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NORSAR

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Semiannual Technical Summary

1 April 1996 - 30 September 1996

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This Semiannual Technical Summary describes the operation, maintenance and research activities at the Norwegian Seismic Array (NORSAR) , the Norwegian Regional Seismic Array (NORESS), the Arctic Regional Seismic Array (ARCESS) and the Spitsbergen Regional Array for the period for the period 1 April - 30 September 1996. Statistics are also presented for additional seismic stations, which through cooperative agreements with institutions in the host countries provide continuous data to the NORSAR Data processing Center (NDPC). These stations comprise the Finnish Regional Seismic Array (FINESS), the German Regional Seismic Array (GERESS), the Hagfors array in Sweden and the regional seismic array in Apatity, Russia.

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Abstract (cont.)

The NORSAR Detection Processing system has been operated throughout the period with an average uptime of 99.9%. A total of 2392 seismic events have been reported in the NORSAR monthly seismic bulletin for April - September 1996. The performance of the continuous alarm system and the automatic bulletin transfer to AFTAC has been satisfactory. The system for direct retrieval of NORSAR waveform data through an X.25 connection has been used successfully for acquiring such data by AFTAC. Processing of requests for full NORSAR and regional array data on magnetic tapes has progressed according to established schedules.

The new hardware installed at the NORSAR array in the recently completed refurbishment project has in general functioned well. However, we have identified a problem with artificial strong signals ("spikes") that are occasionally seen on some data channels, especially during thunderstorms. This problem is currently being investigated. A flexible program to convert NORSAR data recorded in the new format to CSS 3.0 files has been developed.

This Semiannual Report also presents statistics from operation of the Regional Monitoring System (RMS). The RMS has been operated in a limited capacity, with continuous automatic detection and location and with analyst review of selected events of interest for GSETT-3. Data sources for the RMS have comprised all the regional arrays processed at NORSAR. The Generalized Beamforming (GBF) program is now used as a pre-processor to RMS.

On-line detection processing and data recording at the NORSAR Data Processing Center (NDPC) of NORESS, ARCESS, FINESS and GERESS data have been conducted throughout the period. Data from two small-aperture arrays at sites in Spitsbergen and Apatity, Kola Peninsula, as well as the Hagfors array in Sweden, have also been recorded and processed. Monthly processing statistics for the arrays as well as results of the RMS analysis for the reporting period are given.

Maintenance activities in the period comprise preventive/corrective maintenance in connection with all the NORSAR subarrays, NORESS and ARCESS. Other activities have involved repair of defective electronic equipment after thunderstorms in the array area, cable splicing and work in connection with the small-aperture array in Spitsbergen.

Summaries of five scientific contributions are presented in Chapter 7 of this report.

Section 7.1 summarizes the activities and experience gained at the Norwegian NDC so far during the full-scale phase of the GSETT-3 experiment. Norway has been contributing primary station data from three arrays: ARCESS, NORESS and Spitsbergen. NORESS has been a temporary substitute for the large-aperture NORSAR array, awaiting completion of a technical refurbishment of this array. Norway's NDC is also acting as a regional data center, forwarding data to the IDC from GSETT-3 primary stations in several countries. These currently include FINESS (Finland), GERESS (Germany), Hagfors (Sweden) and Sonseca (Spain). In addition, communications for the GSETT-3 auxiliary station at Nilore,

Pakistan, are provided through a VSAT satellite link between Norway's NDC and Pakistan's NDC in Nilore.

The work at the Norwegian NDC has continued to focus on operational aspects, like stable forwarding of data using the Alpha protocol, proper handling of outgoing and incoming messages, improvement to routines for dealing with failure of critical components, as well as implementation of other measures to ensure maximum reliability and robustness in providing data to the IDC. We will continue the efforts towards improvements and hardening of all critical data acquisition and data forwarding hardware and software components, so that future requirements related to operation of IMS stations can be met to the maximum extent possible.

Section 7.2 describes NORSAR's status and plans for implementing algorithms at the GSETT-3 IDC. A prototype system for global Threshold Monitoring (TM) was delivered to the IDC already in October 1994, and a significant software development effort has taken place to integrate the TM software into the operational system at the IDC. The resulting modules were delivered in August 1996. At the same time, software for processing of data from the NORSAR teleseismic array was delivered, and both of these systems are due to be operational at the IDC in the near future. Current plans comprise inter alia the finalization of an operational module for automatic onset time analysis, previously described in NORSAR Semiannual Technical Summaries. Algorithms to improve the tuning of signal processing for GSETT-3 arrays and to implement automatic event post-processing are currently under development. During the next reporting period, we will complete the tuning of the IMS primary network for the global TM system. After this we will technically and seismologically verify the results for threshold monitoring using the full IMS primary network, assist in transferring the TM system into the operational system at the IDC, and develop products for making the output from the TM system available to the international community.

Section 7.3 describes the current status of our algorithms developed so far for tuning the processing parameters of the global Threshold Monitoring system at the IDC. We have used the ASAR array in Australia as an example for illustration purposes. Among the topics analyzed in this paper are:

- The choice of optimum prefilter prior to the STA calculation
- The relationship between event magnitude (log A/T) and log STA
- Signal loss patterns due to beamforming
- Signal loss due to "missteering" of beams (i.e., for target points which are not on the global grid)
- Beam deployment at different distance ranges and frequencies to ensure homogeneous coverage.

In the future, additional stations will be tuned to the global TM following a similar methodology as described in this paper.

Section 7.4 is a study of low-magnitude seismic events near the Novaya Zemlya test site for the past 30 years. The Novaya Zemlya region is a low-seismicity area, with only one earthquake clearly identified over this time period. This is in spite of the fact that this area is well covered with regard to seismic stations at both teleseismic and regional distances. Thus, the detection threshold of the global network has been estimated at close to m_b 4.0 for Novaya Zemlya. Since 1970, the NORSAR array has provided a detection capability near m_b 3.0. Currently, the detection capability for this area is near m_b 2.5, due to the excellent regional array network that has been developed for CTBT monitoring.

Examples have shown that events of magnitude well below 3.0 can be not only detected, but also located with good accuracy (estimated uncertainty 20-30 km) using the present regional network. However, this capability is by no means matched by the capability to identify detected events as either earthquakes or underground explosions. Even identifying the earthquake of 1 August 1986 (m_b=4.3) was not easy, and required extensive work before a positive identification could be made. A study of the 13 June 1995 event (m_b = 3.5) indicates that the available data are not sufficient to confidently identify an event this size.

This study has shown that the calculation of body-wave magnitudes at regional distances needs to take into account the bias effects caused when using high-frequency filters. In fact, a positive bias of up to 0.5 magnitude units is introduced in the examples shown here, when comparing a 4-8 or 8-16 Hz filter band to a "teleseismic" 2-4 Hz band.

Section 7.5 is a study of the calibration explosion on 29 September 1996 in the Kola Peninsula. The explosion, which had a total charge of 350 tons, was detonated in an underground mine in the Khibiny Massif, with coordinates 67.675N, 33.728E. The explosion was applied to provide data to calibrate the GSETT-3 network in this region.

The calibration experiment was carried out as a joint cooperative project between the Ministry of Defense of the Russian Federation and the Kola Regional Seismological Centre of the Russian Academy of Sciences. NORSAR participated in this experiment by providing seismic recordings as well as contributing to the data analysis. The explosion was recorded by several stations in the GSETT-3 network, all of them at regional distances. The event was listed in the Reviewed Event Bulletin (REB) of the IDC with coordinates 67.57N, 32.54E and a magnitude (M_L) of 3.4.

In this paper we analyze available recordings of this explosion, with emphasis on recordings by stations at local distances. We further compare the signal characteristics to those of previously recorded underground explosions in the same mine. The IDC location estimates of this suite of explosions is compared to their true locations, and the differences are used to suggest a velocity model that is expected to largely eliminate systematic bias in the IDC location results for events in this region.

Frode Ringdal

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1 Summary

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Frode Ringdal

2 NORSAR Operation

2.1 Detection Processor (DP) operation

There have been 3 breaks in the otherwise continuous operation of the NORSAR online system within the current 6-month reporting interval. The uptime percentage for the period is 99.9.

Fig. 2.1.1 and the accompanying Table 2.1.1 both show the daily DP downtime for the days between 1 April and 30 September 1996. The monthly recording times and percentages are given in Table 2.1.2.

The breaks can be grouped as follows:

a)	Hardware failure	0
b)	Stops related to program work or error	1
c)	Hardware maintenance stops	0
d)	Power jumps and breaks	0
e)	TOD error correction	0
f)	Communication lines	2

The total downtime for the period was 4 hours and 18 minutes. The mean-time-between-failures (MTBF) was 45.7 days.

J. Torstveit

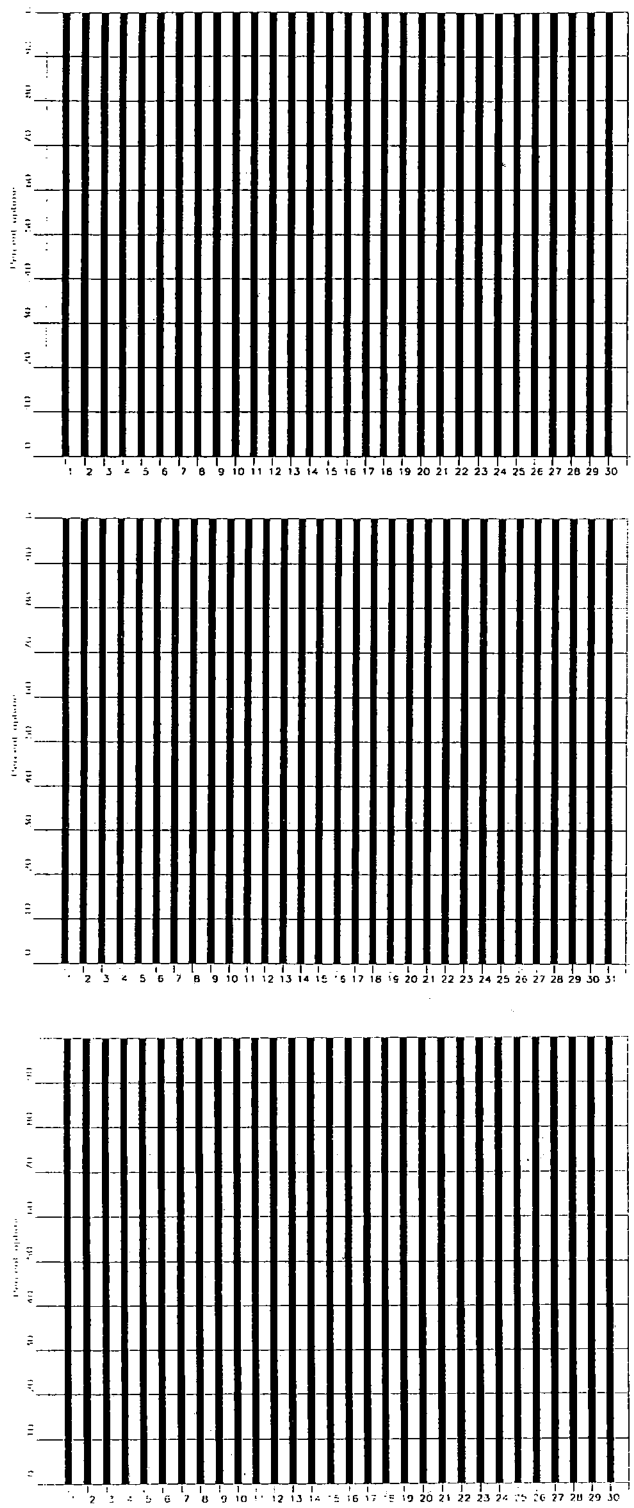
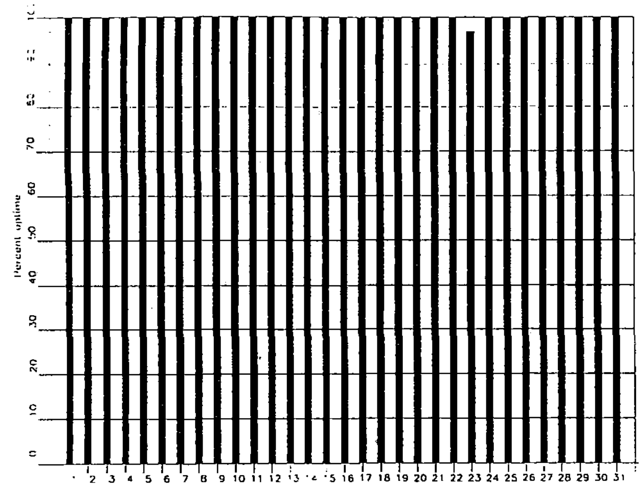
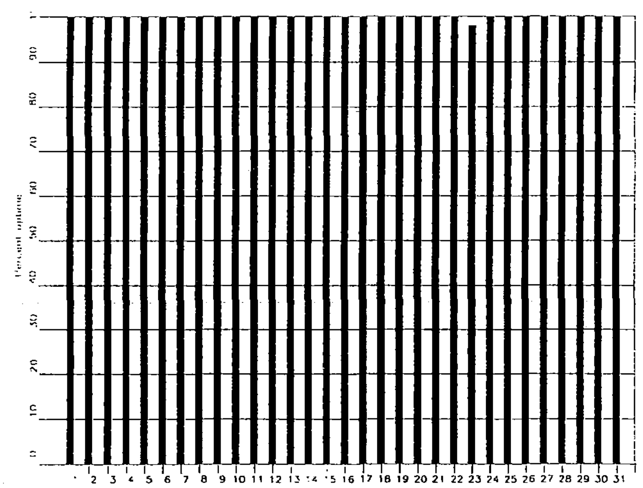


Fig. 2.1.1. Detection Processor uptime for April (top), May (middle) and June (bottom) 1996.





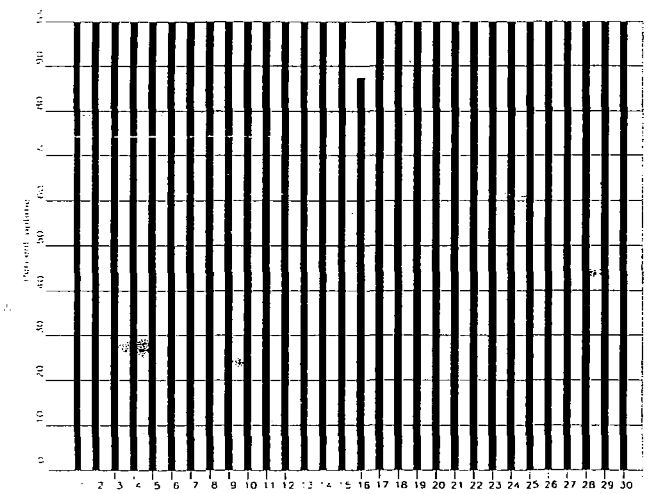


Fig. 2.1.1. Detection Processor uptime for July (top), August (middle) and September (bottom) 1996.

Date	Time	Cause
23 Jul	1041 - 1127	Software maintenance
23 Aug	1058 - 1128	Transmission line failure
16 Sep	1018 - 1320	Transmission line failure

Table 2.1.1. The major downtimes in the period 1 April - 30 September 1996.

Month	DP Uptime Hours	DP Uptime %	No. of DP Breaks	No. of Days with Breaks	DP MTBF* (days)
Apr 96	720.00	100	0	0	30.0
May 96	744.00	100	0	0	31.0
Jun 96	720.00	100	0	0	30.0
Jul 96	743.25	99.90	1	1	15.5
Aug 96	743.50	99.93	1	1	15.5
Sep 96	716.96	99.58	1	1	15.0
		99.90	3	3	45.7

*Mean-time-between-failures = total uptime/no. of up intervals.

Table 2.1.2. Online system performance, 1 April - 30 September 1996.

2.2 Array Communications

After completion of the NORSAR refurbishment project, the operation of the subarray communication lines has proceeded normally.

For a complete description of the NORSAR refurbishment project, reference is made to Section 4.1 of the NORSAR Semiannual Technical Summary, 1 April - 30 September 1995.

From April through September 1996, there were, with only a few exceptions, no significant communications outages at any of the NORSAR subarrays.

A simplified daily summary of the communications performance for the seven individual subarray lines is summarized, on a month-by-month basis, in Table 2.2.1.

F. Ringdal

Table 2..2.1 (Page 1 of 6)
NORSAR Communication Status Report
Month: April 1996

Day	Subarray						
	01A	01B	02B	02C	03C	04C	06C
01	X	X	X	X	X	X	X
02	X	X	X	X	X	X	X
03	X	X	X	X	X	X	X
04	X	X	X	X	X	X	X
05	X	X	X	X	X	X	X
06	X	X	X	X	X	X	X
07	X	X	X	X	X	X	X
08	X	X	X	X	X	X	X
09	X	X	X	X	X	X	X
10	X	X	X	X	X	X	X
11	X	X	X	X	X	X	X
12	X	X	X	X	X	X	X
13	X	X	X	X	X	X	X
14	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X
16	X	X	X	X	X	X	X
17	X	X	X	X	X	X	X
18	X	X	X	X	X	X	X
19	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X
21	X	X	X	X	X	X	X
22	X	X	X	X	X	X	X
23	X	X	X	X	X	X	X
24	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X
26	X	X	X	X	X	X	X
27	X	X	X	X	X	X	X
28	X	X	X	X	X	X	X
29	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X
31	X	X	X	X	X	X	X
Total hours normal operation	720	720	720	720	720	720	720
% normal operation	100	100	100	100	100	100	100

Legend:

X : Normal operations
A : All channels masked for more than 12 hours that day
B : All SP channels masked for more than 12 hours that day
C : All LP channels masked for more than 12 hours that day
I : Communication outage for more than 12 hours

Table 2.2.1 (Page 2 of 6)
NORSAR Communication Status Report
Month: May 1996

Day	Subarray						
	01A	01B	02B	02C	03C	04C	06C
01	X	X	X	X	X	X	X
02	X	X	X	X	X	X	X
03	X	X	X	X	X	X	X
04	X	X	X	X	X	X	X
05	X	X	X	X	X	X	X
06	X	X	X	X	X	X	X
07	X	X	X	X	X	X	X
08	X	X	X	X	X	X	X
09	X	X	X	X	X	X	X
10	X	X	X	X	X	X	X
11	X	X	X	X	X	X	X
12	X	X	X	X	X	X	X
13	X	X	X	X	X	X	X
14	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X
16	X	X	X	X	X	X	X
17	X	X	X	X	X	X	X
18	X	X	X	X	X	X	X
19	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X
21	X	X	X	X	X	X	X
22	X	X	X	X	X	X	X
23	X	X	X	X	X	X	X
24	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X
26	X	X	A	X	X	X	X
27	X	X	A	X	X	X	X
28	X	X	X	X	X	X	X
29	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X
31	X	X	X	X	X	X	X
Total hours normal operation	744	744	685	744	744	744	744
% normal operation	100	100	92	100	100	100	100

Legend:

X : Normal operations
A : All channels masked for more than 12 hours that day
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I : Communication outage for more than 12 hours

Table 2.2.1 (Page 3 of 6)
NORSAR Communication Status Report
Month: June 1996

Day	Subarray						
	01A	01B	02B	02C	03C	04C	06C
01	X	X	X	X	X	X	X
02	X	X	X	X	X	X	X
03	X	X	X	X	X	X	X
04	X	X	X	X	X	X	X
05	X	X	X	X	X	X	X
06	X	X	X	X	X	X	X
07	X	X	X	X	X	X	X
08	X	X	X	X	X	X	X
09	X	X	A	X	X	X	X
10	X	X	A	X	X	X	X
11	X	X	A	X	X	X	X
12	X	X	A	X	X	X	X
13	X	X	X	X	X	X	X
14	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X
16	X	X	X	X	X	X	X
17	X	X	X	X	X	X	X
18	X	X	X	X	X	X	X
19	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X
21	X	X	X	X	X	X	X
22	X	X	X	X	X	X	X
23	X	X	X	X	X	X	X
24	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X
26	X	X	X	X	X	X	X
27	X	X	X	X	X	X	X
28	X	X	X	X	X	X	X
29	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X
31	-	-	-	-	-	-	-
Total hours normal operation	720	720	609	720	720	720	720
% normal operation	100	100	85	100	100	100	100

Legend:

X : Normal operations
A : All channels masked for more than 12 hours that day
B : All SP channels masked for more than 12 hours that day
C : All LP channels masked for more than 12 hours that day
I : Communication outage for more than 12 hours

Table 2.2.1 (Page 4 of 6)
NORSAR Communication Status Report
Month: July 1996

Day	Subarray 01A	01B	02B	02C	03C	04C	06C
01	X	X	X	X	X	X	X
02	X	X	X	X	X	X	X
03	X	X	X	X	X	X	X
04	X	X	X	X	X	X	X
05	X	X	X	X	A	X	X
06	X	X	X	X	X	X	X
07	X	X	X	X	X	X	X
08	X	X	X	X	X	X	X
09	X	X	X	X	X	X	X
10	X	X	X	X	X	X	X
11	X	X	X	X	X	X	X
12	X	X	X	X	X	X	X
13	X	X	X	X	X	X	X
14	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X
16	X	X	X	X	X	X	X
17	X	X	A	X	X	X	X
18	X	X	A	X	X	X	X
19	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X
21	X	X	X	X	X	X	X
22	X	X	X	X	X	X	X
23	X	X	X	X	X	X	X
24	X	X	X	X	X	X	X
25	X	X	A	X	X	X	X
26	X	X	A	X	X	X	X
27	X	X	X	X	X	X	X
28	X	X	A	X	X	X	X
29	X	X	A	X	X	X	X
30	X	X	X	X	X	X	X
31	X	X	X	X	X	X	X
Total hours normal operation	743	743	647	743	726	743	743
% normal operation	99.9	99.9	86.9	99.9	97.6	99.9	99.9

Legend:

X : Normal operations
A : All channels masked for more than 12 hours that day
B : All SP channels masked for more than 12 hours that day
C : All LP channels masked for more than 12 hours that day
I : Communication outage for more than 12 hours

Table 1 (Page 5 of 6)
NORSAR Communication Status Report
Month: August 1996

Day	Subarray						
	01A	01B	02B	02C	03C	04C	06C
01	X	X	X	X	X	X	X
02	X	X	A	X	X	X	X
03	X	X	A	X	X	X	X
04	X	X	A	X	X	X	X
05	X	X	X	X	A	X	X
06	X	X	X	X	X	X	X
07	X	X	X	X	X	X	X
08	X	X	X	X	X	X	X
09	X	X	X	X	X	X	X
10	X	X	X	X	X	X	X
11	X	X	A	X	X	X	X
12	X	X	A	X	X	X	X
13	X	X	X	X	X	X	X
14	X	X	A	X	X	X	X
15	X	X	A	X	X	X	X
16	X	X	A	X	X	X	X
17	X	X	A	X	X	X	X
18	X	X	A	X	X	X	X
19	X	X	A	X	X	X	X
20	X	X	X	X	X	X	X
21	X	X	A	X	X	X	X
22	X	X	A	X	X	X	X
23	X	X	A	X	X	X	X
24	X	X	A	X	X	X	X
25	X	X	A	X	X	X	X
26	X	X	X	X	X	X	X
27	X	X	X	X	X	X	X
28	X	X	X	X	X	X	X
29	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X
31	X	X	X	X	X	X	X
Total hours normal operation	743	743	405	743	743	743	743
% normal operation	99.9	99.9	54.5	99.9	99.9	99.9	99.9

Legend:

X : Normal operations
A : All channels masked for more than 12 hours that day
B : All SP channels masked for more than 12 hours that day
C : All LP channels masked for more than 12 hours that day
I : Communication outage for more than 12 hours

Table 2.2.1 (Page 6 of 6)
NORSAR Communication Status Report
Month: September 1996

Day	Subarray						
	01A	01B	02B	02C	03C	04C	06C
01	X	X	A	X	X	X	X
02	X	X	X	X	X	X	X
03	X	X	X	X	X	X	X
04	X	X	X	X	X	X	X
05	X	X	X	X	A	X	X
06	X	X	X	X	X	X	X
07	X	X	X	X	X	X	X
08	X	X	X	X	X	X	X
09	X	X	X	X	X	X	X
10	X	X	X	X	X	X	X
11	X	X	X	X	X	X	X
12	X	X	X	X	X	X	X
13	X	X	X	X	X	X	X
14	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X
16	X	X	X	X	X	X	X
17	X	X	X	X	X	X	X
18	X	X	X	X	X	X	X
19	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X
21	X	X	X	X	X	X	X
22	X	X	X	X	X	X	X
23	X	X	X	X	X	X	X
24	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X
26	X	X	X	X	X	X	X
27	X	X	X	X	X	X	X
28	X	X	X	X	X	X	X
29	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X
31	X	X	X	X	X	X	X
Total hours normal operation	718	718	684	718	718	718	718
% normal operation	99.6	99.6	95.0	99.6	99.6	99.6	99.6

Legend:

X : Normal operations
A : All channels masked for more than 12 hours that day
B : All SP channels masked for more than 12 hours that day
C : All LP channels masked for more than 12 hours that day
I : Communication outage for more than 12 hours

2.3 NORSAR Event Detection operation

In Table 2.3.1 some monthly statistics of the Detection and Event Processor operation are given. The table lists the total number of detections (DPX) triggered by the on-line detector, the total number of detections processed by the automatic event processor (EPX) and the total number of events accepted after analyst review (teleseismic phases, core phases and total).

	Total DPX	Total EPX	Accepted events		Sum	Daily
			P-phases	Core Phases		
Apr 96	11950	809	315	67	382	12.7
May 96	8805	1041	256	55	311	10.0
Jun 96	8550	1421	489	50	539	18.0
Jul 96	9952	1089	350	86	436	14.1
Aug 96	7415	1417	273	59	332	10.7
Sep 96	10463	1428	327	65	392	13.1
			2010	382	2392	13.1

Table 2.3.1. Detection and Event Processor statistics, 1 April - 30 September 1996.

NORSAR Detections

The number of detections (phases) reported by the NORSAR detector during day 092, 1996, through day 274, 1996, was 51,582, giving an average of 282 detections per processed day (183 days processed). Table 2.3.2 shows daily and hourly distribution of detections for NORSAR.

B. Paulsen

NB2 .DPX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
92	16	12	14	22	6	9	9	1	8	3	4	17	1	10	14	2	6	2	13	4	10	7	8	6	204	Apr 01 Monday
93	8	12	11	10	7	3	5	4	11	8	7	10	21	10	20	16	13	15	15	25	20	12	11	15	289	Apr 02 Tuesday
94	15	12	8	16	14	9	11	9	17	13	12	23	10	17	14	20	27	24	11	18	20	23	16	18	377	Apr 03 Wednesday
95	28	24	11	8	25	25	13	23	31	23	29	37	22	26	27	15	22	20	29	30	23	23	21	23	558	Apr 04 Thursday
96	29	25	20	27	32	33	28	18	25	31	22	28	22	25	26	17	29	20	30	31	26	21	20	16	601	Apr 05 Friday
97	34	20	17	15	32	23	15	14	19	23	20	15	31	16	21	10	14	12	11	19	7	18	14	16	436	Apr 06 Saturday
98	26	21	21	11	21	12	31	10	12	4	12	6	12	16	21	22	10	5	10	13	14	4	5	15	334	Apr 07 Sunday
99	19	6	1	11	9	7	8	5	9	4	6	20	4	5	4	7	3	21	15	9	6	15	2	4	200	Apr 08 Monday
100	9	12	11	12	7	0	9	3	5	5	5	14	3	6	1	0	2	6	2	4	1	2	7	11	137	Apr 09 Tuesday
101	9	4	13	1	1	0	1	0	2	4	0	9	6	9	7	6	1	7	5	7	7	13	4	16	132	Apr 10 Wednesday
102	18	15	27	8	14	16	4	13	14	13	16	13	16	8	9	15	18	20	7	19	19	10	22	17	351	Apr 11 Thursday
103	21	14	11	19	7	8	2	3	11	7	22	11	16	3	9	21	14	10	6	16	9	6	13	15	274	Apr 12 Friday
104	15	6	2	5	11	8	8	12	6	13	10	9	7	16	5	13	15	4	8	11	12	9	9	13	227	Apr 13 Saturday
105	16	11	9	8	16	12	9	9	15	6	8	4	16	4	9	4	2	5	4	4	7	9	9	12	208	Apr 14 Sunday
106	16	19	11	3	11	4	3	6	5	7	9	2	10	5	4	14	5	9	9	11	21	17	13	27	241	Apr 15 Monday
107	23	19	16	17	11	5	6	5	9	9	17	4	11	16	16	7	11	13	22	26	18	19	28	22	350	Apr 16 Tuesday
108	30	23	34	26	13	10	7	7	7	19	12	15	10	8	17	14	18	13	3	8	10	13	20	16	353	Apr 17 Wednesday
109	24	19	18	18	10	4	10	1	7	5	6	20	8	5	5	7	6	15	9	12	18	21	33	13	294	Apr 18 Thursday
110	30	19	35	17	7	3	6	11	5	21	10	8	18	17	17	11	14	15	10	23	16	15	15	23	366	Apr 19 Friday
111	18	20	21	25	38	22	26	18	8	26	15	10	20	19	14	18	31	26	21	15	26	8	15	23	483	Apr 20 Saturday
112	16	16	17	15	12	9	3	17	14	10	13	16	4	6	5	12	16	6	5	5	8	10	14	14	263	Apr 21 Sunday
113	16	15	18	13	19	13	7	0	0	7	6	13	5	12	17	14	4	5	6	6	10	7	4	7	224	Apr 22 Monday
114	14	14	10	10	15	1	3	10	6	0	4	11	3	22	4	6	3	3	7	10	17	10	12	9	204	Apr 23 Tuesday
115	17	23	11	20	9	4	0	2	4	16	5	9	11	17	6	17	10	20	9	22	13	5	9	12	271	Apr 24 Wednesday
116	15	17	18	10	8	5	10	5	3	4	5	7	11	8	8	6	11	3	16	15	11	8	17	6	227	Apr 25 Thursday
117	7	15	11	8	8	5	5	11	5	1	9	6	16	1	9	4	12	11	8	4	5	7	10	8	186	Apr 26 Friday
118	23	14	8	16	15	12	10	6	10	2	5	3	5	5	4	9	6	8	5	11	12	7	7	7	210	Apr 27 Saturday
119	18	14	17	14	17	21	20	21	25	17	23	29	19	15	13	13	18	9	12	13	21	19	11	11	410	Apr 28 Sunday
120	12	15	21	10	9	3	3	12	0	1	10	0	9	5	34	13	7	5	3	19	14	7	21	13	246	Apr 29 Monday
121	5	7	8	12	5	12	8	3	5	8	12	11	5	13	4	7	4	4	3	11	10	8	19	11	195	Apr 30 Tuesday
122	17	17	14	21	17	15	14	27	8	15	17	15	9	13	12	12	13	30	18	1	9	29	26	42	411	May 01 Wednesday
123	17	41	66	39	11	35	37	42	16	1	4	4	10	28	21	8	12	8	10	10	7	15	13	11	466	May 02 Thursday
124	12	18	23	23	26	7	5	10	6	4	4	9	8	8	15	14	10	17	24	16	20	20	28	25	352	May 03 Friday
125	23	20	25	23	23	25	26	25	21	22	19	27	19	18	13	18	32	20	25	29	18	25	25	24	545	May 04 Saturday
126	26	25	36	24	23	22	20	26	23	29	16	24	25	22	24	15	19	15	23	23	23	19	16	24	542	May 05 Sunday
127	18	18	16	16	11	9	9	12	8	7	9	11	15	13	3	7	10	14	30	22	24	14	12	10	318	May 06 Monday
128	12	18	25	13	13	6	3	6	10	18	10	2	15	22	4	5	3	2	5	4	14	8	16	17	251	May 07 Tuesday
129	11	17	15	9	14	3	2	5	4	14	11	30	52	23	18	6	5	10	6	6	14	12	11	17	315	May 08 Wednesday
130	21	13	14	23	15	3	3	4	4	5	14	7	10	9	16	17	8	15	13	11	17	14	15	17	288	May 09 Thursday
131	12	10	30	14	25	10	10	9	4	9	3	7	7	5	4	9	11	7	6	10	11	12	12	14	251	May 10 Friday
132	18	18	15	21	19	10	4	6	7	9	7	1	4	5	14	5	14	10	5	8	2	10	9	8	229	May 11 Saturday
133	8	7	35	9	7	8	5	2	3	1	6	3	3	1	6	9	2	0	4	4	4	2	7	0	136	May 12 Sunday
134	0	2	7	1	7	9	0	0	10	0	7	4	15	9	1	3	4	1	0	6	0	1	5	4	96	May 13 Monday
135	28	13	3	9	55	26	18	3	4	4	9	13	41	118	14	9	16	11	20	25	16	13	7	10	485	May 14 Tuesday
136	14	14	12	11	13	6	13	1	3	17	16	9	17	13	17	14	15	16	19	9	16	14	20	13	312	May 15 Wednesday
137	9	19	14	11	19	18	17	18	9	17	13	12	12	13	9	15	15	17	18	12	13	17	16	10	343	May 16 Thursday
138	13	17	10	23	9	6	12	9	10	6	22	14	11	10	8	6	6	14	10	9	14	8	7	10	264	May 17 Friday
139	14	14	8	23	4	12	10	9	5	2	10	5	10	10	6	7	11	15	5	14	19	21	16	16	266	May 18 Saturday
140	18	20	21	37	13	9	17	18	8	11	12	8	15	10	14	5	11	6	6	12	18	11	7	23	330	May 19 Sunday
141	10	8	12	14	6	3	2	4	3	10	4	9	2	3	7	4	7	8	1	10	2	6	4	6	145	May 20 Monday
142	14	8	6	12	7	2	0	0	3	2	21	2	7	6	14	1	0	7	0	1	14	4	4	7	142	May 21 Tuesday
143	11	2	8	2	2	0	0	5	5	4	3	9	7	3	10	5	8	0	0	0	9	7	0	10	110	May 22 Wednesday
144	4	10	10	5	7	2	7	1	18	10	9	4	9	2	4	0	0	2	7	6	2	4	4	4	131	May 23 Thursday
145	8	8	5	6	2	2	18	19	2	9	9	3	9	7	0	11	13	6	9	6	8	19	11	17	207	May 24 Friday
146	3	0	0	2	7	6	2	4	2	6	9	10	70	27	15	5	5	10	5	2	10	4	3	11	218	May 25 Saturday
147	5	7	15	11	13	3	10	8	8	22	22	13	14	58	38	19	5	8	5	6	10	16	2	6	324	May 26 Sunday

Table 2.3.2 (Page 1 of 4)

NB2 .DPX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
148	10	9	6	15	12	11	10	4	6	11	21	17	33	27	36	25	23	18	23	19	32	29	24	29	450	May 27 Monday
149	27	27	2	22	12	1	1	4	8	2	12	1	7	4	8	2	9	7	4	2	4	8	9	11	194	May 28 Tuesday
150	16	22	20	18	13	23	5	2	4	2	3	5	6	13	7	10	4	10	5	4	2	3	10	13	220	May 29 Wednesday
151	16	14	7	20	4	3	6	2	9	2	17	12	8	7	2	9	5	3	12	3	3	6	7	13	190	May 30 Thursday
152	16	20	13	6	9	4	4	9	3	18	20	8	3	8	12	12	14	19	15	11	12	12	19	20	287	May 31 Friday
153	15	18	15	8	14	16	14	18	12	13	16	11	17	7	17	17	4	12	19	20	19	13	15	17	347	Jun 01 Saturday
154	23	16	28	18	18	15	5	13	10	12	15	7	18	11	14	15	5	11	18	11	16	9	13	15	336	Jun 02 Sunday
155	21	28	14	16	20	3	11	2	13	4	6	36	11	1	7	19	22	9	9	6	15	7	16	19	315	Jun 03 Monday
156	16	9	16	13	7	3	3	5	18	6	1	7	8	0	18	65	73	54	30	8	11	16	12	21	420	Jun 04 Tuesday
157	13	15	11	18	8	4	1	2	2	11	7	2	8	20	30	8	6	8	7	20	7	12	7	12	239	Jun 05 Wednesday
158	21	18	17	11	3	5	16	1	2	3	6	9	7	6	15	11	12	10	11	3	11	4	12	9	223	Jun 06 Thursday
159	7	14	8	8	2	18	8	1	5	5	5	7	13	11	6	0	2	0	1	2	3	4	5	14	149	Jun 07 Friday
160	3	2	4	13	6	13	7	4	6	21	60	74	1	2	1	2	17	5	7	4	7	4	5	15	283	Jun 08 Saturday
161	7	29	5	19	22	10	11	9	15	25	16	2	2	7	3	3	6	2	2	0	8	0	4	26	233	Jun 09 Sunday
162	15	23	13	13	41	48	20	57	54	35	43	20	8	27	7	24	14	42	15	13	7	12	4	7	562	Jun 10 Monday
163	8	16	10	12	50	117	79	40	77	38	12	25	16	20	9	3	18	20	31	4	4	28	7	6	650	Jun 11 Tuesday
164	11	3	11	17	7	3	0	0	2	18	3	10	21	25	61	57	17	5	11	11	8	8	12	11	332	Jun 12 Wednesday
165	23	12	17	11	4	8	2	11	3	8	1	8	11	13	9	13	12	9	10	11	12	5	14	11	238	Jun 13 Thursday
166	19	14	15	13	8	4	6	5	9	8	1	9	3	6	5	24	7	8	3	10	8	10	16	4	215	Jun 14 Friday
167	8	12	13	8	14	9	6	5	6	1	4	4	14	3	9	7	9	4	10	5	7	6	6	10	180	Jun 15 Saturday
168	21	15	15	19	0	7	2	3	4	7	3	5	6	8	1	12	1	7	2	17	5	9	2	9	180	Jun 16 Sunday
169	9	3	10	9	9	3	2	1	4	1	6	64	27	60	135	100	35	14	17	6	8	12	8	8	551	Jun 17 Monday
170	10	5	15	7	7	1	1	6	20	0	15	14	10	10	19	32	27	13	4	16	16	14	20	17	299	Jun 18 Tuesday
171	8	12	14	15	6	2	5	2	3	6	2	11	11	17	16	5	8	11	6	11	10	15	7	10	213	Jun 19 Wednesday
172	19	14	8	15	6	9	2	6	9	12	10	15	11	22	9	10	7	9	10	10	11	11	10	11	256	Jun 20 Thursday
173	22	15	16	17	11	6	2	7	6	11	12	21	2	15	15	13	12	9	10	15	16	25	14	19	311	Jun 21 Friday
174	13	23	12	22	18	8	11	12	11	10	11	17	15	7	7	28	11	6	10	13	8	8	11	19	311	Jun 22 Saturday
175	11	32	18	35	13	13	13	14	17	8	6	22	24	14	17	24	12	9	7	5	17	21	15	9	376	Jun 23 Sunday
176	9	16	11	16	6	3	7	3	4	5	6	12	0	8	17	10	0	1	9	4	12	10	9	7	185	Jun 24 Monday
177	15	8	22	11	5	7	2	11	0	10	16	4	9	7	18	0	12	2	19	3	9	12	3	8	213	Jun 25 Tuesday
178	9	8	20	11	13	4	5	1	11	8	22	14	20	8	13	1	5	12	31	10	2	6	7	6	247	Jun 26 Wednesday
179	6	3	3	5	2	8	3	2	8	9	9	9	13	3	12	0	15	10	3	3	4	9	11	9	159	Jun 27 Thursday
180	1	6	2	11	4	0	4	6	9	11	5	2	5	2	1	15	4	2	2	3	13	10	6	5	129	Jun 28 Friday
181	7	10	6	6	10	6	5	1	15	0	3	4	3	5	6	3	8	7	8	12	9	4	7	11	156	Jun 29 Saturday
182	7	10	7	16	11	9	14	9	17	16	11	10	22	5	7	6	8	12	5	10	11	12	16	20	271	Jun 30 Sunday
183	17	24	14	10	9	11	6	4	8	0	15	9	12	7	7	1	5	9	10	7	4	12	17	7	225	Jul 01 Monday
184	11	9	7	16	8	1	2	13	0	4	0	9	17	6	14	4	9	7	6	8	8	6	8	12	185	Jul 02 Tuesday
185	16	11	7	11	1	0	10	2	10	1	11	8	0	13	6	9	8	9	5	6	4	8	3	3	162	Jul 03 Wednesday
186	1	2	1	14	8	1	2	2	7	5	0	10	13	8	5	17	15	9	7	4	5	3	13	7	159	Jul 04 Thursday
187	6	17	11	6	4	5	6	1	6	2	27	19	18	7	25	13	8	6	16	10	7	8	4	8	240	Jul 05 Friday
188	3	5	6	4	7	13	3	7	7	3	9	9	13	8	0	3	9	12	10	6	7	10	5	5	164	Jul 06 Saturday
189	5	15	3	2	9	4	3	5	4	10	6	17	3	21	10	11	11	8	11	9	0	15	9	3	194	Jul 07 Sunday
190	15	20	10	10	8	1	1	1	0	6	1	17	14	2	1	3	5	8	6	6	5	8	7	9	164	Jul 08 Monday
191	24	7	4	6	13	3	1	3	6	3	10	7	17	17	4	3	5	11	14	5	9	7	6	11	196	Jul 09 Tuesday
192	12	13	8	15	12	15	7	6	4	1	6	1	2	3	17	4	7	5	6	6	7	10	8	8	183	Jul 10 Wednesday
193	10	9	11	9	5	5	4	5	3	4	4	6	10	5	2	2	5	9	13	11	4	6	14	13	169	Jul 11 Thursday
194	5	15	12	11	9	5	4	3	2	15	13	5	8	16	14	19	14	14	90	47	34	20	9	13	397	Jul 12 Friday
195	10	15	10	7	8	12	8	9	9	12	17	15	20	16	16	18	15	9	17	25	17	25	15	20	345	Jul 13 Saturday
196	26	25	17	15	24	29	22	26	15	11	8	15	17	21	13	33	29	19	20	30	15	25	22	26	503	Jul 14 Sunday
197	28	18	29	17	22	19	20	5	14	16	5	9	13	15	14	13	12	18	17	16	12	25	16	19	392	Jul 15 Monday
198	20	20	16	25	23	12	13	8	8	10	18	10	1	17	6	18	10	10	10	16	10	18	21	10	330	Jul 16 Tuesday
199	19	19	15	16	20	6	4	9	2	13	4	6	7	5	3	7	2	4	8	5	13	21	22	17	247	Jul 17 Wednesday
200	5	17	13	11	10	2	1	0	6	19	13	7	3	6	9	2	0	7	1	3	5	6	5	21	172	Jul 18 Thursday
201	6	4	28	6	3	3	11	1	10	10	16	5	1	1	6	10	7	7	4	23	3	5	6	7	183	Jul 19 Friday
202	14	22	10	12	17	9	17	11	16	22	3	8	8	7	9	9	13	17	21	15	7	18	13	14	312	Jul 20 Saturday
203	18	17	4	9	13	10	14	10	5	9	7	9	4	5	15	7	3	2	15	4	15	10	9	15	229	Jul 21 Sunday

Table 2.3.2. (Page 2 of 4)

NB2 .DPX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
204	18	18	11	6	13	12	7	7	11	8	7	12	3	3	38	12	23	6	7	6	11	12	12	6	269	Jul 22 Monday
205	16	22	11	15	12	12	14	4	9	3	6	14	28	6	7	13	0	10	16	4	7	10	23	9	271	Jul 23 Tuesday
206	13	19	5	11	9	3	21	6	9	6	7	12	10	11	7	22	11	39	19	13	18	16	6	12	305	Jul 24 Wednesday
207	26	19	12	25	13	6	10	5	7	6	8	0	0	30	68	64	33	41	32	48	19	9	1	11	493	Jul 25 Thursday
208	8	5	4	6	3	4	2	13	5	8	6	1	12	20	9	10	34	9	9	17	11	14	9	8	227	Jul 26 Friday
209	12	8	14	9	3	4	11	4	17	4	10	12	7	6	6	10	17	11	10	13	10	10	20	14	242	Jul 27 Saturday
210	10	19	12	15	8	10	10	17	9	8	8	3	8	4	14	3	6	10	2	8	6	2	1	2	195	Jul 28 Sunday
211	4	14	5	12	5	3	5	0	0	0	0	5	6	9	4	0	1	6	1	2	16	6	3	4	111	Jul 29 Monday
212	2	10	5	14	9	0	0	0	0	3	15	3	7	13	26	5	0	6	4	0	5	6	4	4	141	Jul 30 Tuesday
213	25	6	4	5	6	7	0	0	18	14	1	10	7	10	12	4	2	9	9	3	6	1	14	6	179	Jul 31 Wednesday
214	4	13	6	13	17	1	0	3	4	7	14	9	8	3	9	1	4	4	4	8	5	9	13	4	163	Aug 01 Thursday
215	9	5	15	9	5	1	3	8	4	4	1	15	5	35	33	15	16	12	3	13	6	7	11	6	241	Aug 02 Friday
216	9	13	14	16	18	25	7	11	9	4	7	10	9	5	6	4	10	11	5	7	6	10	12	18	246	Aug 03 Saturday
217	8	7	16	8	9	16	9	10	12	6	7	3	5	7	8	12	2	12	5	6	8	5	3	6	190	Aug 04 Sunday
218	20	3	13	5	14	5	0	0	1	5	0	3	6	8	8	5	1	5	6	7	9	5	15	11	155	Aug 05 Monday
219	17	4	9	8	0	2	4	0	0	1	15	20	47	17	0	1	2	2	0	0	9	5	4	7	174	Aug 06 Tuesday
220	1	6	6	2	1	0	3	1	0	8	5	2	8	11	4	4	5	0	3	4	2	4	3	2	85	Aug 07 Wednesday
221	3	2	3	4	6	0	4	0	1	7	12	5	20	8	3	7	4	21	11	1	3	0	8	6	139	Aug 08 Thursday
222	13	5	5	2	8	10	5	0	9	6	6	5	10	2	13	14	8	6	14	9	3	7	3	8	171	Aug 09 Friday
223	4	5	5	6	10	15	13	5	1	4	4	8	3	5	11	18	9	9	12	12	9	7	14	14	203	Aug 10 Saturday
224	6	15	13	13	10	10	10	9	12	7	2	10	11	3	9	6	6	8	3	9	0	3	5	0	180	Aug 11 Sunday
225	6	2	3	6	2	12	3	4	0	0	5	0	4	5	3	6	0	20	4	2	4	1	4	6	102	Aug 12 Monday
226	9	3	5	0	0	0	11	2	3	2	42	4	16	11	8	0	0	3	7	5	8	1	5	30	175	Aug 13 Tuesday
227	9	2	27	21	7	0	1	5	0	3	4	18	20	6	14	7	3	6	1	2	0	1	3	9	169	Aug 14 Wednesday
228	1	6	2	4	7	2	0	7	7	0	0	0	1	0	4	2	18	2	0	8	1	2	3	8	85	Aug 15 Thursday
229	3	2	0	3	2	0	2	2	1	16	6	15	13	11	5	6	8	11	5	12	7	8	8	9	155	Aug 16 Friday
230	9	17	7	12	12	6	9	5	8	3	3	26	18	4	2	4	10	5	6	5	3	10	8	6	198	Aug 17 Saturday
231	12	5	6	9	9	11	7	10	13	7	9	10	11	13	6	11	8	6	13	5	14	8	9	14	226	Aug 18 Sunday
232	13	18	11	13	13	3	0	10	3	2	3	10	31	13	8	9	6	10	8	7	13	6	24	6	240	Aug 19 Monday
233	17	18	8	15	13	14	6	7	5	7	8	6	23	10	3	5	8	9	0	3	6	15	10	10	226	Aug 20 Tuesday
234	1	8	15	8	1	3	0	7	8	16	5	16	11	14	10	8	6	2	3	12	5	8	15	9	191	Aug 21 Wednesday
235	10	23	19	14	15	16	11	11	4	5	6	10	9	38	32	26	25	8	30	8	26	33	20	17	416	Aug 22 Thursday
236	9	9	11	10	2	12	4	0	5	6	4	9	53	52	48	51	43	24	8	7	13	3	17	10	410	Aug 23 Friday
237	9	6	19	7	11	12	3	12	10	9	8	9	35	36	46	31	66	82	66	58	21	8	10	8	582	Aug 24 Saturday
238	8	9	13	10	11	15	7	8	4	6	4	3	5	10	7	4	6	10	7	4	6	5	13	14	189	Aug 25 Sunday
239	6	4	10	5	8	1	7	2	0	2	7	9	6	4	2	2	2	6	1	0	3	8	5	6	106	Aug 26 Monday
240	10	7	6	1	9	0	14	0	3	8	7	13	1	6	13	6	3	5	6	1	9	6	11	3	148	Aug 27 Tuesday
241	2	6	13	7	4	0	6	10	10	17	15	13	28	15	16	12	16	18	18	12	12	7	22	16	295	Aug 28 Wednesday
242	20	13	10	22	24	12	7	4	3	11	8	5	5	6	15	20	4	8	6	8	9	12	9	22	263	Aug 29 Thursday
243	11	21	12	10	2	2	8	3	7	42	8	20	17	30	22	26	23	22	15	27	20	19	15	29	411	Aug 30 Friday
244	49	27	41	38	47	62	62	54	46	81	100	41	30	36	38	26	28	10	11	19	25	14	5	13	903	Aug 31 Saturday
245	14	17	21	11	19	17	10	25	21	13	6	16	21	16	7	7	7	3	17	13	8	18	12	12	331	Sep 01 Sunday
246	16	18	27	14	17	3	5	14	9	3	16	7	30	9	9	13	2	8	13	14	17	7	14	12	297	Sep 02 Monday
247	20	16	16	19	9	5	2	3	8	4	16	4	9	8	9	4	14	7	7	5	12	9	10	14	230	Sep 03 Tuesday
248	14	14	11	13	18	0	4	1	1	1	8	3	8	6	21	9	7	10	11	13	17	12	22	12	236	Sep 04 Wednesday
249	16	16	16	10	7	4	2	2	11	3	7	17	4	7	9	7	9	2	8	0	24	23	17	24	245	Sep 05 Thursday
250	29	17	26	12	4	6	4	13	18	3	9	21	32	15	26	16	5	14	26	25	15	27	12	18	393	Sep 06 Friday
251	23	11	22	21	30	16	9	4	11	9	16	18	29	8	5	9	11	17	13	7	17	19	19	13	357	Sep 07 Saturday
252	20	21	24	19	19	20	18	15	20	17	15	20	21	9	11	16	18	23	15	18	19	13	18	20	429	Sep 08 Sunday
253	40	37	29	31	44	19	11	11	16	21	16	20	20	17	17	11	20	17	14	22	15	22	32	32	534	Sep 09 Monday
254	31	30	26	45	30	25	3	10	2	10	8	22	18	16	20	12	7	12	16	19	18	15	21	13	429	Sep 10 Tuesday
255	16	15	21	36	22	5	2	4	7	7	17	12	15	20	10	7	8	9	10	9	19	22	20	29	342	Sep 11 Wednesday
256	23	26	19	33	22	8	9	14	16	9	12	12	11	19	14	17	13	9	15	14	13	19	12	17	376	Sep 12 Thursday
257	23	10	20	28	22	8	5	9	17	11	13	23	25	34	23	16	13	10	15	17	20	27	17	21	427	Sep 13 Friday
258	18	18	23	33	12	11	8	2	23	7	6	7	12	43	32	26	26	16	19	53	47	32	34	32	540	Sep 14 Saturday
259	25	15	16	27	20	18	15	27	19	23	13	29	60	66	42	38	20	19	20	28	25	25	28	33	651	Sep 15 Sunday

Table 2.3.2. (Page 3 of 4)

NB2 .DPX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
260	47	32	18	19	7	6	0	2	2	8	7	0	0	29	94	104	54	25	37	27	17	12	25	25	597	Sep 16 Monday
261	5	10	11	6	1	0	1	0	0	7	0	0	8	20	0	8	1	0	5	12	42	39	49	53	278	Sep 17 Tuesday
262	28	16	11	19	32	21	11	9	3	10	19	15	13	7	13	9	0	12	8	2	3	6	6	8	281	Sep 18 Wednesday
263	10	13	5	9	10	0	0	0	1	0	4	6	7	9	29	8	2	0	1	4	0	13	5	8	144	Sep 19 Thursday
264	21	12	8	5	23	8	4	3	0	2	9	13	12	12	8	7	12	29	28	32	17	20	22	9	316	Sep 20 Friday
265	17	24	11	23	9	11	0	4	11	2	7	4	10	6	5	6	15	9	11	12	14	20	15	18	264	Sep 21 Saturday
266	18	11	12	7	5	10	7	3	11	14	12	4	7	4	9	0	5	3	2	4	15	7	10	12	192	Sep 22 Sunday
267	17	7	17	4	6	1	3	3	2	11	7	13	2	3	1	3	5	6	4	9	16	16	8	14	178	Sep 23 Monday
268	18	20	15	19	7	2	3	1	1	7	1	17	29	13	9	4	7	3	14	17	19	26	23	20	295	Sep 24 Tuesday
269	22	13	24	23	9	4	1	11	8	9	13	8	13	9	15	17	7	10	11	12	15	10	16	18	298	Sep 25 Wednesday
270	18	24	16	20	15	6	1	4	5	16	12	2	12	4	4	12	12	11	7	7	20	15	12	10	265	Sep 26 Thursday
271	16	8	17	18	31	9	10	6	1	7	8	15	16	8	19	5	8	13	11	6	14	11	9	20	286	Sep 27 Friday
272	9	14	11	17	16	14	11	14	22	19	9	20	19	10	22	14	22	29	14	5	11	17	12	19	370	Sep 28 Saturday
273	15	25	19	23	14	16	34	18	19	14	18	18	19	18	15	16	14	17	13	15	19	16	15	14	424	Sep 29 Sunday
274	18	14	15	18	14	11	17	11	8	5	5	14	8	10	15	10	19	16	10	15	15	14	16	10	308	Sep 30 Monday

NB2	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Sum		2595		2551		1748		1471		1741		2126		2422		2296		2060		2093		2190		2451		
	2690		2522		2290		1521		1627		1933		2425		2561		2095		2090		2173		2244		51915	Total sum
183	15	14	14	14	13	10	8	8	9	10	11	12	13	13	14	13	11	11	11	11	12	12	12	13	284	Total average
124	14	14	13	13	11	7	6	6	7	8	9	10	12	13	14	12	10	10	11	10	11	11	12	13	260	Average workdays
59	15	15	14	15	15	14	12	12	13	13	13	14	15	14	13	13	13	13	13	13	13	13	12	15	327	Average weekends

Table 2.3.2. Daily and hourly distribution of NORSAR detections. For each day is shown number of detections within each hour of the day and number of detections for that day. The end statistics give total number of detections distributed for each hour and the total sum of detections during the period. The averages show number of processed days, hourly distribution and average per processed day. (Page 4 of 4)

3 Operation of Regional Arrays

3.1 Recording of NORESS data at NDPC, Kjeller

The average recording time was 89.67% as compared to 99.57% during the previous reporting period.

Table 3.1.1 lists the main outage times and reasons.

Date	Time			Cause
07 May	0702	-	1213	Power break (announced)
09 May	0701	-	1141	Power break (announced)
14 May	0710	-	0941	Power break (announced)
14 May	1958	-	2010	Power failure due to thunderstorm
23 May	0700	-	1153	Power break (announced)
10 Jun	0653	-	0749	Power break
18 Jun	1624	-		Hardware failure due to thunderstorm
20 Jun		-	1127	
12 Jul	2100	-		Hardware failure due to thunderstorm
29 Jul		-	0100	
16 Sep	1018	-	1728	Transmission line failure

Table 3.1.1. Interruptions in recording of NORESS data at NDPC, 1 April - 30 September 1996.

Monthly uptimes for the NORESS on-line data recording task, taking into account all factors (field installations, transmissions line, data center operation) affecting this task were as follows:

April 96	:	99.97
May	:	97.64
June	:	93.88
July	:	47.89
August	:	99.89
September	:	98.77

Fig. 3.1.1 shows the uptime for the data recording task, or equivalently, the availability of NORESS data in our tape archive, on a day-by-day basis, for the reporting period.

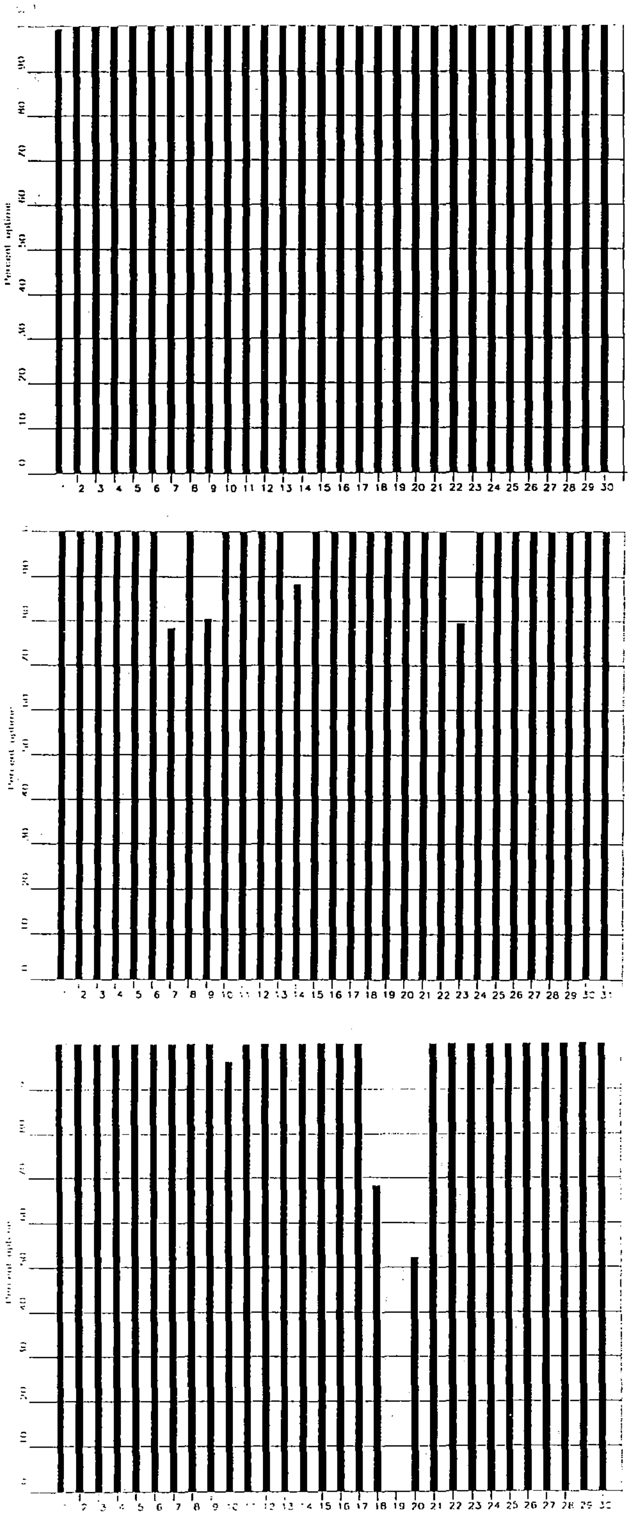

Fig. 3.1.1. NORESS data recording uptime for April (top), May (middle) and June (bottom) 1996.

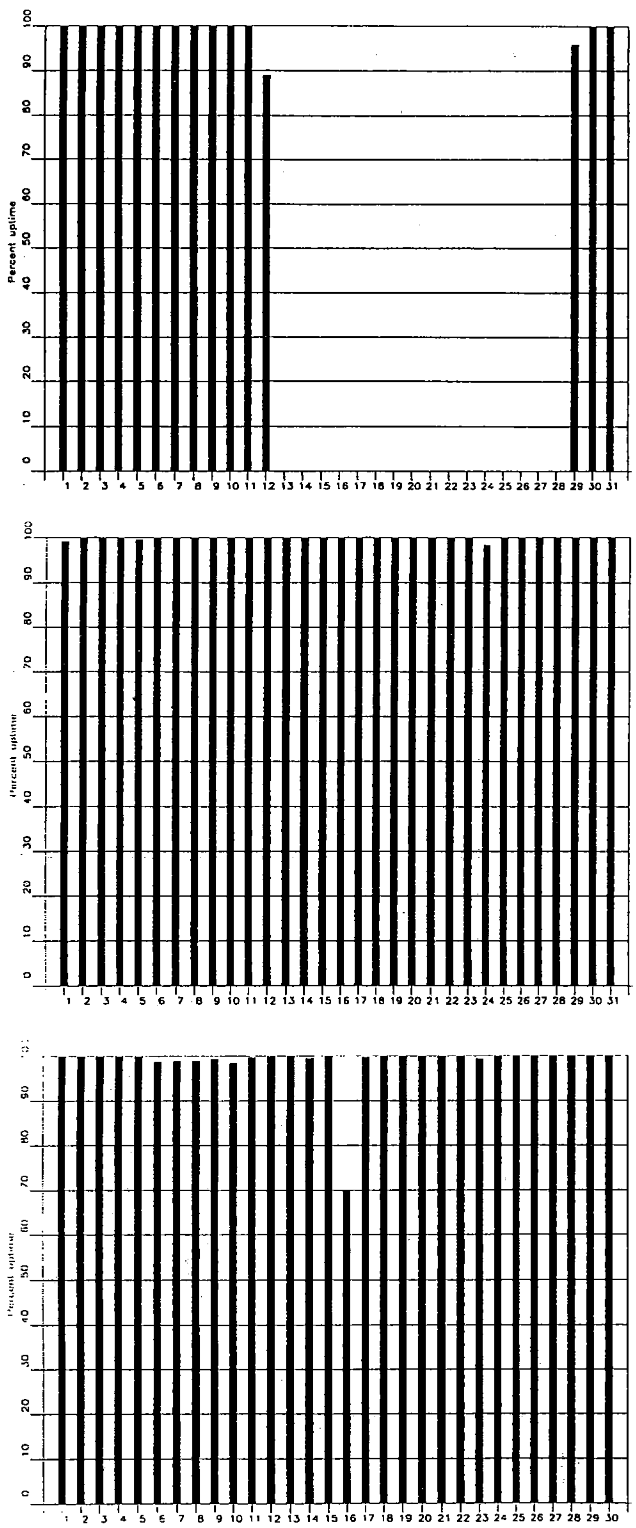

Fig. 3.1.1. (cont.) NORESS data recording uptime for July (top), August (middle) and September (bottom) 1996.

3.2 Recording of ARCESS data at NDPC, Kjeller

The average recording time was 98.42% as compared to 98.82% for the previous reporting period.

Table 3.2.1 lists the main outage times and reasons.

Date	Time			Cause
14 May	1958	-	2130	Power failure DPC due to thunderstorm
10 Jun	0653	-	0749	Power failure DPC
12 Jul	0853	-	1655	Power failure Hub
19 Aug	1000	-	1253	Power failure Hub
19 Aug	1332	-		Power failure Hub
21 Aug		-	1741	
03 Sep	0735	-	1021	Hardware maintenance DPC

Table 3.2.1. The main interruptions in recording of ARCESS data at NDPC, 1 April - 30 September 1996.

Monthly uptimes for the ARCESS on-line data recording task, taking into account all factors (field installations, transmissions line, data center operation) affecting this task were as follows:

April 96	:	99.99%
May	:	99.79%
June	:	99.86%
July	:	98.71%
August	:	92.57%
September	:	99.59%

Fig. 3.2.1. shows the uptime for the data recording task, or equivalently, the availability of ARCESS data in our tape archive, on a day-by-day basis, for the reporting period.

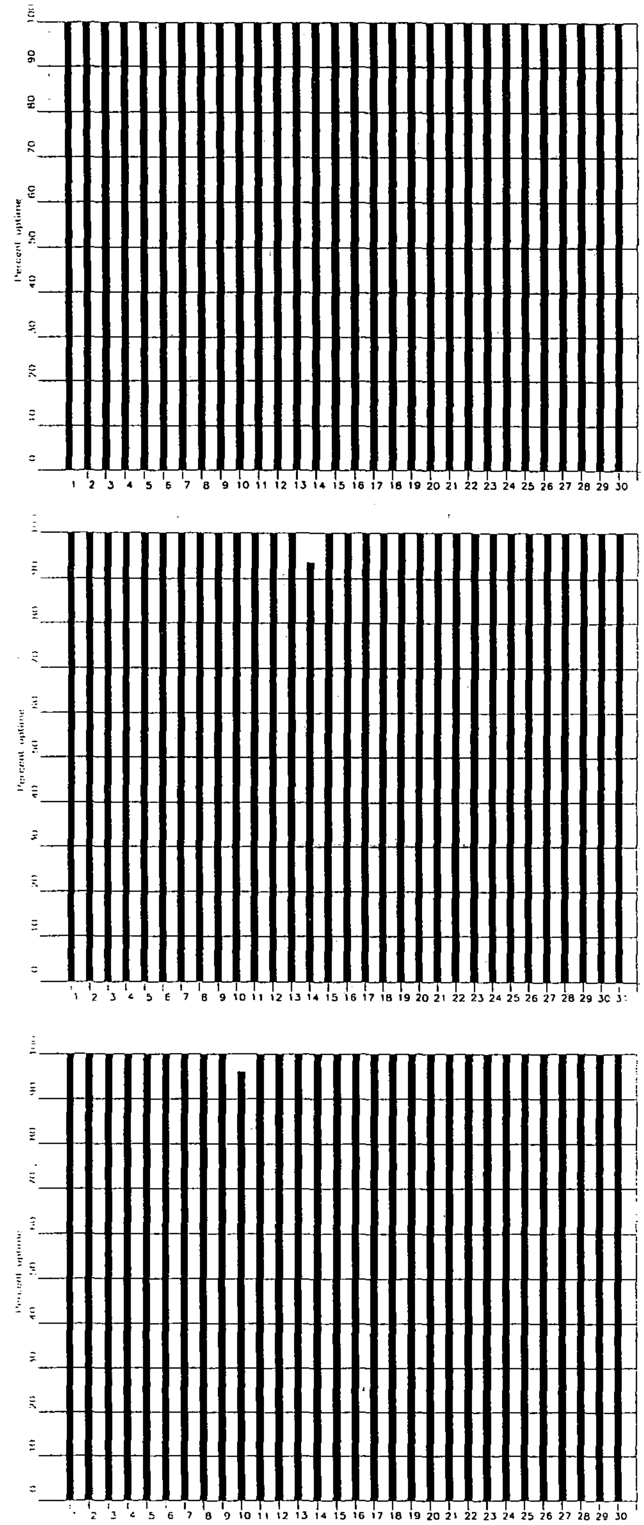

Fig. 3.2.1. ARCESS data recording uptime for April (top), May (middle) and June (bottom) 1996.

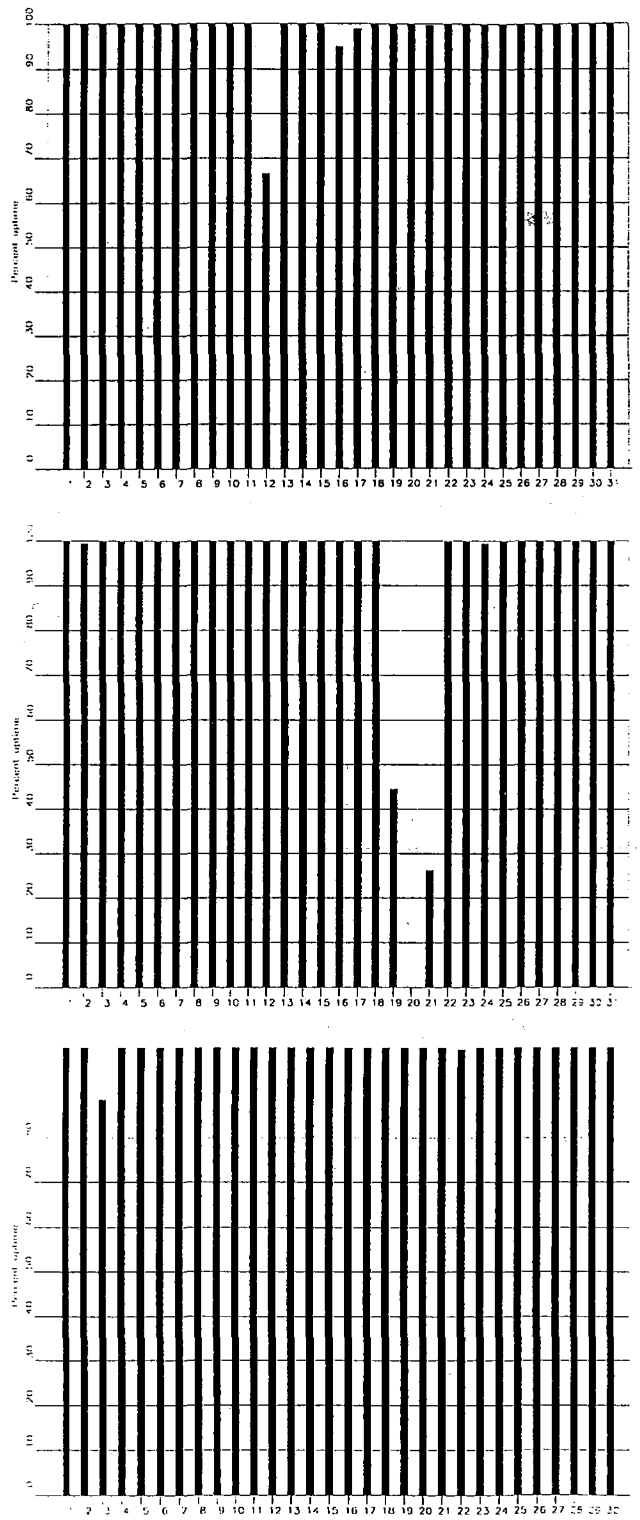

Fig. 3.2.1. ARCESS data recording uptime for July (top), August (middle) and September (bottom) 1996.

3.3 Recording of FINESS data at NDPC, Kjeller

The average recording time was 98.79% as compared to 99.08% for the previous reporting period.

Date	Time		Cause
09 Jun	2330 -		Transmission line failure
10 Jun		- 0556	
06 Jul	1348 -		Transmission line failure
08 Jul		- 1142	

Table 3.3.1. The main interruptions in recording of FINESS data at NDPC, 1 April - 30 September 1996.

Monthly uptimes for the FINESS on-line data recording task, taking into account all factors (field installations, transmission lines, data center operation) affecting this task were as follows:

April 96	:	100.00%
May	:	100.00%
June	:	99.10%
July	:	93.65%
August	:	100.00%
September	:	99.97%

Fig. 3.3.1 shows the uptime for the data recording task, or equivalently, the availability of FINESS data in our tape archive, on a day-by-day basis, for the reporting period.

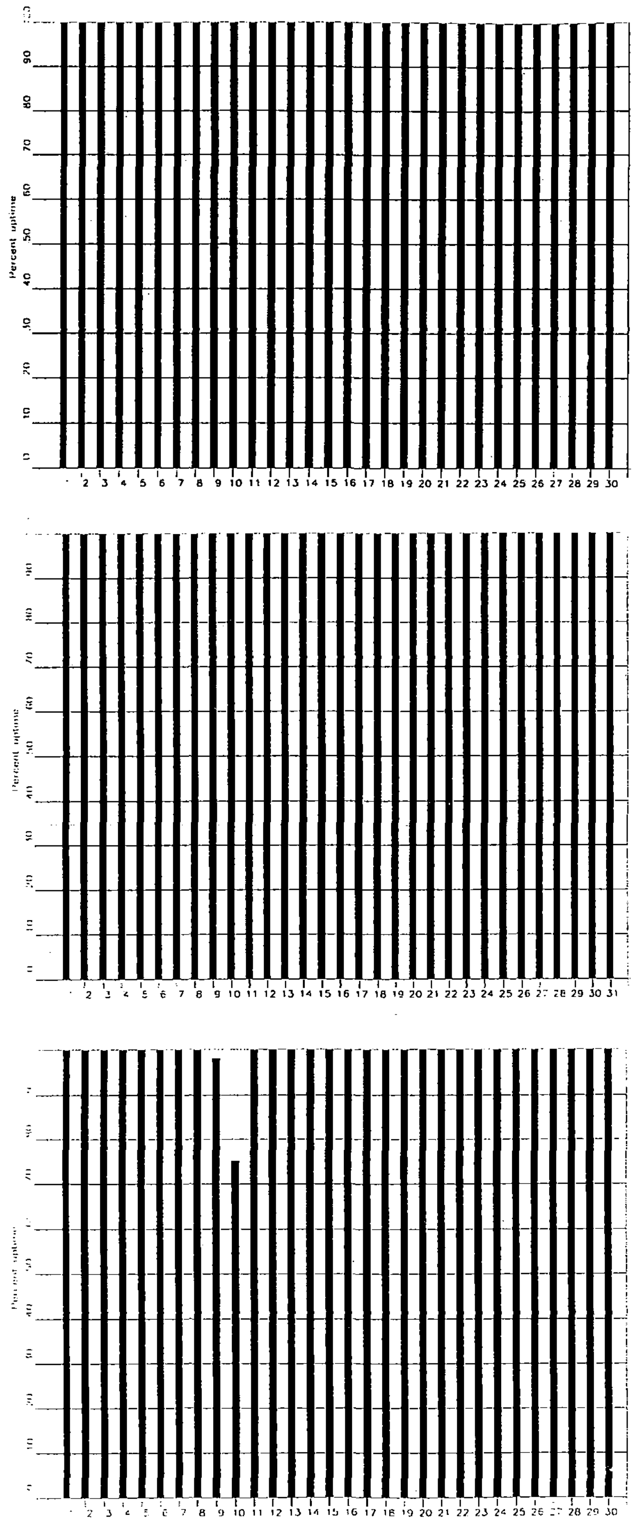

Fig. 3.3.1. FINESS data recording uptime for April (top), May (middle) and June (bottom) 1996.

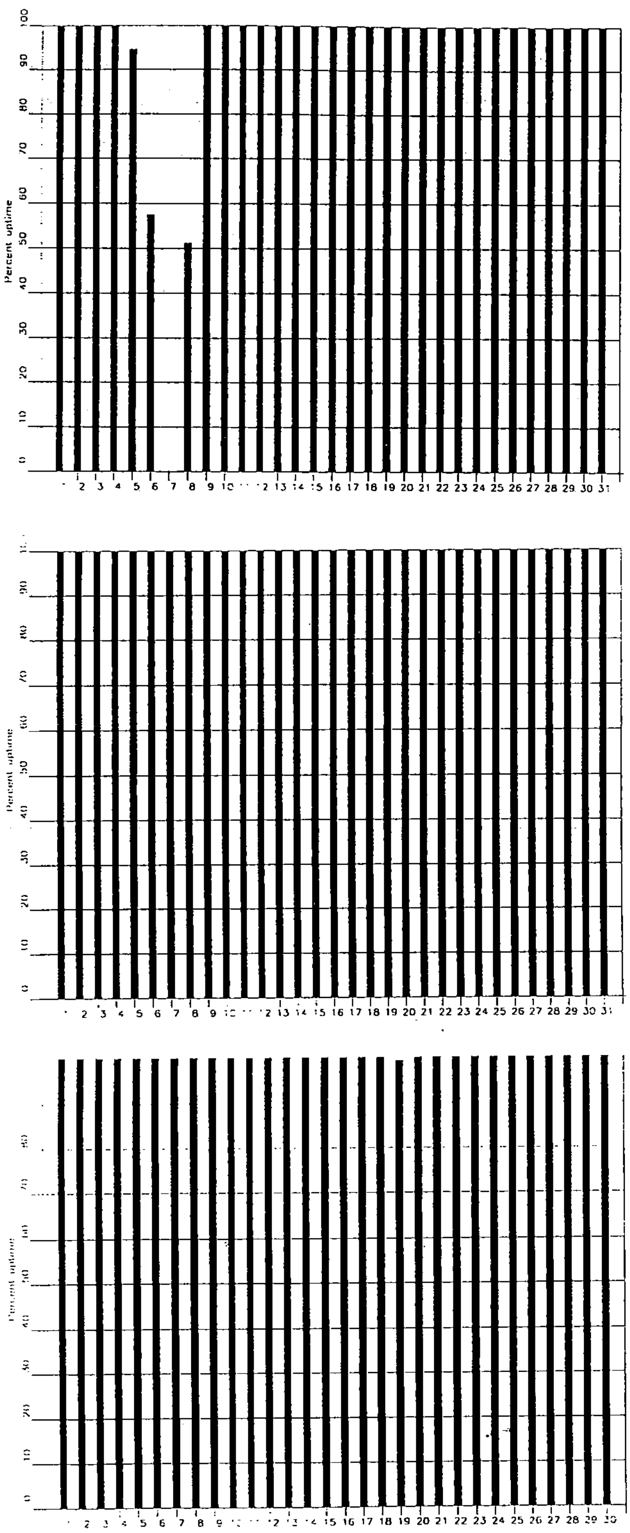

Fig. 3.3.1. FINESS data recording uptime for July (top), August (middle) and September (bottom) 1996.

3.4 Recording of Spitsbergen data at NDPC, Kjeller

The average recording time was 96.63% (from restart on 28 June), as compared to 81.75% for the previous reporting period. The power failure at the array site caused a break in recording between 10 March and 28 June 1996.

The main reasons for downtime follow:

Date	Time	Cause
01 Apr	0000 -	Power failure Spitsbergen from 10 March 96
28 Jun	- 1306	
06 Jul- 07 Aug	-	Poor datalink caused numerous gaps
05 Sep- 06 Sep	-	Poor datalink caused numerous gaps
19 Sep	-	Poor datalink caused numerous gaps

Table 3.4.1. The main interruptions in recording of Spitsbergen data at NDPC, 1 April - 30 September 1996.

Monthly uptimes for the Spitsbergen online data recording task, taking into account all factors (field installations, transmission line, data center operation) affecting this task were as follows:

April 96	:	0.00%
May	:	0.00%
June	:	8.18%
July	:	93.89%
August	:	98.18%
September	:	97.81%

Fig. 3.4.1 shows the uptime for the data recording task, or equivalently, the availability of Spitsbergen data in our tape archive, on a day-by-day basis for the reporting period.

J. Torstveit

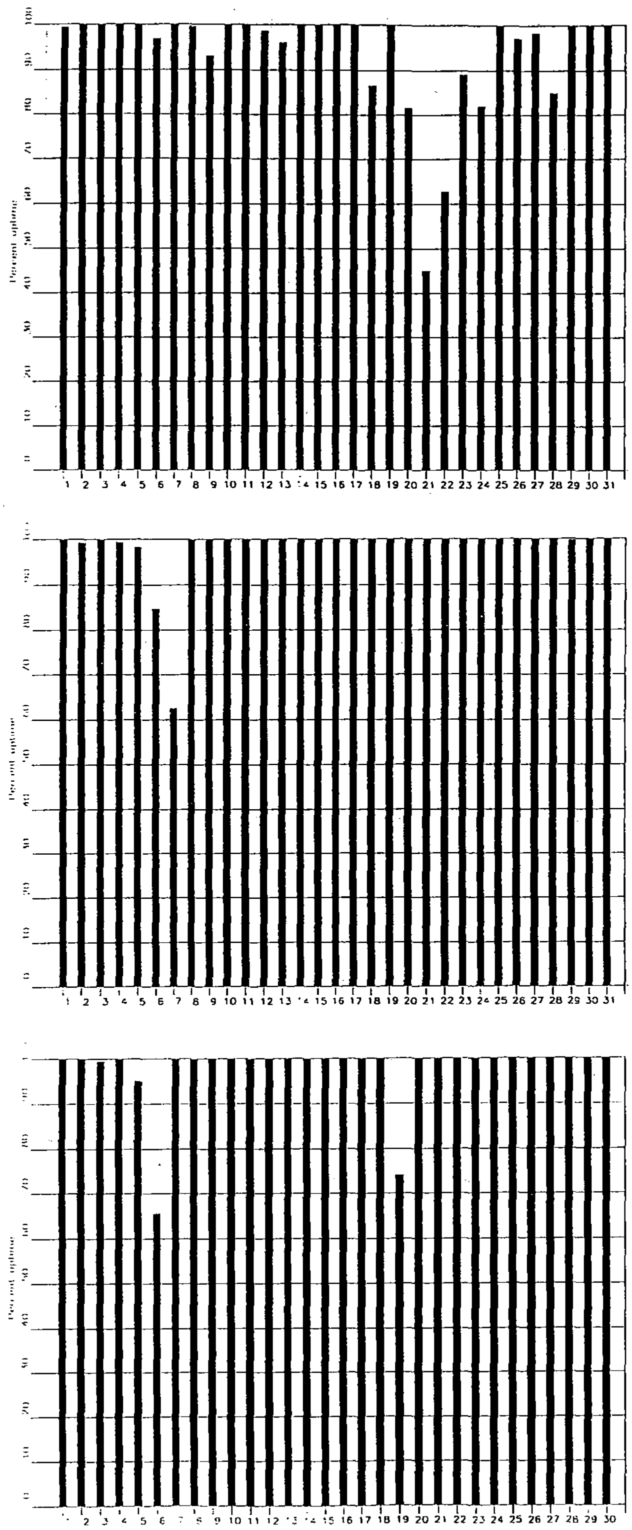

Fig. 3.4.1. Spitsbergen data recording uptime for July (top), August (middle) and September (bottom) 1996.

3.5 Event detection operation

This section reports results from one-array automatic processing using signal processing recipes and "ronapp" recipes for the ep program (NORSAR Sci. Rep. No 2-88/89).

Three systems are in parallel operation to associate detected phases and locate events:

1. The ep program with "ronapp" recipes is operated independently on each array to obtain simple one-array automatic solutions.
2. The Generalized Beamforming method (GBF) (see F. Ringdal and T. Kværna (1989), A mulitchannel processing approach to real time network detection, phase association and threshold monitoring, BSSA Vol 79, no 6, 1927-1940) processes the four arrays jointly and presents locations of regional events.
3. The RMS system (Regional Monitoring System; previously referred to as the IMS system (Intelligent Monitoring System) system) is operated on the same set of arrivals as ep and GBF and reports also teleseismic events in addition to regional ones.

RMS results are reported in section 3.6.

NORESS detections

The number of detections (phases) reported from day 092, 1996, through day 274, 1996, was 37,802, giving an average of 225 detections per processed day (168 days processed).

Table 3.5.1 shows daily and hourly distribution of detections for NORESS.

Events automatically located by NORESS

During days 092, 1996, through 274, 1996, 1939 local and regional events were located by NORESS, based on automatic association of P- and S-type arrivals. This gives an average of 11.5 events per processed day (168 days processed). 57% of these events are within 300 km, and 86% of these events are within 1000 km.

ARCESS detections

The number of detections (phases) reported during day 092, 1996, through day 274, 1996, was 93,800, giving an average of 515 detections per processed day (182 days processed).

Table 3.5.2 shows daily and hourly distribution of detections for ARCESS.

Events automatically located by ARCESS

During days 092, 1996, through 274, 1996, 5527 local and regional events were located by ARCESS, based on automatic association of P- and S-type arrivals. This gives an average of 30.4 events per processed day (182 days processed). 52% of these events are within 300 km, and 83% of these events are within 1000 km.

FINESS detections

The number of detections (phases) reported during day 092, 1996, through day 274, 1996, was 30,842, giving an average of 169 detections per processed day (182 days processed).

Table 3.5.3 shows daily and hourly distribution of detections for FINESS.

Events automatically located by FINESS

During days 092, 1996, through 274, 1996, 2619 local and regional events were located by FINESS, based on automatic association of P- and S-type arrivals. This gives an average of 14.4 events per processed day (182 days processed). 82% of these events are within 300 km, and 93% of these events are within 1000 km.

GERESS detections

The number of detections (phases) reported from day 092, 1996, through day 274, 1996, was 49,678, giving an average of 271 detections per processed day (183 days processed).

Table 3.5.4 shows daily and hourly distribution of detections for GERESS.

Events automatically located by GERESS

During days 092, 1996, through 274, 1996, 4863 local and regional events were located by GERESS, based on automatic association of P- and S-type arrivals. This gives an average of 26.6 events per processed day (183 days processed). 70% of these events are within 300 km, and 88% of these events are within 1000 km.

Apatity array detections

The number of detections (phases) reported from day 092, 1995, through day 274, 1999, was 74,252, giving an average of 406 detections per processed day (183 days processed).

As described in earlier reports, the data from the Apatity array are transferred by one-way (simplex) radio links to Apatity city. The transmission suffers from radio disturbances that occasionally result in a large number of small data gaps and spikes in the data. In order for the communication protocol to correct such errors by requesting retransmission of data, a two-way radio link would be needed (duplex radio). However, it should be noted that noise from cultural activities and from the nearby lakes cause most of the unwanted detections. These unwanted detections are "filtered" in the signal processing, as they give seismic velocities that are outside accepted limits for regional and teleseismic phase velocities.

Table 3.5.5 shows daily and hourly distribution of detections for the Apatity array.

Events automatically located by the Apatity array

During days 092, 1996, through 274, 1996, 801 local and regional events were located by the Apatity array, based on automatic association of P- and S-type arrivals. This gives an average of 4.4 events per processed day (183 days processed). 51% of these events are within 300 km, and 77% of these events are within 1000 km.

Spitsbergen array detections

The number of detections (phases) reported from day 092, 1996, through day 274, 1996, was 89,214, giving an average of 939 detections per processed day (95 days processed).

Table 3.5.6 shows daily and hourly distribution of detections for the Spitsbergen array.

Events automatically located by the Spitsbergen array

During days 092, 1996, through 274, 1996, 7870 local and regional events were located by the Spitsbergen array, based on automatic association of P- and S-type arrivals. This gives an average of 82.8 events per processed day (95 days processed). 49% of these events are within 300 km, and 74% of these events are within 1000 km.

Hagfors array detections

The number of detections (phases) reported from day 092, 1996, through day 274, 1996, was 49,399, giving an average of 270 detections per processed day (183 days processed).

Table 3.5.7 shows daily and hourly distribution of detections for the Hagfors array

Events automatically located by the Hagfors array

During days 092, 1996, through 274, 1996, 1897 local and regional events were located by the Hagfors array, based on automatic association of P- and S-type arrivals. This gives an average of 10.4 events per processed day (183 days processed). 38% of these events are within 300 km, and 79% of these events are within 1000 km

U. Baadshaug

NRS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
92	10	4	3	8	5	9	11	16	19	13	11	9	14	13	9	6	6	5	33	139	5	2	2	5	357	Apr 01 Monday
93	3	3	17	9	1	3	5	14	15	1	5	7	12	2	22	5	6	8	1	27	4	3	0	2	175	Apr 02 Tuesday
94	6	3	2	18	10	7	6	5	13	10	8	18	0	8	14	7	20	11	30	5	11	11	10	8	241	Apr 03 Wednesday
95	6	4	6	2	8	9	32	7	10	18	12	16	12	14	9	3	3	15	5	11	6	9	2	4	223	Apr 04 Thursday
96	5	3	6	5	19	9	7	8	17	16	16	10	10	9	5	12	12	11	14	8	8	7	5	7	229	Apr 05 Friday
97	5	6	4	6	20	12	10	9	37	13	5	9	12	7	7	6	8	7	3	4	4	9	4	9	216	Apr 06 Saturday
98	15	6	8	3	9	3	15	2	9	8	4	4	8	7	13	9	9	4	1	12	7	0	5	6	167	Apr 07 Sunday
99	8	2	11	8	6	4	21	7	24	11	17	37	4	1	4	5	4	12	5	3	6	6	5	1	212	Apr 08 Monday
100	8	23	10	9	5	10	9	4	4	3	9	17	3	8	4	1	5	9	0	12	1	19	4	2	179	Apr 09 Tuesday
101	7	5	7	6	3	8	2	1	6	16	2	7	11	12	9	34	5	9	4	3	16	5	17	3	198	Apr 10 Wednesday
102	12	5	14	11	12	8	3	6	10	9	6	8	13	6	9	16	7	10	1	16	7	17	19	20	245	Apr 11 Thursday
103	14	20	19	19	10	8	9	29	25	19	33	12	27	19	8	19	12	12	1	29	6	7	12	5	374	Apr 12 Friday
104	24	9	8	18	9	10	4	6	4	8	10	9	4	7	2	2	8	4	8	9	27	13	6	15	224	Apr 13 Saturday
105	26	12	17	21	24	32	2	2	8	2	8	10	22	1	5	4	3	1	0	2	37	8	3	2	252	Apr 14 Sunday
106	10	5	27	12	11	11	0	18	13	7	2	6	13	18	3	8	5	11	5	14	4	14	5	8	230	Apr 15 Monday
107	18	19	21	42	15	5	4	0	5	5	17	8	10	16	15	11	17	4	8	19	6	22	13	7	307	Apr 16 Tuesday
108	8	5	10	16	14	3	5	4	11	21	16	18	7	16	9	20	48	6	22	19	2	16	5	4	305	Apr 17 Wednesday
109	11	11	20	8	12	6	6	2	12	4	2	9	13	15	6	4	15	8	3	22	9	19	12	8	237	Apr 18 Thursday
110	8	9	16	15	9	2	3	4	3	17	12	5	20	15	6	3	5	4	8	21	3	18	3	12	221	Apr 19 Friday
111	2	4	3	1	11	6	4	5	9	10	6	5	13	24	23	1	6	3	8	4	12	4	8	8	180	Apr 20 Saturday
112	5	8	7	3	6	8	7	1	2	3	9	6	4	4	5	4	7	2	0	17	5	3	3	6	125	Apr 21 Sunday
113	4	3	4	0	7	3	3	7	0	8	6	15	10	10	12	11	6	7	3	7	4	11	3	5	149	Apr 22 Monday
114	10	6	3	0	5	2	0	4	8	6	2	6	14	27	1	2	3	7	2	7	4	10	3	5	137	Apr 23 Tuesday
115	5	9	8	7	4	3	1	4	3	12	4	14	10	23	3	9	20	22	7	19	1	12	2	2	204	Apr 24 Wednesday
116	14	5	9	13	5	3	7	5	4	8	14	12	18	17	20	4	0	0	5	9	9	13	19	22	235	Apr 25 Thursday
117	21	17	24	28	18	3	3	11	4	3	10	6	14	4	8	8	7	7	6	23	6	15	16	8	270	Apr 26 Friday
118	9	8	5	5	9	11	3	3	4	4	4	2	7	1	2	1	5	6	0	2	2	0	2	1	96	Apr 27 Saturday
119	1	2	1	1	0	10	20	22	7	4	2	9	24	28	9	3	0	1	0	3	3	9	4	14	177	Apr 28 Sunday
120	7	3	13	6	9	3	1	8	1	1	8	5	9	4	15	11	4	4	5	5	4	9	1	5	141	Apr 29 Monday
121	3	4	5	4	2	9	1	1	3	9	9	21	3	14	3	10	4	3	2	15	4	12	10	3	154	Apr 30 Tuesday
122	11	5	4	7	8	10	5	6	6	11	11	11	4	6	8	2	5	4	5	3	3	5	11	3	154	May 01 Wednesday
123	7	14	6	2	7	7	7	2	1	2	3	3	12	13	9	8	10	5	10	9	7	13	4	3	164	May 02 Thursday
124	4	13	9	5	8	3	1	6	4	3	2	1	1	11	7	3	3	4	10	10	0	12	5	11	136	May 03 Friday
125	2	5	6	7	7	8	4	9	1	10	11	13	10	10	10	2	3	7	6	2	1	2	2	4	142	May 04 Saturday
126	6	3	4	1	21	24	0	0	3	4	5	6	12	20	8	19	20	7	4	9	3	1	8	15	203	May 05 Sunday
127	10	2	8	2	0	1	2	1	3	2	9	9	8	5	1	3	2	3	21	14	10	0	0	3	119	May 06 Monday
128	5	3	3	2	7	1	0	0	0	0	0	0	10	23	8	5	4	5	3	8	8	4	8	8	115	May 07 Tuesday
129	6	15	24	4	4	2	2	4	7	5	5	25	42	22	13	1	4	5	4	9	12	13	97	47	372	May 08 Wednesday
130	8	8	9	10	6	1	1	0	0	0	0	2	14	10	13	8	4	8	5	8	9	8	3	6	141	May 09 Thursday
131	5	3	9	10	4	2	3	4	3	5	6	7	9	6	2	7	7	0	0	16	1	3	3	3	118	May 10 Friday
132	3	5	8	3	10	3	3	1	11	1	5	2	2	0	7	2	20	19	9	10	12	24	10	26	196	May 11 Saturday
133	15	9	14	131	67	27	9	11	5	4	4	9	4	2	5	9	0	5	9	5	2	1	1	4	352	May 12 Sunday
134	8	7	13	3	6	9	1	0	10	1	3	2	13	5	2	4	8	2	5	9	1	1	4	2	119	May 13 Monday
135	9	5	15	10	18	8	4	0	0	3	7	14	25	10	1	8	9	5	3	9	2	3	4	8	180	May 14 Tuesday
136	2	20	30	8	13	1	31	15	15	9	17	27	28	15	8	7	9	6	4	0	11	5	5	8	294	May 15 Wednesday
137	2	2	1	1	6	6	3	5	3	8	8	4	6	6	3	7	1	8	5	2	3	13	3	2	108	May 16 Thursday
138	0	4	4	6	1	2	2	1	5	1	13	7	3	1	3	2	2	8	2	2	2	2	3	4	80	May 17 Friday
139	3	5	6	4	1	7	1	5	4	4	13	5	5	5	5	3	0	3	2	6	4	7	2	1	101	May 18 Saturday
140	2	5	5	14	4	4	8	4	5	7	3	6	2	4	8	7	9	2	3	3	4	9	4	8	130	May 19 Sunday
141	4	19	1	6	2	1	3	4	8	4	4	11	6	4	5	5	6	5	1	10	3	20	5	2	139	May 20 Monday
142	7	4	3	6	3	3	4	3	10	6	19	7	10	5	19	1	6	8	1	5	5	15	4	6	160	May 21 Tuesday
143	14	21	2	4	0	1	4	2	4	9	10	12	9	10	19	7	13	4	16	5	7	6	1	5	185	May 22 Wednesday
144	2	24	10	13	19	10	14	0	0	0	0	0	11	11	12	6	3	8	10	8	15	11	21	22	230	May 23 Thursday
145	19	13	21	16	14	9	8	20	9	10	7	1	12	9	5	6	7	8	2	6	11	8	14	9	244	May 24 Friday
146	9	7	11	2	10	8	7	3	9	9	8	1	6	9	1	6	11	14	11	4	8	4	6	5	169	May 25 Saturday
147	5	5	8	4	5	5	3	5	5	8	5	1	5	1	1	3	1	2	5	3	4	9	5	6	104	May 26 Sunday

Table 3.5.1 (Page 1 of 4)

NRS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
148	6	6	7	6	6	9	8	7	4	9	5	13	2	5	14	9	5	7	16	10	10	12	13	11	200	May 27 Monday
149	9	24	8	11	3	1	1	4	12	10	14	5	8	4	8	6	2	3	8	8	20	2	6	7	184	May 28 Tuesday
150	6	9	12	3	8	13	5	3	6	8	6	8	5	12	5	7	3	8	2	9	8	1	2	6	155	May 29 Wednesday
151	0	15	4	11	4	0	1	5	10	3	16	11	12	10	4	17	6	3	10	9	7	10	3	5	176	May 30 Thursday
152	5	21	13	4	5	6	5	3	24	17	11	11	7	5	0	5	3	7	3	6	15	1	3	3	183	May 31 Friday
153	3	3	4	3	4	4	2	1	9	13	7	3	7	10	2	13	8	13	8	8	13	16	23	19	196	Jun 01 Saturday
154	25	31	38	31	21	22	24	22	27	28	15	27	24	17	33	26	19	22	35	27	22	32	39	38	645	Jun 02 Sunday
155	37	50	37	37	33	10	13	14	18	9	11	26	14	25	16	33	18	14	19	23	34	13	18	21	543	Jun 03 Monday
156	30	24	34	26	19	3	2	6	16	4	3	10	9	9	4	6	10	10	12	7	8	6	1	6	265	Jun 04 Tuesday
157	3	7	14	4	5	24	56	10	10	22	10	10	12	19	33	3	5	8	0	9	9	3	4	6	286	Jun 05 Wednesday
158	6	11	6	2	2	5	13	4	7	12	9	13	14	6	8	7	17	5	5	3	17	1	1	8	182	Jun 06 Thursday
159	4	2	21	4	2	6	4	4	10	11	16	14	12	9	5	1	12	2	2	5	18	3	5	7	179	Jun 07 Friday
160	20	11	7	11	7	17	26	12	7	4	3	3	4	1	1	0	9	3	2	2	72	5	0	8	235	Jun 08 Saturday
161	1	8	4	7	4	5	2	2	7	10	9	0	4	5	2	2	5	0	4	23	16	3	14	29	166	Jun 09 Sunday
162	19	39	24	27	35	21	10	2	19	21	11	18	10	21	18	23	7	18	20	11	6	1	4	5	390	Jun 10 Monday
163	5	16	2	3	2	3	0	7	2	7	12	15	9	13	7	3	13	10	18	6	4	9	4	2	172	Jun 11 Tuesday
164	5	2	17	11	6	2	2	3	3	9	6	10	16	19	22	9	3	4	4	4	4	8	5	2	176	Jun 12 Wednesday
165	12	4	11	3	0	10	4	6	5	0	8	14	21	12	13	6	3	9	16	4	6	3	2	6	178	Jun 13 Thursday
166	5	7	8	3	2	4	3	3	8	8	8	6	0	11	7	55	72	4	3	7	14	2	6	6	252	Jun 14 Friday
167	4	2	2	2	3	6	6	3	6	4	3	3	6	4	18	30	7	4	7	5	15	1	3	11	155	Jun 15 Saturday
168	11	7	4	10	1	7	0	3	2	6	4	3	4	4	4	8	10	4	8	14	7	7	2	5	135	Jun 16 Sunday
169	5	20	7	4	3	3	1	6	2	1	5	35	14	13	36	11	15	10	4	2	5	10	8	2	222	Jun 17 Monday
170	1	13	9	0	1	1	0	6	7	6	7	1	22	12	16	3	4	0	0	0	0	0	0	0	109	Jun 18 Tuesday
171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 19 Wednesday
172	0	0	0	0	0	0	0	0	0	0	0	15	22	17	11	8	10	8	9	10	12	14	14	13	163	Jun 20 Thursday
173	17	21	20	9	6	2	1	7	4	10	4	16	6	18	19	9	17	8	15	24	17	17	20	15	302	Jun 21 Friday
174	8	9	8	13	12	28	17	9	12	7	9	17	11	19	8	22	13	6	9	11	17	4	15	6	290	Jun 22 Saturday
175	7	21	28	16	11	12	10	12	12	24	22	34	48	11	16	25	11	14	15	10	15	25	8	8	415	Jun 23 Sunday
176	6	7	28	8	2	1	5	4	5	9	11	11	0	15	16	24	5	14	5	13	4	6	13	4	216	Jun 24 Monday
177	9	21	9	12	2	5	2	7	9	5	10	10	11	10	16	4	6	2	11	15	7	10	2	8	203	Jun 25 Tuesday
178	4	9	21	8	9	1	2	5	10	2	9	12	10	8	13	9	5	12	19	10	2	2	0	3	185	Jun 26 Wednesday
179	4	11	9	5	0	4	4	6	6	8	8	3	7	10	11	3	13	8	0	23	3	6	2	5	159	Jun 27 Thursday
180	6	22	4	5	3	5	6	4	4	7	9	5	9	0	14	13	10	3	5	5	10	5	4	4	162	Jun 28 Friday
181	20	25	5	4	4	6	0	7	14	1	2	2	2	3	7	7	1	0	2	21	9	5	9	3	159	Jun 29 Saturday
182	7	9	3	11	17	6	3	12	13	11	11	6	5	6	2	1	0	3	2	1	7	1	0	6	143	Jun 30 Sunday
183	4	21	4	4	5	1	3	2	6	3	11	9	15	6	12	4	5	4	2	12	0	8	8	8	157	Jul 01 Monday
184	2	26	2	7	4	2	0	9	2	4	1	6	12	5	9	4	4	2	5	9	5	2	2	1	125	Jul 02 Tuesday
185	2	15	2	3	4	7	5	7	10	0	10	15	9	7	13	8	12	5	1	16	5	0	2	5	163	Jul 03 Wednesday
186	5	6	12	7	14	4	3	9	7	10	6	7	10	12	8	5	7	14	15	14	21	20	22	19	257	Jul 04 Thursday
187	17	15	18	16	13	6	3	3	6	4	20	18	15	4	17	7	9	6	28	69	11	5	7	10	327	Jul 05 Friday
188	3	7	3	6	7	10	4	6	11	6	8	10	10	9	3	1	4	5	6	6	19	16	6	4	170	Jul 06 Saturday
189	5	9	6	12	8	9	10	6	8	6	9	4	2	5	3	7	7	3	12	3	6	14	6	2	162	Jul 07 Sunday
190	5	2	1	6	3	11	0	0	4	5	7	14	10	9	9	4	4	4	8	22	8	18	5	16	175	Jul 08 Monday
191	12	10	9	15	14	5	5	7	3	6	7	7	16	20	8	10	15	18	16	38	15	5	3	4	268	Jul 09 Tuesday
192	8	7	6	3	8	9	4	10	3	7	7	3	18	4	12	11	10	15	20	15	7	5	3	2	197	Jul 10 Wednesday
193	4	4	4	1	3	4	3	8	9	3	11	7	18	10	8	1	10	4	13	8	3	0	8	2	146	Jul 11 Thursday
194	2	3	8	7	3	1	6	4	4	8	11	7	11	7	2	10	12	9	20	16	5	17	0	0	173	Jul 12 Friday
195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jul 13 Saturday
196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jul 14 Sunday
197	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jul 15 Monday
198	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jul 16 Tuesday
199	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jul 17 Wednesday
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jul 18 Thursday
201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jul 19 Friday
202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jul 20 Saturday
203	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jul 21 Sunday

Table 3.5.1 (Page 2 of 4)

NRS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
204	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jul 22 Monday
205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jul 23 Tuesday
206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jul 24 Wednesday
207	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	7	Jul 25 Thursday
208	0	20	5	14	4	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	54	Jul 26 Friday
209	0	9	10	6	2	14	3	5	9	9	11	5	11	0	0	0	0	0	0	0	0	0	0	0	94	Jul 27 Saturday
210	0	2	9	19	5	8	13	15	20	21	10	12	12	0	0	0	0	0	0	0	0	0	0	0	146	Jul 28 Sunday
211	0	4	3	6	6	12	12	8	9	10	14	17	12	15	2	9	4	4	12	9	12	8	2	7	197	Jul 29 Monday
212	5	24	5	7	14	5	4	16	12	7	11	10	6	14	15	8	4	10	8	24	3	9	8	14	243	Jul 30 Tuesday
213	22	31	11	9	5	12	4	16	22	14	11	16	18	16	74	24	16	10	13	25	17	3	10	6	405	Jul 31 Wednesday
214	13	16	16	15	10	11	9	19	10	6	14	15	18	8	10	4	18	10	6	19	15	9	11	7	289	Aug 01 Thursday
215	9	35	16	9	10	11	7	8	7	3	6	11	11	30	22	14	18	7	8	22	11	4	11	8	298	Aug 02 Friday
216	10	6	4	12	15	14	4	11	3	3	8	8	6	3	8	6	14	5	8	16	9	23	4	9	209	Aug 03 Saturday
217	5	3	3	8	14	11	8	7	4	1	9	3	8	15	12	4	9	9	19	64	18	4	8	7	253	Aug 04 Sunday
218	21	9	27	8	18	6	3	3	15	10	17	23	16	19	10	11	17	8	10	22	9	7	17	16	322	Aug 05 Monday
219	15	23	19	12	6	4	5	5	5	6	15	56	94	15	8	10	10	7	10	32	16	10	10	16	409	Aug 06 Tuesday
220	10	22	17	14	3	3	9	8	6	14	9	12	18	13	7	10	17	5	11	26	6	9	7	6	262	Aug 07 Wednesday
221	8	13	31	5	2	3	8	6	5	6	13	20	27	17	13	11	7	9	31	16	7	6	8	14	286	Aug 08 Thursday
222	14	8	27	10	8	7	14	4	7	8	5	7	9	6	17	14	12	5	10	26	5	8	9	8	248	Aug 09 Friday
223	15	11	14	33	15	24	14	12	15	20	20	19	10	19	19	25	19	13	18	23	31	21	18	15	443	Aug 10 Saturday
224	34	19	20	22	18	38	22	16	13	14	11	18	9	4	11	10	11	11	12	4	7	15	11	11	361	Aug 11 Sunday
225	10	25	25	8	7	2	9	7	6	8	7	4	9	9	8	8	13	16	15	15	3	9	7	2	232	Aug 12 Monday
226	21	9	19	7	6	5	8	7	3	5	20	5	11	10	6	1	16	11	13	25	6	8	13	9	244	Aug 13 Tuesday
227	16	24	18	16	3	2	6	3	6	8	8	22	19	17	18	11	10	8	23	8	8	4	13	11	282	Aug 14 Wednesday
228	22	18	16	11	2	14	5	12	11	9	2	7	12	7	5	9	26	15	7	39	8	3	7	18	285	Aug 15 Thursday
229	5	31	8	5	1	7	8	3	6	10	4	19	13	15	8	7	5	30	10	37	13	10	10	5	270	Aug 16 Friday
230	7	13	8	5	19	21	5	7	5	19	18	34	15	15	13	22	18	18	7	8	16	10	13	14	330	Aug 17 Saturday
231	12	10	11	6	15	11	13	12	8	8	14	20	5	15	8	9	8	6	4	10	8	8	11	19	251	Aug 18 Sunday
232	14	15	23	13	23	4	5	3	10	6	17	23	40	19	19	7	17	11	22	25	6	2	11	9	344	Aug 19 Monday
233	10	16	24	9	9	16	2	10	6	5	18	21	31	22	10	9	15	10	14	16	10	3	5	7	298	Aug 20 Tuesday
234	5	11	28	9	8	11	2	10	20	14	40	24	31	22	18	9	4	8	11	15	5	2	10	12	329	Aug 21 Wednesday
235	9	23	16	9	10	24	5	15	27	23	13	21	17	28	27	11	24	3	22	7	4	7	8	2	355	Aug 22 Thursday
236	6	7	26	10	140	518	536	146	11	17	35	20	22	12	23	8	12	16	8	15	25	4	6	12	1635	Aug 23 Friday
237	10	9	7	20	8	35	28	10	13	18	19	11	5	7	11	14	42	0	0	0	0	0	0	0	267	Aug 24 Saturday
238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Aug 25 Sunday
239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Aug 26 Monday
240	0	0	0	0	0	0	0	0	0	2	36	19	9	16	10	16	10	7	6	1	4	9	1	2	148	Aug 27 Tuesday
241	9	8	18	7	4	5	7	31	15	17	16	11	16	13	11	6	16	8	8	9	3	3	3	4	248	Aug 28 Wednesday
242	8	5	22	6	6	8	10	7	8	7	8	5	11	12	8	12	19	4	6	13	0	5	1	4	195	Aug 29 Thursday
243	2	6	8	15	7	2	4	4	3	13	2	12	6	9	13	3	10	8	11	10	1	5	1	6	161	Aug 30 Friday
244	23	3	2	2	5	12	1	8	5	3	8	4	9	7	7	7	5	5	9	4	24	4	3	7	167	Aug 31 Saturday
245	5	3	7	3	9	3	4	13	10	8	9	4	7	2	6	3	12	8	10	1	2	8	0	10	147	Sep 01 Sunday
246	7	21	6	5	5	1	2	4	4	3	6	10	17	12	15	14	5	2	12	5	4	3	1	2	166	Sep 02 Monday
247	10	14	3	4	4	3	1	0	7	2	10	5	9	2	9	4	18	8	10	9	2	2	2	5	143	Sep 03 Tuesday
248	4	10	5	14	4	1	4	1	1	1	7	7	13	20	14	15	14	1	15	18	1	3	4	1	178	Sep 04 Wednesday
249	4	13	7	6	4	2	5	4	11	5	9	21	3	15	12	11	10	3	12	8	10	10	6	11	202	Sep 05 Thursday
250	19	13	15	12	3	2	5	14	11	6	9	31	43	17	8	3	13	15	23	15	9	5	5	2	298	Sep 06 Friday
251	14	3	2	7	16	23	2	7	9	11	9	10	15	3	5	11	4	10	7	19	6	6	8	10	217	Sep 07 Saturday
252	4	5	3	2	8	7	20	0	7	4	2	12	13	14	8	5	4	7	5	6	8	2	0	6	152	Sep 08 Sunday
253	12	5	17	3	7	2	12	16	6	12	7	10	17	11	4	2	16	5	10	7	1	6	2	2	192	Sep 09 Monday
254	23	7	18	8	7	5	2	2	3	4	8	12	19	17	16	25	12	4	3	4	10	1	5	3	218	Sep 10 Tuesday
255	6	9	14	17	4	8	6	6	15	6	7	11	20	23	14	6	11	14	2	3	11	3	4	8	228	Sep 11 Wednesday
256	4	15	6	4	10	7	8	6	8	16	9	21	20	25	10	15	6	2	14	9	4	2	2	2	225	Sep 12 Thursday
257	10	18	1	12	6	5	4	6	18	6	7	6	17	13	14	29	28	14	12	3	3	3	0	5	240	Sep 13 Friday
258	4	3	6	8	4	8	11	4	16	3	7	3	4	20	13	24	28	11	7	19	2	4	5	7	221	Sep 14 Saturday
259	2	2	7	7	2	4	10	8	11	5	32	41	19	13	22	15	17	10	6	1	9	11	11	9	274	Sep 15 Sunday

Table 3.5.1 (Page 3 of 4)

NRS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
260	7	19	13	10	4	6	4	2	4	4	3	0	0	0	0	0	0	8	60	38	5	7	8	4	206	Sep 16 Monday
261	3	13	3	6	1	2	3	0	4	8	6	3	11	11	7	21	7	9	23	27	3	0	3	10	184	Sep 17 Tuesday
262	6	13	13	9	8	11	2	4	25	8	15	17	11	11	9	5	5	11	16	1	4	2	3	4	213	Sep 18 Wednesday
263	4	19	6	5	11	1	3	4	10	6	2	10	13	10	15	7	19	1	13	4	3	8	1	39	214	Sep 19 Thursday
264	10	5	3	2	16	8	10	14	6	9	16	24	25	9	10	4	22	14	13	23	11	9	8	8	279	Sep 20 Friday
265	9	12	3	15	6	9	5	6	8	2	5	4	7	5	5	3	4	7	6	15	26	36	6	11	215	Sep 21 Saturday
266	30	12	6	8	13	22	5	3	11	4	7	13	7	7	4	2	8	4	6	8	8	2	8	13	211	Sep 22 Sunday
267	5	23	13	6	4	12	1	0	6	9	14	14	9	10	2	7	6	8	0	11	0	5	5	4	174	Sep 23 Monday
268	6	6	6	6	7	3	12	4	6	7	4	26	22	16	11	5	8	3	13	15	10	4	10	9	219	Sep 24 Tuesday
269	6	8	7	11	12	5	7	12	7	8	20	19	16	14	15	17	14	4	15	10	1	3	10	8	249	Sep 25 Wednesday
270	3	8	9	8	4	11	0	6	4	10	11	4	18	7	3	2	18	7	15	5	8	6	6	2	175	Sep 26 Thursday
271	6	7	9	8	13	4	1	4	5	6	5	27	15	6	17	5	77	23	2	12	2	1	1	8	264	Sep 27 Friday
272	5	4	4	6	11	12	2	8	9	7	3	16	6	7	13	10	17	6	12	5	3	4	3	10	183	Sep 28 Saturday
273	3	5	8	23	9	6	26	2	8	2	17	5	20	3	7	3	4	6	5	3	1	4	2	11	183	Sep 29 Sunday
274	13	9	2	3	1	4	5	2	2	4	3	15	6	9	21	7	3	7	3	11	4	7	4	4	149	Sep 30 Monday
NRS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Sum	1446	1853	1783	1591	1498	1781	1593	1222	1381	1293	1587	1938	2129	1815	1716	1469	1729	1232	1512	2134	1390	1255	1151	1304	37802	Total sum
168	9	11	11	9	9	11	9	7	8	8	9	12	13	11	10	9	10	7	9	13	8	7	7	8	225	Total average
114	9	13	12	9	8	10	10	7	8	7	9	12	14	12	11	9	11	8	10	15	7	7	7	7	233	Average workdays
54	9	7	7	11	10	12	9	7	9	8	9	10	9	8	8	8	9	7	7	9	11	8	7	9	208	Average weekends

Table 3.5.1. (Page 4 of 4) Daily and hourly distribution of NORESS detections. For each day is shown number of detections within each hour of the day, and number of detections for that day. The end statistics give total number of detections distributed for each hour and the total sum of detections during the period. The averages show number of processed days, hourly distribution and average per processed day.

ARC .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
92	18	12	20	32	38	18	23	28	16	10	31	24	11	23	39	18	9	15	16	9	11	18	5	21	465	Apr 01 Monday
93	16	6	8	11	10	11	15	8	22	24	38	12	26	14	12	26	16	20	21	25	15	16	12	19	403	Apr 02 Tuesday
94	10	10	10	6	9	10	12	26	14	11	21	14	15	11	24	11	18	19	10	18	21	12	12	16	340	Apr 03 Wednesday
95	10	10	8	19	15	13	20	17	17	8	4	25	30	10	12	16	15	6	11	21	17	24	19	11	358	Apr 04 Thursday
96	12	10	6	13	26	11	8	8	16	19	18	23	9	14	11	8	7	9	18	10	20	3	21	19	319	Apr 05 Friday
97	13	4	3	6	17	9	19	7	11	23	8	23	19	10	11	17	8	11	13	5	15	23	16	28	319	Apr 06 Saturday
98	18	11	8	11	11	12	29	25	8	6	8	9	13	22	17	12	20	9	7	18	18	7	14	19	332	Apr 07 Sunday
99	13	15	17	15	10	11	13	14	15	15	17	16	9	8	19	28	17	15	15	29	15	20	15	15	376	Apr 08 Monday
100	9	14	10	26	13	19	26	14	20	33	24	31	11	16	9	15	13	33	11	34	17	15	16	18	447	Apr 09 Tuesday
101	12	5	17	16	10	16	18	13	22	28	29	27	23	34	15	23	25	45	22	12	11	15	27	15	480	Apr 10 Wednesday
102	18	23	18	18	14	26	26	32	36	23	31	24	31	37	25	24	14	15	20	19	24	13	16	21	548	Apr 11 Thursday
103	17	10	15	20	12	14	6	9	19	31	27	30	18	13	9	28	15	16	16	21	19	10	19	34	428	Apr 12 Friday
104	10	10	7	15	20	7	20	17	11	25	25	23	11	11	12	10	18	14	9	15	6	7	22	28	353	Apr 13 Saturday
105	8	12	18	12	15	13	27	9	10	14	10	22	21	12	9	10	10	16	12	25	15	13	14	22	349	Apr 14 Sunday
106	16	19	10	7	20	15	10	29	23	24	34	27	38	48	16	34	20	11	12	17	16	16	11	27	500	Apr 15 Monday
107	37	34	47	38	44	44	45	35	45	19	30	28	22	29	14	24	11	5	9	17	10	21	38	14	660	Apr 16 Tuesday
108	14	12	8	11	18	13	16	17	41	29	28	47	33	43	24	35	18	23	13	12	10	9	22	16	512	Apr 17 Wednesday
109	23	19	13	11	12	6	17	27	7	22	31	41	26	46	10	18	28	25	19	30	21	13	30	17	512	Apr 18 Thursday
110	17	9	20	27	9	6	30	18	27	33	26	36	22	25	18	29	21	16	22	19	18	21	16	21	506	Apr 19 Friday
111	7	5	10	11	11	16	10	10	14	11	24	24	20	15	26	8	16	18	25	14	17	24	19	35	390	Apr 20 Saturday
112	12	8	10	4	9	20	20	19	16	11	10	18	14	17	19	24	29	16	16	14	23	20	20	23	392	Apr 21 Sunday
113	11	24	14	9	12	10	17	12	18	23	26	26	21	16	16	32	8	7	26	4	4	26	18	15	395	Apr 22 Monday
114	21	14	14	25	15	12	11	19	16	31	29	42	23	25	17	23	15	21	21	15	23	14	16	25	487	Apr 23 Tuesday
115	17	11	11	13	14	24	42	21	15	20	25	33	35	14	11	20	12	29	20	27	19	9	25	13	480	Apr 24 Wednesday
116	13	12	14	18	34	21	26	19	31	31	25	32	18	23	31	11	32	20	26	32	24	22	24	25	564	Apr 25 Thursday
117	28	23	17	11	13	21	7	27	30	19	26	35	35	18	12	16	15	17	26	23	38	23	25	23	528	Apr 26 Friday
118	20	9	15	26	19	7	15	12	19	23	13	14	12	9	9	26	22	11	7	17	11	23	16	18	373	Apr 27 Saturday
119	8	12	13	15	9	15	22	7	18	9	8	9	8	11	15	9	10	5	22	25	9	12	21	20	312	Apr 28 Sunday
120	10	14	13	19	32	12	9	38	26	29	39	27	18	19	19	34	25	18	15	19	11	14	17	26	503	Apr 29 Monday
121	11	11	28	16	5	20	15	20	25	16	25	38	15	22	21	21	7	6	24	13	15	24	26	23	447	Apr 30 Tuesday
122	22	5	10	21	14	15	23	17	22	27	24	24	22	18	16	12	14	10	29	13	18	9	22	15	422	May 01 Wednesday
123	23	11	11	20	21	11	21	31	11	25	29	29	53	25	19	28	19	14	24	29	21	18	19	25	537	May 02 Thursday
124	17	20	14	27	21	17	17	28	16	22	24	20	28	29	19	17	22	26	25	31	16	17	15	25	513	May 03 Friday
125	21	14	5	10	27	15	12	22	19	15	21	25	16	18	9	5	24	22	7	21	23	15	33	24	423	May 04 Saturday
126	15	10	10	11	11	20	12	11	17	14	31	13	14	20	20	12	16	10	14	13	15	14	11	12	346	May 05 Sunday
127	6	15	23	4	10	6	14	9	19	14	17	15	29	12	24	25	15	8	21	9	13	17	22	18	365	May 06 Monday
128	9	8	10	12	27	12	6	23	24	18	21	14	17	22	16	27	30	23	20	24	18	12	30	20	443	May 07 Tuesday
129	15	15	13	11	12	11	20	23	23	31	31	46	34	24	25	15	18	16	16	10	14	11	24	29	487	May 08 Wednesday
130	4	7	6	9	26	19	17	27	17	25	17	15	38	21	29	41	26	16	26	25	26	10	14	14	475	May 09 Thursday
131	12	18	17	21	15	23	23	24	16	23	40	30	25	49	30	28	26	11	16	13	26	16	26	30	558	May 10 Friday
132	27	37	35	17	30	21	28	38	36	42	33	17	14	16	33	10	17	11	19	14	8	10	9	16	538	May 11 Saturday
133	8	16	19	12	15	19	13	16	22	31	27	12	19	22	13	17	21	22	28	28	17	29	38	36	500	May 12 Sunday
134	29	27	17	34	24	15	20	39	28	13	30	18	29	15	19	26	5	22	22	22	20	11	21	17	523	May 13 Monday
135	24	14	12	19	14	8	6	12	17	23	28	34	38	11	16	24	12	17	16	36	0	9	29	44	463	May 14 Tuesday
136	26	11	12	15	10	15	12	15	30	28	21	37	26	21	30	29	21	34	9	40	31	19	17	33	542	May 15 Wednesday
137	17	9	4	13	11	17	9	9	9	19	20	26	20	35	9	15	20	19	10	16	50	33	28	26	444	May 16 Thursday
138	19	13	18	10	10	8	9	26	14	20	37	20	29	17	15	20	6	32	17	13	11	9	4	18	395	May 17 Friday
139	6	5	10	23	8	12	10	9	17	11	16	19	15	20	8	17	21	6	10	15	19	22	6	8	313	May 18 Saturday
140	20	11	13	22	13	13	16	7	5	19	20	17	5	27	13	15	21	13	13	17	15	23	10	23	371	May 19 Sunday
141	7	27	13	20	14	19	17	16	19	13	23	22	22	27	22	19	16	18	20	25	15	13	30	22	459	May 20 Monday
142	13	18	26	18	21	20	28	37	24	20	36	34	35	22	32	28	31	37	34	30	43	26	23	23	659	May 21 Tuesday
143	25	14	15	13	12	24	6	15	14	30	31	11	13	12	22	21	6	11	20	20	13	16	18	25	407	May 22 Wednesday
144	13	22	21	10	15	7	13	23	34	27	34	18	24	33	18	20	24	25	20	23	19	13	22	25	503	May 23 Thursday
145	10	17	6	12	17	11	28	34	55	35	54	44	32	20	14	29	15	14	27	24	26	11	14	27	576	May 24 Friday
146	17	15	14	16	6	11	14	21	18	29	10	21	13	20	21	10	14	18	25	10	21	10	20	12	386	May 25 Saturday
147	8	15	12	14	11	15	22	12	15	10	14	18	21	14	20	11	13	16	17	10	7	13	32	20	360	May 26 Sunday

Table 3.5.2 (Page 1 of 4)

ARC .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
148	20	20	17	21	16	16	13	31	22	23	24	38	33	17	25	41	14	20	18	15	13	25	32	29	543	May 27 Monday
149	10	10	14	11	10	9	8	19	16	26	29	17	15	29	20	33	23	10	23	25	17	32	13	21	440	May 28 Tuesday
150	18	29	34	34	49	35	26	42	40	45	33	51	43	29	23	14	10	15	13	11	5	8	10	16	633	May 29 Wednesday
151	6	2	5	16	16	18	14	27	26	23	26	17	29	18	17	12	14	13	20	26	17	9	16	11	398	May 30 Thursday
152	11	24	10	6	12	17	15	30	26	25	38	58	35	29	10	29	30	20	21	27	18	14	13	21	539	May 31 Friday
153	7	9	7	8	9	2	10	7	6	14	17	29	14	8	6	11	20	15	27	10	15	19	24	16	310	Jun 01 Saturday
154	12	19	13	11	19	10	13	14	17	26	27	34	27	33	15	28	16	21	28	23	27	12	15	17	477	Jun 02 Sunday
155	6	13	11	9	17	12	39	57	49	20	41	65	41	30	13	24	23	15	10	20	22	13	9	17	576	Jun 03 Monday
156	5	8	11	14	13	17	14	17	29	31	53	31	26	29	18	27	16	27	32	21	20	12	20	23	514	Jun 04 Tuesday
157	14	15	4	1	19	35	26	32	55	29	49	49	32	52	53	56	20	9	26	17	15	7	7	15	637	Jun 05 Wednesday
158	4	7	8	13	5	14	20	28	29	12	71	18	20	24	39	45	38	14	19	16	15	8	10	12	489	Jun 06 Thursday
159	12	3	11	5	9	21	19	25	27	31	17	26	20	19	11	12	12	23	11	15	22	21	25	16	413	Jun 07 Friday
160	17	14	31	13	23	14	30	13	17	26	26	18	8	19	11	6	8	21	15	10	3	15	23	21	402	Jun 08 Saturday
161	17	16	9	12	12	20	32	55	62	76	100	70	56	85	61	49	29	31	18	14	18	12	17	20	891	Jun 09 Sunday
162	8	16	23	12	58	37	35	5	32	26	23	28	16	21	28	40	16	43	20	29	15	15	21	16	583	Jun 10 Monday
163	9	6	6	14	10	15	18	25	31	33	30	49	26	29	12	10	30	14	35	23	10	23	14	15	487	Jun 11 Tuesday
164	21	15	8	13	17	13	23	32	44	26	26	23	34	21	37	16	14	20	21	12	19	13	17	15	500	Jun 12 Wednesday
165	17	7	11	2	4	7	10	17	12	23	14	12	16	12	9	20	10	20	20	21	11	9	15	16	315	Jun 13 Thursday
166	10	4	9	11	11	11	20	25	30	35	61	46	35	41	20	33	13	11	16	24	16	13	33	17	545	Jun 14 Friday
167	11	12	11	17	15	29	18	26	37	17	26	40	29	30	14	9	16	7	18	13	15	12	18	28	468	Jun 15 Saturday
168	14	13	14	17	4	12	15	22	26	34	21	32	24	19	17	18	18	5	20	17	14	13	12	15	416	Jun 16 Sunday
169	7	15	13	14	16	12	10	24	30	23	19	51	30	17	5	24	27	42	18	25	9	15	27	24	497	Jun 17 Monday
170	4	12	5	8	12	15	27	17	32	27	30	47	30	34	16	23	20	14	21	17	19	9	13	19	471	Jun 18 Tuesday
171	18	13	6	11	18	17	22	40	31	20	29	55	35	31	30	29	16	14	27	14	14	16	12	26	544	Jun 19 Wednesday
172	8	22	17	11	18	12	16	19	29	35	35	37	25	8	20	12	16	16	21	18	15	7	13	15	445	Jun 20 Thursday
173	19	9	5	11	13	23	24	31	39	36	34	44	33	25	26	21	16	28	30	33	22	34	33	34	623	Jun 21 Friday
174	24	24	8	17	15	16	19	21	36	37	38	34	25	23	25	21	28	17	19	13	12	23	20	21	536	Jun 22 Saturday
175	9	22	31	18	6	11	16	11	31	26	15	36	32	38	29	23	9	9	21	11	16	27	9	23	479	Jun 23 Sunday
176	16	16	10	25	12	12	22	19	26	36	32	35	34	29	21	39	13	18	14	15	14	25	25	24	532	Jun 24 Monday
177	15	10	13	14	29	8	26	33	59	37	36	43	55	27	21	29	20	31	33	19	19	31	17	18	643	Jun 25 Tuesday
178	17	9	19	16	17	8	18	22	18	27	34	47	37	34	22	25	13	27	44	26	17	21	23	20	561	Jun 26 Wednesday
179	29	11	20	18	22	8	39	27	36	26	56	54	73	70	42	75	47	29	26	21	15	16	22	26	808	Jun 27 Thursday
180	16	7	15	27	10	10	22	26	26	36	38	44	42	7	19	19	21	11	30	12	15	15	35	18	521	Jun 28 Friday
181	7	13	13	17	17	13	26	10	22	30	21	20	27	20	22	19	13	10	23	12	24	13	16	19	427	Jun 29 Saturday
182	25	15	12	26	20	15	20	23	24	19	33	37	33	25	15	17	22	20	25	12	25	17	12	26	518	Jun 30 Sunday
183	12	21	8	18	20	21	18	57	71	32	78	63	46	37	30	20	23	27	27	21	12	11	29	15	717	Jul 01 Monday
184	9	9	19	16	17	15	18	13	55	39	22	33	26	26	24	18	21	12	22	20	25	22	10	15	506	Jul 02 Tuesday
185	17	13	8	15	9	11	24	25	26	34	50	51	47	25	29	19	13	17	24	13	24	8	11	19	532	Jul 03 Wednesday
186	7	10	8	22	18	12	26	21	24	28	33	48	34	41	48	46	27	10	18	16	28	12	18	32	587	Jul 04 Thursday
187	8	13	14	12	16	14	31	27	51	41	59	40	31	27	26	15	20	17	32	18	6	19	9	18	564	Jul 05 Friday
188	11	9	6	9	21	19	20	21	25	29	21	26	44	36	21	18	17	17	20	11	19	11	21	16	468	Jul 06 Saturday
189	13	10	8	7	17	12	20	21	24	24	27	27	18	29	19	14	19	7	17	10	11	13	13	13	393	Jul 07 Sunday
190	15	9	7	14	11	14	19	23	34	35	46	50	26	38	30	33	29	22	38	26	35	11	11	22	598	Jul 08 Monday
191	21	11	20	19	21	15	31	27	59	37	57	60	44	27	22	14	29	30	32	28	22	17	16	16	675	Jul 09 Tuesday
192	8	18	9	15	23	17	15	66	43	28	45	49	33	16	16	13	10	26	28	23	28	25	16	26	596	Jul 10 Wednesday
193	12	4	22	15	22	12	20	21	34	28	36	28	42	40	39	29	14	37	36	22	29	23	19	21	605	Jul 11 Thursday
194	9	11	19	14	18	12	20	18	28	0	0	0	0	0	0	0	6	62	62	22	14	9	16	25	365	Jul 12 Friday
195	15	15	25	29	27	23	73	55	47	62	51	30	108	62	14	25	19	44	48	19	11	20	27	20	869	Jul 13 Saturday
196	14	13	15	16	21	20	12	19	15	29	31	31	17	26	16	14	17	23	18	17	20	13	29	20	466	Jul 14 Sunday
197	18	16	21	16	18	13	22	40	30	30	28	27	30	22	37	29	38	39	44	42	26	40	22	27	675	Jul 15 Monday
198	19	14	28	34	17	17	21	17	30	28	37	31	10	18	20	26	16	15	20	15	11	15	2	22	483	Jul 16 Tuesday
199	20	18	14	19	29	31	22	32	22	39	54	55	35	26	42	20	27	23	32	23	19	26	33	16	677	Jul 17 Wednesday
200	19	20	9	14	14	23	22	42	38	52	56	43	26	31	40	21	17	31	20	14	11	21	19	28	631	Jul 18 Thursday
201	9	3	25	10	12	14	26	32	38	49	48	64	40	28	37	106	87	62	26	29	22	18	20	21	826	Jul 19 Friday
202	20	23	16	18	28	16	26	51	79	52	29	49	48	42	16	26	22	16	22	27	18	8	14	26	692	Jul 20 Saturday
203	45	10	1	14	17	11	19	17	20	42	42	42	29	18	19	24	15	7	23	9	25	21	20	32	522	Jul 21 Sunday

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ARC .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
204	12	10	8	10	9	31	20	20	38	37	39	36	37	20	59	38	35	19	26	21	14	25	18	14	596	Jul 22 Monday
205	30	15	11	24	18	24	19	48	48	36	43	39	36	35	34	28	31	17	21	12	19	21	33	23	665	Jul 23 Tuesday
206	15	25	20	18	26	30	34	36	47	30	62	55	42	40	52	37	28	29	25	30	10	24	16	22	753	Jul 24 Wednesday
207	22	15	9	23	29	20	22	22	27	28	27	33	30	24	26	32	25	35	30	15	19	11	21	11	556	Jul 25 Thursday
208	15	11	15	21	20	5	25	16	22	47	33	49	22	28	20	24	16	12	31	23	15	24	23	17	534	Jul 26 Friday
209	17	12	10	18	18	14	16	11	32	35	36	40	42	34	24	13	17	15	14	23	17	16	23	30	527	Jul 27 Saturday
210	19	15	11	15	24	13	28	17	38	33	44	52	35	19	26	25	21	17	28	20	30	17	32	16	595	Jul 28 Sunday
211	9	15	17	12	26	9	24	23	40	28	44	34	29	22	31	23	8	14	23	23	26	8	14	18	520	Jul 29 Monday
212	15	24	18	23	20	17	25	26	23	24	27	36	22	35	35	23	16	24	18	14	24	20	21	24	554	Jul 30 Tuesday
213	15	10	12	8	12	15	20	20	33	27	30	42	31	28	37	23	19	19	28	19	8	8	27	21	512	Jul 31 Wednesday
214	3	14	9	20	24	12	19	24	43	32	42	31	31	22	24	21	20	28	23	60	33	21	21	16	593	Aug 01 Thursday
215	11	4	7	14	23	26	31	32	24	35	43	45	24	29	47	29	111	72	35	40	39	16	27	23	787	Aug 02 Friday
216	15	22	17	24	25	25	13	23	20	24	34	39	40	34	20	13	17	24	15	14	20	14	15	25	532	Aug 03 Saturday
217	4	3	12	7	16	15	12	12	14	20	33	47	21	29	17	15	16	12	20	7	23	6	28	26	415	Aug 04 Sunday
218	21	5	17	18	18	8	31	26	41	44	49	47	27	28	18	25	13	28	19	38	36	15	29	28	629	Aug 05 Monday
219	15	16	9	15	15	7	10	54	53	24	30	42	35	17	22	22	18	28	17	20	35	21	12	16	553	Aug 06 Tuesday
220	12	9	11	8	8	19	13	28	48	24	55	48	30	26	12	29	42	41	15	21	15	19	20	20	573	Aug 07 Wednesday
221	7	11	8	15	11	17	26	19	34	32	22	49	29	27	31	27	14	46	20	24	12	11	37	24	553	Aug 08 Thursday
222	28	25	21	26	19	13	33	32	29	35	33	64	40	12	12	30	13	15	28	15	22	15	17	20	597	Aug 09 Friday
223	10	20	14	7	18	7	12	28	23	34	32	36	50	30	12	26	26	38	52	21	14	18	28	28	584	Aug 10 Saturday
224	17	11	24	22	12	10	10	11	20	31	14	37	23	35	23	20	28	23	21	26	41	15	19	30	523	Aug 11 Sunday
225	11	21	20	28	10	23	16	10	24	39	42	28	27	27	25	18	30	43	25	18	17	25	26	19	572	Aug 12 Monday
226	14	20	7	15	14	15	24	30	29	35	51	41	28	35	21	35	20	22	25	23	16	19	24	17	580	Aug 13 Tuesday
227	12	9	31	27	22	15	9	26	20	23	47	36	64	38	26	25	23	39	21	21	15	20	16	18	603	Aug 14 Wednesday
228	24	9	23	14	18	10	18	35	34	38	31	21	36	33	17	7	28	16	24	19	12	15	20	35	537	Aug 15 Thursday
229	9	7	16	25	23	9	27	18	37	49	29	33	37	27	21	17	21	29	35	27	25	18	16	26	581	Aug 16 Friday
230	11	17	13	20	32	23	13	9	27	31	21	37	27	39	10	15	16	5	30	28	20	7	17	18	486	Aug 17 Saturday
231	28	11	19	10	14	16	20	10	18	30	56	62	39	26	37	40	45	55	31	29	25	16	23	34	694	Aug 18 Sunday
232	9	16	24	34	37	26	16	36	28	29	0	0	2	24	0	0	0	0	0	0	0	0	0	0	281	Aug 19 Monday
233	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Aug 20 Tuesday
234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	37	19	10	15	20	20	134	Aug 21 Wednesday
235	23	12	20	18	29	17	25	16	24	9	23	23	19	20	33	30	24	42	34	32	28	21	6	22	550	Aug 22 Thursday
236	14	20	6	28	25	23	16	21	35	45	38	37	29	38	34	48	31	48	53	26	14	18	35	26	708	Aug 23 Friday
237	7	9	21	10	15	14	15	22	32	37	11	33	20	32	15	28	29	24	14	19	16	27	12	12	474	Aug 24 Saturday
238	16	11	11	18	8	18	14	19	17	39	19	34	24	37	16	16	36	33	43	27	40	30	23	15	564	Aug 25 Sunday
239	17	22	14	13	18	13	22	44	43	29	27	23	26	27	38	44	35	41	35	33	26	10	18	23	641	Aug 26 Monday
240	27	15	8	11	13	20	28	34	21	38	31	24	19	40	43	45	36	31	28	6	19	18	20	15	590	Aug 27 Tuesday
241	6	18	26	17	9	31	19	39	21	18	28	45	30	33	31	28	29	30	34	12	17	22	21	17	581	Aug 28 Wednesday
242	6	7	14	8	23	13	22	29	30	23	25	34	53	33	32	35	35	30	22	17	22	14	20	17	564	Aug 29 Thursday
243	12	13	21	20	31	14	24	32	35	44	14	54	25	21	9	24	27	36	28	24	11	15	19	11	564	Aug 30 Friday
244	6	8	7	4	6	13	15	16	11	16	32	27	34	12	28	20	23	17	27	20	16	14	24	26	422	Aug 31 Saturday
245	6	11	19	12	22	22	32	13	4	21	15	12	11	10	21	1	16	10	19	18	16	20	11	13	355	Sep 01 Sunday
246	5	6	19	24	18	11	15	26	44	27	20	36	26	17	21	31	22	15	27	32	18	18	20	11	509	Sep 02 Monday
247	9	5	12	7	13	17	26	14	0	0	18	32	37	23	27	26	14	33	28	18	14	9	16	23	421	Sep 03 Tuesday
248	3	13	6	9	18	9	17	11	17	23	31	34	34	26	13	27	22	19	20	24	16	20	29	42	483	Sep 04 Wednesday
249	32	17	23	26	18	16	17	18	26	25	24	16	18	8	26	18	28	20	11	11	22	22	18	19	479	Sep 05 Thursday
250	24	13	16	10	17	15	31	23	39	45	49	30	57	27	28	28	25	37	33	19	37	8	9	22	642	Sep 06 Friday
251	18	11	32	22	20	21	12	23	23	33	18	24	23	23	28	18	18	18	12	14	14	15	22	16	478	Sep 07 Saturday
252	2	12	16	14	7	19	16	14	15	18	28	33	23	30	18	9	31	27	24	18	29	12	16	20	451	Sep 08 Sunday
253	14	4	13	20	18	10	14	25	14	26	26	14	21	26	15	23	17	17	25	23	16	14	22	17	434	Sep 09 Monday
254	9	19	19	19	15	15	14	22	26	20	30	27	37	30	33	20	29	16	19	26	16	9	18	19	507	Sep 10 Tuesday
255	21	21	16	17	34	27	27	29	23	31	50	41	30	37	28	39	24	16	29	13	11	7	29	36	636	Sep 11 Wednesday
256	16	14	22	7	29	13	16	24	36	31	30	39	36	28	21	31	16	27	27	7	25	14	9	15	533	Sep 12 Thursday
257	10	14	12	11	10	14	14	22	22	26	27	25	26	22	17	35	14	18	24	5	11	14	19	17	429	Sep 13 Friday
258	7	15	13	19	19	5	8	25	48	5	22	31	9	24	35	15	9	6	14	18	21	12	22	20	422	Sep 14 Saturday
259	13	6	20	17	23	14	16	27	17	20	20	13	23	17	13	12	19	14	20	12	12	17	23	19	407	Sep 15 Sunday

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ARC .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
260	13	10	10	16	19	21	24	32	33	30	27	21	23	28	23	31	29	31	26	18	15	34	18	21	553	Sep 16 Monday
261	10	4	9	10	36	14	27	27	19	39	24	20	22	32	32	24	15	11	26	15	20	16	16	51	519	Sep 17 Tuesday
262	13	16	23	26	32	25	39	28	19	24	43	32	21	21	20	19	9	19	14	3	11	21	11	12	501	Sep 18 Wednesday
263	11	17	17	18	23	21	26	21	19	28	40	36	37	15	32	42	26	20	28	16	21	18	23	15	570	Sep 19 Thursday
264	14	9	8	17	27	27	34	41	42	31	37	53	30	36	17	40	34	49	58	29	27	35	39	32	766	Sep 20 Friday
265	10	25	14	30	29	26	21	29	30	39	20	38	27	29	24	20	35	46	23	22	16	19	26	40	638	Sep 21 Saturday
266	11	11	15	12	13	21	18	16	23	17	18	32	17	19	19	20	29	26	12	18	20	8	33	31	459	Sep 22 Sunday
267	28	16	20	15	20	14	30	26	42	36	51	27	45	37	50	29	31	22	27	8	11	14	27	18	644	Sep 23 Monday
268	17	11	8	10	15	9	25	35	23	40	30	35	22	35	20	32	18	30	9	23	7	15	12	28	509	Sep 24 Tuesday
269	17	11	10	13	11	34	42	43	31	48	53	36	47	58	29	39	31	39	28	26	16	27	10	21	720	Sep 25 Wednesday
270	7	19	23	20	20	12	26	33	39	35	39	61	29	19	28	27	24	31	36	29	14	10	27	25	633	Sep 26 Thursday
271	25	11	25	19	10	9	14	26	23	12	26	46	24	16	22	38	13	20	26	22	17	10	25	21	500	Sep 27 Friday
272	16	13	10	25	7	12	26	17	31	28	27	25	23	25	33	23	24	18	17	14	14	12	16	23	479	Sep 28 Saturday
273	10	9	5	9	13	9	26	13	5	11	17	14	25	37	24	9	17	12	15	17	14	25	20	17	373	Sep 29 Sunday
274	15	10	16	22	12	30	24	29	49	26	29	31	12	23	25	24	26	27	15	25	22	13	21	8	534	Sep 30 Monday
ARC	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Sum	2625	2433	2607	2907	3195	2895	3692	4331	4987	4993	5626	5980	5105	4687	4101	4327	3821	3977	4157	3594	3329	2994	3580	3857	93800	Total sum
182	14	13	14	16	18	16	20	24	27	27	31	33	28	26	23	24	21	22	23	20	18	16	20	21	515	Total average
123	14	13	15	16	18	16	21	26	30	28	34	35	30	26	24	27	22	24	24	21	18	17	20	21	540	Average workdays
59	14	13	14	15	16	15	19	19	22	25	25	28	25	24	19	18	19	18	20	17	18	16	20	22	460	Average weekends

Table 3.5.2.(Page 4 of 4) Daily and hourly distribution of ARCESS detections. For each day is shown number of detections within each hour of the day, and number of detections for that day. The end statistics give total number of detections distributed for each hour and the total sum of detections during the period. The averages show number of processed days, hourly distribution and average per processed day.

FIN .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
92	10	7	1	6	1	2	2	2	12	7	12	11	10	10	9	4	9	2	3	5	7	6	7	3	148	Apr 01 Monday
93	2	9	3	4	3	3	1	5	15	13	6	13	15	10	7	16	3	7	0	7	9	4	4	4	163	Apr 02 Tuesday
94	3	5	4	1	4	3	3	7	4	21	9	30	18	9	8	7	12	15	1	9	9	9	9	8	208	Apr 03 Wednesday
95	11	10	8	7	8	7	5	11	19	15	23	19	19	18	12	6	5	13	8	12	3	9	8	6	262	Apr 04 Thursday
96	9	5	7	3	7	4	3	2	14	7	11	12	11	7	2	4	2	6	6	2	8	4	8	6	150	Apr 05 Friday
97	4	7	3	7	14	7	4	4	10	8	8	9	14	4	9	3	3	12	4	3	7	4	5	3	156	Apr 06 Saturday
98	8	11	9	2	5	4	8	1	8	7	2	6	6	8	10	3	10	5	2	12	3	2	8	7	147	Apr 07 Sunday
99	4	4	6	2	4	3	3	4	15	5	13	12	5	6	5	6	7	15	8	10	9	12	7	10	175	Apr 08 Monday
100	7	9	9	4	4	2	5	9	7	9	7	18	5	8	8	14	14	18	9	7	3	13	7	6	202	Apr 09 Tuesday
101	8	8	13	4	2	1	4	4	3	12	5	19	16	10	7	6	13	5	5	5	6	8	3	13	180	Apr 10 Wednesday
102	13	14	22	18	1	7	4	6	8	9	12	16	11	4	9	12	7	6	10	24	18	17	30	47	325	Apr 11 Thursday
103	44	39	41	17	5	6	4	10	14	20	19	24	20	7	5	14	11	5	5	8	29	49	58	49	503	Apr 12 Friday
104	58	66	42	23	8	3	4	4	5	10	12	8	2	7	0	1	2	9	3	5	3	5	20	43	343	Apr 13 Saturday
105	87	97	84	42	3	1	4	4	7	2	7	4	9	7	8	3	12	4	14	7	9	9	8	7	439	Apr 14 Sunday
106	7	10	18	5	4	1	3	3	9	6	9	9	8	13	6	11	8	10	8	4	9	9	14	1	185	Apr 15 Monday
107	13	14	5	8	2	3	3	4	11	9	20	15	10	11	2	7	11	12	5	2	9	8	5	7	196	Apr 16 Tuesday
108	9	6	9	5	4	6	2	6	6	13	17	13	7	16	8	4	7	5	4	5	0	5	9	5	171	Apr 17 Wednesday
109	10	11	4	2	4	0	7	3	19	19	8	23	17	5	6	9	2	10	1	2	9	11	12	4	198	Apr 18 Thursday
110	13	7	7	5	2	2	4	11	1	16	18	21	5	12	3	5	3	5	4	6	8	4	12	4	178	Apr 19 Friday
111	7	2	6	4	6	7	3	7	3	4	6	1	5	6	1	4	8	5	7	5	6	4	3	8	118	Apr 20 Saturday
112	4	3	4	4	3	7	6	6	7	5	6	9	5	12	5	4	6	8	10	6	15	11	7	7	160	Apr 21 Sunday
113	5	8	3	2	3	4	7	6	4	11	10	19	8	7	6	22	6	4	10	9	5	2	10	5	176	Apr 22 Monday
114	15	5	5	0	5	4	1	6	10	5	11	23	10	7	11	12	3	11	10	8	7	7	14	9	199	Apr 23 Tuesday
115	5	11	7	8	3	9	6	14	7	27	16	12	3	12	9	8	7	15	21	9	5	11	4	2	231	Apr 24 Wednesday
116	7	3	7	5	5	8	10	5	4	16	14	16	9	8	15	1	10	2	9	7	10	4	6	6	187	Apr 25 Thursday
117	4	9	8	4	3	2	2	11	9	21	18	11	17	13	2	7	6	9	14	6	7	9	5	3	200	Apr 26 Friday
118	13	9	11	12	13	5	6	6	4	5	2	7	4	4	2	4	3	5	9	2	4	6	5	2	143	Apr 27 Saturday
119	2	3	4	3	3	7	4	8	7	5	3	3	4	4	4	5	3	3	6	11	9	6	5	2	114	Apr 28 Sunday
120	4	9	5	5	1	2	3	4	1	4	17	24	8	3	11	27	22	22	8	5	6	8	7	7	213	Apr 29 Monday
121	5	14	10	7	1	3	4	5	11	11	11	17	10	17	5	6	2	8	6	8	8	3	13	11	196	Apr 30 Tuesday
122	5	6	3	12	2	6	5	6	1	11	15	11	13	7	10	3	6	17	16	6	8	11	7	9	196	May 01 Wednesday
123	10	1	10	4	8	9	5	4	3	8	7	11	16	21	17	13	9	10	7	7	8	10	14	2	214	May 02 Thursday
124	3	4	6	10	8	4	1	8	3	11	15	14	8	5	3	4	4	7	8	5	8	7	7	8	161	May 03 Friday
125	8	4	3	7	8	4	6	6	8	6	11	14	9	11	17	14	18	8	7	3	4	6	9	5	196	May 04 Saturday
126	4	6	4	3	3	4	2	12	6	8	8	10	4	9	7	4	6	10	3	7	6	4	5	3	138	May 05 Sunday
127	5	7	5	4	3	1	7	4	7	7	12	10	22	6	1	9	3	4	19	10	11	4	5	7	173	May 06 Monday
128	3	6	4	2	4	1	5	5	7	7	11	19	8	16	4	4	9	6	7	3	6	3	12	7	159	May 07 Tuesday
129	9	3	6	4	2	1	1	8	6	11	9	20	27	17	1	1	13	4	14	9	7	6	7	8	194	May 08 Wednesday
130	2	5	3	0	4	3	1	10	6	7	15	8	5	8	3	6	10	3	7	9	9	2	7	4	137	May 09 Thursday
131	4	6	9	6	5	2	2	4	3	9	17	10	5	3	5	4	6	0	1	2	3	3	5	1	115	May 10 Friday
132	4	5	5	3	9	1	0	3	1	2	2	0	7	2	4	5	5	2	3	3	1	3	2	5	77	May 11 Saturday
133	0	5	4	4	0	4	3	5	7	7	24	28	24	9	12	13	8	7	8	4	8	3	6	7	200	May 12 Sunday
134	6	5	11	4	4	5	2	3	15	14	19	24	10	16	6	17	6	15	7	23	12	8	13	15	260	May 13 Monday
135	10	10	4	4	2	2	1	8	19	12	14	19	26	15	3	16	34	5	6	7	2	3	6	4	232	May 14 Tuesday
136	5	4	1	5	2	8	5	12	9	11	18	11	9	8	11	6	7	3	2	2	0	1	1	3	144	May 15 Wednesday
137	2	5	2	3	11	6	2	9	3	12	9	13	11	9	13	6	2	8	3	6	8	6	2	1	152	May 16 Thursday
138	4	4	0	4	0	4	8	10	8	13	21	20	7	4	6	5	2	8	6	2	3	3	3	1	146	May 17 Friday
139	3	3	5	8	16	49	13	14	11	3	7	2	8	4	3	1	2	2	2	4	4	5	4	0	173	May 18 Saturday
140	5	3	2	9	7	2	5	2	1	2	3	10	7	8	10	3	5	3	8	7	2	5	3	10	122	May 19 Sunday
141	3	7	3	3	4	2	3	5	11	15	15	10	14	20	9	8	9	9	9	5	2	6	10	2	184	May 20 Monday
142	9	5	9	18	7	8	2	7	12	8	11	14	10	7	14	10	7	3	9	5	8	8	13	9	213	May 21 Tuesday
143	18	10	4	3	1	1	3	14	8	17	5	10	12	16	3	14	8	6	6	8	14	8	4	11	204	May 22 Wednesday
144	8	12	11	3	2	7	2	13	10	10	15	5	14	2	3	7	3	6	1	8	5	2	8	2	159	May 23 Thursday
145	8	5	2	1	1	0	14	13	6	9	7	4	11	3	1	7	4	5	4	3	0	2	3	3	116	May 24 Friday
146	3	5	1	3	2	0	0	1	10	4	7	1	4	3	0	3	5	6	2	1	7	7	3	1	79	May 25 Saturday
147	2	5	9	3	3	2	5	8	4	6	9	3	4	2	7	7	5	3	3	6	6	5	4	7	118	May 26 Sunday

Table 3.5.3 (Page 1 of 4)

FIN .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
148	5	8	4	7	4	6	6	3	9	12	8	11	1	6	11	10	4	2	8	6	2	1	3	1	138	May 27 Monday
149	2	8	6	9	3	1	6	0	13	4	14	12	8	8	6	4	9	1	2	2	1	2	6	5	132	May 28 Tuesday
150	1	6	3	3	5	2	4	3	9	7	15	10	5	8	6	9	6	6	1	3	0	1	0	1	114	May 29 Wednesday
151	5	2	1	6	4	0	3	7	11	6	10	13	5	7	11	2	3	3	3	7	6	8	7	4	134	May 30 Thursday
152	5	6	6	5	2	1	4	3	8	14	9	13	10	3	4	1	3	5	2	4	4	2	2	2	118	May 31 Friday
153	3	5	3	2	1	0	3	3	3	6	1	1	5	4	5	1	3	4	6	7	3	2	1	3	75	Jun 01 Saturday
154	4	3	4	3	6	2	2	2	6	5	4	1	10	6	7	3	8	3	2	3	4	3	8	3	102	Jun 02 Sunday
155	5	9	3	4	6	1	4	7	6	4	8	16	19	7	8	12	18	4	4	9	7	4	2	4	171	Jun 03 Monday
156	6	7	7	4	11	3	7	6	11	13	23	24	4	8	5	8	3	5	5	6	4	5	6	8	189	Jun 04 Tuesday
157	10	8	3	3	4	3	1	5	6	19	9	13	18	19	22	6	1	0	4	6	3	1	4	6	174	Jun 05 Wednesday
158	6	5	2	31	10	3	6	1	7	4	10	12	15	7	7	5	8	0	0	0	4	1	2	2	148	Jun 06 Thursday
159	2	3	15	3	0	7	2	5	14	20	9	12	4	3	3	3	2	1	3	5	0	3	1	5	125	Jun 07 Friday
160	5	11	3	6	1	5	10	8	9	10	3	8	17	14	3	3	6	4	3	3	3	4	1	8	148	Jun 08 Saturday
161	4	12	6	11	6	5	7	1	6	14	12	0	2	3	7	9	3	2	6	7	5	9	2	2	141	Jun 09 Sunday
162	0	0	0	0	0	7	13	10	15	20	18	9	19	13	13	19	9	22	14	14	14	11	10	10	260	Jun 10 Monday
163	10	5	16	7	6	3	5	11	13	12	28	25	12	17	27	7	7	6	20	8	5	9	8	4	271	Jun 11 Tuesday
164	10	9	8	7	10	6	35	29	29	19	19	24	21	27	33	13	18	4	4	5	8	4	9	6	357	Jun 12 Wednesday
165	7	10	5	4	11	8	2	9	4	9	19	15	13	23	11	13	6	2	9	2	5	3	1	2	193	Jun 13 Thursday
166	10	3	1	0	8	12	11	4	13	8	6	20	1	5	5	15	6	3	3	6	3	1	4	5	153	Jun 14 Friday
167	1	3	2	16	4	12	6	2	6	1	1	7	5	5	2	4	5	3	4	4	1	1	1	4	100	Jun 15 Saturday
168	5	16	6	8	0	6	1	2	5	4	0	2	7	7	4	6	5	9	0	7	5	2	2	3	112	Jun 16 Sunday
169	2	3	8	8	0	0	1	6	5	11	7	27	17	10	4	13	10	9	7	5	5	3	6	2	169	Jun 17 Monday
170	7	6	1	1	2	3	3	9	11	10	8	15	7	4	15	5	13	7	3	4	6	1	2	5	148	Jun 18 Tuesday
171	7	2	3	2	0	3	1	4	11	14	14	14	13	18	7	9	2	8	2	8	4	2	3	3	154	Jun 19 Wednesday
172	3	7	4	6	2	2	4	4	11	9	23	19	11	7	10	7	6	5	6	6	4	5	7	5	173	Jun 20 Thursday
173	5	2	4	4	2	18	10	12	6	10	2	32	9	8	11	6	4	4	5	5	11	11	1	8	190	Jun 21 Friday
174	8	7	3	6	7	4	4	1	1	2	3	7	3	3	4	15	6	5	6	3	0	3	1	5	107	Jun 22 Saturday
175	2	14	13	9	2	3	2	5	7	1	3	11	11	7	5	16	6	5	5	4	16	9	4	9	169	Jun 23 Sunday
176	5	18	8	4	3	2	8	3	0	6	5	5	7	5	11	5	4	10	3	3	5	3	6	1	130	Jun 24 Monday
177	10	6	4	9	6	4	4	8	8	10	13	8	8	12	7	6	4	3	3	2	9	14	3	1	162	Jun 25 Tuesday
178	6	10	7	12	9	1	2	6	3	9	12	18	4	12	12	6	10	16	16	11	9	7	4	2	204	Jun 26 Wednesday
179	13	3	2	6	11	4	4	7	4	11	10	17	17	3	4	9	6	6	15	6	6	6	11	5	186	Jun 27 Thursday
180	8	7	15	11	6	8	11	2	18	14	21	13	12	7	3	4	11	5	2	11	6	5	9	3	212	Jun 28 Friday
181	4	9	4	1	4	5	4	5	4	3	6	3	7	3	7	8	7	4	2	3	0	0	4	3	100	Jun 29 Saturday
182	4	6	3	6	4	2	9	10	6	6	5	12	11	2	5	1	3	13	7	11	7	7	8	10	158	Jun 30 Sunday
183	3	8	8	2	9	6	7	6	15	6	21	12	8	5	3	7	2	5	6	9	4	5	4	1	162	Jul 01 Monday
184	4	4	6	6	8	4	1	10	14	6	2	10	7	5	11	7	10	1	3	3	4	5	7	5	143	Jul 02 Tuesday
185	4	8	3	5	1	2	10	5	9	7	14	9	14	5	4	10	5	9	7	3	5	6	9	9	163	Jul 03 Wednesday
186	7	1	6	5	2	1	1	8	7	9	10	10	14	8	6	10	6	1	4	3	9	0	9	8	145	Jul 04 Thursday
187	9	22	9	1	5	2	17	8	11	3	20	21	16	6	7	6	4	7	6	2	2	4	1	1	190	Jul 05 Friday
188	2	5	4	3	1	5	3	3	11	10	7	6	8	5	0	0	0	0	0	0	0	0	0	0	73	Jul 06 Saturday
189	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jul 07 Sunday
190	0	0	0	0	0	0	0	0	0	0	0	3	8	3	5	12	3	4	8	4	4	6	8	6	74	Jul 08 Monday
191	12	6	9	5	4	4	2	3	5	7	21	17	27	11	27	4	5	6	6	38	3	3	7	4	236	Jul 09 Tuesday
192	6	12	5	4	4	8	8	7	11	8	4	23	6	7	8	5	5	4	4	4	3	3	2	6	157	Jul 10 Wednesday
193	7	4	5	6	4	1	3	5	9	12	9	12	13	10	9	4	2	5	6	7	8	5	9	3	158	Jul 11 Thursday
194	7	8	10	7	1	0	2	6	4	9	13	14	20	14	10	10	2	6	3	8	6	7	1	6	174	Jul 12 Friday
195	3	7	3	5	5	3	5	4	9	4	6	4	6	3	10	3	3	0	2	8	3	0	7	3	106	Jul 13 Saturday
196	6	8	1	2	2	5	0	5	0	3	1	2	0	6	1	4	1	3	4	5	6	1	2	4	72	Jul 14 Sunday
197	6	5	6	2	6	5	3	5	4	5	6	7	17	6	9	6	4	14	3	3	2	9	6	4	143	Jul 15 Monday
198	5	4	7	13	8	7	6	5	9	10	12	12	11	9	4	2	5	14	4	3	8	0	7	3	168	Jul 16 Tuesday
199	3	9	9	10	9	17	4	10	15	8	19	15	16	11	4	14	7	8	11	5	1	5	7	1	218	Jul 17 Wednesday
200	8	7	2	1	2	1	5	4	6	10	11	11	9	11	3	6	2	5	10	6	3	4	3	10	140	Jul 18 Thursday
201	5	7	11	4	2	5	5	0	6	12	16	12	5	4	0	7	8	4	3	13	4	6	2	1	142	Jul 19 Friday
202	14	14	2	5	10	8	6	12	5	15	3	4	4	0	3	1	2	9	9	7	4	14	4	9	164	Jul 20 Saturday
203	8	4	1	6	7	3	4	3	3	12	12	10	3	10	6	8	4	12	6	8	11	8	4	9	162	Jul 21 Sunday

Table 3.5.3 (Page 2 of 4)

FIN .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
204	7	8	4	4	5	6	4	5	6	9	12	13	7	5	9	10	13	4	3	9	7	9	7	2	168	Jul 22 Monday
205	7	12	4	9	1	5	7	6	6	11	25	13	17	6	5	10	1	5	9	1	4	6	11	7	188	Jul 23 Tuesday
206	12	6	7	11	9	1	8	5	10	14	11	20	14	6	7	6	6	5	3	12	7	11	8	3	202	Jul 24 Wednesday
207	9	9	5	6	8	4	5	7	6	10	9	8	13	9	3	6	6	5	5	4	8	7	8	3	163	Jul 25 Thursday
208	4	3	5	0	2	3	7	12	5	10	13	16	8	8	2	5	0	0	6	4	2	5	7	2	129	Jul 26 Friday
209	4	6	3	4	1	2	3	4	13	1	5	9	5	1	7	3	7	4	0	5	1	2	13	3	106	Jul 27 Saturday
210	1	5	2	14	1	3	5	5	6	2	6	4	0	2	5	4	4	4	6	2	2	6	4	2	95	Jul 28 Sunday
211	5	3	4	1	3	2	4	3	3	2	14	15	6	3	7	2	1	11	1	4	5	5	5	5	114	Jul 29 Monday
212	6	13	3	3	2	1	7	3	4	8	10	7	5	13	16	6	1	5	3	1	6	3	6	1	133	Jul 30 Tuesday
213	6	4	4	2	4	7	6	6	26	14	18	19	14	10	20	0	3	10	10	7	6	11	6	5	218	Jul 31 Wednesday
214	7	12	12	7	6	7	6	4	9	15	11	13	10	6	9	10	5	8	2	11	5	4	6	6	191	Aug 01 Thursday
215	12	5	4	7	5	4	7	6	4	11	10	15	14	17	8	3	8	4	5	3	3	1	5	4	165	Aug 02 Friday
216	6	1	3	11	5	8	5	4	4	4	7	5	6	4	4	5	1	0	2	2	0	3	3	2	95	Aug 03 Saturday
217	0	2	3	1	5	5	3	2	10	2	8	5	1	4	2	2	6	6	5	7	9	4	6	2	100	Aug 04 Sunday
218	12	10	5	0	2	2	2	3	4	14	15	10	6	9	2	3	3	7	5	6	7	7	22	17	173	Aug 05 Monday
219	10	3	9	5	3	8	7	5	2	10	19	16	18	15	5	7	7	7	7	9	8	5	1	7	193	Aug 06 Tuesday
220	3	15	6	3	2	4	2	6	10	12	19	9	10	7	4	8	12	5	6	12	9	2	7	3	176	Aug 07 Wednesday
221	8	3	5	4	9	12	6	6	7	13	15	18	16	20	6	5	5	17	9	8	2	6	4	13	217	Aug 08 Thursday
222	14	7	6	8	5	4	2	7	11	15	17	18	6	5	2	8	5	4	9	12	5	5	6	9	190	Aug 09 Friday
223	1	4	2	1	3	6	10	1	0	2	5	9	5	3	3	12	3	6	14	8	8	3	9	11	129	Aug 10 Saturday
224	4	12	10	6	4	4	7	3	6	3	5	6	5	9	6	3	7	10	10	2	4	7	15	5	153	Aug 11 Sunday
225	5	10	6	5	3	1	2	5	8	1	18	9	44	9	3	9	3	6	9	11	5	6	8	6	192	Aug 12 Monday
226	12	11	12	3	12	4	6	3	11	16	23	10	8	13	3	5	7	4	11	13	6	1	7	8	209	Aug 13 Tuesday
227	3	12	18	15	7	2	4	6	6	5	11	26	24	14	15	14	8	11	8	12	6	7	3	7	244	Aug 14 Wednesday
228	12	5	10	6	7	4	5	8	7	9	12	15	6	11	4	15	14	6	5	5	4	4	6	3	183	Aug 15 Thursday
229	5	8	2	3	6	3	5	10	10	20	15	13	6	12	4	3	6	10	4	16	5	7	4	6	183	Aug 16 Friday
230	4	10	7	9	15	21	22	6	8	10	17	13	8	2	3	6	4	3	1	4	2	1	3	2	181	Aug 17 Saturday
231	3	5	13	4	6	11	6	7	5	6	4	3	2	3	0	5	0	0	5	3	3	4	4	7	109	Aug 18 Sunday
232	6	7	5	5	9	3	3	10	3	9	15	11	27	10	2	8	10	8	6	4	6	0	8	8	183	Aug 19 Monday
233	10	4	2	8	2	2	3	8	8	15	16	17	8	9	0	5	5	12	5	2	7	4	4	8	164	Aug 20 Tuesday
234	1	5	15	7	1	0	1	1	12	15	13	11	5	4	13	5	5	12	5	5	4	5	6	11	162	Aug 21 Wednesday
235	5	6	5	6	6	13	2	6	3	1	9	15	7	3	4	7	4	8	3	10	7	8	9	5	152	Aug 22 Thursday
236	5	4	6	2	2	4	1	3	5	9	14	11	13	2	2	5	2	5	4	4	2	4	6	0	115	Aug 23 Friday
237	3	2	7	3	3	2	4	4	5	7	1	2	2	6	2	2	2	2	3	0	7	3	2	2	76	Aug 24 Saturday
238	11	0	2	2	3	4	6	4	3	8	1	4	5	4	2	0	2	6	6	10	4	10	7	3	107	Aug 25 Sunday
239	0	5	5	1	4	7	5	7	5	2	17	12	10	11	3	6	8	3	4	2	7	5	2	3	134	Aug 26 Monday
240	5	15	5	6	3	5	21	6	22	21	25	14	9	6	10	9	5	6	4	6	8	2	7	6	226	Aug 27 Tuesday
241	5	8	8	0	2	3	6	9	10	10	21	11	22	6	5	6	7	7	6	0	8	5	6	9	180	Aug 28 Wednesday
242	8	10	5	4	4	4	6	5	8	16	15	4	19	9	11	4	9	3	10	5	9	4	3	3	178	Aug 29 Thursday
243	2	11	12	9	4	2	3	9	11	20	6	15	5	9	7	3	5	5	4	5	1	5	4	7	164	Aug 30 Friday
244	2	8	6	6	6	7	4	13	6	2	5	3	9	1	3	4	8	0	8	4	9	5	3	2	124	Aug 31 Saturday
245	3	5	4	2	4	1	1	7	2	8	2	7	6	3	8	6	1	4	9	5	3	3	3	3	100	Sep 01 Sunday
246	3	6	8	7	0	0	1	5	8	5	14	15	22	4	8	12	1	6	5	4	5	6	5	3	153	Sep 02 Monday
247	4	3	10	4	6	3	3	5	11	6	16	11	6	7	2	4	12	3	5	3	3	8	1	3	139	Sep 03 Tuesday
248	8	5	4	2	7	3	3	6	15	7	20	15	9	9	13	9	3	4	5	6	3	1	5	2	164	Sep 04 Wednesday
249	8	2	4	6	2	0	2	4	16	16	20	33	33	16	7	16	2	3	3	6	7	4	8	6	224	Sep 05 Thursday
250	8	9	7	5	1	0	4	7	11	8	12	19	11	7	6	4	3	5	2	5	6	3	1	0	144	Sep 06 Friday
251	8	1	6	7	10	5	1	3	6	9	7	11	10	2	2	5	3	4	4	5	2	5	0	2	118	Sep 07 Saturday
252	1	3	6	3	1	5	1	2	10	3	2	11	4	2	2	0	0	5	2	8	6	3	1	8	89	Sep 08 Sunday
253	5	3	3	4	6	2	3	3	7	16	10	18	22	21	17	4	9	3	9	4	0	0	3	3	175	Sep 09 Monday
254	5	4	3	7	3	4	1	9	11	8	22	12	11	13	5	9	1	0	1	5	1	3	1	2	141	Sep 10 Tuesday
255	4	3	7	7	2	9	7	6	14	10	7	12	16	11	4	5	3	10	5	2	4	3	5	2	158	Sep 11 Wednesday
256	3	2	3	3	1	4	1	7	8	11	5	11	20	17	3	4	3	1	8	6	5	4	9	1	140	Sep 12 Thursday
257	9	5	4	11	10	7	6	6	17	37	30	12	6	11	7	8	6	10	5	6	8	13	0	0	234	Sep 13 Friday
258	1	1	10	6	2	4	3	0	7	2	4	3	1	13	2	1	7	3	2	5	1	2	3	1	84	Sep 14 Saturday
259	4	1	6	9	2	3	2	9	13	5	7	0	4	6	4	2	3	4	4	3	4	4	3	0	102	Sep 15 Sunday

Table 3.5.3 (Page 3 of 4)

FIN .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
260	5	3	6	1	1	5	4	4	4	7	4	8	8	6	17	8	5	4	4	5	3	5	3	3	123	Sep 16 Monday
261	0	6	4	2	3	0	3	0	5	8	4	5	10	4	4	6	2	8	16	6	6	5	5	8	120	Sep 17 Tuesday
262	8	5	9	6	12	5	8	5	16	13	13	14	12	11	7	11	3	7	4	3	2	2	6	9	191	Sep 18 Wednesday
263	4	5	1	2	8	2	1	12	7	12	12	11	27	15	7	3	3	3	2	5	6	9	1	1	159	Sep 19 Thursday
264	9	4	3	4	11	8	7	17	8	2	9	18	22	20	11	10	6	18	20	20	12	13	14	9	275	Sep 20 Friday
265	4	15	11	20	7	5	0	9	3	4	4	6	11	6	3	11	10	15	2	3	6	5	5	7	172	Sep 21 Saturday
266	5	5	6	1	4	11	4	6	6	9	14	6	9	3	8	5	1	4	3	5	11	1	7	11	145	Sep 22 Sunday
267	11	4	8	3	1	7	2	4	8	10	3	13	15	6	6	13	4	1	0	4	6	3	2	2	136	Sep 23 Monday
268	6	5	3	5	2	6	4	3	9	10	11	14	26	17	18	7	6	6	7	13	2	8	7	1	196	Sep 24 Tuesday
269	6	3	8	7	4	4	9	12	8	12	15	24	26	14	10	8	4	8	5	11	4	11	4	3	220	Sep 25 Wednesday
270	8	7	6	5	2	4	3	11	14	12	20	23	15	1	6	2	7	6	6	6	3	5	5	6	183	Sep 26 Thursday
271	7	1	5	2	6	2	3	5	10	15	7	17	16	4	9	5	5	4	0	5	9	2	5	5	149	Sep 27 Friday
272	7	0	3	6	1	3	3	9	6	11	4	13	8	5	12	6	8	9	6	5	7	6	1	6	145	Sep 28 Saturday
273	2	3	5	7	0	1	13	5	0	4	6	2	12	4	4	1	5	4	4	4	3	7	0	3	99	Sep 29 Sunday
274	7	7	4	3	0	13	3	11	10	12	11	17	12	9	4	4	4	1	1	6	1	2	2	6	150	Sep 30 Monday
FIN	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Sum	1265	1366	1219	1049	826	840	879	1133	1495	1738	2061	2269	1999	1535	1270	1266	1087	1151	1071	1145	1032	998	1120	1028	30842	Total sum
182	7	8	7	6	5	5	5	6	8	10	11	12	11	8	7	7	6	6	6	6	6	5	6	6	169	Total average
124	7	7	7	5	4	4	5	6	9	11	13	15	13	10	8	8	6	6	6	7	6	6	7	6	180	Average workdays
58	7	8	7	7	5	6	5	5	6	6	7	7	7	5	5	5	5	6	5	5	5	5	5	5	139	Average weekends

Table 3.5.3. (Page 4 of 4) Daily and hourly distribution of FINESS detections. For each day is shown number of detections within each hour of the day, and number of detections for that day. The end statistics give total number of detections distributed for each hour and the total sum of detections during the period. The averages show number of processed days, hourly distribution and average per processed day.

GER .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
92	11	1	7	9	5	5	7	4	12	14	23	13	13	6	14	15	7	4	6	6	3	3	6	7	201	Apr 01 Monday
93	8	3	8	13	9	1	7	11	10	17	16	22	4	3	6	14	9	14	6	6	7	5	1	6	206	Apr 02 Tuesday
94	6	5	7	4	4	0	5	6	23	18	17	18	16	9	8	7	5	14	6	6	8	7	7	8	214	Apr 03 Wednesday
95	9	10	6	12	12	0	8	10	17	25	23	38	14	10	3	16	7	1	3	7	6	6	6	1	250	Apr 04 Thursday
96	2	1	2	2	13	2	2	4	5	24	7	12	13	9	0	11	2	5	10	3	5	5	2	2	143	Apr 05 Friday
97	3	1	7	4	14	11	6	6	6	6	6	16	9	6	4	11	6	18	6	1	2	5	6	7	167	Apr 06 Saturday
98	5	2	5	1	3	2	11	9	1	0	8	4	1	1	4	9	4	2	0	4	5	2	1	1	85	Apr 07 Sunday
99	3	2	8	5	3	0	8	4	3	6	5	10	3	4	5	4	6	11	14	2	8	12	10	10	146	Apr 08 Monday
100	7	11	13	9	3	7	12	14	18	21	25	11	14	11	12	21	12	12	7	9	4	6	13	4	276	Apr 09 Tuesday
101	9	9	14	6	10	2	2	15	21	24	34	27	12	23	23	10	9	15	14	15	4	9	12	9	328	Apr 10 Wednesday
102	11	15	8	10	6	8	5	12	18	20	34	31	7	13	15	21	16	14	12	16	12	4	7	12	327	Apr 11 Thursday
103	10	11	4	6	2	7	3	8	14	14	40	22	14	13	8	25	15	9	11	8	10	2	10	3	269	Apr 12 Friday
104	9	2	5	12	12	7	17	6	2	12	11	2	5	16	4	9	12	15	7	5	5	3	5	12	195	Apr 13 Saturday
105	9	0	12	1	7	4	4	10	7	1	9	7	5	2	6	10	4	4	2	3	13	19	8	8	155	Apr 14 Sunday
106	14	15	4	1	2	5	6	18	12	20	18	17	17	14	10	23	8	5	4	14	13	11	4	5	260	Apr 15 Monday
107	10	15	14	9	5	4	2	8	12	15	27	29	25	10	12	12	12	10	13	10	7	4	15	6	286	Apr 16 Tuesday
108	11	6	10	6	8	11	5	14	19	13	31	22	22	4	12	11	17	16	8	16	6	3	5	8	284	Apr 17 Wednesday
109	11	11	5	8	5	6	10	6	27	18	33	19	14	23	13	9	10	9	8	7	18	11	13	3	297	Apr 18 Thursday
110	12	5	12	13	10	1	8	9	13	30	29	13	20	9	11	5	25	6	11	9	5	9	15	5	285	Apr 19 Friday
111	12	7	14	16	11	15	16	4	8	13	2	9	3	5	8	3	14	10	9	13	5	3	6	8	214	Apr 20 Saturday
112	8	3	6	1	1	3	8	3	3	8	7	10	4	3	7	5	3	7	0	2	4	17	10	5	128	Apr 21 Sunday
113	5	7	11	10	7	13	9	6	15	23	32	26	11	8	18	14	11	6	23	4	5	5	8	4	281	Apr 22 Monday
114	8	8	7	6	11	8	8	20	11	20	30	30	14	6	18	15	11	17	10	13	6	9	1	1	288	Apr 23 Tuesday
115	9	7	3	0	9	8	6	12	18	20	31	28	23	16	10	11	15	12	11	8	5	9	5	7	283	Apr 24 Wednesday
116	3	12	10	2	6	15	12	17	35	35	25	24	23	11	26	16	16	10	20	9	18	4	2	2	353	Apr 25 Thursday
117	4	14	4	10	5	18	21	24	16	28	40	35	24	21	17	22	18	12	10	7	7	4	5	4	370	Apr 26 Friday
118	10	20	14	27	10	21	15	16	21	15	15	21	4	8	8	12	4	5	1	7	1	0	0	1	256	Apr 27 Saturday
119	2	0	2	6	1	12	4	15	15	3	10	15	11	4	5	9	2	4	6	8	12	9	7	10	172	Apr 28 Sunday
120	7	11	10	7	8	6	21	11	14	25	24	24	32	15	22	15	13	7	5	18	9	21	5	15	345	Apr 29 Monday
121	6	8	7	8	8	11	17	14	35	32	34	19	20	14	14	24	38	11	8	8	8	3	3	0	350	Apr 30 Tuesday
122	1	4	5	15	5	1	3	10	2	10	6	5	4	10	13	5	6	4	7	3	10	14	13	16	172	May 01 Wednesday
123	13	7	15	7	14	14	11	17	8	23	31	23	11	17	10	19	10	11	16	10	10	3	9	15	324	May 02 Thursday
124	12	5	10	15	13	2	7	9	19	13	30	24	9	7	15	18	10	22	6	9	2	3	7	10	277	May 03 Friday
125	5	4	5	10	6	6	15	20	7	13	16	8	11	3	7	3	14	10	7	1	1	3	1	2	178	May 04 Saturday
126	5	3	0	6	5	5	3	5	1	1	9	5	5	1	3	3	0	0	4	3	7	10	5	6	95	May 05 Sunday
127	4	9	5	9	3	8	9	11	13	35	23	25	24	13	20	9	10	15	8	8	11	4	10	5	291	May 06 Monday
128	4	8	6	1	6	6	12	15	19	27	37	15	32	19	12	6	9	10	2	11	13	19	3	7	299	May 07 Tuesday
129	1	3	9	2	7	14	5	17	11	17	24	8	12	3	7	7	10	11	7	13	9	7	13	16	233	May 08 Wednesday
130	23	13	5	9	11	8	9	11	19	12	26	21	15	19	9	11	10	10	10	12	12	9	7	9	300	May 09 Thursday
131	5	6	8	14	17	5	8	18	11	22	35	16	12	7	6	4	14	5	2	2	8	3	10	2	240	May 10 Friday
132	4	14	13	11	12	8	6	10	3	10	23	4	5	3	7	6	9	11	4	3	2	5	0	1	174	May 11 Saturday
133	4	3	3	3	2	2	2	4	26	5	8	3	8	4	7	6	5	7	0	4	1	7	9	8	131	May 12 Sunday
134	6	5	6	1	6	12	19	8	36	25	27	21	23	7	14	11	6	6	13	19	5	4	10	7	297	May 13 Monday
135	4	8	8	2	2	8	9	10	17	30	32	21	24	14	20	9	11	15	4	14	0	4	8	10	284	May 14 Tuesday
136	10	7	5	2	7	14	11	18	23	24	27	22	26	10	12	10	12	15	7	5	1	9	5	8	290	May 15 Wednesday
137	7	0	2	3	10	3	1	4	14	17	13	20	9	10	4	2	1	6	7	2	8	6	11	13	173	May 16 Thursday
138	25	11	11	7	2	6	6	6	7	23	17	21	14	10	3	5	8	16	5	27	15	7	4	5	261	May 17 Friday
139	5	2	1	10	3	6	6	8	8	4	6	24	10	20	12	43	45	26	8	6	6	5	1	1	266	May 18 Saturday
140	1	2	0	6	6	3	4	8	2	10	10	18	10	7	24	4	15	2	0	1	6	14	7	17	177	May 19 Sunday
141	6	10	9	4	4	11	17	11	18	17	19	30	19	16	12	4	10	9	10	5	2	5	5	6	259	May 20 Monday
142	3	8	6	7	10	8	8	21	16	27	41	16	20	28	8	16	10	5	13	6	14	8	3	8	310	May 21 Tuesday
143	7	9	3	7	3	9	10	12	16	19	40	25	26	10	6	9	6	8	14	8	16	9	5	9	286	May 22 Wednesday
144	4	6	3	2	3	14	14	19	26	35	23	28	19	13	7	10	13	11	3	10	7	5	10	10	295	May 23 Thursday
145	4	8	14	3	4	8	16	15	18	22	34	14	16	10	5	23	10	6	4	11	4	5	3	4	261	May 24 Friday
146	3	5	5	8	3	6	9	10	10	8	14	10	4	33	10	2	3	4	7	4	3	1	1	0	163	May 25 Saturday
147	1	1	5	1	1	0	10	5	7	2	6	8	3	7	1	4	1	2	3	1	5	11	2	1	88	May 26 Sunday

Table 3.5.4 (Page 1 of 4)

GER .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
148	8	2	5	2	8	4	2	1	12	17	16	24	26	9	13	13	13	5	5	21	5	5	4	1	221	May 27 Monday
149	3	3	5	3	6	4	18	15	16	21	33	26	23	24	4	12	8	9	11	5	5	7	6	7	274	May 28 Tuesday
150	3	4	6	9	7	8	12	16	16	17	23	18	23	16	7	17	12	10	5	9	9	11	5	8	271	May 29 Wednesday
151	3	3	3	12	4	3	10	15	18	24	23	20	23	13	11	15	9	7	6	15	8	4	4	5	258	May 30 Thursday
152	3	3	6	6	16	6	7	9	20	26	28	7	19	8	7	7	6	5	2	9	11	5	6	6	228	May 31 Friday
153	5	2	5	2	3	7	6	5	7	6	7	19	12	4	7	10	13	8	7	32	0	33	12	3	215	Jun 01 Saturday
154	2	7	9	5	6	8	10	5	4	7	4	12	16	10	1	5	8	5	2	3	8	5	11	11	164	Jun 02 Sunday
155	6	8	14	11	5	7	21	7	27	20	24	33	22	21	15	9	7	7	7	6	12	7	5	7	308	Jun 03 Monday
156	6	2	16	7	5	13	10	10	19	22	34	38	20	14	12	14	4	14	8	9	15	6	8	8	314	Jun 04 Tuesday
157	20	25	7	6	8	1	7	11	20	13	22	20	18	8	33	14	7	11	5	12	9	10	6	6	299	Jun 05 Wednesday
158	2	0	1	2	8	6	7	10	9	9	20	26	17	10	8	8	10	6	2	6	7	20	17	10	221	Jun 06 Thursday
159	6	9	3	5	11	10	6	9	27	24	23	15	17	8	11	17	3	16	7	9	11	12	3	4	266	Jun 07 Friday
160	4	5	3	6	9	9	16	9	7	7	9	6	8	11	6	20	16	10	4	8	5	4	10	16	208	Jun 08 Saturday
161	5	9	5	7	7	6	16	8	5	7	14	7	4	1	2	7	3	4	5	3	26	75	77	21	324	Jun 09 Sunday
162	12	18	10	11	22	19	11	1	12	35	34	32	10	28	15	24	14	19	7	8	20	10	33	19	424	Jun 10 Monday
163	34	4	6	11	3	7	14	31	28	48	25	36	18	33	16	7	15	21	15	7	12	6	10	8	415	Jun 11 Tuesday
164	14	19	11	9	2	8	7	9	23	31	41	20	36	12	10	12	14	6	11	5	20	20	20	10	370	Jun 12 Wednesday
165	17	8	8	2	0	9	3	19	20	19	30	26	14	20	14	13	9	9	6	10	5	9	8	12	290	Jun 13 Thursday
166	8	3	6	3	2	7	10	10	32	35	9	34	18	17	12	11	1	8	13	5	2	8	9	3	266	Jun 14 Friday
167	1	9	5	12	5	5	4	8	12	16	14	17	13	8	4	10	3	3	1	9	3	8	2	9	181	Jun 15 Saturday
168	4	8	5	1	3	5	5	3	11	3	2	4	7	11	2	10	3	2	3	3	3	6	6	10	120	Jun 16 Sunday
169	12	32	9	9	10	8	17	12	20	30	16	43	21	16	11	16	8	11	13	8	1	7	12	4	346	Jun 17 Monday
170	9	7	4	6	5	6	8	22	15	25	30	39	16	13	16	12	10	8	7	8	14	10	0	7	297	Jun 18 Tuesday
171	10	21	7	8	7	15	9	18	17	27	21	21	7	18	16	27	5	14	6	10	5	4	3	7	303	Jun 19 Wednesday
172	7	7	12	3	4	27	0	18	18	27	28	24	9	14	12	4	12	5	6	6	14	6	4	10	277	Jun 20 Thursday
173	7	10	8	7	12	10	11	11	22	15	26	30	16	18	13	16	7	6	12	11	6	14	3	9	300	Jun 21 Friday
174	9	5	8	9	8	11	3	6	2	8	15	6	12	10	3	20	10	13	6	11	5	2	7	5	194	Jun 22 Saturday
175	6	12	12	10	5	8	3	6	6	9	6	11	10	7	3	13	7	6	5	6	12	5	7	10	185	Jun 23 Sunday
176	21	9	11	5	0	11	8	23	17	39	7	27	26	23	18	10	10	17	1	2	7	6	17	3	318	Jun 24 Monday
177	3	6	9	16	7	5	11	22	32	34	30	20	22	12	7	11	8	10	10	6	5	7	4	8	305	Jun 25 Tuesday
178	8	10	11	13	10	4	18	10	22	27	16	37	19	26	11	12	12	10	16	14	2	2	7	24	341	Jun 26 Wednesday
179	4	3	8	4	2	18	13	13	28	25	18	28	38	29	9	18	7	10	11	3	7	6	10	5	317	Jun 27 Thursday
180	9	11	13	19	6	7	14	24	20	22	30	26	20	9	7	10	14	10	4	3	12	8	2	3	303	Jun 28 Friday
181	4	11	5	6	7	15	4	5	17	7	14	33	7	13	5	4	12	22	3	23	2	5	2	6	232	Jun 29 Saturday
182	6	7	2	4	5	5	8	9	4	2	10	5	8	2	3	3	5	5	3	6	5	8	12	20	147	Jun 30 Sunday
183	10	12	12	3	22	11	9	3	7	12	17	24	24	13	23	6	18	5	6	5	4	6	7	5	264	Jul 01 Monday
184	4	0	5	13	7	27	18	21	16	30	25	21	23	13	8	10	16	13	4	7	3	4	2	4	294	Jul 02 Tuesday
185	4	6	9	6	3	9	11	14	16	31	27	20	19	14	11	10	11	16	2	5	8	3	3	3	261	Jul 03 Wednesday
186	14	9	6	47	7	2	11	13	10	20	38	22	7	15	25	28	9	14	14	12	10	11	14	22	380	Jul 04 Thursday
187	7	15	10	8	12	5	11	9	12	22	24	21	15	15	4	11	2	10	2	35	53	1	6	3	313	Jul 05 Friday
188	1	8	1	6	8	6	5	5	3	5	3	9	8	4	1	5	0	1	2	6	1	9	3	1	101	Jul 06 Saturday
189	5	5	4	4	2	3	4	5	3	2	5	4	13	4	5	5	4	5	5	5	4	8	12	5	121	Jul 07 Sunday
190	9	7	9	12	5	5	5	15	14	22	21	19	19	11	4	8	8	7	14	26	6	4	8	9	267	Jul 08 Monday
191	3	2	50	72	20	23	12	33	59	13	31	28	16	16	28	81	33	16	20	4	8	10	5	9	592	Jul 09 Tuesday
192	5	10	16	11	7	17	26	19	19	30	26	38	54	29	8	3	8	6	10	15	50	5	3	2	417	Jul 10 Wednesday
193	1	21	33	25	2	15	13	22	28	21	33	53	18	46	37	25	7	4	9	22	7	10	1	3	456	Jul 11 Thursday
194	3	0	71	45	6	2	20	18	20	22	33	42	33	76	60	51	25	37	51	42	11	70	28	2	768	Jul 12 Friday
195	5	4	4	66	71	16	17	9	19	69	34	10	1	10	9	23	13	13	3	6	5	1	1	0	409	Jul 13 Saturday
196	10	0	1	1	0	0	5	2	8	3	9	2	5	5	5	5	7	5	3	14	4	4	8	7	113	Jul 14 Sunday
197	14	8	9	6	4	27	25	14	28	41	53	42	19	10	22	17	27	17	49	63	5	8	15	3	526	Jul 15 Monday
198	5	4	35	69	40	25	28	44	49	37	59	50	48	21	11	15	16	14	17	44	1	5	1	12	650	Jul 16 Tuesday
199	23	16	18	9	8	5	11	19	11	38	36	25	21	52	48	36	14	12	21	8	4	4	8	15	462	Jul 17 Wednesday
200	5	12	6	19	18	8	34	18	44	22	46	19	24	27	37	17	9	15	4	7	7	4	2	7	411	Jul 18 Thursday
201	3	11	9	8	4	11	22	21	26	25	36	27	4	10	6	8	11	3	2	18	1	9	5	6	286	Jul 19 Friday
202	13	12	8	11	14	1	6	10	10	13	16	8	7	8	4	5	5	13	12	5	2	6	14	3	206	Jul 20 Saturday
203	9	6	6	8	10	0	0	0	0	2	4	9	8	7	7	9	3	4	5	1	7	9	12	17	143	Jul 21 Sunday

Table 3.5.4 (Page 2 of 4)

GER .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
204	11	14	12	6	7	14	16	11	25	43	20	29	14	11	20	18	8	6	9	5	10	8	9	10	336	Jul 22 Monday
205	3	7	3	16	109	13	15	12	39	30	31	35	11	26	15	16	9	8	7	8	3	7	48	18	489	Jul 23 Tuesday
206	11	8	3	6	76	19	16	17	56	26	26	30	21	21	10	9	10	4	7	2	4	10	12	8	412	Jul 24 Wednesday
207	9	9	15	32	1	7	12	12	16	27	31	26	18	10	10	9	18	11	1	2	3	11	7	10	307	Jul 25 Thursday
208	5	3	8	26	8	17	12	15	19	31	43	21	11	18	15	6	0	6	8	6	8	1	7	6	300	Jul 26 Friday
209	10	1	4	13	10	2	12	10	18	6	10	12	7	4	17	22	11	8	6	14	8	4	11	4	224	Jul 27 Saturday
210	2	6	2	3	2	3	6	10	6	3	11	6	7	7	6	5	9	1	4	4	4	12	4	6	129	Jul 28 Sunday
211	13	10	15	87	1	3	12	21	19	23	30	31	27	22	16	6	2	5	3	4	8	7	6	4	375	Jul 29 Monday
212	9	13	6	45	5	8	7	9	19	24	29	41	9	11	15	3	4	6	6	5	1	4	5	6	290	Jul 30 Tuesday
213	9	6	6	33	25	7	13	16	28	20	28	22	16	8	12	14	8	6	11	2	7	8	16	10	331	Jul 31 Wednesday
214	6	11	9	19	16	18	15	21	30	24	29	26	19	9	14	11	11	4	2	9	4	8	14	3	332	Aug 01 Thursday
215	9	12	0	0	0	0	16	12	9	32	36	31	15	12	8	8	23	8	17	9	24	5	36	0	322	Aug 02 Friday
216	0	0	0	0	0	0	0	0	0	4	29	10	2	10	22	15	18	12	4	2	3	1	0	0	132	Aug 03 Saturday
217	2	2	0	2	3	7	5	10	7	21	22	21	1	5	3	7	1	10	2	3	5	5	7	7	158	Aug 04 Sunday
218	7	12	23	39	7	8	7	10	21	22	18	28	21	15	4	5	0	8	4	7	6	4	19	11	306	Aug 05 Monday
219	10	3	8	23	4	8	11	9	20	20	35	23	20	11	8	11	0	3	0	1	10	1	2	9	250	Aug 06 Tuesday
220	3	7	8	1	29	14	14	13	9	26	40	23	24	15	15	8	6	4	3	6	3	6	5	4	286	Aug 07 Wednesday
221	3	6	17	10	6	13	11	9	28	18	29	32	39	19	9	12	1	10	8	2	1	7	19	7	316	Aug 08 Thursday
222	14	7	6	9	6	17	19	13	17	26	40	26	18	6	17	10	9	1	7	1	2	2	3	7	283	Aug 09 Friday
223	14	2	5	10	5	1	10	3	6	17	6	26	5	13	2	9	1	1	10	12	3	1	10	10	182	Aug 10 Saturday
224	5	13	4	7	2	3	3	5	5	3	3	13	9	2	6	0	0	0	0	0	0	0	0	0	83	Aug 11 Sunday
225	0	0	0	0	0	0	0	10	15	26	24	17	10	20	16	16	5	3	9	4	10	11	3	6	205	Aug 12 Monday
226	2	14	9	7	15	18	17	21	14	59	37	17	20	11	21	28	32	15	6	8	8	3	11	4	397	Aug 13 Tuesday
227	4	11	11	9	0	0	17	46	11	16	23	55	22	26	10	13	12	4	2	5	7	4	4	2	314	Aug 14 Wednesday
228	4	1	6	5	8	1	12	10	10	29	38	27	8	18	11	6	4	5	5	9	3	11	3	16	250	Aug 15 Thursday
229	17	8	10	5	15	10	16	12	26	25	45	27	12	19	11	7	7	5	1	8	7	3	3	6	305	Aug 16 Friday
230	4	5	5	4	4	4	4	4	6	12	7	27	10	5	5	12	5	2	1	0	3	2	1	1	133	Aug 17 Saturday
231	4	2	2	3	9	3	4	9	2	7	5	4	4	7	6	7	3	2	5	1	3	6	4	6	108	Aug 18 Sunday
232	4	6	5	6	8	9	15	25	20	38	26	21	14	31	20	2	7	4	8	8	5	6	7	6	301	Aug 19 Monday
233	6	8	3	4	15	21	29	28	23	23	39	16	32	21	12	13	29	7	10	3	4	5	1	7	359	Aug 20 Tuesday
234	5	5	10	3	9	25	16	27	22	31	23	36	22	31	13	23	5	5	6	11	6	5	8	3	350	Aug 21 Wednesday
235	3	7	14	7	6	10	16	30	15	30	96	102	25	9	19	24	10	5	12	18	13	6	2	7	486	Aug 22 Thursday
236	5	11	8	11	12	17	35	19	16	23	38	22	7	14	6	4	1	3	7	18	3	7	2	0	289	Aug 23 Friday
237	1	1	17	1	3	5	2	1	6	8	2	8	11	7	5	8	2	8	12	7	4	11	5	8	143	Aug 24 Saturday
238	8	3	2	2	5	3	3	1	8	6	7	0	8	7	3	8	2	2	0	1	8	5	9	6	107	Aug 25 Sunday
239	5	6	14	4	13	11	13	11	19	35	30	23	21	28	9	5	7	9	6	7	8	3	4	2	293	Aug 26 Monday
240	9	16	9	2	3	7	21	26	17	29	27	33	13	12	41	14	2	5	9	3	1	3	4	9	315	Aug 27 Tuesday
241	5	5	11	4	10	26	20	13	11	17	26	17	23	16	19	8	11	14	10	32	24	6	9	5	342	Aug 28 Wednesday
242	5	8	9	18	5	20	22	11	23	33	21	35	27	12	9	7	4	9	7	9	9	9	47	7	366	Aug 29 Thursday
243	6	8	12	9	5	3	4	18	15	31	35	17	11	11	9	7	14	3	4	7	17	7	4	7	264	Aug 30 Friday
244	4	2	6	7	22	6	4	7	10	14	27	33	27	9	8	18	9	10	5	8	4	8	0	3	251	Aug 31 Saturday
245	1	3	9	3	5	7	19	19	14	18	16	4	3	11	5	7	1	1	3	1	2	3	10	3	168	Sep 01 Sunday
246	12	7	11	14	5	13	13	11	15	28	15	29	29	11	7	10	20	8	9	4	8	10	5	9	303	Sep 02 Monday
247	8	8	5	9	4	7	12	10	20	15	52	27	22	16	7	7	11	2	5	1	7	5	4	4	268	Sep 03 Tuesday
248	9	9	7	7	13	6	17	7	24	29	34	31	28	25	11	23	6	4	11	13	8	8	7	3	340	Sep 04 Wednesday
249	3	6	6	1	11	3	13	9	19	37	24	19	9	7	22	8	5	3	2	7	13	23	12	17	279	Sep 05 Thursday
250	31	21	22	25	12	12	13	20	29	25	29	22	19	13	14	14	24	11	12	14	15	11	1	2	411	Sep 06 Friday
251	11	3	7	21	25	18	6	6	8	10	19	10	5	10	5	0	0	5	9	13	5	4	1	3	204	Sep 07 Saturday
252	6	11	5	6	1	15	15	16	17	18	12	13	21	3	6	4	10	4	1	8	11	10	6	7	226	Sep 08 Sunday
253	15	11	7	10	9	9	11	10	21	28	23	30	27	12	22	8	19	12	15	6	4	5	5	7	326	Sep 09 Monday
254	4	7	6	4	9	14	11	14	19	21	27	24	21	19	6	7	12	13	6	4	7	0	12	6	273	Sep 10 Tuesday
255	10	53	11	23	1	6	5	12	9	29	35	20	18	13	11	8	9	4	0	3	6	3	4	7	300	Sep 11 Wednesday
256	4	4	7	8	10	6	7	10	14	23	16	30	19	14	16	6	4	4	8	8	3	4	7	7	239	Sep 12 Thursday
257	3	12	11	6	4	7	8	21	16	29	39	25	9	4	2	13	4	3	6	7	2	10	4	5	250	Sep 13 Friday
258	2	3	11	6	4	3	12	3	8	4	2	13	13	12	10	7	6	4	3	2	2	1	12	8	151	Sep 14 Saturday
259	7	6	6	8	4	1	3	6	14	11	18	9	11	5	6	5	2	2	6	3	1	4	16	12	166	Sep 15 Sunday

Table 3.5.4 (Page 3 of 4)

GER .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
260	12	7	28	33	26	7	9	10	21	22	13	14	10	12	19	9	7	5	0	1	4	11	5	2	287	Sep 16 Monday
261	2	6	6	4	3	9	7	14	23	18	18	26	18	29	24	14	1	4	9	3	9	5	6	13	271	Sep 17 Tuesday
262	8	4	7	9	4	13	8	14	23	18	30	36	15	13	24	7	8	8	5	2	6	2	0	12	276	Sep 18 Wednesday
263	6	9	8	10	15	11	9	10	17	25	34	23	17	11	25	6	6	7	8	6	7	5	3	4	282	Sep 19 Thursday
264	11	10	8	4	11	6	7	16	12	25	17	30	16	7	8	7	8	18	11	13	8	11	7	8	279	Sep 20 Friday
265	5	12	7	13	3	1	2	11	1	1	5	9	10	5	4	2	4	6	7	7	8	2	10	6	141	Sep 21 Saturday
266	4	8	6	2	6	1	10	4	4	2	3	11	3	3	2	0	2	0	4	2	7	4	5	5	98	Sep 22 Sunday
267	10	10	3	11	3	7	8	8	10	21	34	18	15	18	11	15	12	1	6	3	0	7	5	4	240	Sep 23 Monday
268	11	8	14	2	20	7	3	11	25	32	28	38	14	15	7	3	6	2	6	7	10	5	6	13	293	Sep 24 Tuesday
269	5	10	10	2	12	9	9	13	10	26	34	35	17	13	16	13	11	20	4	7	3	5	7	3	294	Sep 25 Wednesday
270	11	13	10	8	4	23	12	11	37	27	50	20	30	26	11	14	7	2	5	4	5	2	5	2	339	Sep 26 Thursday
271	7	4	12	2	15	11	17	13	15	32	44	23	31	14	19	1	11	10	5	3	9	3	9	4	314	Sep 27 Friday
272	4	6	13	6	2	8	8	10	11	10	20	19	9	4	10	7	5	6	3	11	5	4	2	1	184	Sep 28 Saturday
273	4	5	5	2	0	3	9	7	0	12	7	14	5	12	4	2	5	5	2	7	6	9	5	5	135	Sep 29 Sunday
274	11	9	2	18	10	10	9	20	9	22	34	22	12	16	8	5	13	2	8	10	4	3	6	7	270	Sep 30 Monday
GER	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Sum	1335	1425	1575	1870	1618	1559	1916	2261	2934	3721	4366	3997	2877	2450	2130	2120	1705	1518	1341	1560	1348	1359	1434	1259	49678	Total sum
183	7	8	9	10	9	9	10	12	16	20	24	22	16	13	12	12	9	8	7	9	7	7	8	7	271	Total average
124	8	9	10	11	10	10	12	15	20	25	30	26	19	16	14	13	11	9	9	9	8	7	8	7	317	Average workdays
59	6	5	6	8	7	6	7	7	8	10	11	12	8	7	6	8	7	6	5	6	5	8	7	6	173	Average weekends

Table 3.5.4. (Page 4 of 4) Daily and hourly distribution of GERESS detections. For each day is shown number of detections within each hour of the day, and number of detections for that day. The end statistics give total number of detections distributed for each hour and the total sum of detections during the period. The averages show number of processed days, hourly distribution and average per processed day.

APA .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
92	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	3	Apr 01 Monday
93	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2	Apr 02 Tuesday
94	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	Apr 03 Wednesday
95	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Apr 04 Thursday
96	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	1	0	0	1	0	0	0	0	0	8	Apr 05 Friday
97	0	9	3	6	10	8	11	4	5	14	9	23	13	3	12	16	6	7	0	6	1	12	4	3	185	Apr 06 Saturday
98	1	0	4	4	10	11	21	10	7	3	6	4	11	5	2	10	7	2	2	2	4	5	1	2	134	Apr 07 Sunday
99	3	6	13	14	4	23	19	20	17	10	22	5	13	12	18	4	4	13	6	9	5	4	3	3	250	Apr 08 Monday
100	2	6	8	8	20	22	11	16	19	12	8	18	22	14	5	10	8	13	10	7	2	2	0	2	245	Apr 09 Tuesday
101	4	14	16	10	10	22	20	9	18	16	22	27	13	15	9	12	4	8	4	2	5	6	5	2	273	Apr 10 Wednesday
102	3	4	20	13	13	25	21	16	21	0	12	16	16	13	3	3	2	6	1	7	12	3	1	8	239	Apr 11 Thursday
103	9	6	7	20	9	11	15	9	17	24	21	35	14	9	12	14	6	3	0	3	6	5	8	5	268	Apr 12 Friday
104	6	6	1	3	6	4	9	3	4	14	21	8	7	8	6	5	11	12	3	4	6	3	8	6	164	Apr 13 Saturday
105	4	2	8	5	10	4	4	2	3	8	10	3	12	5	9	2	3	1	5	3	3	2	1	9	118	Apr 14 Sunday
106	2	6	9	15	14	20	19	12	7	11	11	10	18	4	3	3	4	14	2	3	8	5	3	2	205	Apr 15 Monday
107	17	4	8	14	11	11	24	25	8	8	8	11	13	6	2	3	8	6	1	1	7	0	4	9	209	Apr 16 Tuesday
108	8	21	18	23	13	21	15	9	15	22	16	25	18	14	5	3	7	2	6	3	6	10	11	6	297	Apr 17 Wednesday
109	7	13	12	11	22	14	16	13	10	6	9	19	19	10	6	3	6	8	4	7	5	2	12	3	237	Apr 18 Thursday
110	6	7	11	8	8	10	10	18	11	18	6	25	15	18	7	2	6	10	1	0	7	1	4	0	209	Apr 19 Friday
111	2	0	1	2	2	3	4	3	6	4	20	10	6	4	0	6	5	4	7	1	2	2	1	4	99	Apr 20 Saturday
112	2	4	3	3	4	7	3	2	0	5	2	8	4	2	4	2	4	1	0	0	1	1	0	0	62	Apr 21 Sunday
113	2	5	9	10	9	11	9	9	15	14	9	18	10	13	8	5	5	2	3	1	2	3	3	1	176	Apr 22 Monday
114	0	1	10	10	8	7	7	10	15	10	14	14	4	10	6	9	6	3	2	3	6	4	4	14	177	Apr 23 Tuesday
115	5	4	9	5	9	7	8	12	11	11	11	14	14	12	2	2	7	3	0	7	5	3	6	7	174	Apr 24 Wednesday
116	7	2	11	7	9	12	9	19	11	19	18	13	25	15	7	2	5	2	6	7	1	1	0	5	213	Apr 25 Thursday
117	2	4	5	1	3	8	11	12	13	18	9	29	7	12	4	9	8	9	9	6	3	5	1	2	190	Apr 26 Friday
118	2	5	3	7	5	4	4	7	7	11	17	5	7	5	10	2	13	15	5	6	18	6	1	0	165	Apr 27 Saturday
119	1	1	4	2	2	4	10	1	5	3	8	6	11	2	2	5	1	4	7	7	5	4	4	1	100	Apr 28 Sunday
120	4	6	21	12	3	22	36	23	15	8	17	19	38	18	32	16	14	22	5	8	5	4	5	6	359	Apr 29 Monday
121	9	8	21	20	23	17	14	23	15	25	14	23	24	13	18	22	14	13	13	8	6	7	9	4	363	Apr 30 Tuesday
122	8	5	6	3	12	13	18	6	11	8	7	6	5	9	8	7	11	11	12	3	1	6	2	2	180	May 01 Wednesday
123	6	9	13	2	6	15	10	2	4	10	7	5	7	19	15	8	24	4	7	2	3	1	1	7	187	May 02 Thursday
124	0	6	11	13	6	10	11	6	5	11	0	10	8	4	10	9	14	9	6	3	6	2	2	5	167	May 03 Friday
125	0	8	6	0	8	6	8	15	7	13	6	12	12	4	7	8	7	9	5	1	4	2	4	4	156	May 04 Saturday
126	1	17	14	15	15	19	30	14	16	15	22	11	22	17	21	5	14	8	11	10	6	2	3	6	314	May 05 Sunday
127	2	14	21	13	25	43	41	26	39	26	27	37	24	23	13	28	18	20	7	7	5	1	2	1	463	May 06 Monday
128	17	5	14	14	31	34	34	44	30	25	36	39	21	21	23	32	20	21	13	14	10	13	7	8	526	May 07 Tuesday
129	10	8	20	22	15	38	37	29	22	34	41	28	30	21	27	29	23	17	6	14	14	8	8	2	503	May 08 Wednesday
130	5	1	3	9	18	1	6	9	2	4	12	6	17	15	18	6	22	5	15	4	3	1	3	1	186	May 09 Thursday
131	4	1	13	4	8	7	9	5	13	9	20	5	12	4	7	17	12	13	10	11	16	3	2	4	209	May 10 Friday
132	7	3	20	10	22	14	13	11	9	17	3	10	6	7	14	6	11	7	7	1	7	4	8	5	222	May 11 Saturday
133	8	5	10	13	20	16	24	24	15	15	12	19	16	12	16	11	7	16	19	6	4	9	11	3	311	May 12 Sunday
134	12	8	32	17	23	43	29	50	36	33	28	26	45	22	7	19	11	12	11	7	5	3	6	2	487	May 13 Monday
135	3	8	11	18	23	56	36	47	18	16	28	20	32	25	10	17	10	10	9	7	6	0	6	2	418	May 14 Tuesday
136	7	8	21	26	20	37	35	26	27	32	19	29	28	20	14	16	13	9	7	12	7	10	2	1	426	May 15 Wednesday
137	1	9	31	18	21	24	45	19	23	19	26	41	32	26	17	10	6	11	2	8	1	0	13	10	413	May 16 Thursday
138	9	13	10	30	32	31	30	36	19	28	40	39	25	48	17	26	17	15	8	5	5	6	7	2	498	May 17 Friday
139	6	9	13	12	3	11	9	17	20	10	8	17	10	15	11	11	20	3	6	6	9	3	4	5	238	May 18 Saturday
140	5	6	4	12	13	19	9	5	6	6	9	9	10	7	10	6	5	15	2	12	5	4	4	19	202	May 19 Sunday
141	8	15	23	17	16	30	34	37	39	17	24	25	25	27	19	18	13	9	6	7	5	2	1	3	420	May 20 Monday
142	4	12	30	23	30	43	37	50	31	36	18	27	26	31	34	20	18	14	13	12	5	9	5	0	528	May 21 Tuesday
143	8	13	29	32	26	50	31	28	43	33	36	24	32	31	18	9	19	16	12	8	1	6	4	0	509	May 22 Wednesday
144	5	15	26	17	33	23	36	73	58	30	28	32	45	37	13	13	11	7	3	8	6	4	2	1	526	May 23 Thursday
145	5	5	17	19	16	28	42	38	44	34	20	38	31	33	23	14	23	10	7	8	24	1	9	9	498	May 24 Friday
146	1	7	2	2	11	16	9	4	10	16	18	14	15	10	11	0	10	11	10	1	7	5	0	2	192	May 25 Saturday
147	8	9	1	0	12	5	15	6	15	12	26	25	12	19	13	2	6	16	6	1	0	8	4	0	221	May 26 Sunday

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APA .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
148	4	5	13	11	28	31	30	37	35	17	17	26	33	23	24	19	12	10	9	7	5	8	3	4	411	May 27 Monday
149	4	11	18	18	38	45	31	21	35	31	37	41	27	37	30	15	20	15	11	20	3	1	6	5	520	May 28 Tuesday
150	8	13	26	13	23	36	43	29	47	42	40	39	33	42	32	20	15	20	13	9	12	5	8	16	584	May 29 Wednesday
151	32	37	56	46	45	76	52	66	68	84	104	81	115	87	67	52	61	50	29	32	19	4	4	9	1276	May 30 Thursday
152	8	16	15	8	14	40	36	22	26	35	31	40	21	20	19	22	18	10	2	5	9	8	12	8	445	May 31 Friday
153	10	4	12	6	9	15	20	14	6	15	9	10	20	14	9	4	14	12	6	10	0	7	5	5	236	Jun 01 Saturday
154	1	4	12	15	8	12	11	3	9	12	2	9	7	13	13	7	13	8	3	6	2	0	4	1	175	Jun 02 Sunday
155	13	4	14	22	28	27	41	44	11	20	29	21	26	28	21	7	8	7	12	3	6	2	2	10	406	Jun 03 Monday
156	0	13	26	16	28	21	39	20	21	18	29	37	27	28	17	15	8	8	8	3	9	0	10	5	406	Jun 04 Tuesday
157	8	24	20	33	28	10	4	8	10	12	10	30	40	30	16	22	12	5	0	5	2	1	6	3	339	Jun 05 Wednesday
158	3	12	20	23	48	44	43	105	129	31	27	44	28	19	21	18	20	26	11	4	5	0	6	2	689	Jun 06 Thursday
159	9	20	12	26	30	44	33	43	33	35	50	53	34	24	22	12	14	17	19	9	1	11	11	11	573	Jun 07 Friday
160	5	6	32	15	20	10	20	4	4	11	6	11	10	14	12	2	18	8	6	4	5	8	3	15	249	Jun 08 Saturday
161	5	16	6	11	13	9	17	4	11	23	4	27	18	24	20	20	22	12	10	13	28	23	5	23	364	Jun 09 Sunday
162	11	15	24	22	46	33	36	27	29	38	37	32	29	35	13	28	18	17	2	2	8	11	4	1	518	Jun 10 Monday
163	8	14	12	21	19	51	24	8	34	31	38	52	25	26	15	14	20	11	21	6	0	8	1	2	461	Jun 11 Tuesday
164	4	5	8	21	7	10	7	4	8	10	11	14	10	8	24	3	5	7	9	1	4	8	5	0	193	Jun 12 Wednesday
165	6	13	21	17	28	36	30	40	21	32	22	25	32	22	15	17	8	23	9	28	13	3	3	3	467	Jun 13 Thursday
166	16	14	25	37	30	38	67	37	45	62	47	55	50	52	43	46	34	28	28	31	35	21	19	25	885	Jun 14 Friday
167	12	22	12	21	8	2	12	10	10	15	19	23	9	15	15	8	5	5	5	7	8	3	3	5	254	Jun 15 Saturday
168	1	4	7	5	13	9	6	10	17	22	22	27	6	11	14	14	16	10	20	19	25	8	23	37	346	Jun 16 Sunday
169	24	29	24	32	55	65	55	60	55	51	51	57	35	53	40	36	13	11	18	7	10	12	16	0	809	Jun 17 Monday
170	6	6	23	17	28	30	40	31	63	34	38	29	27	46	20	18	19	6	0	10	5	0	4	7	507	Jun 18 Tuesday
171	1	14	17	11	28	48	50	33	43	29	19	36	23	35	20	20	16	10	18	10	8	7	2	6	504	Jun 19 Wednesday
172	3	5	21	25	23	29	40	22	17	26	29	18	26	27	9	24	9	7	15	7	2	2	14	7	407	Jun 20 Thursday
173	8	11	10	18	24	27	30	35	30	35	35	59	29	1	3	14	11	19	5	9	1	3	3	0	420	Jun 21 Friday
174	2	7	7	13	11	14	17	4	28	16	20	16	15	12	14	4	14	10	8	2	1	0	1	8	244	Jun 22 Saturday
175	2	7	17	9	13	14	16	5	21	2	9	9	22	15	11	18	8	6	0	7	7	9	2	1	230	Jun 23 Sunday
176	8	13	15	13	24	34	33	24	26	31	37	35	29	27	20	11	20	15	7	16	0	1	3	0	442	Jun 24 Monday
177	3	10	24	24	13	50	55	37	26	27	27	39	33	42	12	25	17	16	16	6	9	4	4	2	521	Jun 25 Tuesday
178	13	18	12	22	25	26	37	41	30	33	41	44	35	21	12	27	14	19	22	3	4	8	10	4	521	Jun 26 Wednesday
179	7	3	27	22	29	49	28	25	20	23	18	31	28	26	21	27	8	15	11	6	6	2	6	5	443	Jun 27 Thursday
180	4	22	28	16	25	22	31	32	28	29	34	53	24	35	26	13	24	14	7	7	5	10	2	1	492	Jun 28 Friday
181	0	0	20	9	13	6	13	9	11	12	9	17	12	13	21	5	15	11	4	3	5	0	4	2	214	Jun 29 Saturday
182	3	3	5	5	6	13	20	9	18	12	20	16	11	14	16	10	9	5	1	2	0	4	9	8	219	Jun 30 Sunday
183	5	6	13	16	18	23	39	27	51	11	22	39	30	22	17	13	11	15	15	11	3	5	7	7	426	Jul 01 Monday
184	0	11	12	19	26	56	26	22	32	21	24	26	22	21	26	15	22	9	8	6	2	2	1	2	411	Jul 02 Tuesday
185	5	5	6	7	9	12	13	11	9	6	15	9	4	6	2	8	17	3	6	5	0	3	0	2	163	Jul 03 Wednesday
186	6	24	19	24	27	36	58	36	26	35	38	36	31	31	22	15	22	19	6	12	3	3	11	5	545	Jul 04 Thursday
187	12	7	25	21	20	27	47	33	16	29	34	31	39	26	24	20	34	15	15	8	3	2	13	2	503	Jul 05 Friday
188	2	15	6	7	19	25	10	27	18	9	11	19	15	9	8	10	7	15	7	1	7	10	2	7	266	Jul 06 Saturday
189	2	7	5	10	8	4	13	4	13	19	10	12	13	16	6	12	8	6	8	2	7	9	15	18	227	Jul 07 Sunday
190	32	26	35	44	25	43	37	47	33	23	40	42	31	31	23	21	13	17	10	18	15	4	10	5	625	Jul 08 Monday
191	16	3	24	31	32	42	40	36	42	40	42	27	29	46	26	32	15	14	1	9	9	3	2	2	563	Jul 09 Tuesday
192	7	8	9	23	21	39	30	43	23	38	28	33	21	27	14	9	20	18	2	17	0	12	3	2	447	Jul 10 Wednesday
193	0	11	13	15	21	29	30	41	30	33	38	38	33	34	23	28	20	19	5	16	6	4	8	0	495	Jul 11 Thursday
194	2	9	17	17	16	37	39	34	25	40	26	57	38	32	26	21	27	9	23	12	3	4	0	2	516	Jul 12 Friday
195	1	10	13	4	11	13	17	10	22	10	13	15	8	10	15	13	14	10	4	9	4	3	13	7	249	Jul 13 Saturday
196	4	2	7	4	6	9	18	5	12	6	16	4	8	10	16	14	8	6	5	9	1	0	0	11	181	Jul 14 Sunday
197	12	9	22	24	36	49	34	33	42	37	27	26	42	29	26	18	6	19	12	5	15	19	0	0	542	Jul 15 Monday
198	6	10	21	19	34	46	44	50	39	33	52	28	17	35	25	6	20	16	6	8	19	14	4	1	553	Jul 16 Tuesday
199	6	14	21	18	19	34	40	34	27	32	42	35	31	29	23	8	29	17	12	12	1	8	3	5	500	Jul 17 Wednesday
200	13	15	15	17	11	42	37	32	44	28	47	43	27	35	17	13	6	3	5	11	2	8	5	9	485	Jul 18 Thursday
201	3	11	11	12	13	36	42	52	12	36	47	54	27	22	19	18	23	9	12	10	0	4	3	4	480	Jul 19 Friday
202	8	9	4	5	16	11	4	11	12	19	6	3	6	3	10	14	9	9	6	11	1	9	0	5	191	Jul 20 Saturday
203	3	4	8	6	11	11	13	13	12	5	1	9	13	3	10	16	7	10	0	8	8	0	0	7	178	Jul 21 Sunday

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APA .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
204	3	5	15	17	23	22	49	35	44	25	58	26	29	10	26	18	13	4	1	10	13	7	4	4	461	Jul 22 Monday
205	9	7	13	36	20	43	31	34	22	21	20	31	26	20	12	14	11	5	12	13	14	7	5	1	427	Jul 23 Tuesday
206	3	21	9	27	18	33	40	39	37	26	21	46	27	46	14	19	5	9	2	9	4	5	6	0	466	Jul 24 Wednesday
207	11	12	8	29	24	57	37	35	41	12	45	49	36	34	16	21	18	13	11	18	11	5	1	3	547	Jul 25 Thursday
208	12	14	8	28	37	39	46	29	29	40	24	37	29	31	20	34	25	11	13	16	9	9	16	4	560	Jul 26 Friday
209	4	12	10	10	12	7	18	15	36	11	16	27	23	23	10	14	3	8	3	0	6	0	3	5	276	Jul 27 Saturday
210	2	0	10	16	13	5	13	21	11	4	17	7	17	17	11	10	2	7	15	7	6	12	0	5	228	Jul 28 Sunday
211	7	18	14	19	21	41	49	37	29	22	35	36	30	32	27	12	7	8	9	8	14	8	2	5	490	Jul 29 Monday
212	1	6	25	23	23	35	44	27	15	26	27	23	41	17	29	10	19	18	0	15	9	0	5	4	442	Jul 30 Tuesday
213	0	12	14	27	28	50	47	23	35	32	28	55	17	35	22	16	10	20	5	19	3	0	1	3	502	Jul 31 Wednesday
214	2	26	13	14	20	42	54	84	35	23	23	20	25	37	23	15	9	14	10	4	5	4	7	5	514	Aug 01 Thursday
215	10	10	24	21	28	39	32	51	45	43	33	36	37	34	27	18	24	9	10	7	4	7	2	7	558	Aug 02 Friday
216	6	1	17	3	18	1	11	5	10	7	4	21	2	4	9	5	6	6	3	4	8	2	4	4	161	Aug 03 Saturday
217	2	7	13	11	12	22	25	17	34	28	22	26	17	16	21	21	17	10	9	10	2	6	10	27	385	Aug 04 Sunday
218	17	14	34	45	55	58	79	39	30	40	29	38	31	42	31	15	17	22	16	12	4	3	23	8	702	Aug 05 Monday
219	2	8	12	34	40	27	47	36	25	39	26	52	23	37	26	13	25	10	7	6	10	9	4	6	524	Aug 06 Tuesday
220	2	3	19	25	28	28	32	54	35	29	54	31	26	38	18	13	19	13	12	9	5	7	0	12	512	Aug 07 Wednesday
221	9	10	16	31	37	40	31	65	46	22	33	28	20	29	29	18	6	23	18	21	10	12	2	11	567	Aug 08 Thursday
222	20	5	21	22	35	27	50	33	38	42	41	51	34	27	14	21	8	18	23	15	16	14	3	4	582	Aug 09 Friday
223	1	19	3	17	19	16	34	10	46	20	43	15	54	19	26	25	6	25	19	41	17	0	9	4	488	Aug 10 Saturday
224	0	5	4	11	15	10	3	12	17	0	4	11	11	18	15	10	12	9	11	5	2	6	0	3	194	Aug 11 Sunday
225	2	6	18	21	18	44	39	42	41	26	19	37	28	22	15	14	19	17	6	9	0	4	5	4	456	Aug 12 Monday
226	6	3	17	19	18	31	48	35	35	23	54	8	21	40	24	27	17	14	1	13	7	7	7	2	477	Aug 13 Tuesday
227	2	11	24	36	45	35	39	26	30	33	30	46	44	26	21	12	18	18	2	5	7	7	4	3	524	Aug 14 Wednesday
228	0	7	13	21	34	47	42	22	24	33	38	28	23	29	14	22	42	27	12	13	5	0	10	2	508	Aug 15 Thursday
229	6	6	20	13	27	45	47	41	46	54	46	35	52	37	42	18	27	9	5	9	10	7	2	8	612	Aug 16 Friday
230	1	3	13	5	24	19	12	11	50	12	35	28	6	16	6	6	11	9	2	6	3	3	0	2	283	Aug 17 Saturday
231	8	2	10	13	13	10	13	4	20	3	16	23	19	22	9	6	15	3	0	0	0	0	0	0	209	Aug 18 Sunday
232	0	0	0	1	28	36	40	46	50	9	29	40	36	30	31	8	16	13	14	6	1	7	3	0	444	Aug 19 Monday
233	11	8	25	28	34	51	38	41	22	41	44	45	45	25	39	26	16	16	7	5	16	2	6	6	597	Aug 20 Tuesday
234	5	8	23	30	30	56	41	37	53	44	34	47	30	16	43	30	18	13	15	10	3	0	6	3	595	Aug 21 Wednesday
235	3	23	13	26	34	43	44	50	36	16	24	47	40	28	37	14	21	8	17	21	5	4	18	7	579	Aug 22 Thursday
236	2	16	21	25	29	44	36	28	47	29	46	59	42	33	34	24	8	13	14	7	1	9	7	5	579	Aug 23 Friday
237	1	6	10	5	13	7	17	12	10	12	5	4	5	8	20	18	19	16	6	13	16	1	3	12	239	Aug 24 Saturday
238	0	6	7	8	12	4	19	11	17	5	15	4	2	11	9	7	13	7	1	2	7	6	4	2	179	Aug 25 Sunday
239	4	15	26	24	14	51	42	40	45	27	29	38	33	31	39	6	8	19	11	0	8	1	0	1	512	Aug 26 Monday
240	0	3	63	20	13	41	54	42	31	47	28	27	45	28	40	44	35	42	43	31	40	35	17	2	771	Aug 27 Tuesday
241	0	10	50	40	24	35	35	34	45	24	29	46	38	22	28	21	25	17	4	4	10	0	0	8	549	Aug 28 Wednesday
242	5	9	16	29	26	51	40	34	28	38	32	28	37	38	35	38	12	11	18	2	8	2	2	7	546	Aug 29 Thursday
243	1	11	25	24	29	40	38	43	34	45	24	35	34	29	21	14	21	46	47	17	4	7	6	8	603	Aug 30 Friday
244	0	5	16	5	13	5	12	25	14	10	15	11	16	21	19	13	12	3	6	0	7	10	7	0	245	Aug 31 Saturday
245	0	5	8	11	25	7	6	7	21	8	6	9	7	11	9	19	20	9	7	0	3	4	8	6	216	Sep 01 Sunday
246	3	25	7	34	10	35	54	48	55	33	26	29	50	35	26	10	21	19	18	9	4	0	5	11	567	Sep 02 Monday
247	11	21	19	19	25	52	34	22	33	35	23	33	37	25	24	20	26	18	6	19	9	2	3	7	523	Sep 03 Tuesday
248	3	13	14	30	31	47	48	67	59	30	41	46	32	51	40	21	33	28	32	58	62	29	62	72	949	Sep 04 Wednesday
249	57	42	75	96	81	61	60	110	43	46	58	110	31	38	26	22	19	13	6	19	19	10	10	17	1069	Sep 05 Thursday
250	12	19	23	34	13	42	34	49	35	40	43	60	64	40	43	24	36	43	74	47	34	9	30	28	876	Sep 06 Friday
251	23	43	48	32	70	45	25	14	12	16	53	48	38	54	48	54	59	87	60	21	4	8	12	7	881	Sep 07 Saturday
252	7	6	10	8	5	17	21	15	13	10	17	24	7	11	24	14	1	0	0	0	0	0	0	0	210	Sep 08 Sunday
253	0	0	0	0	9	23	42	57	34	19	33	29	28	44	18	15	21	21	15	8	11	6	17	9	459	Sep 09 Monday
254	11	16	18	23	22	29	45	35	32	16	30	25	21	39	22	29	14	12	17	1	9	4	8	4	482	Sep 10 Tuesday
255	6	6	17	33	10	49	39	30	38	32	23	52	31	46	28	21	13	14	17	5	3	1	5	1	520	Sep 11 Wednesday
256	2	3	28	31	35	45	29	22	36	60	23	35	45	25	35	27	21	21	12	14	16	22	11	14	612	Sep 12 Thursday
257	19	28	33	29	38	41	55	36	34	55	31	31	37	38	26	8	32	13	19	10	6	1	3	7	630	Sep 13 Friday
258	1	3	28	11	16	16	25	5	35	9	37	5	25	22	11	27	14	4	2	0	6	5	3	6	316	Sep 14 Saturday
259	0	1	11	3	17	13	12	6	10	7	10	14	14	13	23	25	13	19	8	6	1	4	2	5	237	Sep 15 Sunday

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APA .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
260	6	6	26	33	19	47	47	40	28	37	32	34	20	29	20	15	8	7	8	7	4	3	3	3	482	Sep 16 Monday
261	1	9	27	33	18	33	40	39	45	37	20	38	36	33	25	26	9	16	10	9	1	1	4	6	516	Sep 17 Tuesday
262	5	7	12	42	43	60	89	72	71	59	45	54	41	32	34	18	29	17	20	24	23	25	30	41	893	Sep 18 Wednesday
263	121	117	31	66	43	48	50	42	33	30	53	39	38	30	16	30	15	19	17	12	9	20	4	1	884	Sep 19 Thursday
264	10	9	16	23	28	48	59	42	48	25	45	54	49	33	33	45	23	24	29	29	11	13	10	6	712	Sep 20 Friday
265	4	3	24	17	27	16	19	11	18	29	19	14	14	37	13	9	20	14	7	11	2	7	2	0	337	Sep 21 Saturday
266	3	0	11	4	11	15	12	9	17	15	23	20	18	14	7	32	24	15	6	4	10	7	0	13	290	Sep 22 Sunday
267	3	8	11	18	30	22	35	46	37	29	29	22	22	27	25	29	16	16	14	5	8	1	0	2	455	Sep 23 Monday
268	6	12	11	24	20	31	42	37	47	25	40	44	39	28	45	18	17	7	8	16	4	6	1	1	529	Sep 24 Tuesday
269	6	3	21	20	33	28	57	39	27	23	36	42	39	26	38	33	16	13	18	11	11	13	10	2	565	Sep 25 Wednesday
270	5	4	21	17	25	52	43	41	26	30	35	31	19	38	19	24	16	19	1	1	18	8	3	1	497	Sep 26 Thursday
271	6	8	19	30	14	38	40	49	41	26	32	46	30	43	37	33	21	19	32	31	10	2	3	0	610	Sep 27 Friday
272	8	5	19	11	16	11	25	12	25	19	5	29	26	17	21	11	19	17	4	3	5	1	4	9	322	Sep 28 Saturday
273	3	0	3	7	15	11	49	19	19	14	20	13	14	13	22	23	25	20	10	6	12	7	4	4	333	Sep 29 Sunday
274	9	9	14	26	15	30	30	37	36	41	28	24	38	40	15	28	14	10	7	6	2	4	6	4	473	Sep 30 Monday
APA	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Sum	1193	1811	2909	3214	3706	4948	5310	4833	4765	4188	4536	5062	4416	4192	3410	2892	2684	2357	1787	1631	1321	1006	1028	1053	74252	Total sum
183	7	10	16	18	20	27	29	26	26	23	25	28	24	23	19	16	15	13	10	9	7	5	6	6	406	Total average
124	8	11	18	22	23	34	35	34	31	28	29	34	29	27	21	18	16	14	11	10	8	6	6	6	480	Average workdays
59	4	6	10	9	14	12	16	11	15	12	15	15	14	14	13	12	11	11	7	6	6	5	4	6	246	Average weekends

Table 3.5.5.(Page 4 of 4) Daily and hourly distribution of Apatity array detections. For each day is shown number of detections within each hour of the day, and number of detections for that day. The end statistics give total number of detections distributed for each hour and the total sum of detections during the period. The averages show number of processed days, hourly distribution and average per processed day.

SPI .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 01 Monday
93	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 02 Tuesday
94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 03 Wednesday
95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 04 Thursday
96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 05 Friday
97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 06 Saturday
98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 07 Sunday
99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 08 Monday
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 09 Tuesday
101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 10 Wednesday
102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 11 Thursday
103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 12 Friday
104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 13 Saturday
105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 14 Sunday
106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 15 Monday
107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 16 Tuesday
108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 17 Wednesday
109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 18 Thursday
110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 19 Friday
111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 20 Saturday
112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 21 Sunday
113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 22 Monday
114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 23 Tuesday
115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 24 Wednesday
116	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 25 Thursday
117	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 26 Friday
118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 27 Saturday
119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 28 Sunday
120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 29 Monday
121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 30 Tuesday
122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 01 Wednesday
123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 02 Thursday
124	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 03 Friday
125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 04 Saturday
126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 05 Sunday
127	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 06 Monday
128	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 07 Tuesday
129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 08 Wednesday
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 09 Thursday
131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 10 Friday
132	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 11 Saturday
133	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 12 Sunday
134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 13 Monday
135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 14 Tuesday
136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 15 Wednesday
137	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 16 Thursday
138	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 17 Friday
139	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 18 Saturday
140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 19 Sunday
141	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 20 Monday
142	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 21 Tuesday
143	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 22 Wednesday
144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 23 Thursday
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 24 Friday
146	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 25 Saturday
147	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 26 Sunday

Table 3.5.6 (Page 1 of 4)

SPI .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 27 Monday
149	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 28 Tuesday
150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 29 Wednesday
151	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 30 Thursday
152	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 31 Friday
153	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 01 Saturday
154	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 02 Sunday
155	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 03 Monday
156	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 04 Tuesday
157	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 05 Wednesday
158	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 06 Thursday
159	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 07 Friday
160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 08 Saturday
161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 09 Sunday
162	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 10 Monday
163	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 11 Tuesday
164	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 12 Wednesday
165	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 13 Thursday
166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 14 Friday
167	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 15 Saturday
168	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 16 Sunday
169	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 17 Monday
170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 18 Tuesday
171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 19 Wednesday
172	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 20 Thursday
173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 21 Friday
174	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 22 Saturday
175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 23 Sunday
176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 24 Monday
177	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 25 Tuesday
178	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 26 Wednesday
179	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Jun 27 Thursday
180	0	0	0	0	0	0	0	0	0	0	0	0	0	13	22	31	46	40	0	2	71	39	51	15	330	Jun 28 Friday
181	25	34	38	24	34	18	13	30	37	43	48	36	47	24	37	31	38	30	34	31	27	47	67	19	812	Jun 29 Saturday
182	23	41	22	28	25	26	35	29	43	50	83	26	25	12	10	26	20	19	22	22	20	17	29	40	693	Jun 30 Sunday
183	36	23	19	6	22	24	30	32	59	26	27	12	17	23	21	29	26	23	32	22	25	21	43	31	629	Jul 01 Monday
184	27	19	20	36	34	13	15	43	39	15	24	22	21	16	13	23	14	35	13	24	15	29	26	17	553	Jul 02 Tuesday
185	21	17	15	11	21	28	20	35	21	14	18	18	14	20	13	12	29	19	10	21	3	12	16	19	427	Jul 03 Wednesday
186	19	18	9	14	14	11	19	6	29	21	18	28	20	11	17	26	26	25	17	30	17	26	26	28	475	Jul 04 Thursday
187	28	23	28	25	23	18	17	31	31	29	33	36	38	25	25	14	21	19	23	32	32	22	22	46	641	Jul 05 Friday
188	33	41	21	25	26	34	27	39	25	30	39	32	28	23	38	13	14	29	30	37	45	41	34	36	740	Jul 06 Saturday
189	17	10	32	22	33	22	18	20	21	24	45	33	36	31	16	18	20	28	31	21	16	23	29	20	586	Jul 07 Sunday
190	23	22	98	67	29	23	16	35	33	27	30	46	16	22	28	35	20	39	26	25	27	17	31	24	759	Jul 08 Monday
191	41	31	24	22	24	29	25	19	10	8	15	22	35	28	27	23	28	22	7	8	8	14	10	12	492	Jul 09 Tuesday
192	26	14	11	19	17	25	30	28	28	33	14	21	20	12	18	13	24	26	39	50	41	43	60	60	672	Jul 10 Wednesday
193	67	45	47	36	39	46	33	31	44	46	28	41	18	18	28	47	27	35	39	35	46	40	40	44	920	Jul 11 Thursday
194	31	34	31	39	43	59	62	47	41	42	31	31	30	26	30	26	22	40	21	30	36	22	25	23	822	Jul 12 Friday
195	39	32	50	53	27	45	27	42	54	42	44	51	31	38	47	26	22	12	27	51	23	35	49	62	929	Jul 13 Saturday
196	64	60	50	50	42	52	48	62	63	44	51	55	61	67	78	41	29	26	21	28	40	32	20	33	1117	Jul 14 Sunday
197	27	20	22	37	42	33	36	28	45	35	40	41	26	21	30	38	33	32	36	24	47	42	28	59	822	Jul 15 Monday
198	42	67	105	91	63	44	47	40	37	50	59	65	40	49	56	65	42	44	46	35	42	52	47	44	1272	Jul 16 Tuesday
199	20	29	52	39	33	34	34	39	34	48	38	30	29	18	22	25	28	28	18	37	24	22	29	21	731	Jul 17 Wednesday
200	26	21	39	24	19	30	28	26	34	30	40	43	25	30	23	25	54	42	22	14	31	17	13	23	679	Jul 18 Thursday
201	29	43	30	30	33	25	40	36	42	20	49	34	16	21	22	26	33	27	23	41	37	32	31	14	734	Jul 19 Friday
202	45	40	31	43	30	38	36	65	60	41	33	42	39	23	29	28	18	9	17	13	7	8	9	7	711	Jul 20 Saturday
203	26	25	26	24	24	27	24	11	0	0	0	2	0	0	0	0	0	4	14	19	14	25	29	23	317	Jul 21 Sunday

Table 3.5.6 (Page 2 of 4)

SPI .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
204	24	12	41	35	36	40	36	25	25	4	13	6	33	22	23	10	12	1	16	15	22	15	33	16	515	Jul 22 Monday
205	28	38	50	34	32	32	52	40	36	39	34	35	33	30	28	38	21	34	39	33	28	8	0	0	742	Jul 23 Tuesday
206	0	0	0	0	18	11	25	38	12	34	15	21	18	13	18	21	19	23	20	26	37	29	17	38	453	Jul 24 Wednesday
207	31	41	48	49	50	52	44	50	49	46	18	26	31	37	42	20	20	30	21	15	37	29	21	32	839	Jul 25 Thursday
208	29	30	27	43	39	27	49	46	38	52	23	38	33	37	25	34	40	62	36	43	23	27	34	44	879	Jul 26 Friday
209	9	19	28	30	24	24	34	27	31	33	33	22	39	14	34	28	22	39	34	36	29	35	28	50	702	Jul 27 Saturday
210	51	40	44	43	54	35	51	13	0	0	0	31	23	23	26	30	63	37	46	57	48	45	64	51	875	Jul 28 Sunday
211	46	54	42	60	83	88	49	45	22	26	48	33	27	23	16	36	27	40	29	55	54	34	75	77	1089	Jul 29 Monday
212	88	38	40	29	34	29	48	28	48	32	37	25	49	37	35	31	26	31	43	49	49	37	37	57	957	Jul 30 Tuesday
213	46	33	53	50	76	59	56	77	65	65	57	50	46	51	44	31	36	38	42	46	30	48	46	44	1189	Jul 31 Wednesday
214	55	63	48	43	48	43	55	48	47	49	30	38	18	39	17	37	26	45	65	67	53	65	64	55	1118	Aug 01 Thursday
215	47	51	52	43	60	73	50	64	72	60	61	61	47	40	57	30	42	42	33	34	46	48	51	60	1224	Aug 02 Friday
216	45	50	58	77	67	82	66	67	76	66	51	51	56	35	52	47	44	44	43	29	39	61	84	57	1347	Aug 03 Saturday
217	69	50	63	70	78	69	48	60	70	49	52	30	55	29	48	54	50	56	38	43	33	49	32	37	1232	Aug 04 Sunday
218	53	44	44	53	48	46	50	40	58	28	38	35	50	37	29	38	49	24	48	52	57	47	62	44	1074	Aug 05 Monday
219	39	41	34	43	43	30	39	44	34	32	37	41	39	45	34	29	31	40	14	28	23	2	0	0	742	Aug 06 Tuesday
220	0	0	0	0	0	0	7	3	0	24	30	29	35	41	36	37	64	33	41	25	26	31	56	38	556	Aug 07 Wednesday
221	46	41	38	65	72	57	44	30	47	34	32	30	39	38	36	27	28	44	52	34	38	44	37	45	998	Aug 08 Thursday
222	52	46	46	45	45	46	45	42	36	13	16	27	27	33	44	31	25	32	24	32	29	24	30	19	809	Aug 09 Friday
223	15	31	24	16	33	29	63	29	17	16	28	31	27	32	48	58	55	46	52	71	86	56	59	59	981	Aug 10 Saturday
224	39	44	45	32	38	37	19	21	34	26	34	20	24	17	13	26	35	32	23	45	45	33	54	41	777	Aug 11 Sunday
225	62	35	62	72	45	44	55	61	61	71	58	62	53	50	52	50	49	72	41	43	66	40	53	47	1304	Aug 12 Monday
226	41	48	53	53	43	54	44	47	44	41	55	53	22	27	40	46	32	33	37	47	64	46	53	54	1077	Aug 13 Tuesday
227	28	48	50	36	37	34	39	31	38	33	33	29	31	29	37	36	46	39	57	32	64	39	49	57	952	Aug 14 Wednesday
228	47	44	46	53	49	54	50	44	54	52	37	41	37	50	59	53	65	42	68	56	54	62	57	39	1213	Aug 15 Thursday
229	42	47	51	53	57	53	61	51	53	73	62	39	39	40	40	39	42	24	44	29	43	49	32	34	1097	Aug 16 Friday
230	44	50	40	62	61	40	36	33	36	64	37	38	41	51	48	29	36	34	47	39	50	52	23	44	1035	Aug 17 Saturday
231	23	53	44	36	40	42	38	36	26	45	26	39	35	40	33	34	26	30	35	29	27	44	52	38	871	Aug 18 Sunday
232	38	24	48	43	53	27	24	48	41	49	37	50	59	58	51	35	23	23	28	22	29	29	35	46	920	Aug 19 Monday
233	174	132	142	155	128	99	74	73	55	67	91	75	91	81	90	76	89	90	78	78	94	77	74	76	2259	Aug 20 Tuesday
234	76	57	58	60	52	55	42	59	49	58	42	30	30	39	51	57	42	43	57	70	48	43	71	43	1232	Aug 21 Wednesday
235	55	36	67	41	41	57	54	39	43	59	33	39	46	50	46	36	42	41	37	31	55	35	41	60	1084	Aug 22 Thursday
236	41	66	73	60	48	54	38	31	53	34	46	33	22	40	22	36	31	49	23	42	43	70	104	89	1148	Aug 23 Friday
237	95	61	74	61	98	58	58	58	77	78	65	83	72	63	72	48	59	49	53	61	75	56	35	41	1550	Aug 24 Saturday
238	41	36	38	44	30	9	12	5	25	10	16	11	15	14	11	9	6	11	22	26	28	16	13	11	459	Aug 25 Sunday
239	25	60	36	20	34	51	9	30	27	28	26	22	26	58	33	26	35	53	37	53	31	25	32	30	807	Aug 26 Monday
240	35	51	36	40	51	36	42	36	38	31	30	37	34	52	44	46	61	40	36	51	53	43	29	40	992	Aug 27 Tuesday
241	39	62	58	48	46	66	56	30	51	36	67	26	28	51	33	30	36	43	35	25	21	25	44	20	976	Aug 28 Wednesday
242	26	22	29	33	37	39	43	39	45	45	40	16	31	30	34	20	30	35	18	27	22	31	49	43	784	Aug 29 Thursday
243	36	46	34	49	59	68	40	55	44	58	48	47	46	31	42	52	56	62	48	40	59	62	53	40	1175	Aug 30 Friday
244	48	39	37	43	28	55	44	59	55	60	61	58	32	39	40	51	57	34	41	51	34	31	36	48	1081	Aug 31 Saturday
245	35	24	20	34	32	34	31	21	23	16	17	8	30	27	34	18	18	24	22	22	14	27	38	19	588	Sep 01 Sunday
246	46	64	54	54	43	55	32	45	53	38	41	45	53	57	63	37	19	32	41	56	30	40	31	33	1062	Sep 02 Monday
247	50	44	51	42	48	48	43	47	42	39	46	31	41	48	27	38	40	54	52	40	45	32	43	38	1029	Sep 03 Tuesday
248	49	33	49	40	47	32	37	33	34	48	39	31	46	29	40	49	57	56	29	46	22	63	30	41	980	Sep 04 Wednesday
249	38	52	46	51	55	45	59	58	52	33	61	33	38	33	31	35	36	24	26	33	31	20	9	12	911	Sep 05 Thursday
250	5	7	1	5	13	10	19	22	21	18	22	21	19	31	19	23	17	16	1	6	4	7	16	53	376	Sep 06 Friday
251	69	58	54	71	75	86	76	87	62	71	61	40	27	17	27	22	16	18	21	16	35	30	23	35	1097	Sep 07 Saturday
252	31	34	35	27	37	37	29	37	34	21	35	21	16	19	32	25	13	30	23	24	42	10	19	23	654	Sep 08 Sunday
253	35	28	41	41	36	25	27	62	30	31	28	32	44	38	37	35	42	33	43	36	59	59	86	83	1011	Sep 09 Monday
254	123	118	106	121	77	36	35	41	24	26	22	39	41	33	33	29	31	29	36	23	21	28	25	30	1127	Sep 10 Tuesday
255	38	37	27	53	26	14	19	26	17	36	35	29	36	36	21	27	45	38	58	34	42	47	53	36	830	Sep 11 Wednesday
256	72	84	44	87	64	38	49	60	53	68	47	33	29	32	44	48	47	49	59	46	36	65	36	44	1234	Sep 12 Thursday
257	43	41	43	53	52	33	31	28	37	57	52	32	42	50	52	48	34	52	59	39	28	52	40	23	1021	Sep 13 Friday
258	36	30	34	25	9	23	26	19	16	22	8	8	14	16	11	22	31	12	15	25	5	25	9	13	454	Sep 14 Saturday
259	12	14	23	13	30	17	20	39	30	30	21	23	25	36	38	26	48	47	52	39	45	42	50	40	760	Sep 15 Sunday

Table 3.5.6 (Page 3 of 4)

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SPI .FKX Hourly distribution of detections

Day  00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23  Sum Date

260  74 97 68 48 31 44 52 52 51 57 38 36 64 67 50 49 46 59 53 50 67 63 56 47 1319 Sep 16 Monday
261  27120255117 35 39 38 26 34 30 29 29 51 42 27 32 34 35 44 36 46 37 34 40 1237 Sep 17 Tuesday
262  43 34 35 51 31 39 23 39 25 43 30 24 36 55 61 49 38 50 60 41 39 58 32 74 1010 Sep 18 Wednesday
263  71 51 29 55 35 18  5  0  4 11  8  3  7 10 21 21 31 36 22 25 17 46 41 33  600 Sep 19 Thursday
264  39 42 36 35 30 44 48 43 68 46 36 33 47 28 29 45 50 72 47154127 77 51 28 1255 Sep 20 Friday
265  46 52 60 54 52 46 17 51 38 43 33 33 41 31 41 48 52 47 36 40 42 71 67 51 1092 Sep 21 Saturday
266  56 45 62 52 80 59 73 44 71 48 55 72 69 54 48 63 46 69112165118 75 60 71 1667 Sep 22 Sunday
267  64 57 51 73 74 70 94 42 57 43 71102 27 38 58 51 40 68 33 29 26 14 21 23 1226 Sep 23 Monday
268  25 42 23 52 47 51 67 27 53 36 41 48 50 59 49 55 50 35 49 25 34 44 63 61 1086 Sep 24 Tuesday
269  52 48 56 69 41 25 67 56 57 44 36 67 40 65 47117 43 41 43 34 64 68 46 56 1282 Sep 25 Wednesday
270  57 60 67 69 52 64 43 58 26 42 57 30 49 55 69105 74 51 67 58 85 62 39 92 1431 Sep 26 Thursday
271  53 44 37 61 36 52 31 31 27 16 16 27 23 28 34 41 25 19 18 29 55 29 39 35  806 Sep 27 Friday
272  26 42 48 51 52 67 63 44 31 62 32 55 71 73 57 41 74 56 48 71 68 76 35 47 1290 Sep 28 Saturday
273  60 36 50 66 39 63 84 51 49 50 57 45 73 41 56 52 49 44 48 54 64 61 75 51 1318 Sep 29 Sunday
274  45 41 45 41 47 65 45 55 38 57 40 48 50 26 30 32 36 21 67 65 49 44 55 34 1076 Sep 30 Monday

SPI  00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23

Sum    3981  4316  3914  3746  3643  3381  3334  3442  3503  3709  3697  3756
    3990  4287  4058  3781  3745  3543  3394  3438  3429  3463  3853  3811   89214 Total sum

 95  42 42 45 45 43 41 40 39 39 38 37 36 36 35 36 36 36 37 36 39 41 39 40 40  939 Total average

 67  43 43 47 47 42 40 39 39 39 38 37 35 35 36 36 37 37 38 37 38 41 38 40 40  941 Average workdays

 28  40 39 41 42 43 42 40 39 39 39 38 36 38 32 37 33 34 33 36 42 40 40 40 38  919 Average weekends
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Table 3.5.6. (Page 4 of 4) Daily and hourly distribution of Spitsbergen array detections. For each day is shown number of detections within each hour of the day, and number of detections for that day. The end statistics give total number of detections distributed for each hour and the total sum of detections during the period. The averages show number of processed days, hourly distribution and average per processed day.

HFS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
92	14	9	12	21	11	7	4	5	6	5	4	10	10	14	25	13	5	6	19	15	22	36	24	34	331	Apr 01 Monday
93	24	27	15	36	17	5	7	12	15	10	15	21	16	9	22	6	3	7	5	28	23	22	21	30	396	Apr 02 Tuesday
94	29	25	24	32	29	12	8	7	11	20	59	64	32	26	19	5	13	8	1	2	12	13	12	27	490	Apr 03 Wednesday
95	36	45	39	41	21	6	4	14	11	10	9	22	12	9	16	10	10	17	4	4	2	2	3	20	367	Apr 04 Thursday
96	25	40	70	67	76	47	23	16	17	20	18	11	18	25	7	5	6	14	9	5	9	15	24	43	610	Apr 05 Friday
97	46	86	87	111	114	56	8	18	5	16	14	30	12	14	3	11	2	8	5	4	4	12	11	12	689	Apr 06 Saturday
98	31	49	20	14	10	6	20	8	14	5	9	14	7	10	25	12	9	8	5	13	6	4	5	16	320	Apr 07 Sunday
99	10	18	13	7	11	4	10	8	4	4	14	28	6	14	13	4	7	12	15	0	4	8	6	13	233	Apr 08 Monday
100	18	9	27	15	9	11	6	4	4	4	6	22	5	17	7	7	4	9	3	3	2	3	5	5	205	Apr 09 Tuesday
101	1	1	15	2	5	4	7	6	8	5	3	10	17	17	17	13	7	5	2	4	19	33	60	48	309	Apr 10 Wednesday
102	34	78	87	95	79	48	2	5	14	15	10	12	15	13	6	15	5	46	58	86	100	108	129	116	1176	Apr 11 Thursday
103	141	154	154	170	129	52	15	7	7	16	15	14	28	27	15	24	8	8	7	9	27	45	88	126	1286	Apr 12 Friday
104	135	160	155	159	146	111	24	11	4	11	14	9	11	13	5	20	14	14	9	17	16	21	18	48	1145	Apr 13 Saturday
105	75	115	109	149	155	122	39	28	19	7	16	17	18	12	11	13	8	3	6	15	2	13	18	26	996	Apr 14 Sunday
106	67	116	117	128	118	36	23	6	1	13	9	8	16	17	12	6	5	12	10	1	10	7	8	7	753	Apr 15 Monday
107	28	48	71	64	49	9	6	2	5	10	24	13	7	9	23	5	18	8	9	21	5	15	10	5	464	Apr 16 Tuesday
108	15	1	9	7	9	3	5	3	2	11	12	45	22	17	24	8	15	2	4	3	3	4	6	4	234	Apr 17 Wednesday
109	8	13	14	19	12	1	10	4	22	8	10	25	11	5	4	2	7	11	6	5	3	1	14	8	223	Apr 18 Thursday
110	9	6	26	12	3	5	2	3	1	19	10	17	25	35	10	10	12	3	12	7	6	3	6	2	244	Apr 19 Friday
111	6	3	6	9	11	4	7	7	6	21	8	11	12	11	6	11	21	1	17	16	29	12	24	27	286	Apr 20 Saturday
112	31	16	25	21	18	9	21	21	17	9	14	20	9	8	11	10	18	5	20	12	3	3	8	3	332	Apr 21 Sunday
113	6	5	5	6	9	3	6	3	5	15	8	17	9	13	11	12	8	1	4	1	9	4	4	4	168	Apr 22 Monday
114	11	8	4	5	4	3	1	3	3	4	1	6	9	29	3	0	4	8	1	3	6	0	6	7	129	Apr 23 Tuesday
115	2	4	4	5	3	7	4	5	6	26	6	10	17	27	6	6	17	8	1	4	2	4	4	1	179	Apr 24 Wednesday
116	4	0	11	4	1	6	6	2	1	0	7	4	14	13	6	3	9	3	17	7	5	7	8	5	143	Apr 25 Thursday
117	2	9	2	3	1	6	5	8	2	6	21	4	10	3	22	9	13	10	11	7	16	16	14	9	209	Apr 26 Friday
118	19	10	13	25	5	9	6	17	9	7	5	5	12	6	5	7	10	7	10	2	4	8	6	2	209	Apr 27 Saturday
119	7	3	9	8	2	14	4	8	8	4	9	5	3	2	10	2	7	4	5	5	3	6	2	4	134	Apr 28 Sunday
120	2	2	9	2	2	4	1	9	1	2	9	9	11	6	25	16	8	4	9	3	5	2	6	6	153	Apr 29 Monday
121	2	1	5	2	4	5	3	1	0	14	9	34	8	19	4	9	1	6	1	4	6	4	9	6	157	Apr 30 Tuesday
122	5	6	8	19	10	6	4	13	7	9	11	8	6	6	20	1	11	9	7	12	7	0	6	1	192	May 01 Wednesday
123	10	4	4	1	5	16	13	1	2	3	2	22	19	24	16	9	17	8	13	3	3	5	7	2	209	May 02 Thursday
124	5	8	11	11	4	13	5	5	8	19	4	6	13	27	37	8	7	4	10	1	4	5	10	10	235	May 03 Friday
125	3	4	4	6	10	0	2	7	8	10	3	9	4	3	6	6	12	8	12	6	3	4	13	14	157	May 04 Saturday
126	17	3	5	8	6	3	4	5	35	10	12	33	6	9	19	6	7	2	16	11	12	8	20	9	266	May 05 Sunday
127	17	5	10	7	1	5	7	9	5	9	18	17	4	10	5	1	6	3	40	13	14	2	4	5	217	May 06 Monday
128	4	2	5	6	6	6	9	3	9	9	5	1	11	19	12	6	5	1	9	3	13	4	13	7	168	May 07 Tuesday
129	4	5	10	3	1	6	1	8	7	7	7	35	52	27	12	1	11	2	1	2	5	3	3	4	217	May 08 Wednesday
130	3	4	4	13	17	12	3	12	2	3	17	12	11	8	17	9	7	22	26	5	7	7	2	2	225	May 09 Thursday
131	11	8	5	7	7	2	2	1	6	5	1	3	5	10	4	10	1	3	4	10	3	7	4	8	127	May 10 Friday
132	4	4	4	3	18	15	6	6	11	1	13	6	3	18	22	23	8	7	16	15	6	8	6	15	238	May 11 Saturday
133	10	6	26	18	12	14	7	12	8	7	9	15	12	5	3	12	8	4	4	6	4	9	6	9	226	May 12 Sunday
134	2	5	8	5	7	5	1	0	8	2	5	3	10	8	0	5	2	2	2	6	2	2	1	6	97	May 13 Monday
135	7	3	4	2	1	2	0	3	4	1	3	17	24	9	4	12	7	8	0	16	3	7	3	6	146	May 14 Tuesday
136	6	2	5	3	2	4	3	2	3	15	11	7	11	14	19	3	5	2	4	4	3	1	1	5	135	May 15 Wednesday
137	2	3	4	7	3	5	2	3	7	4	14	3	2	11	2	10	3	8	2	4	2	11	2	7	121	May 16 Thursday
138	6	1	5	10	4	3	2	4	6	3	19	9	7	1	0	9	1	9	5	1	6	0	1	4	116	May 17 Friday
139	7	5	4	8	2	6	2	2	6	2	8	3	7	4	5	0	3	4	8	8	6	10	3	5	118	May 18 Saturday
140	0	9	2	13	6	5	5	9	6	2	7	7	9	7	17	2	11	4	5	3	8	9	2	3	151	May 19 Sunday
141	2	6	6	6	5	6	2	1	11	2	6	4	6	1	5	2	8	9	1	1	3	3	10	1	107	May 20 Monday
142	2	5	4	5	9	4	2	34	3	2	14	4	14	5	17	6	2	5	1	4	11	11	5	11	180	May 21 Tuesday
143	8	3	3	5	0	5	3	1	0	0	5	8	2	14	21	20	13	2	5	6	13	5	7	5	154	May 22 Wednesday
144	1	6	7	5	3	1	3	11	17	19	4	12	17	8	13	5	5	10	9	3	1	1	9	8	178	May 23 Thursday
145	2	1	2	2	1	3	10	16	2	16	5	0	16	4	6	5	5	1	5	2	1	5	2	6	118	May 24 Friday
146	6	3	0	2	2	2	15	11	6	11	11	11	13	3	8	9	6	8	5	5	11	9	2	1	160	May 25 Saturday
147	0	5	14	0	7	7	16	9	7	9	20	5	5	8	12	12	12	5	10	10	5	9	1	4	192	May 26 Sunday

Table 3.5.7 (Page 1 of 4)

HFS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
148	9	8	7	4	6	7	4	6	8	14	6	8	8	2	26	11	7	0	5	2	6	3	3	8	168	May 27 Monday
149	3	13	3	4	4	3	2	2	9	2	8	5	9	7	8	3	8	8	13	17	7	4	6	13	161	May 28 Tuesday
150	1	12	1	5	4	16	3	5	2	5	9	7	5	23	8	11	6	11	2	7	2	3	3	1	152	May 29 Wednesday
151	1	2	1	11	4	2	6	5	7	3	26	8	14	10	10	6	6	0	16	6	2	1	0	1	148	May 30 Thursday
152	4	5	5	2	6	0	3	2	6	18	2	16	11	7	2	5	5	3	2	5	2	2	1	5	119	May 31 Friday
153	3	3	1	4	1	0	2	5	4	6	2	5	12	10	12	5	10	8	17	9	6	4	2	1	132	Jun 01 Saturday
154	3	2	17	6	7	3	2	6	6	8	2	1	13	8	4	4	6	7	2	2	3	8	3	2	125	Jun 02 Sunday
155	9	16	3	2	7	1	2	1	7	3	8	16	17	10	13	32	10	9	12	3	3	3	0	5	192	Jun 03 Monday
156	4	3	5	8	10	7	2	3	15	2	8	10	10	6	13	2	5	5	5	7	6	2	2	8	148	Jun 04 Tuesday
157	5	4	1	0	11	3	2	3	4	20	12	17	16	19	51	12	3	4	3	15	0	1	2	7	215	Jun 05 Wednesday
158	7	3	4	3	2	2	19	0	12	2	7	13	13	21	10	9	16	4	7	5	13	5	4	8	189	Jun 06 Thursday
159	1	1	5	6	1	26	20	19	29	42	50	28	21	22	16	3	1	1	2	2	2	2	3	10	313	Jun 07 Friday
160	0	3	11	8	12	10	12	10	36	72	64	28	35	12	8	3	10	7	5	4	6	5	11	10	382	Jun 08 Saturday
161	4	13	14	13	10	9	9	9	17	15	15	13	13	12	7	8	10	8	9	5	6	5	2	13	239	Jun 09 Sunday
162	4	22	2	2	65	34	15	13	19	24	23	23	10	29	18	25	19	31	12	11	6	5	5	9	426	Jun 10 Monday
163	10	7	3	4	6	8	7	13	4	9	20	17	18	13	18	17	8	14	20	6	7	13	3	4	249	Jun 11 Tuesday
164	6	4	6	9	9	2	1	3	7	16	10	9	6	12	26	12	2	9	4	2	8	5	7	8	183	Jun 12 Wednesday
165	18	2	6	4	3	6	1	8	3	1	6	10	18	4	7	5	4	6	5	7	2	1	5	3	135	Jun 13 Thursday
166	2	0	1	2	5	3	3	5	9	14	8	4	4	17	12	23	7	9	11	6	1	7	14	13	180	Jun 14 Friday
167	5	5	4	0	13	3	11	6	13	5	10	10	14	4	9	12	10	10	9	10	8	7	6	15	199	Jun 15 Saturday
168	23	10	17	13	8	3	4	16	4	10	5	8	14	15	9	11	14	8	6	18	15	8	5	3	247	Jun 16 Sunday
169	6	9	12	7	4	2	1	1	0	4	13	48	13	2	16	16	14	14	8	6	2	10	9	2	219	Jun 17 Monday
170	3	8	10	2	0	2	11	6	6	5	8	3	16	14	31	6	5	11	4	7	8	6	4	3	179	Jun 18 Tuesday
171	7	6	8	2	1	5	4	3	11	6	5	11	9	23	7	11	12	3	3	1	5	9	4	2	158	Jun 19 Wednesday
172	1	3	4	1	2	3	6	5	8	19	9	11	9	16	17	10	5	3	3	6	14	10	9	4	178	Jun 20 Thursday
173	10	4	1	11	3	2	4	2	4	11	13	24	19	16	35	12	13	13	18	22	16	20	9	16	298	Jun 21 Friday
174	9	12	8	13	11	1	9	4	2	6	15	21	17	12	6	30	12	20	16	21	12	17	11	10	295	Jun 22 Saturday
175	5	41	29	31	10	9	10	12	15	13	10	33	43	25	27	40	23	14	17	17	28	13	11	34	510	Jun 23 Sunday
176	19	9	6	14	3	8	10	4	5	5	6	14	1	8	24	18	5	7	5	5	4	12	10	1	203	Jun 24 Monday
177	12	3	17	17	3	7	4	15	3	9	20	10	13	17	23	2	11	10	7	11	24	10	10	2	260	Jun 25 Tuesday
178	7	4	19	13	13	5	16	9	12	5	12	14	16	13	26	23	10	12	45	15	12	6	4	0	311	Jun 26 Wednesday
179	4	2	0	2	1	5	7	7	14	12	18	12	15	15	16	9	15	7	2	5	5	6	5	0	184	Jun 27 Thursday
180	2	1	2	9	17	12	20	10	21	8	13	3	17	2	12	6	9	10	2	1	14	9	11	4	215	Jun 28 Friday
181	2	10	5	5	7	3	14	7	23	8	5	11	9	4	3	7	9	12	10	6	7	7	0	7	181	Jun 29 Saturday
182	10	12	4	10	10	1	3	6	16	17	9	19	26	8	9	17	7	18	11	12	7	9	4	14	259	Jun 30 Sunday
183	8	11	9	6	7	4	10	17	6	5	12	4	17	12	19	4	3	4	10	3	6	9	11	6	203	Jul 01 Monday
184	7	8	4	9	4	1	1	13	4	6	6	13	15	12	12	14	11	4	5	5	18	2	4	4	182	Jul 02 Tuesday
185	2	6	5	3	2	1	13	7	8	4	10	32	7	17	10	27	5	8	4	12	12	3	2	1	201	Jul 03 Wednesday
186	0	2	3	5	1	2	0	7	10	9	7	9	17	9	10	14	9	9	6	1	5	4	9	14	162	Jul 04 Thursday
187	4	8	9	0	5	3	6	5	18	10	20	21	13	10	22	5	14	8	7	19	9	5	3	10	234	Jul 05 Friday
188	1	2	2	4	2	13	5	10	10	25	13	11	13	17	20	10	14	12	22	20	14	27	7	3	277	Jul 06 Saturday
189	3	7	2	8	7	5	6	8	3	8	15	18	18	17	18	11	21	22	20	12	9	12	4	2	256	Jul 07 Sunday
190	8	10	4	3	9	2	3	4	1	3	2	13	9	10	7	15	4	15	6	9	9	17	3	7	173	Jul 08 Monday
191	12	9	5	8	9	8	9	4	14	7	7	15	23	20	6	11	3	23	13	7	4	7	9	5	238	Jul 09 Tuesday
192	12	9	7	6	12	11	8	6	6	7	5	43	6	11	19	10	7	10	18	14	2	2	5	2	238	Jul 10 Wednesday
193	2	5	4	3	5	2	29	18	23	8	10	9	13	8	18	3	8	8	25	6	8	6	9	1	231	Jul 11 Thursday
194	4	3	7	12	6	9	9	12	0	12	17	7	19	18	13	14	17	9	11	21	8	18	7	3	256	Jul 12 Friday
195	6	10	9	3	5	13	2	10	30	25	23	16	16	7	17	9	5	5	10	17	11	5	16	2	272	Jul 13 Saturday
196	10	3	6	3	4	10	2	14	5	20	10	5	15	14	9	17	22	16	11	19	6	5	7	9	242	Jul 14 Sunday
197	12	5	17	1	28	13	7	4	6	3	6	9	7	8	7	4	15	27	10	14	11	13	7	2	236	Jul 15 Monday
198	9	14	6	19	15	11	12	3	11	13	12	3	4	10	4	11	16	10	19	17	7	3	8	2	239	Jul 16 Tuesday
199	6	11	8	4	7	10	14	17	3	9	12	11	5	2	17	9	17	16	13	9	11	9	12	3	235	Jul 17 Wednesday
200	4	9	2	3	5	2	2	4	1	15	12	11	10	9	17	3	11	11	8	7	5	16	1	13	181	Jul 18 Thursday
201	4	7	10	7	10	3	12	5	9	4	12	9	14	14	15	18	22	17	10	26	7	7	2	2	246	Jul 19 Friday
202	15	16	13	17	15	6	14	23	21	33	24	32	22	16	6	17	23	19	27	16	9	13	19	4	420	Jul 20 Saturday
203	16	10	13	3	9	8	13	6	15	22	12	25	17	10	31	40	24	41	18	5	20	11	1	10	380	Jul 21 Sunday

Table 3.5.7 (Page 2 of 4)

HFS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
204	7	19	7	5	15	10	8	9	15	10	11	8	8	16	29	17	26	7	21	15	6	15	4	7	295	Jul 22 Monday
205	2	9	3	16	13	26	23	3	4	16	13	18	20	11	6	4	4	15	21	10	11	13	27	10	298	Jul 23 Tuesday
206	9	13	8	10	19	7	15	7	17	5	19	24	24	10	15	19	17	16	9	14	14	12	3	3	309	Jul 24 Wednesday
207	9	10	10	17	12	10	8	5	20	8	5	10	9	53	58	31	12	19	44	98	51	7	3	21	530	Jul 25 Thursday
208	4	5	4	5	2	10	10	6	17	15	7	23	45	38	21	29	17	19	14	12	14	7	20	40	384	Jul 26 Friday
209	8	3	4	4	8	7	8	8	16	8	23	26	18	10	14	15	25	19	9	17	14	11	20	9	304	Jul 27 Saturday
210	6	10	1	5	5	9	3	22	13	19	21	21	11	7	11	13	20	12	13	3	16	5	1	5	252	Jul 28 Sunday
211	6	6	6	5	6	11	2	7	2	15	3	33	9	30	5	5	5	14	9	5	16	8	3	3	214	Jul 29 Monday
212	4	6	7	9	12	4	12	5	7	13	15	29	22	20	34	19	7	10	7	6	8	13	6	9	284	Jul 30 Tuesday
213	15	4	11	9	5	12	5	10	14	18	8	20	15	14	40	17	10	14	14	8	6	7	16	10	302	Jul 31 Wednesday
214	4	11	5	7	5	6	2	3	17	15	3	18	11	8	20	10	5	10	11	6	10	2	14	5	208	Aug 01 Thursday
215	4	5	8	6	9	2	12	4	4	24	4	12	9	31	16	20	23	81	66	1	9	8	6	7	371	Aug 02 Friday
216	8	4	10	15	13	11	3	17	5	15	12	13	16	5	17	16	9	12	6	8	4	10	14	5	248	Aug 03 Saturday
217	18	11	17	11	17	7	7	12	13	16	21	16	10	12	15	12	14	21	10	19	13	7	10	5	314	Aug 04 Sunday
218	13	9	17	3	12	2	2	0	15	5	4	9	9	18	16	8	17	13	3	8	5	8	14	22	232	Aug 05 Monday
219	11	7	8	4	2	3	4	1	7	4	12	22	35	9	5	14	14	14	6	0	10	11	3	6	212	Aug 06 Tuesday
220	2	9	6	4	2	3	1	1	7	11	7	7	11	20	9	9	11	7	8	4	3	5	4	10	161	Aug 07 Wednesday
221	5	7	8	7	1	9	7	8	4	9	13	10	13	7	18	16	5	12	9	6	5	2	5	10	196	Aug 08 Thursday
222	21	4	4	8	6	8	11	6	12	24	16	6	9	12	9	27	26	12	12	12	12	5	1	9	272	Aug 09 Friday
223	2	4	9	8	14	17	14	21	15	12	16	19	17	10	10	22	20	12	18	17	26	22	24	30	379	Aug 10 Saturday
224	20	16	19	14	25	25	20	34	22	30	11	20	23	17	17	34	19	20	10	5	2	8	7	11	429	Aug 11 Sunday
225	10	9	3	3	2	1	3	7	2	5	12	6	7	13	13	18	9	25	4	11	7	3	6	4	183	Aug 12 Monday
226	16	7	9	4	7	3	13	7	5	12	37	15	36	28	43	50	45	19	31	39	17	8	9	4	464	Aug 13 Tuesday
227	5	8	51	39	40	18	19	22	28	36	34	37	31	44	47	60	80	47	34	43	7	6	1	10	747	Aug 14 Wednesday
228	5	7	7	46	32	27	46	37	13	10	3	12	7	5	20	10	19	9	13	17	12	3	9	11	380	Aug 15 Thursday
229	5	11	5	6	8	1	7	0	7	15	9	27	16	13	9	12	13	24	18	19	7	6	6	5	249	Aug 16 Friday
230	5	24	11	3	9	14	10	11	5	25	16	34	16	12	12	8	10	6	19	7	13	16	19	14	319	Aug 17 Saturday
231	18	6	33	3	8	25	10	12	12	15	8	15	12	24	18	10	16	7	18	9	6	6	3	6	300	Aug 18 Sunday
232	3	8	6	8	12	4	9	5	6	2	11	25	40	18	8	8	1	3	4	10	4	3	10	3	211	Aug 19 Monday
233	10	11	2	13	7	3	4	4	5	16	8	17	30	8	18	17	13	17	3	3	5	5	7	14	240	Aug 20 Tuesday
234	4	4	6	4	3	1	2	11	4	13	9	15	14	22	14	5	9	3	7	4	1	4	8	3	170	Aug 21 Wednesday
235	2	8	6	5	14	10	11	16	15	16	4	13	12	35	18	6	17	14	11	8	10	12	17	11	291	Aug 22 Thursday
236	10	8	7	1	9	9	18	4	10	16	8	10	11	9	22	9	8	21	4	10	4	6	8	6	228	Aug 23 Friday
237	6	5	8	4	10	7	4	11	13	16	7	5	12	16	4	12	6	23	23	19	18	14	13	20	276	Aug 24 Saturday
238	30	14	21	11	9	13	5	22	7	10	8	7	15	11	12	10	7	17	11	6	6	9	2	0	263	Aug 25 Sunday
239	4	3	7	9	8	6	6	5	3	5	11	5	9	16	11	3	14	4	6	7	4	11	4	3	164	Aug 26 Monday
240	7	12	7	6	5	6	12	9	8	9	8	37	10	16	25	17	10	10	7	4	1	3	2	2	233	Aug 27 Tuesday
241	0	5	8	7	5	2	9	12	4	10	20	14	36	19	15	6	6	12	10	5	4	5	8	5	227	Aug 28 Wednesday
242	8	1	6	1	1	6	13	5	5	8	3	5	10	14	12	14	4	6	7	7	3	5	5	7	156	Aug 29 Thursday
243	2	7	9	2	3	2	1	4	5	17	5	15	11	6	13	3	14	6	8	7	1	8	11	11	171	Aug 30 Friday
244	2	4	6	4	12	13	11	8	11	37	27	11	14	16	3	7	10	3	17	5	7	9	10	5	252	Aug 31 Saturday
245	15	6	8	8	17	3	9	17	11	16	10	11	16	10	16	12	7	21	18	1	2	5	6	5	250	Sep 01 Sunday
246	1	4	8	3	7	3	2	9	8	5	20	14	15	9	10	20	1	3	4	9	5	0	5	3	168	Sep 02 Monday
247	4	0	0	4	9	3	5	3	11	9	27	15	14	10	14	5	19	8	3	2	3	4	2	3	177	Sep 03 Tuesday
248	14	5	4	21	20	14	48	19	14	7	12	11	15	28	20	21	15	10	16	9	7	0	4	3	337	Sep 04 Wednesday
249	4	3	30	7	2	4	2	1	16	4	5	24	3	19	19	5	9	15	20	8	16	11	8	14	249	Sep 05 Thursday
250	22	20	44	17	9	5	12	15	17	13	9	22	36	25	17	13	3	9	13	68	113	114	117	140	873	Sep 06 Friday
251	80	1	6	10	15	11	4	6	12	13	14	13	13	9	2	14	7	9	14	7	12	10	11	10	303	Sep 07 Saturday
252	5	8	9	5	7	8	3	4	25	7	5	19	12	6	1	6	14	11	8	10	9	8	6	5	201	Sep 08 Sunday
253	10	4	5	8	8	7	3	7	10	7	8	9	13	11	1	3	9	11	8	5	0	2	4	1	154	Sep 09 Monday
254	0	2	1	3	4	4	7	2	20	10	13	34	21	15	14	4	11	1	2	1	3	4	4	4	184	Sep 10 Tuesday
255	7	2	13	21	11	10	9	4	9	5	2	11	10	22	16	7	3	5	8	6	5	1	1	7	195	Sep 11 Wednesday
256	9	7	8	7	5	10	3	0	12	17	4	11	14	19	14	6	4	3	9	4	4	8	6	3	187	Sep 12 Thursday
257	6	9	4	15	4	10	3	4	19	11	6	2	10	22	9	11	2	5	5	7	1	8	3	7	183	Sep 13 Friday
258	13	3	14	11	10	9	9	7	12	5	8	5	7	20	16	5	11	10	17	12	5	6	7	2	224	Sep 14 Saturday
259	3	3	10	11	5	5	11	14	10	7	14	7	7	9	5	9	12	9	13	3	13	11	5	4	200	Sep 15 Sunday

Table 3.5.7 (Page 3 of 4)

HFS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
260	4	11	9	4	15	3	11	4	6	8	11	15	25	21	26	18	9	18	11	3	8	10	7	3	260	Sep 16 Monday
261	6	4	4	3	5	13	12	3	4	14	6	6	13	27	7	20	13	3	4	2	3	1	5	12	190	Sep 17 Tuesday
262	7	1	4	8	8	7	10	7	20	12	16	11	15	14	9	13	3	21	11	1	2	2	4	5	211	Sep 18 Wednesday
263	0	2	4	0	13	7	2	3	10	2	8	25	14	24	17	9	13	2	2	2	2	14	4	2	181	Sep 19 Thursday
264	14	2	8	3	18	7	4	8	3	9	15	16	21	20	12	11	16	14	16	27	12	10	18	6	290	Sep 20 Friday
265	11	17	11	21	8	10	3	5	10	4	7	10	19	7	3	8	10	23	7	8	3	8	12	7	232	Sep 21 Saturday
266	9	7	10	2	2	4	5	8	10	12	10	14	10	9	15	4	7	13	5	6	6	2	3	1	174	Sep 22 Sunday
267	1	4	3	3	6	4	2	8	27	10	9	17	17	18	6	13	6	9	15	8	0	4	1	1	192	Sep 23 Monday
268	9	4	4	5	11	2	9	7	7	4	8	43	26	25	20	8	7	4	9	20	3	7	2	0	244	Sep 24 Tuesday
269	3	2	10	12	8	3	2	13	11	4	9	25	17	11	24	23	8	10	5	13	4	5	2	0	224	Sep 25 Wednesday
270	1	4	3	5	11	5	7	5	4	9	8	2	12	7	1	3	12	6	2	1	3	3	0	2	116	Sep 26 Thursday
271	7	1	7	3	8	3	5	3	11	7	3	19	21	5	14	3	9	5	2	4	0	4	4	8	156	Sep 27 Friday
272	6	1	9	8	3	8	5	11	8	7	1	13	15	6	12	14	6	9	10	8	5	8	7	7	187	Sep 28 Saturday
273	2	2	2	4	8	9	17	7	3	8	18	10	30	6	5	2	1	4	9	8	3	7	3	6	174	Sep 29 Sunday
274	11	5	3	5	1	7	4	4	12	6	4	25	12	9	6	6	5	11	1	6	4	2	3	1	153	Sep 30 Monday
HFS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Sum	2002	2124	2398	2421	2366	1730	1500	1515	1792	2039	2125	2767	2677	2573	2620	2132	1950	1972	1974	1831	1668	1654	1703	1866	49399	Total sum
183	11	12	13	13	13	9	8	8	10	11	12	15	15	14	14	12	11	11	11	10	9	9	9	10	270	Total average
124	9	9	11	11	11	7	8	7	9	10	11	15	15	16	16	11	10	10	10	10	9	9	10	10	253	Average workdays
59	15	15	17	17	17	13	9	11	12	13	13	14	13	10	11	12	11	11	11	9	9	9	8	10	290	Average weekends

Table 3.5.7. (Page 4 of 4) Daily and hourly distribution of Hagfors array detections. For each day is shown number of detections within each hour of the day, and number of detections for that day. The end statistics give total number of detections distributed for each hour and the total sum of detections during the period. The averages show number of processed days, hourly distribution and average per processed day

3.6 Regional Monitoring System operation

The Regional Monitoring System (RMS) was installed at NORSAR in December 1989 and was operated at NORSAR from 1 January 1990 for automatic processing of data from ARCESS and NORESS. A second version of RMS that accepts data from an arbitrary number of arrays and single 3-component stations was installed at NORSAR in October 1991, and regular operation of the system comprising analysis of data from the 4 arrays ARCESS, NORESS, FINESS and GERESS started on 15 October 1991. As opposed to the first version of RMS, the one in current operation also has the capability of locating events at teleseismic distance.

Data from the Apatity array were included on 14 December 1992, and from the Spitsbergen array on 12 January 1994. Detections from the Hagfors array were available to the analysts and could be added manually during analysis from 6 December 1994. After 2 February 1995, Hagfors detections were also used in the automatic phase association.

The operational stability of RMS has been very good during the reporting period. In fact the RMS event processor (pipeline) has had no downtime of its own; i.e., all data available to RMS have been processed by RMS.

Phase and event statistics

Table 3.6.1 gives a summary of phase detections and events declared by RMS. From top to bottom the table gives the total number of detections by the RMS, the number of detections that are associated with events automatically declared by the RMS, the number of detections that are not associated with any events, the number of events automatically declared by the RMS, the total number of events defined by the analyst, and finally the number of events accepted by the analyst without any changes (i.e., from the set of events automatically declared by the RMS).

Due to reductions in the FY94 funding for RMS activities (relative to previous years), new criteria for event analysis were introduced from 1 January 1994. Since that date, only regional events in areas of special interest (e.g, Spitsbergen, since it is necessary to acquire new knowledge in this region) or other significant events (e.g, felt earthquakes and large industrial explosions) were thoroughly analyzed. Teleseismic events were analyzed as before.

To further reduce the workload on the analysts and to focus on regional events in preparation for Gamma-data submission during GSETT-3, a new processing scheme was introduced on 2 February 1995. The GBF (Generalized Beamforming) program is used as a pre-processor to RMS, and only phases associated to selected events in northern Europe are considered in the automatic RMS phase association. All detections, however, are still available to the analysts and can be added manually during analysis.

There is one exception to the new rule for automatic phase association: all detections from the Spitsbergen array are passed directly on to the RMS. This allows for thorough analysis of all events in the Spitsbergen region.

	Apr 96	May 96	Jun 96	Jul 96	Aug 96	Sep 96	Total
Phase detections	49876	48613	56095	55741	95034	86911	392270
- Associated phases	2870	2974	2860	3580	7617	7262	27163
- Unassociated phases	47006	45639	53235	52161	87417	79649	365107
Events automatically declared by RMS	594	585	597	942	2130	2015	6863
No. of events defined by the analyst	111	128	159	394	980	624	2396
No. of events accepted without modifications	0	0	0	162	6	0	168

Table 3.6.1. RMS phase detections and event summary.

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4 Improvements and Modifications

4.1 NORSAR

NORSAR naming convention

The naming convention for NORSAR stations has been modified. See section 7.2 for details.

NORSAR configuration changes 1969-1996

The NORSAR array has undergone several significant changes over time. The original array with 22 subarrays, each with 6 short period seismometers and one three-component long period seismometer, was reduced to 7 subarrays as of 1 October 1976. This configuration remained stable for many years. However, in the early 1990s, it became more and more difficult to operate the old communication system, and from 1 January 1994 a backup system was operated awaiting a complete refurbushment of the array. From 20 December 1994 the current system has been operated.

In addition to these major changes, several experiments temporarily affecting the array configuration have been performed, especially in connection with the installation of the NORESS array.

For the period 1969 to September 1982, we retain segmented short period data stored on magnetic tapes. These segments correspond to selected events only. We are still able to read such data tapes, even those from the earliest time period. From September 1982, all data recorded (i.e., continuous data) are archived.

It is important to know the status of each "data channel" throughout the history of NORSAR. An effort has been made to record all relevant information into CSS 3.0 tables. We have now completed site, sensor, sitechan and instrument tables for the entire operational period of the NORSAR array which uniquely describe the system for any point in time. Any data requested hereafter will be delivered in CSS 3.0 format with appropriate site, sensor, sitechan and instrument information.

NORSAR data acquisition

See NORSAR Sci.Rep. No. 1-95/96 for a description of the final phase of the NORSAR refurbishment effort.

The Science Horizons XAVE data acquisition system has been operating satisfactorily during and after the installation period. A block diagram of the digitizer and communication controller components is found in NORSAR Sci. Rep No 2-94/95.

NORSAR detection processing and feature extraction

The NORSAR detection processor has been running satisfactorily. To maintain consistent detection capability, the NORSAR beam tables have remained unchanged.

Detection statistics for the NORSAR array are given in section 2.

The NORSAR detecting beams include slowness vector and time delay corrections using precalculated, calibrated time delays. The method has been implemented into DFX, and IDC testbed operation of station NOA has been initiated.

See NORSAR Sci. Rep. 2-95/96 for a description of NORSAR beamforming techniques. See also section 7.2.

NORSAR event processing

The automatic routine processing of NORSAR events as described in NORSAR Sci. Rep No. 2-93/94, has been running satisfactorily. The analyst tools for reviewing and updating the solutions have been continuously modified to simplify operations and improve results.

J. Fyen

5 Maintenance Activities

Activities in the field and at the Maintenance Center

This section summarizes the activities at the Maintenance Center (NMC) Hamar, and includes activities related to monitoring and control of the NORSAR teleseismic array, as well as the NORESS, ARCESS, FINESS, GERESS, Apatity, Spitsbergen and Hagfors small-aperture arrays.

Activities also involve preventive and corrective maintenance, planning and activities related to the refurbishment of the NORSAR teleseismic array.

NORSAR

Visits to subarrays in connection with:

- Replacement of protection control cards at various sites
- Replacement of AIM-24 digitizers and preamplifiers at various sites
- Power line and equipment failure due to thunderstorms
- Cable splicing at various sites

NORESS

- Repair of digitizer unit and seismometers from site C2 after the vault was found to be filled with water.
- Extensive repairs of array electronics after thunderstorms in June and July

ARCESS

- Restart of the UPS unit after a local power outage

Spitsbergen

- Reinstallation of seismometers, GPS receiver and telemetry equipment at the array. An extra battery regulator was installed in parallel with the old one.
- Replacement of the main board in the NORAC unit at NTA in Longyearbyen.

NMC

- Repair of defective electronic equipment removed from the arrays.

Additional details for the reporting period are provided in Table 5.1.

P.W. Larsen
K.A. Løken

Subarray/ area	Task	Date
	April 1996	
NORSAR 04C	Disconnected data from remote site SP01 due to defective communication	11/4
Spitsbergen	Replaced the 12V battery with a 24 V battery. The 12V battery had been overcharged due to a defective diode in the charge regulator. The generator in the windmill was replaced and returrned to the manufacturer for tests. The whole installation at the site was found to be damaged by overvoltage. The Guralp seismometers were returned to England for repair. The digitizers, GPS receiver and the telemetry equipment were taken to the maintenance center for repair.	22-24/4
NMC	Repair of defective electronic equipment	April
	May 1996	
NORSAR 01A	Replaced protection-control card at SP02 and SP05. Replaced +9V zender diode in junction box at SP00	14/5
01A	Took AIM-24 digitizer and Brick amplifier out from SP02 for testing at NMC. The remote site SP02 did not work due a defective cable between site and CTV. Replaced Brick amplifier at remote site SP05.	20/5
01B	Replaced Brick amplifier at SP01 due to noisy data. The remote site SP02 does not work due defective cable between site and CTV	21/5
06C	Replaced broken fuses on the protection cards in CTV for remote sites SP03, 04 and 05. Replaced -9V zender diode in the junction box at SP03.	23/5
04C	Replaced protection-control card at SP03 and 04. At SP04 we also had to replace the Brick amplifier	30/5
01B	The AIM-24 digitizer at remote site SP02 was found to be defective and was taken to the NMC for repair.	31/5
NORESS	The vault at C2 was found to be full of water. The frozen ground during the winter had damaged the cable entrance pipe. The digitizer unit and seismometers were taken to NMC for repair.	26/5

Subarray/ area	Task	Date
NMC	Repair of defective electronic equipment	May
	June 1996	
NORSAR		
04C	Replaced the preamplifier at SP03	3/6
06C	Replaced the preamplifier at SP03	5/6
03C	Replaced protection-control card at SP02 and SP00	6/6
06C	Replaced protection-control card at SP00. The digitizer and the preamplifier at SP05 were taken to NMC for repair. The cable to SP01 was found to be damaged by lighting 330 m from the CTV	7/6
02C	Replaced preamplifier at SP05	10/6
02B	The 1000 VAC power line was found to be damaged by lightning	11/6
04C	Replaced protection-control card at SP01; a fault was also found in the cable to this remote site	11/6
04C	The digitizer and preamplifier at SP04 were taken to NMC for repair. The cable to SP03 was found to be damaged by lightning	24/6
NORESS	Repaired the LF-DC receiver/digital clock, the HUB digital interface card, the HUB CPU card and the HUB power unit, all damaged by lightning.	10-20/6
Spitsbergen	Reinstallation of seismometers, GPS receiver and telemetry equipment at the array. An extra battery regulator was installed in parallel with the old one. The main board in the NORAC unit at NTA in Longyearbyen was also replaced.	28-30/6
NMC	Repair of defective electronic equipment	June
	July 1996	
NORSAR		
03C	Visited site due to power line failure	5/7

Subarray/ area	Task	Date
02B	Visited site due to power line failure caused by lightning	8/7
02C	Repaired broken surge protection card in the AIM-24BB digitizer	9/7
02B	Visited the site due to power line problems all caused by lightning	26/7, 29/7 & 31/7
NORESS	A severe thunderstorm over the array damaged 3/4 of the entire installation. The Hub installation and the following remote sites were in operation again at the end of July: A1, A2, A3, B1, B3, B4, B5, C1, C5, C6, D1, D2, D7 and D8.	12-31/7
ARCESS	The UPS unit had to be restarted after a local power surge.	12/7
NMC	Repair of defective electronic equipment	July
August 1996		
NORSAR		
02B	Visited site due to power line problems all caused by lightning	1,5,12,16, 19 & 30/8
02B	Replaced the battery card at remote sites SP04 and SP00	16/8
03C	Cable splicing at SP01	13, 15 & 20/8
06C	Cable splicing at SD03, SP04 and SP00	21, 22, 23 & 27/8
04C	Replaced AIM-BB digitizer in LPV.	26/8
06C	Replaced AIM-24 digitizer at remote sites SP03, SP04 and SP05	28/8
02B	Replaced battery card at remote sites SP04 and SP00	30/8
NORESS	Repaired A0, C4, C7, D4 and D9 remote site electronic units. The electronic units from remote sites B2, C2, D5 and D6 were all taken to NMC for repair. The Hub power supply unit was also repaired during the period.	1-14/8
NMC	Repair of defective electronic equipment	August

Subarray/ area	Task	Date
	September 1996	
NORSAR		
02B	Replaced the +9V protection diode at remote site SP02	2/9
06C	Replaced AIM-24 digitizer and preamplifier at remote sites SP03 and SP05	3/9
02B	The AIM-24 digitizer and preamplifier at remote sites SP05 and SP00 were taken to NMC for repair. Replaced the +9V protection diode at SP03	3/9
02C	Cable splicing at SP05 Replaced the protection card for the BB digitizer at remote site SP03	4, 5 &6/9
02B	Replaced blown fuses on the protection card for remote site SP03	9/9
01A	All main fuses and the lightning protection for the 220VAC line were found to be damaged by lightning. The 48 VDC power supply in the UPS unit was also defective and had to be taken to NMC for repair	9/9
01A	Replaced the 48 VDC power supply	10.9
03C	Cable splicing at SP04, SP05 and SP00	11, 12, 13/9
03C	Cable splicing at SP01 and SP02	16, 17, 18, 19, 20/9
04C	Cable splicing at SP01, SP03 and SP 04 Replaced preamplifier at SP03	23, 24 & 25/9
01B	Cable splicing at SP02 and SP04. Replaced SP seismometer at SP01 At SP05 we found the vault empty except for the SP seismometer. Someone had stolen the AIM-24 digitizer, GPS clock, preamplifier and the modem/control box	26, 27 & 30/9
NMC	Repair of defective electronic equipment	September

Table 5.1. Activities in the field and the NORSAR Maintenance Center during 1 April - 30 September 1996.

6 Documentation Developed

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Semiannual Technical Summary, 1 October 1995 - 31 March 1996, NORSAR Sci. Rep. 2-95/96, Kjeller, Norway.

7 Summary of Technical Reports / Papers Published

7.1 Status Report: Norway's participation in GSETT-3

Introduction

A fairly detailed account of Norway's participation in GSETT-3 during January 1995 - June 1996 was given in Mykkeltveit & Baadshaug (1996). The present contribution is essentially an update of that report, but offers in addition some material on use of the AutoDRM protocol in conjunction with the change of status on 1 October 1996 of the Spitsbergen array from a primary to an auxiliary station in GSETT-3.

Norwegian GSETT-3 stations and communications arrangements

From the second half of 1993, Norway has provided continuous data from three GSETT-3 primary array stations: ARCESS, NORESS and Spitsbergen. The location and configurations of these three stations are shown in Fig. 7.1.1. ARCESS and NORESS are 25-element arrays with identical geometries and an aperture of 3 km, whereas the Spitsbergen array has 9 elements within a 1-km aperture. All three stations have a broadband three-component seismometer at the array center.

Data from these three stations are transmitted continuously and in real time to NOR_NDC. The NORESS data transmission uses a dedicated 64 Kbits/s land line, whereas data from the other two arrays are transmitted via satellite links of capacity 64 Kbits/s and 19.2 Kbits/s for the ARCESS and Spitsbergen arrays , respectively.

The NORESS array has been used in GSETT-3 as a temporary substitute for the NORSAR teleseismic array (also shown in Fig. 7.1.1; station code NOA), awaiting a complete technical refurbishment of the latter. This effort has now been completed, and starting 30 August 1996, data from the NORSAR array have been transmitted continuously to the IDC. The NORESS array will, however, be retained as a GSETT-3 primary station at least until such time that the NORSAR array data are fully used in the IDC operational processing cycle. We are cooperating with the IDC on the task of preparing for the processing of NORSAR data at the IDC, and the status of this effort is given in Section 7.2 of this report.

On 1 October 1996 numerous changes were made worldwide to the GSETT-3 network. The purpose of these coordinated changes was to bring the GSETT-3 network in line with the seismic component of the International Monitoring System (IMS) to the extent possible. As the Spitsbergen array is an auxiliary station in IMS, this station changed its status from primary to auxiliary in GSETT-3 on that date. This involved terminating the continuous forwarding of SPITS data to the IDC and making data from this station available to the IDC on a request basis via the AutoDRM protocol (Kradolfer, 1993; Kradolfer, 1996). Initial experience on the use of AutoDRM for SPITS is reported below.

Uptimes and data availability

Figs. 7.1.2 - 7.1.4 show the monthly uptimes for the three Norwegian GSETT-3 primary stations ARCESS, NORESS and Spitsbergen, respectively, for the period January -

September 1996, given as the hatched (taller) bars in these figures. These barplots reflect the percentage of the waveform data that are available in the NOR_NDC tape archives for each of these three stations. The downtimes inferred from these figures thus represent the cumulative effect of field equipment outages, station site to NOR_NDC communication outages and NOR_NDC data acquisition outages. Some of the larger downtimes are due to specific reasons, as follows:

- The NORESS hub facility was hit by lightning on 12 July, resulting in serious damage to a number of electronic components. Repairs were completed on 27 July.
- The Spitsbergen array was down almost continuously between 10 March and late June, due to damage to the battery bank at the array site, caused by overcharging by the windmill system.

Figs. 7.1.2-7.1.4 also give the data availability for these three stations as reported by the IDC in the IDC Station Status reports. The main reason for the discrepancies between the NOR_NDC and IDC data availabilities as observed from these figures is the difference in the ways the two data centers report data availability for arrays: Whereas NOR_NDC reports an array station to be up and available if at least one channel produces useful data, the IDC uses weights where the reported availability (capability) is based on the number of actually operating channels.

It is of interest to compare NOR_NDC and IDC data availabilities, based on identical definitions of this term. This has been done in Fig. 7.1.5 for data from the ARCESS array. To produce this figure, we retained the above NOR_NDC definition of data availability, and then queried the IDC database for the existence therein of *any* (one or more channels) ARCES data from the period January - September 1996. The result, as shown in Fig. 7.1.5, is that (with the exception of a discrepancy in June) the loss of data between the NOR_NDC diskloops and the IDC database is very modest indeed. This shows that the data reformatting and forwarding routines running at NOR_NDC (the AlphaRead/-Send suite of programs) with associated hardware, the link between NOR_NDC and the IDC, and the data acquisition software and hardware at the IDC are all reasonably stable and well-operating elements of a complicated data acquisition arrangement.

Initial experience with the AutoDRM protocol

NOR_NDC's AutoDRM has been operational since November 1995 (Mykkeltveit & Baadshaug, 1996).

Between November 1995 and the network changes on 1 October 1996, only 207 requests from external users were processed.

After SPITS changed station status from primary to auxiliary, the request load increased sharply, and for the month of October 1996, the NOR_NDC AutoDRM responded to 12338 requests for SPITS waveforms from two different accounts at the IDC: 9555 response messages were sent to the "pipeline" account and 2783 to "testbed".

The number of requests sent from the IDC were compared to responses returned from NOR_NDC. The NOR_NDC AutoDRM only logs requests after they have been processed. Should a request for some reason get lost before processing has finished, it will not appear in any NOR_NDC AutoDRM log-files. The incoming request mail will, however, be present in the log files of the NOR_NDC central mailhost.

At the IDC, 9662 requests for SPITS data are logged as sent from the "pipeline" account.

For each of these, a corresponding response is logged at NOR_NDC, except for 107 requests. They were all sent on 30 October 1996, between 01:35:43 and 15:47:51. No incoming mail from "pipeline" was logged at the NOR_NDC mailhost during this interval.

Mail from other accounts at the IDC did get logged at the NOR_NDC mailhost, so we have reason to believe that the 107 missing requests were lost before they ever reached NOR_NDC.

In conclusion, it seems that all request messages which have reached the AutoDRM from the "pipeline" account at the IDC have been answered. No error messages have been found in the AutoDRM log-files. Apparently, all requests have been properly formatted and the requested data intervals have been inside the NOR_NDC diskloops.

The total volumes of the response messages for October 1996, are:

- 157 MB in 9555 messages to "pipeline",
- 40 MB in 2783 messages to "testbed".

NDC automatic processing and data analysis

These tasks have proceeded in accordance with the descriptions given in Mykkeltveit and Baadshaug (1996). For the period July - September 1996, NOR_NDC derived information on 1832 supplementary events in northern Europe and submitted this information to the Finnish IDC as the NOR_NDC contribution to the joint Nordic Supplementary (Gamma) Bulletin, which in turn is forwarded to the IDC. These events are plotted in Fig. 7.1.6. As can be seen in this figure, the seismic activity in and around Spitsbergen was particularly high during this period.

Data forwarding for GSETT-3 stations in other countries

NOR_NDC continues to forward data to the IDC from GSETT-3 primary stations in several countries. These currently include FINESS (Finland), GERESS (Germany) and Sonseca (Spain). In addition, communications for the GSETT-3 auxiliary station at Nilore, Pakistan, are provided through a VSAT satellite link between NOR_NDC and Pakistan's NDC in Nilore. Data from the Hagfors array (HFS) in Sweden were provided continuously through NOR_NDC until 1 October 1996, on which date this station changed its status in GSETT-3 from primary to auxiliary, in accordance with the status of HFS in IMS. From 1 October 1996, the IDC obtains HFS data through requests to the AutoDRM server at NOR_NDC (in the same way requests for Spitsbergen array data are now handled, see above).

Future plans

NOR_NDC will continue the efforts towards improvements and hardening of all critical data acquisition and data forwarding hardware and software components, so that future requirements related to operation of IMS stations can be met to the maximum extent possible.

NOR_NDC will continue to contribute data to the IDC in the context of the GSETT-3 experiment for as long as that experiment will last. It is now foreseen that the CTBT PrepCom with its Provisional Technical Secretariat will be established in Vienna in 1997, and that this new organization will take over the responsibility for activities like the GSETT-3 experiment once it becomes technically capable of doing so. We then envisage continuing the provision of data from Norwegian IMS stations without interruption to the appropriate structure that will be established for this in Vienna.

S. Mykkeltveit
U. Baadshaug

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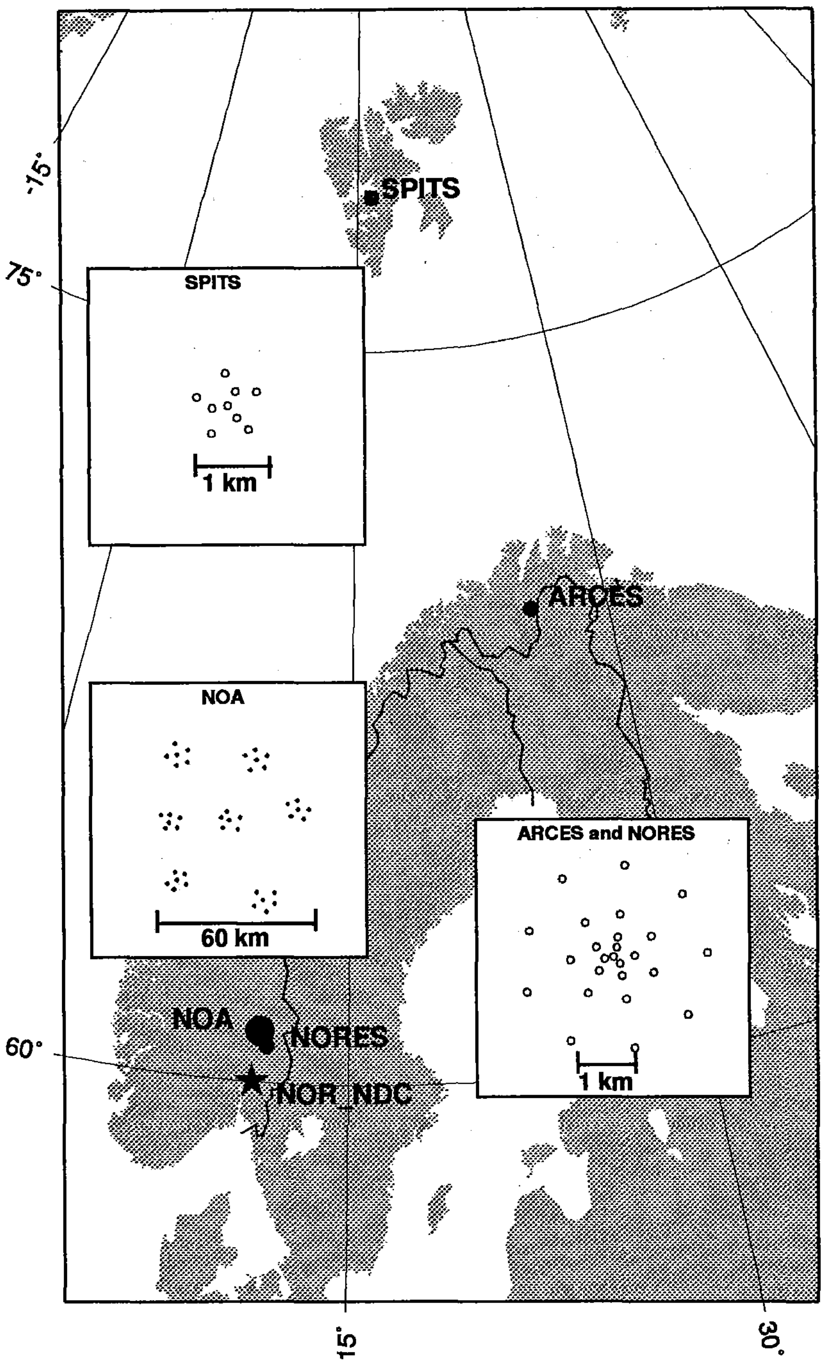

Fig. 7.1.1. The figure shows the locations and configurations of the three Norwegian GSETT-3 primary array stations with station codes NORES, ARCES and SPITS. The data from these stations are transmitted continuously and in real time to the Norwegian NDC (NOR_NDC) and then on to the GSETT-3 IDC. The figure also shows the location of the teleseismic NORSAR array (with station code NOA), which is soon to be fully used in GSETT-3 as a primary station.

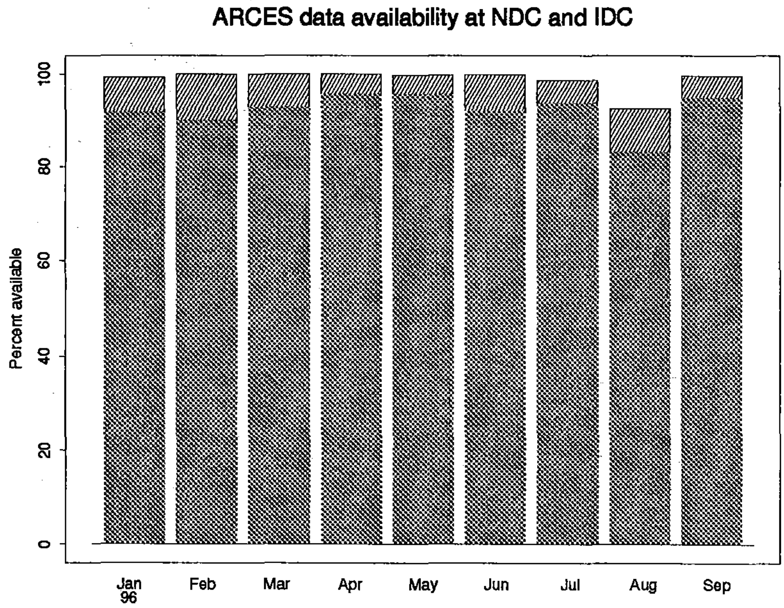

Fig. 7.1.2. The figure shows the monthly availability of ARCESS array data for the period January - September 1996 at NOR_NDC and the IDC. See the text for explanation of differences in definition of the term "data availability" between the two centers. The higher values (hatched bars) represent the NOR_NDC data availability.

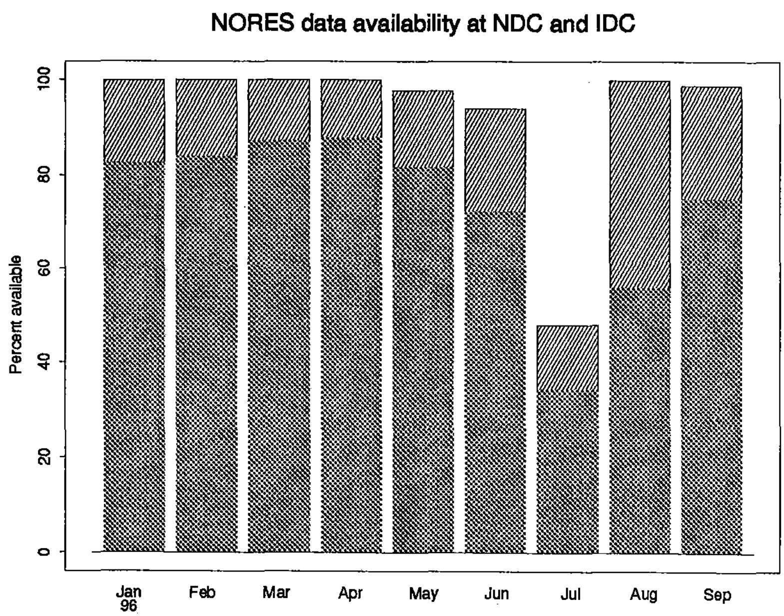

Fig. 7.1.3. The figure shows the monthly availability of NORESS array data for the period January - September 1996 at NOR_NDC and the IDC. See the text for explanation of differences in definition of the term "data availability" between the two centers. The higher values (hatched bars) represent the NOR_NDC data availability.

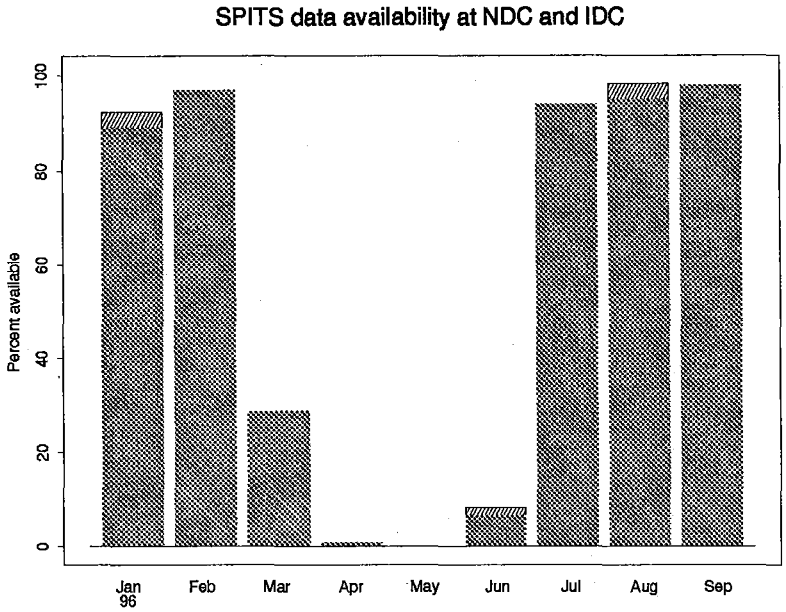

Fig. 7.1.4. The figure shows the monthly availability of Spitsbergen array data for the period January - September 1996 at NOR_NDC and the IDC. See the text for explanation of differences in definition of the term "data availability" between the two centers. The higher values (hatched bars) represent the NOR_NDC data availability.

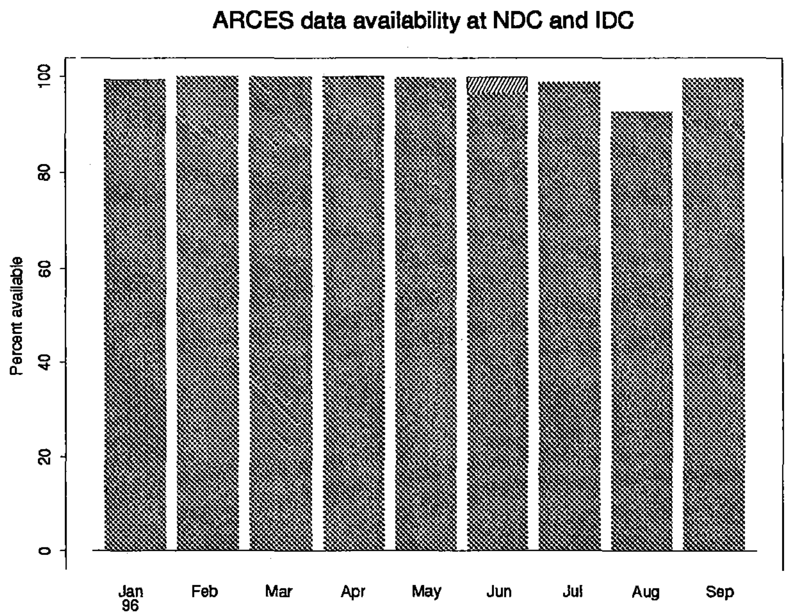

Fig. 7.1.5. The same as Fig. 7.1.2, except that the definition of the term "data availability" at the IDC has been changed to be identical to that used by NOR_NDC. The higher values (hatched bars; difference only observable here for June) represent the NOR_NDC data availabity.

Reviewed Gamma Events

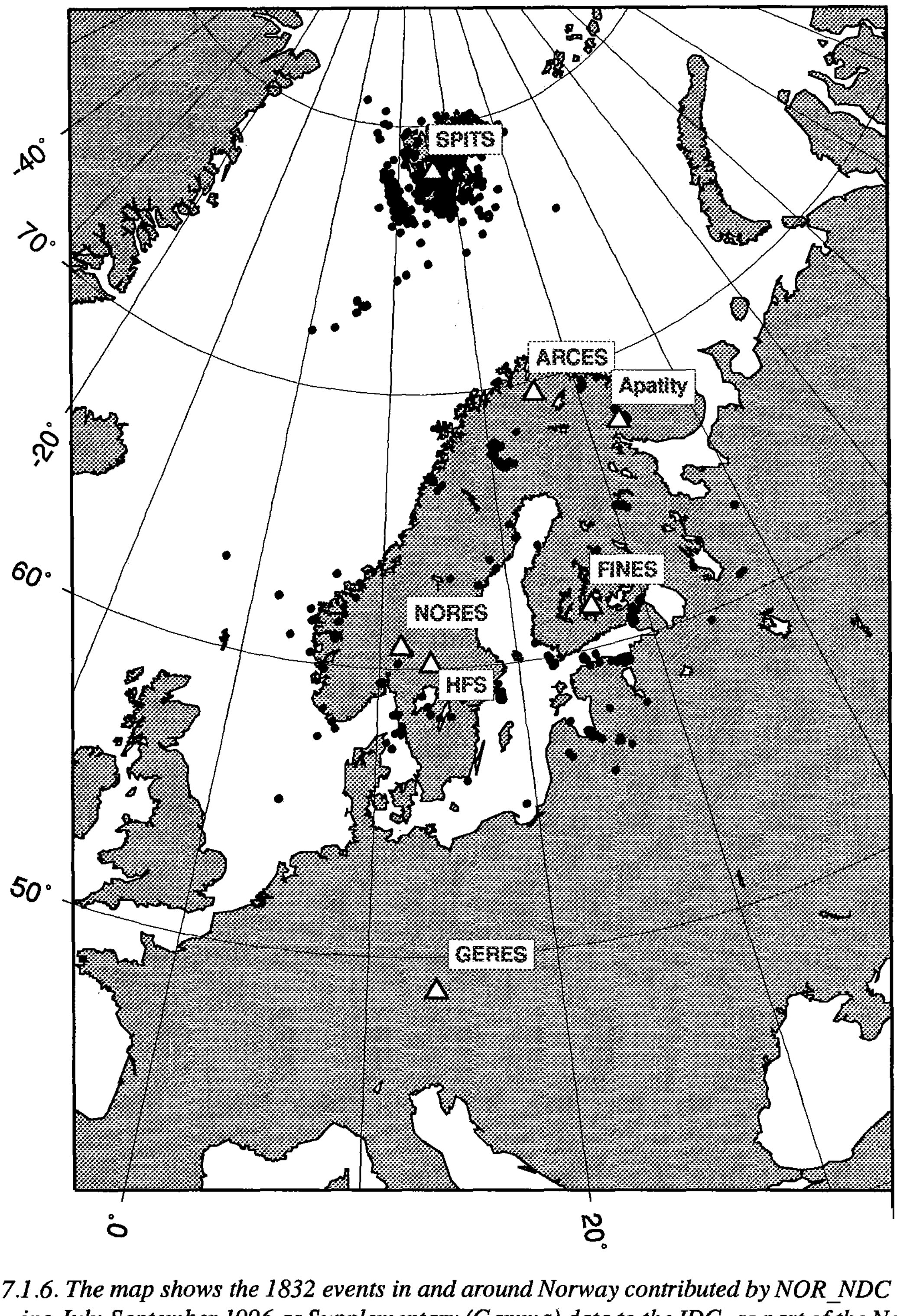

Fig. 7.1.6. The map shows the 1832 events in and around Norway contributed by NOR_NDC during July-September 1996 as Supplementary (Gamma) data to the IDC, as part of the Nordic Supplementary data compiled by the Finnish NDC. The map also shows the seismic stations used in the data analysis to define these events.

7.2 Status and plans for implementing algorithms at the GSETT-3 IDC

Introduction

Research and development efforts at NORSAR have for quite some time focused on methods and procedures that could be useful in the data processing carried out at the GSETT-3 IDC. These efforts have given results in terms of new knowledge, ideas, advice and recommendations that have been communicated to the IDC, and also results in terms of products, like the prototype Threshold Monitoring system delivered to the IDC in October 1994, and a modified DFX for large array processing delivered in June 1996.

For our FY96 R&D effort for ARPA, we have focused on integration of NORSAR knowledge emerging from our research program into the Detection and Feature Extraction (DFX) software. Our ability to operate DFX, define problems and implement solutions came as a result of close cooperation with DFX developers at SAIC, San Diego. The study of the DFX software and its structure has continued, and we are now able to operate the IDC version at our data processing center, using on-line data from e.g. the large NORSAR teleseismic array.

NORSAR large array data at the IDC

As of September 1, 1996, NORSAR array data have been continuously transmitted to the IDC. Upon request from the IDC, we changed the naming of the NORSAR array on October 2, 1996. The naming convention is now:

NOA	Denotes the large-aperture NORSAR array. Will enter the IDC bulletin as station name for phase readings. Will be used for requests for data for all stations within the array.
NB200	Reference station name for NORSAR array beamforming. Center site of subarray NB2, which has stations NB200, NB201, NB202, NB203, NB204 and NB205. A request for NB2 will mean data from all stations in subarray NB2. A request for NB200 will mean data from station NB200 only. Station name NB2 has been used as reference for the entire NORSAR array from October 1, 1976 to October 2, 1996.
NAO00	Center site of subarray NAO, which has stations NAO00, NAO01, NAO02, NAO03, NAO04 and NAO05. A request for NAO will mean data from all stations in subarray NAO. A request for NAO00 will mean data from station NAO00 (center instrument) only. Station name NAO was used as reference for the entire NORSAR array up to October 1, 1976.

The complete list of station names for NORSAR are now:

NB200,	NB201,	NB202,	NB203,	NB204,	NB205,	subarray NB2.
NAO00,	NAO01,	NAO02,	NAO03,	NAO04,	NAO05,	subarray NAO.
NBO00,	NBO01,	NBO02,	NBO03,	NBO04,	NBO05,	subarray NBO.
NC200,	NC201,	NC202,	NC203,	NC204,	NC205,	subarray NC2.

NC300,	NC301,	NC302,	NC303,	NC304,	NC305,	subarray NC3.
NC400,	NC401,	NC402,	NC403,	NC404,	NC405,	subarray NC4.
NC600,	NC601,	NC602,	NC603,	NC604,	NC605,	subarray NC6.

The subarray names are registered ISC codes. The station NC602 is co-located with station NRA0 of the NORESS array.

The main components of SPV (Short Period Vault) sites are one Teledyne Browne 20171-0104 seismometer with sensitivity 650 Volts/meter/second, one Teledyne Browne Brick amplifier with gain 39.8, one Science Horizons AIM24-1 digitizer with gain 10, and one Trimbledone GPS receiver. The seismometers are emplaced in 132 mm boreholes of depth 3.5 meter for 22 sites and 6 - 12 m for 13 sites. (7 of the SP seismometers are in the subarray LPV(Long Period Vault)). Other electronic components include items such as 9600 baud synchronous modem, battery, battery charger and lightning protection. Communication to each subarray Central Terminal Vault, CTV, is achieved through buried cables. These buried cables also carry 60 Volts DC for providing power to the SPVs, and are up to 14 km in length.

The stations NAO01, NBO00, NB201, NC204, NC303, NC405 and NC602 have in addition to the short period vertical seismometer one three-component broadband seismometer installed in the Long Period Vault, LPV. The main components of the LPV are (in addition to one SPV system): one Teledyne Browne KS54000P-0105 "Posthole" seismometer with sensitivity 5000 Volts/meter/second, one Science Horizons AIM24BB-3 digitizer and one Trimbledone GPS receiver. In addition there are other electronics as within the SPVs. The LPV is situated close to a CTV which has lightning protection, modems and a Science Horizons CIM II which communicates with 7 AIM digitizers and the NORSAR Data Processing Center (NDPC) at Kjeller.

The array diameter is approximately 60 km, and each subarray diameter is in the range 7-10 km. The data are transmitted to the NDPC using 7 individual leased telephone lines. Some delay in data transmission may occur which means that parts of the array data might arrive at later times. "Later" means, in this context a delay from 10 seconds up to 2 hours after real-time.

The transmission of data to the IDC is achieved by use of the Science Horizons dl2alpha program and the IDC's AlphaSend program. An inspection of the operations data base at the IDC has shown that, occasionally, minor gaps in data are observed at the IDC even in cases when data are present at NDPC. The cause of this discrepancy is, however, not known at present.

NORSAR array processing at the IDC testbed

Following a period of intensive software development and testing, a new version of DFX was delivered to SAIC, San Diego, on 18 June 1996. This version accommodates the NORSAR large array processing as described in NORSAR Sci. Rep. 2-95/96.

Testbed operation of this version for NOA data was initiated on October 9, 1996.

The initial results from NOA processing demonstrated that a change in parameter setting needs to be done. Due to large beamforming time delays introduced for the large-aperture NOA array, the detection triggers for each signal will span much larger time intervals as compared to smaller arrays. The parameters controlling the triggering of signals by the DFX detection algorithm has been studied, and new parameters for station NOA will be suggested.

The general impression from the first week of DFX operation on NOA data, compared to local NDPC detection processing, is that all real signals are detected and that the slowness vector estimates are consistent with those resulting from the NDPC processing. The number of false triggers due to spikes and data gaps are significantly reduced as compared to the NDPC processing.

Although the DFX masking process effectively removes bad data, we still see a need for an operator-initiated masking process. We suggest that a database table is defined that contains:

sta	Station name
chan	Channel name
time	Start time for abnormal channel status
endtime	End time for abnormal channel status
status	Descriptive code for abnormal channel status. E.g. channel masked during processing.
commid	Comment id for description of status.

The table should be maintained by the IDC operator in cooperation with the NDC station operator. It would be a manageable effort to use this information within DFX for channel masking.

NORSAR processing algorithms

The new algorithm used for large array slowness vector estimation is the DFX function *"compute-beamform-fk"* which is described in Fyen (1996a, 1996b).

Future plans for NORSAR processing.

The current detection recipe for NOA has 180 beams. This number has been kept unchanged to minimize the need for computing power during testbed operation. As soon as the NOA station processing has proven to be working satisfactorily, we will supply a new beam set with a larger number of beams.

Experiments with individual subarray processing have been conducted, and initial results show that due to large amplitude differences across the array, improved detectability can be obtained compared to the full array beam. Within this framework, the NORESS array, which is located within the NOA array, could be processed as a subarray. The problem is how to reduce individual subarray detections to one detection representing the NOA array, and then make a decision on what array configuration and method to use for slowness vector estimation. The challenge is to submit high quality arrivals for the IDC phase association algorithm (GA) and not to confuse the GA process with several subarray detections for the same event. Efforts to solve this problem will continue.

Threshold Monitoring at the IDC testbed

During a visit to the IDC in the time period Aug. 20-23, the Threshold Monitoring (TM) system was installed on the testbed. The DFX program was configured to do the STA calculations for each of the available stations, using the extended functionality provided by NORSAR. The programs for subsequent calculations of network magnitude thresholds were installed in the so-called Delta-pipeline, operating with a time delay of 10-12 hours behind real-time. Since then, the processing has been running without technical problems, confirming the robustness of the TM system with respect to continuous operation. Initially a couple of bugs were detected in the configuration of DFX, but these were soon corrected.

A common baseline beam deployment was used for STA calculation of data from all available arrays. For details, see Fyen et al, 1996. In order to obtain more precise estimates of the magnitude thresholds, we have started an effort of tuning the beam deployments for each of the primary stations of the IMS network, see section 7.3 of this report.

During the next reporting period, we will complete the tuning of the IMS primary network. After this we will technically and seismologically verify the results for threshold monitoring using the full IMS primary network, assist in transferring the TM system into the operational system at the IDC, and develop adequate products with associated graphical displays for making the output from the TM system available to the international community.

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7.3 Tuning of processing parameters for Global Threshold Monitoring at the IDC

Introduction

Detailed presentations of the Global Threshold Monitoring System developed for the IDC have been given in several of the NORSAR Semiannual Technical Summaries (Kværna et al., 1994a; Kværna et al., 1994b; Ringdal et al., 1995). To optimize the overall performance of the system, we have in this reporting period focused on tuning of the processing parameters and the beam deployments for the different stations of the IMS primary network, see Fig. 7.3.1. This has been done by requesting event segments from the IDC followed by detailed analysis of several events for each of the stations.

Generic global attenuation and travel-time curves form the basis for the calculation of network magnitude thresholds. As is well known, the attenuation curves are accompanied with significant uncertainties. For example, studies made on P-wave amplitude variability (Veith and Clawson, 1972; Lilwall, 1986; Ringdal and Fyen, 1979) indicate a standard deviation of about 0.4 magnitude units. This uncertainty is, however, accounted for in the calculation of magnitude thresholds.

In order to obtain optimized and realistic magnitude thresholds there are also other uncertainty factors that need to be addressed. These are:

- The use of STA envelopes as a representation of log(A/T)
- The effect of beamforming, filtering and different instrument responses on the seismic amplitude
- The effect of each target point representing a finite geographical area, and mis-steering of the array beams

These factors will be addressed in the following where we present the results from the tuning of the array station ASAR (Alice Springs, Australia).

Event selection

For each station it is important to have available a data set that is representative for the different types of P-phases usually observed. For the assessment of seismic magnitude thresholds the most significant variables are the dominant signal frequencies, the signal loss due to beamforming and mis-steering of the beams, and the characteristics of the seismic noise field. The signal variables are usually strongly dependent on the source-receiver distance, and we have therefore decided to collect data from events located at different distance ranges. High SNR signals are needed for the assessment of signal loss due to missteering of the beams, and we have found that data from about 10 events would allow us to derive reasonably representative processing parameters. Information on the events used for tuning of ASAR are given in Table 7.3.1.

Prefiltering

For magnitude estimation at the IDC, a 3rd order Butterworth filter with a passband between 0.8 and 4.5 Hz is applied to the data prior to the estimation of the signal amplitude and period. To resemble the procedure used for m_b calculation at the IDC, we will also apply the same baseline filter to the data prior to the generation of STA envelopes. For some stations, this passband may, however, be contaminated by high noise amplitudes, e.g., due to local noise sources or to the broadband characteristics of the instrument.

Another factor to consider is the frequency content of the different kinds of signals (local, regional, teleseismic and core phases). We should also have in mind that the global P-wave attenuation relationship (e.g. Veith and Clawson, 1972) is derived from instruments with a peak response around 1 Hz, and that we do not know the validity of this relation for signals with high dominant frequencies, like many local and regional P-phases.

Our approach to a possible adjustment of the filter setting is that we will need very strong arguments to change the filter parameters.

Ideally we would like there to be a close correspondence between the most energetic frequency range of the signal and the frequency range providing the highest SNR. In this way we could prefilter the data in a passband that ensured both correct magnitude thresholds during event intervals as well as optimum performance during noise conditions. This is, however, not the usual situation for **ASAR**. A typical example is given in Fig. 7.3.2, where we have analyzed a P-phase from an event at a distance of 33.6 degrees. The highest SNR is found between 2 and 3 Hz, whereas the largest A/T value is measured between 1 and 1.5 Hz.

The same characteristics are also illustrated in Fig. 7.3.3, where we compare the dominant signal frequency measured on the filtered beams providing the highest SNR, with the dominant frequency used for the estimation of event magnitude. The data set is **ASAR** P-phase information given in the database associated with the IDC Reviewed Event Bulletin (REB) for the year 1996. This comparison clearly shows that the highest SNR is usually found at higher frequencies than those providing the largest A/T value. Also notice the absence of REB events located within 10 degrees of **ASAR**.

From analysis of the 10 **ASAR** events and the statistics shown in Fig. 7.3.3, we have found no strong arguments for changing the parameters of the prefilter. For the 10 events, we have also manually measured the maximum A/T on both unfiltered and filtered (0.8-4.5 Hz) data. Except for the largest event of m_b 5.6, the correspondence was good, and log(A/T) was on the average about 0.05 m_b units lower after prefiltering, see Fig. 7.3.4.

For the m_b 5.6 event, log(A/T) was measured 0.69 m_b units lower after prefiltering, indicating that the main signal energy is found below the lower cutoff. When looking at the narrowband log(A/T) measurements of Fig. 7.3.5, we clearly see this behavior where the largest A/T is measured at about 0.5 Hz. For estimation of event magnitudes, the 0.8-4.5 Hz prefiltering will obviously give rise to errors. But for threshold monitoring we are assessing the **upper** magnitude limit of possible seismic events that might have occurred in a given area, and are therefore almost always focusing on magnitude levels close to the background noise level. For events at such magnitude levels, we do not expect signals to have the main energy below the lower cutoff of the filter. We therefore argue that even though large events may have the main energy below 0.8 Hz, this will have very little influence on the calculation of magnitude thresholds.

The use of STA envelopes as a representation of log(A/T)

If we assume that an instrument response is flat to velocity, and that the length of the short-term-average (STA) includes a full cycle of a sinusoidal signal, we have the following relation between the STA and the amplitude (A) and period (T) of the signal:

$$\frac{A}{T} = \frac{\pi}{2} \cdot calib \cdot STA \qquad (1)$$

where *calib* is the calibration constant at the reference period.

The continuous calculation of STA traces of filtered beams forms the basis for the calculation of magnitude thresholds. For the 10 ASAR events, we have in Fig. 7.3.6 compared the manually measured maximum A/T values with the corresponding values of STA, both measured on data bandpass filtered between 0.8 and 4.5 Hz. The STA length was 1 second. For this small data set there is good correspondence, and the log(A/T) values have a mean bias of 0.04 m_b units relative to the log(STA) values. This serves to confirm the validity of using the continuous STA traces as a basis for the calculation of magnitude thresholds.

Signal loss due to beamforming

As seen from Figs. 7.3.2 and 7.3.5, beamforming of teleseismic P-phases using the sensors of the ASAR array provide significant SNR improvement without significantly reducing the signal amplitudes, at least for frequencies below 2 Hz. For higher frequencies, signal decorrelation starts to cause reduction of the beam amplitudes. The signal loss referred to in the following is defined as:

$$\text{Signal loss} = \text{Beam STA} \,/\, \text{Average STA of the individual sensors} \qquad (2)$$

where the STA was taken to be the maximum within 8 seconds after the signal onset.

When calculating the total signal loss due to beamforming in the fairly wide 0.8 - 4.5 Hz frequency band, it is clear that this loss is dependent on the dominant frequency range of the signal. For teleseismic events, we generally expect that the higher frequencies have been attenuated such that the main signal energy is found at lower frequencies, which again would imply little signal loss. For local and regional events, see Fig. 7.3.7, the major signal energy is typically found above 2 Hz, and a higher signal loss is expected.

Due to the large variation in signal spectra, we can only operate with approximate a priori estimates of the signal loss, but it will be reasonable to categorize the expected signal loss into bins of source-receiver distances. Fig. 7.3.8 shows the signal loss due to beamforming of the 10 ASAR events. For distances above 30 degrees we find the signal loss to be within 0.5 dB, and for distances between 15 and 30 degrees a maximum signal loss of 3.2 dB is observed. For distances below 15 degrees we have so far no data, but for signals with dominant frequencies approaching 4.5 Hz, we expect that signal losses up to 4 dB may be found for the full **ASAR** array configuration.

From this small data set it would be reasonable to set the expected signal loss for events above 30 degrees to about 0.3 dB. For distances between 15 and 30 degrees, the average is a bit less than 2 dB. Below 15 degrees we have no data, so we have to look for more data or use information from other arrays to obtain an estimate of the expected signal loss.

Beam deployment and signal loss due to mis-steering

When deploying a beam set for processing of array data, we often require the signal loss due to mis-steering of the beams to be less than a given value, e.g. 3 dB. If we know the approximate value of the slowness mis-steering (s/km) corresponding to the 3 dB signal loss, we can derive the steering parameters (azimuth and slowness) of the necessary beam deployment.

When analyzing the **ASAR** events, we have calculated the signal loss due to mis-steering for data filtered between 0.8 and 4.5 Hz. Fig 7.3.9 shows the steering points used in this analysis, with values relative to the observed slowness and azimuth of the event. Figs. 7.3.10 and 7.3.11 show two examples of signal loss plotted as a function of the absolute value of the mis-steering for two events at 15.9 and 33.6 degrees distance, respectively.

The expected signal loss due to mis-steering is dependent on the frequency range of the main signal energy, which again shows a strong dependency on the source-receiver distance. As previously suggested, we have categorized the data into two bins, one for the distance interval 15-30 degrees, and another for 30-180 degrees.

Fig. 7.3.12 gives the average signal loss curve for the 4 events in the distance interval 15-30 degrees. After smoothing, the signal loss for the correct beam steering is 1.56 dB, and additional 3 dB signal loss is found for a mis-steering of 0.036 s/km. In order to deploy beams for events in the distance interval 15-30 degrees, we find in the IASP91 travel-time table that we expect the slowness to fall within the range 8.85 s/deg. to 13.63 s/deg. For the purpose of deploying the minimum number of beams required to cover a given slowness area, we have developed a semi-automatic procedure. The result is shown in Fig. 7.3.13 where the area between the two bold circles represent the slowness range for the 15-30 degrees distance interval, now in units s/km. We initially found that complete coverage within the 3 dB level could be achieved with deployment of 12 beams, but by extending the beam deployment to 17 beams and moving the steering points to larger slowness, the same beams could also be used for monitoring the distance range 2-15 degrees. The radii of the small circles is 0.036 s/km, corresponding to the expected mis-steering associated with the 3 dB signal loss.

Fig. 7.3.14 gives the average signal loss curve for the 6 events in the distance interval 30-180 degrees. After smoothing, the signal loss for the correct beam steering is as low as 0.16 dB, and additional 3 dB signal loss is found for a mis-steering of 0.041 s/km. As seen from the figure there is some spread in the observations, and in particular one event is less sensitive to mis-steering, primarily due to low dominant signal frequencies. The standard deviation associated with the 3 dB level is about 0.1 m_b units. For the distance interval 30-

180 degrees we expect the slowness to fall within the range 0.0 - 8.85 s/deg, illustrated by the disc within the bold circle of Fig. 7.3.15. In order to ensure complete coverage within the 3 dB level (0.041 s/km), 7 beams were necessary, represented by the centers of the small circles.

For the distance interval below 15 degrees, we have so far no data in our tuning set. From analysis of local and regional events at the ILAR array (in Alaska, USA), which has approximately the same configuration as ASAR, we have found it reasonable to assume the signal loss to be 30% more sensitive to mis-steering than for events between 15 and 30 degrees, i.e., slowness associated with the 3 dB signal loss is reduced by 30% down to 0.025 s/km. If we exclude P-phases from surface events within 2 degrees, there is very little difference between the theoretical slowness at 2 and 15 degrees. The slowness range is from 13.63-13.75 s/deg., illustrated by the small area between the bold circles of Fig. 7.3.16. By using the same 17 beams as for the 15-30 degrees interval, but now with smaller 3 dB circles, we see from Fig. 7.3.16 that complete coverage is ensured for the 2-15 degrees slowness interval.

Geographical grid spacing and time/azimuth/slowness tolerances

In our current implementation of the Threshold Monitoring system we have divided the Earth's surface into 2562 grid points, where each grid point covers a target area with a radius of about 2.7 degrees. In threshold monitoring there is a trade-off between the size of the target area and the tolerances of the parameter values used in the threshold computations. With a given grid, it is necessary to make the tolerances of each aiming point compatible with the grid spacing. An illustration of the need for introducing azimuth tolerances is given in Fig. 7.3.17, now for a global grid system with 162 points. From this figure we can see that the necessary azimuth tolerance will increase with decreasing distance to the aiming point.

If we are deploying a beam with a slowness and azimuth corresponding to the coordinates of the center of a target area, it is necessary to allow for some mis-steering such that every point within the target area is covered. We have in Fig. 7.3.18.a plotted the calculated maximum mis-steering (s/km) for each of the 2562 grid points, versus the distance to the grid points. When comparing the maximum mis-steering of each target region with the signal loss for events between 30 and 180 degrees (Fig. 7.3.14), we find that the mis-steering associated with the grid spacing cause much less than 1 dB signal loss. In the legend of Fig. 7.3.18a we have given the station-target distances where we find that the mis-steering associated with the grid spacing cause 1, 3, 5, 7 and 9 dB signal loss when using the relation between signal loss and mis-steering representative for events between 30 and 180 degrees.

In Fig. 7.3.18.b we have done the same calculations, but now for events between 15 and 30 degrees. The relation between signal loss and mis-steering for events between 15 and 30 degrees is given in Fig. 7.3 12. From the legend of Fig. 7.3.18.b we read that the mis-steering introduced to cover the target regions will correspond to 1 dB signal loss at a station-target distance of 17 degrees, and about 1.5 dB at 15 degrees.

As previously outlined, we have no data for the distance interval below 15 degrees, but if we assume that the signal loss for events between 2 and 15 degrees is 30% more sensitive to mis-steering than events between 15 and 30 degrees, we get the numbers given in the legend of Fig. 7.18.c. This tells us that we need to compensate for a signal loss of 3 dB at 13.3 degrees, 5 dB at 9.87 degrees, 7 dB at 7.9 degrees and 9 dB at 6.6 degrees. If we look at the beamforming SNR improvement of the event at 15.9 degrees distance (Fig. 7.3.7), we find a gain of about 9 dB. For events at closer distances than 15.9 degrees we do not expect this number to increase. This would imply that for distances within 6-7 degrees, the signal loss attributed to the mis-steering needed to cover the target regions (9 dB) will cancel the SNR improvement (9 dB) gained through beamforming.

Under the assumption that the 2-15 degrees model for the relation between signal loss and mis-steering is reasonable, we would for targets within about 7 degrees distance use the STA traces from a single array channel as the basis for calculating magnitude thresholds. When using a single array channel, the problem of signal loss vanishes, and there is no need to take into account such effects in the processing. For target distances closer than 7 degrees, the use of STA traces from a single channel would give better performance than using STAs from a beam based on the full ASAR configuration.

An alternative to using the data from a single channel, would be to use a smaller sub-configuration of the ASAR array for beamforming. In this way the signal loss would become less sensitive to mis-steering, and it could make sense to use STAs from beams also for a distance interval within 7 degrees. Such a decision would also have to take into account the fact that fewer array sensors provide less SNR improvement by beamforming.

Conclusions

When estimating the processing parameters for a given station for use in the Threshold Monitoring system, there are a couple of principles that we should have in mind:

- We want to be conservative with respect to estimating the upper magnitude thresholds, such that we should avoid using too optimistic values.
- At the same time we should be aware that the generic global attenuation relationship has an attributed uncertainty of about 0.4 m_b units, and that using average parameter estimates with an associated uncertainty of, e.g., 0.05 m_b units has little influence on the overall performance of the system.

We will in the following summarize the findings from the tuning analysis of the ASAR array:

- *Prefiltering*
  There seems to be no problem with the 0.8-4.5 Hz prefiltering of the ASAR array data, see Fig. 7.3.4. After excluding the large m_b 5.6 event, we did observe an average reduction in the estimated log(A/T) values of 0.05 m_b units after prefiltering. This should be taken into account in the parametrization of ASAR.

- *The relation between log(A/T) and log(π/2*calib*STA)*
  There is good correspondence between the manual signal measurements of log(A/T) and the automatic estimates of log(π/2*calib*STA) when measured on 0.8-4.5 Hz pre-filtered data, see Fig. 7.3.6. The automatic STA measurement had a small reduction of 0.04 m_b units relative to the manual A/T measurement, and this will be accounted for in the parametrization.

- *Signal loss by beamforming*
  For teleseismic events we found very little reduction in the signal amplitudes when beamforming with steering delays corresponding to the estimated azimuth and slowness of the observed P-phases, and as seen from Fig. 7.3.8, an average value of 0.25 dB was found.
  In the distance range 15-30 degrees, the average signal loss for the 4 events was 1.7 dB, but there was a relatively large scatter in the observations. In order to be conservative with the estimation of magnitude thresholds, we will increase this number to 2.5 dB in the parametrization.
  For the distance interval 7-15 degrees, we have no data in our tuning set, but from experience with analysis of ILAR events, we will increase the expected signal loss in the 15-30 degree distance range by 30%, such that the number becomes 3.25 dB.
  For the distance range within 7 degrees, we will derive the magnitude thresholds from a single array channel, and we will therefore have no signal loss due to beamforming.

- *Signal loss by mis-steering of the beams*
  Average curves for the relation between mis-steering of the beams and the reduction of signal amplitude are given in Fig.7.3.12 (15-30 degrees) and in Fig.7.3.14 (30-180 degrees). These will be used in the processing of the ASAR data.
  For the distance interval 7-15 degrees, we use the curve for the 15-30 degrees distance range, but increase the sensitivity to mis-steering by 30%.
  The problem of mis-steering is avoided for the distance range within 7 degrees where we use data from a single array channel

- *Beam deployment*
  Plots of the beam deployments for the different distance ranges are given in Figs. 7.3.13, 7.3.15 and 7.3.16. Details on the beamforming steering parameters are summarized in Table 7.3.2

With the information provided above at hand, the program for calculation of network magnitude thresholds will automatically include additional variables like the STA sampling rate, size of the target regions and the distribution of the beam deployment.

For quality control of the ASAR processing parametrization we plan to inspect a few time intervals with magnitude thresholds based on ASAR data alone, and check that the results are in agreement with general seismological knowledge.

We have in this contribution discussed in great detail the different aspects of the tuning process of the ASAR array for use in the Global Threshold Monitoring system at the IDC.

For tuning of the remaining stations of the IDC primary network, we plan to present only the final results as outlined above in this chapter.

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Table 7.3.1. Information on the 10 events used for tuning for the Threshold Monitoring Parameters at the ASAR array.

Station	Orid	Lat	Lon	Depth	Origin time	Ndef	M_b	Delta	Phase	SNR	Azim	Vel
ASAR	808519	-12.8037	121.5608	0.0	1996:263:11.44.08.5	12	4.3	15.930	Pn	111.91	310.65	9.2
ASAR	808685	-6.0600	128.9550	321.2	1996:263:18.45.07.5	15	3.5	18.142	P	291.60	347.64	9.7
ASAR	808530	-4.0314	135.6428	0.0	1996:263:12.17.34.0	12	4.4	19.593	P	224.45	7.20	10.3
ASAR	817516	0.9085	126.7151	25.8	1996:273:09.00.45.2	48	4.8	25.408	P	114.15	343.33	18.2
ASAR	808621	-19.6428	169.8287	0.0	1996:263:14.04.38.2	14	4.4	33.573	P	249.52	86.78	12.5
ASAR	808505	-25.3101	179.8348	487.3	1996:263:21.05.28.6	50	4.3	41.676	P	394.12	95.32	14.2
ASAR	815191	-17.5973	-178.8668	626.8	1996:271:16.47.43.8	9	3.5	44.455	P	602.50	87.28	13.2
ASAR	817504	51.6327	161.2944	26.6	1996:272:17.07.05.4	50	4.7	78.740	P	208.29	16.79	20.2
ASAR	809239	-52.9173	9.8323	0.0	1996:264:17.37.05.8	38	5.6	89.622	P	40.08	205.56	24.3
ASAR	805509	11.5426	-85.3205	194.0	1996:262:17.34.22.2	75	5.0	140.847	PKhKP	67.30	107.20	34.8

Table 7.3.2. Information on the ASAR beam deployment used for global threshold monitoring.

No	Distance range	Type	Config	Vel	Azi	3dB	Filter
1	0-7	Single	AS12	-	-	-	0.8-4.5
2	7-15	Beam	ASAR	8.96	0.0	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
3	7-15	Beam	ASAR	8.96	21.2	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
4	7-15	Beam	ASAR	8.96	42.4	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
5	7-15	Beam	ASAR	8.96	63.5	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
6	7-15	Beam	ASAR	8.96	84.7	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
7	7-15	Beam	ASAR	8.96	105.9	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
8	7-15	Beam	ASAR	8.96	127.1	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
9	7-15	Beam	ASAR	8.96	148.2	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
10	7-15	Beam	ASAR	8.96	169.4	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
11	7-15	Beam	ASAR	8.96	190.6	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
12	7-15	Beam	ASAR	8.96	211.8	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
13	7-15	Beam	ASAR	8.96	232.9	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
14	7-15	Beam	ASAR	8.96	254.1	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
15	7-15	Beam	ASAR	8.96	275.3	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
16	7-15	Beam	ASAR	8.96	296.5	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
17	7-15	Beam	ASAR	8.96	317.6	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5
18	7-15	Beam	ASAR	8.96	338.8	0.025	0.8-4.5
	15-30	-	-	-	-	0.036	0.8-4.5

No	Distance range	Type	Config	Vel	Azi	3dB	Filter
19	30-180	Beam	ASAR	13.58	26.6	0.041	0.8-4.5
20	30-180	Beam	ASAR	13.58	153.4	0.041	0.8-4.5
21	30-180	Beam	ASAR	13.58	206.6	0.041	0.8-4.5
22	30-180	Beam	ASAR	13.58	333.4	0.041	0.8-4.5
23	30-180	Beam	ASAR	15.18	90.0	0.041	0.8-4.5
24	30-180	Beam	ASAR	15.18	270.0	0.041	0.8-4.5
25	30-180	Beam	ASAR	Inf	0.0	0.041	0.8-4.5

The fields of the table are the following:

Distance range: Station-target distance range (in degrees) for which the STA data from the given beam should be used to derive the magnitude thresholds.

Type: Type of STA data to be used, a beam or a single channel.

Config: Configuration used for beamforming, or name of the single channel.

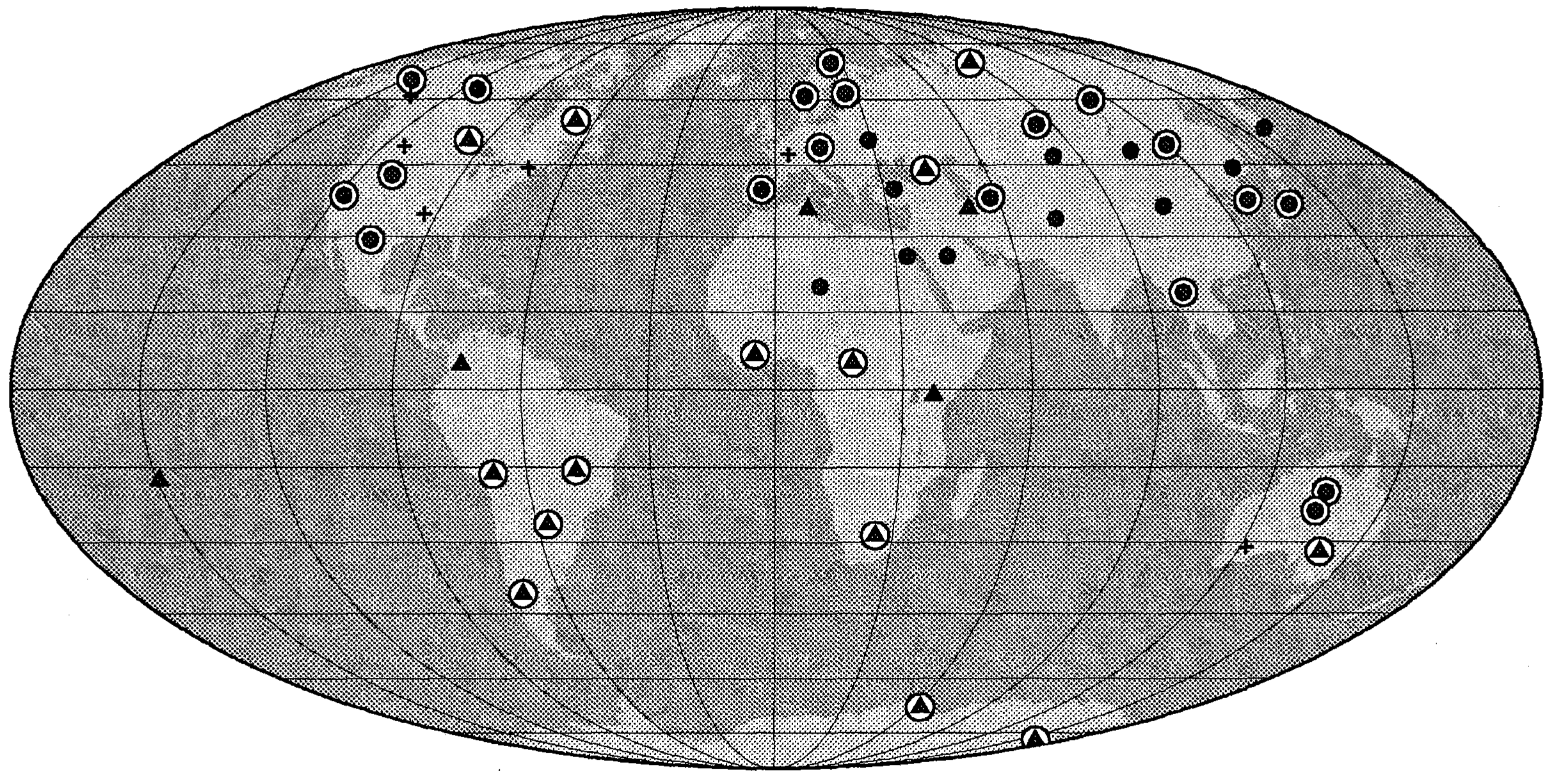
Vel: Apparent velocity of the beam.

Azi: Azimuth of the beam.

3dB: Expected mis-steering (in s/km) corresponding to 3 dB signal loss.

Filter: Prefilter applied to the data (3rd order Butterworth)

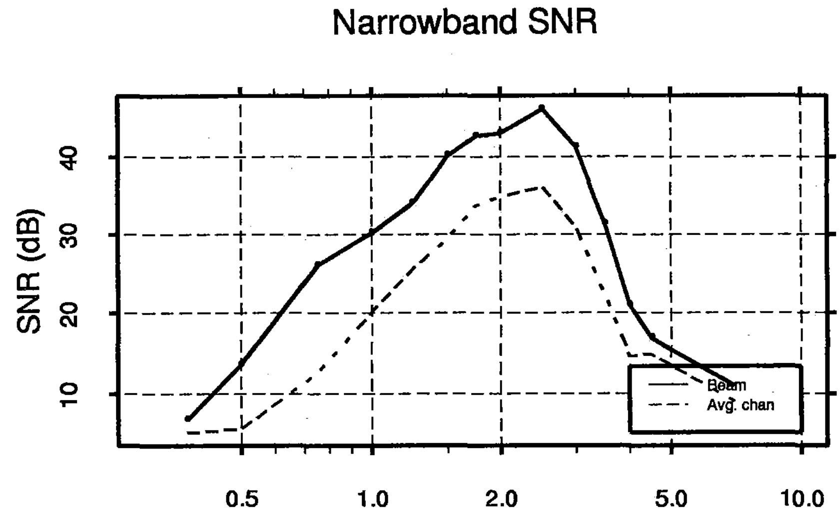
IMS PRIMARY SEISMIC STATIONS



LEGEND

- ● IMS array station
- ▲ IMS 3-C station
- ○ Station operational in GSETT-3 as of October 1996
- \+ Non-IMS GSETT-3 primary station

Fig. 7.3.1. Global map of the stations in the IMS primary network.



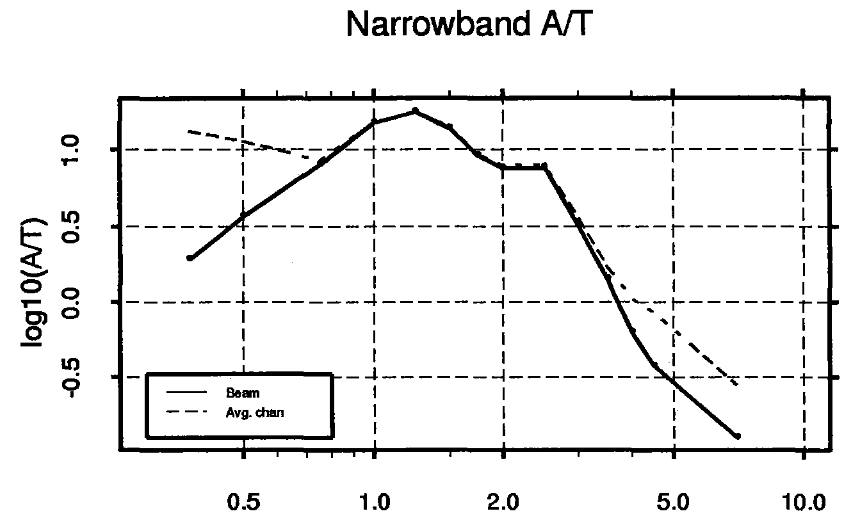


Fig. 7.3.2. The upper part of the figure shows the maximum SNR of the signal from an event at 33.6 degrees distance (no. 5 in Table 7.3.1) measured in a series of narrow filters, where the x-axis corresponds to the center of the filter bands.
The filters were the following given in Hz: 0.25-0.50, 0.25-0.75, 0.50-1.00, 0.75-1.25, 1.00-1.50, 1.25-1.75, 1.50-2.00, 1.75-2.25, 2.0-3.0, 2.5-3.5, 3.0-4.0, 3.5-4.5, 4.0-5.0, 6.0-8.0.
The solid line represents the SNR of the beam and the dashed line represents the average SNR of the array channels. The difference between the two curves can be interpreted as the SNR gain by beamforming.
The lower part of the figure shows the maximum A/T (nm/s) of the narrowband filtered data, measured within 8 seconds of the signal onset. Again the solid line represents the beam, and the dashed line represents the average of the array channels. For the part of the frequency range where the signal is above the background noise level, in this case above 0.75 Hz, the difference between the two curves can be interpreted as the signal loss by beamforming.

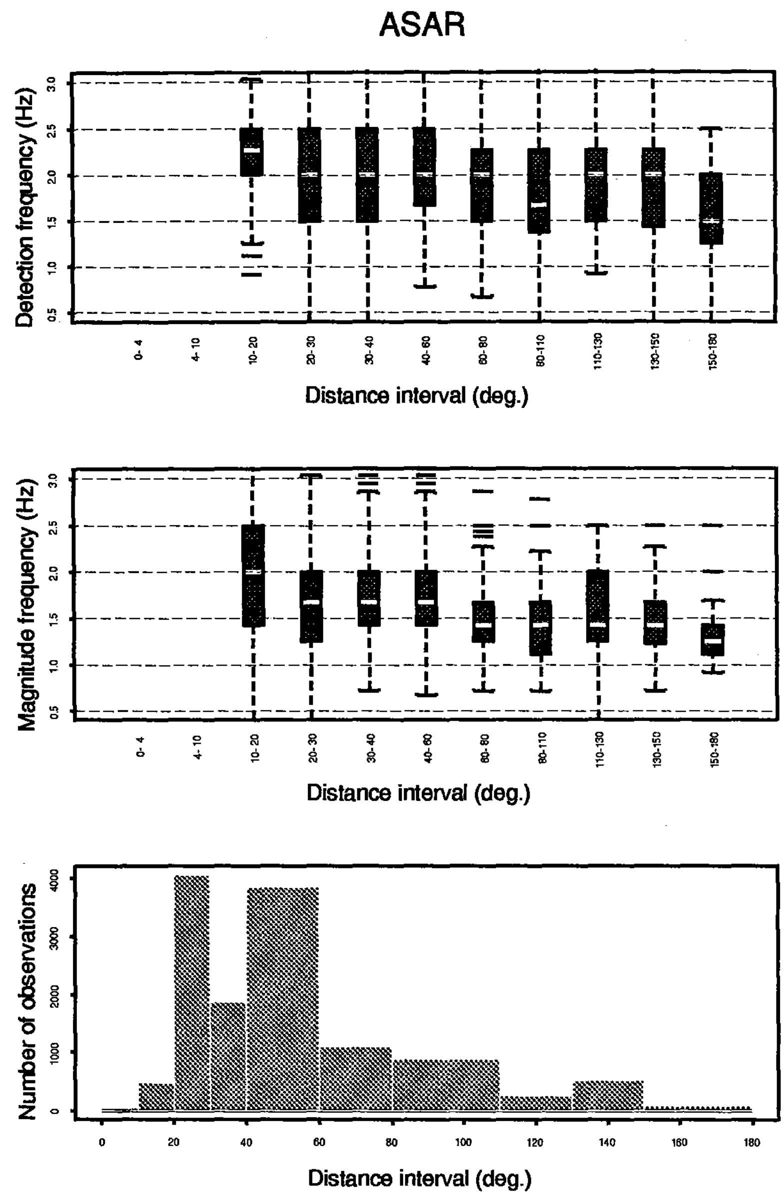


Fig. 7.3.3. The upper part of the figure shows the dominant signal frequencies measured on the filtered beams providing the highest SNR. The data set is **ASAR** *P-phase information given in the database associated with the IDC Reviewed Event Bulletin. For each distance bin, the box represents the span between the 1st and 3rd quartile of the data, and the line in the middle is plotted at the median value. The whiskers extend to 1.5*(inter quartile distance), and observations falling outside this range are given by separate lines. For each distance bin, this plot should thus give us an idea about the frequency range where we would expect the highest SNR.*

The middle part of the figure shows the same type of statistics, but now for the dominant frequencies used in the estimation of event magnitude. Notice that the array beams used in the estimation of m_b have been prefiltered between 0.8 and 4.5 Hz. This plot should give us an idea about the frequency range where we would expect the highest signal amplitudes.

The lower part of the figure shows the number of observations in each distance bin.

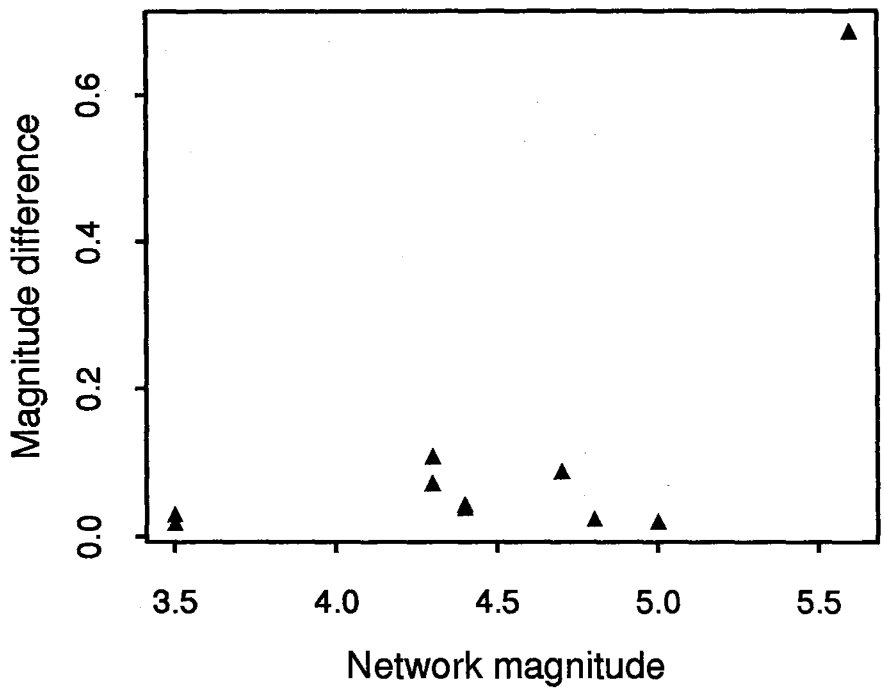
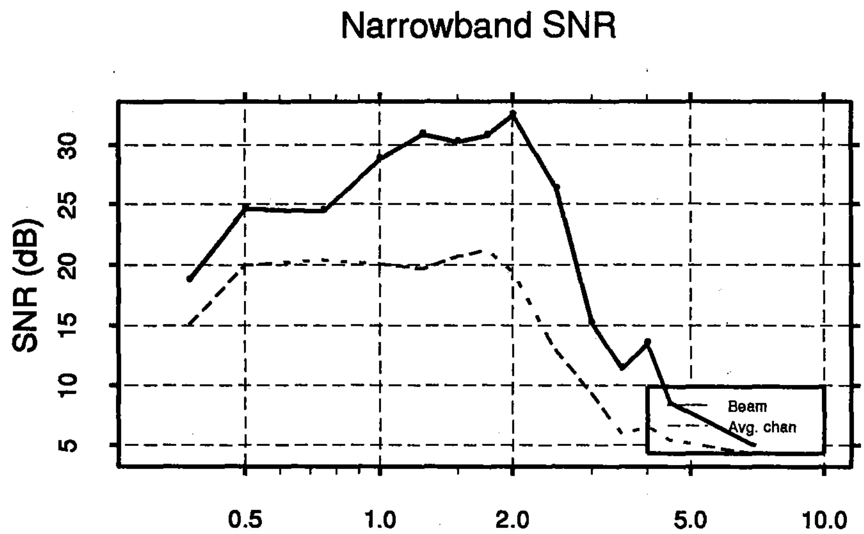


Fig. 7.3.4. For the 10 **ASAR** *events given in Table 7.3.1, we have manually measured the maximum A/T (amplitude and period) on both unfiltered and filtered (0.8-4.5 Hz) data. The magnitude difference,* $\log(A/T)_{unfiltered}-\log(A/T)_{filtered}$*, is plotted versus the network magnitude of the events. Except for the largest event of* m_b *5.6, the correspondence was good, and log(A/T) was on the average about 0.05* m_b *units lower after prefiltering.*



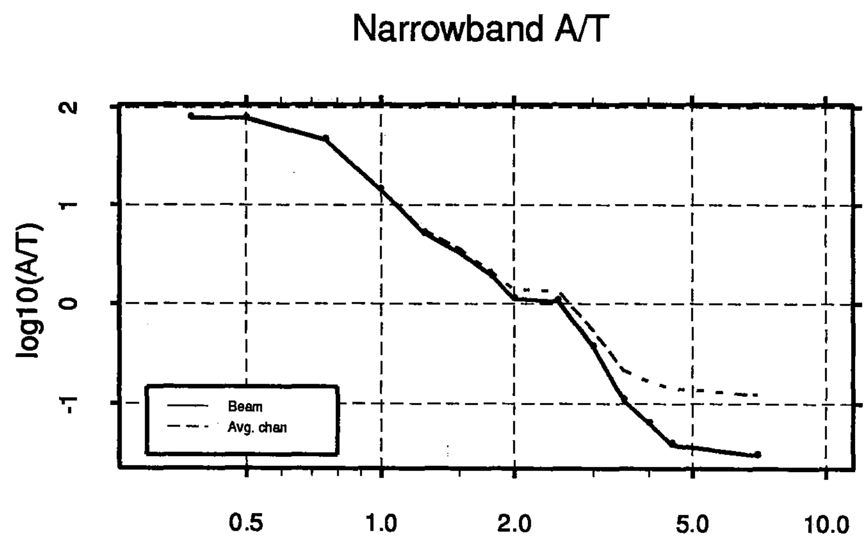


Fig. 7.3.5. Narrowband SNR and narrowband A/T for the m_b 5.6 event (event no. 9 of Table 7.3.1). For details on the plot and data analysis see Fig. 7.3.2. Notice that the largest values of log(A/T) are found for frequencies below 0.8 Hz, whereas the highest SNR is measured between 1 and 2.5 Hz.

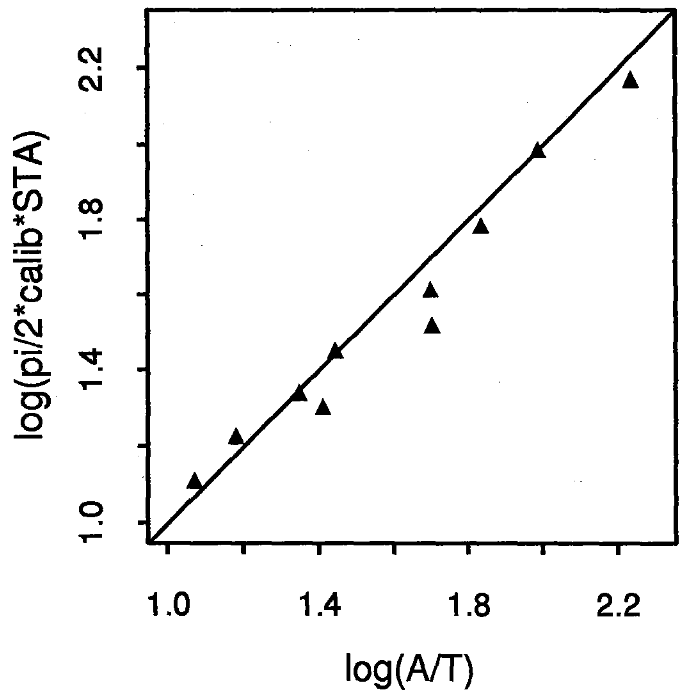


Fig. 7.3.6. This figure shows the relation between the manually measured log(A/T) values and the corresponding values of $\log(\frac{\pi}{2} \cdot calib \cdot STA)$*, where calib is the calibration constant at the reference period. log(A/T) is for this small data set 0.04 units higher than* $\log(\frac{\pi}{2} \cdot calib \cdot STA)$*.*

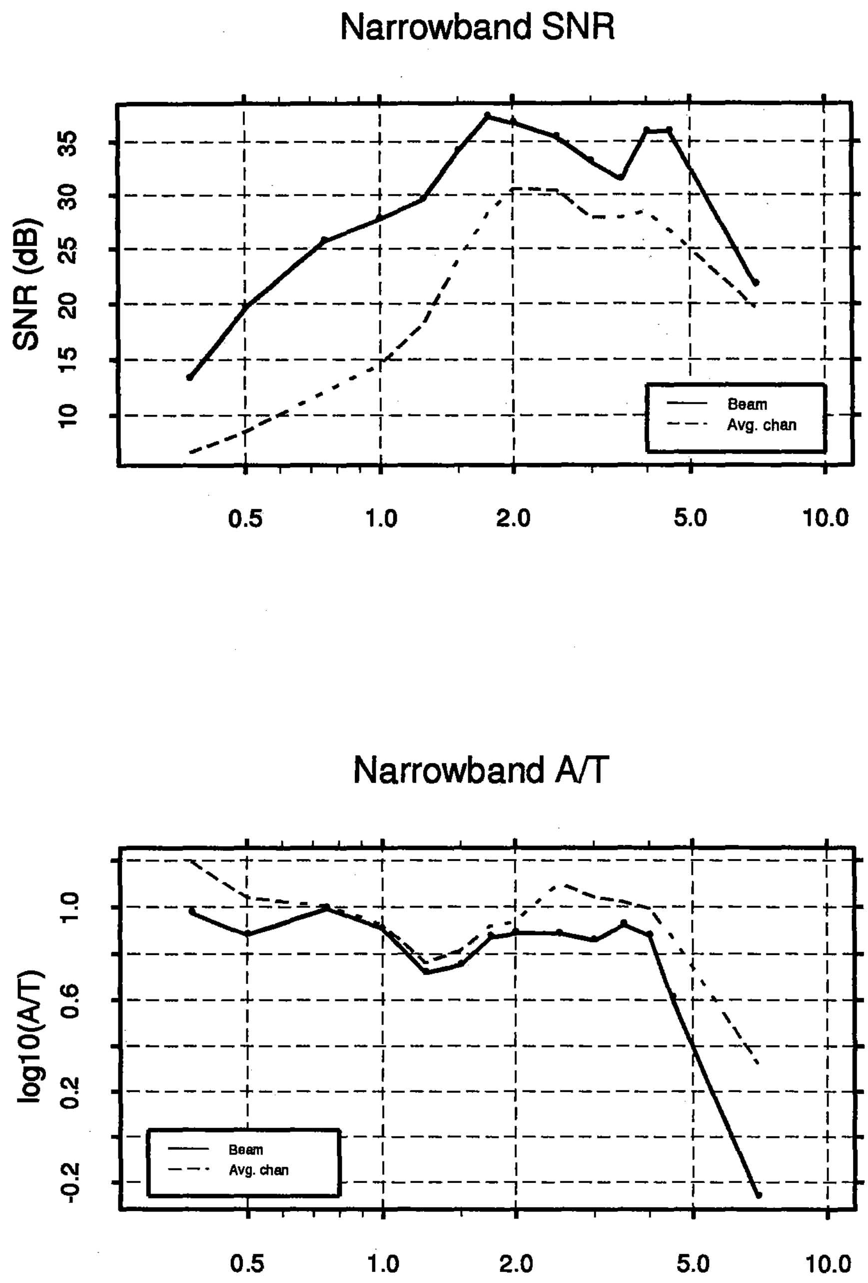


Fig. 7.3.7. Narrowband SNR and narrowband A/T for the regional event at 15.9 degrees distance (event no. 1 of Table 7.3.1). For details on the plot and data analysis see Fig. 7.3.2. Notice the relatively high signal energy up to 4 Hz, as shown on the lower panel of the plot.

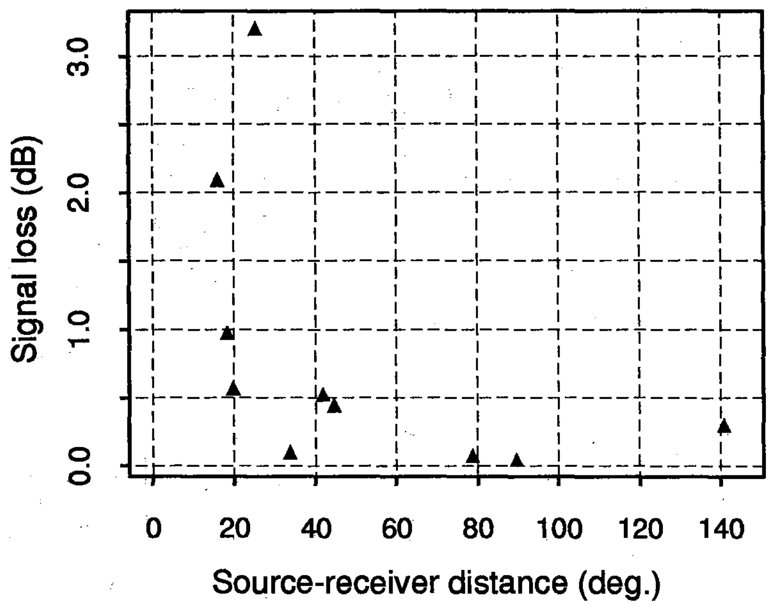


Fig. 7.3.8. Signal loss in the 0.8-4.5 Hz passband after beamforming of the 10 **ASAR** *events given in Table 7.3.1. The beamforming steering parameters are taken from f-k analysis in a 5.5 second window starting 0.5 seconds ahead of the P-phase onset.*

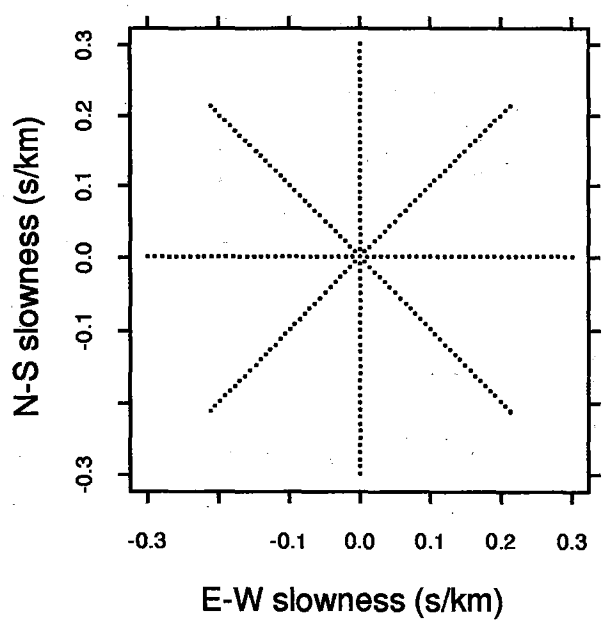


Fig. 7.3.9. This diagram represents the beamforming steering points used for the assessment of signal loss due to mis-steering of the beams. The values are relative to the observed azimuth and slowness of the events. The reason for conducting the analysis using such a pattern of steering points is to obtain representative estimates of signal loss also for arrays with a non-circular configuration like WRA and YKA.

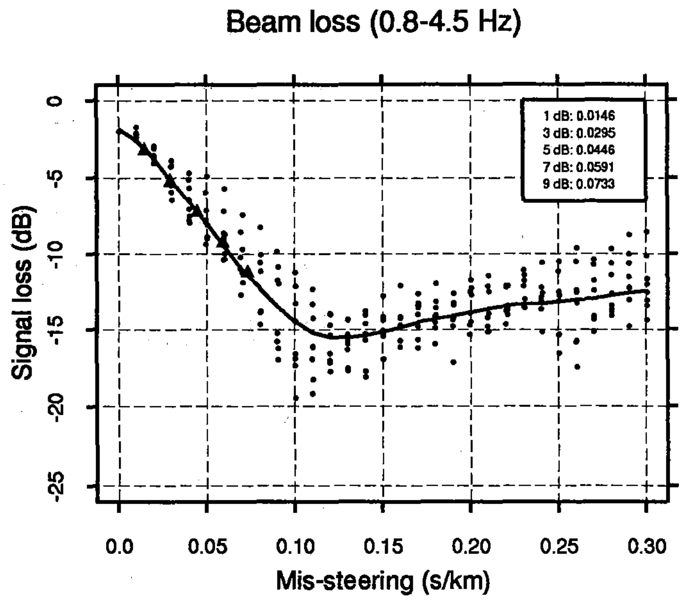


Fig. 7.3.10. Signal loss in the 0.8-4.5 Hz passband of the event at 15.9^o distance (event no. 1 of Table 7.3.1) plotted as a function of the absolute value (s/km) of the mis-steering of the beams. The mis-steering points correspond to those shown in Fig. 7.3.9. The smoothed line is calculated using the S-plus function **supsmu**. *The signal loss with no mis-steering is calculated to 2.1 dB and the smoothed values of mis-steering (s/km) corresponding to additional 1, 3, 5, 7 and 9 dB signal loss are given in the legend of the figure, as well as indicated by filled triangles on the plot.*

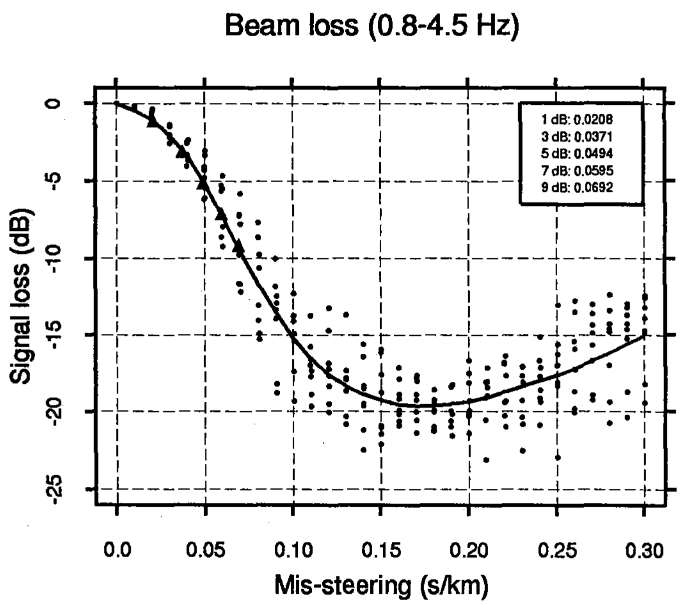


Fig. 7.3.11. Signal loss in the 0.8-4.5 Hz passband of the event at 33.6^o distance (event no. 5 of Table 7.3.1) plotted as a function of the absolute value (s/km) of the mis-steering of the beams. The signal loss with no mis-steering is calculated to 0.1 dB and the smoothed values of mis-steering (s/km) corresponding to additional 1, 3, 5, 7 and 9 dB signal loss are given in the legend of the figure.

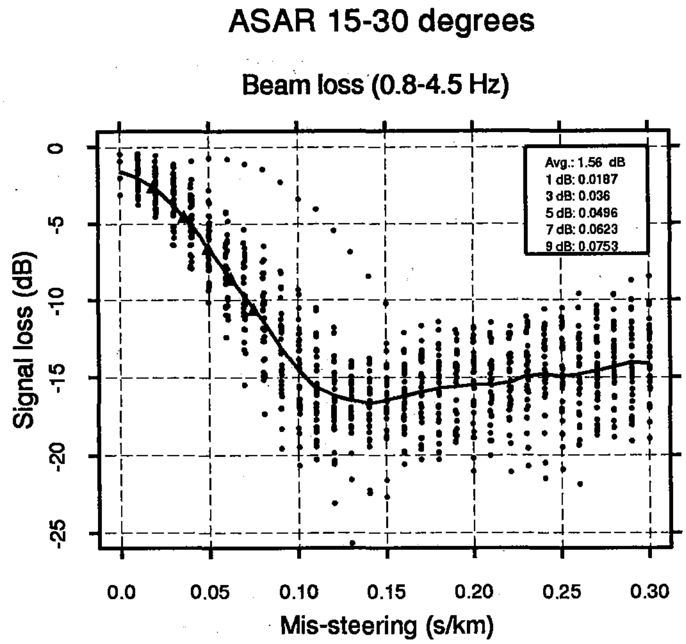


Fig. 7.3.12. Average loss in the 0.8-4.5 Hz passband of the events in the distance interval 15-30^0 plotted as a function of the absolute value (s/km) of the mis-steering of the beams. The smoothed estimate of signal loss with no mis-steering is calculated to 1.56 dB and the smoothed values of mis-steering (s/km) corresponding to additional 1, 3, 5, 7 and 9 dB signal loss are given in the legend of the figure.

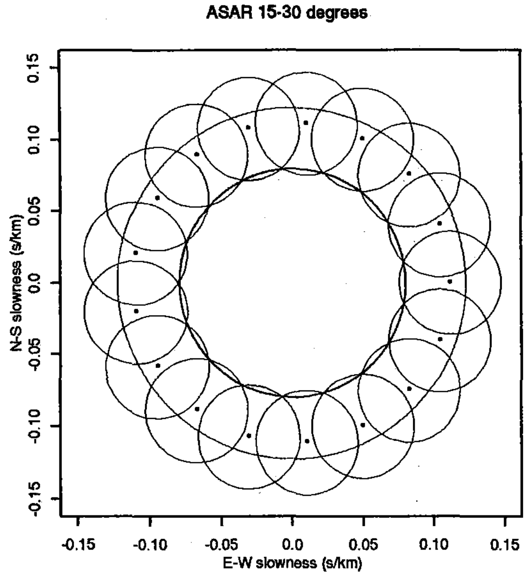


Fig. 7.3.13. Beam deployment for threshold monitoring of events between 15 and 30 degrees distance. The area between the two bold circles corresponds to the expected slowness range according to the IASP91 travel-time table for P-phases from surface events between 15 and 30 degrees. In order to ensure complete coverage within the 3 dB level, it was necessary to deploy only 12 beams. But by extending the beam deployment to 17 beams, and moving the steering points to larger slownesses, the same beam deployment could be used for processing of the 2-15 degrees interval. The steering points of the 17 beams are given by the centers of the small circles. The radii of the small circles are 0.036 s/km, corresponding to the expected mis-steering associated with the 3 dB signal loss (see Fig. 7.3.12).

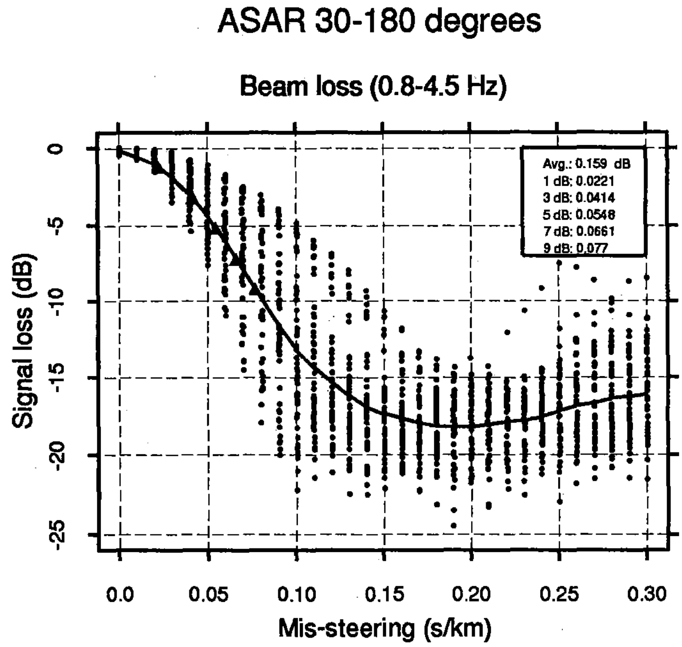


Fig. 7.3.14. Average loss in the 0.8-4.5 Hz passband of the events in the distance interval 30-180^0 plotted as a function of the absolute value (s/km) of the mis-steering of the beams. The signal loss with no mis-steering is calculated to 0.16 dB and the smoothed values of mis-steering (s/km) corresponding to additional 1, 3, 5, 7 and 9 dB signal loss are given in the legend of the figure.

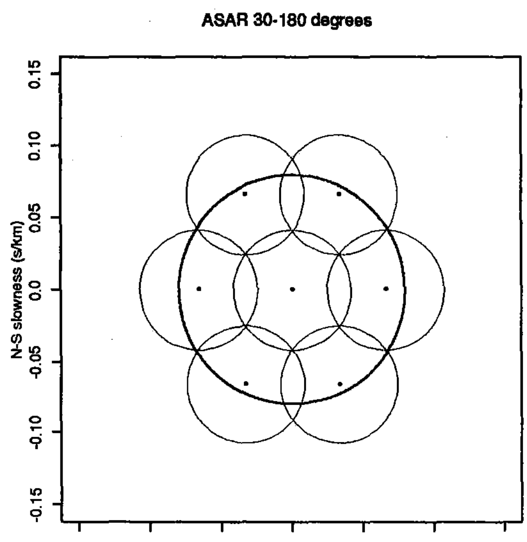


Fig. 7.3.15. Beam deployment for threshold monitoring of events in the distance interval 30-180 degrees. The area within the bold circle corresponds to the expected slowness range according to the IASP91 travel-time table for P-phases from surface events in this distance interval. In order to ensure close to complete coverage within the 3 dB level, it was necessary to deploy 7 beams, represented by the centers of the small circles. The radii of the small circles are 0.041 s/km, corresponding to the expected mis-steering associated with the 3 dB signal loss (see Fig. 7.3.14).

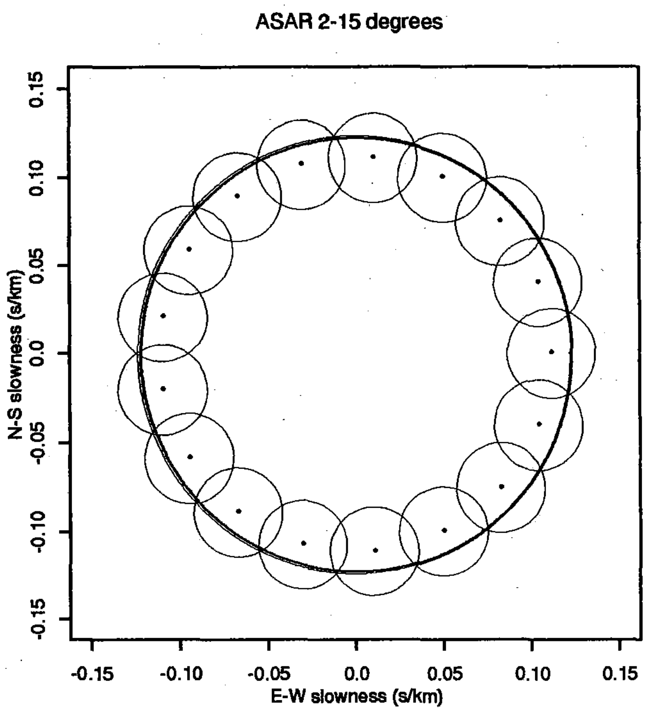


Fig. 7.3.16. Estimated beam deployment for threshold monitoring of events between 2 and 15 degrees distance, assuming a 30% increase in signal loss due to mis-steering relative to events between 15 and 30 degrees. The small area between the two bold circles corresponds to the expected slowness range according to the IASP91 travel-time table for P-phases from surface events between 2 and 15 degrees. By extending the beam deployment for the 15-30 degrees interval to 17 beams and moving the steering points to larger slowness, the same beam deployment could be used for processing of the 2-15 degrees interval. The estimated radii of the small circles are 0.025 s/km, which is 30% smaller than for events within the 15-30 degrees distance range.

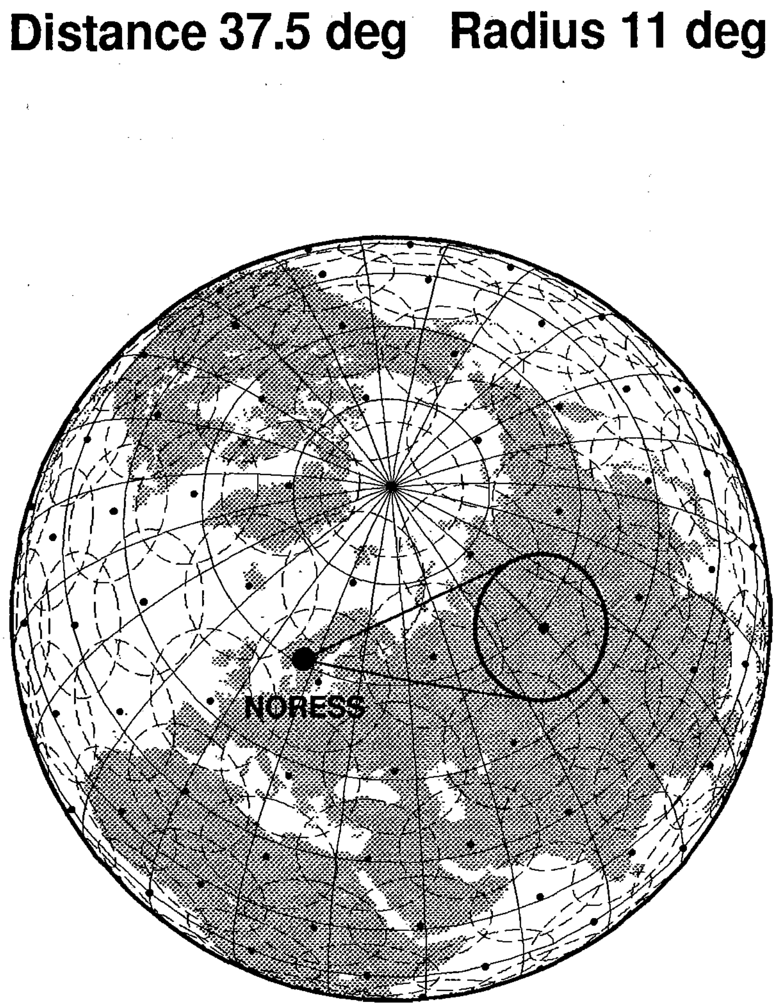


Fig. 7.3.17. Example of a global grid system for threshold monitoring. In order to ensure complete coverage of the Earth's surface, each grid point represents a circular target area. As illustrated on the figure, hypothetical events from a given target area (in this case the highlighted) will span a given range of azimuths, slowness and travel-time when recorded at a given station (in this case NORESS). If we at NORESS deploy a beam with steering parameters corresponding to the center of the highlighted target area, we will need to allow for some mis-steering to cover the entire target area. This mis-steering will generally increase with decreasing distance to the grid points. In order to obtain realistic network magnitude thresholds, the signal loss caused by this mis-steering needs to be taken into account.

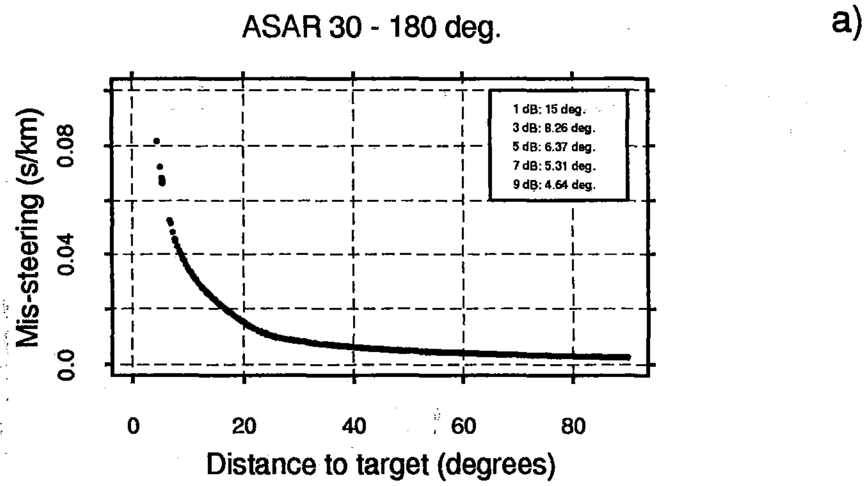


Fig. 7.3.18a. Maximum mis-steering (in s/km) associated with the 2562 globally distributed grid points used in the Threshold Monitoring at the IDC, plotted versus the distance from ASAR *to each of the grid points. Grid points more distant than 90 degrees have not been plotted. The legend provides information on the station-target distances for which the mis-steering causes 1, 3, 5, 7 and 9 dB signal loss when using the relation between signal loss and mis-steering representative for events between 30 and 180 degrees (see Fig. 7.3.14). Notice that for distance above 30 degrees, the mis-steering necessary to compensate for the area of the target regions causes significantly less than 1 dB signal loss.*

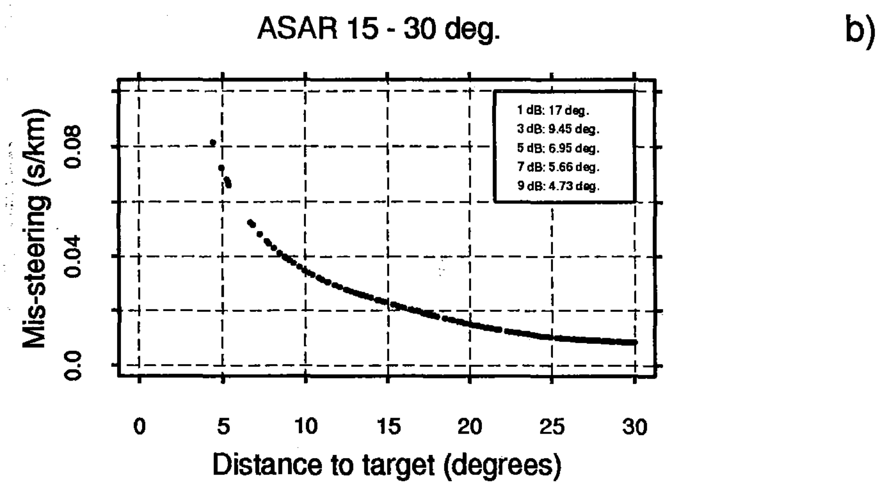


Fig. 7.3.18b. Same as Fig. 7.3.18a, but now for grid points between 15 and 30 degrees. For information on the relation between mis-steering and signal loss, see Fig. 7.3.12. Notice that for the distance interval under discussion (15-30 degrees), the mis-steering necessary to compensate for the area of the target regions causes 1 dB signal loss at 17 degrees distance, and about 1.5 dB at 15 degrees.

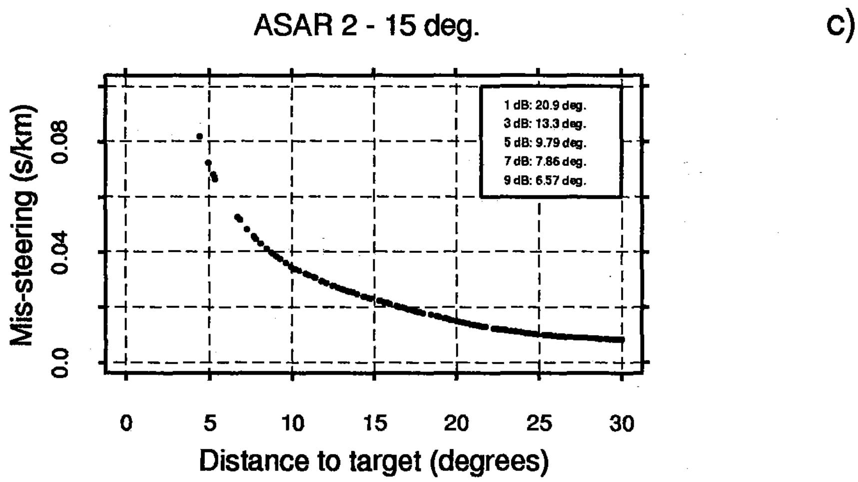


Fig. 7.3.18c. Same as Fig. 7.3.18a, but now for grid points between 2 and 15 degrees. The basis for the relation between mis-steering and signal loss are the values derived for events between 15 and 30 degrees, see Fig. 7.3.12, but now assuming a 30% increase in the sensitivity to mis-steering. Under this assumption we read from the legend that for the distance interval under discussion (2-15 degrees), the mis-steering necessary to compensate for the area of the target regions causes 3 dB signal loss at 13.3 degrees, 5 dB at 9.8 degrees, 7 dB at 7.9 degrees and 9 dB at 6.6 degrees.

7.4 Study of low-magnitude seismic events near the Novaya Zemlya nuclear test site

Introduction

The seismic component of the envisaged CTBT International Monitoring System (IMS) has for some years been nearly complete in Fennoscandia and adjacent regions. This means that the projected capabilities of the monitoring system in these areas can be assessed with basis in actually observed performance of the regional array network in Northern Europe. In particular, the capabilities of this network are representative when it comes to monitoring low magnitude seismic events, since such events would not usually be detectable at teleseismic distances. Thus, even though additional high-quality teleseismic stations in other regions are planned to be included in the IMS network at a later date, the capabilities of the global network to detect and locate small events in the region surrounding Fennoscandia will remain largely unchanged.

Of particular interest is to evaluate the performance of the regional network for seismic events in Novaya Zemlya. These islands comprised one of the two main USSR nuclear test sites for many decades, and became, after the breakup of the USSR, the only designated nuclear testing grounds in the Russian Federation.

This paper provides a brief overview of the history of underground nuclear testing at Novaya Zemlya, with a discussion of the seismic recordings both by the global network and the regional array network in Fennoscandia. This is followed by a discussion in some detail of seismic events at Novaya Zemlya other than the announced nuclear explosions. We focus in particular on some recent, low-magnitude events, for which an excellent coverage of regional arrays has been available.

This paper makes mainly use of seismic stations actually envisaged for the IMS. However, we also use supplementary data from other stations when appropriate, and also make an assessment of the potential contributions of such supplementary data in a CTBT monitoring context.

Station network

The network of regional arrays used in this study is shown in Fig. 7.4.1 and has been described in previous NORSAR Semiannual Technical Summaries. It comprises in general small-aperture arrays, supplemented by the large NORSAR array which has been in operation since 1970. For events occurring before 1985, the NORSAR data have been the main source of information on small events at Novaya Zemlya, whereas for later years, the regional network has provided a significant improvement in monitoring capability for this region.

The first regional array, NORESS, was established in southern Norway in 1984, and has formed the standard for later development of such arrays worldwide, both with regard to array geometry, instrumentation and processing techniques. While NORESS and ARCESS (in northern Norway) were configured with as many as 25 SP sensor sites deployed over an area of 3 km in diameter, most of the arrays constructed later have been somewhat smaller. Thus, the FINESS array has 16 sites and about half the aperture of NORESS, whereas there are 9 sites within an area 1 km in diameter for the arrays at Spitsbergen and Apatity. The recently installed Amderma array is an example of a microarray (Kværna and Ringdal, 1992), comprising 4 SP sites, with a 3-component seismometer in the center, and an aperture of only about 100 m.

All of the arrays in the regional network, with the exception of Amderma, have telemetry to the NORSAR data center at Kjeller. This enables continuous automatic detection processing to be made, supplemented by interactive analysis of the detected signals. The resulting regional bulletins complement the bulletins produced at the GSETT-3 IDC, and provide a useful reference for evaluation and calibration purposes. NORSAR has produced such regional bulletins since 1989.

The regional processing algorithms in use at the NORSAR Data Center comprise the following steps:

- Automatic single array processing, using a suite of bandpass filters in parallel, and a beam deployment that covers both P and S type phases for the region of interest.
- An STA/LTA detector applied independently to each beam, with broadband f-k analysis for each detected phase in order to estimate azimuth and phase velocity.
- Single-array phase association for initial location of seismic events, and also for the purpose of chaining together phases belonging to the same event, so as to prepare for the subsequent multiarray processing.
- Multi-array event detection, using the Generalized Beamforming approach (Ringdal and Kværna, 1989) to associate phases from all stations in the regional network, and thereby provide automatic network locations for events in all of northern Europe.

The processing steps described above result in an automated bulletin that is made available on-line via the Internet. Experience over the past several years has demonstrated that the procedure described above is extremely efficient, and is furthermore "complete" in the sense that it provides an exhaustive search of all possible phase combinations that could correspond to real events. The processing steps described above have now been adopted, with appropriate modifications, at the IDC for global processing, and are also gaining use for other networks.

Seismic events at Novaya Zemlya

Confirmed underground nuclear explosions

A comprehensive list of nuclear explosions in the former USSR has recently been published by Russian authorities (Mikhailov et al, 1996). Table 7.4.1 lists the 42 announced underground explosions that have taken place from 1964 through 1990 at these testing grounds. The table contains comments on the detection of these explosions by the global network of seismograph stations. As can be seen, all of the larger explosions have been well recorded teleseismically, and have been listed in the bulletins of the International Seismological Centre (ISC) and the US National Earthquake Information Service (NEIS). In those cases where two explosions have been carried out simultaneously, only one entry is listed in the global bulletins.

One of the explosions, on 27 July 1972, has not been detected by the global network. We have reviewed the automatic NORSAR detection list for this particular day, and found no detection that could correspond to a Novaya Zemlya explosion. This indicates that the explosion must have been very small, probably below m_b 3.0, which is the approximate detection threshold of the automatic processing at NORSAR. Since the raw data for this day has not been retained, we have not been able to go back and use optimized processing techniques to try to detect this event by more specialized methods than those applied routinely, and we are therefore not in a position to provide a more precise upper limit on the magnitude of this event. Nevertheless, the large scaled depth of this explosion (>400m/(kt)$^{1/3}$ according to Russian sources) suggests that it went off at a yield significantly below the planned yield.

The magnitudes listed in Table 7.4.1 are station-corrected m_b, most of them from Lilwall and Marshall (1986). For events not listed in their paper, we have calculated m_b in a way consistent with their estimates, using either world-wide data or NORSAR recordings.

Other detected seismic events

Very few Novaya Zemlya seismic events apart from the nuclear explosions listed in Table 7.4.1 have been detected by the available station network over the past 25 years. A list of such events, detected either by the global network, by NORSAR or by the regional array network described above, is given in Table 7.4.2. Below, we comment briefly on some of these events, while others will be discussed in more detail in the subsequent sections.

The events in 1973-74, which were all near the southern Novaya Zemlya test site, are thought to be aftershocks of the very large underground nuclear explosions (several megatons yield) at that time. A detailed description of the aftershocks for the first 4 hours following the explosion on 27 October 1973 has been published by Israelson, Slunga and Dahlman (1974).

The event on 1 August 1986 has been analyzed by Marshall, Stewart and Lilwall (1989), who found that this event could be confidently classified as an earthquake at a depth of 24 km. This is the only confirmed, teleseismically recorded, earthquake that is known from this region. In fact, Marshall et al (1989) in their analysis of the 1 August 1986 Novaya Zemlya earthquake, noted that all previous teleseismically detected signals from this region appear to have been resulting from nuclear tests or post-test tectonic activity such as cavity collapses and aftershocks.

It is interesting to note that all of the events in Tables 7.4.1 and 7.4.2 with magnitude 4.0 and higher have been reported in the ISC bulletin, while almost none below this threshold have been listed. This performance is generally consistent with the expected teleseismic detection capability of the global network, which, according to the estimates by Ringdal (1986) would be approximately m_b=4.0 at the 90 per cent level for the Novaya Zemlya region.

NORSAR P-wave recordings of selected events

The large-aperture NORSAR array is situated about 20 degrees from Novaya Zemlya, and has an excellent detection capability for events from this area. The recorded waveforms are usually complex and very high-frequent due to the short epicentral distance and triplication effects caused by heterogeneities in the upper mantle. The signal amplitude variation across the array is quite large, which is a feature attributed to upper mantle focusing effects that is generally typical for signals recorded at this array, at regional as well as teleseismic distances (Ringdal and Husebye, 1982).

A study of such focusing effects for Novaya Zemlya events has been carried out by Ringdal (1990). Fig. 7.4.2 shows the typical amplitude pattern at NORSAR for events from the northern test site. The amplitudes vary by an amount corresponding to more than one magnitude unit, with the strongest signals recorded at subarrays 02C and 03C. In particular, the site at 03C01 has very high amplitudes, even compared to other sites in the same subarray. The amplitude pattern across 02C is much more consistent. Fig. 7.4.3 illustrates the variability in signal shapes and amplitude levels for one of the events in the data base.

In practice, detectability is determined by the signal-to-noise ratio in the "best" frequency band. For NORSAR recordings of Novaya Zemlya events, the filter band of 2.5-4.5 Hz is close to optimum, and because of the amplitude variations described above, the "best" single sensor or subarray has a SNR comparable to or higher than the full array beam. Thus, the focusing effects can be exploited to obtain improved detectability.

Figs. 7.4.4 and 7.4.5 give comparisons of NORSAR P-wave recordings of 3 small events in the data base, one of which is a nuclear explosion. A comparison of the waveforms reveals no significant differences in signal shapes, except for such differences that could be attributed to local (near-source) geology and seismic noise interference, and thus indicates that all of these events are likely to be of a similar source nature. Presumably, the two unknown events are chemical explosions conducted at the test site.

The examples given previously show that seismometers located at sites with favorable receiver effects can be exploited to provide improved detectability, and indicate that signals well below magnitude 3.0 could be detected, using an appropriate high-frequency filter, at a single NORSAR sensor or subarray. Nevertheless, the traditional detection algorithms employed at NORSAR require detection on an array beam in order to provide a location estimate, and high-frequency filters have not been routinely applied in the past. In practice, the actual detection capability of NORSAR, as represented by events listed in the NORSAR bulletin, is estimated to approximately $m_b = 3.0$ for the Novaya Zemlya region. For the years 1970-1990, the list of detected events provided in Tables 7.4.1 and 7.4.2 can therefore be expected to be nearly complete at m_b 3.0 and above.

Recent events recorded by the regional network

As earlier mentioned, the capabilities for monitoring Novaya Zemlya have significantly improved in recent years, with the installation of a high-quality regional array network in Fennoscandia and adjacent regions.

On 31 December, 1992, the regional array system detected and located a small seismic event (m_b=2.7) near the northern Novaya Zemlya test site. This event has been extensively analyzed by the nuclear monitoring community (see e.g. Ryall, 1993). The general consensus in these analyses was that the event could not be confidently classified as either an earthquake or explosion, based on the available data.

On 13 June 1995, the GSETT-3 IDC reported a small seismic event (m_b=3.4) near Novaya Zemlya, Russia. The estimated epicenter in the REB was 75.32°N, 54.85°E, placing the event approximately 100 km west of the islands, but the location error ellipse was rather large and an onshore location could not be excluded. The event was re-analyzed by Ringdal (1996), who located the event near the shore of the northern Novaya Zemlya island, but still at a significant distance from the test site.

On 13 January 1996, the ARCESS and Spitsbergen arrays detected a small seismic event (m_b=2.4) close to the epicenter of the 13 June 1995 event. Although both stations were participating in the GSETT-3 experiment at the time, the IDC did not report the event, presumably because it did not satisfy the criteria imposed to form an event.

It might be of interest to comment briefly on the performance of the automatic detector algorithms employed at the NORSAR data center for such small events. As an example, Table 7.4.3 shows the automatic detection log for the Spitsbergen array during the time periods of the 13 June 1995 and 13 January 1996 events. It can be seen that several phases with consistent azimuths are detected in each case, and that the estimated velocities can be readily used to assign phase type (P or S) to each detection. Note in particular the interfering phase for the 13 January event — this is discussed later in the text.

These three seismic events recorded since 1990 are of special interest in a seismic monitoring context, since they can serve to illustrate the capabilities and limitations of the envisaged International Monitoring System. In the following we present an analysis of these events in some detail, with comparisons to previously recorded underground nuclear explosions at Novaya Zemlya.

Location of the three events since 1992

Fig. 7.4.6 shows our epicentral locations, with error ellipses, of the events of 31 December 1992, 13 June 1995 and 13 January 1996. The figure also shows the approximate geographical extent of the Novaya Zemlya nuclear testing grounds.

As is well known, the 31 December 1992 event was quite close to the test site, and our error ellipse does not exclude a possible on-site location. We note that analysis of this event by other authors has given a smaller error ellipse in some cases (with no overlap with the test site). However, as appropriately noted by both Ryall (1993) and Israelson (1993), there are many unknown factors in the regional calibration for this area, and arrival times are difficult to compare between large and small events, due to the emergent onset of regional phases. It should also be noted that a key station like Spitsbergen has no recordings for known nuclear explosions that could be used for calibration purposes.

The analysis of the 13 June 1995 event has been based on recordings obtained at the three regional arrays Spitsbergen, ARCESS, and Amderma in the distance range 7-10 degrees, whereas we have used only ARCESS and Spitsbergen for locating the 13 January 1996 event. Figs. 7.4.7 and 7.4.8 show filtered Spitsbergen records (4-8 Hz) of a P-beam, an S-beam and one vertical sensor from each of these two events, and it is seen that both the Pn and Sn phases can be clearly identified.We have not been able to observe any Lg phase for these event at Spitsbergen or ARCESS, probably due to the Lg blockage associated with thick sedimentary layers below the Barents Sea as noted in numerous earlier studies. At Amderma, a low frequency Lg phase could be observed for the 13 June 1995 event (Ringdal, 1996), but we have not made use of it in this study.

The events of 13 June 1995 and 13 January 1996 appear to have occurred at approximately the same place, and can with high confidence be located near the coast of the northern Novaya Zemlya islands. Without question, these two events were located at a considerable distance from the northern testing grounds.

Waveform comparisons

It is interesting to compare the waveform characteristics of the small events discussed above to previous nuclear explosions at Novaya Zemlya. In particular it would be of interest to see whether or not it might be possible to "screen out" such events in an automatic screening procedure as envisaged in the CTBT protocol. While we have not at this stage attempted to develop specific screening criteria, there are some obvious comparisons that could be applied to get an indication of how such a procedure might work. We will briefly address this issue in the following.

We have made waveform comparisons of the 5 most recent events at Novaya Zemlya using the ARCESS array. The reason for selecting ARCESS is that this is the only station for which we have high SNR recordings of both the three recent small events and of previous known nuclear explosions. Fig. 7.4.9 shows, as a representative example, ARCESS data from the D4 sensor filtered in a 4-8 Hz band for five events: 13 January 1996, 13 June 1995, 31 December 1992, 24 October 1990 and 4 December 1988 (the latter two being confirmed nuclear explosions).

From Fig. 7.4.9 we note first of all the large differences in SNR as indicated by the amplitude scaling in front of each trace. This is of course due to the differences in event size — the two confirmed nuclear explosions being 2-3 magnitude units larger than the other events. The P-to-S ratios are of particular interest. The S phase is relatively much stronger for the three smaller events, although there is some difference also between the two nuclear explosions.

In Fig. 7.4.10, which shows the same sensor filtered in a high-frequency band (8-16 Hz), the difference in P/S ratio between the two nuclear and the three unknown events is even more pronounced. However, it is premature to draw any firm conclusions about the source type from these observations. First of all, the inherent variability in P/S ratio for the same source type is unknown, and the significance of the observed differences in these ratios is therefore not possible to assess. Moreover, source scaling may be a factor in explaining this difference.

We also note from these two figures that the P/S ratios of the 13 January 1996, 13 June 1995 and the 31 December 1992 events are quite similar in both frequency bands. (The P-S time difference is slightly larger for the former two events because of a greater station-to-event distance.) Again, however, we cannot confidently state that these three events are of the same source type, but the short period data shown are certainly consistent with such a hypothesis.

Magnitudes

In view of the different P/S ratios shown earlier for the five events, their relative magnitudes, as estimated from ARCESS data, would show a different pattern if we use P-phases or S-phases (or S coda phases) for magnitude estimation purposes. We have chosen to use the P-phase in this study and Fig. 7.4.11 shows the P-beam in the 2-4 Hz filter band at ARCESS for the 5 events discussed above. The resulting magnitude (m_b) values are listed in Table 7.4.4.

Our reason for selecting the 2-4 Hz band is that this band is close to the frequencies used at teleseismic distances for m_b computation. In fact, small-aperture arrays in shield areas (such as NORESS and ARCESS) usually have their best teleseismic SNR in this filter band or a band close to it. We note, however, that for events at regional distances, it might sometimes be necessary to choose a higher filter passband, especially for small events with little or no "low frequency" signal energy. This would, because of source-scaling effects, cause a shift towards relatively higher magnitudes for smaller events, when comparing them to larger events with the same filter.

To illustrate this point, we can consider the two filters previously shown (Figs. 7.4.9 and 7.4.10) for ARCESS, and assess the relative sizes of the P-waves in these filter bands. We have found it reasonable to use the single sensor (D4) displayed in these figures, rather than the array beam, in order to avoid beamforming loss at these high frequencies. We use the peak amplitudes of P in each filter band as representative of the relative mb values. The relative magnitude increase for the smaller events at high frequencies is up to 0.5 m_b units, as is reflected in the m_b values listed in Table 7.4.4. This confirms that calculation of magnitudes at regional distances can easily result in ambiguous values. The frequency range of the recorded signal must be given special consideration, and must probably be compensated for by some empirical formula.

Finally, we have looked at the surface waves for the events recorded by the regional network. Once more, the ARCESS array is the most useful reference system. Not unexpectedly, it has been impossible for us to detect surface waves from the two smallest events (31 Dec 92 and 13 Jan 96), but the event of 13 June 95 is large enough to be of interest in this connection. Ringdal (1996) showed narrow-band filtered long period recordings (0.04-0.06 Hz or 17-25 seconds) for the ARCESS center sensor for the two events 24 October 1990 and 13 June 1995. The surface waves for the first event were clearly seen, and the M_s is estimated to 3.5 using Marshall and Basham's (1972) formula. The surface waves of the 13 June 1995 event were marginal, but appeared to just exceed the background noise. The corresponding M_s for this event would be 2.4, using the same formula.

While the M_s:m_b is an effective discriminant at teleseismic distances, its performance in the regional range is not generally proven (recall that the distance from ARCESS to the two events is 10-11 degrees). The values for 13 June 1995 (m_b=3.5, M_s=2.4) would seem to place this event in an intermediate category between the "expected" earthquake population and explosion population, but an appropriate reference data base is not available for this region. It should also be noted that these single-station magnitudes (in particular the M_s value) have a fair amount of uncertainty. Thus, the M_s:m_b data cannot conclusively be used to identify the 13 June 1995 event, but a reasonable screening criterion based on M_s:m_b would probably point out this event as a candidate for more extensive analysis. For the two smallest events (m_b below 3.0), surface waves are not possible to extract with the available station data, and M_s:m_b is therefore not applicable.

Some comments on the location of the 13 January 1996 event

The location of the Novaya Zemlya event of 13 January 1996 has been the subject of considerable debate among seismologists, as discussed in the paper by van der Vink and Wallace (1996). To our knowledge, location estimates for this event range from several tens of kilometers west of our location to as much as 100 kilometers away. We will briefly discuss some of the uncertainties that in our opinion have led to these widely diverging estimates.

We first note that this event has been particularly difficult to locate precisely. In fact, the event serves well to illustrate that very careful analysis is required in order to avoid large location errors when using a sparse network. The problems in this case are twofold:

1. With only two arrays available and poor azimuthal resolution, the application of properly calibrated travel-time curves becomes essential.
2. At one of the arrays (Spitsbergen) there is an interfering local signal immediately preceding the S phase of the Novaya Zemlya event, thus causing problems in reading the S onset.

In the following, we comment briefly on these two points.

Effects of uncalibrated travel-time curves

There are several regional travel-time curves available for the Fennoscandian-Barents region, and Figure 7.4.12a) compares the model used at NORSAR to the IASPEI 1991 model. The figure shows Sn-Pn times as a function of epicentral distance (zero depth), and illustrate the typical systematic bias that could be introduced at a distance of 9-10 degrees if uncalibrated travel-time curves are used. It is seen that this bias alone can cause an error in the distance estimate from a given station of about 60 km. It might be noted that for the 13 January 1996 event, the distance relative to Novaya Zemlya is largely governed by the S-P time of the Spitsbergen array. Thus the application of an uncorrected model to locate this event would result in a location estimate close to 60 km offshore, even if the correct phase readings are made.

Effects of the interfering phase at Spitsbergen

It appears that the S-phase at the Spitsbergen array is preceded by an interfering high-frequency local P-phase, probably originating from an earthquake on the North Atlantic Ridge near 80N, 9E. This is illustrated in Fig. 7.4.13, which shows one sensor trace (B2) filtered in different frequency bands, together with array f-k analysis results. The first arriving phase has a P-type apparent velocity and an azimuth toward the northwest, and the spectral characteristics of this phase are very different from the real S-phase that has an onset about 5 seconds later. As can be seen, the f-k results from this second phase show an S-velocity and an azimuth toward east, in the direction of Novaya Zemlya.

Moreover, we have analyzed recordings from the IRIS station at Kings Bay (KBS), which is situated about 130 km northwest of the Spitsbergen array, and which thus should be closer to the interfering event. This analysis has in fact indicated the presence of both a P and an S phase consistent with such a local event.

It is of course quite a coincidence that this local phase appears just before the S phase of the 13 January 1996 event, but extensive analysis seems to confirm unambiguously that this is in fact the case. It might be noted that local signals are very common at the Spitsbergen array, occurring at a rate of typically several hundred per day, from various azimuths.

With this interpretation, combined with our regional velocity model, the resulting location is at the NZ coast, quite close to the 13 June 1995 event, as previously shown in this paper.

Figure 7.4.12b) illustrates the combined effects of using an uncalibrated velocity model and picking an early arrival (due to the local phase) at the Spitsbergen array. The resulting mislocation would be about 100 km, and this explains the reasons for the very diverging location estimates obtained by different seismologists for the 13 January 1996 event.

An important point resulting from this case study is that locating small events using a sparse network can easily cause ambiguous and sometimes very diverging results, even when the data are analyzed by experts. Awareness of such possible differences in interpretation will be important in a future CTBT monitoring regime.

Conclusions

The Novaya Zemlya region is a low-seismicity area, with only one earthquake clearly identified over the past 30 years. This is in spite of the fact that this area is well covered with regard to seismic stations at both teleseismic and regional distances. Thus, the detection capability of the global network has been estimated at close to m_b 4.0 for Novaya Zemlya. Since 1970, the NORSAR array has provided a detection capability near m_b 3.0. Currently, the detection capability for this area is near m_b 2.5, due to the excellent regional array network that has been developed for CTBT monitoring.

Examples have shown that events of magnitude well below 3.0 can be not only detected, but also located with good accuracy (estimated uncertainty 20-30 km) using the present regional network. However, this capability is by no means matched by the capability to identify detected events as either earthquakes or underground explosions. Even identifying the earthquake of 1 August 1986 (m_b=4.3) was not easy, and required extensive work before a positive identification could be made (Marshall et. al., 1989).

This study has shown that the calculation of body-wave magnitudes at regional distances needs to take into account the bias effects caused when using high-frequency filters. In fact, a positive bias of up to 0.5 magnitude units is introduced in the examples shown here, when comparing a 4-8 or 8-16 Hz filter band to a “teleseismic” 2-4 Hz band.

The 13 June 1995 event provides a particularly interesting case study for the Novaya Zemlya region. It highlights the fact that even for this well-calibrated region, where numerous well-recorded underground nuclear explosions have been conducted, it is a difficult process to reliably classify a seismic event of approximate m_b 3 1/2. It is also shown that supplementary data from a national network can provide useful constraints on event location, especially if the azimuthal coverage of the monitoring network is inadequate. It is clear from this study that more research is needed on regional travel-time calibration, regional signal characteristics and application of M_s:m_b at regional distances. In applying the latter criterion, it would be particularly useful to estimate an upper confidence limit on M_s for events with marginal or non-detected surface waves.

F. Ringdal

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Table 7.4.1: List of the 42 underground nuclear explosions conducted at Novaya Zemlya during 1964-1990, as published by Mikhailov et al (1996). Seismic information is taken mostly from ISC or NEIS bulletins, supplemented by m_b values from Lilwall and Marshall (1986).

No	Date	Time (GMT)	Lat	Lon	Depth	mb	Comment
1	64-09-18	7:59:57.8	73.3	55.4	0	4.20	
2	64-10-25	7:59:58.8	73.5	53.7	0	4.82	
3-4	66-10-27	5:57:57.7	73.4	54.9	0	6.47	Double
5-6	67-10-21	4:59:58.4	73.4	54.4	0	5.99	Double
7	68-11-07	10:02:05.3	73.4	54.9	0	6.11	
8-9	69-10-14	7:00:06.2	73.4	54.8	0	6.18	Double
10	70-10-14	5:59:57.1	73.3	55.1	0	6.77	
11	71-09-27	5:59:55.2	73.4	55.1	0	6.63	
12	72-07-27		71.0	54.0			No detection
13	72-08-28	5:59:56.5	73.3	55.1	0	6.46	
14	73-09-12	6:59:54.3	73.3	55.2	0	6.96	
15	73-09-27	6:59:58.0	70.8	53.9	0	5.83	
16	73-10-27	6:59:57.4	70.8	54.2	0	6.90	
17	74-08-29	9:59:55.5	73.4	55.1	0	6.54	
18	74-11-02	4:59:58.0	70.8	53.8	0	6.75	
19	75-08-23	8:59:57.9	73.4	54.6	0	6.55	
20-21	75-10-18	8:59:56.3	70.8	53.7	0	6.70	Double
22	75-10-21	11:59:57.3	73.4	55.1	0	6.59	
23	76-09-29	2:59:57.4	73.4	54.8	0	5.77	
24	76-10-20	7:59:57.7	73.4	54.6	0	4.89	
25	77-09-01	2:59:57.5	73.4	54.6	0	5.71	
26	77-10-09	11:00:00.3	73.6	53.2	0	4.51	
27	78-08-10	7:59:57.7	73.3	54.8	0	6.04	
28	78-09-27	2:04:58.2	73.4	54.7	0	5.68	
29	79-09-24	3:29:58.3	73.4	54.7	0	5.80	
30	79-10-18	7:09:58.3	73.3	54.8	0	5.85	
31-32	80-10-11	7:09:57.0	73.4	55.0	0	5.80	Double
33	81-10-01	12:14:56.8	73.3	54.8	0	5.91	
34	82-10-11	7:14:58.2	73.4	54.6	0	5.52	
35	83-08-18	16:09:58.6	73.4	54.9	0	5.84	
36	83-09-25	13:09:57.7	73.3	54.5	0	5.71	
37	84-08-26	3:30:00.0	74.1	53.8	0	3.80	NORSAR only
38	84-10-25	6:29:57.7	73.4	55.0	0	5.77	

No	Date	Time (GMT)	Lat	Lon	Depth	mb	Comment
39	87-08-02	1:59:59.8	73.3	54.6	0	5.71	
40	88-05-07	22:49:58.1	73.4	54.4	0	5.52	
41	88-12-04	5:19:53.0	73.4	55.0	0	5.79	
42	90-10-24	14:57:58.1	73.4	54.7	0	5.60	

Table 7.4.2: List of additional seismic events at Novaya Zemlya from ISC bulletins, supplemented by NORSAR and regional array data.

No	Date	Time (GMT)	Lat	Lon	Depth	mb	Source
1	73-10-27	7:52:25.8	71.0	52.6	0	4.5	ISC
2	73-10-27	8:03:58.2	71.0	52.7	0	4.5	ISC
3	73-10-27	8:09:36.0	70.7	53.4	0		ISC
4	73-10-27	8:21:21.8	71.0	52.6	0	4.6	ISC
5	73-10-27	8:56:04.0	71.7	50.7	0	4.0	ISC
6	73-10-27	9:13:51.3	71.2	51.8	0	4.6	ISC
7	74-07-07	16:11:02.0	70.9	52.7	0		ISC
8	74-07-22	1:32:21.5	70.7	53.5	0		ISC
9	74-11-02	5:22:38.0	70.8	53.8	0		ISC
10	78-11-15	8:30:00.0	73.4	55.0	0	3.6	NORSAR
11	86-08-01	13:56:37.8	73.0	56.7	24	4.3	Marshall et al
12	87-08-25	14:00:00.0	74.1	54.6	0	3.2	NORSAR
13	92-12-31	9:29:24.0	73.6	55.2	0	2.7	Reg. arrays
14	95-06-13	19.22.37.9	75.2	56.7	0	3.5	Reg. arrays
15	96-01-13	17:17:23.0	75.2	56.7	0	2.4	Reg. arrays

Table 7.4.3: Excerpts of Spitsbergen array automatic detection log corresponding to the times of two events discussed in the text (13 June 95 and 13 January 96). Note the interfering phase on 13 January, marked as *).

	Station	DPX	Arrival_time	Beam	SNR	Vel	Azi	Phase
13 Jun 1995	SPI	911511	164:19.24.54.3	S083	363.10	7.40	98.70	Pn
	SPI	911513	164:19.24.57.8	S021	5.40	6.10	95.80	Px
	SPI	911514	164:19.25.02.1	S077	9.30	7.30	94.00	Px
	SPI	911515	164:19.25.04.7	SI05	5.60	7.60	100.10	Px
	SPI	911518	164:19.25.06.7	SI04	3.20	7.60	94.80	Px
	SPI	911523	164:19.26.38.1	SI05	8.70	3.20	87.10	Sn
	SPI	911525	164:19.26.41.9	S076	8.10	3.80	89.80	Sx
	SPI	911526	164:19.26.42.4	S097	7.80	4.20	95.40	Sx
13 Jan 1996	SPI	620810	013:17.19.38.6	S073	25.20	7.80	98.90	Pn
	SPI	620813	013:17.19.42.3	S084	9.60	7.10	97.20	Px
	SPI	620816	013:17.19.43.0	S058	5.80	7.20	94.40	Px
	SPI	620818	013:17.19.47.9	S074	6.70	7.00	97.30	Px
	SPI	620820	013:17.21.17.3	S066	4.60	12.00	306.90	*)
	SPI	620821	013:17.21.24.3	SI05	6.30	3.70	84.40	Sn
	SPI	620823	013:17.21.26.8	S075	5.50	3.90	83.80	Sx

Table 7.4.4: Magnitudes (m_b and M_s) measured at ARCESS for the five events discussed in the text. The m_b values (2-4 Hz) have been normalized using m_b=5.6 of the 24 October 1990 event as a reference, and the effect of choosing two higher frequency bands is also shown.

	ARCESS m_b	"High-frequency" m_b		ARCESS M_s
	2-4 Hz	4-8 Hz	8-16 Hz	(20 s)
4 Dec 1988	5.67	5.65	5.71	-
24 Oct 1990 (reference)	5.60	5.60	5.60	3.5
31 Dec 1992	2.75	3.16	3.34	-
13 Jun 1995	3.54	3.88	3.85	2.4
13 Jan 1996	2.40	2.62	2.81	-

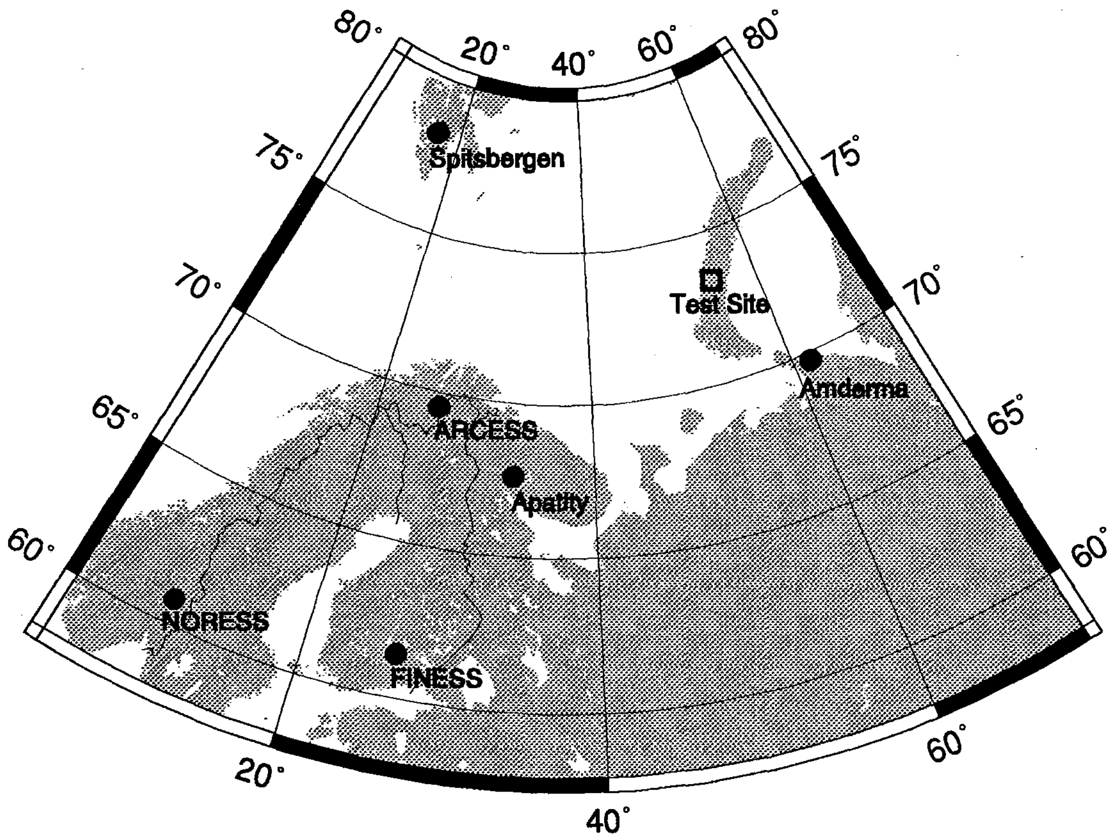


Fig.7.4.1. Map showing the locations of regional arrays in Northern Europe. The location of the northern Novaya Zemlya nuclear test site is also shown.

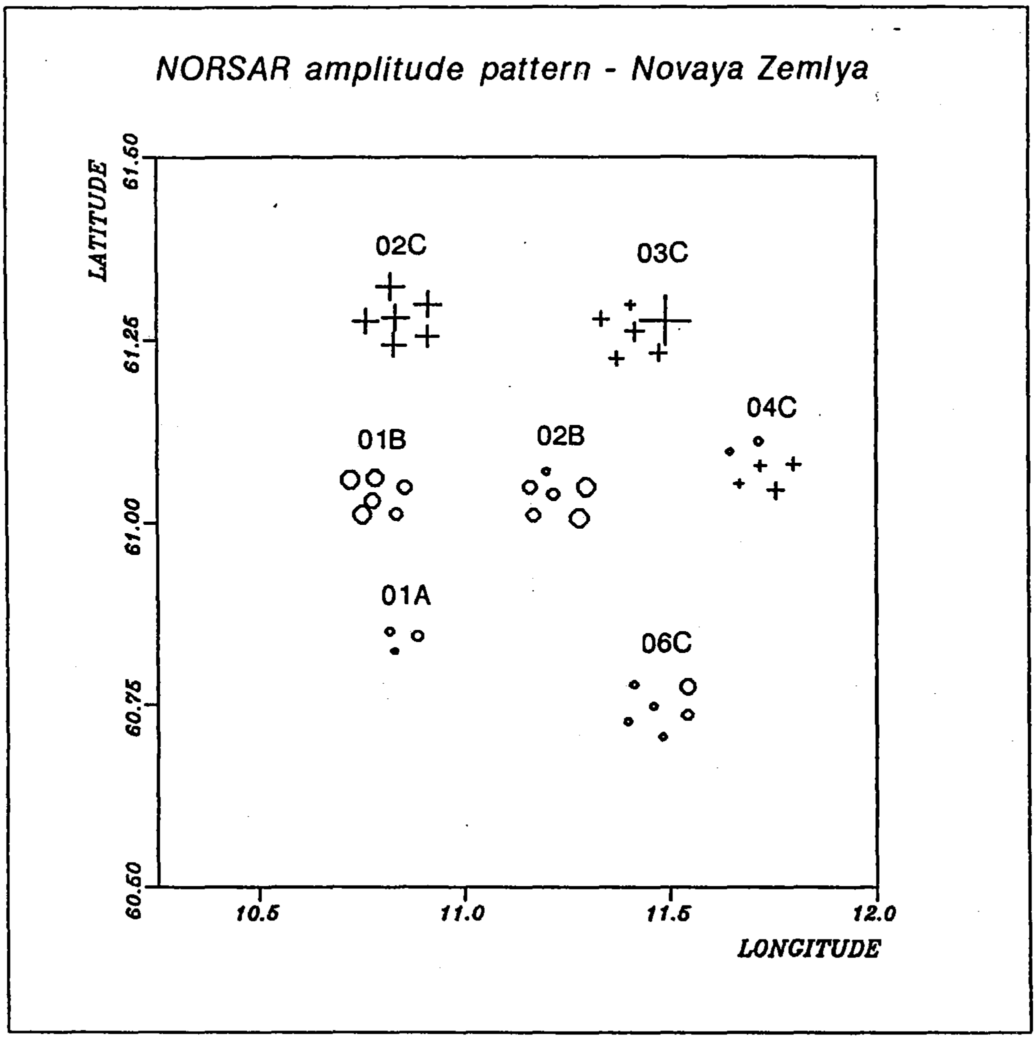
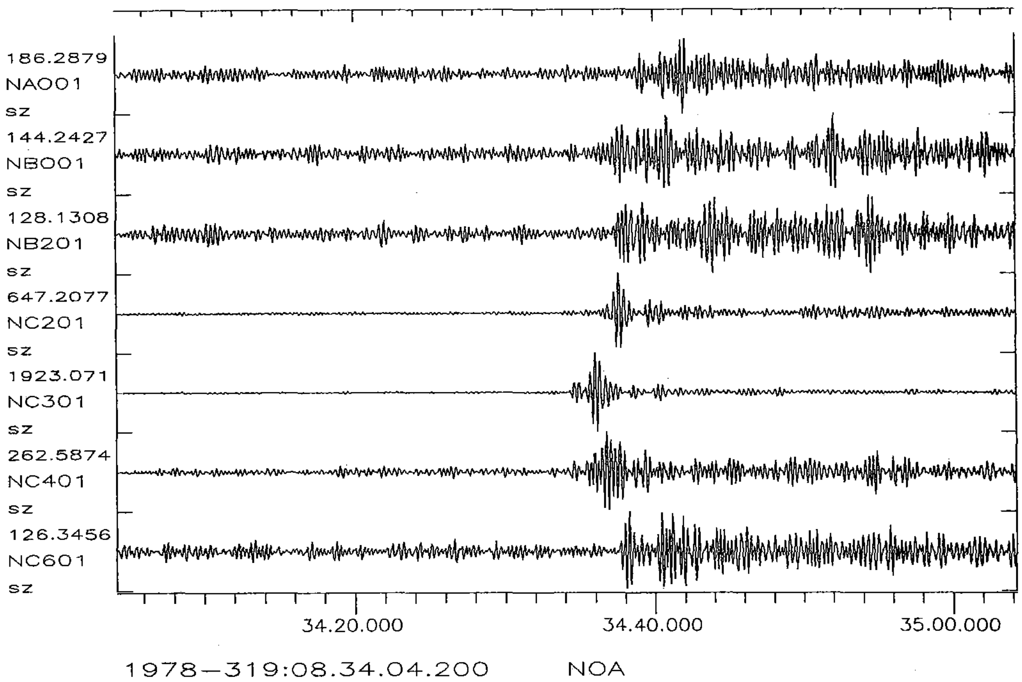


Fig. 7.4.2. Typical P-wave amplitude pattern across the NORSAR array for seismic events from the northern Novaya Zemlya test site. The symbols represent magnitude bias relative to average NORSAR m_b. Plusses indicate positive values), and the symbol size is proportional to the size of the bias. Note the high bias for all sites within subarray 02C, and the especially high bias value at 03C01. The range of the bias values is from +0.9 (03C01) to -0.3 (01B05).

Novaya Zemlya 15 Nov 78 (NORSAR center sensors)



Novaya Zemlya 15 Nov 78 (NORSAR subarray 03C)

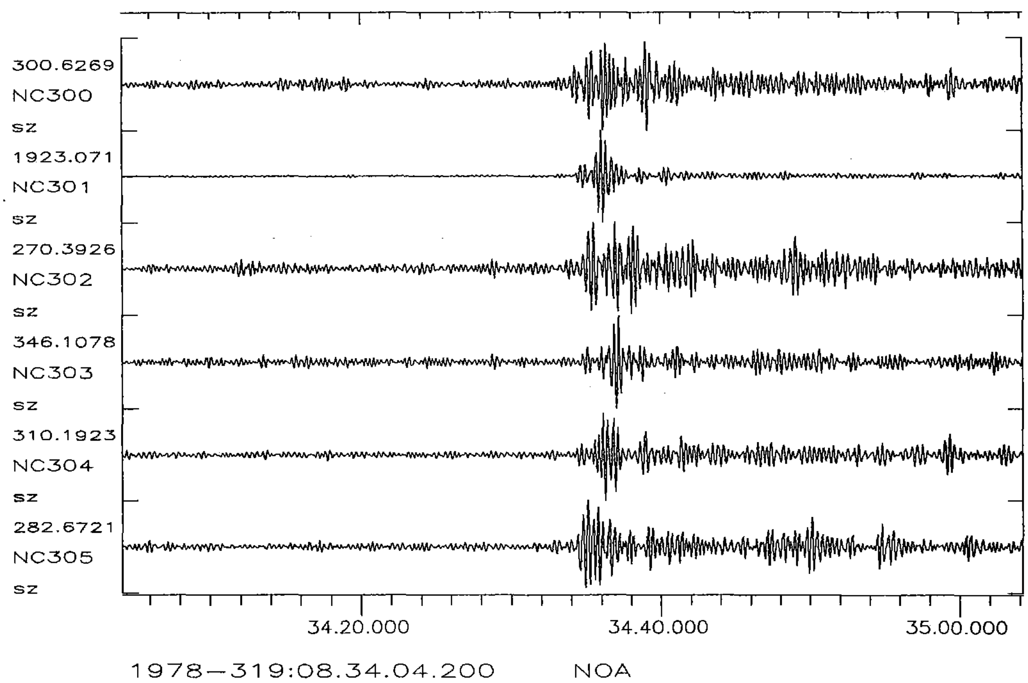
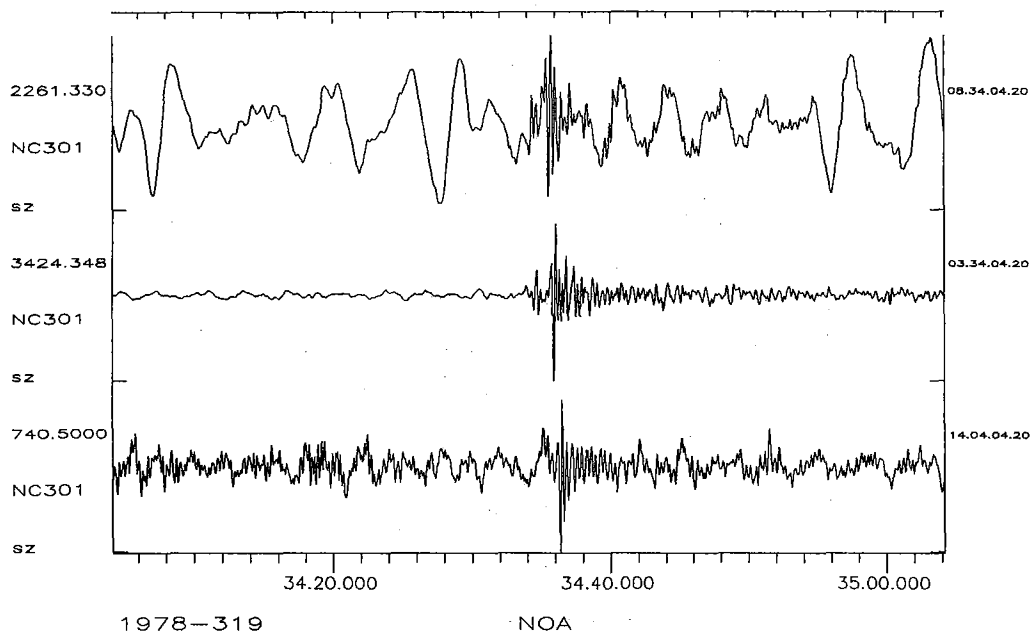


Fig. 7.4.3a and b. Recordings of a Novaya Zemlya event (15 Nov 78) at the center sites of the NORSAR subarrays (top) and at all sites of subarray 03C (bottom). Data have been filtered in the band 2.5-4.5 Hz, and scaling factors are shown to the left of each trace. Note the large variations in amplitudes, signal shapes and signal-to-noise ratios.

NORSAR 03C01 data for 3 Novaya Zemlya events (unfiltered)



NORSAR 03C01 data for 3 Novaya Zemlya events (2.5-4.5 Hz)

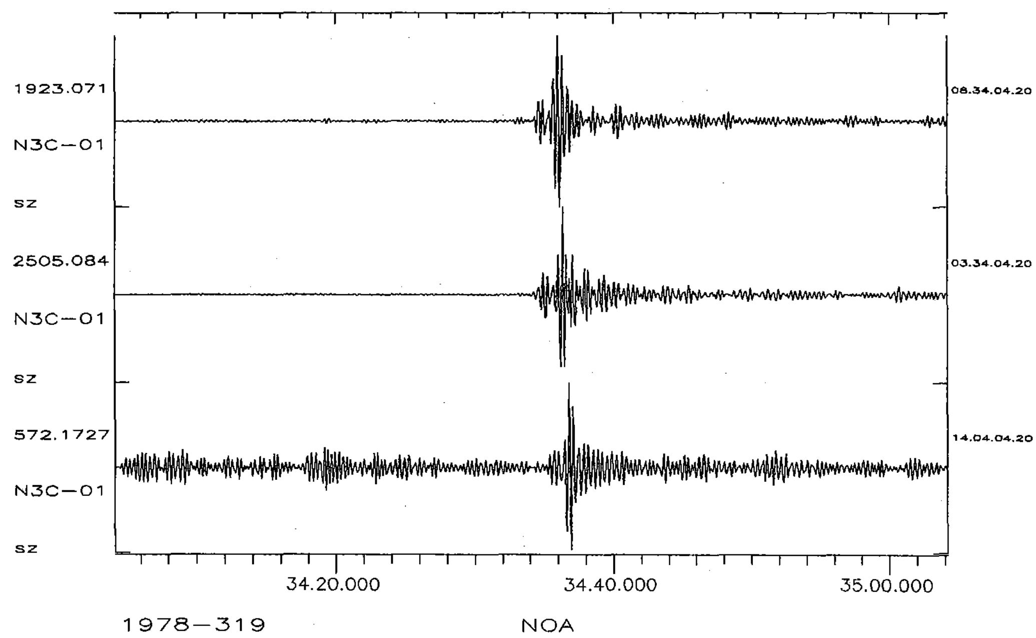


Fig. 7.4.4 a and b. Comparison of recordings at NORSAR site 03C01 for three low-magnitude events near the northern Novaya Zemlya test site (from top to bottom 15 Nov 78, 26 Aug 84 and 25 Aug 87). Data are shown unfiltered (top) and in the 2.5-4.5 Hz passband (bottom). One of these (the middle trace, 26 Aug 84) is a confirmed nuclear explosion. Note the similarity of the three event recordings.

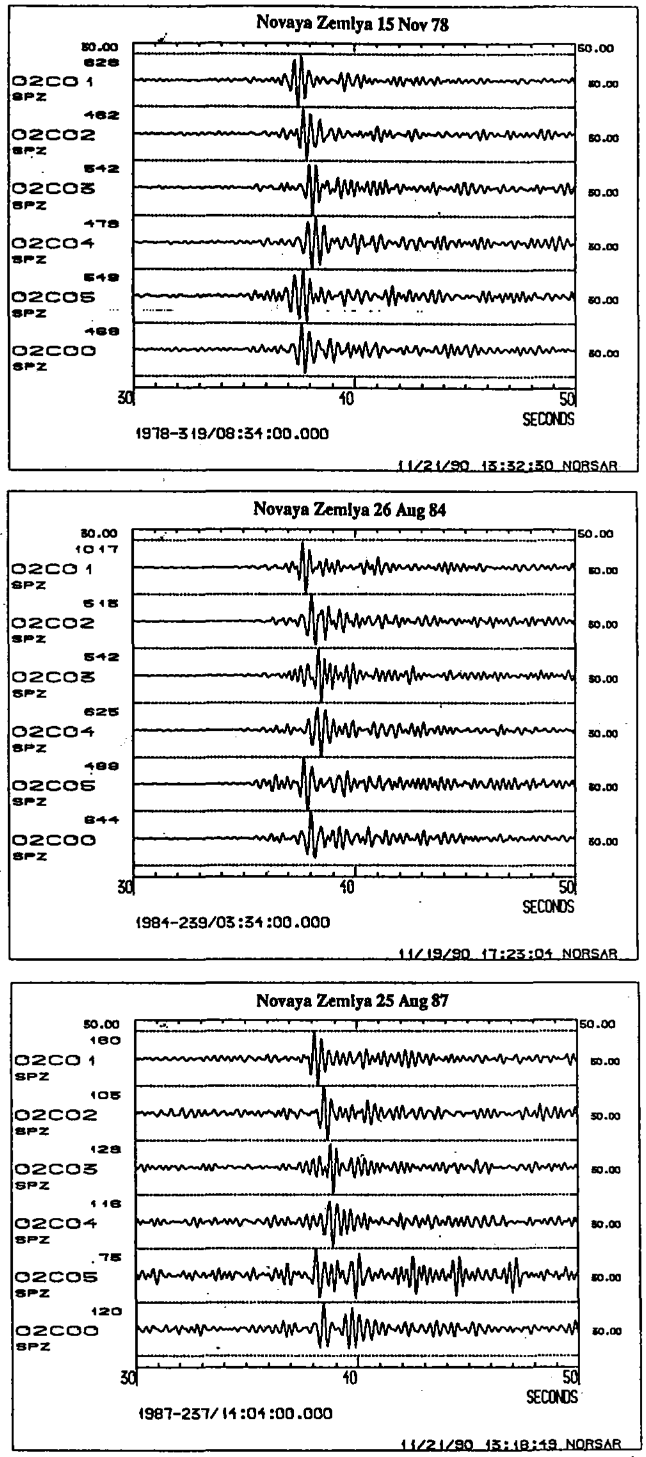


Fig. 7.4.5. Comparison of the same three events as displayed in Fig. 7.4.4, showing the recordings across a NORSAR subarray (02C). The signal patterns are very similar, with slight differences between the events that could be explained by a combination of local (near-source) scattering and interference of background seismic noise.

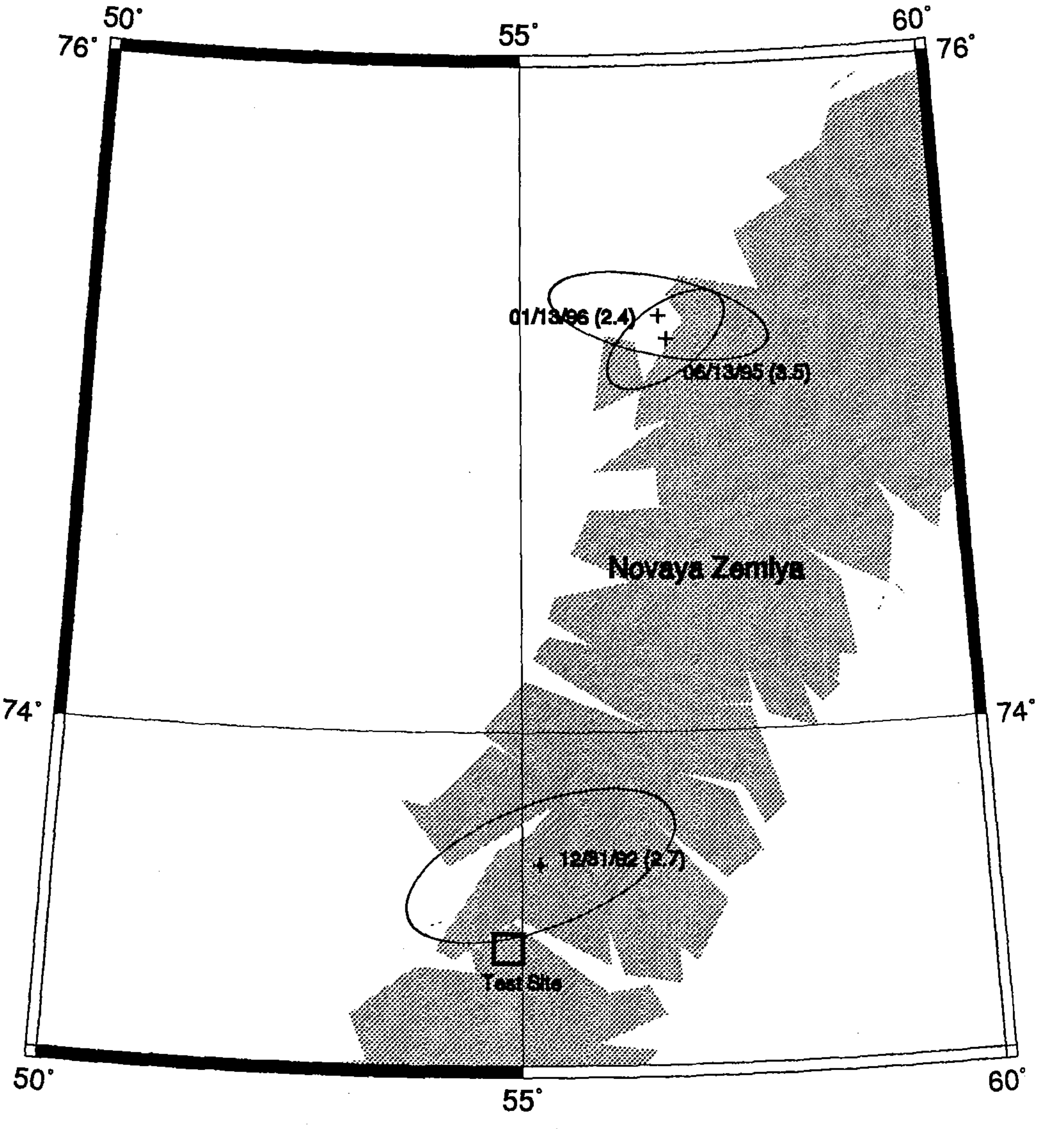


Fig. 7.4.6. NORSAR's location estimates of the three small events at Novaya Zemlya detected since 1992. The error ellipses (90% confidence) are based on assumed prior uncertainties in the regional travel-time tables and onset time readings, and must be taken as only a tentative indication of the actual epicentral accuracy.

Novaya Zemlya 13 Jun 1995 — Spitsbergen

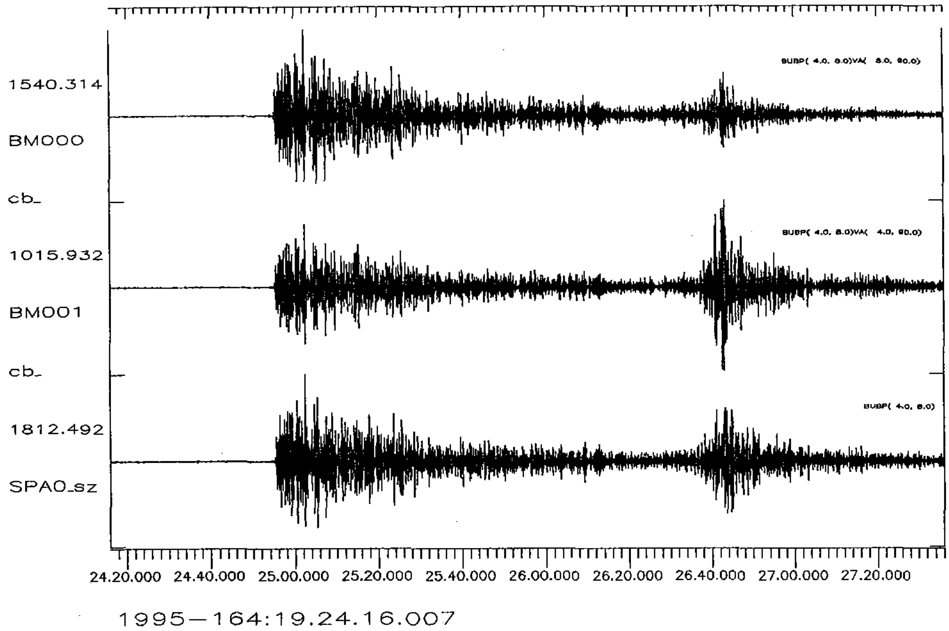


Fig. 7.4.7. Recordings by the Spitsbergen array of the event of 13 Jun 95. The traces represent (from top to bottom) an array beam steered with P-velocity toward the epicenter, an array beam with S-velocity and the array center sensor, each filtered in the band 4-8 Hz.

Novaya Zemlya 13 Jan 1996 — Spitsbergen

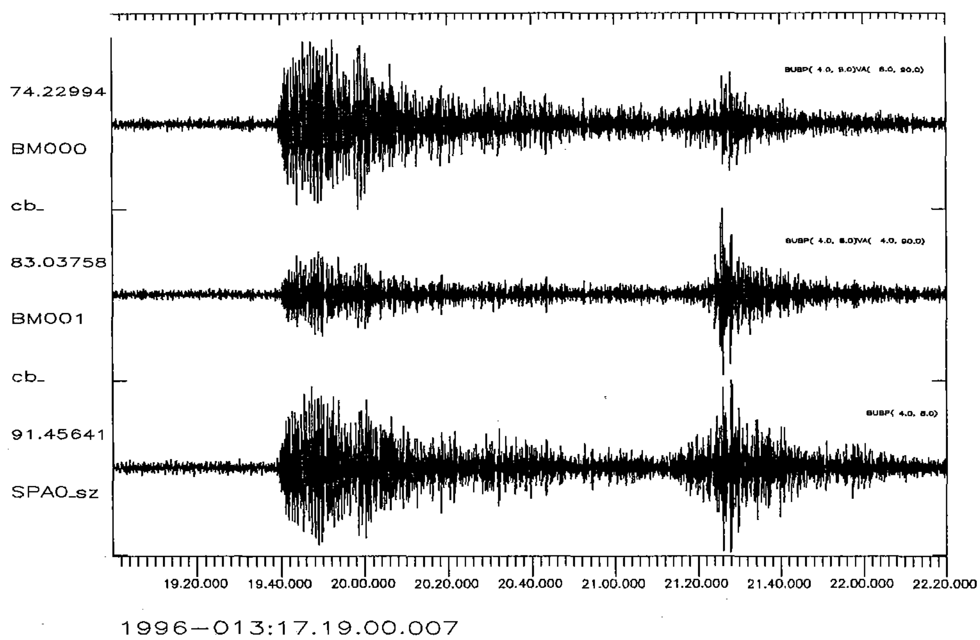


Fig. 7.4.8. Recordings by the Spitsbergen array of the event of 13 Jan 96. The traces represent (from top to bottom) an array beam steered with P-velocity toward the epicenter, an array beam with S-velocity and the array center sensor, each filtered in the band 4-8 Hz. Note the similarity to Fig. 7.4.7.

ARCESS data for 5 Novaya Zemlya events (4-8 Hz)

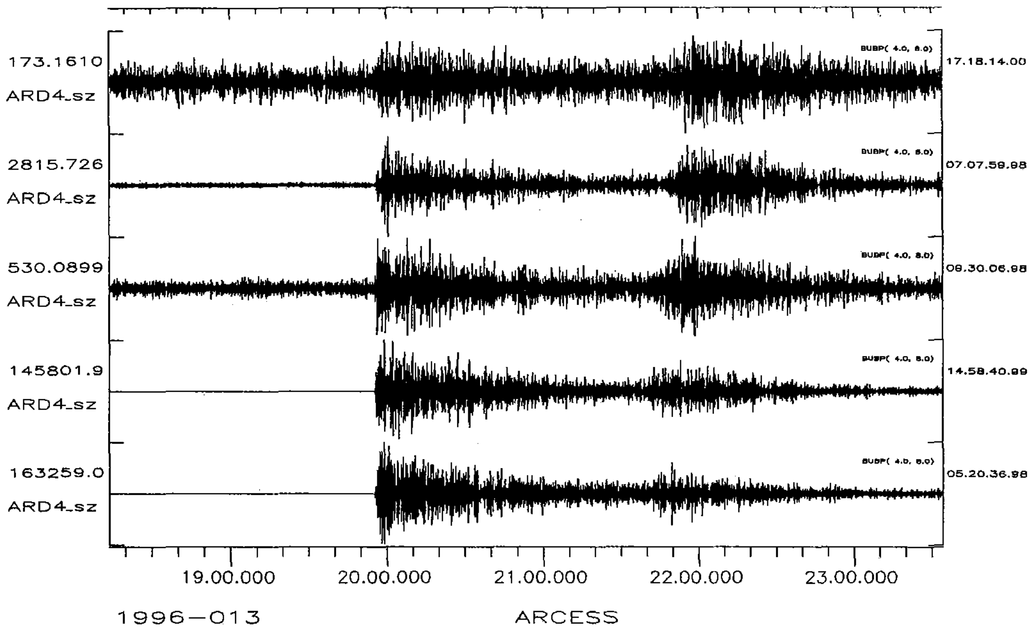


Fig. 7.4.9. Bandpass filtered recordings (4-8 Hz) of the ARCESS D4 sensor for 5 Novaya Zemlya events. From top to bottom: 13 Jan 96, 13 Jun 95, 31 Dec 92, 24 Oct 90 and 4 Dec 88. Note the variations in P/S ratios.

ARCESS data for 5 Novaya Zemlya events (8-16 Hz)

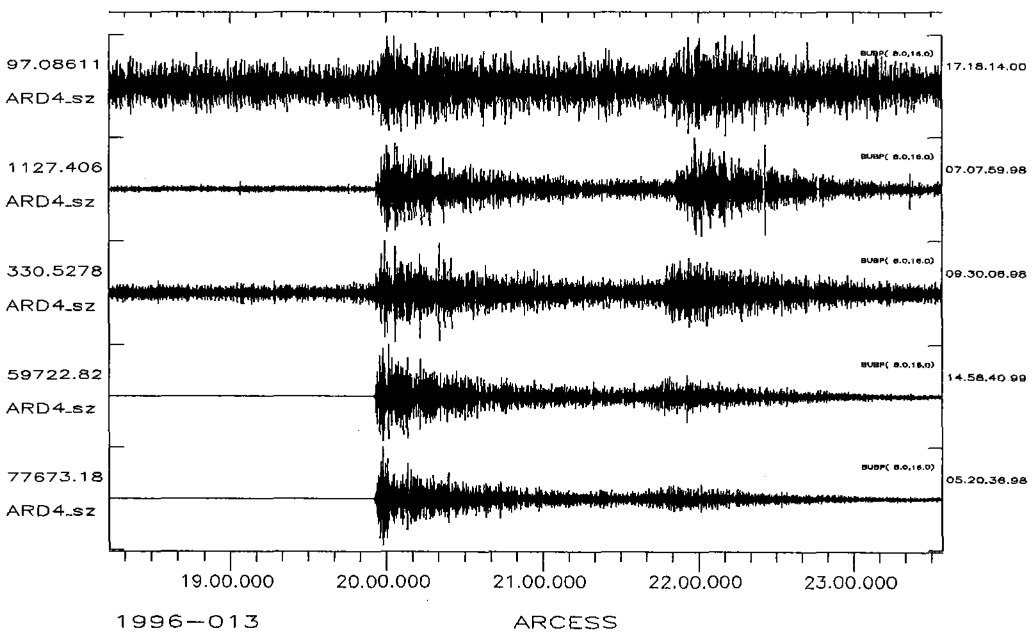


Fig. 7.4.10. Same as Fig. 7.4.9, but for the 8-16 Hz filter band.

ARCESS P-beams for 5 Novaya Zemlya events (2-4 Hz)

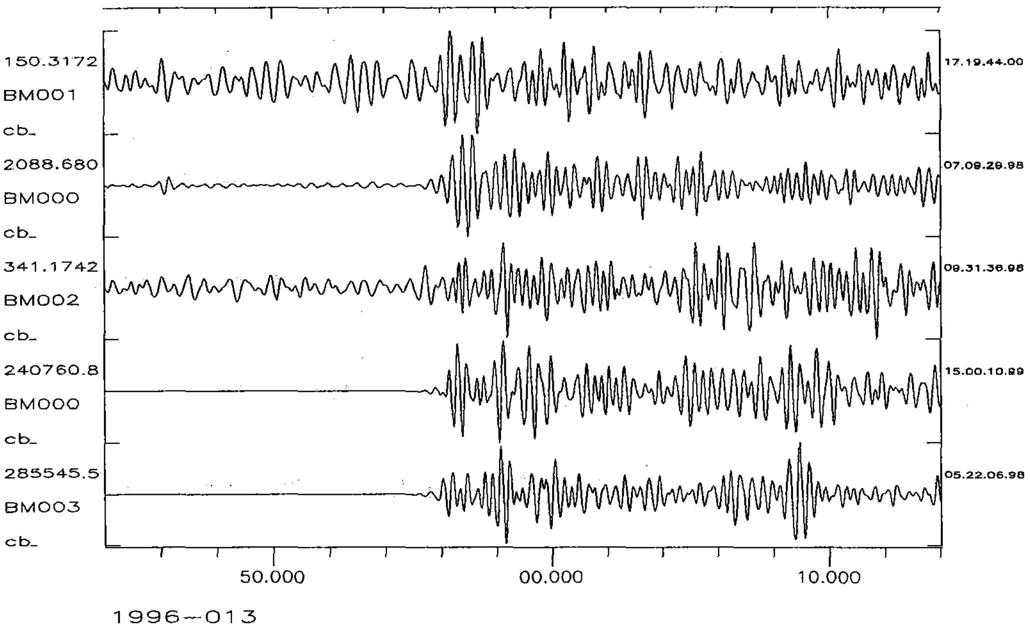
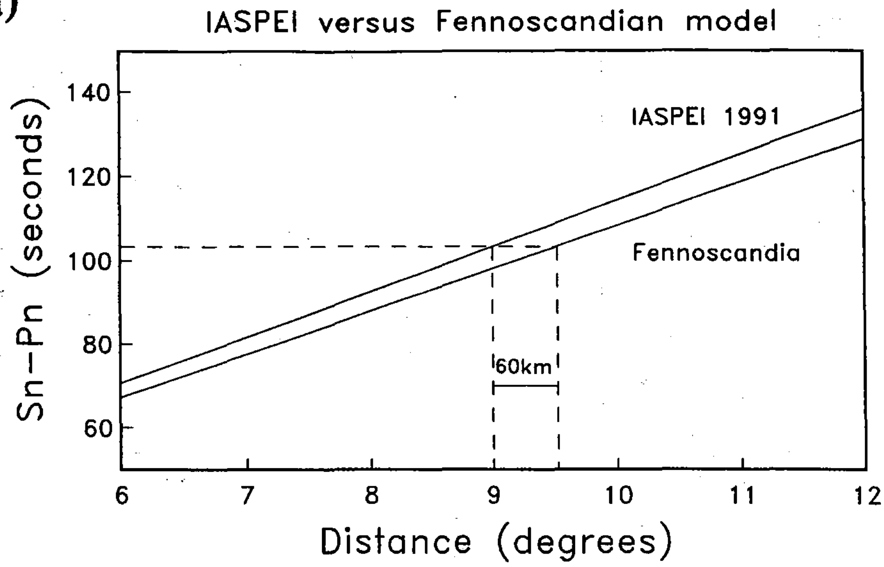


Fig. 7.4.11. P-waves (ARCESS array beam) for five Novaya Zemlya events. From top to bottom: 13 Jan 96, 13 Jun 95, 31 Dec 92, 24 Oct 90 and 4 Dec 88. The data have been filtered in the 2-4 Hz band, which is not the best band for detection, but which provides consistency in magnitude estimates between large and small events. Scaling factors are shown to the left of each trace.

a)



b)

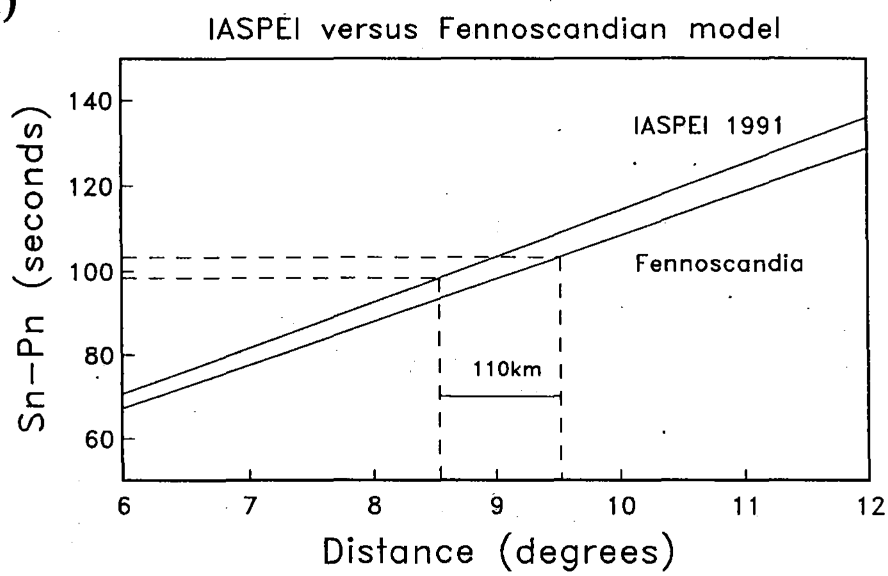


Fig. 7.4.12. Illustration of differences in epicentral distance estimates as discussed in the text:

a) "Error" resulting from applying the IASPEI91 traveltime curves rather than the Fennoscandian model. The difference is about 60 km for the Spitsbergen array.

b) Combined "error" resulting from applying an uncorrected model as well as reading the S-phase at Spitsbergen 5 seconds early. The location "error" in this case amounts to about 110 km.

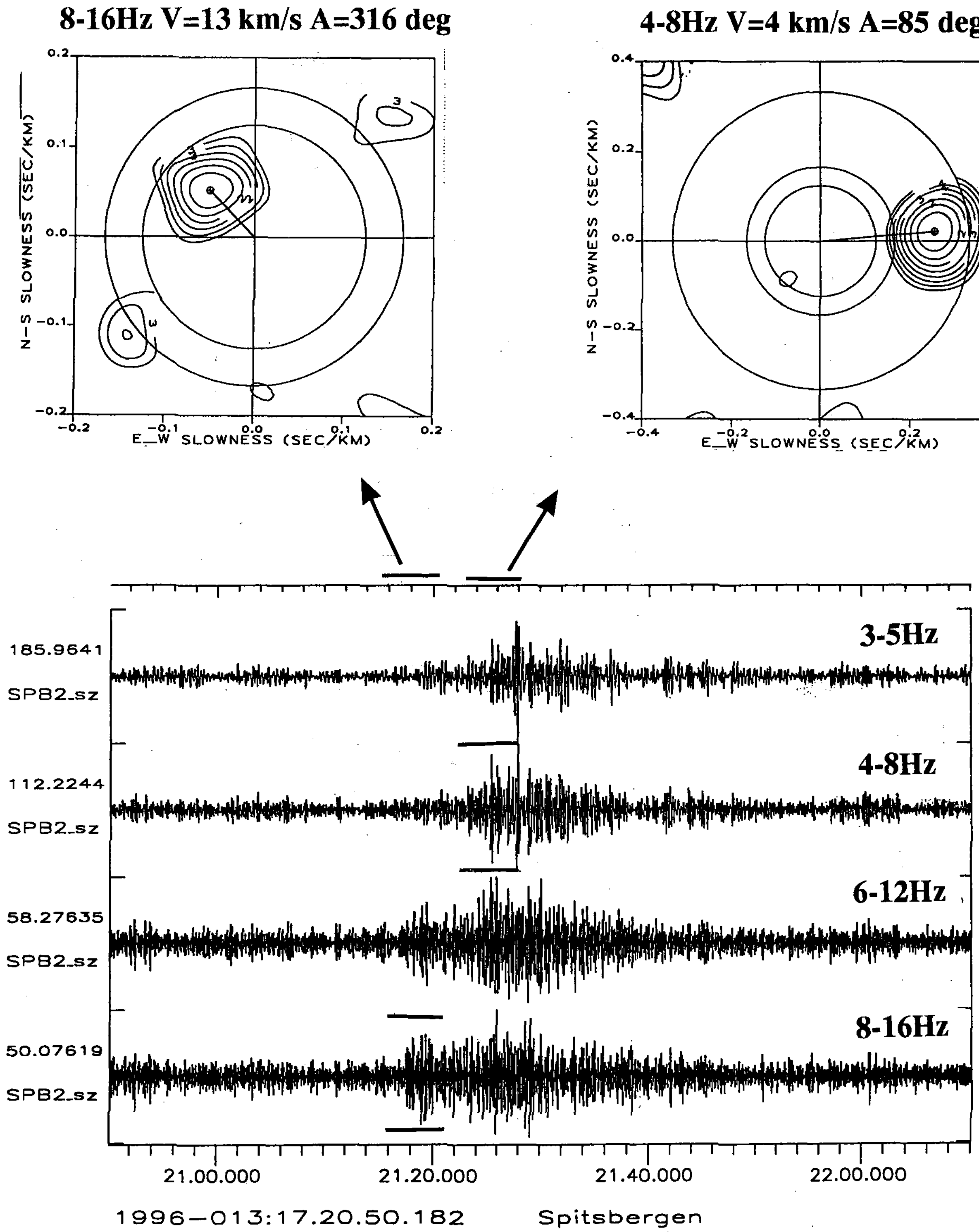


Fig. 7.4.13. Recordings of the January 13, 1996 event at the Spitsbergen B2 seismometer, in four different filter bands. Note the local P-phase preceding the S-phase from the Novaya Zemlya event. This P-phase has both a different f-k solution and different spectral characteristics compared with the S-phase following it.

7.5 Study of the calibration explosion on 29 September 1996 in the Khibiny Massif, Kola Peninsula

Introduction

On 29 September, 1996, a 350 ton industrial explosion was carried out in the Kola Peninsula, Russia. The explosion was detonated in an underground mine in the Khibiny Massif, with coordinates 67.675N, 33.728E. The explosion was applied to provide data to calibrate the GSETT-3 network in this region.

The calibration experiment was carried out as a joint cooperative project between the Ministry of Defense of the Russian Federation and the Kola Regional Seismological Centre of the Russian Academy of Sciences. NORSAR participated in this experiment by providing seismic recordings as well as contributing to the data analysis.. The explosion was recorded by several stations in the GSETT-3 network, all of them at regional distances. The event was listed in the Reviewed Event Bulletin (REB) of the IDC with coordinates 67.57N, 32.54E and a magnitude (M_L) of 3.4.

In this paper we analyze available recordings of this explosion, with emphasis on recordings by stations at local distances. We further compare the signal characteristics to those of previously recorded underground explosions in the same mine. The IDC location estimates of this suite of explosions is compared to their true locations, and the differences are used to suggest a velocity model that is expected to largely eliminate systematic bias in the IDC location results for events in this region.

The Khibiny Massif

The Khibiny Massif occupies a mountainous territory of 1327 square kilometers in the central part of the Kola Peninsula, northwestern Russia. The complex is part of the Kola Alkaline Province of the Baltic Shield. The eastern edge of Khibiny is only 5 km away from the Lovozero massif, therefore these massifs can be regarded as two parts of a single intrusive complex having similar ages. These alkaline intrusions consist of nearly the same rock types but differ in their internal structure.

The Khibiny massif intrudes in the contact zone between Archaean gneisses and Middle Proterozoic volcanic-sedimentary complexes. According to geophysical data and drilling, the outer edges of the massif are vertical down to a depth of 3 km. At deeper levels the western and southern edges plunge towards the center at an angle of 50-60 degrees. The eastern edge dips outwards at an angle of 80 degrees thus showing a possible joining with the Lovozero complex.

Khibiny Seismicity and Mining Activity

The exploitation of the Khibiny apatite ores started in 1930 and since then about $2.5*10^9$ tons of the rock have been excavated from an area of about 10 sq. km. At the present time more than 10^8 tons of ore are extracted annually from three underground and three open-pit mines. The velocity of the uplift of the near-surface parts is of the order of 70 mm/year for some tunnels (Panasenko and Yakovlev, 1983).

Seismic activity in the Khibiny Massif has shown a significant increase since 1980. Two main factors seem to be jointly contributing to this increased activity. One is the change in tectonic stress regime caused by the removal of large masses of rock, the second is an apparent earthquake triggering effect observed in connection with some of the explosions.

During the time period since 1980 the annual ore excavation at the Khibiny mines has increased from 19.1 to 46.5 million tons. A correspondence between the amount of annual ore extraction and the energy release of recorded earthquakes was demonstrated by Kremenetskaya and Trjapitsin (1995). They explained this effect as a result of the disruption of the natural geodynamic process in the area, causing a redistribution of crustal stresses which in turn has led to increased seismicity.

Kremenetskaya et. al.(1995) made a detailed study of the proposed triggering effect, and showed that underground explosions in Khibiny in many cases act as a direct trigger of rockbursts. Such triggering effects were demonstrated to take place when the depth of the mining exceeds 100 meters. Currently about 30% of all underground explosions have been found to trigger significant rockbursts, i.e., rockbursts that are detectable at a distance of at least 50 km. The triggered rockbursts usually occur within a few tens of seconds after the explosion. These studies did not reveal any similar triggering effect for open-pit mining explosions in Khibiny.

There are 6 mines in the Khibiny Massif (see Table 7.5.1). Mines 1, 2 and 3 have underground parts and quarries, whereas at mines 4, 5 and 6 there are open (quarry) explosions only. At mines 1 and 2 the underground and open (quarry) explosions take place on the same day, sometimes at very close times, (within several seconds or minutes). At mine 3 underground and open explosions are usually carried out on different days.

Table 7.5.1: Reference numbers and coordinates of the Khibiny mines

Name	Mine No	Latitude	Longitude
Kirovsk	1	67.670	33.729
Yukspor	2	67.647	33.761
Rasvumchorr	3	67.631	33.835
Central	4	67.624	33.896
Koashva	5	67.632	34.011
Nyurkpakh	6	67.665	34.146

The underground explosions are single (ripple-fired) explosions with typical shot delays of 20-35 ms and typical total duration of a few hundred milliseconds.

The quarry explosions are made by separate charges situated at different places (distances up to 2 km) and the time interval between the individual explosions amounts to several tens of minutes.

Aggregate yield (total weight of explosive material) is typically:

15-400 t for underground explosions (mines 1,2,3, single (ripple-fired) charge);
0.5-50 t for quarry explosions at mines 1,2,3 (separate charges)
10-400 t for quarry explosions at mines 4,5,6 (separate charges)

The main source of information on types and yields of the explosions is the mine administration, whereas data on their times and magnitudes are taken from seismic recordings.

The Station Network

The regional seismic network in the Kola Peninsual currently comprises 7 seismic stations, as described by Kremenetskaya et. al. (1995). For the present study of the calibration explosion, only those stations with digitally recording equipment have been used. In addition, several stations in Fennoscandia recorded the calibration event, but we have only used data from the nearest station, the ARCESS array (distance about 400 km), in our analysis. All the station data are available both at NORSAR (Kjeller) and at KRSC (Apatity) via a dedicated satellite link connecting the two data centers. The stations are listed in Table 7.5.2, and a brief description is given in the following.

Table 7.5.2: List of seismic stations used in this study

Name	Latitude	Longitude
APZ9 (Broadband)	67.568N	33.388E
PLQ	66.410N	32.750E
ARCESS (Array)	69.534N	25.511E
APA0 (HF element)	67.603N	32.994E
APA0 (Array)	67.603N	32.994E

The Apatity array was installed in late September 1992, approximately 17 km to the west of KRSC in Apatity, at the location indicated in Fig. 7.5.1. The seismometers are placed on two concentric rings plus one in the center, and the aperture is approximately 1 km. Sampling rate for the array elements is 40Hz. The center element contains in addition a 3-component high-frequency system, with sampling rate of 80Hz. Seismic data registered at the array site are digitized on-site and transmitted via three radio channels to Apatity, where an array controller of type NORAC receives, time-tags and stores the data. Timing is provided by a GPS receiver.

The Apatity station APZ9 is a 3-component Guralp broadband system installed in 1991 in the town of Apatity. The location relative to the Khibiny Massif is shown in Fig. 7.5.1. The data are digitized at a sampling rate of 40Hz and multiplexed with the array data before being stored on disk and magnetic tape.

The station PLQ is normally operated as an analog recording station, but for the purpose of this experiment, a 3-component digital system was installed at this site. Timing was provided by GPS, and the data sampling rate was 50 Hz.

The ARCESS array in northern Norway comprises 25 SP seismometers distributed in four concentric rings together with a center element. The array diameter is 3 km. Data are digitized on-site (sampling rate 40 Hz), time-tagged using a GPS clock and transmitted by satellite to the NORSAR Data Center at Kjeller.

Data

According to information available at this time, the parameters for the calibration explosion were as follows:

Date: 29 September, 1996

Origin time: 06.05.46.2 (GMT)

Total charge size: 350 tons

Location: 67.675N, 33.728E (inside Mine 1)

The explosion was ripple-fired, in 18 separate stages and a time delay of 23 ms between each stage. Each stage of the explosion comprised 200 separate explosive charges in individual boreholes, detonated simultaneously. The total duration of the explosion was 400 ms, which is similar to, although slightly shorter, than the duration of usual mining explosions of comparable size.

The explosive charges were distributed over an area covering 70 by 95 meters, as illustrated in Fig. 7.5.2. This figure also shows the location of the calibration explosion relative to selected other large explosions in the same mine.

Waveform recordings

Short period seismic recordings for the stations in the Kola Peninsula are shown in Figs. 7.5.3 through 7.5.6. These stations are all at local distances (less than 200 km) and the seismic phases P, S and Rg can be clearly identified. As is well known, the presence of the Rg phase is indicative of the shallow depth of the explosion, and Rg is in fact the largest amplitude phase on the seismogram. Fig. 7.5.7 shows a summary plot of the SPZ sensor trace for each of the stations used in this study.

We have calculated the signal-to-noise ratio (SNR) of the P-wave at each of the stations. Not unexpectedly, the SNR, which represents the maximum linear ratio STA/LTA, is highest (more than 1000) for the array beam at the Apatity array. However, even for the 3-component station PLQ (and also for the ARCESS array) the SNR exceeds 100.

In comparison, SNR for other GSETT-3 stations recording this event is at best around 10, even though these stations are also within a relatively short distance (about 10 degrees or less) from the epicenter. This emphasizes the usefulness of the local recordings, not only in terms of detectability, but perhaps more importantly: the onset time readings at these stations can be made with a far higher precision than for low-SNR stations at greater distances. This is part of the problem of location precision that will be further addressed below.

Automatic detection processing

All of the arrays in the regional network, with the exception of PLQ, have telemetry to the NORSAR data center at Kjeller. This enables continuous automatic detection processing to be made, supplemented by interactive analysis of the detected signals. Such analysis is carried out both at NORSAR and at KRSC. The resulting regional bulletins complement the bulletins produced at the GSETT-3 IDC, and provide a useful reference for evaluation and calibration purposes. NORSAR has produced such regional bulletins since 1989.

The regional processing algorithms in use at the NORSAR Data Center comprise the following steps:

- Automatic single array processing, using a suite of bandpass filters in parallel, and a beam deployment that covers both P and S type phases for the region of interest.
- An STA/LTA detector applied independently to each beam, with broadband f-k analysis for each detected phase in order to estimate azimuth and phase velocity.
- Single-array phase association for initial location of seismic events, and also for the purpose of chaining together phases belonging to the same event, so as to prepare for the subsequent multiarray processing.
- Multi-array event detection, using the Generalized Beamforming approach (Ringdal and Kværna, 1989) to associate phases from all stations in the regional network, and thereby provide automatic network locations for events in all of northern Europe.

The processing steps described above result in an automated bulletin that is made available on-line via the Internet. Experience over the past several years has demonstrated that the procedure described above is extremely efficient, and is furthermore "complete" in the sense that it provides an exhaustive search of all possible phase combinations that could correspond to real events. The processing steps described above have now been adopted, with appropriate modifications,at the IDC for global processing, and are also gaining use for other networks.

The automatic bulletin produced by the NORSAR Generalized Beamforming for the Kola calibration event is shown in Table 7.5.4. As can be seen, a total of 25 phases from the regional array network have been associated to this event, with 13 phases used in the automatic location process. The resulting location (67.75N, 33.65E) is quite close to the true location of the event, and forms a useful starting point for further interactive processing.

Location and signal characteristics

Because of the excellent coverage of stations at local distances, we have been able to estimate a very accurate location of the calibration event by interactive analysis of the available seismic data (see Fig. 7.5.1). However, in the context of the GSETT-3 experimental monitoring system, the location problem becomes far more difficult because of the sparseness of the GSETT-3 network. Partly, the difficulties are related to the problems in reading accurate phase onsets at low SNR. Another problem is the possible inaccuracy of the seismic travel time curves employed for this region. Such inaccuracy will cause a systematic mislocation, whereas the uncertainty in onset time readings could cause a mixture of random error and systematic error (the latter occurring, e.g., if P-wave arrivals are read consistently late).

We have collected data for all large underground explosions in Mine 1 so far during GSETT-3, and compared the IDC solutions to the actual epicenters. The events (15 in all) are listed in Table 7.5.3. Fig. 7.5.8 is a plot showing the IDC locations for these events. The explosions are mislocated by typically 20-30 km. A systematic shift in epicenters is clearly seen, with a general shift westwards compared to the true location.

Table 7.5.3: Explosions in Khibiny Mine 1 processed by the IDC

DATE	IDC Origin time	Latitude (IDC)	Longitude (IDC)	Yield tons	M_L IDC	M_L KRSC
1995/01/22	04:27:07.2	67.5400	33.2600	136	2.1	2.1
1995/02/12	03:34:54.1	67.6800	33.0200	131	2.2	2.6
1995/03/19	03:15:05.3	67.6000	33.4100	67	2.2	2.4
1995/04/02	03:26:43.4	67.6100	32.6900	59	2.5	2.8
1995/05/21	03:23:35.3	67.5900	32.5800	123	3.7	2.2
1995/07/30	09:23:40.9	67.5600	32.8200	100	3.6	2.1
1995/10/01	04:27:58.4	67.5600	32.7500	152	3.9	2.1
1995/10/29	04:53:45.0	67.6100	32.7700	156	3.2	2.7
1995/12/11	04:42:17.4	67.5200	33.1600	245	3.3	2.4
1995/12/31	03:45:18.4	67.5600	33.0200	100	3.3	2.3
1996/01/28	03:47:17.9	67.7100	33.3500	148	3.1	2.0
1996/03/31	03:40:24.9	67.5200	32.8400	92	3.1	2.0
1996/06/23	02:34:15.3	67.5200	32.6300	82	3.0	2.4
1996/07/28	03:14:31.0	67.6700	33.2800	95	2.9	2.4
1996/09/29	06:05:50.0	67.5700	32.5400	350	3.4	2.9

We have carried out a simple experiment to model the combination of random and systematic errors causing the observed scatter in IDC locations. In this model, we used only the parameters that are the most significant for the IDC solutions, namely, the arrival times of P and S phases from ARCESS, NORESS and FINESS. We did not consider azimuths, since these have relatively modest effect on the network location estimates.

For each of the phases mentioned above, we assigned a random uncertainty of 1.0 seconds (P) or 2.0 seconds (S). While these values may seem high, especially for the P-phase, it must be remembered that low SNR contributes to the reading uncertainty, especially for the more distant stations. Furthermore, we assumed a systematic error in the IDC velocity model of 0.15 km/sec (P-waves) and 0.09 km/sec (S-waves) for this area.

The resulting 90 per cent "uncertainty" ellipse is shown in Fig. 7.5.8, and seems to correspond well to the actually observed data. Thus, a first order correction to the model would be quite simple to make, and as a result the epicenters would be shifted towards the true location, although the scatter would not be reduced. In practice, station-specific travel time corrections would probably be the simplest way to implement this improvement. This is also consistent with the general philosophy now applied at the IDC, which is based upon global and regional geographical grid systems of varying density to assign regional calibration corrections.

We note that the travel-time corrections introduced on the basis of this calibration explosion could be expected to be appropriate for the general Khibiny region, not just Mine 1. An interesting question is to which extent these corrections would apply to the entire Kola Peninsula, or more generally, the Baltic Shield as a whole. This will require extensive study, and is outside the scope of this paper.

A comparison of the waveforms of 5 large underground explosions at Mine 1 is shown in Fig. 7.5.9. The recordings have been made by the vertical component of the High-frequency element in the Apatity array. The calibration explosion (bottom of the figure) is not possible to separate from most of the other explosions, based upon the waveform characteristics. The only explosion that appears different is explosion no. 2 from top (5 Dec. 93), which has a relatively much larger Rg phase than the others, and correspondingly lower proportion of high frequency energy.

We have investigated the explosion of 5 Dec. 93 in some detail, and have found that it was followed by a significant number of rockbursts. It is therefore possible that there was some tectonic release occurring simultaneously with the explosion, and that this could explain the anomalous recording. None of the other explosions in this figure had a similar aftershock sequence, although the calibration event was in fact followed by a few rockbursts. In conclusion, the seismic "signature" of the calibration event is not unusual compared to other explosions in the same mine.

We also make a note on the magnitudes provided in Table 7.5.3. The IDC magnitudes were generally lower than our ML values during the first half of 1995, but have been significantly larger since then. This is because the IDC changed its local magnitude estimation procedure at that time. The KRSC magnitude estimates are consistent throughout the period, and have in fact been shown to have a good correlation with yield, when considering underground mining explosions in Khibiny in general (Kremenetskaya, Asming and Ringdal, 1995).

Conclusions

The calibration explosion of 29 September 1996 has provided valuable data for the purpose of improving the routine location process at the IDC for the Khibiny area. The excellent recordings achieved by the stations in the Kola Peninsula could prove useful also for more detailed geophysical investigations, including mapping the crustal velocity structure.

This explosion has been one of the first conducted for calibration purposes in GSETT-3. There is clearly a need for additional such explosions in various areas, including other explosions in Fennoscandia to validate the travel-time corrections for other areas. In addition, the efforts to obtain detailed "ground truth" data for selected mining explosions should continue.

It has been argued that calibration events are most useful if they are large enough to be detected teleseismically. While this is generally true, it seems unrealistic to obtain such events in all regions of the world where calibration is needed. Calibration explosions that are recorded only at regional distances are therefore also important, and will contribute to improve the processing of many small events that might otherwise be significantly mislocated in the IDC bulletin.

F. Ringdal, NORSAR
E. Kremenetskaya, KRSC, Apatity
V. Asming, KRSC, Apatity
I. Kuzmin, KRSC, Apatity
S. Evtuhin, Ministry of Defense, Moscow
V. Kovalenko, Ministry of Defense, Moscow

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Panasenko, G.D. and Yakovlev, V.M. (1983). About the nature of anomalous deformation of a transport tunnel in the mountain Yukspor. In: Geophysical Investigations in the European North of the USSR, KB AS USSR, Apatity, pp. 38-44 (in Russian).

Ringdal, F. and T. Kværna (1989), A multi-channel processing approach to real time network detection, phase association and threshold monitoring, Bull. Seism. Soc. Am. 79, 1927-1940.

Table 7.5.4: Kola explosion 29.09.96 — NORSAR's automatic Generalized Beamforming solution

Origin time	Lat	Lon	Azres	Timres	Wres	Nphase	Ntot	Nsta	Netmag
1996-273:06.05.46.0	67.75	33.65	9.63	1.86	4.27	13	25	5	2.41

Sta	Dist	Az	Ph	Time	Tres	Azim	Ares	Vel	Snr	Amp	Freq	Fkq	Pol	Arid	Mag
APA	32.4	58.6	Pg	06.05.50.8	-0.5	76.8	18.2	6.1	1249.4	6678.8	1.26	1		221346	-
APA	32.4	58.6	Lg	06.05.59.1	4.1	82.7	24.1	5.2	9.5	13516.3	4.71	3	-3	221350	1.27
ARC	386.1	117.1	Pn	06.06.41.9	0.9	121.4	4.3	7.7	163.5	5055.7	5.74	2	1	221366	-
ARC	386.1	117.1	p	06.06.50.1		109.6	-7.5	7.4	8.7	4648.5	2.34	1	1	221367	-
ARC	386.1	117.1	p	06.06.59.3		126.1	9.0	7.7	2.6	1177.0	5.87	3		221371	-
ARC	386.1	117.1	Sn	06.07.22.7	-2.1	126.3	9.2	4.4	4.7	5079.8	4.83	2	-2	221373	1.96
ARC	386.1	117.1	s	06.07.29.6		124.8	7.7	3.9	2.5	3785.3	1.63	2		221378	-
ARC	386.1	117.1	Lg	06.07.32.6	-1.4	112.4	-4.7	3.7	6.9	5569.9	1.25	2	-2	221381	2.02
ARC	386.1	117.1	s	06.07.39.9		115.0	-2.1	3.7	3.1	8202.0	1.94	1	-3	221384	2.42
ARC	386.1	117.1	s	06.07.45.3		116.7	-0.4	3.7	2.5	8657.8	2.66	3		221385	-
ARC	386.1	117.1	Rg	06.07.57.6	0.7	106.7	-10.4	3.2	3.2	11081.5	0.86	1		221387	-
FIN	790.8	23.9	Pn	06.07.29.9	-0.5	23.6	-0.3	8.2	7.4	111.1	5.27	3		221358	-
FIN	790.8	23.9	p	06.07.35.9		16.9	-7.0	8.2	4.5	62.1	4.90	2		221363	-
FIN	790.8	23.9	p	06.07.38.9		24.7	0.8	8.5	6.3	116.1	4.81	2		221369	-

SPI 06.08.30.8

Sta	Dist	Az	Ph	Time	Tres	Azim	Ares	Vel	Snr	Amp	Freq	Fkq	Pol	Arid	Mag
FIN	790.8	23.9	Sn	06.08.58.0	6.2	25.7	1.8	5.0	2.5	371.4	2.53	1		221379	2.16
FIN	790.8	23.9	s	06.09.09.7		13.1	-10.8	4.6	2.9	561.2	2.82	1		221388	-
FIN	790.8	23.9	s	06.09.20.4		19.2	-4.7	3.7	8.4	1455.6	1.33	1		221392	-
FIN	790.8	23.9	Lg	06.09.30.7	3.5	22.4	-1.5	4.2	2.7	1099.2	2.54	1		221398	2.63
HFS	1285.9	40.4	Lg	06.11.44.4	-1.3	55.0	14.6	4.6	4.1	277.1	2.05	1		221374	2.99
NRS	1316.8	44.3	Pn	06.08.33.2	-1.1	59.8	15.5	8.4	7.3	271.1	2.81	2		221357	-
NRS	1316.8	44.3	Sn	06.10.42.6	-1.0	60.3	16.0	4.2	2.9	441.8	2.20	2	-1	221390	2.37
NRS	1316.8	44.3	s	06.10.48.6		45.5	1.2	4.9	3.6	622.0	1.84	2		221397	-
NRS	1316.8	44.3	Lg	06.11.55.4	1.1	39.8	-4.5	3.8	2.8	1890.9	1.27	1		221405	2.64
NRS	1316.8	44.3	s	06.12.01.4		52.2	7.9	4.7	2.7	597.9	2.33	2		221407	2.77
NRS	1316.8	44.3	s	06.12.02.6		50.1	5.8	4.3	3.6	967.6	1.72	2		221412	-

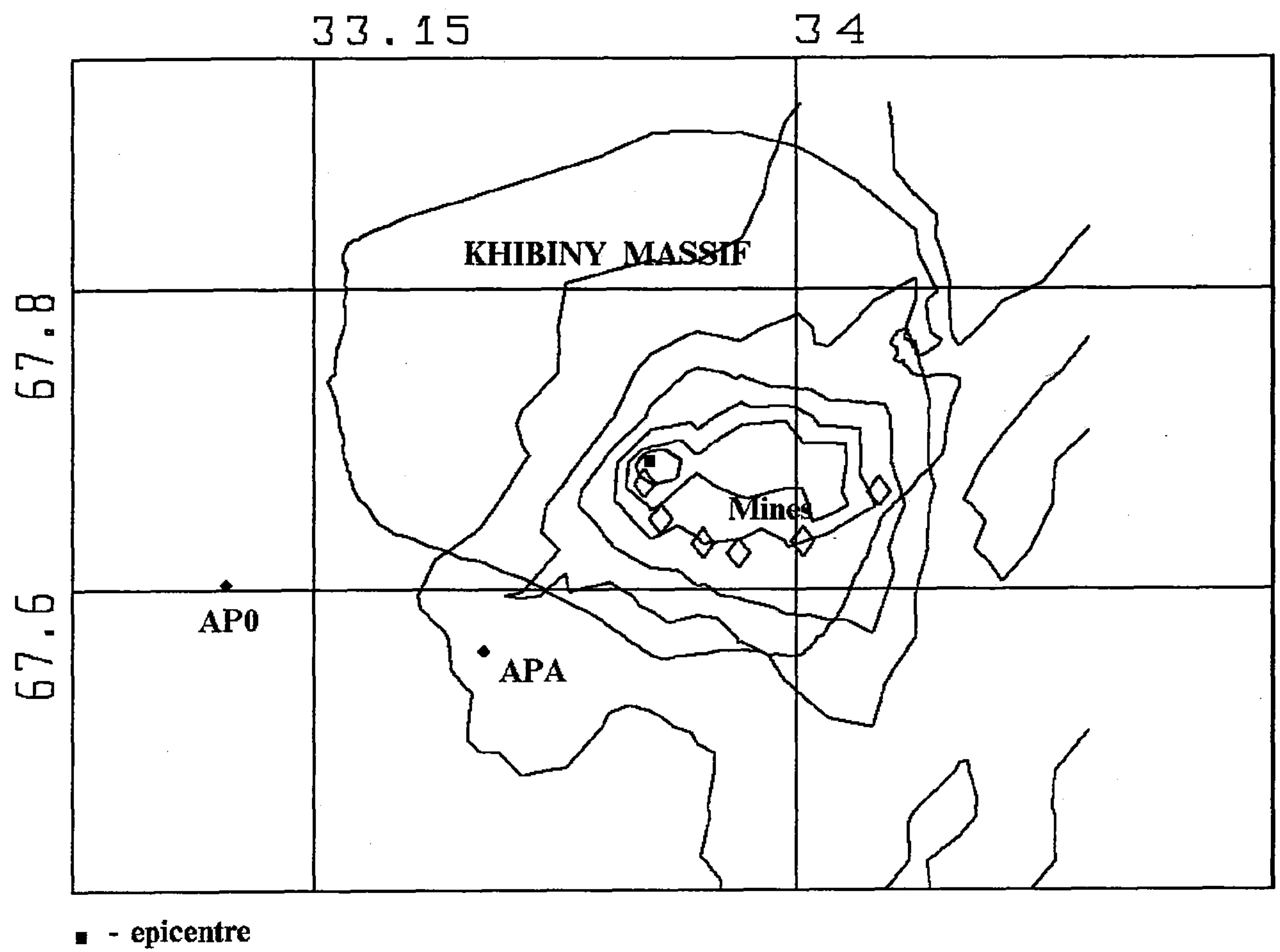


Fig. 7.5.1. The Khibiny Massif, with locations of 6 mines. The seismic stations AP0 (array) and APA are shown, together with the epicenter of the calibration explosion estimated from seismic recordings.

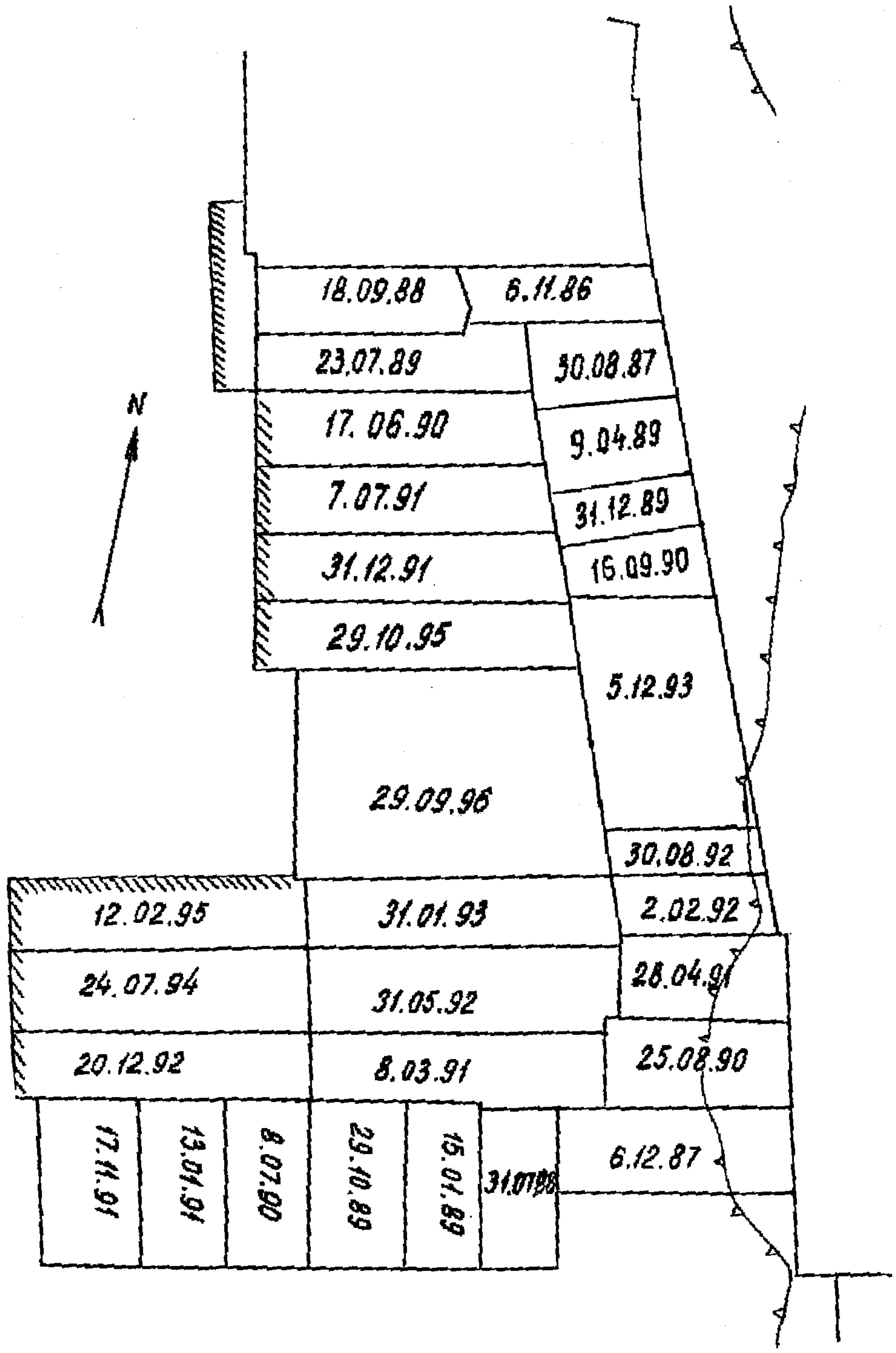


Fig. 7.5.2. Relative locations of selected large mining explosions in Khibiny Mine 1. The calibration explosion of 29.09.96 took place near the center of the mine.

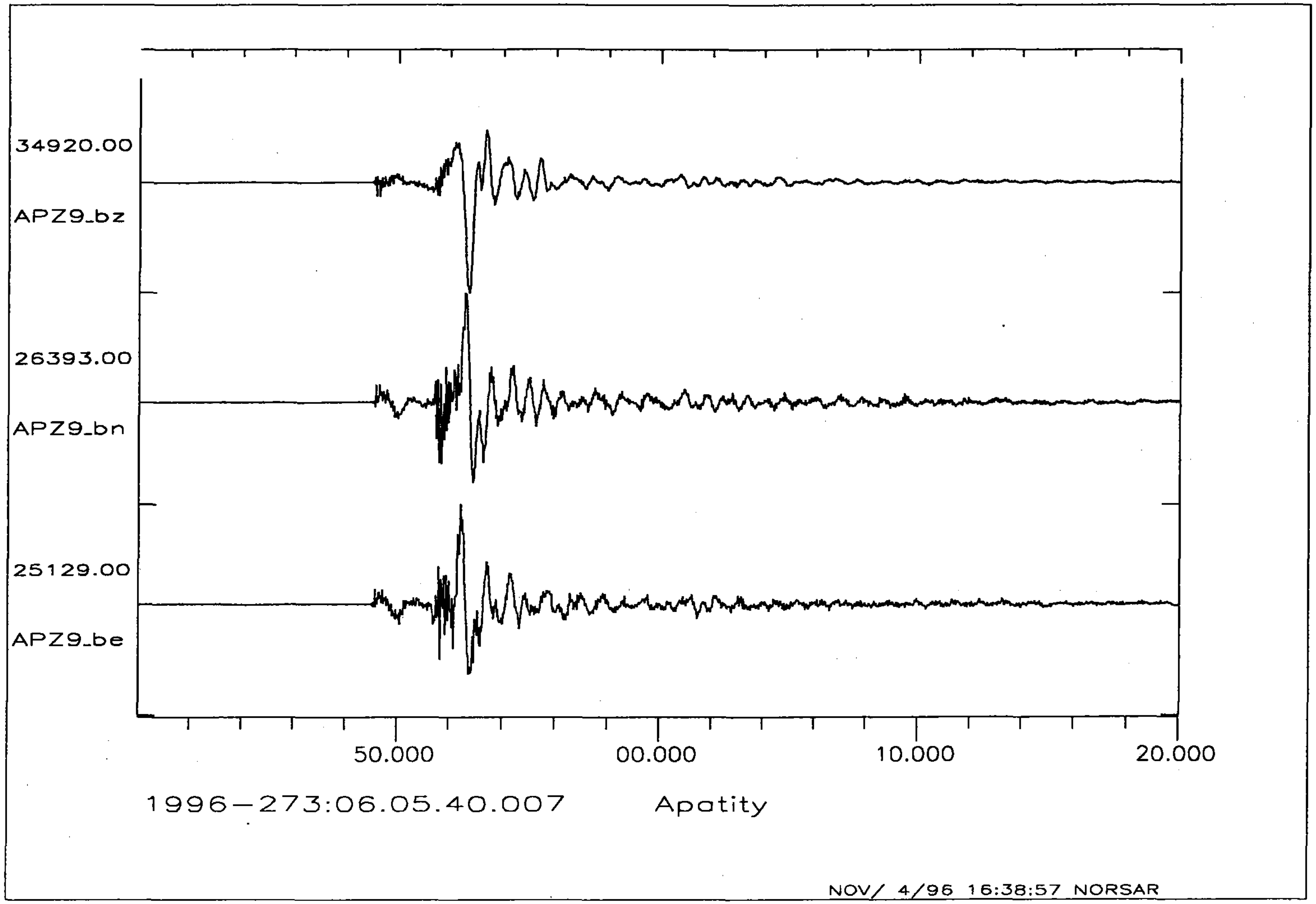


Fig. 7.5.3. Kola explosion 29.09.96 — Station APZ9; 3-component broadband recordings.

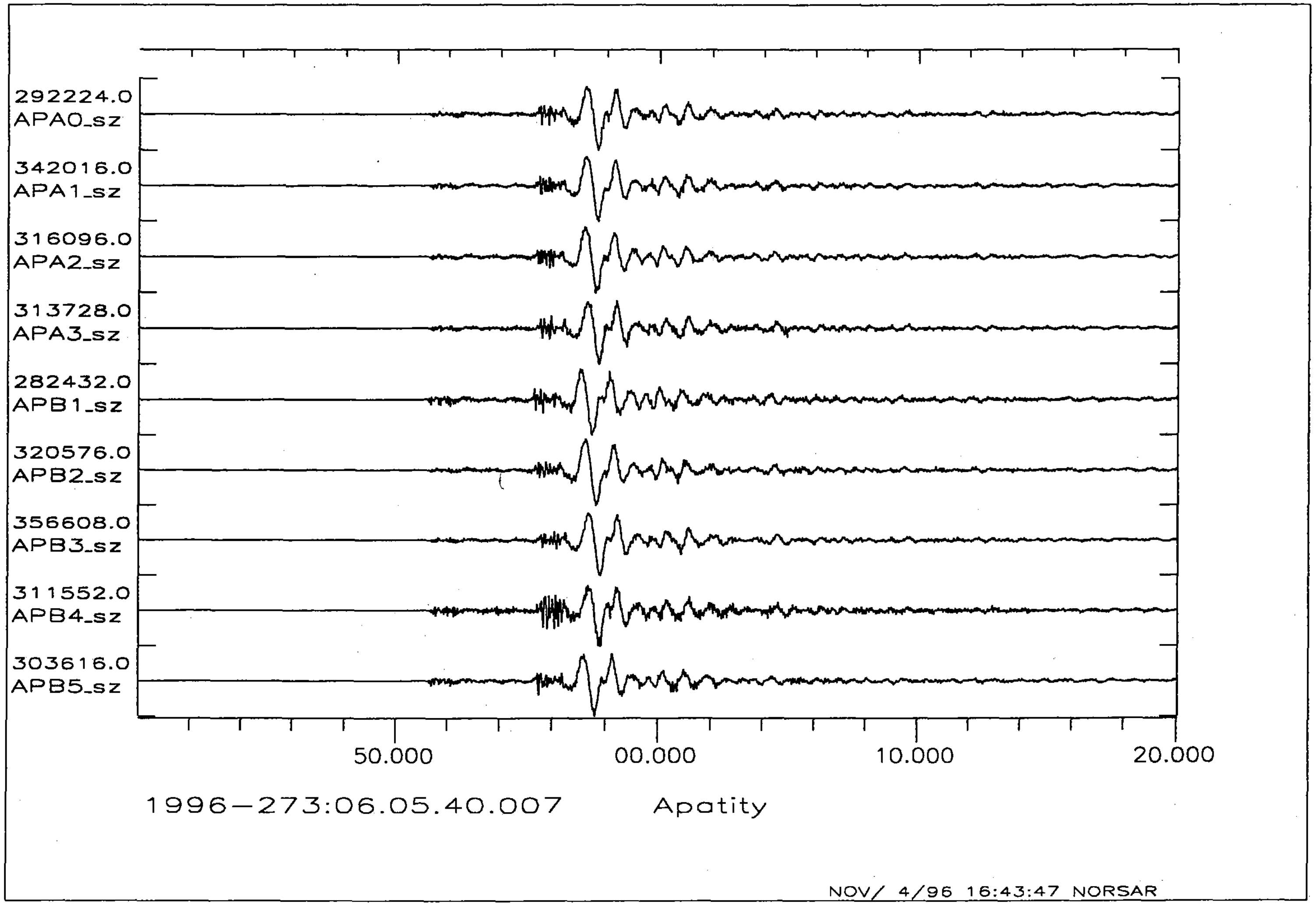


Fig. 7.5.4. Kola explosion 29.09.96 — Apatity array (APA0).

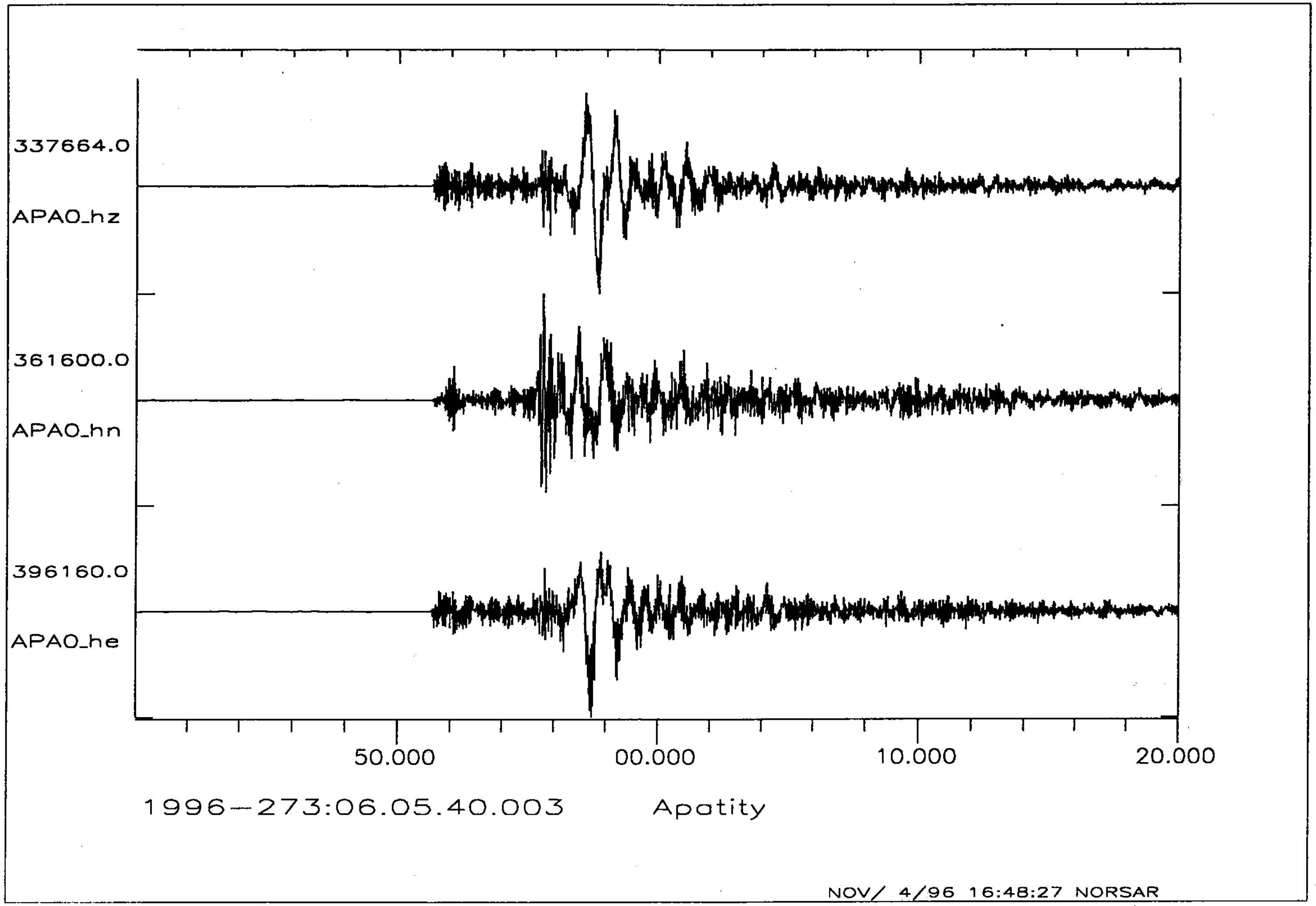


Fig. 7.5.5. Kola explosion 29.09.96 — Station APA0; high frequency element, 3-component recordings.

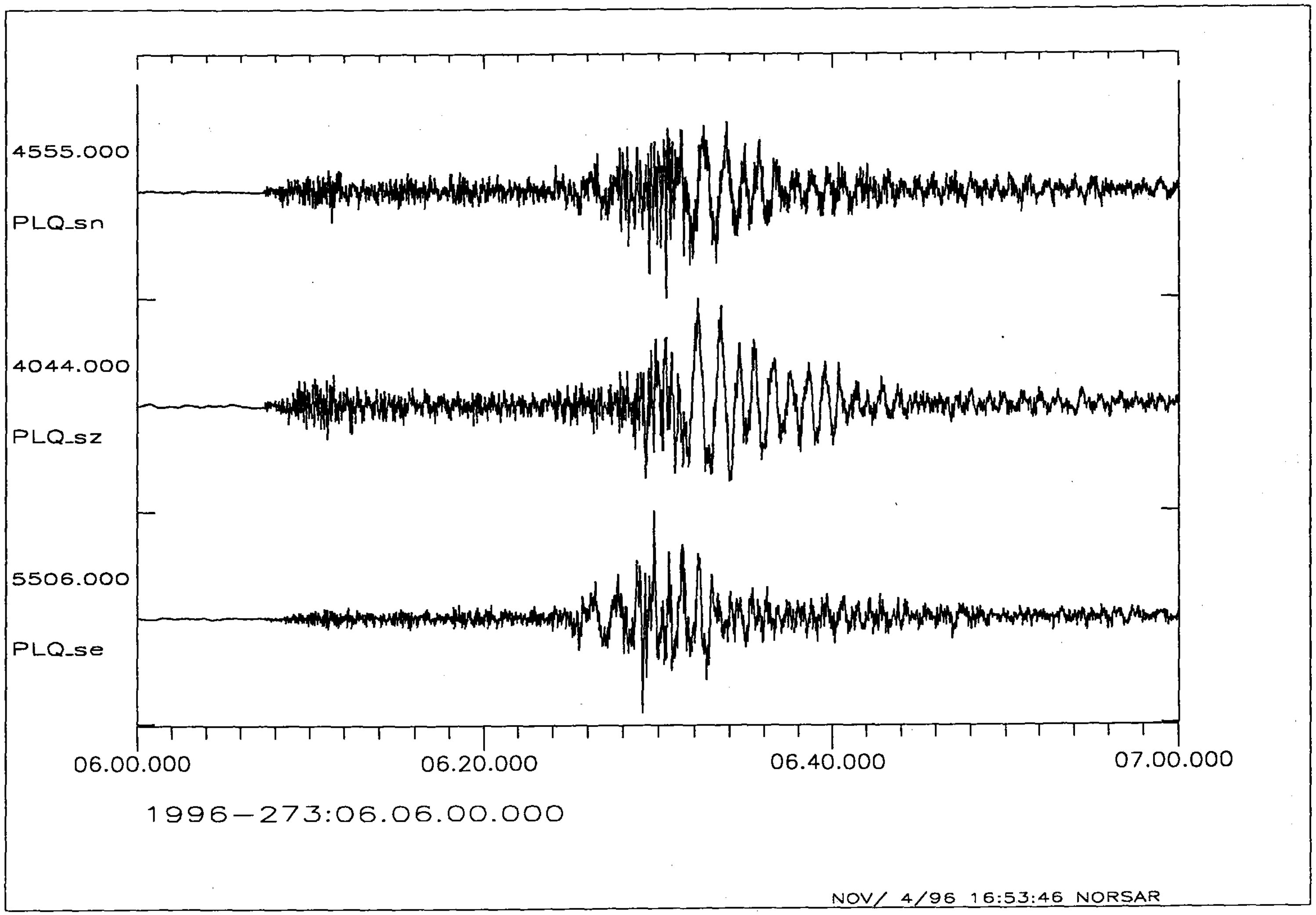


Fig. 7.5.6. Kola explosion 29.09.96 — Station PLQ; 3-component recordings.

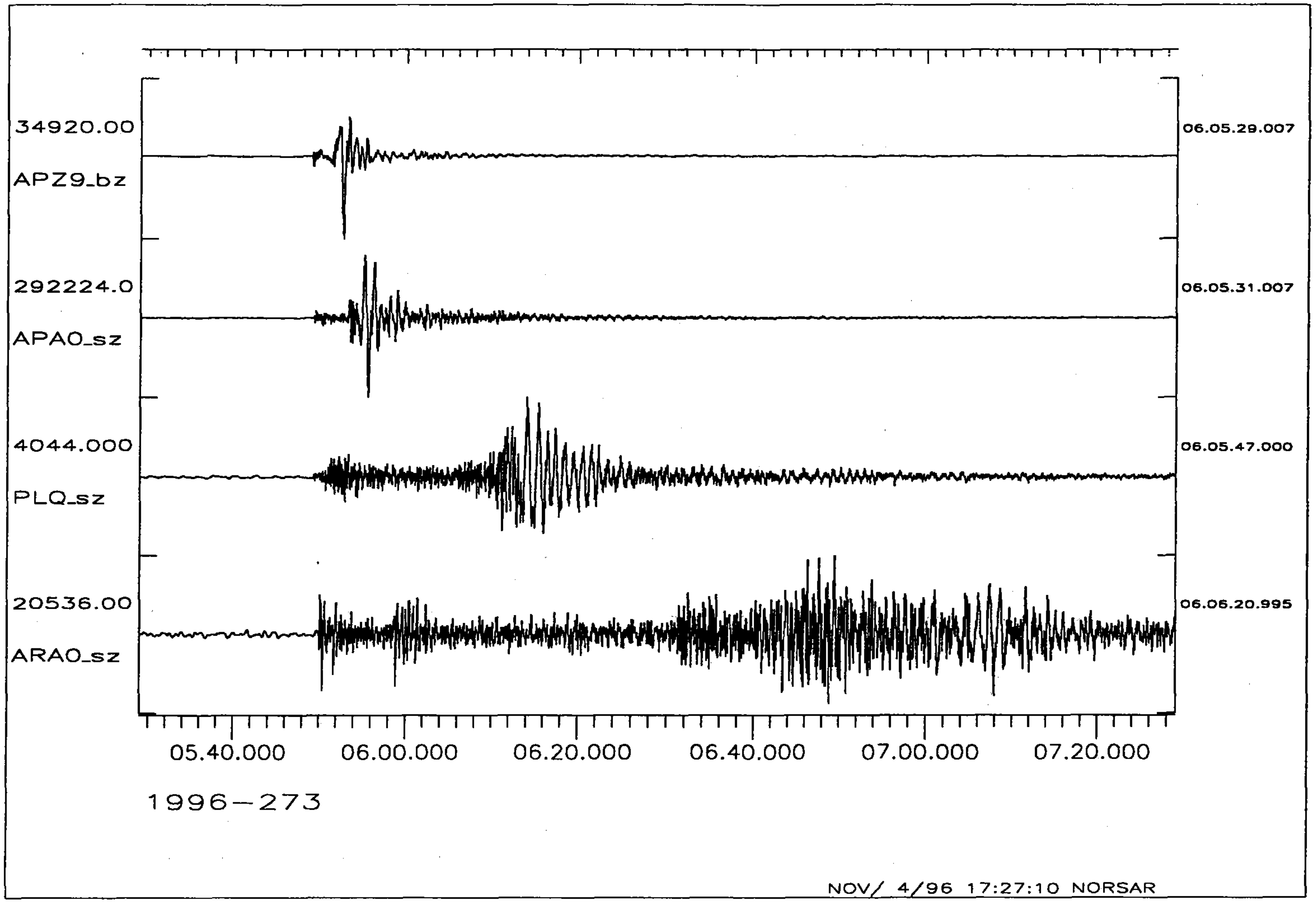
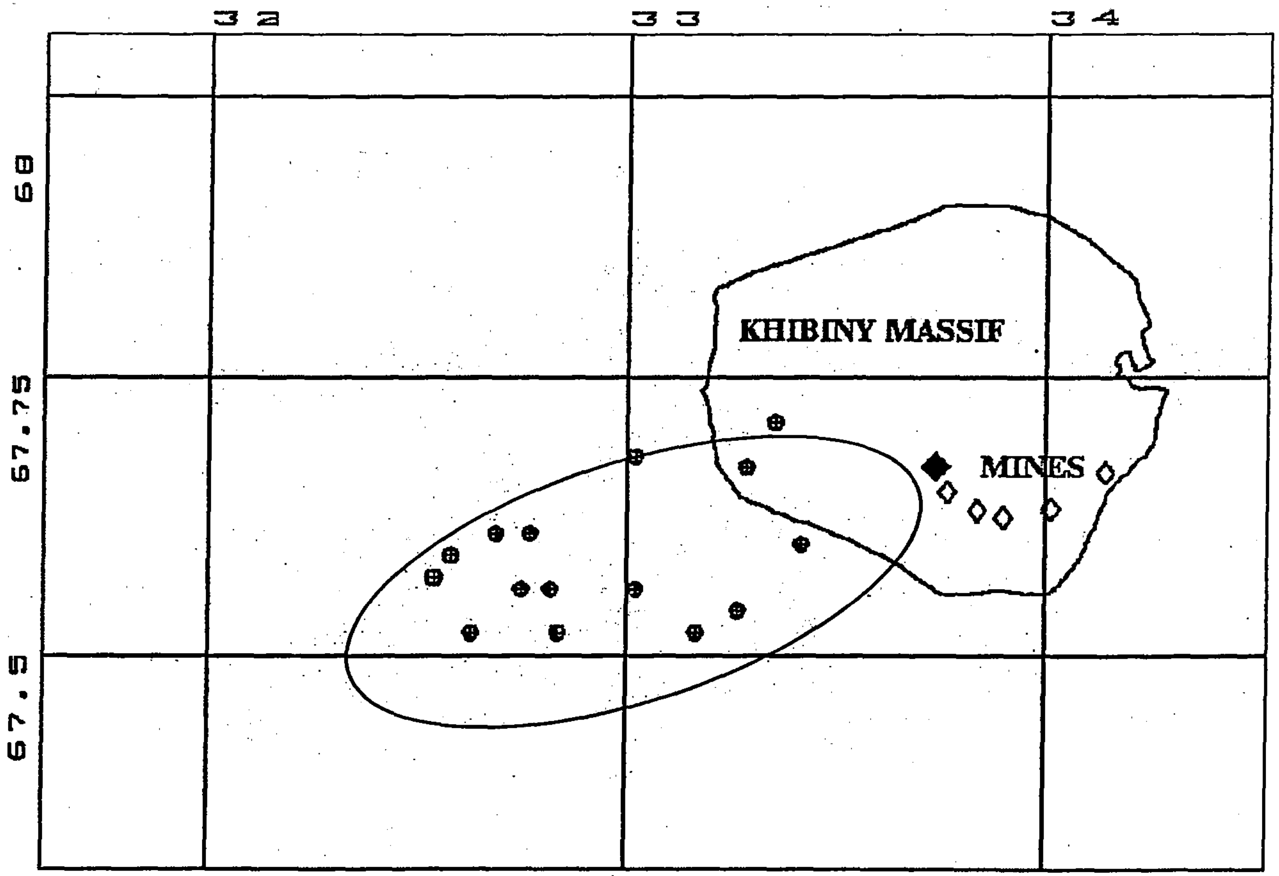


Fig. 7.5.7. Kola explosion 29.09.96 — Comparison of station recordings. The figure shows 2 minutes of data for each trace, and the traces are lined up according to their P-arrival times.



◆ - place of the explosions; ● - IDC locations; · - modelled locations;

Fig. 7.5.8. GSETT-3 IDC location estimates for large explosions in Mine 1. The ellipse indicates the model simulation described in the text.

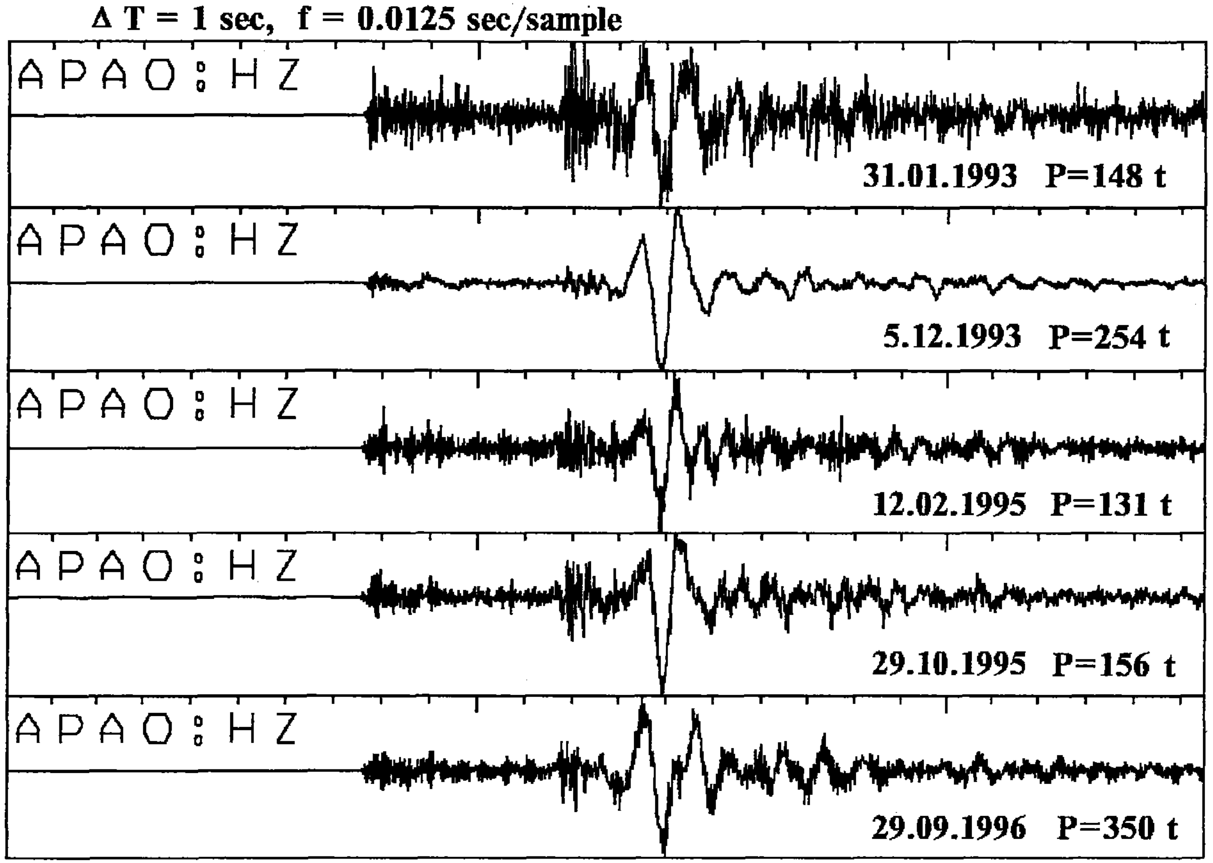


Fig. 7.5.9. Waveform comparisons of 5 large explosions in Mine 1. Note the similarities of the waveforms, except for no. 2 from top (see text for details).