# NORSAR

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# SEMIANNUAL TECHNICAL REPORT
# NORSAR PHASE 3

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## C. INVESTIGATIONS OF POSSIBLE BIAS IN $m_b$ MAGNITUDE MEASUREMENTS

The $m_b$ magnitude parameter, measured on records of short period waves, is a convenient and widely used tool for ranking of earthquakes. The problem of a possible bias in the NORSAR estimation procedure of $m_b$ magnitudes and also that used by the International Seismological Centre (ISC) in Edinburgh have been investigated.

TABLE C1

Estimated magnitude biases due to subarray power loss and skewed maximum power distribution, conditioned on the number of subarrays. The latter parameter represents a decreasing ordering of subarrays based on maximum power ranking.

| No. of Subarrays | dm(loss) ($m_b$-units) | dm(skew) ($m_b$-units) |
|---|---|---|
| 3 | 0.28 ± 0.06 | 0.0 ± 0.01 |
| 6 | 0.23 ± 0.05 | -0.01 ± 0.01 |
| 9 | 0.20 ± 0.04 | -0.02 ± 0.01 |
| 12 | 0.16 ± 0.04 | -0.03 ± 0.02 |
| 15 | 0.14 ± 0.04 | -0.04 ± 0.02 |
| 18 | 0.11 ± 0.03 | -0.05 ± 0.03 |
| Operational $19 \leq No \leq 22$ | 0.08 ± 0.03 | -0.07 ± 0.03 |

| | |
|---|---|
| Estimated skewness of subarray max. power distribution | 1.26 ± 0.63 |
| Estimated skewness for log-transformation of max. power | -0.10 ± 0.42 |
| Correlation between signal loss and skewness effects | -0.40 corr. units |
| Sample size | 222 events |

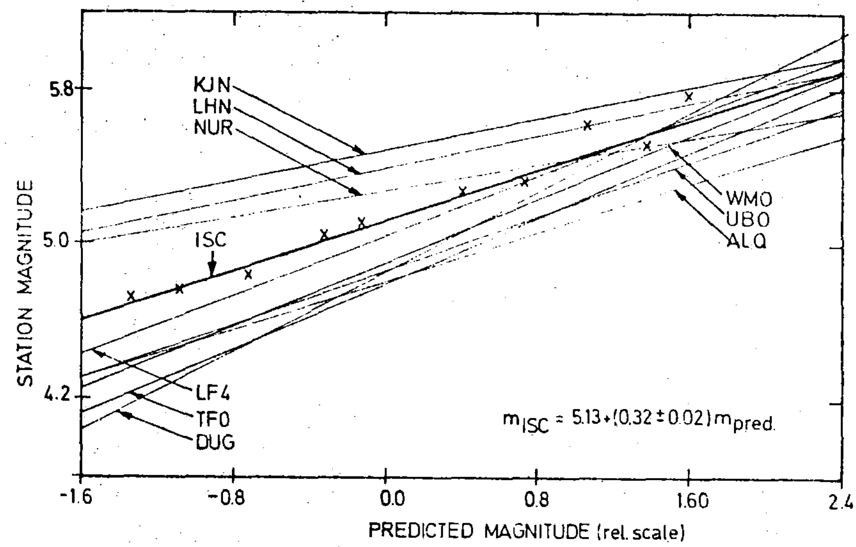


Fig. C1 Comparison between event magnitudes as predicted from a multivariate analysis of ISC data for Japan, and that of the individual stations used in the analysis. The relationship between ISC reported magnitudes and predicted magnitude is also given. Dots are observed points for this line. This figure is based on 40 events occurring in the Japan region in 1968 and reported jointly by the 9 stations listed on the figure.

The signal energy losses observed during NORSAR P-wave beamforming do not affect its event magnitude estimates due to a skew, approximately lognormal, P-amplitude distribution across the array (see Table C1). Using a linear prognosis model for checking the NORSAR-NOAA magnitude relationship, we found that for most regions the regression coefficients were significantly different from 1.0. In other words, the magnitude correction cannot be considered a constant, but depends on event magnitude and source region.

A multivariate analysis of ISC data for Japan and the Aleutian Islands gave a consistent and linear relationship between the ISC event magnitude and that predicted from subsets of 5-9 stations in the $m_b$ 4.0-6.0 magnitude range investigated. In this respect the ISC reported magnitudes are considered unbiased. We also found that the magnitude observations may be approximated by a normal distribution which corresponds to a lognormal amplitude distribution.

In the analysis of the ISC data, a linear physical model was used, i.e., the relationship between individual station magnitude and true event magnitude. It is here interesting to note that for the Japan region the regression coefficients were significantly different from each other (see Fig. C1), i.e., the magnitude correction is a function of event magnitude even when physical models are used in the magnitude analysis. This phenomenon is quantitatively explained as the combined effect of the seismic spectra scaling law and the frequency dependent crust-upper mantle transfer function.

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REFERENCES

Husebye, E.S., A. Dahle and K.A. Berteussen: 'Bias analysis of NORSAR and ISC reported $m_b$ magnitudes, In preparation.