**NORSAR** ROYAL NORWEGIAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

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# FINAL TECHNICAL SUMMARY

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Edited by

H. Gjøystdal

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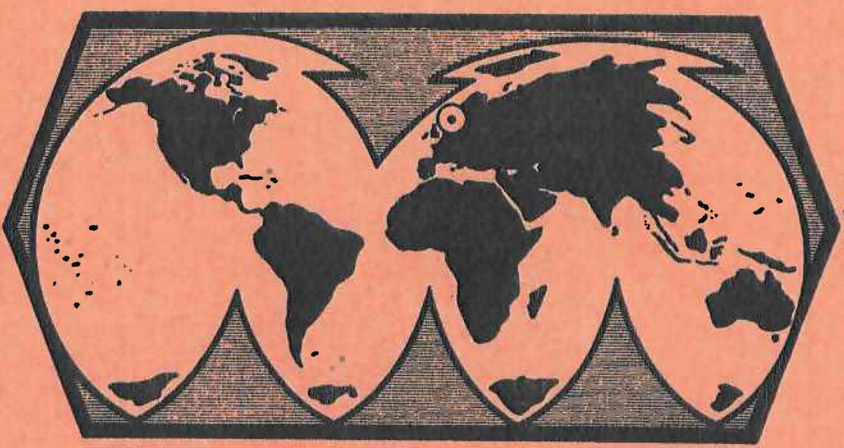

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## VI.6 Long Period Noise Level Variations at NORSAR

Ringdal and Bungum (1977) have in a comprehensive study discussed the effect of noise level variations on the NORSAR detectability of seismic events. The paper was confined to the study of microseismic noise conditions, and time intervals containing signals from earthquakes or explosions were therefore excluded from consideration in order not to bias the noise statistics. However, to obtain a proper picture of the capability of NORSAR to detect signals from an event of a given magnitude, it is important also to assess the amount of degraded performance due to interfering signals. This is the background for the present study, which is intended to compare the 'noise' statistics that are obtained including time periods when interfering events occur, to those discussed by Ringdal and Bungum (1976). Only the LPZ components are included in this summary, as the problem of interest mainly applies to the detection of Rayleigh waves of explosions in the presence of an interfering earthquake.

For the present study, two years (1973-74) of hourly sampled noise statistics (Long Term Average - LTA) of 22 unfiltered LPZ components, as accumulated by the NORSAR On-line Detection Processor, were analyzed statistically. (For further description of the sampling process, we refer to Ringdal and Bungum, 1977.) Figure VI.6.1 shows the resulting fluctuations of RMS noise levels averaged across the array for the year 1973. The interfering events are manifested as spikes of very short duration, usually much less than one hour. Nonetheless, these spikes dominate the picture at large amplitudes, and are also seen to cause considerable influence at lower noise levels. Note that the limited dynamic range of the detection processor causes clipping of the very largest RMS values - this is, however, of no consequence in the following discussion.

Figure VI.6.2 shows cumulative noise level statistics over the two years 1973-74. The plots are made on normal probability paper, with logarithmic scaling of the amplitude axis. We note that each of the two distributions appears slightly curved, and thus may not be well approximated by a straight line over the whole range of values. This indicates that the commonly assumed lognormal distribution of noise amplitudes at a given station may not be entirely adequate for long period data. Comparing the two distributions, we note that the influence of including time intervals of interfering events in the observations is of little consequence at the 50 per cent level (a difference of only 1.4 dB or less than 0.1 $M_s$ units). Even at the 90 per cent level the difference is modest (3.2 dB). However, at higher probability levels the two distributions diverge rapidly, and their difference reaches 12 dB at 99 per cent level. It is expected that the differences at low probability levels would be more significant in a narrow frequency band around 20 seconds period than in the wide-band case considered here, since small signals would then more easily influence the noise level. Thus, von Seggern and Blandford (1976) obtained differences of nearly 0.3 magnitude units at the 50 per cent level when considering noise peaks of periods around 20 seconds observed at the VLPE station at Charters Towers, Australia. One should, however, remember that the expected decrease in detectability in the presence of interfering events could be partly offset by applying multichannel techniques to suppress the unwanted signals.

In conclusion, in a statistical model, it appears that the presence of interfering events will have a relatively modest influence on the NORSAR detection probability of surface waves, up to the 90 per cent level. Above this level, the influence will be more significant, and should be dealt with accordingly when establishing models either for NORSAR detection capabilities or for the surface wave detection capability of global networks.

F. Ringdal

## References

Ringdal, F., and H. Bungum (1977): Noise level variation at NORSAR and its effect on detectability, Bull. Seism. Soc. Amer., 67, 479-492.

von Seggern, D., and R. Blandford (1976): Seismic threshold determination, Bull. Seism. Soc. Amer., 66, 753-788.

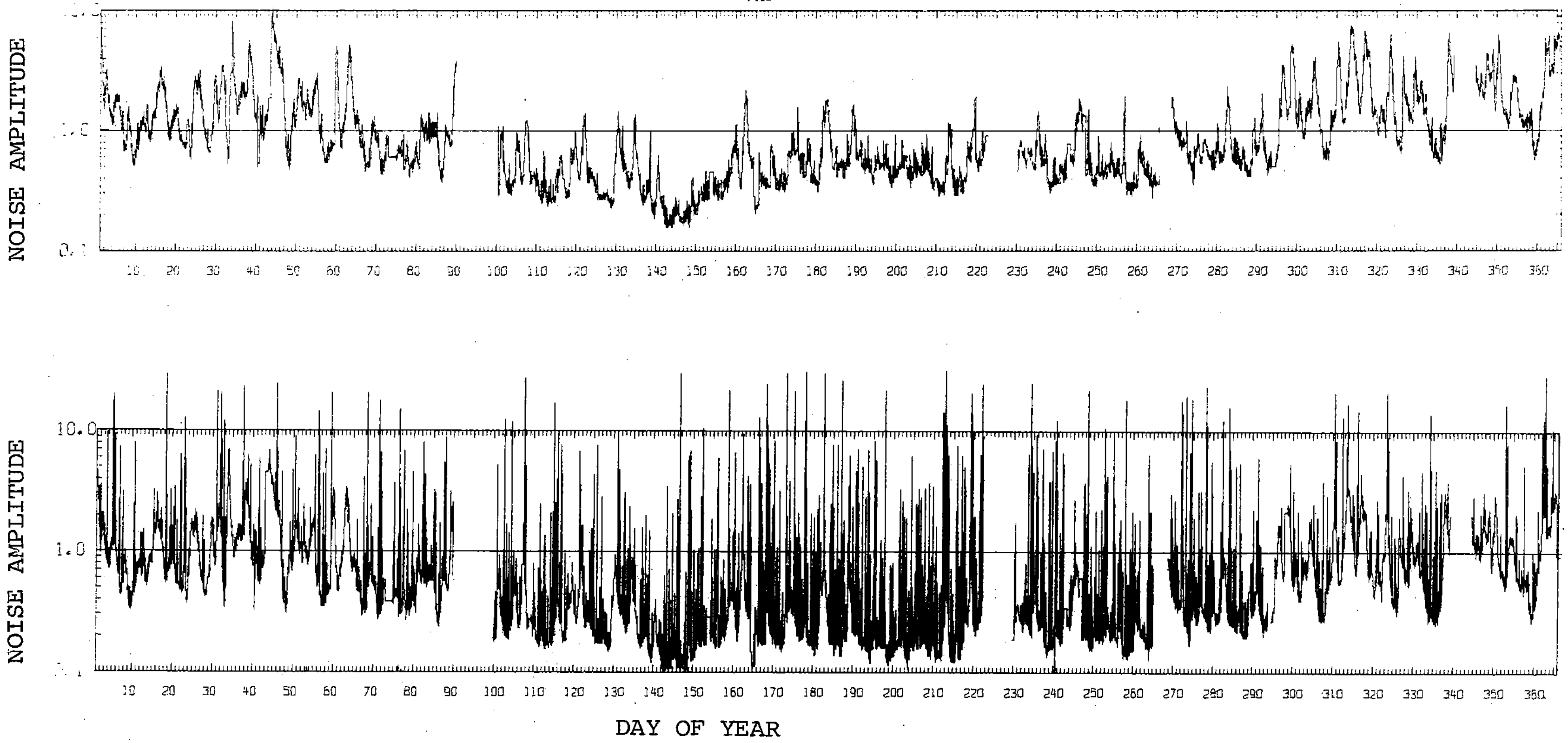


Fig. VI.6.1 Fluctuations in seismic noise level at NORSAR (average RMS value across the array for LPZ instruments) during the year 1973. The upper curve represents data where time intervals containing signals from interfering events have been excluded from consideration. The lower curve has been obtained not applying these restrictions, i.e., using the entire time interval. Both curves are scaled relative to the average value during the year.

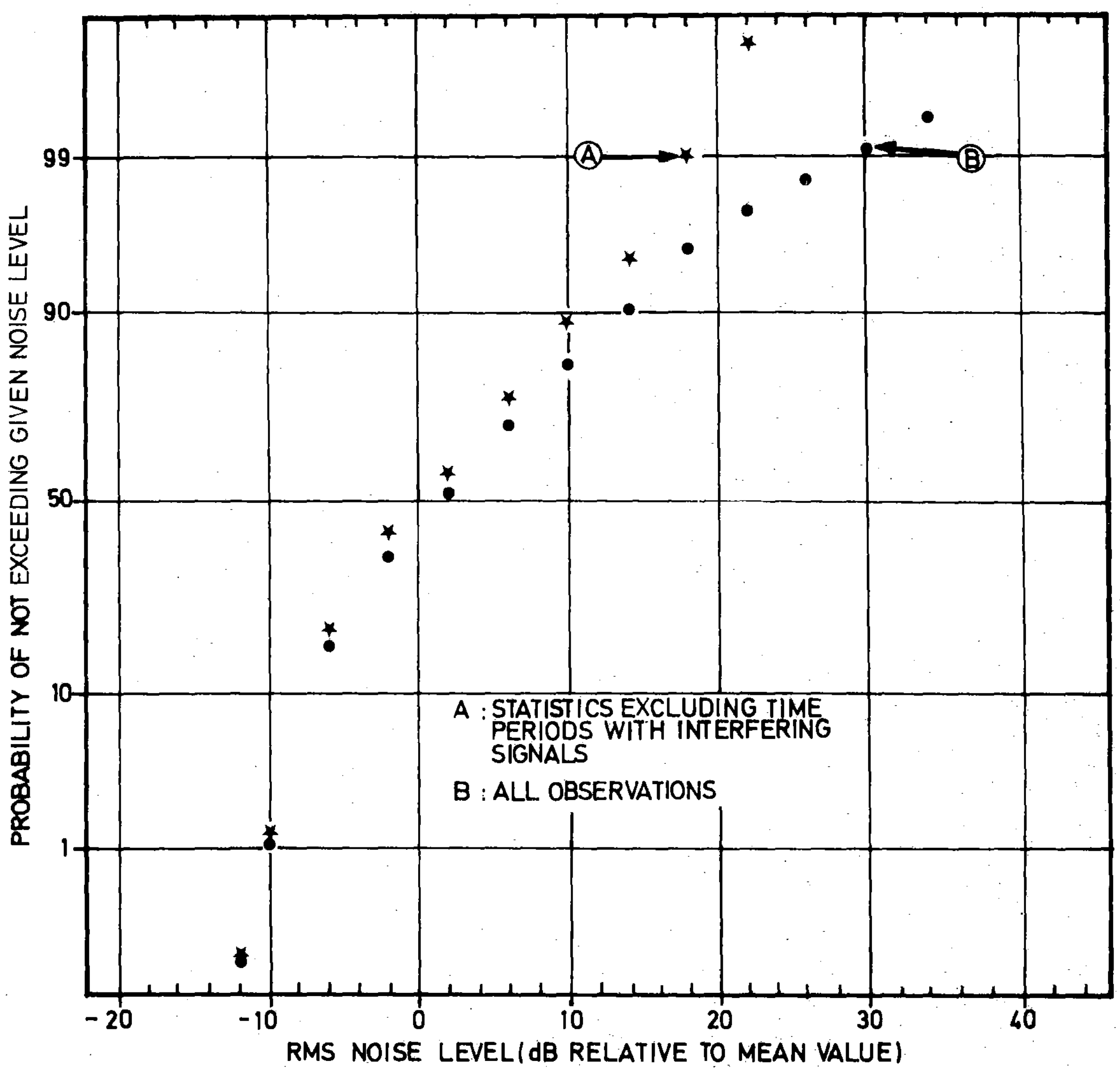


Fig. VI.6.2 Cumulative RMS noise level statistics for the average LPZ channel (unfiltered) at NORSAR during the years 1973-74. Two cases are displayed, one including and one excluding time periods where interfering signals from earthquakes have occurred.