NORSAR

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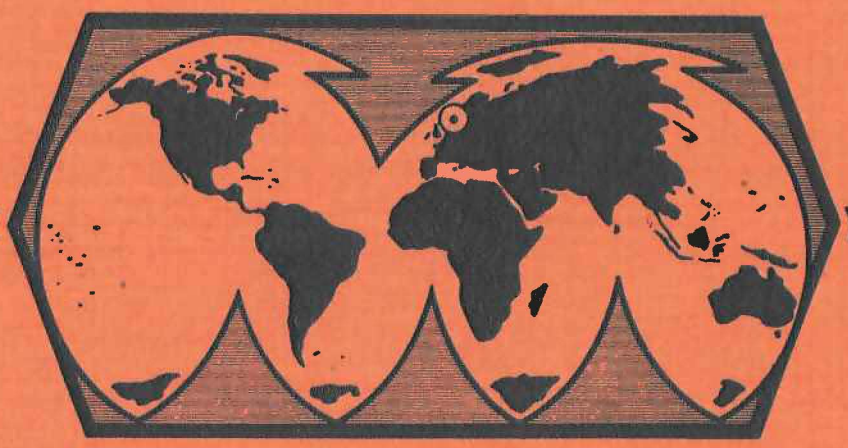

VI.3 The effect of aliasing on the NORSAR detector performance

The standard NORSAR data are recorded with a sampling rate of 20 Hz, but with an anti-aliasing filter at 5 Hz (4.75 Hz to be precise). The reason for this is that the on-line Detection Processing (DP) has always been done at a 10 Hz sampling rate, and the filter has been kept low enough to avoid aliasing problems there.

With the increased interest for regional phases and higher frequencies the question has been raised if the filter could be changed from 5 Hz to 8 Hz, and we have therefore now investigated the effect of this on the on-line detector system. This has been done on the basis of data that have been recorded experimentally with 8 Hz filters at some individual channels. Most of the events analyzed, shown in Table VI.3.1, are taken from a time period in 1978/79 when we had 5 subarray center seismometers equipped with 8 Hz filters (01A00, 02B00, 02C00, 04C00, 06C00), and the rest of the data are from 1982/83, with only 2 '8 Hz channels' in operation.

We have selected events (see Table VI.3.1) from regions with particularly high-frequency signals, which are the signals that presumably should be most affected by aliasing problems as a result of combining 8 Hz filters with 10 Hz processing. The analysis procedure has been as follows:

1. The 17 events in Table VI.3.1 were selected and the data put on disk files.

2. For each event, the data were then plotted as shown on the example in Fig. VI.3.1, with 2 sampling rates (20 and 10 Hz) and 2 filters (1.2-3.2 and 2.0-4.0 Hz). These filter bands are identical to those presently used in NORSAR DP. For comparison, the unfiltered trace was also plotted.

3. For each of the 4 filtered traces, STA/LTA was computed in a way as close as possible to what is done in DP, with options to plot both STA, LTA and STA/LTA traces. The latter ones are shown in Fig. VI.3.2 for the data plotted in Fig. VI.3.1. It is seen from that figure that we do lose some SNR as a result of the decimating process, for the 1.2-3.2 Hz the SNR drops from 3.97 to 3.83 and for the and for the 2.0-4.0 Hz filter from 7.27 to 6.40.

The results for all of the events analyzed are shown in Figs. VI.3.3-4, plotted individually for teleseismic and regional events, and for each of the 2 filters for each event group. We can draw the following conclusions from the figures:

1. For teleseismic events processed at 1.2-3.2 Hz, a change from 5 to 8 Hz anti-aliasing filters would not affect the performance of the 10 Hz DP.

2. For teleseismic events processed at 2.0-4.0 Hz there is a loss in SNR typically around 1-2 dB. For the events analyzed here (and generally for most Eurasian events recorded at NORSAR) this filter band has a significantly better SNR, and a filter change as discussed can therefore not be implemented without a clear negative effect on the DP performance.

3. For regional and local events we see from Fig. VI.3.4 that the scatter in the SNR values is much larger than for the teleseismic events, but with no systematic difference in the SNR range critical for detections. A filter change should therefore not be a problem for these events.

The above analysis has been done on single channels, and it should be expected that the high-frequency beamforming loss should decrease a little the adverse effects of a filter change to 8 Hz. Our conclusion

is nevertheless that an overall change from 5 to 8 Hz anti-aliasing filters should not be implemented unless combined with a change from 10 to 20 Hz processing in DP.

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No.	Date	Region	Arr. Time	(deg)	m_b	NCH	Comments
1	77/12/26	E. Kazakh	04.10.17	38	4.9	5	Expl.
2	78/05/29	E. Kazakh	05.04.17	38	4.7	4	Expl.
3	78/09/20	E. Kazakh	05.10.17	38	4.2	3	Expl.
4	78/12/20	E. Kazakh	04.40.17	38	4.7	4	Expl.
5	79/09/06	C. Siberia	18.07.17	38	4.9	3	Expl.
6	79/09/17	S. Norway	15.22.18	3	2.8	5	Expl.
7	79/09/18	S. Norway	17.56.09	4	2.6	4	Expl.
8	79/09/23	N. Norway	13.54.29	6	3.1	5	
9	79/10/02	S. Norway	14.19.15	3	2.4	4	Expl.
10	79/10/07	C. Siberia	21.08.06	44	4.9	4	Expl.
11	82/12/25	E. Kazakh	04.30.27	39	4.7	2	Expl.
12	83/01/05	Honshu, Japan	07.29.44	71	5.1	1	
13	83/01/07	Honshu, Japan	18.30.32	74	5.1	1	
14	83/02/13	N.W. Kashmir	02.00.55	47	5.1	2	
15	83/02/18	Persian Gulf	07.48.25	47	5.0	1	
16	83/02/20	Hokkaido, Japan	01.32.44	70	5.1	1	
17	83/02/28	Aleutian Isl.	05.44.23	70	5.2	1	

Table VI.3.1 List of events used in analysis of 8 Hz filter aliasing. NCH indicates number of channels analyzed (i.e., number of channels with 8 Hz filters.

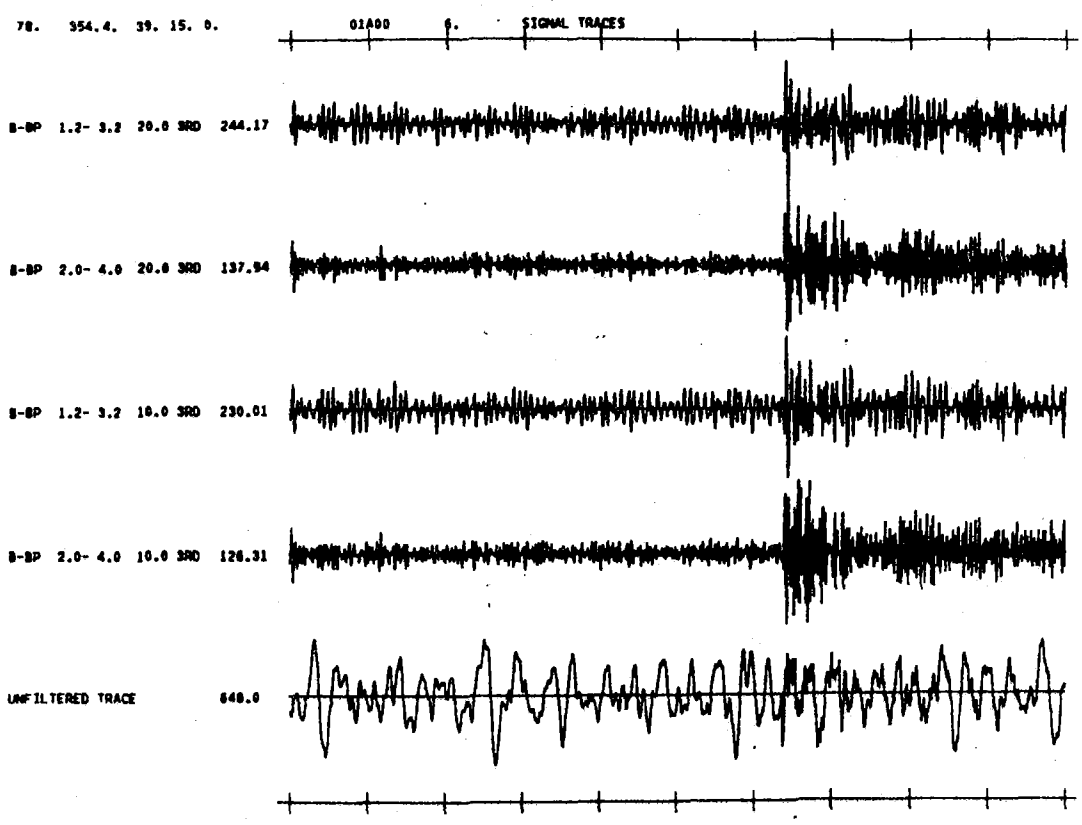


Fig. VI.3.1 Signal traces (100 seconds) for Event 4 in Table VI.3.1, recorded at channel 01A00 with 8 Hz filter and 20 Hz sampling rate. The unfiltered data are shown in the bottom trace, while the first 2 traces show the data filtered 1.2-3.2 Hz and 2.0-4.0 Hz, respectively. Trace 3 and 4 are resampled to 10 Hz and then filtered in the same pass bands. The numbers to the left of each trace are maximum amplitudes, and the traces are scaled individually.

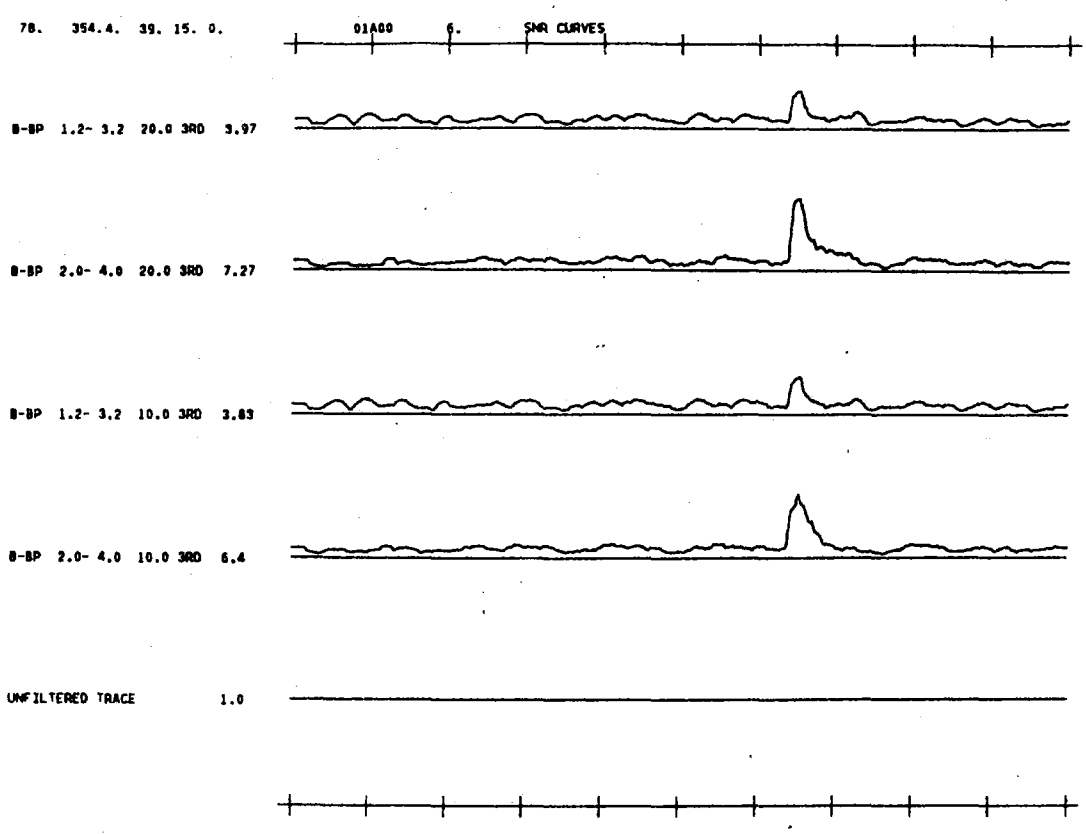
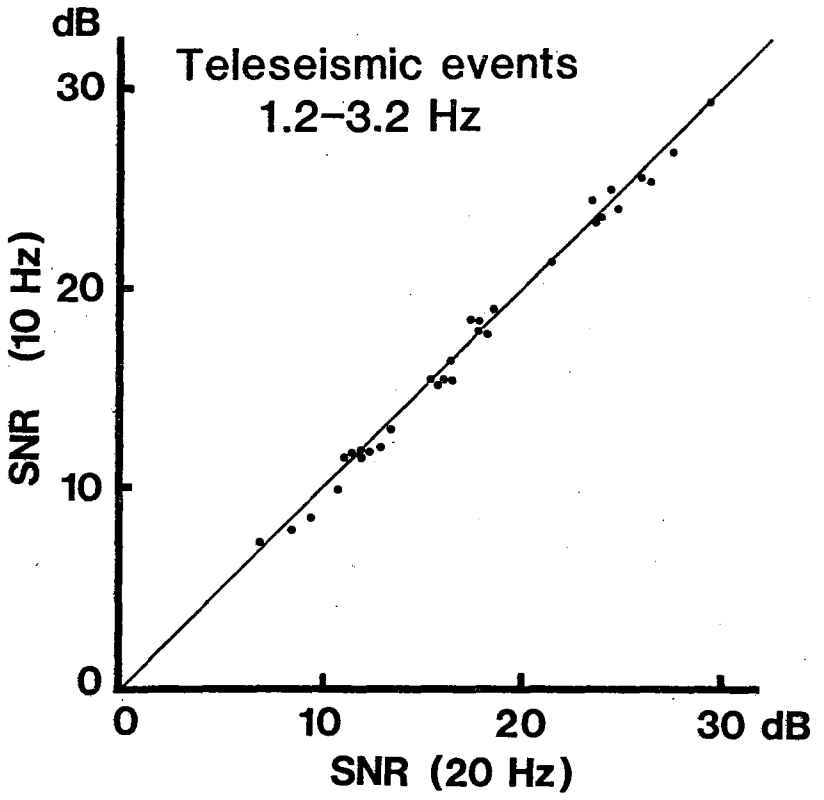


Fig. VI.3.2 SNR (or STA/LTA) curves for the traces plotted in Fig. VI.3.1 (Event 4), i.e., for 2 sampling rates (20 and 10 Hz) and 2 filters (1.2-3.2 and 2.0-4.0 Hz). The numbers to the left of each trace show maximum SNR, and the traces are plotted to the same scale.



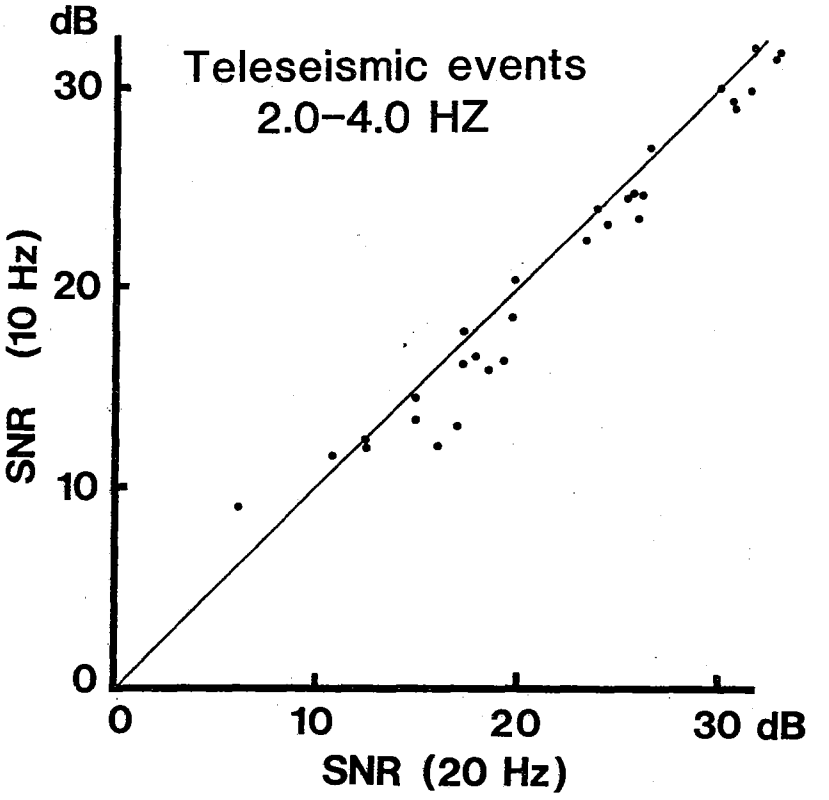
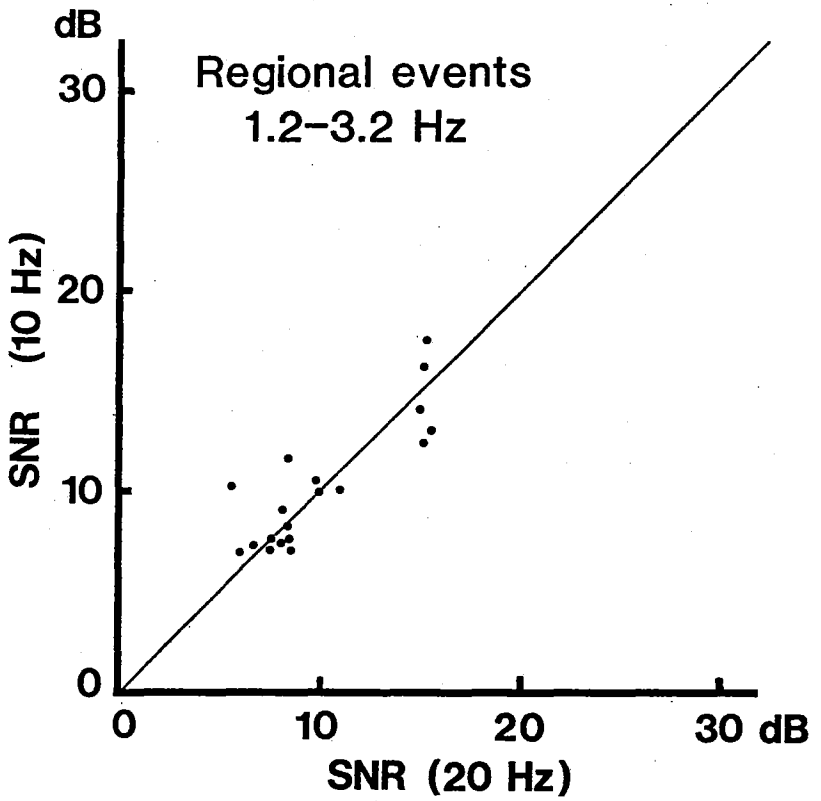


Fig. VI.3.3 SNR (20 Hz) vs SNR (10 Hz) for the teleseismic events (No. 1-5, 10-17) in Table VI.3.1, filtered 1.2-3.2 Hz and 2.0-4.0 Hz.



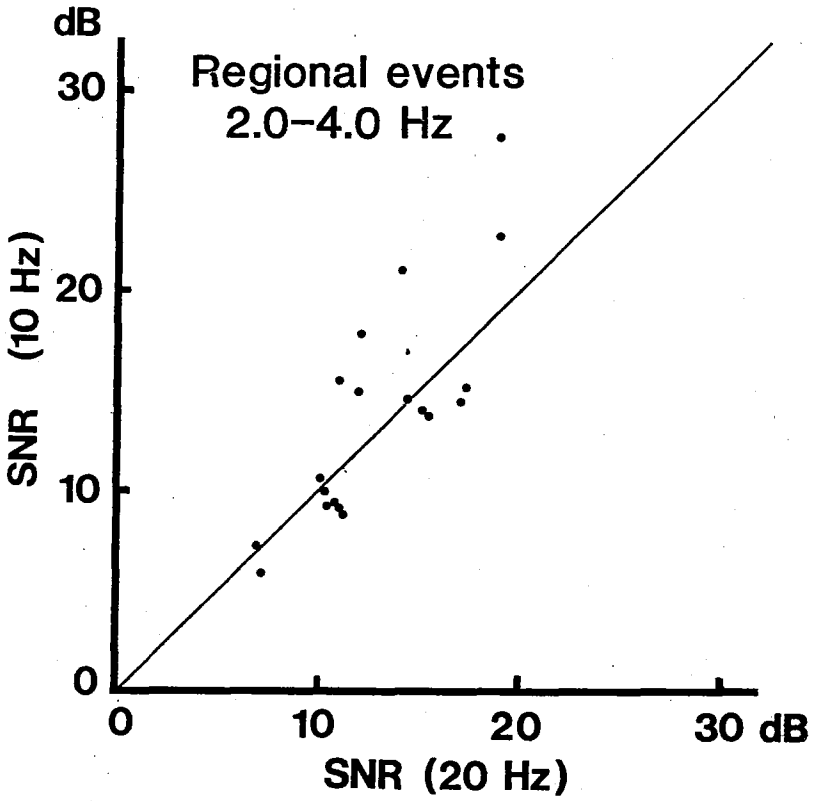


Fig. VI.3.4 SNR (20 Hz) vs SNR (10 Hz) for the regional events (No. 6-9) in Table VI.3.1, filtered 1.2-3.2 Hz and 2.0-4.0 Hz.