The Research Council of Norway (NFR)

NORSAR

NORSAR Scientific Report No. 2-95/96

Semiannual Technical Summary

1 October 1995 - 31 March 1996

Kjeller, May 1996

APPROVED FOR PUBLIC RELEASE, DISTRIBUTION UNLIMITED

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS Not applicable
2a. SECURITY CLASSIFICATION AUTHORITY Not Applicable 2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution unlimited
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Scientific Rep. 2-95/96	5. MONITORING ORGANIZATION REPORT NUMBER(S) Scientific Rep. 2-95/96
6a. NAME OF PERFORMING ORGANIZATION NFR/NORSAR — 6b. OFFICE SYMBOL *(If applicable)*	7a. NAME OF MONITORING ORGANIZATION HQ/AFTAC/TTS
6c. ADDRESS *(City, State, and ZIP Code)* Post Box 51 N-2007 Kjeller, Norway	7b. ADDRESS *(City, State, and ZIP Code)* Patrick AFB, FL 32925-6001
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Advanced Research Projects Agency/NTPO — 8b. OFFICE SYMBOL *(If applicable)* NMRO/NTPO	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER Contract No. F08650-96-C-0001
8c. ADDRESS *(City, State, and ZIP Code)* 1901 N. Moore St., Suite 609 Arlington, VA 22209	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO.: R&D PROJECT NO.: NORSAR Phase 3 TASK NO.: SOW Task 5.0 WORK UNIT ACCESSION NO.: Sequence No. 004A2

11. TITLE *(Include Security Classification)*
Semiannual Technical Summary, 1 October 1995 - 31 March 1996

12. PERSONAL AUTHOR(S)

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT *(Year, Month, Day)*	15. PAGE COUNT
Scientific Summary	FROM 1 OCT 95 TO 31 MAR 96	1996 May	152

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
FIELD	GROUP	SUB-GROUP	
8	11		NORSAR, Norwegian Seismic Array

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

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(cont.)

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION
22a. NAME OF RESPONSIBLE INDIVIDUAL Mr. Michael C. Baker	22b. TELEPHONE *(Include Area Code)* (407) 494-4219 — 22c. OFFICE SYMBOL AFTAC/TTS

DD Form 1473, JUN 86 — *Previous editions are obsolete.* — SECURITY CLASSIFICATION OF THIS PAGE

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

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

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

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

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

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

The work at the Norwegian NDC has focused on operational aspects, like stable forwarding of data using the Alpha protocol, proper handling of outgoing and incoming messages, improvement to routines for dealing with failure of critical components, as well as implementation of other measures to ensure maximum reliability and robustness in providing data to the IDC. Messages in the appropriate format are sent to the IDC whenever we detect a problem that has affected or will affect the routine provision of data to the IDC. The goal of 99 per cent or better data availability at the NDC has been reached for extended periods of time for all the Norwegian primary stations, but over the entire 18-month period, the average data availability is less. Thus a significant hardening of critical components is needed.

In the near future, we will start modifying the Norwegian station participation in GSETT-3 so as to become in agreement with what is now envisaged for the International Monitoring System (IMS) that will be installed to verify compliance with a future CTBT. The NORSAR array data will be included in the IDC processing once the processing software developed by NOR_NDC becomes operational at the IDC. The Spitsbergen array will at a suitable time change status from being a primary to becoming an auxiliary station in GSETT-3, in conformity with its status in IMS. Subject to the availability of appropriate funds, we plan to make the seismic station on Jan Mayen island operational in GSETT-3 by the end of 1996. This station is also in the list of envisaged IMS auxiliary stations.

Section 7.2 describes NORSAR's status and plans for implementing algorithms at the GSETT-3 IDC. A prototype system for global Threshold Monitoring was delivered to the IDC already in October 1994, and a significant software development effort has taken place to integrate the TM software into the operational system at the IDC. The resulting modules were delivered in June 1996. At the same time, software for processing of data from the NORSAR teleseismic array was delivered, and both of these systems are due to be operational at the IDC in the near future. Current plans comprise inter alia the finalization of an operational module for automatic onset time analysis, previously described in NORSAR Semiannual Technical Summaries. Algorithms to improve the tuning of signal processing for GSETT-3 arrays and to implement automatic event post-processing are currently under development.

Section 7.3 is a paper entitled "Quality assessment of automatic onset times estimated by an autoregressive method". The paper is a follow-up study of previously reported work on an autoregressive onset time estimation method denoted AR-AIC. The purpose is to develop quality metrics to assist in judging the reliability of automatic onset estimates. A database of 83 P-phases with SNR > 100 recorded at different GSETT-3 stations has been used in this study. The arrival times of each of the phases were picked manually and stored for reference. By successively reducing the SNR by adding scaled noise samples, the performance of the AR-AIC method and the associated quality measures were evaluated using the manually picked onsets as the reference.

The results show that the quality mesurements made on the optimally filtered beam or single trace can be used both for selection of the best AR-AIC model and as a tool for identifying onsets that have a high likelihood of being wrong. The data set should, however, be expanded before concluding on any final decision rules. It should also be noticed that the approach of comparing various quality metrics can easily be extended to cases where several different models or parameterizations of the AR-AIC method are run in parallel, and we plan to test such approaches in the future.

Section 7.4, entitled "Monitoring a CTBT: Lessons learned from the GSETT-3 experiment" is a paper which was presented at the ARPA CTBT Monitoring Technologies Conference, San Juan, Puerto Rico, in January 1996. The paper gives an overview over how the GSETT-3 experience could be useful in preparing the establishment of a CTBT monitoring system. It addresses the experience at the IDC, NDCs, stations and communications, with emphasis on the efforts required for enlisting the necessary international participation and organizing appropriate training of personnel. The benefits demonstrated during GSETT-3 of careful planning, including limited small-scale tests, a step-by-step approach to gain operational experience, as well as a continued and focused evaluation effort during the entire experiment are pointed out.

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Section 7.6 contains an analysis of the seismic event on Novaya Zemlya on 13 June 1995. This event was reported in the REB, with m_b=3.4, and was located by the IDC about 100 km west of the islands, but with a large location ellipse that did not exclude an onshore location. We have carried out a detailed analysis of the 13 June 1995 event, with comparisons to previously recorded events at Novaya Zemlya, including past nuclear explosions as well as the well-known New Year's event of 31 December 1992. In our analysis, we have benefited from access to additional data from stations on Russian territory provided through a cooperative agreement with the Kola Regional Seismological Centre, and we have thus been in a position to determine the epicenter and signal characteristics more accurately than was possible at the time the REB was generated. Our analysis thus shows that the event was located near the coast of the northern Novaya Zemlya island, about 100 km north of the test site.

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

Section 7.7 is an investigation of the double-couple earthquake mechanisms and its influence on m_b residuals. It demonstrates that a dependency exists between the double-couple radiation of earthquakes and the observed station magnitudes and consequently the corresponding m_b-values. If fault-plane solutions are available, it is easy to correct for this effect. Normally such solutions are only known for larger events, but whenever individual station m_b-values are needed with a very high accuracy (e.g., to investigate magnitude relations), or when station-magnitude residuals should be estimated, the correction of amplitude observations for the double-couple radiation will reduce the scatter and should be taken into account. Also the NEIC and the ISC could calculate corrected m_b-values for all events with known double-couple radiation and publish them in their bulletins.

On the other hand, this study has shown that the effects of double-couple source radiation on short-period amplitude patterns is much smaller than the variations associated with other factors such as lateral heterogeneities in the earth. This means that when calculating *average* event magnitudes from a well-distributed global network, quite accurate values can be obtained even when the source mechanism is unknown.

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AFTAC Project Authorization	:	T/6141/NORSAR
ARPA Order No.	:	4138 AMD # 53
Program Code No.	:	0F10
Name of Contractor	:	Royal Norwegian Council for Scientific and Industrial Research (NTNF)
Effective Date of Contract	:	1 Oct 1995
Contract Expiration Date	:	30 Sep 1996
Project Manager	:	Frode Ringdal (63) 81 71 21
Title of Work	:	The Norwegian Seismic Array (NORSAR) Phase 3
Amount of Contract	:	$ 1,311,394
Contract Period Covered by Report	:	1 October 95 - 31 March 96

This research was supported by the Advanced Research Projects Agency of the Department of Defense and was monitored by AFTAC, Patrick AFB, FL32925, under contract no. F08650-96-C-0001.

NORSAR Contribution No. 598

Table of Contents

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Frode Ringdal

2 NORSAR Operation

2.1 Detection Processor (DP) operation

The operation of the NORSAR array was suspended on 1 September 1995 due to refurbishment work and the array brought back into operation on 13 November 1995. Backup during this period was provided by the NORESS array, co-located with NORSAR subarray 06C. NORESS continued to be in full operation during the refurbishment work.

Fig. 2.1.1 and the accompanying Table 2.1.1 both show the daily DP downtime for the days between 1 October 1995 and 31 March 1996. The monthly recording times and percentages are given in Table 2.1.2.

The breaks can be grouped as follows:

a)	Hardware failure	8
b)	Stops related to program work or error	0
c)	Hardware maintenance stops	0
d)	Power jumps and breaks	0
e)	TOD error correction	0
f)	Communication lines	0

The total downtime for the period was 1093 hours and 23 minutes, of which 1042.5 hours were due to refurbishment work.

J. Torstveit

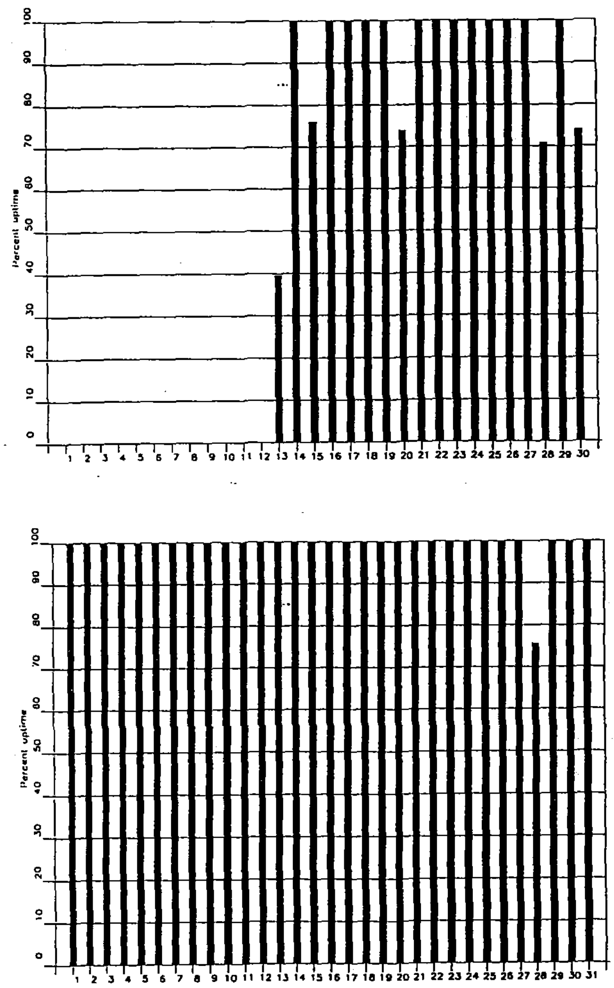

Fig. 2.1.1. Detection Processor uptime for November (Top) and December (bottom) 1995.

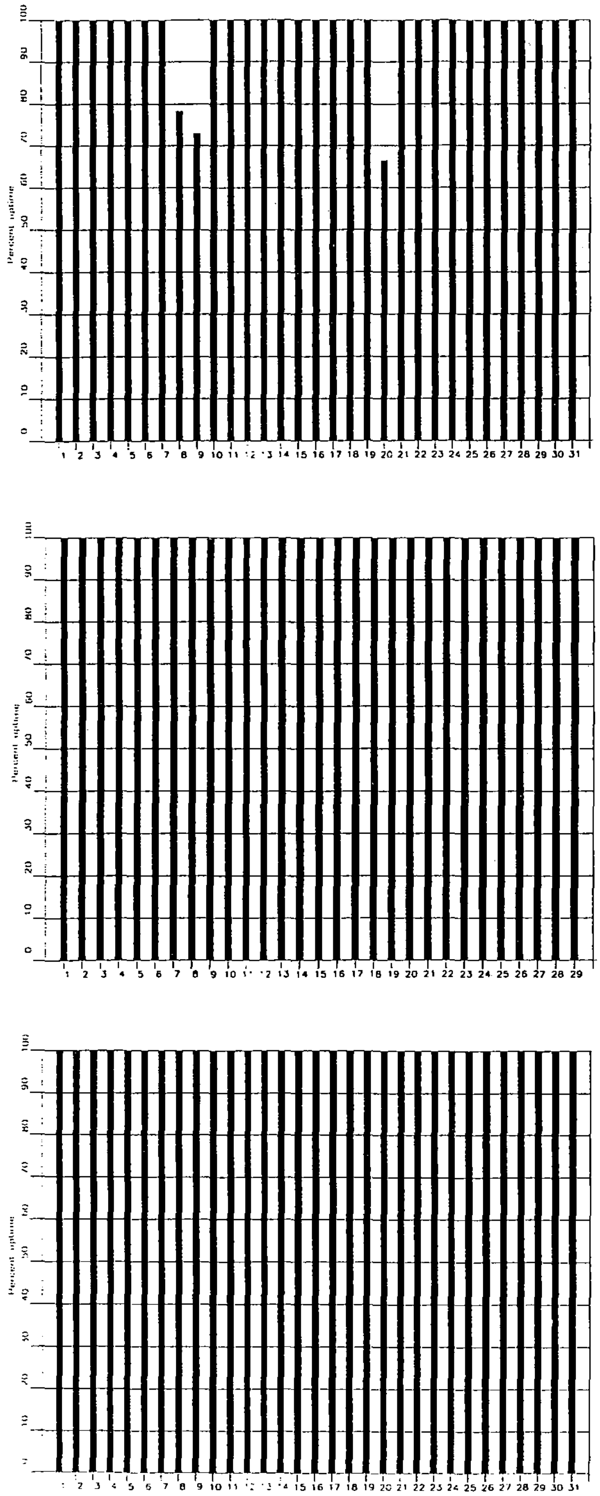

Fig. 2.1.1. Detection Processor uptime for January (top), February (middle) and March (bottom) 1996.

Date	Time	Cause
15 Nov	0029 - 0614	Hardware failure
20 Nov	0019 - 0636	Hardware failure
28 Nov	0019 - 0720	Hardware failure
30 Nov	0019 - 0634	Hardware failure
28 Dec	0126 - 0717	Hardware failure
08 Jan 09 Jan	1848 - - 0629	Hardware failure
20 Jan	0132 - 0935	Hardware failure

Table 2.1.1. The major downtimes in the period 1 October 1995 - 31 March 1996.

Month	DP Uptime Hours	DP Uptime %	No. of DP Breaks	No. of Days with Breaks	DP MTBF* (days)
Oct 95	0	0	0	0	0
Nov 95	392.11	54.46	5	5	2.9
Dec 95	738.12	99.21	1	1	15.4
Jan 96	724.28	97.35	2	3	10.1
Feb 96	695.93	99.99	1	1	14.5
Mar 96	744.00	100	0	0	

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

Table 2.1.2. Online system performance, 1 October 1995 - 31 March 1996.

2.2 Array Communications

As stated in Section 2.1, the final phase of the NORSAR refurbishment project continued until mid-November 1995, and the operation of the subarray communication lines was temporarily suspended during this period. Backup recordings were provided by NORESS, which essentially had no communication outages during this period.

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

From mid-November 1995 through March 1996, there were, with only a few exceptions, no significant communications outages at any of the NORSAR subarrays.

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

F. Ringdal

Table 2.2.1 (Page 1 of 6)
NORSAR/NORESS Communication Status Report
Month: October 1995

Day	Subarray							
	01A	01B	02B	02C	03C	04C	06C	NORESS
01	A	A	A	A	A	A	A	X
02	A	A	A	A	A	A	A	X
03	A	A	A	A	A	A	A	X
04	A	A	A	A	A	A	A	X
05	A	A	A	A	A	A	A	X
06	A	A	A	A	A	A	A	X
07	A	A	A	A	A	A	A	X
08	A	A	A	A	A	A	A	X
09	A	A	A	A	A	A	A	X
10	A	A	A	A	A	A	A	X
11	A	A	A	A	A	A	A	X
12	A	A	A	A	A	A	A	X
13	A	A	A	A	A	A	A	X
14	A	A	A	A	A	A	A	X
15	A	A	A	A	A	A	A	X
16	A	A	A	A	A	A	A	X
17	A	A	A	A	A	A	A	X
18	A	A	A	A	A	A	A	X
19	A	A	A	A	A	A	A	X
20	A	A	A	A	A	A	A	X
21	A	A	A	A	A	A	A	X
22	A	A	A	A	A	A	A	X
23	A	A	A	A	A	A	A	X
24	A	A	A	A	A	A	A	X
25	A	A	A	A	A	A	A	X
26	A	A	A	A	A	A	A	X
27	A	A	A	A	A	A	A	X
28	A	A	A	A	A	A	A	X
29	A	A	A	A	A	A	A	X
30	A	A	A	A	A	A	A	X
31	A	A	A	A	A	A	A	X
Total hours normal operation	0	0	0	0	0	0	0	737
% normal operation	0	0	0	0	0	0	0	99

Legend:

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

Table 2.2.1 (Page 2 of 6)
NORSAR/NORESS Communication Status Report
Month: November 1995

Day	Subarray							
	01A	01B	02B	02C	03C	04C	06C	NORESS
01	A	A	A	A	A	A	A	X
02	A	A	A	A	A	A	A	X
03	A	A	A	A	A	A	A	X
04	A	A	A	A	A	A	A	X
05	A	A	A	A	A	A	A	X
06	A	A	A	A	A	A	A	X
07	A	A	A	A	A	A	A	X
08	A	A	A	A	A	A	A	X
09	A	A	A	A	A	A	A	X
10	A	A	A	A	A	A	A	X
11	A	A	A	A	A	A	A	X
12	A	A	A	A	A	A	A	X
13	A	X	X	X	A	A	X	X
14	A	X	X	X	X	A	X	X
15	A	X	X	X	X	A	X	X
16	A	X	X	X	X	A	X	X
17	A	X	X	X	X	A	X	X
18	A	X	X	X	X	A	X	X
19	A	X	X	X	X	A	X	X
20	A	X	X	X	X	X	X	X
21	X	X	X	X	X	X	X	X
22	X	X	A	X	X	X	X	X
23	X	X	X	X	X	X	X	X
24	X	X	X	X	X	X	X	X
25	X	X	X	X	X	A	X	X
26	X	X	X	X	X	A	X	X
27	X	X	X	X	X	X	X	X
28	X	X	X	X	X	X	X	X
29	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X
31	-	-	-	-	-	-	-	-
Total hours normal operation	240	432	408	432	408	216	432	716
% normal operation	33.3	60.0	56.7	60.0	56.7	30.0	60.0	99.5

Legend:

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

Table 2.2.1 (Page 3 of 6)
NORSAR Communication Status Report
Month: December 1995

Day	Subarray						
	01A	01B	02B	02C	03C	04C	06C
01	X	X	X	X	X	X	X
02	X	X	X	X	X	X	X
03	X	X	X	X	X	X	X
04	X	X	X	X	X	X	X
05	X	X	X	X	X	X	X
06	X	X	X	X	X	X	X
07	X	X	X	X	X	X	X
08	X	X	X	X	X	X	X
09	X	X	X	X	X	X	X
10	X	X	X	X	X	X	X
11	X	X	X	X	X	X	X
12	X	X	A	X	X	X	X
13	X	X	X	X	X	X	X
14	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X
16	X	X	X	X	X	X	X
17	X	X	X	X	X	X	X
18	X	X	X	X	X	X	X
19	X	X	X	X	X	X	X
20	X	X	X	X	X	A	X
21	X	X	X	X	X	A	X
22	X	X	X	X	X	X	X
23	X	X	X	X	X	X	X
24	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X
26	X	X	X	X	X	X	X
27	X	X	X	X	X	X	X
28	X	X	X	X	X	X	X
29	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X
31	X	X	X	X	X	X	X
Total hours normal operation	744	744	744	744	744	696	744
% normal operation	100	100	100	100	100	93.6	100

Legend:

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

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

Day	Subarray						
	01A	01B	02B	02C	03C	04C	06C
01	X	X	X	X	X	X	X
02	X	X	X	X	X	X	X
03	X	X	X	X	X	X	X
04	X	X	X	X	X	X	X
05	X	X	X	X	X	X	X
06	X	X	X	X	I	X	X
07	X	X	X	X	I	X	X
08	X	X	X	X	I	X	X
09	X	X	X	X	X	X	X
10	X	X	X	X	X	X	X
11	X	X	X	X	X	X	X
12	X	X	X	X	X	X	X
13	X	X	X	X	X	X	X
14	X	X	I	X	X	X	X
15	X	X	I	X	X	X	X
16	X	X	X	X	X	X	X
17	X	X	X	X	X	X	X
18	X	X	X	X	X	X	X
19	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X
21	X	X	X	X	X	X	X
22	X	X	X	X	X	X	X
23	X	X	X	X	X	X	X
24	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X
26	X	X	X	X	X	X	X
27	X	X	X	X	X	X	X
28	X	X	X	X	X	X	X
29	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X
31	X	X	X	X	X	X	X
Total hours normal operation	724	724	693	724	658	724	724
% normal operation	97.35	97.35	93.15	97.35	88.48	97.35	97.35

Legend:

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

Table 2.2.1 (Page 5 of 6)
NORSAR Communication Status Report
Month: February 1996

Day	Subarray						
	01A	01B	02B	02C	03C	04C	06C
01	X	X	X	X	X	X	X
02	X	X	X	X	X	X	X
03	X	X	X	X	X	X	X
04	X	X	X	X	X	X	X
05	X	X	X	X	X	X	X
06	X	X	X	X	X	X	X
07	X	X	X	X	X	X	X
08	X	X	X	X	X	X	X
09	X	X	X	X	X	X	X
10	X	X	X	X	X	X	X
11	X	X	X	X	X	X	X
12	X	X	X	X	X	X	X
13	X	X	X	X	X	X	X
14	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X
16	X	X	X	X	X	X	X
17	X	X	X	X	X	X	X
18	X	X	X	X	X	X	X
19	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X
21	X	X	X	X	X	X	X
22	X	X	X	X	X	X	X
23	X	X	X	X	X	X	X
24	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X
26	X	X	X	X	X	X	X
27	X	X	X	X	X	A	X
28	X	X	X	X	X	X	X
29	X	X	A	X	X	X	X
30							
31							
Total hours normal operation	696	696	680	696	696	679	696
% normal operation	100	100	97.70	100	100	97.60	100

Legend:

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

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

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

Legend:

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

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		
Oct 95	0	0	0	0	0	0
Nov 95	0	0	0	0	0	0
Dec 95	14184	1805	640	54	694	22.4
Jan 96	14469	1890	244	75	319	10.3
Feb 96	11957	961	282	73	355	12.2
Mar 96	10272	928	404	62	466	15.0
			1570	264	1834	15.0

Table 2.3.1. Detection and Event Processor statistics, 1 October 1995 - 31 March 1996.

NORSAR Detections

The number of detections (phases) reported by the NORSAR detector during day 274, 1995, through day 091, 1996, was 55,323, giving an average of 398 detections per processed day (139 days processed). Table 2.3.2 shows daily and hourly distribution of detections for NORSAR.

B. Paulsen

NB2 .DPX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
274	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	Oct 01 Sunday
275	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	Oct 02 Monday
276	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	Oct 03 Tuesday
277	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	Oct 04 Wednesday
278	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	Oct 05 Thursday
279	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	Oct 06 Friday
280	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	Oct 07 Saturday
281	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	Oct 08 Sunday
282	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	Oct 09 Monday
283	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	Oct 10 Tuesday
284	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	Oct 11 Wednesday
285	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	Oct 12 Thursday
286	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	Oct 13 Friday
287	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	Oct 14 Saturday
288	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	Oct 15 Sunday
289	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	Oct 16 Monday
290	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	Oct 17 Tuesday
291	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	Oct 18 Wednesday
292	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	Oct 19 Thursday
293	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	Oct 20 Friday
294	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	Oct 21 Saturday
295	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	Oct 22 Sunday
296	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	Oct 23 Monday
297	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	Oct 24 Tuesday
298	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	Oct 25 Wednesday
299	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	Oct 26 Thursday
300	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	Oct 27 Friday
301	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	Oct 28 Saturday
302	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	Oct 29 Sunday
303	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	Oct 30 Monday
304	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	Oct 31 Tuesday
305	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	Nov 01 Wednesday
306	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	Nov 02 Thursday
307	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	Nov 03 Friday
308	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	Nov 04 Saturday
309	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	Nov 05 Sunday
310	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	Nov 06 Monday
311	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	Nov 07 Tuesday
312	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	Nov 08 Wednesday
313	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	Nov 09 Thursday
314	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	Nov 10 Friday
315	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	Nov 11 Saturday
316	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	Nov 12 Sunday
317	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	Nov 13 Monday
318	16	15	11	3	8	13	36	43	45	40	54	43	46	44	58	35	12	11	3	4	11	5	8	3	567	Nov 14 Tuesday
319	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	0	2	9	23	Nov 15 Wednesday
320	0	6	5	3	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	22	Nov 16 Thursday
321	0	2	2	0	0	2	0	0	1	0	1	0	2	4	0	0	3	0	0	0	4	4	2	0	27	Nov 17 Friday
322	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	1	6	Nov 18 Saturday
323	8	0	0	0	0	0	0	2	0	0	2	0	0	0	1	0	0	1	0	0	0	0	3	1	18	Nov 19 Sunday
324	2	0	0	0	0	0	0	0	1	0	0	3	1	0	0	1	0	0	3	0	0	0	0	1	12	Nov 20 Monday
325	0	0	0	0	2	1	0	0	1	0	2	3	0	1	4	0	0	0	1	0	1	0	1	0	17	Nov 21 Tuesday
326	0	0	0	0	8	0	0	2	1	0	0	21	14	2	1	1	0	0	0	0	0	5	1	0	56	Nov 22 Wednesday
327	0	0	0	0	7	0	0	0	0	0	0	2	1	0	7	1	0	0	6	0	0	0	0	0	24	Nov 23 Thursday
328	0	0	1	1	0	0	1	0	0	2	3	0	2	4	23	14	31	15	15	18	15	17	31	18	211	Nov 24 Friday
329	22	16	18	26	20	20	21	18	14	14	20	14	25	16	10	19	14	22	23	18	36	22	18	11	457	Nov 25 Saturday

Table 2.3.2 (Page 1 of 4)

NB2 .DPX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
330	17	19	15	21	13	21	22	13	14	13	19	15	5	17	19	14	12	15	14	18	22	20	15	22	395	Nov 26 Sunday
331	13	20	16	20	18	16	9	6	2	4	2	6	4	6	16	9	32	22	24	34	24	17	21	29	370	Nov 27 Monday
332	9	0	0	0	0	0	1	15	3	13	8	20	28	11	55	17	38	20	23	29	30	30	33	35	418	Nov 28 Tuesday
333	16	39	94	70	99	61	79	45	17	4	18	15	9	5	16	33	33	17	18	14	25	34	28	16	805	Nov 29 Wednesday
334	12	0	0	0	0	25	7	9	8	6	4	11	22	24	16	14	8	12	10	4	14	11	11	16	244	Nov 30 Thursday
335	28	20	21	15	17	14	12	16	8	9	11	4	8	12	15	16	12	15	16	16	16	19	18	9	347	Dec 01 Friday
336	23	27	15	25	24	22	20	16	17	13	14	13	18	14	20	18	19	32	49	63	51	23	32	30	598	Dec 02 Saturday
337	34	29	21	29	30	11	22	20	28	33	29	16	32	30	30	17	26	17	89	80	82	61	62	51	879	Dec 03 Sunday
338	50	47	38	25	33	25	19	24	29	24	11	15	23	26	11	19	15	14	17	24	23	18	12	22	564	Dec 04 Monday
339	34	23	24	21	19	11	22	4	5	1	12	11	12	20	9	23	2	5	29	14	11	13	16	24	365	Dec 05 Tuesday
340	13	31	20	21	14	6	7	3	6	1	4	2	17	21	11	2	5	4	12	5	7	10	16	18	256	Dec 06 Wednesday
341	18	14	19	33	17	18	10	8	6	9	14	17	20	36	7	1	19	17	9	23	18	20	15	13	381	Dec 07 Thursday
342	15	21	16	25	20	12	19	18	21	9	7	19	10	18	10	21	10	10	17	25	24	7	22	18	394	Dec 08 Friday
343	25	26	22	22	26	23	18	16	14	24	27	21	20	21	33	21	22	23	27	22	24	31	19	22	549	Dec 09 Saturday
344	21	21	20	20	24	29	23	20	28	21	24	21	14	16	22	20	17	16	13	3	15	14	29	30	481	Dec 10 Sunday
345	26	23	28	12	26	20	22	10	9	4	4	7	9	7	16	6	7	10	14	16	5	6	9	8	304	Dec 11 Monday
346	14	15	15	9	10	12	6	7	6	3	16	6	8	3	17	9	11	8	13	9	17	16	15	17	262	Dec 12 Tuesday
347	22	15	12	12	14	14	22	9	12	10	9	10	17	13	13	8	15	13	12	8	18	15	17	20	330	Dec 13 Wednesday
348	11	22	29	18	14	15	13	7	11	9	15	12	4	19	6	6	9	11	1	6	9	19	8	11	285	Dec 14 Thursday
349	5	12	23	18	12	12	8	2	15	6	10	14	4	28	14	22	13	16	13	20	14	16	13	42	352	Dec 15 Friday
350	21	14	17	20	18	21	10	12	13	8	21	5	14	12	6	11	5	8	1	12	13	4	7	8	281	Dec 16 Saturday
351	9	28	16	17	14	12	12	19	23	17	20	14	17	9	9	15	15	20	7	17	10	23	16	18	377	Dec 17 Sunday
352	18	18	19	20	16	19	13	7	12	9	5	7	16	12	18	10	17	14	14	15	10	17	8	11	325	Dec 18 Monday
353	17	25	24	25	18	12	19	19	12	11	22	8	24	18	33	4	12	16	15	13	14	17	14	30	422	Dec 19 Tuesday
354	16	17	17	14	20	17	14	16	13	11	13	18	14	11	9	14	22	12	17	15	19	18	19	7	363	Dec 20 Wednesday
355	13	22	16	20	7	14	16	5	12	10	12	14	15	14	13	14	14	18	20	17	19	11	10	24	350	Dec 21 Thursday
356	20	16	20	16	23	15	21	8	15	6	13	17	19	27	21	18	29	20	22	14	21	22	10	29	442	Dec 22 Friday
357	16	19	28	16	18	42	17	29	23	28	32	24	32	24	30	22	39	36	25	32	29	22	22	25	630	Dec 23 Saturday
358	19	23	19	20	21	22	21	23	22	26	19	18	18	22	37	25	20	16	25	22	24	27	25	20	534	Dec 24 Sunday
359	21	19	36	26	23	43	30	29	27	21	28	21	20	13	20	24	33	36	36	38	40	37	36	32	689	Dec 25 Monday
360	33	37	32	32	35	36	26	36	23	17	26	16	30	14	19	23	16	25	27	27	32	38	31	30	661	Dec 26 Tuesday
361	50	36	19	40	34	27	22	30	30	19	20	21	26	20	20	24	25	33	25	35	42	30	34	38	700	Dec 27 Wednesday
362	38	17	0	0	0	0	0	67	47	35	24	14	23	22	29	51	52	38	29	32	36	33	41	18	646	Dec 28 Thursday
363	28	17	22	20	18	20	22	21	27	23	19	19	18	30	26	28	23	23	35	33	31	18	16	15	552	Dec 29 Friday
364	25	28	20	11	26	26	23	23	18	14	15	13	39	20	12	21	23	27	20	13	12	17	16	13	475	Dec 30 Saturday
365	18	10	12	25	13	8	12	14	12	11	19	17	23	13	19	30	33	14	20	16	18	21	17	22	417	Dec 31 Sunday
1	8	16	18	16	22	20	22	26	31	39	40	26	27	24	14	21	37	20	18	24	24	27	18	19	557	Jan 01 Monday
2	26	27	25	27	28	27	38	23	14	34	16	17	18	15	17	30	29	25	33	24	29	25	44	37	628	Jan 02 Tuesday
3	31	30	32	34	37	18	19	15	36	20	20	16	29	27	17	20	24	25	12	27	31	30	33	36	619	Jan 03 Wednesday
4	39	34	35	30	24	29	22	26	18	22	13	10	30	20	20	18	23	21	27	25	33	25	30	33	607	Jan 04 Thursday
5	44	34	35	48	51	45	28	28	22	21	22	10	17	10	16	30	20	32	47	42	44	57	50	44	797	Jan 05 Friday
6	46	38	56	46	54	52	40	31	25	26	31	15	21	20	45	34	42	40	38	44	39	32	53	55	923	Jan 06 Saturday
7	38	51	33	33	44	22	28	33	26	29	17	25	32	34	29	24	39	34	26	24	48	79	24	30	802	Jan 07 Sunday
8	47	32	36	34	52	97	92	81	53	57	53	32	32	34	41	21	20	17	12	0	0	0	0	0	843	Jan 08 Monday
9	0	0	0	0	0	0	0	18	12	24	16	12	13	21	15	17	18	12	18	15	25	13	20	16	285	Jan 09 Tuesday
10	17	23	23	19	20	20	22	12	12	11	6	10	16	15	40	38	42	30	34	30	32	34	63	39	608	Jan 10 Wednesday
11	34	46	38	38	58	47	18	32	20	13	19	15	58	10	23	34	18	18	21	18	17	32	32	15	674	Jan 11 Thursday
12	24	30	55	21	36	8	15	17	15	10	36	8	21	30	29	25	22	20	35	54	41	44	23	42	661	Jan 12 Friday
13	45	32	44	38	31	43	59	44	23	34	31	25	39	38	38	26	29	24	19	35	30	40	50	29	846	Jan 13 Saturday
14	38	47	49	38	29	34	34	37	33	30	42	40	43	47	30	51	36	30	25	29	34	46	19	19	860	Jan 14 Sunday
15	36	47	37	52	29	23	19	16	15	26	17	6	9	54	39	16	16	20	31	35	25	38	40	39	685	Jan 15 Monday
16	34	41	37	28	46	46	32	25	9	9	9	10	16	14	9	7	10	6	6	11	5	10	13	14	447	Jan 16 Tuesday
17	21	14	17	18	15	11	8	2	4	3	10	16	22	19	8	6	8	12	6	7	6	6	10	14	263	Jan 17 Wednesday
18	16	17	10	28	21	12	10	5	9	18	4	6	8	6	15	14	11	12	10	17	19	25	10	12	315	Jan 18 Thursday
19	15	20	24	9	19	13	7	4	1	6	7	9	14	10	17	10	16	11	22	16	14	8	13	16	301	Jan 19 Friday
20	8	9	0	0	0	0	0	0	0	3	7	10	12	9	18	16	11	14	14	10	21	15	23	16	216	Jan 20 Saturday

Table 2.3.2. (Page 2 of 4)

NB2 .DPX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
21	17	15	37	10	8	9	13	13	12	4	15	11	15	18	13	12	9	10	10	19	21	31	22	20	364	Jan 21 Sunday
22	26	13	24	21	10	11	13	7	10	10	4	9	8	9	13	5	4	10	9	13	9	12	5	20	275	Jan 22 Monday
23	17	17	18	8	17	14	8	6	5	2	5	18	16	13	6	6	9	16	7	4	17	4	11	9	253	Jan 23 Tuesday
24	9	9	12	7	4	15	9	5	3	18	4	8	2	15	7	8	6	12	10	11	2	9	5	6	196	Jan 24 Wednesday
25	8	9	14	12	13	6	8	7	6	12	16	5	18	11	5	7	16	12	24	9	16	11	15	6	266	Jan 25 Thursday
26	10	15	14	10	15	17	6	4	8	11	7	14	12	9	10	13	16	16	21	13	19	5	14	8	287	Jan 26 Friday
27	12	16	11	17	14	17	10	9	19	12	21	7	25	18	13	15	19	14	16	14	10	18	15	19	361	Jan 27 Saturday
28	19	16	20	27	14	19	22	14	22	16	15	12	17	19	15	11	17	10	12	19	11	8	10	12	377	Jan 28 Sunday
29	10	13	8	7	13	5	7	12	4	1	11	3	10	28	11	6	20	10	8	3	6	12	10	17	235	Jan 29 Monday
30	17	17	28	11	20	23	6	6	3	3	14	6	13	9	4	8	8	16	14	12	13	14	38	29	332	Jan 30 Tuesday
31	33	19	30	31	15	25	16	6	2	8	6	10	13	8	4	2	17	8	2	14	24	28	23	17	361	Jan 31 Wednesday
32	27	22	18	26	33	5	11	12	6	2	11	7	9	20	13	18	11	8	11	11	9	4	5	5	304	Feb 01 Thursday
33	29	14	5	9	14	19	4	0	3	6	3	13	25	8	12	14	11	8	22	13	16	21	19	18	306	Feb 02 Friday
34	20	17	19	26	22	22	16	24	17	24	24	18	35	31	14	18	14	19	18	26	25	32	19	26	526	Feb 03 Saturday
35	26	22	19	23	30	29	24	19	20	9	13	18	25	13	9	14	14	19	6	15	12	22	12	42	455	Feb 04 Sunday
36	12	10	14	18	16	24	10	13	15	7	16	15	18	9	15	9	29	18	18	9	13	20	11	19	358	Feb 05 Monday
37	15	18	28	25	19	23	3	13	18	9	13	11	12	16	8	10	13	19	16	12	12	5	11	12	341	Feb 06 Tuesday
38	29	27	18	22	23	21	15	14	17	11	6	12	29	11	6	17	10	15	20	13	17	37	16	21	427	Feb 07 Wednesday
39	20	23	14	19	31	15	10	3	11	13	6	6	23	30	10	8	8	14	13	13	29	26	21	37	403	Feb 08 Thursday
40	46	22	36	24	21	24	18	4	11	26	12	9	18	12	18	17	15	17	17	17	15	8	16	10	433	Feb 09 Friday
41	11	21	12	24	13	14	19	19	13	20	23	18	18	18	19	13	18	29	13	18	16	21	16	25	431	Feb 10 Saturday
42	18	24	23	8	30	19	15	25	12	23	15	11	23	17	23	26	13	22	29	13	19	13	15	14	450	Feb 11 Sunday
43	18	20	20	15	17	12	4	7	6	15	3	3	21	3	5	10	8	10	10	13	7	3	5	8	243	Feb 12 Monday
44	15	13	21	17	16	12	10	7	6	15	7	12	21	9	15	16	18	22	18	18	19	24	10	15	356	Feb 13 Tuesday
45	20	20	15	17	14	14	2	7	6	8	13	18	14	12	11	11	13	9	11	18	20	14	12	15	314	Feb 14 Wednesday
46	22	13	21	26	15	18	7	13	10	14	13	20	16	23	26	29	29	21	20	25	22	17	18	11	449	Feb 15 Thursday
47	26	25	21	14	17	9	8	4	7	12	8	18	15	26	32	29	31	24	34	21	21	21	19	12	454	Feb 16 Friday
48	29	21	24	16	16	17	47	19	18	19	26	13	21	16	27	13	23	18	9	24	23	24	15	20	498	Feb 17 Saturday
49	16	38	40	12	23	22	19	17	27	19	31	12	19	12	20	20	19	20	25	28	15	12	23	18	507	Feb 18 Sunday
50	25	18	21	14	23	12	12	10	16	11	8	8	15	9	10	19	13	11	20	16	26	19	22	17	375	Feb 19 Monday
51	22	28	20	19	20	13	7	5	6	12	4	8	11	15	9	11	13	10	7	8	11	8	15	15	297	Feb 20 Tuesday
52	17	24	29	14	21	25	8	9	16	10	16	13	14	20	28	13	14	15	15	17	16	10	17	18	399	Feb 21 Wednesday
53	22	17	25	28	18	14	17	18	9	9	9	10	17	16	14	12	12	7	10	14	10	11	17	14	350	Feb 22 Thursday
54	11	21	20	17	21	8	9	6	12	7	11	9	25	9	15	15	17	15	14	17	17	24	15	12	347	Feb 23 Friday
55	24	26	22	27	29	24	13	21	19	15	20	14	26	12	21	20	34	32	15	12	30	19	20	16	511	Feb 24 Saturday
56	22	32	23	31	23	27	32	29	30	34	29	23	35	28	31	30	40	26	18	23	22	24	19	31	662	Feb 25 Sunday
57	25	26	24	16	14	22	13	18	12	12	15	13	14	14	5	21	14	12	13	16	22	18	19	22	400	Feb 26 Monday
58	22	23	23	21	18	12	5	3	11	12	16	18	32	21	19	8	11	22	10	14	15	15	12	14	377	Feb 27 Tuesday
59	24	25	23	22	21	12	9	9	4	13	16	15	35	10	16	9	18	15	6	7	10	9	5	12	345	Feb 28 Wednesday
60	13	18	6	1	5	0	1	3	6	9	2	14	10	20	13	9	9	7	15	12	10	15	12	14	224	Feb 29 Thursday
61	17	13	13	14	16	9	15	8	7	10	8	10	11	3	7	11	20	12	12	14	24	7	7	6	274	Mar 01 Friday
62	19	17	27	14	21	16	19	19	9	12	11	15	9	14	11	18	19	18	20	9	15	11	12	10	365	Mar 02 Saturday
63	16	11	14	12	21	10	15	17	24	10	22	7	12	18	10	20	23	24	14	23	11	18	24	19	395	Mar 03 Sunday
64	28	22	16	12	17	12	6	7	15	12	6	9	23	9	10	14	15	11	10	13	11	13	12	12	315	Mar 04 Monday
65	19	19	15	8	12	7	4	7	14	11	1	2	24	0	8	8	13	15	6	7	8	14	11	10	243	Mar 05 Tuesday
66	8	15	17	19	18	16	14	6	10	14	11	1	19	5	19	13	6	6	2	5	8	7	1	12	252	Mar 06 Wednesday
67	17	11	22	9	9	6	10	7	11	6	5	5	7	7	5	8	7	9	5	3	8	1	2	19	199	Mar 07 Thursday
68	10	17	7	11	10	4	7	5	3	7	2	12	10	6	5	13	7	10	9	12	16	12	12	7	214	Mar 08 Friday
69	22	26	10	18	25	21	25	18	12	16	10	16	11	15	17	18	44	38	36	17	18	15	17	20	485	Mar 09 Saturday
70	15	14	24	23	19	31	20	27	25	25	15	23	20	19	30	25	24	20	22	18	15	14	18	22	508	Mar 10 Sunday
71	23	11	24	20	16	24	20	12	12	10	11	9	21	25	10	20	17	5	12	14	11	18	14	11	370	Mar 11 Monday
72	22	18	11	18	14	12	2	6	6	11	19	4	7	8	13	21	8	7	23	14	11	25	28	19	327	Mar 12 Tuesday
73	25	23	23	16	19	12	11	4	12	8	8	10	14	20	13	9	9	11	5	12	21	14	9	10	318	Mar 13 Wednesday
74	15	18	27	25	39	26	11	9	13	7	6	7	17	8	26	15	17	14	17	18	7	17	22	15	396	Mar 14 Thursday
75	15	14	13	20	16	11	12	10	6	16	10	4	24	7	13	11	7	20	16	14	6	11	18	10	304	Mar 15 Friday
76	16	13	15	22	19	16	27	15	17	12	16	9	12	8	18	14	15	13	12	6	8	9	35	12	359	Mar 16 Saturday

Table 2.3.2. (Page 3 of 4)

NB2 .DPX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
77	19	9	14	25	20	16	17	11	13	16	25	10	21	18	21	26	7	10	21	10	7	12	10	23	381	Mar 17 Sunday
78	13	9	8	13	8	5	2	12	13	7	14	5	6	7	7	11	3	3	8	2	6	7	13	7	189	Mar 18 Monday
79	8	11	10	6	10	4	2	14	0	3	11	17	10	14	8	26	3	10	11	13	13	15	14	19	252	Mar 19 Tuesday
80	18	26	14	15	21	14	6	8	5	7	4	3	6	21	23	9	18	8	19	13	15	13	24	8	318	Mar 20 Wednesday
81	14	12	11	12	24	17	5	0	16	12	12	5	8	14	9	4	6	6	6	13	9	23	12	12	262	Mar 21 Thursday
82	10	8	12	25	41	18	4	4	17	14	15	12	16	11	17	26	4	16	10	2	5	15	14	19	335	Mar 22 Friday
83	14	15	12	17	20	18	13	40	22	16	19	12	10	26	24	19	20	13	18	17	22	16	11	22	436	Mar 23 Saturday
84	27	18	27	34	29	19	30	27	25	21	15	23	16	18	22	21	22	13	16	23	13	17	21	14	511	Mar 24 Sunday
85	24	17	20	17	13	17	11	11	10	7	15	6	9	4	13	8	7	10	11	14	28	19	18	17	326	Mar 25 Monday
86	21	14	18	16	24	16	12	0	8	10	10	22	21	4	18	11	15	24	11	12	20	19	16	22	364	Mar 26 Tuesday
87	21	9	30	20	16	15	7	9	7	23	9	8	33	18	12	24	14	20	15	15	13	11	16	15	380	Mar 27 Wednesday
88	17	24	23	19	22	12	16	14	6	10	11	14	18	18	7	18	15	12	16	8	25	18	12	18	373	Mar 28 Thursday
89	16	19	13	26	13	15	9	4	4	5	11	6	23	3	10	18	14	10	10	10	16	18	11	18	302	Mar 29 Friday
90	33	17	27	35	16	41	34	21	16	32	14	12	10	38	22	48	10	28	13	21	16	22	24	63	613	Mar 30 Saturday
91	15	36	32	33	6	6	14	3	23	6	3	3	2	7	1	13	7	3	4	9	9	19	13	21	288	Mar 31 Sunday

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NB2  00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23

Sum   2690  2614  2419  1963  1842  1688  2166  2231  2162  2288  2492  2552
   2750  2775  2695  2098  1870  1920  2395  2257  2285  2259  2470  2442   55323 Total sum
```

NB2	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
139	20	19	20	19	19	17	15	14	13	13	14	12	17	16	16	16	16	16	16	16	18	18	18	18	398	Total average
96	19	18	19	17	19	16	12	11	11	11	11	11	16	14	15	14	14	13	15	14	16	16	16	16	356	Average workdays
43	21	22	22	22	21	21	21	20	19	18	20	15	20	19	20	20	21	20	20	21	22	23	21	23	491	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 99.57% as compared to 97.79% during the previous reporting period.

Date	Time	Cause
04 Oct	1321 - 1402	Hardware/software failure
16 Oct	0221 - 0640	Hardware/software failure
21 Oct	1410 - 1455	Hardware/software failure
31 Oct	0824 - 0907	Transmission line failure
08 Nov	1159 - 1315	Transmission line failure
21 Nov	1721 - 1822	Hardware failure
27 Nov	1157 - 1234	Power break
02 Dec	0654 - 0725	Hardware/software failure
05 Dec	1033 - 1221	Power break Hub
07 Dec	0855 - 1155	Power break Hub
16 Dec	0936 - 1010	Hardware/software failure
20 Dec	0227 - 0255	Transmission line failure
31 Dec	2311 - 2359	Problems with change to new year

Table 3.1.1. Interruptions in recording of NORESS data at NDPC, 1 October 1995 - 31 March 1996.

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

October 95	:	99.06
November	:	99.53
December	:	98.98
January 96	:	99.87
February	:	100.00
March	:	99.99

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

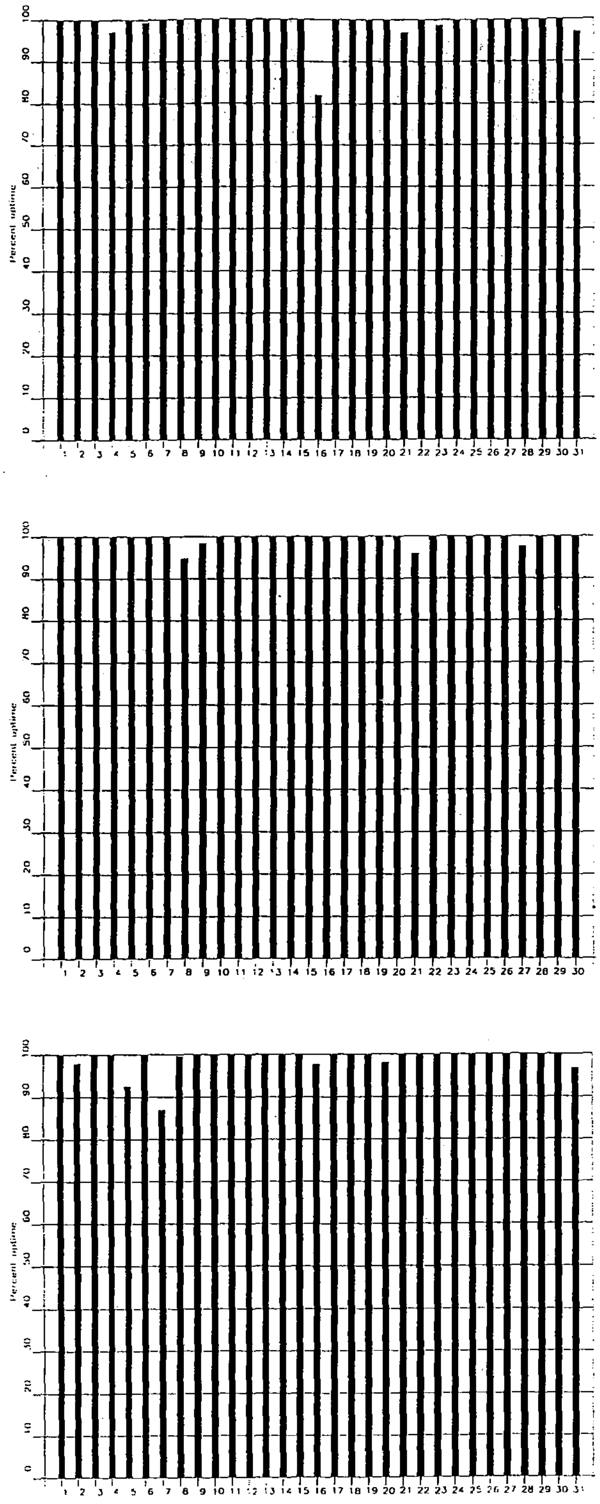


Fig. 3.1.1. NORESS data recording uptime for October (top), November (middle) and December (bottom) 1995.

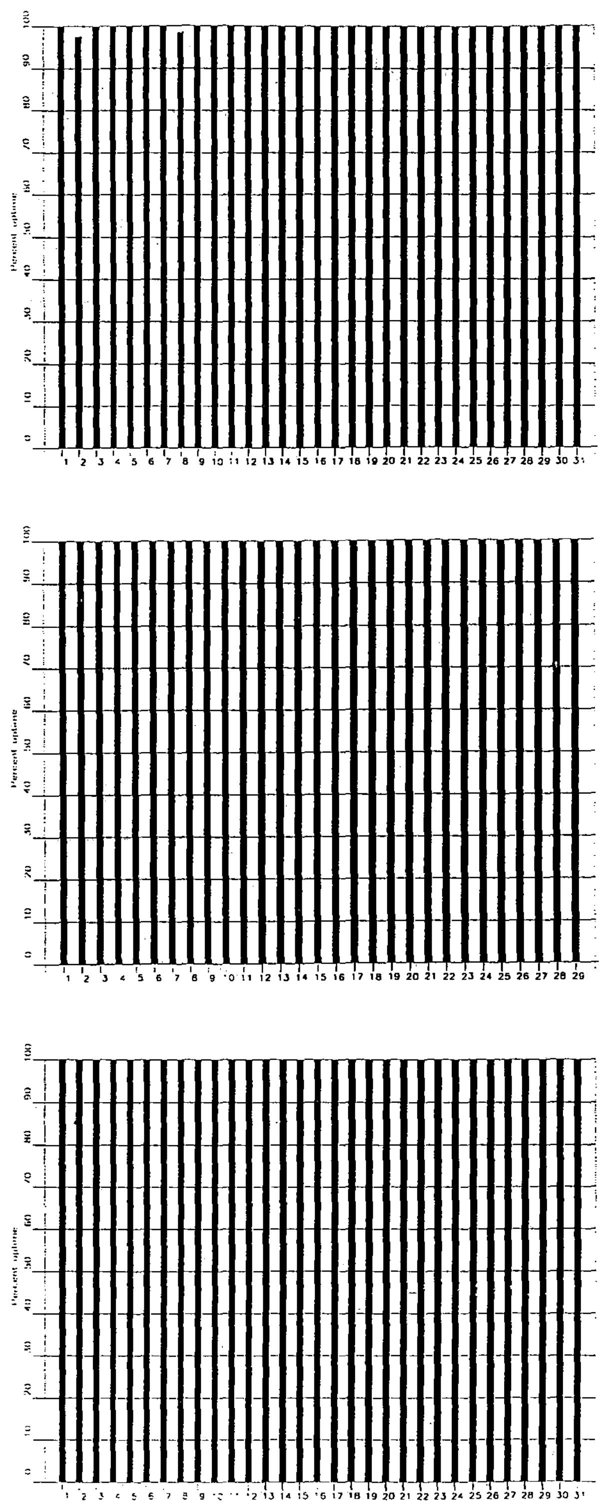


Fig. 3.1.1. (cont.) NORESS data recording uptime for January (top), February (middle) and March (bottom) 1996.

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 98.82% as compared to 92.56% for the previous reporting period.

Date	Time	Cause
02 Dec	2023 -	Problems at Hub after power break
04 Dec	- 1730	
22 Dec	1120 - 1224	Service on transmission antenna
31 Dec	2311 - 2359	Problems with change to new year
16 Jan	1436 - 1743	Hardware failure NDPC
24 Jan	1910 - 2045	Hardware failure NDPC
30 Jan	1134 - 1306	Power break at Hub

Table 3.2.1. The main interruptions in recording of ARCESS data at NDPC, 1 October 1995 - 31 March 1996.

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

October 95	:	99.96%
November	:	99.99%
December	:	93.63%
January 96	:	99.34%
February	:	99.99%
Marcy	:	99.98%

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

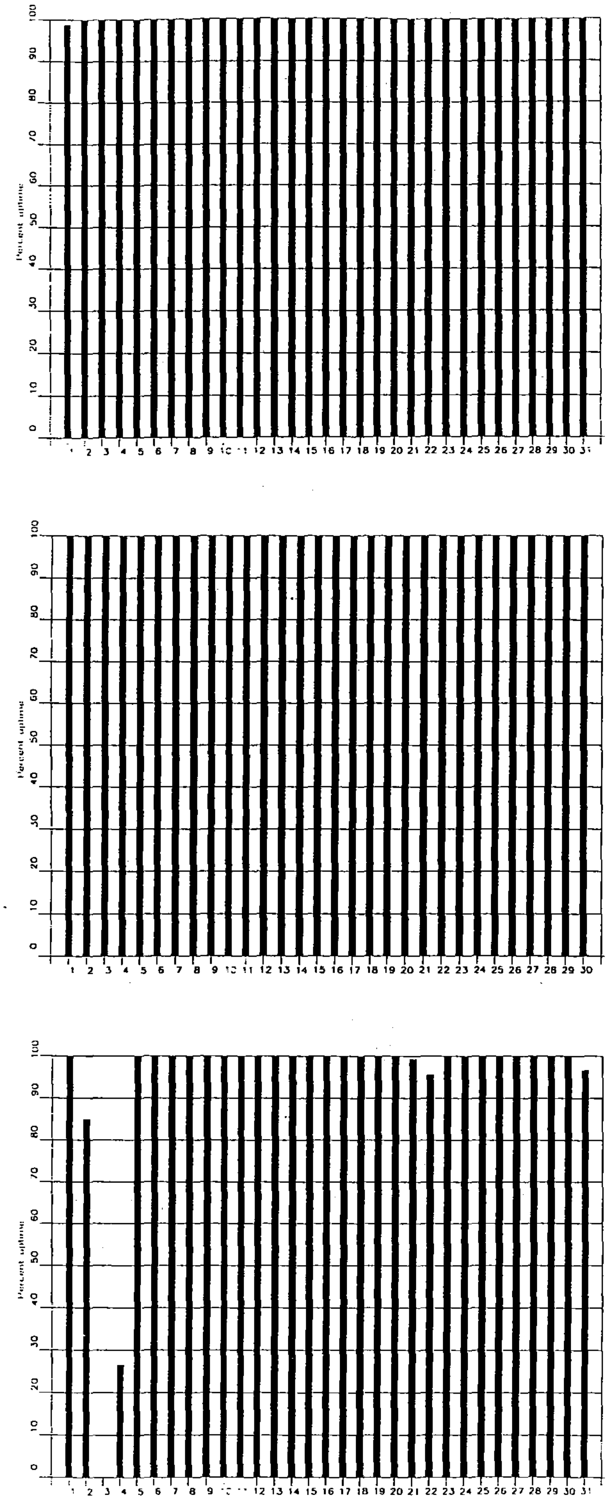
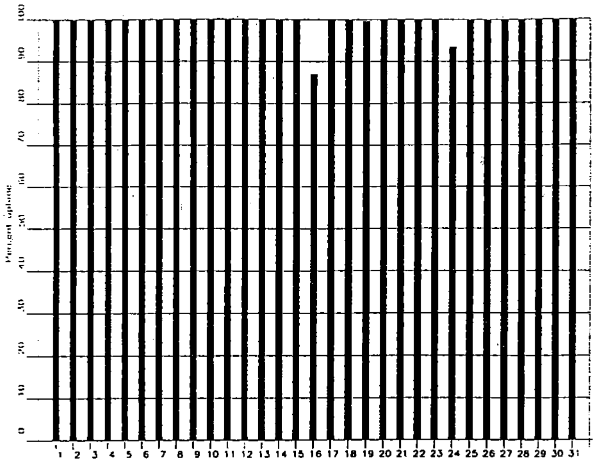
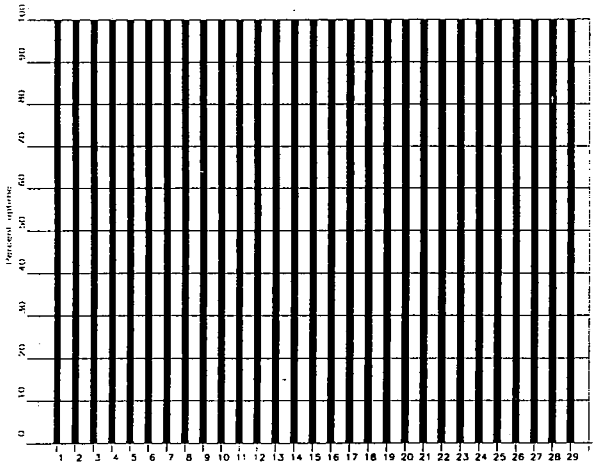


Fig. 3.2.1. ARCESS data recording uptime for October (top), November (middle) and December (bottom) 1995.





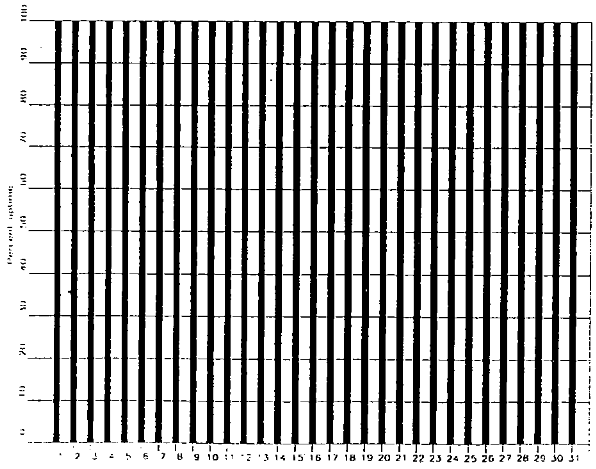


Fig. 3.2.1. ARCESS data recording uptime for January (top), February (middle) and March (bottom) 1996.

3.3 Recording of FINESS data at NDPC, Kjeller

The average recording time was 99.08% as compared to 98.55% for the previous reporting period.

Date	Time			Cause
09 Oct	2055	-		Transmission line array-Helsinki down
10 Oct		-	0910	
09 Nov	1341	-	1745	Stop in Helsinki
16 Nov	1007	-	1159	Stop in Helsinki
21 Nov	1823	-	1931	Power break in Helsinki
27 Jan	1922	-	2029	Stop in Helsinki
05 Feb	0654	-	0717	Software problems in Helsinki
05 Feb	0749	-	0849	Software problems in Helsinki
06 Feb	2356	-		Software problems in Helsinki
07 Feb		-	0646	
01 Mar	0008	-	0632	Hardware problems in Helsinki

Table 3.3.1. The main interruptions in recording of FINESS data at NDPC, 1 October 1995 - 31 March 1996.

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

October 95	:	98.33%
November	:	99.02%
December	:	100.00%
January 96	:	99.82%
February	:	98.19%
March	:	99.14%

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

J. Torstveit

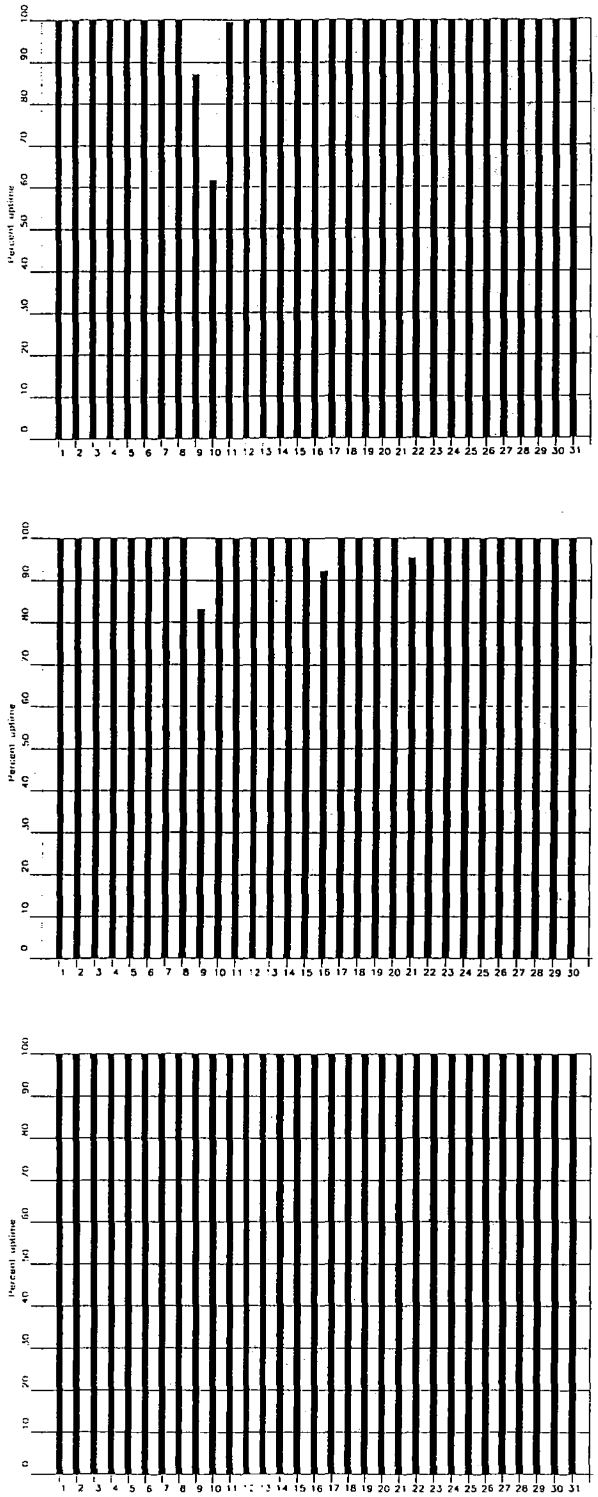


Fig. 3.3.1. FINESS data recording uptime for October (top), November (middle) and December (bottom) 1995.

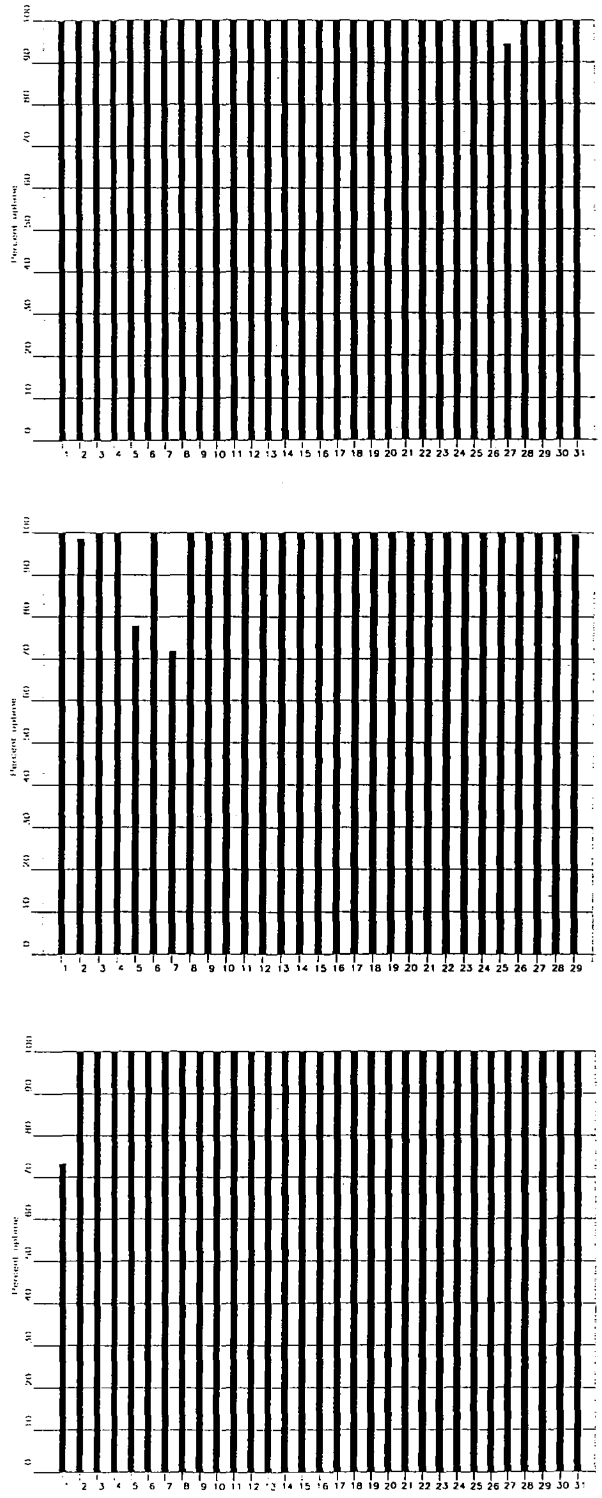


Fig. 3.3.1. FINESS data recording uptime for January (top), February (middle) and March (bottom) 1996.

3.4 Recording of Spitsbergen data at NDPC, Kjeller

The average recording time was 81.75% as compared to 65.81% for the previous reporting period. The main reason for the downtime was a power failure at the array site on 10 March 1996. By the end of the reporting period (31 March), this problem was still not corrected. Otherwise, there were numerous short outages, as indicated below.

The main reasons for downtime follow:

Date	Time	Cause
04 Oct	2312 -	Communication line failure
05 Oct	- 0726	
19 Oct	0720 - 1217	Power failure Spitsbergen
24 Oct	0605 - 0659	Communication line failure
14 Nov	0747 - 1005	Communication line failure
23 Nov	1402 - 1431	Communication line failure
29 Nov	2236 -	Communication line failure
30 Nov	- 0731	
02 Dec	0400 - 1503	Communication line failure
03 Dec	0239 - 0921	Communication line failure
03 Dec	1118 - 1149	Communication line failure
03 Dec	1215 - 1611	Communication line failure
03 Dec	2024 -	Communication line failure
04 Dec	- 0718	
04 Dec	1233 - 1511	Communication line failure
04 Dec	1532 - 2026	Communication line failure
04 Dec	2051 -	Communication line failure
05 Dec	- 0241	
05 Dec	0327 - 0511	Communication line failure
05 Dec	0602 - 0824	Communication line failure
05 Dec	1552 -	Communication line failure
06 Dec	- 0534	
08 Dec	0543 - 1337	Communication line failure
14 Dec	2146 -	Communication line failure
15 Dec	- 0755	
23 Dec	0940 -	Hardware failure Spitsbergen
27 Dec	- 0853	

Date	Time			Cause
28 Dec	0001	-	0816	Communication line failure
01 Jan	0658	-	0723	Communication line failure
02 Jan	2005	-	2113	Communication line failure
07 Jan	1704	-	1836	Communication line failure
07 Jan	2058	-	2135	Communication line failure
10 Jan	1241	-	1326	Communication line failure
11 Jan	0658	-	0725	Communication line maintenance
13 Jan	0019	-	0147	Communication line failure
15 Jan	0455	-	0627	Communication line failure
16 Jan	2207	-	2328	Communication line failure
17 Jan	0418	-	0429	Communication line failure
18 Jan	0342	-	0541	Communication line failure
18 Jan	1043	-	1826	Communication line failure
18 Jan	1857	-	2229	Communication line failure
19 Jan	0007	-	1009	Communication line failure
20 Jan	0343	-	0416	Communication line failure
20 Jan	0526	-	0549	Communication line failure
22 Jan	1113	-	1141	Communication line failure
22 Jan	1224	-	1333	Communication line failure
23 Jan	0927	-	1126	Communication line failure
25 Jan	1333	-	1951	Communication line failure
26 Jan	0227	-	0254	Communication line failure
26 Jan	0604	-	0634	Communication line failure
26 Jan	1322	-	1452	Communication line failure
26 Jan	1520	-	1709	Communication line failure
28 Jan	0229	-	1047	Hardware failure NDPC
05 Feb	1303	-	1345	Communication line failure
12 Feb	0637	-	0739	Communication line failure
16 Feb	2211	-	2251	Communication line failure
21 Feb	1533	-		Hardware failure Spitsbergen
22 Feb		-	0745	
22 Feb	0745	-	0951	Communication line failure
22 Feb	1034	-	1124	Communication line failure
22 Feb	1841	-	1934	Communication line failure

Date	Time			Cause
05 Mar	0352	-	0649	Hardware failure Spitsbergen
08 Mar	1208	-	1419	Communication line failure
09 Mar	0545	-	0626	Communication line failure
09 Mar	0720	-	0834	Commuication line failure
09 Mar	1028	-	1158	Communication line failure
10 Mar	0059	-		Power failure Spitsbergen

Table 3.4.1. The main interruptions in recording of Spitsbergen data at NDPC, 1 October 1995 - 31 March 1996.

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

October 95	:	98.02%
November	:	98.27%
December	:	76.92%
January 96	:	92.38%
February	:	96.87%
March	:	28.01%

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

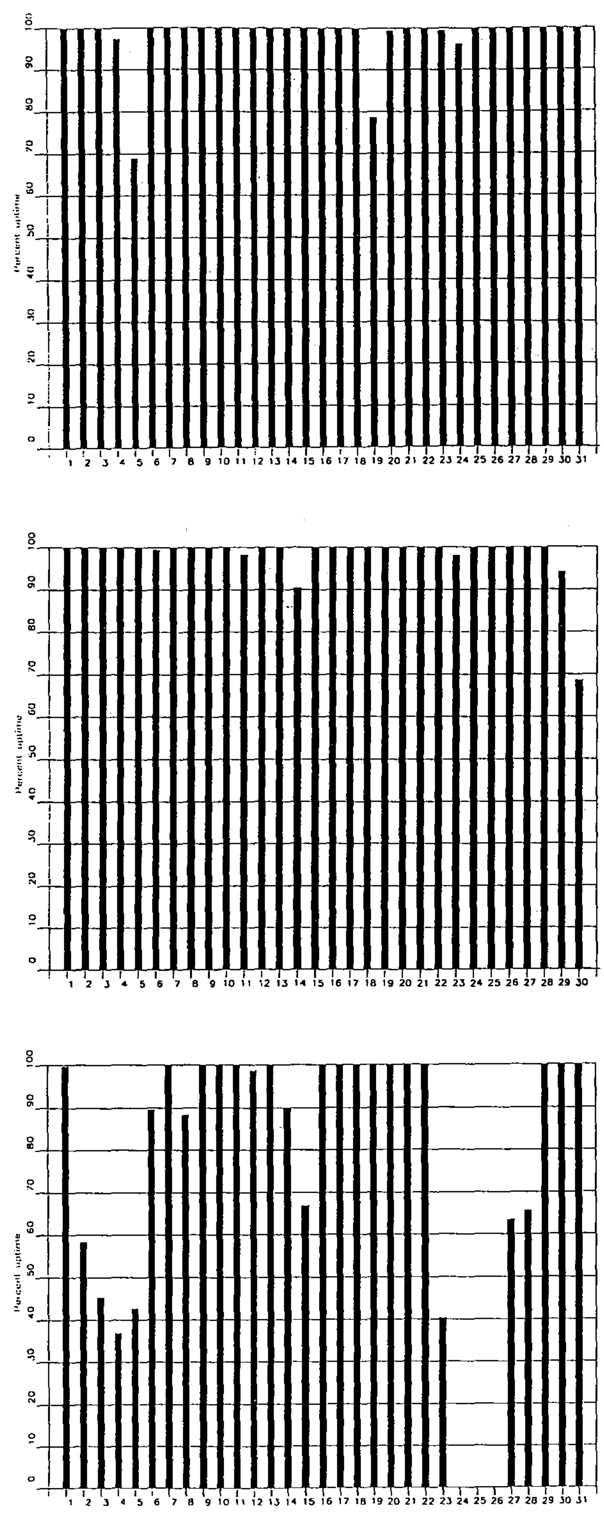


Fig. 3.4.1. Spitsbergen data recording uptime for October (top), November (middle) and December (bottom) 1995.

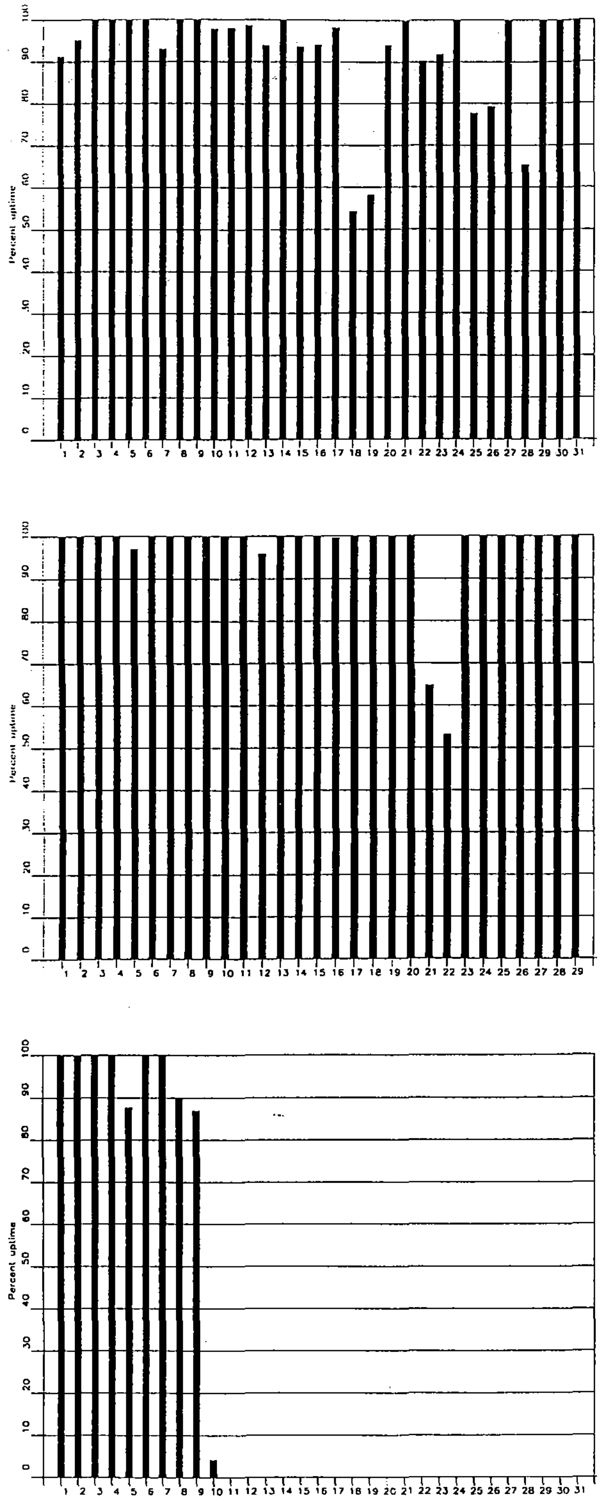


Fig. 3.4.1. Spitsbergen data recording uptime for January (top), February (middle) and March (bottom) 1996.

3.5 Event detection operation

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

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

1. The ep program with "ronapp" recipes is operated independently on each array to obtain simple one-array automatic solutions.
2. The Generalized Beamforming method (GBF) (see F. Ringdal and T. Kværna (1989), A mulitchannel processing approach to real time network detection, phase association and threshold monitoring, BSSA Vol 79, no 6, 1927-1940) processes the four arrays jointly and presents locations of regional events.
3. The 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 section 3.6.

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 continuously in time to estimate the upper magnitude limit of an event that might go undetected by the network. 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 274, 1995, through day 091, 1996, was 68,670, giving an average of 375 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 274, 1995, through 091, 1996, 2390 local and regional events were located by NORESS, based on automatic association of P- and S-type arrivals. This gives an average of 13.1 events per processed day (183 days processed). 57% of these events are within 300 km, and 84% of these events are within 1000 km.

ARCESS detections

The number of detections (phases) reported during day 274, 1995, through day 091, 1996, was 110,672, giving an average of 608 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 274, 1995, through 091, 1996, 6047 local and regional events were located by ARCESS, based on automatic association of P- and S-type arrivals. This gives an average of 33.2 events per processed day (182 days processed). 45% of these events are within 300 km, and 81% of these events are within 1000 km.

FINESS detections

The number of detections (phases) reported during day 274, 1995, through day 091, 1996, was 41,380, giving an average of 226 detections per processed day (183 days processed).

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

Events automatically located by FINESS

During days 274, 1995, through 091, 1996, 2598 local and regional events were located by FINESS, based on automatic association of P- and S-type arrivals. This gives an average of 14.2 events per processed day (183 days processed). 82% of these events are within 300 km, and 93% of these events are within 1000 km.

GERESS detections

The number of detections (phases) reported from day 274, 1995, through day 091, 1996, was 35,009, giving an average of 191 detections per processed day (183 days processed).

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

Events automatically located by GERESS

During days 274, 1995, through 091, 1996, 3566 local and regional events were located by GERESS, based on automatic association of P- and S-type arrivals. This gives an average of 19.5 events per processed day (183 days processed). 71% of these events are within 300 km, and 90% of these events are within 1000 km.

Apatity array detections

The number of detections (phases) reported from day 274, 1995, through day 091, 1999, was 34,744, giving an average of 208 detections per processed day (167 days processed).

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

These unwanted detections are "filtered" in the signal processing, as they give seismic velocities that are outside accepted limits for regional and teleseismic phase velocities.

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

Events automatically located by the Apatity array

During days 274, 1995, through 091, 1996, 589 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 3.5 events per processed day (167 days processed). 60% of these events are within 300 km, and 84% of these events are within 1000 km.

Spitsbergen array detections

The number of detections (phases) reported from day 274, 1995, through day 091, 1996, was 221,530, giving an average of 1393 detections per processed day (159 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 274, 1995, through 091, 1996, 34,093 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 214.4 events per processed day (159 days processed). 57% of these events are within 300 km, and 80% of these events are within 1000 km.

Hagfors array detections

The number of detections (phases) reported from day 274, 1995, through day 091, 1996, was 87,710, giving an average of 479 detections per processed day (183 days processed).

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

Events automatically located by the Hagfors array

During days 274, 1995, through 091, 1996, 2072 local and regional events were located by the Hagfors array, based on automatic association of P- and S-type arrivals. This gives an average of 11.3 events per processed day (183 days processed). 31% of these events are within 300 km, and 76% 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
274	11	13	16	6	10	5	17	4	2	3	12	4	7	3	6	14	10	7	10	2	3	5	5	8	183	Oct 01 Sunday
275	6	7	13	2	3	8	4	1	5	1	3	9	4	14	7	7	4	9	1	7	12	2	6	1	136	Oct 02 Monday
276	5	1	17	7	6	12	18	7	2	10	1	7	11	11	11	6	5	4	0	6	9	1	11	6	174	Oct 03 Tuesday
277	5	4	15	2	7	8	8	2	3	8	7	10	29	4	24	10	11	15	2	3	22	1	12	4	216	Oct 04 Wednesday
278	4	2	2	9	2	4	10	5	8	5	15	12	25	25	14	17	5	5	7	3	13	4	11	2	209	Oct 05 Thursday
279	1	5	9	14	1	16	8	12	3	12	11	23	15	20	16	9	12	7	8	61	11	27	70	5	421	Oct 06 Friday
280	2	5	4	3	4	4	7	3	5	1	3	2	2	6	1	3	15	41	4	5	6	4	3	10	143	Oct 07 Saturday
281	7	11	9	3	3	4	2	1	6	15	6	7	5	8	3	8	6	6	10	2	3	8	10	4	147	Oct 08 Sunday
282	7	3	2	12	9	3	8	11	8	6	9	8	7	8	7	11	10	11	8	3	3	10	4	14	182	Oct 09 Monday
283	4	12	12	4	16	1	6	3	6	7	3	5	9	5	16	15	5	8	18	21	21	6	10	7	220	Oct 10 Tuesday
284	12	11	2	21	9	1	4	1	5	16	5	6	11	15	7	2	5	6	8	3	11	3	14	5	183	Oct 11 Wednesday
285	10	6	3	23	7	7	8	2	6	11	2	7	11	9	2	15	6	15	7	2	5	2	4	2	172	Oct 12 Thursday
286	5	0	0	10	2	3	2	9	3	3	5	9	9	10	17	5	15	15	6	4	14	6	8	2	162	Oct 13 Friday
287	4	7	8	2	67	36	24	8	9	5	3	13	3	9	16	3	8	4	9	6	7	12	10	11	284	Oct 14 Saturday
288	12	12	12	8	5	5	12	15	8	14	6	3	31	14	14	11	7	8	8	3	9	6	9	8	240	Oct 15 Sunday
289	4	10	1	0	0	0	5	3	3	4	1	17	35	12	7	9	19	4	4	4	13	4	13	3	175	Oct 16 Monday
290	6	4	13	5	4	10	5	13	31	28	9	29	22	25	21	12	4	26	13	2	9	6	7	2	306	Oct 17 Tuesday
291	3	7	4	7	8	13	3	11	9	22	7	34	16	20	16	7	10	5	6	3	7	7	12	12	249	Oct 18 Wednesday
292	14	8	10	6	3	8	6	5	5	9	8	8	7	11	8	7	8	6	2	1	8	31	103	7	289	Oct 19 Thursday
293	5	4	8	9	4	12	3	10	20	16	5	30	12	12	5	9	3	3	2	12	12	4	8	3	211	Oct 20 Friday
294	8	2	8	11	1	2	6	10	34	34	14	15	19	24	4	8	5	3	6	8	9	3	3	11	248	Oct 21 Saturday
295	6	9	8	7	17	9	7	31	35	24	5	19	12	4	3	4	0	3	2	2	3	5	0	2	217	Oct 22 Sunday
296	5	7	23	5	71	29	4	5	6	8	2	7	14	13	13	11	6	3	4	2	3	10	6	11	268	Oct 23 Monday
297	7	10	5	5	0	10	10	2	8	30	16	14	11	15	16	15	3	9	2	4	20	1	8	3	224	Oct 24 Tuesday
298	5	5	6	14	5	9	4	4	11	14	19	24	14	8	22	25	6	4	1	1	2	8	12	2	225	Oct 25 Wednesday
299	2	8	3	3	8	13	10	3	16	17	9	3	8	18	7	13	6	9	3	1	8	1	7	2	178	Oct 26 Thursday
300	2	1	7	8	1	8	17	3	4	4	12	11	7	16	9	3	11	0	3	1	13	3	1	0	145	Oct 27 Friday
301	13	10	6	1	5	9	12	6	2	3	3	4	5	8	6	3	9	6	8	8	5	1	1	1	135	Oct 28 Saturday
302	1	3	1	2	6	5	12	3	13	9	13	6	7	12	4	4	1	5	7	17	6	4	1	4	146	Oct 29 Sunday
303	2	8	13	7	1	2	3	3	6	0	8	11	14	8	18	25	5	8	9	4	14	18	9	3	199	Oct 30 Monday
304	4	0	7	6	10	8	6	4	1	3	3	6	2	15	11	8	4	0	7	3	6	9	2	10	135	Oct 31 Tuesday
305	6	6	3	1	2	5	1	1	3	10	6	2	4	9	17	7	5	10	8	1	10	12	1	0	130	Nov 01 Wednesday
306	5	16	5	4	2	6	3	3	5	0	6	4	8	20	6	4	4	5	6	2	7	4	4	5	134	Nov 02 Thursday
307	2	2	12	6	6	3	1	1	5	4	11	8	5	9	10	8	4	3	6	7	7	6	6	12	144	Nov 03 Friday
308	7	4	5	1	3	4	10	10	2	10	12	6	3	3	3	8	8	16	12	8	13	20	21	10	199	Nov 04 Saturday
309	11	32	26	22	12	11	19	13	26	3	7	11	9	0	4	4	12	7	7	6	5	9	0	4	260	Nov 05 Sunday
310	3	10	6	3	8	5	3	0	1	0	4	5	10	8	10	13	1	7	1	5	14	9	12	8	146	Nov 06 Monday
311	14	12	19	14	16	9	2	17	3	4	0	8	4	21	27	10	5	10	4	8	20	5	16	9	257	Nov 07 Tuesday
312	2	7	5	9	4	5	3	6	8	9	15	9	0	13	24	2	11	5	1	2	15	6	6	1	168	Nov 08 Wednesday
313	0	9	2	7	1	6	3	3	6	8	1	13	6	15	22	9	4	6	8	8	11	10	4	17	179	Nov 09 Thursday
314	7	11	13	7	3	2	8	7	6	12	5	3	11	24	18	25	23	23	17	26	24	26	30	20	351	Nov 10 Friday
315	22	10	18	44	38	44	38	23	6	10	17	3	4	9	25	44	52	46	66	46	43	57	42	51	758	Nov 11 Saturday
316	53	48	52	65	54	45	40	30	16	5	8	7	2	12	33	58	71	76	64	58	35	31	17	28	908	Nov 12 Sunday
317	90	98	64	46	64	44	33	23	21	1	0	12	26	26	23	16	7	23	48	68	126	89	72	74	1094	Nov 13 Monday
318	75	47	21	4	34	15	24	18	13	16	12	12	22	12	31	25	7	4	1	4	9	3	6	6	421	Nov 14 Tuesday
319	5	4	8	3	4	9	9	9	10	15	6	18	34	42	38	34	17	36	33	35	43	18	24	58	512	Nov 15 Wednesday
320	64	45	37	48	54	40	19	18	12	15	13	13	21	21	24	15	15	10	4	0	8	2	1	6	505	Nov 16 Thursday
321	19	39	59	46	81	60	29	6	4	8	5	8	11	11	52	103	94	89	69	57	64	66	83	75	1138	Nov 17 Friday
322	64	49	43	36	9	17	9	8	2	7	4	16	8	24	27	71	96	116	67	45	13	11	5	4	751	Nov 18 Saturday
323	33	41	6	3	7	13	82	5	8	2	8	5	7	10	3	19	18	58	70	97	112	116	85	68	876	Nov 19 Sunday
324	70	38	24	12	47	22	6	34	19	5	16	11	11	23	13	8	34	49	53	43	25	28	35	59	685	Nov 20 Monday
325	42	33	20	5	21	19	19	12	2	7	19	39	25	13	23	4	8	11	2	1	7	10	5	9	356	Nov 21 Tuesday
326	7	8	5	8	15	6	15	19	17	23	12	42	54	73	81	37	31	50	25	66	61	64	85	72	876	Nov 22 Wednesday
327	68	66	65	49	65	57	25	19	3	5	9	8	4	10	14	4	6	2	5	3	12	0	6	4	509	Nov 23 Thursday
328	5	12	3	4	2	0	6	8	8	3	5	5	9	8	14	10	10	6	4	20	3	5	15	2	167	Nov 24 Friday
329	3	4	4	8	11	2	4	5	2	5	2	9	4	7	4	6	6	3	9	14	9	3	7	3	134	Nov 25 Saturday

Table 3.5.1 (Page 1 of 4)

NRS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
330	6	5	5	12	4	6	12	8	4	0	8	9	12	11	7	12	18	10	5	6	9	30	50	70	319	Nov 26 Sunday
331	73	71	141	49	554	455	265	285	275	205	244	95	11	10	30	2	9	6	1	10	16	12	21	12	4094	Nov 27 Monday
332	2	6	5	5	13	9	16	5	2	4	11	10	13	16	14	9	2	4	2	5	24	3	9	2	191	Nov 28 Tuesday
333	20	18	4	7	8	6	3	3	9	13	14	11	10	10	19	11	9	11	5	7	19	4	17	22	260	Nov 29 Wednesday
334	26	12	15	13	9	14	8	8	12	13	9	14	23	27	27	19	10	10	11	12	13	21	15	15	356	Nov 30 Thursday
335	19	13	6	6	13	16	6	8	8	11	19	13	8	26	31	10	8	9	6	15	21	7	8	21	308	Dec 01 Friday
336	24	37	43	43	39	19	34	18	37	56	37	45	19	12	16	22	25	28	30	49	28	35	19	19	734	Dec 02 Saturday
337	31	25	20	21	18	7	19	8	4	12	14	4	16	22	9	10	11	12	75	77	66	62	51	53	647	Dec 03 Sunday
338	38	40	35	14	20	16	12	13	22	22	10	11	15	25	19	16	21	16	17	9	12	14	7	10	434	Dec 04 Monday
339	25	12	22	3	7	9	13	13	7	12	9	0	18	27	20	12	15	24	34	28	23	32	30	43	438	Dec 05 Tuesday
340	30	35	40	46	40	37	23	17	14	13	17	19	19	36	34	9	7	3	4	2	13	2	20	6	486	Dec 06 Wednesday
341	22	8	15	20	12	8	17	6	2	0	0	3	19	32	15	7	6	6	23	11	18	5	39	20	314	Dec 07 Thursday
342	19	12	7	17	9	5	13	19	20	3	7	20	20	25	35	6	7	15	8	19	29	5	13	18	351	Dec 08 Friday
343	5	10	4	7	12	5	8	4	6	14	13	8	13	6	10	7	2	7	9	15	8	9	10	10	202	Dec 09 Saturday
344	10	10	8	14	6	4	5	13	8	6	8	8	7	9	7	12	3	10	6	6	7	5	27	24	223	Dec 10 Sunday
345	18	21	21	5	14	11	17	15	17	18	20	20	14	21	37	10	4	13	7	6	11	2	6	0	328	Dec 11 Monday
346	5	6	16	0	6	5	6	8	17	5	15	8	9	8	14	6	6	7	6	0	8	2	9	0	172	Dec 12 Tuesday
347	5	3	2	4	4	2	4	5	7	4	6	15	5	17	15	3	3	11	6	2	11	16	14	4	168	Dec 13 Wednesday
348	28	25	11	16	19	8	8	5	11	9	4	18	7	24	12	1	2	6	3	6	10	4	13	5	255	Dec 14 Thursday
349	2	6	8	4	4	7	7	4	6	12	8	11	11	22	18	17	15	18	13	27	29	21	20	34	324	Dec 15 Friday
350	35	30	7	13	12	8	24	31	14	6	17	23	16	17	26	20	19	13	4	16	10	10	5	4	380	Dec 16 Saturday
351	8	15	8	6	10	12	33	29	39	5	10	11	4	1	7	5	2	6	4	4	4	9	27	45	304	Dec 17 Sunday
352	46	2	14	8	4	9	7	3	2	2	6	7	20	19	23	11	15	13	26	32	40	23	19	40	391	Dec 18 Monday
353	32	40	32	34	19	19	10	14	6	14	8	7	23	10	20	16	25	27	22	16	27	29	31	42	523	Dec 19 Tuesday
354	42	30	34	56	25	32	26	24	28	20	10	6	17	11	12	7	6	22	13	21	28	40	50	63	623	Dec 20 Wednesday
355	57	67	72	75	62	51	46	38	41	33	15	11	11	6	17	35	63	68	64	85	75	88	74	64	1218	Dec 21 Thursday
356	69	53	47	40	74	45	54	65	65	46	31	26	24	44	68	98	111	96	96	83	98	86	83	96	1598	Dec 22 Friday
357	105	108	106	95	99	117	102	103	99	79	61	36	33	30	30	53	82	86	91	111	112	108	85	96	2027	Dec 23 Saturday
358	99	106	138	74	73	62	29	29	48	38	19	30	17	18	16	25	35	56	71	76	96	113	111	116	1495	Dec 24 Sunday
359	110	95	100	109	97	86	90	89	101	73	55	46	31	24	34	45	61	77	92	89	97	99	82	93	1875	Dec 25 Monday
360	88	88	100	85	71	69	64	61	66	47	36	24	26	10	23	21	30	51	50	35	54	75	58	55	1287	Dec 26 Tuesday
361	72	100	76	59	70	74	58	65	79	26	18	36	17	23	14	19	31	44	45	68	85	76	82	98	1335	Dec 27 Wednesday
362	83	103	108	87	97	99	83	92	86	77	30	36	25	19	14	30	47	63	37	52	71	82	67	44	1532	Dec 28 Thursday
363	37	15	16	7	14	7	6	13	10	5	3	8	15	38	29	26	10	2	4	6	0	2	3	1	277	Dec 29 Friday
364	2	6	18	7	15	13	9	6	9	5	5	8	24	4	3	9	12	9	4	3	9	4	4	2	190	Dec 30 Saturday
365	9	6	0	8	7	3	9	6	6	8	6	9	14	7	10	13	6	2	3	5	9	6	6	1	159	Dec 31 Sunday
1	5	7	4	5	1	9	2	4	17	14	13	29	58	15	4	5	24	18	3	2	15	3	2	2	261	Jan 01 Monday
2	2	9	13	11	13	16	28	32	16	73	45	41	49	44	45	39	42	40	41	42	42	64	53	53	853	Jan 02 Tuesday
3	42	16	7	3	8	4	2	4	9	6	5	13	7	13	14	15	5	12	7	0	16	9	10	7	234	Jan 03 Wednesday
4	9	8	4	15	8	8	6	8	3	6	13	9	16	11	17	8	7	12	6	7	20	18	14	29	262	Jan 04 Thursday
5	27	52	45	42	36	32	35	23	17	28	14	13	10	4	20	20	37	51	61	64	71	51	66	45	864	Jan 05 Friday
6	73	65	63	54	58	73	37	12	13	13	16	9	9	5	7	6	6	9	10	6	2	5	7	4	562	Jan 06 Saturday
7	13	13	67	41	15	15	16	12	16	12	6	7	8	12	7	5	5	1	0	5	4	2	4	4	290	Jan 07 Sunday
8	4	4	2	10	3	1	3	2	3	7	13	8	7	8	11	7	4	4	3	4	12	8	13	2	143	Jan 08 Monday
9	3	8	5	7	5	6	11	4	2	4	7	3	10	21	7	5	2	10	12	11	14	2	17	2	178	Jan 09 Tuesday
10	6	5	5	4	4	6	6	3	8	3	4	5	14	19	15	14	7	7	4	13	30	9	16	13	220	Jan 10 Wednesday
11	4	10	5	4	14	4	4	7	6	4	2	4	19	13	15	4	0	6	5	4	5	14	15	3	171	Jan 11 Thursday
12	4	5	12	13	8	3	4	6	6	7	11	11	11	11	14	4	4	13	4	12	22	12	16	5	218	Jan 12 Friday
13	12	5	10	4	5	11	10	4	5	9	10	6	6	10	0	7	6	12	6	4	5	7	7	6	167	Jan 13 Saturday
14	10	2	14	12	7	7	11	3	3	5	5	8	9	11	7	4	6	4	9	4	5	8	7	2	163	Jan 14 Sunday
15	10	13	18	10	9	9	4	7	1	11	5	9	7	21	11	8	9	6	8	6	12	10	12	9	225	Jan 15 Monday
16	10	7	3	11	6	8	11	2	7	8	5	10	18	15	10	12	4	13	5	1	16	10	11	3	206	Jan 16 Tuesday
17	3	2	2	9	9	7	5	1	10	5	8	5	23	9	8	13	4	12	4	0	12	7	7	3	168	Jan 17 Wednesday
18	6	9	7	17	6	8	10	4	15	11	7	15	11	12	15	9	3	13	4	4	14	11	5	7	223	Jan 18 Thursday
19	3	13	13	4	4	3	8	6	1	9	2	9	15	15	16	4	4	11	6	5	24	4	9	4	192	Jan 19 Friday
20	9	9	4	5	16	28	17	14	12	8	18	11	6	11	15	17	14	26	27	25	26	31	62	43	454	Jan 20 Saturday

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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
21	44	49	61	67	56	50	43	42	51	20	25	16	25	37	38	38	34	33	29	31	38	42	42	39	950	Jan 21 Sunday
22	26	29	30	22	28	13	11	6	8	13	8	12	13	7	13	14	8	6	10	10	10	5	19	20	341	Jan 22 Monday
23	5	16	15	21	18	7	7	8	14	3	7	19	19	15	19	3	10	6	2	3	9	5	9	12	252	Jan 23 Tuesday
24	15	25	24	9	25	16	6	2	4	21	12	11	8	11	14	3	7	33	5	17	11	4	17	5	305	Jan 24 Wednesday
25	17	34	31	21	15	7	5	4	3	4	6	5	11	12	10	3	9	3	8	5	14	4	14	5	250	Jan 25 Thursday
26	10	9	18	13	9	5	5	5	10	14	7	15	17	10	14	15	13	17	8	15	25	18	26	24	322	Jan 26 Friday
27	24	16	20	24	18	23	31	26	17	22	20	18	17	18	7	4	5	5	19	7	9	16	9	19	394	Jan 27 Saturday
28	8	19	12	17	10	43	38	16	9	10	8	6	10	12	5	5	13	4	8	8	4	7	8	6	286	Jan 28 Sunday
29	12	8	16	17	8	9	4	7	6	2	11	4	14	18	11	18	18	11	7	4	18	8	16	9	256	Jan 29 Monday
30	10	12	17	11	7	9	8	2	2	4	17	3	11	13	19	11	3	12	7	9	12	10	39	18	266	Jan 30 Tuesday
31	26	9	14	16	9	17	7	11	7	15	9	19	29	10	9	9	12	8	2	10	20	7	13	6	294	Jan 31 Wednesday
32	16	7	8	11	10	5	9	6	6	10	13	17	10	15	11	16	1	11	5	6	10	8	11	7	229	Feb 01 Thursday
33	20	6	8	15	19	15	4	1	2	12	8	19	14	7	25	13	8	21	11	14	24	16	14	11	307	Feb 02 Friday
34	7	9	11	13	14	8	12	13	9	16	10	18	18	17	19	13	5	4	16	14	13	16	4	10	289	Feb 03 Saturday
35	11	15	9	8	15	9	37	28	29	4	10	9	8	7	8	8	2	10	6	7	8	5	10	24	287	Feb 04 Sunday
36	12	12	15	20	15	26	5	6	14	6	8	12	28	16	17	20	23	24	24	24	18	25	18	13	401	Feb 05 Monday
37	12	8	20	14	10	11	6	7	7	4	11	10	16	22	13	16	10	17	12	10	14	8	7	14	279	Feb 06 Tuesday
38	16	6	22	8	10	7	5	8	12	13	7	13	19	18	10	12	14	11	7	8	22	26	12	8	294	Feb 07 Wednesday
39	8	7	4	3	12	7	62	84	12	10	14	7	15	23	10	10	4	8	6	5	8	18	18	5	360	Feb 08 Thursday
40	6	10	15	5	8	7	4	7	6	6	7	7	16	8	7	8	5	11	15	8	32	8	15	4	225	Feb 09 Friday
41	12	9	5	15	5	14	5	4	13	5	15	2	7	3	9	1	10	6	4	8	2	6	14	7	181	Feb 10 Saturday
42	5	2	6	2	9	7	9	5	5	7	3	3	6	3	12	11	6	3	11	5	13	7	2	8	150	Feb 11 Sunday
43	7	5	6	20	40	462	51	5	6	12	8	4	17	7	14	7	9	5	20	17	17	17	14	8	562	Feb 12 Monday
44	7	3	6	8	6	2	4	4	2	15	8	7	17	19	13	9	12	12	6	7	15	10	18	5	215	Feb 13 Tuesday
45	0	1	2	14	5	1	3	6	2	16	12	11	10	13	14	13	5	5	12	9	18	20	15	12	219	Feb 14 Wednesday
46	10	9	15	11	9	9	5	6	5	7	9	11	10	18	21	3	14	7	3	2	15	10	16	3	228	Feb 15 Thursday
47	5	4	8	8	2	6	2	1	5	8	7	14	9	13	6	17	10	6	6	8	13	10	16	29	213	Feb 16 Friday
48	76	66	52	49	52	10	21	7	2	5	6	7	4	7	14	13	6	1	4	4	5	12	13	4	440	Feb 17 Saturday
49	14	16	6	6	3	12	7	15	13	13	16	9	3	8	7	10	6	9	5	7	9	6	7	6	213	Feb 18 Sunday
50	9	5	8	25	13	5	5	10	11	4	9	7	7	9	10	14	4	5	4	4	9	5	13	6	201	Feb 19 Monday
51	8	9	6	11	6	4	2	5	6	15	8	10	4	21	8	9	9	14	9	13	11	16	4	14	222	Feb 20 Tuesday
52	23	27	7	4	4	9	6	5	5	7	8	12	20	22	17	6	13	7	6	5	18	15	22	13	281	Feb 21 Wednesday
53	8	10	6	14	12	5	11	3	15	5	14	13	16	9	16	17	6	3	5	11	15	3	19	9	245	Feb 22 Thursday
54	9	6	2	12	5	5	5	9	6	11	7	17	13	13	12	6	13	10	7	9	76	45	31	12	341	Feb 23 Friday
55	6	14	12	4	8	3	17	15	10	23	10	10	15	13	8	21	14	4	8	2	12	6	8	4	247	Feb 24 Saturday
56	5	8	3	17	8	1	8	9	21	16	8	19	18	14	22	20	6	8	26	6	19	13	7	7	289	Feb 25 Sunday
57	6	8	15	6	3	2	5	6	13	5	9	4	9	17	14	19	7	4	3	5	5	23	13	14	215	Feb 26 Monday
58	8	6	9	9	8	8	7	3	6	10	11	15	15	20	14	12	12	10	5	5	10	2	20	12	237	Feb 27 Tuesday
59	6	6	5	10	9	8	3	7	7	14	10	10	19	25	19	8	10	4	3	9	4	8	5	3	212	Feb 28 Wednesday
60	3	6	7	3	2	1	3	3	7	7	3	5	10	25	5	8	3	7	6	4	14	1	13	6	152	Feb 29 Thursday
61	4	4	6	5	11	4	7	6	5	4	6	15	6	3	4	5	9	9	8	2	23	3	13	5	167	Mar 01 Friday
62	4	4	9	6	11	2	9	5	10	9	4	7	16	6	8	11	5	6	6	2	5	5	3	6	159	Mar 02 Saturday
63	5	4	4	8	10	4	15	4	2	4	5	6	5	7	3	11	17	6	10	10	4	8	13	9	174	Mar 03 Sunday
64	4	6	11	19	11	3	9	3	9	3	5	12	18	14	12	13	9	12	4	3	9	14	8	11	222	Mar 04 Monday
65	5	0	15	3	6	2	3	4	8	8	5	6	29	12	6	15	10	21	9	3	16	11	18	4	219	Mar 05 Tuesday
66	6	15	6	21	14	7	11	14	10	9	5	7	14	17	14	14	6	11	7	9	11	12	6	2	248	Mar 06 Wednesday
67	4	7	12	11	7	4	11	7	12	10	14	12	16	8	13	4	6	7	14	3	16	3	12	67	280	Mar 07 Thursday
68	15	8	3	22	4	4	2	6	8	4	6	14	5	8	7	9	5	8	8	1	18	15	13	2	195	Mar 08 Friday
69	6	3	2	4	5	12	11	16	12	19	9	14	6	5	5	13	23	25	22	10	11	12	10	4	259	Mar 09 Saturday
70	6	9	16	7	5	12	12	8	7	18	11	11	3	4	6	6	18	24	13	3	8	4	6	3	220	Mar 10 Sunday
71	5	2	2	15	4	10	7	8	6	5	7	7	17	22	9	15	4	5	5	4	0	11	5	3	178	Mar 11 Monday
72	2	4	4	19	5	6	1	0	2	12	17	8	14	8	6	7	3	8	8	8	12	6	12	2	174	Mar 12 Tuesday
73	5	7	2	4	3	4	7	2	5	0	6	16	9	20	13	13	7	12	6	0	14	3	8	2	168	Mar 13 Wednesday
74	11	1	3	4	10	8	2	4	7	6	1	8	17	10	16	5	0	10	6	8	16	18	22	32	225	Mar 14 Thursday
75	59	60	48	70	42	9	0	4	4	16	9	9	13	5	14	14	5	19	12	11	20	5	28	13	489	Mar 15 Friday
76	9	6	6	15	13	16	86	23	16	16	23	17	20	19	22	25	13	3	5	7	9	7	21	12	409	Mar 16 Saturday

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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
77	13	12	4	19	4	7	12	9	13	18	17	8	24	12	27	54	31	12	7	3	10	7	4	12	339	Mar 17 Sunday
78	2	5	9	4	1	1	0	4	6	5	8	7	51	19	6	8	12	8	12	5	9	8	7	7	204	Mar 18 Monday
79	10	7	6	3	1	1	2	5	2	2	11	15	11	26	7	17	8	11	7	4	13	6	8	10	193	Mar 19 Tuesday
80	8	5	8	3	7	14	2	14	6	5	12	4	12	15	22	7	17	9	13	9	10	2	8	8	220	Mar 20 Wednesday
81	7	4	2	17	6	6	7	2	9	13	10	10	8	15	15	18	14	7	7	27	11	12	17	12	256	Mar 21 Thursday
82	2	7	4	12	18	13	4	6	11	7	16	12	12	13	15	13	9	13	9	3	5	23	24	7	258	Mar 22 Friday
83	3	8	7	8	8	11	9	13	14	3	10	11	8	1	16	12	13	5	4	3	5	4	3	10	189	Mar 23 Saturday
84	4	6	0	8	3	5	11	4	3	10	2	6	0	8	4	3	6	6	16	4	4	5	6	53	177	Mar 24 Sunday
85	43	8	5	27	8	8	5	7	3	9	12	5	12	8	15	6	3	11	5	5	18	4	12	4	243	Mar 25 Monday
86	6	7	9	11	3	5	1	1	6	10	6	15	13	6	10	13	3	9	8	2	12	6	15	7	184	Mar 26 Tuesday
87	3	2	10	7	3	3	2	3	3	18	5	14	46	13	18	15	5	12	2	11	9	10	23	10	247	Mar 27 Wednesday
88	6	5	4	20	10	1	4	8	3	17	7	21	11	26	13	14	9	4	9	4	18	7	13	6	240	Mar 28 Thursday
89	2	8	4	9	2	6	4	3	0	8	12	5	15	4	11	5	7	7	6	5	21	6	16	5	171	Mar 29 Friday
90	4	17	18	6	6	6	6	4	0	10	19	6	14	15	11	10	4	5	6	4	7	8	5	14	205	Mar 30 Saturday
91	7	9	8	19	6	8	8	5	22	6	2	2	2	2	5	5	5	2	5	1	7	7	8	5	156	Mar 31 Sunday

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	3218	3123	3182	3016	2926	2970	3257	2651	2712	2701	2401	2671	2579	2678	2757	2526	2369	2759	2516	2541	3610	2991	3464	3052	68670	Total sum
183	18	17	17	16	16	16	18	14	15	15	13	15	14	15	15	14	13	15	14	14	20	16	19	17	375	Total average
127	16	15	15	15	14	15	16	14	14	15	13	16	15	16	17	13	11	14	11	12	20	15	19	15	357	Average workdays
56	21	21	22	21	19	18	22	16	17	15	13	12	12	11	12	15	17	18	19	18	19	20	19	20	418	Average weekends

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

ARC .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
274	72	53	47	57	71	27	17	20	22	18	11	16	17	44	29	41	55	37	38	13	17	9	34	75	840	Oct 01 Sunday
275	60	36	14	19	78	28	28	24	30	33	38	39	31	26	27	33	91	64	32	45	41	45	35	52	949	Oct 02 Monday
276	66	55	77	68	61	37	30	34	52	35	42	31	33	34	43	40	49	41	58	16	28	36	12	24	1002	Oct 03 Tuesday
277	8	17	13	4	14	10	23	24	30	36	15	57	53	31	29	47	56	47	18	45	49	11	62	30	729	Oct 04 Wednesday
278	53	45	5	6	21	17	33	25	29	63	47	40	29	64	78	77	54	21	27	17	5	14	26	11	807	Oct 05 Thursday
279	14	8	6	11	16	30	16	13	17	42	23	39	38	42	33	13	26	13	17	21	20	2	4	23	487	Oct 06 Friday
280	19	12	15	14	21	15	16	13	13	34	33	30	14	21	31	22	16	17	29	16	17	29	10	20	477	Oct 07 Saturday
281	15	18	9	7	14	11	15	29	7	21	12	12	19	15	12	12	20	28	16	14	16	9	6	4	341	Oct 08 Sunday
282	20	10	5	15	7	13	34	16	25	27	23	38	36	28	41	34	50	12	20	24	13	15	17	23	546	Oct 09 Monday
283	21	11	14	17	13	20	36	33	23	20	18	28	22	12	22	5	17	12	5	6	4	10	4	15	388	Oct 10 Tuesday
284	9	4	3	6	20	27	41	15	31	31	25	43	32	24	16	29	23	10	24	33	13	19	29	42	549	Oct 11 Wednesday
285	36	31	52	26	23	31	45	28	32	44	36	56	40	31	48	36	37	38	37	41	16	24	26	15	829	Oct 12 Thursday
286	13	20	24	23	27	24	39	31	40	30	30	37	61	44	16	37	28	13	20	8	14	12	8	38	637	Oct 13 Friday
287	28	26	19	15	12	29	31	10	18	29	17	38	49	21	33	18	36	24	10	19	23	56	47	59	667	Oct 14 Saturday
288	62	61	46	50	41	92	78	53	35	23	22	33	27	54	84	37	20	28	70	66	49	43	17	25	1116	Oct 15 Sunday
289	14	6	12	27	6	9	14	16	27	28	20	47	30	40	26	21	25	24	21	20	12	13	13	28	499	Oct 16 Monday
290	57	54	70	58	75	77	69	43	41	32	34	20	43	36	18	24	25	36	28	34	33	24	28	34	993	Oct 17 Tuesday
291	34	11	12	25	15	17	60	85	70	85	154	93	155	108	131	125	103	64	85	79	108	116	83	55	1873	Oct 18 Wednesday
292	128	91	29	45	30	26	50	40	26	50	29	38	41	35	40	19	18	17	46	19	14	28	26	30	915	Oct 19 Thursday
293	40	22	30	45	23	38	42	28	43	28	34	51	47	45	40	11	33	27	20	32	23	33	15	33	783	Oct 20 Friday
294	36	13	14	14	16	9	9	20	21	7	15	18	35	10	25	23	14	7	14	12	11	8	4	13	368	Oct 21 Saturday
295	13	4	5	11	13	18	12	10	22	17	8	14	23	43	34	33	27	27	15	30	35	14	21	9	458	Oct 22 Sunday
296	10	17	14	9	14	10	20	16	12	21	13	33	21	25	14	18	32	35	24	9	8	12	18	31	436	Oct 23 Monday
297	16	15	13	14	18	17	25	29	65	35	36	28	23	18	38	12	10	15	17	20	11	11	14	27	527	Oct 24 Tuesday
298	18	23	9	16	15	16	17	19	11	26	16	23	39	16	36	11	14	21	17	28	33	23	25	41	513	Oct 25 Wednesday
299	46	51	47	43	51	47	56	36	30	30	22	18	22	24	33	8	17	27	20	24	22	16	28	32	750	Oct 26 Thursday
300	46	45	50	32	56	42	57	45	40	45	46	51	34	41	20	25	15	25	17	15	19	20	10	16	812	Oct 27 Friday
301	16	13	25	37	36	26	21	13	15	11	5	5	29	6	11	5	7	9	7	14	18	17	7	21	374	Oct 28 Saturday
302	12	8	6	8	13	9	15	9	9	14	10	13	37	42	33	30	77	74	82	104	81	110	89	78	963	Oct 29 Sunday
303	88	60	46	49	43	91	19	56	167	107	23	64	124	98	35	86	103	123	130	134	117	97	90	75	2025	Oct 30 Monday
304	55	57	77	72	69	31	46	52	30	20	29	37	54	37	35	59	55	55	57	53	34	85	119	146	1364	Oct 31 Tuesday
305	87	39	47	48	24	22	34	48	87	53	53	73	42	47	39	27	34	48	47	54	35	37	65	102	1192	Nov 01 Wednesday
306	110	73	90	99	89	33	55	42	35	32	49	43	51	35	51	52	34	48	22	27	15	20	21	28	1154	Nov 02 Thursday
307	31	26	20	19	39	38	44	61	86	104	62	42	64	54	74	89	138	125	138	131	133	137	121	135	1911	Nov 03 Friday
308	140	136	131	85	72	48	40	95	80	91	105	99	91	120	82	48	18	23	30	22	34	25	26	24	1665	Nov 04 Saturday
309	35	15	22	14	29	17	12	16	17	23	12	17	10	8	17	23	38	50	44	41	19	12	22	22	535	Nov 05 Sunday
310	20	9	5	18	29	8	12	7	3	14	17	10	8	7	11	6	16	23	13	5	20	20	24	11	316	Nov 06 Monday
311	27	11	26	40	33	58	26	8	6	12	15	27	19	17	24	29	27	12	7	16	12	16	22	30	520	Nov 07 Tuesday
312	20	12	24	18	21	11	26	27	7	19	14	20	24	16	13	19	18	15	14	12	17	18	20	17	422	Nov 08 Wednesday
313	14	15	14	20	22	20	17	17	19	12	23	14	34	22	15	4	19	16	17	22	11	10	8	22	407	Nov 09 Thursday
314	15	16	10	16	33	22	18	12	8	20	18	21	36	21	13	9	25	7	24	17	6	18	12	23	420	Nov 10 Friday
315	65	64	90	13	17	18	22	8	6	25	17	11	18	8	10	22	13	28	16	8	13	11	14	10	527	Nov 11 Saturday
316	36	41	18	24	10	21	5	27	11	8	12	25	9	5	9	10	8	12	5	12	8	5	5	13	339	Nov 12 Sunday
317	16	3	15	17	2	12	10	28	19	12	31	31	51	56	31	25	27	32	15	10	15	7	14	19	498	Nov 13 Monday
318	24	25	22	13	18	13	9	24	23	22	29	27	18	18	15	24	33	37	22	16	21	16	26	25	520	Nov 14 Tuesday
319	17	14	11	17	6	15	5	9	8	23	23	11	23	23	27	12	23	25	32	25	18	11	27	20	425	Nov 15 Wednesday
320	13	20	14	9	7	25	27	32	17	25	11	37	17	16	22	25	33	20	22	28	21	18	8	21	488	Nov 16 Thursday
321	15	12	17	7	5	21	27	30	22	35	25	24	43	21	26	16	15	4	14	26	19	17	17	20	478	Nov 17 Friday
322	20	13	21	11	27	24	19	25	33	37	27	26	37	44	43	56	63	58	56	47	44	44	51	62	888	Nov 18 Saturday
323	56	49	47	59	56	30	42	25	15	28	16	23	11	7	33	24	18	18	11	15	16	27	17	29	672	Nov 19 Sunday
324	22	32	27	20	11	26	29	22	18	16	7	7	10	18	17	11	23	19	13	20	20	9	4	12	413	Nov 20 Monday
325	14	12	21	2	2	9	8	5	9	23	28	26	31	12	22	11	22	23	18	10	16	14	14	17	369	Nov 21 Tuesday
326	12	11	7	3	25	17	8	13	13	27	20	22	28	16	14	19	8	7	6	10	13	10	20	14	343	Nov 22 Wednesday
327	16	8	14	26	18	30	17	26	44	23	14	33	18	41	27	12	26	39	26	22	22	11	19	20	552	Nov 23 Thursday
328	18	10	6	23	33	8	15	19	34	29	23	44	52	46	45	17	19	46	41	26	19	25	20	21	639	Nov 24 Friday
329	32	28	42	33	44	49	50	29	22	23	17	27	26	15	19	18	13	28	29	36	33	38	31	39	721	Nov 25 Saturday

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ARC .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date	
330	36	35	22	34	31	41	30	36	50	43	25	27	16	8	28	16	18	20	16	15	13	31	11	18	620	Nov 26	Sunday
331	23	19	12	19	21	45	14	12	22	15	7	20	17	34	32	15	25	16	31	16	16	5	7	26	469	Nov 27	Monday
332	16	9	8	20	11	12	10	14	18	17	12	15	23	29	29	32	51	18	18	10	14	14	6	12	418	Nov 28	Tuesday
333	12	13	3	3	8	5	7	17	7	13	22	31	12	15	20	32	15	15	16	20	16	6	9	20	337	Nov 29	Wednesday
334	13	13	14	9	12	10	4	6	6	6	8	9	14	10	6	8	10	6	4	9	10	5	4	7	203	Nov 30	Thursday
335	17	6	4	4	6	13	3	6	20	9	8	15	37	25	11	17	21	10	13	18	12	16	18	25	334	Dec 01	Friday
336	14	30	56	52	85	62	48	31	20	19	16	18	14	5	12	15	21	29	19	34	12	0	0	0	612	Dec 02	Saturday
337	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	Dec 03	Sunday
338	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	33	27	24	8	11	23	135	Dec 04	Monday
339	30	10	19	22	7	15	26	17	12	12	12	16	18	16	16	25	15	12	12	17	10	16	9	17	381	Dec 05	Tuesday
340	20	18	5	9	14	12	5	15	14	6	7	23	17	16	8	7	4	10	13	16	13	16	13	24	305	Dec 06	Wednesday
341	25	47	40	56	43	34	31	37	59	42	37	32	53	30	33	61	38	34	26	13	6	15	10	33	835	Dec 07	Thursday
342	43	37	20	21	22	35	53	40	50	45	37	41	65	53	82	75	82	78	86	109	103	116	122	121	1536	Dec 08	Friday
343	100	112	106	109	75	45	16	28	20	40	36	21	20	23	10	14	10	25	7	11	16	4	8	26	882	Dec 09	Saturday
344	20	6	13	22	10	16	8	12	4	13	18	8	13	27	17	27	24	19	15	12	31	18	27	32	412	Dec 10	Sunday
345	44	34	32	17	14	11	24	11	16	11	13	23	8	25	15	7	17	9	12	22	11	9	9	9	403	Dec 11	Monday
346	19	11	7	8	15	8	12	16	13	13	13	9	14	13	9	14	8	6	4	2	13	6	3	9	245	Dec 12	Tuesday
347	17	5	4	6	12	8	12	12	9	10	10	7	13	15	8	14	14	6	4	0	4	3	10	24	227	Dec 13	Wednesday
348	10	7	7	4	7	8	24	4	11	17	14	18	22	24	14	17	26	12	5	16	15	4	5	19	310	Dec 14	Thursday
349	11	3	2	8	9	12	15	19	6	23	14	20	44	24	31	17	27	10	21	19	9	19	9	25	397	Dec 15	Friday
350	25	11	7	5	8	13	2	11	13	9	6	4	13	7	11	14	12	6	4	15	5	2	4	15	222	Dec 16	Saturday
351	9	4	5	11	10	1	3	7	16	2	9	5	5	5	9	14	4	4	13	14	15	11	15	24	215	Dec 17	Sunday
352	31	19	15	35	8	17	19	22	16	28	11	7	31	23	35	33	48	42	51	60	59	99	73	76	858	Dec 18	Monday
353	83	68	73	83	74	87	58	68	77	81	73	81	82	80	59	54	45	48	39	30	38	28	10	14	1433	Dec 19	Tuesday
354	40	20	15	21	36	18	20	30	62	58	44	56	54	30	22	19	37	19	23	23	32	36	52	68	835	Dec 20	Wednesday
355	52	55	70	54	41	35	36	35	42	51	28	31	25	17	19	21	23	10	14	22	23	32	37	43	816	Dec 21	Thursday
356	36	44	38	14	16	20	16	5	12	23	24	2	17	18	10	7	17	19	8	8	14	10	2	26	406	Dec 22	Friday
357	29	7	11	15	14	12	22	10	7	17	18	15	24	20	17	23	28	12	16	22	10	9	6	24	388	Dec 23	Saturday
358	25	8	7	20	11	20	23	23	23	23	23	39	20	18	29	31	16	10	15	8	9	9	18	3	431	Dec 24	Sunday
359	13	8	4	23	8	23	10	19	9	6	4	9	12	10	22	13	10	10	19	14	10	6	13	14	289	Dec 25	Monday
360	9	8	14	11	14	7	10	16	17	7	8	6	12	7	12	7	5	4	7	12	11	16	6	21	247	Dec 26	Tuesday
361	23	17	34	28	67	30	34	30	21	31	29	28	25	41	41	71	66	55	54	71	57	60	67	63	1043	Dec 27	Wednesday
362	58	56	55	53	65	53	73	55	60	55	44	46	66	54	53	56	82	85	73	62	57	82	87	87	1517	Dec 28	Thursday
363	77	92	92	81	88	94	81	77	84	75	84	82	93	99	83	103	92	77	76	83	77	63	21	34	1908	Dec 29	Friday
364	27	16	9	12	16	9	8	18	14	17	25	25	30	2	18	19	14	17	19	12	19	10	7	17	380	Dec 30	Saturday
365	20	18	11	19	18	18	13	28	22	10	17	19	20	7	27	19	10	9	6	12	4	9	12	2	350	Dec 31	Sunday
1	10	10	9	8	1	3	2	7	8	9	8	8	4	8	4	5	3	1	7	14	6	7	3	13	158	Jan 01	Monday
2	7	2	5	4	7	8	7	4	5	17	7	5	2	13	16	11	12	11	20	11	7	16	11	12	220	Jan 02	Tuesday
3	14	14	3	6	18	23	14	22	12	7	8	19	31	13	17	11	24	10	11	10	4	6	17	14	328	Jan 03	Wednesday
4	10	22	7	5	23	17	4	17	11	19	20	20	28	9	10	14	18	9	8	18	23	11	4	30	357	Jan 04	Thursday
5	25	28	33	54	49	55	63	92	68	83	107	87	109	86	95	99	91	89	102	107	97	100	99	110	1928	Jan 05	Friday
6	101	109	104	122	115	104	105	100	109	104	101	74	59	49	46	19	25	25	16	10	13	9	15	31	1565	Jan 06	Saturday
7	13	6	9	20	19	18	24	24	9	12	6	5	6	25	19	6	5	14	16	11	20	15	13	17	332	Jan 07	Sunday
8	21	10	13	23	9	18	13	15	10	27	21	32	18	28	25	17	14	12	16	20	40	7	19	24	452	Jan 08	Monday
9	14	5	16	18	9	9	22	12	20	15	9	23	9	14	12	27	22	13	10	23	10	9	17	18	356	Jan 09	Tuesday
10	14	9	10	6	21	19	13	19	23	13	16	35	19	15	19	23	25	11	24	18	11	21	21	16	421	Jan 10	Wednesday
11	23	24	17	9	17	21	5	25	24	22	24	37	33	28	28	17	17	19	12	21	12	11	14	12	472	Jan 11	Thursday
12	14	4	16	15	22	15	14	24	22	21	16	20	31	28	12	28	26	7	26	17	4	11	31	24	448	Jan 12	Friday
13	18	10	15	14	16	13	19	14	15	24	14	16	25	9	24	14	14	29	23	20	7	9	18	14	394	Jan 13	Saturday
14	18	4	13	13	11	7	31	11	7	20	19	12	20	14	24	12	17	14	25	11	19	10	11	4	347	Jan 14	Sunday
15	13	12	9	2	8	11	7	22	21	16	16	27	15	11	35	8	14	18	13	15	15	14	13	39	374	Jan 15	Monday
16	18	31	16	14	7	17	15	14	34	17	12	31	21	27	10	0	0	7	22	20	16	16	16	87	468	Jan 16	Tuesday
17	11	10	27	46	33	27	15	11	23	39	42	57	70	61	43	50	54	49	35	48	43	49	61	44	948	Jan 17	Wednesday
18	39	73	43	68	67	85	52	70	66	69	77	87	86	66	73	72	65	57	56	53	53	53	58	57	1545	Jan 18	Thursday
19	59	69	48	45	43	38	29	22	19	29	21	26	56	13	8	23	23	16	16	21	21	9	11	15	680	Jan 19	Friday
20	19	4	9	13	8	12	7	6	11	14	15	22	18	8	20	23	25	13	15	26	32	24	26	42	412	Jan 20	Saturday

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ARC .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
21	31	29	39	44	43	42	30	30	24	14	23	11	10	13	7	5	7	26	20	13	9	20	10	17	517	Jan 21 Sunday
22	27	19	12	13	18	3	13	24	9	19	11	26	17	23	28	18	11	5	14	18	8	16	11	36	399	Jan 22 Monday
23	19	9	16	7	6	16	8	12	23	18	5	28	32	20	16	20	26	22	43	46	64	66	67	59	648	Jan 23 Tuesday
24	72	75	81	78	71	59	84	69	81	81	80	75	71	74	67	73	74	53	46	8	14	42	47	61	1536	Jan 24 Wednesday
25	50	68	59	55	67	65	61	64	68	57	62	57	52	44	35	40	37	24	29	11	13	20	13	16	1067	Jan 25 Thursday
26	11	10	6	9	17	15	3	13	36	13	15	20	27	34	9	21	15	9	14	22	4	15	18	14	370	Jan 26 Friday
27	21	22	8	11	6	14	7	8	9	24	29	10	12	9	13	12	16	10	18	30	13	14	12	36	364	Jan 27 Saturday
28	18	5	19	15	8	23	22	15	8	12	9	9	11	9	12	6	7	6	2	8	7	14	16	18	279	Jan 28 Sunday
29	24	13	13	14	22	6	13	31	25	29	19	34	14	22	25	14	26	39	6	16	10	8	11	14	448	Jan 29 Monday
30	26	9	12	12	14	10	6	14	7	7	6	4	7	0	2	2	1	1	1	0	3	3	5	4	156	Jan 30 Tuesday
31	8	4	4	5	3	5	5	5	5	2	10	9	5	11	23	29	43	37	36	28	24	13	11	16	341	Jan 31 Wednesday
32	17	6	4	13	7	10	7	16	12	10	19	24	15	10	22	9	9	18	22	11	14	11	5	13	304	Feb 01 Thursday
33	16	12	10	16	13	15	13	19	14	19	20	33	24	15	32	23	19	21	35	14	16	25	24	25	473	Feb 02 Friday
34	19	19	15	20	26	21	19	15	6	24	18	15	27	18	14	6	5	18	7	19	25	14	12	21	403	Feb 03 Saturday
35	18	12	13	18	19	33	29	29	17	12	12	9	9	6	7	18	9	24	10	7	14	19	15	29	388	Feb 04 Sunday
36	18	7	12	21	16	18	9	16	30	18	21	26	42	18	25	12	24	34	19	25	22	18	17	27	495	Feb 05 Monday
37	26	14	19	21	15	12	12	13	31	27	40	39	29	17	34	19	12	15	14	26	26	23	12	33	529	Feb 06 Tuesday
38	20	13	11	15	21	16	9	18	30	27	28	14	27	49	27	32	16	33	23	12	12	29	18	24	524	Feb 07 Wednesday
39	22	27	10	23	28	27	17	29	27	24	24	23	15	25	15	13	16	25	16	17	16	11	14	23	487	Feb 08 Thursday
40	26	14	9	19	8	6	27	10	17	29	22	20	31	41	17	12	6	16	15	14	5	12	13	21	410	Feb 09 Friday
41	26	26	8	10	7	10	9	11	15	19	23	19	33	16	13	31	14	24	28	27	17	33	27	56	502	Feb 10 Saturday
42	58	56	69	66	42	45	42	33	41	27	32	25	35	37	44	32	34	45	51	46	60	52	69	72	1113	Feb 11 Sunday
43	73	79	51	80	69	60	46	46	45	21	17	27	27	48	23	17	11	10	14	11	30	18	14	13	850	Feb 12 Monday
44	27	11	12	7	17	16	10	29	36	25	15	32	24	25	32	23	42	27	15	27	19	17	3	15	506	Feb 13 Tuesday
45	15	4	16	11	20	4	15	26	12	20	17	40	13	26	27	17	22	12	12	15	16	11	9	15	395	Feb 14 Wednesday
46	16	8	13	10	8	11	15	22	34	28	22	49	27	22	22	16	43	15	21	16	18	17	19	13	485	Feb 15 Thursday
47	24	9	6	8	7	9	7	12	19	19	13	18	35	30	21	22	19	19	13	17	13	31	21	29	421	Feb 16 Friday
48	17	15	22	24	12	10	40	44	27	26	21	19	26	27	16	20	8	22	9	8	9	12	20	17	471	Feb 17 Saturday
49	17	10	17	5	7	19	8	14	16	9	14	25	16	11	18	22	23	11	4	26	23	16	13	32	376	Feb 18 Sunday
50	25	12	23	17	2	4	8	9	12	24	11	14	13	28	21	19	24	4	12	7	28	2	9	25	353	Feb 19 Monday
51	16	10	11	23	9	10	26	19	24	36	24	37	17	17	33	21	24	30	19	14	4	5	16	23	468	Feb 20 Tuesday
52	21	9	12	6	25	15	12	22	30	16	16	33	25	19	26	17	16	23	10	6	11	12	19	7	408	Feb 21 Wednesday
53	15	5	7	4	10	12	15	15	27	14	11	23	21	11	27	12	16	18	13	11	11	6	9	8	321	Feb 22 Thursday
54	20	16	10	6	16	12	13	27	30	18	23	38	31	33	31	23	26	33	40	46	62	55	59	56	724	Feb 23 Friday
55	48	55	59	42	57	62	44	54	49	41	47	54	44	25	36	32	30	19	31	27	27	44	41	41	1009	Feb 24 Saturday
56	40	34	24	37	24	25	20	11	10	19	9	16	6	12	19	19	18	17	17	15	9	22	15	17	455	Feb 25 Sunday
57	16	15	20	21	9	6	20	19	25	22	22	14	30	18	17	25	8	18	17	10	21	15	14	25	427	Feb 26 Monday
58	23	9	17	19	13	19	19	22	16	26	20	34	33	33	29	28	19	20	13	16	16	16	15	26	501	Feb 27 Tuesday
59	19	19	16	6	9	14	19	13	21	22	28	31	29	33	30	14	28	20	14	21	18	10	22	23	479	Feb 28 Wednesday
60	12	12	16	11	15	18	24	24	25	37	24	41	44	34	30	29	15	13	19	29	27	23	19	15	556	Feb 29 Thursday
61	16	19	17	8	22	32	36	26	17	24	26	36	34	42	16	17	16	21	21	21	25	19	16	19	546	Mar 01 Friday
62	27	10	27	15	7	22	16	19	15	27	8	24	22	24	12	13	14	23	14	14	20	14	17	31	435	Mar 02 Saturday
63	19	10	7	19	12	13	15	24	5	11	9	8	9	19	19	20	32	11	13	18	23	9	19	26	370	Mar 03 Sunday
64	16	17	19	5	12	12	9	8	9	10	17	13	16	7	10	20	16	22	18	8	8	25	12	10	319	Mar 04 Monday
65	13	18	4	12	23	14	10	17	28	26	13	22	17	20	34	35	13	13	14	23	13	25	28	16	451	Mar 05 Tuesday
66	16	15	20	10	12	20	25	20	27	35	19	33	34	28	26	30	15	16	19	26	13	2	18	15	494	Mar 06 Wednesday
67	17	11	11	8	6	12	9	7	2	9	8	7	14	6	5	15	14	8	13	7	14	10	10	12	235	Mar 07 Thursday
68	34	13	8	7	15	11	19	16	27	12	10	30	20	12	19	25	20	14	14	15	26	5	12	11	395	Mar 08 Friday
69	21	13	7	12	27	20	10	15	13	19	23	10	17	7	15	28	23	20	22	25	36	55	64	64	566	Mar 09 Saturday
70	70	61	68	72	86	74	60	56	63	44	39	39	31	34	26	26	27	22	42	54	63	58	67	42	1224	Mar 10 Sunday
71	49	37	35	28	35	30	27	21	35	31	17	29	32	17	14	18	43	10	8	14	6	16	16	10	578	Mar 11 Monday
72	17	12	1	21	6	8	16	8	17	22	23	18	18	7	10	23	15	3	16	16	14	7	33	15	346	Mar 12 Tuesday
73	20	19	4	8	16	14	10	13	12	12	27	25	32	20	21	17	17	6	13	28	22	25	26	22	429	Mar 13 Wednesday
74	44	38	60	74	70	85	68	40	34	38	40	36	44	44	54	29	14	22	13	24	35	44	71	75	1096	Mar 14 Thursday
75	75	78	78	86	108	98	83	81	74	63	45	49	54	40	49	31	21	12	13	18	11	21	12	18	1218	Mar 15 Friday
76	23	13	7	17	19	17	8	17	11	21	20	20	13	16	8	5	7	16	12	19	16	16	25	18	364	Mar 16 Saturday

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
77	31	14	5	13	8	9	10	26	12	12	23	7	23	12	16	29	13	12	28	31	19	47	35	42	477	Mar 17 Sunday
78	52	42	41	54	52	41	20	29	39	48	29	34	32	33	18	25	9	17	14	13	21	15	12	21	711	Mar 18 Monday
79	17	11	21	16	12	25	10	13	26	31	12	32	28	21	20	35	18	14	14	22	19	11	12	21	461	Mar 19 Tuesday
80	23	17	17	13	11	20	23	8	16	23	4	19	30	31	8	15	26	18	10	12	17	10	10	16	397	Mar 20 Wednesday
81	16	10	7	12	13	8	16	15	14	22	14	25	17	29	24	17	18	24	16	15	20	20	8	20	400	Mar 21 Thursday
82	21	7	4	32	26	17	10	18	36	48	35	18	42	19	21	14	12	14	30	10	12	9	5	30	490	Mar 22 Friday
83	22	19	30	47	46	55	42	41	13	7	20	27	42	16	12	19	24	9	25	9	8	12	4	17	566	Mar 23 Saturday
84	22	9	14	26	19	14	24	12	9	4	21	13	10	21	19	12	30	16	15	20	21	5	19	26	401	Mar 24 Sunday
85	13	12	11	12	15	20	23	11	16	9	16	25	25	21	16	19	9	19	21	16	11	12	16	11	379	Mar 25 Monday
86	33	32	47	63	67	42	53	43	29	46	22	40	20	30	23	14	14	10	11	18	27	26	30	44	784	Mar 26 Tuesday
87	29	31	25	27	11	10	18	17	21	27	7	11	30	20	14	20	15	10	19	9	13	20	23	19	446	Mar 27 Wednesday
88	20	24	9	14	25	9	17	23	19	21	26	10	22	10	21	15	23	25	12	18	23	13	16	31	446	Mar 28 Thursday
89	17	7	18	20	12	19	32	12	20	33	32	23	32	23	22	27	33	25	25	15	17	7	3	15	489	Mar 29 Friday
90	19	18	9	12	29	17	10	23	6	18	27	31	27	29	21	26	20	15	11	13	14	10	17	27	449	Mar 30 Saturday
91	12	12	11	20	5	12	26	3	18	11	7	11	15	7	21	20	23	14	14	10	10	17	20	22	341	Mar 31 Sunday

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	4380	4551	4471	4476	4916	5096	4806	4491	4281	4332	4148	5323	5347	4285	4652	4401	4735	4403	5460	4772	4719	4274	4120	4233	110672	Total sum
182	29	24	24	25	26	25	24	25	26	27	24	28	30	26	26	25	26	24	23	24	23	23	23	29	608	Total average
127	28	23	22	24	25	24	24	25	28	29	26	31	33	29	28	26	28	25	25	25	23	23	24	30	630	Average workdays
55	32	26	27	28	27	26	23	24	20	22	21	21	22	20	22	20	20	20	20	21	21	21	21	27	550	Average weekends

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

FIN .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date		
274	3	1	4	6	5	8	10	4	2	5	4	2	3	5	4	5	11	9	7	6	4	6	5	9	128	Oct	01	Sunday
275	6	5	7	11	2	9	7	17	10	13	8	16	14	12	12	3	1	2	3	5	3	2	1	3	172	Oct	02	Monday
276	9	4	11	3	1	5	6	5	3	10	19	17	17	10	2	6	3	2	0	5	2	1	4	8	153	Oct	03	Tuesday
277	2	4	4	4	1	9	7	9	9	36	13	17	16	11	10	8	5	0	1	3	14	2	3	4	192	Oct	04	Wednesday
278	4	2	4	3	3	0	9	8	25	18	17	12	18	18	11	5	3	4	3	3	2	3	5	12	192	Oct	05	Thursday
279	0	5	6	8	14	21	6	5	9	11	17	22	11	17	11	4	8	14	18	5	3	3	3	9	230	Oct	06	Friday
280	6	3	3	12	10	2	6	6	5	3	4	5	5	4	2	1	5	2	1	0	7	3	4	11	110	Oct	07	Saturday
281	4	1	1	5	0	8	2	2	4	10	6	6	5	3	1	6	2	4	12	0	3	1	5	0	91	Oct	08	Sunday
282	2	1	3	6	9	26	9	14	4	9	9	9	19	5	9	4	5	5	1	2	4	0	0	0	155	Oct	09	Monday
283	0	0	0	0	0	0	0	0	0	17	7	9	16	11	3	7	2	6	5	3	4	3	4	1	98	Oct	10	Tuesday
284	4	4	8	11	5	17	7	6	6	5	11	20	21	8	2	12	3	2	5	5	6	7	3	10	188	Oct	11	Wednesday
285	2	2	4	2	1	1	3	3	3	10	7	26	23	7	4	12	10	5	3	2	5	3	7	3	148	Oct	12	Thursday
286	6	2	1	1	5	2	3	0	9	16	26	28	34	28	14	18	14	9	1	2	2	1	1	6	229	Oct	13	Friday
287	0	1	7	16	29	28	17	10	17	6	5	1	27	26	17	15	6	1	2	0	3	4	6	2	246	Oct	14	Saturday
288	0	3	2	2	2	2	3	9	4	6	9	2	20	11	1	7	2	1	3	3	1	2	4	13	112	Oct	15	Sunday
289	4	2	2	1	0	0	1	1	3	4	2	19	17	13	0	3	4	1	4	3	2	3	1	2	92	Oct	16	Monday
290	6	2	2	3	0	2	8	10	6	10	9	10	14	11	0	6	4	22	3	6	0	2	2	5	143	Oct	17	Tuesday
291	3	2	2	1	1	4	3	4	4	10	21	55	28	27	11	15	19	12	10	7	8	11	15	13	286	Oct	18	Wednesday
292	20	11	10	27	12	11	6	7	8	13	6	22	10	13	10	10	6	8	8	4	2	11	9	10	254	Oct	19	Thursday
293	7	4	7	7	9	3	4	6	19	16	12	14	20	10	6	7	2	2	3	9	1	3	2	2	175	Oct	20	Friday
294	9	5	10	4	4	18	15	18	10	17	14	10	24	5	4	3	8	2	6	8	8	2	4	13	221	Oct	21	Saturday
295	1	5	0	5	4	5	6	5	14	16	14	24	8	3	3	8	0	5	3	3	10	2	1	3	148	Oct	22	Sunday
296	4	10	5	4	4	4	1	8	11	12	6	4	18	13	15	4	4	3	1	4	3	0	6	8	152	Oct	23	Monday
297	6	10	6	6	0	3	1	5	2	4	19	18	14	13	9	3	2	3	0	3	4	5	6	5	147	Oct	24	Tuesday
298	3	7	3	1	2	1	1	2	10	10	7	20	19	9	7	5	2	2	8	3	4	2	1	6	135	Oct	25	Wednesday
299	2	3	1	6	6	7	0	1	6	9	11	11	14	12	7	1	3	11	2	1	3	1	0	1	119	Oct	26	Thursday
300	9	2	6	1	1	0	2	2	5	17	15	21	13	4	2	3	7	4	0	1	2	2	4	0	123	Oct	27	Friday
301	6	5	2	1	1	3	2	1	0	0	2	4	6	5	3	6	4	1	3	1	3	0	0	1	60	Oct	28	Saturday
302	0	3	1	2	7	0	5	1	4	2	1	3	4	2	4	2	2	4	5	22	13	5	3	9	104	Oct	29	Sunday
303	4	6	4	1	3	5	9	4	5	7	6	14	24	11	5	4	5	0	6	4	12	5	2	5	151	Oct	30	Monday
304	2	1	9	4	6	3	7	7	19	12	11	10	25	14	10	3	3	2	0	0	1	1	4	11	165	Oct	31	Tuesday
305	15	8	9	4	6	5	4	3	5	10	4	13	22	7	8	4	8	5	5	2	14	7	4	5	177	Nov	01	Wednesday
306	8	4	21	29	12	5	4	6	5	6	11	16	14	13	24	3	23	24	8	0	6	5	8	3	258	Nov	02	Thursday
307	2	4	8	3	4	10	9	10	16	10	15	15	13	10	3	2	3	7	19	7	3	4	2	6	185	Nov	03	Friday
308	5	2	0	3	3	2	4	7	5	3	10	11	10	4	3	16	43	24	28	29	25	42	55	27	361	Nov	04	Saturday
309	11	52	28	26	13	6	5	3	6	5	4	4	3	3	2	5	8	5	8	0	1	19	5	8	230	Nov	05	Sunday
310	4	1	3	3	7	1	9	6	7	7	5	5	17	13	4	11	8	7	1	4	3	2	1	3	132	Nov	06	Monday
311	6	3	9	25	17	20	27	9	15	11	18	30	16	35	28	24	58	49	48	37	38	56	31	57	667	Nov	07	Tuesday
312	21	55	26	25	29	14	6	17	12	10	5	12	20	15	17	33	42	59	12	19	18	29	4	6	506	Nov	08	Wednesday
313	4	28	7	7	0	9	1	4	4	3	8	16	30	8	0	0	0	0	4	5	1	4	2	4	149	Nov	09	Thursday
314	4	6	6	2	6	19	12	17	19	28	9	14	20	12	4	0	2	0	2	2	1	2	3	3	193	Nov	10	Friday
315	4	4	3	5	5	3	3	1	5	10	6	2	11	17	6	15	16	57	68	34	51	62	55	10	453	Nov	11	Saturday
316	6	4	32	43	71	40	78	18	35	16	13	13	77	30	5	1	0	5	1	4	5	5	1	4	507	Nov	12	Sunday
317	7	13	8	6	4	9	14	5	27	5	9	22	27	17	4	1	5	1	2	1	14	12	20	7	240	Nov	13	Monday
318	12	10	5	3	7	2	2	15	10	15	20	12	18	5	8	9	4	4	2	2	6	1	5	2	179	Nov	14	Tuesday
319	3	4	3	2	2	17	13	13	16	10	26	21	24	27	10	2	7	5	2	2	9	16	45	48	327	Nov	15	Wednesday
320	6	8	19	25	56	42	33	9	6	14	0	0	24	11	9	8	19	11	7	2	12	6	3	7	337	Nov	16	Thursday
321	6	5	4	4	2	3	3	5	6	9	12	11	14	11	9	5	2	0	2	2	5	2	3	5	130	Nov	17	Friday
322	1	6	4	3	3	3	4	1	6	7	4	5	2	2	1	1	5	3	2	3	4	1	1	4	76	Nov	18	Saturday
323	5	1	1	2	7	1	3	5	0	0	3	5	2	3	6	3	3	4	6	2	3	1	3	4	73	Nov	19	Sunday
324	3	3	2	3	2	1	0	9	9	3	8	10	15	9	3	4	5	0	9	6	2	6	3	2	117	Nov	20	Monday
325	7	8	7	7	0	11	11	11	8	5	22	24	29	17	5	2	4	3	3	7	14	9	3	1	218	Nov	21	Tuesday
326	3	3	5	2	8	7	1	1	6	4	19	22	15	15	8	2	2	0	4	0	4	2	5	4	142	Nov	22	Wednesday
327	2	2	2	0	3	5	25	17	21	5	10	8	26	25	6	3	14	2	6	3	1	1	3	1	191	Nov	23	Thursday
328	1	0	2	0	3	10	4	4	2	13	11	17	21	5	4	5	8	5	0	2	2	6	11	7	143	Nov	24	Friday
329	4	0	2	5	6	4	4	0	5	4	3	6	0	6	2	0	1	2	3	5	4	7	3	2	78	Nov	25	Saturday

Table 3.5.3 (Page 1 of 4)

FIN .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
330	2	1	1	6	1	2	4	0	3	1	2	10	4	6	3	2	4	9	7	1	3	6	3	4	85	Nov 26 Sunday
331	5	8	1	3	1	8	4	3	7	2	2	17	3	4	6	5	16	2	4	8	1	2	5	4	121	Nov 27 Monday
332	0	3	4	1	1	1	1	5	4	4	7	10	9	22	5	9	1	4	2	9	13	4	10	7	136	Nov 28 Tuesday
333	5	3	4	2	5	3	15	2	8	12	14	22	27	19	8	10	3	2	5	1	2	3	2	9	186	Nov 29 Wednesday
334	6	2	1	5	4	4	4	4	13	11	16	14	21	16	5	7	6	1	3	1	0	4	2	6	156	Nov 30 Thursday
335	11	4	5	4	3	5	3	10	2	15	23	20	10	1	3	4	6	3	1	4	5	4	3	1	150	Dec 01 Friday
336	8	2	4	2	3	2	4	6	12	32	13	11	9	21	19	20	18	20	21	25	29	35	31	43	390	Dec 02 Saturday
337	45	44	37	51	55	46	46	42	15	16	11	8	23	40	62	65	69	40	62	60	68	90	70	85	1150	Dec 03 Sunday
338	84	83	63	25	14	7	8	9	14	14	9	22	16	35	18	17	23	8	16	13	6	14	6	10	534	Dec 04 Monday
339	17	11	5	3	7	7	13	4	7	9	16	15	15	12	6	10	5	3	8	9	6	13	4	7	212	Dec 05 Tuesday
340	3	10	8	10	1	5	5	3	8	15	14	15	16	9	8	2	3	7	5	5	3	6	3	9	173	Dec 06 Wednesday
341	7	11	9	10	5	4	30	6	10	9	17	11	23	11	5	3	2	4	13	7	9	3	6	2	217	Dec 07 Thursday
342	6	7	2	3	5	3	10	8	11	17	13	22	20	14	3	7	14	34	23	25	8	7	9	7	278	Dec 08 Friday
343	3	6	2	5	2	1	4	9	12	13	14	8	8	7	5	3	1	5	2	7	8	1	4	13	143	Dec 09 Saturday
344	2	2	2	9	1	1	2	5	2	0	4	4	3	8	13	8	1	4	1	4	8	9	24	20	137	Dec 10 Sunday
345	18	13	14	5	9	6	8	7	2	8	12	11	8	16	16	3	3	6	3	6	4	0	2	3	183	Dec 11 Monday
346	5	6	2	0	3	1	5	5	4	2	15	7	19	6	4	2	4	6	4	6	4	2	2	4	118	Dec 12 Tuesday
347	6	1	2	0	1	0	5	4	1	13	15	9	13	12	3	4	5	4	3	2	5	4	6	10	128	Dec 13 Wednesday
348	10	19	16	17	17	8	9	5	4	10	13	16	11	15	9	7	5	2	4	3	5	4	2	3	214	Dec 14 Thursday
349	1	0	5	6	6	4	5	6	4	11	12	11	16	18	2	7	6	7	8	22	9	7	6	8	187	Dec 15 Friday
350	10	5	9	6	2	7	3	5	4	3	6	2	8	5	2	4	1	2	3	5	5	5	1	1	104	Dec 16 Saturday
351	4	7	7	0	1	1	4	1	2	2	3	2	2	0	0	4	7	7	10	6	13	17	33	25	158	Dec 17 Sunday
352	31	32	22	27	17	20	11	16	22	23	18	18	26	20	17	18	33	25	29	29	31	20	19	15	539	Dec 18 Monday
353	21	16	14	20	12	12	8	9	6	13	9	13	17	10	8	1	7	6	4	2	2	9	2	5	226	Dec 19 Tuesday
354	5	3	3	1	8	3	4	6	1	3	16	20	19	22	13	5	9	3	3	2	5	2	4	4	164	Dec 20 Wednesday
355	7	4	6	3	8	5	6	9	3	13	13	17	27	16	24	5	9	8	9	10	11	12	26	19	270	Dec 21 Thursday
356	23	17	25	28	21	23	24	16	27	21	26	23	43	17	8	18	16	19	15	7	22	11	5	6	461	Dec 22 Friday
357	5	0	6	2	2	4	7	2	3	1	5	2	10	1	7	4	4	3	3	2	4	4	1	5	87	Dec 23 Saturday
358	1	11	6	7	13	12	17	20	16	8	5	4	4	6	14	21	27	26	33	43	39	50	45	56	484	Dec 24 Sunday
359	55	68	63	49	61	42	28	10	10	5	10	7	8	5	3	8	3	7	3	3	1	4	1	5	459	Dec 25 Monday
360	3	6	1	3	1	4	8	3	3	7	5	3	8	2	3	2	3	3	2	7	9	9	19	16	130	Dec 26 Tuesday
361	12	9	2	2	4	5	17	3	6	10	13	10	19	22	13	20	27	27	26	54	21	30	16	6	374	Dec 27 Wednesday
362	16	2	11	7	10	31	32	43	21	15	9	12	10	5	3	4	11	3	8	1	6	6	6	4	276	Dec 28 Thursday
363	10	6	7	4	2	26	24	16	15	16	22	14	13	16	2	10	4	6	6	7	5	5	1	4	241	Dec 29 Friday
364	1	3	7	4	3	7	0	0	1	3	10	11	11	0	1	6	13	1	3	3	6	0	4	6	104	Dec 30 Saturday
365	8	0	2	10	1	1	5	2	6	3	4	6	9	0	8	6	2	1	2	5	3	3	8	2	97	Dec 31 Sunday
1	2	8	2	5	2	4	6	0	9	8	15	4	10	4	1	6	4	5	2	2	10	2	2	1	114	Jan 01 Monday
2	7	7	11	1	5	6	2	1	4	9	6	12	12	7	5	7	6	4	11	3	1	5	4	5	141	Jan 02 Tuesday
3	7	4	5	1	6	1	2	3	7	11	2	16	22	15	13	3	8	4	6	3	7	18	22	24	210	Jan 03 Wednesday
4	34	45	47	34	43	34	21	24	27	24	29	14	34	33	32	23	22	19	13	12	11	5	12	13	605	Jan 04 Thursday
5	8	5	5	4	3	3	4	7	2	12	21	19	13	15	5	20	8	2	4	4	3	0	2	6	175	Jan 05 Friday
6	3	2	3	3	2	2	5	3	2	6	9	6	0	4	2	6	7	3	5	6	5	4	1	5	94	Jan 06 Saturday
7	8	3	4	2	8	8	7	7	2	2	7	4	4	7	6	6	2	10	5	4	7	5	11	8	137	Jan 07 Sunday
8	3	7	4	4	4	3	5	1	1	8	22	17	23	14	3	10	27	11	0	6	7	4	9	8	201	Jan 08 Monday
9	13	9	3	3	3	2	6	4	8	6	19	21	16	27	33	34	5	3	6	7	7	3	3	6	247	Jan 09 Tuesday
10	13	7	2	3	2	10	7	2	0	5	14	13	28	19	16	5	10	4	4	4	5	6	8	6	193	Jan 10 Wednesday
11	6	11	6	5	7	4	1	7	10	10	15	16	24	23	8	4	39	18	6	8	6	4	4	7	249	Jan 11 Thursday
12	2	4	7	6	10	6	4	5	10	17	19	17	14	20	6	9	6	2	4	9	9	4	4	9	203	Jan 12 Friday
13	6	2	11	3	5	7	6	11	4	2	11	9	8	7	0	3	1	2	5	4	2	2	7	3	121	Jan 13 Saturday
14	13	3	9	5	4	2	5	4	5	3	2	2	9	12	2	6	5	4	2	5	5	2	6	2	117	Jan 14 Sunday
15	6	8	29	21	3	4	2	2	3	9	11	9	12	9	7	9	10	15	6	4	5	1	5	0	190	Jan 15 Monday
16	12	2	3	2	4	6	1	2	4	10	8	26	20	15	8	10	3	6	2	4	3	7	0	2	160	Jan 16 Tuesday
17	3	4	1	4	4	2	8	0	5	8	12	23	23	25	4	5	4	4	3	1	4	4	2	8	161	Jan 17 Wednesday
18	4	8	2	3	1	1	0	2	4	9	9	16	21	14	7	11	16	6	13	6	3	4	3	6	169	Jan 18 Thursday
19	4	3	7	5	1	14	7	5	6	9	21	25	13	20	1	6	11	8	8	2	7	4	5	6	198	Jan 19 Friday
20	14	6	1	3	8	2	2	4	18	17	9	12	3	5	3	1	1	8	2	1	5	1	0	4	130	Jan 20 Saturday

Table 3.5.3 (Page 2 of 4)

FIN .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
21	9	2	12	3	2	2	2	3	4	5	1	2	4	1	6	3	4	2	4	7	4	8	5	10	105	Jan 21 Sunday
22	6	4	8	5	2	1	3	3	4	7	5	13	21	17	6	2	5	3	3	8	5	5	1	9	146	Jan 22 Monday
23	1	5	5	9	4	1	4	4	5	12	5	12	24	23	16	16	11	10	5	3	13	2	3	9	202	Jan 23 Tuesday
24	4	6	5	7	2	2	5	5	5	9	15	13	23	12	14	3	11	10	23	13	17	25	19	29	277	Jan 24 Wednesday
25	30	19	16	17	22	7	7	15	20	20	21	27	12	14	16	15	22	19	25	22	24	26	15	22	453	Jan 25 Thursday
26	18	22	26	19	10	14	12	13	10	13	20	18	10	10	10	10	16	24	19	17	25	17	17	14	384	Jan 26 Friday
27	20	16	21	21	24	29	15	18	10	9	16	5	6	9	10	13	22	15	12	4	5	19	13	7	339	Jan 27 Saturday
28	5	4	6	8	2	3	7	2	4	6	1	5	4	2	4	2	6	4	3	6	6	5	4	5	104	Jan 28 Sunday
29	5	6	2	10	4	2	5	6	3	10	7	21	15	18	10	16	9	3	1	3	10	7	5	11	189	Jan 29 Monday
30	3	3	10	8	9	7	2	1	6	5	13	8	11	14	7	6	6	5	5	7	3	6	27	18	190	Jan 30 Tuesday
31	22	11	15	19	14	17	16	21	18	36	13	21	16	11	12	7	17	32	24	34	33	49	45	48	551	Jan 31 Wednesday
32	50	27	23	10	13	1	1	8	4	7	18	16	14	25	9	5	6	8	7	5	5	3	5	9	279	Feb 01 Thursday
33	18	24	35	70	57	37	39	41	36	42	30	32	32	29	38	36	65	65	65	52	41	42	28	17	971	Feb 02 Friday
34	15	11	11	28	56	72	56	53	45	49	26	15	15	5	4	6	3	5	6	7	4	8	1	4	505	Feb 03 Saturday
35	6	3	1	5	5	1	6	2	2	1	0	3	8	2	2	7	4	7	4	3	10	8	9	18	117	Feb 04 Sunday
36	4	4	7	5	8	7	6	9	8	2	0	0	0	4	12	6	12	8	7	3	4	13	4	6	139	Feb 05 Monday
37	17	24	42	48	38	32	31	22	41	30	28	31	25	19	18	11	10	25	31	20	44	44	33	41	705	Feb 06 Tuesday
38	0	0	0	0	0	0	4	10	12	10	4	18	28	19	15	5	4	8	5	8	7	13	7	10	187	Feb 07 Wednesday
39	6	7	6	8	6	5	5	3	9	18	16	9	24	7	13	7	0	4	6	2	6	8	10	6	191	Feb 08 Thursday
40	14	3	3	2	2	3	2	2	10	14	16	19	24	11	7	9	4	10	7	7	8	5	9	9	200	Feb 09 Friday
41	4	5	2	8	11	10	5	11	3	7	10	5	11	3	7	4	5	8	11	7	12	17	22	35	223	Feb 10 Saturday
42	38	36	42	43	50	39	51	46	42	30	18	10	9	8	6	4	7	11	11	11	12	12	18	20	574	Feb 11 Sunday
43	22	24	24	22	21	19	15	15	8	10	8	23	20	6	15	7	3	5	10	8	5	9	5	10	314	Feb 12 Monday
44	10	6	6	5	2	4	4	5	2	14	7	15	22	8	4	9	13	4	2	3	7	7	5	14	178	Feb 13 Tuesday
45	2	7	4	5	3	2	4	10	4	11	11	8	15	15	14	9	2	6	4	8	7	11	9	3	174	Feb 14 Wednesday
46	7	3	7	10	12	4	7	3	2	11	13	14	17	16	7	5	7	5	2	8	5	4	2	3	174	Feb 15 Thursday
47	8	4	7	3	4	4	6	3	3	10	17	23	18	10	9	14	5	3	7	5	8	7	7	7	192	Feb 16 Friday
48	8	3	6	12	10	9	18	9	10	8	7	4	9	11	11	5	5	13	7	7	13	12	14	15	226	Feb 17 Saturday
49	9	22	17	13	11	14	19	19	18	16	20	14	12	5	9	6	5	9	7	10	13	24	31	27	350	Feb 18 Sunday
50	27	47	34	34	36	27	21	21	14	22	23	22	24	12	14	9	8	6	9	9	5	14	12	24	474	Feb 19 Monday
51	23	33	26	37	31	23	27	26	16	21	20	17	16	11	16	3	9	5	5	11	3	7	11	3	400	Feb 20 Tuesday
52	12	13	10	12	7	10	14	12	22	15	23	17	15	17	22	8	3	3	4	9	7	12	7	7	281	Feb 21 Wednesday
53	5	5	13	4	3	3	4	5	7	8	8	20	12	14	15	11	5	11	6	0	8	3	2	8	180	Feb 22 Thursday
54	8	8	2	6	6	3	1	4	8	6	26	16	15	15	3	7	5	4	4	7	3	9	2	3	171	Feb 23 Friday
55	7	6	9	9	4	5	4	5	3	4	5	4	10	4	3	3	12	3	3	4	9	2	3	4	125	Feb 24 Saturday
56	4	7	3	14	7	5	6	6	2	10	6	1	4	6	8	4	8	9	4	2	8	7	7	5	143	Feb 25 Sunday
57	5	7	7	5	4	2	5	6	8	4	18	11	17	10	12	8	15	18	0	3	4	6	2	4	181	Feb 26 Monday
58	7	2	6	5	1	1	2	5	7	11	14	6	15	18	9	7	3	12	3	4	6	5	5	3	157	Feb 27 Tuesday
59	3	6	5	5	3	3	1	2	9	19	15	19	31	16	10	10	7	8	5	1	5	5	6	8	202	Feb 28 Wednesday
60	8	9	6	3	5	6	2	5	5	8	13	14	12	23	17	9	3	4	4	3	6	4	3	5	177	Feb 29 Thursday
61	0	0	0	0	0	0	6	3	11	13	19	20	23	14	5	2	6	6	11	7	7	5	4	4	166	Mar 01 Friday
62	4	0	14	2	4	0	6	3	6	4	0	2	5	7	0	4	5	7	7	8	0	0	5	4	97	Mar 02 Saturday
63	5	3	2	11	4	3	7	2	3	5	0	0	4	0	6	10	9	4	5	6	4	9	11	9	122	Mar 03 Sunday
64	7	7	9	2	11	5	8	5	8	9	13	23	17	16	8	11	7	8	3	4	4	5	2	9	201	Mar 04 Monday
65	5	4	7	3	4	5	2	6	6	13	11	15	28	18	8	18	7	7	4	5	6	8	10	5	205	Mar 05 Tuesday
66	4	8	3	2	1	3	11	6	5	21	13	11	27	14	10	12	4	5	4	8	11	7	6	7	203	Mar 06 Wednesday
67	4	10	8	7	2	4	10	8	11	15	21	20	19	14	14	13	11	6	9	5	5	14	5	8	243	Mar 07 Thursday
68	11	10	8	13	3	7	5	2	5	9	16	20	13	10	9	10	9	3	7	4	7	5	6	8	200	Mar 08 Friday
69	4	8	5	6	7	2	6	3	2	5	8	5	2	1	2	10	23	17	12	8	10	3	10	1	160	Mar 09 Saturday
70	6	1	9	7	3	9	2	6	4	2	3	8	1	8	1	5	4	3	3	7	10	6	6	5	119	Mar 10 Sunday
71	10	1	5	10	1	4	10	4	9	9	9	17	23	9	6	11	4	4	2	6	7	11	4	7	183	Mar 11 Monday
72	6	3	9	11	7	4	2	1	5	11	10	13	13	17	8	11	15	8	13	3	9	6	9	7	201	Mar 12 Tuesday
73	7	4	4	3	5	3	3	5	6	11	14	15	18	20	12	10	13	2	6	10	6	11	8	9	205	Mar 13 Wednesday
74	5	7	6	5	26	20	7	8	9	16	12	17	21	9	17	12	6	7	7	9	6	13	8	15	268	Mar 14 Thursday
75	5	5	9	7	3	4	2	4	4	15	18	19	19	4	6	6	6	3	5	5	8	3	8	6	174	Mar 15 Friday
76	7	4	3	6	3	3	5	11	5	6	1	3	9	9	6	3	7	1	7	11	4	1	11	7	133	Mar 16 Saturday

Table 3.5.3 (Page 3 of 4)

FIN .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
77	4	3	2	4	6	3	4	2	9	3	9	4	9	11	8	21	6	4	12	1	3	6	10	6	150	Mar 17 Sunday
78	9	6	8	6	1	4	5	7	13	10	18	19	16	13	7	11	11	12	7	6	9	11	7	11	227	Mar 18 Monday
79	3	9	5	3	5	4	2	8	21	12	14	28	5	23	5	19	8	12	7	7	2	8	2	8	220	Mar 19 Tuesday
80	8	6	8	4	4	10	4	3	7	15	13	15	20	19	15	8	15	7	10	10	11	4	13	12	241	Mar 20 Wednesday
81	10	2	5	6	8	5	6	3	12	9	9	19	19	23	8	6	18	3	7	10	8	15	6	16	233	Mar 21 Thursday
82	4	3	10	12	12	9	6	8	16	11	22	16	25	13	16	9	5	12	4	5	8	9	7	11	253	Mar 22 Friday
83	3	4	8	5	7	2	4	8	2	2	7	8	7	8	8	4	7	7	6	6	3	0	2	6	124	Mar 23 Saturday
84	3	6	4	13	8	7	13	9	6	7	2	6	6	4	7	3	7	12	4	10	9	3	15	4	168	Mar 24 Sunday
85	13	18	19	12	11	9	7	6	10	6	18	9	15	7	10	4	14	10	13	12	14	15	7	6	265	Mar 25 Monday
86	14	5	9	8	8	3	2	3	12	7	6	18	24	4	6	5	10	6	6	6	3	4	7	4	180	Mar 26 Tuesday
87	4	6	4	10	9	3	3	5	9	19	3	12	27	8	12	13	12	3	7	9	9	7	5	6	205	Mar 27 Wednesday
88	8	5	8	4	4	4	7	6	5	11	21	14	15	15	8	5	13	5	6	7	8	8	6	12	205	Mar 28 Thursday
89	8	3	4	8	2	6	1	1	2	13	17	18	27	6	5	5	6	4	4	4	2	4	6	2	158	Mar 29 Friday
90	4	4	3	7	7	5	2	0	4	5	6	8	3	10	6	9	5	6	7	4	3	2	1	14	125	Mar 30 Saturday
91	5	6	7	13	1	1	8	4	9	5	6	4	4	4	1	11	8	6	2	2	5	7	3	10	132	Mar 31 Sunday

FIN	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Sum	1597	1562	1610	1650	1572	1510	1563	1408	1623	1968	2150	2458	2908	2239	1575	1503	1685	1524	1440	1382	1520	1616	1561	1756	41380	Total sum
183	9	9	9	9	9	8	9	8	9	11	12	13	16	12	9	8	9	8	8	8	8	9	9	10	226	Total average
127	9	9	9	8	8	8	8	7	9	12	14	17	19	14	10	8	10	8	7	7	8	8	7	9	231	Average workdays
56	8	8	8	10	10	9	10	8	8	8	7	6	9	7	6	7	8	8	8	8	9	10	11	11	203	Average weekends

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

GER .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date	
274	0	1	6	4	4	3	5	4	3	11	6	4	21	16	5	15	9	11	10	1	7	7	12	8	173	Oct 01	Sunday
275	5	9	1	9	5	10	11	6	13	21	37	17	25	28	13	12	0	6	7	10	16	3	0	1	265	Oct 02	Monday
276	11	5	11	6	7	6	9	5	7	13	4	22	26	9	11	3	11	10	6	6	6	3	3	9	209	Oct 03	Tuesday
277	4	2	9	6	7	5	8	13	22	23	30	33	23	11	20	17	16	3	4	2	6	14	4	3	285	Oct 04	Wednesday
278	5	5	14	7	8	1	11	14	21	16	23	13	28	18	16	4	18	6	4	4	4	4	4	10	258	Oct 05	Thursday
279	0	0	0	0	0	4	5	12	7	25	17	37	47	10	13	6	6	4	12	4	3	3	12	3	230	Oct 06	Friday
280	3	12	1	4	8	5	4	7	12	6	5	6	10	3	1	7	4	4	6	5	5	5	4	4	131	Oct 07	Saturday
281	4	2	1	1	2	7	10	1	3	5	4	11	7	6	6	5	8	6	6	1	8	4	11	5	124	Oct 08	Sunday
282	6	8	10	7	10	3	24	5	10	9	18	22	29	12	11	18	14	7	7	4	9	5	4	4	256	Oct 09	Monday
283	8	4	2	3	15	12	8	8	8	26	19	26	22	19	21	10	11	10	11	5	6	1	1	5	261	Oct 10	Tuesday
284	7	6	9	7	13	4	2	5	11	28	27	24	8	3	12	2	15	5	0	2	5	5	2	1	203	Oct 11	Wednesday
285	1	0	6	10	10	2	1	6	14	31	20	34	16	17	19	14	14	7	2	5	4	2	6	3	244	Oct 12	Thursday
286	8	2	6	8	8	11	6	2	11	22	24	27	28	34	9	11	9	6	4	8	4	1	6	4	259	Oct 13	Friday
287	0	3	5	8	3	4	2	8	13	2	9	19	16	17	5	4	6	6	16	10	9	9	1	1	176	Oct 14	Saturday
288	0	2	0	9	1	9	2	7	1	7	4	8	16	7	8	9	3	1	2	3	3	7	6	4	119	Oct 15	Sunday
289	4	1	5	5	0	3	10	11	27	18	21	38	32	14	15	13	13	5	3	6	14	5	4	6	273	Oct 16	Monday
290	2	4	4	2	8	7	2	10	15	13	9	33	38	31	12	14	12	5	1	2	6	8	2	1	241	Oct 17	Tuesday
291	1	3	7	17	9	6	1	2	39	22	19	43	26	20	10	11	6	9	4	6	9	7	10	11	298	Oct 18	Wednesday
292	14	7	15	11	17	16	5	6	15	23	28	35	27	11	25	19	6	4	6	3	4	4	7	7	315	Oct 19	Thursday
293	9	3	6	17	12	10	6	2	13	28	22	21	16	6	1	10	1	8	3	8	4	3	7	3	219	Oct 20	Friday
294	4	3	11	9	8	3	2	3	10	6	13	4	8	10	3	8	6	1	3	7	5	2	1	0	130	Oct 21	Saturday
295	1	3	1	1	3	5	2	7	3	4	3	12	6	7	5	2	5	3	0	2	7	9	5	4	100	Oct 22	Sunday
296	11	9	1	5	12	3	18	9	4	14	22	28	19	7	12	16	7	3	2	0	2	6	8	5	223	Oct 23	Monday
297	8	10	5	3	2	7	7	13	11	9	15	34	22	31	27	9	8	5	1	5	8	8	4	7	259	Oct 24	Tuesday
298	5	6	1	0	0	0	6	5	6	12	17	25	26	15	19	5	8	4	1	1	2	3	2	6	175	Oct 25	Wednesday
299	10	12	0	0	5	1	0	4	9	15	24	29	36	11	7	15	7	5	2	4	5	11	2	4	218	Oct 26	Thursday
300	12	4	6	7	4	2	7	7	12	11	10	25	23	18	8	9	4	6	6	0	1	2	4	10	198	Oct 27	Friday
301	3	9	4	3	22	2	2	2	4	5	3	3	9	10	5	8	3	9	4	5	5	1	3	1	125	Oct 28	Saturday
302	7	2	1	11	2	2	6	1	11	6	9	4	14	10	3	4	6	4	1	18	3	8	8	2	143	Oct 29	Sunday
303	8	6	13	9	7	3	5	8	8	13	30	15	17	5	7	12	13	3	0	0	10	9	8	4	213	Oct 30	Monday
304	5	1	7	8	9	6	14	7	10	12	18	22	13	26	11	7	1	2	5	2	5	7	7	6	211	Oct 31	Tuesday
305	4	8	3	0	8	1	6	1	4	14	26	15	18	9	11	8	2	3	3	0	3	3	4	3	157	Nov 01	Wednesday
306	6	10	7	5	8	3	6	6	8	13	19	23	25	21	11	8	8	2	5	6	5	1	7	2	215	Nov 02	Thursday
307	11	1	8	5	2	3	0	0	12	20	12	29	27	18	7	9	1	3	3	7	3	1	3	2	187	Nov 03	Friday
308	2	1	3	4	3	0	0	1	0	0	3	3	6	5	2	1	0	0	3	2	4	3	0	1	47	Nov 04	Saturday
309	2	1	3	5	2	0	2	5	2	2	3	1	12	3	0	1	8	2	3	0	1	4	2	4	68	Nov 05	Sunday
310	5	7	10	3	7	15	11	4	13	5	18	12	14	10	20	3	8	4	0	3	3	3	0	1	179	Nov 06	Monday
311	2	3	4	2	4	3	0	6	15	17	12	23	17	15	16	3	4	3	3	2	3	1	3	5	166	Nov 07	Tuesday
312	1	5	11	4	4	6	10	16	23	14	25	7	25	15	19	12	8	9	0	2	4	2	2	0	224	Nov 08	Wednesday
313	0	0	0	0	0	0	0	3	10	10	27	23	34	19	13	18	2	5	8	2	3	1	0	10	188	Nov 09	Thursday
314	16	22	7	7	6	2	5	3	12	20	28	27	19	19	14	4	6	3	6	4	1	7	13	4	255	Nov 10	Friday
315	2	2	1	8	5	2	4	11	11	3	16	5	5	13	5	10	15	6	3	4	6	13	6	10	166	Nov 11	Saturday
316	1	3	6	8	2	1	1	3	3	6	6	5	4	6	5	3	2	0	2	3	0	10	4	2	86	Nov 12	Sunday
317	11	4	8	14	3	6	2	6	16	16	29	38	31	19	8	11	17	2	1	14	6	9	9	7	287	Nov 13	Monday
318	5	2	2	5	6	5	11	8	21	8	17	25	24	26	19	28	5	5	5	4	4	5	3	5	248	Nov 14	Tuesday
319	4	3	14	10	5	1	2	8	6	16	26	28	16	14	14	15	7	9	4	11	6	4	3	5	231	Nov 15	Wednesday
320	7	3	4	5	0	8	6	15	16	27	13	38	24	4	12	12	1	13	5	2	7	2	2	0	226	Nov 16	Thursday
321	3	2	7	9	0	1	2	11	10	16	20	24	28	11	7	9	3	7	8	2	2	7	4	1	194	Nov 17	Friday
322	3	6	6	2	3	9	4	4	4	10	8	4	12	0	6	4	3	5	1	1	7	3	0	0	105	Nov 18	Saturday
323	5	2	2	0	3	3	1	11	5	4	9	5	4	2	1	5	2	2	2	1	0	5	5	6	85	Nov 19	Sunday
324	2	4	6	7	2	2	1	0	22	7	19	12	28	13	12	9	1	9	8	2	3	3	1	1	174	Nov 20	Monday
325	8	22	3	1	5	0	5	8	4	12	16	33	27	19	19	21	6	9	5	6	4	8	6	2	249	Nov 21	Tuesday
326	2	4	4	7	14	10	6	9	16	10	28	27	24	17	14	12	4	7	8	4	5	7	7	6	252	Nov 22	Wednesday
327	2	4	5	4	7	18	0	4	11	5	15	30	20	16	17	13	3	4	6	3	2	2	4	3	198	Nov 23	Thursday
328	1	2	4	4	5	4	7	9	25	16	8	18	33	18	9	5	8	8	4	4	5	9	6	2	214	Nov 24	Friday
329	4	2	5	4	10	2	6	2	7	10	6	11	29	7	10	6	2	5	1	2	7	1	5	2	146	Nov 25	Saturday

Table 3.5.4 (Page 1 of 4)

GER .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
330	2	0	4	8	1	1	2	5	3	3	17	5	14	5	1	2	1	5	6	2	2	6	4	9	108	Nov 26 Sunday
331	5	5	4	9	1	10	4	9	11	26	25	23	26	22	22	11	11	8	1	13	0	4	7	10	267	Nov 27 Monday
332	3	3	6	6	3	2	5	14	14	19	7	33	29	8	12	10	5	3	4	7	9	7	1	5	215	Nov 28 Tuesday
333	7	4	8	3	4	1	1	7	11	9	24	27	22	13	28	5	10	7	11	8	6	1	1	11	229	Nov 29 Wednesday
334	9	5	4	5	11	27	10	3	10	13	31	29	26	17	20	29	14	2	10	3	8	1	6	7	300	Nov 30 Thursday
335	5	8	10	9	7	10	0	10	16	17	20	19	38	15	13	18	13	5	5	8	6	9	3	11	275	Dec 01 Friday
336	2	1	2	5	7	13	10	7	3	8	8	18	9	8	0	10	5	23	18	25	15	0	6	4	207	Dec 02 Saturday
337	6	12	3	6	1	3	1	4	3	6	12	2	13	4	4	1	4	2	48	44	31	26	16	23	275	Dec 03 Sunday
338	21	19	15	4	10	5	5	14	15	21	19	23	17	24	24	9	7	6	6	3	7	5	4	5	288	Dec 04 Monday
339	10	18	6	13	12	3	9	11	4	10	25	13	36	16	22	14	5	6	12	4	1	4	4	5	263	Dec 05 Tuesday
340	7	9	4	5	1	4	2	11	10	11	7	8	19	29	19	21	7	2	4	7	4	6	8	6	211	Dec 06 Wednesday
341	6	5	9	10	14	8	6	8	5	17	20	19	20	38	29	19	7	10	17	8	11	7	3	3	299	Dec 07 Thursday
342	3	4	2	9	6	6	7	7	26	11	19	28	17	16	5	19	9	10	6	6	9	1	9	3	238	Dec 08 Friday
343	4	7	3	9	6	1	3	5	8	9	16	14	13	6	8	8	7	4	6	9	2	1	1	5	155	Dec 09 Saturday
344	4	0	0	8	2	2	1	5	2	7	6	0	3	4	2	8	0	2	1	5	3	1	15	13	94	Dec 10 Sunday
345	14	9	9	6	4	9	6	9	5	22	28	25	19	20	20	2	5	9	10	9	4	3	0	1	248	Dec 11 Monday
346	3	0	2	11	4	6	1	11	8	16	13	9	34	21	18	3	2	5	11	5	5	3	4	2	197	Dec 12 Tuesday
347	4	5	2	21	11	5	2	14	5	22	18	21	23	29	14	13	8	10	30	11	10	4	2	3	287	Dec 13 Wednesday
348	4	1	3	2	15	19	8	3	7	11	9	16	21	16	8	6	4	6	9	10	3	3	1	3	188	Dec 14 Thursday
349	12	5	11	2	1	2	6	5	8	9	11	14	22	17	14	7	7	5	6	5	4	6	4	8	191	Dec 15 Friday
350	5	2	2	6	4	8	9	6	8	7	7	7	14	4	3	7	10	7	9	6	8	5	1	1	146	Dec 16 Saturday
351	2	3	10	4	1	0	4	1	4	4	7	5	4	15	3	0	0	1	3	0	3	7	7	3	91	Dec 17 Sunday
352	7	10	3	4	5	10	10	3	5	5	21	16	18	17	7	7	9	11	5	17	2	2	7	5	206	Dec 18 Monday
353	11	4	2	7	3	2	5	6	8	13	13	27	10	19	17	9	12	14	6	10	5	10	4	9	226	Dec 19 Tuesday
354	14	3	2	4	8	0	3	4	8	55	60	41	50	11	12	2	3	3	6	4	11	8	3	3	318	Dec 20 Wednesday
355	2	4	2	7	7	9	2	4	5	4	5	25	20	20	5	1	3	9	2	6	14	2	1	3	162	Dec 21 Thursday
356	4	4	5	2	5	2	3	10	5	11	6	14	18	14	8	5	6	9	1	3	1	2	4	2	144	Dec 22 Friday
357	0	2	4	2	3	3	5	5	3	0	5	19	7	0	3	0	1	2	6	5	4	5	0	1	85	Dec 23 Saturday
358	1	5	5	3	4	8	5	9	15	4	0	3	3	1	12	2	3	2	2	1	1	2	0	1	92	Dec 24 Sunday
359	1	0	2	17	6	11	3	3	2	11	3	4	10	1	1	2	5	2	5	4	0	3	4	3	103	Dec 25 Monday
360	2	5	2	0	5	16	12	7	1	2	2	0	16	13	15	3	1	7	1	1	8	6	9	23	157	Dec 26 Tuesday
361	9	1	1	4	4	3	3	3	6	24	19	7	25	24	11	11	7	8	11	1	9	7	3	16	217	Dec 27 Wednesday
362	14	5	17	3	2	5	5	6	13	13	6	9	13	7	2	3	10	2	9	8	2	8	9	4	175	Dec 28 Thursday
363	2	2	2	2	4	4	5	3	7	8	3	9	9	13	12	5	7	9	1	0	3	2	10	3	125	Dec 29 Friday
364	1	3	3	7	0	4	3	5	6	9	7	0	0	0	0	0	0	0	0	0	0	0	0	5	53	Dec 30 Saturday
365	1	0	1	1	9	3	8	6	18	10	4	7	12	2	5	8	4	4	14	1	1	11	10	9	149	Dec 31 Sunday
1	4	7	3	7	1	5	0	7	26	11	12	6	9	13	7	5	9	8	6	3	5	3	4	2	163	Jan 01 Monday
2	9	5	6	6	2	10	7	5	13	5	14	9	8	10	3	7	4	6	5	12	1	2	8	0	157	Jan 02 Tuesday
3	4	5	0	9	4	4	9	7	7	8	17	26	10	22	9	12	5	10	10	9	3	5	10	6	211	Jan 03 Wednesday
4	1	2	3	1	10	18	3	4	7	19	19	11	18	11	13	10	9	19	4	4	11	2	4	6	209	Jan 04 Thursday
5	1	3	1	3	6	12	0	1	12	18	10	15	16	13	11	5	6	6	4	5	4	2	0	3	157	Jan 05 Friday
6	1	7	4	0	4	8	0	9	4	6	10	9	4	2	4	5	3	2	5	7	3	0	0	2	99	Jan 06 Saturday
7	7	3	5	1	8	3	6	7	8	8	1	5	19	20	7	3	4	9	3	0	1	4	8	7	147	Jan 07 Sunday
8	5	2	3	0	3	7	2	6	15	18	15	13	19	13	12	7	2	8	7	1	2	1	3	3	167	Jan 08 Monday
9	3	9	3	8	4	4	4	2	8	8	10	11	17	20	8	13	3	6	7	4	16	2	1	3	174	Jan 09 Tuesday
10	4	10	1	4	3	4	10	7	9	2	15	12	10	9	8	9	13	11	5	6	4	3	7	6	172	Jan 10 Wednesday
11	4	5	5	8	6	4	1	3	5	13	18	15	15	17	4	6	10	2	5	11	5	6	5	4	177	Jan 11 Thursday
12	2	4	4	9	8	4	2	1	8	15	16	22	11	19	23	6	11	9	5	14	5	4	1	5	208	Jan 12 Friday
13	9	11	2	0	7	8	9	12	10	8	6	11	25	3	5	7	5	5	1	2	6	0	7	0	159	Jan 13 Saturday
14	0	2	8	9	6	2	8	1	12	3	1	10	6	10	8	6	1	2	3	1	2	6	10	8	125	Jan 14 Sunday
15	6	5	4	3	5	2	3	3	9	11	9	17	14	11	5	2	10	7	9	11	4	11	12	3	176	Jan 15 Monday
16	7	8	4	7	5	3	2	15	8	6	20	10	23	20	4	1	7	12	4	8	6	7	3	4	194	Jan 16 Tuesday
17	9	2	8	9	3	5	2	2	8	8	13	18	13	14	18	5	15	10	11	12	3	6	1	1	196	Jan 17 Wednesday
18	4	3	5	7	5	6	3	4	3	15	17	11	7	22	11	3	5	3	1	5	10	9	2	6	167	Jan 18 Thursday
19	3	4	5	0	10	4	3	5	7	9	14	29	9	15	6	6	8	12	7	10	12	2	1	6	187	Jan 19 Friday
20	9	3	8	1	10	2	8	10	4	6	2	5	3	4	11	2	3	7	3	2	6	0	2	0	111	Jan 20 Saturday

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
21	4	10	10	6	2	2	1	1	3	11	3	5	15	8	6	4	12	0	1	2	0	6	6	7	125	Jan 21 Sunday
22	3	7	1	2	1	3	2	7	8	11	15	12	13	19	2	11	10	1	11	2	1	7	3	6	158	Jan 22 Monday
23	3	2	3	2	13	8	1	6	8	17	9	18	14	11	5	10	8	4	2	4	5	3	8	3	167	Jan 23 Tuesday
24	1	4	1	1	5	4	2	1	5	11	8	19	11	6	16	2	3	7	1	11	4	2	1	1	127	Jan 24 Wednesday
25	1	3	4	0	2	1	1	8	2	10	9	19	10	9	8	11	9	7	12	6	9	2	9	1	153	Jan 25 Thursday
26	6	2	9	3	10	6	2	5	5	13	6	23	11	22	8	6	5	6	6	8	8	1	1	5	177	Jan 26 Friday
27	15	2	5	3	5	2	4	0	21	5	5	6	10	7	14	14	3	3	7	8	4	3	2	6	154	Jan 27 Saturday
28	2	2	2	0	4	3	3	5	7	3	3	4	10	12	8	2	6	4	3	2	1	1	4	4	95	Jan 28 Sunday
29	3	0	0	3	6	6	8	3	5	7	17	10	14	9	4	3	4	5	4	3	3	4	9	3	133	Jan 29 Monday
30	1	1	4	4	3	6	4	2	7	18	11	20	25	20	18	4	4	17	3	10	3	4	11	10	210	Jan 30 Tuesday
31	2	5	1	3	6	2	2	0	5	11	4	19	11	13	6	6	19	7	6	7	11	5	0	1	152	Jan 31 Wednesday
32	5	3	9	6	17	1	5	4	15	6	16	12	26	9	23	9	20	11	9	8	5	4	0	4	227	Feb 01 Thursday
33	5	5	4	11	8	4	2	2	9	5	14	18	9	25	13	11	9	9	17	0	13	5	3	7	208	Feb 02 Friday
34	2	9	4	4	9	5	3	5	7	5	8	12	14	2	5	4	15	3	3	9	9	15	0	4	156	Feb 03 Saturday
35	11	4	3	2	2	2	2	3	3	5	5	8	13	22	16	2	5	5	1	2	3	6	4	13	142	Feb 04 Sunday
36	2	3	5	8	5	2	6	5	9	20	6	10	23	5	13	2	16	7	8	7	5	3	10	6	186	Feb 05 Monday
37	6	1	9	3	4	7	7	9	5	8	12	16	11	17	12	9	3	7	5	1	4	4	4	12	176	Feb 06 Tuesday
38	5	6	8	8	3	5	1	6	10	14	9	12	16	9	15	8	6	5	4	2	5	13	6	7	183	Feb 07 Wednesday
39	2	3	4	0	7	8	3	1	11	14	13	13	23	18	10	10	6	6	8	2	5	1	15	2	185	Feb 08 Thursday
40	4	1	5	5	12	4	12	8	7	7	9	31	9	15	7	5	7	19	8	6	10	3	7	1	202	Feb 09 Friday
41	5	5	8	5	7	2	9	6	2	6	9	3	9	10	10	6	4	4	5	6	5	4	6	5	141	Feb 10 Saturday
42	2	1	7	1	3	0	3	4	3	3	5	6	12	9	6	13	0	4	3	1	5	5	8	8	112	Feb 11 Sunday
43	6	4	2	6	6	2	1	4	8	19	25	15	5	7	5	4	18	10	10	6	1	2	6	2	174	Feb 12 Monday
44	7	1	6	9	10	5	2	1	8	16	5	28	20	9	10	4	17	14	12	5	5	3	0	5	202	Feb 13 Tuesday
45	1	5	6	5	7	5	1	0	5	8	27	22	25	3	11	15	10	11	8	5	7	6	12	1	206	Feb 14 Wednesday
46	10	1	7	3	7	4	4	3	9	26	13	24	14	14	7	6	9	6	6	3	10	4	4	5	199	Feb 15 Thursday
47	6	6	3	3	6	3	1	2	10	19	7	26	11	6	3	21	5	2	4	6	4	5	2	4	165	Feb 16 Friday
48	0	6	3	3	9	3	17	12	5	12	15	9	3	7	21	1	3	4	1	8	7	3	7	1	160	Feb 17 Saturday
49	4	6	10	5	5	3	3	1	35	30	8	11	2	6	14	3	4	7	0	5	2	7	5	4	180	Feb 18 Sunday
50	5	1	11	2	9	2	1	7	12	12	14	21	11	7	15	12	9	7	9	3	2	7	5	8	192	Feb 19 Monday
51	5	3	8	6	7	3	4	5	10	22	11	20	22	17	14	15	7	4	8	12	7	1	2	1	214	Feb 20 Tuesday
52	6	1	3	2	3	7	3	4	5	13	17	14	17	18	17	21	10	9	10	2	7	4	5	2	200	Feb 21 Wednesday
53	3	3	3	13	3	4	5	6	18	11	18	16	34	16	20	9	15	9	7	12	1	7	5	1	239	Feb 22 Thursday
54	10	11	1	3	8	2	1	4	12	16	18	18	11	9	8	7	11	5	7	1	6	10	0	5	184	Feb 23 Friday
55	4	1	2	7	1	2	5	7	2	5	2	9	7	0	16	3	6	8	7	3	4	1	3	0	105	Feb 24 Saturday
56	1	8	5	6	5	4	3	2	2	17	19	23	19	9	18	9	9	5	2	0	1	0	10	6	183	Feb 25 Sunday
57	3	4	9	5	9	5	7	9	18	11	25	16	16	18	20	18	19	4	4	9	4	6	7	3	249	Feb 26 Monday
58	0	5	9	11	1	8	4	3	12	17	18	25	32	17	15	7	12	9	7	17	6	8	6	5	254	Feb 27 Tuesday
59	10	4	8	20	5	3	8	5	14	23	15	29	10	34	33	14	22	10	3	5	1	2	8	6	292	Feb 28 Wednesday
60	0	0	0	0	0	0	1	11	2	18	16	25	7	25	12	11	8	8	7	8	14	4	2	7	186	Feb 29 Thursday
61	1	3	4	5	12	4	12	7	8	12	18	23	8	12	7	5	4	3	5	4	8	2	2	3	172	Mar 01 Friday
62	0	0	9	1	3	3	7	4	5	8	9	14	10	13	1	5	2	7	3	0	8	0	2	0	114	Mar 02 Saturday
63	1	2	1	7	7	4	3	4	3	5	6	10	6	3	11	8	9	4	8	5	0	1	17	6	131	Mar 03 Sunday
64	4	3	11	6	3	3	5	1	8	13	19	23	18	10	5	12	14	11	11	2	8	5	11	4	210	Mar 04 Monday
65	5	1	4	7	8	3	4	7	9	16	17	25	15	23	16	11	19	6	15	3	2	13	8	8	245	Mar 05 Tuesday
66	6	4	4	5	5	7	3	6	13	15	18	14	33	20	19	17	9	2	13	9	6	5	6	6	245	Mar 06 Wednesday
67	1	3	6	12	10	5	3	5	5	7	15	18	32	8	9	10	20	8	12	8	3	13	3	5	221	Mar 07 Thursday
68	4	3	2	11	3	5	4	1	7	18	10	23	24	13	6	4	6	8	12	2	9	7	4	9	195	Mar 08 Friday
69	4	2	5	12	12	5	7	1	3	6	8	20	3	13	10	15	12	12	17	2	8	5	9	4	195	Mar 09 Saturday
70	0	1	1	3	3	3	1	0	2	9	4	7	3	8	0	1	5	7	0	2	2	3	7	6	78	Mar 10 Sunday
71	3	3	11	9	9	4	8	1	8	21	14	32	29	2	7	15	12	9	4	3	5	8	2	3	222	Mar 11 Monday
72	3	3	8	7	9	5	4	4	9	15	21	23	12	11	8	5	10	8	6	11	6	5	4	1	198	Mar 12 Tuesday
73	3	4	6	2	7	3	7	2	6	4	19	13	11	18	17	2	13	9	7	4	15	6	4	2	184	Mar 13 Wednesday
74	5	6	3	10	12	9	2	8	13	12	28	21	17	16	13	11	18	8	10	8	10	5	9	7	261	Mar 14 Thursday
75	5	3	5	5	3	17	5	8	7	18	24	26	10	20	12	6	3	4	3	4	7	6	7	3	211	Mar 15 Friday
76	1	4	0	5	6	14	3	2	6	9	8	19	3	7	4	6	11	8	6	4	8	3	12	4	153	Mar 16 Saturday

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
77	2	1	2	5	3	5	4	1	2	6	11	7	6	14	4	8	1	12	11	1	1	5	3	0	115	Mar 17 Sunday
78	1	0	6	5	1	2	2	5	11	12	24	21	12	21	29	14	7	13	10	10	6	5	5	4	226	Mar 18 Monday
79	1	3	0	7	10	3	0	10	10	16	19	29	14	13	5	11	22	20	7	2	10	5	2	3	222	Mar 19 Tuesday
80	3	6	11	7	11	8	2	4	12	7	12	24	26	16	15	14	16	12	17	11	7	6	8	9	264	Mar 20 Wednesday
81	4	6	13	4	6	4	3	5	11	9	19	22	27	10	24	17	19	11	3	6	16	10	3	6	258	Mar 21 Thursday
82	2	10	1	5	12	3	5	8	9	14	17	28	20	12	14	15	6	16	8	10	7	4	3	12	241	Mar 22 Friday
83	2	3	3	15	12	8	10	10	2	5	10	17	14	6	3	8	14	11	4	10	2	2	6	6	183	Mar 23 Saturday
84	6	3	1	7	3	4	9	3	8	8	0	13	18	5	10	4	3	11	4	2	3	8	22	5	160	Mar 24 Sunday
85	3	7	9	7	4	6	6	3	11	15	20	21	11	11	16	7	11	14	8	5	8	4	2	8	217	Mar 25 Monday
86	0	9	5	2	6	8	2	4	12	11	20	27	22	13	16	14	11	5	5	0	3	9	15	11	230	Mar 26 Tuesday
87	4	12	7	15	11	5	1	6	14	35	4	37	28	17	7	23	2	15	8	5	2	8	3	3	272	Mar 27 Wednesday
88	8	10	6	5	10	10	9	4	12	15	22	21	22	14	12	11	12	5	11	8	10	9	5	13	264	Mar 28 Thursday
89	7	8	6	13	15	12	5	2	8	15	21	18	13	12	12	10	11	12	6	7	5	4	5	1	228	Mar 29 Friday
90	10	9	9	3	3	15	8	4	5	2	8	9	1	12	9	9	7	4	1	4	6	3	5	14	160	Mar 30 Saturday
91	9	6	8	4	1	4	12	4	5	19	2	4	7	3	5	4	2	4	2	3	4	11	5	3	131	Mar 31 Sunday

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	862	836	931	1045	1100	954	874	1027	1697	2274	2589	3213	3132	2405	2006	1571	1409	1227	1127	996	1010	903	931	890	35009	Total sum
183	5	5	5	6	6	5	5	6	9	12	14	18	17	13	11	9	8	7	6	5	6	5	5	5	191	Total average
127	5	5	5	6	6	5	5	6	10	15	17	22	20	16	13	10	9	7	7	6	6	5	5	5	215	Average workdays
56	3	4	4	5	5	4	5	5	6	7	7	8	10	7	6	5	5	5	5	5	5	5	6	5	132	Average weekends

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

APA .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
274	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	Oct 01 Sunday
275	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	Oct 02 Monday
276	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	Oct 03 Tuesday
277	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	Oct 04 Wednesday
278	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	Oct 05 Thursday
279	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	Oct 06 Friday
280	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	Oct 07 Saturday
281	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	Oct 08 Sunday
282	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	Oct 09 Monday
283	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	Oct 10 Tuesday
284	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	Oct 11 Wednesday
285	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	Oct 12 Thursday
286	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	Oct 13 Friday
287	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	Oct 14 Saturday
288	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	Oct 15 Sunday
289	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	Oct 16 Monday
290	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	35	18	17	17	6	4	7	1	12	123	Oct 17 Tuesday
291	6	10	7	19	34	59	66	71	35	60	75	63	70	53	43	35	14	19	8	15	6	9	13	17	807	Oct 18 Wednesday
292	19	9	14	29	32	25	41	24	27	32	20	16	13	17	17	6	10	10	8	6	6	2	7	0	390	Oct 19 Thursday
293	4	6	4	9	12	21	20	18	14	20	14	16	31	24	15	5	6	5	14	9	0	8	4	1	280	Oct 20 Friday
294	5	3	12	7	11	10	2	6	8	4	8	14	5	3	3	5	3	3	4	3	2	3	0	0	124	Oct 21 Saturday
295	4	3	2	6	6	6	3	4	7	12	7	3	5	6	5	12	4	1	7	2	5	3	3	10	126	Oct 22 Sunday
296	11	28	14	6	11	7	9	13	13	19	3	13	4	10	6	13	4	4	1	3	5	0	11	1	209	Oct 23 Monday
297	1	2	2	5	10	5	16	9	3	13	19	9	16	7	10	4	2	4	2	5	4	2	3	0	153	Oct 24 Tuesday
298	1	2	5	8	11	6	14	22	11	22	30	18	22	9	18	8	6	10	11	6	1	4	1	3	249	Oct 25 Wednesday
299	8	2	5	6	12	11	24	9	11	4	8	8	8	7	13	0	6	15	4	4	3	2	6	1	177	Oct 26 Thursday
300	9	7	15	7	12	12	5	16	6	26	28	6	18	14	5	9	3	2	7	1	5	1	6	0	220	Oct 27 Friday
301	3	7	3	9	12	13	9	9	16	18	19	15	18	16	7	13	8	19	13	17	28	14	20	15	321	Oct 28 Saturday
302	9	9	9	13	7	5	23	12	12	18	11	11	13	7	10	7	1	2	1	16	14	3	5	2	220	Oct 29 Sunday
303	7	3	6	8	16	9	22	10	20	10	17	14	10	8	16	7	4	9	8	8	5	2	2	2	223	Oct 30 Monday
304	4	5	6	9	10	11	17	20	9	11	3	16	0	0	0	0	0	0	0	0	0	0	0	0	121	Oct 31 Tuesday
305	0	0	0	0	0	0	14	26	14	14	11	10	19	6	0	0	6	0	3	3	4	5	8	12	155	Nov 01 Wednesday
306	12	4	15	14	11	7	12	4	8	13	13	7	13	7	10	12	3	5	7	10	7	0	6	3	203	Nov 02 Thursday
307	1	2	7	10	6	16	13	12	9	7	10	8	37	17	12	8	7	15	5	5	5	6	9	9	236	Nov 03 Friday
308	2	8	9	6	12	19	37	30	32	15	39	19	24	26	9	15	16	9	6	4	6	11	7	4	365	Nov 04 Saturday
309	2	1	9	7	15	3	9	30	25	11	23	12	8	9	5	11	12	6	5	2	0	7	5	11	228	Nov 05 Sunday
310	39	21	3	3	12	3	9	7	12	5	5	42	52	29	8	19	18	14	15	17	18	24	23	8	406	Nov 06 Monday
311	24	24	12	20	19	15	17	27	32	23	12	6	11	8	9	9	0	0	4	7	2	12	6	3	302	Nov 07 Tuesday
312	1	2	5	3	10	3	6	15	8	13	4	5	5	4	9	4	9	4	8	1	5	4	4	0	132	Nov 08 Wednesday
313	2	10	2	5	14	10	6	9	6	7	12	14	4	9	10	9	6	12	5	4	0	0	2	3	161	Nov 09 Thursday
314	3	4	6	10	13	9	9	11	6	15	4	17	30	10	2	5	9	13	17	3	4	8	3	1	212	Nov 10 Friday
315	0	2	2	6	9	12	6	8	7	13	7	15	12	4	13	9	4	8	8	9	4	2	4	3	167	Nov 11 Saturday
316	0	8	3	12	9	13	4	9	23	7	4	4	6	17	1	4	7	6	3	7	3	2	6	1	159	Nov 12 Sunday
317	3	9	10	6	4	8	7	6	21	10	7	5	12	16	5	9	4	0	6	4	4	5	0	3	164	Nov 13 Monday
318	4	1	3	6	16	10	7	32	31	15	22	22	23	14	11	7	7	2	5	3	31	27	43	36	378	Nov 14 Tuesday
319	28	21	33	14	7	5	5	13	23	30	26	19	13	6	7	5	4	7	6	2	3	2	8	8	295	Nov 15 Wednesday
320	1	6	3	9	16	16	11	12	17	18	16	24	16	19	8	7	21	6	7	2	16	6	4	1	262	Nov 16 Thursday
321	2	4	12	15	9	7	8	21	3	30	24	25	33	9	16	9	5	5	5	5	2	3	0	2	254	Nov 17 Friday
322	2	2	1	8	8	6	5	12	3	9	18	21	11	14	12	9	15	8	11	2	12	2	2	6	199	Nov 18 Saturday
323	9	17	14	12	14	12	10	23	15	15	16	11	16	36	31	33	8	11	11	16	12	7	35	4	388	Nov 19 Sunday
324	2	4	13	5	16	9	18	8	11	16	38	49	7	0	0	5	10	7	6	8	4	4	9	5	254	Nov 20 Monday
325	11	6	7	3	9	12	4	3	2	9	16	13	10	12	1	3	5	5	9	1	2	8	4	8	163	Nov 21 Tuesday
326	5	8	8	10	20	11	13	16	10	19	12	8	19	13	9	10	4	5	3	6	1	1	11	5	227	Nov 22 Wednesday
327	4	5	6	13	16	10	10	17	19	3	12	6	9	5	15	6	8	3	9	4	1	2	4	3	190	Nov 23 Thursday
328	1	2	1	10	9	5	15	7	12	16	10	22	30	8	16	5	17	13	9	5	5	5	5	0	228	Nov 24 Friday
329	1	4	5	3	4	4	1	5	5	8	3	9	9	4	2	2	4	2	1	17	5	0	2	1	101	Nov 25 Saturday

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
330	6	7	29	3	2	0	3	6	8	8	4	13	3	4	2	1	0	6	3	2	5	5	3	3	126	Nov 26 Sunday
331	6	7	9	17	15	12	7	12	14	10	21	16	23	9	14	9	16	3	6	4	3	4	1	3	241	Nov 27 Monday
332	4	2	12	7	5	4	16	16	10	20	13	11	8	10	5	4	2	4	8	34	10	19	5	4	233	Nov 28 Tuesday
333	5	8	4	8	13	5	14	23	8	0	7	26	18	7	14	10	3	5	6	14	2	7	4	2	213	Nov 29 Wednesday
334	2	6	9	16	8	9	18	9	12	6	6	13	19	13	9	12	3	3	0	13	7	20	13	24	250	Nov 30 Thursday
335	35	17	7	19	22	16	14	29	15	15	13	12	33	12	19	12	9	8	4	3	1	4	3	3	325	Dec 01 Friday
336	6	11	36	2	4	3	5	4	10	1	14	36	17	7	11	5	9	15	6	9	12	11	8	10	252	Dec 02 Saturday
337	11	11	13	12	12	4	10	10	6	3	5	4	3	4	4	4	0	2	32	17	5	5	16	63	256	Dec 03 Sunday
338	39	9	3	8	8	3	13	13	8	9	12	2	4	6	4	5	3	11	3	1	3	3	4	1	175	Dec 04 Monday
339	3	5	13	9	5	4	7	14	16	14	15	12	6	12	3	5	6	8	12	10	6	7	8	6	206	Dec 05 Tuesday
340	4	9	11	17	15	18	20	19	19	15	17	7	32	8	6	6	16	5	8	16	20	22	42	22	374	Dec 06 Wednesday
341	6	10	17	17	29	21	14	18	25	9	40	18	29	15	12	13	9	8	15	5	2	7	8	2	349	Dec 07 Thursday
342	1	5	3	6	11	2	18	22	13	7	31	39	36	10	8	6	3	4	4	2	7	0	3	0	241	Dec 08 Friday
343	4	5	7	3	12	6	9	7	9	6	20	14	12	4	4	4	3	8	11	1	1	2	1	2	155	Dec 09 Saturday
344	4	0	0	13	1	8	0	7	2	3	2	2	5	7	2	8	2	4	1	1	0	2	10	4	88	Dec 10 Sunday
345	7	2	1	1	13	5	9	8	4	5	8	6	6	8	4	4	1	3	7	6	2	5	1	2	118	Dec 11 Monday
346	3	2	2	4	3	6	4	3	3	3	9	4	7	4	6	7	6	1	4	4	11	10	13	14	133	Dec 12 Tuesday
347	40	14	14	4	10	8	11	16	14	6	21	4	10	24	15	11	10	11	16	11	10	12	9	7	308	Dec 13 Wednesday
348	6	7	15	15	14	9	14	13	17	13	7	11	6	27	11	5	8	8	8	6	6	6	12	5	249	Dec 14 Thursday
349	7	4	10	13	10	11	21	20	28	8	17	18	38	17	14	11	10	13	5	8	2	10	3	8	306	Dec 15 Friday
350	5	0	5	1	3	1	2	4	6	4	21	1	17	6	4	11	3	3	0	4	6	0	3	0	110	Dec 16 Saturday
351	5	3	4	2	2	2	3	10	2	0	1	5	5	6	7	3	10	5	2	2	4	5	5	13	106	Dec 17 Sunday
352	11	4	7	8	15	16	23	14	22	12	20	12	11	11	6	5	18	9	9	4	3	9	8	5	262	Dec 18 Monday
353	12	9	10	14	15	12	16	19	24	20	24	37	18	22	12	19	7	9	5	11	21	11	9	18	374	Dec 19 Tuesday
354	21	11	13	26	13	15	24	11	28	17	16	10	18	13	1	4	4	1	6	5	3	9	6	16	291	Dec 20 Wednesday
355	7	1	5	8	15	11	3	6	9	16	8	8	4	14	6	14	4	4	7	4	1	8	6	3	172	Dec 21 Thursday
356	1	2	2	5	6	3	10	11	9	10	27	18	35	11	21	7	11	12	6	7	14	11	5	8	252	Dec 22 Friday
357	5	6	7	9	5	2	2	13	2	4	6	5	20	9	6	1	6	4	5	4	0	1	1	2	125	Dec 23 Saturday
358	0	3	1	2	5	4	6	4	5	5	8	11	9	4	7	6	5	3	5	0	1	8	22	55	179	Dec 24 Sunday
359	10	0	3	7	10	13	7	4	8	7	10	15	7	17	9	10	5	4	2	2	3	1	2	2	158	Dec 25 Monday
360	1	2	0	5	13	8	10	9	6	8	15	9	13	0	0	4	8	6	12	5	5	15	13	33	200	Dec 26 Tuesday
361	51	6	5	17	11	21	11	10	9	20	7	7	12	8	6	8	7	6	3	5	3	5	4	3	245	Dec 27 Wednesday
362	11	5	5	4	11	9	10	13	26	21	20	29	22	6	9	8	13	4	6	9	10	9	11	4	275	Dec 28 Thursday
363	13	14	23	18	24	22	14	32	22	25	22	16	34	34	19	13	12	23	20	20	15	12	6	19	472	Dec 29 Friday
364	21	17	18	8	22	14	11	15	18	14	26	17	30	20	2	3	4	2	0	0	0	1	0	0	263	Dec 30 Saturday
365	0	0	1	4	3	4	1	6	3	2	2	6	5	2	2	6	1	3	2	2	1	5	1	1	63	Dec 31 Sunday
1	1	4	2	1	2	8	3	0	10	18	6	5	4	8	9	11	7	3	3	6	9	3	4	7	134	Jan 01 Monday
2	9	7	7	11	5	6	3	7	7	12	7	9	9	7	7	15	9	19	9	3	0	5	3	6	182	Jan 02 Tuesday
3	3	7	6	4	6	6	8	10	15	4	15	21	9	6	7	9	3	4	3	0	4	5	3	11	169	Jan 03 Wednesday
4	5	7	5	6	9	3	5	8	14	16	7	3	5	14	6	13	9	6	1	4	1	5	2	20	174	Jan 04 Thursday
5	17	26	6	6	8	3	2	14	13	19	33	13	25	19	9	13	12	5	8	8	16	7	8	7	297	Jan 05 Friday
6	10	7	11	9	11	8	3	4	9	20	9	18	12	13	9	11	2	4	6	3	1	3	4	10	197	Jan 06 Saturday
7	3	1	1	2	2	5	3	8	5	6	2	2	2	9	2	3	2	1	2	0	2	1	0	5	69	Jan 07 Sunday
8	0	0	0	1	0	1	1	7	7	4	4	4	2	3	7	0	2	2	2	1	1	1	0	1	51	Jan 08 Monday
9	0	2	3	9	2	6	13	2	3	3	1	15	3	4	2	8	1	2	8	0	0	5	1	4	97	Jan 09 Tuesday
10	0	0	5	3	4	7	6	17	14	6	9	15	17	13	10	6	8	9	6	1	1	10	7	0	174	Jan 10 Wednesday
11	3	3	6	3	12	7	17	19	4	5	21	7	8	10	0	8	0	8	5	6	2	1	3	1	159	Jan 11 Thursday
12	5	0	4	8	8	10	5	6	11	13	6	6	16	8	2	0	14	10	8	3	3	3	11	2	162	Jan 12 Friday
13	3	0	3	2	3	4	2	10	5	2	1	17	9	1	5	6	3	5	4	2	1	2	3	1	94	Jan 13 Saturday
14	5	0	1	2	2	0	17	2	2	0	3	2	9	6	0	0	1	2	4	0	1	0	0	0	59	Jan 14 Sunday
15	0	2	0	4	5	2	7	1	8	1	7	1	4	9	6	4	1	4	1	0	0	0	1	3	71	Jan 15 Monday
16	0	1	1	5	5	9	7	5	2	7	5	4	9	7	5	16	6	3	3	3	3	4	1	1	112	Jan 16 Tuesday
17	2	0	0	5	4	10	9	19	12	10	22	23	26	17	2	13	8	2	1	4	3	0	1	0	193	Jan 17 Wednesday
18	2	2	5	6	6	8	4	11	14	14	10	7	4	9	8	5	3	10	3	1	5	6	1	6	150	Jan 18 Thursday
19	5	1	0	8	7	7	9	19	12	26	14	18	60	30	27	31	8	5	6	10	4	1	3	1	312	Jan 19 Friday
20	1	0	2	5	2	4	6	20	23	29	23	39	31	29	21	35	14	3	2	5	5	2	3	0	304	Jan 20 Saturday

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
21	2	3	19	2	4	7	2	19	14	8	11	6	10	20	11	13	4	4	4	4	2	5	2	5	181	Jan 21 Sunday
22	4	4	6	12	2	3	4	13	12	24	9	10	18	16	14	16	3	4	7	0	2	14	3	18	218	Jan 22 Monday
23	5	0	6	8	6	3	7	16	21	18	4	18	17	13	5	11	11	1	3	1	2	4	7	5	192	Jan 23 Tuesday
24	2	1	6	9	6	14	20	15	14	19	16	32	44	40	20	19	21	4	4	11	7	6	6	9	345	Jan 24 Wednesday
25	2	4	10	12	3	8	16	15	15	11	16	8	14	11	8	19	6	3	5	3	4	11	2	5	211	Jan 25 Thursday
26	1	1	8	7	12	5	21	12	29	15	16	7	28	19	20	13	9	10	5	9	3	9	11	3	273	Jan 26 Friday
27	2	5	2	8	2	4	9	6	5	10	11	11	6	12	6	8	1	16	8	3	2	4	5	5	151	Jan 27 Saturday
28	3	7	1	8	7	8	3	12	3	1	9	11	4	3	4	3	1	1	0	1	4	2	0	1	97	Jan 28 Sunday
29	1	5	4	5	6	7	7	10	8	9	18	23	18	20	10	8	4	3	1	4	6	3	3	2	185	Jan 29 Monday
30	3	1	2	15	13	8	11	4	7	9	7	6	15	8	10	3	2	9	3	3	4	6	16	19	184	Jan 30 Tuesday
31	32	25	12	14	13	22	25	17	30	16	41	38	43	43	43	55	28	10	24	6	7	4	1	14	563	Jan 31 Wednesday
32	15	11	8	12	12	16	25	37	36	42	18	10	43	39	26	33	16	39	26	22	21	14	4	5	530	Feb 01 Thursday
33	3	7	4	11	7	20	18	60	38	57	8	11	28	49	34	33	15	10	11	5	19	11	12	16	487	Feb 02 Friday
34	8	11	4	16	9	19	18	20	24	34	9	16	12	14	6	8	0	2	4	3	0	2	6	8	253	Feb 03 Saturday
35	10	13	1	3	2	6	4	15	13	13	9	11	19	18	7	9	11	6	3	8	2	3	4	2	192	Feb 04 Sunday
36	2	4	11	13	4	8	9	12	25	24	12	7	22	11	9	9	11	8	3	7	6	2	5	8	232	Feb 05 Monday
37	4	4	1	4	7	8	11	24	23	15	15	19	14	12	11	4	6	6	5	7	4	9	5	8	226	Feb 06 Tuesday
38	8	4	12	19	11	8	9	17	10	13	8	12	7	27	14	11	13	6	12	2	1	24	6	2	256	Feb 07 Wednesday
39	3	2	5	6	6	7	6	6	8	9	6	2	6	8	6	4	6	3	5	4	1	9	0	2	120	Feb 08 Thursday
40	1	2	5	10	2	3	12	6	10	9	15	9	17	11	3	7	3	9	11	7	13	12	2	2	181	Feb 09 Friday
41	13	21	6	2	2	11	6	16	13	2	11	1	17	13	15	1	3	5	4	4	6	7	2	2	183	Feb 10 Saturday
42	4	1	2	5	1	5	6	4	1	2	3	5	6	5	1	3	2	4	4	5	8	4	2	2	85	Feb 11 Sunday
43	16	1	10	9	14	13	19	13	11	8	6	10	0	8	8	7	7	8	4	4	11	9	8	2	206	Feb 12 Monday
44	6	2	3	3	13	16	12	4	9	7	7	1	10	7	3	7	17	6	4	8	23	7	6	5	186	Feb 13 Tuesday
45	1	5	5	8	7	6	12	18	8	9	3	16	6	6	14	14	4	4	2	9	9	4	5	3	178	Feb 14 Wednesday
46	7	1	3	8	8	15	20	10	9	3	5	15	8	5	1	11	4	2	2	4	7	4	5	0	157	Feb 15 Thursday
47	7	2	1	6	5	5	5	13	5	21	19	12	11	10	16	16	4	6	7	5	7	6	2	4	195	Feb 16 Friday
48	6	0	7	9	4	3	10	5	10	4	9	13	12	7	10	6	4	3	3	3	4	6	2	3	143	Feb 17 Saturday
49	7	3	4	0	4	5	1	16	7	2	7	5	3	5	7	3	1	2	2	20	2	3	4	0	113	Feb 18 Sunday
50	12	6	6	10	7	17	18	11	14	5	8	3	7	15	10	9	13	8	0	6	17	13	2	11	228	Feb 19 Monday
51	13	7	20	33	11	11	5	10	7	12	7	14	9	9	8	5	8	6	7	2	4	9	9	5	231	Feb 20 Tuesday
52	7	3	4	18	5	15	11	15	18	7	20	7	16	3	10	22	6	1	3	0	2	6	6	1	206	Feb 21 Wednesday
53	5	8	5	4	11	10	14	8	16	7	6	9	27	6	27	15	4	4	11	1	1	3	1	2	205	Feb 22 Thursday
54	4	4	7	3	7	5	6	9	8	6	10	11	20	9	7	7	7	4	2	6	7	1	0	0	150	Feb 23 Friday
55	0	2	0	2	1	8	6	1	10	20	8	21	12	9	4	5	4	4	0	3	5	0	2	1	128	Feb 24 Saturday
56	2	3	1	10	5	4	12	17	9	17	1	5	10	11	6	5	3	3	0	2	2	0	2	1	131	Feb 25 Sunday
57	0	5	1	13	18	12	16	32	11	19	12	11	10	4	5	14	11	11	7	4	7	3	4	1	231	Feb 26 Monday
58	3	3	2	12	4	17	5	23	14	9	5	10	10	10	11	6	7	6	2	3	7	5	3	1	178	Feb 27 Tuesday
59	7	6	8	21	13	12	21	13	21	21	22	18	20	17	9	7	3	6	4	8	4	10	2	1	274	Feb 28 Wednesday
60	1	6	5	3	7	5	10	12	6	6	3	10	7	6	8	2	2	8	4	1	1	4	1	5	123	Feb 29 Thursday
61	5	6	8	10	12	6	22	19	17	7	10	18	7	12	10	3	6	11	1	7	12	0	13	3	225	Mar 01 Friday
62	7	2	9	3	7	6	2	8	4	9	7	20	6	4	5	3	12	5	4	4	9	4	6	2	148	Mar 02 Saturday
63	6	9	3	16	2	9	7	13	10	4	6	4	4	3	13	7	7	1	12	6	4	2	2	4	154	Mar 03 Sunday
64	3	5	6	4	6	8	9	9	20	11	3	6	7	11	6	12	13	2	13	1	4	4	3	1	167	Mar 04 Monday
65	2	1	4	8	6	4	21	16	14	13	11	6	14	13	26	14	10	7	10	7	6	2	1	6	222	Mar 05 Tuesday
66	3	6	7	10	16	19	12	15	7	5	15	3	21	12	9	12	1	6	1	1	2	3	0	3	189	Mar 06 Wednesday
67	14	5	8	10	5	13	7	13	13	11	18	24	15	5	10	11	7	11	6	6	17	5	9	10	253	Mar 07 Thursday
68	9	4	5	1	4	2	6	6	3	3	5	4	13	4	3	7	6	1	6	4	3	8	2	4	113	Mar 08 Friday
69	2	2	1	1	2	4	2	5	3	3	1	0	3	3	1	2	7	6	2	3	3	3	7	3	69	Mar 09 Saturday
70	2	3	0	1	4	5	0	6	0	5	2	5	0	3	4	3	0	3	1	11	2	3	2	2	67	Mar 10 Sunday
71	4	2	6	8	3	1	16	11	4	7	8	2	11	7	8	4	1	5	2	3	5	2	2	2	124	Mar 11 Monday
72	2	14	8	27	17	15	20	18	6	18	12	14	18	14	3	6	4	7	16	16	12	6	8	5	286	Mar 12 Tuesday
73	9	11	7	15	19	12	21	13	7	4	8	17	27	11	13	6	1	6	6	7	1	1	6	3	231	Mar 13 Wednesday
74	0	3	7	16	16	19	22	18	13	2	7	7	14	7	3	7	4	3	1	2	5	6	1	1	184	Mar 14 Thursday
75	5	5	5	20	10	8	19	14	24	20	8	13	13	9	9	1	7	10	3	6	1	5	6	0	221	Mar 15 Friday
76	1	7	5	11	2	9	3	12	2	9	1	18	7	8	2	7	2	2	2	0	3	3	11	0	127	Mar 16 Saturday

Table 3.5.5 (Page 3 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
77	4	3	1	3	4	7	5	11	3	7	5	3	3	4	2	8	1	3	3	5	1	6	4	1	97	Mar 17 Sunday
78	0	4	4	14	6	8	7	15	5	9	9	8	8	13	4	15	0	2	2	0	6	2	6	6	153	Mar 18 Monday
79	5	9	7	16	13	17	10	9	8	19	9	20	17	7	4	20	0	4	0	3	1	3	0	4	205	Mar 19 Tuesday
80	6	1	6	10	7	13	16	6	8	17	8	9	14	5	3	9	1	1	4	2	13	6	2	4	171	Mar 20 Wednesday
81	4	5	5	11	18	8	9	18	9	6	2	15	11	13	7	6	8	6	6	8	2	4	2	2	185	Mar 21 Thursday
82	3	4	0	22	9	12	26	13	28	12	22	6	26	6	10	8	3	11	2	5	12	3	4	5	252	Mar 22 Friday
83	10	1	2	1	7	3	8	4	2	1	8	14	7	0	11	2	4	2	0	2	2	2	2	0	95	Mar 23 Saturday
84	5	0	1	1	4	1	11	3	2	1	1	2	6	3	1	0	0	2	3	2	3	2	8	2	64	Mar 24 Sunday
85	6	2	7	6	7	8	28	21	8	6	20	7	0	1	6	7	1	5	3	5	4	5	1	4	168	Mar 25 Monday
86	3	2	3	7	5	15	11	15	12	8	5	7	8	9	3	1	1	2	5	2	8	10	1	3	146	Mar 26 Tuesday
87	4	2	3	16	7	6	9	19	2	6	6	10	11	7	5	8	1	2	12	6	3	5	4	1	155	Mar 27 Wednesday
88	1	9	5	11	5	11	12	9	4	9	9	13	13	13	5	7	9	12	8	9	11	22	7	2	216	Mar 28 Thursday
89	5	2	10	14	9	11	8	7	8	19	23	5	27	17	18	9	13	7	4	6	18	3	5	3	251	Mar 29 Friday
90	3	4	5	3	10	6	5	6	2	10	10	13	1	14	3	4	8	1	4	0	9	1	0	0	122	Mar 30 Saturday
91	0	0	0	1	0	0	0	0	0	0	0	0	3	0	0	1	1	0	0	0	0	0	0	0	6	Mar 31 Sunday
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	1067	906	1065	1459	1491	1500	1848	2189	1985	1987	2049	2093	2459	1906	1488	1515	1080	1029	977	911	943	942	918	937	34744	Total sum
167	6	5	6	9	9	9	11	13	12	12	12	13	15	11	9	9	6	6	6	5	6	6	5	6	208	Total average
116	7	6	7	10	10	10	13	15	13	13	14	13	17	12	10	10	7	7	6	6	6	6	6	5	229	Average workdays
51	5	5	6	6	6	6	7	10	8	8	9	11	10	9	6	7	5	5	5	5	4	4	5	6	156	Average weekends

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

SPI .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
274	59	77	58	100	82	65	81	91	64	60	89	58	74	84	66	71	54	68	95	69	61	79	89	81	1775	Oct 01 Sunday
275	64	55	101	78	42	70	78	62	66	52	50	76	89	83	61	67	63	69	56	57	57	79	67	63	1605	Oct 02 Monday
276	52	45	78	79	55	38	80	54	49	54	19	30	37	62	92	76	76	116	83	145	100	76	57	80	1633	Oct 03 Tuesday
277	47	83	80	126	72	64	105	125	136	159	137	165	139	160	144	105	127	135	169	144	134	120	114	69	2859	Oct 04 Wednesday
278	0	0	0	0	0	0	0	87	180	184	153	169	177	210	166	130	211	168	159	169	161	126	135	159	2744	Oct 05 Thursday
279	155	122	134	116	148	132	111	136	102	106	95	122	87	90	113	87	72	83	101	77	94	95	63	61	2502	Oct 06 Friday
280	75	104	71	70	56	69	75	56	62	46	58	48	51	64	62	47	61	59	50	63	62	52	32	48	1441	Oct 07 Saturday
281	44	49	60	57	50	78	52	57	56	60	51	40	71	48	49	47	57	55	57	51	37	45	43	30	1244	Oct 08 Sunday
282	40	39	46	54	46	62	51	64	49	41	41	35	52	53	52	46	43	63	43	31	55	26	55	24	1111	Oct 09 Monday
283	35	17	29	31	30	36	38	34	39	39	22	28	48	26	38	49	55	51	39	33	46	52	36	27	878	Oct 10 Tuesday
284	26	43	20	19	42	41	45	16	47	37	31	24	53	20	41	28	42	47	37	53	54	31	38	40	875	Oct 11 Wednesday
285	37	25	58	37	46	40	34	38	23	44	43	36	30	41	35	48	53	77	56	67	44	63	62	46	1083	Oct 12 Thursday
286	53	40	54	47	83	67	62	61	69	62	78	97	93	107	87	144	126	80	115	102	76	56	67	50	1876	Oct 13 Friday
287	62	69	87	47	64	81	79	54	74	52	54	35	56	23	39	26	37	27	46	39	65	82	38	56	1292	Oct 14 Saturday
288	46	41	43	38	40	46	52	55	62	39	50	63	112	55	49	47	62	63	51	64	71	63	49	17	1278	Oct 15 Sunday
289	45	46	34	29	41	57	47	57	54	52	54	52	52	68	51	48	40	38	55	51	45	38	60	78	1192	Oct 16 Monday
290	67	68	62	51	39	46	61	64	64	47	50	46	39	55	54	58	63	55	51	66	58	72	53	55	1344	Oct 17 Tuesday
291	80	64	50	55	62	73	63	35	47	61	66	69	69	71	57	66	58	51	44	57	55	62	64	48	1427	Oct 18 Wednesday
292	72	53	74	67	58	51	71	0	0	0	0	0	65	128	89	89	119	100	102	71	103	119	144	76	1651	Oct 19 Thursday
293	124	117	105	95	129	97	109	129	107	114	95	121	101	142	125	90	86	73	66	74	60	70	75	93	2397	Oct 20 Friday
294	95	98	101	80	135	125	115	82	88	102	75	77	107	59	62	61	63	61	82	71	88	71	80	77	2055	Oct 21 Saturday
295	76	81	102	76	90	92	78	85	66	63	66	83	68	93	76	72	86	73	61	61	65	51	78	57	1799	Oct 22 Sunday
296	64	54	65	59	60	61	63	50	25	36	48	27	41	26	57	56	36	56	35	46	42	61	64	79	1211	Oct 23 Monday
297	51	47	60	51	50	47	0	22	40	26	53	40	57	56	37	58	25	55	46	40	52	44	45	56	1058	Oct 24 Tuesday
298	46	47	46	41	42	49	42	56	65	64	52	36	49	29	37	58	74	87	75	82	62	65	76	55	1335	Oct 25 Wednesday
299	89	79	87	99	85	93	106	88	121	163	82	100	124	110	100	91	116	113	131	106	104	125	87	80	2479	Oct 26 Thursday
300	103	98	97	99	94	103	109	97	101	100	75	104	110	107	84	112	114	111	108	90	117	90	98	95	2416	Oct 27 Friday
301	118	85	102	93	99	90	99	113	110	101	82	86	88	91	102	85	105	82	99	95	105	103	90	74	2297	Oct 28 Saturday
302	68	71	71	69	79	84	92	76	86	55	75	64	95	68	75	81	64	83	69	71	76	63	76	27	1738	Oct 29 Sunday
303	48	60	60	34	36	52	48	51	68	47	70	63	51	61	61	40	61	57	54	49	55	74	60	40	1300	Oct 30 Monday
304	59	34	60	59	57	57	48	98	104	75	61	75	82	98	56	96	83	108	66	106	62	59	55	60	1718	Oct 31 Tuesday
305	65	94	80	80	70	95	86	83	101	69	56	78	76	84	72	59	99	72	77	74	58	82	88	73	1871	Nov 01 Wednesday
306	74	118	91	87	74	76	94	195	175	158	136	137	133	170	153	176	156	137	168	175	156	150	152	138	3279	Nov 02 Thursday
307	134	154	131	126	157	119	104	139	127	125	111	108	144	129	111	79	102	118	99	91	83	110	114	112	2827	Nov 03 Friday
308	102	105	89	119	82	91	84	80	75	73	68	62	65	58	58	73	43	45	74	58	52	64	83	68	1771	Nov 04 Saturday
309	67	54	87	84	69	73	73	54	83	76	58	64	57	43	72	58	66	77	66	66	59	80	67	72	1625	Nov 05 Sunday
310	78	76	89	114	105	106	59	99	150	87	56	65	80	83	76	58	60	83	101	67	68	56	75	55	1946	Nov 06 Monday
311	58	88	97	69	56	62	85	94	61	48	81	76	55	63	63	74	55	52	40	74	72	59	65	79	1626	Nov 07 Tuesday
312	82	77	84	88	87	90	108	84	71	115	84	99	94	97	101	98	90	113	110	85	99	93	115	109	2273	Nov 08 Wednesday
313	83	93	67	87	88	93	86	62	49	82	75	77	81	77	70	58	64	85	79	82	58	82	74	75	1827	Nov 09 Thursday
314	64	62	58	46	65	65	65	58	62	92	88	84	113	117	87	85	89	96	103	78	72	69	56	73	1847	Nov 10 Friday
315	68	50	60	66	37	36	56	41	58	48	32	50	50	56	74	73	77	90	42	47	77	59	91	84	1422	Nov 11 Saturday
316	76	79	75	82	53	57	67	67	57	68	81	63	67	88	83	43	54	64	57	66	64	104	44	69	1628	Nov 12 Sunday
317	62	95	84	56	58	81	60	70	63	49	64	71	61	84	50	62	62	69	62	94	82	70	66	51	1626	Nov 13 Monday
318	46	53	55	71	51	54	61	39	0	0	84	55	89	63	64	42	75	69	63	56	98	105	68	55	1416	Nov 14 Tuesday
319	54	53	45	44	54	50	40	76	90	96	70	111	92	97	64	78	75	58	79	72	69	69	84	68	1688	Nov 15 Wednesday
320	72	81	78	65	61	59	79	54	41	82	60	68	66	65	86	52	54	48	85	75	78	61	52	77	1599	Nov 16 Thursday
321	60	48	80	71	71	90	61	71	62	100	78	96	129	110	97	116	108	92	117	110	103	112	101	76	2159	Nov 17 Friday
322	67	77	71	95	92	103	104	102	73	83	99	105	110	134	107	111	126	113	123	111	108	140	157	112	2523	Nov 18 Saturday
323	159	168	149	168	116	135	101	125	118	127	125	132	117	127	137	134	111	122	98	139	106	99	96	105	3014	Nov 19 Sunday
324	82	100	112	101	111	97	106	128	110	107	121	159	133	111	99	124	170	136	131	142	140	181	159	158	3018	Nov 20 Monday
325	106	125	95	113	108	86	102	114	65	91	102	141	107	98	97	73	97	120	92	84	98	110	94	106	2424	Nov 21 Tuesday
326	136	107	80	145	152	128	129	106	86	55	69	78	74	94	60	106	96	93	86	76	108	108	120	80	2372	Nov 22 Wednesday
327	69	95	103	69	101	103	78	99	107	79	77	70	77	76	55	72	71	92	83	96	92	88	89	84	2025	Nov 23 Thursday
328	84	85	81	82	73	95	80	71	48	79	55	63	68	72	98	78	84	76	86	67	89	94	108	102	1918	Nov 24 Friday
329	111	108	103	111	109	103	118	124	116	123	141	136	127	108	146	140	138	130	129	139	150	129	148	161	3048	Nov 25 Saturday

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	
330	142	150	156	150	147	156	141	137	89	130	138	140	128	117	121	131	117	141	130	109	121	87	90	87	3055	Nov 26	Sunday
331	94	90	83	90	80	81	84	78	86	62	52	73	83	71	57	79	76	65	96	107	106	99	82	103	1977	Nov 27	Monday
332	83	87	82	107	71	85	62	43	70	92	64	69	49	36	72	70	53	89	92	67	76	67	85	69	1740	Nov 28	Tuesday
333	50	75	74	73	73	84	91	83	50	68	77	90	83	78	87	89	71	57	47	50	36	51	24	0	1561	Nov 29	Wednesday
334	0	0	0	0	0	0	0	16	48	44	40	49	43	44	63	39	26	45	64	45	57	61	69	68	821	Nov 30	Thursday
335	72	79	78	90	94	73	52	66	55	48	52	38	53	53	31	56	60	70	62	64	84	64	65	98	1557	Dec 01	Friday
336	75	64	77	72	22	0	0	10	43	0	3	26	7	31	52	83	62	85	67	80	56	65	74	53	1107	Dec 02	Saturday
337	65	63	43	21	0	2	5	2	3	72	119	67	41	65	33	15	85	78	131	122	70	1	2	4	1109	Dec 03	Sunday
338	13	0	1	7	0	0	7	55	29	53	66	34	27	1	6	16	10	1	26	10	34	23	0	0	419	Dec 04	Monday
339	0	0	30	45	11	59	20	11	71	32	20	58	43	45	47	39	0	4	5	2	0	2	10	8	562	Dec 05	Tuesday
340	29	33	15	33	43	42	52	43	46	49	70	67	98	99	75	51	61	72	96	77	47	63	80	83	1424	Dec 06	Wednesday
341	77	82	90	122	72	103	79	88	74	78	84	103	99	118	120	127	131	103	91	124	120	68	86	97	2336	Dec 07	Thursday
342	160	103	99	130	168	92	114	205	79	23	49	111	119	117	105	70	66	63	66	82	85	63	81	64	2314	Dec 08	Friday
343	73	64	91	86	58	75	87	65	55	67	48	66	68	83	59	51	60	64	57	74	49	56	60	38	1554	Dec 09	Saturday
344	70	55	45	71	64	59	57	79	49	71	60	66	69	53	57	41	59	58	74	68	75	64	79	57	1500	Dec 10	Sunday
345	62	60	62	50	29	47	52	45	52	32	52	59	58	53	36	53	39	22	57	35	31	20	29	21	1056	Dec 11	Monday
346	30	26	36	36	55	40	62	48	48	59	77	53	56	44	42	35	28	25	55	31	47	31	33	48	1045	Dec 12	Tuesday
347	40	48	47	24	46	34	50	56	33	52	54	60	43	44	66	70	58	28	20	42	82	84	98	78	1257	Dec 13	Wednesday
348	60	80	75	76	93	80	91	81	89	70	78	71	63	81	85	81	105	81	71	91	91	54	0	0	1747	Dec 14	Thursday
349	0	0	0	0	0	0	0	5	107	62	53	63	71	60	58	29	42	40	46	45	49	42	44	45	861	Dec 15	Friday
350	40	42	36	35	43	51	44	51	40	51	66	63	53	67	46	66	78	85	62	84	55	80	36	26	1300	Dec 16	Saturday
351	57	34	22	63	79	120	117	109	88	101	132	123	108	118	122	116	131	130	114	95	124	98	97	138	2436	Dec 17	Sunday
352	127	107	117	119	125	118	122	127	112	92	96	104	88	102	99	93	97	100	84	72	76	63	68	82	2390	Dec 18	Monday
353	80	82	71	57	87	74	100	95	66	77	78	78	92	99	98	100	96	127	110	103	86	96	91	84	2127	Dec 19	Tuesday
354	102	88	93	111	116	78	79	76	96	79	96	100	80	80	101	97	103	105	102	112	98	97	97	104	2290	Dec 20	Wednesday
355	106	92	122	106	104	78	68	122	93	51	61	45	55	60	46	106	86	79	93	83	73	71	56	52	1908	Dec 21	Thursday
356	73	81	47	83	68	73	61	66	63	55	66	103	47	82	63	59	66	93	80	136	96	98	80	64	1803	Dec 22	Friday
357	78	115	69	83	69	81	78	75	83	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	791	Dec 23	Saturday
358	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	Dec 24	Sunday
359	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	Dec 25	Monday
360	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	Dec 26	Tuesday
361	0	0	0	0	0	0	0	0	9	104	92	121	118	102	98	131	102	97	112	84	99	108	102	90	1569	Dec 27	Wednesday
362	0	0	0	0	0	0	0	0	68	62	88	81	98	107	80	72	94	98	98	89	107	84	105	122	1453	Dec 28	Thursday
363	122	109	95	95	89	90	96	89	101	94	83	93	112	102	97	105	105	93	101	125	112	118	103	86	2415	Dec 29	Friday
364	104	90	97	85	53	74	117	78	71	66	72	84	86	94	45	62	62	75	71	81	77	84	60	53	1841	Dec 30	Saturday
365	69	76	59	47	48	34	44	37	40	18	22	27	34	20	9	35	20	21	26	22	25	16	17	39	805	Dec 31	Sunday
1	16	36	37	43	29	24	11	14	33	40	29	25	0	16	23	66	45	45	53	45	34	46	35	41	786	Jan 01	Monday
2	50	48	46	55	55	48	53	70	77	69	55	63	55	73	53	75	58	63	64	91	10	88	100	98	1517	Jan 02	Tuesday
3	107	131	157	167	156	146	146	134	130	127	119	124	139	143	138	134	154	126	136	146	130	142	137	147	3316	Jan 03	Wednesday
4	143	126	113	134	149	152	152	162	122	134	127	133	117	132	140	145	148	158	116	135	136	146	144	150	3314	Jan 04	Thursday
5	157	131	144	145	115	129	120	115	119	123	130	79	97	92	101	101	101	99	83	96	78	62	87	91	2595	Jan 05	Friday
6	79	75	67	67	58	78	92	74	76	69	90	64	87	66	65	78	60	64	50	67	73	46	66	48	1659	Jan 06	Saturday
7	78	58	46	28	52	47	46	60	28	25	28	17	38	44	29	26	27	34	35	67	36	47	22	31	949	Jan 07	Sunday
8	59	46	62	74	59	39	81	41	54	56	68	52	48	58	61	53	72	54	55	43	37	41	57	40	1310	Jan 08	Monday
9	37	39	60	46	48	44	61	57	40	48	47	37	42	26	28	37	25	45	50	47	52	52	39	24	1031	Jan 09	Tuesday
10	33	31	22	45	34	147	40	38	43	45	55	23	41	212	28	29	20	31	37	21	21	23	32	24	1075	Jan 10	Wednesday
11	49	22	40	49	43	36	55	55	36	28	31	34	28	50	50	34	31	48	42	41	27	19	42	27	917	Jan 11	Thursday
12	28	38	38	47	50	51	25	85	48	38	44	48	51	34	36	24	24	19	35	46	39	31	49	46	974	Jan 12	Friday
13	24	11	50	56	74	55	53	47	43	48	85	52	63	36	44	30	21	20	27	111	45	42	74	46	1157	Jan 13	Saturday
14	34	47	42	69	32	51	30	11	43	32	57	60	30	19	16	27	38	39	24	15	14	8	15	15	768	Jan 14	Sunday
15	3	12	8	16	13	0	52	60	11	13	14	16	5	11	7	12	1	14	10	3	22	10	15	16	344	Jan 15	Monday
16	9	8	16	7	15	41	10	19	19	31	25	13	18	12	25	6	37	25	12	17	30	30	2	31	458	Jan 16	Tuesday
17	45	90	45	50	47	34	16	20	17	12	17	23	26	34	11	19	11	33	21	22	20	36	18	25	692	Jan 17	Wednesday
18	43	31	38	17	25	17	23	15	45	42	51	17	13	2	19	13	2	3	34	1	18	22	35	31	557	Jan 18	Thursday
19	12	0	2	1	0	0	0	0	0	11	31	28	11	26	19	25	26	21	48	29	25	21	23	22	381	Jan 19	Friday
20	7	16	27	36	29	18	49	19	23	32	49	45	29	35	25	47	30	25	25	17	15	13	27	10	648	Jan 20	Saturday

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
21	52	22	27	37	28	25	24	11	21	24	13	16	25	30	21	42	25	51	41	50	50	32	44	24	735	Jan 21 Sunday
22	36	26	29	22	41	28	53	47	55	27	83	62	26	36	49	28	20	21	21	12	6	14	12	21	775	Jan 22 Monday
23	19	6	13	30	33	34	39	53	34	17	0	41	49	32	62	40	44	53	48	46	41	33	51	24	842	Jan 23 Tuesday
24	49	49	36	50	50	40	41	37	39	39	30	25	28	23	39	36	39	23	38	43	43	20	46	37	900	Jan 24 Wednesday
25	44	32	20	14	19	29	5	41	11	20	61	67	40	15	25	24	1	3	6	27	13	8	9	14	548	Jan 25 Thursday
26	11	9	23	44	23	17	21	27	8	41	49	14	20	28	2	10	12	46	7	27	15	9	8	9	480	Jan 26 Friday
27	21	15	23	17	18	21	13	29	16	26	15	22	16	19	47	29	25	18	15	52	24	40	13	4	538	Jan 27 Saturday
28	16	15	8	0	0	0	0	0	0	0	13	75	78	96	80	63	49	62	38	48	20	6	19	21	707	Jan 28 Sunday
29	29	20	15	8	18	16	13	23	12	20	35	28	32	29	8	16	40	41	21	19	8	4	6	28	489	Jan 29 Monday
30	21	12	17	17	15	25	15	7	7	14	7	14	20	18	20	36	39	52	57	45	70	73	82	78	761	Jan 30 Tuesday
31	62	43	42	44	17	22	37	26	11	37	48	4	25	8	20	8	15	17	10	21	18	11	32	72	650	Jan 31 Wednesday
32	91	106	56	108	92	89	76	97	85	86	86	51	59	57	68	16	14	21	26	68	53	52	65	55	1577	Feb 01 Thursday
33	53	50	65	60	70	44	43	88	55	76	115	76	85	86	78	51	66	61	66	50	117	91	111	58	1715	Feb 02 Friday
34	101	106	105	41	82	116	92	62	54	41	50	85	85	79	72	93	87	63	75	102	77	70	83	64	1885	Feb 03 Saturday
35	85	80	82	67	78	57	77	84	89	65	56	59	67	86	62	62	67	80	63	79	70	81	67	51	1714	Feb 04 Sunday
36	36	52	46	35	41	81	64	47	39	44	63	46	49	11	62	45	44	71	44	44	46	83	56	49	1198	Feb 05 Monday
37	58	57	20	6	7	16	13	9	22	18	35	16	5	8	33	31	31	40	56	20	9	7	3	12	532	Feb 06 Tuesday
38	4	15	14	6	7	4	8	14	17	2	3	13	5	15	8	1	3	12	2	3	7	58	23	17	261	Feb 07 Wednesday
39	47	64	16	25	27	6	52	65	42	53	36	19	46	28	48	46	53	37	63	41	30	68	30	30	972	Feb 08 Thursday
40	49	39	47	24	25	35	16	18	19	14	9	27	20	36	21	28	22	42	21	9	10	18	29	26	604	Feb 09 Friday
41	21	32	20	25	14	33	14	24	25	21	37	24	38	25	34	31	24	26	23	26	18	13	33	19	600	Feb 10 Saturday
42	21	17	42	22	24	33	28	32	20	33	37	29	20	24	30	29	16	44	24	32	26	43	39	20	685	Feb 11 Sunday
43	27	21	18	37	18	41	38	41	25	23	26	40	47	48	35	39	13	55	32	35	32	64	44	39	838	Feb 12 Monday
44	54	15	19	18	5	10	72	59	62	42	31	41	26	61	28	37	49	9	30	20	34	11	3	6	742	Feb 13 Tuesday
45	70	47	40	31	32	29	43	34	12	11	31	5	9	19	30	30	48	39	63	32	20	38	33	34	780	Feb 14 Wednesday
46	21	31	24	30	37	21	46	62	40	26	38	43	29	52	43	41	30	38	39	24	47	45	21	44	872	Feb 15 Thursday
47	30	69	109	71	45	24	32	37	24	45	24	38	47	31	62	305	374	5	17	12	14	26	19	22	1482	Feb 16 Friday
48	10	26	19	35	26	24	36	28	39	24	35	40	33	34	49	78	52	74	123	63	80	48	62	51	1089	Feb 17 Saturday
49	53	37	74	56	42	41	60	59	47	42	53	45	24	43	31	39	46	44	43	42	45	34	34	48	1082	Feb 18 Sunday
50	48	55	58	61	73	62	61	71	61	71	92	61	59	70	51	64	69	72	108	86	75	93	66	57	1644	Feb 19 Monday
51	76	72	52	76	70	60	73	69	56	53	44	67	52	30	68	75	48	42	19	50	36	48	15	10	1261	Feb 20 Tuesday
52	20	20	20	42	53	58	35	49	36	35	42	70	31	28	23	10	0	0	0	0	0	0	0	0	572	Feb 21 Wednesday
53	0	0	0	0	0	0	0	0	78	140	25	31	7	21	19	22	36	47	18	7	11	9	26	17	514	Feb 22 Thursday
54	77	26	17	25	7	22	12	16	13	11	26	29	25	30	26	40	45	10	41	37	67	36	57	46	741	Feb 23 Friday
55	26	28	15	14	11	20	21	23	20	25	31	55	14	18	34	38	49	22	16	10	4	3	4	2	503	Feb 24 Saturday
56	10	19	4	19	13	30	34	34	11	17	22	38	58	61	36	38	29	20	6	11	5	17	26	17	575	Feb 25 Sunday
57	11	8	15	12	4	19	22	20	42	39	28	16	10	20	20	29	18	18	21	15	24	17	22	13	463	Feb 26 Monday
58	10	22	18	8	20	6	40	14	22	14	15	8	22	14	23	10	10	12	2	8	5	8	5	10	326	Feb 27 Tuesday
59	16	30	41	13	22	13	20	13	17	15	29	16	26	37	32	49	39	37	15	23	40	29	12	15	599	Feb 28 Wednesday
60	23	23	25	32	52	40	35	48	48	35	31	46	65	32	22	65	72	40	52	40	75	24	36	25	986	Feb 29 Thursday
61	33	33	47	60	27	25	28	24	17	19	103	11	35	16	26	41	36	32	15	12	48	16	22	22	748	Mar 01 Friday
62	20	30	38	17	28	14	23	9	23	19	10	12	10	8	29	13	12	22	20	12	50	22	42	14	497	Mar 02 Saturday
63	20	16	29	27	15	23	17	17	10	11	48	20	17	14	15	66	28	23	13	11	14	7	25	26	512	Mar 03 Sunday
64	18	27	8	38	29	4	7	9	27	7	34	23	10	0	20	32	16	13	8	6	9	18	26	21	410	Mar 04 Monday
65	24	23	32	29	0	0	7	38	49	55	36	31	47	15	19	49	50	20	18	6	16	11	25	20	620	Mar 05 Tuesday
66	8	14	10	5	15	8	54	34	46	22	32	18	9	17	18	54	22	28	27	46	35	39	24	38	623	Mar 06 Wednesday
67	13	10	29	27	15	18	35	30	21	24	24	22	26	26	30	37	30	30	33	44	26	41	25	30	646	Mar 07 Thursday
68	20	34	27	23	15	27	43	33	31	44	472	489	67	1	22	17	85	101	74	61	111	61	19	5	1882	Mar 08 Friday
69	9	10	0	2	7	2	1	3	1	17	12	2	42	19	10	3	5	0	2	1	1	2	4	4	159	Mar 09 Saturday
70	0	11	11	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	Mar 10 Sunday
71	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	Mar 11 Monday
72	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	Mar 12 Tuesday
73	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	Mar 13 Wednesday
74	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	Mar 14 Thursday
75	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	Mar 15 Friday
76	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	Mar 16 Saturday

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
77	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	Mar 17 Sunday
78	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	Mar 18 Monday
79	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	Mar 19 Tuesday
80	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	Mar 20 Wednesday
81	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	Mar 21 Thursday
82	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	Mar 22 Friday
83	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	Mar 23 Saturday
84	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	Mar 24 Sunday
85	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	Mar 25 Monday
86	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	Mar 26 Tuesday
87	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	Mar 27 Wednesday
88	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	Mar 28 Thursday
89	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	Mar 29 Friday
90	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	Mar 30 Saturday
91	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	Mar 31 Sunday
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	8904	8856	8882	9033	8623	8775	8978	9293	8956	8966	9693	9798	9542	9704	9210	9644	9787	9617	9540	9578	9412	9196	9101	8442	221530	Total sum
159	56	56	56	57	54	55	56	58	56	56	61	62	60	61	58	61	62	60	60	60	59	58	57	53	1393	Total average
112	55	54	54	56	55	54	56	60	58	58	63	64	61	63	59	62	64	61	61	60	61	60	59	56	1416	Average workdays
47	59	59	59	58	53	57	58	54	52	52	56	56	57	56	54	57	56	58	56	60	55	52	53	47	1335	Average weekends

Table 3.5.6. (Page 4 of 4) Daily and hourly distribution of Spitsbergen array detections. For each day is shown number of detections within each hour of the day, and number of detections for that day. The end statistics give total number of detections distributed for each hour and the total sum of detections during the period. The averages show number of processed days, hourly distribution and average per processed day.

HFS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
274	3	8	7	5	3	2	8	3	7	3	12	6	10	10	8	14	14	10	10	7	5	21	51	27	254	Oct 01 Sunday
275	9	14	41	53	5	9	3	12	26	6	7	16	19	24	1	22	20	57	22	17	7	8	45	11	454	Oct 02 Monday
276	4	1	9	3	20	31	21	12	13	32	63	9	0	0	0	20	18	51	27	12	20	19	13	10	408	Oct 03 Tuesday
277	5	5	3	2	50	51	11	7	0	0	0	11	28	9	16	36	38	11	4	15	38	21	2	4	367	Oct 04 Wednesday
278	3	6	1	2	15	70	29	22	11	26	48	30	28	22	15	54	37	26	12	12	94	15	8	2	588	Oct 05 Thursday
279	2	0	13	6	24	39	6	11	11	13	8	30	31	25	26	18	7	4	15	2	1	2	6	2	302	Oct 06 Friday
280	5	2	2	4	2	4	12	7	3	8	3	7	4	2	9	5	5	2	2	2	4	8	4	7	113	Oct 07 Saturday
281	5	5	3	4	3	8	5	4	4	21	15	11	9	3	22	7	21	54	26	2	8	4	3	3	250	Oct 08 Sunday
282	1	4	2	2	10	11	19	31	17	17	19	14	21	20	17	13	30	32	18	3	30	6	3	13	353	Oct 09 Monday
283	14	1	3	1	7	15	26	37	15	12	29	24	59	15	12	21	5	20	19	5	3	3	0	6	352	Oct 10 Tuesday
284	1	1	1	33	20	11	12	10	10	35	10	15	25	28	8	12	4	3	4	5	5	6	1	3	263	Oct 11 Wednesday
285	9	3	4	3	6	12	20	11	4	29	9	7	14	11	16	17	22	45	3	2	1	1	6	2	257	Oct 12 Thursday
286	5	2	2	4	13	17	9	9	3	9	26	19	21	19	15	8	8	8	6	1	3	1	1	5	214	Oct 13 Friday
287	2	2	6	2	72	9	8	5	55	22	12	8	32	37	15	16	18	2	4	2	7	9	1	2	348	Oct 14 Saturday
288	1	0	1	6	2	7	4	28	3	9	16	8	44	20	17	9	7	4	3	3	4	3	11	1	211	Oct 15 Sunday
289	0	4	2	0	14	44	19	10	21	5	23	14	7	17	14	34	11	26	9	5	6	6	3	2	296	Oct 16 Monday
290	1	2	1	2	6	16	18	14	18	9	9	20	10	24	27	19	3	48	11	3	3	13	11	2	290	Oct 17 Tuesday
291	1	0	1	1	10	34	9	4	5	23	38	43	12	22	9	6	12	9	6	4	30	18	10	13	320	Oct 18 Wednesday
292	12	3	10	12	5	18	13	7	8	10	27	15	9	7	10	20	8	5	35	12	11	7	24	0	288	Oct 19 Thursday
293	3	3	53	24	8	11	2	21	22	23	18	30	14	5	6	7	11	4	6	14	4	1	3	2	295	Oct 20 Friday
294	7	2	11	3	1	7	5	11	10	14	9	16	16	2	3	14	10	10	11	10	9	0	4	4	189	Oct 21 Saturday
295	1	5	2	4	3	4	4	5	9	23	12	5	2	11	6	4	1	7	7	4	2	6	2	1	130	Oct 22 Sunday
296	5	9	1	2	8	1	4	6	1	5	4	8	2	18	13	10	10	12	2	0	1	1	8	6	137	Oct 23 Monday
297	3	4	4	3	5	9	13	0	8	22	24	24	13	20	27	19	3	4	9	5	3	5	7	10	244	Oct 24 Tuesday
298	3	8	2	3	7	6	1	0	17	12	22	17	22	18	15	22	9	19	3	1	2	1	19	22	251	Oct 25 Wednesday
299	0	9	3	4	8	12	4	1	5	8	9	3	12	11	16	9	24	5	4	1	5	10	15	3	181	Oct 26 Thursday
300	3	2	24	14	2	8	0	7	6	10	10	10	3	17	5	33	16	5	5	0	5	5	1	3	194	Oct 27 Friday
301	4	4	3	6	4	8	8	12	5	11	7	10	9	9	17	9	9	12	6	6	7	2	8	6	182	Oct 28 Saturday
302	3	5	2	4	6	7	11	1	16	5	12	8	43	12	8	8	4	6	12	14	8	4	6	1	206	Oct 29 Sunday
303	2	5	3	5	17	38	4	18	8	19	28	25	18	10	27	24	46	24	4	20	18	4	4	4	375	Oct 30 Monday
304	1	1	9	4	39	36	15	15	7	41	28	24	10	26	75	41	12	3	41	7	2	4	11	6	458	Oct 31 Tuesday
305	8	2	8	6	40	33	11	31	13	27	46	14	21	10	16	14	11	3	9	1	3	1	6	2	336	Nov 01 Wednesday
306	10	2	3	5	14	36	49	17	11	24	36	46	24	25	8	23	22	0	7	1	2	3	8	3	379	Nov 02 Thursday
307	9	4	3	10	19	38	6	8	2	25	32	18	6	10	6	14	4	4	3	3	5	5	5	11	250	Nov 03 Friday
308	6	5	1	4	5	7	12	6	2	10	11	6	13	6	4	9	11	4	3	7	7	6	5	4	154	Nov 04 Saturday
309	0	0	0	0	0	0	0	0	0	4	8	9	9	11	5	3	10	12	13	7	2	3	1	2	99	Nov 05 Sunday
310	3	3	78	21	15	5	8	25	7	1	4	7	30	25	18	50	30	3	2	4	7	8	8	5	367	Nov 06 Monday
311	11	8	10	14	5	12	10	39	9	23	9	11	5	33	41	16	12	14	39	25	12	2	18	14	392	Nov 07 Tuesday
312	18	5	2	1	10	3	3	17	6	4	7	2	9	8	13	8	6	0	4	3	8	4	2	2	145	Nov 08 Wednesday
313	4	16	1	3	7	5	7	4	4	11	12	3	4	10	14	7	1	4	3	5	0	4	4	8	141	Nov 09 Thursday
314	4	7	6	8	3	3	6	9	3	5	9	9	22	12	16	20	4	7	16	5	9	13	10	13	219	Nov 10 Friday
315	12	15	14	15	22	21	15	17	10	14	25	8	6	5	12	20	22	19	31	18	20	27	29	40	437	Nov 11 Saturday
316	26	29	53	45	39	35	53	16	14	15	12	9	10	14	22	52	51	49	60	40	41	68	36	78	867	Nov 12 Sunday
317	71	71	119	64	25	47	48	8	29	2	6	11	20	23	13	18	17	12	54	23	24	67	24	42	838	Nov 13 Monday
318	87	73	84	69	63	49	29	15	21	15	6	10	17	6	32	24	8	9	5	8	9	3	14	7	663	Nov 14 Tuesday
319	3	4	5	4	6	0	5	3	4	15	5	3	3	21	13	23	6	9	1	13	33	41	19	16	255	Nov 15 Wednesday
320	41	49	26	7	7	36	15	8	9	29	16	13	15	26	23	14	13	9	22	11	13	9	12	45	468	Nov 16 Thursday
321	35	32	44	27	20	10	11	7	2	8	9	7	1	8	10	39	35	29	18	4	38	53	44	90	581	Nov 17 Friday
322	94	106	117	115	119	44	31	1	25	26	13	8	15	27	78	55	89	107	27	39	78	63	49	15	1341	Nov 18 Saturday
323	7	86	155	16	12	6	20	13	23	20	26	38	14	22	22	13	7	9	85	81	86	48	78	114	1001	Nov 19 Sunday
324	119	108	122	108	118	98	38	95	16	5	18	12	13	21	18	10	7	35	44	2	36	117	94	100	1354	Nov 20 Monday
325	99	98	67	7	19	1	14	1	5	8	29	72	39	20	28	11	11	9	3	3	4	4	6	1	559	Nov 21 Tuesday
326	4	4	23	61	29	4	1	5	7	3	4	16	13	29	25	11	6	3	4	3	5	9	10	4	283	Nov 22 Wednesday
327	2	4	2	18	24	14	2	5	4	6	5	3	4	7	17	9	6	5	7	3	9	5	5	3	169	Nov 23 Thursday
328	6	4	2	15	15	1	10	7	1	7	24	20	11	1	12	25	13	24	5	7	3	8	19	5	245	Nov 24 Friday
329	8	4	2	6	6	2	1	3	9	9	8	11	3	7	4	8	5	2	5	15	15	4	5	7	149	Nov 25 Saturday

Table 3.5.7 (Page 1 of 4)

HFS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date	
330	10	5	4	14	7	8	9	13	8	9	8	10	9	18	10	8	7	8	3	4	6	5	12	2	197	Nov 26	Sunday
331	2	7	2	6	2	5	6	3	1	6	4	4	6	0	20	6	11	6	2	7	1	7	7	18	139	Nov 27	Monday
332	1	10	5	2	3	2	3	5	1	6	3	13	10	24	9	5	3	3	2	10	29	5	6	4	164	Nov 28	Tuesday
333	5	3	7	6	3	2	7	5	6	14	13	6	17	11	5	32	44	35	49	41	27	15	37	42	432	Nov 29	Wednesday
334	40	49	50	22	32	39	32	15	6	5	2	8	15	15	53	62	57	60	56	38	40	52	55	49	852	Nov 30	Thursday
335	55	78	65	48	42	46	25	38	6	5	12	4	20	5	8	11	4	2	3	2	8	10	2	7	506	Dec 01	Friday
336	6	7	9	8	12	12	9	5	11	15	3	15	10	10	4	8	10	31	37	43	20	27	17	35	364	Dec 02	Saturday
337	70	22	9	26	18	3	13	6	12	40	64	32	68	68	50	19	16	15	85	85	70	49	45	34	919	Dec 03	Sunday
338	48	36	30	14	33	44	32	33	30	19	7	13	15	21	15	65	69	79	106	80	17	19	36	70	931	Dec 04	Monday
339	88	48	27	7	10	7	9	8	3	5	5	7	14	32	47	61	31	63	97	79	92	93	72	78	983	Dec 05	Tuesday
340	59	34	13	13	3	4	5	4	8	5	4	14	17	33	7	10	8	3	4	2	6	4	9	10	279	Dec 06	Wednesday
341	7	4	11	19	7	10	11	12	30	33	13	17	38	55	10	2	11	6	8	10	14	52	48	68	496	Dec 07	Thursday
342	63	12	4	11	9	8	10	15	12	7	7	8	12	9	8	14	6	12	10	42	7	7	2	13	308	Dec 08	Friday
343	2	5	4	4	6	8	4	11	11	13	16	13	13	7	10	2	1	5	5	14	4	4	8	7	177	Dec 09	Saturday
344	5	11	3	15	6	3	6	9	3	7	6	4	11	7	5	8	4	3	6	4	6	11	30	22	195	Dec 10	Sunday
345	18	15	14	5	9	6	11	8	7	5	7	12	7	10	19	3	2	8	11	10	11	12	21	13	244	Dec 11	Monday
346	18	8	19	7	3	2	8	6	7	4	17	12	12	8	11	4	3	0	2	1	2	3	3	4	164	Dec 12	Tuesday
347	3	18	23	37	45	33	24	13	9	11	2	15	6	12	8	5	7	18	16	8	2	16	23	49	403	Dec 13	Wednesday
348	46	23	12	1	8	40	43	11	1	6	6	7	4	15	8	30	34	39	46	31	13	21	30	31	506	Dec 14	Thursday
349	44	34	9	4	2	5	12	8	12	9	3	2	7	15	11	17	13	46	80	78	63	100	46	43	663	Dec 15	Friday
350	26	4	6	9	15	22	23	11	26	67	72	33	58	130	88	65	58	58	81	77	52	55	62	93	1191	Dec 16	Saturday
351	69	94	90	27	10	3	10	10	7	8	9	8	7	10	6	5	5	1	5	1	2	3	4	7	401	Dec 17	Sunday
352	8	6	8	8	1	9	10	4	4	4	14	1	11	11	30	16	33	44	91	101	55	74	27	33	603	Dec 18	Monday
353	45	58	86	76	76	58	27	20	15	13	19	7	22	19	20	27	95	138	134	114	97	104	109	91	1470	Dec 19	Tuesday
354	90	80	86	47	39	52	47	79	61	49	16	20	17	25	86	156	166	155	144	116	143	138	149	166	2127	Dec 20	Wednesday
355	145	168	172	157	151	140	128	114	105	43	18	26	11	12	12	15	53	124	147	137	161	156	171	155	2521	Dec 21	Thursday
356	161	144	172	179	167	154	143	121	158	72	37	10	18	9	9	20	80	137	109	81	46	63	89	143	2322	Dec 22	Friday
357	192	201	214	188	206	161	69	45	24	14	28	14	14	27	21	26	51	31	35	58	51	32	13	29	1744	Dec 23	Saturday
358	13	20	22	33	36	73	68	85	97	58	30	11	22	18	42	79	106	111	111	131	120	118	115	129	1648	Dec 24	Sunday
359	138	126	137	150	151	125	121	158	116	46	14	13	4	4	14	10	5	21	12	12	27	19	39	68	1530	Dec 25	Monday
360	110	131	151	150	151	140	134	134	95	69	35	10	19	6	9	23	55	121	128	106	90	114	89	115	2185	Dec 26	Tuesday
361	132	140	134	129	132	107	108	82	87	45	19	11	10	15	9	16	23	29	80	77	116	130	104	119	1854	Dec 27	Wednesday
362	103	127	127	118	92	117	100	117	113	63	25	8	10	12	3	32	63	79	108	131	114	132	122	123	2039	Dec 28	Thursday
363	118	97	117	76	30	6	7	3	0	5	5	12	9	26	24	13	11	16	16	9	7	2	3	4	616	Dec 29	Friday
364	3	8	18	8	14	4	8	7	8	5	10	8	23	4	4	11	13	6	2	1	12	2	3	5	187	Dec 30	Saturday
365	7	2	11	7	10	4	10	11	16	7	12	12	14	12	14	22	16	17	21	18	27	25	20	6	321	Dec 31	Sunday
1	3	10	3	2	2	5	2	9	24	26	18	14	16	15	9	5	1	5	4	5	12	3	3	2	198	Jan 01	Monday
2	0	5	9	9	17	4	4	5	5	22	21	51	76	46	64	57	55	61	95	89	88	87	91	101	1062	Jan 02	Tuesday
3	105	124	140	111	113	27	20	2	11	8	6	2	8	11	3	15	4	4	4	5	1	12	3	7	746	Jan 03	Wednesday
4	6	2	6	6	7	3	3	4	4	5	11	4	12	8	7	8	9	7	2	13	18	10	15	31	201	Jan 04	Thursday
5	30	57	106	95	69	50	69	56	65	59	40	33	22	61	75	84	105	94	110	111	127	95	79	73	1765	Jan 05	Friday
6	92	81	107	73	53	33	38	8	9	9	16	17	6	6	13	14	14	24	8	22	18	17	18	24	720	Jan 06	Saturday
7	15	6	13	11	20	7	17	14	10	18	10	10	6	14	8	8	10	4	7	5	10	3	5	9	240	Jan 07	Sunday
8	8	5	8	11	9	6	3	4	5	6	12	4	16	9	11	8	5	8	6	6	5	0	1	1	157	Jan 08	Monday
9	7	3	0	1	3	5	11	2	7	9	3	2	3	21	2	8	8	2	5	6	3	2	2	7	122	Jan 09	Tuesday
10	4	6	4	4	10	5	4	5	9	2	7	3	10	14	9	8	9	5	3	14	5	3	8	4	155	Jan 10	Wednesday
11	2	4	3	3	8	5	6	9	3	5	4	5	20	9	9	7	2	6	6	7	2	2	4	2	133	Jan 11	Thursday
12	2	5	12	4	14	5	5	3	12	5	15	4	5	7	13	6	5	10	7	6	3	7	5	10	170	Jan 12	Friday
13	7	4	14	8	14	19	13	6	1	15	8	15	12	12	10	7	9	12	11	11	8	11	15	13	255	Jan 13	Saturday
14	15	10	9	14	5	2	12	8	3	3	7	8	14	17	13	2	9	5	9	7	8	5	7	5	197	Jan 14	Sunday
15	9	7	1	3	5	3	6	6	0	10	2	3	7	25	7	5	5	5	11	3	0	5	7	6	141	Jan 15	Monday
16	11	4	0	2	5	9	4	1	1	2	2	14	11	15	7	4	6	5	5	4	1	14	2	1	130	Jan 16	Tuesday
17	3	0	3	2	7	4	5	1	9	8	6	5	26	14	8	4	10	10	13	17	25	14	10	21	225	Jan 17	Wednesday
18	31	34	46	34	20	22	15	11	17	36	36	26	15	16	15	13	2	9	9	8	9	7	3	3	437	Jan 18	Thursday
19	3	9	7	6	4	2	4	3	0	5	7	2	21	6	11	9	9	6	5	1	9	5	2	1	137	Jan 19	Friday
20	4	7	6	5	16	8	9	11	8	7	5	10	6	9	5	2	6	9	5	16	8	8	12	4	186	Jan 20	Saturday

Table 3.5.7 (Page 2 of 4)

HFS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
21	5	10	39	24	16	25	13	14	21	8	12	9	17	13	24	67	95	42	27	22	4	12	6	6	531	Jan 21 Sunday
22	15	15	1	11	7	2	4	4	1	4	6	7	9	12	22	10	7	8	7	5	10	6	5	8	186	Jan 22 Monday
23	8	5	8	10	13	6	5	8	3	4	10	11	15	17	22	21	11	27	24	26	22	7	6	11	300	Jan 23 Tuesday
24	20	8	7	6	13	9	15	11	3	12	14	12	8	13	15	7	2	8	5	9	5	4	4	2	212	Jan 24 Wednesday
25	2	3	6	4	8	9	5	6	2	3	5	5	6	11	11	25	6	6	21	15	12	8	6	14	199	Jan 25 Thursday
26	18	24	23	26	36	17	18	17	23	31	29	37	30	33	37	64	68	42	57	63	68	54	54	39	908	Jan 26 Friday
27	52	51	72	37	38	41	43	62	58	38	50	41	23	13	5	7	3	8	16	23	15	11	16	5	728	Jan 27 Saturday
28	21	11	27	14	11	17	14	6	7	9	14	2	9	3	6	10	7	22	11	13	15	6	5	8	268	Jan 28 Sunday
29	14	25	25	19	20	18	17	15	9	1	8	10	9	12	8	7	14	6	6	3	5	11	10	8	280	Jan 29 Monday
30	7	7	9	9	17	13	12	2	5	4	13	7	8	14	18	18	7	19	17	12	6	15	51	50	340	Jan 30 Tuesday
31	41	44	57	28	40	36	35	15	13	25	33	36	22	9	10	15	24	11	16	23	20	9	6	5	573	Jan 31 Wednesday
32	11	10	11	14	14	8	4	7	4	4	5	7	12	12	10	14	13	5	7	3	1	6	12	12	206	Feb 01 Thursday
33	19	10	20	11	4	10	9	3	8	3	11	7	11	6	12	8	19	8	3	3	10	4	2	6	207	Feb 02 Friday
34	6	14	13	9	2	3	1	16	7	11	5	18	22	8	11	16	6	5	9	7	10	14	6	9	228	Feb 03 Saturday
35	11	7	6	4	12	15	27	17	18	8	4	7	8	5	6	25	31	35	32	16	32	15	22	42	405	Feb 04 Sunday
36	35	31	45	49	41	33	27	49	51	38	76	66	59	57	46	50	60	27	53	19	25	21	14	13	985	Feb 05 Monday
37	9	9	15	26	4	7	3	6	7	8	9	7	10	18	8	11	6	11	13	3	9	6	1	6	212	Feb 06 Tuesday
38	7	8	3	3	5	7	6	7	8	7	3	10	31	18	4	9	6	0	3	2	4	22	8	5	186	Feb 07 Wednesday
39	3	5	5	7	11	2	4	8	2	9	11	7	24	33	5	3	2	4	2	2	2	7	13	4	175	Feb 08 Thursday
40	8	4	2	8	3	2	3	3	7	4	8	4	7	6	12	9	8	12	4	2	7	1	8	3	135	Feb 09 Friday
41	4	3	1	4	6	2	2	4	5	2	8	9	4	7	5	4	0	4	4	3	1	2	0	4	88	Feb 10 Saturday
42	6	3	8	3	3	3	4	2	2	4	6	6	10	14	6	3	2	7	14	6	4	5	4	3	128	Feb 11 Sunday
43	9	5	5	5	3	10	4	7	2	9	4	4	9	4	18	10	15	7	6	7	8	0	7	6	164	Feb 12 Monday
44	7	14	18	15	10	15	10	14	4	18	6	4	13	13	14	5	11	21	19	20	29	26	22	23	351	Feb 13 Tuesday
45	22	16	17	21	21	7	10	14	15	9	7	12	18	11	8	5	5	4	9	6	16	10	5	6	274	Feb 14 Wednesday
46	8	4	5	20	3	7	1	4	5	12	12	71	4	21	19	7	6	5	6	6	2	7	7	9	251	Feb 15 Thursday
47	20	11	10	14	6	10	5	1	2	10	5	15	14	8	5	20	5	4	7	5	7	8	4	2	198	Feb 16 Friday
48	4	5	8	8	8	4	20	11	4	2	4	8	0	7	8	28	19	12	19	21	23	24	31	27	305	Feb 17 Saturday
49	32	35	49	31	25	19	45	4	12	19	32	22	32	24	24	35	44	45	51	52	50	48	42	37	809	Feb 18 Sunday
50	40	16	38	9	15	10	8	11	6	4	2	8	13	7	22	6	2	9	18	15	11	18	21	23	332	Feb 19 Monday
51	30	11	30	14	20	16	13	4	4	10	9	8	5	27	8	11	8	7	17	27	29	15	19	13	355	Feb 20 Tuesday
52	17	18	23	4	5	12	14	13	5	8	5	9	14	16	17	8	8	14	21	19	28	16	17	19	330	Feb 21 Wednesday
53	21	20	28	37	33	22	23	14	27	19	15	14	30	29	27	12	5	10	3	5	14	25	21	45	499	Feb 22 Thursday
54	35	27	43	20	21	15	4	1	7	4	4	9	10	4	7	6	4	3	12	5	2	10	3	2	258	Feb 23 Friday
55	1	5	6	3	2	2	1	5	1	2	5	10	14	5	6	6	2	6	10	3	13	2	3	6	119	Feb 24 Saturday
56	3	9	6	6	8	2	25	9	3	11	10	8	5	10	12	5	12	11	3	3	3	3	5	4	176	Feb 25 Sunday
57	4	9	5	1	5	4	7	9	10	4	16	2	14	11	9	17	6	3	13	6	5	8	4	10	182	Feb 26 Monday
58	7	3	5	8	8	3	4	1	3	8	5	13	10	15	13	5	54	64	15	17	7	10	2	3	283	Feb 27 Tuesday
59	2	2	11	3	9	6	1	0	1	11	10	8	14	20	13	3	6	4	1	8	2	6	4	6	151	Feb 28 Wednesday
60	2	6	7	0	5	1	4	4	9	6	1	3	7	19	5	6	9	9	15	8	18	12	16	10	182	Feb 29 Thursday
61	18	4	2	5	11	4	8	1	1	10	3	11	7	7	12	4	9	1	5	7	24	16	10	15	195	Mar 01 Friday
62	13	18	47	47	37	43	45	40	33	28	14	16	25	21	11	10	10	20	37	41	56	52	53	51	768	Mar 02 Saturday
63	88	86	104	86	106	109	92	82	80	62	99	77	67	33	25	17	21	7	2	10	5	4	27	14	1303	Mar 03 Sunday
64	8	12	7	0	12	3	6	4	5	5	3	4	12	3	8	13	6	10	2	3	13	17	4	34	194	Mar 04 Monday
65	26	6	7	5	5	5	2	5	4	9	1	11	24	9	6	17	8	24	9	19	32	34	39	32	339	Mar 05 Tuesday
66	39	37	28	22	13	6	14	13	9	20	12	12	13	4	12	9	6	6	1	3	5	6	5	3	298	Mar 06 Wednesday
67	13	8	21	12	18	8	15	9	15	11	14	8	17	12	13	20	9	6	14	14	22	22	30	39	370	Mar 07 Thursday
68	33	27	43	47	43	19	14	7	15	19	23	34	40	26	23	13	6	17	10	12	22	25	28	31	577	Mar 08 Friday
69	34	25	35	43	43	35	32	23	18	33	41	47	61	31	29	22	42	23	26	21	26	30	40	42	802	Mar 09 Saturday
70	36	40	58	39	39	37	20	27	27	16	28	31	34	40	25	8	13	13	37	26	42	30	30	31	727	Mar 10 Sunday
71	29	17	33	17	25	24	22	16	18	18	22	13	22	23	15	19	3	1	3	8	6	14	24	14	406	Mar 11 Monday
72	23	15	31	27	4	3	8	3	2	19	26	10	8	13	13	15	5	16	19	21	25	28	19	23	376	Mar 12 Tuesday
73	15	19	25	9	8	2	13	1	4	4	12	4	10	27	12	11	6	9	15	13	17	12	18	14	280	Mar 13 Wednesday
74	15	18	13	11	10	20	8	3	4	5	8	20	27	9	24	14	5	15	5	6	4	6	7	6	263	Mar 14 Thursday
75	4	5	6	11	8	1	2	2	4	20	17	8	12	5	13	4	4	11	4	6	2	8	7	2	166	Mar 15 Friday
76	2	11	13	16	12	21	10	16	10	16	8	13	6	31	19	15	11	4	7	13	14	17	30	10	325	Mar 16 Saturday

Table 3.5.7 (Page 3 of 4)

HFS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
77	24	48	15	28	19	6	26	9	32	20	32	18	30	24	23	35	9	8	4	6	7	13	9	17	462	Mar 17 Sunday
78	14	16	18	17	8	9	2	11	9	10	6	4	11	14	7	15	18	20	18	16	24	23	23	39	352	Mar 18 Monday
79	41	34	42	37	24	17	21	58	66	50	56	41	30	43	22	23	18	7	18	19	19	23	34	39	782	Mar 19 Tuesday
80	44	53	53	57	73	44	23	29	53	50	75	67	55	24	24	20	13	4	7	15	25	26	37	37	908	Mar 20 Wednesday
81	34	37	41	52	34	17	11	4	17	15	22	12	11	20	8	13	17	9	15	23	24	54	14	4	508	Mar 21 Thursday
82	2	4	7	20	22	12	8	4	10	11	10	17	19	9	17	25	10	20	22	15	14	24	26	22	350	Mar 22 Friday
83	10	7	2	16	15	9	13	19	15	4	8	19	16	9	21	1	7	4	21	33	25	26	34	35	369	Mar 23 Saturday
84	30	33	44	47	38	16	21	19	17	26	15	33	16	16	18	17	16	11	12	24	29	26	26	35	585	Mar 24 Sunday
85	52	40	38	40	29	20	8	9	6	9	24	8	13	13	15	5	6	8	4	2	11	9	0	4	373	Mar 25 Monday
86	4	7	5	10	9	9	7	8	11	2	6	22	12	4	20	4	4	19	16	9	7	19	12	21	247	Mar 26 Tuesday
87	27	32	15	54	28	15	1	10	3	18	7	14	25	22	19	26	4	6	3	5	4	5	12	4	359	Mar 27 Wednesday
88	3	12	7	4	9	6	9	11	4	21	13	7	18	32	22	17	11	7	5	9	20	18	13	8	286	Mar 28 Thursday
89	3	6	3	25	10	24	9	5	7	4	4	11	19	11	1	14	12	14	9	33	29	39	39	33	364	Mar 29 Friday
90	47	46	73	38	38	24	24	15	11	5	8	6	7	18	14	17	11	17	5	5	2	8	5	30	474	Mar 30 Saturday
91	15	5	11	11	7	5	8	9	20	13	8	18	18	7	12	18	14	11	6	8	18	27	6	16	291	Mar 31 Sunday
HFS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Sum	4500	4384	5164	4360	4321	3829	3298	3036	2873	2862	2916	2736	3091	3117	3052	3349	3321	3693	4010	3660	3919	3991	3932	4296	87710	Total sum
183	25	24	28	24	24	21	18	17	16	16	16	15	17	17	17	18	18	20	22	20	21	22	21	23	479	Total average
127	24	22	26	22	22	20	16	15	14	14	15	14	16	17	17	19	17	20	21	19	21	22	21	23	454	Average workdays
56	25	27	33	27	27	22	22	20	19	18	18	15	18	17	16	17	19	20	22	22	22	21	22	24	512	Average weekends

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

3.6 Intelligent Monitoring System 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, FINESS and GERESS started on 15 October 1991. As opposed to the first version of IMS, the one in current operation also has the capability of locating events at teleseismic distance.

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

The operational stability of 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 summary 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)

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

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

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

	Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96	Total
Phase detections	104792	127489	129701	85374	73543	58475	579374
- Associated phases	6924	8789	5380	4931	4650	3715	34389
- Unassociated phases	97868	118700	124321	80443	68893	54760	544985
Events automatically declared by IMS	2038	2628	1526	1384	1202	800	9578
No. of events defined by the analyst	102	174	130	115	125	171	817
No. of events accepted without modifications	0	0	0	0	0	0	0

Table 3.6.1. IMS phase detections and event summary.

U. Baadshaug
B.Kr. Hokland
B. Paulsen

4 Improvements and Modifications

4.1 NORSAR

NORSAR data acquisition

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

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

An unexpected problem with artificial, strong signals (spikes) has arisen, especially during thunderstorms. After analysis of data, hardware and software components, we have reached the conclusion that electric discharges are picked up by the cable between the seismometer and the Brick amplifier. It was found that the seismometer cables were delivered with a mix of pin couplings, which leads to a lack of common mode rejection. This is further investigated to find whether the combination of the delivered seismometer cables and Brick amplifier can be modified to obtain proper common mode rejection and thus avoid recording of atmospheric discharges.

An example of such an artificial signal is given in Fig. 4.1.1.

NORSAR detection processing

The NORSAR detection processor has been continuously updated for the during the refurbishment effort, especially with respect to large DC offset problems and electronic spikes, and it has been running satisfactorily. To maintain consistent detection capability, the NORSAR beam tables have not been changed.

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

The NORSAR detecting beams include slowness and time delay corrections using precalculated, corrected time delays. The method has now been implemented into DFX (the processing package in use at the GSETT-3 IDC) for detection by time delay corrected beams (see Section 7.2).

NORSAR detection feature extraction

For each detection, the data feature extraction progam DFX will refine the onset time and estimate the slowness vector using F/K broadband analysis on array data. For the large aperture NORSAR array, F/K analysis initially did not give robust solutions, and instead a 'beampacking" method was used to refine the detecting beam slowness.

Later investigations have shown that broadband F/K analysis works rather well if data are prefiltered in the time domain within the F/K analysis frequency band. Of course, the

Another method of slowness estimation is to replace the frequency domain calculation with time domain beamforming for the same slowness grid points as used for the frequency domain F/K analysis. For each slowness, time delay corrections are then more easily adopted. This method is refferred to as "beamforming F/K analysis".

This method has been evaluated within the NORSAR event processing programs, and it has been implemented into DFX as the function "compute-beamform-fk". Test operations demonstrate that beamforming F/K analysis gives robust and corrected estimates of the slowness vector. For a good time delay corrections data base, the estimated slowness is automatically corrected for systematic slowness deviations.

Note that if the beamforming process is ignoring elevation differences, then elevation corrections may be included in the time delay correction data base.

The "beamforming F/K" results are shown in Fig. 4.1.2 for the 8 June 1996 Lop Nor explosion. The corresponding broadband F/K analysis is shown in Fig. 4.1.3. The F/K analysis time window must be wide enough to include all individual channel phase arrivals.

For this well correlated signal, the resulting contour plots are very similar, as seen from the two figures. This means that the resolution of slowness is the same. However, with optimum time delay corrections, the time delay corrected beamforming gives an implicitly corrected slowness vector, and the resulting beam gives a better estimate of the signal amplitude as compared to the beam computed from F/K analysis. Note that time delay corrections as implemented gives the best result when the beam is aimed at the 'true' slowness vector (i.e. as predicted by IASPEI 91 tables). If the beam is computed from F/K estimates, then the slowness vector is biased and wrong corrections will be applied.

Although frequency-domain F/K analysis works surprisingly well, the "beamforming F/K" has been suggested for DFX processing.

The different array processing techniques are documented in Fyen(1996a) : "NORSAR basic array processing" and in Fyen (1996b) : "Time delay measurements and NORSAR large array processing". The latter report is under revision to include a more detailed study of the performance of frequency domain F/K analysis for large arrays. In the early stage of NORSAR developments, narrow band F/K analysis was found useless for array processing, and this apprehension has survived 20 years of array processing. It is truly time for new thinking on this topic, and the work has started.

NORSAR event processing

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

J. Fyen

4.2 Waveconv — a tool for NDPC format to CSS 3.0 format conversion

All data transmitted to the NORSAR Data Processing Center (NDPC) are origininally grouped into one second frames per channel, including seismic data and status information. At NDPC all raw data are recorded in a time-indexed disk loop, and once per day, the raw data frames are automatically archived on Exabyte tapes.

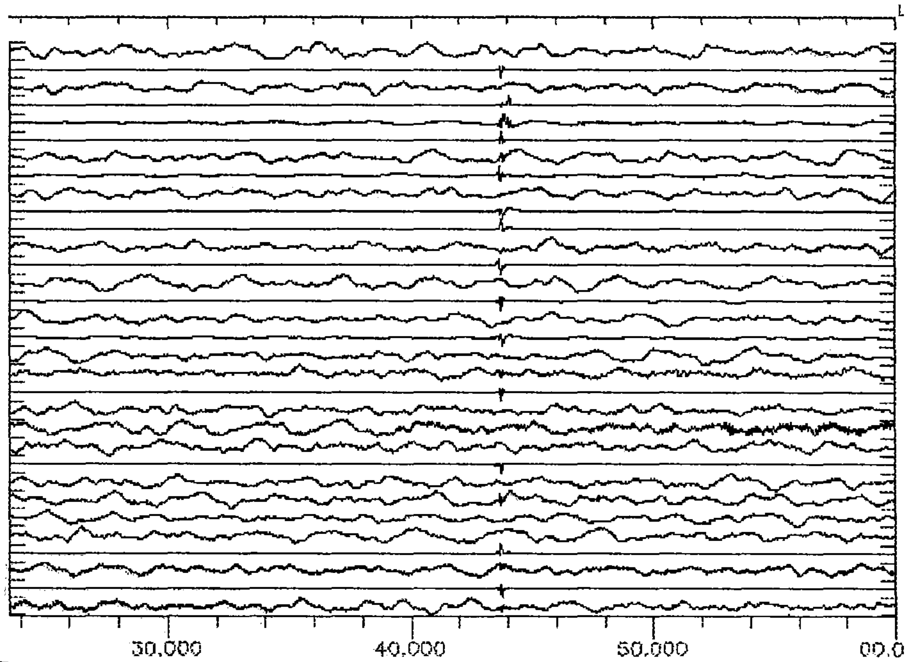
Keeping all status information is proved to be important also for 'old' data. However, the data retreival from tapes for long time intervals has been rather complicated and time-consuming.

In using the CSS 3.0 format, the status information is lost, but long time intervals are more easily created using, e.g., 1 or 4-hour segments to form several days of continous data. Standard unix archive tools can also be used for backup and retrieval.

The "waveconv" is a new tool that can input any of the NDPC raw data format archive tapes, and convert this to CSS 3.0 files. Interactive Motif menues are used for channel, time segement and other parameter selection.

Options are included to perform channel "masking", i.e., a seismic data channel may be left out from the selected list, or the channel may be left out automatically by analysing the raw data status information. If the original data acquisition system has declared the data "bad" by a status indicator, then the system will "mask" (leave out) that channel for the time period indicated by the status information.

J. Fyen
H. Iversen



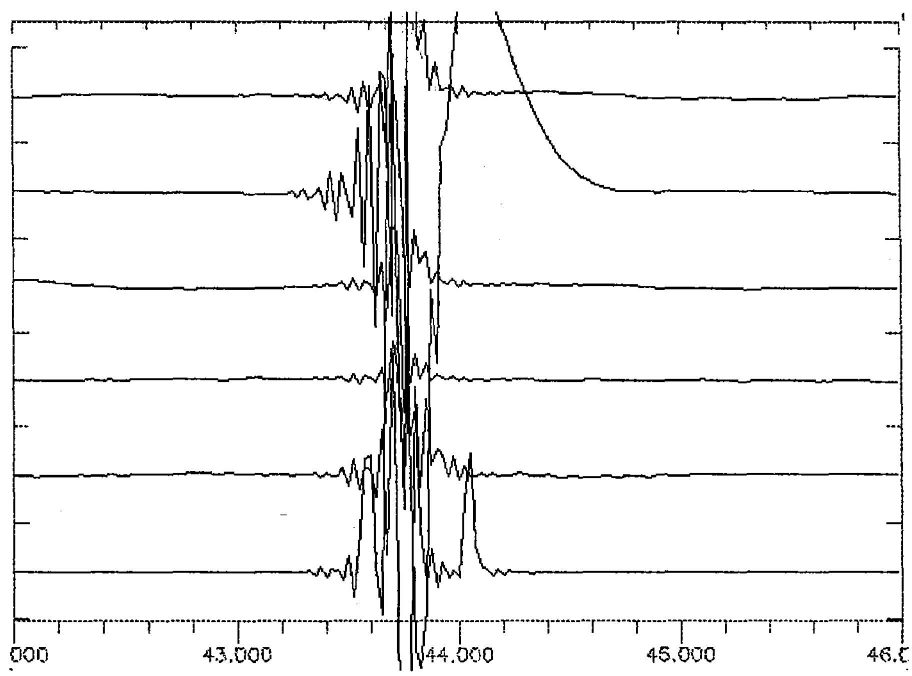


Fig. 4.1.1. NORSAR data for an unidentified artificial signal that occurs at same time for several sites within the array. The upper figure shows that approximately half of the sensors are affected for this case. The lower figure shows a blowup for a 4 s window, with data for each ι 6 subarrays.

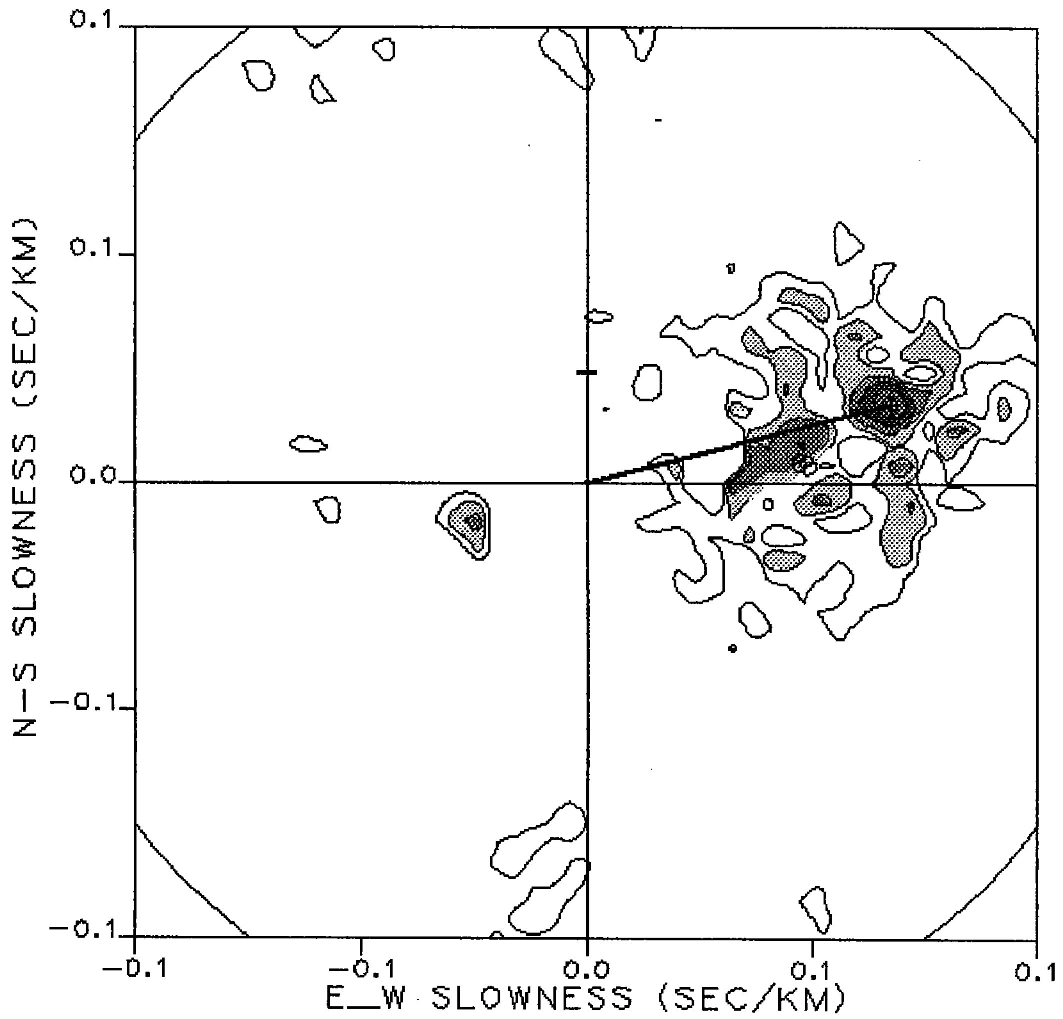


Fig. 4.1.2. NORSAR "beamforming F/K" analysis of the Lop Nor explosion on June 8, 1996. The data have been prefiltered 1.2 - 3.2 Hz. The time domain beam window has a lead relative to signal onset time of 1.0 s and a lag of 5.0 s. The slowness grid has 51x51 points with a maximum slowness of 0.1 s/km. The resulting apparent velocity is 14.41 km/s; backazimuth is 75.81 degrees. The predicted velocity and azimuth using the IDC_REB solution are 14.47 km/s and 76.10 degrees, respectively.

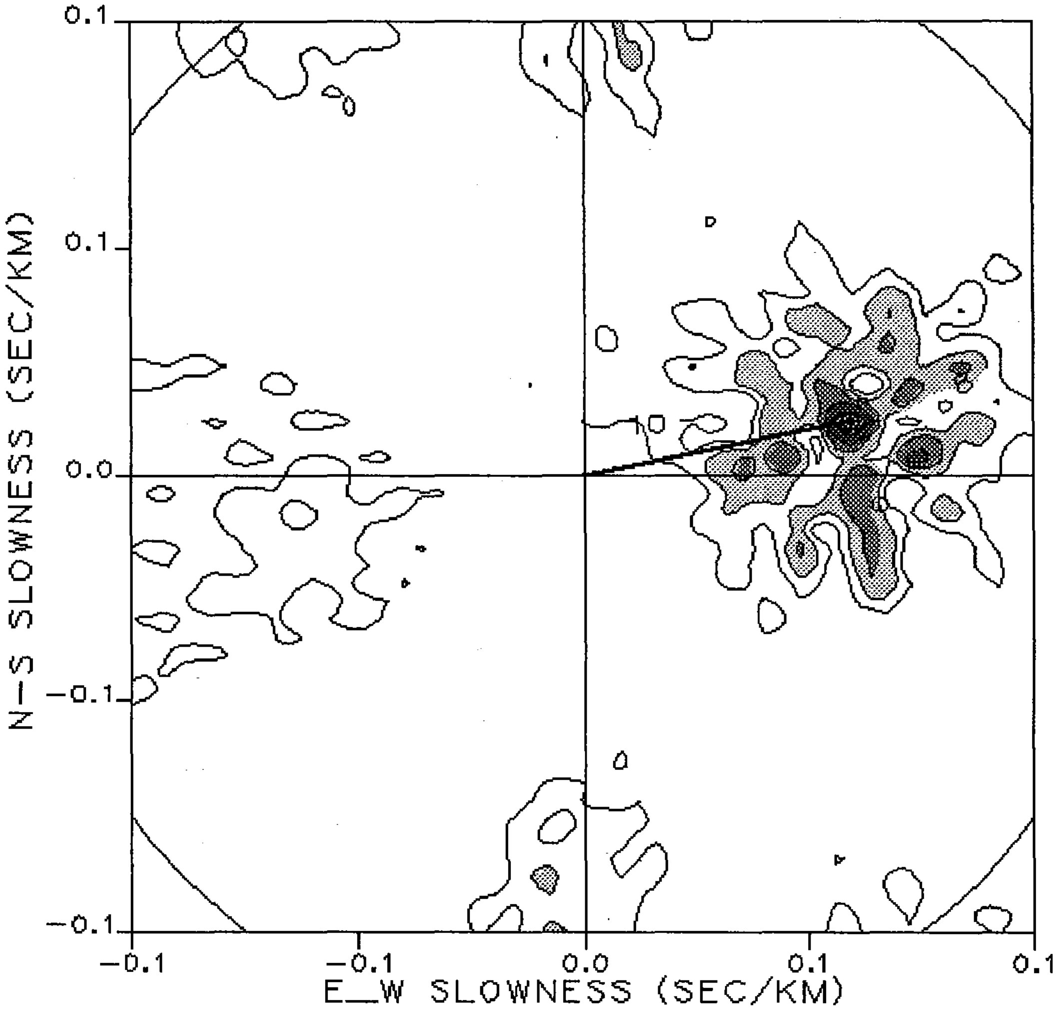


Fig. 4.1.3. NORSAR broadband F/K analysis of the Lop Nor explosion on June 8, 1996. The data have been prefiltered 1.2 - 3.2 Hz. The time domain channel window has a lead relative to signal onset time of 5.5 s and a lag of 5.5 s.. The F/K grid has 51x51 points with a maximum slowness of 0.1 s/km. The resulting apparent velocity is 16.54 km/s, backazimuth is 78.65 degrees. The predicted velocity and azimuth using the IDC_REB solution are 14.47 km/s and 76.10 degrees, respectively.

5 Maintenance Activities

Activities in the field and at the Maintenance Center

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

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

NORSAR

Visits to subarrays in connection with:

- Installation of SP seismometers, preamplifiers, digitizers and control electronics at remote sites
- Installation of broadband seismometers, SP seismometers, preamplifiers, digitizers and control electronics in LPVs
- Maintenance work at remote sites, CTVs and LPVs

NORESS

- Replacement of power supply and repair of preamplifier at remote site C7
- Replacement of fiber optic transmitter at remote site C6

ARCESS

- Replaced fiber optic transmitters and adjusted optic links
- Maintenance of UPS unit

NMC

- Continued the NORSAR refurbishment work

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

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K.A. Løken

Subarray/ area	Task	Date
October - December1995		
NORSAR	Refurbishment work continued at all subarrays with installation of SP seismometers, preamplifiers, 24-bit digitizers and CTV electronics	October - December
NMC	NORSAR refurbishment work continued at the maintenance center, including production of seismometer interconnection cables, construction of control cards and preparation of the remote site electronics to become a "plug-in" system.	October - December
January 1996		
NORSAR		
06C	Installation of the KS-54000 broadband seismometer and the shallow hole SP seismometer in LPV.	3/1
03C	Installation of the KS-54000 broadband seismometer and the shallow hole SP seismometer in LPV	4/1
04C	Installation of the KS-54000 broadband seismometer and the shallow hole SP seismometer in LPV	5/1
03C	The main 220 VAC line was found to be cut by a falling tree	8/1
04C	Worked in LPV with GPS problems	8/1
02B	Worked in LPV with GPS problems	9-10/1
03C	Replaced the 48 VDC power supply in CTV	10/1
02C	Finished the installation of the broadband seismometer system in LPV	11/1
NMC	Continued NORSAR refurbishment work	January
February 1996		
NORSAR		
06C	Corrected wiring in the junction box SP00 for the remote sites SP04 and SP05	1/2
02B	Replaced the main fuse in the modem power supply	29/2

Subarray/ area	Task	Date
NMC	Continued NORSAR refurbishment work	February
	March 1996	
NORSAR		
02C	Replaced preamplifier at remote site SP00	7/3
NORESS	Replaced broken power supply and repaired defective preamplifier card at site C7	6/3
	Replaced broken fiber optic transmitter at site C6	6/3
ARCESS	Replaced fiber optic transmitter at the Hub for site A0, B1 and C3. Adjusted all fiber optic links except the link to site C4. At this site the optic connector has to be replaced	21-22/3
	The UPS unit was found to be damaged by lighning. New cards have been ordered.	21-22/3
NMC	Continued NORSAR refurbishment work	March

Table 5.1. Activities in the field and the NORSAR Maintenance Center during 1 October 1995 - 31 March 1996.

6 Documentation Developed

Fyen, J., T. Kværna & S. Mykkeltveit (1996): Status and plans for implementing algorithms at the GSETT-3 IDC. Semiannual Tech. Summary, 1 October 1995 - 31 March 1996, NORSAR Sci. Rep. 2-95/96, NORSAR, Kjeller, Norway.

Kværna, T. (1996): Quality assessment of automatic onset times estimated by an autoregressive method. Semiannual Tech. Summary, 1 October 1995 - 31 March 1996, NORSAR Sci. Rep. 2-95/96, NORSAR, Kjeller, Norway.

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Mykkeltveit, S. & U. Baadshaug (1996): Norway's NDC: Experience from the first eighteen months of the full-scale phase of GSETT-3. Semiannual Tech. Summary, 1 October 1995 - 31 March 1996, NORSAR Sci. Rep. 2-95/96, NORSAR, Kjeller, Norway.

Ringdal, F. (1995): GSETT-3: Testing the Experimental International Seismic Monitoring System. Disamament. A periodic review by the United Nations, Vol. XVIII, No. 1, 153-162, 1995.

Ringdal, F. (1996): The seismic event on Novaya Zemlya 13 June 1995. Semiannual Tech. Summary, 1 October 1995 - 31 March 1996, NORSAR Sci. Rep. 2-95/96, NORSAR, Kjeller, Norway.

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Schweitzer, J. & T. Kværna (1996): Double-couple radiation and m_b residuals. Semiannual Tech. Summary, 1 October 1995 - 31 March 1996, NORSAR Sci. Rep. 2-95/96, NORSAR, Kjeller, Norway.

Semiannual Tech. Summary, 1 April - 30 September 1995, NORSAR Sci. Rep. 1-95/96, NORSAR, Kjeller, Norway.

7 Summary of Technical Reports / Papers Published

7.1 Norway's NDC: Experience from the first eighteen months of the full-scale phase of GSETT-3

Background

In order to test its new design ideas for an international seismic monitoring system, the GSE decided in 1993 to embark on its third technical test — GSETT-3. An equally important objective of this test is to furnish the Conference on Disarmament, which started negotiations on a Comprehensive Test Ban Treaty in January of 1994, with timely and relevant technical information.

The Norwegian GSETT-3 National Data Center (NOR_NDC) was established at the NORSAR Data Processing Center (NDPC) at Kjeller in the fall of 1993. Many of the activities at NOR_NDC represent a continuation of work that had been carried out at the NDPC for quite some period of time. Also, most of the infrastructure needed for NOR_NDC was already in place. For example, the dedicated, high-speed link utilized to transmit data to the GSETT-3 IDC in Arlington, Virginia, USA, had already been established in the 1980s in conjunction with the close cooperation in R&D between NORSAR and the CSS (Center for Seismic Studies, later on to become host for the GSETT-3 IDC).

NOR_NDC has evolved gradually over time. Initially, the efforts concentrated on establishing basic NDC functions (in accordance with the NDC requirements defined by the GSE). Later on, the resources available have permitted some voluntary NDC activities that have been encouraged by the GSE (submission of Supplementary data, participation in evaluation efforts, etc.). The Norwegian participation in GSETT-3 (with stations, transmission lines, NDC functions, etc.) has been funded through cooperative programs with the United States and grants from the Norwegian Ministry of Foreign Affairs.

This contribution gives a summary of activities and experience gained at NOR_NDC during the first eighteen months of the full-scale phase of GSETT-3, which started on 1 January 1995.

Norwegian GSETT-3 stations and communications arrangements

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

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

All data are acquired at NOR_NDC and stored on cyclic disk buffers of length 5-7 days, and are also copied to Exabyte cassettes for permanent archival. The AlphaRead/-Send software (see below) is used to send the data without delay to the GSETT-3 via a dedicated fiber optic link between our NDC and the GSETT-3 IDC in Arlington, Virginia, USA. The capacity of this link was originally 64 Kbits/s, but has been upgraded twice; in July 1994 from 64 Kbits/s to 128 Kbits/s, and in March 1995 to the current speed of 256 Kbits/s.

Uptimes and data availability

Figs. 7.1.2 - 7.1.4 show the monthly uptimes for the three Norwegian GSETT-3 primary stations ARCESS, NORESS and Spitsbergen, respectively. These barplots reflect the percentage of the waveform data that are available in the NOR_NDC tape archives for each of these three stations. The downtimes inferred from these figures thus represent the cumulative effect of field equipment outages, station site to NOR_NDC communication outages and NOR_NDC data acquisition outages. Some of the larger downtimes are due to specific reasons, as follows:

- For ARCESS, the downtimes in June and July of 1995 were mostly caused by announced (by electric company service personnel) and un-announced power cuts at the field site, and the downtime in September 1995 was caused by problems with the satellite transmission hardware at the array site.
- NORESS was down for several days in July 1995 when a severe thunderstorm damaged equipment at the site. There was again a stroke of lightning causing data outage on 18 June 1996.
- The Spitsbergen array was down between 10 and 20 April 1995 when two digitizers were disabled by hardware problems, and again between 20 June 1995 and 3 August 1995 when first an array controller broke and then the windmill which supplies power to the array failed and had to be replaced. The latest problem with SPITS occurred on 10 March 1996 when the battery bank at the site was overcharged by the windmill and exploded, causing severe damage to electronic field equipment. The array remained down throughout June, but resumed normal operation on 1 July 1996, after extensive equipment repair.

Fig. 7.1.5 gives a comparison between the ARCESS data availability as reported by NOR_NDC and the GSETT-3 IDC. Since the ARCESS data are channeled through NOR_NDC, data availability at the IDC would at best be equal to that of NOR_NDC. As can be seen from the figure, the differences in the data availability (with the exception of April 1995) are of the order of 3% and more, and this finding is also representative for the data loss (between NOR_NDC and the IDC) for NORESS and the Spitsbergen array. Some of the reasons for the differences seen in Fig. 7.1.5 are as follows:

- The link between NOR_NDC and the IDC was down for about two days and a half during 25-27 March 1995.
- Due to a disk failure at the IDC, no ARCESS data were recorded at the IDC for a period of about six days in May 1995.

- Some of the discrepancies can be explained by the ways the two data centers report data availability for arrays: NOR_NDC reports an array station to be up and available if at least one channel produces useful data, whereas the IDC uses weights where the reported availability/capability is based on the number of actually operating channels.

Error handling and reporting

To secure reliable forwarding of data to the IDC, procedures have been implemented at the NOR_NDC which, in addition to software systems, include an operator on duty. The operator is responsible for keeping data acquisition and AlphaRead/-Send machines and programs running and for detecting stops and irregularities in data processing and communications. Several alarm systems and interactive tools have been constructed to facilitate these tasks.

During normal office hours, the regular operations personnel rely on alarm display programs with graphical displays running on their workstations; see Fig 7.1.6 (some of the displayed text is in Norwegian, as the programs were tailor-made for internal NOR_NDC use.) At the particular time shown in Fig 7.1.6, the SPITS primary station was down, causing color-changes both in the data acquisition field (svalbard — Norwegian for the Spitsbergen archipelago) and in the AlphaRead/-Send fields.

During unattended operations(with operations personnel being away from their workstations), a problem or an error situation will cause the alarm program to call the pager worn by the operator on duty. If the problem occurs outside office hours, the operator will normally use a home-PC with modem to log in and check the reason for the alarm. The alarm software logs all problems in text files with the time and the reason for the alarm.

When the source of the problem has been identified, the operator will decide whether the problem has affected or will affect the forwarding of waveform data to the IDC. If this is the case, a GSE 2.0 PROBLEM message is written and sent to the IDC (staqc@cdidc.org). The operator will also answer incoming PROBLEM messages to alpha@norsar.no.

Between 1 January 1995 and 30 June 1996, NOR_NDC has sent 65 logged (i.e., with an official NOR_NDC MSG_ID) PROBLEM messages to the IDC. Here follows a summary of the PROB_LOCs (the station where the problem occurred, or the location of the transmit side of a communication link with problems) for the Norwegian GSETT-3 stations, as well as for other stations forwarding their data through NOR_NDC:

SPITS:	18
ARCES:	12
NORES:	9
FINES:	8
GERES:	8
HFS:	5
ESDC:	2
NOR_NDC:	5 (4 about NOR_NDC - IDC link outages, 1 about AC power outage at the NDC)

The sum is larger than 65 as a few messages concerned two or more stations.

Below is an example of a typical message exchange where the IDC staqc (Station Quality Control) personnel have discovered a break in the continuous dataflow from the primary station SPITS. NOR_NDC acknowledges receiving the message by adding a NEW_ENTRY section and then adding another as more information about the problem is available.

```
BEGIN GSE2.0
MSG_TYPE PROBLEM
MSG_ID NOR_960314_004 NOR_NDC
REF_ID NOR_960311_014 NOR_NDC
E-MAIL alpha@norsar.no
PROB_TYPE HARDWARE
PROB_LOC SPITS
AFFECTED_STA SPITS
EFFECTIVE_DATE 1996/03/10
PROBLEM Station Down
ENTRY
 The IDC received only 29% of data from SPITS for 10 Mar 1996.

NEW_ENTRY
 We are aware of the problem. NOR_NDC has not received data from SPITS
 since 1996/03/10 07:00:32. We do not know the reason yet, but will come
 back with another message when we do.

NEW_ENTRY
 Members of our field team yesterday visited the SPITS array site
 to find that the battery bank had exploded due to overcharging.
 The repair will take some time. As work progress, we will keep you
 informed.

STOP
```

The PROB_TYPE- and PROB_LOC-fields were originally entered as UNKNOWN by the IDC, but were filled in by NOR_NDC as the reason for the problem was discovered.

NDC automatic processing

Detection and event processing is performed for all stations for which data are available at NOR_NDC (i.e., also for stations not contributing data to GSETT-3). For the regional arrays, the automatic part of this one-array processing consists of signal processing to detect phases, and event processing with “ronapp” recipes for the EP program to locate seismic events (see Fyen, 1989). The results from these processing steps are routinely reported in the NORSAR Semiannual Technical Summaries, see Section 3.5 in this volume for detailed reports of the last six months. For the NORSAR teleseismic array, data are processed using the Detection and Event Processor, and the results for the last six months are reported in Section 2.3 of this report. Fig. 7.1.7 is a barplot showing the monthly distribution of detections for the various stations for the period January 1995 - June 1996.

It is seen from Fig. 7.1.7 that there are some pronounced seasonal variations in the number of detections, with the higher numbers during the winter. The low number of NORSAR detections during September-November 1995 is due to downtimes related to the array refurbishment effort. Note also the overall high number of detections on the Spitsbergen array.

Fig. 7.1.8 shows the automatically formed single-station events for all stations processed at NOR_NDC. Note the very high number of events automatically formed from the Spitsbergen array data, especially during the winter season.

In addition to the single-station automatic event processing, automatic multi-array processing for event location is performed using the Generalized Beamforming (GBF) method (Ringdal and Kværna, 1989), with phase detection data from the network of regional arrays as input. For the time interval January 1995 - June 1996, GBF automatically located 42,930 events within a geographical window covering central and northern Europe. All the automatic GBF bulletins are available on the World Wide Web at http://www.norsar.no/bulletins/.

NDC data analysis

Events at local and regional distances are manually analyzed using data from the regional arrays. The system used in this work is the Intelligent Monitoring System (see Section 3.6 of this report). The GBF program is used as a pre-processor to the Intelligent Monitoring System, and only phases associated by GBF to events in central and northern Europe are considered. The analysts check the output from this automatic process and select events in accordance with certain criteria (relating to magnitudes and regions of interest) for subsequent manual analysis. The events analyzed in this way comprise the NOR_NDC input to the Nordic Supplementary (Gamma) data, which are compiled by the Finnish NDC and forwarded to the IDC.

For the period January 1995 - June 1996, NOR_NDC submitted 1,087 such supplementary events. These events are shown in Fig 7.1.9. It should be noted that the analysts use data from all the regional arrays available at NOR_NDC, so that in addition to the Norwegian primary stations ARCES, NORES and SPITS, waveforms and detections from HFS (Sweden), FINES (Finland), GERES (Germany) and the Apatity array (Kola peninsula, Russia) are used in this context.

Data from the NORSAR array are analyzed to produce a monthly bulletin of events worldwide. These bulletins contain 5,683 events for the January 1995 - June 1996 time interval. The events are shown in Fig. 7.1.10.

Tools developed

To start operation as a National Data Center, NOR_NDC implemented programs both to forward continuous waveform data to the IDC and to respond to requests for additional data from the IDC and from other NDCs.

The program system used for forwarding of primary data, is the AlphaRead/-Send suite of programs developed at the IDC. AlphaRead reads continuous waveform data from the local NDC recording system (circular diskloops at NOR_NDC) and writes them to LIFO (Last In First Out) buffer files in a system-independent format. These files are read by AlphaSend which sends them to the IDC after a connection has been opened. For a detailed discussion of the Exchange of Continuous Data, see GSE/CRP/243 (1995). To install the AlphaRead/-Send package at NOR_NDC, a small number of low-level subroutines had to be modified to access the diskloop files. After installation, the programs have been running almost un-interrupted and are currently using LIFO buffer files capable of holding 24 hours of data (this number can be increased if deemed necessary.)

For external access to NOR_NDC parameter and waveform data, the Automatic Data Request Manager (AutoDRM; Kradolfer, 1993) retrieved from the Swiss Seismological Service (SED) has been installed. This program accepts email-messages containing formatted requests and returns the requested data by email or through ftp, depending on the amount of data. The AutoDRM version installed at NOR_NDC is 2.8 from November 1995. The data center-specific parts of AutoDRM are localized to a few subroutines and to install the program, only a small number of files had to be modified to read from NOR_NDC diskloops, gap lists and parameter files. Currently, these request types are supported:

- WAVEFORM (only data still on the diskloops, i.e., no data older than 5-6 days. For older data, the archive database at the IDC should be queried)
- CHANNEL (channel information with location, emplacement and seismometer type)
- RESPONSE (instrument response information)
- OUTAGE (outage reports - gap lists)

To request data from NOR_NDC, send an email-message with the following content to autodrm@norsar.no (substitute the appropriate values for MSG_ID and the return email address):

```
BEGIN GSE2.0
MSG_TYPE request
MSG_ID example ANY_NDC
E-MAIL name@my.computer
HELP
STOP
```

The IDC uses a similar AutoDRM program (messages@cdidc.org) which gives access to both the operational (recent) data and the archived waveforms and parameters. Since a number of research projects at NOR_NDC depend on fast and easy access to large amounts of archived waveforms, a program system for semi-automatic requesting and retrieval was developed. The system consists of a collection of UNIX shell-scripts and small FORTRAN programs to automatically request all waveforms associated (following certain criteria) to an event. The program will take an origin identifier (orid - found in IDC bulletins, AELs, REBs, etc.), request a list of phases associated to the origin, compute time intervals to request, and format and send the complete GSE2.0 REQUEST-message to the IDC.

The reply message from the IDC is automatically forwarded into another program which will read the message, decide if it contains a small GSE2.0 WAVEFORM segment which can be unpacked at once or, alternatively, read and execute the necessary ftp-commands to retrieve larger segments. Error conditions (missing waveforms, format errors, etc.) are also handled gracefully.

Contributions to IDC development, evaluation and operation

During the period January 1995 - June 1996, NOR_NDC has, in cooperation with the United States, contributed towards IDC development through software deliveries, as follows:

- NOR_NDC installed a prototype system for Continuous Threshold Monitoring at the IDC in October 1994. An extension of this system to include full GSETT-3 primary network processing was delivered and installed in May 1995. A fully operational version of the system is planned for implementation in the fall of 1996 (see also Section 7.2 of this report).
- In June of 1996, NOR_NDC delivered software for IDC processing of data from the NORSAR teleseismic array in DFX (Detection and Feature Extraction; the software currently used at the IDC to automatically detect and analyze seismic signals), as well as certain DFX extensions to accommodate STA calculations for the Threshold Monitoring system. These deliveries, as well as plans for future deliveries of software to the IDC, are described in some detail in Section 7.2 of this report. One of the future deliveries described in Section 7.2 is an algorithm for improved automatic onset-time estimation. Our initial findings related to this subject are described in Kværna (1995), and further results are reported in Sections 7.3 and 7.8 of this report.

NOR_NDC has participated in the evaluation of several aspects of the IDC operation:

- NOR_NDC participated in the evaluation of the IDC AutoDRM data request manager in May and June 1995 by sending a large number (175 in May and 167 in June) of data requests to the IDC and evaluating the response to these requests in terms of timeliness and completeness. The results of this evaluation are reported in GSE/CRP/262 (1996). NOR_NDC has also participated in testing of the IDC World Wide Web service, as well as in testing of direct IDC database access using SQL.
- A study of the performance of the IDC processing of data from the Spitsbergen array has been conducted by Mykkeltveit et al (1995). The study gave recommendations for certain improvements in the IDC software.
- Magnitude estimation at the IDC has been assessed in a case study by Ringdal (1995) on an earthquake sequence in Greece during May-June 1995.

NOR_NDC has contributed to IDC operations by providing an experienced analyst to the international staff at the IDC. Bernt Kr. Hokland started his work at the IDC on 1 January 1995 and continued his work there through August of 1995.

Other related activities

NOR_NDC is forwarding data to the IDC from GSETT-3 primary stations in several countries. These currently include FINESS (Finland), GERESS (Germany), Hagfors (Sweden) and Sonseca (Spain). In addition, communications for the GSETT-3 auxiliary station at Nilore, Pakistan, are provided through a VSAT satellite link between NOR_NDC and Pakistan's NDC in Nilore. Fig. 7.1.11 shows the locations of these GSETT-3 stations and also indicates the 256 Kbits/s fiber optic link used to transmit these data as well as the Norwegian GSETT-3 data to the IDC.

We have negotiated an agreement with the Norwegian Telecom on the establishment of a VSAT network that enables transmission to the IDC via NOR_NDC of data from stations in Europe, Africa and Asia. So far, data from FINESS, Hagfors, Spitsbergen and the auxiliary station at Nilore, Pakistan, are transmitted to Norway using this VSAT system. The link between NOR_NDC and the IDC has a capacity of 256 Kbits/s, which would permit forwarding data from additional stations to the IDC via NOR_NDC. It has so far been planned that data from an envisged GSETT-3 primary station in Tunisia will be forwarded to the IDC in this manner, and we are also looking into possibilities for routing data from other GSETT-3 primary stations to the IDC via NOR_NDC.

Concluding remarks and future plans

This contribution has summarized activities and experience gained at the Norwegian NDC during the first year and a half of the full-scale phase of the GSETT-3 experiment. The following conclusions can be drawn with respect to current status and directions for future work at NOR_NDC:

- The statistics presented on data availability for the Norwegian GSETT-3 primary stations ARCESS, NORESS and Spitsbergen demonstrate that the goal of 99% data availability at the IDC is not reached. The NOR_NDC data availability exceeds 99% for extended periods of time for these stations, but it is found that a substantial amount of data is lost between the NOR_NDC and the IDC (some of, but not all of this loss is due to discrepancies between the ways the NOR_NDC and the IDC report data availability, as explained earlier). Further work, within available resources, is thus needed to harden those components and processes that most frequently have caused loss of data. More detailed statistics than have been presented in this contribution are available for a study of the reasons for the outages, and this information will be used to assess the value of various possible measures to improve the situation.
- A fairly substantial effort at the NOR_NDC is directed towards processing of the data acquired, for detection and location of events. Besides the obvious value of this in the context of research, IDC evaluation and development, provision of Supplementary data, etc., we think that routine NDC processing is the best means of checking on and ensur-

ing the data quality and integrity. To the extent that the NDCs will be responsible for quality of data from stations on their own territory (as is the case in GSETT-3), NOR_NDC will continue to direct appropriate attention to the data processing task.

- Within available resources, NOR_NDC will continue to contribute to the evaluation and further development of the IDC. Based on our experience over the past couple of years, we believe we are in a good position to pursue several tasks that could lead to improvements in the IDC system.
- NOR_NDC has assisted a number of countries in their efforts towards contributing data to the IDC (see Section 7.5 of this report), and as described in this contribution, several countries send their data to the IDC via NOR_NDC. We intend to pursue these efforts, and we think that the VSAT service offered by the Norwegian Telecom is particularly well suited to solve problems often encountered in ensuring reliable transmission of data from remotely located seismic stations.

In the near future, we will start modifying the Norwegian station participation in GSETT-3 so as to become in agreement with what is now envisaged for the International Monitoring System (IMS) that will be installed to verify compliance with a future CTBT. The NORESS array has been a temporary substitute for the large-aperture NORSAR array, awaiting the completion of a technical refurbishment of this array. This refurbishment program was completed in late 1995, and efforts are now underway to integrate the NORSAR array in the IDC processing, as described earlier. The NORSAR array data will be included in the IDC processing once the processing software developed by NOR_NDC becomes operational at the IDC. The Spitsbergen array will at a suitable time change status from being a primary to becoming an auxiliary station in GSETT-3, in conformity with its status in IMS. Subject to the availability of appropriate funds, we plan to make the seismic station on the Jan Mayen island operational in GSETT-3 by the end of 1996. This station is also in the list of envisaged IMS auxiliary stations.

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U. Baadshaug

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Ringdal, F. (1995): Magnitude estimation at the IDC — a case study. *Seminannual Tech. Summary, 1 April - 30 September 1995*, NORSAR Sci. Rep. No. 1-95/96, Kjeller, Norway.

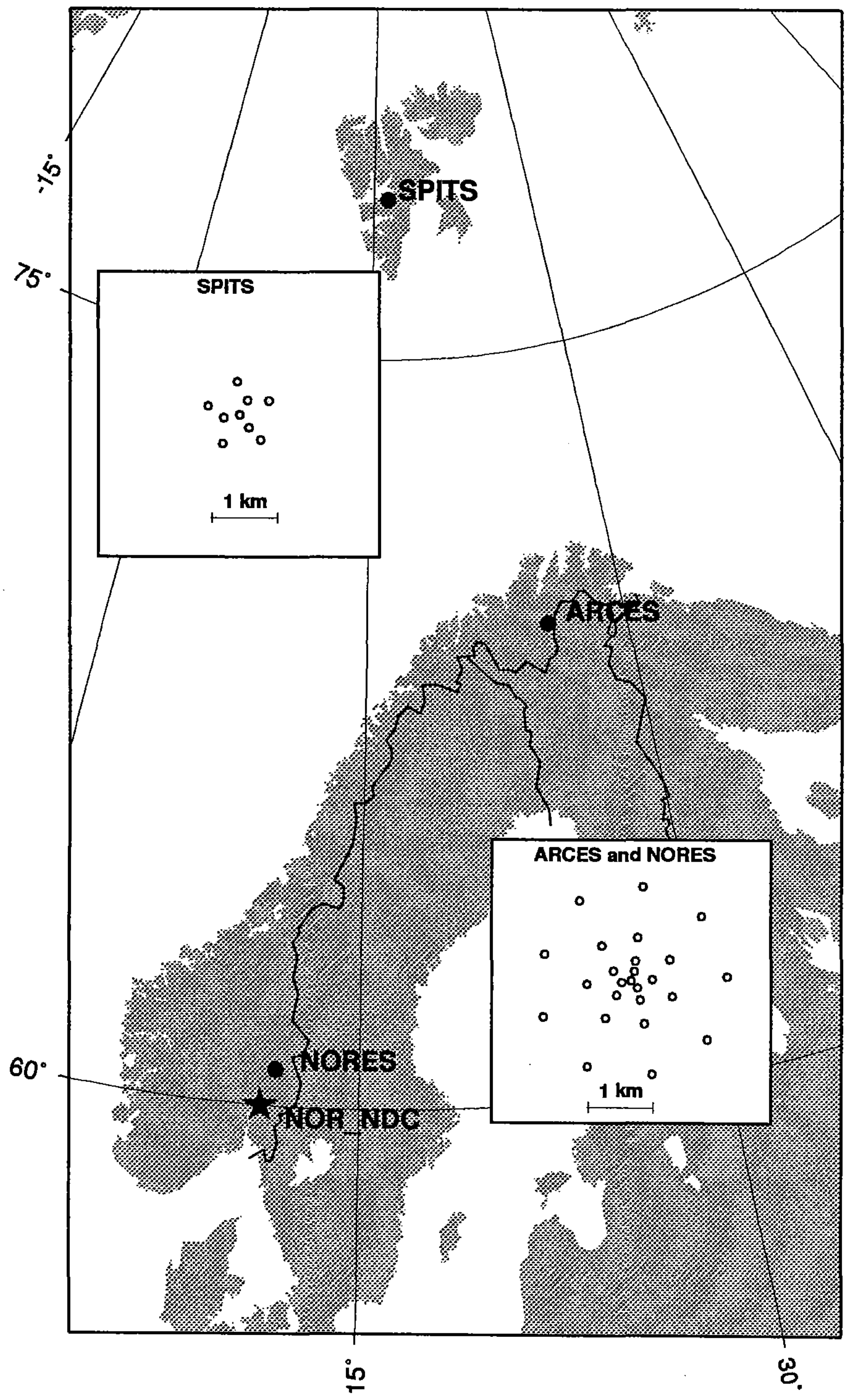


Fig. 7.1.1. The figure shows the locations and configurations of the three Norwegian GSETT-3 primary array stations. The data from these stations are transmitted continuously and in real time to the Norwegian NDC (NOR_NDC) and then on to the GSETT-3 IDC.

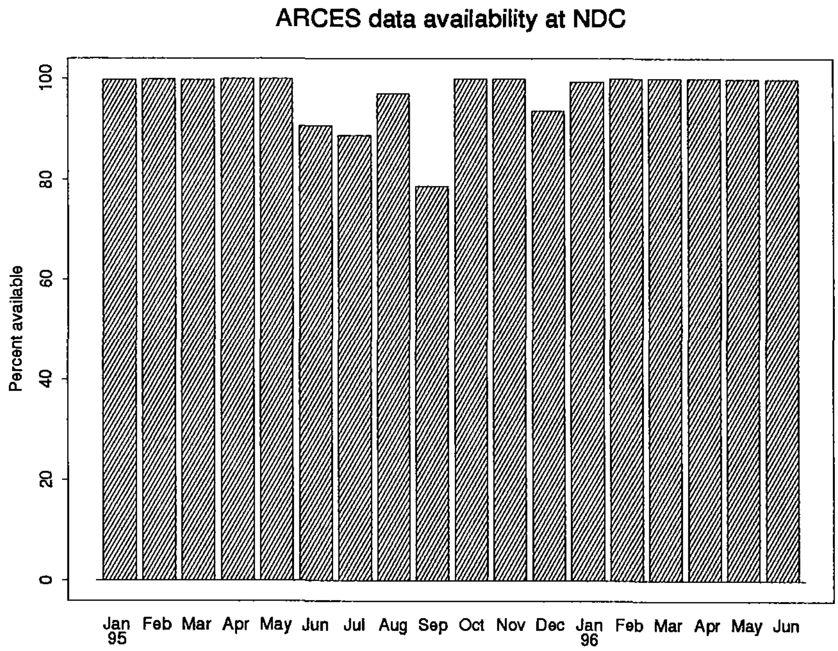


Fig. 7.1.2. The figure shows the monthly uptimes for the ARCESS array for the period January 1995 - June 1996. The barplots reflect the percentage of waveform data from ARCESS that is available in the NOR_NDC tape archives for each month.

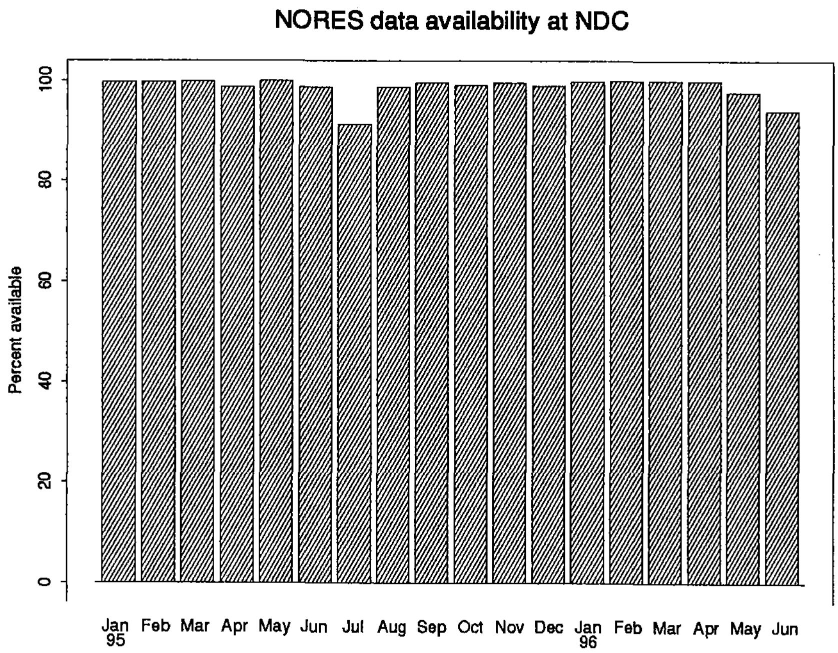


Fig. 7.1.3. The figure shows the monthly uptimes for the NORESS array for the period January 1995 - June 1996. The barplots reflect the percentage of waveform data from NORESS that is available in the NOR_NDC tape archives for each month.

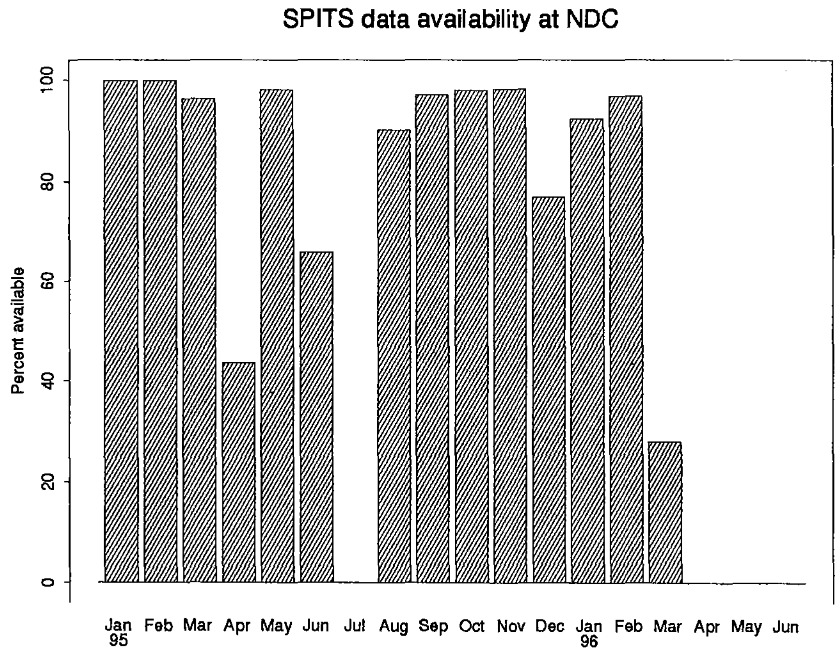


Fig. 7.1.4. The figure shows the monthly uptimes for the Spitsbergen array for the period January 1995 - June 1996. The barplots reflect the percentage of waveform data from the Spitsbergen array that is available in the NOR_NDC tape archives for each month.

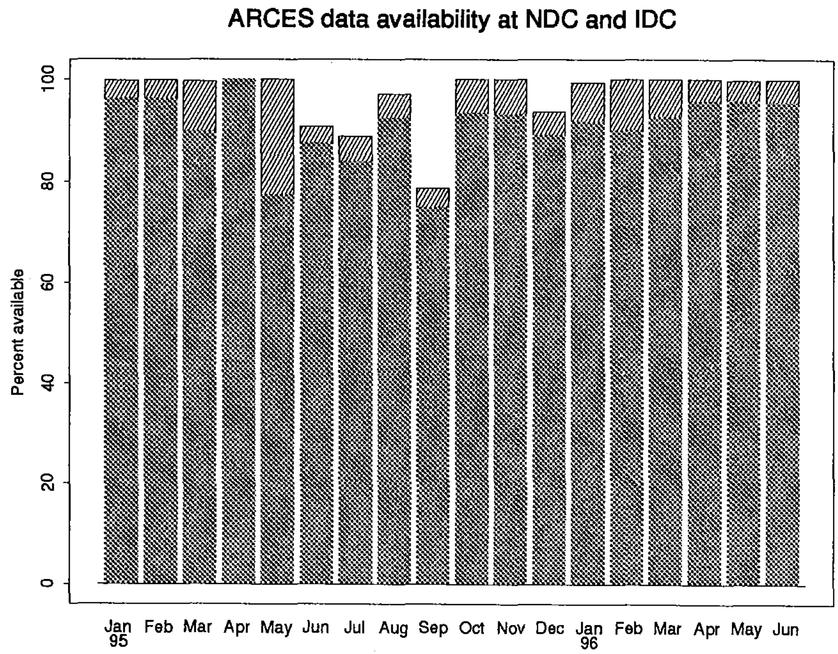


Fig. 7.1.5. The figure shows the monthly availability of ARCESS data in the NOR_NDC and IDC archives, with the higher values representing NOR_NDC data availability, as the ARCESS data are sent to the IDC via the NOR_NDC.

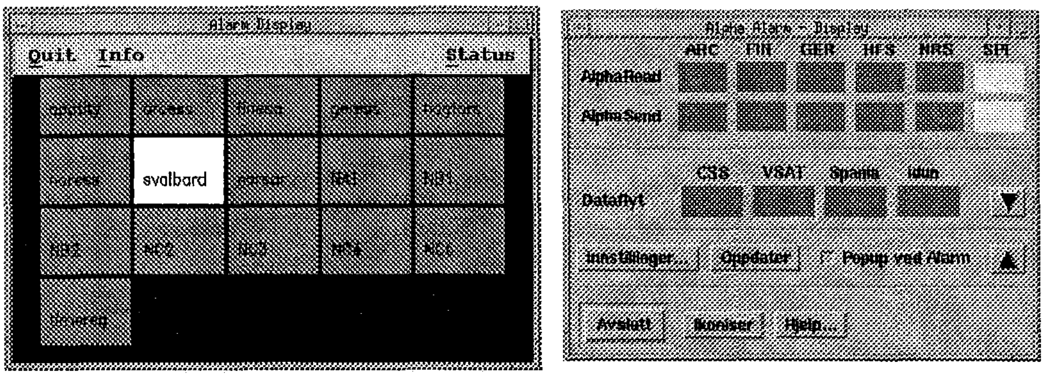


Fig. 7.1.6. The figure shows the graphics of the alarm display program running on the workstations of the operations personnel at the NOR_NDC. See the text for further details.

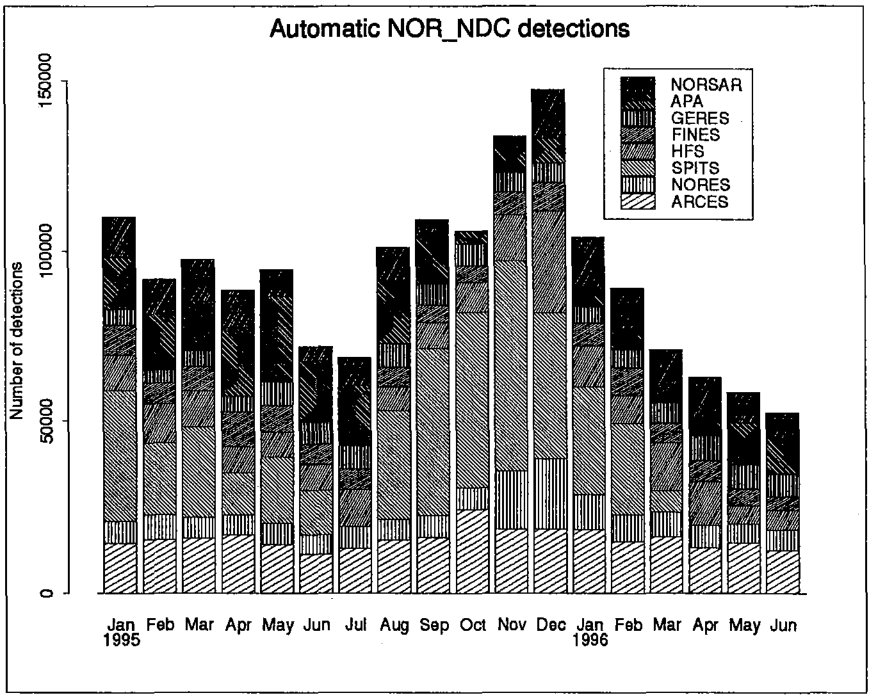


Fig. 7.1.7. The figure shows the number of automatic NOR_NDC detections for the various regional arrays and the NORSAR teleseismic array, for the time interval January 1995 - June 1996.

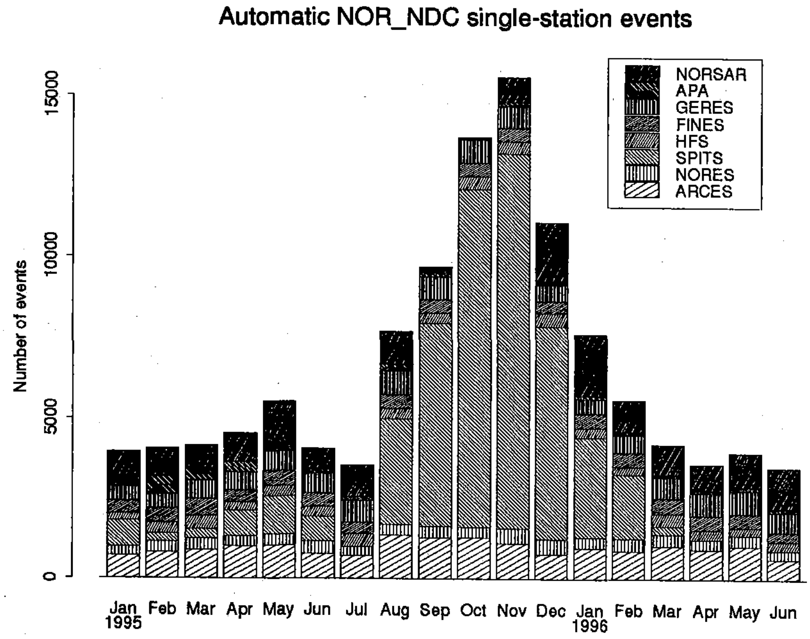


Fig. 7.1.8. The figure shows the number of automatic single-station events formed by the NOR_NDC processing for the various regional arrays and the NORSAR teleseismic array, for the time interval January 1995 - June 1996.

Reviewed Gamma events

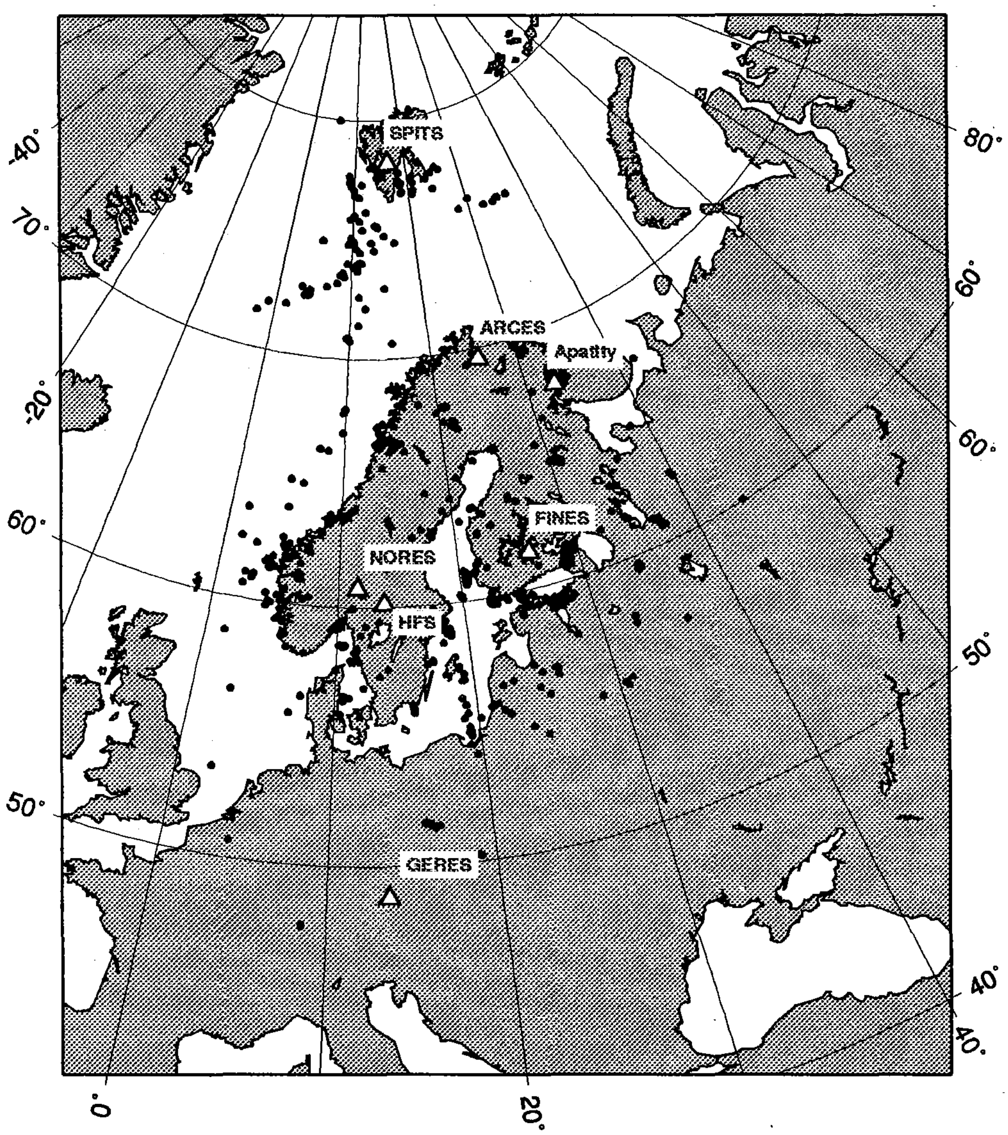


Fig. 7.1.9. The map shows the 1,087 events in and around Norway contributed by NOR_NDC during January 1995 - June 1996 as Supplementary (Gamma) data to the IDC, as part of the Nordic Supplementary data compiled by the Finnish NDC.

Analyst reviewed NORSAR events

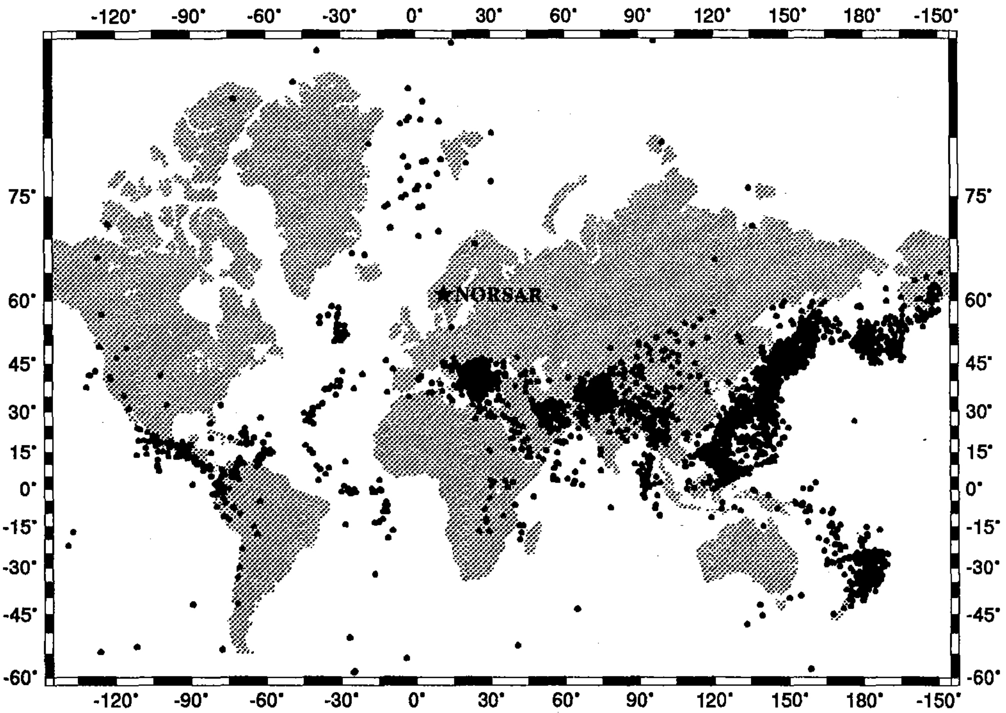


Fig. 7.1.10. The map shows 5,683 events worldwide, analyzed and located from data recorded at the NORSAR teleseismic array during the period January 1995 - June 1996.

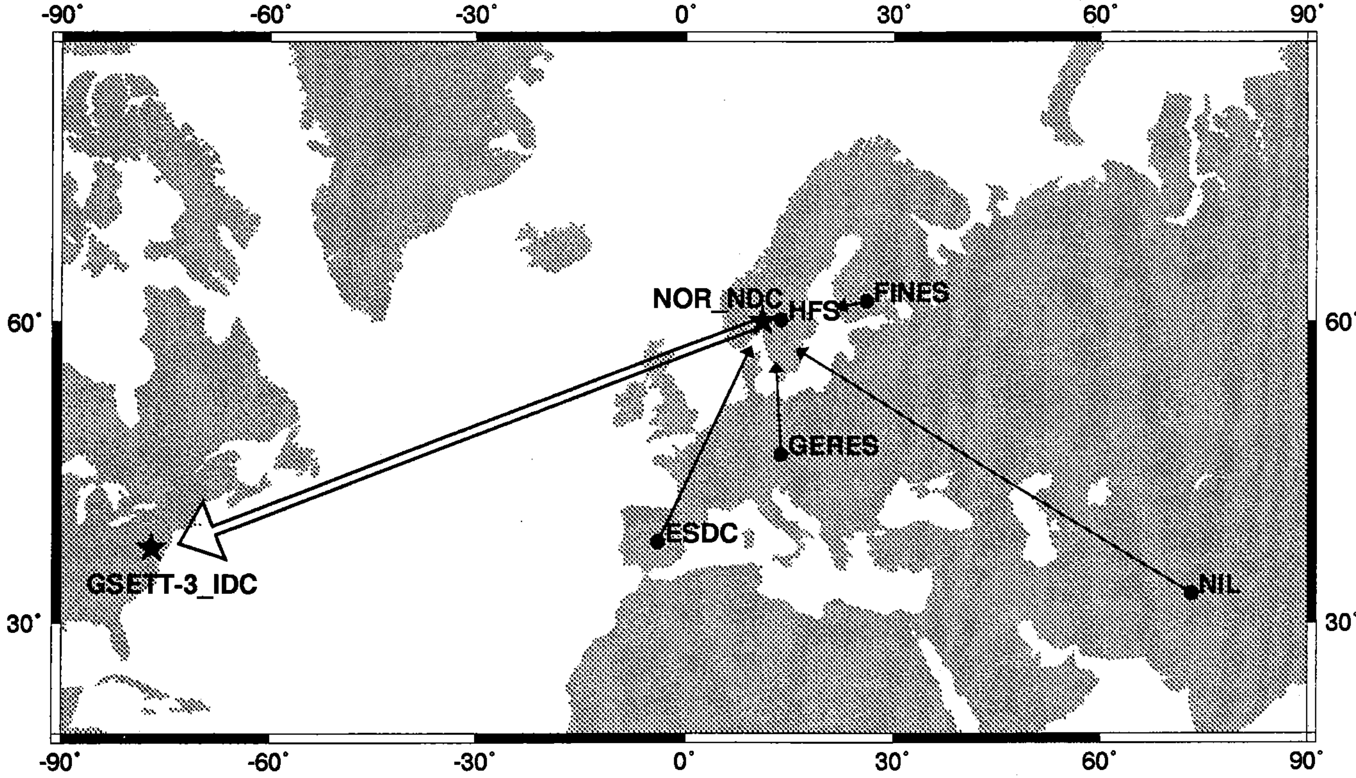


Fig. 7.1.11. The figure shows the locations of GSETT-3 stations outside Norway that use NOR_NDC as a communications node in forwarding the data to the IDC. The high-speed link (256 Kbits/s) between NOR_NDC and the IDC is also indicated.

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

Introduction

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

For our FY96 R&D effort for ARPA, it is a requirement that new knowledge emerging from our research program should be delivered, installed and tested within the software infrastructure on the testbed at the GSETT-3 IDC. In practice, this calls for integration of most of the NORSAR deliverables within the new Detection and Feature Extraction (DFX) software that became operational at the IDC in January of this year. To comply with this requirement, we have made a considerable effort to study the DFX software and its structure, and a visit by members of our staff to the DFX developers at SAIC, San Diego, in April has greatly facilitated this undertaking. This contribution summarizes the status of our software deliveries so far, as well as further plans.

Software delivered so far

The visit to SAIC, San Diego, provided an opportunity to agree on a delivery schedule for NORSAR contributions to the IDC software. It was agreed that the first products to be delivered should be software for IDC processing of data from the NORSAR teleseismic array in DFX, as well as certain DFX extensions to accommodate STA calculations for the Threshold Monitoring system. Following a period of intensive software development and testing, these products were delivered to SAIC, San Diego, on 18 June 1996. Provided that no severe difficulties are encountered during the final integration and testing to be carried out by SAIC, San Diego, the intent is to have this new software operational at the IDC as part of the planned 1 July release of DFX. Details on the software delivered so far are given in the following.

NORSAR processing algorithms

A technical refurbishment of the NORSAR teleseismic array was carried out during 1992-1995, and the array is now ready for participation in the GSETT-3 experiment as a primary station. The array has 42 short-period vertical sensor instruments (Teledyne Geotech 20171-0104) and 7 three-component broadband instruments (Teledyne Geotech KS54000P). The instruments are logically grouped into 7 subarrays, each with 6 short-period and one three-component broadband instrument. The array diameter is approximately 60 km, and each subarray diameter is in the range 7-10 km.

The NORSAR array will differ significantly from the rest of the GSETT-3 stations, both in terms of array diameter and amount of data transmitted. Due to the array diameter, special processing techniques are required to fully utilize the array's potential for both signal detection and precise teleseismic slowness estimation. The IDC has a fairly standardized way of processing seismic array data, using DFX to detect signals and perform feature extractions for each detection. Slowness estimates are obtained by standard broadband frequency-wavenumber (F/K) analysis. For NORSAR, plane wave beamforming will result in loss of signal power unless time delay corrections are applied (see Fyen, 1996). It is thus necessary to introduce time delay corrections both for the detecting beams and within the slowness estimation process.

The F/K analysis is a simple process to obtain signal power on a grid of slowness values within a frequency band, and the resulting slowness is taken to be the slowness corresponding to the peak power. In Fyen (1996), it is demonstrated that equivalent results are obtained by: 1) applying the standard F/K process and 2) prefiltering the data in the F/K frequency band and performing beamforming in the time domain for equivalent slowness values as for the F/K process (DFX function *"compute-beamform-fk"*), which is of course expected. Such a beamforming process requires more computer power than F/K computations, but time delay corrections for each beam point in slowness space are more easily adopted. It is also shown that the beamform method is more robust as compared to the "beampacking" method currently used at NORSAR. The "beampacking" method uses the trigger beam slowness vector as a starting point, and uses beamforming within a limited region surrounding the detection beam to refine the slowness estimate. The "compute-beamform-fk" will use the full specified slowness space, and calculate all beams. This will reduce the problem with sidelobe detections, since the alternative "beampack" process has a tendency to stay within the sidelobe.

During the visit to San Diego in April, NORSAR processing techniques were presented to the DFX development team, and two requirements were identified, the fulfillment of which would enable the processing of NORSAR data with DFX:

- Modification of the beam recipe and beamform code to include an option for time delay corrections;
- Addition of a new process which resembles F/K analysis for slowness estimation using time domain beamforming.

During the visit agreement was reached on a new beam recipe format which does not require any changes to former recipes for standard processing. In the new recipe, a beam may be defined in three different ways: by slowness and azimuth with no time delay corrections, by slowness and azimuth, with indication that time delay corrections should be used, or by giving absolute time delays. A new parameter defines a time delay correction data base file, which will be used in cases when the beam needs time delay corrections.

Following the San Diego meeting, the beamforming code has been changed, a time delay correction process has been included, and we are now able to do detection processing on NORSAR data using the new software. The "compute-beamform-fk" has subsequently been implemented into DFX at NORSAR, and testing demonstrates that we are able to process NORSAR array data with results comparable to or better than those regularly produced for the NORSAR array using our previous software ("beampacking"). As stated above, the new software was delivered to SAIC on 18 June.

DFX extension to accommodate STA calculation for the Threshold Monitoring system

The Threshold Monitoring (TM) system, developed by NORSAR, consists of three main modules. The first module computes short-term averages (STAs) for each station of the global network, using filtered traces for each 3-component station and a set of filtered beams for each array. The second module computes magnitude threshold on a global grid using the pre-calculated STAs, and the third module is used for visualization and analysis of the calculated magnitude thresholds.

In the prototype TM system delivered to the IDC in October 1994, the first TM module doing station STA amplitude calculations made use of a stand-alone program developed at NORSAR. Logically, the STA calculations should be done within the IDC signal processing module (DFX) as functions for database access, quality control, beamforming and filtering are already available in that context. During the visit to San Diego, we decided to take on the task of integrating the STA calculations for the TM analysis with the DFX program. In this way, the IDC operational team would also benefit from having fewer processes to monitor.

The DFX extension with the new STA calculations was delivered to SAIC on 18 June. As part of this DFX extension, we also modified the parameter files for the GSETT-3 primary stations to include STA calculations for the TM system. The following stations were included:

ABKT, ARCES, ARMA, ASAR, BDFB, BGCA, BJT, BOSA, CMAR, CPUP, DBIC, ESDC, FCC, FINES, GERES, HFS, HIA, KBZ, LBNH, LOR, LPAZ, MAW, MBC, MIAR, MJAR, NOA, NORES, NPO, NRI, PDAR, PDY, PFO, PLCA, SCHQ, SPITS, STKA, TXAR, ULM, VNDA, WALA, WHY, WOOL, WRA, YKA and ZAL.

To conform with the regular m_b calculations at the IDC, we have initially decided to compute the STAs from vertical component traces or beams filtered between 0.8 and 4.5 Hz with a 3rd order Butterworth filter. Both the STA length and the STA sampling interval is set to 1 s. In the code, the STAs are first calculated with the sampling rate of the original data, and the decimation to 1 s sampling interval is done by finding the maximum STA within each 1 s block.

For each of the three-component primary stations, only one STA trace is calculated from the vertical component channel and written to a cyclic disk file of 24-hour length. For each of the array primary stations, STA traces are computed from 15 beams deployed to cover the slowness range of P-phases. The beam steering points are given in Table 7.2.1.

Further plans for software delivery

Future plans for delivery of algorithms to the GSETT-3 IDC include making the prototype Threshold Monitoring system fully operational, provide a basis for improved onset-time estimation, contribute towards event post-processing, and making an effort to tune the signal processing for other GSETT-3 arrays than those already considered. Current status for each of these work items are briefly described in the following:

Threshold Monitoring system

Once the STA calculations for the TM system have been implemented in DFX, we will be ready to continue with making the rest of the prototype TM system operational. The resources needed for operational testing of the global threshold calculations and the visualization and analysis module are much less than those needed for the STAs, such that most of this work can be carried out at NORSAR utilizing the 256 Kbit/s link to the IDC.

As mentioned earlier, the first of the three current TM modules is completed and has been delivered to SAIC, and few changes are envisaged. The source codes for the second and third modules are closely integrated, and we have estimated the following numbers for the existing code (FORTRAN and NG-USE Macro language):

Number of FORTRAN files:	517
Number of NG-USE files:	340
Lines of FORTRAN code:	49930
Lines of FORTRAN comments:	25572
Lines of NG-USE code:	10402
Lines of NG-USE comments	1358

In addition to the modifications necessary to ensure stable operation, we would in the future like to extend the functionality of the TM system to include "optimized" site-specific monitoring as well as provide summary results requested by the international community. Another option which might be considered is to extend the global TM system to include surface waves. For integration of these options, the changes to the existing code are expected to be about 10% and additions about 30%.

Improved onset-time estimation

Our results on autoregressive onset-time estimation were presented to the DFX developers during the April visit. There is good indication that the algorithm we have developed will contribute to improve the onset-time estimation currently operational in DFX. This integration will, however, require that our onset algorithm is implemented as a self-contained C-function, and not in a signal processing macro language as currently available. We hope that our algorithm can be implemented in the IDC processing in conjunction with a DFX release later this year.

Event post-processing

We have during the last couple of months been experimenting with a post-processing scheme for events located in the Japan area, with the aim of obtaining more precise event location (both using automatic and/or analyst time picks). Our improved onset-time estimation routine is a key element in this research. During this research we have made several interesting findings on the use of arrival-time picks and master-event location techniques in this context of getting more precise event locations. Unfortunately, some of our results indicate that the use of master-event location techniques or regionalized travel-time curves is more complex than we previously anticipated. We will make an assessment of these problems to see what can realistically be achieved and then plan accordingly with respect to future deliveries of software for IDC processing.

Tuning of signal processing for GSETT-3 arrays

We have looked into the signal processing for the SPITS array and briefly the MJAR array for the purpose of tuning the signal processing parameters. From what we have seen, it may not be sufficient to change only the processing parameters in DFX to obtain good performance. From our point of view, it seems beneficial to make some extensions to the signal measuring methods. With our current understanding and knowledge of the DFX software, we consider ourselves to be in a position to provide such extensions, if required.

J. Fyen
T. Kværna
S. Mykkeltveit

Reference

Fyen, J. (1996): Time delay measurements and NORSAR large array processing, NORSAR Technical Report, June 1996, Kjeller, Norway.

Table 7.2.1: Array beam deployment for magnitude threshold calculations

Beam Name	Azimuth	App. vel. (km/s)
TM001	0.0	∞
TM002	0.0	11.5
TM003	60.0	11.5
TM004	120.0	11.5
TM005	180.0	11.5
TM006	240.0	11.5
TM007	300.0	11.5
TM008	0.0	8.5
TM009	45.0	8.5
TM010	90.0	8.5
TM011	135.0	8.5
TM012	180.0	8.5
TM013	225.0	8.5
TM014	270.0	8.5
TM015	315.0	8.5

7.3 Quality assessment of automatic onset times estimated by an autoregressive method

Introduction

In the previous semiannual report (Kværna, 1995), we described an experiment where we used an autoregressive method, denoted AR-AIC, for automatic estimation of phase onset times. In this report we will expand on the use of accompanying onset quality estimates as a tool to choose between onset times derived from different types of AR-AIC models, as well as for flagging onsets that have a high probability of being incorrect.

The human observation of a seismic phase is attributed to an amplitude increase and/or a change in the frequency content of the data. If the trace is properly filtered, an amplitude increase should be observable. For quality assessment of the automatically estimated onsets, we decided to derive additional signal parameters from the time domain data, filtered in the band that provides the highest SNR.To analyze the amplitude increase we found it convenient to create an envelope of the data from the filtered trace and its Hilbert transformed counterpart. The Hilbert envelope was gently smoothed with a lowpass filter. The procedure is illustrated in Fig. 7.3.1.

We defined the following set of measurements to be made on the envelope:

- $NOISE_{max}$ was taken to be the maximum of the envelope within a 3 second interval preceding the automatically estimated onset.
- $AMP_{0.5}$, $AMP_{1.0}$, $AMP_{2.0}$, $AMP_{3.0}$ and $AMP_{5.0}$ were the maxima of the envelope within 0.5, 1.0, 2.0, 3.0 and 5.0 seconds after the onset, respectively. The corresponding (quality) signal-to-noise ratios $QSNR_{0.5,...,5.0}$ were defined to be $AMP_{0.5,...,5.0}$ / $NOISE_{max}$.
- $T_{QSNR1.5}$ was the time from the onset to the point where QSNR exceeded 1.5.

Data

A database of 83 P-phases with SNR > 100 recorded at different GSETT-3 stations was created. The arrival times of each of the phases were picked manually and stored for reference. By successively reducing the SNR by adding scaled noise samples, the performance of the AR-AIC method and the associated quality measures were evaluated using the manually picked onsets as the reference.

AR-AIC models and quality metrics

For each of the down scaled signals, the AR-AIC method was applied with two different models as described by Kværna (1995):

- The first model, denoted $AR\text{-}AIC_{F+S}$, applies autoregressive coefficients derived both in a preceding noise interval and in a window within the signal.
- The second model, denoted $AR\text{-}AIC_F$, applies autoregressive coefficients derived only from the preceding noise interval.

Generally speaking, the overall accuracy of both manually and automatically estimated onsets depends on the SNR of the signal. It was therefore obvious to us that a quality metric should take into account this factor. To ensure that the SNR was measured in the vicinity of the actual onset we decided to use the envelope measurement $QSNR_{2.0}$, being the maximum QSNR-within 2 seconds of the onset. At the same time we wanted to include a factor that specifically contained information on a possible erroneous onset estimate. From experiments we found that the envelope measurement $T_{QSNR1.5}$, being the time from the onset to the point where QSNR exceeded 1.5, would yield low values for correct onsets and high values for both early and late onsets.

The working hypothesis was to compute the composite quality metric

$$QAIC = QSNR_{2.0} / T_{QSNR1.5}$$

for the onsets estimated by two different models of AR-AIC, and then from this quality metric to decide which one was the best.

The second working hypothesis was that once the best AR-AIC onset estimate was chosen, we could compare QAIC with the standard STA/LTA based SNR to identify onsets that had a high probability of being incorrect.

Results

Fig. 7.3.2a shows the time difference between $AR\text{-}AIC_{F+S}$ onsets and the corresponding manual pick of the unscaled signals, plotted against the standard SNR in the best frequency band. We can see that for SNR less than 5, the $AR\text{-}AIC_{F+S}$ onsets become random and unstable. We do currently not know if this is due to the method itself, or is an artifact of quantization problems introduced by the noise scaling or due to other small signals present in the scaled noise samples. However, we will in the following restrict our analysis to the cases where SNR exceeds 5.0.

As seen from Fig. 7.3.2a, one problem that arose with the $AR\text{-}AIC_{F+S}$ model, was that it sometimes estimated the onset too early even for large SNRs. When comparing to the $AR\text{-}AIC_F$ results shown in Fig. 7.3.2b, we find the number of early onsets to be much less. On the other hand, we found that in general the $AR\text{-}AIC_F$ onsets had a tendency of being late and that the $AR\text{-}AIC_{F+S}$ model should initially be preferred.

For phases with $SNR \geq 10$ we have in Fig. 7.3.3a plotted the composite quality metric of the $AR\text{-}AIC_{F+S}$ onsets versus the composite quality metric of $AR\text{-}AIC_F$ onsets, denoted $QAIC_{F+S}$ and $QAIC_F$, respectively. The cases where the $AR\text{-}AIC_F$ onsets are more than 0.2 seconds closer to the reference manual pick than the $AR\text{-}AIC_{F+S}$ onsets are emphasized by circles, being representative for the cases where $AR\text{-}AIC_F$ onsets should be preferred. It can be seen from this figure that we can, on the basis of comparing the quality metrics, come up with a general rule for when to use the onsets estimated by the $AR\text{-}AIC_F$ model instead of the $AR\text{-}AIC_{F+S}$ onsets. In fact, by slightly adapting the simple working hypothesis described above (i.e., selecting the onset with the highest QAIC value), we succeeded in making the correct choice in about 75% of the cases. Similar results for $5 \leq SNR < 10$ are shown in Fig. 7.3.3b.

By applying a somewhat more sophisticated selection method, it ought to be possible to improve these initial results. However, before concluding the details of the general selection rule, we plan to extend our database somewhat so that we can split the data set into two populations, i.e., one for learning and one for testing. It should also be noticed that the approach of comparing the quality metrics can easily be extended to cases where several different models or parametrizations of the AR-AIC method are run in parallel, and we plan to test such approaches as well.

After selection of the "best" AR-AIC model has been made in each case, the next step will be to assess the actual accuracy of the selected onset time. We note that even with optimized selection criteria there will be AR-AIC onsets that can be considered as “wrong”, and it will be important to identify these cases to avoid erroneous input to the subsequent event location process. In Fig. 7.3.4 we have plotted the QAIC metric (obtained by selecting the "best" model in each case) versus the standard SNR of the signal, and we have labelled with a “B” the onsets that are considered “bad”, i.e., onsets that are more than 0.3 seconds ahead of the reference manual pick or more than 2 seconds late. It can be seen that a majority of the “bad” onsets cluster in the lower left part of this plot, thus making it possible to design a rule for automatic flagging of the less reliable onset estimates. Developing such an algorithm will be a task for future work.

Conclusions

This study has demonstrated that the quality measurements made on the optimally filtered beam or single trace can be used both for selection of the best AR-AIC model as well as a tool for identifying onsets that have a high likelihood of being wrong. The data set should, however, be expanded before concluding on any final decision rules, and it is also our intention to further investigate the relation between the envelope quality measurements and the onset picking error. So far we have only utilized two of the envelope measurements, but with a larger data set we can through the use of neural networks or statistical analysis investigate the utility of the other measurements.

T. Kværna

References

Kværna, T., 1995. Automatic onset time estimation based on autoregressive processing. Semiannual Technical Summary, 1 April - 30 September 1995, NORSAR Sci. Rep. No. 1 95/96, Kjeller Norway.

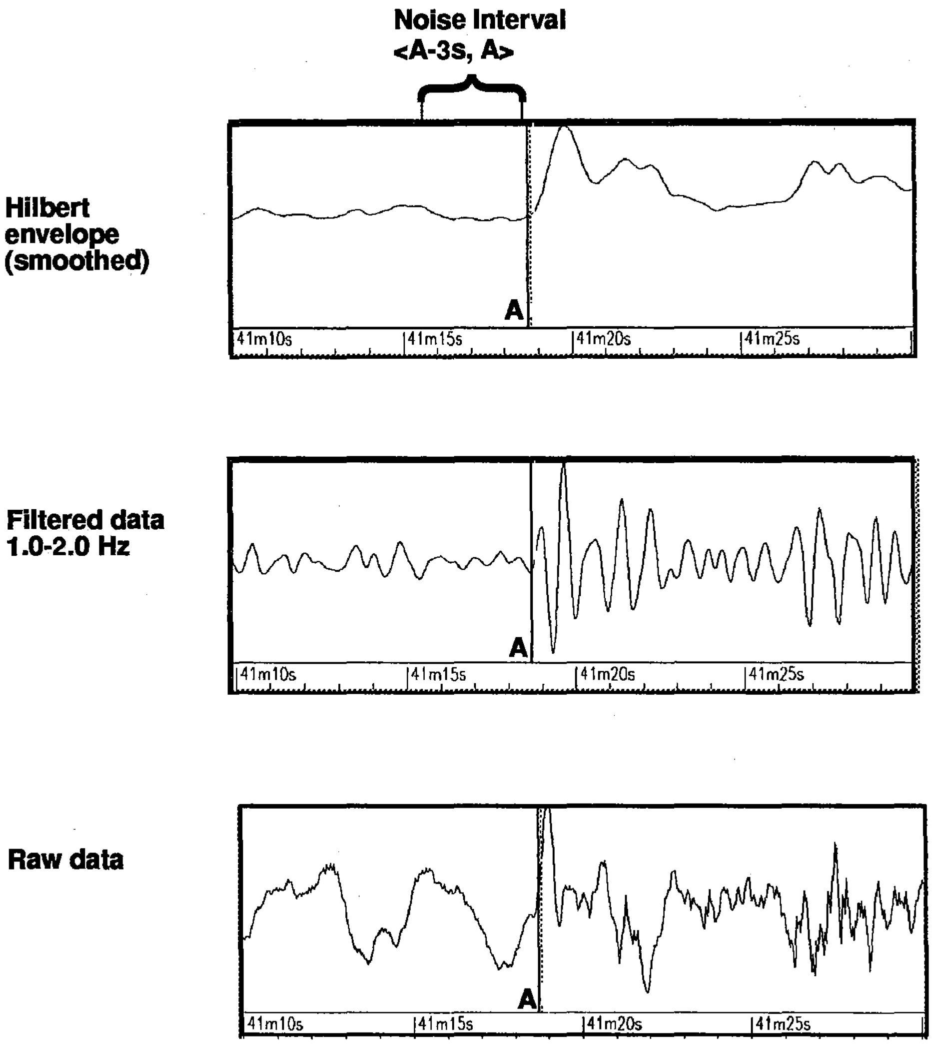


Fig. 7.3.1. Figure showing the raw data (lower panel), the data filtered in the best frequency band (middle panel) and the smoothed envelope (top panel) computed from the filtered time series and its Hilbert transformed counterpart. The 3 sec noise interval is indicated on the top panel.

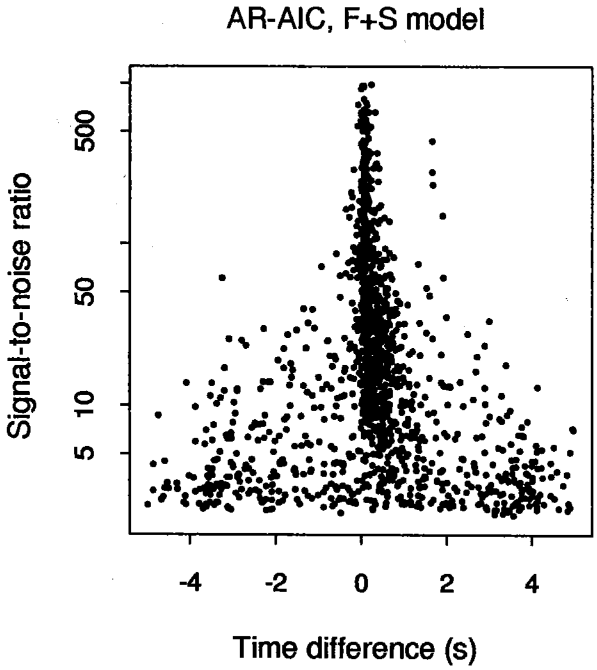


Fig. 7.3.2a. Time differences between AR-AIC$_{F+S}$ onsets and the reference manual picks plotted against the standard SNR of the signals.

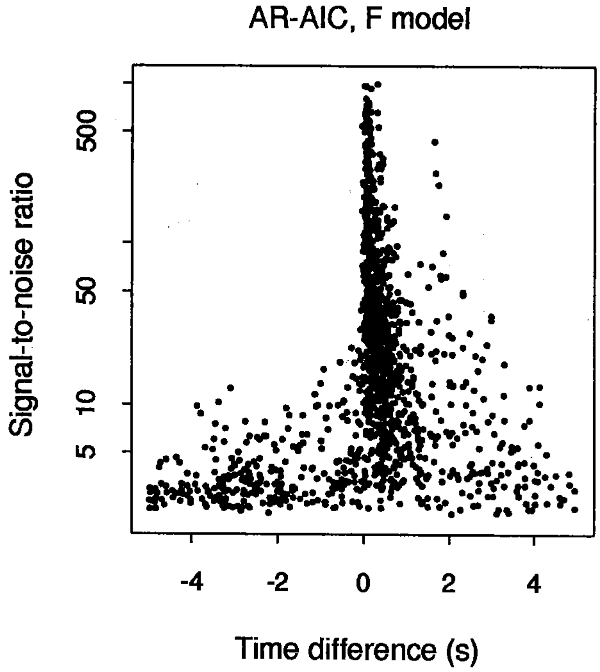


Fig. 7.3.2b. Time differences between AR-AIC$_F$ onsets and the reference manual picks plotted against the standard SNR of the signals.

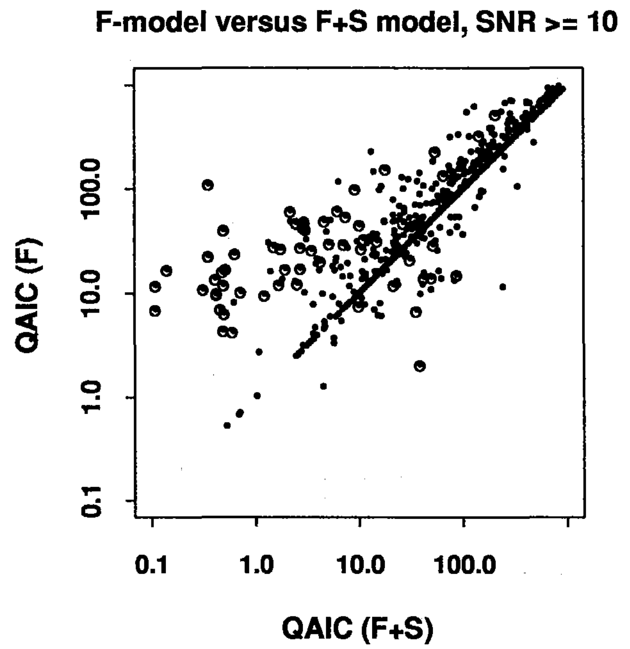


Fig. 7.3.3a. Onset quality metric for AR-AIC$_{F+S}$ plotted against the onset quality for AR-AIC$_F$ for phases with SNR >=10. The cases where the AR-AIC$_F$ onsets are more than 0.2 seconds closer to the reference manual pick than the AR-AIC$_{F+S}$ onsets are emphasized by circles.

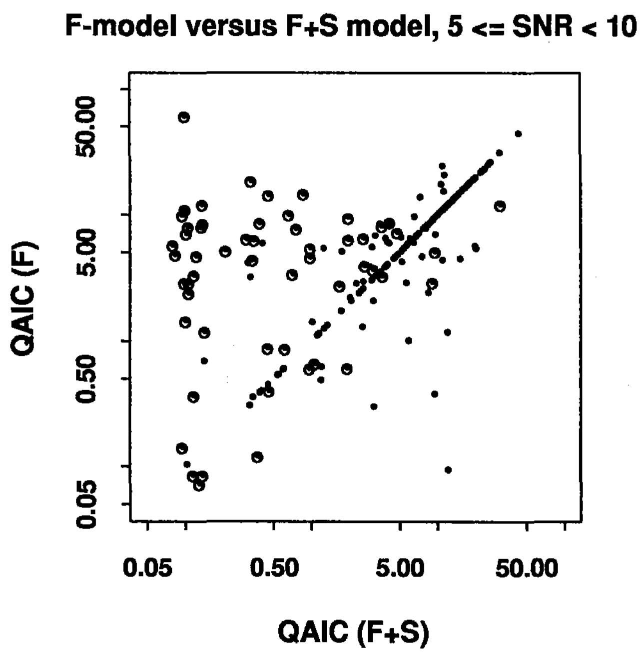


Fig. 7.3.3b. Onset quality metric for AR-AIC$_{F+S}$ plotted against the onset quality for AR-AIC$_F$ for phases with SNR between 5 and 10. The cases where the AR-AIC$_F$ onsets are more than 0.2 seconds closer to the reference manual pick than the AR-AIC$_{F+S}$ onsets are emphasized by circles.

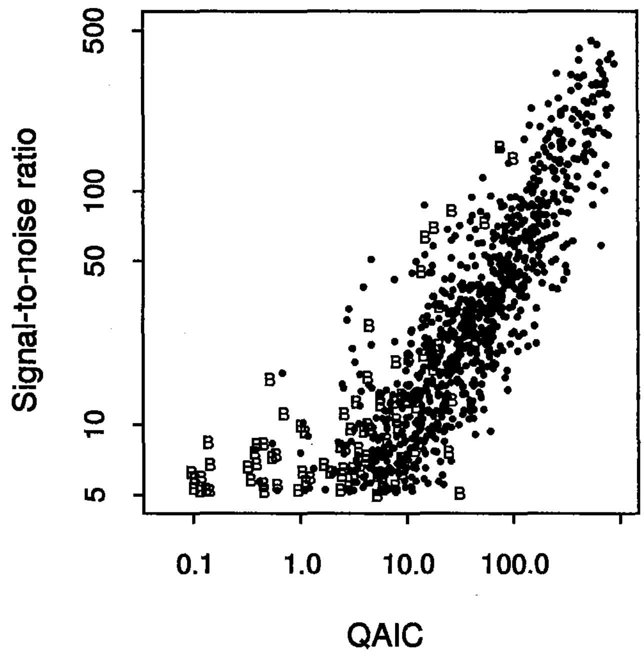


Fig. 7.3.4. QAIC metric plotted against the standard SNR of the signal. The "bad" onsets being more than 0.3 seconds ahead of the reference manual pick or more than 2 seconds late, are labelled "B".

7.4 Monitoring a CTBT: Lessons learned from the GSETT-3 experiment

Paper presented at the ARPA CTBT Monitoring Technologies Conference, San Juan, Puerto Rico, January 1996

Introduction

An effective, permanent International Monitoring System (IMS) will form a crucial part of the future global verification regime of a CTBT, currently being negotiated by the Conference on Disarmament (CD). The IMS is expected to include global networks designed to monitor the seismic, radioactive, infrasound and hydroacoustic effects of possible nuclear explosions, and will be supported by an International Data Center.

Seismic monitoring is today the most well developed of the four mentioned technologies. This is due in a large part to the work of the CD's Ad Hoc Group of Scientific Experts to Consider International Co-operative Measures to Detect and Identify Seismic Events (the GSE). Over the years, the GSE has developed and tested the basic principles for an international seismic monitoring system, culminating with the GSE Third Technical Test (GSETT-3) which began full-scale operation on 1 January 1995.

GSETT-3 objectives

The primary objectives of GSETT-3 are to:

- Develop and test new concepts for an experimental International Seismic Monitoring System (ISMS), building upon previous experience;
- Provide a practical basis upon which to furnish the CD with timely technical information;
- Develop an experimental system that can evolve and adapt to support future requirements that may be specified for an ISMS.

GSETT-3 is an unprecedented global effort to conduct an operationally realistic test of rapid collection, distribution and processing of seismic data. It incorporates the most advanced seismic sensors, global communications, data management and data processing technologies currently available. The GSETT-3 system needs to process and disseminate a volume of data about 10 times greater than that of any existing seismic monitoring system.

Overall GSETT-3 experience

The first year of GSETT-3 experience has demonstrated a number of technical and scientific results, which could be useful in the development of an International Monitoring System for a CTBT. It has served to validate the effectiveness of the GSE concept for a seismic monitoring system comprising a single centralized International Data Center (IDC), a specifically designed high-quality seismographic network consisting of about 50 primary stations and 100-150 auxiliary stations, National Data Centers (NDCs) in participating countries, and a modern communications system to support data exchange among these elements. Sustained operation of the GSETT-3 system during a full year has been achieved. At present, 45 countries are providing data from 42 primary and 85 auxiliary stations world-wide to the GSETT-3 network.

While the scope of GSETT-3 is limited to seismic monitoring, the GSETT-3 system design has proved flexible enough to incorporate the collection, archiving and distribution of data from other technologies considered for the IMS (Figs. 7.4.1 and 7.4.2).

IDC experience

GSETT-3 has demonstrated that a single International Data Center, of the structure and size established during GSETT-3, can acquire and archive the volume of seismic data that is anticipated from the IMS to be established under a CTBT. It has been shown that a single IDC can routinely analyze this large volume of data in a timely manner and produce and distribute a set of defined products that are usable and useful for seismological monitoring and system evaluation. Additional work is needed, however, to further develop methods to provide characterization parameters and for providing user-friendly reporting products.

Full redundancy of key equipment at the IDC is essential for reliable operations and to avoid loss of data. Key elements of the ISMS must be improved in terms of robustness and, often, redundancy in order to provide the 99% or higher reliability specified in CD/1254.

The IDC experience has shown that successful development and evolution can be combined with efficient routine operation. During the first year of GSETT-3, invaluable experience has been gained at the IDC on organization, staffing, costs, development and training.

NDC experience

NDCs play a critical role in the operation and maintenance of reliable stations and communication links, and form an effective interface between the IDC and participating States through which data and products can be accessed and evaluated. NDCs can also serve a useful role in providing backup storage capability to the IDC, if equipped with sufficient redundancy.

During GSETT-3, the NDCs have comprised a wide range of size, equipment and technical capabilities. GSETT-3 has contributed significantly to improving the operation and competence at the participating NDCs, and has benefited from a number of national evaluation efforts.

Participating NDCs have made available to the IDC supplementary information on seismic events based on analyzing data from national networks, which are maintained to individual national standards. These supplementary data have proven useful in evaluating the performance of the GSETT-3 network and should be useful in improving the capability of the network by calibration.

Station network and communications

Seismic arrays at low-noise sites will be the most valuable type of installation in the primary network of the seismic component of the envisaged IMS. The GSETT-3 has shown the value of upgrading stations from three components to arrays. Digital data from stations with high operational capability and reliability are essential.

GSETT-3 has proven to be a valuable impetus to countries participating in the experiment for the installation of high-quality seismic equipment and communications equipment.

The GSETT-3 experience has shown that a seismic monitoring system comprising a mixture of different types of seismic instrumentation and communication links can function well. However, this requires that basic minimum standards are satisfied with regard to functionality, formats and instrument calibration. There is a need for further developments of technical facilities at many seismograph stations and NDCs. Likewise, some existing data communication links are inadequate and must be improved. There is also a need for further development and testing of authentication procedures and data and system security.

International participation

To reach the envisaged GSETT-3 participation has been more difficult and taken much more time than expected. Bilateral cooperation and financial/technical support has been essential in enlisting new participants. Practical training of international staff at the IDC and national staff at the NDCs has proved important during GSETT-3. This training should be continued and expanded to encompass other technologies as the transition to IMS begins.

The international participation at the IDC has been crucial to the success of GSETT-3, with respect to both development efforts and regular operation. GSETT-3 has demonstrated that an international technical staff can work efficiently together at the IDC.

GSETT-3 structure/organization

During GSETT-3, the Group of Scientific Experts (GSE) has acted as an international supervising body, meeting regularly in Geneva. A considerable amount of work has taken place between sessions, coordinated by three working groups for Planning, Operation, and Evaluation, each headed by a Convenor.

The IDC has had a main "executive" function, with responsibility for development and operations in accordance with GSE guidelines. The NDCs have appointed technical "points of contact", who have acted as the main responsible people to interface with the IDC in the daily operation.

Regular working group Convenors' meetings have been held, with participation also by the GSE Chairman and Scientific Secretary, as well as an IDC representative, in order to coordinate their work. The GSETT-3 has also benefited from a number of informal technical workshops arranged by participating countries.

In summary, GSETT-3 has successfully achieved a balance between international coordination and practical day-to-day execution/development. This experience could be useful in the transition to IMS.

Evaluation

Evaluation has been an essential component of and prerequisite for the success of GSETT-3. Experience from previous tests has shown that evaluation procedures must be carefully planned before system development begins. Both on-going and day-to-day evaluation and periodic comprehensive evaluation are important in this connection, and have in fact been carried out during GSETT-3. GSETT-3 has shown the advantages of having the evaluation performed by experts not directly involved in the operation, but still with close knowledge and understanding of the system and its purpose.

The global station coverage during the first year of GSETT-3 has been uneven, and many of the conclusions drawn are based on observational data from selected regions only. These are regions with station coverage corresponding to the original GSETT-3 plan, and the observational results are supplemented by theoretical modelling and are continuously evaluated.

The GSETT-3 experience has confirmed the validity of theoretical 90% detection/location capabilities for well-covered areas. This gives confidence that the theoretical estimates are achievable for other areas as well. However, considerable work remains on calibrating the network in order to obtain the envisaged location accuracy of 1000 km^2 or better in all continental areas.

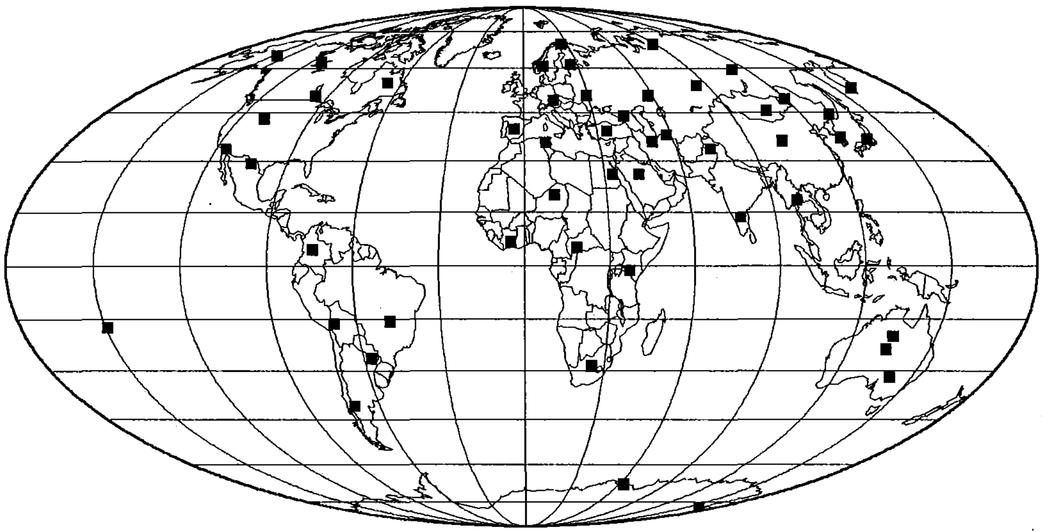
Concluding remarks

There has been a considerable and lengthy effort to establish the infrastructure needed for GSETT-3, including the stations, NDCs, the IDC and communications links. GSETT-3 has demonstrated the value of careful preparation and planning, including several limited small-scale tests. A step-by-step approach has led to a steadily improved performance at all levels as operational experience has been gained.

Continuous experimental operation over an extended period of time has been the key to developing and demonstrating the viability of the GSETT-3 concept for a seismic monitoring system. However, many important system components require further development and evaluation. It is therefore essential to maintain key elements of the GSETT-3 structure that could contribute to the future IMS established under a CTBT.

F. Ringdal

Proposed IMS Primary Stations



Current GSETT-3 Primary Stations

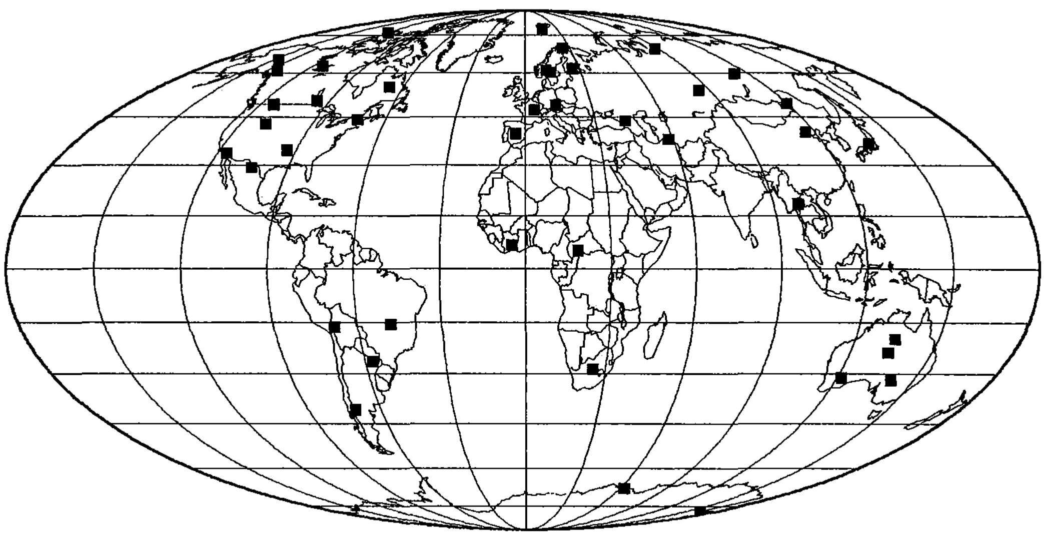


Fig. 7.4.1. Comparison between the primary seismic network proposed for IMS (top) and the GSETT-3 primary network as of January 1996. Note that the majority of IMS primary stations are already taking part in the GSETT-3 experiment.

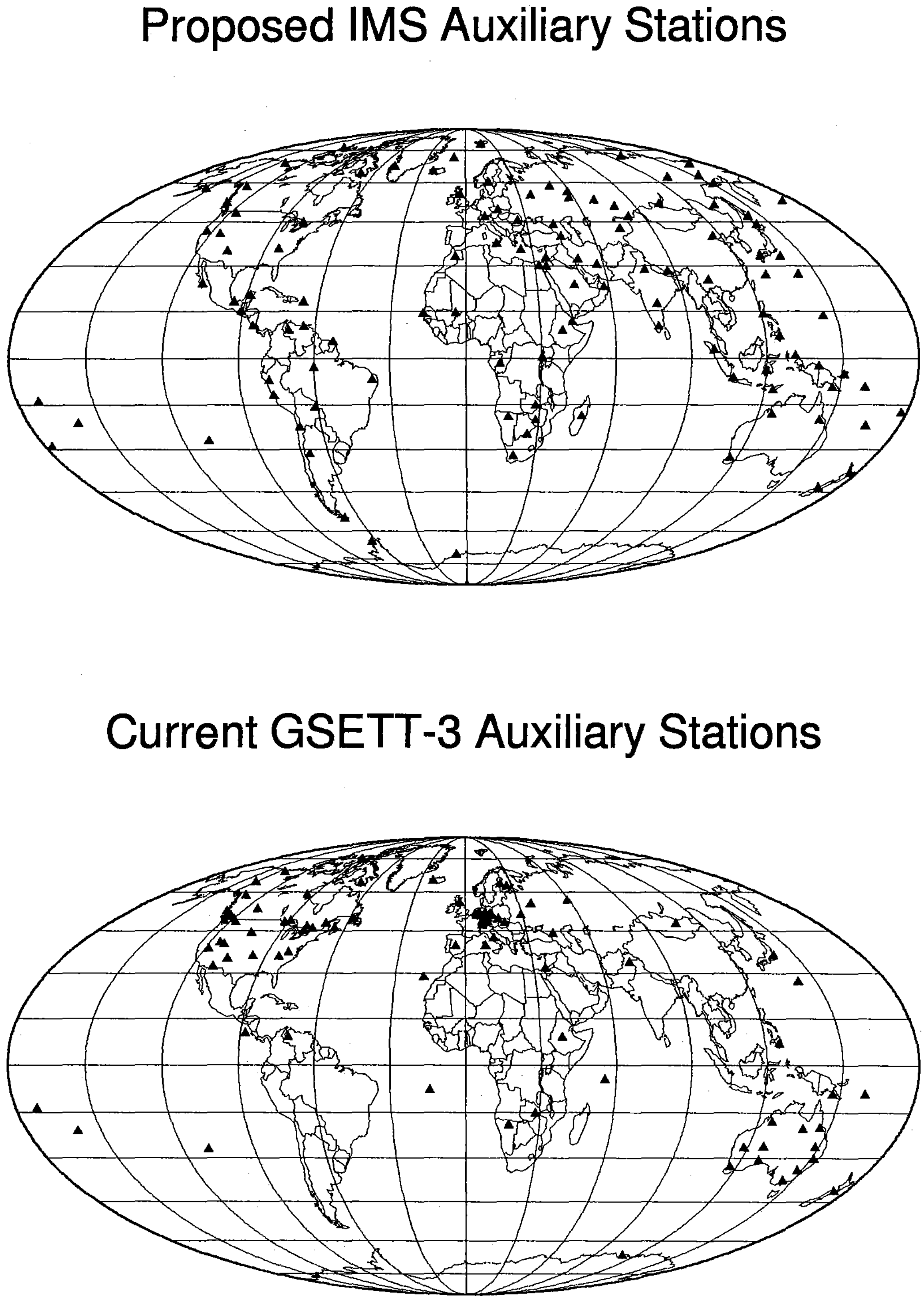


Fig. 7.4.2. Comparison between the auxiliary seismic network proposed for IMS (top) and the GSETT-3 auxiliary network as of January 1996. Note that the GSETT-3 auxiliary stations are much less homogeneously distributed than the IMS stations. Nevertheless, in selected regions the GSETT-3 network has provided an excellent data base for evaluation purposes.

7.5 NORSAR's contributions to increased participation in GSETT-3

This short contribution summarizes NORSAR's efforts over the past two years towards assisting National Data Centers (NDCs) in various countries in providing data from their stations to the GSETT-3 International Data Center (IDC) in Arlington, Virginia, USA. The services rendered are related to creating appropriate data acquisition and communications interfaces to existing seismic stations, and to establishing communications from station sites to the IDC via the Norwegian NDC located at the NORSAR premises at Kjeller, Norway.

Japan

NORSAR has cooperated with the Japan Meteorological Agency and the Japan Weather Association in the development of a data acquisition system for the Matsushiro array (MJAR), which is a primary station in GSETT-3. The system developed is a variant of the NORAC (NORSAR Array Controller) unit. It is specially designed to accommodate the data stream from the Matsushiro array and to forward the data to the Japanese National Data Center in Tokyo via a land line. This NORAC unit was installed at the array site in Japan in September of 1994. Since then, this unit has operated successfully with very few interruptions, as evidenced by the very high percentages for the availability of Matsushiro array data in the IDC archives.

During the implementation work in Japan, NORSAR representatives assisted personnel at the Japanese NDC in Tokyo in installing the AlphaRead/-Send suite of programs. These are the routines that reformat GSETT-3 primary station data and provide for continuous transmission of such data to the IDC, using in this case a dedicated line between the Japanese NDC and the IDC.

Spain

Personnel from the Norwegian NDC visited Madrid in January of 1995 and cooperated with personnel at the Spanish NDC in the implementation of the AlphaRead/-Send software and subsequent start-up of the transmission of Sonseca (ESDC) GSETT-3 primary station data to the IDC via the Norwegian NDC.

The data from the Sonseca array are transmitted from the Spanish NDC in Madrid via a satellite link (EUTELSAT) to the Norwegian NDC , and then forwarded to the IDC via the dedicated 256 Kbits/s fiber optic link between the Norwegian NDC and the IDC.

Sweden

A NORAC unit was installed by NORSAR at the GSETT-3 primary station Hagfors (HFS) in Sweden in the spring of 1994. Initially, the data from the Hagfors array were transmitted to Kjeller, Norway, via a land line, but in the fall of 1994, this line was replaced by a satellite link (Norwegian Telecom's VSAT satellite system). Data from the Hagfors array are recorded at the Norwegian NDC, where the AlphaRead/-Send software provides for the forwarding of the Hagfors array data to the IDC.

Finland and Germany

Data from the primary stations FINESS in Finland and GERESS in Germany have been transmitted to the IDC via the Norwegian NDC throughout GSETT-3. Currently, the GERESS data are transmitted from the GERESS array site to Norway utilizing a German VSAT system, whereas FINESS data are sent from the Finnish NDC in Helsinki to Norway using Norwegian Telecom's VSAT system. AlphaRead/-Send software running at the Norwegian NDC provides for the forwarding of data from these two arrays to the IDC.

Pakistan

A VSAT satellite link was established by Norwegian Telecom and NORSAR personnel in October 1995 between the Pakistan NDC in Nilore close to Islamabad and the Norwegian NDC. This link provides communications for the Nilore (NIL) GSETT-3 auxiliary station. AutoDRM software has been installed at the Pakistan NDC in Nilore, and the IDC can thus automatically access the Nilore station by routing the request through the Norwegian NDC.

Further plans

There are plans for a GSETT-3 primary station in Thala, Tunisia, as a cooperative effort between Tunisia, Italy, Sweden and Norway. If these plans come to fruition, a NORAC unit will be installed at the Thala site, and a Norwegian Telecom VSAT system will provide for the communications between Thala and the Norwegian NDC.

NORSAR is also considering assisting the Ukraine in transmitting data from the planned GSETT-3 primary station UKRSAR in the Ukraine to the IDC. This can again be accomplished through installation of a NORAC unit, and a Norwegian Telecom VSAT link between the Ukraine and the Norwegian NDC. Work is in progress to find the financial resources required for this.

Finally, NORSAR is looking into the use of Norwegian Telecom's VSAT system for transmission of data from the planned GSETT-3 primary station at Kilimanbogo in Kenya to the Norwegian NDC. This is technically feasible, but a sponsor for such an undertaking still needs to be found.

S. Mykkeltveit

7.6 The seismic event on Novaya Zemlya 13 June 1995

Introduction

On 13 June 1995, the GSETT-3 IDC reported a small seismic event (m_b=3.4) near Novaya Zemlya, Russia. The estimated epicenter in the REB was 75.32°N, 54.85°E, placing the event approximately 100 km west of the islands, but the location error ellipse was rather large and an onshore location could not be excluded.

This event is of interest because of its proximity to the Russian nuclear test site, and also because the Novaya Zemlya region is a low-seismicity area as far as natural earthquakes are concerned. Thus, Marshall et al (1989) in their analysis of the 1 August 1986 Novaya Zemlya earthquake, noted that all previous teleseismically detected signals from this region appear to have been resulting from nuclear tests or post-test tectonic activity such as cavity collapses and aftershocks.

This paper presents a detailed analysis of the 13 June 1995 event, with comparisons to previously recorded events at Novaya Zemlya, including past nuclear explosions as well as the well-known New Year's eve event of 31 December 1992, which has previously been extensively analyzed (Ryall, 1993). In our analysis, we have benefited from access to additional data from stations on Russian territory provided through a cooperative agreement with the Kola Regional Seismological Centre, and we have thus been in a position to determine the epicenter and signal characteristics more accurately than was possible at the time the REB was generated.

Data

The 13 June 1995 event was recorded by several stations in Fennoscandia and NW Russia, as shown on Fig. 7.6.1. The most distant stations detecting the event were the arrays NORSAR/NORESS, Hagfors and FINESS, at a distance range of 17-20 degrees, but these stations all had relatively low SNR and no well-defined P-wave onset.

By far the best recordings were obtained at the four regional arrays in the distance range 7-10 degrees (Spitsbergen, ARCESS, Amderma and Apatity). Figs. 7.6.2-7.6.4 show filtered records (4-16 Hz) of one three-component sensor from the arrays Spitsbergen, ARCESS and Amderma, and it is seen that both the Pn and Sn phases are very strong in all three cases. In contrast, we have not been able to observe any Lg phase for this event at Spitsbergen or ARCESS, probably due to the Lg blockage associated with thick sedimentary layers below the Barents Sea as noted in numerous earlier studies. At Amderma, a low frequency Lg phase could be observed (see Fig. 7.6.5), but we have not made use of it in this study.

It should be noted that the ARCESS array experienced a clock problem at the time of this event, so that the absolute time associated with the ARCESS recordings is incorrect. For this reason, ARCESS data could not be retrieved by the IDC for the 13 June 1995 event. We were, however, able to extract the ARCESS data from the disk loop at NORSAR, and we can therefore use these data for waveform comparisons and also for epicentral distance estimation using the relative (Pn-Sn) arrival time difference.

Location of the 13 June 1995 event

For reasons previously explained, the IDC had only a small number of stations available to compute its epicenter solution (SPITS, FINESS, NORESS and HFS), and the large error ellipse of the REB location shown in Fig. 7.6.6 must be seen in this perspective. Using our additional data sources, we have been able to constrain the solution much better, and located the event with high confidence near the coast of the northern Novaya Zemlya islands (also shown in Fig. 7.6.6). In particular, the Amderma data have been essential in constraining the solution. While we did not use ARCESS data in our relocation (because of the timing problem), we note that the relative Pn-Sn times at ARCESS are quite consistent with the solution, and thus provide added confidence. Table 7.6.1 lists the arrival data used in the location calculation.

Fig. 7.6.6 shows, in addition to the 13 June 1995 event, also NORSAR's solution for the 31 December 1992 event, as well as the approximate geographical extent of the Novaya Zemlya nuclear testing grounds. As is well known, the 31 December 1992 event was quite close to the test site, and our error ellipse does not exclude a possible on-site location. We note that analysis of this event by other authors has given a smaller error ellipse in some cases (with no overlap with the test site). However, as appropriately noted by both Ryall (1993) and Israelson (1993), there are many unknown factors in the regional calibration for this area, and arrival times are difficult to compare between large and small events, due to the emergent onset of regional phases. It should also be noted that a key station like Spitsbergen has no recordings for known nuclear explosions that could be used for calibration purposes.

From Fig. 7.6.6, it is clear that the 13 June 1995 event is located well outside the nuclear testing grounds, at a distance of at least 100 km. However, it is close enough to the test site to make a waveform comparison with other Novaya Zemlya events interesting. In particular it would be of interest to see whether or not it might be possible to "screen out" such an event in an automatic screening procedure as envisaged in the CTBT negotiations. While we have not at this stage attempted to develop specific screening criteria, there are some obvious comparisons that could be applied to get an indication of how such a procedure might work. We will briefly address this issue in the following.

Waveform comparisons

We have compared the waveforms of the 13 June 1995 event to those of other seismic events at Novaya Zemlya, using the ARCESS array. The reason for focusing on ARCESS is that this is the only station for which we have high SNR recordings of both the 13 June 1995 event and of previous known nuclear explosions. Fig. 7.6.7 shows, as a representative example, ARCESS data from the C4 sensor filtered in a 4-8 Hz band for four events: 13 June 1995, 31 December 1992, 24 October 1990 and 4 December 1988 (the latter two being confirmed nuclear explosions).

From Fig. 7.6.7 we note first of all the large differences in SNR as indicated by the amplitude scaling in front of each trace. This is of course due to the differences in event size — the two confirmed nuclear explosions being 2-3 magnitude units larger than the other events. The P-to-S ratios are of particular interest. The S phase is relatively much stronger for the two smaller events, although there is some difference also between the two nuclear explosions.

In Fig. 7.6.8, which shows the same sensor filtered in a high-frequency band (8-16 Hz), the difference in P/S ratio between the two nuclear and the two unknown events is even more pronounced. However, it is premature to draw any firm conclusions about the source type from these observations. First of all, the inherent variability in P/S ratio for the same source type is unknown, and the significance of the observed differences in these ratios is therefore not possible to assess. Moreover, source scaling may be a factor in explaining this difference.

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

Magnitudes

In view of the different P/S ratios shown earlier for the four events, their relative magnitudes, as estimated from ARCESS data, would show a different pattern if we use P-phases or S-phases (or S coda phases) for magnitude estimation purposes. We have chosen to use the P-phase in this study and Fig. 7.6.9 shows the P-beam in the 2-4 Hz filter band at ARCESS for the 4 events discussed above. The resulting magnitude (m_b) values are listed in Table 7.6.2, and our result for the 13 June 1995 event (m_b=3.54) is quite consistent with the IDC estimate.

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

To illustrate this point, we again use the same four P-traces at ARCESS. In Fig. 7.6.10, the P-wave data have been filtered in the 8-16 Hz band, which is one of the best bands for P-detection at ARCESS for Novaya Zemlya events. We have used a single sensor (D4) in order to avoid beamforming loss at these high frequencies. The relative scaling between the largest and smallest of the 4 events has been reduced from 2.92 magnitude units (2-4 Hz band) to 2.37 (8-16 Hz band). Thus the relative shift is about 0.5 m_b units, as is also reflected in the relative m_b values listed in Table 7.6.2. This confirms that calculation of magnitudes at regional distances is a difficult problem, where the frequency range of the recording signal must be given special consideration, and probably compensated for by some empirical formula.

Finally, we have looked at the surface waves for the events analyzed in this paper. Once more, the ARCESS array is the most useful reference system. Figs. 7.6.11 and 7.6.12 show narrow-band filtered broadband recordings (0.04-0.06 Hz or 17-25 seconds) for the ARCESS center sensor for the two events 24 October 1990 and 13 June 1995. The surface waves for the first event are clearly seen, and the M_s is estimated to 3.5 using Marshall and Basham's (1972) formula. The surface waves of the 13 June 1995 event are marginal, but appear to just exceed the background noise. The corresponding M_s for this event would be 2.4, using the same formula.

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

Conclusions

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

F. Ringdal

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Marshall, P.D. & P.W. Basham (1972): Discrimination between earthquakes and underground explosions employing an improve M_s scale. *Geophys. J.R. astr. Soc.*, 28, 431-458.

Marshall, P.D., R.C. Stewart & R.C. Lilwall (1989): The seismic disturbance on 1986 August 1 near Novaya Zemlya: a source of concern? *Geophys. J.*, 98, 565-573.

Israelsson, H. (1993): Estimates of the epicenter uncertainty for a small Novaya Zemlya event Dec 31 1992, Sci. Rep. No. 1, Center for Seismic Studies.

Ryall, A. (1993): The Novaya Zemlya event of 31 December 1992 and seismic identification issues. ARPA Rep., 15th Seismic Research Symposium, 8-10 Sep 1993, Vail, Colorado.

Table 7.6.1: NORSAR's epicentral solution for the 13 June 1995 event at Novaya Zemlya. The depth has been constrained to zero.

Novaya Zemlya, Russia

Date	Time	Latitude Smajor	Longitude Sminor	Az	Depth	Magl
1995/06/13	19:22:40.8	75.17 23.0	56.74 11.1	53	0.0 f	mb 3.4

Sta	Dist (deg)	Phase	Date	Time	TRes	Azim	Def
AMD	5.6	Pn	1995/06/13	19:24:02.4	0.3		T
AMD	5.6	Sn	1995/06/13	19:25:04.0	-1.3		T
SPITS	9.5	Pn	1995/06/13	19:24:54.9	-0.2	98.3	T
SPITS	9.5	Sn	1995/06/13	19:26:38.7	0.0	85.4	T
APA	10.5	Pn	1995/06/13	19:25:10.0	1.2		T
APA	10.5	Sn	1995/06/13	19:27:03.1	0.3		T
FINES	17.0	P	1995/06/13	19:26:38.4	-1.6	30.9	T
NORES	21.3	P	1995/06/13	19:27:27.9	2.1	31.5	T
HFS	21.3	P	1995/06/13	19:27:24.0	-1.7	35.9	T

Table 7.6.2: Magnitudes (m_b and M_s) measured at ARCESS for the four events discussed in the text. The m_b values (2-4 Hz) have been normalized using m_b=5.6 of the 24 October 1990 event as a reference, and the relative effect of choosing two higher frequency bands is also shown.

	ARCESS m_b	Relative m_b		ARCESS M_s
	2-4 Hz	4-8 Hz	8-16 Hz	(20 s)
4 Dec 1988	5.67	+0.07	+0.04	-
24 Oct 1990 (reference)	5.60	0	0	3.5
31 Dec 1992	2.75	+0.39	+0.59	-
13 Jun 1995	3.54	+0.24	+0.28	2.4

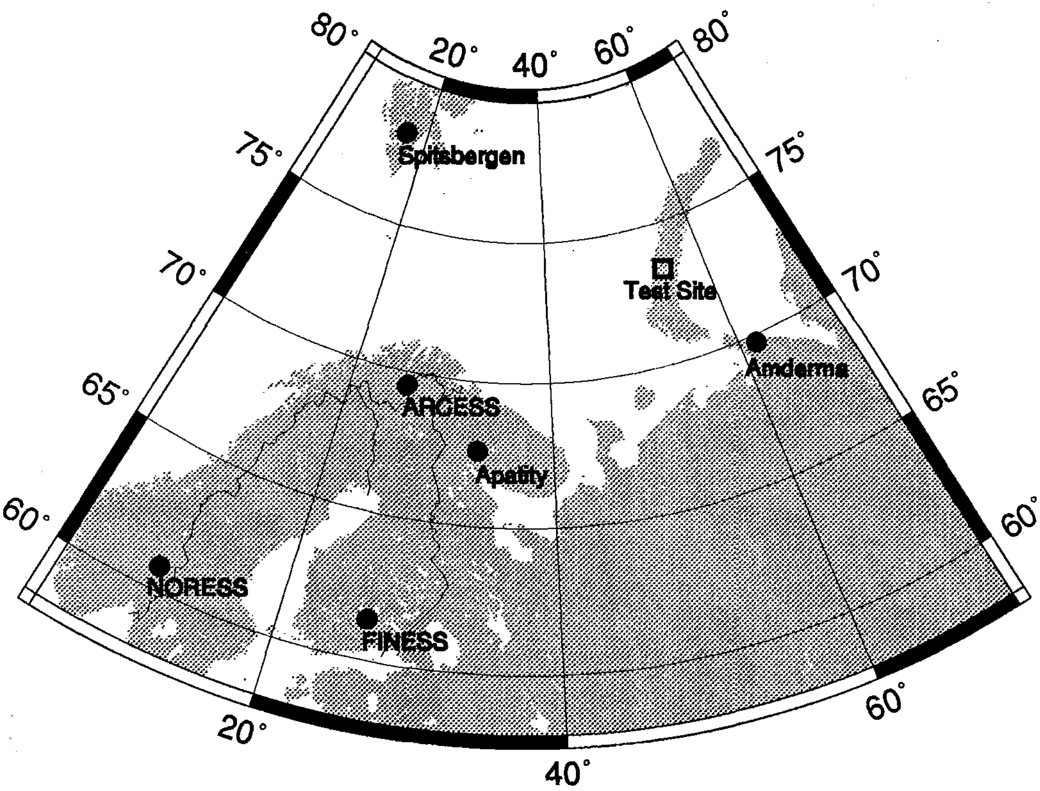

Fig. 7.6.1. Map showing the location of regional seismic arrays in Northern Europe. The location of the Novaya Zemlya nuclear test site is also shown.

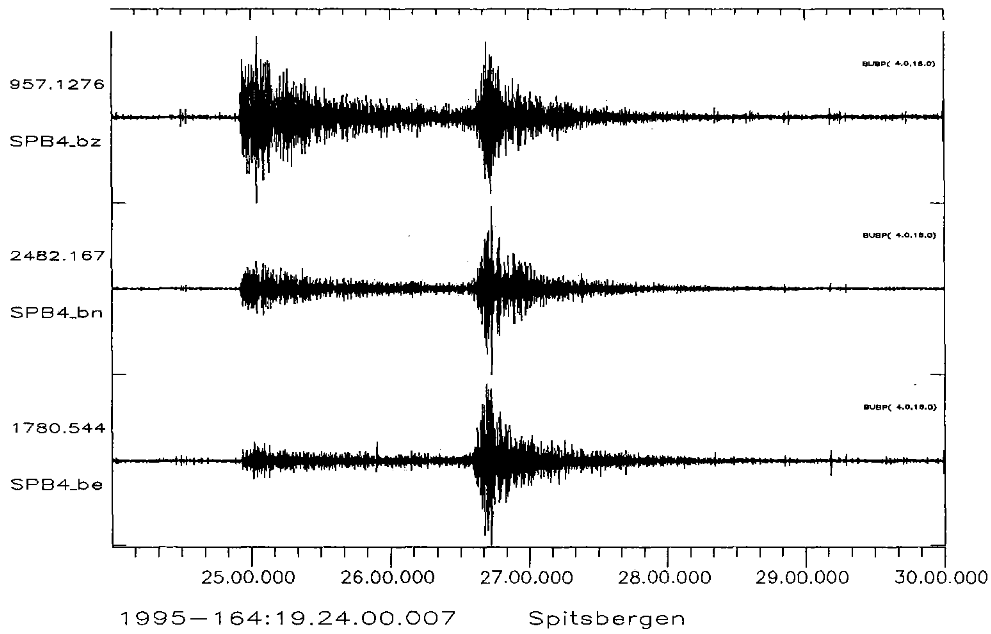

Fig. 7.6.2. Three-component recordings by the Spitsbergen array for the 13 June 1995 event at Novaya Zemlya. The data have been filtered in the 4-16 Hz band. Note the clear P and S phases.

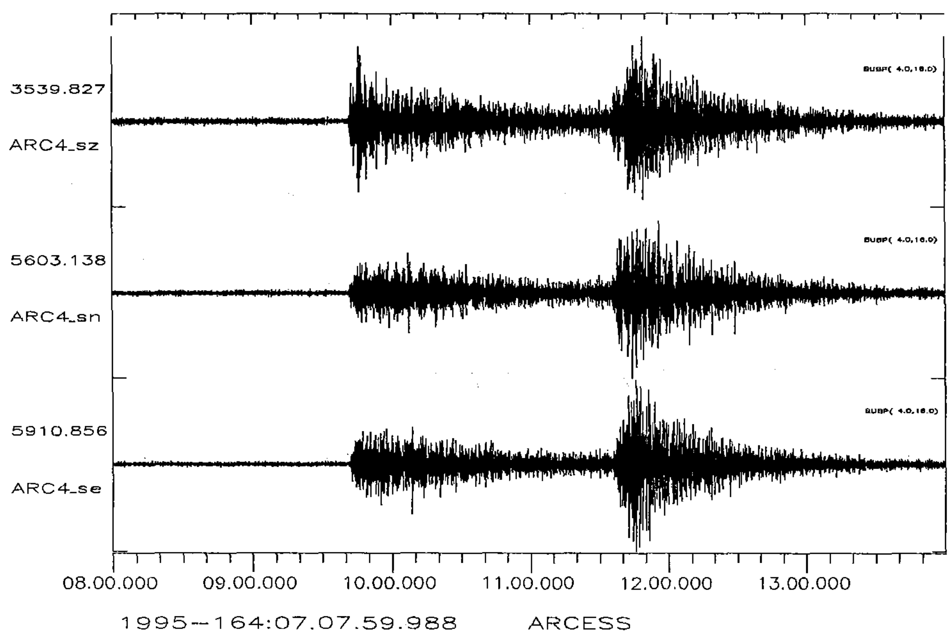

Fig. 7.6.3. Same as Fig. 7.6.2, but showing the three-component recordings at the ARCESS array. Note that the absolute time is incorrect (see text), but the waveform characteristics as well as the relative P-S time can be used in the analysis.

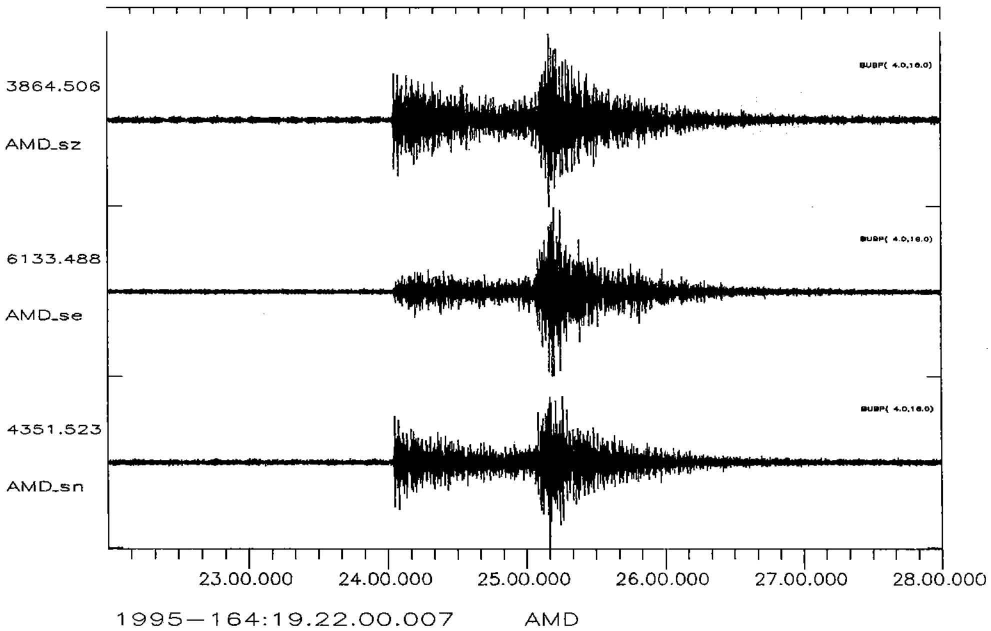

Fig. 7.6.4. Same as Fig. 7.6.2, but showing the three-component recordings at the Amderma array south of Novaya Zemlya.

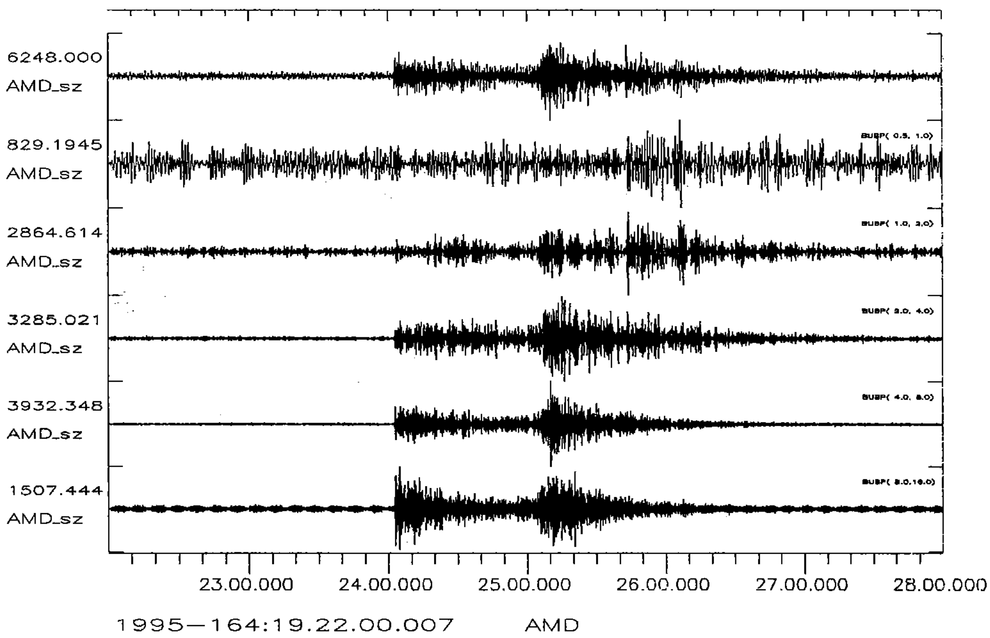

Fig. 7.6.5. Bandpass filtered recordings of the Amderma Center SPZ sensor, in the following bands (top to bottom): Unfiltered, 0.5-1 Hz, 1-2 Hz, 2-4 Hz, 4-8 Hz, 8-16 Hz. Note that the Lg phase is visible in the two lowest frequency filter bands.

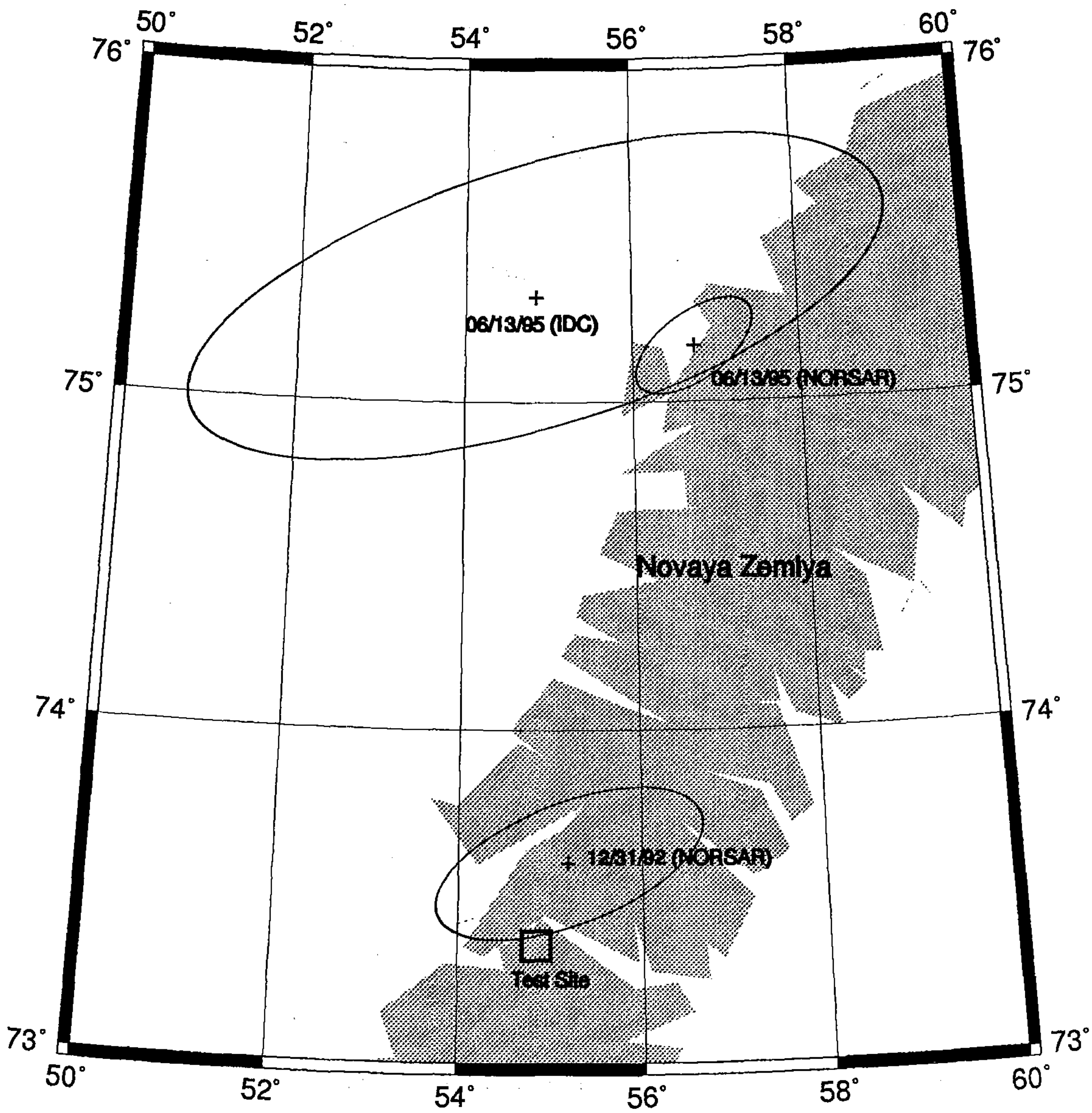

Fig. 7.6.6. Estimated locations and error ellipses by the IDC and NORSAR (this study) for the 13 June 1995 event. The event on 31 December 1992 is shown for comparison (NORSAR solution). The approximate extent of the Novaya Zemlya test site is indicated.

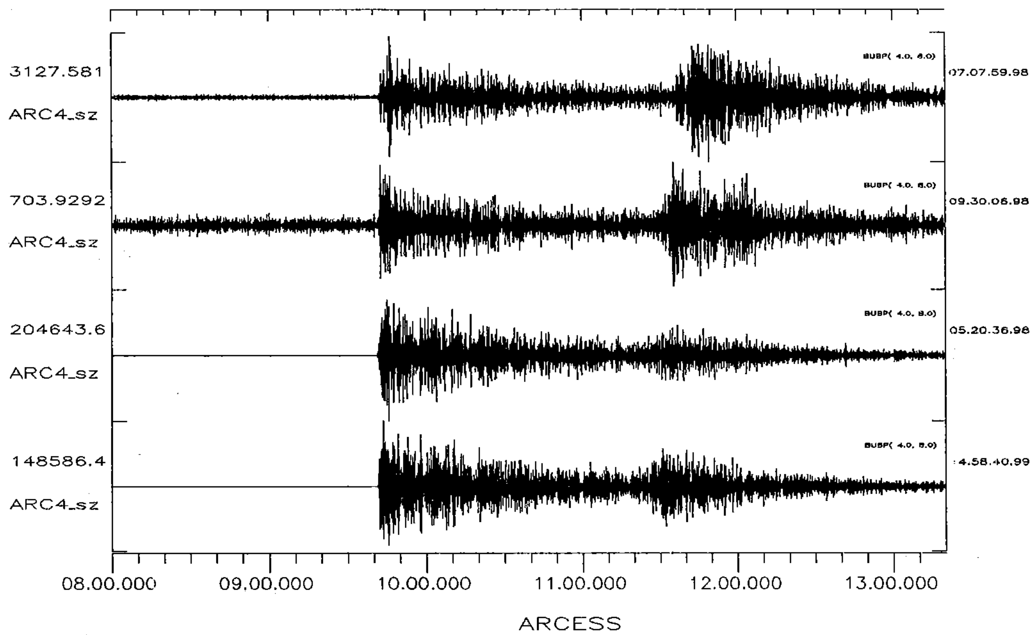

Fig. 7.6.7. Bandpass filtered records (4-8 Hz) of the ARCESS C4 sensor for 4 Novaya Zemlya events: From top: 13 June 1995, 31 December 1992, 4 December 1988 and 24 October 1990. Note the variation in P/S ratio.

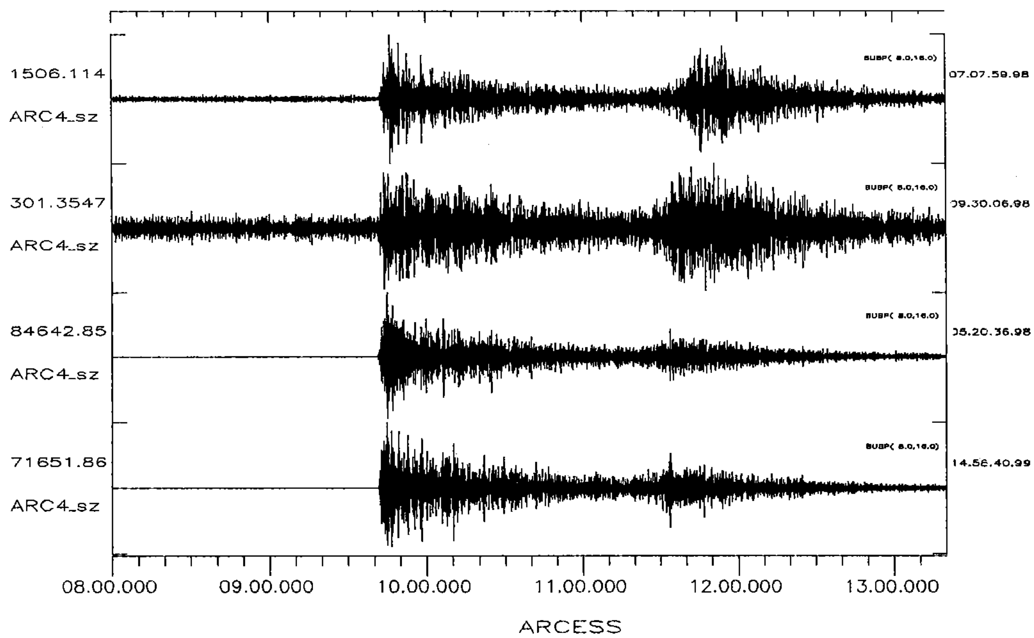

Fig. 7.6.8. Same as Fig. 7.6.7, but for the 8-16 Hz filter band.

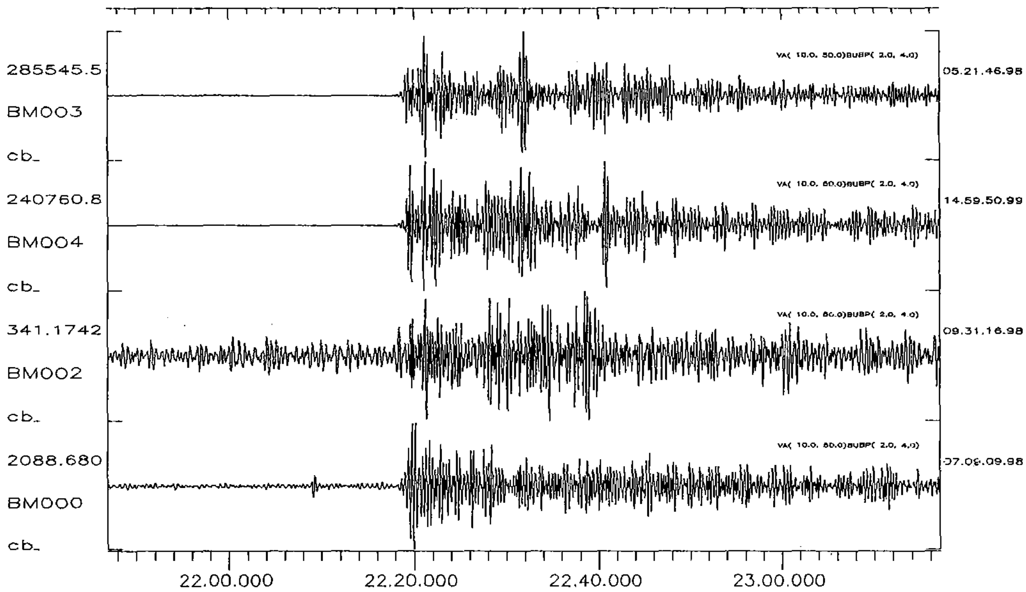

Fig. 7.6.9. P-waves (ARCESS array beam) for four Novaya Zemlya events. From top to bottom: 4 Dec 88, 24 Oct 90, 31 Dec 92 and 13 Jun 95. The data have been filtered in the 2-4 Hz band, and the maximum amplitudes are given to the left of each trace. Note that the complexity of the waveforms makes it difficult to compare onset times.

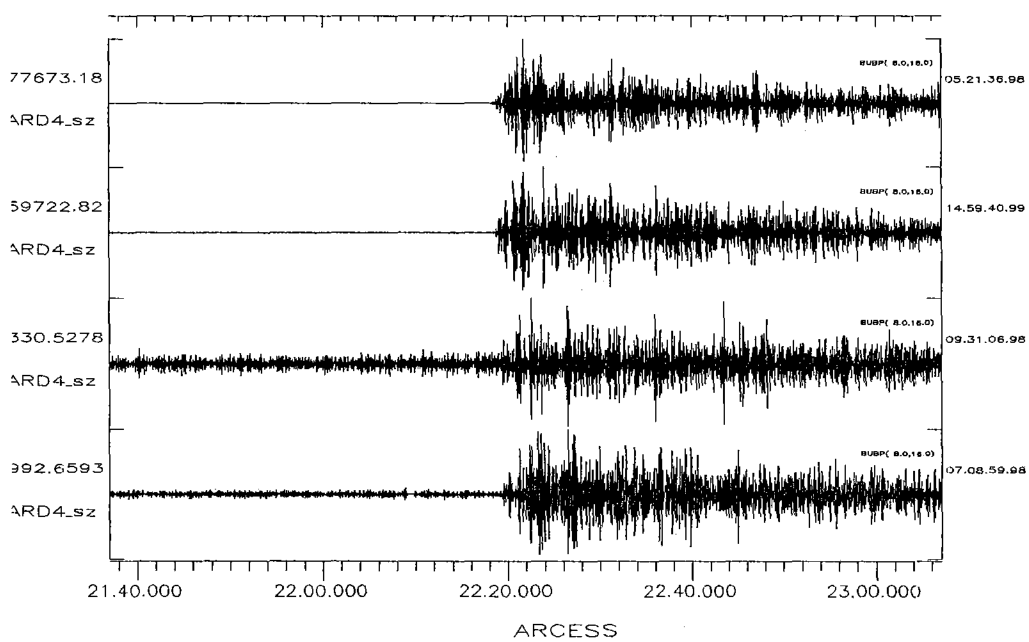

Fig. 7.6.10. Same as Fig. 7.6.9, but for a single sensor (D4) in a high frequency passband (8-16 Hz). Note that the amplitudes of the large and small events show less difference than in Fig. 7.6.9.

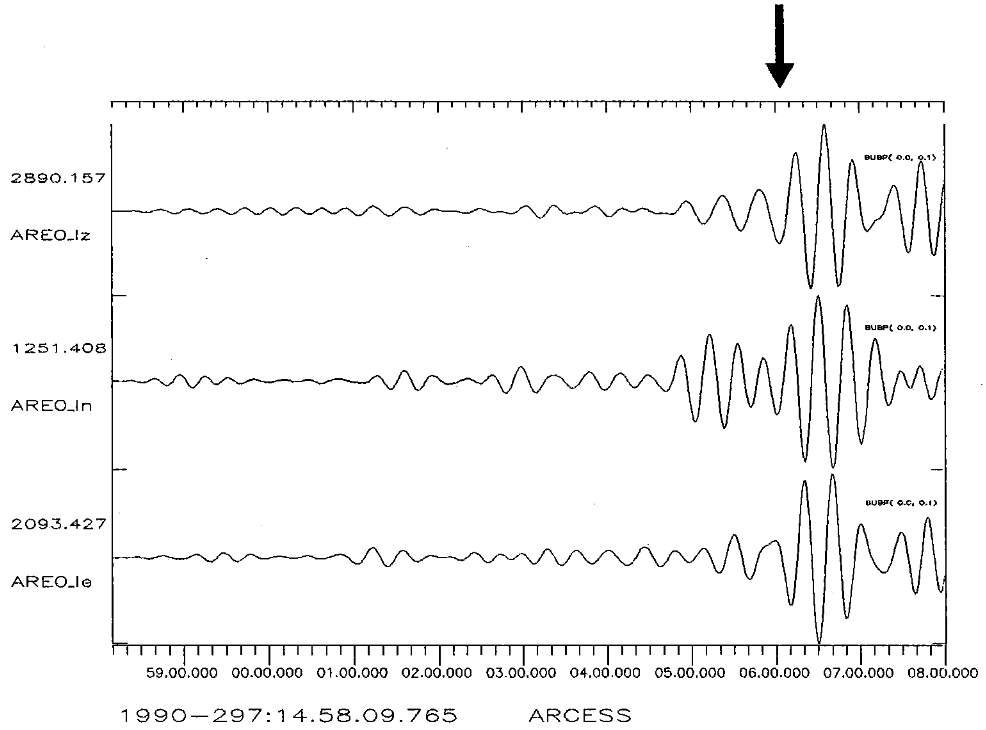

Fig. 7.6.11. Three-component long period ARCESS data for the 24 October 1990 nuclear explosion filtered in a 17-25 sec band. The arrival of the 20-second energy is indicated with an arrow.

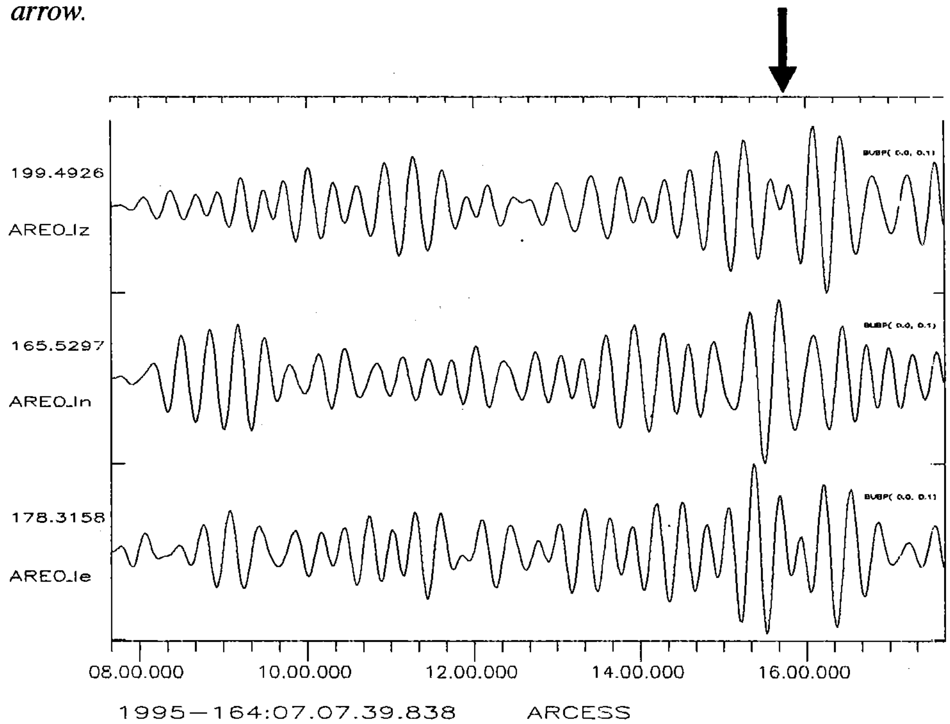

Fig. 7.6.12. Three-component long period ARCESS data for the 13 June 1995 event filtered in a 17-25 sec band. The arrow marks the expected arrival of 20-second energy. Note that the Rayleigh wave is marginal, but probably can be observed on these recordings.

7.7 Double-couple radiation and m_b residuals

Introduction

Since the double-couple force was established to model shear fractures, observed amplitudes have been used in different ways to determine fault plane solutions of earthquakes. In particular, amplitude ratios between P- and S-phases and the radiation pattern of surface waves are often applied for this purpose. P-phase amplitudes observed at different stations have also been used to estimate the parameters of the source mechanism. Particularly for long-period data observed amplitudes correlate well with the theoretically estimated radiation pattern. Consequently, amplitudes or amplitude ratios of long-period body waves are useful to estimate the double-couple radiation pattern.

On the other hand, the body-wave magnitude m_b, the most commonly used estimate of the size of an earthquake, is calculated from short-period P-type phases. The observed amplitudes show a large scatter which is the result of several effects like source complexity, lateral heterogeneities in the source region and along the ray path, different transfer functions of the crust below the stations, uncertainties in the station characteristics, non unified measuring procedures, and amplitude variations due to the double-couple radiation of the source.

The m_b-values and their corresponding station residuals are usually estimated under the assumption that the influence of the double-couple radiation is averaged out when amplitude observations are available from different azimuths. The contribution of the double-couple radiation to the observed magnitude residuals is the topic for investigation in this study.

Data

To study the influence of the double-couple radiation for m_b one needs a large set of events with known radiation pattern, and for the same suite of events one also needs a set of observed amplitudes. Such data are now available. Since January 1995 the GSETT-3 International Data Center (IDC) provides amplitudes and periods of all phases automatically analyzed with a common algorithm. Additionally, the seismological group of the Harvard University publishes for all larger events (m_b about 5.0 or larger) Centroid Moment Tensor (CMT) solutions with the best fitting double-couple mechanism for these events. By comparing these two data sources 728 common events in the first nine month of 1995 were found. For these events, all available m_b-observations were retrieved from the IDC data base. All observations from stations with poor data quality or uncertain instrument response were excluded, but altogether 9728 amplitude observations could be used.

To reduce the influence of several changes in the IDC software during the first year of the GSETT-3 experiment, the source parameters were taken from the CMT-solutions. It is especially important to obtain reliably estimated depth values. After reestimating the epicentral distance and correcting all amplitude measurements using the Veith-Clawson (1972) attenuation values, 9728 new station magnitudes, 728 new m_b-values, and 9728 new magnitude residuals were calculated. Fig. 7.7.1 shows the absolute value of all residuals as a function of the new m_b-values.

Influence of the double-couple radiation on m_b

The rule applied to automatically measure amplitudes at the IDC is to use the maximum amplitude within the first 5 seconds after the arrival time. Therefore all phases at each station theoretically arriving in the first 5 seconds after the first P-type onset were calculated using the IASPEI91 tables (Kennett and Engdahl, 1991). For these phases the relative amplitude radiation from the double-couple source was calculated (e.g. Aki and Richards, 1980) using azimuth and ray parameter of the onset. For surface-reflected phases (pP or sP), the relative radiation was multiplied by the corresponding surface reflection coefficient for plane waves (e.g. Müller, 1985). To model the effect of smaller ray-path perturbations these relative radiation factors were calculated for many radiation angles around the theoretical value (i.e. ± 5 deg azimuth, ± 5 deg dip angle for direct P-onsets, ± 15 deg dip for surface reflections, and ± 15 deg for the incidence angle at the surface) and then a mean relative radiation value was calculated for all onsets. Finally, the phase with the maximum radiation was taken to represent the relative double-couple radiation for each event-station combination. With this procedure the phase which theoretically contributes the most to the observed amplitude was used, but it was not possible to model the interference effects between the different onsets arriving within the first 5 seconds of the signal.

Fig. 7.7.2 shows all observed m_b-residuals as a function of the relative double-couple radiation and a straight line calculated with a least-squares fit. The observed residuals show, beside all scatter, a small but clearly visible dependency on the relative double-couple radiation.

Observed station magnitudes can now be corrected for this effect and new m_b-values can be calculated. Because the recalculated m_b-values were also a function of the double-couple radiation, several iterations were necessary to reduce the double-couple effect. Finally the following magnitude-correction formula for the double-couple radiation was found:

$$m_b\,(dc) = \log\,(A/T) + q + a1*dc + a2$$

with:

A - measured amplitude [nm]

T - dominant period [s]

q - Veith-Clawson attenuation value

dc - relative double-couple radiation

a1 = 0.39609 ± 0.12085

a2 = -0.19925 ± 0.09210

Fig. 7.7.3 shows the station residuals after applying the correction formula for the double-couple radiation. The corrected mean absolute station residuals and the standard deviation are about 2% smaller than without the correction (0.31675 ± 0.41726 instead of 0.32356 ± 0.42519). This can also be seen in Fig. 7.7.4, where all corrected absolute magnitude residuals are plotted versus the corrected m_b-values. These corrected m_b-values are up to

0.2 magnitude units different from the uncorrected ones. Fig. 7.7.5 shows the change in the m_b-values due to double-couple compensation plotted as a function of the uncorrected m_b-values. No specific magnitude-dependent trend can be seen in the data.

Testing the results with NEIC-data

The estimated relation between double-couple radiation and magnitude residuals was also tested on another independent data set. For 3639 events between 1 March 1990 and 31 December 1994, published Harvard CMT-solutions were used to correct the corresponding 212,696 reported amplitude observations in the EDRs of the NEIC. A similar technique as described for the IDC-data was applied. All distances were taken from the EDRs and, as far as available, an estimated instead of a fixed value was taken as depth of the events, either from the EDRs or from the CMT-solutions. As done by the NEIC, the uncorrected m_b-values were recalculated with the Gutenberg-Richter (1956) attenuation values. To see the effect of the radiation pattern, the new magnitudes and residuals were calculated for *all* reported amplitudes for which b-values from the Gutenberg-Richter tables were available. This is somehwat different from the NEIC procedure which uses a 25% trimmed mean.

In contrast to the IDC-data the EDRs contain a large number of relatively shallow events for which also sP contributes to the maximum amplitude in the first 5 seconds. Because of the high reflection coefficient of sP at the Earth's surface, the relative amplitude radiation of sP can become larger than 1. This range of relative radiation was not modeled with the IDC-data and therefore the formula developed could not fit the NEIC data equally well. But with the following quadratic relation, for which the linear part is similar to the values in the formula for the EIDC-data, the double-couple radiation could be described as:

$$m_b\,(dc) = \log\,(A/T) + b + a1*dc*dc + a2*dc + a3$$

where

A - measured amplitude [nm]

T - dominant period [s]

b - Gutenberg-Richter attenuation value

dc - relative double-couple radiation

$a1 = -0.12447 \pm 0.05584$

$a2 = 0.43326 \pm 0.07288$

$a3 = -0.17193 \pm 0.04672$

Fig. 7.7.6 shows the uncorrected residuals. Although the spread of the data is now much larger than for the GSETT-3 data set, the dependency of the residuals on the double-couple radiation is still visible (note the unequal distribution of the large symbols around the zero line). The size of the symbols corresponds with the number of hits per radiation-residual combination. Fig. 7.7.7 shows the magnitude residuals after correcting the amplitudes with the NEIC correction formula. The larger symbols (more data) between 0 and 1 are now distributed more symmetrically around the zero line. The rare data with a relative double-couple radiation above 3.0 are considered as outlayers and are not modelled. The reduction of the mean absolute residuals and the standard deviation is for this data set about 1.5%, a little bit less than in the case of the IDC-data, but still significant (0.31228 ± 0.41845 instead of 0.31704 ± 0.42344). Another estimation of this relation was done using the Veith-Clawson attenuation curve instead of the Gutenberg-Richter values. The results were very similar and the values for a1, a2, and a3 were within the above estimated standard deviations.

Again the m_b-values estimated with double-couple corrections differ up to about 0.2 magnitude units from the uncorrected values (Fig. 7.7.8), and again no specific magnitude-dependent trend is seen. To test if these corrected m_b-values are better than the uncorrected, both data sets were compared with the corresponding seismic moments M_0 published with the CMT-solutions. Fig. 7.7.9 shows for all 3639 *uncorrected* NEIC events the m_b-values versus M_0. Assuming a linear relation between M_0 and m_b a least squares fit gives:

$$m_b = a1 * M_0 + a2$$

with

a1 = 0.41507 ± 0.07445 a2 = -4.77852 ± 0.36850

and a mean absolute m_b residual of 0.17554 ± 0.22614. The discrepancy for large M_0-values is the result of the known saturation of the m_b-scale for larger events. Fig. 7.7.10 shows for the same events the relation between M_0 and the *corrected* m_b-values. The parameters of the least squares fit are now:

a1 = 0.42159 ± 0.07381 a2 = -4.95596 ± 0.36533

and a mean absolute m_b residual of 0.17268 ± 0.22227. The double-couple corrected m_b-values correlate better with the independently estimated M_0-values as the parameters of the M_0/m_b-relation show smaller standard deviations and the mean m_b residual is 1.7% smaller.

Conclusion

It has been demonstrated that a dependency exists between the double-couple radiation of earthquakes and the observed station magnitudes and consequently the corresponding m_b-values. If fault-plane solutions are available, it is easy to correct for this effect. Normally such solutions are only known for larger events, but whenever individual station m_b-values are needed with a very high accuracy (e.g., to investigate magnitude relations), or when station-magnitude residuals should be estimated, the correction of amplitude observations for the double-couple radiation will reduce the scatter and should be taken into account. Also the NEIC and the ISC could calculate corrected m_b-values for all events with known double-couple radiation and publish them in their bulletins.

On the other hand, this study has shown that the effects of double-couple source radiation on short-period amplitude patterns is much smaller than the variations associated with other factors such as lateral heterogeneities in the earth. This means that when calculating *average* event magnitudes from a well-distributed global network, quite accurate values can be obtained even when the source mechanism is unknown.

Acknowledgement

We thank the Seismological Group of the Harvard University for making all the thousands of CMT-solutions available via the Internet.

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T. Kværna

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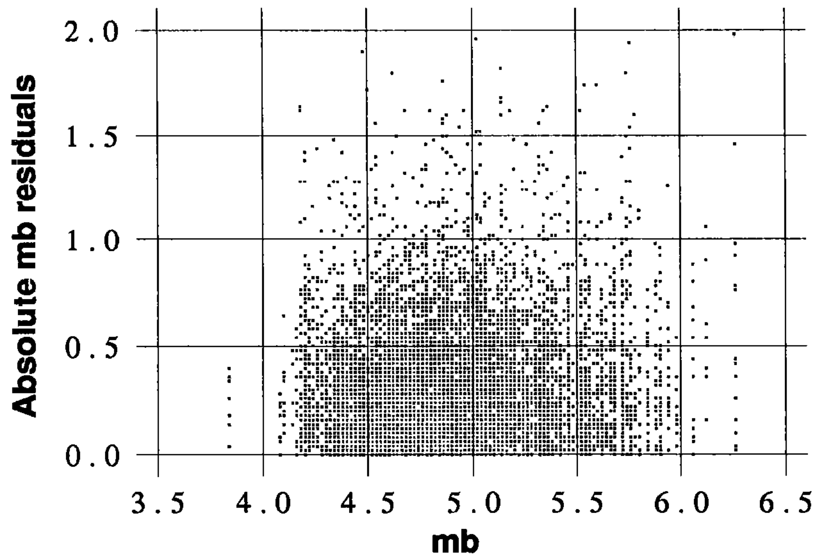

Fig. 7.7.1. Absolute values of station magnitude residuals plotted as a function of event magnitude. The database used in this figure consists of 728 events recorded at the GSETT-3 stations with altogether 9728 phase observations.

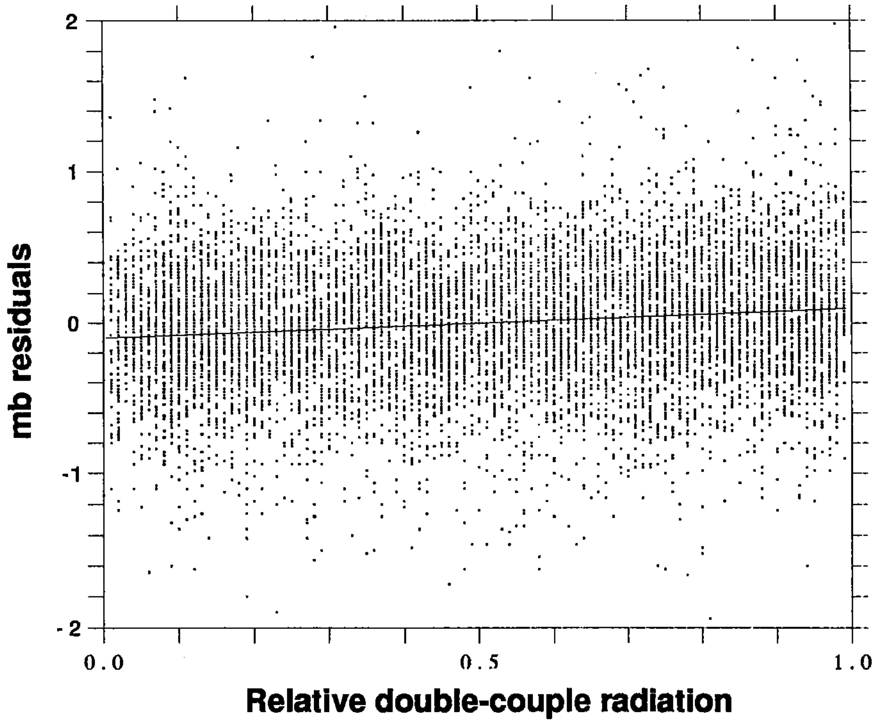

Fig. 7.7.2. Station magnitude residuals plotted a a function of relative double-couple radiation, for the database described in the text. The coefficients of the straight line were calculated by least squares.

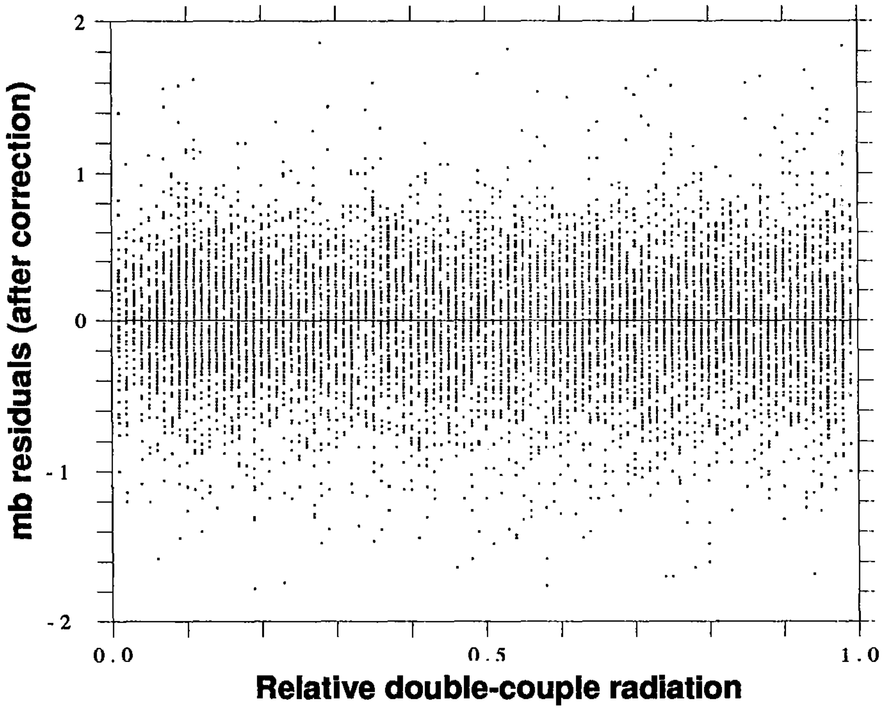

Fig. 7.7.3. Same as in Fig. 7.7.2, but after applying the correction formula for double-couple radiation.

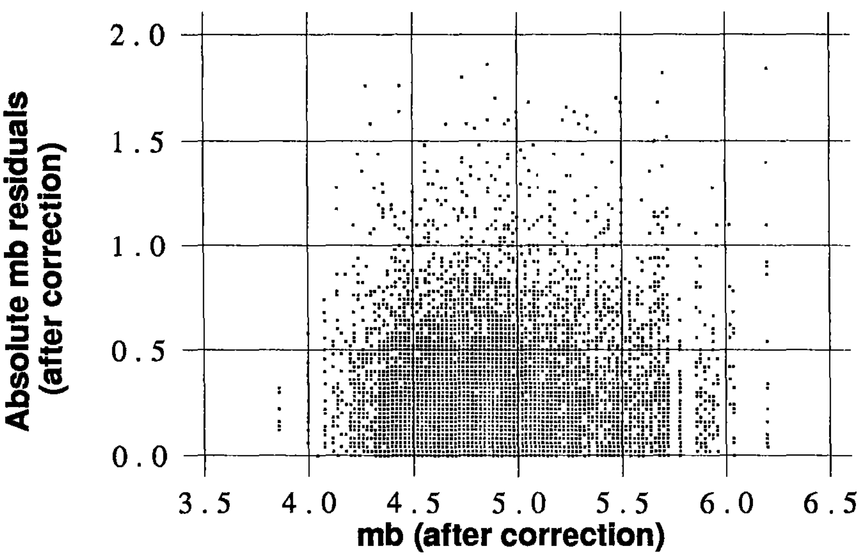

Fig. 7.7.4. Absolute values of station magnitude residuals plotted as a function of event magnitude, both calculated after applying the correction formula for double-couple radiation.

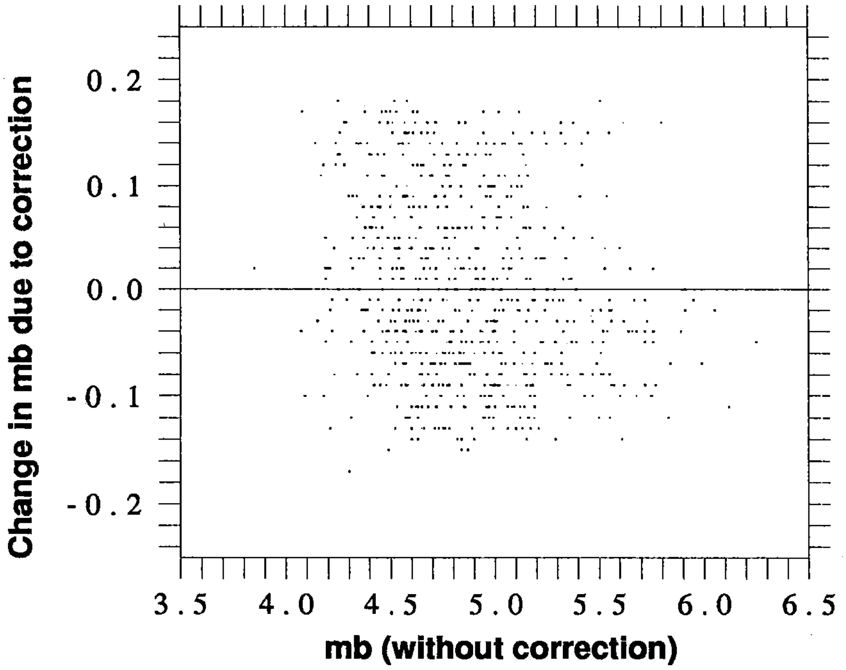

Fig. 7.7.5. Change in event magnitude introduced by applying the correction formula for double-couple radiation, plotted against the uncorrected event magnitude.

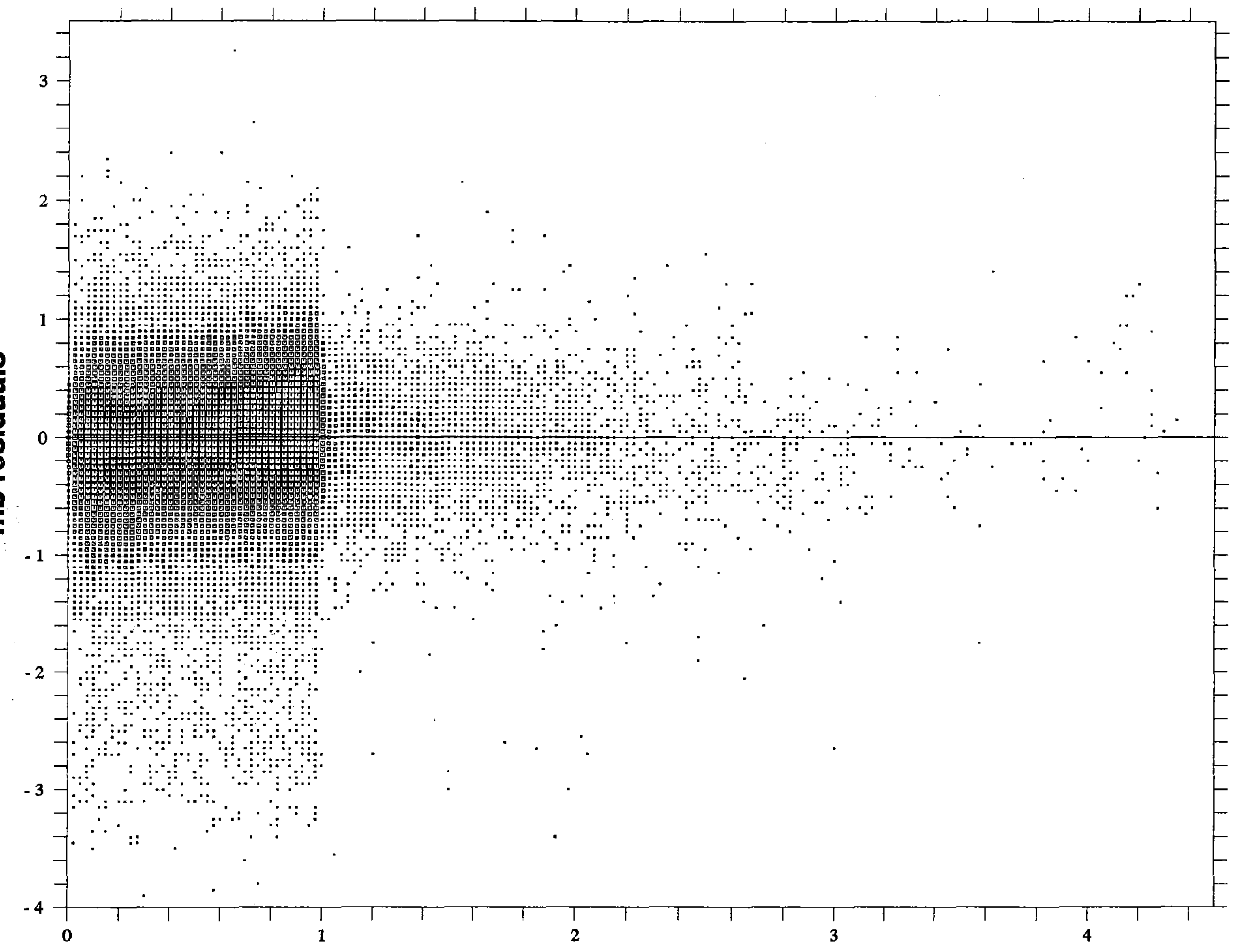

Fig. 7.7.6. Station magnitude residuals plotted as a function of relative double-couple radiation. The database used in this figure consists of 3639 events reported by NEIC with altogether 212696 amplitude observations. The size of the symbols represents the number of hits per radiation-residual combination.

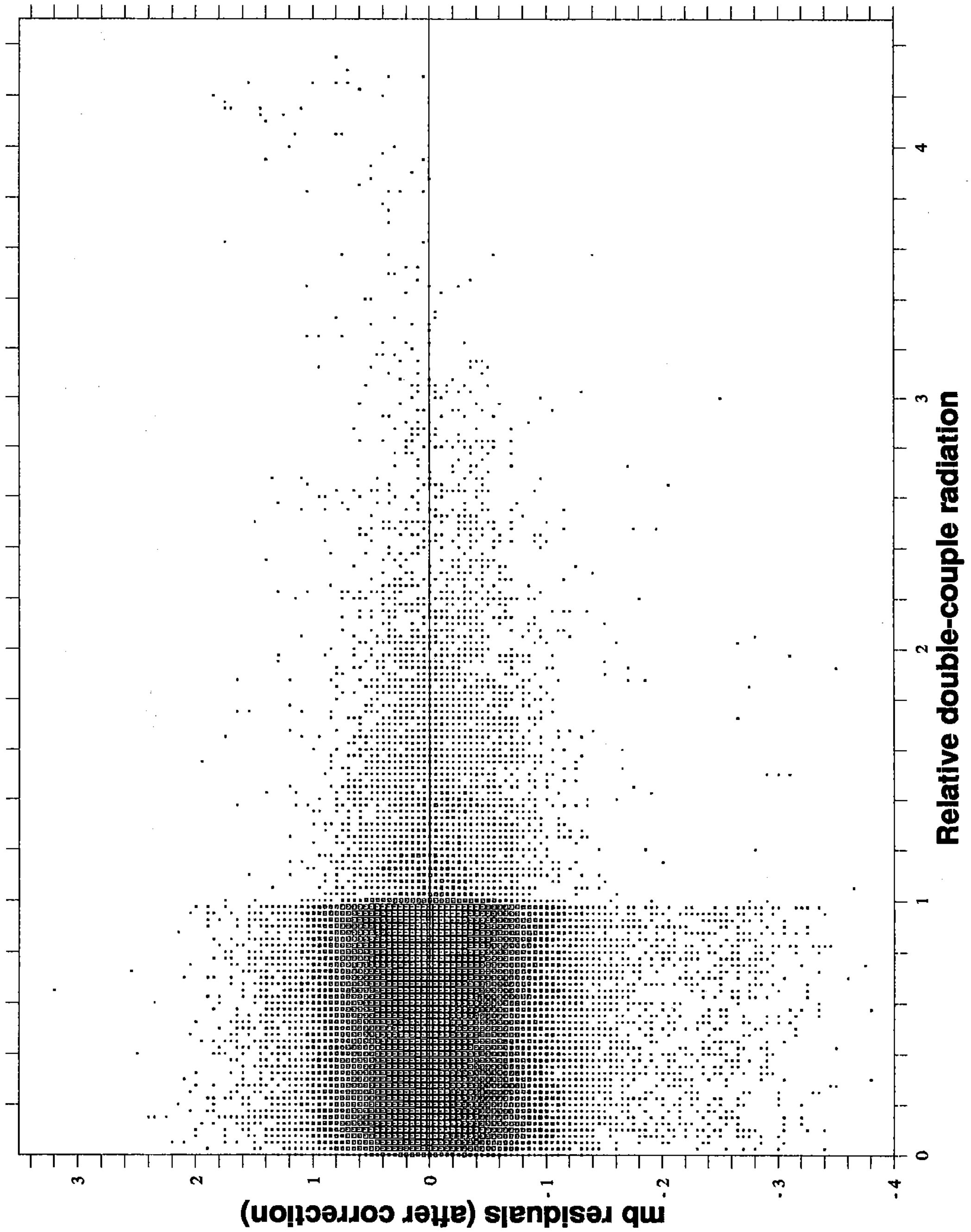

Fig. 7.7.7. Same as in Fig. 7.7.6, but after applying the correction formula for double-couple radiation.

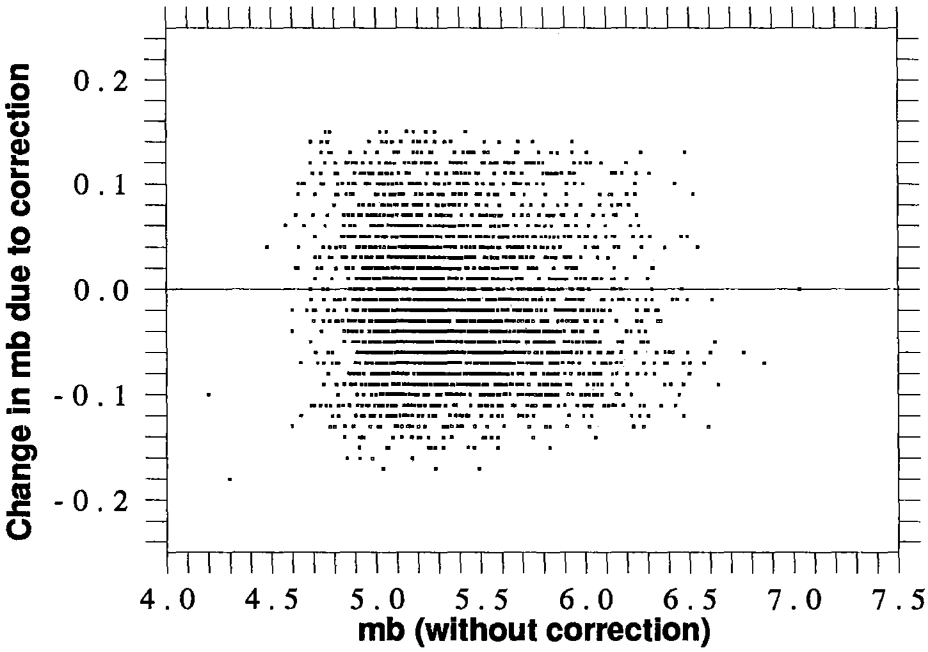

Fig. 7.7.8. Change in event magnitude introduced by applying the correction formula for double-couple radiation, plotted against the uncorrected event magnitude.

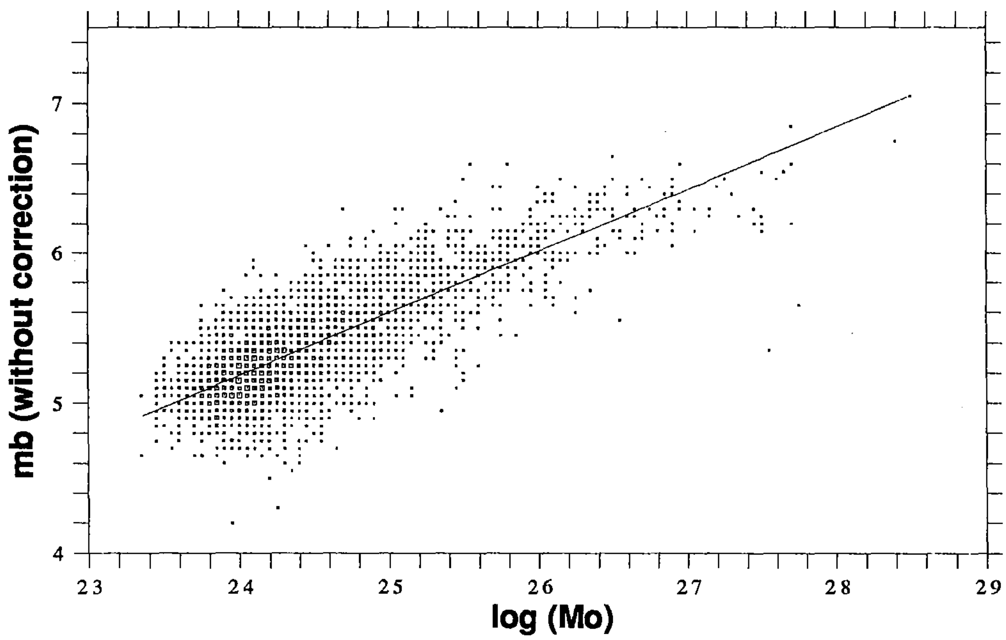

Fig. 7.7.9. Uncorrected event magnitude plotted against the seismic moment of the 3639 NEIC events. The coefficients of the straight line were calculated by least squares.

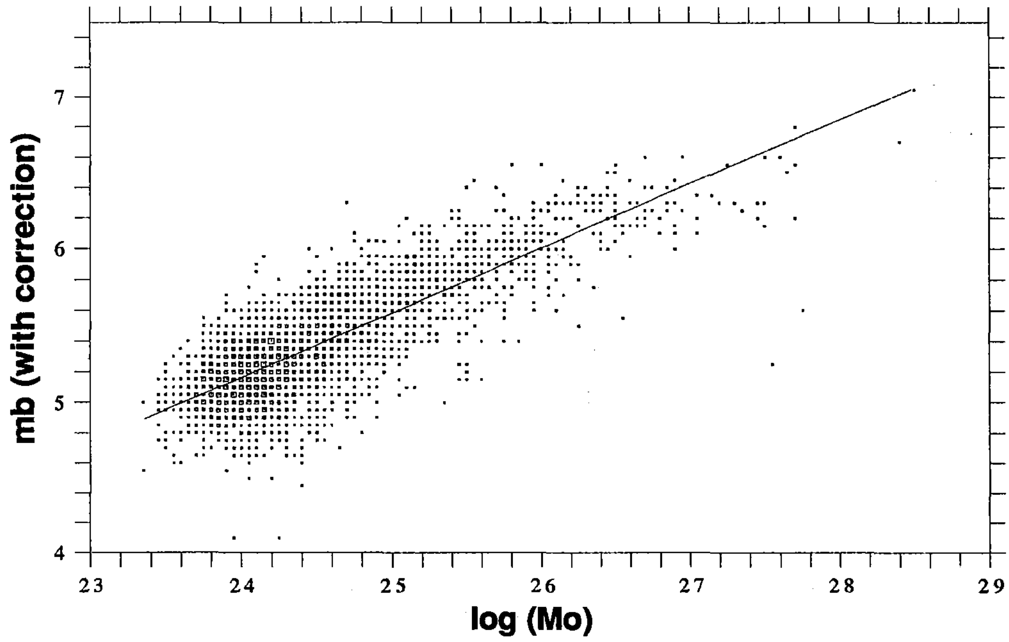

Fig. 7.7.10. Event magnitudes calculated after applying the correction formula for double-couple radiation plotted against the seismic moment of the 3639 NEIC events. The coefficients of the straight line were calculated by least squares.

7.8 Time shifts of phase onsets caused by SNR variations

Introduction

In section 7.3 of this report (Kværna, 1996) we described an experiment where quality metrics associated with the AR-AIC onset time estimation method were evaluated by successively reducing the SNR by adding scaled noise samples. The evaluation was done by comparing the AR-AIC onsets estimated on SNR reduced simulated records with the manual time picks of the original high SNR signals (SNR > 100). We were able to derive onset quality metrics that could be used both for selecting the best AR-AIC model as well as for flagging onsets that had a high probability of being incorrect.

Another interesting finding was that we could clearly observe the SNR dependent delay of the automatic AR-AIC phase onsets, see Fig. 7.8.1. In this figure we have divided the onsets into 5 SNR categories. For each category we have computed the median and the inter-quartile range of the time difference between the AR-AIC_{F+S} onsets and the corresponding reference phase picks. The original 83 phases included in Fig. 7.8.1 are mainly teleseismic P-phases from different events recorded at the GSETT-3 stations, and should thus include a wide variety of signal signatures. From the good correspondence between manual phase picks and automatic AR-AIC onsets found by Kværna (1995), we could also infer that the SNR dependent delay of the phase onsets would also apply to manual phase picks done by an analyst.

We will in the following present in more detail the results for a couple of specific events.

Impulsive signals; Lop Nor nuclear explosion

Teleseismic P-phases from nuclear explosions are usually among the most impulsive signals observable, and we would therefore expect a relatively small time delay when the SNR is reduced. Fig. 7.8.2 shows P-phases recorded at a few of the GSETT-3 stations from the 17 August 1995 Chinese nuclear test at Lop Nor.

In Fig. 7.8.3 we have plotted the corresponding simulated SNR dependent delays for the phase onsets. Notice that for the SNR category 2.8-5 the onset estimation was quite unstable, such that these results should be interpreted with caution. It is, however, interesting to observe that even for the SNR range 20-50, a consistent time delay of 0.2 seconds is found, and for the SNR range 5-10 the delay is increased to 0.5 seconds.

Emergent signals; Yunnan earthquake

This large earthquake located in the Yunnan province of China had an m_b of 6.3 and an M_s of 6.5 (PDE). As seen from the P waveforms of Fig. 7.8.4, the signals are quite complex and emergent, and it is therefore reasonable to expect that the estimated onsets will become strongly delayed when the SNR is reduced. In the PDE bulletin it was noted that analysis of broadband data indicated that the earthquake consisted of 2 events, separated by 1.5 seconds. Although this means that the event is somewhat anomalous, its P-wave characteristics can nevertheless be used to illustrate the class of emergent signals, particularly attributed to larger earthquakes or to signals from certain distance ranges.

For the Yunnan earthquake we have in Fig. 7.8.5 again, for 5 SNR categories, plotted the median and the inter-quartile range of the time difference between the AR-AIC_{F+S} onsets and the corresponding reference phase picks. Compared to the results from the Lop Nor explosion, shown in Fig. 7.8.3, the time delays due to the SNR reduction are substantially larger, approaching 3 seconds at the lowest SNRs.

The effect of bandpass filtering

The AR-AIC onset estimation process includes 2nd order causal Butterworth bandpass filtering of the data in the widest possible so-called "usable" frequency band (Kværna, 1995). The group delay of a Butterworth filter is known to increase with decreasing bandwidth. The "usable" frequency band usually becomes narrower for lower SNR, so that the onset time delays due to filtering are expected to increase with decreasing SNR. In order to investigate the filtering effects on the AR-AIC onset estimates of Figs. 7.8.1, 7.8.3 and 7.8.5, we conducted the following experiment:

- For a set of 130 reference teleseismic P-phases with varying SNR, we ran the AR-AIC_{F+S} method without bandpass filtering. The onset estimates were checked by an analyst, so that erroneous onsets were removed.
- For each of the reference onsets, we ran the AR-AIC_{F+S} method on data filtered respectively in 2 Hz, 1 Hz and 0.5 Hz bandwidths centered on the dominant signal frequency.
- For each of the bandwidths, we plotted the time difference between the AR-AIC_{F+S} onsets on filtered data and AR-AIC_{F+S} onsets on unfiltered data. The results are shown in Figs. 7.8.6a, 7.8.6b and 7.8.6c.

It can be seen that for all bandwidths the effect of bandpass filtering is small, and a maximum time delay approaching 0.1 seconds is observed for the lowest SNR's. The difference in time delay between the 2 Hz bandwidth filter (Fig. 7.8.6a) and the 0.5 Hz bandwidth filter (Fig. 7.8.6c) is also observed to be small. These findings suggest that the results shown in Figs. 7.8.1, 7.8.3 and 7.8.5 are generally representative for the SNR-dependent delays and that only a small fraction of the delays are due to the bandpass filtering.

Implications

For impulsive signals illustrated in Figs. 7.8.2 and 7.8.3, the onset time delay caused by reduced SNR will have relatively little effect on the event locations when locating with an average global model. This is primarily due to the fact that the model uncertainty will be significantly larger than the corresponding uncertainty of the time picks. If we on the other hand are conducting master event or JHD location, the model uncertainty will be significantly reduced, and the picking uncertainty can be the limiting factor of the location precision. In such cases it might be appropriate to correct the timing of the phase onsets with the SNR dependent corrections shown in Fig. 7.8.3, but this needs to be tested in practice.

The implications of using emergent phase onsets in the event location process can be quite severe, especially when including phases with low SNR. As illustrated in Fig.

7.8.5, large time inconsistencies can occur between high and low SNR phases, resulting in erroneous event locations, and/or large travel-time residuals.

The SNR measure itself can also be quite misleading for emergent signals, as the reported SNR is often measured as the maximum SNR within, e.g., 3-5 seconds after the onset, and therefore not being representative for impulsiveness of the actual onset. The envelope onset quality measurements described in section 7.3 of this report, can on the other hand be used to characterize events with emergent phase onsets due to extended source time functions or rupture area. If the event recordings at the stations with the highest SNR are analyzed by the envelope quality measurements, we can in an automatic way describe the event as being of the emergent type, and thereby exercise due care when using low SNR phases in the event location process.

We have also shown that the phase shift of the signal caused by bandpass filtering has relatively small effects on the actual onset estimates. This observation is in contrast to the filter compensation included in the current processing at the IDC, where a 2nd order Butterworth bandpass filter with 2 Hz bandwidth is assumed to introduce a time delay of 0.25 sec for all SNR's. For a 3rd order filter the corresponding number is 0.38 seconds. Based on our results, this is a substanstial overcompensation, and it would actually give better results not to introduce a filter delay compensation at all. We therefore believe that the topic of correcting the phase onsets for the effect of filtering should be revisited carefully, and that there is a strong need to improve the algorithms at the IDC.

T. Kværna

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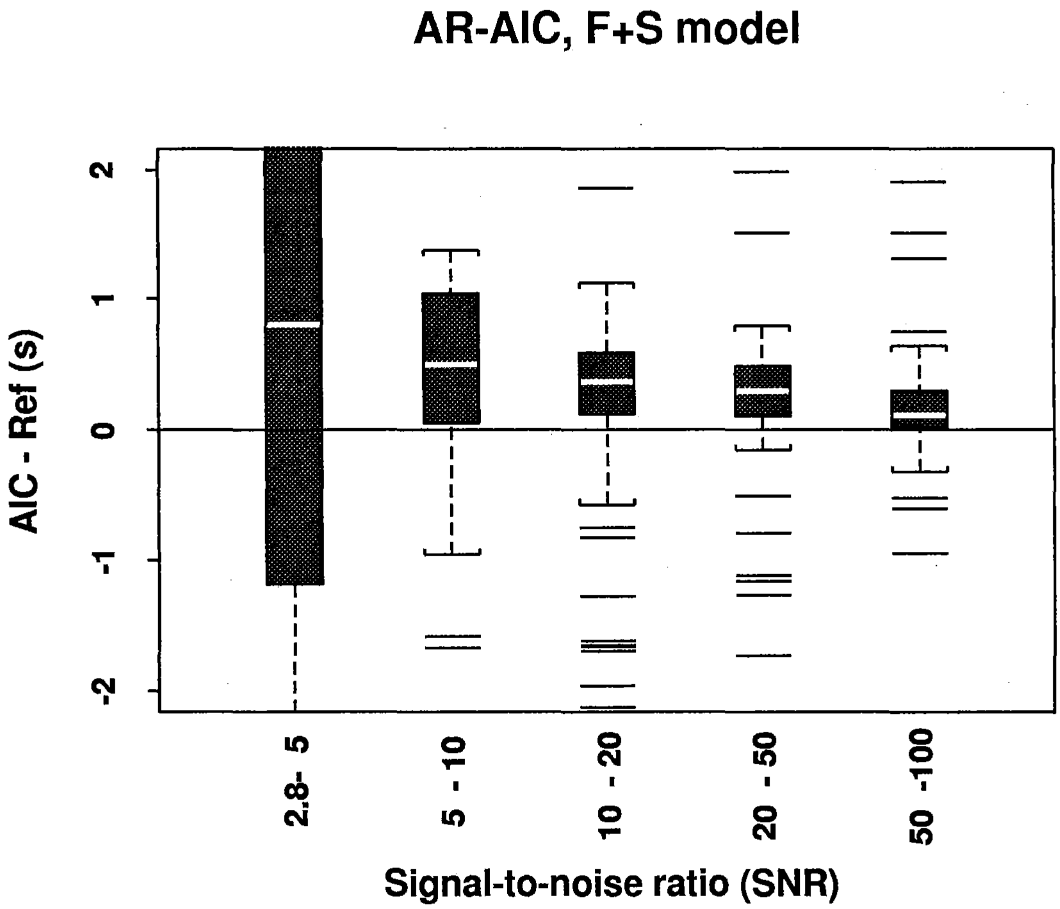


Fig.7.8.1. The database used in this figure consists of 83 P-phases with SNR greater than 100. The observations at the GSETT-3 stations are mainly done at teleseismic distances. For each of the phases, the SNR was successively reduced by adding scaled noise samples, and the AR-AIC method (F+S model) was used to estimate the onsets on the simulated SNR reduced phases. By comparing these AR-AIC onsets to the manual time picks on the original high SNR phases, we could investigate the dependency of the AR-AIC onset estimates on the SNR. In this figure we have divided the onsets into 5 SNR categories. For each category we have computed the median and the inter-quartile range of the time difference between the AR-AIC onsets and the corresponding reference phase picks. The horizontal line in each box is located at the median of the data, and the box itself spans the distance from the first to the third quartile. The whiskers extend to the extreme values of the data or to a distance of 1.5 times the interquartile distance from the center, whichever is the smaller. The lines outside the whiskers represent single observations.

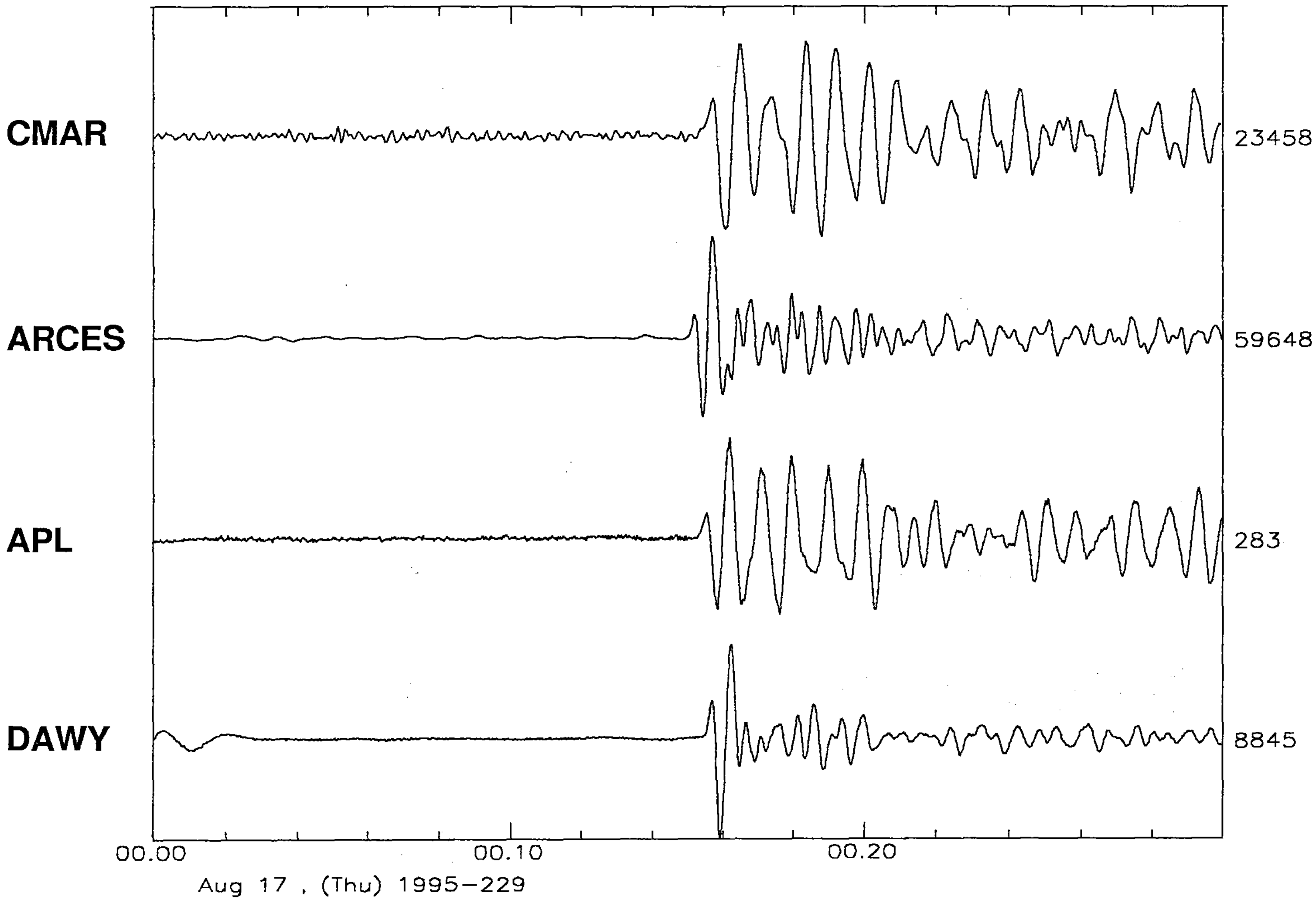


Fig. 7.8.2. P-phases recorded at four of the GSETT-3 stations from the 17 August 1995 Chinese nuclear test at Lop Nor.

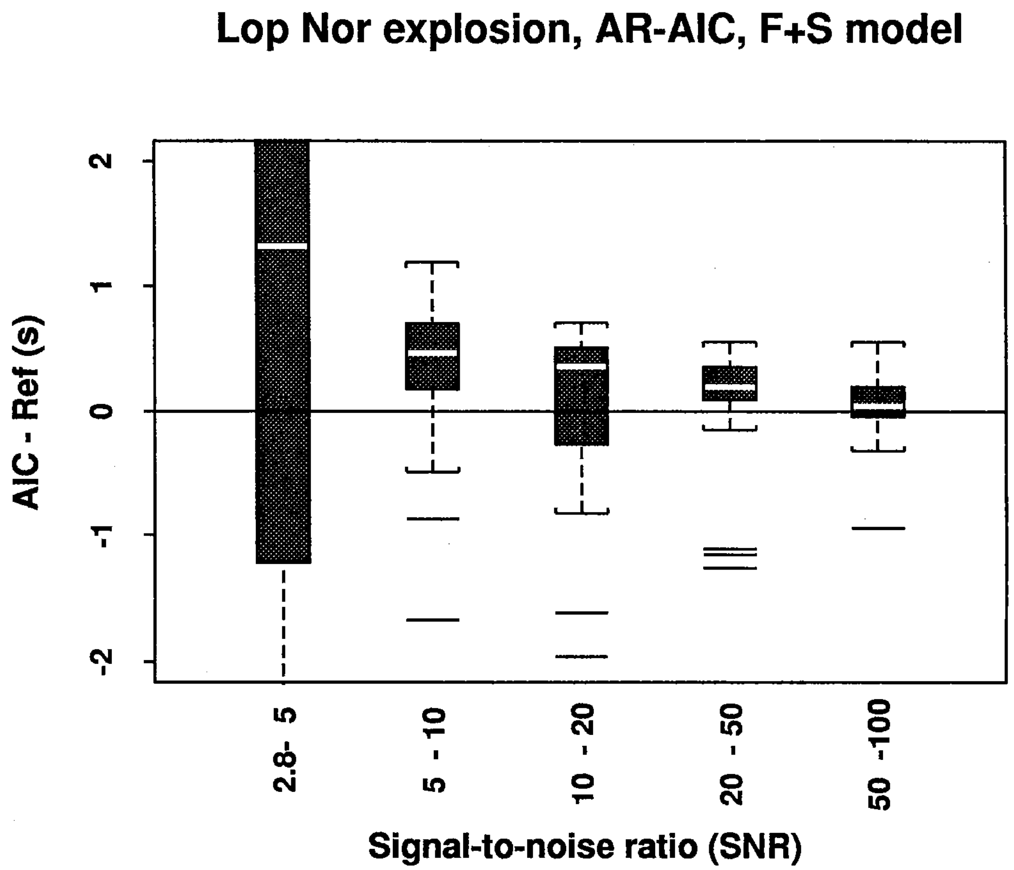


Fig. 7.8.3. Simulated SNR dependent time delays of phase onsets at the GSETT-3 stations from the 17 August 1995 Chinese nuclear test at Lop Nor. For plotting details see the caption of Fig. 7.8.1.

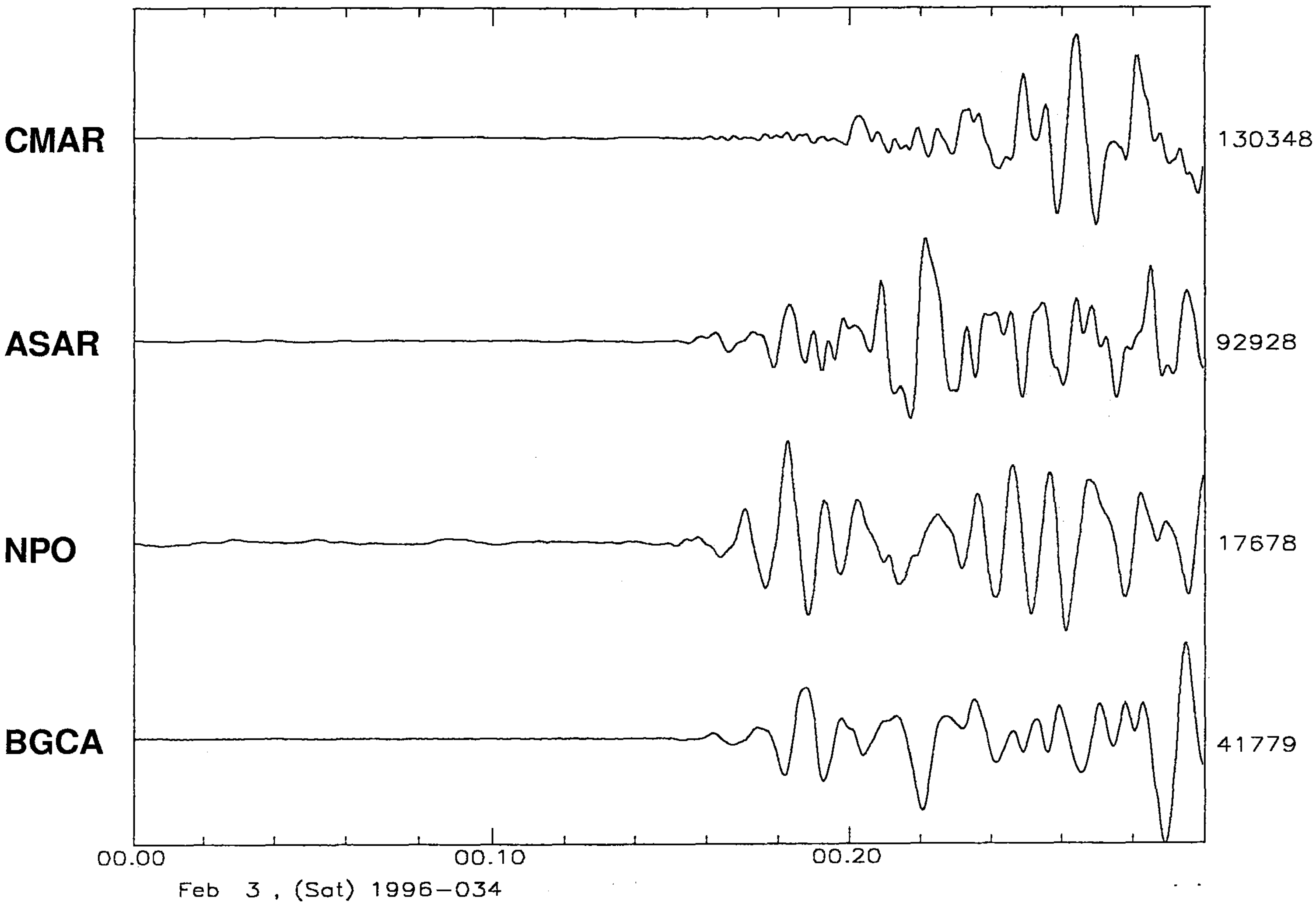


Fig. 7.8.4. P-phases recorded at four of the GSETT-3 stations from the 3 February 1996 Yunnan earthquake.

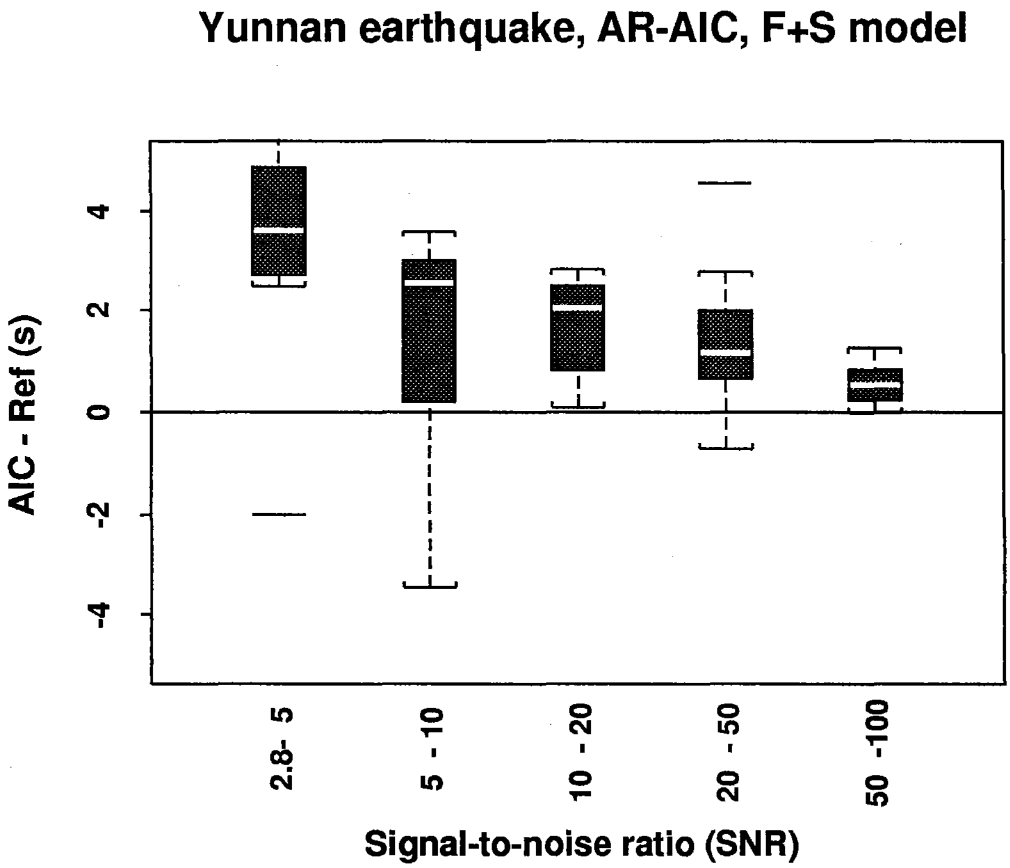
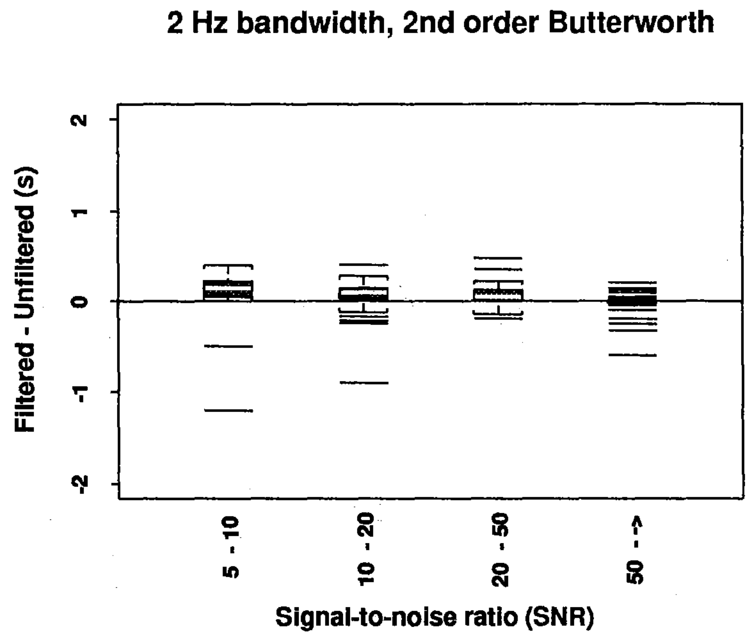


Fig. 7.8.5 Simulated SNR dependent time delays of phase onsets at the GSETT-3 stations from the 3 February 1996 Yunnan earthquake. For plotting details see the caption of Fig. 7.8.1

a)



b)

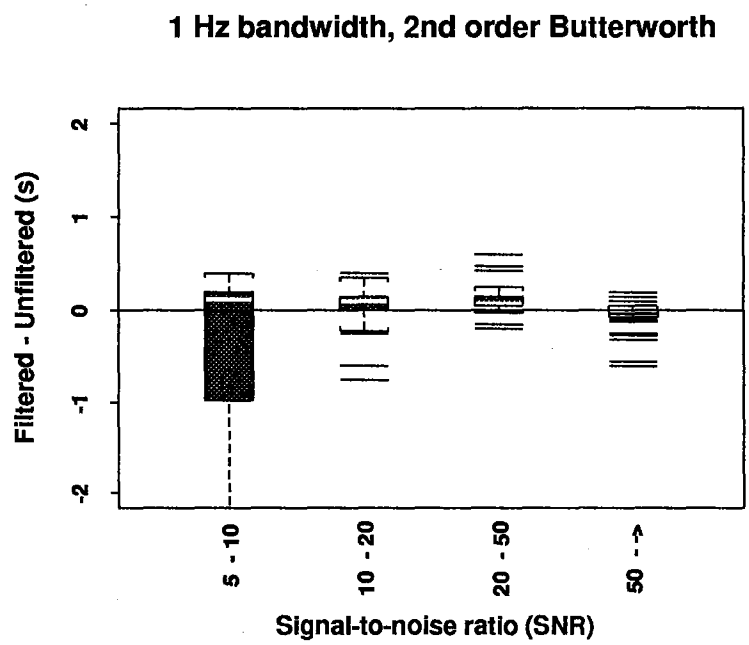
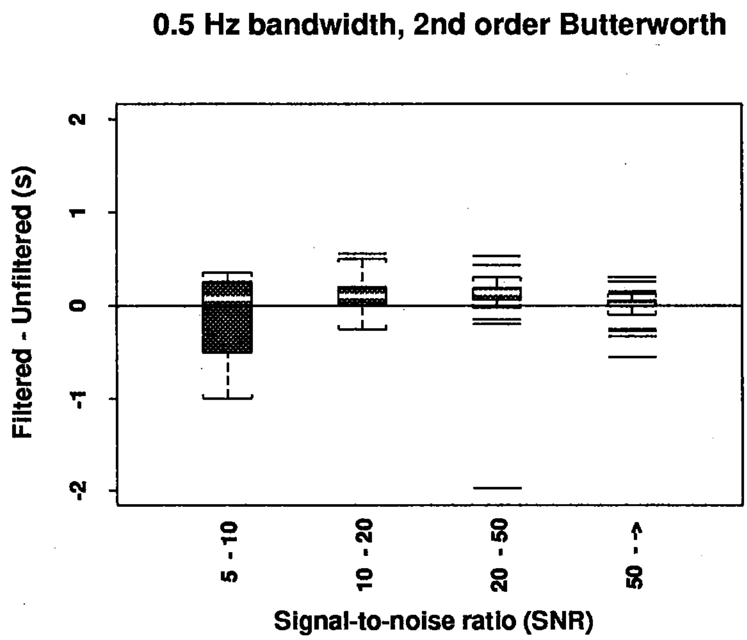


Fig. 7.8.6a-c. The data set used in these figures consists of teleseismic P-phases with varying SNR. For each of the phases, we estimated the AR-AIC$_{F+S}$ onsets on both filtered and unfiltered data, and the time difference between filtered and unfiltered AR-AIC$_{F+S}$ onsets are plotted as boxplots as a function of SNR. For further plotting details see the caption of Fig. 7.8.1. In Fig. 7.8.6a, we have used a causal 2nd order Butterworth filter with 2 Hz bandwidth centered on the dominant signal frequency. In Fig. 7.8.6b the bandwidth was 1 Hz and in Fig. 7.8.6c the bandwidth was 0.5 Hz.

c)


0.5 Hz bandwidth, 2nd order Butterworth
Filtered - Unfiltered (s)
2
1
0
-1
-2
5 - 10
10 - 20
20 - 50
50 - ->
Signal-to-noise ratio (SNR)