ SHL	+.33	33
▲ MOX	-.04	37	○ FBC	+.38	26
▲ KEV	-.02	35	★ EDM	+.45	30
			★ POO	+.57	77

- WESTERN NORTH AMERICA
- NORTHERN NORTH AMERICA
- ★ EASTERN NORTH AMERICA
- ALASKA
- ▲ EUROPE
- ★ ASIA

Table 2

REGION 7 (Andreanof Islands)

1970 EVENT NUMBER	MEAN MAGNITUDE				NO. OBS.
	UNCORRECTED		CORRECTED		
	ESTI- MATE	STD. DEV.	ESTI- MATE	STD. DEV.	
717	5.91	0.41	5.94	0.38	33
961	5.38	0.41	5.36	0.31	22
509	5.00	0.30	5.09	0.22	19
1162	4.85	0.48	4.91	0.31	13
1133	4.99	0.41	5.06	0.16	10
721	4.72	0.46	4.87	0.27	9
723	4.73	0.49	4.87	0.29	8
728	4.53	0.53	4.63	0.24	8
718	5.21	0.70	5.15	0.36	7
1036	4.70	0.51	4.77	0.32	7
719	4.24	0.53	4.39	0.31	6
720	4.82	0.47	4.69	0.24	6
739	4.59	0.36	4.70	0.24	6
915	4.27	0.35	4.58	0.29	6
236	4.00	0.25	4.34	0.16	5
659	4.15	0.31	4.41	0.11	5
1009	4.24	0.35	4.42	0.12	4

4.0 CONCLUSIONS AND RECOMMENDATIONS

It has been demonstrated in this paper that uncertainties exist in routinely reported m_b estimates of Aleutian earthquakes owing to significant variations of individual station magnitude estimates for a given event. Part of this variation is due to a biasing effect which is associated with each station-source region pair. The precision of estimation of m_b for small and moderate magnitude events is improved when correction for the station-source region bias has been made.

Preliminary interpretation of the bias corrections computed for this study suggests broad regional clustering of similar bias values that may be related to geotectonic provinces. However, resolution of purely station and source region parts of the bias function, and hence correlation with structural features, must await studies employing more complicated magnitude models.

On the basis of the results of this study, the following recommendations are made:

1. Calculation of station-source region biases for other seismic regions of the Earth should be continued for further testing of the magnitude bias model employed in this study.
2. More complicated models of the bias function incorporating source and station effects should be attempted for Aleutian earthquakes.
3. The possible effects of radiation pattern on bias estimates should be investigated for further refinement of the bias function model.
4. The upper magnitude limit of m_b as a realistic earthquake parameter should be determined by comparison with surface wave magnitudes and long-period body wave magnitudes.
5. Consideration should be given to the eventual incorporation of a magnitude bias model into systems routinely computing and reporting earthquake hypocenter data.

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17

PRINCIPAL AFTERSHOCK

19 MAR 1970

$m_b = 5.4$

Figure 2. Magnitude residuals, 19 March 1970 Aleutian Trench earthquake

Figure 3. Magnitude biases, Region 7 (Andreanof Islands)

Figure 4. Magnitude biases, Station BMO

APPENDIX I

It is proposed that the hypothetical model

$$y_{ijk} = m_{jk} + c_{ij} + e_{ijk} \quad (A1)$$

be used for the magnitude computation process, with the constraint that

$$\sum_i c_{ij} = 0 \quad (\text{all } j = 1, 2, 3 \dots J) \quad (A2)$$

It is required that the sum of the squares of the errors

$$\phi = \sum_i \sum_j \sum_k \delta_{ijk} (y_{ijk} - m_{jk} - c_{ij})^2 \quad (A3)$$

be minimized; the following conditions must hold

$$\frac{\partial \phi}{\partial m_{jk}} = -2 \sum_i \delta_{ijk} (y_{ijk} - m_{jk} - c_{ij}) = 0 \quad (A4)$$

$$\frac{\partial \phi}{\partial c_{ij}} = -2 \sum_k \delta_{ijk} (y_{ijk} - m_{jk} - c_{ij}) = 0 \quad (A5)$$

From (A4) it is seen that

$$m_{jk} = \frac{\sum_i \delta_{ijk} y_{ijk} - \sum_i \delta_{ijk} c_{ij}}{\delta_{.jk}} = \bar{m}_{jk} - \frac{\sum_i \delta_{ijk} c_{ij}}{\delta_{.jk}} \quad (A6)$$

where the unweighted mean of the observations $\bar{m}_{jk}$ corresponds to the m_b presently computed by NOS. It is clear that the mean of the biases $\sum_i \delta_{ijk} c_{ij} / \delta_{.jk}$ is nonzero. Also, from (A5) it is seen that

$$\begin{aligned} \delta_{ij.} c_{ij} &= \sum_k \delta_{ijk} y_{ijk} - \sum_k \delta_{ijk} m_{jk} \\ &= \sum_k \delta_{ijk} y_{ijk} - \sum_k \delta_{ijk} \left\{ \frac{\sum_r \delta_{rjk} y_{rjk}}{\delta_{.jk}} - \frac{\sum_r \delta_{rjk} c_{rj}}{\delta_{.jk}} \right\} \quad (A7) \\ &= \sum_k \delta_{ijk} (y_{ijk} - \bar{m}_{jk}) + \sum_k \sum_r \frac{\delta_{ijk} \delta_{rjk} c_{rj}}{\delta_{.jk}} \end{aligned}$$

Rearranging terms casts (A7) in a form appropriate for matrix representation

$$\begin{aligned} \left(\delta_{ij.} - \sum_k \frac{\delta_{ijk}}{\delta_{.jk}} \right) c_{ij} - \sum_{r \neq i} \sum_k \frac{\delta_{ijk} \delta_{rjk}}{\delta_{.jk}} c_{rj} &= \quad (A8) \\ \sum_k \delta_{ijk} y_{ijk} - \sum_r \sum_k \frac{\delta_{ijk} \delta_{rjk}}{\delta_{.jk}} y_{rjk} \end{aligned}$$

Written as matrix equations, (A8) and (A2) become

$$\underline{A}^{(j)} \underline{C}^{(j)} = \underline{Z}^{(j)} \quad (\text{all } j) \quad (A9)$$

$$\underline{1}' \underline{C}^{(j)} = \underline{0} \quad (\text{all } j) \quad (A10)$$

where $\underline{1} = \begin{pmatrix} 1 \\ 1 \\ 1 \\ \vdots \\ \vdots \\ 1 \end{pmatrix}$

$$1' = (1 \ 1 \ 1 \ \dots 1)$$

and $\underline{0}$ = null matrix

The diagonal elements of A

$$A_{ii}^{(j)} = \delta_{ij} - \sum_k \frac{\delta_{ijk}}{\delta_{.jk}} \quad (\text{all } i) \quad (A11)$$

are composed of the number of events δ_{ij} observed by station i in region j less a sum of terms, each of which is the reciprocal of the number of stations observing the k^{th} event in the j^{th} region. The off-diagonal elements

$$A_{ir}^{(j)} = - \sum_k \frac{\delta_{ijk} \delta_{rjk}}{\delta_{.jk}} \quad (A12)$$

are composed of a sum of terms, each of which is the reciprocal of the number of stations observing the jk^{th} event when stations i and r are simultaneously in the suite. The A matrix is clearly a weighting matrix, removing in the reciprocal terms the self-biasing effects of the station. The elements of the vector $Z^{(j)}$ are

$$\begin{aligned} Z_i^{(j)} &= \sum_k \delta_{ijk} y_{ijk} - \sum_r \sum_k \frac{\delta_{ijk} \delta_{rjk}}{\delta_{.jk}} y_{rjk} \\ &= \sum_k \delta_{ijk} y_{ijk} - \sum_k \delta_{ijk} \bar{m}_{jk} = \sum_k \delta_{ijk} (y_{ijk} - \bar{m}_{jk}) \end{aligned} \quad (A13)$$

which are the sum of the magnitude residuals of station i for events in region j .

APPENDIX II

STATION-SOURCE REGION MAGNITUDE BIASES

1 January 1965 - 30 June 1970

<u>Station Abbrev.</u>	<u>Station Location</u>	<u>Latitude-Longitude</u>	
		0	0
AD-	Adak, Alaska	51.87 N.	176.68 W.
ALE	Alert, Canada	82.48 N.	62.40 W.
ALQ	Albuquerque, New Mexico	34.94 N.	106.46 W.
ATL	Atlanta, Georgia	33.43 N.	84.34 W.
BKS	Byerly, California	37.88 N.	122.23 W.
BMO	Blue Mountains Array, Oregon	44.85 N.	117.31 W.
BNS	Bensberg, West Germany	50.96 N.	7.18 E.
BOZ	Bozeman, Montana	45.60 N.	111.63 W.
CAR	Caracas, Venezuela	10.51 N.	66.93 W.
CLL	Collmberg, East Germany	51.31 N.	13.00 E.
COL	College Outpost, Alaska	64.90 N.	147.79 W.
COP	Copenhagen, Denmark	55.68 N.	12.43 E.
CPO	Cumberland Plateau, Tennessee	35.59 N.	85.57 W.
DUG	Dugway, Utah	40.19 N.	112.81 W.
EDM	Edmonton, Canada	53.22 N.	113.35 W.
EUR	Eureka, Nevada	39.48 N.	115.97 W.
FBC	Frobisher Bay, Canada	63.73 N.	68.47 W.
FUR	Furstenfeldbruck, West Germany	48.17 N.	11.28 E.
GDH	Godhavn, Greenland	69.25 N.	53.53 W.
GIL	Gilmore Creek, Alaska	64.97 N.	147.49 W.
GOL	Golden, Colorado	39.70 N.	105.37 W.
GRF	Graefenberg Array, West Germany	49.69 N.	11.22 E.
ILG	Inge Lehmann, Greenland	77.95 N.	39.18 W.
JCT	Junction City, Texas	30.48 N.	99.80 W.
KEV	Kevo, Finland	69.76 N.	27.01 E.
KJN	Kajaani, Finland	64.09 N.	27.71 E.
KTG	Kap Tobin, Greenland	70.42 N.	21.98 W.
LAO	Lasa Array, Montana	46.69 N.	106.22 W.
LON	Longmire, Washington	46.75 N.	121.81 W.
LPS	La Palma, El Salvador	14.29 N.	89.16 W.
MBC	Mould Bay, Canada	76.24 N.	119.36 W.
MOX	Moxa, West Germany	50.65 N.	11.62 E.
NEW	Newport, Washington	48.26 N.	117.12 W.
NOR	Nord, Greenland	81.60 N.	16.68 W.
NP-	Mould Bay, Canada	76.25 N.	119.37 W.
NUR	Nurmijarvi, Finland	60.51 N.	24.65 E.
OIS	Oishiyama, Honshu, Japan	34.11 N.	135.33 E.
PMG	Pory Moeresby, Papua	9.41 S.	147.15 E.
POO	Poona, India	18.53 N.	73.85 E.
PRU	Pruhonice, Czechoslovakia	49.99 N.	14.54 E.
RAB	Rabaul, New Britain	4.19 S.	152.17 E.
RCD	Rapid City, South Dakota	44.07 N.	103.21 W.
SHL	Shillong, India	22.57 N.	91.88 E.
SJG	San Juan, Puerto Rico	18.11 N.	66.15 W.
STU	Stuttgart, West Germany	48.77 N.	9.19 E.
TFO	Tonto Forest Array, Arizona	34.27 N.	111.27 W.
TSK	Tsukuba, Honshu, Japan	36.21 N.	140.11 E.
TUC	Tucson, Arizona	32.31 N.	110.78 W.
UBO	Uinta Basin Array, Utah	40.32 N.	109.57 W.
WMO	Wichita Mountains Array, Oklahoma	34.72 N.	98.59 W.

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
1	CENTRAL ALASKA	AD-	.13	1
1	CENTRAL ALASKA	ALE	-.51	3
1	CENTRAL ALASKA	ALQ	-.25	11
1	CENTRAL ALASKA	ATL	-.13	1
1	CENTRAL ALASKA	BKS	.43	5
1	CENTRAL ALASKA	BMO	-.42	87
1	CENTRAL ALASKA	BNS	.24	4
1	CENTRAL ALASKA	BOZ	-.36	5
1	CENTRAL ALASKA	WMO	-.20	53
1	CENTRAL ALASKA	UBO	.11	127
1	CENTRAL ALASKA	COL	1.03	1
1	CENTRAL ALASKA	TUC	-.21	9
1	CENTRAL ALASKA	CPO	.08	44
1	CENTRAL ALASKA	DUG	-.20	28
1	CENTRAL ALASKA	EDM	.54	7
1	CENTRAL ALASKA	EUR	.00	47
1	CENTRAL ALASKA	FBC	.58	1
1	CENTRAL ALASKA	TSK	-.28	4
1	CENTRAL ALASKA	GDH	.02	3
1	CENTRAL ALASKA	TFO	-.33	97
1	CENTRAL ALASKA	GOL	-.21	5
1	CENTRAL ALASKA	STU	.01	2
1	CENTRAL ALASKA	ILG	.03	13
1	CENTRAL ALASKA	JCT	-.22	2
1	CENTRAL ALASKA	KEV	.08	4
1	CENTRAL ALASKA	KJN	-.02	12
1	CENTRAL ALASKA	KTG	-.10	2
1	CENTRAL ALASKA	LAO	-.13	25
1	CENTRAL ALASKA	LCN	-.34	15
1	CENTRAL ALASKA	LPS	.48	3
1	CENTRAL ALASKA	MBC	.03	5
1	CENTRAL ALASKA	MOX	.24	6
1	CENTRAL ALASKA	NEW	-.02	5
1	CENTRAL ALASKA	NCR	-.26	4
1	CENTRAL ALASKA	NP-	-.33	19
1	CENTRAL ALASKA	NUR	-.03	3
1	CENTRAL ALASKA	SJG	-.16	4
1	CENTRAL ALASKA	PMG	.50	3
1	CENTRAL ALASKA	P00	.26	3
1	CENTRAL ALASKA	PRU	-.04	3
1	CENTRAL ALASKA	RAB	-.17	2
1	CENTRAL ALASKA	RCD	.45	1
1	CENTRAL ALASKA	SHL	-.28	4

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
2	SOUTHERN ALASKA	AD-	-.13	2
2	SOUTHERN ALASKA	ALE	.01	6
2	SOUTHERN ALASKA	ALQ	-.30	22
2	SOUTHERN ALASKA	ATL	.10	5
2	SOUTHERN ALASKA	BKS	.01	10
2	SOUTHERN ALASKA	BMO	-.43	184
2	SOUTHERN ALASKA	BNS	.28	7
2	SOUTHERN ALASKA	BCZ	-.42	13
2	SOUTHERN ALASKA	CAR	-.12	6
2	SOUTHERN ALASKA	CLL	.10	4
2	SOUTHERN ALASKA	CCL	.67	34
2	SOUTHERN ALASKA	COP	.31	7
2	SOUTHERN ALASKA	CPO	-.34	46
2	SOUTHERN ALASKA	DUG	-.50	38
2	SOUTHERN ALASKA	EDM	.11	7
2	SOUTHERN ALASKA	EUR	-.23	81
2	SOUTHERN ALASKA	FBC	.52	4
2	SOUTHERN ALASKA	FLR	-.07	4
2	SOUTHERN ALASKA	GDH	.10	9
2	SOUTHERN ALASKA	GIL	.47	7
2	SOUTHERN ALASKA	GOL	-.48	12
2	SOUTHERN ALASKA	GRF	-.11	3
2	SOUTHERN ALASKA	ILG	.37	17
2	SOUTHERN ALASKA	JCT	.26	5
2	SOUTHERN ALASKA	KEV	.06	21
2	SOUTHERN ALASKA	KJN	.20	28
2	SOUTHERN ALASKA	KTG	.02	6
2	SOUTHERN ALASKA	LAO	-.20	59
2	SOUTHERN ALASKA	LCN	-.49	20
2	SOUTHERN ALASKA	LPS	.38	22
2	SOUTHERN ALASKA	MBC	-.24	23
2	SOUTHERN ALASKA	MCX	.24	20
2	SOUTHERN ALASKA	NEW	-.11	21
2	SOUTHERN ALASKA	NCR	-.04	11
2	SOUTHERN ALASKA	NP-	-.52	34
2	SOUTHERN ALASKA	NUR	.28	14
2	SOUTHERN ALASKA	OIS	.24	3
2	SOUTHERN ALASKA	PMG	.46	7
2	SOUTHERN ALASKA	PCO	.24	10
2	SOUTHERN ALASKA	PRU	.28	4
2	SOUTHERN ALASKA	RAB	-.17	2
2	SOUTHERN ALASKA	RCD	.09	1
2	SOUTHERN ALASKA	SHL	.22	13
2	SOUTHERN ALASKA	SJG	.01	4
2	SOUTHERN ALASKA	STU	-.15	9
2	SOUTHERN ALASKA	TFO	-.44	146
2	SOUTHERN ALASKA	TSK	.27	10
2	SOUTHERN ALASKA	TUC	-.31	17
2	SOUTHERN ALASKA	UBO	-.16	186
2	SOUTHERN ALASKA	WMO	-.29	109

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
4	KOMANDORSKY ISLANDS REGION	AD-	.93	2
4	KOMANDORSKY ISLANDS REGION	ALE	-.27	5
4	KOMANDORSKY ISLANDS REGION	ALQ	-.31	12
4	KOMANDORSKY ISLANDS REGION	ATL	.78	1
4	KOMANDORSKY ISLANDS REGION	BKS	-.12	2
4	KOMANDORSKY ISLANDS REGION	BMO	-.31	42
4	KOMANDORSKY ISLANDS REGION	BNS	-.12	3
4	KOMANDORSKY ISLANDS REGION	BOZ	-.07	10
4	KOMANDORSKY ISLANDS REGION	WMO	-.08	47
4	KOMANDORSKY ISLANDS REGION	CLL	.28	2
4	KOMANDORSKY ISLANDS REGION	COL	-.16	41
4	KOMANDORSKY ISLANDS REGION	COP	.32	5
4	KOMANDORSKY ISLANDS REGION	CPO	-.30	28
4	KOMANDORSKY ISLANDS REGION	DUG	-.41	14
4	KOMANDORSKY ISLANDS REGION	EDM	.29	4
4	KOMANDORSKY ISLANDS REGION	EUR	-.05	39
4	KOMANDORSKY ISLANDS REGION	FBC	.86	1
4	KOMANDORSKY ISLANDS REGION	UBO	.12	51
4	KOMANDORSKY ISLANDS REGION	GDM	-.02	3
4	KOMANDORSKY ISLANDS REGION	GIL	-.23	7
4	KOMANDORSKY ISLANDS REGION	GOL	-.25	10
4	KOMANDORSKY ISLANDS REGION	TUC	-.34	6
4	KOMANDORSKY ISLANDS REGION	ILG	.28	6
4	KOMANDORSKY ISLANDS REGION	JCT	-.06	1
4	KOMANDORSKY ISLANDS REGION	KEV	-.31	5
4	KOMANDORSKY ISLANDS REGION	KJN	.08	7
4	KOMANDORSKY ISLANDS REGION	KTG	-.28	1
4	KOMANDORSKY ISLANDS REGION	LAO	-.08	14
4	KOMANDORSKY ISLANDS REGION	LCN	-.55	4
4	KOMANDORSKY ISLANDS REGION	LPS	-.15	1
4	KOMANDORSKY ISLANDS REGION	MBC	-.07	3
4	KOMANDORSKY ISLANDS REGION	MOX	-.01	4
4	KOMANDORSKY ISLANDS REGION	NEW	-.12	3
4	KOMANDORSKY ISLANDS REGION	NCR	.07	1
4	KOMANDORSKY ISLANDS REGION	NP-	.02	6
4	KOMANDORSKY ISLANDS REGION	NUR	.37	6
4	KOMANDORSKY ISLANDS REGION	OIS	-.45	1
4	KOMANDORSKY ISLANDS REGION	PMG	.03	7
4	KOMANDORSKY ISLANDS REGION	POO	.09	7
4	KOMANDORSKY ISLANDS REGION	PRU	-.04	2
4	KOMANDORSKY ISLANDS REGION	RAB	.40	6
4	KOMANDORSKY ISLANDS REGION	RCD	.51	4
4	KOMANDORSKY ISLANDS REGION	SHL	.11	6
4	KOMANDORSKY ISLANDS REGION	SJG	.16	3
4	KOMANDORSKY ISLANDS REGION	STU	-.06	4
4	KOMANDORSKY ISLANDS REGION	TFO	-.33	52
4	KOMANDORSKY ISLANDS REGION	TSK	-.14	3

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
5	NEAR ISLANDS, ALEUTIAN ISLANDS	AD-	.33	56
5	NEAR ISLANDS, ALEUTIAN ISLANDS	ALE	-.25	38
5	NEAR ISLANDS, ALEUTIAN ISLANDS	ALQ	-.32	72
5	NEAR ISLANDS, ALEUTIAN ISLANDS	ATL	.20	26
5	NEAR ISLANDS, ALEUTIAN ISLANDS	BKS	-.04	9
5	NEAR ISLANDS, ALEUTIAN ISLANDS	BMO	-.50	393
5	NEAR ISLANDS, ALEUTIAN ISLANDS	BNS	.05	9
5	NEAR ISLANDS, ALEUTIAN ISLANDS	BCZ	-.04	144
5	NEAR ISLANDS, ALEUTIAN ISLANDS	CAR	.03	1
5	NEAR ISLANDS, ALEUTIAN ISLANDS	CLL	.26	8
5	NEAR ISLANDS, ALEUTIAN ISLANDS	COL	-.09	394
5	NEAR ISLANDS, ALEUTIAN ISLANDS	COP	.31	28
5	NEAR ISLANDS, ALEUTIAN ISLANDS	CPO	-.16	437
5	NEAR ISLANDS, ALEUTIAN ISLANDS	DUG	-.34	38
5	NEAR ISLANDS, ALEUTIAN ISLANDS	EDM	.35	11
5	NEAR ISLANDS, ALEUTIAN ISLANDS	EUR	.06	303
5	NEAR ISLANDS, ALEUTIAN ISLANDS	FBC	.13	52
5	NEAR ISLANDS, ALEUTIAN ISLANDS	FUR	-.29	4
5	NEAR ISLANDS, ALEUTIAN ISLANDS	GDH	.26	68
5	NEAR ISLANDS, ALEUTIAN ISLANDS	GIL	-.22	20
5	NEAR ISLANDS, ALEUTIAN ISLANDS	GOL	-.19	27
5	NEAR ISLANDS, ALEUTIAN ISLANDS	GRF	.16	4
5	NEAR ISLANDS, ALEUTIAN ISLANDS	ILG	.67	10
5	NEAR ISLANDS, ALEUTIAN ISLANDS	JCT	.03	12
5	NEAR ISLANDS, ALEUTIAN ISLANDS	KEV	-.09	46
5	NEAR ISLANDS, ALEUTIAN ISLANDS	KJN	.27	34
5	NEAR ISLANDS, ALEUTIAN ISLANDS	KTG	.29	36
5	NEAR ISLANDS, ALEUTIAN ISLANDS	LAC	.07	35
5	NEAR ISLANDS, ALEUTIAN ISLANDS	LON	-.75	31
5	NEAR ISLANDS, ALEUTIAN ISLANDS	LPS	.10	4
5	NEAR ISLANDS, ALEUTIAN ISLANDS	MBC	-.09	54
5	NEAR ISLANDS, ALEUTIAN ISLANDS	MCX	.02	27
5	NEAR ISLANDS, ALEUTIAN ISLANDS	NEW	-.06	12
5	NEAR ISLANDS, ALEUTIAN ISLANDS	NCR	-.25	6
5	NEAR ISLANDS, ALEUTIAN ISLANDS	NF-	-.06	17
5	NEAR ISLANDS, ALEUTIAN ISLANDS	NUR	.42	82
5	NEAR ISLANDS, ALEUTIAN ISLANDS	OIS	-.12	2
5	NEAR ISLANDS, ALEUTIAN ISLANDS	PMG	-.06	17
5	NEAR ISLANDS, ALEUTIAN ISLANDS	PCO	.21	46
5	NEAR ISLANDS, ALEUTIAN ISLANDS	PRU	-.02	55
5	NEAR ISLANDS, ALEUTIAN ISLANDS	RAB	.20	11
5	NEAR ISLANDS, ALEUTIAN ISLANDS	RCD	.35	109
5	NEAR ISLANDS, ALEUTIAN ISLANDS	SHL	.22	112
5	NEAR ISLANDS, ALEUTIAN ISLANDS	SJG	.12	20
5	NEAR ISLANDS, ALEUTIAN ISLANDS	STU	-.04	36
5	NEAR ISLANDS, ALEUTIAN ISLANDS	TFO	-.42	521
5	NEAR ISLANDS, ALEUTIAN ISLANDS	TSK	-.25	6
5	NEAR ISLANDS, ALEUTIAN ISLANDS	TUC	-.14	79
5	NEAR ISLANDS, ALEUTIAN ISLANDS	UBO	-.23	589
5	NEAR ISLANDS, ALEUTIAN ISLANDS	WMC	-.04	481

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
6	RAT ISLANDS, ALEUTIAN ISLANDS	AD-	.09	10
6	RAT ISLANDS, ALEUTIAN ISLANDS	ALE	-.11	49
6	RAT ISLANDS, ALEUTIAN ISLANDS	ALQ	-.32	64
6	RAT ISLANDS, ALEUTIAN ISLANDS	ATL	.29	22
6	RAT ISLANDS, ALEUTIAN ISLANDS	BKS	.08	30
6	RAT ISLANDS, ALEUTIAN ISLANDS	BMO	-.61	655
6	RAT ISLANDS, ALEUTIAN ISLANDS	BNS	.20	13
6	RAT ISLANDS, ALEUTIAN ISLANDS	BOZ	-.03	125
6	RAT ISLANDS, ALEUTIAN ISLANDS	CAR	.28	6
6	RAT ISLANDS, ALEUTIAN ISLANDS	CLL	.07	3
6	RAT ISLANDS, ALEUTIAN ISLANDS	COL	-.40	408
6	RAT ISLANDS, ALEUTIAN ISLANDS	COP	.37	26
6	RAT ISLANDS, ALEUTIAN ISLANDS	CPO	-.21	508
6	RAT ISLANDS, ALEUTIAN ISLANDS	DUG	-.23	83
6	RAT ISLANDS, ALEUTIAN ISLANDS	EDM	.53	17
6	RAT ISLANDS, ALEUTIAN ISLANDS	EUR	.02	445
6	RAT ISLANDS, ALEUTIAN ISLANDS	FBC	.41	36
6	RAT ISLANDS, ALEUTIAN ISLANDS	FUR	-.15	3
6	RAT ISLANDS, ALEUTIAN ISLANDS	GDH	.23	29
6	RAT ISLANDS, ALEUTIAN ISLANDS	GIL	-.38	32
6	RAT ISLANDS, ALEUTIAN ISLANDS	GOL	-.43	33
6	RAT ISLANDS, ALEUTIAN ISLANDS	GRF	-.04	3
6	RAT ISLANDS, ALEUTIAN ISLANDS	ILG	.31	16
6	RAT ISLANDS, ALEUTIAN ISLANDS	JCT	.10	9
6	RAT ISLANDS, ALEUTIAN ISLANDS	KEV	-.03	46
6	RAT ISLANDS, ALEUTIAN ISLANDS	KJN	.26	50
6	RAT ISLANDS, ALEUTIAN ISLANDS	KTG	.28	39
6	RAT ISLANDS, ALEUTIAN ISLANDS	LAO	-.18	54
6	RAT ISLANDS, ALEUTIAN ISLANDS	LON	-.61	29
6	RAT ISLANDS, ALEUTIAN ISLANDS	LPS	.04	9
6	RAT ISLANDS, ALEUTIAN ISLANDS	MBC	-.04	93
6	RAT ISLANDS, ALEUTIAN ISLANDS	MOX	.03	23
6	RAT ISLANDS, ALEUTIAN ISLANDS	NEW	.05	12
6	RAT ISLANDS, ALEUTIAN ISLANDS	NOR	-.26	5
6	RAT ISLANDS, ALEUTIAN ISLANDS	NP-	-.08	54
6	RAT ISLANDS, ALEUTIAN ISLANDS	NUR	.29	86
6	RAT ISLANDS, ALEUTIAN ISLANDS	OIS	-.03	3
6	RAT ISLANDS, ALEUTIAN ISLANDS	PMG	-.06	17
6	RAT ISLANDS, ALEUTIAN ISLANDS	POO	.35	54
6	RAT ISLANDS, ALEUTIAN ISLANDS	PRU	-.14	25
6	RAT ISLANDS, ALEUTIAN ISLANDS	RAB	.06	10
6	RAT ISLANDS, ALEUTIAN ISLANDS	RCD	.17	29
6	RAT ISLANDS, ALEUTIAN ISLANDS	SHL	.30	135
6	RAT ISLANDS, ALEUTIAN ISLANDS	SJG	.48	62
6	RAT ISLANDS, ALEUTIAN ISLANDS	STU	-.00	40
6	RAT ISLANDS, ALEUTIAN ISLANDS	TFO	-.46	743
6	RAT ISLANDS, ALEUTIAN ISLANDS	TSK	-.13	19
6	RAT ISLANDS, ALEUTIAN ISLANDS	TUC	-.06	86
6	RAT ISLANDS, ALEUTIAN ISLANDS	UPQ	-.14	814
6	RAT ISLANDS, ALEUTIAN ISLANDS	WMO	-.17	536

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
7	ANDREANOF ISLANDS, ALEUTIAN IS.	WMO	-.20	227
7	ANDREANOF ISLANDS, ALEUTIAN IS.	ALE	-.26	12
7	ANDREANOF ISLANDS, ALEUTIAN IS.	ALQ	-.36	60
7	ANDREANOF ISLANDS, ALEUTIAN IS.	ATL	.15	6
7	ANDREANOF ISLANDS, ALEUTIAN IS.	BKS	-.08	20
7	ANDREANOF ISLANDS, ALEUTIAN IS.	BMO	-.46	356
7	ANDREANOF ISLANDS, ALEUTIAN IS.	BNS	.23	19
7	ANDREANOF ISLANDS, ALEUTIAN IS.	BOZ	.02	86
7	ANDREANOF ISLANDS, ALEUTIAN IS.	CAR	.32	15
7	ANDREANOF ISLANDS, ALEUTIAN IS.	CLL	.01	18
7	ANDREANOF ISLANDS, ALEUTIAN IS.	COL	-.31	224
7	ANDREANOF ISLANDS, ALEUTIAN IS.	COP	.25	15
7	ANDREANOF ISLANDS, ALEUTIAN IS.	CFO	.08	248
7	ANDREANOF ISLANDS, ALEUTIAN IS.	DUG	-.24	181
7	ANDREANOF ISLANDS, ALEUTIAN IS.	EDM	.44	30
7	ANDREANOF ISLANDS, ALEUTIAN IS.	EUR	-.19	202
7	ANDREANOF ISLANDS, ALEUTIAN IS.	FBC	.38	26
7	ANDREANOF ISLANDS, ALEUTIAN IS.	FUR	-.40	8
7	ANDREANOF ISLANDS, ALEUTIAN IS.	GDH	-.08	9
7	ANDREANOF ISLANDS, ALEUTIAN IS.	GIL	-.42	87
7	ANDREANOF ISLANDS, ALEUTIAN IS.	GCL	-.16	102
7	ANDREANOF ISLANDS, ALEUTIAN IS.	GRF	.06	19
7	ANDREANOF ISLANDS, ALEUTIAN IS.	ILG	.22	31
7	ANDREANOF ISLANDS, ALEUTIAN IS.	JCT	-.06	15
7	ANDREANOF ISLANDS, ALEUTIAN IS.	KEV	-.02	35
7	ANDREANOF ISLANDS, ALEUTIAN IS.	KJN	.09	81
7	ANDREANOF ISLANDS, ALEUTIAN IS.	KTG	-.08	13
7	ANDREANOF ISLANDS, ALEUTIAN IS.	LAO	.11	138
7	ANDREANOF ISLANDS, ALEUTIAN IS.	LON	-.34	56
7	ANDREANOF ISLANDS, ALEUTIAN IS.	LPS	-.14	10
7	ANDREANOF ISLANDS, ALEUTIAN IS.	MBC	.05	49
7	ANDREANOF ISLANDS, ALEUTIAN IS.	MCX	-.04	37
7	ANDREANOF ISLANDS, ALEUTIAN IS.	NEW	.27	62
7	ANDREANOF ISLANDS, ALEUTIAN IS.	NCR	-.30	25
7	ANDREANOF ISLANDS, ALEUTIAN IS.	NP-	-.07	69
7	ANDREANOF ISLANDS, ALEUTIAN IS.	NLR	.29	55
7	ANDREANOF ISLANDS, ALEUTIAN IS.	OIS	.20	14
7	ANDREANOF ISLANDS, ALEUTIAN IS.	PMG	-.00	12
7	ANDREANOF ISLANDS, ALEUTIAN IS.	PCO	.57	77
7	ANDREANOF ISLANDS, ALEUTIAN IS.	PRU	-.14	7
7	ANDREANOF ISLANDS, ALEUTIAN IS.	RAB	-.07	12
7	ANDREANOF ISLANDS, ALEUTIAN IS.	RCD	.47	16
7	ANDREANOF ISLANDS, ALEUTIAN IS.	SHL	.33	70
7	ANDREANOF ISLANDS, ALEUTIAN IS.	SJG	.33	33
7	ANDREANOF ISLANDS, ALEUTIAN IS.	STU	.10	21
7	ANDREANOF ISLANDS, ALEUTIAN IS.	TFO	-.42	423
7	ANDREANOF ISLANDS, ALEUTIAN IS.	TSK	.03	49
7	ANDREANOF ISLANDS, ALEUTIAN IS.	TUC	-.16	45
7	ANDREANOF ISLANDS, ALEUTIAN IS.	UBO	.01	401

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
9	FOX ISLANDS, ALEUTIAN ISLANDS	AD-	.64	3
9	FOX ISLANDS, ALEUTIAN ISLANDS	ALE	-.23	8
9	FOX ISLANDS, ALEUTIAN ISLANDS	ALQ	-.35	52
9	FOX ISLANDS, ALEUTIAN ISLANDS	ATL	-.06	3
9	FOX ISLANDS, ALEUTIAN ISLANDS	BKS	.10	8
9	FOX ISLANDS, ALEUTIAN ISLANDS	BMO	-.46	211
9	FOX ISLANDS, ALEUTIAN ISLANDS	BNS	.28	20
9	FOX ISLANDS, ALEUTIAN ISLANDS	BOZ	-.16	55
9	FOX ISLANDS, ALEUTIAN ISLANDS	CAR	.46	24
9	FOX ISLANDS, ALEUTIAN ISLANDS	CLL	.17	12
9	FOX ISLANDS, ALEUTIAN ISLANDS	COL	-.62	161
9	FOX ISLANDS, ALEUTIAN ISLANDS	CCP	.39	15
9	FOX ISLANDS, ALEUTIAN ISLANDS	CPO	-.17	146
9	FOX ISLANDS, ALEUTIAN ISLANDS	DUG	-.42	147
9	FOX ISLANDS, ALEUTIAN ISLANDS	EDM	.38	15
9	FOX ISLANDS, ALEUTIAN ISLANDS	EUR	-.23	234
9	FOX ISLANDS, ALEUTIAN ISLANDS	FBC	.43	19
9	FOX ISLANDS, ALEUTIAN ISLANDS	FUR	-.14	8
9	FOX ISLANDS, ALEUTIAN ISLANDS	GDH	-.11	9
9	FOX ISLANDS, ALEUTIAN ISLANDS	GIL	-.68	39
9	FOX ISLANDS, ALEUTIAN ISLANDS	GOL	-.39	67
9	FOX ISLANDS, ALEUTIAN ISLANDS	GRF	.28	6
9	FOX ISLANDS, ALEUTIAN ISLANDS	ILG	.25	47
9	FOX ISLANDS, ALEUTIAN ISLANDS	JCT	-.09	10
9	FOX ISLANDS, ALEUTIAN ISLANDS	KEV	.21	50
9	FOX ISLANDS, ALEUTIAN ISLANDS	KJN	.43	99
9	FOX ISLANDS, ALEUTIAN ISLANDS	KTG	.19	15
9	FOX ISLANDS, ALEUTIAN ISLANDS	LAO	-.19	103
9	FOX ISLANDS, ALEUTIAN ISLANDS	LON	-.39	23
9	FOX ISLANDS, ALEUTIAN ISLANDS	LPS	-.15	15
9	FOX ISLANDS, ALEUTIAN ISLANDS	MBC	.00	24
9	FOX ISLANDS, ALEUTIAN ISLANDS	MCX	.22	46
9	FOX ISLANDS, ALEUTIAN ISLANDS	NEW	.09	49
9	FOX ISLANDS, ALEUTIAN ISLANDS	NCR	-.14	28
9	FOX ISLANDS, ALEUTIAN ISLANDS	NP-	-.19	60
9	FOX ISLANDS, ALEUTIAN ISLANDS	NUR	.58	37
9	FOX ISLANDS, ALEUTIAN ISLANDS	OIS	.31	11
9	FOX ISLANDS, ALEUTIAN ISLANDS	PMG	.03	26
9	FOX ISLANDS, ALEUTIAN ISLANDS	PGO	.43	24
9	FOX ISLANDS, ALEUTIAN ISLANDS	PRU	.03	18
9	FOX ISLANDS, ALEUTIAN ISLANDS	RAB	-.05	6
9	FOX ISLANDS, ALEUTIAN ISLANDS	RCD	.09	5
9	FOX ISLANDS, ALEUTIAN ISLANDS	SHL	.16	36
9	FOX ISLANDS, ALEUTIAN ISLANDS	SJG	.07	23
9	FOX ISLANDS, ALEUTIAN ISLANDS	STU	.10	19
9	FOX ISLANDS, ALEUTIAN ISLANDS	TFO	-.55	353
9	FOX ISLANDS, ALEUTIAN ISLANDS	TSK	.13	45
9	FOX ISLANDS, ALEUTIAN ISLANDS	TUC	-.13	32
9	FOX ISLANDS, ALEUTIAN ISLANDS	UBO	-.24	345
9	FOX ISLANDS, ALEUTIAN ISLANDS	WMO	-.31	236

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
10	UNIMAK ISLAND REGION	AD-	.64	2
10	UNIMAK ISLAND REGION	ALE	-.00	6
10	UNIMAK ISLAND REGION	ALQ	-.68	7
10	UNIMAK ISLAND REGION	WMO	-.29	52
10	UNIMAK ISLAND REGION	UBO	-.45	75
10	UNIMAK ISLAND REGION	BMO	-.61	59
10	UNIMAK ISLAND REGION	BNS	.39	7
10	UNIMAK ISLAND REGION	BOZ	-.48	3
10	UNIMAK ISLAND REGION	CAR	.39	5
10	UNIMAK ISLAND REGION	CLL	.27	4
10	UNIMAK ISLAND REGION	CCL	.01	41
10	UNIMAK ISLAND REGION	TUC	-.29	6
10	UNIMAK ISLAND REGION	CPO	-.16	46
10	UNIMAK ISLAND REGION	DUG	-.34	30
10	UNIMAK ISLAND REGION	TSK	.08	8
10	UNIMAK ISLAND REGION	EUR	-.01	77
10	UNIMAK ISLAND REGION	FBC	.71	6
19	UNIMAK ISLAND REGION	FUR	.44	2
10	UNIMAK ISLAND REGION	GDH	.55	1
10	UNIMAK ISLAND REGION	GIL	-.33	10
10	UNIMAK ISLAND REGION	GCL	-.62	12
10	UNIMAK ISLAND REGION	GRF	.31	2
10	UNIMAK ISLAND REGION	ILG	-.10	6
10	UNIMAK ISLAND REGION	JCT	.13	4
10	UNIMAK ISLAND REGION	KEV	.40	15
10	UNIMAK ISLAND REGION	KJN	.22	11
10	UNIMAK ISLAND REGION	KTG	.31	3
10	UNIMAK ISLAND REGION	LAO	-.20	21
10	UNIMAK ISLAND REGION	LGN	-.68	5
10	UNIMAK ISLAND REGION	LPS	-.02	3
10	UNIMAK ISLAND REGION	MBC	.03	2
10	UNIMAK ISLAND REGION	MOX	.29	10
10	UNIMAK ISLAND REGION	NEW	-.26	5
10	UNIMAK ISLAND REGION	NOR	-.13	7
10	UNIMAK ISLAND REGION	NP-	-.31	9
10	UNIMAK ISLAND REGION	NUR	.45	10
10	UNIMAK ISLAND REGION	OIS	.08	1
10	UNIMAK ISLAND REGION	PMG	.13	6
10	UNIMAK ISLAND REGION	PCO	.60	2
10	UNIMAK ISLAND REGION	PRU	.17	1
10	UNIMAK ISLAND REGION	TFO	-.64	88
10	UNIMAK ISLAND REGION	RCD	.19	1
10	UNIMAK ISLAND REGION	SHL	.12	10
10	UNIMAK ISLAND REGION	SJG	-.18	5
10	UNIMAK ISLAND REGION	STU	-.12	3

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
12	ALASKA PENINSULA	AD-	.69	2
12	ALASKA PENINSULA	ALE	-.02	3
12	ALASKA PENINSULA	ALQ	-.69	6
12	ALASKA PENINSULA	ATL	.04	1
12	ALASKA PENINSULA	BKS	-.10	3
12	ALASKA PENINSULA	BMO	-.76	38
12	ALASKA PENINSULA	BNS	-.06	4
12	ALASKA PENINSULA	BOZ	-.72	3
12	ALASKA PENINSULA	CAR	.20	3
12	ALASKA PENINSULA	CLL	-.22	1
12	ALASKA PENINSULA	COL	.39	29
12	ALASKA PENINSULA	COP	.46	2
12	ALASKA PENINSULA	CPO	-.09	28
12	ALASKA PENINSULA	DUG	-.27	11
12	ALASKA PENINSULA	EDM	.17	3
12	ALASKA PENINSULA	EUR	-.13	30
12	ALASKA PENINSULA	FBC	.45	4
12	ALASKA PENINSULA	FUR	.29	1
12	ALASKA PENINSULA	GDH	.12	4
12	ALASKA PENINSULA	GIL	.31	7
12	ALASKA PENINSULA	GOL	-.25	5
12	ALASKA PENINSULA	GRF	-.16	1
12	ALASKA PENINSULA	ILG	.04	6
12	ALASKA PENINSULA	JCT	.31	2
12	ALASKA PENINSULA	KEV	.25	14
12	ALASKA PENINSULA	KJN	.18	12
12	ALASKA PENINSULA	KTG	.41	1
12	ALASKA PENINSULA	LAO	-.09	16
12	ALASKA PENINSULA	LON	-.76	7
12	ALASKA PENINSULA	LPS	.20	10
12	ALASKA PENINSULA	MBC	-.11	8
12	ALASKA PENINSULA	MCX	.25	10
12	ALASKA PENINSULA	NEW	-.01	5
12	ALASKA PENINSULA	NCR	-.46	7
12	ALASKA PENINSULA	NP-	-.37	10
12	ALASKA PENINSULA	NUR	.52	9
12	ALASKA PENINSULA	OIS	.29	2
12	ALASKA PENINSULA	PPG	.23	7
12	ALASKA PENINSULA	POO	.23	3
12	ALASKA PENINSULA	PRU	.32	1
12	ALASKA PENINSULA	WHO	-.28	37
12	ALASKA PENINSULA	RCD	.32	1
12	ALASKA PENINSULA	SHL	-.09	5
12	ALASKA PENINSULA	SJG	-.08	5
12	ALASKA PENINSULA	STU	-.15	2
12	ALASKA PENINSULA	TFO	-.44	59
12	ALASKA PENINSULA	TSK	-.01	10
12	ALASKA PENINSULA	TUC	-.25	5
12	ALASKA PENINSULA	UBO	-.10	54

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
13	KODIAK ISLAND REGION	AD-	-.01	8
13	KODIAK ISLAND REGION	ALE	.05	24
13	KODIAK ISLAND REGION	ALQ	-.32	15
13	KODIAK ISLAND REGION	ATL	.28	2
13	KODIAK ISLAND REGION	BKS	.06	9
13	KODIAK ISLAND REGION	BMO	-.59	139
13	KODIAK ISLAND REGION	BNS	.36	8
13	KODIAK ISLAND REGION	BOZ	-.47	9
13	KODIAK ISLAND REGION	CAR	.13	12
13	KODIAK ISLAND REGION	CLL	.32	9
13	KODIAK ISLAND REGION	COL	.50	93
13	KODIAK ISLAND REGION	COP	.39	8
13	KODIAK ISLAND REGION	CPO	-.00	86
13	KODIAK ISLAND REGION	DUG	-.55	24
13	KODIAK ISLAND REGION	EDM	-.17	3
13	KODIAK ISLAND REGION	EUR	-.29	77
13	KODIAK ISLAND REGION	FBC	-.04	4
13	KODIAK ISLAND REGION	FUR	.16	4
13	KODIAK ISLAND REGION	GEH	.10	11
13	KODIAK ISLAND REGION	GIL	.46	12
13	KODIAK ISLAND REGION	GOL	-.48	14
13	KODIAK ISLAND REGION	GRF	.05	3
13	KODIAK ISLAND REGION	ILG	.04	15
13	KODIAK ISLAND REGION	JCT	.20	6
13	KODIAK ISLAND REGION	KEV	.24	35
13	KODIAK ISLAND REGION	KJN	.35	51
13	KODIAK ISLAND REGION	KTG	.19	11
13	KODIAK ISLAND REGION	LAO	-.29	29
13	KODIAK ISLAND REGION	LON	-.39	23
13	KODIAK ISLAND REGION	LPS	.22	20
13	KODIAK ISLAND REGION	MEC	-.00	53
13	KODIAK ISLAND REGION	MCX	.25	32
13	KODIAK ISLAND REGION	NEW	-.17	14
13	KODIAK ISLAND REGION	NCR	-.21	22
13	KODIAK ISLAND REGION	NP-	-.05	46
13	KODIAK ISLAND REGION	NUR	.46	29
13	KODIAK ISLAND REGION	OIS	-.08	1
13	KODIAK ISLAND REGION	PMG	.05	12
13	KODIAK ISLAND REGION	PCO	.21	10
13	KODIAK ISLAND REGION	PRU	-.01	7
13	KODIAK ISLAND REGION	RAB	-.10	6
13	KODIAK ISLAND REGION	RCD	.25	8
13	KODIAK ISLAND REGION	SHL	-.17	15
13	KODIAK ISLAND REGION	SJG	.04	13
13	KODIAK ISLAND REGION	STU	-.01	15
13	KODIAK ISLAND REGION	TFO	-.31	164
13	KODIAK ISLAND REGION	TSK	.12	8
13	KODIAK ISLAND REGION	TUC	-.18	11
13	KODIAK ISLAND REGION	UBO	-.18	170
13	KODIAK ISLAND REGION	WMO	-.41	110

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
14	KENAI PENINSULA, ALASKA	WMO	-.18	25
14	KENAI PENINSULA, ALASKA	ALE	.08	1
14	KENAI PENINSULA, ALASKA	ALQ	-.54	4
14	KENAI PENINSULA, ALASKA	UBO	-.02	47
14	KENAI PENINSULA, ALASKA	TUC	-.23	2
14	KENAI PENINSULA, ALASKA	BMO	-.38	42
14	KENAI PENINSULA, ALASKA	TSK	.51	2
14	KENAI PENINSULA, ALASKA	BOZ	-.53	3
14	KENAI PENINSULA, ALASKA	TFO	-.36	22
14	KENAI PENINSULA, ALASKA	SHL	-.21	3
14	KENAI PENINSULA, ALASKA	COL	.85	13
14	KENAI PENINSULA, ALASKA	PMG	-.15	1
14	KENAI PENINSULA, ALASKA	CPO	-.21	8
14	KENAI PENINSULA, ALASKA	DUG	-.38	6
14	KENAI PENINSULA, ALASKA	EDM	.40	4
14	KENAI PENINSULA, ALASKA	EUR	-.01	12
14	KENAI PENINSULA, ALASKA	FBC	.11	1
14	KENAI PENINSULA, ALASKA	NUR	.47	1
14	KENAI PENINSULA, ALASKA	NP-	-.47	10
14	KENAI PENINSULA, ALASKA	NEW	-.99	4
14	KENAI PENINSULA, ALASKA	GOL	-.28	1
14	KENAI PENINSULA, ALASKA	MOX	.37	3
14	KENAI PENINSULA, ALASKA	ILG	.34	5
14	KENAI PENINSULA, ALASKA	MBC	.03	3
14	KENAI PENINSULA, ALASKA	KEV	.08	3
14	KENAI PENINSULA, ALASKA	KJN	.31	8
14	KENAI PENINSULA, ALASKA	KTG	.23	1
14	KENAI PENINSULA, ALASKA	LAO	-.11	11
14	KENAI PENINSULA, ALASKA	LON	-.27	3
14	KENAI PENINSULA, ALASKA	LPS	.62	3

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
15	GULF OF ALASKA	WMO	-.27	59
15	GULF OF ALASKA	ALE	-.05	2
15	GULF OF ALASKA	ALG	-.22	6
15	GULF OF ALASKA	ATL	.19	5
15	GULF OF ALASKA	BKS	-.09	6
15	GULF OF ALASKA	BMO	-.21	70
15	GULF OF ALASKA	BNS	.27	6
15	GULF OF ALASKA	BOZ	.00	7
15	GULF OF ALASKA	CAR	-.30	2
15	GULF OF ALASKA	UBO	-.04	71
15	GULF OF ALASKA	COL	.37	31
15	GULF OF ALASKA	COP	.47	5
15	GULF OF ALASKA	CPO	-.28	22
15	GULF OF ALASKA	DUG	-.49	16
15	GULF OF ALASKA	TUC	-.16	4
15	GULF OF ALASKA	EUR	-.25	34
15	GULF OF ALASKA	FBC	.10	3
15	GULF OF ALASKA	FUR	-.11	4
15	GULF OF ALASKA	GDH	.22	2
15	GULF OF ALASKA	GIL	.34	2
15	GULF OF ALASKA	GOL	-.56	5
15	GULF OF ALASKA	GRF	.34	1
15	GULF OF ALASKA	ILG	.16	5
15	GULF OF ALASKA	JCT	.10	6
15	GULF OF ALASKA	KEV	-.06	5
15	GULF OF ALASKA	KJN	.05	12
15	GULF OF ALASKA	KTG	-.08	4
15	GULF OF ALASKA	LAO	-.15	20
15	GULF OF ALASKA	LON	-.38	11
15	GULF OF ALASKA	LPS	.47	4
15	GULF OF ALASKA	MBC	-.33	14
15	GULF OF ALASKA	MOX	.25	10
15	GULF OF ALASKA	NEW	-.10	4
15	GULF OF ALASKA	NOR	-.02	6
15	GULF OF ALASKA	NP-	-.28	21
15	GULF OF ALASKA	NUR	.22	6
15	GULF OF ALASKA	TSK	.04	7
15	GULF OF ALASKA	PMG	.51	2
15	GULF OF ALASKA	P00	.31	4
15	GULF OF ALASKA	PRU	-.06	1
15	GULF OF ALASKA	RAB	-.43	2
15	GULF OF ALASKA	TFO	-.30	61
15	GULF OF ALASKA	SHL	.21	9
15	GULF OF ALASKA	SJG	.05	6
15	GULF OF ALASKA	STU	-.20	3

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE EIAS	NUMBER OBSERVATIONS
16	ALEUTIAN ISLANDS REGION	MMO	-.08	45
16	ALEUTIAN ISLANDS REGION	ALE	-.64	1
16	ALEUTIAN ISLANDS REGION	ALQ	-.11	2
16	ALEUTIAN ISLANDS REGION	UBO	-.08	70
16	ALEUTIAN ISLANDS REGION	OKS	.35	2
16	ALEUTIAN ISLANDS REGION	BMO	-.21	39
16	ALEUTIAN ISLANDS REGION	TUC	-.06	2
16	ALEUTIAN ISLANDS REGION	BOZ	.15	16
16	ALEUTIAN ISLANDS REGION	CAR	.56	1
16	ALEUTIAN ISLANDS REGION	TFO	-.49	62
16	ALEUTIAN ISLANDS REGION	COL	-.37	26
16	ALEUTIAN ISLANDS REGION	COP	.66	2
16	ALEUTIAN ISLANDS REGION	CPO	-.19	45
16	ALEUTIAN ISLANDS REGION	DUG	-.58	1
16	ALEUTIAN ISLANDS REGION	SJG	.66	2
16	ALEUTIAN ISLANDS REGION	EUR	.17	22
16	ALEUTIAN ISLANDS REGION	FBC	-.29	1
16	ALEUTIAN ISLANDS REGION	SHL	.26	5
16	ALEUTIAN ISLANDS REGION	GDH	-.06	1
16	ALEUTIAN ISLANDS REGION	RCD	.21	4
16	ALEUTIAN ISLANDS REGION	GOL	.74	1
16	ALEUTIAN ISLANDS REGION	RAB	-.36	2
16	ALEUTIAN ISLANDS REGION	PRU	.29	1
16	ALEUTIAN ISLANDS REGION	POO	-.09	2
16	ALEUTIAN ISLANDS REGION	KEV	-.19	1
16	ALEUTIAN ISLANDS REGION	NUR	.32	4
16	ALEUTIAN ISLANDS REGION	KTG	.47	2
16	ALEUTIAN ISLANDS REGION	LAO	-.38	1
16	ALEUTIAN ISLANDS REGION	LON	-.38	2
16	ALEUTIAN ISLANDS REGION	LPS	-.22	2
16	ALEUTIAN ISLANDS REGION	MBC	-.06	2

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
17	SOUTH OF ALASKA	AD-	.70	5
17	SOUTH OF ALASKA	ALE	-.08	5
17	SOUTH OF ALASKA	ALQ	-.47	11
17	SOUTH OF ALASKA	ATL	.05	1
17	SOUTH OF ALASKA	BKS	-.12	3
17	SOUTH OF ALASKA	BMO	-.51	33
17	SOUTH OF ALASKA	BNS	.18	4
17	SOUTH OF ALASKA	BOZ	-.08	11
17	SOUTH OF ALASKA	CAR	.22	5
17	SOUTH OF ALASKA	WMO	-.04	45
17	SOUTH OF ALASKA	COL	.19	16
17	SOUTH OF ALASKA	COP	.19	6
17	SOUTH OF ALASKA	CPO	-.04	31
17	SOUTH OF ALASKA	DUG	-.16	19
17	SOUTH OF ALASKA	EDM	.41	3
17	SOUTH OF ALASKA	EUR	-.02	28
17	SOUTH OF ALASKA	FBC	.19	7
17	SOUTH OF ALASKA	FUR	-.45	2
17	SOUTH OF ALASKA	GDH	-.09	5
17	SOUTH OF ALASKA	GIL	-.35	3
17	SOUTH OF ALASKA	GOL	-.33	6
17	SOUTH OF ALASKA	GRF	-.09	3
17	SOUTH OF ALASKA	ILG	-.07	15
17	SOUTH OF ALASKA	JCT	.47	3
17	SOUTH OF ALASKA	KEV	.31	11
17	SOUTH OF ALASKA	KJN	.27	9
17	SOUTH OF ALASKA	KTG	.17	4
17	SOUTH OF ALASKA	LAO	-.11	9
17	SOUTH OF ALASKA	LON	-.49	10
17	SOUTH OF ALASKA	LPS	.29	3
17	SOUTH OF ALASKA	MBC	.07	16
17	SOUTH OF ALASKA	MOX	.09	7
17	SOUTH OF ALASKA	NEW	.02	8
17	SOUTH OF ALASKA	NOR	-.07	7
17	SOUTH OF ALASKA	NP-	.09	12
17	SOUTH OF ALASKA	NUR	.41	9
17	SOUTH OF ALASKA	OIS	-.13	2
17	SOUTH OF ALASKA	PMG	.17	11
17	SOUTH OF ALASKA	P00	.13	4
17	SOUTH OF ALASKA	PRU	-.02	3
17	SOUTH OF ALASKA	RAB	-.29	1
17	SOUTH OF ALASKA	RCD	.30	5
17	SOUTH OF ALASKA	SHL	-.15	7
17	SOUTH OF ALASKA	SJG	.11	5
17	SOUTH OF ALASKA	STU	-.04	4
17	SOUTH OF ALASKA	TFO	-.40	52
17	SOUTH OF ALASKA	TSK	-.06	3
17	SOUTH OF ALASKA	TUC	-.33	7
17	SOUTH OF ALASKA	UBO	.01	52

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
19	SOUTHEASTERN ALASKA	WMO	-.12	13
19	SOUTHEASTERN ALASKA	ALE	-.18	1
19	SOUTHEASTERN ALASKA	ALQ	.08	1
19	SOUTHEASTERN ALASKA	ATL	-.23	1
19	SOUTHEASTERN ALASKA	UBO	-.32	14
19	SOUTHEASTERN ALASKA	BMO	-.54	10
19	SOUTHEASTERN ALASKA	TSK	.39	1
19	SOUTHEASTERN ALASKA	BOZ	-.43	6
19	SOUTHEASTERN ALASKA	TFO	-.44	14
19	SOUTHEASTERN ALASKA	STU	.34	1
19	SOUTHEASTERN ALASKA	COL	.33	8
19	SOUTHEASTERN ALASKA	SJG	.19	1
19	SOUTHEASTERN ALASKA	CPO	-.49	4
19	SOUTHEASTERN ALASKA	DUG	-.16	5
19	SOUTHEASTERN ALASKA	SHL	.34	1
19	SOUTHEASTERN ALASKA	EUR	-.15	10
19	SOUTHEASTERN ALASKA	FBC	.11	1
19	SOUTHEASTERN ALASKA	NUR	.70	2
19	SOUTHEASTERN ALASKA	GDH	.08	1
19	SOUTHEASTERN ALASKA	NP-	-.52	2
19	SOUTHEASTERN ALASKA	GOL	-.55	1
19	SOUTHEASTERN ALASKA	NOR	.37	1
19	SOUTHEASTERN ALASKA	NEW	.47	2
19	SOUTHEASTERN ALASKA	MOX	.51	6
19	SOUTHEASTERN ALASKA	KEV	.50	3
19	SOUTHEASTERN ALASKA	KJN	.33	4
19	SOUTHEASTERN ALASKA	KTG	-.45	1
19	SOUTHEASTERN ALASKA	LAO	-.24	3
19	SOUTHEASTERN ALASKA	LON	-.02	5
19	SOUTHEASTERN ALASKA	MBC	.10	1

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
22	QUEEN CHARLOTTE ISLANDS REGION	WMO	-.06	8
22	QUEEN CHARLOTTE ISLANDS REGION	UBO	-.26	10
22	QUEEN CHARLOTTE ISLANDS REGION	ALQ	-.27	2
22	QUEEN CHARLOTTE ISLANDS REGION	TFO	-.40	12
22	QUEEN CHARLOTTE ISLANDS REGION	RCD	.59	1
22	QUEEN CHARLOTTE ISLANDS REGION	BMO	.45	7
22	QUEEN CHARLOTTE ISLANDS REGION	NP-	-.13	3
22	QUEEN CHARLOTTE ISLANDS REGION	BOZ	-.15	3
22	QUEEN CHARLOTTE ISLANDS REGION	CAR	.17	1
22	QUEEN CHARLOTTE ISLANDS REGION	NEW	.76	1
22	QUEEN CHARLOTTE ISLANDS REGION	COL	-.23	5
22	QUEEN CHARLOTTE ISLANDS REGION	MOX	-.08	1
22	QUEEN CHARLOTTE ISLANDS REGION	CPO	-.22	4
22	QUEEN CHARLOTTE ISLANDS REGION	DUG	-.46	6
22	QUEEN CHARLOTTE ISLANDS REGION	MBC	-.32	2
22	QUEEN CHARLOTTE ISLANDS REGION	EUR	-.67	9
22	QUEEN CHARLOTTE ISLANDS REGION	LPS	.86	1
22	QUEEN CHARLOTTE ISLANDS REGION	LON	.48	4
22	QUEEN CHARLOTTE ISLANDS REGION	GDH	-.20	1
22	QUEEN CHARLOTTE ISLANDS REGION	LAO	-.30	4
22	QUEEN CHARLOTTE ISLANDS REGION	GOL	-.57	3
22	QUEEN CHARLOTTE ISLANDS REGION	KJN	.74	1
22	QUEEN CHARLOTTE ISLANDS REGION	ILG	.24	2

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
25	VANCOUVER ISLAND REGION	WMO	-.13	64
25	VANCOUVER ISLAND REGION	UBO	-.22	72
25	VANCOUVER ISLAND REGION	ALQ	-.19	21
25	VANCOUVER ISLAND REGION	TUC	-.10	10
25	VANCOUVER ISLAND REGION	BKS	.75	2
25	VANCOUVER ISLAND REGION	BMO	.28	62
25	VANCOUVER ISLAND REGION	BNS	-.10	3
25	VANCOUVER ISLAND REGION	BOZ	.36	7
25	VANCOUVER ISLAND REGION	CAR	.19	3
25	VANCOUVER ISLAND REGION	TFO	-.26	74
25	VANCOUVER ISLAND REGION	COL	-.34	25
25	VANCOUVER ISLAND REGION	SJG	.53	2
25	VANCOUVER ISLAND REGION	CPO	-.00	13
25	VANCOUVER ISLAND REGION	DUG	-.46	24
25	VANCOUVER ISLAND REGION	NUR	.27	2
25	VANCOUVER ISLAND REGION	EUR	.10	61
25	VANCOUVER ISLAND REGION	NP-	-.18	12
25	VANCOUVER ISLAND REGION	NOR	.35	1
25	VANCOUVER ISLAND REGION	GDH	.01	4
25	VANCOUVER ISLAND REGION	GIL	-.29	13
25	VANCOUVER ISLAND REGION	GOL	-.44	12
25	VANCOUVER ISLAND REGION	NEW	.60	3
25	VANCOUVER ISLAND REGION	ILG	-.86	1
25	VANCOUVER ISLAND REGION	JCT	.10	7
25	VANCOUVER ISLAND REGION	KEV	.02	2
25	VANCOUVER ISLAND REGION	KJN	.14	13
25	VANCOUVER ISLAND REGION	MOX	.04	1
25	VANCOUVER ISLAND REGION	LAO	-.49	12
25	VANCOUVER ISLAND REGION	LON	.27	22
25	VANCOUVER ISLAND REGION	LPS	.27	4
25	VANCOUVER ISLAND REGION	MBC	-.21	1

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
30	OFF COAST OF OREGON	AD-	-.19	1
30	OFF COAST OF OREGON	ALE	.30	2
30	OFF COAST OF OREGON	ALQ	-.58	34
30	OFF COAST OF OREGON	ATL	.17	5
30	OFF COAST OF OREGON	BKS	.12	5
30	OFF COAST OF OREGON	BMO	.26	117
30	OFF COAST OF OREGON	BNS	.06	1
30	OFF COAST OF OREGON	BOZ	.57	18
30	OFF COAST OF OREGON	CAR	.52	4
30	OFF COAST OF OREGON	WMO	.14	126
30	OFF COAST OF OREGON	COL	-.41	24
30	OFF COAST OF OREGON	COP	.05	1
30	OFF COAST OF OREGON	CPO	.09	51
30	OFF COAST OF OREGON	DUG	.08	39
30	OFF COAST OF OREGON	EDM	.83	1
30	OFF COAST OF OREGON	EUR	.45	65
30	OFF COAST OF OREGON	FBC	.06	1
30	OFF COAST OF OREGON	UBO	-.25	110
30	OFF COAST OF OREGON	GDH	-.33	4
30	OFF COAST OF OREGON	GIL	-.54	4
30	OFF COAST OF OREGON	GOL	-.81	25
30	OFF COAST OF OREGON	TUC	-.40	8
30	OFF COAST OF OREGON	ILG	.59	5
30	OFF COAST OF OREGON	JCT	-.18	2
30	OFF COAST OF OREGON	KEV	.05	2
30	OFF COAST OF OREGON	KJN	.11	8
30	OFF COAST OF OREGON	KTG	-.07	1
30	OFF COAST OF OREGON	LAO	-.37	11
30	OFF COAST OF OREGON	LON	.35	41
30	OFF COAST OF OREGON	LPS	.15	1
30	OFF COAST OF OREGON	MBC	.15	4
30	OFF COAST OF OREGON	MOX	-.10	2
30	OFF COAST OF OREGON	NEW	.52	4
30	OFF COAST OF OREGON	TSK	-.39	2
30	OFF COAST OF OREGON	NP-	-.26	15
30	OFF COAST OF OREGON	TFO	-.47	123
30	OFF COAST OF OREGON	STU	.01	1
30	OFF COAST OF OREGON	PMG	-.47	1
30	OFF COAST OF OREGON	SJG	.21	5
30	OFF COAST OF OREGON	RCD	.01	2

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
34	OFF COAST OF NORTHERN CALIFORNIA	WMO	-.25	52
34	OFF COAST OF NORTHERN CALIFORNIA	UBO	.21	57
34	OFF COAST OF NORTHERN CALIFORNIA	ALQ	-.75	4
34	OFF COAST OF NORTHERN CALIFORNIA	TUC	-.41	2
34	OFF COAST OF NORTHERN CALIFORNIA	TFO	-.01	59
34	OFF COAST OF NORTHERN CALIFORNIA	BMO	.31	55
34	OFF COAST OF NORTHERN CALIFORNIA	SJG	.25	3
34	OFF COAST OF NORTHERN CALIFORNIA	BOZ	.57	9
34	OFF COAST OF NORTHERN CALIFORNIA	CAR	.39	1
34	OFF COAST OF NORTHERN CALIFORNIA	CLL	.14	1
34	OFF COAST OF NORTHERN CALIFORNIA	COL	-.75	3
34	OFF COAST OF NORTHERN CALIFORNIA	RCD	-.03	2
34	OFF COAST OF NORTHERN CALIFORNIA	CPO	-.16	21
34	OFF COAST OF NORTHERN CALIFORNIA	DUG	.43	18
34	OFF COAST OF NORTHERN CALIFORNIA	PRU	.31	1
34	OFF COAST OF NORTHERN CALIFORNIA	EUR	.23	48
34	OFF COAST OF NORTHERN CALIFORNIA	NUR	-.11	2
34	OFF COAST OF NORTHERN CALIFORNIA	NP-	-.53	2
34	OFF COAST OF NORTHERN CALIFORNIA	GDH	.29	2
34	OFF COAST OF NORTHERN CALIFORNIA	MOX	.37	2
34	OFF COAST OF NORTHERN CALIFORNIA	GOL	-.65	5
34	OFF COAST OF NORTHERN CALIFORNIA	LON	.21	17
34	OFF COAST OF NORTHERN CALIFORNIA	ILG	.71	4
34	OFF COAST OF NORTHERN CALIFORNIA	JCT	-.22	3
34	OFF COAST OF NORTHERN CALIFORNIA	LAO	-.69	9
34	OFF COAST OF NORTHERN CALIFORNIA	KJN	-.35	1
34	OFF COAST OF NORTHERN CALIFORNIA	KTG	.49	1

DEPTH RANGE 0 KM TO 700 KM NMAX = 1

REGION NO.	GEOGRAPHICAL REGION	STATION	MAGNITUDE BIAS	NUMBER OBSERVATIONS
39	CENTRAL CALIFORNIA	WMO	-.68	13
39	CENTRAL CALIFORNIA	UBO	.34	65
39	CENTRAL CALIFORNIA	ALQ	-.14	1
39	CENTRAL CALIFORNIA	TFO	.09	91
39	CENTRAL CALIFORNIA	STU	.20	1
39	CENTRAL CALIFORNIA	BMC	.09	28
39	CENTRAL CALIFORNIA	BNS	.37	1
39	CENTRAL CALIFORNIA	BOZ	.81	1
39	CENTRAL CALIFORNIA	CAR	.04	1
39	CENTRAL CALIFORNIA	CLL	.80	1
39	CENTRAL CALIFORNIA	COL	-.34	4
39	CENTRAL CALIFORNIA	SJG	.20	2
39	CENTRAL CALIFORNIA	CPO	-.34	11
39	CENTRAL CALIFORNIA	DUG	.02	22
39	CENTRAL CALIFORNIA	NP-	-.25	3
39	CENTRAL CALIFORNIA	EUR	-.35	39
39	CENTRAL CALIFORNIA	FBC	.12	1
39	CENTRAL CALIFORNIA	NOR	-.42	1
39	CENTRAL CALIFORNIA	MOX	.34	2
39	CENTRAL CALIFORNIA	GIL	.97	1
39	CENTRAL CALIFORNIA	GOL	-.28	2
39	CENTRAL CALIFORNIA	MBC	-.18	1
39	CENTRAL CALIFORNIA	ILG	-.28	1
39	CENTRAL CALIFORNIA	JCT	-.83	1
39	CENTRAL CALIFORNIA	KEV	.36	1
39	CENTRAL CALIFORNIA	KJN	-.05	2
39	CENTRAL CALIFORNIA	LON	.05	5
39	CENTRAL CALIFORNIA	LAO	-.65	2