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1 April — 30 September 1993

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Abstract (cont.)

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The NORSAR Detection Processing system has been operated throughout the period with an average uptime of 97.3% as compared to 97.8% for the previous reporting period. A total of 2290 seismic events have been reported in the NORSAR monthly seismic bulletin. The performance of the continuous alarm system and the automatic bulletin transfer by telex 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. There have been no modifications made to the NORSAR data acquisition system.

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Maintenance activities in the period comprise preventive/corrective maintenance in connection with all the NORSAR subarrays, NORESS and ARCESS. Other activities have involved testing of the NORSAR communications systems and work in connection with the experimental small-aperture arrays in Spitsbergen and Russia.

Starting 1 October 1991, an effort began to carry out a complete technical refurbishment of the NORSAR array. This project is funded jointly by AFTAC, ARPA and NFR. During the reporting period, we have continued evaluation and laboratory testing of technical options for field instrumentation, in particular state-of-the-art A/D converters, data acquisition and synchronization devices. During the reporting period, we have also received a complete subarray evaluation unit from Science Horizons, and this unit has been subjected to a long-term operational test in subarray 06C. In addition, we have been converting the NORSAR Detection/Event Processing software to be compatible with our UNIX-based workstations. Our detailed status regarding this work is reported on separately, most recently in a status report dated 16 August 1993.

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

Section 7.1 describes an experiment in continuous threshold monitoring of the Lop Nor, China, nuclear test site. The monitoring period comprised the five days up to and including the day of the latest nuclear explosion at Lop Nor (5 October 1993). NORESS, ARCESS and GERESS regional array data were used. We have been compiling daily sta-

tistics of all peaks on the threshold diagram exceeding m_b 3.5 and associating these peaks to regional or teleseismic events whenever possible. Based on this experiment, it appears that this threshold (3.5), which is about 0.75 m_b units higher than for Novaya Zemlya, is representative for the combined threshold monitoring capabilities (at the 99 per cent level) of these three regional arrays.

Section 7.2 presents some observations for the m_b = 5.9 Lop Nor explosion on 5 October 1993. This explosion was naturally observed on the threshold plot of Section 7.1 as a very sharp peak. The contribution summarizes the automatic processing results for all six arrays processed at Kjeller. The NORESS array has the best signal-to-noise ratio (1376.2) for this event, and by extrapolation this array would be expected to have a detectable signal for an event from Lop Nor about 2.5 magnitude units lower. ARCESS and NORSAR also show outstanding SNR. The velocity/azimuth estimates are within the expected uncertainty for all arrays. It is also noted that a large earthquake and aftershock sequence occurred in the Southern Sinkiang province only three days before the explosion, and this gave an opportunity to make some interesting comparisons, elaborated upon in this study.

Section 7.3 summarizes observations from 22 September 1993, when the US Department of Energy detonated a one kiloton conventional explosion at the Nevada Test Site (NTS), in an experiment named the Non-Proliferation Experiment (NPE). The experiment was conducted in the context of future CTBT/NPT monitoring, and it has the potential of providing data useful for discrimination between chemical and nuclear explosions. The explosion was detected automatically at three of the northern/central European arrays: NORESS, NORSAR and GERESS. The NPE explosion was detonated in the N-tunnel in Rainier Mesa very close to the hypocenters of several previous nuclear explosions, some of which had yields similar to that of the NPE explosion. In particular, we compared the NPE to the nuclear explosion "Hunters Trophy" on 18 September 1992. We found that these two explosions showed very similar characteristics, both with regard to signal shape and magnitude (4.14 for "Hunters Trophy", 4.10 for NPE, based on IMS results). With an m_b of 4.4 as given by USGS for "Hunters Trophy", it is clear that NORSAR's recordings of the NPE event confirm that this one kiloton conventional explosion produced amplitudes somewhat larger than those expected from a one kiloton fully contained nuclear explosion.

Section 7.4 describes a generic algorithm for accurate determination of P-phase arrival times. This is a continuation of our studies reported on in the previous NORSAR Semiannual Technical Summary. In that report, we focused upon an optimum processing approach for one particular mining area (Khibiny Massif). We have now developed a generic procedure to reestimate the onsets of all types of first-arriving P-phases, assuming that the phase identification is known. By applying the autoregressive likelihood technique, we have obtained automatic onset times of a quality such that 70% of the automatic picks are within 0.1 s of the best manual pick. For the onset time procedure currently used by IMS, the corresponding number is 28%. This confirms that automatic reestimation of first-arriving P-onsets using the autoregressive likelihood technique has the potential of significantly reducing the retiming efforts of the analyst.

Section 7.5 likewise represents a follow-up on the Intelligent Post-Processing (IPP) of seismic events proposed in the previous Semiannual Technical Summary. This procedure has been shown to give a substantial improvement in location accuracy when applied to seismic events in the Khibiny Massif, Kola Peninsula. In this paper, we compare the performance of the analyst using the Analyst Review Station (ARS) to these results. As part of the study, we estimate the uncertainty in analyst time picks for phases from various regional arrays, and we discuss the implication of these uncertainties in terms of the resulting effect on location accuracy. An important conclusion inferred from this work is that, in many cases, location accuracy does *not* improve when adding new phase readings and applying current location programs.

Section 7.6 describes an application of Generalized Beamforming (GBF) applied to the W. Caucasus aftershock sequence of 29 April 1991. This sequence occurred during the GSETT-2 main phase, and the GBF results could therefore be compared to the results of the four Experimental International Data Centers (after reprocessing). The GBF association process reported more events than any of the four EIDCs, and also had the most events corresponding to the reference catalogue (Starovoit et al, 1991). In addition, the GBF method produced 17 reports that did not correspond to entries in Starovoit et al's bulletin. Each of the EIDCs also had events in this category, but not as many as the GBF process. One event reported by one EIDC and confirmed by Starovoit et al's bulletin was not reported by the GBF method. The reason was that the event had only two valid phases, and thus did not satisfy our GBF detection criterion. On the other hand, the GBF reported 4 confirmed events that were not in any of the EIDC bulletins. The study concludes that the GBF technique provides a simple and rapid way to associate large numbers of phases from an aftershock sequence with a very low false alarm rate. In fact, the GBF aftershock processing of 24 hours of data for the day in question (29 April 1991) took only 5 minutes on a SUN sparcstation 2.

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1 Summary

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2 NORSAR Operation

2.1 Detection Processor (DP) operation

There have been 82 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 97.3 as compared to 97.8 for the previous period.

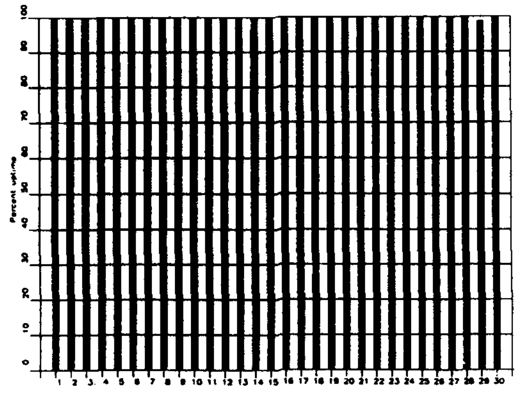
Fig. 2.1.1 and the accompanying Table 2.1.1 both show the daily DP downtime for the days between 1 April and 30 September 1993. The monthly recording times and percentages are given in Table 2.1.2.

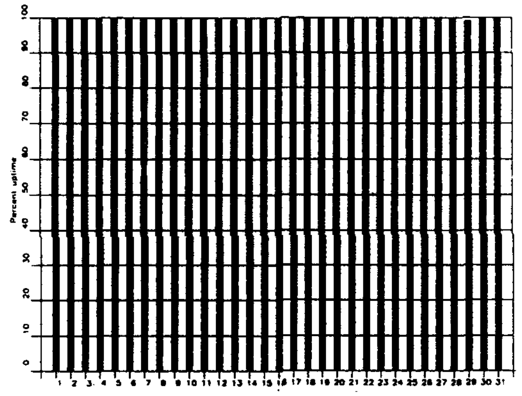
The breaks can be grouped as follows:

a)	Hardware failure	39
b)	Stops related to program work or error	0
c)	Hardware maintenance stops	5
d)	Power jumps and breaks	0
e)	TOD error correction	12
f)	Communication lines	26

The total downtime for the period was 127 hours and 27 minutes. The mean-time-between-failures (MTBF) was 2.8 days, as compared to 3.6 for the previous period.

J. Torstveit





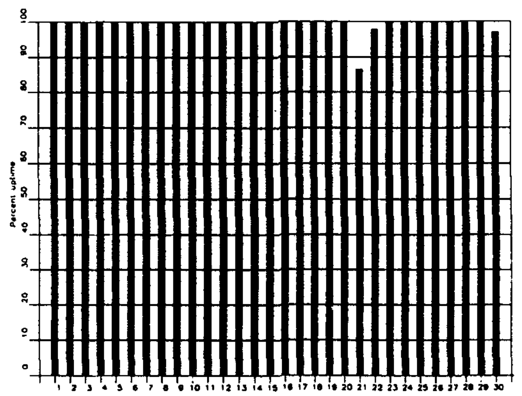


Fig. 2.1.1. Detection Processor uptime for April (top), May (middle) and June (bottom) 1993.

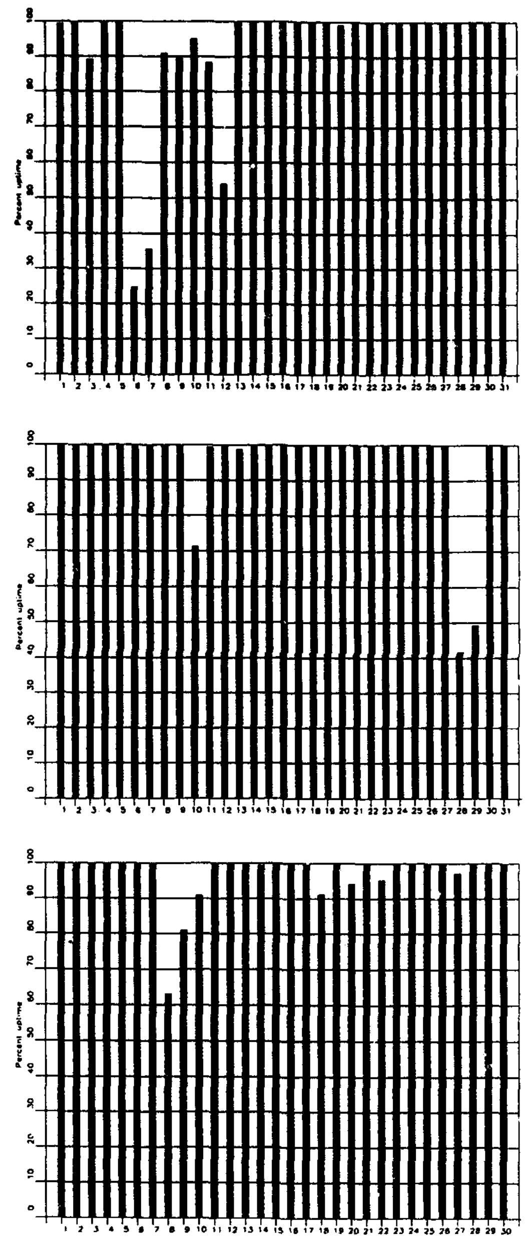


Fig. 2.1.1. Detection Processor uptime for July (top), August (middle) and September (bottom) 1993.

Date	Time	Cause
21	Jun 2045 -	Line failure
22 Jun	- 0032	Line failure
30 Jun	0700 - 0744	Hardware failure
03 Jul	1150 - 1427	Hardware failure
06 Jul	0304 - 0437	Hardware failure
06 Jul	0728 -	Hardware failure
07 Jul	- 1514	Hardware failure
08 Jul	1500 - 1540	Hardware failure
08 Jul	2200 - 2306	Hardware failure
09 Jul	0532 - 0613	Hardware failure
09 Jul	1104 - 1143	Hardware failure
09 Jul	1441 - 1502	Hardware failure
09 Jul	2200 - 2237	Hardware failure
10 Jul	2200 - 2239	Hardware failure
11 Jul	1407 - 1442	Hardware failure
11 Jul	2200 -	Hardware failure
12 Jul	- 0531	Hardware failure
12 Jul	0744 - 1307	Hardware service
10 Aug	0821 - 1514	Line failure
29 Aug	1000 -	Line failure
30 Aug	- 1211	Line failure
08 Sep	1518 -	Line failure
09 Sep	- 0428	Line failure
10 Sep	0821 - 1030	Hardware failure
18 Sep	0817 - 1024	Hardware failure
20 Sep	1208 - 1316	Hardware service
22 Sep	0804 - 0825	Hardware failure
22 Sep	2230 - 2317	Hardware failure
27 Sep	1719 - 1759	Hardware failure

Table 2.1.1. The major downtimes in the period 1 April - 30 September 1993.

Month	DP Uptime Hours	DP Uptime %	No. of DP Breaks	No. of Days with Breaks	DP MTBF* (days)
Apr 93	719.29	99.93	4	4	4.6
May 93	743.23	99.92	6	4	3.4
Jun 93	715.29	99.37	2	3	7.9
Jul 93	686.46	92.40	37	14	0.6
Aug 93	701.15	95.47	7	8	2.8
Sep 93	698.11	96.97	26	18	0.8
		97.34	82	53	2.8

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

Table 2.1.2. Online system performance, 1 April - 30 September 1993.

2.2 Array communications

General

Table 2.2.1 reflects the performance of the communications system throughout the reporting period.

The following lists the most prominent events which have affected individual and/or all systems simultaneously:

- Loss of synch
- Damaged cables
- Scheduled communications cable work (NTA)
- Unspecified work related to communications line (NTA)
- Line unit / CTV modem
- Timing problems after installation of digital central
- Failing DACCS (Digital Access Cross Connection System/NTA)
- Scheduled maintenance DACCS Lillestrøm/Hamar
- Lightning in CTV area (spec. 02B, 04C, 06C)
- Modcomp memory chip failure
- IBM disk 3656 controller failure (loss of power)
- 2701 IBM Data Adapter failure
- 2701-Modcomp data transfer stop

Detailed Summary

April (weeks 13-17), 29.3-2.5.93

The subaarray 02C was turned off 26 April at 1349 hrs due to bad status in the communications system (NO DATA). A modcomp restart 27 April reinitiated the operation.

A NORSAR stop occurred 29 April at 0903 hrs, probably due to an irregularity between the 2701 adapter and modcomp. The system was restarted at 0922 hrs.

Average outages for April, individual weeks

Week 13 (all)	:	0.004%
Week 14 (all)	:	0.014%
Week 15 (all)	:	0.0003%
Week 16 (all)	:	0.005%
Week 17 (-02C)	:	0.0009 %

May (weeks 18-21), 3-30.5.93

In the period the three subarrays 02B, 02C and 06C have been affected. Modcomp restarts reinitiated the systems again.

Average outages in May, individual weeks:

Week 18 (all)	:	0.004%
Week 19 (all)	:	0.036%
Week 20 (all)	:	0.005%
Week 21(all)	:	0.117%

June (weeks 22-26), 31.5-4.7.93

All systems were affected in the period. 04C was down 1 June between 2000 and 2242 hrs GMT in connection with scheduled cable work.

On 5 June data was lost from 02B kl 1701 GMT caused by lightning. Electricians from Rena Power Plant replaced fuses 1240 hrs GMT 7 June.

02B was affected again on 18 June between 0814 and 1230 hrs GMT. NTA carried out cable rerouting.

On 21 June 02C data disappeared after NTA/Hamar had replaced the original analog central at the NTA Sjursøen premises with a digital central (PCM). In addition, the operation also involved a change in the routing of data.

The same day NTA/Lillestrøm carried out scheduled maintenance of a DACCS in the NTA/Lillestrøm premises, affecting all the NORSAR subarrays and the 64 Kbit Spitsbergen line. All the subarrays were masked 2045 hrs GMT.

On 22 June, at 0038 hrs GMT, all the subarrays (-01A, 02C) were demasked.

On 24 June 01A resumed operation after replacing a line unit in the CTV modem.

On 30 June the communications between the 2701 Data Adapter and modem/modcomp stopped for approximately 44 minutes.

NORSAR time was set back 1 second on 1 July.

On 2 July a modcomp memory chip failed and was replaced. Downtime was approximately 2 hrs 35 minutes.

Average outage in June, individual weeks:

Week 22 (-02B)	:	0.002%
Week 23 (-02B)	:	0.002%
Week 24 (all)	:	0.002%
Week 25 (-01A,02C)	:	0.003%
Week 26 (-02C)	:	1.488%

July (weeks 27-30), 5.7-1.8.93

3 July the modcomp failed. A memory chip was replaced and the system was started again. Approximate downtime was 2.5 hrs.

On 6 July an IBM disk controller (channel 1) lost power approximately 0304 hrs. Started again 0437 hrs.

The 2701 Data Adapter also failed on 6 July. After the +3 Volt power supply was repaired, the system was started again. NORSAR downtime was 28 hrs.

On 12 July Memorex replaced the +5 Volt power supply in the disk controller 3656 (channel 1). Between 7 and 12 July the controller stopped 28 times.

19-20 July the 04C communications line was down approximately 16.5 hrs.

At the end of July 02C was still down

Average outages in July, individual weeks:

Week 27 (-02C)	:	0.0005%
Week 28 (-02C)	:	0.0009%
Week 29 (-02C,04C)	:	0.0008%
Week 30 (-02C,04C)	:	0.002%

August (weeks 31-34), 2-29.8.93

The 02C communications problems started 21 June when the existing communications equipment was replaced (modified) with PCM equipment in the Sjusjøen area, thereby introducing timing problems. The first step in trying to solve the problem was to replace the NDPC/CTV modems as quickly as possible.

02B was down between 4 and 12 August due to a broken cable between Kjeller and Lillestrøm.

06C was down between 7 and 9 August, probably caused by synch problems.

On 10 August all the subarrays were affected by a failing DACCS in the NTA premises/Hamar.

On 19 August 06C was again affected and resumed operation after a modcomp restart 23 August.

On 26 August NTA/Hamar carried out unspecified work related to the 01A communications system. Two days later, 28 August, the performance of the 01A communications system gradually was reduced. On 30 August 01A was declared down and masked.

Average outages in August, individual weeks:

Week 31 (-02B,02C,06C)	:	0.001%
Week 32 (-02C)	:	3.610%
Week 33 (-02C,06C)	:	0.003%
Week 34 (-02C)	:	0.050%

September (weeks 35-39), 30.8-3.10.93

01A, which went down 28 August due to a bad cable, was restarted 13 September after repair.

Between 8 September 1306 hrs and 9 September 0428 hrs all communications systems were affected (13.5 hrs).

Reduced 01B performance started 10 September when stop messages were received pertaining to the communications lines.

7 and 8 September NTA/Lillestrøm and Hamar tried to solve the 02C communications problems. The problem started when a new PCM-system was introduced 21 June 93. Their first initiative was to install new modems here at Kjeller and in the CTV. The test revealed error-free transmission in both directions modem to modem, but failed when the remaining NORSAR equipment was attached. The conclusion was timing problems. New initiatives will be taken.

The 01B communications cable was repaired, according to NTA/Hamar, on 13 September. An attempt to start the line failed.

Between 9 and 20 September there were a large number of modcomp restarts in connection with the misalignment of data related to clock pulses.

On 22 September two stops occurred, in both cases because the data transfer between the 2701 and the high-speed modems had stopped.

Also on 23 and 29 September and 1 October there were misalignments of data related to clock pulses. In order to resynch the 06C, the modcomp was restarted 28 September.

There seems to be a connection between misalignment of data related to clock pulses and the DACCS installed in the NTA premises in Lillestrøm and Hamar. We have observed data misalignment both before and after an announced DACCS corrective maintenance 30 September (which failed). Finally, we lost data between 0915 hrs and 1130 hrs in connection with DACCS replacment at NTA/Lillestrøm.

Average outages in September, individual weeks:

Week 35 (-01A, 02C)	:	0.003%
Week 36 (-01A,01B,02C)	:	0.56 %
Week 37 (N/A)	:	--
Week 38 (-01B,02C)	:	0.005%
Week 39 (-01B,02C,06C)	:	1.49 %

O.A. Hansen

Subarrays	Apr (5) 29.3-2.5.93	May (4) 3-30.5.93	Jun (5) 31.5-4.7.93	Jul (4) 5.7-1.8.93	Aug (4) 2-29.8.93	Sep (5) 30.8-3.10.93	Average 1/2 year
01A	0.005	0.002	0.001 3)	0.0007	0.024 11)	N/A	0.006 23)
01B	0.004	0.0006	0.0006 4)	0.001	0.001 12)	N/A	0.0007 24)
02B	0.009	0.009	0.0004 5)	0.001	0.013 13)	0.012 16)	0.007
02C	0.020 1)	0.012	0.006 6)	N/A	N/A	N/A	0.012 25)
03C	0.005	0.0006	0.0007 7)	0.0004	0.0004 14)	0.004 17)	0.001
04C	0.001	0.002	0.001 8)	0.001 10)	0.002 15)	0.002 18)	0.001
06C	0.001	0.340 2)	0.001 9)	0.001	N/A	0.006 19)	0.010 26)
AVER	0.005	0.052	0.001	0.0008 20)	0.008 21)	0.006 22)	0.005

Figures representing error rate (in per cent) followed by number 1), 2), etc., are related to legend below.

Table 2.2.1. Communications performance. The numbers represent error rates in per cent based on total transmitted frames/week (29 Mar - 3 Oct 93).

5), 10), 13)	average 2 weeks (24,25/27,28)
2), 3), 6), 11), 13) 14), 16), 18), 19)	average 3 weeks (19,20,21/22,23,24/31,33,34/35,36,37/35,37,38)
1), 4), 7), 8), 9), 17)	average 4 weeks (13,14,15,16/22,23,24,25/25,26,27,28)
25)	average 3 months (Apr, May, Jun)
23), 24)	average 5 months (Apr, May, Jun, Jul, Aug)
26)	average 5 months (Apr, May, Jun, Jul, Sep)
20)	average 6 subarrays (01A,02B, 03C-06C)
21)	average 5 subarrays (01A-02B, 03C, 04C)
22)	average 4 subarrays (02B, 03C-06C)

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 93	10725	1398	248	76	324	10.8
May 93	4525	830	305	92	397	12.8
Jun 93	7825	1214	292	130	422	14.1
Jul 93	6750	1146	342	68	410	13.2
Aug 93	7900	1232	285	54	339	10.9
Sep 93	9575	1418	285	113	398	13.3
			1757	533	2290	12.5

Table 2.3.1. Detection and Event Processor statistics, 1 Apr - 30 Sep 1993.

NORSAR Detections

The number of detections (phases) reported by the NORSAR detector during day 091 through day 273, 1993, was 47,524, giving an average of 263 detections per processed day (183 days processed). Table 2.3.2 shows daily and hourly distribution of detections for NORSAR.

B. Paulsen

NAO .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		
91	12	22	15	14	10	5	12	2	5	6	5	2	6	11	8	11	15	11	20	30	10	14	14	22	282	Apr 01	Thursday	
92	18	15	20	10	16	5	7	6	15	5	19	18	13	23	18	14	12	11	20	14	21	20	17	26	363	Apr 02	Friday	
93	23	12	14	19	28	15	20	11	8	9	15	16	11	12	16	18	25	21	15	15	25	17	21	14	402	Apr 03	Saturday	
94	18	17	18	30	20	17	12	17	20	21	13	12	32	7	18	19	17	16	18	14	19	17	14	29	435	Apr 04	Sunday	
95	17	19	24	19	31	22	10	5	5	9	11	21	10	14	14	12	13	20	19	15	13	27	18	25	393	Apr 05	Monday	
96	26	18	18	28	12	19	19	13	12	18	8	13	18	8	20	15	10	22	17	27	26	18	29	38	452	Apr 06	Tuesday	
97	28	25	34	21	19	20	14	18	10	31	22	20	22	18	18	15	16	25	16	21	25	18	19	17	492	Apr 07	Wednesday	
98	22	19	17	22	17	12	21	10	23	28	23	28	21	27	24	16	26	22	22	24	21	24	21	25	515	Apr 08	Thursday	Skj{rt
99	22	23	26	37	20	28	27	26	23	26	30	15	35	25	26	24	19	23	32	28	26	25	18	18	602	Apr 09	Friday	Langfr
100	19	25	23	23	24	23	31	17	18	23	13	9	20	20	20	26	22	17	24	25	20	17	15	15	489	Apr 10	Saturday	
101	13	20	16	21	29	30	29	26	8	19	18	30	15	14	11	16	14	16	31	26	23	18	14	22	479	Apr 11	Sunday	F°rste
102	29	25	21	23	24	24	28	18	17	11	23	18	19	10	15	33	23	17	10	8	20	8	15	12	451	Apr 12	Monday	Annen
103	12	20	33	27	15	23	13	2	11	5	13	13	8	6	1	5	5	2	12	9	15	18	11	11	290	Apr 13	Tuesday	
104	9	12	15	10	8	6	18	10	17	17	18	7	7	6	6	2	2	9	3	14	9	7	11	24	247	Apr 14	Wednesday	
105	25	21	12	14	2	5	3	9	7	4	7	22	13	12	9	7	26	13	16	16	13	20	10	22	308	Apr 15	Thursday	
106	30	14	18	16	20	16	12	14	6	11	11	11	17	21	22	25	17	22	16	21	24	21	20	21	426	Apr 16	Friday	
107	19	23	24	27	30	13	12	18	16	41	13	12	22	18	26	16	21	30	27	15	18	25	31	30	527	Apr 17	Saturday	
108	29	21	39	37	23	20	27	32	25	20	20	23	27	24	25	28	16	23	26	24	22	31	29	33	624	Apr 18	Sunday	
109	20	31	25	25	15	19	9	12	10	13	6	14	13	6	13	10	10	12	11	15	10	30	11	15	355	Apr 19	Monday	
110	16	9	18	15	9	3	1	5	14	3	39	24	13	9	12	12	11	17	7	10	20	23	17	24	328	Apr 20	Tuesday	
111	12	23	15	15	17	7	9	14	18	11	11	15	6	23	19	19	26	16	12	17	15	13	10	17	357	Apr 21	Wednesday	
112	14	32	21	24	11	12	3	18	21	7	18	12	24	6	7	6	5	8	13	14	15	13	13	11	328	Apr 22	Thursday	
113	19	17	5	13	11	7	3	1	5	10	4	8	12	19	13	12	8	15	22	16	8	18	25	19	290	Apr 23	Friday	
114	34	23	31	25	29	18	16	14	11	14	19	11	23	20	23	21	16	22	23	15	15	19	22	12	476	Apr 24	Saturday	
115	20	15	7	11	13	14	8	13	10	5	10	4	5	3	13	3	14	4	6	8	11	9	15	9	230	Apr 25	Sunday	
116	8	6	7	12	5	4	1	0	1	1	9	10	6	10	5	14	1	5	3	1	3	5	3	6	126	Apr 26	Monday	
117	0	0	3	11	5	3	3	0	7	10	0	3	8	10	12	14	4	2	2	4	10	3	9	7	130	Apr 27	Tuesday	
118	8	6	9	11	2	8	0	6	10	0	5	10	4	3	24	15	2	1	3	5	3	5	7	4	151	Apr 28	Wednesday	
119	5	8	1	16	2	0	2	4	6	10	5	11	3	5	1	0	1	1	0	4	13	7	6	0	111	Apr 29	Thursday	
120	1	3	1	0	3	1	1	8	12	4	6	10	7	4	1	0	0	1	3	1	0	1	3	2	71	Apr 30	Friday	
121	0	0	3	7	3	2	4	15	4	9	0	0	1	0	0	3	0	1	0	2	1	1	1	1	58	May 01	Saturday	F°rste
122	0	0	2	2	15	0	7	4	2	3	5	12	3	0	9	14	6	7	6	10	2	5	1	3	118	May 02	Sunday	
123	2	1	2	1	2	2	1	0	2	5	1	1	7	1	0	0	1	0	2	4	2	6	3	4	50	May 03	Monday	
124	9	2	3	2	8	2	2	7	1	2	7	2	5	6	6	2	4	4	0	3	5	0	13	3	98	May 04	Tuesday	
125	4	4	4	2	14	0	2	5	5	8	1	17	15	5	10	10	1	3	14	0	0	3	0	2	129	May 05	Wednesday	
126	1	10	3	3	1	3	1	1	7	8	20	21	0	26	9	2	8	4	0	5	13	4	4	14	168	May 06	Thursday	
127	3	14	0	4	2	2	1	7	3	1	9	9	3	1	0	4	5	4	0	4	4	0	4	4	88	May 07	Friday	
128	2	1	0	3	3	0	0	5	2	3	1	0	1	2	2	4	3	2	2	1	1	1	3	1	43	May 08	Saturday	
129	3	6	2	10	1	2	1	0	13	4	0	3	0	1	2	1	4	7	1	0	5	0	6	1	73	May 09	Sunday	
130	3	3	6	1	6	4	4	0	1	0	5	3	1	0	4	1	5	8	2	8	3	4	1	4	77	May 10	Monday	
131	2	6	2	6	0	2	11	26	5	0	7	13	8	3	19	4	1	0	18	1	1	4	4	5	148	May 11	Tuesday	
132	2	8	7	2	3	0	1	3	9	3	4	9	7	15	5	2	3	2	2	0	9	12	11	13	132	May 12	Wednesday	
133	13	13	8	12	10	6	5	2	4	4	16	6	11	18	2	10	6	12	12	6	15	16	12	12	231	May 13	Thursday	
134	6	18	13	11	5	3	2	3	2	9	5	5	6	33	2	2	2	5	4	3	9	5	5	31	189	May 14	Friday	
135	10	24	10	18	8	10	8	6	6	13	5	7	7	3	4	15	4	11	12	5	8	12	29	17	252	May 15	Saturday	
136	21	16	10	24	21	13	8	10	13	14	15	6	8	7	11	5	3	2	6	10	3	12	18	9	265	May 16	Sunday	
137	10	10	8	6	17	7	17	11	4	14	16	9	8	20	10	8	17	15	12	10	13	16	8	15	281	May 17	Monday	Sytten
138	12	18	6	6	4	2	1	3	10	3	11	35	25	6	7	6	3	3	4	9	0	4	3	4	185	May 18	Tuesday	
139	8	0	1	3	8	5	7	11	1	0	13	4	5	3	5	0	3	0	2	0	4	2	0	4	89	May 19	Wednesday	
140	0	4	9	2	7	4	0	0	4	0	1	18	0	0	2	1	0	3	1	0	8	2	9	2	77	May 20	Thursday	Kristi
141	0	6	8	5	1	5	9	2	2	1	0	4	9	4	3	8	3	4	4	3	0	7	3	2	93	May 21	Friday	
142	0	7	1	1	8	2	2	5	2	0	4	3	1	6	5	1	1	7	3	3	3	1	1	1	68	May 22	Saturday	
143	7	6	19	13	4	4	4	22	5	3	1	5	7	4	2	14	7	14	5	3	4	0	1	3	157	May 23	Sunday	
144	6	0	0	4	2	5	8	1	9	1	3	16	2	6	10	4	2	3	5	5	6	5	2	10	115	May 24	Monday	
145	33	9	13	5	5	3	2	7	11	2	15	5	10	4	9	10	9	13	10	7	10	12	13	27	244	May 25	Tuesday	
146	8	10	8	12	10	3	5	4	13	7	8	2	10	12	8	5	6	7	2	4	0	4	9	6	163	May 26	Wednesday	

Table 2.3.2 (Page 1 of 4)

NAO .DFX 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	
147	3	7	3	4	0	10	0	1	3	16	9	16	25	6	8	6	0	6	12	2	0	5	8	3	153	May 27 Thursday	
148	7	3	5	3	4	2	1	5	4	10	3	17	10	2	7	1	13	7	3	6	2	15	1	3	134	May 28 Friday	
149	14	7	6	6	1	8	8	6	11	3	10	10	14	2	7	2	3	21	10	11	11	7	8	16	202	May 29 Saturday	
150	8	12	2	3	5	5	9	1	1	2	3	5	0	0	10	4	10	23	7	8	12	6	13	15	164	May 30 Sunday	Første
151	13	17	10	10	4	7	8	8	9	20	12	8	12	21	10	14	10	11	14	9	10	15	15	14	281	May 31 Monday	Annen
152	16	6	7	12	15	6	2	10	10	11	0	10	8	9	6	8	2	7	5	21	5	4	12	5	197	Jun 01 Tuesday	
153	4	11	13	9	5	1	1	4	10	6	6	18	3	4	2	1	8	10	11	5	4	14	17	11	178	Jun 02 Wednesday	
154	11	14	7	4	7	7	1	7	4	9	5	2	10	5	16	4	6	1	5	1	12	12	7	3	160	Jun 03 Thursday	
155	4	15	1	18	4	1	7	0	6	6	6	28	10	13	11	1	7	2	4	2	5	32	15	8	206	Jun 04 Friday	
156	13	9	14	22	13	15	10	16	3	7	4	8	6	16	12	14	10	6	14	21	15	26	25	14	313	Jun 05 Saturday	
157	13	17	21	10	21	16	12	9	5	16	11	22	11	16	6	9	17	13	7	10	5	12	5	29	313	Jun 06 Sunday	
158	10	5	18	8	5	1	2	4	10	13	0	10	14	10	7	11	1	11	1	8	7	8	10	1	175	Jun 07 Monday	
159	10	5	1	12	5	1	1	3	3	6	8	13	10	28	10	13	5	1	1	7	10	5	12	28	198	Jun 08 Tuesday	
160	9	5	3	3	10	2	2	8	5	0	0	15	19	20	1	2	10	16	6	11	6	13	4	11	181	Jun 09 Wednesday	
161	5	11	3	2	9	9	0	0	26	25	7	0	9	14	14	10	15	4	13	16	12	8	9	9	230	Jun 10 Thursday	
162	12	18	13	11	10	2	2	6	8	15	7	13	14	15	7	11	6	8	6	11	13	13	11	11	243	Jun 11 Friday	
163	8	17	10	11	10	20	14	16	15	24	6	17	20	8	12	14	13	13	21	16	29	9	22	17	362	Jun 12 Saturday	
164	26	27	16	18	18	20	25	17	16	19	24	13	13	13	10	10	16	10	8	19	11	10	16	15	390	Jun 13 Sunday	
165	19	13	8	9	9	3	5	11	12	11	7	2	10	12	13	16	2	4	5	10	17	7	9	9	223	Jun 14 Monday	
166	6	6	13	15	12	11	8	5	2	6	5	6	23	22	2	7	5	7	9	6	8	12	14	18	228	Jun 15 Tuesday	
167	18	15	17	13	10	9	3	7	4	2	9	31	13	12	4	4	2	7	3	1	4	2	15	6	211	Jun 16 Wednesday	
168	8	3	2	6	7	2	3	3	4	11	12	10	6	11	5	10	16	6	3	16	14	13	17	7	195	Jun 17 Thursday	
169	10	8	16	6	3	12	3	0	5	19	5	9	18	1	6	3	0	29	21	13	19	13	15	19	253	Jun 18 Friday	
170	12	17	15	15	14	11	3	4	7	3	10	10	13	17	11	11	10	24	10	22	14	17	11	11	292	Jun 19 Saturday	
171	23	16	25	23	17	27	34	16	24	14	10	16	11	29	12	8	14	16	12	14	16	15	22	31	445	Jun 20 Sunday	
172	31	23	16	20	9	6	4	10	9	4	3	22	6	16	12	18	7	12	18	7	5	0	0	0	258	Jun 21 Monday	
173	8	22	10	10	8	3	2	4	14	8	14	3	21	9	11	15	16	9	11	6	13	18	11	15	261	Jun 22 Tuesday	
174	12	15	18	16	7	5	2	5	4	9	13	25	22	27	11	5	16	23	12	13	9	12	25	19	325	Jun 23 Wednesday	
175	19	24	25	18	12	12	4	6	9	11	9	10	7	12	13	7	8	11	13	27	7	17	22	26	329	Jun 24 Thursday	
176	23	18	14	15	7	5	8	16	12	11	14	5	5	16	13	11	18	17	19	14	12	11	12	15	311	Jun 25 Friday	
177	20	16	11	13	7	18	4	6	2	4	11	14	2	15	20	19	8	11	23	23	12	11	22	11	303	Jun 26 Saturday	
178	19	25	27	20	18	18	12	13	14	12	10	18	15	14	15	14	14	11	13	18	30	9	13	12	392	Jun 27 Sunday	
179	3	17	14	5	2	2	4	8	6	4	7	10	6	11	10	10	19	10	4	7	13	8	4	7	191	Jun 28 Monday	
180	23	3	8	4	21	0	4	3	10	9	7	23	9	2	12	3	3	6	5	12	5	8	7	6	193	Jun 29 Tuesday	
181	7	11	6	8	22	3	19	5	3	9	12	13	23	20	7	6	7	14	6	11	5	6	17	17	257	Jun 30 Wednesday	
182	19	2	4	6	4	6	21	11	3	14	5	18	7	2	23	4	2	7	3	11	11	8	12	14	217	Jul 01 Thursday	
183	9	10	6	6	18	1	5	11	0	3	5	15	12	10	3	17	9	13	16	10	15	24	15	13	246	Jul 02 Friday	
184	16	13	15	16	17	12	16	6	11	30	17	8	0	0	8	13	17	16	12	18	13	16	15	20	325	Jul 03 Saturday	
185	14	13	13	10	11	11	20	10	14	12	10	16	14	18	11	15	15	11	6	17	12	14	18	28	334	Jul 04 Sunday	
186	20	23	12	13	19	11	8	12	15	11	10	23	7	12	18	9	11	8	11	14	15	9	15	11	317	Jul 05 Monday	
187	15	11	10	1	4	2	21	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	65	Jul 06 Tuesday	
188	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	11	17	9	11	5	14	6	15	97	Jul 07 Wednesday	
189	15	11	8	8	7	4	4	11	1	19	8	27	12	15	9	3	17	7	18	33	15	10	0	22	284	Jul 08 Thursday	
190	17	17	19	15	20	2	3	14	1	7	12	6	19	12	4	16	12	5	12	11	17	24	2	0	267	Jul 09 Friday	
191	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 10 Saturday	
192	25	16	24	10	17	11	18	8	19	12	23	5	10	26	6	18	23	12	10	12	17	20	0	0	342	Jul 11 Sunday	
193	0	0	0	0	0	1	5	3	0	0	0	0	0	47	59	38	19	13	29	16	11	16	21	8	286	Jul 12 Monday	
194	16	11	30	22	11	25	3	4	1	13	18	24	21	4	22	14	9	7	12	9	9	4	3	10	302	Jul 13 Tuesday	
195	7	8	7	5	5	9	11	0	7	3	11	17	18	16	1	20	3	18	1	9	7	7	9	2	201	Jul 14 Wednesday	
196	1	12	11	9	10	3	4	12	15	17	3	2	16	9	1	1	6	3	8	20	7	5	11	9	195	Jul 15 Thursday	
197	9	5	7	11	2	5	4	0	5	8	12	7	15	2	13	9	4	5	3	4	4	13	5	6	158	Jul 16 Friday	
198	6	7	11	6	2	9	5	6	7	11	7	6	13	3	25	28	31	25	9	10	4	7	5	7	250	Jul 17 Saturday	
199	9	2	9	26	1	12	7	8	4	6	6	5	9	2	13	6	6	9	3	8	9	10	10	7	187	Jul 18 Sunday	
200	10	8	11	18	8	2	2	3	8	3	7	4	10	20	11	11	4	16	6	17	3	7	12	11	214	Jul 19 Monday	
201	9	11	15	13	10	5	1	9	9	8	9	5	4	12	4	9	7	15	5	5	8	4	14	7	198	Jul 20 Tuesday	
202	11	10	14	6	8	9	4	3	7	11	10	14	13	5	11	4	6	9	5	8	3	10	17	7	205	Jul 21 Wednesday	

Table 2.3.2. (Page 2 of 4)

NAO .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
203	11	10	14	11	4	16	9	9	4	0	16	12	17	25	10	3	5	12	14	21	14	10	16	14	277	Jul 22 Thursday
204	11	10	12	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	Jul 23 Friday
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 24 Saturday
206	8	11	6	9	10	12	5	5	10	4	6	6	4	8	8	8	5	6	7	8	5	12	12	15	190	Jul 25 Sunday
207	7	11	10	10	4	5	6	0	10	3	4	10	4	7	5	7	7	2	3	6	3	5	3	4	136	Jul 26 Monday
208	6	8	4	3	8	5	4	3	4	5	7	16	6	2	14	3	9	14	4	16	7	7	11	4	170	Jul 27 Tuesday
209	6	4	7	6	2	7	0	3	5	11	7	7	10	10	5	1	5	9	14	5	2	2	2	4	134	Jul 28 Wednesday
210	10	5	3	4	15	1	2	2	5	11	1	2	12	5	10	20	2	1	3	3	6	4	7	9	143	Jul 29 Thursday
211	7	7	4	5	4	3	3	8	4	4	5	12	8	2	27	1	5	7	2	2	6	0	4	5	135	Jul 30 Friday
212	9	6	6	5	7	5	3	5	2	7	5	10	6	4	11	7	1	5	5	18	10	6	6	14	163	Jul 31 Saturday
213	12	8	18	15	5	10	5	10	11	11	9	9	11	7	12	18	8	8	5	17	6	7	11	9	242	Aug 01 Sunday
214	10	14	6	19	4	2	2	3	2	5	4	5	1	4	17	7	19	5	7	5	7	8	8	12	176	Aug 02 Monday
215	9	6	10	10	11	6	5	8	5	9	15	9	22	37	9	8	19	10	12	6	5	7	5	5	248	Aug 03 Tuesday
216	8	3	4	4	2	2	14	6	9	18	2	23	7	10	6	10	0	2	5	19	8	7	2	2	173	Aug 04 Wednesday
217	5	11	3	1	4	5	5	13	15	3	1	11	21	21	5	3	3	10	8	0	6	8	11	10	183	Aug 05 Thursday
218	9	10	2	8	4	3	3	4	5	1	3	27	13	4	5	0	12	5	20	3	4	11	4	14	174	Aug 06 Friday
219	8	6	7	5	10	3	5	1	12	12	11	13	11	6	4	4	10	9	14	16	14	6	8	9	204	Aug 07 Saturday
220	30	8	12	9	4	6	6	6	16	24	9	9	28	5	8	12	15	8	10	9	20	13	22	15	304	Aug 08 Sunday
221	13	10	16	14	11	12	7	7	10	14	11	11	24	10	10	10	5	7	7	9	8	7	7	5	245	Aug 09 Monday
222	10	14	5	7	6	5	16	6	6	0	122	53	0	0	19	4	14	22	13	19	5	19	16	17	398	Aug 10 Tuesday
223	21	14	18	20	27	8	7	10	2	8	8	9	12	11	18	5	7	9	4	9	10	8	11	7	261	Aug 11 Wednesday
224	20	10	20	8	13	2	4	2	10	13	3	16	9	15	11	7	3	4	6	9	7	4	5	9	210	Aug 12 Thursday
225	19	9	4	14	10	7	4	19	8	16	5	12	4	7	8	14	8	14	7	10	13	14	12	7	245	Aug 13 Friday
226	8	14	10	11	16	11	8	10	15	16	7	11	9	16	20	17	14	6	11	10	8	6	10	11	275	Aug 14 Saturday
227	12	15	5	23	14	18	8	6	10	11	13	9	6	8	7	9	4	11	10	6	5	3	6	13	232	Aug 15 Sunday
228	4	5	5	5	8	3	2	1	3	4	2	4	15	1	13	3	7	10	5	6	20	10	12	16	164	Aug 16 Monday
229	15	13	15	7	13	11	7	9	2	14	6	8	15	14	11	16	13	9	11	12	14	11	7	16	269	Aug 17 Tuesday
230	7	14	7	4	17	6	1	15	13	17	5	13	14	10	8	13	7	7	2	5	11	13	13	11	233	Aug 18 Wednesday
231	19	11	11	11	13	6	12	10	11	12	10	12	6	9	6	30	10	6	9	6	9	8	17	7	261	Aug 19 Thursday
232	14	8	15	9	3	14	6	8	5	9	11	21	6	9	9	10	13	31	9	17	21	27	14	18	307	Aug 20 Friday
233	20	22	18	27	31	20	19	10	10	22	16	14	18	12	11	25	8	21	23	16	20	16	23	19	441	Aug 21 Saturday
234	27	16	29	20	25	16	27	22	17	22	26	13	22	22	18	14	11	5	11	10	16	16	20	13	438	Aug 22 Sunday
235	15	11	12	21	12	18	7	8	4	14	8	7	8	10	21	4	16	14	12	27	17	13	15	24	318	Aug 23 Monday
236	23	20	14	17	13	9	6	7	11	5	4	9	6	15	13	20	3	14	14	18	9	12	7	14	283	Aug 24 Tuesday
237	8	7	17	6	6	8	3	1	7	3	1	14	14	19	14	13	3	7	9	14	7	8	9	13	211	Aug 25 Wednesday
238	12	23	16	17	10	7	7	1	13	16	34	9	13	15	6	13	15	16	16	27	16	27	31	9	369	Aug 26 Thursday
239	16	14	14	11	5	2	6	5	2	11	0	5	7	12	3	8	4	6	6	7	8	11	11	8	182	Aug 27 Friday
240	13	21	11	15	14	6	8	8	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	Aug 28 Saturday
241	0	0	0	0	0	0	0	0	0	0	0	0	17	20	26	17	19	16	14	22	16	18	22	26	233	Aug 29 Sunday
242	29	19	25	24	16	9	6	9	7	7	5	8	22	7	19	17	10	5	15	17	14	10	12	15	327	Aug 30 Monday
243	16	6	6	5	5	0	0	17	8	1	9	10	7	18	14	8	4	9	3	6	6	12	11	10	191	Aug 31 Tuesday
244	23	8	4	14	16	2	11	7	2	21	15	10	28	25	38	1	11	13	12	6	8	14	4	12	305	Sep 01 Wednesday
245	11	3	5	7	9	4	3	4	4	12	16	9	8	9	18	10	16	12	18	17	17	20	18	20	270	Sep 02 Thursday
246	26	23	19	27	17	11	9	6	15	6	7	14	20	8	15	9	14	16	21	15	31	15	26	20	390	Sep 03 Friday
247	22	17	20	25	21	23	20	32	17	14	22	31	16	17	15	21	14	17	9	10	20	25	27	21	476	Sep 04 Saturday
248	15	18	12	22	35	17	17	20	25	17	25	17	21	14	14	13	10	5	11	10	22	27	27	19	433	Sep 05 Sunday
249	13	18	9	27	25	9	7	3	11	5	9	7	6	17	6	6	11	9	10	11	17	14	17	21	288	Sep 06 Monday
250	19	13	19	18	4	3	8	5	6	1	13	12	7	34	4	6	6	19	8	15	12	16	14	0	262	Sep 07 Tuesday
251	21	13	24	8	12	0	7	8	3	13	7	23	24	15	16	1	0	0	0	0	0	0	0	0	195	Sep 08 Wednesday
252	0	0	0	0	10	3	0	15	6	8	4	6	29	18	9	24	10	13	10	10	15	11	17	13	231	Sep 09 Thursday
253	9	14	16	12	7	8	6	19	4	0	21	20	17	21	17	36	12	21	15	30	23	14	14	13	369	Sep 10 Friday
254	18	23	14	17	16	25	17	13	20	18	23	14	15	10	21	12	13	18	12	29	11	10	16	17	402	Sep 11 Saturday
255	16	9	16	25	12	13	8	19	18	12	13	8	12	8	20	12	16	8	11	12	14	11	17	18	328	Sep 12 Sunday
256	10	21	16	23	15	25	6	6	6	8	13	19	15	30	24	36	14	16	9	15	26	21	25	24	423	Sep 13 Monday
257	30	36	34	31	18	23	24	12	12	15	13	19	23	10	12	7	33	15	6	12	10	20	12	10	437	Sep 14 Tuesday
258	5	18	21	17	6	6	11	27	6	11	12	6	14	8	18	14	6	9	15	14	35	26	23	26	354	Sep 15 Wednesday

Table 2.3.2. (Page 3 of 4)

NAO .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
259	29	37	12	13	6	9	10	8	6	3	19	11	15	21	10	19	9	11	13	6	17	13	11	15	323	Sep 16 Thursday
260	9	14	13	10	4	5	1	4	4	14	18	15	20	22	0	10	5	7	1	9	10	8	7	18	228	Sep 17 Friday
261	24	10	15	6	10	17	12	12	23	0	3	10	6	16	5	5	10	8	9	19	20	30	9	11	290	Sep 18 Saturday
262	11	12	11	22	17	40	5	9	6	19	7	3	8	8	12	13	12	4	11	15	15	22	20	28	330	Sep 19 Sunday
263	36	41	29	28	15	8	7	7	3	21	7	11	10	18	7	6	9	2	9	20	18	18	20	30	380	Sep 20 Monday
264	14	18	20	27	11	11	9	8	1	17	10	2	11	20	8	7	13	3	7	23	9	6	10	21	286	Sep 21 Tuesday
265	18	16	13	12	3	7	6	5	0	8	5	30	10	10	6	3	5	7	8	6	4	8	7	22	219	Sep 22 Wednesday
266	14	30	20	31	11	1	8	12	3	9	12	10	10	7	5	9	4	6	10	4	15	3	6	10	250	Sep 23 Thursday
267	6	17	3	10	5	2	2	2	4	5	10	11	1	9	6	0	4	8	9	12	8	13	12	13	172	Sep 24 Friday
268	23	12	20	17	22	15	7	8	17	9	8	9	13	15	17	9	10	13	19	14	17	19	20	18	351	Sep 25 Saturday
269	16	18	21	18	22	16	17	20	17	23	16	12	14	23	13	22	16	13	19	17	16	14	14	21	418	Sep 26 Sunday
270	22	26	22	21	12	10	5	3	2	3	3	7	12	12	3	8	2	1	2	9	3	6	12	11	217	Sep 27 Monday
271	9	17	11	11	11	1	1	1	1	5	10	3	7	5	14	6	19	13	5	5	8	12	18	22	215	Sep 28 Tuesday
272	15	13	14	27	18	25	4	6	7	9	10	27	21	16	24	8	9	13	11	20	19	25	24	14	379	Sep 29 Wednesday
273	24	22	23	19	24	23	7	9	12	13	7	9	9	12	15	9	17	17	14	13	18	14	9	17	356	Sep 30 Thursday
NAO	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	2396	2356	2223	2337	2009	1622	1436	1522	1540	1789	1865	2183	2129	2173	2037	1874	1718	1873	1778	2064	2027	2097	2159	2317	47524	Total sum
181	13	13	12	13	11	9	8	8	9	10	10	12	12	12	11	10	9	10	10	11	11	12	12	13	263	Total average
125	12	13	11	11	9	6	6	7	7	8	9	12	11	12	10	9	8	9	9	10	10	11	11	12	234	Average workdays
56	15	14	14	16	14	13	12	12	12	13	11	11	12	11	12	13	12	12	12	13	13	13	14	15	310	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

Table 3.1.1 lists the main outage times and reasons.

The average recording time was 99.94% as compared to 99.96% during the previous reportin, period.

Date	Time	Cause
14 Jul	2245 - 2254	Transmission line failure
03 Aug	1054 - 1224	Hardware maintenance
26 Sep	0100 - 0200	Software failure

Table 3.1.1. Interruptions in recording of NORESS data at NDPC, 1 April - 30 September 1993.

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	:	100.00
May	:	100.00
June	:	100.00
July	:	99.97
August	:	99.79
September	:	99.86

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.

J. Torstveit

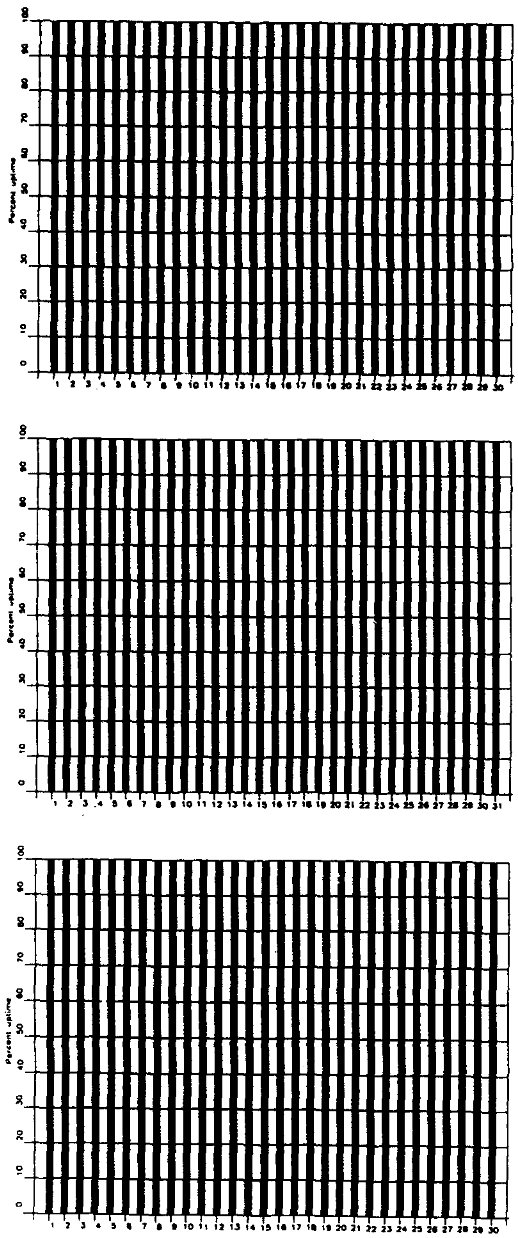


Fig. 3.1.1. NORESS data recording uptime for Apirl (top), May (middle) and June (bottom) 1993.

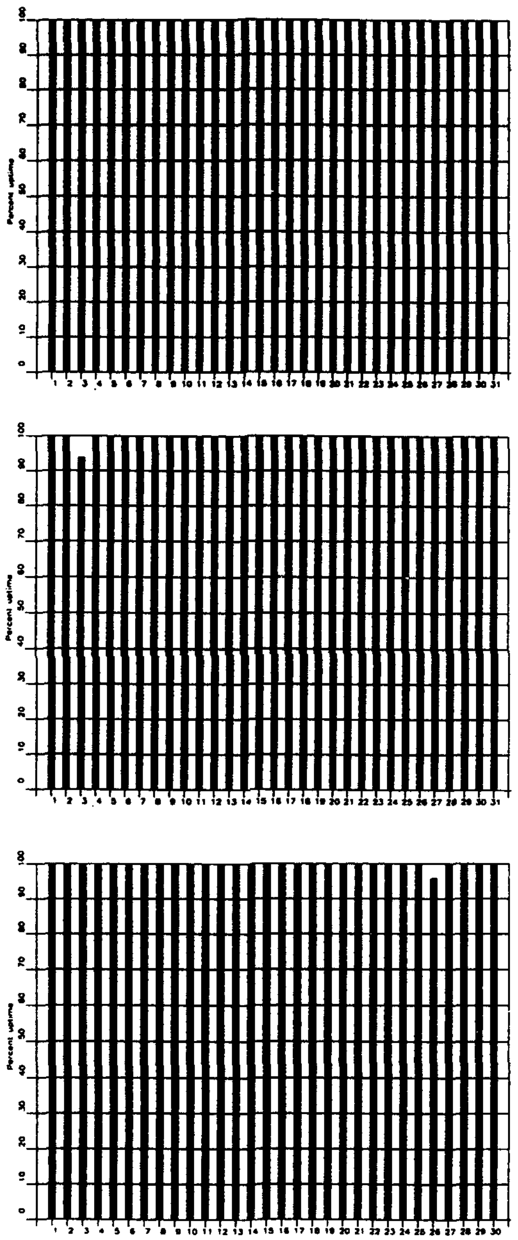


Fig. 3.1.1. (cont.) NORESS data recording uptime for July (top), August (middle) and September (bottom) 1993.

3.2 Recording of ARCESS data at NDPC, Kjeller

Table 3.2.1 lists the main outage times and reasons.

The average recording time was 99.19% as compared to 99.61% for the previous reporting period.

Date	Time	Cause
09 Apr	1953 - 2054	Software failure
26 Apr	0231 - 0344	Satellite link failure
10 May	1028 - 1300	Powerline work HUB
11 May	1039 - 1235	Powerline work HUB
12 May	1031 - 1244	Powerline work HUB
13 May	1041 - 1227	Powerline work HUB
04 Jun	2045 -	Hardware failure HUB
05 Jun	- 0706	Hardware failure HUB
05 Jun	1035 - 1108	Hardware failure NDPC
06 Jul	1049 - 1348	Hardware failure NDPC
09 Jul	0107 - 0515	Satellite link failure
13 Jul	0739 - 0800	Hardware failure NDPC
10 Aug	0707 - 1038	Satellite link service

Table 3.2.1. The main interruptions in recording of ARCESS data at NDPC, 1 April - 30 Septemer 1993.

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	:	99.68%
May	:	98.82%
June	:	98.23%
July	:	98.98%
August	:	99.48%
March	:	99.96%

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.

J. Torstveit

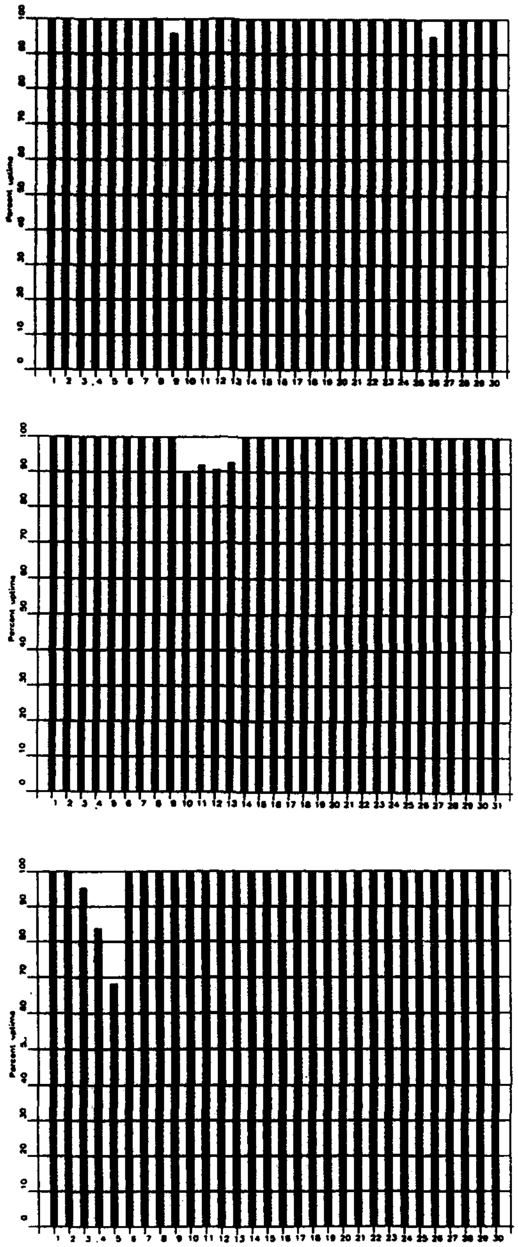


Fig. 3.2.1. ARCESS data recording uptime for April (top), May (middle) and June (bottom) 1993.

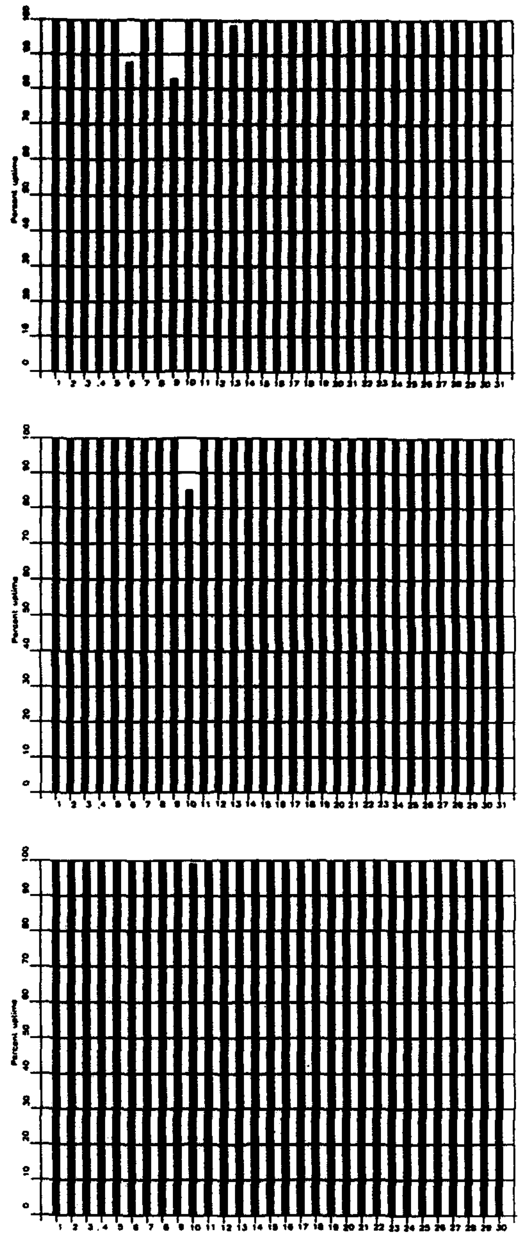


Fig. 3.2.1. ARCESS data recording uptime for July (top), August (middle) and September (bottom) 1993.

3.3 Recording of FINESA data at NDPC, Kjeller

The HUB field system was hit by lightning on May 16 and not brought back into operation again, as work related to a planned refurbishment started shortly afterwards.

Date	Time	Cause
11 Apr	1056 -	HUB failure
12 Apr	- 0111	HUB failure
16 Apr	0832 - 1027	Transmission line test
08 May	1404 - 1508	Transmission line failure
08 May	1524 - 1544	Transmission line failure
08 May	1551 - 1610	Transmission line failure
16 May	1342 -	HUB failure, field system upgrade

Table 3.3.1. The main interruptions in recording of FINESA data at NDPC, 1 April - 16 May 1993.

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

April	:	97.68%
May	:	49.99%
June	:	0.00%
July	:	0.00%
August	:	0.00%
September	:	0.00%

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

J. Torstveit

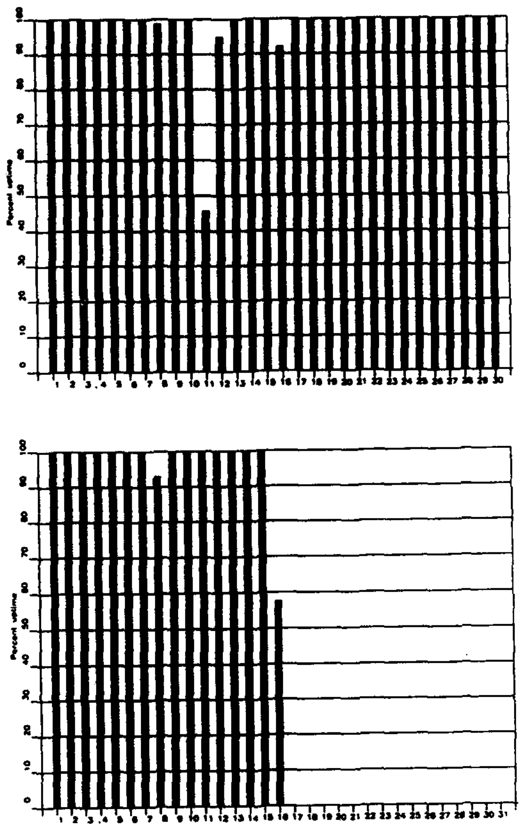


Fig. 3.3.1. FINESA data recording uptime for April (top) and May (bottom) 1993.

3.4 Recording of Spitsbergen data at NDPC, Kjeller

The average recording time was 99.16%.

The main reasons for downtime follow:

Date	Time	Cause
12 May	1955 - 2036	Communication line failure
21 May	1944 - 2026	Communication line failure
21 May	2131 - 2313	Communication line failure
23 May	2223 - 2300	Communication line failure
21 Jun	2133 - 2316	Communication line failure
30 Jun	0743 - 0827	Communication line failure
01 Jul	1313 - 1427	Communication line failure
01 Jul	1518 - 1612	Communication line failure
06 Jul	1750 - 1853	Communication line failure
06 Jul	1909 - 2002	Communication line failure
30 Jul	1900 - 2012	Communication line failure
02 Aug	2000 - 2141	Communication line failure
10 Aug	1146 - 1242	Communication line failure
10 Aug	1939 - 2010	Communication line failure
11 Aug	0919 - 1023	Communication line failure
12 Aug	1555 - 1647	Communication line failure
03 Sep	0852 - 1136	Maintenance work at array site
06 Sep	0842 - 1000	Maintenance work at array site
22 Sep	0814 - 0938	Communication line failure
24 Sep	0439 - 0600	Communication line failure

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	:	99.91%
May	:	99.07%
June	:	99.43%
July	:	98.58%
August	:	98.97%
September	:	99.00%

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

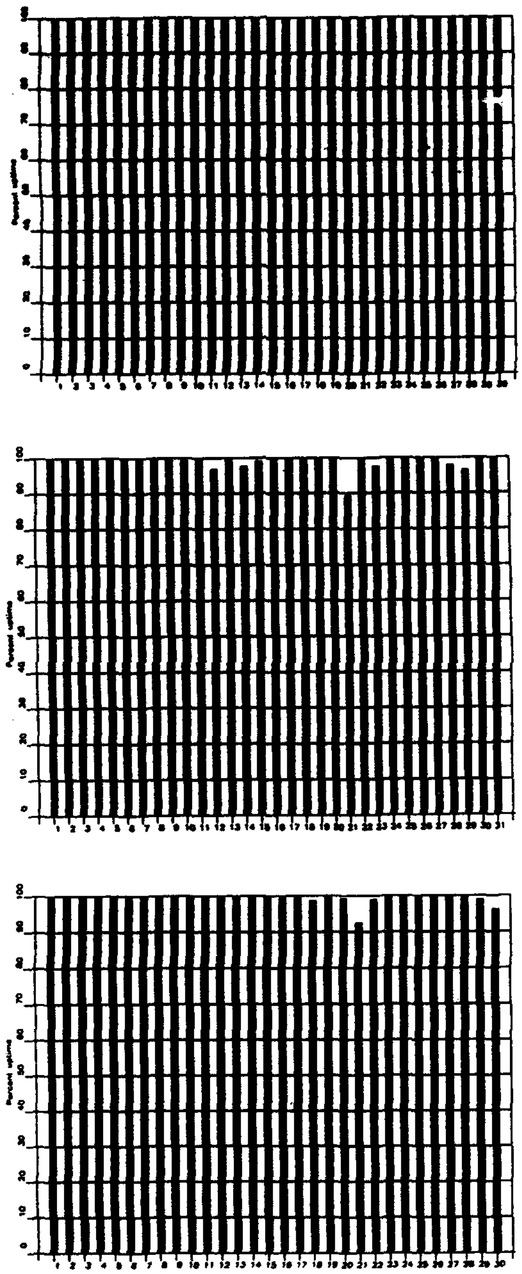


Fig. 3.4.1. Spitsbergen data recording uptime for April (top), May (middle) and June (bottom) 1993.

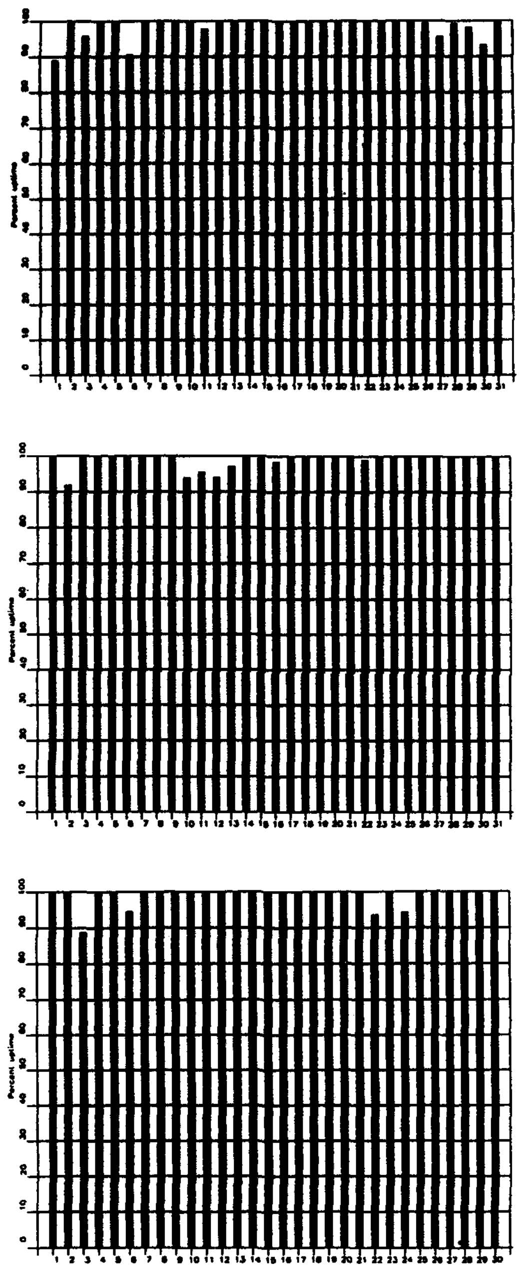


Fig. 3.4.1. Spitsbergen data recording uptime for July (top), August (middle) and September (bottom) 1993.

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 Ringdal and Kværna (1989), "A mulitchannel processing approach to real time network detection, phase association and threshold monitoring", *Bull. Seism. Soc. Am.* 79, 6, 1927-1940) processes the regional arrays jointly and presents locations of regional events.
3. The IMS system is operated on the same set of arrivals as ep and GBF and reports also teleseismic events in addition to regional ones.

IMS results are reported in sections 3.6 and 3.7 and GBF results in section 3.8.

In addition to these three event association processes, we are running test versions of the so-called Threshold Monitoring (TM) process. This is a process that monitors the seismic amplitude level at the regional arrays continuously in time to estimate the upper magnitude limit of an event that might go undetected by the network. The current TM process is beamed to several sites of interest, including the Novaya Zemlya test site. Simple displays of so-called threshold curves reveal instants of particular interest; i.e., instants when events above a certain magnitude threshold may have occurred in the target region. Results from the three processes described above are used to help resolve what actually happened during these instances.

NORESS detections

The number of detections (phases) reported from day 091, 1993, through day 273, 1993, was 31,905, giving an average of 174 detections per processed day (183 days processed).

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

Events automatically located by NORESS

During days 091, 1993, through 273, 1993, 2113 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 (183 days processed). 68% of these events are within 300 km, and 89% of these events are within 1000 km.

ARCESS detections

The number of detections (phases) reported during day 091, 1993, through day 273 1993, was 72,987, giving an average of 401 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 091, 1993, through 273, 1993, 3917 local and regional events were located by ARCESS, based on automatic association of P- and S-type arrivals. This gives an average 21.5 events per processed day (182 days processed). 51% of these events are within 300 km, and 88% of these events are within 1000 km.

FINESA detections

The number of detections (phases) reported during day 091, 1993, through day 136, 1993, was 23,403, giving an average of 509 detections per processed day (46 days processed).

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

Events automatically located by FINESA

During days 091, 1993, through 136, 1993, 999 local and regional events were located by FINESA, based on automatic association of P- and S-type arrivals. This gives an average of 21.7 events per processed day (46 days processed). 52% of these events are within 300 km, and 81% of these events are within 1000 km.

GERESS detections

The number of detections (phases) reported from day 091, 1993, through day 273, 1993, was 34,424, giving an average of 190 detections per processed day (181 days processed).

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

Events automatically located by GERESS

During days 091, 1993, through 273,1993, 3444 local and regional events were located by GERESS, based on automatic association of P- and S-type arrivals. This gives an average of 19.0 events per processed day (181 days processed). 76% of these events are within 300 km, and 91% of these events are within 1000 km.

Apatity array detections

The number of detections (phases) reported from day 091, 1993, through day 273, 1993, was 159,561, giving an average of 891 detections per processed day (179 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 results in a large number of small data gaps and spikes in the data. Although the communication protocol may correct such errors by requesting retransmission of data, this cannot presently be done at Apatity. For such error corrections, a two-way radio link is 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 091, 1993, through 273, 1993, 2142 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 12.1 events per processed day (179 days processed). 41% of these events are within 300 km, and 72% of these events are within 1000 km.

Spitsbergen array detections

The number of detections (phases) reported from day 091, 1993, through day 273, 1993, was 58,034, giving an average of 317 detections per processed day (183 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 091, 1993, through 273,1993, 3880 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 23.1 events per processed day (183 days processed). 34% of these events are within 300 km, and 72% 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	
91	0	13	0	1	8	2	8	3	5	8	5	9	6	10	9	7	8	15	7	17	3	2	4	8	158	Apr 01 Thursday	
92	0	2	10	1	2	0	2	6	11	8	11	15	11	21	10	7	8	17	4	13	3	3	8	6	179	Apr 02 Friday	
93	3	3	3	3	6	14	9	5	5	5	6	10	6	8	5	6	7	3	3	8	6	4	11	8	147	Apr 03 Saturday	
94	4	1	5	11	3	3	7	2	2	0	2	3	14	1	5	6	1	5	3	2	6	1	3	7	97	Apr 04 Sunday	
95	8	4	5	10	16	8	13	9	4	7	6	19	7	7	4	1	18	5	16	7	3	6	7	5	195	Apr 05 Monday	
96	7	4	1	4	3	2	14	1	4	8	2	7	6	5	19	7	5	8	2	14	1	2	2	13	141	Apr 06 Tuesday	
97	4	2	3	3	2	9	9	4	7	20	12	14	15	3	10	2	1	6	2	4	4	1	3	0	140	Apr 07 Wednesday	
98	4	4	0	6	4	5	9	4	8	7	4	18	8	2	6	2	5	6	4	6	1	9	1	3	126	Apr 08 Thursday	Skj(rt
99	4	5	21	43	45	43	17	7	2	5	6	10	2	12	28	4	5	3	6	3	12	14	61	75	433	Apr 09 Friday	Langfr
100	83	75	67	52	30	20	21	29	21	16	11	3	7	4	7	0	4	2	3	6	3	0	4	2	470	Apr 10 Saturday	
101	3	1	4	11	12	17	9	7	2	1	6	7	0	10	3	1	6	7	5	10	8	4	1	8	143	Apr 11 Sunday	F*rste
102	15	21	29	40	29	27	25	9	37	44	24	5	11	3	8	6	6	7	1	0	4	6	10	2	369	Apr 12 Monday	Annen
103	5	10	17	15	12	7	8	6	11	18	13	9	7	10	9	10	14	7	11	18	13	7	8	2	247	Apr 13 Tuesday	
104	8	6	6	13	5	4	15	4	8	12	16	6	8	14	12	10	5	14	7	17	5	8	2	4	209	Apr 14 Wednesday	
105	8	2	0	6	2	4	7	4	6	8	12	14	10	21	10	6	15	5	12	12	1	5	2	3	175	Apr 15 Thursday	
106	5	1	3	3	7	1	1	7	4	1	14	13	12	9	9	8	6	4	6	13	5	4	0	3	139	Apr 16 Friday	
107	4	0	3	2	2	2	5	4	1	5	3	3	2	19	9	2	8	10	4	1	2	3	8	18	120	Apr 17 Saturday	
108	24	35	4	11	0	8	2	8	4	7	4	1	1	5	6	2	3	5	0	1	6	4	2	2	145	Apr 18 Sunday	
109	2	6	2	4	2	6	5	2	2	9	9	8	11	6	6	6	2	18	2	3	3	11	5	2	132	Apr 19 Monday	
110	1	3	9	8	0	2	5	0	10	6	35	41	16	11	9	6	10	17	6	3	5	5	2	4	204	Apr 20 Tuesday	
111	5	0	1	3	1	3	5	6	13	9	8	11	9	17	5	2	11	9	5	4	2	3	1	4	137	Apr 21 Wednesday	
112	0	7	5	3	1	1	4	20	26	13	18	11	23	8	9	0	4	15	1	1	1	3	6	5	185	Apr 22 Thursday	
113	2	0	3	11	3	5	1	1	10	14	5	9	14	10	15	10	7	4	15	11	0	2	3	0	155	Apr 23 Friday	
114	2	1	5	5	5	5	7	2	7	2	18	2	10	4	7	4	1	3	1	2	6	4	2	6	111	Apr 24 Saturday	
115	7	2	1	3	1	9	7	3	2	2	3	3	6	1	8	3	8	2	6	5	3	5	11	2	103	Apr 25 Sunday	
116	7	4	2	6	0	3	9	0	0	2	12	9	11	9	8	8	5	14	7	7	2	5	6	9	145	Apr 26 Monday	
117	12	7	18	11	15	9	3	2	9	10	2	7	17	10	18	12	0	1	1	8	2	2	1	3	180	Apr 27 Tuesday	
118	1	0	7	1	1	3	2	11	12	4	19	7	10	5	11	13	0	2	1	6	2	1	4	3	126	Apr 28 Wednesday	
119	1	0	2	10	0	0	2	7	7	4	6	22	4	11	5	4	7	8	0	14	8	6	3	1	132	Apr 29 Thursday	
120	0	2	2	1	4	1	4	5	12	1	7	12	6	2	1	1	2	4	7	5	1	0	4	3	87	Apr 30 Friday	
121	2	2	0	6	3	6	6	3	3	1	0	0	2	0	0	1	1	4	0	3	1	0	1	2	47	May 01 Saturday	F*rste
122	2	1	3	1	10	0	2	4	1	3	4	7	0	1	3	6	1	10	3	8	0	3	1	1	75	May 02 Sunday	
123	2	2	3	2	2	1	4	0	1	7	5	6	7	8	9	10	12	6	4	6	4	6	2	3	112	May 03 Monday	
124	7	4	5	2	4	0	1	1	3	5	12	6	6	14	4	10	7	2	0	2	7	6	11	7	126	May 04 Tuesday	
125	7	11	14	7	7	3	1	1	5	11	7	12	12	5	6	7	0	3	13	5	2	3	1	1	144	May 05 Wednesday	
126	4	6	4	3	5	8	4	2	5	4	13	13	5	19	2	8	6	9	2	10	7	3	2	8	152	May 06 Thursday	
127	0	3	0	4	2	1	1	3	2	3	8	13	10	0	3	1	18	8	0	10	3	1	5	1	100	May 07 Friday	
128	1	0	1	4	4	3	5	2	1	2	5	2	2	3	2	3	1	1	5	3	0	1	1	0	52	May 08 Saturday	
129	1	3	1	4	0	3	3	3	5	3	0	4	1	2	3	0	1	6	1	0	1	2	3	1	51	May 09 Sunday	
130	2	0	1	3	2	1	3	0	10	1	3	4	4	2	7	1	10	16	0	9	10	3	0	0	92	May 10 Monday	
131	0	0	0	2	1	0	5	15	5	6	4	3	12	4	14	9	3	4	7	8	1	2	1	3	109	May 11 Tuesday	
132	1	5	1	0	2	0	3	3	7	5	2	12	11	13	14	2	3	5	1	6	11	5	2	2	116	May 12 Wednesday	
133	1	4	6	3	5	2	2	7	11	5	11	11	12	20	6	6	5	6	9	3	3	5	3	8	154	May 13 Thursday	
134	1	3	2	7	3	3	3	6	6	13	12	13	9	31	5	1	4	11	0	9	1	6	3	18	170	May 14 Friday	
135	2	10	6	12	2	6	8	9	4	3	4	4	7	1	12	7	2	1	0	0	5	17	18	3	143	May 15 Saturday	
136	9	4	1	5	7	1	2	3	4	6	3	1	2	2	1	1	7	0	2	1	2	4	8	0	76	May 16 Sunday	
137	2	3	2	0	3	1	6	3	2	3	6	7	3	6	3	1	3	4	3	3	3	4	0	7	78	May 17 Monday	Sytten
138	2	3	3	0	1	3	1	0	4	3	8	26	28	10	6	4	3	5	2	11	0	2	2	0	127	May 18 Tuesday	
139	3	1	0	2	3	3	5	7	4	1	11	4	8	3	5	3	2	2	0	9	8	4	3	2	93	May 19 Wednesday	
140	2	1	2	2	1	4	5	2	2	1	3	13	4	2	1	4	3	5	2	2	4	0	7	3	75	May 20 Thursday	Kristi
141	2	1	4	4	0	4	6	5	5	5	0	5	8	3	3	7	1	6	1	2	0	3	0	0	75	May 21 Friday	
142	0	1	1	0	5	0	3	5	1	1	4	3	1	5	3	3	4	6	2	2	1	1	0	1	53	May 22 Saturday	
143	1	5	6	1	0	2	3	14	5	3	3	2	3	3	2	6	7	11	3	4	4	1	3	2	94	May 23 Sunday	
144	4	5	4	5	0	5	1	7	12	0	18	17	2	9	9	2	5	3	4	13	2	1	3	4	135	May 24 Monday	
145	15	0	4	1	0	0	2	8	5	9	12	12	4	8	4	6	2	6	4	6	3	2	0	10	123	May 25 Tuesday	
146	1	8	1	13	1	4	2	7	7	9	12	5	15	11	13	5	6	1	3	8	8	6	9	5	160	May 26 Wednesday	

Table 3.5.1. (Page 1 of 4)

NRS .PKX 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		
147	10	6	8	8	2	9	5	10	4	22	29	30	50	13	18	16	6	14	16	12	15	10	5	5	323	May 27	Thursday	
148	13	9	11	8	11	2	0	4	5	5	8	9	10	13	18	15	12	7	16	12	11	15	12	5	[illegible]	May 28	Friday	
149	8	1	5	2	1	12	7	3	8	6	6	7	6	8	8	5	3	12	5	3	2	3	2	3	129	May 29	Saturday	
150	3	5	2	1	4	8	4	1	6	1	7	1	3	4	10	10	6	17	1	3	3	2	8	9	119	May 30	Sunday	Første
151	7	5	0	3	7	3	2	4	3	5	4	3	2	8	2	5	0	1	4	5	3	4	3	1	[illegible]	May 31	Monday	Annen
152	4	3	2	1	3	4	4	8	6	9	2	19	17	15	9	5	6	6	6	15	10	13	13	9	189	Jun 01	Tuesday	
153	15	12	13	15	11	7	10	8	17	24	10	24	17	10	13	16	9	20	23	20	18	20	22	24	378	Jun 02	Wednesday	
154	21	26	25	19	12	12	10	14	6	18	7	8	9	24	26	14	17	12	16	21	22	24	11	16	390	Jun 03	Thursday	
155	16	21	18	23	8	5	7	2	3	5	5	16	12	13	9	6	10	1	10	2	15	14	6	5	230	Jun 04	Friday	
156	1	2	2	6	5	6	13	14	6	0	8	6	2	1	9	3	5	6	1	10	2	2	7	1	[illegible]	Jun 05	Saturday	
157	3	0	2	2	1	3	4	4	6	8	0	13	9	5	3	1	4	9	3	1	5	0	1	[illegible]	87	Jun 06	Sunday	
158	2	8	8	3	2	4	4	1	9	11	4	9	16	6	5	6	5	5	7	12	8	3	14	1	153	Jun 07	Monday	
159	0	2	4	6	2	5	4	7	4	11	13	19	7	27	5	8	7	2	4	21	7	[illegible]	[illegible]	15	184	Jun 08	Tuesday	
160	2	2	2	8	4	4	5	2	6	5	9	17	18	16	5	3	9	13	9	7	15	3	0	20	184	Jun 09	Wednesday	
161	1	0	2	3	6	7	6	7	21	16	13	9	11	11	8	9	12	11	11	12	14	4	[illegible]	[illegible]	208	Jun 10	Thursday	
162	3	3	6	3	3	1	1	7	4	7	6	6	9	15	10	4	0	2	6	3	3	5	3	3	113	Jun 11	Friday	
163	2	7	1	4	1	16	12	7	7	9	5	15	5	3	20	10	7	5	12	5	8	1	5	5	172	Jun 12	Saturday	
164	12	4	5	0	5	7	5	7	2	0	1	0	4	10	5	1	0	12	3	4	2	3	2	8	102	Jun 13	Sunday	
165	7	9	6	8	2	2	8	10	9	6	10	7	14	12	12	12	7	4	4	9	15	1	4	7	185	Jun 14	Monday	
166	7	5	2	7	6	3	11	8	9	7	6	8	12	15	8	7	1	5	8	6	7	5	0	13	166	Jun 15	Tuesday	
167	6	6	3	5	7	9	3	15	4	3	11	20	13	12	4	2	6	4	9	2	6	2	6	2	160	Jun 16	Wednesday	
168	3	0	1	2	4	5	2	9	12	9	14	14	11	18	2	10	14	2	5	3	13	3	2	5	163	Jun 17	Thursday	
169	11	7	5	0	0	4	11	8	4	17	6	5	22	5	10	3	2	15	18	4	26	9	2	10	204	Jun 18	Friday	
170	5	10	11	7	6	15	14	8	12	1	11	10	8	2	14	14	6	17	6	12	14	4	5	16	228	Jun 19	Saturday	
171	1	3	17	5	9	11	7	3	8	6	8	5	3	8	7	13	5	5	3	11	8	1	4	8	159	Jun 20	Sunday	
172	5	4	2	4	2	2	0	5	7	9	3	17	15	7	10	11	1	6	10	4	2	16	0	0	142	Jun 21	Monday	
173	1	4	2	2	0	2	2	12	12	13	7	7	23	11	11	12	11	4	4	4	4	18	8	6	180	Jun 22	Tuesday	
174	4	4	1	1	1	5	3	9	3	14	8	24	12	15	8	11	12	14	10	5	12	2	8	14	200	Jun 23	Wednesday	
175	9	4	8	8	2	4	6	5	7	2	8	7	8	12	10	2	1	10	4	15	3	5	3	4	147	Jun 24	Thursday	
176	1	3	3	4	6	4	2	7	7	6	10	3	12	19	5	4	5	6	2	12	7	3	4	1	136	Jun 25	Friday	
177	4	1	4	0	1	15	5	8	2	7	7	8	6	10	22	16	12	7	19	18	9	12	3	9	205	Jun 26	Saturday	
178	9	13	17	14	5	7	8	5	6	8	7	9	16	8	4	0	6	2	1	5	4	4	4	4	166	Jun 27	Sunday	
179	3	1	5	0	3	2	1	2	11	4	5	8	7	6	10	0	12	6	2	6	12	6	2	1	115	Jun 28	Monday	
180	11	1	1	7	14	1	4	16	7	11	16	20	16	3	10	4	0	5	7	14	15	4	1	1	189	Jun 29	Tuesday	
181	5	5	4	4	7	4	11	9	1	11	13	14	26	12	8	6	3	10	6	8	22	3	8	10	210	Jun 30	Wednesday	
182	14	1	7	8	7	0	9	12	8	6	8	15	14	13	15	11	2	4	5	12	11	1	3	10	196	Jul 01	Thursday	
183	3	3	3	5	8	9	6	8	3	5	8	12	12	8	2	4	4	4	8	10	2	11	3	3	144	Jul 02	Friday	
184	6	4	10	3	1	3	9	1	3	2	11	5	8	2	6	6	3	3	5	2	13	5	7	3	121	Jul 03	Saturday	
185	4	8	2	4	7	4	6	5	4	12	3	6	3	11	4	6	0	3	7	8	1	1	3	3	115	Jul 04	Sunday	
186	1	4	3	5	2	1	0	3	6	12	5	11	3	3	8	11	3	2	4	3	11	5	7	5	118	Jul 05	Monday	
187	5	5	2	9	0	2	9	4	6	8	11	7	15	16	6	2	9	8	6	12	8	1	7	0	158	Jul 06	Tuesday	
188	4	15	5	7	3	2	1	2	6	2	8	24	9	11	0	3	3	16	0	12	7	5	0	3	148	Jul 07	Wednesday	
189	4	3	2	8	2	5	6	4	1	8	13	13	7	15	5	8	13	0	14	6	14	7	1	4	163	Jul 08	Thursday	
190	2	3	1	4	5	2	1	8	1	5	16	14	10	9	5	9	14	2	4	17	7	14	12	9	174	Jul 09	Friday	
191	7	3	1	5	1	9	5	4	9	8	2	14	1	3	12	4	9	6	8	16	21	5	17	6	176	Jul 10	Saturday	
192	11	12	23	10	7	11	9	13	9	6	16	10	10	10	4	3	11	8	7	2	2	7	11	9	221	Jul 11	Sunday	
193	7	4	3	2	5	13	5	14	9	8	8	5	9	34	22	18	9	1	15	5	3	13	10	2	224	Jul 12	Monday	
194	4	7	4	5	11	21	6	3	2	6	14	22	14	3	8	7	7	10	5	12	4	1	6	3	185	Jul 13	Tuesday	
195	10	2	8	1	4	7	9	0	10	0	7	14	18	9	4	14	10	26	16	23	15	19	20	25	271	Jul 14	Wednesday	
196	18	28	28	20	20	25	23	19	25	16	16	14	23	28	16	27	25	21	34	38	39	31	37	42	613	Jul 15	Thursday	
197	31	33	26	29	9	3	7	2	3	4	5	8	13	7	10	3	2	9	3	10	1	7	1	7	233	Jul 16	Friday	
198	3	2	4	7	2	1	3	8	1	8	4	8	12	2	4	4	1	9	4	9	0	2	3	4	105	Jul 17	Saturday	
199	4	2	5	12	0	6	2	3	5	10	3	4	3	3	7	4	4	5	3	3	6	7	1	3	105	Jul 18	Sunday	
200	1	2	1	9	4	1	2	10	14	6	8	9	7	14	13	7	2	8	10	22	4	15	10	11	192	Jul 19	Monday	
201	9	16	11	6	6	4	4	4	6	7	8	7	6	5	6	12	7	16	6	19	1	4	8	6	184	Jul 20	Tuesday	
202	12	2	5	2	6	5	5	4	4	15	10	10	11	14	12	6	10	15	8	21	1	7	7	2	194	Jul 21	Wednesday	

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
203	1	3	6	7	3	19	14	3	3	4	15	6	11	20	8	8	9	8	6	22	6	2	3	2	189	Jul 22 Thursday
204	2	1	1	3	4	1	2	3	8	8	16	20	5	7	0	14	14	2	5	21	4	1	8	2	152	Jul 23 Friday
205	5	3	11	5	1	6	3	5	6	9	10	1	3	5	4	21	24	26	21	28	34	28	39	30	328	Jul 24 Saturday
206	27	38	38	37	29	27	28	20	7	8	10	11	3	11	6	4	3	1	4	5	5	3	7	5	337	Jul 25 Sunday
207	8	9	5	4	2	4	2	9	20	17	25	28	30	24	16	21	30	8	3	6	1	1	1	1	275	Jul 26 Monday
208	5	0	6	3	3	2	11	10	15	5	11	27	6	26	17	5	10	8	5	15	4	1	0	2	197	Jul 27 Tuesday
209	2	2	0	6	3	4	15	22	24	21	6	16	6	18	22	6	3	14	9	15	1	0	3	3	221	Jul 28 Wednesday
210	3	1	3	2	10	5	4	12	16	10	6	14	18	6	10	16	1	6	8	6	13	2	1	2	175	Jul 29 Thursday
211	4	1	1	2	4	4	4	9	7	4	4	7	9	7	30	0	6	6	2	8	2	1	1	2	125	Jul 30 Friday
212	1	2	6	2	3	1	8	2	5	5	1	5	9	4	9	2	6	4	5	4	7	1	4	2	98	Jul 31 Saturday
213	3	5	11	5	1	10	4	5	4	7	0	6	5	5	8	7	6	4	4	5	5	6	6	7	129	Aug 01 Sunday
214	4	8	11	10	6	3	0	3	8	2	4	15	5	1	17	7	12	7	7	12	1	5	4	6	158	Aug 02 Monday
215	3	9	8	7	8	7	4	10	18	13	10	0	23	54	53	76	12	17	6	12	1	6	2	3	362	Aug 03 Tuesday
216	6	2	2	7	9	2	10	44	26	28	7	18	7	19	11	10	4	9	13	9	10	2	5	8	268	Aug 04 Wednesday
217	7	14	6	10	8	2	8	18	12	8	16	16	34	24	11	10	11	10	10	4	16	10	9	8	282	Aug 05 Thursday
218	7	8	4	10	4	1	1	34	28	53	57	28	18	40	76	14	20	16	26	20	16	18	21	42	562	Aug 06 Friday
219	23	40	26	31	32	26	30	26	18	18	18	20	19	18	17	20	8	14	19	26	20	18	14	12	513	Aug 07 Saturday
220	19	13	15	16	12	10	8	3	10	7	4	2	12	3	1	4	7	4	2	10	5	1	7	1	176	Aug 08 Sunday
221	1	4	8	1	2	7	43	50	12	8	24	37	20	24	10	0	1	4	6	9	2	2	3	0	278	Aug 09 Monday
222	1	10	2	4	1	9	16	12	15	18	18	29	13	16	16	5	16	7	13	12	7	3	6	0	249	Aug 10 Tuesday
223	12	12	9	8	11	15	12	17	6	24	12	22	8	13	16	12	7	19	18	13	19	29	24	24	362	Aug 11 Wednesday
224	22	21	17	14	16	10	8	10	12	13	8	15	11	8	8	12	9	6	7	7	6	0	7	8	255	Aug 12 Thursday
225	4	5	3	10	5	3	2	6	4	3	5	8	4	6	8	9	4	4	1	3	2	15	0	2	116	Aug 13 Friday
226	0	2	1	1	5	5	10	6	7	8	4	4	2	6	8	10	3	1	11	4	5	5	12	6	126	Aug 14 Saturday
227	4	10	5	13	5	8	12	7	2	7	3	6	2	2	9	10	8	5	6	7	9	3	3	2	148	Aug 15 Sunday
228	2	3	2	2	3	3	2	8	7	5	5	7	12	4	10	8	7	12	3	8	4	4	2	0	123	Aug 16 Monday
229	0	0	5	5	3	7	2	6	3	3	17	5	9	12	7	7	5	3	11	11	6	1	1	5	134	Aug 17 Tuesday
230	1	1	2	0	4	1	3	15	16	23	7	5	10	9	6	20	9	7	1	9	3	4	0	2	158	Aug 18 Wednesday
231	8	5	6	4	3	0	11	4	6	9	11	7	9	12	12	23	10	10	13	0	10	0	4	1	178	Aug 19 Thursday
232	0	1	4	4	4	4	5	2	1	10	7	16	10	9	9	23	12	12	11	21	6	4	1	2	178	Aug 20 Friday
233	1	11	0	2	7	10	12	9	10	10	11	3	8	9	9	3	2	4	5	3	8	3	29	15	184	Aug 21 Saturday
234	25	29	27	20	30	21	20	18	20	10	25	8	19	18	18	21	21	30	23	29	21	19	22	24	518	Aug 22 Sunday
235	11	6	5	2	5	4	3	1	2	9	9	8	7	5	13	8	3	2	3	6	13	5	3	4	137	Aug 23 Monday
236	4	4	2	4	7	2	2	2	4	9	0	3	4	17	8	6	3	7	3	12	4	2	4	6	119	Aug 24 Tuesday
237	3	2	9	2	6	7	3	2	2	6	2	6	16	16	19	22	7	10	11	11	3	2	5	4	176	Aug 25 Wednesday
238	7	11	7	9	2	4	5	1	9	6	26	4	16	13	2	8	6	10	1	14	3	8	1	1	174	Aug 26 Thursday
239	5	1	7	4	0	0	3	2	2	9	8	12	7	14	1	4	3	4	5	16	1	1	2	2	113	Aug 27 Friday
240	0	4	4	3	2	0	4	4	1	3	4	6	2	8	6	6	3	7	5	0	15	4	0	5	96	Aug 28 Saturday
241	1	3	5	10	11	1	7	10	2	5	17	2	3	2	10	7	2	3	1	1	4	2	3	2	114	Aug 29 Sunday
242	4	1	3	1	6	4	2	3	5	6	3	8	18	10	11	5	6	4	8	10	6	3	5	4	136	Aug 30 Monday
243	9	9	6	4	11	3	6	13	9	2	5	16	4	19	12	12	6	5	5	10	0	9	0	2	177	Aug 31 Tuesday
244	5	2	4	4	8	4	6	1	4	21	6	15	20	23	12	4	8	10	5	6	10	5	7	3	193	Sep 01 Wednesday
245	3	3	3	0	4	2	3	6	3	9	8	12	4	19	25	15	22	25	21	23	24	23	23	26	306	Sep 02 Thursday
246	24	12	18	23	12	6	4	3	9	5	10	19	24	7	3	3	1	6	8	7	10	0	1	5	220	Sep 03 Friday
247	5	4	6	4	9	7	7	6	11	9	23	14	8	14	11	13	12	8	11	5	9	13	11	4	224	Sep 04 Saturday
248	0	0	0	4	10	2	4	14	8	6	13	10	8	9	6	0	2	1	2	4	5	7	5	3	123	Sep 05 Sunday
249	5	7	5	1	12	2	3	3	9	1	6	10	2	23	4	5	3	4	4	16	4	5	3	3	140	Sep 06 Monday
250	0	4	12	12	6	4	3	2	7	4	19	11	7	16	5	3	0	7	9	9	4	2	2	4	152	Sep 07 Tuesday
251	3	2	1	7	6	0	5	11	6	6	5	9	25	9	4	6	12	8	3	12	3	2	4	0	149	Sep 08 Wednesday
252	8	4	3	7	7	9	4	5	4	1	7	9	16	11	3	18	7	12	6	6	3	3	5	4	162	Sep 09 Thursday
253	2	0	3	7	8	1	11	9	6	5	11	11	3	14	17	11	5	9	8	15	12	5	10	6	189	Sep 10 Friday
254	3	3	10	4	9	24	19	3	10	9	10	2	10	5	14	9	13	12	13	10	9	13	11	8	233	Sep 11 Saturday
255	4	6	6	15	2	4	13	8	15	9	8	5	3	5	7	7	2	6	1	1	4	2	2	10	145	Sep 12 Sunday
256	11	7	8	7	4	14	0	0	3	10	8	5	8	24	15	17	3	7	6	16	8	6	6	6	199	Sep 13 Monday
257	2	18	14	4	8	6	2	5	2	6	8	8	16	11	11	17	15	17	6	7	5	7	3	2	200	Sep 14 Tuesday
258	2	8	12	6	2	2	9	4	3	7	8	7	9	8	12	9	3	10	5	6	3	1	4	1	141	Sep 15 Wednesday

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
259	4	8	0	1	4	4	7	6	7	2	6	7	7	7	7	6	4	4	6	10	7	2	0	3	119	Sep 16 Thursday
260	0	1	3	4	2	2	1	3	3	1	5	12	9	13	5	4	2	4	7	11	1	1	1	0	95	Sep 17 Friday
261	8	2	6	3	11	14	4	2	7	6	2	4	4	9	5	4	15	6	5	9	3	30	10	1	170	Sep 18 Saturday
262	3	3	1	2	12	15	2	1	5	3	2	4	1	6	6	4	7	4	4	2	7	3	8	6	111	Sep 19 Sunday
263	10	10	3	2	1	5	1	9	1	9	8	8	2	13	14	9	5	5	3	11	7	2	3	5	146	Sep 20 Monday
264	2	3	0	6	3	5	8	1	4	8	4	3	12	20	8	5	8	1	5	13	4	2	2	10	137	Sep 21 Tuesday
265	3	0	3	4	0	3	4	4	2	7	4	11	3	10	7	3	3	5	2	8	1	1	1	2	91	Sep 22 Wednesday
266	2	9	1	0	2	0	2	6	1	13	7	8	18	10	5	1	3	2	8	8	2	1	0	2	111	Sep 23 Thursday
267	1	3	1	2	1	2	5	2	14	3	8	22	4	9	9	3	7	5	8	12	0	3	0	4	128	Sep 24 Friday
268	4	3	3	0	5	2	3	3	4	7	4	6	4	3	5	3	7	6	4	5	16	14	1	3	115	Sep 25 Saturday
269	2	0	9	8	6	1	5	8	4	5	6	3	12	3	1	3	11	5	3	3	1	3	2	7	111	Sep 26 Sunday
270	7	2	5	6	7	2	7	1	0	10	5	1	10	10	1	11	2	1	0	16	10	0	3	0	117	Sep 27 Monday
271	0	5	0	2	3	1	2	3	2	4	3	0	13	7	16	4	22	10	1	3	11	3	3	0	118	Sep 28 Tuesday
272	2	1	1	8	3	1	3	2	9	7	15	14	18	14	15	9	3	13	8	7	6	2	7	2	170	Sep 29 Wednesday
273	1	3	7	3	2	5	2	7	3	9	4	4	12	10	7	12	12	8	8	6	16	1	2	4	148	Sep 30 Thursday
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	1059	1109	1122	1198	1027	1042	1140	1262	1309	1456	1614	1873	1816	1924	1722	1407	1227	1381	1168	1643	1238	1009	1043	1108	31905	Total sum
183	6	6	6	7	6	6	6	7	7	8	9	10	10	11	9	8	7	8	6	9	7	6	6	6	174	Total average
125	5	5	5	6	5	4	5	7	7	9	10	12	12	13	10	9	7	8	7	10	7	5	5	6	180	Average workdays
58	7	8	8	8	8	9	8	7	6	6	7	6	6	6	7	6	6	7	5	6	6	6	8	7	162	Average weekends

Table 3.5.1. *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. (Page 4 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		
91	8	9	8	13	9	13	23	23	18	17	28	30	28	20	23	20	27	16	21	17	12	8	25	19	435	Apr 01	Thursday	
92	9	10	14	4	9	14	11	20	18	21	29	38	19	14	15	14	4	14	9	11	9	6	30	8	350	Apr 02	Friday	
93	6	1	4	12	13	14	14	14	24	15	15	19	14	24	5	9	8	11	16	5	6	5	23	4	281	Apr 03	Saturday	
94	7	6	0	19	17	20	20	14	8	8	10	15	12	16	15	10	9	17	25	8	10	6	29	4	305	Apr 04	Sunday	
95	11	9	8	12	33	19	16	10	24	21	10	17	7	23	12	12	10	15	46	22	12	19	17	12	397	Apr 05	Monday	
96	8	12	10	8	6	7	17	11	31	26	21	22	19	9	9	19	17	11	14	18	10	13	23	13	354	Apr 06	Tuesday	
97	12	4	20	7	11	13	10	15	20	40	35	18	17	13	12	5	14	12	18	15	14	17	27	10	379	Apr 07	Wednesday	
98	11	4	8	11	16	10	8	33	31	18	18	29	5	11	9	19	9	13	16	12	16	15	9	6	337	Apr 08	Thursday	Skj{rt
99	8	9	19	12	4	12	9	8	10	8	16	25	14	7	13	12	8	8	6	7	0	10	13	7	245	Apr 09	Friday	Langfr
100	12	7	9	8	7	8	2	12	16	10	30	12	7	17	9	2	15	15	8	5	15	11	16	9	262	Apr 10	Saturday	
101	7	12	4	18	9	15	8	16	2	3	14	9	7	10	5	7	6	11	6	11	11	13	13	14	231	Apr 11	Sunday	F*rste
102	8	6	10	7	3	10	7	16	11	10	22	17	15	10	16	14	17	19	24	9	12	17	14	7	301	Apr 12	Monday	Annen
103	8	6	13	5	5	16	13	15	17	35	36	29	8	17	13	15	12	3	20	25	17	6	21	4	359	Apr 13	Tuesday	
104	11	9	10	7	8	16	32	14	32	14	32	21	23	17	9	29	21	11	12	15	18	18	12	10	401	Apr 14	Wednesday	
105	7	7	8	6	6	19	27	23	26	16	15	29	26	26	15	21	15	7	18	18	19	16	13	21	404	Apr 15	Thursday	
106	7	5	14	10	15	10	20	20	17	21	22	36	15	22	17	20	13	7	15	13	16	12	22	8	377	Apr 16	Friday	
107	8	8	10	9	15	14	6	16	18	25	19	17	8	8	9	7	5	7	18	17	11	18	19	8	300	Apr 17	Saturday	
108	5	7	6	12	8	19	19	8	17	20	13	15	11	10	9	17	7	8	13	15	6	6	21	9	281	Apr 18	Sunday	
109	3	9	9	4	13	14	11	11	9	18	4	28	12	20	12	12	21	14	15	21	11	14	20	6	310	Apr 19	Monday	
110	6	2	8	9	7	6	7	10	29	20	23	44	13	28	23	16	15	3	17	18	21	7	33	9	374	Apr 20	Tuesday	
111	6	9	3	8	12	18	16	19	28	27	21	22	24	25	33	11	13	18	21	11	14	9	29	9	406	Apr 21	Wednesday	
112	19	15	9	11	6	10	12	11	18	29	50	20	29	21	16	22	10	17	13	8	18	21	18	9	412	Apr 22	Thursday	
113	7	2	5	15	19	15	24	20	25	21	29	43	16	27	20	20	17	37	29	8	14	15	28	7	463	Apr 23	Friday	
114	7	21	8	17	13	6	19	17	18	21	38	21	13	16	12	19	6	19	12	12	10	13	31	11	360	Apr 24	Saturday	
115	15	2	8	4	8	20	9	12	12	16	13	30	10	25	26	18	21	34	22	19	29	14	30	13	410	Apr 25	Sunday	
116	16	16	11	3	9	14	17	37	15	24	15	27	33	25	15	27	22	23	21	21	18	10	13	11	442	Apr 26	Monday	
117	4	6	13	7	15	12	12	12	12	11	17	21	12	35	22	24	8	12	8	10	8	15	20	4	320	Apr 27	Tuesday	
118	11	3	15	5	2	7	9	5	10	5	7	18	13	9	13	13	10	3	9	16	16	7	21	6	233	Apr 28	Wednesday	
119	9	6	5	8	5	4	3	8	19	12	17	19	7	14	11	9	14	7	6	21	8	20	14	4	250	Apr 29	Thursday	
120	24	18	9	11	8	15	11	14	19	11	20	35	22	9	22	21	6	15	13	13	18	13	15	14	377	Apr 30	Friday	
121	9	8	12	16	9	13	12	12	18	16	7	10	10	4	5	15	3	17	8	9	4	8	9	15	249	May 01	Saturday	F*rste
122	4	8	3	13	6	12	12	13	16	9	7	27	8	24	13	16	16	18	25	14	18	20	24	13	339	May 02	Sunday	
123	11	5	21	20	6	18	15	21	20	22	11	9	14	15	17	11	13	12	14	17	14	6	12	11	335	May 03	Monday	
124	9	6	4	10	5	13	5	14	13	20	15	12	29	12	15	13	18	24	21	27	15	11	28	11	350	May 04	Tuesday	
125	2	11	5	8	9	16	18	12	25	22	13	33	14	40	32	22	17	20	34	13	22	13	20	13	432	May 05	Wednesday	
126	4	12	6	5	12	13	13	23	21	27	24	45	18	33	15	27	11	15	25	10	20	17	25	20	441	May 06	Thursday	
127	14	19	3	2	8	13	13	17	18	14	17	52	30	28	22	18	20	14	19	18	21	13	19	13	425	May 07	Friday	
128	11	5	5	9	15	9	7	14	13	15	29	20	5	25	17	14	19	16	14	9	14	10	17	5	317	May 08	Saturday	
129	11	8	6	12	14	15	8	6	20	20	9	16	16	16	14	6	15	13	17	5	15	10	24	8	304	May 09	Sunday	
130	8	11	6	7	13	10	11	10	6	8	1	0	0	7	2	8	12	23	13	9	6	10	13	4	198	May 10	Monday	
131	14	6	5	5	6	12	13	19	12	21	7	0	9	29	22	10	12	16	18	11	16	7	28	14	312	May 11	Tuesday	
132	8	7	11	7	9	17	7	18	17	15	11	0	1	15	13	11	13	13	14	15	5	21	26	21	295	May 12	Wednesday	
133	14	14	12	6	20	17	14	19	33	20	24	0	13	30	27	24	14	29	18	37	40	41	26	34	526	May 13	Thursday	
134	49	30	12	5	16	11	14	37	21	15	45	23	29	29	25	32	5	10	8	14	9	22	17	28	506	May 14	Friday	
135	10	11	12	17	14	11	16	11	24	31	17	26	14	7	23	23	9	9	14	5	8	13	41	21	387	May 15	Saturday	
136	23	9	5	14	5	1	13	3	9	13	8	2	18	16	8	13	16	4	7	1	3	7	26	4	228	May 16	Sunday	
137	2	2	10	3	8	3	13	20	11	6	14	11	10	16	11	6	18	11	10	11	14	19	29	17	275	May 17	Monday	Sytten
138	9	12	14	8	14	19	9	26	23	16	29	56	27	28	10	31	23	8	19	17	23	22	19	6	468	May 18	Tuesday	
139	12	1	10	7	8	19	33	8	22	11	19	32	27	16	14	16	16	20	10	4	6	8	16	6	341	May 19	Wednesday	
140	8	9	7	5	11	17	11	9	12	15	4	24	10	11	14	11	13	9	11	5	17	6	25	8	272	May 20	Thursday	Kristi
141	8	3	13	14	1	19	18	21	25	27	18	52	39	8	13	28	20	14	25	11	10	5	20	7	419	May 21	Friday	
142	16	11	6	9	10	7	12	12	13	21	35	26	18	21	16	15	14	13	9	9	1	8	12	2	316	May 22	Saturday	
143	2	5	12	3	13	9	2	16	11	6	14	23	15	12	18	19	14	23	17	8	10	9	15	11	287	May 23	Sunday	
144	4	12	11	15	7	38	25	19	39	13	19	33	22	21	14	18	23	8	19	16	9	7	20	4	416	May 24	Monday	
145	23	1	9	7	16	7	14	34	12	14	19	16	21	24	11	18	10	10	26	9	6	14	14	21	356	May 25	Tuesday	
146	10	4	3	6	9	14	15	18	11	11	26	20	12	11	12	13	16	18	17	9	7	14	20	11	307	May 26	Wednesday	

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	
147	7	13	7	11	10	23	8	20	16	14	12	29	18	14	18	3	6	11	30	20	8	12	17	8	335	May 27 Thursday	
148	12	4	4	5	12	13	12	17	25	30	21	31	38	19	19	11	20	9	19	23	25	22	18	7	416	May 28 Friday	
149	3	10	11	7	8	23	5	13	34	15	14	16	21	21	19	16	18	11	24	11	6	4	13	13	336	May 29 Saturday	
150	3	6	2	2	11	6	9	13	11	6	19	9	18	12	11	16	5	18	19	9	7	12	17	10	251	May 30 Sunday	F°rste
151	8	6	6	5	12	4	6	23	10	13	11	19	31	13	20	11	17	12	34	22	12	16	12	11	334	May 31 Monday	Annen
152	6	7	13	20	12	21	18	38	32	31	25	28	38	27	27	16	17	12	18	19	31	11	21	12	500	Jun 01 Tuesday	
153	11	11	11	14	19	19	14	37	33	24	25	49	35	29	36	24	25	12	21	12	17	14	20	3	515	Jun 02 Wednesday	
154	7	9	4	3	5	20	17	31	31	129	388	118	0	0	0	0	0	0	0	0	0	0	0	0	762	Jun 03 Thursday	
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 04 Friday	
156	0	0	0	0	0	0	0	12	10	19	23	9	40	21	19	14	14	9	16	14	14	2	27	8	271	Jun 05 Saturday	
157	9	9	9	6	9	9	14	13	11	15	14	25	31	46	10	17	18	24	37	13	19	17	27	6	408	Jun 06 Sunday	
158	9	2	16	8	17	22	23	38	22	46	44	37	16	57	11	26	29	23	12	6	16	11	19	11	521	Jun 07 Monday	
159	6	4	1	5	4	17	12	27	27	16	15	23	18	21	22	8	13	5	19	11	18	10	29	12	343	Jun 08 Tuesday	
160	10	8	8	9	4	20	16	17	12	10	30	41	34	17	13	14	9	16	7	2	24	6	11	6	344	Jun 09 Wednesday	
161	11	7	4	15	6	21	14	20	22	32	24	25	31	35	11	16	20	21	15	11	24	22	29	2	438	Jun 10 Thursday	
162	6	6	8	13	10	33	19	29	27	38	39	49	50	32	11	14	20	7	21	14	11	4	23	9	493	Jun 11 Friday	
163	2	1	7	9	0	8	23	17	24	40	22	26	34	19	17	6	8	7	9	6	5	3	16	5	314	Jun 12 Saturday	
164	6	17	4	7	14	37	22	21	10	14	11	34	41	43	23	12	24	12	15	6	10	6	10	12	411	Jun 13 Sunday	
165	7	7	6	5	6	34	30	40	40	44	30	44	41	36	30	14	14	37	20	19	24	9	24	20	581	Jun 14 Monday	
166	21	1	6	10	16	27	22	13	24	40	27	28	38	39	7	7	19	27	23	12	20	9	27	20	483	Jun 15 Tuesday	
167	15	9	7	4	1	24	32	42	34	27	36	53	38	28	22	6	19	9	13	9	5	3	21	7	464	Jun 16 Wednesday	
168	6	8	2	4	11	26	30	33	23	31	35	34	39	38	17	20	36	24	48	28	26	9	15	15	558	Jun 17 Thursday	
169	16	5	7	11	4	29	24	34	39	47	36	37	53	31	26	5	8	22	22	18	10	12	16	6	518	Jun 18 Friday	
170	11	3	7	6	7	16	13	19	42	31	42	41	44	29	15	13	18	16	15	11	13	12	10	5	439	Jun 19 Saturday	
171	7	5	13	9	17	11	13	13	28	32	30	28	45	36	11	6	24	24	13	34	19	3	21	6	448	Jun 20 Sunday	
172	3	4	2	2	3	8	12	14	27	43	28	44	34	20	4	17	19	18	23	10	4	20	22	4	385	Jun 21 Monday	
173	3	20	4	1	2	17	19	17	23	35	24	33	45	41	19	15	30	21	18	40	14	14	27	22	502	Jun 22 Tuesday	
174	4	8	0	17	8	17	11	20	17	18	26	39	36	17	7	22	5	21	4	14	10	12	26	6	365	Jun 23 Wednesday	
175	13	8	11	2	12	23	12	17	19	31	21	25	41	33	28	26	23	13	21	5	10	3	18	10	425	Jun 24 Thursday	
176	6	4	13	1	6	18	40	38	40	51	52	51	40	39	22	24	8	12	22	14	10	11	10	12	544	Jun 25 Friday	
177	0	12	9	9	3	13	9	18	16	57	20	30	28	40	10	23	7	15	11	9	6	12	5	3	365	Jun 26 Saturday	
178	7	8	9	6	4	7	13	21	14	32	16	23	37	25	17	18	5	25	16	13	15	7	17	12	367	Jun 27 Sunday	
179	3	1	6	7	5	32	28	45	31	28	53	52	46	40	33	25	21	25	42	33	11	12	31	9	619	Jun 28 Monday	
180	9	10	8	5	26	16	16	21	31	17	16	16	31	28	25	6	8	16	14	25	8	21	10	11	394	Jun 29 Tuesday	
181	12	7	5	8	8	12	27	36	37	32	39	44	44	36	25	28	16	20	27	12	9	16	20	15	535	Jun 30 Wednesday	
182	22	5	4	10	6	19	39	32	34	29	31	39	36	30	24	21	15	9	16	12	21	7	15	10	486	Jul 01 Thursday	
183	6	7	13	21	10	25	16	31	33	26	23	21	15	19	23	8	19	4	9	18	8	15	20	3	393	Jul 02 Friday	
184	13	11	8	15	5	8	9	17	19	28	44	19	22	14	3	10	4	11	14	5	2	13	2	3	299	Jul 03 Saturday	
185	4	4	0	12	18	12	9	13	10	19	17	28	35	9	15	8	16	20	16	11	13	15	4	14	322	Jul 04 Sunday	
186	4	10	7	10	11	13	18	13	10	24	16	28	33	32	38	27	6	9	13	15	9	6	17	4	373	Jul 05 Monday	
187	13	5	12	2	1	1	16	9	10	16	12	0	0	0	19	9	10	2	17	7	11	6	13	8	199	Jul 06 Tuesday	
188	3	5	5	11	6	11	9	4	8	10	6	16	9	8	3	17	4	8	6	8	5	13	11	10	196	Jul 07 Wednesday	
189	9	6	7	11	5	6	7	5	15	18	14	15	9	11	10	13	10	13	12	10	11	7	16	12	252	Jul 08 Thursday	
190	7	2	0	0	0	6	18	17	28	34	49	48	25	33	17	15	15	19	5	15	13	16	22	16	420	Jul 09 Friday	
191	6	6	2	8	10	8	16	8	25	22	35	23	28	16	17	5	12	15	4	6	16	10	13	10	321	Jul 10 Saturday	
192	3	6	5	4	6	11	7	15	15	12	16	25	13	14	12	6	8	20	16	10	19	6	20	20	291	Jul 11 Sunday	
193	13	4	8	6	11	27	26	34	28	25	20	24	33	47	41	37	27	17	22	13	23	14	29	11	540	Jul 12 Monday	
194	6	15	14	11	11	29	19	17	24	26	24	46	56	16	14	24	8	24	16	16	36	7	27	15	501	Jul 13 Tuesday	
195	11	5	13	9	7	17	24	22	17	22	26	40	30	43	32	20	13	23	31	32	7	12	19	4	479	Jul 14 Wednesday	
196	4	17	8	9	12	32	20	18	21	22	33	41	33	16	16	14	20	8	16	24	13	15	22	3	437	Jul 15 Thursday	
197	7	1	4	20	7	11	18	28	28	24	29	36	26	22	10	8	12	4	30	12	6	14	23	6	386	Jul 16 Friday	
198	7	9	6	23	10	5	14	31	26	29	43	27	22	20	13	13	11	17	10	13	9	4	16	8	386	Jul 17 Saturday	
199	5	6	16	13	20	13	19	20	18	37	10	29	9	22	20	11	13	11	30	13	15	28	21	90	489	Jul 18 Sunday	
200	16	7	11	28	8	34	26	22	26	26	41	30	32	39	37	23	39	42	29	27	33	15	37	11	639	Jul 19 Monday	
201	31	15	12	14	16	24	16	33	34	26	24	46	34	25	14	20	14	7	13	20	11	14	27	10	500	Jul 20 Tuesday	
202	10	10	2	14	13	12	10	19	18	39	30	42	29	35	32	31	40	9	20	12	10	18	25	10	490	Jul 21 Wednesday	

Table 3.5.2. (Page 2 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	
203	8	6	7	10	14	21	34	14	35	24	29	28	41	45	24	59	16	32	18	25	7	7	23	9	534	Jul 22	Thursday
204	8	8	7	10	2	7	14	13	27	25	33	41	47	15	26	10	13	19	11	15	4	18	23	9	405	Jul 23	Friday
205	7	11	10	10	7	16	10	34	12	34	45	25	36	26	11	16	7	13	5	6	16	13	14	3	387	Jul 24	Saturday
206	12	11	8	24	6	9	39	19	12	14	29	17	16	11	8	21	13	16	7	5	2	9	7	15	330	Jul 25	Sunday
207	7	11	13	7	6	12	8	17	15	19	27	24	40	40	22	14	8	24	19	18	64	25	21	7	468	Jul 26	Monday
208	4	11	9	8	10	10	5	27	35	21	45	43	35	26	12	14	11	9	35	17	22	15	19	3	446	Jul 27	Tuesday
209	7	8	4	14	11	20	13	19	26	25	30	37	30	36	17	15	22	14	29	14	19	6	17	12	445	Jul 28	Wednesday
210	19	5	9	14	22	12	22	33	37	37	26	40	44	23	17	31	20	13	31	29	17	5	15	5	526	Jul 29	Thursday
211	4	8	5	6	14	23	16	17	38	21	26	47	62	36	21	18	9	15	14	9	4	15	15	12	455	Jul 30	Friday
212	8	3	15	8	9	10	12	25	26	33	22	27	30	23	6	20	5	21	7	9	5	7	4	7	346	Jul 31	Saturday
213	16	7	2	13	0	13	6	7	16	15	18	27	25	11	7	8	10	11	10	4	6	6	7	5	250	Aug 01	Sunday
214	13	12	1	16	7	28	15	8	23	19	17	12	20	32	15	18	14	12	14	25	7	13	22	9	372	Aug 02	Monday
215	12	4	8	17	12	8	29	26	29	21	51	38	85	72	28	20	19	25	24	21	7	22	19	17	614	Aug 03	Tuesday
216	12	6	10	6	4	12	24	37	23	30	67	96	121	36	33	19	11	24	31	12	30	10	47	29	730	Aug 04	Wednesday
217	1	16	2	15	9	19	15	94	54	24	72	68	66	39	21	15	13	10	22	17	5	14	62	40	713	Aug 05	Thursday
218	19	5	9	2	9	9	18	36	38	16	25	28	27	11	15	7	15	23	28	7	7	3	19	11	387	Aug 06	Friday
219	26	9	9	7	18	38	29	35	30	29	25	17	25	21	25	21	21	22	26	18	6	3	16	11	487	Aug 07	Saturday
220	14	4	17	5	4	5	8	12	34	46	26	23	25	28	14	10	27	15	15	22	45	8	26	13	446	Aug 08	Sunday
221	8	11	12	6	12	9	29	34	24	20	28	26	23	33	20	22	14	21	21	16	18	15	18	7	447	Aug 09	Monday
222	5	32	23	16	16	12	12	3	0	0	10	34	21	27	17	21	16	17	21	29	13	15	14	10	384	Aug 10	Tuesday
223	13	7	10	10	19	13	22	14	15	8	11	18	17	17	18	16	9	16	18	11	12	7	29	7	337	Aug 11	Wednesday
224	8	10	5	10	13	12	13	23	20	36	25	15	24	22	11	9	9	7	24	20	11	20	11	6	364	Aug 12	Thursday
225	10	8	11	31	39	22	29	36	47	64	18	37	82	38	22	16	12	11	35	15	16	15	26	6	646	Aug 13	Friday
226	8	12	4	15	8	11	20	11	20	42	33	23	22	26	10	4	10	9	17	7	3	3	9	8	335	Aug 14	Saturday
227	7	13	6	20	13	12	7	16	7	16	11	33	40	19	21	13	26	20	29	19	16	3	2	11	380	Aug 15	Sunday
228	9	7	2	6	15	9	13	20	21	18	16	25	27	26	27	26	9	17	11	15	11	15	19	6	370	Aug 16	Monday
229	3	4	6	9	4	18	16	23	20	15	20	22	29	14	22	19	14	13	22	13	21	12	21	21	361	Aug 17	Tuesday
230	5	11	21	11	12	7	10	18	16	25	21	18	33	27	19	24	17	16	20	28	14	18	11	15	417	Aug 18	Wednesday
231	10	10	10	12	6	22	16	18	29	27	32	35	39	33	26	30	19	18	29	14	10	13	17	4	479	Aug 19	Thursday
232	10	15	8	9	13	34	36	33	36	31	18	41	45	14	12	11	12	20	24	20	12	12	25	11	502	Aug 20	Friday
233	10	20	4	1	12	10	15	12	26	14	38	10	6	17	7	12	7	10	10	10	8	8	11	4	282	Aug 21	Saturday
234	2	3	12	1	12	17	6	11	7	11	13	18	14	10	13	9	5	12	14	7	12	16	19	5	249	Aug 22	Sunday
235	4	3	13	7	8	9	10	11	27	31	36	32	21	21	10	12	15	6	27	40	13	12	15	6	389	Aug 23	Monday
236	9	12	9	7	6	12	16	7	21	25	25	57	51	21	19	15	32	22	21	27	13	8	31	16	482	Aug 24	Tuesday
237	11	4	8	11	10	15	10	16	20	9	10	20	19	19	12	16	14	14	12	8	12	10	18	8	306	Aug 25	Wednesday
238	3	16	7	7	12	9	7	18	20	24	29	6	18	19	15	9	15	16	16	9	16	13	17	2	325	Aug 26	Thursday
239	10	15	7	17	17	18	18	21	21	17	16	28	18	24	20	25	17	20	14	22	12	12	20	4	413	Aug 27	Friday
240	3	9	12	7	12	14	8	31	13	15	32	6	30	18	22	9	21	15	20	7	16	3	23	5	351	Aug 28	Saturday
241	6	1	4	9	10	4	7	7	13	8	16	14	5	15	11	16	15	14	9	13	5	13	15	4	234	Aug 29	Sunday
242	4	8	8	5	12	17	26	19	34	13	20	21	30	23	25	27	31	21	37	15	20	1	20	14	451	Aug 30	Monday
243	14	7	6	5	11	10	2	26	30	13	27	23	19	20	28	15	17	12	24	16	9	15	11	8	368	Aug 31	Tuesday
244	12	5	11	4	15	15	23	21	32	20	24	18	27	22	32	27	15	13	14	19	7	14	16	6	412	Sep 01	Wednesday
245	5	7	10	15	7	12	9	21	29	30	26	29	16	15	18	21	8	15	22	13	19	4	16	11	375	Sep 02	Thursday
246	9	8	4	13	6	15	9	11	23	28	16	23	29	35	25	11	11	26	41	36	24	24	24	24	475	Sep 03	Friday
247	16	25	45	17	7	14	8	22	80	156	89	76	98	79	59	41	75	95	28	26	18	15	31	4	1124	Sep 04	Saturday
248	5	7	8	12	14	16	8	7	18	43	8	20	20	18	22	22	18	18	12	3	7	8	19	4	337	Sep 05	Sunday
249	7	11	12	6	22	10	40	11	25	27	19	16	14	23	21	20	14	28	40	18	15	34	36	11	480	Sep 06	Monday
250	7	8	12	14	15	18	27	15	42	38	27	28	29	27	40	23	10	20	22	16	16	11	16	12	493	Sep 07	Tuesday
251	11	7	10	10	8	10	18	23	6	24	22	31	51	60	20	15	33	48	11	14	7	9	23	12	483	Sep 08	Wednesday
252	12	10	6	9	13	6	19	68	56	18	26	61	41	33	33	20	14	25	18	10	14	14	17	4	547	Sep 09	Thursday
253	6	9	4	4	15	16	13	28	30	16	24	33	36	23	8	33	59	48	39	41	41	21	25	3	575	Sep 10	Friday
254	12	7	4	11	16	17	9	8	21	13	34	33	18	23	21	12	20	18	59	49	50	23	33	41	552	Sep 11	Saturday
255	35	4	15	14	12	12	11	13	10	14	4	14	9	20	13	4	11	10	7	9	5	7	15	7	275	Sep 12	Sunday
256	10	3	10	8	10	28	7	9	11	20	16	31	28	18	29	20	21	14	16	9	23	13	22	10	386	Sep 13	Monday
257	15	22	21	5	8	20	23	26	12	12	25	11	49	26	29	13	20	32	9	8	14	13	11	10	434	Sep 14	Tuesday
258	5	17	17	14	8	30	12	20	3	27	7	29	25	17	21	39	12	13	17	16	10	10	25	1	395	Sep 15	Wednesday

Table 3.5.2 (Page 3 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
259	3	11	6	2	6	13	22	11	12	20	16	18	33	13	10	16	17	13	11	17	4	15	17	11	317	Sep 16 Thursday
260	7	5	3	3	9	16	18	22	20	26	22	34	34	24	23	8	8	13	11	13	10	11	19	6	365	Sep 17 Friday
261	12	3	12	7	10	12	10	7	10	16	18	13	6	10	11	4	11	8	16	7	21	12	17	13	266	Sep 18 Saturday
262	0	3	1	9	14	21	12	10	6	6	9	15	9	8	27	21	14	42	18	4	17	7	22	7	302	Sep 19 Sunday
263	7	7	8	5	9	16	13	21	18	21	21	15	25	10	18	32	12	13	23	11	17	12	13	10	357	Sep 20 Monday
264	2	11	9	16	14	17	20	7	28	19	24	17	13	21	11	20	16	18	10	20	16	9	32	9	379	Sep 21 Tuesday
265	7	10	9	4	12	8	11	26	14	10	23	19	17	18	22	14	23	22	16	6	9	12	20	11	341	Sep 22 Wednesday
266	6	6	8	9	19	15	40	12	13	12	11	36	44	8	19	22	18	18	14	12	15	7	19	5	388	Sep 23 Thursday
267	7	16	11	9	5	21	71	54	38	20	23	37	22	21	39	28	16	23	17	8	9	9	17	5	526	Sep 24 Friday
268	9	2	11	5	10	7	14	23	4	17	22	19	11	25	13	16	11	7	17	11	4	12	6	5	281	Sep 25 Saturday
269	3	9	6	11	3	4	12	9	16	5	4	6	25	11	12	9	18	14	12	8	13	7	6	12	235	Sep 26 Sunday
270	10	8	7	10	11	9	8	22	16	23	23	17	41	68	26	32	11	13	8	17	4	22	13	16	435	Sep 27 Monday
271	1	17	3	9	4	4	26	57	37	48	9	47	25	19	21	11	16	12	13	8	12	10	12	17	438	Sep 28 Tuesday
272	4	3	12	7	4	2	9	10	13	21	25	26	38	17	27	16	21	13	11	27	24	11	20	25	386	Sep 29 Wednesday
273	11	6	17	11	5	15	11	8	15	13	26	19	28	21	16	31	20	7	11	11	12	16	5	23	358	Sep 30 Thursday

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	1664	1522	1559	1718	1833	2706	2896	3641	3970	4279	4662	5108	4870	4255	3279	3062	2813	2972	3324	2668	2517	2183	3543	1946	72987	Total sum
182	9	8	9	9	10	15	16	20	22	24	26	28	27	23	18	17	15	16	18	15	14	12	19	11	401	Total average
124	9	9	9	9	10	16	18	22	24	24	28	31	29	25	20	18	16	16	19	16	15	13	21	11	427	Average workdays
58	9	8	8	10	10	12	12	15	18	22	21	21	21	19	15	13	14	16	16	11	12	10	17	11	342	Average weekends

Table 3.5.2. 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. (Page 4 of 4)

FIN .FEX 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		
91	18	7	11	6	3	3	5	7	9	10	6	18	16	12	11	6	7	7	14	15	8	11	10	26	246	Apr 01	Thursday	
92	9	12	18	6	10	6	1	11	17	13	19	31	10	9	12	2	11	5	11	11	10	31	5	12	282	Apr 02	Friday	
93	9	22	26	17	9	8	10	4	5	7	17	17	20	38	19	15	4	13	11	31	13	20	13	31	379	Apr 03	Saturday	
94	47	56	51	71	23	13	8	8	8	8	5	15	20	4	6	6	10	13	33	24	73	53	40	30	625	Apr 04	Sunday	
95	32	47	45	31	23	12	9	6	11	7	12	19	23	43	29	16	12	12	2	8	6	17	6	16	444	Apr 05	Monday	
96	8	10	3	9	12	3	3	7	12	9	5	28	21	18	29	21	7	7	9	9	7	14	9	13	273	Apr 06	Tuesday	
97	6	6	11	6	2	6	1	8	9	14	23	23	21	11	16	8	9	10	10	8	3	8	6	5	230	Apr 07	Wednesday	
98	16	9	4	9	10	4	10	12	15	21	11	14	21	15	16	9	14	15	12	16	15	16	11	11	306	Apr 08	Thursday	Skj(rt
99	19	27	17	29	36	31	5	11	18	15	13	27	13	17	13	4	10	32	44	45	53	54	67	67	667	Apr 09	Friday	Langfr
100	70	74	72	79	83	64	41	20	27	19	19	10	8	20	14	19	12	8	13	22	23	42	47	38	844	Apr 10	Saturday	
101	52	52	53	62	46	52	55	27	12	4	8	0	0	0	0	0	0	0	0	0	0	0	0	0	423	Apr 11	Sunday	F*rste
102	0	57	60	59	56	71	61	41	18	14	31	15	23	18	22	24	15	18	18	28	12	22	21	27	731	Apr 12	Monday	Annen
103	27	33	15	11	12	11	7	12	13	10	19	24	27	15	14	16	19	17	16	13	18	15	14	22	400	Apr 13	Tuesday	
104	19	20	21	23	10	19	8	6	25	24	27	19	25	17	15	22	11	15	10	16	26	28	44	44	494	Apr 14	Wednesday	
105	66	45	55	48	28	24	28	19	18	12	16	31	11	16	19	15	14	11	15	20	13	14	23	17	578	Apr 15	Thursday	
106	25	39	42	30	25	24	19	24	13	0	7	18	10	23	15	11	9	3	10	6	7	10	10	15	395	Apr 16	Friday	
107	20	13	23	9	5	5	10	11	2	7	8	8	11	4	8	3	5	7	4	2	2	2	3	7	179	Apr 17	Saturday	
108	8	3	5	16	9	14	4	6	2	5	11	23	34	19	43	78	9	10	2	15	13	8	6	7	350	Apr 18	Sunday	
109	10	7	26	6	3	3	2	11	32	14	20	53	35	13	30	15	10	11	17	8	11	17	5	15	374	Apr 19	Monday	
110	15	12	12	21	3	2	3	6	14	7	21	33	17	11	11	12	12	8	15	6	11	9	8	15	284	Apr 20	Tuesday	
111	19	21	19	10	10	5	9	8	9	14	12	23	18	13	16	15	12	8	11	15	11	19	15	8	320	Apr 21	Wednesday	
112	14	10	13	12	5	9	10	13	19	16	23	22	16	3	10	12	11	25	11	5	14	17	14	11	315	Apr 22	Thursday	
113	14	17	22	16	4	2	8	9	18	11	18	20	15	5	16	7	15	22	11	5	8	6	15	12	296	Apr 23	Friday	
114	17	15	9	18	8	8	16	8	9	18	30	33	70	39	69	30	29	9	12	11	28	86	13	24	609	Apr 24	Saturday	
115	18	12	18	6	7	7	15	87	35	17	15	6	14	31	33	24	22	21	8	15	15	23	16	30	495	Apr 25	Sunday	
116	14	11	22	16	2	6	6	15	10	16	62	40	34	27	23	15	22	41	14	10	19	12	15	18	470	Apr 26	Monday	
117	16	27	13	38	47	33	15	20	10	12	14	21	20	31	11	13	11	26	11	39	33	31	26	24	542	Apr 27	Tuesday	
118	47	21	44	17	33	11	12	18	22	21	57	31	23	21	18	5	13	9	7	8	11	11	14	12	486	Apr 28	Wednesday	
119	12	8	19	11	3	3	8	8	18	11	17	16	24	33	29	28	14	31	20	7	21	20	24	13	398	Apr 29	Thursday	
120	11	14	21	12	9	3	2	19	19	15	26	20	17	36	31	28	25	12	15	11	11	12	12	13	394	Apr 30	Friday	
121	8	9	11	11	5	6	7	6	8	4	21	26	31	27	45	27	27	43	27	26	24	19	21	27	466	May 01	Saturday	F*rste
122	13	15	17	15	17	13	14	10	17	21	35	41	65	30	45	45	36	41	35	25	21	35	15	27	648	May 02	Sunday	
123	18	20	32	12	2	5	3	10	14	18	22	20	21	42	38	31	24	12	20	24	14	10	9	6	427	May 03	Monday	
124	17	10	12	7	5	5	8	9	9	14	20	11	15	23	15	22	20	22	9	16	14	9	17	12	321	May 04	Tuesday	
125	16	26	14	10	14	5	5	11	13	16	14	22	19	23	19	16	17	10	20	9	9	10	16	10	344	May 05	Wednesday	
126	10	9	15	8	1	4	7	15	6	14	11	30	5	18	14	19	15	11	7	14	14	11	8	15	281	May 06	Thursday	
127	13	22	21	14	4	6	9	13	6	8	13	24	17	22	12	26	34	19	25	30	25	10	8	10	391	May 07	Friday	
128	8	14	14	18	5	4	7	9	10	7	12	18	33	58	5	56	100	67	65	79	29	40	57	49	772	May 08	Saturday	
129	73	78	59	70	51	61	65	36	82	48	39	71	44	57	40	42	26	53	21	24	27	22	23	22	1134	May 09	Sunday	
130	22	17	29	17	9	8	9	11	26	31	28	38	33	35	38	31	23	27	42	30	52	41	42	38	677	May 10	Monday	
131	30	54	42	36	27	16	29	37	33	27	39	33	34	29	38	34	34	37	42	38	30	55	38	29	841	May 11	Tuesday	
132	39	48	37	36	22	21	30	27	44	49	33	40	41	29	31	26	31	20	45	31	34	36	44	41	835	May 12	Wednesday	
133	43	49	54	48	31	33	27	37	47	33	48	58	31	48	45	38	30	41	37	32	43	40	39	37	969	May 13	Thursday	
134	36	56	49	31	30	23	33	51	47	45	48	49	32	50	27	28	22	30	32	40	24	32	33	44	892	May 14	Friday	
135	30	55	34	28	29	32	27	36	32	24	23	24	31	29	28	22	21	28	32	31	31	28	30	16	701	May 15	Saturday	
136	30	26	33	26	16	22	23	33	18	28	25	32	69	69	24	0	0	0	0	0	0	0	0	0	474	May 16	Sunday	

Table 3.5.3. Daily and hourly distribution of FINESA 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.

[illegible] .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		
91	3	2	0	1	3	2	7	11	8	18	26	15	12	8	14	8	5	6	4	4	6	4	5	7	179	Apr 01	Thursday	
92	8	13	7	6	5	1	6	8	13	17	21	18	24	5	6	4	6	1	6	0	2	1	3	5	186	Apr 02	Friday	
93	3	2	0	7	4	5	2	1	2	9	5	4	5	1	2	1	3	1	2	3	2	3	0	0	67	Apr 03	Saturday	
94	1	0	1	3	5	2	2	1	2	4	8	13	7	3	4	3	2	4	4	5	3	8	1	9	95	Apr 04	Sunday	
95	7	12	6	10	18	2	12	2	18	10	7	10	2	6	9	1	13	2	1	4	3	4	4	2	165	Apr 05	Monday	
96	2	5	3	3	4	1	7	12	13	32	21	23	5	7	2	7	6	8	4	4	2	3	7	12	193	Apr 06	Tuesday	
97	7	4	2	6	2	1	10	18	16	15	27	13	24	11	13	5	10	4	9	13	11	16	2	1	240	Apr 07	Wednesday	
98	13	2	5	6	3	9	3	9	12	24	27	15	8	12	12	10	3	4	1	8	4	6	3	1	200	Apr 08	Thursday	Skj(rt
99	1	3	0	11	2	6	10	10	3	17	18	10	2	2	2	4	6	3	0	6	6	7	1	6	136	Apr 09	Friday	Langfr
100	1	4	2	9	1	3	3	4	1	10	1	0	4	4	0	0	3	3	4	2	3	4	3	1	70	Apr 10	Saturday	
101	2	0	2	0	0	0	0	0	0	0	0	0	0	0	2	12	5	4	1	2	3	2	3	6	44	Apr 11	Sunday	F°rste
102	2	5	1	7	1	1	5	3	3	1	3	2	7	1	8	3	2	2	2	2	4	4	7	10	86	Apr 12	Monday	Annen
103	5	11	7	5	2	5	13	7	11	25	18	19	18	28	10	3	9	5	5	1	9	5	7	2	230	Apr 13	Tuesday	
104	8	6	11	10	4	6	14	15	18	6	37	31	8	6	55	14	11	4	1	5	2	2	1	6	281	Apr 14	Wednesday	
105	3	2	2	0	0	0	6	15	11	36	21	107	58	43	55	32	17	12	2	12	1	1	1	1	438	Apr 15	Thursday	
106	1	4	2	3	5	1	3	14	21	30	16	42	27	27	17	18	1	10	7	15	6	3	0	2	275	Apr 16	Friday	
107	4	0	4	3	1	1	1	2	4	6	3	10	3	2	3	5	2	6	5	4	6	2	6	0	83	Apr 17	Saturday	
108	3	4	6	5	1	6	4	1	9	10	14	6	1	0	12	7	6	9	19	12	10	13	21	13	192	Apr 18	Sunday	
109	19	18	12	14	16	21	13	16	23	30	23	22	11	16	11	9	7	4	4	3	6	8	2	6	314	Apr 19	Monday	
110	1	1	4	8	3	1	1	7	11	23	28	14	11	12	9	2	10	3	4	5	4	2	3	7	174	Apr 20	Tuesday	
111	4	1	3	10	1	4	9	11	18	31	16	24	28	29	13	13	4	10	3	10	3	4	3	2	254	Apr 21	Wednesday	
112	2	4	7	4	0	2	1	15	5	8	18	18	39	11	5	6	4	12	3	13	8	15	6	6	212	Apr 22	Thursday	
113	6	5	4	8	0	3	11	8	12	17	21	24	11	11	5	6	6	1	6	1	5	3	0	5	179	Apr 23	Friday	
114	0	0	2	5	5	2	1	0	6	2	11	4	4	1	2	2	4	2	1	5	4	3	1	1	68	Apr 24	Saturday	
115	7	0	0	2	2	3	1	5	1	5	3	4	2	12	20	2	0	0	12	4	6	0	6	3	100	Apr 25	Sunday	
116	0	5	7	9	0	0	8	5	3	22	25	25	13	10	9	8	10	2	6	3	2	2	3	7	184	Apr 26	Monday	
117	4	6	6	10	0	0	9	12	13	20	27	14	18	10	9	10	3	10	3	6	4	6	2	1	203	Apr 27	Tuesday	
118	7	4	8	6	2	2	10	15	10	21	20	13	14	10	8	9	11	3	9	1	4	0	2	5	194	Apr 28	Wednesday	
119	1	3	3	2	0	4	4	19	17	21	22	23	7	6	8	15	1	2	1	7	4	6	12	4	192	Apr 29	Thursday	
120	10	3	10	1	6	2	7	8	21	15	22	14	4	5	2	7	8	4	3	4	7	2	12	2	179	Apr 30	Friday	
121	5	8	1	7	5	1	2	8	9	2	0	3	12	5	2	9	2	7	6	3	0	4	4	0	105	May 01	Saturday	F°rste
122	3	13	55	6	7	0	6	5	8	8	11	22	17	42	23	17	17	9	13	6	12	9	4	1	314	May 02	Sunday	
123	5	7	7	6	3	4	24	6	19	18	40	14	17	17	15	19	9	4	5	7	1	2	8	10	267	May 03	Monday	
124	5	3	3	8	0	6	11	19	29	33	38	25	12	14	21	15	10	12	4	1	12	4	4	1	288	May 04	Tuesday	
125	4	3	12	4	6	2	8	15	9	16	13	31	10	12	15	12	13	6	8	3	3	4	4	3	216	May 05	Wednesday	
126	10	4	4	4	2	8	10	10	20	27	30	22	15	13	9	9	4	2	25	2	10	8	7	1	256	May 06	Thursday	
127	3	6	6	5	3	3	5	7	17	19	11	14	8	15	4	9	4	9	6	31	4	1	2	7	179	May 07	Friday	
128	1	6	9	6	1	5	4	4	2	2	6	8	3	16	8	2	8	4	3	0	4	0	4	4	110	May 08	Saturday	
129	4	3	2	7	0	1	1	1	3	14	9	2	2	4	3	4	2	4	2	4	4	10	6	5	97	May 09	Sunday	
130	7	7	9	3	9	10	15	12	15	24	19	19	10	17	18	5	10	5	2	1	4	2	3	5	231	May 10	Monday	
131	6	8	9	4	2	12	8	16	20	16	16	22	15	18	12	13	1	4	11	3	4	3	2	2	227	May 11	Tuesday	
132	4	7	6	8	4	7	11	11	13	26	34	22	15	19	10	9	9	7	7	2	5	5	9	11	261	May 12	Wednesday	
133	11	5	11	4	4	8	10	13	8	31	32	10	15	25	17	7	1	1	10	10	2	3	8	6	252	May 13	Thursday	
134	6	6	6	8	2	10	12	8	15	28	20	17	5	13	5	1	5	4	1	6	5	7	2	1	193	May 14	Friday	
135	2	1	15	12	3	8	12	9	2	10	19	6	7	6	3	3	4	3	2	4	6	4	13	3	157	May 15	Saturday	
136	9	2	1	6	0	2	2	4	8	9	8	8	5	2	1	3	3	1	1	4	7	2	18	7	113	May 16	Sunday	
137	6	1	7	10	2	7	11	17	26	23	38	25	18	14	21	6	5	7	4	10	6	5	0	10	279	May 17	Monday	Sytten
138	3	8	6	4	8	20	16	17	23	29	27	29	11	19	11	6	6	2	4	2	2	1	6	5	265	May 18	Tuesday	
139	6	1	3	14	3	7	12	16	23	32	31	32	28	43	10	7	7	5	4	5	9	3	8	2	311	May 19	Wednesday	
140	2	1	3	2	3	5	1	12	23	8	14	22	28	27	41	6	5	3	4	8	7	2	6	4	237	May 20	Thursday	Kristi
141	6	13	5	20	0	0	11	13	7	12	18	12	10	10	29	23	19	19	15	15	13	13	13	17	313	May 21	Friday	
142	11	7	4	13	11	6	10	7	16	8	22	13	7	13	4	7	2	2	6	3	2	5	0	2	181	May 22	Saturday	
143	0	1	8	3	1	7	2	15	3	3	9	9	8	12	7	8	3	7	3	5	5	1	4	6	130	May 23	Sunday	
144	6	8	4	6	5	8	6	11	6	30	10	20	15	16	20	15	2	3	2	7	0	0	9	2	211	May 24	Monday	
145	16	6	10	4	5	9	22	14	5	29	24	27	21	4	13	7	10	7	5	7	1	0	2	14	262	May 25	Tuesday	
146	4	3	0	10	1	8	5	18	7	26	16	19	3	10	13	10	5	8	3	2	0	1	5	4	181	May 26	Wednesday	

Table 3.5.4 (Page 1 of 4)

[illegible] .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	
147	7	4	8	11	4	12	7	10	14	27	21	21	12	13	11	16	9	4	11	1	1	13	109	24	370	May 27 Thursday	
148	7	6	8	3	7	14	17	18	29	20	34	28	11	11	3	6	8	3	14	94	4	6	2	0	350	May 28 Friday	
149	8	1	4	4	0	4	7	11	31	5	13	4	11	12	4	5	3	0	9	18	0	2	4	1	161	May 29 Saturday	
150	3	12	0	6	0	4	2	0	2	4	4	6	0	0	7	9	2	9	1	26	10	0	0	0	107	May 30 Sunday	F°rste
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 31 Monday	Annen
152	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	6	5	16	3	8	4	9	4	10	79	Jun 01 Tuesday	
153	2	4	0	10	6	2	13	11	22	19	36	18	9	5	5	13	32	97	40	3	10	4	4	6	371	Jun 02 Wednesday	
154	4	17	12	9	11	13	16	18	14	21	26	22	22	13	23	12	8	9	11	6	9	5	3	12	316	Jun 03 Thursday	
155	4	16	10	21	8	21	5	6	21	14	22	13	7	3	5	4	10	104	16	3	4	17	12	5	351	Jun 04 Friday	
156	1	3	9	9	1	4	4	3	5	6	4	8	10	11	6	13	1	5	2	8	3	2	5	2	118	Jun 05 Saturday	
157	3	2	4	3	2	0	7	3	14	16	6	18	38	13	2	6	5	9	10	3	3	1	5	6	179	Jun 06 Sunday	
158	6	11	9	13	1	2	11	9	13	11	16	20	5	10	48	13	9	3	4	3	3	7	3	3	233	Jun 07 Monday	
159	1	5	5	5	2	1	8	8	14	24	14	17	16	23	13	2	2	4	4	5	8	2	5	17	205	Jun 08 Tuesday	
160	8	1	2	9	3	7	0	14	13	18	11	19	12	11	7	3	12	6	9	9	8	2	4	2	190	Jun 09 Wednesday	
161	3	5	2	3	4	5	3	3	22	28	6	25	13	7	6	10	7	5	9	5	3	9	7	11	201	Jun 10 Thursday	
162	6	5	10	7	1	3	5	3	10	11	22	22	10	11	1	9	4	2	6	19	45	20	5	12	249	Jun 11 Friday	
163	10	2	4	8	5	6	3	5	9	17	4	17	7	4	1	5	3	0	8	9	6	3	1	8	145	Jun 12 Saturday	
164	10	10	3	3	0	13	6	1	9	9	8	9	11	21	10	9	2	1	7	5	5	2	1	12	167	Jun 13 Sunday	
165	4	4	17	3	2	2	6	17	16	9	7	13	15	5	10	3	1	2	3	9	7	3	4	8	170	Jun 14 Monday	
166	9	4	6	3	5	13	17	11	7	18	13	11	7	10	22	9	2	4	3	3	5	2	4	5	193	Jun 15 Tuesday	
167	3	15	8	1	1	5	4	18	4	25	14	22	14	3	7	5	2	10	2	4	6	2	7	3	185	Jun 16 Wednesday	
168	2	7	7	9	2	6	3	17	11	17	20	19	9	11	20	12	4	9	4	8	6	0	8	2	213	Jun 17 Thursday	
169	3	4	8	1	1	6	11	8	4	15	21	9	24	6	12	8	3	9	13	4	7	4	4	6	191	Jun 18 Friday	
170	6	2	3	11	10	9	4	1	11	0	11	11	7	6	4	11	3	8	6	4	1	3	3	1	136	Jun 19 Saturday	
171	1	0	8	66	20	9	8	4	10	8	9	12	13	11	3	5	2	7	4	9	4	4	6	4	227	Jun 20 Sunday	
172	4	0	3	4	2	1	6	13	11	24	20	15	10	7	8	11	0	9	3	5	3	6	3	2	170	Jun 21 Monday	
173	4	3	6	6	13	4	5	14	11	18	15	23	12	15	1	17	24	4	3	2	9	8	3	3	223	Jun 22 Tuesday	
174	2	3	6	2	2	1	16	7	5	20	28	27	18	13	7	7	9	4	2	1	4	0	8	6	198	Jun 23 Wednesday	
175	6	7	5	3	1	3	2	14	8	36	17	18	21	9	18	14	11	4	2	8	3	4	2	2	218	Jun 24 Thursday	
176	1	2	4	7	1	0	5	7	24	32	28	33	16	7	6	7	6	6	5	7	0	4	0	2	210	Jun 25 Friday	
177	1	4	4	10	3	1	0	3	2	2	5	2	10	7	7	4	2	6	1	3	0	1	3	1	82	Jun 26 Saturday	
178	1	0	0	4	2	1	3	4	5	3	5	3	8	7	6	2	0	2	2	9	6	3	6	3	85	Jun 27 Sunday	
179	4	1	2	2	0	9	12	7	12	0	0	11	17	11	12	5	9	3	13	0	1	4	7	3	145	Jun 28 Monday	
180	7	2	0	5	11	5	6	12	22	15	22	25	7	20	7	11	5	4	7	11	1	2	3	3	213	Jun 29 Tuesday	
181	8	6	4	6	8	5	2	7	8	25	32	37	14	4	13	19	6	0	3	2	3	7	3	7	229	Jun 30 Wednesday	
182	18	5	8	2	4	1	10	9	1	0	0	0	0	4	8	8	3	4	3	0	8	1	6	13	116	Jul 01 Thursday	
183	6	7	5	12	3	1	5	17	10	23	19	16	13	10	3	5	6	2	2	6	2	3	5	2	183	Jul 02 Friday	
184	2	2	2	6	5	1	2	13	9	4	2	8	6	13	16	17	0	5	4	2	2	2	0	8	131	Jul 03 Saturday	
185	0	2	2	1	4	1	2	3	2	13	7	8	3	4	10	2	2	1	3	8	6	1	7	6	98	Jul 04 Sunday	
186	10	5	9	6	0	2	2	11	12	18	16	3	10	8	6	9	5	1	1	4	0	6	5	4	153	Jul 05 Monday	
187	13	4	4	10	3	9	6	4	9	18	22	13	8	14	5	12	9	0	6	2	2	5	7	4	189	Jul 06 Tuesday	
188	6	4	7	11	6	5	3	12	11	17	16	17	18	11	6	7	7	3	5	2	3	9	8	7	201	Jul 07 Wednesday	
189	8	3	5	11	9	5	6	9	16	12	28	15	5	16	8	15	8	8	14	4	3	2	8	5	223	Jul 08 Thursday	
190	0	11	6	5	0	1	10	15	10	21	24	13	15	13	2	11	6	1	2	2	4	7	3	3	185	Jul 09 Friday	
191	4	3	2	7	1	1	6	0	10	6	3	8	4	2	6	10	3	0	0	4	15	1	10	2	108	Jul 10 Saturday	
192	3	3	4	1	3	1	16	9	7	12	5	0	4	6	2	3	2	1	4	1	4	2	9	6	108	Jul 11 Sunday	
193	4	6	5	6	4	8	7	14	9	14	10	7	5	27	30	18	4	3	11	1	1	5	11	2	212	Jul 12 Monday	
194	3	4	13	5	0	4	6	9	8	35	29	25	12	5	12	9	11	11	2	9	9	0	5	5	231	Jul 13 Tuesday	
195	2	8	9	5	3	5	7	8	25	18	29	22	20	3	12	12	7	12	1	5	4	7	5	8	237	Jul 14 Wednesday	
196	5	6	9	8	6	5	11	11	13	21	31	28	26	12	22	4	21	2	2	8	4	9	8	8	280	Jul 15 Thursday	
197	11	5	6	6	0	4	6	7	14	24	28	14	11	23	22	13	61	3	11	8	12	8	2	2	301	Jul 16 Friday	
198	6	1	12	31	11	9	17	13	9	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	114	Jul 17 Saturday	
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 18 Sunday	
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	Jul 19 Monday	
201	4	3	4	11	3	4	1	14	17	20	16	10	5	24	18	2	0	3	0	2	10	5	6	2	184	Jul 20 Tuesday	
202	4	4	6	6	1	0	4	3	19	5	19	30	13	8	8	10	2	1	3	3	4	1	8	10	172	Jul 21 Wednesday	

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
203	3	8	5	2	14	10	11	17	13	8	21	25	23	45	38	8	6	4	2	12	5	1	3	5	289	Jul 22 Thursday
204	4	3	2	5	2	5	8	13	15	23	13	23	14	6	3	9	9	5	9	15	6	9	3	8	212	Jul 23 Friday
205	4	2	12	7	9	2	6	7	5	9	13	6	9	4	6	7	3	5	7	4	10	6	5	1	149	Jul 24 Saturday
206	2	6	2	1	0	3	2	9	1	2	5	11	9	11	8	8	2	2	6	5	5	5	1	6	112	Jul 25 Sunday
207	7	3	4	3	5	1	6	3	15	16	8	17	10	4	9	4	4	10	9	1	1	2	1	3	146	Jul 26 Monday
208	1	0	6	7	2	4	10	8	8	22	16	17	18	5	10	7	4	10	11	8	4	5	6	5	194	Jul 27 Tuesday
209	4	4	2	5	4	1	17	4	6	17	31	24	19	9	7	6	0	5	4	6	2	7	2	4	190	Jul 28 Wednesday
210	3	1	4	9	4	4	4	8	16	19	22	8	10	12	23	9	6	3	7	3	6	6	1	1	189	Jul 29 Thursday
211	7	6	9	3	0	0	2	3	10	5	6	25	17	25	44	3	0	0	0	0	0	7	1	4	177	Jul 30 Friday
212	6	5	4	10	2	4	16	5	11	11	11	10	17	14	10	5	2	7	2	12	6	1	4	5	180	Jul 31 Saturday
213	5	1	5	1	1	12	0	2	7	11	20	9	0	0	0	4	0	1	2	5	2	1	9	4	102	Aug 01 Sunday
214	9	3	5	17	11	7	4	6	7	19	22	12	8	15	11	10	20	5	1	3	3	9	6	6	219	Aug 02 Monday
215	6	12	8	9	1	5	4	15	11	24	14	33	17	20	4	4	9	9	6	2	6	0	8	2	229	Aug 03 Tuesday
216	13	3	0	2	10	4	7	5	15	20	20	8	14	11	14	2	6	9	5	11	12	20	13	10	234	Aug 04 Wednesday
217	9	10	7	14	7	5	6	9	5	20	13	16	12	14	22	3	9	12	7	7	3	4	9	5	228	Aug 05 Thursday
218	5	7	3	4	5	8	10	13	4	24	30	39	21	22	10	8	4	2	8	8	1	0	2	8	244	Aug 06 Friday
219	9	3	2	2	4	4	2	13	8	11	5	8	8	4	5	6	1	0	10	11	3	0	1	0	120	Aug 07 Saturday
220	3	3	9	2	8	1	7	7	17	11	14	9	7	5	4	8	0	1	0	3	9	1	8	6	143	Aug 08 Sunday
221	7	4	6	3	2	2	5	2	9	24	17	17	14	9	13	9	7	8	6	3	2	1	2	1	173	Aug 09 Monday
222	2	15	7	6	6	3	4	10	12	24	28	12	12	25	17	13	11	17	1	5	1	3	3	4	241	Aug 10 Tuesday
223	5	4	4	5	15	3	4	4	15	16	24	29	6	8	14	13	5	4	2	3	2	0	3	5	193	Aug 11 Wednesday
224	1	7	12	4	1	5	3	11	18	20	15	27	15	19	11	3	5	4	1	7	1	1	3	4	198	Aug 12 Thursday
225	9	6	8	11	2	6	12	14	14	17	19	15	5	9	2	5	8	4	6	1	2	1	1	5	182	Aug 13 Friday
226	2	3	0	3	3	5	4	5	10	5	1	9	2	6	10	13	3	4	9	2	5	2	1	1	108	Aug 14 Saturday
227	2	4	2	11	1	3	3	2	2	7	1	4	1	1	6	4	4	11	8	1	4	2	3	8	95	Aug 15 Sunday
228	6	4	5	6	3	2	4	4	4	6	16	16	17	8	7	13	6	6	1	2	1	3	0	3	143	Aug 16 Monday
229	5	0	4	8	3	0	1	2	17	28	19	18	12	10	10	10	3	3	3	2	5	3	2	5	171	Aug 17 Tuesday
230	1	3	3	4	13	0	7	11	8	10	17	34	20	6	9	7	5	2	4	7	6	6	9	3	195	Aug 18 Wednesday
231	3	6	4	6	3	6	6	12	23	14	13	15	16	14	14	9	6	0	3	1	1	1	4	5	185	Aug 19 Thursday
232	1	2	1	10	5	8	8	2	5	17	22	14	12	10	5	12	5	8	6	5	3	4	5	10	180	Aug 20 Friday
233	4	12	4	2	1	3	2	6	3	13	9	6	3	4	5	10	7	1	0	5	15	2	3	2	122	Aug 21 Saturday
234	3	1	5	1	1	0	1	5	6	1	9	1	0	7	7	2	7	8	10	6	11	9	11	8	120	Aug 22 Sunday
235	5	7	3	9	4	17	3	9	13	18	21	10	7	9	9	8	4	1	11	25	5	11	1	7	217	Aug 23 Monday
236	5	2	4	12	6	0	6	8	15	12	8	15	8	8	7	1	7	7	2	2	0	2	16	11	162	Aug 24 Tuesday
237	3	1	12	1	1	4	4	7	6	24	22	9	3	3	12	2	6	2	3	1	1	4	5	7	143	Aug 25 Wednesday
238	2	4	4	6	2	0	2	6	16	16	19	18	18	7	13	11	3	10	4	3	4	5	2	1	176	Aug 26 Thursday
239	6	5	8	6	3	0	7	8	10	9	26	21	12	4	5	3	11	1	0	1	1	0	3	2	152	Aug 27 Friday
240	1	2	1	3	3	3	1	4	5	4	2	11	3	7	3	5	4	4	3	0	8	3	2	10	92	Aug 28 Saturday
241	2	5	0	2	4	2	3	5	9	6	13	1	3	2	4	6	10	7	2	0	3	7	9	4	109	Aug 29 Sunday
242	5	5	4	1	5	1	1	3	18	28	3	18	14	19	9	7	4	1	13	6	8	6	0	1	180	Aug 30 Monday
243	7	6	5	3	2	2	9	9	11	21	25	14	8	16	8	7	3	8	5	2	1	1	1	1	173	Aug 31 Tuesday
244	7	2	4	11	3	2	8	10	21	16	33	20	9	18	21	7	3	4	6	5	3	3	3	2	221	Sep 01 Wednesday
245	2	1	2	13	4	4	3	7	17	12	24	19	10	13	13	4	2	12	2	3	0	4	4	1	176	Sep 02 Thursday
246	3	1	3	9	4	5	6	11	14	21	21	18	12	18	21	19	7	10	3	1	5	3	1	5	221	Sep 03 Friday
247	4	1	1	5	10	3	6	4	10	23	15	20	1	2	2	15	3	11	7	8	11	7	7	2	178	Sep 04 Saturday
248	3	2	1	2	3	2	6	1	4	20	5	13	4	9	8	0	5	3	2	2	2	4	6	1	108	Sep 05 Sunday
249	5	1	11	4	11	2	8	9	14	26	23	42	12	6	8	7	3	1	3	4	8	1	4	4	217	Sep 06 Monday
250	1	3	2	10	1	2	5	8	8	28	18	13	15	8	16	4	5	3	3	2	3	3	6	4	171	Sep 07 Tuesday
251	1	4	4	3	2	5	9	5	11	21	22	21	7	12	11	5	3	4	0	3	3	3	6	5	170	Sep 08 Wednesday
252	10	9	5	11	4	2	8	7	18	22	30	15	15	18	8	7	13	4	3	2	4	6	6	4	231	Sep 09 Thursday
253	3	3	3	2	3	1	6	3	14	28	19	29	7	10	10	7	6	4	2	11	3	5	12	3	194	Sep 10 Friday
254	2	2	3	7	5	8	5	7	10	19	14	6	3	6	20	3	5	3	6	12	3	0	0	3	152	Sep 11 Saturday
255	2	5	3	8	6	2	10	12	18	17	15	8	15	14	10	5	0	3	1	3	5	5	4	9	180	Sep 12 Sunday
256	8	4	8	2	3	6	3	3	20	17	24	12	14	12	13	9	7	4	6	7	9	8	6	4	209	Sep 13 Monday
257	8	9	8	8	11	3	0	4	12	34	15	11	16	10	7	10	14	5	0	6	0	10	6	4	211	Sep 14 Tuesday
258	0	1	0	0	0	0	0	0	4	27	15	22	24	7	12	15	4	7	3	1	2	0	3	7	154	Sep 15 Wednesday

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
259	1	3	5	4	3	6	16	13	29	24	26	35	33	20	14	3	8	7	9	6	1	4	1	8	279	Sep 16 Thursday
260	2	5	9	3	2	4	5	2	23	17	17	32	8	3	12	1	11	8	4	2	0	9	5	0	184	Sep 17 Friday
261	7	7	5	2	4	7	6	3	6	2	7	11	9	16	0	8	0	2	2	2	0	2	0	2	110	Sep 18 Saturday
262	8	3	0	4	4	7	2	6	7	2	9	13	14	4	10	11	10	10	1	1	7	1	6	4	144	Sep 19 Sunday
263	7	4	8	3	2	4	7	18	10	8	16	19	4	11	5	7	3	7	3	7	8	2	3	3	169	Sep 20 Monday
264	9	0	1	9	6	8	5	12	7	21	32	17	13	8	11	0	8	0	4	9	3	0	2	2	187	Sep 21 Tuesday
265	2	6	1	9	1	4	13	9	5	21	23	22	13	19	16	7	2	15	3	1	0	5	3	8	208	Sep 22 Wednesday
266	1	2	5	2	13	11	3	16	18	13	30	28	8	9	17	3	11	5	2	3	4	1	8	1	212	Sep 23 Thursday
267	3	7	7	5	6	2	7	15	16	11	12	16	9	5	8	6	7	4	4	8	0	2	1	4	165	Sep 24 Friday
268	3	3	4	6	1	2	4	27	17	20	5	11	1	10	4	1	7	4	0	2	7	4	0	2	145	Sep 25 Saturday
269	3	3	5	7	4	6	1	9	1	4	7	5	8	6	2	7	1	1	2	1	2	2	6	4	97	Sep 26 Sunday
270	12	9	2	7	8	6	3	15	10	21	16	25	15	11	7	16	3	16	1	3	3	2	5	3	219	Sep 27 Monday
271	2	8	2	7	2	0	3	2	10	3	25	12	15	9	8	11	3	3	2	1	6	8	4	3	149	Sep 28 Tuesday
272	1	5	9	6	3	1	2	3	9	16	28	23	11	21	12	11	11	1	11	7	0	5	11	6	213	Sep 29 Wednesday
273	2	4	3	6	5	8	7	4	12	9	25	39	15	11	9	7	8	7	7	6	9	5	4	4	216	Sep 30 Thursday

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	870	853	971	1200	721	810	1175	1566	2080	2921	3066	3023	2095	2024	1946	1437	1123	1112	922	1034	858	771	965	881	34424	Total sum
181	5	5	5	7	4	4	6	9	11	16	17	17	12	11	11	8	6	6	5	6	5	4	5	5	190	Total average
125	5	5	6	6	4	5	7	10	13	19	20	20	13	13	12	9	7	7	5	6	4	5	6	5	212	Average workdays
56	4	3	4	7	4	4	5	6	8	9	9	8	7	8	7	6	3	4	4	5	5	3	5	4	132	Average weekends

Table 3.5.4. 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. (Page 4 of 4)

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		
91	9	4	8	4	5	9	9	8	17	7	15	21	26	17	22	16	14	6	7	9	4	0	0	5	242	Apr 01	Thursday	
92	5	3	13	14	17	26	25	52	17	11	25	37	18	10	10	11	8	20	10	8	3	2	5	4	354	Apr 02	Friday	
93	4	3	3	5	7	16	9	9	19	8	20	16	10	5	3	5	6	3	3	7	6	1	0	1	169	Apr 03	Saturday	
94	3	4	4	17	13	14	15	6	4	4	21	8	4	1	12	9	12	14	12	4	6	11	8	16	222	Apr 04	Sunday	
95	14	16	12	30	34	23	24	17	11	6	11	15	8	18	3	1	8	11	14	5	6	3	11	5	306	Apr 05	Monday	
96	7	11	7	17	13	15	15	5	9	4	6	17	17	9	7	13	6	8	5	15	5	11	5	9	236	Apr 06	Tuesday	
97	10	15	13	11	12	14	22	7	14	27	18	23	14	6	12	6	10	5	22	28	19	24	22	20	374	Apr 07	Wednesday	
98	15	11	21	31	21	27	22	23	18	9	15	28	14	12	25	9	12	8	20	16	33	16	14	18	438	Apr 08	Thursday	Skj(rt
99	13	22	23	28	15	33	23	9	10	23	18	32	23	9	5	12	9	22	12	8	10	3	9	9	380	Apr 09	Friday	Langfr
100	16	6	12	10	7	12	11	7	16	14	29	9	13	7	3	4	10	9	5	10	19	9	28	21	287	Apr 10	Saturday	
101	25	30	17	16	6	21	14	8	19	4	3	6	3	7	13	4	3	11	12	7	4	5	1	14	253	Apr 11	Sunday	F*rste
102	14	9	7	20	21	28	16	14	8	9	8	22	17	19	18	15	9	12	2	8	3	5	17	6	307	Apr 12	Monday	Annen
103	18	15	18	36	30	24	27	19	22	34	19	29	16	22	23	18	12	21	16	37	16	35	20	14	541	Apr 13	Tuesday	
104	23	20	25	22	20	19	60	29	10	18	19	19	24	11	5	19	6	6	5	14	15	10	21	1	421	Apr 14	Wednesday	
105	3	7	14	10	17	16	22	17	16	33	19	35	11	12	15	5	11	13	8	5	5	3	4	8	309	Apr 15	Thursday	
106	4	12	13	11	31	26	31	27	19	16	12	30	14	35	26	14	5	16	7	7	5	1	4	10	376	Apr 16	Friday	
107	6	6	4	3	13	12	12	17	17	33	44	38	42	29	27	19	42	21	42	39	30	21	29	34	580	Apr 17	Saturday	
108	25	34	31	34	19	15	8	2	11	1	3	2	3	4	6	22	14	9	10	23	14	14	39	54	397	Apr 18	Sunday	
109	34	38	33	36	32	64	56	43	58	24	30	41	34	23	21	10	7	16	21	12	16	19	15	15	698	Apr 19	Monday	
110	11	14	15	27	29	26	9	17	23	23	20	16	13	7	18	22	18	17	17	15	15	11	11	4	398	Apr 20	Tuesday	
111	11	7	8	21	12	22	11	11	11	17	8	21	13	22	30	21	14	10	36	12	27	18	16	16	395	Apr 21	Wednesday	
112	16	19	20	22	23	18	9	13	13	30	50	26	21	15	15	14	9	8	2	10	7	5	9	2	374	Apr 22	Thursday	
113	2	3	14	14	19	28	17	15	30	25	39	38	15	16	14	16	18	17	13	6	10	8	6	1	381	Apr 23	Friday	
114	0	11	9	1	13	10	23	12	13	23	33	15	19	5	7	12	10	6	4	2	4	12	7	12	263	Apr 24	Saturday	
115	1	4	13	13	4	10	26	5	9	10	14	8	9	9	14	14	11	11	0	6	7	5	4	0	207	Apr 25	Sunday	
116	4	5	26	64	76	77	87	69	54	59	51	60	67	61	38	40	39	13	21	6	7	1	8	10	943	Apr 26	Monday	
117	6	6	12	32	41	38	48	45	57	38	50	58	71	58	44	29	29	24	20	13	7	7	1	8	742	Apr 27	Tuesday	
118	13	7	27	34	54	78	35	63	53	54	66	65	66	77	29	42	39	37	25	9	12	7	7	6	905	Apr 28	Wednesday	
119	5	10	23	48	56	70	78	57	82	63	51	75	63	46	56	42	39	41	44	32	17	8	3	19	1028	Apr 29	Thursday	
120	10	15	21	41	47	56	44	48	62	59	53	69	37	40	48	33	19	13	6	19	19	8	4	16	787	Apr 30	Friday	
121	4	4	10	14	10	5	17	8	9	12	13	12	9	9	14	7	15	13	6	3	3	0	1	2	200	May 01	Saturday	F*rste
122	0	5	11	5	15	9	13	14	11	19	13	17	18	12	8	14	11	5	3	2	0	6	12	15	238	May 02	Sunday	
123	5	11	4	15	12	35	17	21	19	6	17	19	17	17	22	6	9	8	0	0	3	1	19	12	295	May 03	Monday	
124	28	15	9	41	43	70	52	34	47	41	57	48	77	50	62	33	39	19	20	11	1	20	40	9	866	May 04	Tuesday	
125	2	13	17	38	56	81	78	62	87	61	37	65	66	66	61	18	26	30	35	17	27	12	14	6	975	May 05	Wednesday	
126	7	13	31	45	72	95	84	76	87	72	75	72	83	83	61	48	40	22	13	15	9	20	3	4	1130	May 06	Thursday	
127	9	15	16	46	64	68	43	63	62	74	57	80	78	59	40	37	31	25	35	8	3	1	17	7	938	May 07	Friday	
128	7	0	3	7	27	23	16	10	32	11	25	24	25	16	37	6	15	10	8	7	8	4	30	8	359	May 08	Saturday	
129	26	21	22	32	34	16	13	11	19	15	2	5	6	8	21	4	9	2	8	4	1	5	9	8	301	May 09	Sunday	
130	7	14	8	24	51	57	32	33	35	45	35	67	67	42	50	45	47	47	57	42	51	50	29	32	967	May 10	Monday	
131	35	23	19	55	80	92	72	83	62	69	66	90	64	68	63	18	22	15	11	9	8	4	3	4	1035	May 11	Tuesday	
132	5	22	24	38	91	95	73	61	75	78	61	84	77	70	59	36	34	16	14	16	43	16	2	7	1097	May 12	Wednesday	
133	5	13	32	74	70	89	61	67	90	56	73	62	90	88	60	35	26	30	22	16	16	18	7	8	1108	May 13	Thursday	
134	2	18	52	62	82	77	77	72	76	80	94	85	89	79	33	33	31	35	47	15	21	13	11	3	1187	May 14	Friday	
135	9	11	19	22	22	25	22	31	24	28	24	32	24	17	25	6	10	10	8	3	6	11	14	8	411	May 15	Saturday	
136	17	20	26	29	25	32	25	18	34	15	22	33	23	23	22	27	18	13	10	3	2	6	7	3	453	May 16	Sunday	
137	8	2	26	56	68	92	91	74	72	64	93	92	75	85	36	37	31	22	11	25	9	7	4	9	1089	May 17	Monday	Sytten
138	5	16	41	58	71	91	133	106	86	87	100	116	81	47	46	55	37	30	22	17	12	21	7	0	1285	May 18	Tuesday	
139	4	16	47	69	82	95	91	90	87	70	113	85	99	70	50	29	43	23	18	10	2	7	17	12	1229	May 19	Wednesday	
140	26	34	70	142	141	157	105	126	90	101	104	92	88	68	64	65	39	41	24	15	28	26	11	4	1661	May 20	Thursday	Kristi
141	7	38	47	69	99	101	107	81	86	94	82	111	95	90	74	66	60	52	23	46	0	9	6	12	1455	May 21	Friday	
142	5	10	4	8	19	21	11	10	14	32	31	28	13	45	24	0	15	13	11	17	6	0	3	7	347	May 22	Saturday	
143	3	2	8	6	16	44	57	53	37	37	47	36	43	19	27	6	30	20	8	5	7	3	2	11	527	May 23	Sunday	
144	5	7	29	53	96	103	122	83	91	121	108	105	88	105	66	43	41	44	20	47	26	23	8	6	1440	May 24	Monday	
145	15	8	83	70	102	115	78	156	101	87	82	107	87	66	79	37	58	41	41	46	17	11	8	6	1501	May 25	Tuesday	
146	11	25	38	59	109	126	79	85	98	83	81	83	90	74	51	45	33	21	15	16	6	20	12	3	1263	May 26	Wednesday	

Table 3.5.5 (Page 1 of 4)

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		
147	9	14	29	97	109	76	78	87	94	135	111	107	93	91	50	33	59	19	37	32	8	18	8	14	1408	May 27	Thursday	
148	6	15	44	68	80	82	98	86	78	57	92	101	68	91	41	31	52	35	20	32	22	9	7	3	1218	May 28	Friday	
149	2	8	14	11	21	32	30	25	35	16	50	31	35	19	28	7	17	14	15	12	12	0	5	6	445	May 29	Saturday	
150	17	9	4	1	12	16	5	9	19	7	7	16	19	16	18	13	14	17	6	5	3	3	7	6	249	May 30	Sunday	Første
151	9	13	25	49	71	111	104	79	89	76	77	83	100	79	56	37	37	31	21	33	13	5	6	8	1212	May 31	Monday	Annen
152	11	17	30	81	97	122	114	75	116	122	89	91	85	94	61	29	34	59	32	31	15	15	9	9	1438	Jun 01	Tuesday	
153	18	10	45	80	77	105	126	82	102	87	87	107	65	92	74	58	49	27	27	44	15	12	11	8	1408	Jun 02	Wednesday	
154	10	17	49	73	97	97	99	76	89	100	79	82	61	46	62	53	51	25	23	28	15	2	16	3	1253	Jun 03	Thursday	
155	7	30	81	63	88	77	160	238	131	179	151	129	139	178	168	72	77	87	92	69	88	83	93	90	2537	Jun 04	Friday	
156	73	61	94	73	74	59	75	47	64	71	69	22	85	23	24	41	87	31	14	11	8	10	8	9	1133	Jun 05	Saturday	
157	12	18	24	16	28	20	35	26	20	23	10	37	16	23	19	9	12	21	18	19	9	12	3	2	432	Jun 06	Sunday	
158	6	19	12	40	63	75	85	56	38	53	63	62	24	91	67	145	139	44	48	40	58	15	9	29	1281	Jun 07	Monday	
159	4	11	43	52	83	106	125	104	165	19	22	0	0	0	0	0	0	0	0	0	0	0	0	0	734	Jun 08	Tuesday	
160	0	0	0	0	0	0	0	0	74	64	84	64	77	80	71	41	37	18	27	21	7	13	4	3	655	Jun 09	Wednesday	
161	7	12	29	54	66	84	60	87	84	52	64	68	68	66	45	43	44	33	33	40	24	32	22	12	1129	Jun 10	Thursday	
162	24	31	49	52	62	84	88	108	80	102	113	123	46	60	61	81	68	93	63	79	92	71	51	47	1728	Jun 11	Friday	
163	59	71	63	43	49	77	90	55	67	78	88	75	64	57	18	34	36	30	21	17	11	3	11	10	1125	Jun 12	Saturday	
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 13	Sunday	
165	0	0	10	13	19	14	17	16	24	9	6	17	27	14	23	22	15	9	9	18	19	0	8	20	329	Jun 14	Monday	
166	6	12	24	59	70	96	86	84	71	70	60	88	76	68	51	31	49	31	28	8	19	12	5	25	1129	Jun 15	Tuesday	
167	2	19	31	61	74	88	77	86	76	47	84	93	74	92	50	44	38	27	14	28	30	16	16	2	1169	Jun 16	Wednesday	
168	7	27	31	78	64	99	90	99	88	58	76	61	83	71	56	61	49	27	34	15	50	11	1	7	1223	Jun 17	Thursday	
169	16	15	43	67	63	88	85	78	85	72	90	58	66	54	36	29	41	26	41	35	6	11	5	6	1116	Jun 18	Friday	
170	3	7	5	16	12	18	44	22	27	17	56	32	19	25	31	34	17	19	17	9	16	10	0	3	459	Jun 19	Saturday	
171	12	6	8	4	19	22	20	19	27	12	13	24	20	19	16	1	12	5	11	3	5	8	11	8	305	Jun 20	Sunday	
172	24	20	37	60	72	103	84	101	81	67	50	69	59	57	50	50	39	39	22	37	19	12	13	2	1167	Jun 21	Monday	
173	10	16	21	55	85	93	89	77	70	69	61	67	88	93	72	37	48	50	34	16	36	35	19	17	1258	Jun 22	Tuesday	
174	26	47	77	81	102	108	119	73	88	92	110	96	93	88	53	68	29	49	45	40	20	26	29	24	1583	Jun 23	Wednesday	
175	32	47	73	71	96	107	92	76	94	82	78	107	93	85	57	62	42	23	29	23	5	6	13	13	1406	Jun 24	Thursday	
176	7	15	31	58	78	112	88	82	85	96	78	74	64	62	49	21	48	40	35	10	9	0	5	5	1152	Jun 25	Friday	
177	7	18	21	29	32	44	31	39	47	96	37	43	37	25	25	18	29	11	11	10	18	13	7	4	652	Jun 26	Saturday	
178	0	4	9	17	3	10	11	16	36	28	17	26	20	18	11	9	4	10	9	2	2	6	6	6	280	Jun 27	Sunday	
179	0	9	24	54	59	96	102	93	77	49	69	81	66	78	70	33	34	39	31	24	16	12	21	2	1139	Jun 28	Monday	
180	8	25	36	97	92	77	101	93	78	81	105	84	94	90	69	86	66	59	42	47	43	37	66	47	1623	Jun 29	Tuesday	
181	42	39	51	64	68	91	94	62	70	103	85	65	81	81	71	58	42	44	32	41	39	24	20	13	1380	Jun 30	Wednesday	
182	16	23	28	59	82	90	98	98	85	73	71	83	75	84	47	43	51	28	12	27	33	33	9	16	1264	Jul 01	Thursday	
183	11	32	55	75	80	85	93	81	91	62	92	75	71	72	53	56	41	28	16	47	5	11	25	14	1271	Jul 02	Friday	
184	7	4	8	19	16	20	29	14	51	27	29	26	24	44	19	12	10	3	5	4	8	7	2	18	406	Jul 03	Saturday	
185	16	4	5	5	8	21	12	8	13	7	14	13	11	22	9	10	8	6	21	11	0	3	0	19	246	Jul 04	Sunday	
186	12	15	22	57	61	98	90	78	74	52	56	71	78	59	53	47	40	33	14	21	3	5	22	23	1084	Jul 05	Monday	
187	43	46	69	90	108	97	110	87	127	88	83	111	117	96	92	65	73	55	56	42	45	50	34	16	1800	Jul 06	Tuesday	
188	28	50	47	67	83	78	99	54	66	73	46	83	91	69	49	54	41	19	17	17	23	30	39	62	1285	Jul 07	Wednesday	
189	50	19	37	68	64	73	58	63	62	66	78	65	95	65	47	31	33	34	57	37	32	30	34	57	1255	Jul 08	Thursday	
190	52	51	69	71	62	83	81	80	86	64	99	80	59	64	44	40	37	13	29	27	20	7	13	3	1234	Jul 09	Friday	
191	0	2	6	5	19	28	23	8	25	14	54	21	11	16	25	17	6	18	15	6	3	2	2	1	327	Jul 10	Saturday	
192	3	6	8	0	13	8	24	14	19	5	6	10	12	15	11	7	19	10	12	7	33	3	12	4	261	Jul 11	Sunday	
193	6	10	33	78	82	82	90	80	57	83	64	52	83	64	152	61	28	27	20	24	5	4	5	11	1201	Jul 12	Monday	
194	11	23	32	74	74	84	100	83	63	64	77	77	70	85	47	28	50	25	17	21	18	9	6	21	1159	Jul 13	Tuesday	
195	6	17	41	62	83	94	107	61	60	78	81	72	82	62	71	37	32	20	21	18	17	7	1	2	1132	Jul 14	Wednesday	
196	17	12	43	63	77	87	95	87	89	79	65	71	74	75	52	40	29	24	24	38	25	1	4	5	1176	Jul 15	Thursday	
197	3	15	23	46	63	85	72	83	78	70	60	81	80	72	53	29	30	33	29	16	3	5	4	10	1063	Jul 16	Friday	
198	9	7	18	27	34	23	20	12	37	16	41	22	27	11	33	0	13	20	7	9	7	3	6	0	402	Jul 17	Saturday	
199	5	5	20	24	21	13	17	21	13	4	11	23	14	17	21	2	12	16	4	13	6	8	0	4	294	Jul 18	Sunday	
200	0	14	31	47	88	84	107	69	85	69	109	88	66	82	48	40	58	173	101	161	112	58	78	87	1875	Jul 19	Monday	
201	51	91	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	148	Jul 20	Tuesday	
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 21	Wednesday	

Table 3.5.5 (Page 2 of 4)

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	
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 22	Thursday
204	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	73	50	54	26	32	10	35	11	10	349	Jul 23	Friday
205	11	10	9	17	37	35	25	30	9	5	24	28	24	9	26	16	20	10	12	4	20	9	4	24	418	Jul 24	Saturday
206	1	23	14	7	20	28	22	19	14	9	5	13	20	30	30	6	15	12	2	9	17	11	11	19	357	Jul 25	Sunday
207	17	20	14	62	75	84	66	78	78	48	62	74	54	67	42	47	38	29	22	19	13	6	3	2	1020	Jul 26	Monday
208	9	8	31	61	85	99	103	106	88	71	100	96	18	13	0	0	0	0	0	0	10	12	14	2	926	Jul 27	Tuesday
209	10	19	30	74	73	75	85	72	61	75	71	3	0	63	40	34	48	10	24	17	15	15	4	9	927	Jul 28	Wednesday
210	7	7	33	70	86	62	90	94	72	84	72	53	57	76	41	31	53	21	19	43	18	12	7	11	1119	Jul 29	Thursday
211	10	25	33	49	72	100	74	76	73	71	63	79	89	51	68	60	36	33	24	36	7	9	0	5	1143	Jul 30	Friday
212	2	11	19	16	15	23	34	23	18	22	20	17	19	19	17	29	11	6	2	27	11	3	8	4	376	Jul 31	Saturday
213	4	9	17	1	22	13	13	32	16	11	14	10	8	20	8	7	16	4	14	9	10	1	0	0	259	Aug 01	Sunday
214	13	3	27	44	79	91	73	69	39	42	65	70	62	65	48	34	39	21	13	21	25	5	0	2	950	Aug 02	Monday
215	1	8	41	59	73	88	90	80	66	78	103	72	91	77	52	35	50	35	38	18	14	6	12	5	1192	Aug 03	Tuesday
216	14	7	28	70	61	79	85	57	78	91	75	84	66	71	42	57	35	33	39	28	12	19	10	4	1145	Aug 04	Wednesday
217	15	18	48	94	95	107	101	101	123	119	111	102	87	98	64	77	64	61	55	39	14	8	12	31	1644	Aug 05	Thursday
218	6	14	30	58	82	93	73	75	92	55	85	82	57	51	40	36	47	32	59	44	45	30	22	39	1247	Aug 06	Friday
219	32	12	29	20	35	20	26	26	45	18	30	19	29	26	20	30	14	11	22	17	3	3	5	5	497	Aug 07	Saturday
220	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 08	Sunday
221	2	6	21	57	85	85	85	56	71	75	78	63	74	78	34	40	28	34	37	32	7	2	14	2	1066	Aug 09	Monday
222	3	31	59	70	70	79	82	90	76	71	78	76	82	105	82	43	32	22	27	22	13	6	8	2	1229	Aug 10	Tuesday
223	4	18	41	74	63	68	79	55	47	69	78	60	73	63	51	18	26	28	21	37	35	7	13	0	1028	Aug 11	Wednesday
224	3	18	29	65	76	102	74	67	63	72	69	81	46	73	54	56	35	42	27	23	6	10	10	7	1108	Aug 12	Thursday
225	16	8	37	50	73	83	79	69	66	89	74	104	84	80	38	45	50	27	33	55	21	9	13	5	1208	Aug 13	Friday
226	7	3	3	17	25	26	39	27	39	43	30	32	33	51	29	46	26	13	1	24	1	15	3	6	539	Aug 14	Saturday
227	14	12	10	17	15	15	18	25	16	10	20	32	22	28	37	15	13	21	14	8	24	21	12	6	425	Aug 15	Sunday
228	21	23	19	52	87	81	91	68	76	74	66	79	77	88	43	40	34	30	36	36	33	7	4	5	1168	Aug 16	Monday
229	6	19	30	79	86	106	97	65	78	78	85	83	75	71	58	41	35	38	28	29	19	3	10	4	1223	Aug 17	Tuesday
230	8	22	47	63	93	101	90	80	81	61	99	71	96	95	59	35	37	34	18	19	14	10	3	4	1240	Aug 18	Wednesday
231	7	24	40	86	99	103	81	85	74	69	75	71	81	80	44	51	45	22	29	23	21	13	13	11	1247	Aug 19	Thursday
232	10	15	26	70	71	96	61	70	66	69	74	63	74	56	55	35	51	31	23	38	13	3	6	12	1088	Aug 20	Friday
233	11	20	18	19	24	28	29	23	41	40	49	34	27	38	37	10	22	25	6	40	13	1	4	3	562	Aug 21	Saturday
234	8	8	25	15	28	31	28	18	17	9	24	44	15	20	28	12	13	11	8	20	12	23	11	13	441	Aug 22	Sunday
235	21	26	23	43	86	118	93	81	76	55	69	65	79	79	53	23	32	22	53	12	14	30	8	2	1163	Aug 23	Monday
236	9	10	59	57	86	75	80	61	72	55	78	67	63	80	75	51	39	37	17	28	47	23	22	30	1221	Aug 24	Tuesday
237	44	34	24	41	89	43	60	56	47	64	70	70	72	74	79	47	47	36	35	23	9	5	9	11	1089	Aug 25	Wednesday
238	19	41	27	58	70	82	72	83	75	94	82	77	64	88	60	21	41	23	14	12	21	32	48	61	1265	Aug 26	Thursday
239	67	67	77	103	92	101	94	73	75	76	82	96	85	83	77	70	61	39	41	18	15	8	3	8	1511	Aug 27	Friday
240	7	8	13	12	19	31	28	30	18	31	23	51	24	28	42	12	19	9	17	13	10	6	5	7	463	Aug 28	Saturday
241	54	39	25	10	22	25	18	16	18	21	32	30	23	23	18	20	16	9	23	12	4	14	6	1	479	Aug 29	Sunday
242	13	10	31	45	57	84	74	88	85	82	63	76	87	59	62	37	40	32	26	38	22	9	17	11	1148	Aug 30	Monday
243	6	24	41	62	88	87	80	143	72	69	65	82	69	57	66	52	42	64	35	25	30	1	7	4	1271	Aug 31	Tuesday
244	15	30	50	71	89	84	78	52	84	57	72	78	60	80	63	48	28	40	9	37	16	13	7	6	1167	Sep 01	Wednesday
245	4	10	31	76	84	90	89	81	80	94	56	86	77	74	68	50	36	34	35	24	22	18	12	6	1237	Sep 02	Thursday
246	17	16	37	43	83	86	59	73	76	93	58	87	71	76	58	46	45	55	35	35	13	29	24	3	1218	Sep 03	Friday
247	15	19	18	24	34	29	18	38	23	56	84	37	40	38	25	10	26	31	10	2	18	17	10	7	629	Sep 04	Saturday
248	9	10	11	9	37	26	20	34	34	21	22	33	28	25	26	16	13	7	4	19	14	8	7	1	434	Sep 05	Sunday
249	20	25	15	59	68	97	82	77	75	47	71	67	68	73	54	43	32	36	23	25	12	7	8	10	1094	Sep 06	Monday
250	11	19	40	56	78	77	97	64	64	68	72	75	77	72	34	45	29	18	18	6	11	1	2	7	1041	Sep 07	Tuesday
251	8	16	30	60	78	89	65	62	59	66	58	83	72	75	53	40	55	24	38	15	8	20	14	13	1101	Sep 08	Wednesday
252	2	20	48	78	85	84	88	78	57	65	79	103	80	74	73	53	45	33	32	15	8	14	14	25	1253	Sep 09	Thursday
253	11	18	19	75	65	92	100	65	86	64	92	80	67	87	52	39	50	56	42	30	12	5	7	2	1206	Sep 10	Friday
254	2	12	31	22	18	25	20	24	25	27	55	30	36	24	27	26	12	24	10	13	14	5	1	8	491	Sep 11	Saturday
255	5	12	12	10	9	25	20	28	14	14	0	5	40	30	39	21	19	17	18	2	10	1	23	4	378	Sep 12	Sunday
256	8	9	35	52	76	90	81	66	75	55	58	71	68	57	50	34	36	29	11	6	17	6	3	2	995	Sep 13	Monday
257	10	47	20	60	82	77	101	72	70	60	87	82	69	80	51	38	59	49	33	14	25	0	4	3	1193	Sep 14	Tuesday
258	5	6	25	62	63	83	80	76	58	71	95	73	39	70	50	40	65	15	35	14	12	18	12	25	1090	Sep 15	Wednesday

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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
259	4	20	25	48	72	72	73	78	115	68	184	140	107	144	85	44	39	31	32	8	10	5	5	1	1410	Sep 16 Thursday
260	3	14	30	50	86	68	68	57	77	75	90	129	192	203	48	48	56	35	38	30	16	10	8	5	1436	Sep 17 Friday
261	8	10	20	14	30	27	61	53	64	41	43	77	45	62	60	36	34	30	16	40	51	33	25	23	903	Sep 18 Saturday
262	23	30	33	24	21	13	25	23	14	14	7	20	15	45	25	21	29	28	26	44	19	16	5	4	524	Sep 19 Sunday
263	7	12	14	50	60	79	85	80	68	48	63	70	75	39	68	53	53	21	26	6	14	1	13	8	1013	Sep 20 Monday
264	10	11	30	62	80	91	87	92	78	74	88	68	80	85	55	48	52	45	17	18	16	14	13	9	1223	Sep 21 Tuesday
265	12	22	10	48	70	84	60	67	76	70	65	69	84	72	71	48	34	40	30	17	15	6	3	11	1084	Sep 22 Wednesday
266	9	8	26	81	59	90	95	49	77	71	76	76	71	84	65	44	58	27	17	16	13	7	20	12	1131	Sep 23 Thursday
267	16	22	28	63	81	67	77	73	73	113	170	162	145	125	48	40	31	17	36	27	28	16	20	6	1484	Sep 24 Friday
268	10	7	10	14	14	41	55	40	19	43	26	47	45	31	51	29	32	21	23	14	13	9	17	14	625	Sep 25 Saturday
269	34	9	27	20	9	28	21	18	32	31	14	27	35	38	31	25	25	20	28	6	13	12	0	11	514	Sep 26 Sunday
270	6	6	23	22	43	38	50	72	53	53	50	71	65	68	63	51	31	23	19	42	13	21	6	8	897	Sep 27 Monday
271	7	8	21	27	46	50	78	72	73	77	68	94	79	100	77	50	30	34	33	27	15	11	5	5	1085	Sep 28 Tuesday
272	14	8	10	22	68	69	95	90	62	85	53	71	80	85	73	67	34	35	22	25	14	10	15	14	1121	Sep 29 Wednesday
273	9	10	30	30	67	82	81	83	73	91	86	78	67	72	69	44	25	40	43	55	18	23	20	10	1206	Sep 30 Thursday
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	2244	3017	4797	7672	9667	10969	10816	9858	9972	9449	10142	10450	9719	9622	7693	5868	5691	4663	4042	3828	2957	2224	2140	2061	159561	Total sum
179	13	17	27	43	54	61	60	55	56	53	57	58	54	54	43	33	32	26	23	21	17	12	12	12	891	Total average
123	12	18	31	53	67	76	75	69	68	65	69	71	67	67	51	40	38	31	27	25	19	14	13	12	1078	Average workdays
56	13	14	18	20	25	29	29	25	28	26	30	29	27	25	24	17	19	15	12	13	11	8	9	9	476	Average weekends

Table 3.5.5. Daily and hourly distribution of Apatity 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)

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		
91	3	2	1	0	1	0	4	8	2	6	9	82	1	13	24	6	10	2	6	4	17	5	7	6	219	Apr 01	Thursday	
92	2	0	4	0	0	4	2	2	2	7	71	34	43	30	25	8	25	2	7	1	4	3	6	0	282	Apr 02	Friday	
93	3	2	6	0	3	6	5	7	6	0	4	7	7	17	15	2	2	0	6	1	3	1	1	0	104	Apr 03	Saturday	
94	1	1	1	1	2	0	0	0	22	168	71	5	4	1	22	21	2	17	18	8	0	2	5	4	376	Apr 04	Sunday	
95	2	0	0	0	6	0	2	5	8	6	35	18	49	34	2	58	3	48	11	16	1	4	0	2	310	Apr 05	Monday	
96	0	3	1	0	5	2	0	4	4	12	126	37	0	8	2	28	6	28	0	5	4	6	16	4	301	Apr 06	Tuesday	
97	5	1	0	8	1	0	5	0	0	5	8	88	25	16	8	19	6	20	17	3	3	0	5	2	245	Apr 07	Wednesday	
98	1	0	0	3	7	0	3	14	2	25	13	2	2	2	1	6	5	6	30	9	19	1	1	2	154	Apr 08	Thursday	Skj(rt
99	1	0	6	1	0	0	4	102	30	61	52	5	13	21	5	35	8	22	11	7	0	0	2	3	389	Apr 09	Friday	Langfr
100	1	1	0	8	1	5	1	4	8	3	0	9	3	19	3	20	10	0	2	1	0	0	2	3	104	Apr 10	Saturday	
101	1	1	2	1	0	3	7	5	5	9	48	135	93	53	11	10	22	1	54	8	11	8	0	5	493	Apr 11	Sunday	F°rste
102	3	6	0	0	0	0	0	6	54	6	75	11	11	4	8	1	19	16	22	11	4	0	2	9	268	Apr 12	Monday	Annen
103	0	8	1	1	2	6	2	1	38	9	6	6	14	43	19	3	2	1	1	0	5	1	1	0	170	Apr 13	Tuesday	
104	0	0	0	2	2	0	5	6	3	9	0	2	3	8	46	1	2	40	5	3	25	2	2	0	166	Apr 14	Wednesday	
105	1	3	1	1	3	2	7	13	26	3	20	26	13	30	18	1	15	4	1	1	7	2	7	1	206	Apr 15	Thursday	
106	1	2	1	0	6	2	1	0	13	2	3	9	0	17	59	24	70	24	5	2	0	7	0	7	255	Apr 16	Friday	
107	0	2	4	2	1	6	20	6	45	6	13	6	5	21	2	30	22	6	3	50	77	70	46	9	452	Apr 17	Saturday	
108	18	2	0	1	0	3	2	13	38	21	2	2	17	1	22	6	23	15	9	2	7	3	4	4	215	Apr 18	Sunday	
109	17	20	13	0	0	1	1	12	17	9	7	15	5	3	2	49	47	50	32	4	13	13	1	6	337	Apr 19	Monday	
110	3	0	3	8	7	6	4	4	18	4	0	2	3	14	6	11	7	1	3	2	1	10	1	2	120	Apr 20	Tuesday	
111	5	1	5	0	2	1	4	5	2	1	4	2	5	2	24	7	3	0	15	26	0	4	0	4	122	Apr 21	Wednesday	
112	1	3	0	4	0	18	5	10	0	1	0	12	40	0	1	1	2	29	0	7	12	10	4	1	161	Apr 22	Thursday	
113	0	0	1	1	2	0	1	1	9	4	3	3	1	0	34	11	4	44	32	25	0	2	2	1	181	Apr 23	Friday	
114	1	3	0	6	2	2	1	15	1	4	118	4	0	17	7	15	2	7	2	4	3	0	2	27	243	Apr 24	Saturday	
115	69	56	26	0	0	2	11	3	0	0	0	8	1	3	6	2	30	1	1	1	0	1	1	3	225	Apr 25	Sunday	
116	0	0	0	1	4	19	22	28	58	38	67	50	19	10	1	5	5	3	6	13	6	4	0	1	360	Apr 26	Monday	
117	1	7	2	2	0	0	0	0	2	16	27	37	57	7	9	79	14	29	9	12	1	1	7	3	322	Apr 27	Tuesday	
118	9	0	3	7	0	2	1	9	8	6	2	3	5	1	2	7	7	10	3	12	3	2	6	9	117	Apr 28	Wednesday	
119	7	2	1	0	13	8	1	4	8	5	12	4	7	17	29	4	5	20	9	10	2	7	9	6	190	Apr 29	Thursday	
120	3	3	3	0	3	0	16	5	23	13	5	28	20	19	39	30	33	36	96	94	62	64	80	117	792	Apr 30	Friday	
121	73	71	57	57	27	4	2	13	62	29	3	13	3	9	42	5	4	24	6	6	0	0	0	1	511	May 01	Saturday	F°rste
122	2	3	0	2	0	2	0	5	14	38	15	44	11	27	74	45	27	14	86	63	23	25	11	14	545	May 02	Sunday	
123	70	28	8	9	1	8	8	14	14	2	14	2	13	8	1	1	20	63	83	44	2	4	5	2	424	May 03	Monday	
124	4	1	1	1	6	4	10	18	12	8	21	36	22	70	51	38	33	58	75	26	6	16	2	1	520	May 04	Tuesday	
125	1	3	0	2	1	2	0	0	9	3	3	30	36	49	50	34	17	3	5	14	8	2	7	3	282	May 05	Wednesday	
126	3	2	5	7	63	13	22	82	43	75	36	0	26	22	66	27	27	19	21	1	26	3	5	50	644	May 06	Thursday	
127	11	9	3	29	32	68	72	73	49	80	87	78	69	26	42	5	42	70	15	19	68	47	0	4	998	May 07	Friday	
128	4	3	1	8	5	2	28	39	11	38	99	44	7	52	71	9	33	73	14	12	4	8	5	12	582	May 08	Saturday	
129	33	12	5	1	8	0	0	20	3	9	72	13	1	3	9	5	6	15	5	27	4	1	2	1	255	May 09	Sunday	
130	2	2	1	6	0	1	29	7	1	3	1	9	2	0	26	12	42	3	0	4	0	12	9	3	175	May 10	Monday	
131	1	0	1	0	32	46	56	33	4	5	34	76	95	128	72	109	80	78	94	87	21	81	66	74	1273	May 11	Tuesday	
132	35	10	40	33	1	23	35	61	33	37	23	52	36	18	14	55	34	79	46	11	8	11	16	13	724	May 12	Wednesday	
133	20	10	4	1	0	0	0	11	0	0	7	4	10	0	15	12	1	12	2	2	2	21	22	15	171	May 13	Thursday	
134	26	58	56	26	27	32	40	77	45	111	155	97	17	0	45	23	30	56	10	5	4	2	3	98	1043	May 14	Friday	
135	108	60	74	32	0	2	9	1	1	21	2	38	85	85	45	26	35	81	91	51	62	103	44	61	1117	May 15	Saturday	
136	67	25	24	12	6	0	0	7	8	3	68	47	33	22	6	3	3	21	13	17	42	22	61	63	573	May 16	Sunday	
137	53	42	56	41	48	29	46	21	35	51	48	45	59	43	33	66	56	46	48	52	54	45	60	49	1126	May 17	Monday	Sytten
138	45	9	15	33	40	11	27	29	46	54	49	46	35	45	35	90	55	48	42	71	45	6	0	6	882	May 18	Tuesday	
139	1	0	10	53	71	33	24	36	45	63	7	0	0	0	29	27	23	31	52	3	8	9	6	4	535	May 19	Wednesday	
140	0	1	8	1	4	7	4	0	5	112	7	4	6	19	18	2	12	9	2	38	0	10	4	4	277	May 20	Thursday	Kristi
141	0	0	5	6	0	19	46	29	41	23	85	62	40	72	54	66	62	61	74	49	38	17	0	39	888	May 21	Friday	
142	1	5	4	8	20	31	33	19	2	0	76	16	4	4	66	6	10	5	4	7	65	73	39	62	560	May 22	Saturday	
143	68	28	56	13	21	40	83	54	54	57	50	38	50	40	21	68	48	19	23	10	40	50	37	20	988	May 23	Sunday	
144	6	49	63	69	58	67	38	31	11	12	2	10	6	5	34	55	42	68	55	73	69	12	18	19	872	May 24	Monday	
145	33	30	26	17	2	1	0	2	2	7	5	1	1	4	0	18	57	36	47	46	75	10	5	21	446	May 25	Tuesday	
146	14	12	34	1	4	2	3	14	15	6	5	3	6	2	47	71	60	11	0	10	23	0	2	1	346	May 26	Wednesday	

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		
147	1	1	4	2	6	3	5	48	78	63	80	30	37	30	29	46	51	11	9	52	42	68	25	50	771	May 27	Thursday	
148	73	41	13	11	3	11	57	59	40	45	21	5	17	4	8	6	63	54	22	23	0	0	21	3	600	May 28	Friday	
149	0	0	1	2	2	18	57	53	43	62	33	12	31	53	57	67	34	66	21	78	63	49	32	46	880	May 29	Saturday	
150	16	34	60	67	33	50	62	52	48	25	33	55	67	42	24	67	55	11	30	67	7	22	6	2	935	May 30	Sunday	Første
151	2	1	4	14	46	3	49	51	73	27	11	8	21	64	23	69	76	48	20	4	54	41	89	36	834	May 31	Monday	Annen
152	52	16	11	12	47	11	3	8	6	0	9	6	0	23	2	3	10	4	11	2	6	2	10	0	254	Jun 01	Tuesday	
153	0	0	1	4	0	3	1	10	28	51	75	41	31	32	48	48	47	60	51	29	57	42	79	65	803	Jun 02	Wednesday	
154	80	76	60	50	43	21	66	19	11	27	11	0	4	38	41	33	18	5	31	14	11	0	0	1	660	Jun 03	Thursday	
155	3	18	6	11	6	8	31	70	54	8	30	84	33	42	45	32	8	2	29	68	5	6	9	21	629	Jun 04	Friday	
156	3	1	3	5	3	0	0	2	15	4	1	3	27	5	3	7	3	1	3	4	7	3	0	0	103	Jun 05	Saturday	
157	3	0	4	1	2	2	1	0	1	4	2	7	0	9	2	1	3	2	12	3	0	2	15	7	83	Jun 06	Sunday	
158	1	10	1	0	0	12	2	3	3	10	4	1	7	3	0	2	6	0	0	1	14	4	1	4	89	Jun 07	Monday	
159	0	0	2	0	1	1	0	4	8	0	6	8	40	57	61	36	66	13	3	0	4	0	0	6	316	Jun 08	Tuesday	
160	0	0	0	0	1	1	8	5	8	13	11	11	5	20	36	15	5	12	46	36	46	34	51	75	439	Jun 09	Wednesday	
161	59	55	58	48	58	63	44	27	49	53	51	81	69	59	64	64	53	53	66	33	45	63	67	36	1318	Jun 10	Thursday	
162	67	28	29	36	45	40	22	32	37	36	39	19	11	13	8	32	58	67	34	24	48	9	0	0	734	Jun 11	Friday	
163	1	0	1	1	1	0	0	1	3	1	0	4	1	0	1	2	4	3	21	43	8	30	32	8	166	Jun 12	Saturday	
164	1	11	15	67	54	47	36	61	49	63	54	28	2	0	0	0	0	6	0	1	7	27	12	61	602	Jun 13	Sunday	
165	64	2	0	41	44	32	16	7	17	4	20	0	11	1	3	2	1	19	2	2	1	1	1	0	291	Jun 14	Monday	
166	0	2	6	36	42	64	68	73	46	26	26	14	7	1	5	2	0	3	8	3	0	0	0	6	438	Jun 15	Tuesday	
167	9	0	5	1	3	9	0	3	4	1	10	1	2	3	1	0	3	4	7	0	1	0	2	1	70	Jun 16	Wednesday	
168	0	4	1	2	3	1	5	8	4	3	3	6	1	6	6	0	7	0	3	12	4	0	5	36	120	Jun 17	Thursday	
169	47	29	24	25	40	27	36	31	25	16	21	20	26	39	19	39	16	13	36	62	11	0	4	1	607	Jun 18	Friday	
170	3	0	0	0	0	0	4	0	8	5	8	1	1	1	3	12	44	22	46	44	39	31	30	22	324	Jun 19	Saturday	
171	21	47	45	56	51	73	49	29	11	41	46	22	28	77	53	22	5	3	4	39	37	30	40	33	862	Jun 20	Sunday	
172	34	29	53	22	32	39	18	30	37	29	35	42	66	51	49	20	30	37	22	0	3	0	0	2	680	Jun 21	Monday	
173	2	4	0	6	0	3	3	3	1	4	5	14	4	9	6	2	9	5	2	1	5	0	0	4	92	Jun 22	Tuesday	
174	4	2	5	3	9	11	3	10	8	9	5	14	7	9	10	7	8	4	3	6	10	12	6	5	170	Jun 23	Wednesday	
175	7	4	4	28	48	42	65	50	48	67	62	55	48	50	52	49	69	33	7	4	10	9	14	8	830	Jun 24	Thursday	
176	9	6	8	10	8	12	8	12	10	4	12	15	4	11	6	10	19	4	19	13	7	9	23	3	242	Jun 25	Friday	
177	11	10	7	10	7	8	11	4	7	8	7	14	6	8	4	5	10	11	7	5	12	7	14	0	193	Jun 26	Saturday	
178	4	13	11	4	8	4	14	8	13	8	13	4	14	4	7	7	6	5	17	19	5	14	13	26	241	Jun 27	Sunday	
179	15	12	24	9	7	5	8	9	5	8	15	10	10	6	4	5	8	5	11	2	2	5	5	9	199	Jun 28	Monday	
180	6	8	10	2	17	3	5	9	12	12	18	18	3	5	4	5	4	5	5	3	3	34	3	6	200	Jun 29	Tuesday	
181	3	6	5	2	4	5	8	6	6	3	8	8	3	3	3	1	4	3	5	5	5	4	3	7	110	Jun 30	Wednesday	
182	4	8	3	5	6	2	9	4	3	1	1	6	7	0	0	0	5	1	1	5	9	9	15	10	114	Jul 01	Thursday	
183	7	6	2	1	15	2	3	3	10	1	7	7	4	2	4	12	4	1	1	3	1	8	1	3	108	Jul 02	Friday	
184	0	1	3	1	8	14	7	0	6	9	3	10	2	5	7	7	11	4	4	1	7	11	10	6	137	Jul 03	Saturday	
185	6	32	8	24	42	61	48	63	12	10	24	53	57	66	46	53	48	67	50	58	66	54	47	63	1058	Jul 04	Sunday	
186	32	36	79	70	78	55	68	64	34	41	58	71	60	50	84	66	45	37	33	37	3	6	6	7	1140	Jul 05	Monday	
187	11	1	2	4	0	2	12	9	7	2	9	1	2	17	14	13	10	7	0	0	10	4	10	6	153	Jul 06	Tuesday	
188	6	4	3	12	8	8	5	12	1	0	1	0	0	1	4	36	25	43	9	3	5	4	5	1	196	Jul 07	Wednesday	
189	6	11	12	22	23	22	20	21	10	0	8	0	1	1	6	5	4	5	5	1	5	1	0	6	195	Jul 08	Thursday	
190	4	2	16	6	35	59	76	73	64	43	41	6	3	3	2	9	6	6	10	6	13	3	8	7	501	Jul 09	Friday	
191	6	7	2	1	2	2	10	25	30	31	26	6	13	1	7	3	9	15	6	22	19	6	9	14	272	Jul 10	Saturday	
192	22	14	24	11	14	19	10	10	13	2	5	6	3	12	17	46	50	34	36	62	84	35	48	68	645	Jul 11	Sunday	
193	81	73	44	59	58	45	20	3	8	15	9	11	10	31	15	10	24	22	14	20	13	21	25	19	650	Jul 12	Monday	
194	26	28	19	15	20	15	10	12	7	13	21	26	18	23	27	12	8	13	7	16	17	36	16	41	446	Jul 13	Tuesday	
195	31	31	28	30	27	48	23	12	12	11	20	26	21	14	12	12	13	16	2	4	4	5	3	4	409	Jul 14	Wednesday	
196	9	8	18	8	10	3	6	4	1	1	0	2	10	6	4	5	7	7	5	9	10	11	15	16	175	Jul 15	Thursday	
197	22	26	16	17	9	13	10	7	13	4	1	7	5	6	2	2	3	2	10	4	9	5	9	4	206	Jul 16	Friday	
198	6	7	15	19	6	15	13	12	14	12	6	12	15	6	8	8	9	9	5	8	14	4	4	3	230	Jul 17	Saturday	
199	7	5	6	5	8	10	14	7	7	2	3	1	1	4	4	4	4	9	2	5	8	10	9	5	140	Jul 18	Sunday	
200	7	2	2	2	9	2	4	1	3	5	11	5	4	1	6	0	0	1	3	7	10	9	4	10	108	Jul 19	Monday	
201	9	3	3	1	15	14	6	4	10	7	3	2	0	5	5	2	2	1	0	2	1	1	0	1	97	Jul 20	Tuesday	
202	7	1	2	6	0	2	2	4	4	4	9	8	2	5	1	3	6	1	11	0	1	2	3	3	87	Jul 21	Wednesday	

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
203	2	4	2	2	1	7	9	2	13	11	23	46	32	15	24	57	61	10	2	3	2	2	0	0	330	Jul 22 Thursday
204	1	2	1	2	3	1	3	2	3	4	1	7	6	10	9	4	3	0	1	1	2	2	6	6	80	Jul 23 Friday
205	10	3	3	7	3	4	2	4	1	2	3	3	4	2	5	6	2	4	2	5	9	5	1	3	93	Jul 24 Saturday
206	7	0	3	5	0	3	2	2	3	4	5	1	1	1	3	12	1	2	5	4	1	1	2	2	70	Jul 25 Sunday
207	1	13	0	9	5	3	1	9	2	1	1	2	1	0	4	2	3	6	0	1	0	0	3	1	68	Jul 26 Monday
208	0	3	1	0	0	1	2	4	0	0	0	1	5	7	1	1	0	5	3	2	3	2	14	5	60	Jul 27 Tuesday
209	8	15	34	16	32	16	21	35	48	44	17	4	2	5	3	3	9	2	7	9	9	0	3	6	348	Jul 28 Wednesday
210	10	5	6	9	8	5	1	8	1	1	2	1	9	4	7	11	1	4	8	14	3	4	3	2	127	Jul 29 Thursday
211	2	0	7	4	3	1	2	0	11	6	5	6	3	6	3	3	3	1	9	0	4	8	7	7	101	Jul 30 Friday
212	2	5	14	9	7	2	8	4	7	6	3	2	9	0	5	7	7	12	4	2	1	7	4	5	132	Jul 31 Saturday
213	13	3	5	2	5	13	7	4	3	5	0	1	4	4	2	7	3	5	2	2	1	0	2	1	94	Aug 01 Sunday
214	3	3	7	9	6	1	1	4	6	27	8	3	5	4	8	5	19	11	10	2	0	12	5	0	159	Aug 02 Monday
215	7	4	3	4	2	8	14	7	9	12	14	7	13	17	7	11	20	11	11	14	2	6	4	23	230	Aug 03 Tuesday
216	8	15	1	6	5	4	10	8	9	6	10	18	6	10	11	10	2	7	2	2	4	5	7	4	170	Aug 04 Wednesday
217	4	6	6	7	4	12	4	8	1	6	9	6	7	9	1	2	2	1	7	2	7	16	13	7	147	Aug 05 Thursday
218	3	3	1	1	2	2	5	5	0	7	3	2	1	4	1	1	1	5	1	2	5	3	3	6	67	Aug 06 Friday
219	17	5	6	5	14	2	0	0	4	0	8	5	4	14	12	11	5	7	21	11	4	3	5	6	169	Aug 07 Saturday
220	3	2	4	0	9	13	7	1	19	7	11	4	9	5	2	4	2	0	2	5	4	6	7	1	127	Aug 08 Sunday
221	0	1	1	2	6	0	5	21	42	10	5	8	14	1	3	2	7	1	6	0	7	4	8	9	163	Aug 09 Monday
222	0	14	4	6	4	2	0	4	1	4	5	0	0	1	1	3	5	4	25	33	17	30	13	13	189	Aug 10 Tuesday
223	12	2	16	24	28	33	16	22	23	6	11	9	13	34	31	42	42	20	43	55	39	30	38	41	631	Aug 11 Wednesday
224	29	30	37	32	16	23	35	43	45	30	23	22	46	27	6	0	6	15	32	14	17	11	2	4	545	Aug 12 Thursday
225	7	1	2	0	0	48	87	33	3	6	9	18	12	6	9	16	3	1	0	2	0	3	11	7	284	Aug 13 Friday
226	10	36	15	10	3	8	7	17	8	10	10	13	13	0	9	15	11	3	4	5	1	2	1	0	211	Aug 14 Saturday
227	2	0	1	1	0	0	0	2	2	4	1	0	2	21	4	1	9	2	8	2	4	5	4	2	67	Aug 15 Sunday
228	7	11	3	3	12	1	11	7	7	7	5	2	5	7	8	5	9	0	1	6	1	0	16	5	139	Aug 16 Monday
229	15	8	1	10	4	19	3	0	1	2	0	0	2	1	8	3	0	2	0	1	5	0	2	0	87	Aug 17 Tuesday
230	7	8	10	0	2	7	4	2	0	0	8	3	1	0	0	2	2	1	3	1	3	4	3	1	72	Aug 18 Wednesday
231	3	5	5	4	6	5	1	6	8	3	2	4	1	4	4	11	4	1	0	8	2	2	8	4	101	Aug 19 Thursday
232	3	20	3	2	12	5	2	6	7	1	2	5	4	8	3	7	2	13	1	23	3	15	5	12	164	Aug 20 Friday
233	6	4	0	1	3	2	1	1	2	4	3	1	1	0	1	0	1	2	3	1	2	0	1	2	42	Aug 21 Saturday
234	0	0	3	1	1	0	4	0	4	2	2	8	10	8	6	6	5	0	0	7	0	3	1	1	72	Aug 22 Sunday
235	1	1	1	3	0	2	0	4	1	3	0	3	0	3	4	8	0	2	2	1	2	0	1	1	43	Aug 23 Monday
236	1	0	2	1	2	5	2	3	2	0	6	4	0	14	1	2	0	5	1	1	0	1	2	1	56	Aug 24 Tuesday
237	2	8	0	2	8	3	1	1	2	9	5	7	8	8	8	1	2	3	0	5	3	3	3	9	101	Aug 25 Wednesday
238	0	8	3	7	0	1	2	22	6	4	8	11	6	4	0	0	0	2	2	0	1	4	1	2	94	Aug 26 Thursday
239	5	8	2	0	4	5	6	4	4	8	21	12	3	1	8	1	0	0	1	4	2	1	2	3	105	Aug 27 Friday
240	6	11	9	6	12	3	6	4	5	6	3	6	3	0	6	1	5	3	6	0	7	6	7	2	123	Aug 28 Saturday
241	2	3	6	1	5	6	5	10	8	3	4	3	3	1	1	2	4	0	1	3	1	1	4	6	83	Aug 29 Sunday
242	2	4	3	2	1	4	1	9	4	1	3	5	3	2	1	7	7	8	5	6	14	3	2	1	98	Aug 30 Monday
243	1	6	2	5	10	7	1	8	0	2	1	1	2	3	1	4	0	0	5	2	12	2	2	0	77	Aug 31 Tuesday
244	2	5	6	5	15	9	1	6	3	0	3	4	4	1	26	3	5	4	2	4	3	5	9	6	131	Sep 01 Wednesday
245	5	9	2	9	8	2	3	0	2	6	7	2	30	21	48	66	19	6	4	11	6	13	10	5	294	Sep 02 Thursday
246	24	26	10	11	14	40	11	10	9	0	0	44	69	16	14	12	14	12	5	1	3	3	6	7	361	Sep 03 Friday
247	8	6	3	1	6	0	3	1	7	6	10	14	28	37	15	5	7	12	8	5	5	1	3	7	198	Sep 04 Saturday
248	10	3	4	6	9	9	4	24	4	0	1	1	8	4	3	1	0	1	4	2	17	24	14	10	163	Sep 05 Sunday
249	5	4	3	5	13	5	5	3	16	0	0	4	4	5	5	4	2	8	11	3	6	2	6	1	120	Sep 06 Monday
250	11	1	5	0	2	10	8	11	0	2	5	2	9	4	5	2	5	2	8	8	17	8	5	5	135	Sep 07 Tuesday
251	3	7	6	11	19	25	6	3	5	5	3	10	6	1	0	6	4	20	2	1	3	3	3	9	161	Sep 08 Wednesday
252	8	2	1	0	8	3	2	4	2	1	1	4	2	13	4	8	5	15	11	15	21	12	34	8	184	Sep 09 Thursday
253	11	7	6	7	2	3	2	11	2	6	10	2	4	3	13	4	1	10	2	17	3	3	5	9	143	Sep 10 Friday
254	3	5	4	7	5	8	6	0	4	7	2	7	3	5	7	5	16	5	3	3	4	10	5	4	128	Sep 11 Saturday
255	3	1	2	3	1	4	7	3	3	2	1	2	6	12	1	1	12	1	11	0	10	10	6	2	104	Sep 12 Sunday
256	10	35	18	7	9	5	8	1	1	1	13	23	14	4	10	1	7	8	8	5	2	3	4	4	201	Sep 13 Monday
257	5	1	3	4	6	4	5	48	3	0	0	3	1	3	2	0	4	5	0	0	3	6	5	2	113	Sep 14 Tuesday
258	8	1	7	1	2	1	7	1	2	13	5	8	4	2	0	2	3	0	3	5	2	7	1	0	85	Sep 15 Wednesday

Table 3.5.6 (Page 3 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
259	7	3	2	2	1	5	5	3	1	0	12	5	4	6	10	1	4	1	3	5	10	6	10	1	107	Sep 16 Thursday
260	3	3	4	7	6	8	4	1	1	2	1	4	0	3	20	0	4	6	17	10	4	6	1	1	116	Sep 17 Friday
261	2	4	4	0	7	20	2	0	0	8	1	1	2	4	2	2	22	6	7	3	14	3	4	11	129	Sep 18 Saturday
262	3	12	6	1	6	17	24	12	4	7	4	4	0	0	8	4	6	2	9	4	10	1	4	2	150	Sep 19 Sunday
263	3	5	3	8	1	2	4	1	3	1	4	5	6	1	3	1	0	2	1	1	3	5	1	6	70	Sep 20 Monday
264	2	5	1	7	1	2	4	1	13	6	1	4	3	4	3	0	8	5	0	3	3	6	1	6	89	Sep 21 Tuesday
265	10	4	6	3	6	3	1	11	4	2	9	6	4	1	7	2	4	6	15	0	8	5	0	2	119	Sep 22 Wednesday
266	3	3	2	6	5	6	2	6	1	22	3	6	1	8	9	4	5	7	5	3	25	16	18	6	172	Sep 23 Thursday
267	3	2	15	8	14	0	1	3	1	4	8	7	4	8	1	3	1	0	4	2	3	5	5	1	103	Sep 24 Friday
268	2	11	8	2	1	5	2	7	2	7	1	11	3	6	2	8	2	3	6	1	9	3	1	0	103	Sep 25 Saturday
269	2	2	3	20	0	4	3	0	8	2	0	11	2	1	0	0	4	1	3	12	3	7	4	1	93	Sep 26 Sunday
270	2	2	2	3	1	1	1	1	0	5	2	5	10	8	4	1	0	3	18	19	3	3	1	0	95	Sep 27 Monday
271	6	4	1	4	4	5	4	3	2	4	1	9	10	7	2	4	6	8	8	3	1	9	1	1	107	Sep 28 Tuesday
272	4	7	5	5	2	3	4	1	1	1	1	9	5	0	4	0	0	2	1	0	10	4	12	3	84	Sep 29 Wednesday
273	1	0	5	3	5	3	6	10	2	1	12	7	4	2	0	0	3	2	1	3	4	5	0	0	79	Sep 30 Thursday

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	2166	1843	1815	1813	2040	2093	2343	2666	2544	2671	3224	2892	2556	2683	2850	2858	2813	2730	2567	2481	2299	2036	1919	2104	58034	Total sum
183	12	10	10	10	11	11	13	15	14	15	18	16	14	15	16	16	15	15	14	14	13	11	10	11	317	Total average
125	11	10	9	10	12	12	13	15	13	13	16	16	14	14	16	16	15	16	14	12	11	9	9	10	306	Average workdays
58	13	11	11	10	9	10	13	14	15	18	20	14	14	16	15	15	15	14	15	16	17	15	14	14	338	Average weekends

Table 3.5.6. Daily and hourly distribution of Spitsbergen 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)

3.6 IMS operation

The Intelligent Monitoring System (IMS) 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 IMS 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, FINESA and GERESS started on 15 October 1991. As opposed to the first version of IMS, the one in current operation also locates events at teleseismic distance.

On 14 December 1992, phase detections from the Apatity array were included in the automatic phase association. The phase detections from the Spitsbergen array were made available to the analysts on 5 February 1993. These detections are not used in the automatic phase association, but can be added manually during analysis.

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

Phase and event statistics

Table 3.6.1 gives a sumary of phase detections and events declared by IMS. From top to bottom the table gives the total number of detections by the IMS, the number of detections that are associated with events automatically declared by the IMS, the number of detections that are not associated with any events, the number of events automatically declared by the IMS, 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 IMS)

U. Baadshaug
B. Ferstad
B.Kr. Hokland
L.B. Loughran
B. Paulsen

	Apr 93	May 93	Jun 93	Jul 93	Aug 93	Sep 93	Total
Phase detections	54641	78795	67666	57248	59054	57115	374519
-Associated phases	8757	7376	6206	6395	6785	6749	42268
-Unassociated phases	45884	71419	61460	50853	52269	50366	332251
Events automatically declared by IMS	2500	2206	1935	1914	1981	2030	12566
No. of events defined by the analyst	2084	1664	1495	1542	1687	1754	10226
No. of events accepted without modifications	1549	1336	1267	1287	1378	1354	8171

Table 3.6.1. IMS phase detections and event summary.

3.7 ESAL time-lag statistics

During two years of continuous operation, the operational performance of the IMS Expert System for Association and Location (ESAL) has in general been very good. When data are available from all arrays, and all EP-SigPro processes are working normally, ESAL processes phase detections at close to real-time speed.

From time to time, however, some process that provides ESAL with input data will fail or slow down and ESAL will fall behind real-time, waiting for the detections to become available. The Chinese test explosion on 5 October 1993, for example, was not defined until 8 hours after the event occurred because the processing of ARCESS detections was behind.

To monitor to what degree ESAL keeps up with real-time, recording of time-lag was started.

Every ten minutes, the UNIX system time (based on a GPS satellite clock) is written to a file together with the detection time last processed by ESAL (found in the timestamp database table). Once a week, the results are plotted and for each peak in the plot, an explanation is sought.

The first three of these weekly plots are displayed in Figs. 3.7.1 - 3.7.3

The sawtooth appearance of the plots is a result of the way phase detections are processed in the IMS: Each array has a separate EP-SigPro process which extracts detection parameters and writes them to a SIGPRO database common to all arrays. Once an hour, the database used by ESAL. ESAL wakes up every 30 minutes, reads the new phase detections, defines events from them and goes back to sleep for another 30 minutes. There is therefore an inherent delay of up to 90 minutes in the processing scheme. In addition, some time is spent by EP-SigPro processing each detection before it is written to the database and lastly, ESAL processes all the detections in the batch before it updates the timestamp database table. As can be seen in the plots the combined effect is that ESAL during normal operation stays between approximately 30 minutes and 2 hours behind real-time.

The plots also show examples of several different reasons for time-lag peaks: Computer hardware errors, missing data, too many detections and software stops. In the following, a detailed explanation of the reason for each peak is provided

Oct 12-13: The number of ARCESS phase detections rose from 20-50 per hour to 150-200 for a 4 hour period. This was probably caused by a temperature-fall and ice-cracking. The extra processing load was too much for the computer running the Ep-SigPro process and ESAL had to wait for the detections to become available.

Oct 14-16: Too many detections at the Apatity array. The extra, top peak on Oct 15 came from a hardware-error on an IMS computer (a broken CPU on njaard). All IMS processes were shut down while the machine was being repaired.

Oct 17: No data available from GERESS. The transmission line from Germany was down. Since GERESS data are also recorded in Bochum, the missing data could be retrieved when the line came back up. For arrays without local recording, data are lost totally when the line goes down. This is apparent in the ESAL time-lag plots: When the data transmission comes back (Oct17-Oct18) the delayed data has to be processed and there is a slowly descending, saw-toothed line. If ESAL had been waiting for data from an array with no local recording, there would be no data to process and ESAL could have proceeded with the other already-processed arrays. (This is seen as a straight, sharp drop as on Oct 28 when ARCESS came back after an outage.)

Oct 18-19: No data from the Apatity array because of problems related to positioning the satellite antenna in Apatity. To bring the ESAL-processing forward, it was decided on Oct 19 to leave Apatity temporarily out of the IMS-processing. This accounts for the sharp drop on Oct 19.

The second, smaller peak late on Oct 19 is due to a stop in the ARCESS EP-SigPro processing. The reason for the stop is not clear, but may have been caused by bad data.

Oct 20: The GetArrivals program failed on two consecutive invocations, no detections were transferred from the SIGPRO- to the IMS-database for three hours. The reason is unknown but probably database-related.

Oct 21-23: The satellite antenna problem in Apatity had been fixed. It was decided to include the Apatity array in the IMS processing again. ESAL moved slowly forward while the missing data were being retrieved from the local disk-loop in Apatity and processed.

Oct 24: A full day of continuous, error-free processing.

Oct 24: A full day of continuous, error-free processing.

Oct 25: ESAL stopped. Aborted in a time-interval where no events were defined.

Oct 26: Delayed GERESS data. Data-transmission from Germany down.

Oct 27-28: ARCESS data acquisition computer hardware error. (Faulty disk-controller on rein). The data that were not recorded during repair were lost. No processing required.

Oct 28-30: Large number of Apatity detections due to local disturbances and radio link problems.

Oct 31-Nov 1:Close to ideal processing. No major delays.

This exercise of closely monitoring the ESAL time-lags provides considerable insight into the complexity of the task of keeping a system like IMS running at close to real-time. Considering the experimental and research-oriented role of the IMS operation, the priority is, for the time being, on collecting data from all arrays before doing the network association and event location. This strategy may, however, change with changing operational requirements.

U. Baadshaug

3.8 GBF operation

Events automatically located by GBF

The automatic GBF processing was temporarily discontinued for a period of 47 days during the reporting period, but was otherwise run on a continuous basis.

During days 091 through 180, and 222 through 267, 1993, 8445 local and regional events were located by GBF. This gives an average of 62.0 events per processed day (136 days processed). 69% of these events are within 300 km of the nearest station, and 84% of these events are within 1000 km of the nearest station.

72.2% of these events were defined by 2 regional phases. Teleseismic phases are currently not used by GBF. 88.8% of all events had 3 defining phases or less.

T. Kværna

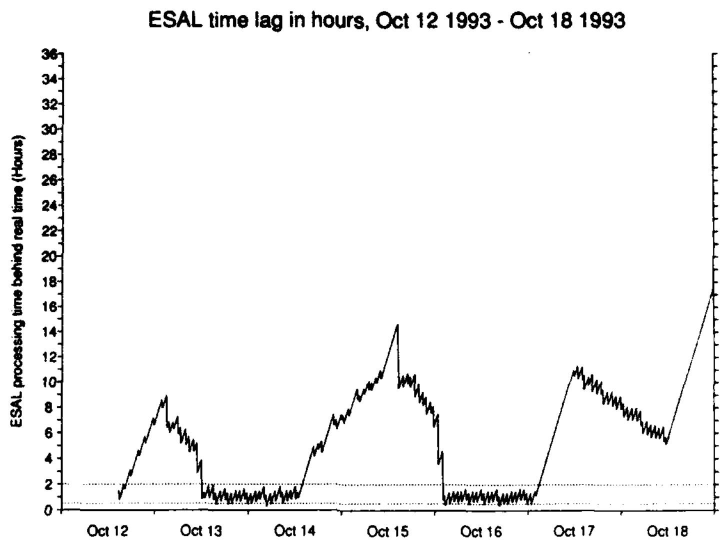

Fig. 3.7.1.

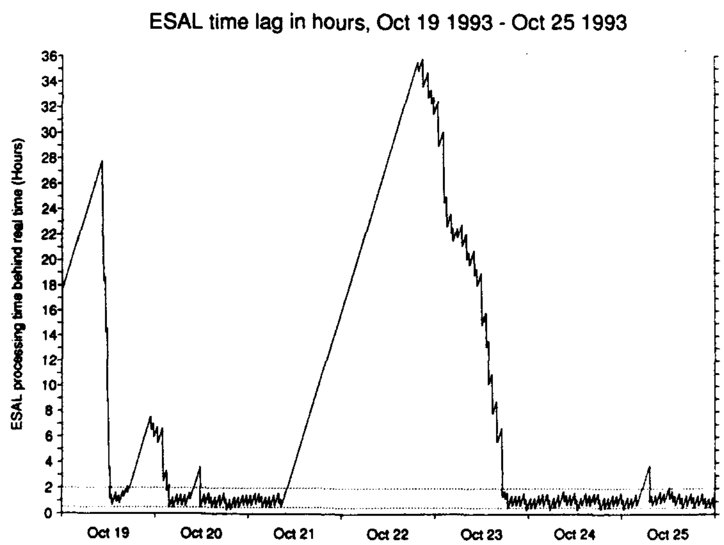

Fig. 3.7.2.

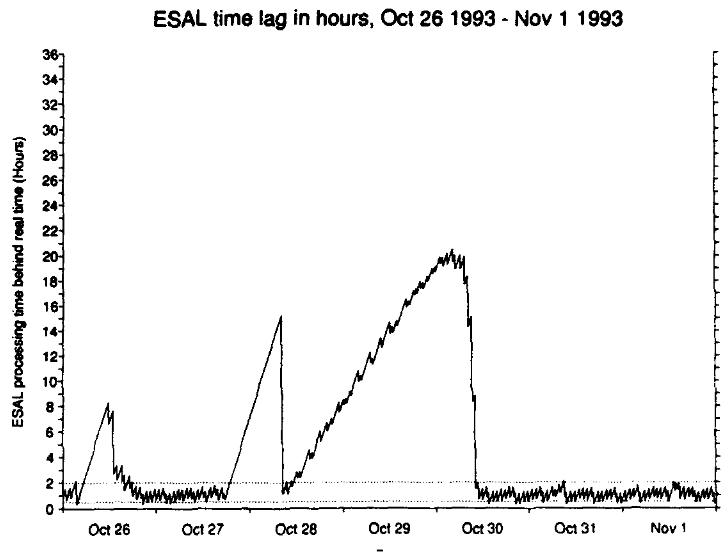
ESAL time lag in hours, Oct 26 1993 - Nov 1 1993
ESAL processing time behind real time (Hours)
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Oct 26
Oct 27
Oct 28
Oct 29
Oct 30
Oct 31
Nov 1

Fig. 3.7.3.

4 Improvements and Modifications

4.1 NORSAR

NORSAR data acquisition

No modification has been made to the NORSAR data acquisition system.

The data are recorded on a 30-hour circular disk buffer on the IBM system, and archived onto 1/2 inch magnetic tapes. In addition to this, the data are now regularly transmitted to a SUN system for recording on a 48-hour circular disk buffer.

The data from the 7 subarrays are transmitted over 2400 bps leased lines between the Short and Long Period Electronic Modules (SLEMs) in the subarray vaults and a Modcomp computer at NDPC. Severe problems have occurred with the communications, and have led to problems with data quality and timing. An independent process has been developed which samples a time pulse to automatically control the timing of the old NORSAR system.

The transmission between IBM and SUN has also experienced problems due to old transmission devices. Thus all new processes developed for NORSAR data may be delayed due to malfunctions of the IBM-to-SUN communication processor.

NORSAR detection processing

The NORSAR detection processor has been running satisfactorily on the IBM 4381 computer during this reporting period.

Detection statistics are given in section 2. In addition to the detection processing done on IBM, the DP program is doing regular detection processing on a SUN system, using the unix-based circular disk buffer (see below). A detection SNR threshold of 20.0 triggers automatic saving of waveforms into CSS 3.0 data files.

NORSAR event processing

There have been no changes in the routine processing of NORSAR events, using the IBM system.

In parallel with the IBM processing, routine event processing is also done on a SUN computer using the "old" IBM time delay correction data base that has been converted to SUN/UNIX. The automatic solutions produced are equal to or better than the old system with a lower false alarm rate. Alert messages are sent to USGS for events above magnitude 5.5.

NORSAR refurbishment

We have purchased 6 AIM24-1 digitizers and one AIM24-3 digitizer from Science Horizons. These 7 digitizers together with 7 GPS clocks have been installed in the subarray

06C vault. We are successfully recording data at NDPC using an experimental VSAT communication link. Details on the refurbishment effort are reported on separately.

Both short period and long period instruments of the current system are functioning well, although the long period instruments require a high amount of manual calibration. The most critical part of the old NORSAR system is the data acquisition system, in particular the disks, the Modcomp communication processor and the telecommunication lines. The refurbishment project was delayed due to lack of suitable digitizers, but it now seems to be possible to operate the AIM24 digitizers at the remote sites of the NORSAR array. After a long-term field test, we may be ready to start installation of a new data acquisition system starting summer 1994.

4.2 Regional Arrays

Detection processing

The routine detection processing of the arrays is running satisfactorily on each of the array's SUN-3/280 or Sparcstation 1 acquisition systems. The same program is used for NORSAR, NORESS, ARCESS, FINESA, GERESS, the Apatity and Spitsbergen arrays, but with different "recipes". The beam table for NORESS and ARCESS is found in NORSAR Sci. Rep. No. 1-89/90. The beam table for FINESA and GERESS is found in NORSAR Sci. Rep. No. 1-90/91. The beam table for the Apatity array is found in NORSAR Sci. Rep. No. 1-92/93, and that for the Spitsbergen array is found in NORSAR Sci.Rep. No. 2-92/93.

Detection statistics are summarized in section 3.

Signal processing. Phase estimation

This process performs f-k and polarization analysis for each detection to determine phase velocity, azimuth and type of phase, and the results are put into the ORACLE detection and arrival tables for use by the IMS.

Event Processing. Plot and epicenter determination

A description of single-array event processing is found in NORSAR Sci. Rep. No. 2-88/89, and NORSAR Sci. Rep. No. 2-89/90.

J. Fyen

5 Maintenance Activities

5.1 Activities in the field and at the Maintenance Center

This section summarizes the activities at the Maintenance Center (NMC) Hamar, and NDPC activities related to monitoring and control of NORSAR, including monitoring of NORESS, ARCESS, FINESA, GERESS and the Apatity and Spitsbergen arrays.

Activities involve preventive and corrective maintenance, planning and activities related to NORSAR refurbishment (NMC/06C). Preparation of a miniarray in Amderma, Russia, involved assembling a 6-channel array (with NMC-produced amplifiers). In August 1993 P.W. Larsen (NMC) joined a delegation to Russia, where they visited Dubna near Moscow and Peleduy in Siberia in connection with array siting surveys.

The Spitsbergen installation was completed in September 1993.

NORSAR

Visits to subarrays in connection with:

- Replacement of RA-5 card
- Replacement of MP motors
- Replacement of FP motors
- Adjustment of LP seismometers, VE/NS/EW
- Adjustment of gain SP/LP channels
- Cable location
- Cable splicing
- NTA/Hamar assistance (communications check)
- Demounting six telemetry stations
- Line/modem checks
- Installation of data acquisition equipment in connections with NORSAR refurbishment

NMC

- NORSAR refurbishment preparations
- Preparation of a miniarray for Amderma in Russia, involving assembly of a six-channel array (dispatched to Russia in June 1993)
- NGI (Norwegian Geotechncal Institute) survey (PWL) at Kjeller in connection with preparation of a 3-component noise study
-

NORESS

- Adjustment of offset site D8
- Fiber optical link repair

Spitsbergen

- **Installation completion**

Subarray/ area	Task	Date
NORSAR		
	No visits to subarray	April
NORESS	Adjustment of DC offset site D8	20 Apr
NMC	Preparations for the NORSAR refurbishment, involving testing of different seismometers and digitizers.	April
NPDC	Daily checks of the following arrays have been carried out, i.e., NORSAR, NORESS, ARCESS, FINESA, GERES, Apatity and Spitsbergen. SP/LP instruments have been calibrated (NORSAR). Free Period (FP) and Mass Pos. (MP) were measured. Those outside specifications adjusted (when feasible from NDPC).	April
NORSAR		
03C	Assisted the landowner in pointing out a cable in the SP point 00 area	28 May
NMC	NORSAR refurbishment continued	May
NDPC	Daily checks of the following arrays have been carried out, i.e., NORSAR, NORESS, ARCESS, FINESA, Apatity and Spitsbergen (partly). SP/LP instruments have been calibrated (NORSAR), excl. week 20. FP/ MP were measured. Those outside specifications adjusted (when feasible from NDPC).	May
NORSAR		
02B	Replaced RA-5 amplifier SP ch 01	2 June
02B	Replaced MP-motor vertical seismometer	30 June
02B	Replaced MP/FP motor NS seismometer	30 June
ARCESS	NMC-staff installed a new air-condition unit	4-8 June
NMC	The Amderma miniarray prepared at the NMC dispatched to Russia	June

Subarray/ area	Task	Date
NDPC	Daily checks of the following arrays have been carried out, i.e., NORSAR, NORESS, ARCESS, FINESA, Apatity and Spitsbergen. SP/LP instruments were calibrated (NORSAR), excl. week 26. FP/ MP were measured. Those outside specifications adjusted (when feasible from NDPC).	June
NORSAR		July
04C	SP03 dead due to a bad cable. Checked gain of the remaining SP channels. Adjusted VE/EW LP seismometer. Not able to operate NS seismometer	1 July
01B	SP02 was dead due to a bad cable. Adjusted MP/FP VE/NS/ EW LP seismometer	2 July
04C	Spliced cable SP03	5 July
01B	Spliced cable SP02	7 July
02C	Replaced RA-5 SP01	8 July
02C	Assisted NTA/Hamar in connection with a communications check. Also checked LP-channels	9 July
04C	Replaced MP/FP motors (RCDs), NS and EW LP seismometers	26,27 July
NMC	P.W. Larsen (NMC) took part in a survey at Kjeller 28 July in connection with preparing a 3-component noise study installation.	28 July
NDPC	Daily checks of the following arrays have been carried out, i.e., NORSAR, NORESS, ARCESS, FINESA, Apatity and Spitsbergen. SP/LP instruments were calibrated (NORSAR), excl. weeks 30, 31. FP/ MP were measured. Those outside specifications adjusted (when feasible from NDPC).	July
NORSAR		August
02B(telem.)	Demounted the six telemetry stations and brought the equipment to the NMC	August
02B	Line check. Adjusted gain SP-channels 1, 2, 4 and 5	11 Aug
01A	Line check	31 Aug
NORESS	Repaired fiber optic link D3	25 Aug

Subarray/ area	Task	Date
NMC	In conection with NORSAR refurbishment, Science Horizons data acquisition equipment was installed in the 06C CTV.	August
	P.W. Larsen visited Dubna near Moscow in connection with plans for upgrading the existing Peleduy station.	9-20 Aug
NDPC	Daily checks of the following arrays have been carried out, i.e., NORSAR, NORESS, ARCESS, FINESA, Apatity and Spitsbergen. SP/LP instruments were calibrated (NORSAR), excl. week 32.. FP/ MP were measured. Those outside specifications adjusted (when feasible from NDPC), excl. week 32.	August
NORSAR		September
01A	Repaired SP04 cable	16,17,27, 29 Sept
02B	Repaired SP03 dable	16,17,27, 29 Sept
01A	Replaced RA-5 SP03	21 Sept
01A	Pointed out a cable for the power company. Adjusted ch. gain SP03 and LP/NS seismometer. Adjusted MP all LP instruments	30 Sept
02B	Replaced Remote Centering Device (RCD), EW MP/FP	14 Sept
02B	Replaced damping coil EW seismometer	15 Sept
02B	Adjusted ch. gain sp ch 1, 4 and LP vertical channel	20 Sept
02B	Adjusted MP and FP all LP seismometers. Soldered bad contact on data coil vertical LP seismometer	20 Sept
06C	Cable sp03 spliced. Adjusted ch. gain sp ch 1, 3 and all LP channels. Adjusted MP and FP all seismometers	10 Sept
ARCESS	Repaired fiber optical link A2, A3, B2, B4, C2, D6 and D7	7-9 Sept
Spitsbergen	Installation completed. Cables have been laid down to the remote sites A1, A2 and B3. Only sites A0, A2, B2, B4 and B5 have good instruments. The remaining were damaged during transport.	1-6 Sept

Subarray/ area	Task	Date
NPDC	Daily checks of the following arrays have been carried out, i.e., NORSAR, NORESS, ARCESS, FINESA, Apatity and Spitsbergen. SP/LP instruments were calibrated (NORSAR), excl. week 37. FP/ MP were measured. Those outside specifications adjusted (when feasible from NDPC), excl. week 37.	September

Table 5.1. Activities in the field and the NORSAR Maintenance Center, including NDPC activities related to NORSAR, NORESS, ARCESS, FINESA, GERESS and the Apatity and Spitsbergen arrays 1 April - 30 September 1993.

5.2 Array status

As of 30 September 1993 the following NORSAR channels deviated from tolerances:

01A	01	8 Hz filter
	02	8 Hz filter
	04	30 dB attenuation
01B		Out of operation
02B	07	
	08	
	09	
02C		Out of operation
03C	04	
	08	
04C	08	
06C		Subarray out of operation from 27 September.

O.A. Hansen

6 Documentation Developed

Fyen, J. and S. Mykkeltveit (1993): Observations at NORSAR of the 22 September 1993 NPE/CKE explosion at the Nevada Test Site, in *Semiann. Tech. Summ. 1 Apr - 30 Sep 93*, NORSAR Sci. Rep. 1-93/94, Kjeller, Norway.

Fyen, J. and F. Ringdal (1993): The Lop Nor nuclear explosion of 5 October 1993, in *Semiann. Tech. Summ. 1 Apr - 30 Sep 93*, NORSAR Sci. Rep. 1-93/94, Kjeller, Norway.

Kværna, T. (1993): Accurate determination of phase arrival times using autoregressive likelihood estimation, Proc. Erice Workshop, Italy, Nov 93.

Kværna, T. (1993): A generic algorithm for accurate determination of P-phase arrival times, in *Semiann. Tech. Summ. 1 Apr - 30 Sep 93*, NORSAR Sci. Rep. 1-93/94, Kjeller, Norway.

Kværna, T. and F. Ringdal (1993): Intelligent post-processing of seismic events, Proc. Erice Workshop, Italy, Nov 93.

Ringdal, F. and T. Kværna (1993): Continuous threshold monitoring of the Lop Nor, China, test site, in *Semiann. Tech. Summ. 1 Apr - 30 Sep 93*, NORSAR Sci. Rep. 1-93/94, Kjeller, Norway.

Ringdal, F. and T. Kværna (1993): Generalized Beamforming as a tool in IDC processing of large earthquake sequences, in *Semiann. Tech. Summ. 1 Apr - 30 Sep 93*, NORSAR Sci. Rep. 1-93/94, Kjeller, Norway.

Ringdal, F., T. Kværna and B.Kr. Hokland (1993): Onset time estimation and location of events in the Khibiny Massif, Kola Peninsula, using the Analyst Review Station, in *Semiann. Tech. Summ. 1 Apr - 30 Sep 93*, NORSAR Sci. Rep. 1-93/94, Kjeller, Norway

Semiannual Tech. Summary, 1 Oct 92 - 31 Mar 93, NORSAR Sci. Rep. 2-92/93, NORSAR, Kjeller, Norway.

7 Summary of Technical Reports / Papers Published

7.1 Continuous threshold monitoring of the Lop Nor, China, test site

Introduction

The continuous threshold monitoring technique (Ringdal and Kværna, 1989) represents a new approach toward achieving reliable seismic monitoring for the purpose of verifying nuclear test ban treaties.

Traditionally, seismic monitoring has relied upon applying signal detectors to individual stations within a monitoring network, associating detected phases and locating possible events in the region of interest. This procedure has been accompanied by assessments of network capabilities for the target region, usually by applying statistical models for the noise level distribution, introducing station corrections for signal attenuation and devising a combinational procedure to determine the detection threshold as a function of the number of phase detections required for reliable location.

The statistical noise models used in these capability assessments are not able to accommodate the effect of interfering signals, such as the coda of large earthquakes, which may cause the estimated thresholds to be quite unrealistic at times. Furthermore, only a statistical capability assessment is achieved, and no indication is given as to particular time intervals when the possibility of undetected clandestine explosions is particularly high.

The continuous threshold monitoring technique alleviates these problems. It makes it possible to ascertain, at any point in time, for a given target region, the maximum magnitude of a possible clandestine explosion at a predefined level of confidence. This makes it possible to focus attention upon those specific time intervals when realistic evasion opportunities exist, while retaining confidence that no treaty violation has occurred at other times.

The continuous threshold monitoring technique has previously been applied experimentally in connection with the Novaya Zemlya test site (Ringdal and Kværna, 1992; Kværna, 1992). This test site is within regional distance of the Fennoscandian arrays, and consequently an excellent monitoring capability ($m_b \sim 2.5$) has been achieved for this site.

Application to the Lop Nor test site

In order to further demonstrate how continuous threshold monitoring could be performed in a practical operation situation, we have conducted an experiment during which we have applied continuous threshold monitoring to the Chines test site at Lop Nor for a five-day period. Our data base has been the regional array network NORESS, ARCESS and GERESS. As illustrated in Fig. 7.1.1, these three arrays are all at teleseismic distances from the test site, with excellent P-phase detection capabilities (see Fig. 7.1.2). In particular, the NORESS array has an excellent detection capability for this test site.

The parameters used in the threshold monitoring experiment are given in Table 7.1.1. For each array, we steer "optimum" P beams towards the test site, and calibrate these beams using actually observed signal attenuation from previous Lop Nor explosions. By focusing in this way on the target region, we can at any point in time measure the "noise magnitude" for a given phase at a given array, and combine these data to obtain a network threshold as explained in detail by Ringdal and Kværna (1989).

Results

Figs. 7.1.3-7.1.7 show the results of the monitoring experiment. Each of these figures covers one data day, starting 1 October 1993. The upper three traces of each figure represent the thresholds (i.e., 90% upper magnitude limits) obtained from the three individual arrays, whereas the bottom trace illustrates the network threshold. Typically, the individual array traces have a number of significant peaks for each 24-hour period, due to interfering events (local or teleseismic). On the network trace, the number and sizes of these peaks are greatly reduced, because an interfering event will usually not provide matching signals at all the stations. From probabilistic considerations, it can in such cases be inferred that the actual network threshold is lower than these individual peaks might indicate.

We will not discuss in detail the individual peaks on the network trace. Here, we will just note that on 2 October (day 275) an aftershock sequence occurred in the S. Sinkiang province. Furthermore, the last day, 5 October 1993, was the day of an actual nuclear explosion (m_b = 5.9) at Lop Nor, and this event naturally stands out on the plot. The peak value of the network threshold plot does not represent the actual magnitude of the event, but is slightly lower (see discussion below).

As a general comment to Figs. 7.1.3-7.1.7, we note that such plots are a useful supplement to the Intelligent Monitoring System (IMS) (Bache et al, 1993), and will enable the analyst to obtain an instant assessment of the actual threshold level of the monitoring network. The peaks on the network traces may be quickly correlated with the IMS detection bulletin, in order to decide whether they originate from interfering events or from events in the target region.

Discussion

In a monitoring situation, it will be important to isolate and analyze more extensively those time intervals which offer significant evasion opportunities. Table 7.1.2 gives a statistic of the number of occasions during which the upper magnitude limit exceeded a given level. In theory, if this limit is, e.g., at 4.0, it might be possible that a clandestine m_b = 4.0 explosion had occurred without being detected. There are many options available to investigate such a hypothesis in more detail, although we have not attempted to do so in this study. The most immediate approach would be to analyze high-frequency signals for the time interval being considered.

It is significant that the 3-array network studied in this paper can monitor the Lop Nor test site down to m_b 3.5 or below more than 99% of the time (Fig. 7.1.8). Further improvements would clearly be possible by adding more stations to the monitoring network, especially highly sensitive stations at other azimuths than those covered by the northern

European network. This would in particular contribute to lowering the peaks due to interfering events, whereas any event truly originating in the target region would of course still stand out clearly on the combined network traces.

As a final comment, we will address the apparent contradiction that the magnitude at the time of the nuclear explosion on the threshold trace is slightly lower than the actual event magnitude. In order to explain this, we recall that the network TM calculation assumes that a "hidden" signal is "less than or equal to" the actually observed trace value for each station. While this is a correction assertion for each individual station, it can create a bias if used in a network context, assuming that there is a detectable signal present.

Strictly speaking, this model should only be used during periods with non-detectable signals, or when detections occur from events outside the target area. If there is a detection that could possibly correspond to an event in the target region, "equal" should be used instead of "less than or equal". Hence, the "worst case" (upper 90% limit) magnitude in this case would be the 90 per cent quantile of the distribution for the maximum-likelihood m_b estimate.

If this philosophy is adopted in calculating the threshold traces, it will result in a slightly increased height of the peaks that are consistent (in azimuth and velocity) with events in the target region. The "background" threshold level will not change, and the peaks that can be confidently assigned to events in other regions will be reduced in the same way as before. The resulting threshold trace computations will be slightly more complex in those cases where peaks at individual stations occur.

The above considerations amplify the importance of using TM *in combination with* a conventional detection/location system. Used in this way, a detectable event will be processed in the conventional way, whereas upper magnitude limits of non-detectable events will be provided by the TM method.

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References

Bache, T.C., S.R. Bratt, H.J. Swanger, G.W. Beall and F.K. Dashiell (1993): Knowledge-based interpretation of seismic data in the Intelligent Monitoring System, *Bull. Seism. Soc. Am.*, 83, 1507-1526.

Kværna, T. (1992): Continuous seismic threshold monitoring of the northern Novaya Zemlya test site: Long-term operational characteristics; *Report PL-TR-92-2118*, Phillips Laboratory, Hanscom AFB, MA, USA.

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

Ringdal, F. and T. Kværna (1992): Continuous seismic threshold monitoring, *Geophys. J. Int.*, 111, 505-514.

Station	Phase	Tr. Time	App. Vel.	Azim.	Filter	Config.	STA_len.	Tim. Tol.	Sta_calib.
ARC	P	479.7	13.1	84.8	2-4Hz	A0,C,D	2.0	2.0	1.908
GER	P	550.5	16.1	67.1	0.8-2.8Hz	A0,C,D	2.0	2.0	2.023
NRS	P	530.5	19.1	78.1	1-3 Hz	A0,C,D	1.0	2.0	1.133

Tr. time	--	Travel time of phase
App. vel.	--	Apparent velocity from broadband F-K measurement
Azim.	--	Azimuth from broadband F-K mesurement
Filter	--	Cutoffs of bandpass filter (3rd order Butterworth)
Config.	--	Array configuration used in beamforming. A0,B,C means A0Z, B-ring and C-ring
STA_len.	--	STA length in seconds
Tim. tol.	--	Time tolerance when searching for maximum STA
STA_calib.	--	Calibration factor used when converting STA values (in quantum units) to magnitude Magnitude = log10(STA) + STA_calib.

Table 7.1.1. Parameters used in threshold monitoring experiment.

	Day-of-Year					Total
	274	275	276	277	278	
$m_b \geq 5.0$	0	2	0	0	1	3
$m_b \geq 4.5$	0	3	0	0	1	4
$m_b \geq 4.0$	0	8	0	1	1	10
$m_b \geq 3.75$	1	13	0	2	3	19

Table 7.1.2. Statistics of peaks in the network threshold traces.

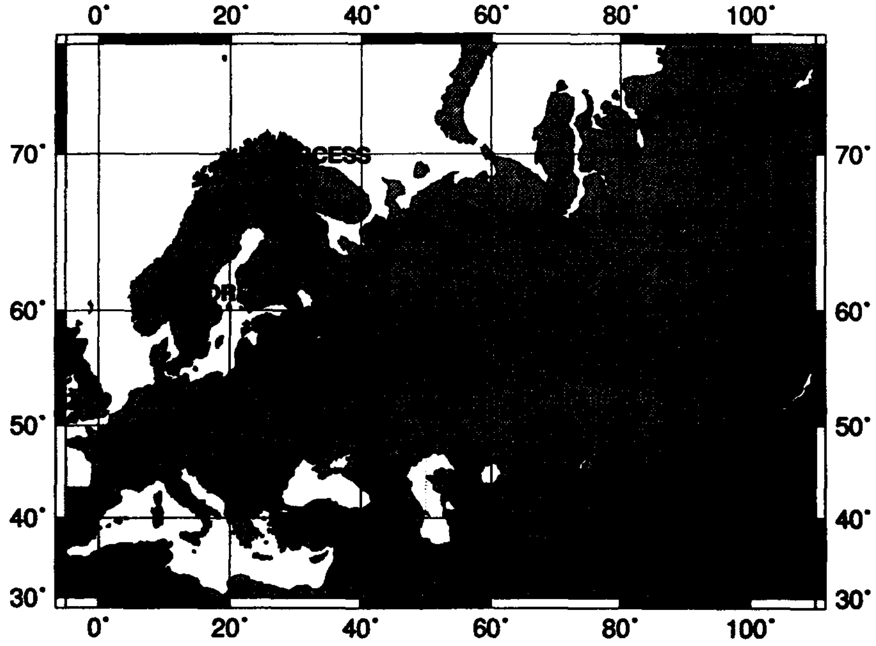

Fig. 7.1.1. Map showing the location of the Lop Nor test site and the three arrays used in the monitoring experiment.

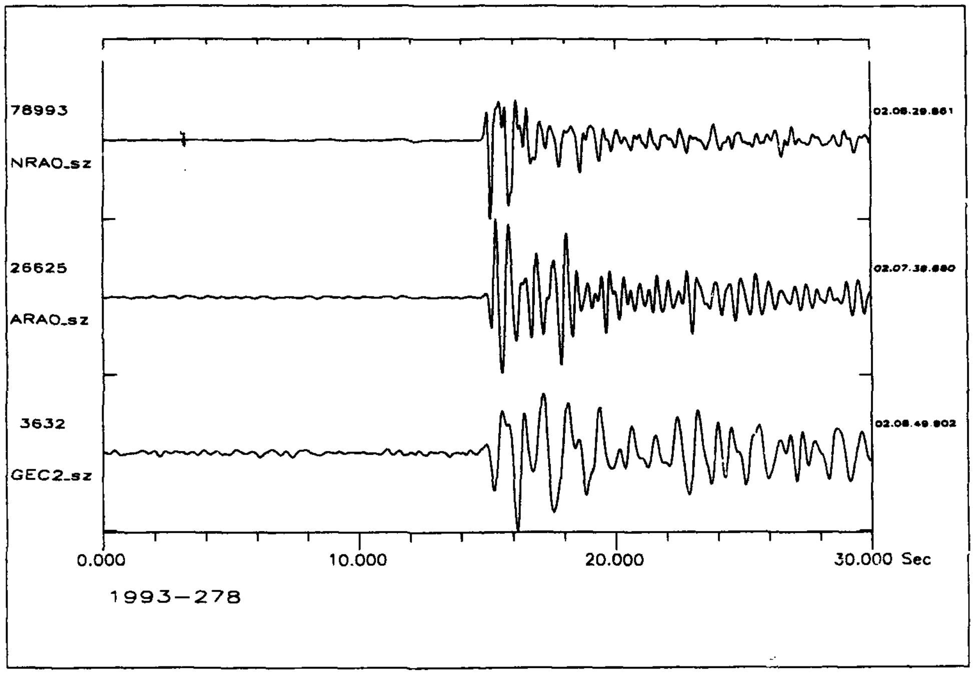

Fig. 7.1.2. NORESS, ARCESS and GERESS recordings of the Lop Nor explosion of 5 Oct 1993 ($m_b \approx 5.9$).

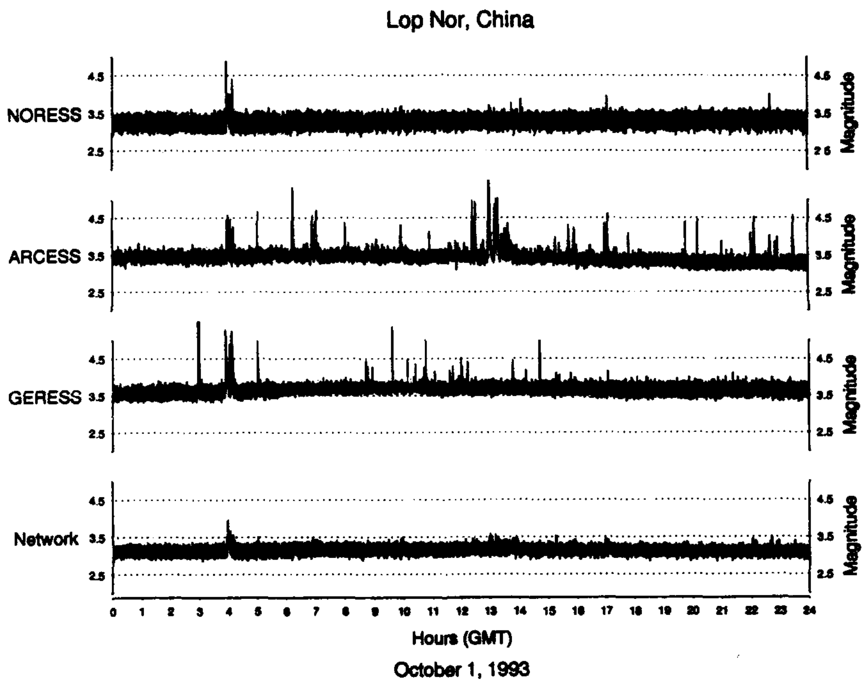

Fig. 7.1.3. Threshold monitoring of the Novaya Zemlya test site for day 274 (1 October 1993). The top three traces represent thresholds (upper 90 per cent magnitude limits) obtained from each of the three arrays (ARCESS, NORESS, GERESS), whereas the bottom trace shows the combined network thresholds.

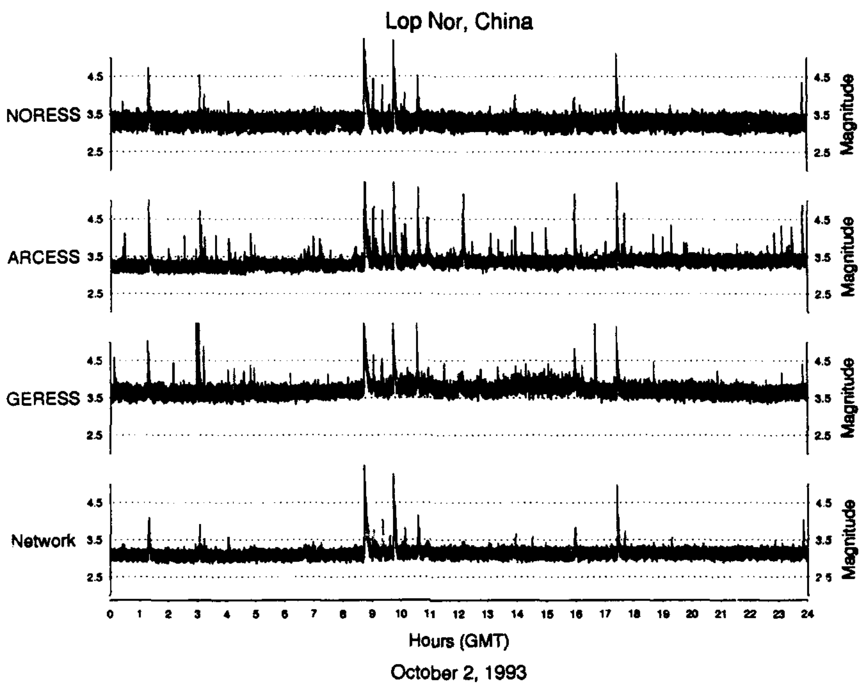

Fig. 7.1.4. Same as Fig. 7.1.3, but for day 275 (2 October 1993). The large number of threshold peaks are caused by an earthquake sequence in Sinkiang, China.

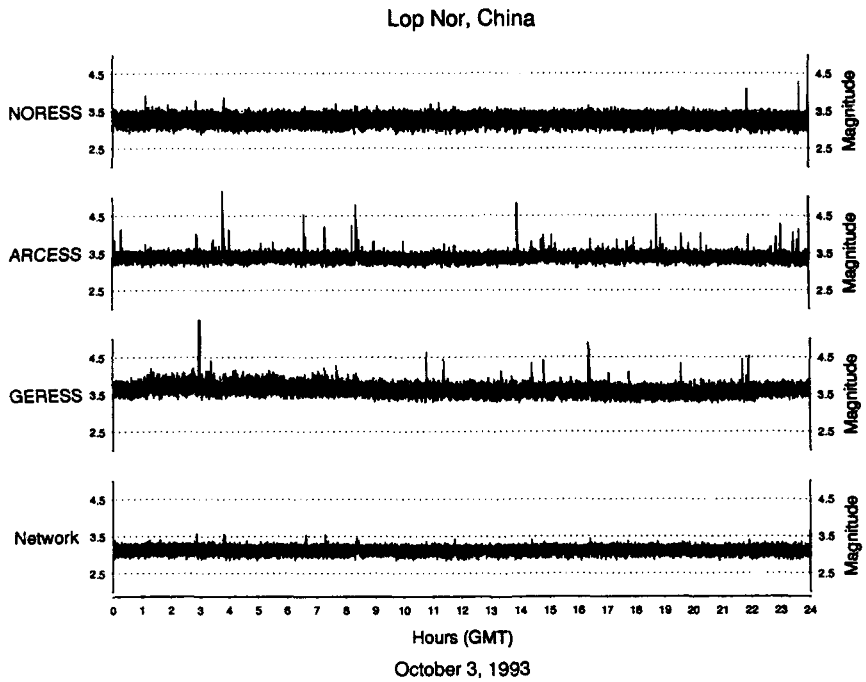

Fig. 7.1.5. Same as Fig. 7.1.3, but for day 276 (3 October 1993).

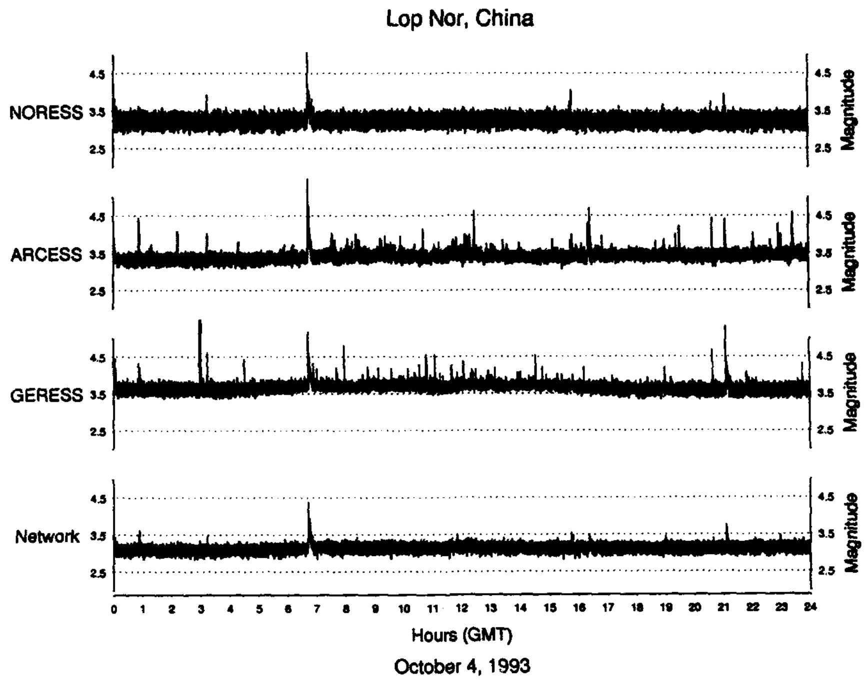

Fig. 7.1.6. Same as Fig. 7.1.3, but for day 277 (4 October 1993).

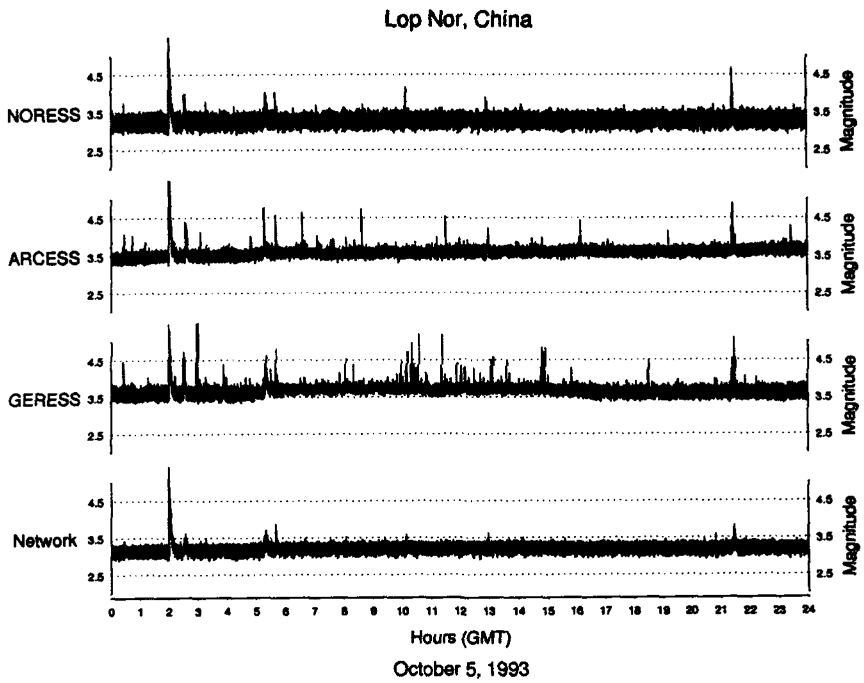

Fig. 7.1.7. Same as for Fig. 7.1.3, but for day 278 (5 October 1993). The threshold peak at 0200 hrs is due to the Lop Nor nuclear test.

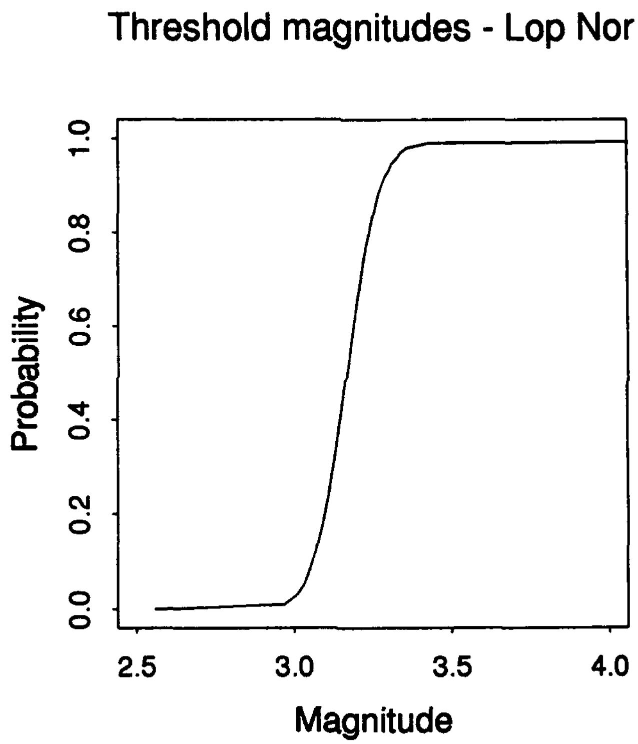

Fig. 7.1.8. Cumulative statistics of the network threshold magnitudes for the five-day period, 1-5 October 1993.

7.2 The Lop Nor nuclear explosion of 5 October 1993

Introduction

As described in Section 7.1, we conducted a threshold monitoring experiment for the Lop Nor test site in Southern Sinkiang, China, for several days prior to the 5 October nuclear explosion. A large earthquake and aftershock sequence occurred in the Southern Sinkiang province only three days before the explosion, and this gave an opportunity to make some interesting comparisons, elaborated upon in this study.

The Lop Nor nuclear explosion of 5 October 1993

The explosion took place on 5 October 1993, with origin time 02.00 GMT. Table 7.2.1 lists the basic parameters of the event as provided by various sources. The m_b magnitudes range from 5.65 to 5.90. The most accurate location is provided by the PDE bulletin, which uses a world-wide network for location purposes. The solutions by the Intelligent Monitoring System (IMS) (Bache et al, 1993), both automatic (IMS) and after analyst processing (ARS), are also listed. The NORSAR automatic and reprocessed solutions (based on the new SUN-based processing system) are included in the table. The SUN-based NORSAR trace plot is shown in Fig. 7.2.1.

Figs. 7.2.2 and 7.2.3 show plots of the interactive IMS processing results. The trace plots of Fig. 7.2.3 are based on array beams for the four arrays Apatity, ARCESS, NORESS, GERESS and a single channel (A0) for Spitsbergen. The FINESS array was not yet operational at the time of the explosion.

Table 7.2.2 summarizes the automatic processing results for the six arrays. The NORESS array has the best signal-to-noise ratio (1376.2) for this event, and by extrapolation this array would be expected to have a detectable signal for an event about 2.5 magnitude units lower. ARCESS and NORSAR also show outstanding SNR. The velocity/azimuth estimates are within the expected uncertainty for all arrays. Note that the Spitsbergen array is only partially installed, and this is reflected in its processing results.

Comparison with previous events

We now proceed to make a brief comparison between the 5 October 1993 explosion, the large 21 May 1992 explosion at the same site and the two largests events in the 2 October S. Sinkiang earthquake sequence.

Table 7.2.3 summarizes the PDE parameters for these four events. The 21 May 1992 explosion is comparable in m_b to the main shock of 2 October 1993, and the 5 October 1993 explosion is comparable to the 2 October 1993 aftershock. This similarity is illustrated by Fig. 7.2.3, which shows the NORESS P-wave recordings (A0Z seismometer) for the four events, all plotted to the same scale.

Fig. 7.2.4 show long-period recordings, from the NORESS broad-band seismometers for the four events. Again, the same scale is used in all four cases. The surface waves of the main earthquake have been "clipped" (for display purposes). This figure is very illustrative, and the following observations may be made.

- As expected, the main earthquake and the large May 1992 explosion have vastly different size of surface waves, in spite of their similar m_b value. Thus, discrimination based on M_s:m_b is simple in these cases.
- The October 1993 Lop Nor explosion can likewise be readily identified as an explosion on the basis of M_s:m_b at NORESS, either by measuring M_s on the "marginal" surface wave shown on Fig. 7.2.4, or by using "negative evidence" in the case of NORESS. In fact, the long-period "noise magnitude" is well below the expected M_s value for any earthquake of corresponding m_b value.
- The surface waves of the 2 October aftershock cannot be measured on NORESS recordings, and this event cannot be identified as an earthquake from NORESS data using M_s:m_b. The reason is the large coda level even one full hour after the main shock.

It has previously been found, on the basis of the GSETT-2 experiment (see section 7.6) that a modern network dominated by high-frequency arrays is very efficient in detecting aftershocks closely following large earthquakes (see also Ringdal, 1992). The reason is that the high-frequency coda drops very rapidly after the initial P onset, and the high-frequency arrays are able to exploit this drop-c ' in the detection processing. On the other hand, the long-period coda stays at a high level for many hours following large earthquakes, and no efficient methods have been found so far to suppress this coda sufficiently to extract very small surface waves. This is only one of many examples illustrating that the progress in recent years in seismic event detection has not been matched by a similar progress in event identification.

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References

Bache, T.C., S.R. Bratt, H.J. Swanger, G.W. Beall and F.K. Dashiell (1993): Knowledge-based interpretation of seismic data in the Intelligent Monitoring System, *Bull. Seism. Soc. Am.*, 83, 1507-1526.

Ringdal, F. (1992): GSETT-2 evaluation: Detection of aftershocks from the W. Caucasus earthquake of 29 April 1991, *Semiann. Tech. Summary, 1 Oct 91 - 31 Mar 92*, NORSAR Sci. Rep. 2-91/92, Kjeller, Norway.

Ref.	Origin time	Lat	Lon	mb
IMS (automatic)	01.59.59.7	41.386	89.619	5.65
ARS	01.59.54.8	41.110	89.371	5.65
NORSAR SUN (automatic)	02.00.01.0	42.449	89.195	5.88
NORSAR Rerun SUN	02.00.01.3	41.365	87.339	5.83
PDE	01.59.56.5	41.647	88.681	5.90

Table 7.2.1. Location estimates by various systems of the 5 October 1993 Lop Nor nuclear explosion. Two of the estimates were made automatically (indicated in the table).

Array	Onset time	Res	STA/LTA	Vel	Res	Azi	Res
NORESS	278:02.08.44.398	1.71	1376.2	16.8	2.36	77.5	1.4
ARCESS	278:02.07.54.320	2.66	566.7	14.3	0.66	82.2	-14.9
GERESS	278:02.09.04.350	2.62	121.9	17.5	2.71	65.8	-2.2
Apatity	278:02.07.28.750	2.16	177.3	14.8	1.50	103.3	0.9
Spitsbergen	278:02.08.23.900	3.35	37.2	7.9	-6.17	94.0	-2.9
NORSAR	278:02.08.44.800	1.48	408.9	14.5	0.05	77.4	1.3

Table 7.2.2. Automatic detection list for the Lop Nor nuclear explosion 05 October 1993. The columns show array name, automatic SigPro onset time, onset residual relative to PDE origin time, maximum signal-to-noise ratio (STA/LTA), apparent velocity (km/sec), residual in km/sec, back-azimuth in degrees, back-azimuth residual. All residuals are relative to predictions using IASPEI91 tables and PDE origin time and location.

Event	Ref.	Origin time	Lat	Lon	mb	Ms
Lop Nor 92	PDE	21 May 92 04.59.57.5	41.604	88.813	6.5	5.0
Lop Nor 93	PDE	05 Oct 93 01.59.56.5	41.647	88.681	5.9	4.8
Main shock	PDE	02 Oct 93 08.42.32.8	38.141	88.638	6.2	6.3
Aftershock	PDE	02 Oct 93 09.43.19.5	38.127	88.502	5.7	5.3

Table 7.2.3. PDE parameters for four events discussed in the text.

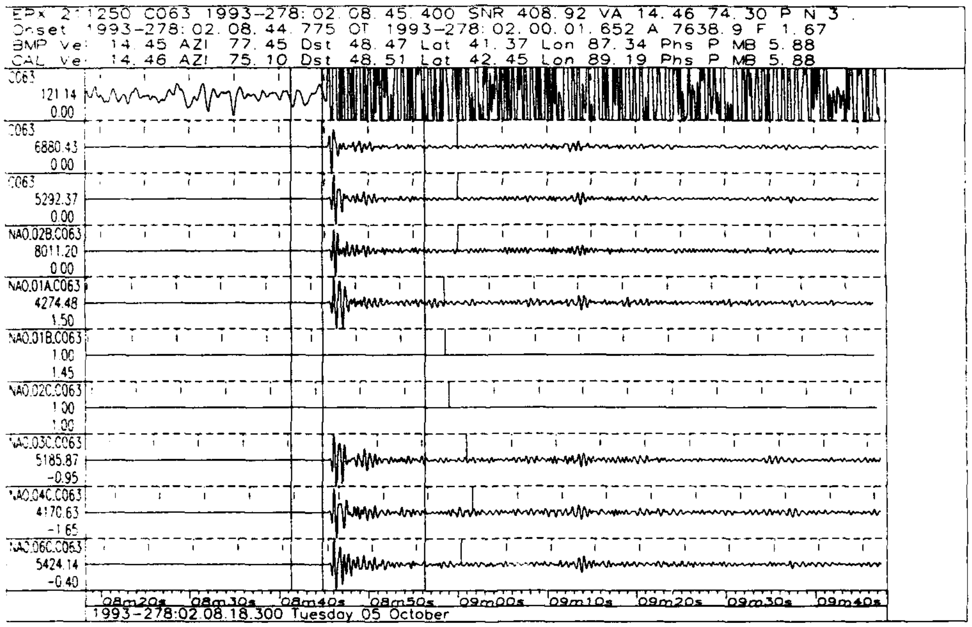

Fig. 7.2.1. Plot of the automatic NORSAR detection/event processor output for the nuclear explosion of 5 Oct 93.

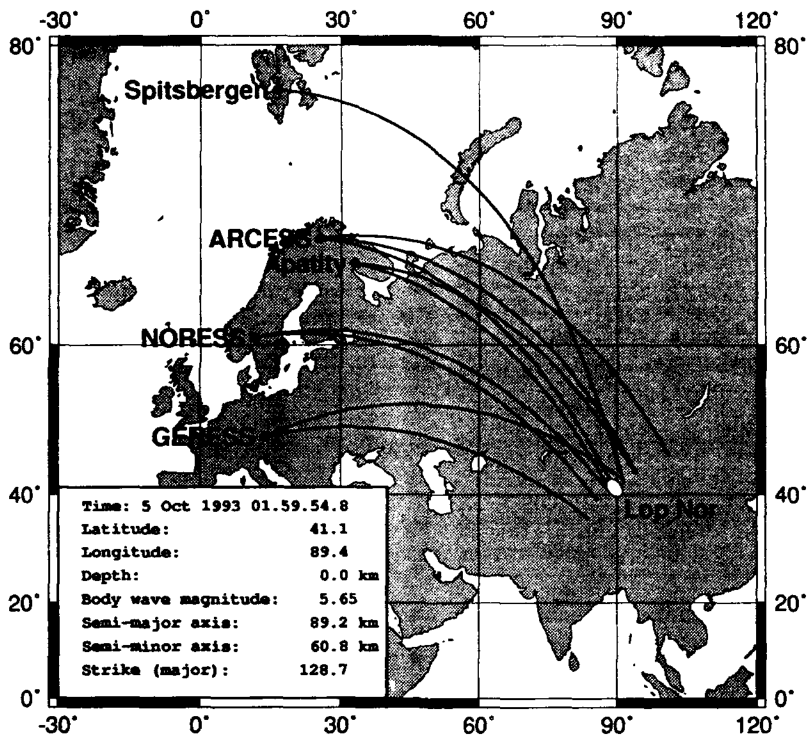

Fig. 7.2.2. Map showing the IMS solution (after analyst review) of 5 Oct 93 explosion. The great circle path for the detecting arrays (based on P and PcP estimated azimuths) are also shown.

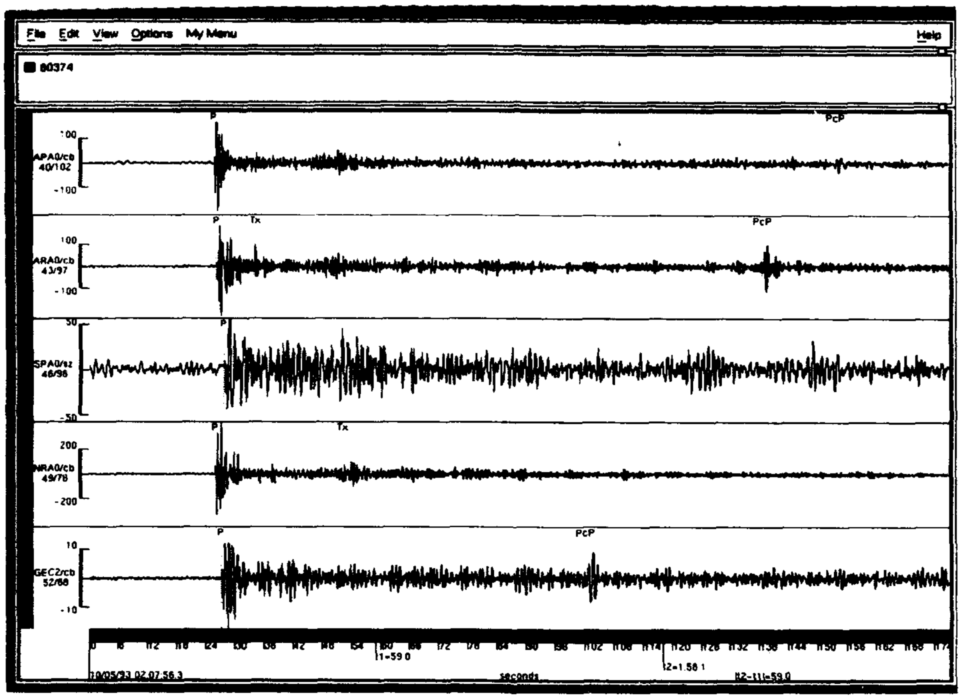

Fig. 7.2.3. P-phase waveforms of the 5 array SP traces (single sensor for Spitsbergen, otherwise array beams) for the 5 Oct 93 explosion.

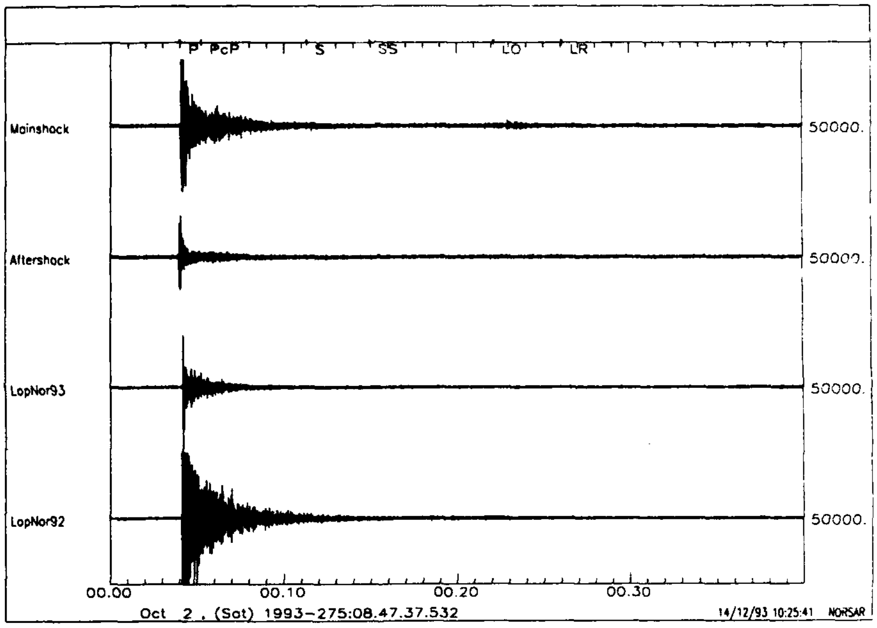

Fig. 7.2.4. NORESS P-waves (A0Z seismometer) for the four events discussed in the text. All traces are in the same scale. Note that, for display purposes, two of the traces have been "clipped".

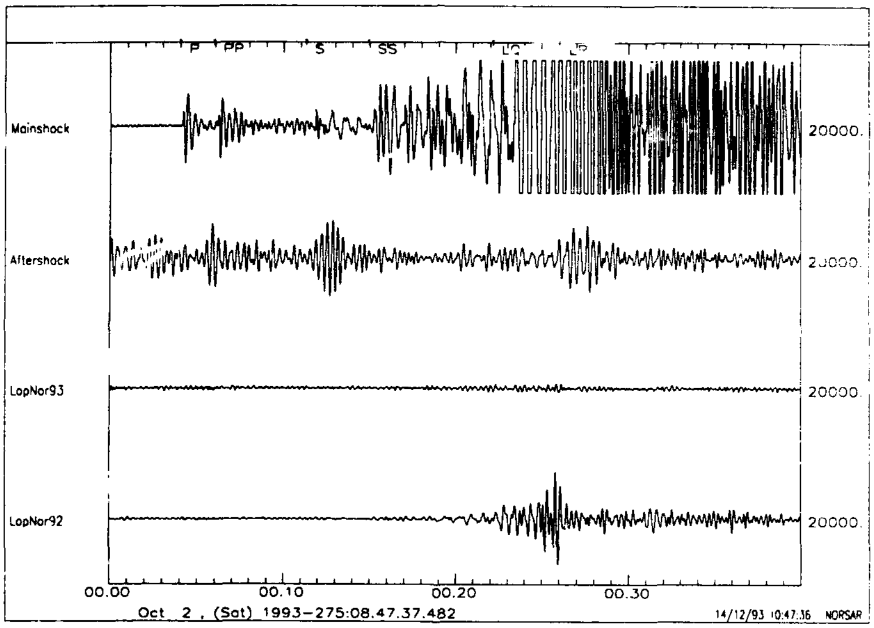

Fig. 7.2.5. NORESS surface waves (Broad-band seismometer) for the four events discussed in the text. All traces are in the same scale. Note that, for display purposes, the top trace has been "clipped".

7.3 Observations at NORSAR of the 22 September 1993 NPE/CKE explosion at the Nevada Test Site

Introduction

On 22 September 1993, the US Department of Energy detonated a one kiloton conventional explosion at the Nevada test site (NTS), in an experiment named the Non-Proliferation Experiment (NPE) (Springer, 1993). The experiment has also been referred to as the Chemical Kiloton Experiment (CKE). The experiment was conducted in the context of future CTBT/NPT monitoring, and it has the potential of providing data useful for discrimination between chemical and nuclear explosions. The NPE explosion was detonated in the N-tunnel in Rainier Mesa very close to the hypocenters of several previous nuclear explosions, some of which had yields similar to that of the NPE explosion. Through comparison with observations from previous shots at NTS, the NPE experiment should thus offer an opportunity to determine differences in characteristics of chemical and nuclear explosions.

The NPE explosion was recorded on many especially-deployed instruments in the local and regional distance range. Preliminary reports indicate that the shot was recorded with amplitudes that were in general larger than those that would be expected from a similar-size nuclear shot.

The NPE explosion was automatically detected and located by some of the arrays in northern Europe contributing data to the NORSAR Data Processing Center (NDPC). The purpose of this short contribution is to present relevant detection and event location data for these stations, and to make comparisons with observations for a nuclear test conducted at NTS in 1992.

Data analysis

The nuclear explosion that we will compare the NPE/CKE with is the explosion conducted at NTS on 18 September 1992 and referred to as "Hunters Trophy". According to the EDR of the USGS, this explosion was conducted at 17:00:00.008 GMT, at 37°12'24.93"N, 116°12'35.94"W, surface elevation 2239 m and depth of burial 385 m. Magnitude is given as m_b 4.4. The NPE/CKE explosion was conducted within 1 km of "Hunters Trophy" and at about the same depth of burial.

At the time of the "Hunters Trophy" explosion, NDPC received and processed automatically data from the NORSAR large-aperture array as well as the high-frequency arrays NORESS, ARCESS, FINESA and GERESS. At the time of the NPE/CKE event, data from two additional high-frequency arrays were available, namely, the arrays at Apatity and Spitsbergen. The FINESA array was not operational at the time of the NPE/CKE event, due to work related to a refurbishment of this array.

At NDPC all data are subject to standard detection processing including beamforming, filtering and estimation of STA/LTA ratios for signal detection (EP_SigPro processing). Tables 7.3.1 and 7.3.2 show automatic detection parameters for the "Hunters Trophy" and

NPE/CKE events, respectively. It is seen that the events are detected at NORSAR, NORESS and GERESS (and "Hunters Trophy" at FINESA) at distances ranging from 73 to 83 degrees. The high-frequency small-aperture NORESS array has not only the best SNR, but broadband frequency wave number analysis is capable of estimating back azimuth and apparent velocity about as well as the larger NORSAR array. It should be noted, however, that the automatic processing of the NORSAR array is using the full array. With site-specific processing using the "best" subarrays, NORSAR beam SNR can be improved. From Figs. 7. 3.1 and 7.3.2 we see that NORSAR subarray NC6 colocated with NORESS has a larger SNR than the other subarrays. However, for event location the full NORSAR array will be superior to that of individual subarrays. ARCESS detected neither of the two events. The NPE/CKE event was not detected on the Apatity nor the Spitsbergen array.

The data from the high-frequency arrays are processed using the Intelligent Monitoring System (IMS). Arrivals on the various arrays are automatically associated to form events at both local, regional and teleseismic distances. IMS results, as reviewed by the analyst, are given in Figs. 7.3.3 and 7.3.4. It can be seen that the event solution for "Hunters Trophy" is better than that for the NPE/CKE event. The main reason appears to be the fact that FINESA was not operational at the time of the NPE/CKE event. The m_b magnitudes as determined by IMS are 4.14 and 4.10, for the "Hunters Trophy" and NPE/CKE events, respectively.

Concluding remarks

The NORSAR, NORESS and GERESS arrays at epicentral distances ranging from 73 to 83 degrees all detected both the "Hunters Trophy" explosion and the NPE/CKE event automatically. The NPE/CKE event was recorded with amplitudes that were only slightly smaller (generally by 0.1 m_b units) than those of "Hunters Trophy" (see e.g. Figs. 7.3.1 and 7.3.2, where the scaling factors to the left of the traces can be directly compared for the two events. Amplitudes at NORESS can be compared through the scaling factors in Fig. 7.3.5.) With an m_b of 4.4 as given by USGS for "Hunters Trophy", it is clear that also NORSAR's recordings of the NPE/CKE event confirm that this one kiloton conventional explosion produced amplitudes somewhat larger than those expected from a one kiloton fully contained nuclear explosion.

As expected, the signals recorded at NDPC for these two events had SNRs that were too low to permit meaningful attempts at discriminating between their nuclear and chemical origins through analysis of signal characteristics. This is illustrated in Fig. 7.3.5, which shows the optimum beams at NORESS for these two events.

J. Fyen
S. Mykkeltveit

References

Springer, D.L. (1993): The Non-Proliferation Experiment (NPE): Preliminary Status Report. Presentation given at GSETT-3 Workshop, Erice, Italy, 11-13 November 1993.

Array	Onset time	Res	STA/LTA	Vel	Res	Azi	Res
NORSAR	262:17.11.31.631	-0.83	4.8	17.7	-1.04	320.9	2.4
NORESS	262:17.11.33.970	-0.47	7.9	17.5	-1.36	323.3	4.5
ARCESS	No detection						
FINESA	262:17.11.53.250	-1.57	4.5	28.8	9.06	316.8	-13.1
GERESS	262:17.12.29.348	-0.21	5.8	18.9	-2.74	21.8	59.9
Apatity	Not installed						
Spitsbergen	Not installed						

Table 7.3.3. ***Automatic*** detection information for the "Hunters Trophy" event of 18 September 1992. The columns show array, automatic EP_SigPro onset time, onset time residual, detection STA/LTA, apparent velocity in km/s, residual in km/s, back azimuth in degrees and back azimuth residual. All residuals are relative to the IASPEI91 travel time tables and USGS event parameters.

Array	Onset time	Res	STA/LTA	Vel	Res	Azi	Res
NORSAR	265:07.12.32.608	0.09	3.5	17.6	-1.21	322.9	4.6
NORESS	265:07.12.34.212	-.028	6.7	15.9	-2.98	323.4	4.8
ARCESS	No detection						
FINESA	Not operational						
GERESS	265:07.13.29.073	-0.32	5.2	13.0	-8.67	342.5	20.7
Apatity	No detection						
Spitsbergen	No detection						

Table 7.3.2. ***Automatic*** detection information for the NPE/CKE event of 22 September 1993. The columns show array, automatic EP_SigPro onset time, onset time residual, detection STA/LTA, apparent velocity in km/s, residual in km/s, back azimuth in degrees and back azimuth residual. All residuals are relative to the IASPEI91 travel time tables. The origin time is assumed to be 07:01:00.000, and location is assumed to be the same as that for "Hunters Trophy".

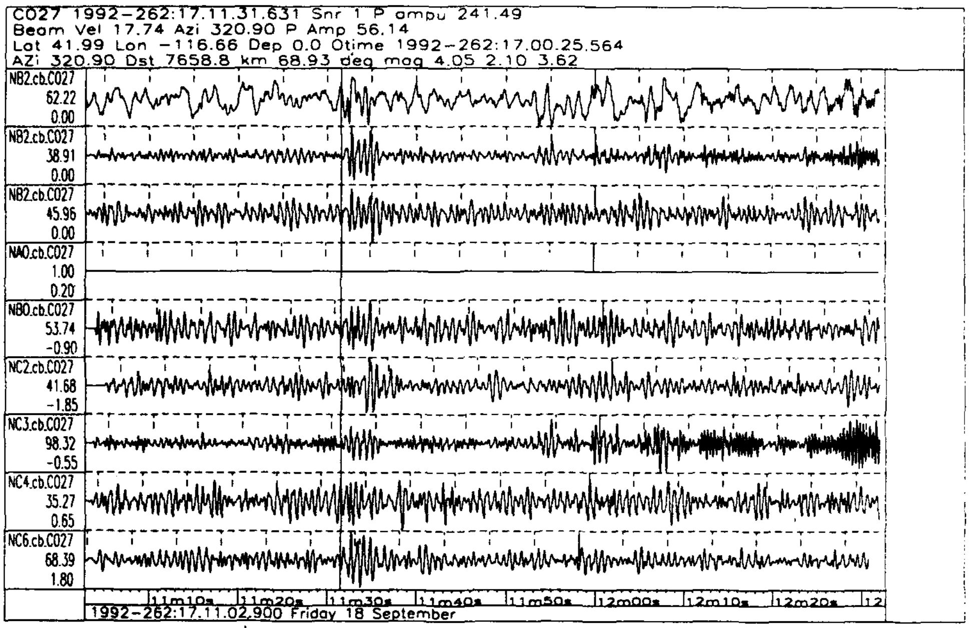

Fig. 7.3.1. NORSAR array ***automatic*** event plot for the "Hunters Trophy" event. The traces show from top to bottom the unfiltered (full) array beam, the filtered (full) array beam, followed by seven filtered subarray beams (subarrays NB2, NA0, NB0, NC2, NC3, NC4 and NC6). The passband used is 1.2 to 3.2 Hz. Note that subarray NA0 was out of operation at the time of this event. The vertical line marks the automatic detection time, with reference to subarray NB2. The automatic event location given is within about 4 degrees of the true location.

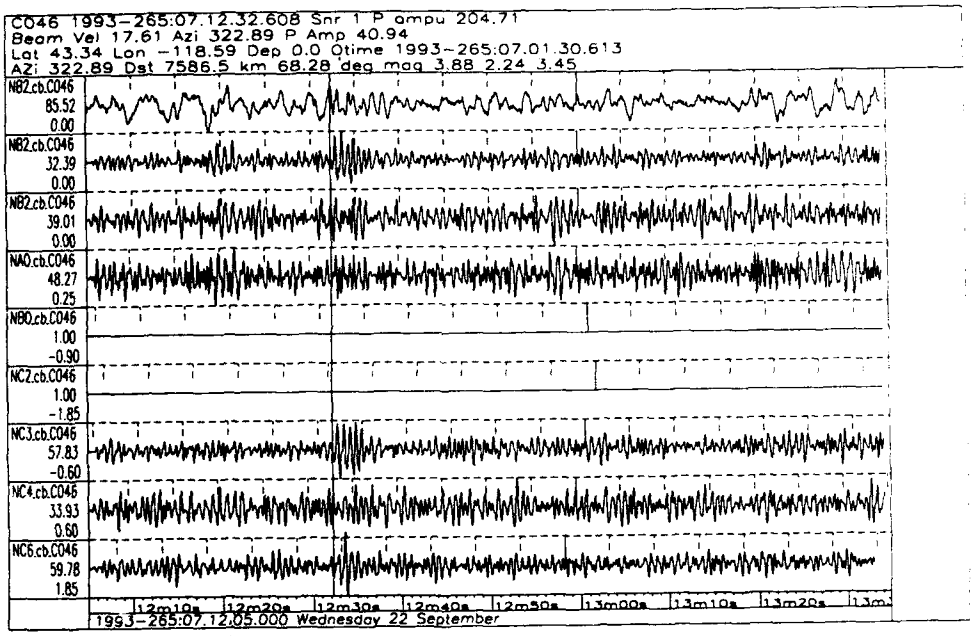

Fig. 7.3.2. NORSAR array ***automatic*** event plot for the NPE/CKE event. See caption for Fig. 7.3.1 for details of figure content and passband. Note that subarrays NB0 and NC2 were out of operation at the time of this event. The automatic event location is within about 6 degrees of the true location.

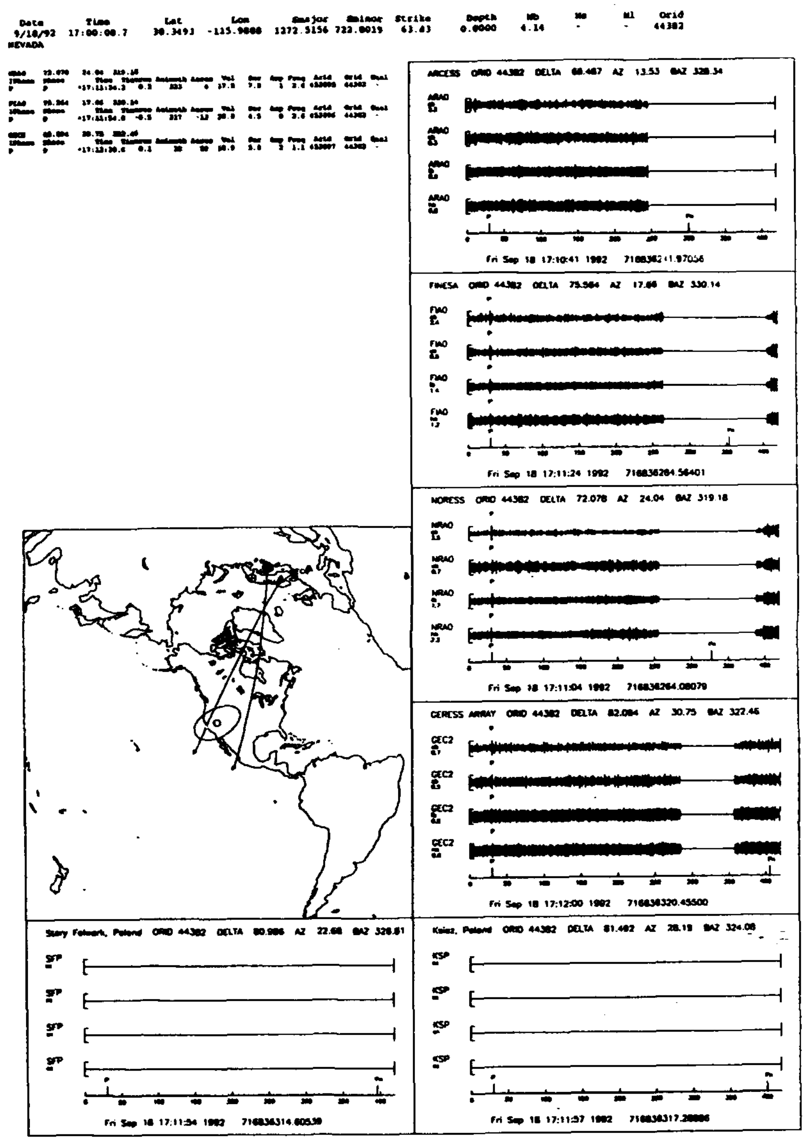

Fig. 7.3.3. IMS results for the "Hunters Trophy" event, as reviewed by an analyst. Detections with associated slowness values at NORESS, FINESA and GERESS are used to form the event solution.

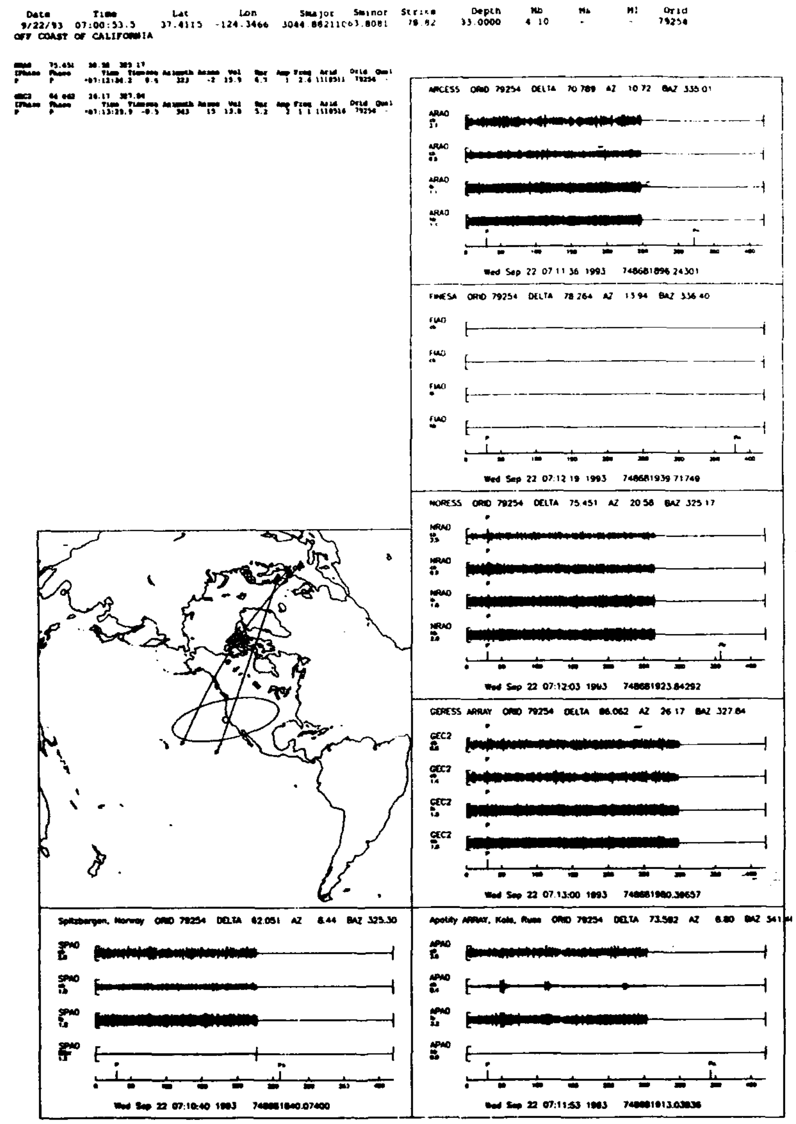

Fig. 7.3.4. IMS result for the NPE/CKE event, as reviewed by an analyst. Only information from NORESS and GERESS was available to form the event solution shown.

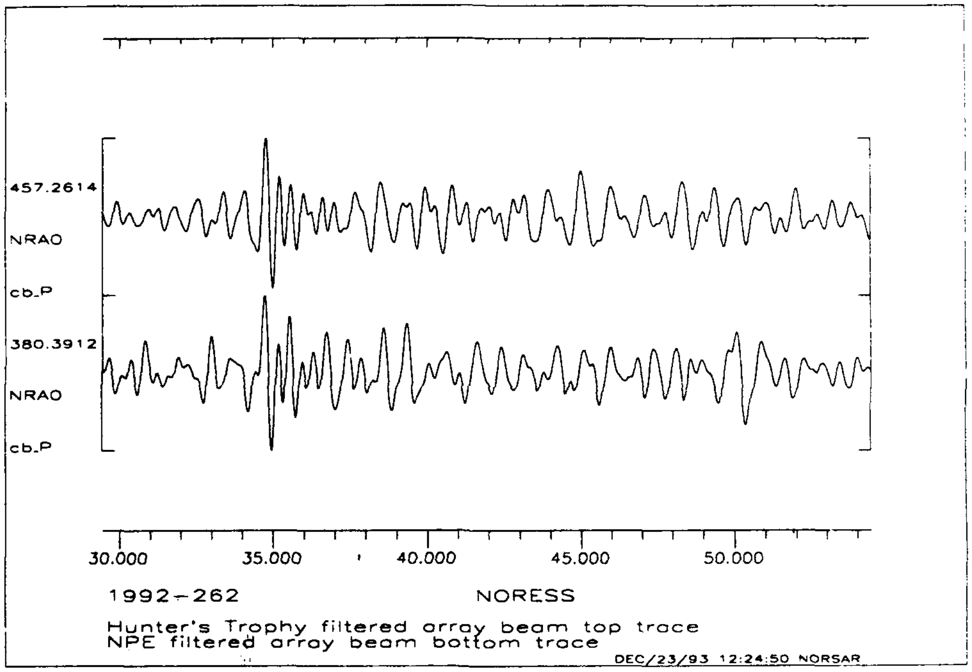

Fig. 7.3.5. Optimum NORESS array beams (with respect to steering parameters) filtered in the passband 1.2 to 3.2 Hz for the "Hunters Trophy" event (top) and the NPE/CKE event (bottom). The two traces are aligned so that the signal onset is 5 s after the start time of the trace. The numbers to the left of the traces are amplitude scaling factors.

7.4 A generic algorithm for accurate determination of P-phase arrival times

Introduction

A precise estimate of the onset time of seismic phases is needed to obtain an accurate event location. To obtain very precise onset times for all types of seismic signals, seismological observatories around the world mostly rely on the picks provided by their human analysts. However, the increase in the number of seismic stations worldwide has not been followed up by a similar increase in the number of analysts. The availability and operational use of reliable, automatic procedures therefore become more and more important.

In the automatic detection and signal processing module (SigPro) used for processing the regional array data at NORSAR, a two-step onset time algorithm is in use. This procedure consists of first applying a series of short-term to long-term average (STA/LTA) detectors in parallel to a set of filtered beams. When one or more of the STA/LTA detectors exceed a predefined threshold, a phase detection is declared and a detection time is found. Subsequently, a time domain phase timing algorithm is applied to the filtered beam with the highest SNR, using the detection time as the starting value. A detailed description of this algorithm is found in Mykkeltveit and Bungum (1984).

These SigPro estimates of the onset times are subsequently used by the automatic phase association and event location procedure (ESAL) of the Intelligent Monitoring System (IMS) (Bache et al, 1993) to produce a fully automatic event bulletin. The IMS currently provides for joint processing of data from six arrays located in northern and central Europe, see Fig. 7.4.1. The events in the automatic bulletin are finally reviewed and corrected by the analyst using the Analyst Review Station (ARS) of the IMS. Through the analyst review we have experienced that the phase onset times often have to be significantly adjusted. In order to improve the precision of the automatic event locations provided by the IMS and in order to reduce the analyst's workload, there is therefore a strong need to improve the precision of the automatic onset time estimates.

Autoregressive modelling has been shown to provide a useful tool in characterizing seismic noise and signals. Tjøstheim (1975a,b) applied such modelling to the seismic discrimination problem. Takanami (1991) used autoregressive models for onset time estimation for microearthquake networks. Pisarenko et al (1987) developed a general autoregressive onset time estimator, which was further elaborated by Kushnir et al (1990). In this study we will investigate the use and performance of this onset time estimation method when applied in an automatic mode under various types of conditions.

In this paper, we develop a generic procedure to reestimate the onsets of all types of first-arriving P-phases using the SigPro onset estimates as a starting point. By applying the autoregressive likelihood technique, we have obtained automatic onset times of a quality such that 70% of the automatic picks are within 0.1 s of the best manual pick. For the SigPro onset time procedure currently used at NORSAR, the corresponding number is 28%. We conclude that automatic reestimation of first-arriving P-onsets using the autoregressive likelihood technique has the potential of significantly reducing the retiming efforts of the analyst.

Autoregressive likelihood estimation of onset time

Following Pisarenko et al (1987) and Kushnir et al (1990), the autoregressive likelihood algorithm for onset time estimation is based on regarding the signal onset as the time when the statistical features of the observed time series are abruptly changed. For each argument τ within a predefined search interval (t_1, t_2) of length N, autoregressive models of the observations within the intervals (t_1, τ) and (τ, t_2) are calculated by a Levinson-Durbin procedure. From the variances σ_1^2 and σ_2^2 of the autoregressive model residuals of the two time intervals, a maximum-likelihood algorithm is used to calculate the likelihood function $L(\tau)$ in accordance with the formula

$$L(\tau) = [\tau ln\sigma_1(\tau) - (N-\tau) ln\sigma_2(\tau)] \quad (1)$$

where the argument to the maximum of $L(\tau)$ defines the onset time of the signal, see Fig. 7.4.2.

The algorithm working on single component data, hereafter denoted ESTON1, takes into account changes in both power and frequency content, and it is therefore important that the broadband signal waveforms are retained. This is very different from the onset time estimator currently used in SigPro, which only exploits power differences within the narrow frequency band with the highest signal-to-noise ratio (SNR). The algorithm working on three component data, hereafter denoted ESTON3, is in addition sensitive to changes in the polarization characteristics of the three-component observations. Following the recommendations of Pisarenko et al (1987), we have in all our calculations used autoregressive modelling of order 3.

It is noteworthy that both ESTON1 and ESTON3 require that the search be limited to a relatively short time window. If an initial event location and origin time is known, we can determine the required short time window for the search. Alternatively, the phase onsets provided by SigPro can be used to restrict the search. In any case, the autoregressive likelihood estimation of onset time should be well-suited to a post-processing application.

Generic application; retiming of first-arriving P-phases

We have conducted an experiment in reestimating the onset time of all first-arriving P-phases defined in the automatic IMS bulletin, using the ESTON1 method. For a period of four days (September 27 - 30, 1993), 391 first-arriving P-phases associated with events in the IMS bulletin were defined. They were distributed among all the arrays shown in Fig. 7.4. 1, and originated from events at both local, regional and teleseismic distances. All P-phases were carefully retimed using an interactive signal processing package (EP) with high-resolution graphics (Fyen, 1989), and about 10% of them were rejected due to false detections or erroneous phase association, such that 350 first-arriving P-phases remained for further analysis after this manual screening process. When comparing these numbers to the general IMS performance (Mykkeltveit et al, 1993), it appears that this sample is fairly typical for an operational situation.

The 149 P-phases recorded during the two first days of the time period were used to tune the implementation of ESTON1. By comparing the differences between the manual and the SigPro onset times, a maximum difference of 2.8 s was observed. Consequently, the search interval to be used by ESTON1 was set to ±3 s around the SigPro onset.

The different types of P-phases (Pg, Pn, P and PKP) spanned a wide range of signal characteristics with respect to spectral content, complexity, SNR and signature (impulsive, emergent). From extensive testing of ESTON1, we found that in order to successfully process all types of signals, we had to identify the widest possible spectral band for which the signal had usable SNR. This was done in the time domain by estimating the maximum SNR within the search interval in a series of narrow passbands. The spectral band was defined such that we initially selected the narrow frequency band with the highest SNR. If the neighboring frequency bands had an SNR within a factor of 5 of the maximum and also exceeded an SNR of 4, the spectral band was extended so as to include this band as well.

Our experiments also showed that in order to obtain stable estimates of the likelihood function $L(\tau)$, it was important to filter and decimate the data in accordance with the highest frequency of the signal spectrum. For signals with a high SNR (typically above 40) and a wide bandwidth, no filtering or decimation was needed.

We found that the onsets provided by ESTON1 were biased slightly late, and the delay appeared to be linearly dependent on the dominant period of the signal. By linear regression of all signals with SNR > 6, the bias b could be approximated by the relation $b \approx 0.38p$ where p is the dominant period of the signal. The flowchart of Fig. 7.4.3 outlines the processing steps involved in the reestimation of the arrival time of first-arriving P-phases using the ESTON1 method.

The 201 P-phases recorded during the last two days of the test period were used to evaluate the new procedure. Fig. 7.4.4a shows the difference between the manually picked onsets and the automatic onsets from SigPro versus the highest SNR measured in any narrow filter band. For comparison, Fig. 7.4.4b shows the difference between the manually picked onsets and the automatically reestimated onset times using the ESTON1 method. From comparing these two figures it is apparent that the improvement when using ESTON1 is significant for all SNRs.

To quantify the improvement, we have in Fig. 7.4.5 plotted the percentage of the observations within a range of absolute time differences between the automatic and the manual picks. For SigPro, 50 percent of the automatic onsets were within 0.23 s of the manual pick, whereas for ESTON1 the 50 percent level (median) was as low as 0.05 s.

We also divided the observations into a teleseismic and a local/regional data set. For SigPro, the median time differences were about equal for the two data sets. For ESTON1, the median time difference was slightly smaller for the local/regional data set than for the teleseismic. This difference could be due to generally longer dominant periods of the teleseismic P-phases.

As expected and also seen from Figs. 7.4.4a and 7.4.4b, the precision of the automatic onsets is best for high SNRs. By again dividing the observations into two data sets, one with SNR less than or equal to 10 and one with SNR greater than 10, we found that SigPro had a median difference of 0.29 s for the low SNR data set and 0.19 s for the other. The corresponding numbers for ESTON1 were 0.10 s and 0.04 s, respectively.

The implications on the analyst's retiming efforts can be illustrated by the following example: If we assume that the analyst will accept a maximum deviation of 0.1 s from the "correct" manual pick without doing retiming, we can from Fig. 7.4.5 see that 28 percent of the SigPro onsets are acceptable, whereas 70 percent of the ESTON1 onsets are acceptable. Clearly, automatic reestimation of first-arriving P-onsets using the algorithm described above has the potential of significantly reducing the retiming efforts of the analyst.

Conclusions

The results presented in this study show that very precise automatic estimates of phase onsets can be obtained with the autoregressive likelihood estimation technique. Implementation of the method requires that we have available approximate estimates of the phase arrival, and we have shown that such approximate estimates can be obtained from automatic event definitions (phase association and event location) by the Intelligent Monitoring System (IMS). In this way the autoregressive likelihood estimation method can provide phase onsets that match the human precision. This has previously been demonstrated for events from the Khibiny Massif, by quantifying the uncertainty of both manual and automatic onset estimates of various phases at the Apatity stations and at ARCESS (Kværna, 1993). Furthermore, the precision of the automatic phase picks shows very large improvement in comparison to the automatic phase onsets from the continuous processing providing input to the IMS.

We realize that in order to obtain accurate event locations, precise onset time estimates are necessary, but not sufficient. If the theoretical travel-time model used in the event location deviates from the true travel-times, the accuracy of the event locations will be reduced. Introduction of travel-time corrections as well as other aspects of accurate event location are discussed by Kværna and Ringdal (1993).

During the work with the autoregressive likelihood estimation method, we have experienced that the display of the likelihood functions, as illustrated in Fig. 7.4.2 can assist the analyst in picking the correct phase onsets. In the context of interactive analysis of seismic data, we believe that the idea of making such likelihood functions available to the analyst should be pursued.

It is clear that when estimating arrival times by the autoregressive method, the results for specific, well-calibrated regions are more precise than can be obtained when the method is used in a "generic" mode. Efforts should be made to extend the number of well-calibrated regions in order to make such optimum use of the method.

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References

Bache, T.C., S.R. Bratt, H.J. Swanger, G W. Beall and F.K. Dashiell (1993): Knowledge-based interpretation of seismic data in the Intelligent Monitoring System, *Bull. Seism. Soc. Am.*, 83, 1507-1526..

Fyen, J. (1989): Event processor program package, in *NORSAR Semiannual Tech. Summ. 1 Oct 1988 - 31 Mar 1989*, Scientific Rep. No.2-88/89, Kjeller, Norway.

Kushnir, A.F., V.M. Lapshin, V.I. Pinsky and J. Fyen (1990): Statistically optimal event detection using small array data, *Bull. Seism. Soc. Am.*, 8C Part B, 1934-1950

Kværna, T. (1993): Intelligent post-processing of seismic events -- Part 2: Accurate determination of phase arrival times using autoregressive likelihood estimation, in *NORSAR Semiannual Tech. Summ. 1 Oct 1992 - 31 Mar 1993*, Scientific Rep. No. 2-92/93, Kjeller, Norway.

Kværna, T. and F. Ringdal (1993): Intelligent post-processing of seismic events, submitted for publication.

Mykkeltveit, S. and H. Bungum (1984): Processing of regional seismic events using data from small-aperture seismic arrays, *Bull. Seism. Soc. Am.*, 74, 2313-2333.

Mykkeltveit, S., U. Baadshaug, B. Kr. Hokland, T. Kværna and L. B. Loughran (1993): An evaluation of the performance of the Intelligent Monitoring System, in *NORSAR Semiannual Tech. Summ. 1 Oct 1992 - 31 Mar 1993*, Scientific Rep. No.2-92/93, Kjeller, Norway.

Pisarenko, V.F., A.F. Kushnir and I.V.Savin (1987): Statistical adaptive algorithms for estimation of onset moments of seismic phases: *Phys. Earth Planet. Int.*, 47, 4-10.

Sereno, T.J. (1990): Attenuation of regional phases in Fennoscandia and estimates of arrival time and azimuth uncertainty using data recorded by regional arrays, *NORSAR Seminann. Tech. Rep. No. 3, 1 Jan 89 - 30 Jun 90*, Science Applications International Corp., San Diego, CA, USA.

Takanami, T., (1991): A study of detection and extraction methods for microearthquake waves by autoregressive models, *Journal of the Faculty of Science, Hokkaido University Series VII (Geophysics)*, Vol. 9, No. 1

Tjøstheim, D., (1975a): Some automatic models for short-period noise, *Bull. Seism. Soc. Am.*, 65, 677-691.

Tjøstheim, D., (1975b): Autoregressive representation of seismic P-wave signals with an application to the problem of short-period discriminants, *Geophys. J. Roy. Astron. Soc.*, 43, 269-291.

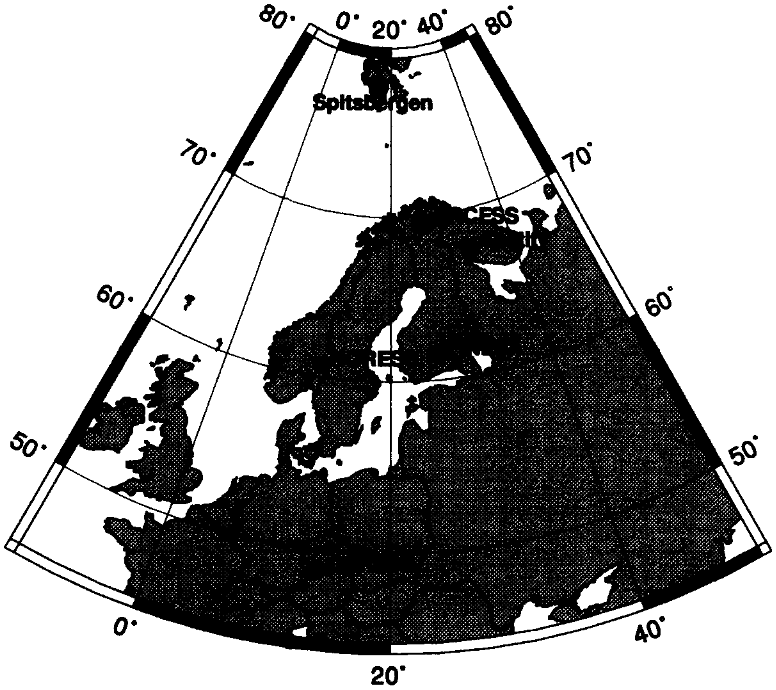


Fig. 7.4.1. Map showing the locations of the six regional arrays currently used by the Intelligent Monitoring System at the NORSAR data processing center.

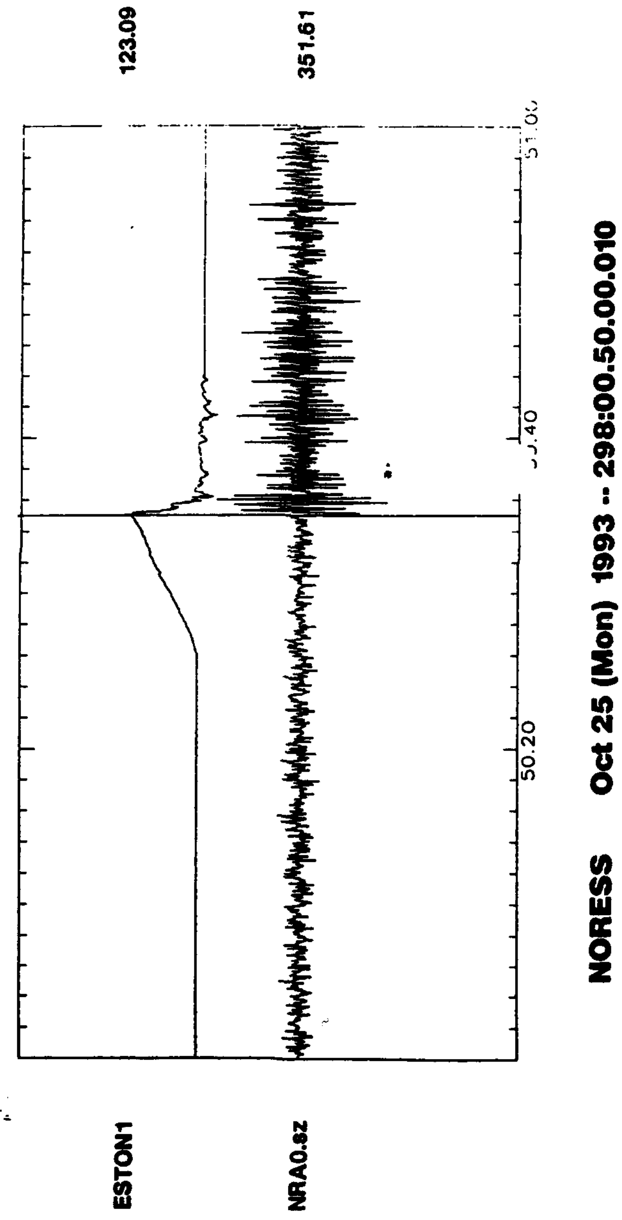


Fig. 7.4.2. The top trace is the likelihood function resulting from autoregressive onset time estimation of the data in the bottom trace. The maximum of the likelihood function corresponds to the estimated onset time.

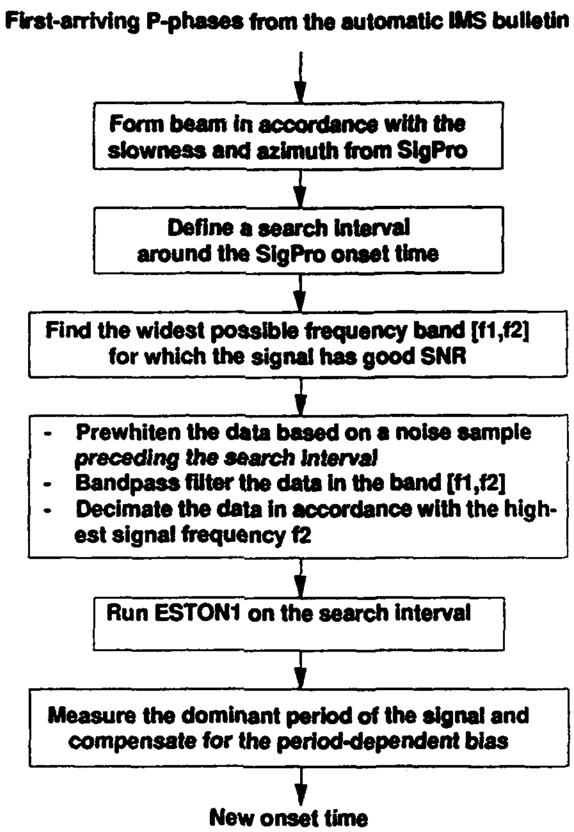
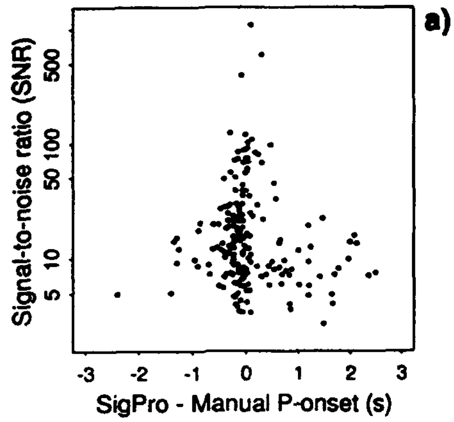


Fig. 7.4.3. Flowchart illustrating the processing steps involved in the reestimation of the arrival time of first-arriving P-phases using the ESTON1 method.



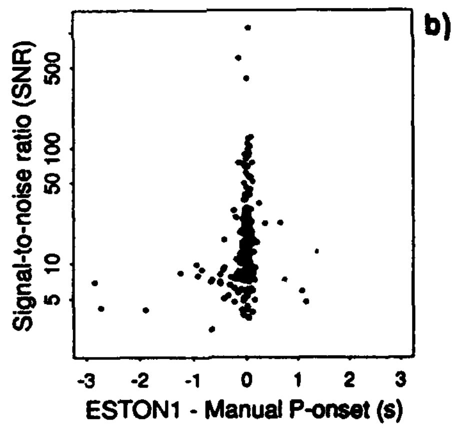


Fig. 7.4.4: This figure show the time difference between the automatic and the manually picked onsets of the 201 first-arriving P-phases analyzed in this study plotted versus the SNR of the signal.
a) shows the time differences between the automatic onsets from SigPro and the manual picks. The median absolute time difference is 0.23 s.
b) shows the time differences between the reestimated onsets from ESTON1 and the manual picks. The median absolute time difference is 0. 05 s.

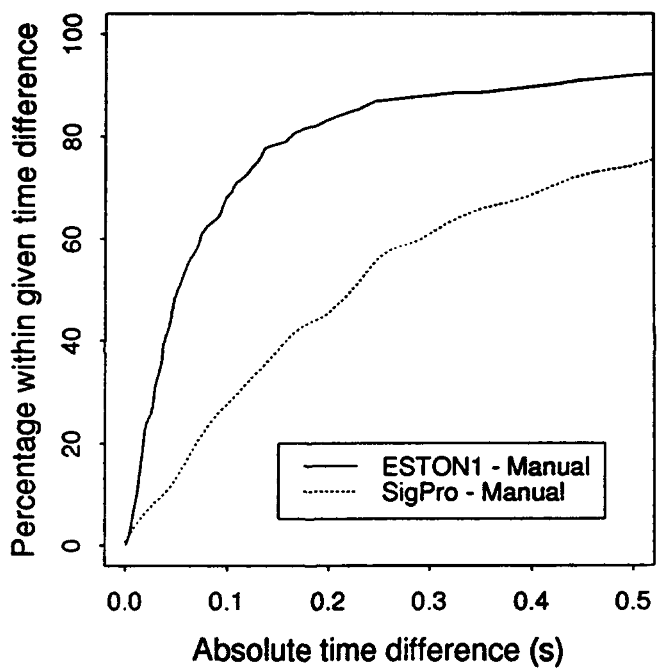


Fig. 7.4.5. These two curves show the percentage of the automatic onsets within a range of absolute time differences from the manual picks. For SigPro (dashed line), 50 percent of the onsets are within 0.23 s of the manual pick, whereas for ESTON1 (solid line) the 50 percent level (median) is as low as 0.05 s.

7.5 Onset time estimation and location of events in the Khibiny Massif, Kola Peninsula, using the Analyst Review Station

Introduction

The technique of intelligent post-processing of seismic events proposed by Kværna and Ringdal (1993) has been shown to give a substantial improvement in location accuracy when applied to seismic events in the Khibiny Massif, Kola Peninsula. In this paper, we compare the performance of the analyst using the Analyst Review Station (ARS) to these results. As part of this study, we estimate the uncertainty in analyst time picks for phases from various regional arrays (see Fig. 7.5.1), and we discuss the implication of these uncertainties in terms of the resulting effect on location accuracy. An important conclusion inferred from this work is that, in many cases, location accuracy does *not* improve when adding new phase readings and applying current location programs.

The Khibiny Massif events

Six apatite mines are located within an area of about 10 km^2 in the Khibiny Massif on the Kola Peninsula of Russia (see Fig. 7.5.2). A detailed description of these mines and the mining activity is found in Mykkeltveit (1992). Although we have no explicit information on the exact sizes of these mines, interpretation of various maps suggests that the typical size is about 1 km^2. The Kola Regional Seismological Centre has since the beginning of 1991 provided NORSAR with information on mining blasts in the six Khibiny Massif mines. Detailed information on the 58 events used in this study is given in Kværna (1993).

Kværna (1993) investigated the potential automatic use of an onset picker based on autoregressive likelihood estimation. Both a single-component version and a three-component version of this method were tested on data from events located in the Khibiny Massif, recorded at the Apatity array, the Apatity three-component station and the ARCESS array. Using this method, he was able to estimate onset times to an accuracy (standard deviation) of about 0.05 s for P-phases and 0.15-0.20 s for S-phases. He noted that these accuracies are as good as the best analyst picks, and considerably better than the accuracies of the current onset procedure used for processing of regional array data at NORSAR.

Estimating the precision of manual onset time picks

As reported by Kværna (1993), P and S onsets at two stations in Apatity, APA0 and APZ9, and the Pn onsets at ARCESS were manually picked using the interactive EP program (Fyen, 1989). Given the fact that the characteristics of the Khibiny Massif events were known, the manual phase picking was considered to be done under "optimum conditions". By "optimum conditions" we mean that the analyst utilized information on the approximate phase arrival times and looked for typical signatures of the different phases. He also selected filters and seismometer components so as to obtain the highest SNR.

For the purpose of the study reported in this paper, all events were reviewed by another analyst using the Analyst Review Station (ARS) of the IMS. This analyst made time picks for available phases for four arrays (NORESS, ARCESS, FINESA, APATITY) as well as for the APZ9 station. We consider the phase picks from the ARS to be obtained under so-called "operational conditions" and they may therefore be less precise than those obtained under "optimum conditions". This is due to the fact that ARS is used as a tool for routine analysis (i.e., relatively short time spent on each pick) of large quantities of data and that the analyst did not have readily available information on the characteristics of the Khibiny Massif events.

Following Sereno (1990), an unbiased estimate of the measurement variance is determined from the arrival time difference between two phase observations for repeated events in the same mine.
Specifically:

$$\sigma^2_{1,pick} + \sigma^2_{2,pick} = \frac{\sum_{k=1}^{N_{mines}} \sum_{i=1}^{N_{obs}} [\Delta T_{obs_{ik}} - \langle \Delta T_{obs} \rangle_k]^2}{(N_{obs} - N_{mines})} \tag{1}$$

where σ_1^2 and σ_2^2 are the picking variance of each phase, $\Delta T_{obs_{ik}}$ is the ith observation of the arrival time difference for the kth mine. $\langle \Delta T_{obs} \rangle_k$ is the mean arrival time difference for the kth mine. N_{obs} is the total number of observations (at all mines), and N_{mines} is the number of mines.

Kværna (1993) used formula (1) in various combinations to estimate standard deviations of time picks for various phase types and stations. He found that the P-phase at APA0 could be picked with a precision of $\sigma = 0.04$ seconds when the pick was made by the analyst under "optimum conditions". In the present study, we will use these P-times (for APA0) as reference, and we will assume that their standard deviation $\sigma_{2,pick}$ is 0.04. In this way, we can estimate $\sigma_{1,pick}$ directly from (1) for each mine, and average these data over the six mines (using the number of events as a weighting factor) to obtain overall estimates of the uncertainty.

Results

The resulting estimates of the precision in time picks by the analyst, using the ARS station, are presented in Table 7.5.1 and Figs. 7.5.3-7.5.4.

Fig. 7.5.3 shows the results for the Apatity array APA0 and the 3-component station APZ9. The array has a better precision for P phases (0.05 versus 0.08), probably because of a far better P-wave SNR (see Table 7.5.1). However, the 3-component station has more precise S and Rg estimates, probably because of their more impulsive nature compared to the array recordings. Note that these secondary phases have a far lower accuracy in the time picks than the P-phases. Also note that for the P and S phases the ARS analyst picks are not as precise as the automatic time picks presented by Kværna (1993).

Fig. 7.5.4 shows the results for Pn, Sn and Lg at the three arrays ARCESS, FINESA and NORESS. Pg for ARCESS is also shown. Not unexpectedly, Pn has the most precise picks, followed by Sn and Lg. The ARCESS Pn has by far the best precision. This is reasonable in view of the very high SNR for these phases (Table 7.5.1). Note also that for FINESA and NORESS it is possible to read phases for only about half of the events or fewer.

The much larger uncertainty in FINESA and NORESS P-precision compared to ARCESS (about 0.8 versus 0.09 seconds) is noteworthy. Clearly, the location program ought to take this difference into account and weigh the data accordingly. At present no routine mechanism for doing such weighing is applied in the IMS system, although the option to do so exists.

Location results

Figs. 7.5.5-7.5.7 show plots of event locations obtained under three different scenarios. All location estimates have been made with an assumed 0 km depth.

Fig. 7.5.5 shows the location provided by the automatic IMS system with no analyst review. All the arrival times used here are taken directly from the SigPro processing, and are thus subject of significant uncertainty. The median location error is 10.6 km, which must be considered excellent for a fully automatic system. Some "outliers" are due to occasional erroneous phase identification by the automatic system.

Fig. 7.5.6 shows the results after applying intelligent post-processing to the ARCESS and Apatity arrays. The median error is now 1.9 km and the worst case error is 5.9 km.

Fig. 7.5.7 shows the results after using the analyst (ARS) reviewed data in the location procedure. The median error is 3.3 km, and the worst case error is 14.5 km. These results are much better than the automatic IMS processing, but not as good as for the intelligent post-processing.

As shown by Kværna (1993), the ARS picks for the Apatity stations and ARCESS are not quite as good as the intelligent post-processing picks. A slight degradation in location accuracy must therefore be expected. Nevertheless, we consider that a main reason why the ARS locations do not match those of the intelligent post-processing is the inclusion of NORESS and FINESA readings in the data base, without appropriate weighting. We plan to pursue this problem further in the future.

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References

Bache, T.C., S.R. Bratt, H.J. Swanger, G.W. Beall and F.K. Dashiell (1993): Knowledge-based interpretation of seismic data in the Intelligent Monitoring System, *Bull. Seism. Soc. Am.*, 83, 1507-1526.

Fyen, J. (1989): Event processor program package, *NORSAR Semiannual Tech. Summ. 1 Oct 1988 - 31 Mar 1989*, Scientific Rep. No.2-88/89, Kjeller, Norway.

Kværna, T. (1993): Accurate determination of phase arrival times using autoregressive likelihood estimation, *NORSAR Semiannual Tech. Summ. 1 Oct 1992 - 31 Mar 1993*, Scientific Rep. No. 2-92/93, Kjeller, Norway.

Kværna, T. and F. Ringdal (1993): Intelligent post-processing of seismic events, *NORSAR Semiannual Tech. Summ. 1 Oct 1992 - 31 Mar 1993*, Scientific Rep. No. 2-92/93, Kjeller, Norway.

Mykkeltveit, S. and H. Bungum (1984): Processing of regional seismic events using data from small-aperture seismic arrays, *Bull. Seism. Soc. Am.*, 74, 2313-2333.

Mykkeltveit, S. (1992): Mining Explosions in the Khibiny Massif (Kola Peninsula of Russia) Recorded at the Apatity Three-component Station, *Report PL-TR-92-2253*, Phillips Laboratory, Hanscom AFB, MA, USA.

Sereno, T.J. (1990): Attenuation of regional phases in Fennoscandia and estimates of arrival time and azimuth uncertainty using data recorded by regional arrays, *NORSAR Seminann. Tech. Rep. No. 3, 1 Jan 89 - 30 Jun 90*, Science Applications International Corp., San Diego, CA, USA.

Table 7.5.1 (2 pages)

ARCESS

	N	σ	SNR
Pn	57	0.087	52.9
Pg	53(1)	0.647	5.8
Sn	57	0.563	4.1
Lg	57	1.13	5.4

FINESA

	N	σ	SNR
Pn	23	0.781	5.00
Sn	28	1.465	2.67
Lg	33	2.149	3.46

NORESS

	N	σ	SNR
Pn	22	0.854	6.21
Sn	13	1.290	3.02
Lg	12	3.360	2.81

APATITY ARRAY (APA0)

	N	σ	SNR
Pg	58	0.051	57.60
Lg	58	0.389	8.43
Rg	57	0.494	8.59

APATITY 3-COMPONENT STATION (APZ9)

	N	σ	SNR
Pg	58	0.080	15.20
Lg	58	0.184	7.79
Rg	57	0.254	8.89

Table 7.5.1. Basic data corresponding to Figs. 7.5.3 and 7.5.4. The entries in the tables are:

N : Number of phases analyzed (outliers in parantheses)

σ : Estimated standard deviations (s) of ARS time picks

SNR : Geometric average of the linear signal-to-noise ratio (STA/LTA) of the N phases. SNR of non-detections have been set to 3.5 for P-phases and 2.5 for S-phases.

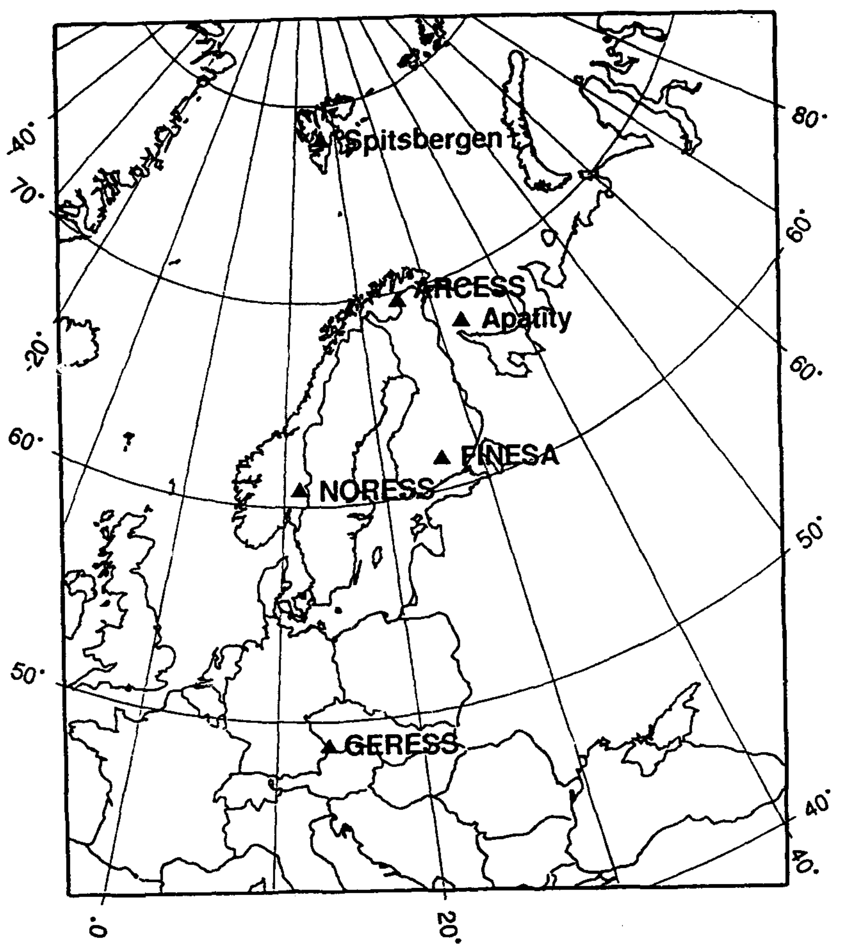

Fig. 7.5.1. Map showing the locations of the six regional arrays currently used by the Intelligent Monitoring System at the NORSAR data processing center.

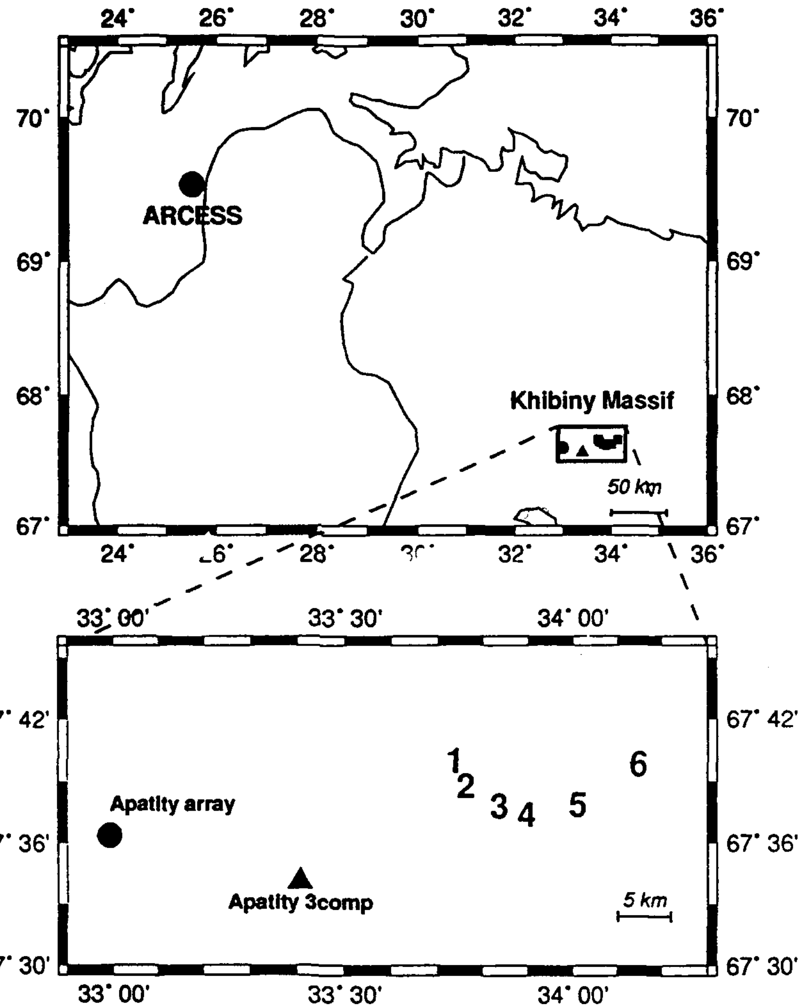

Fig. 7.5.2. In the *upper part*, a large reference area is shown. The location of the ARCESS array is given by a filled circle, and the location of the Khibiny Massif region is shown. The *lower part* shows a detailed picture of the Khibiny Massif region. The locations of the six mining sites are given by large numbers 1-6. The Apatity array (APA0) is shown as a filled circle and the three-component station (APZ9) in the town of Apatity is shown as a large triangle.

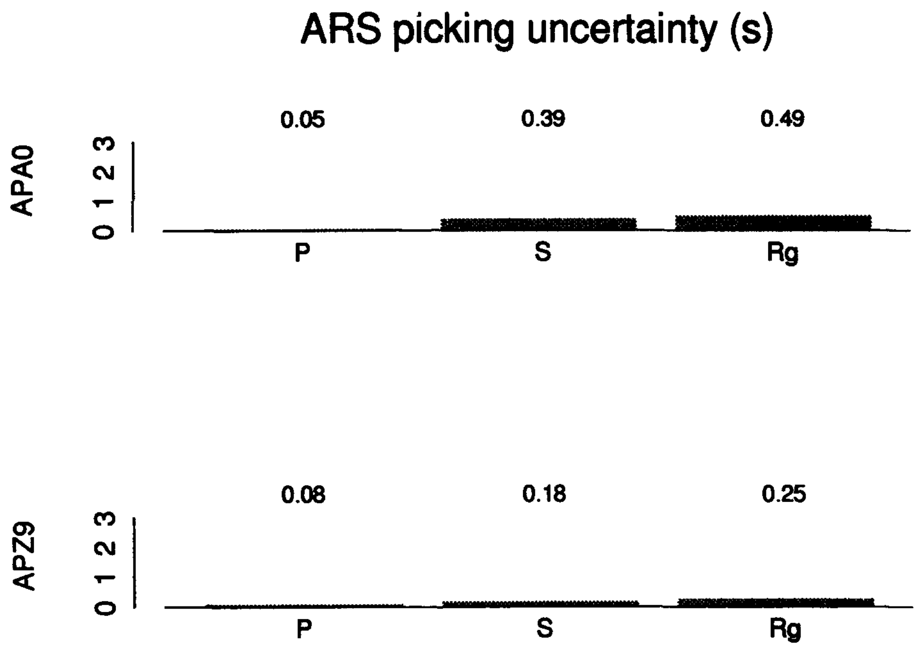

Fig. 7.5.3. Standard deviations of analyst time picks for stations APA0 and APZ9 using the Analyst Review Station (ARS) for the event data base described in the text.

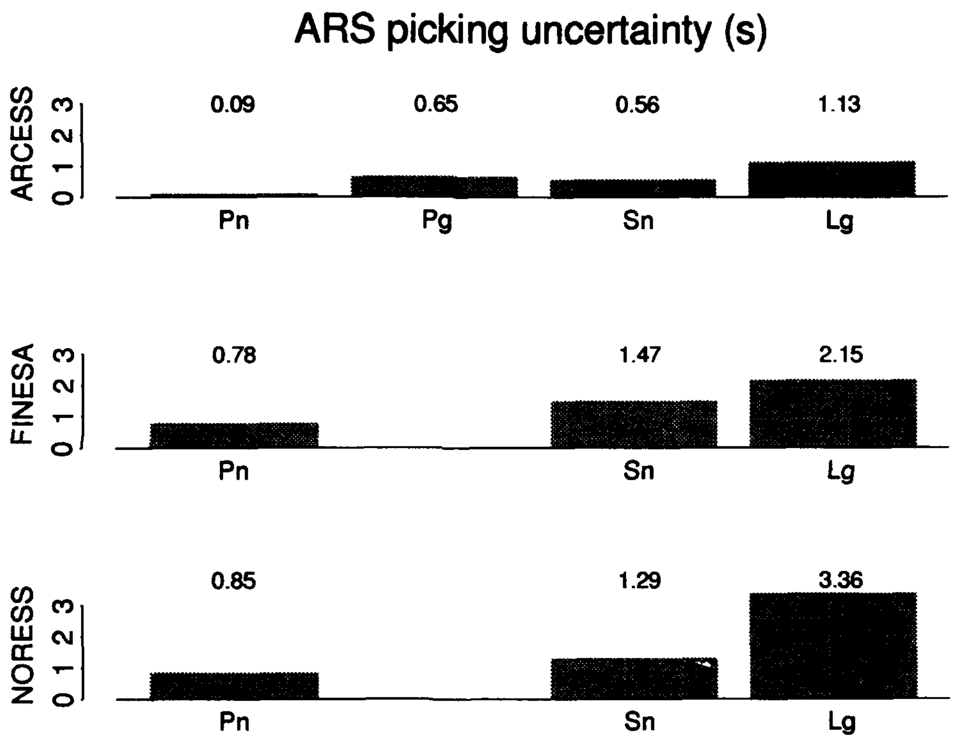

Fig. 7.5.4. Standard deviations of analyst time picks for the arrays ARCESS, FINESA, NORESS using the Analyst Review Station (ARS) for the event data base described in the text.

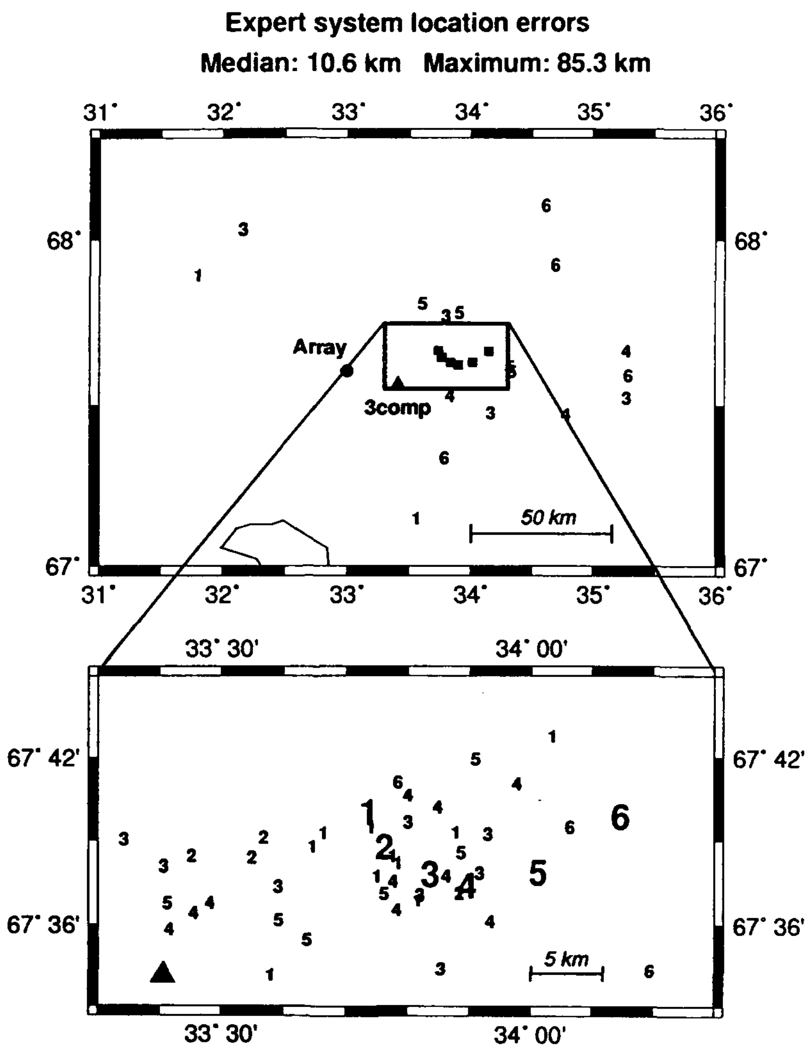

Fig. 7.5.5. Location of the six mining sites in the Khibiny Massif (large numbers 1-6) and the locations of the 58 reference events (small numbers 1-6) as given by the automatic IMS processing. In the *upper part*, a large reference area is shown, with the mines plotted as filled squares. The *lower part* shows a detailed picture for the area near the mines. The small numbers (1-6) associated with each event represent the mine in which the event actually occurred. The Apatity array is shown as a filled circle and the three-component station in the town of Apatity is shown as a filled triangle.

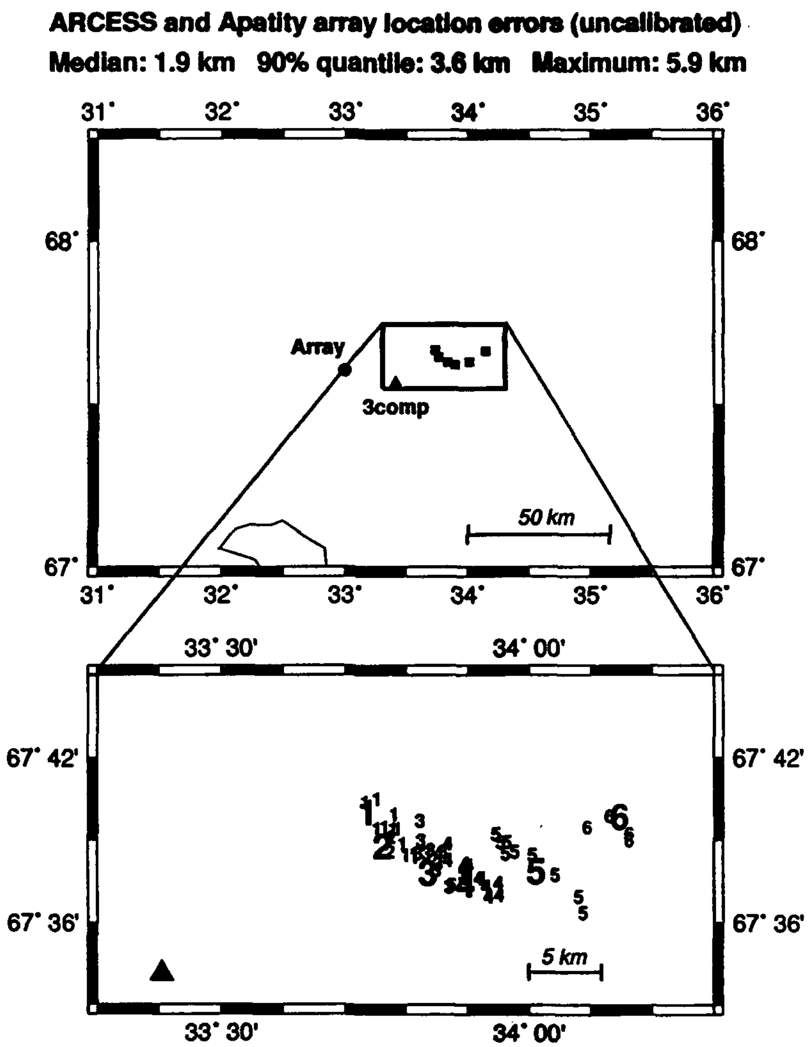

Fig. 7.5.6. Same as Fig. 7.5.5, but showing location results by the automatic post-processing method described by Kværna and Ringdal (1993). Only ARCESS and the Apatity array are used.

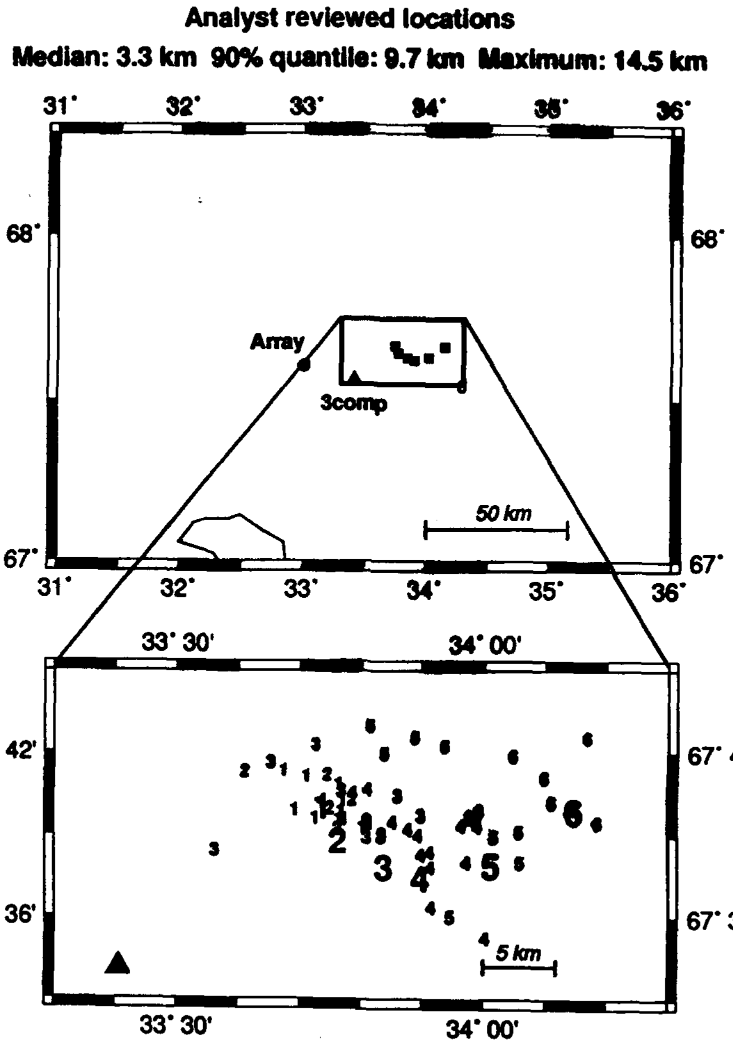

Fig. 7.5.7. Same as Fig. 7.5.5., but showing location results using ARS analysis with four regional arrays (ARCESS, APATITY, NORESS, FINESA).

7.6 Generalized Beamforming as a tool in IDC processing of large earthquake sequences

Introduction

Generalized Beamforming (Ringdal and Kværna, 1989) is a technique for joint processing of time-aligned waveforms from a seismic network. The time-alignment is made for a grid of beampoints, and the density and spatial coverage of the beam deployment can be set without any restrictions.

The Generalized Beamforming (GBF) method has been applied successfully for phase association and event location, both at regional distances (Ringdal and Kværna, 1989; Kværna, 1990, 1992a) and in a teleseismic context (Taylor and Leonard, 1992; Kværna, 1992b). In this paper we investigate the potential of the GBF technique in achieving a rapid, preliminary association of phases for a large aftershock sequence. As is well known, such sequences are often problematic to process using conventional phase association techniques since there are so many individual phase detections that the number of possible combinations becomes very large.

The W. Caucasus earthquake sequence, April 1991

On 29 April 1991 a large earthquake (M_S =7.3) occurred in western Caucasus, with coordinates 42.453N, 43.673E, h = 17 km (NEIC).

The earthquake was followed by a large number of aftershocks. According to the catalogue of Starovoit et al (1992), 114 aftershocks were recorded on the day of the main shock (29 April) and 360 aftershocks had been recorded by the end of May.

The earthquake occurred early during the Group of Scientific Experts (GSE) Second Technical Test (GSETT-2, main phase, see GSE/CRP/190/Rev.4, 1991), and caused a considerable load at the National Data Centers (NDCs) as well as the four Experimental International Data Centers (EIDCs). The day 29 April was selected as one of the days for which reprocessing was to be made at EIDCs. Consequently, this day is useful for studying the performance of the experimental global system during a day of particularly high seismic activity. Moreover, it provides an excellent opportunity to evaluate the GBF technique applied to a large aftershock sequence.

Method

We selected 11 stations from the total of 60 participating in GSETT-2 for this analysis (see Fig. 7.6.1). These 11 stations comprised those that had the best detection performance for the W. Caucasus area. Table 7.6.1 lists the stations and summarizes the GBF parameters for this experiment. Note that only one generalized beam was formed, and it was steered to 42.5N 43.5E. The time and azimuth tolerances were set in accordance with the GSE requirements, and adjusted for the beam focus area of 0.5 degrees radius. These tolerances were narrow enough to avoid many false associations, while still allowing for the typical uncertainty in detection times and automatic parameter estimates. Detection threshold was set at 3 matching phases, and GBF detections less than 15 seconds apart were grouped together.

Table 7.6.2 shows the detection list generated by the automatic GBF process for the day in question. For each line our assessment of the detection is given (whether or not it was confirmed by the Starovoit et al bulletin and the number of EIDCs that reported the event). We note that more than 90% of the entries are in the confirmed category (either listed by Starovoit et al or reported by at least one EIDC).

Table 7.6.3 summarizes the number of detected events by the various systems. We note that the four EIDCs (reprocessed bulletins from Stockholm, Moscow, Canberra and Washington) had similar performances, and reported about half of the events in the reference catalogue. NEIC reported only one third of the reference events in their monthly bulletin. The rapid QED service (Quick Epicenter Determination) reported very few of the events.

The GBF association process reported more events than any of the four EIDCs, and also had the most events corresponding to the reference catalogue. In addition, the GBF method produced 17 reports that did not correspond to entries in Starovoit et al's bulletin. Each of the EIDCs also had events in this category, but not as many as the GBF process. It should be noted that one event reported by one EIDC and confirmed by Starovoit et al's bulletin was not reported by the GBF method. The reason was that the event had only two valid phases, and thus did not satisfy our GBF detection criterion. On the other hand, the GBF reported 4 confirmed events that were not in any of the EIDC bulletins.

We also conducted an experiment to test the likelihood of false associations. The GBF process with the parameters used in this study was run on a 7-day period prior to day 119. A false association would normally correspond to phases from a real event occurring somewhere else, but for which the phases happened to match our criteria. Table 7.6.4 shows the events associated for this 7-day period. Only six events were associated, two of which were in fact close to the beam steering point. Thus only four definite false alarms were observed during this one-week period. We conclude that the false alarm rate is very low for this processing method.

Conclusions

The GBF technique provides a simple and rapid way to associate large numbers of phases from an aftershock sequence with a very low false alarm rate. In fact, the GBF aftershock processing of 24 hours of data for the day in question (29 April 1991) took only 5 minutes on a SUN sparcstation2.

We consider that the GBF would be very useful as a preprocessor to the expert system algorithm to be applied at a future International Data Center (IDC). By first using the GBF to extract aftershock sequences, and remove the corresponding phase detections, the remaining task of associating events from other locations would be much simplified. Other applications of GBF in the context of IDC processing can also be envisaged. Furthermore, the interaction between GBF and threshold monitoring, in terms of eliminating "unlikely" phase associations, deserves to be studied in detail.

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References

GSE/CRP/190/Rev. 4 (1991): *Instructions for the conduct of Phase 3 of GSETT-2*, Group of Scientific Experts, UN Conference of Disarmament, Geneva, Switzerland.

Kværna, T. (1990): Generalized beamforming using a network of four regional arrays, *Semiann. Tech. Summary, 1 April - 30 September 1990*, NORSAR Sci. Rep. No. 1-90/91, Kjeller, Norway.

Kværna, T. (1992a): Automatic phase association and event location using data from a network of seismic microarrays, *Semiann. Tech. Summary, 1 October 1991 - 31 March 1992*, NORSAR Sci. Rep. No. 2-91/92, Kjeller, Norway.

Kværna, T. (1992b): On the use of regionalized wave propagation characteristics in automatic global phase association, *Semiann. Tech. Summary, 1 April - 30 September 1992*, NORSAR Sci. Rep. No. 1-92/93, Kjeller, Norway.

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.

Starovoit et al (1992): Catalog of aftershocks of the West Caucasus earthquake of 29 April 1991.

Taylor, D.W.A. and S.K. Leonard (1992): Generalized beamforming for automatic association, in Papers presented at the 14th Annual PL/DARPA Seismic Research Symposium, 16-18 September 1992, Loews Ventana Canyon Resort, Tucson, AZ, USA.

Station	Type	Lat	Lon	Distance	Phase	Trtime	Azimuth	Slowness
KIV	Single	43.95	42.68	1.57	Pn	28.87	157.33	13.73
KIV	Single	43.95	42.68	1.57	Sn	50.21	157.33	24.17
ARU	Single	56.40	58.60	16.47	P	236.95	221.31	12.66
GAR	Single	39.00	70.30	20.57	P	279.67	288.38	11.01
FIN	Hfarray	61.44	26.07	21.66	P	291.44	143.15	10.52
GER	Hfarray	48.85	13.70	21.68	P	291.58	95.77	10.51
OSS	Single	46.69	10.13	24.02	P	315.08	87.84	9.61
HFS	Sparray	60.13	13.68	25.33	P	327.43	120.73	9.28
NRS	Hfarray	60.73	11.54	26.55	P	338.63	118.86	9.07
ARC	Hfarray	69.54	25.51	28.66	P	353.11	151.55	8.92
GBA	Sparray	13.62	77.59	41.16	P	465.27	320.96	8.23
YKA	Sparray	62.49	-114.61	73.89	P	696.14	16.68	5.87

Table 7.6.1. Station and phase parameters used for GBF processing of the Caucasus aftershock sequence (42.5N, 43.5E, Depth 0).

Origin time	Lat	Lon	Depth	Nph	Nsta	Tres	Nazi	Azres	Nslow	Slres	Nslv	Slvres	Starov	EIDCs
1991-119:09.12.49.0	42.50	43.50	0.00	11	11	1.45	7	4.53	7	1.15	7	1.45	Yes	4
1991-119:09.27.48.0	42.50	43.50	0.00	3	3	2.84	2	4.10	2	1.71	2	1.87	Yes	3
1991-119:09.31.05.0	42.50	43.50	0.00	3	3	1.12	3	7.45	3	1.09	3	1.74	No	3
1991-119:09.37.39.0	42.50	43.50	0.00	11	10	2.29	7	4.86	7	1.24	7	1.64	Yes	2
1991-119:09.38.08.0	42.50	43.50	0.00	5	5	3.53	4	4.48	3	0.93	3	1.17	No	4
1991-119:09.38.34.0	42.50	43.50	0.00	4	4	2.32	4	3.23	3	1.92	3	2.00	No	3
1991-119:09.41.52.0	42.50	43.50	0.00	4	3	1.23	2	7.25	1	0.93	1	2.02	Yes	3
1991-119:09.50.49.0	42.50	43.50	0.00	3	2	1.22	1	4.27	0	0.00	0	0.00	No	2
1991-119:09.54.37.0	42.50	43.50	0.00	6	5	2.87	4	5.33	3	1.01	3	1.42	Yes	4
1991-119:09.59.24.0	42.50	43.50	0.00	11	10	1.12	6	4.43	6	0.90	6	1.19	Yes	4
1991-119:10.01.15.0	42.50	43.50	0.00	9	8	2.32	5	2.94	5	0.94	5	1.05	Yes	4
1991-119:10.06.23.0	42.50	43.50	0.00	4	3	3.93	2	2.84	2	1.70	2	1.77	Yes	3
1991-119:10.08.37.0	42.50	43.50	0.00	3	2	1.02	1	4.27	0	0.00	0	0.00	Yes	-
1991-119:10.15.35.0	42.50	43.50	0.00	10	9	1.84	5	5.72	4	1.16	4	1.65	Yes	4
1991-119:10.15.57.0	42.50	43.50	0.00	5	5	2.26	4	4.98	3	0.98	3	1.35	No	4
1991-119:10.19.42.0	42.50	43.50	0.00	9	8	1.52	5	4.44	5	0.93	5	1.24	Yes	4
1991-119:10.30.42.0	42.50	43.50	0.00	6	5	1.21	4	6.01	3	0.91	3	1.54	Yes	4
1991-119:10.35 33.0	42.50	43.50	0.00	5	4	6.83	2	2.48	1	0.42	1	0.43	Yes	3
1991-119:10.41.00.0	42.50	43.50	0.00	4	3	1.35	2	3.48	1	0.43	1	0.52	Yes	3
1991-119:10.52.43.0	42.50	43.50	0.00	11	10	2.03	6	2.47	6	0.85	6	1.05	Yes	4
1991-119:10.53.05.0	42.50	43.50	0.00	3	3	4.25	2	10.16	2	1.30	2	2.19	No	-
1991-119:10.56.12.0	42.50	43.50	0.00	5	4	0.90	3	4.79	2	1.10	2	1.69	Yes	3
1991-119:11.04.31.0	42.50	43.50	0.00	9	8	2.01	4	4.34	4	0.60	4	0.94	Yes	4
1991-119:11.08.04.0	42.50	43.50	0.00	3	3	1.22	3	2.21	2	1.30	2	1.32	No	2
1991-119:11.10.14.0	42.50	43.50	0.00	10	9	2.34	5	6.35	4	0.72	4	1.42	Yes	4
1991-119:11.12.21.0	42.50	43.50	0.00	3	3	0.39	2	7.52	1	0.94	1	2.26	Yes	3
1991-119:11.38.38.0	42.50	43.50	0.00	4	3	0.46	2	2.29	1	0.14	1	0.14	Yes	3
1991-119:11.43.19.0	42.50	43.50	0.00	5	4	2.02	2	2.48	2	0.66	2	0.81	Yes	4
1991-119:11.5[illegible] 13	42.50	43.50	0.00	9	8	2.41	5	3.53	4	1.04	4	1.28	Yes	4
1991-119:1[illegible].56.0	42.50	43.50	0.00	10	9	2.98	6	6.76	5	0.77	5	1.57	Yes	4
1991-119:13.02.12.0	42.50	43.50	0.00	4	3	1.13	2	3.29	2	0.41	2	0.64	Yes	4
1991-119:1[illegible].12.38.0	42.50	43.50	0.00	6	5	1.79	3	5.06	3	0.23	3	0.97	Yes	4
1991-119:[illegible].13.26.0	42.50	43.50	0.00	4	3	2.05	2	6.46	2	1.01	2	1.50	No	4
1991-119:13.19.50.0	42.50	43.50	0.00	6	5	0.80	2	2.29	1	0.14	1	0.14	Yes	4
19[illegible]1-119:13.27.17.0	42.50	43.50	0.00	9	8	2.64	4	7.83	3	0.33	3	1.67	Yes	4
1991-119:13.49.59.0	42.50	43.50	0.00	7	6	0.67	3	2.94	2	0.66	2	0.73	Yes	4
1991-119:13.53.10.0	42.50	43.50	0.00	5	4	0.82	2	2.93	2	0.72	2	1.03	Yes	4
1991-119:14.00.28.0	42.50	43.50	0.00	4	3	2.38	1	0.68	1	0.20	1	0.21	Yes	4
1991-119:14.20.57.0	42.50	43.50	0.00	3	2	0.49	1	4.27	1	0.82	1	1.10	No	2
1991-119:14.43.08.0	42.50	43.50	0.00	11	10	2.34	6	2.84	6	0.80	6	1.03	Yes	4
1991-119:14.43.30.0	42.50	43.50	0.00	3	3	4.90	2	6.21	2	0.31	2	1.11	No	-
1991-119:15.28.48.0	42.50	43.50	0.00	6	5	1.29	4	7.45	4	0.95	4	1.75	Yes	4
1991-119:15.38.56.0	42.50	43.50	0.00	4	3	2.38	1	11.77	1	1.90	1	2.73	Yes	2
1991-119:16.03.09.0	42.50	43.50	0.00	6	6	5.62	3	2.55	3	1.03	3	1.14	Yes	3
1991-119:16.12.49.0	42.50	43.50	0.00	5	4	1.55	2	5.70	2	1.06	2	1.47	Yes	3
1991-119:16.22.27.0	42.50	43.50	0.00	5	4	1.45	2	2.29	1	0.64	1	0.64	Yes	4

Nph - Number of associated phases
Nsta - Number of stations
Tres - Mean absolute time residual
Nazi - Number of azimuth observations
Azres - Mean absolute azimuth residual
Nslow - Number of slowness observations
Slres - Mean absolute slowness residual
Nslv - Number of horizontal slowness vector observations
Slvres - Mean absolute horizontal slowness vector residual
Starov - Event confirmed by Starovoit et al catalogue (Yes/No)
EIDCs - Number of confirming EIDCs

Table 7.6.2. List of event parameters for the events detected on the generalized beam steered to 42.5°N, 43.5°E for day 119 (29 April) 1991. See text for details. (Page 1 of 2)

1991-119:16.48.43.0	42.50	43.50	0.00	10	9	2.73	5	2.11	5	1.20	5	1.34	Yes	4
1991-119:16.49.59.0	42.50	43.50	0.00	8	7	2.03	3	7.88	2	1.59	2	2.58	Yes	4
1991-119:16.58.51.0	42.50	43.50	0.00	7	6	2.30	3	4.27	2	1.52	2	1.67	Yes	4
1991-119:17.10.29.0	42.50	43.50	0.00	6	5	1.42	2	2.98	1	0.43	1	0.47	Yes	4
1991-119:17.20.40.0	42.50	43.50	0.00	3	3	0.57	3	6.21	2	0.89	2	1.55	No	4
1991-119:17.21.27.0	42.50	43.50	0.00	7	6	1.99	4	3.32	3	1.48	3	1.63	Yes	4
1991-119:17.34.43.0	42.50	43.50	0.00	4	3	2.01	1	3.77	1	1.83	1	1.94	Yes	3
1991-119:17.55.01.0	42.50	43.50	0.00	9	8	2.07	4	3.45	3	1.17	3	1.28	Yes	4
1991-119:18.14.44.0	42.50	43.50	0.00	5	4	3.85	2	5.75	1	1.19	1	1.83	Yes	4
1991-119:18.17.22.0	42.50	43.50	0.00	4	3	2.92	1	1.73	1	1.05	1	1.09	Yes	2
1991-119:18.23.18.0	42.50	43.50	0.00	10	10	2.62	6	4.09	6	1.11	6	1.36	Yes	4
1991-119:18.30.43.0	42.50	43.50	0.00	9	9	2.37	5	3.86	4	1.22	4	1.38	Yes	4
1991-119:18.51.37.0	42.50	43.50	0.00	4	3	1.88	2	5.78	2	0.65	2	1.36	Yes	4
1991-119:19.07.05.0	42.50	43.50	0.00	12	11	1.59	7	3.81	6	1.17	6	1.38	Yes	4
1991-119:19.16.06.0	42.50	43.50	0.00	6	5	1.91	2	4.96	2	0.74	2	1.06	Yes	4
1991-119:19.19.58.0	42.50	43.50	0.00	10	9	2.78	5	4.10	4	0.77	4	1.22	Yes	4
1991-119:19.26.52.0	42.50	43.50	0.00	3	2	0.18	0	0.00	0	0.00	0	0.00	Yes	-
1991-119:19.44.56.0	42.50	43.50	0.00	9	8	2.26	4	1.85	4	0.50	4	0.69	Yes	4
1991-119:19.52.52.0	42.50	43.50	0.00	4	4	1.40	3	2.24	2	0.18	2	0.24	Yes	4
1991-119:20.01.42.0	42.50	43.50	0.00	3	2	0.21	1	7.85	1	2.17	1	2.52	Yes	-
1991-119:20.12.08.0	42.50	43.50	0.00	9	8	1.77	4	5.59	4	0.84	4	1.33	No	4
1991-119:20.19.47.0	42.50	43.50	0.00	5	4	1.91	3	3.06	3	0.99	3	1.16	Yes	4
1991-119:20.24.45.0	42.50	43.50	0.00	10	9	1.88	5	4.13	4	1.07	4	1.34	Yes	4
1991-119:20.32.54.0	42.50	43.50	0.00	9	9	0.87	5	3.50	4	1.48	4	1.63	Yes	4
1991-119:21.23.16.0	42.50	43.50	0.00	4	3	1.93	1	1.27	1	0.41	1	0.46	No	2
1991-119:21.24.11.0	42.50	43.50	0.00	8	8	1.34	5	7.72	4	1.07	4	1.91	Yes	4
1991-119:21.25.24.0	42.50	43.50	0.00	4	4	0.95	3	8.45	2	0.77	2	1.96	No	4
1991-119:21.30.32.0	42.50	43.50	0.00	3	2	2.58	0	0.00	0	0.00	0	0.00	No	3
1991-119:22.25.07.0	42.50	43.50	0.00	3	2	1.54	0	0.00	0	0.00	0	0.00	No	2
1991-119:22.28.25.0	42.50	43.50	0.00	10	9	2.62	5	5.00	4	0.61	4	1.29	Yes	4
1991-119:23.10.54.0	42.50	43.50	0.00	4	3	0.70	1	4.27	0	0.00	0	0.00	Yes	2
1991-119:23.17.56.0	42.50	43.50	0.00	3	2	1.13	1	4.27	0	0.00	0	0.00	Yes	-
1991-119:23.32.32.0	42.50	43.50	0.00	9	8	2.68	4	5.26	3	0.87	3	1.27	Yes	4
1991-119:23.32.50.0	42.50	43.50	0.00	3	3	6.58	2	4.89	2	0.70	2	1.27	No	-
1991-119:23.34.18.0	42.50	43.50	0.00	3	3	0.55	2	7.25	1	0.03	1	1.87	No	4

Table 7.6.2 (cont.). (Page 2 of 2)

Source	Total number of events	Confirmed by Starovoit et al's catalogue	Not in Starovoit et al's catalogue
Starovoit et al catalogue	115	115	0
Canberra EIDC (reprocessed)	57	48	9
Stockholm EIDC (reprocessed	73	62	11
Moscow EIDC (reprocessed)	76	61	15
Washington EIDC (reprocessed)	71	58	13
GBF (automatic)	82	65	17
NEIC monthly list	35	35	0
QED list	6	6	0

Table 7.6.3. Number of events reported by various sources for the W. Caucasus sequence of 29 April 1991. From our analysis, all reported GBF events for that day were real (no false alarms). A few events reported by the EIDCs or GBF were close in time (possibly multiple events) and therefore not included as separate events in Starovoit et al's catalogue.

a) GBF detection list, day 112-118

Origin time	Lat	Lon	Depth	Nph	Nsta	Tres	Nazi	Azres	Nslow	Slres	Nslv	Slvres	Actual event location
1991-114:10.54.48.0	42.50	43.50	0.00	3	3	3.07	3	5.01	3	0.32	3	0.78	Turkey (40N 41E)
1991-116:17.09.43.0	42.50	43.50	0.00	5	5	3.52	5	4.50	5	1.81	5	1.98	S. Iran (28N 55E)
1991-116:22.28.43.0	42.50	43.50	0.00	3	2	1.93	1	3.77	1	2.52	1	2.60	Tadzik (39N 71E)
1991-117:03.32.11.0	42.50	43.50	0.00	5	5	5.82	2	4.04	2	0.92	2	1.13	Turkey (40N 44E)
1991-117:09.54.01.0	42.50	43.50	0.00	3	3	4.68	2	12.81	2	1.48	2	2.71	Hindu Kush (37N 71E)
1991-118:03.46.32.0	42.50	43.50	0.00	3	3	1.16	3	2.86	3	1.13	3	1.28	Pers. Gulf (28N 51E)

b) Number of GBF detections by day

Day	Number of Detections
112	0
113	0
114	1
115	0
116	2
117	2
118	1
Total	6

Table 7.6.4. Detection statistics for the W. Caucasus GBF beam covering the one-week period prior to day 119. 1991. Note that two of the six events were actually in the Caucasus area, while the four remaining detections were "side lobes" from large events elsewhere in Eurasia. Consequently, there were only 4 "false alarms" for the entire 7-day period.

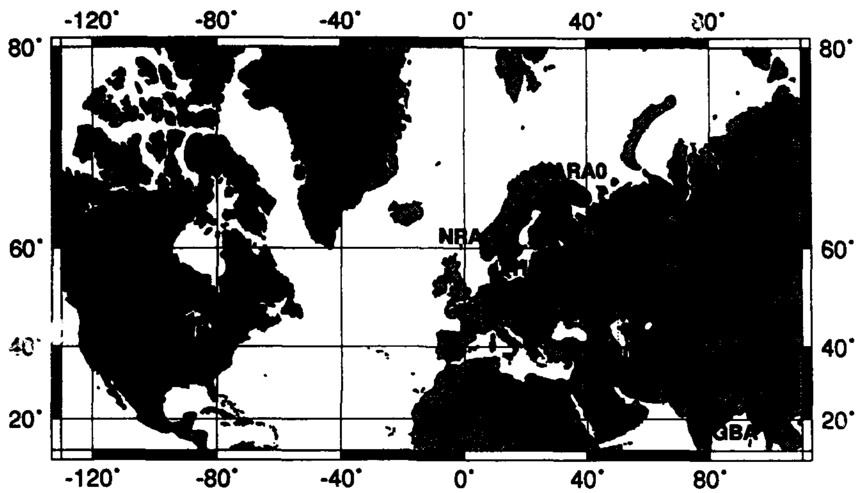

Fig. 7.6.1. Map showing the stations used for GBF processing of the Caucasus aftershock sequence.