The Research Council of Norway (NFR)

NORSAR

NORSAR Scientific Report No. 1-98/99

Semiannual Technical Summary

1 April – 30 September 1998

Kjeller, October 1998

APPROVED FOR PUBLIC RELEASE, DISTRIBUTION UNLIMITED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

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.1-98/99	5. MONITORING ORGANIZATION REPORT NUMBER(S) Scientific Rep. 1-98/99
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 April - 30 September 1998

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 APR 98 TO 30 SEP 98	1998 October	140

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)

This Semiannual Technical Summary describes the operation, maintenance and research activities at the Norwegian Seismic Array (NORSAR), the Norwegian Regional Seismic Array (NORESS), the Arctic Regional Seismic Array (ARCESS) and the Spitsbergen Regional Array for the period 1 April - 30 September 1998. Statistics are also presented for additional seismic stations, which through cooperative agreements with institutions in the host countries provide continuous data to the NORSAR Data processing Center (NDPC). These stations comprise the Finnish Regional Seismic Array (FINESS), the German Regional Seismic Array (GERESS), the Hagfors array in Sweden and the regional seismic array in Apatity, Russia.

(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, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

Abstract (cont.)

The NORSAR Detection Processing system has been operated throughout the period with an average uptime of 99.77%. A total of 2049 seismic events have been reported in the NORSAR monthly seismic bulletin for April through September 1998. The performance of the continuous alarm system and the automatic bulletin transfer to AFTAC has been satisfactory. Processing of requests for full NORSAR and regional array data on magnetic tapes has progressed according to established schedules.

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

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

The operation of the regional arrays has proceeded normally in the period. Maintenance activities in the period comprise preventive/corrective maintenance in connection with all the NORSAR subarrays, NORESS and ARCESS. Other activities have involved repair of defective electronic equipment, cable splicing and work in connection with the small-aperture array in Spitsbergen.

Summaries of seven scientific and technical contributions are presented in Chapter 7 of this report.

Section 7.1 is entitled "Seismic monitoring of the Barents/Kara Sea region". This paper, which was presented at the 20th Annual Seismic Research Symposium, is a joint effort between Kola Regional Seismological Centre and NORSAR. The paper demonstrates that the excellent capabilities of the IMS network for the Barents/Kara Sea region can be further improved by taking advantage of the regional seismic network in northern Europe. The paper presents analysis of several interesting seismic events occurring in the region in recent years, including the small (m_b=3.8) nuclear explosion on 26 August 1984 and the two small events on 16 August 1997. Case studies, some of which are discussed briefly in this paper, have demonstrated that traditional regional discriminants are not effective for separating between seismic source types at low event magnitudes in this region. In particular, the authors conclude that the P/S ratio, even at high frequencies, is rather unstable and should not be relied upon for regional event discrimination. The authors of this paper disagree with those scientists who have claimed that the 16 August 1997 events can be positively identified as earthquakes on the basis of seismological evidence. On the other hand, neither is there any seismological evidence to confidently classify these events as explosions. In the opinion of these authors, the source type of these two events remains unresolved.

Section 7.2 is entitled "Optimized Threshold Monitoring", and contains excerpts of a paper presented at the 20th Annual Seismic Research Symposium. The objective of this work has

been to improve the Threshold Monitoring (TM) algorithm for use in monitoring compliance with the Comprehensive Test Ban Treaty. In particular, we have investigated improvements associated with the use of station-specific travel-time and slowness/azimuth corrections, optimized bandpass filters for sites to be monitored, and integration of results with traditional detectors. The paper addresses the problem of automatically associating peaks in the threshold plots with possible interfering events from sites outside the target region, and gives examples to illustrate how such an approach might work in a practical application. Further work will focus on improving these automatic algorithms to "explain" as many as possible of the peaks not associated with the target area, so that the analysts' efforts can be focused on those peaks which might be related to actual seismic events at the target site.

Section 7.3 is entitled "Norwegian Experience with IDC Metrics during GSETT-3", and gives a summary of a presentation at the Workshop on Review and Definition of IDC Metrics in Vienna, 7-9 September 1998. The paper addresses previous studies undertaken on a variety of topics, including:

- Metrics for event size
- Metrics to define location accuracy
- Metrics for capability estimation
- Metrics for REB completeness
- Metrics for event screening

Some more recent studies are also included, including a demonstration of the usefulness of applying "high-frequency" filtering to regional recordings of long-period waves in order to enhance the extraction of surface waves in the presence of long-period coda from large teleseismic earthquakes. The paper focuses on issues and problems that are at the present time still not resolved, and gives suggestions for future improvements.

Section 7.4 describes a study of M_s:m_b based on surface waves recorded at the Apatity LP station. The paper notes that the current event screening procedure employed at the IDC focuses on two criteria: event focal depth and M_s:m_b, which are considered to be by far the most robust criteria currently available, but have the disadvantage that they are difficult to apply to small events or events recorded only by few stations. By focusing on regional recordings of surface waves, it would be possible to apply the M_s:m_b discriminant to low magnitude events, perhaps approaching m_b=3.0-3.5. This paper shows that APA surface wave recordings can provide a promising separation of earthquakes and explosions in the Barents region using the M_s:m_b discriminant in a wide frequency band (5-30 seconds period).

We note that this result gives promise for applying the M_s:m_b discriminants down to lower magnitudes than is possible using teleseismic recordings. Additional work is required in regionalization of the propagation paths to take into account the major tectonic features in the region. The body-wave magnitudes provided by the ISC are far from good enough for events in this region, and must be reassessed in order to make full use of the earthquake-explosion discrimination potential.

Section 7.5 is entitled "Tuning the automatic data processing for the Spitsbergen array (SPITS)". The Spitsbergen array (SPITS) usually reports a large number of detections, which can easily exceed several thousand per day. A detailed analysis shows that these detections are real seismic signals mostly caused by small sources located at close distances. These local sources are mining induced events from a coal mining area near Longyearbyen on Spitsbergen and so-called icequakes, which means active faults and fissures in the ice of nearby glaciers or step-wise movements of these glaciers. Because SPITS was not designed for optimized detection and analysis of such signals, they are not properly handled by the current automatic data processing and cause many erroneous results. In this study we have developed new processing recipes for automatic processing of SPITS array data.

The new recipes have been applied to 168 days of continuous data beginning 11 April 1998, and the results have been compared to the conventional processing. The new recipes clearly increase the quality of all estimated parameters. Starting from detection processing via signal analysis to the final location process, this paper shows the advantages of the new set of recipes for an automatic analysis of SPITS data. After implementing these new processing, SPITS onsets can now be included more easily in the GBF process for network phase association and event location and will most likely help to improve the event detection capability for the Arctic.

Section 7.6 is a study of the Indian nuclear explosions on 11 and 13 May 1998. Using observations of the 11 May 1998 explosion we have derived optimum Threshold Monitoring (TM) processing parameters for the eleven IMS stations assumed to have the best detection capability for the Indian test site. Our results, in terms of TM thresholds, can be summarized as follows:

- The magnitude threshold of the IMS primary network for the Indian test site is around m_b 2.9 during normal noise conditions. The stations of this network are located at teleseismic distances from the test site.
- During background noise conditions, regional data from the Nilore (NIL) station alone provides magnitude threshold of about m_b 2.4 for the Indian test site. Supplementing NIL data with data from the other teleseismic IMS stations does not lower the magnitude thresholds during normal noise conditions, but are important if interfering events occur.
- During background noise conditions, the IMS three-station detection capability vary around m_b 3.5, both with and without the use of NIL data. This illustrates that supplementing a network with one additional good station does not necessarily improve significantly the three-station detection capability of the network.

In particular, the paper applies the Threshold Monitoring method to assess the capabilities of the IMS primary and auxiliary networks during the reported time of the 13 May explosion, which was not detected by any known seismic station. The upper magnitude limit of any event which might have occurred at the time of this announced Indian nuclear test of 13 May 1998 is estimated at:

- m_b 2.4 using NIL data (distance 700 km) either alone or in combination with teleseismic IMS data
- m_b 2.9 using teleseismic IMS data only

Except for a small threshold peak caused by a P-phase at NIL from an m_b 4.5 event in Java, Indonesia, the upper magnitude limit stays below m_b 2.5 for several hours around the reported origin time of the 13 May 1998 event.

Section 7.7 summarizes the activities related to the GSETT-3 experiment and experience gained at the Norwegian NDC during the period 1 April - 30 September 1998. Norway has been contributing primary station data from the two arrays: ARCESS and NORSAR and auxiliary station data from the Spitsbergen array. Norway's NDC is also acting as a regional data center, forwarding data to the IDC from GSETT-3 primary and auxiliary stations in several countries. The work at the Norwegian NDC has continued to focus on operational aspects, like stable forwarding of data using the Alpha protocol, proper handling of outgoing and incoming messages, improvement to routines for dealing with failure of critical components, as well as implementation of other measures to ensure maximum reliability and robustness in providing data to the IDC. NOR_NDC will continue the efforts towards improvements and hardening of all critical data acquisition and data forwarding hardware and software components, so as to meet future requirements related to operation of IMS stations to the maximum extent possible.

The PrepCom has tasked its Working Group B with overseeing, coordinating and evaluating the GSETT-3 experiment until the end of 1998. The PrepCom has also encouraged states that operate IMS-designated stations to continue to do so on a voluntary basis and in the framework of the GSETT-experiment until such time that the stations have been certified for formal inclusion in IMS. In line with this, and provided that adequate funding is obtained, we envisage continuing the provision of data from Norwegian IMS-designated stations without interruption to the PIDC, and later on, following certification, to the IDC in Vienna, via the new global communications infrastructure currently being elaborated by the PrepCom.

AFTAC Project Authorization	:	T/6141/NORSAR
ARPA Order No.	:	4138 AMD # 53
Program Code No.	:	0F10
Name of Contractor	:	The Norwegian Research Council (NFR)
Effective Date of Contract	:	1 Oct 1995
Contract Expiration Date	:	30 Sep 1999
Project Manager	:	Frode Ringdal +47 63 80 59 00
Title of Work	:	The Norwegian Seismic Array (NORSAR) Phase 3
Amount of Contract	:	$ 3,083,528
Contract Period Covered by Report	:	1 April - 30 September 1998

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. 644

Table of Contents

1 Summary

This Semiannual Technical Summary describes the operation, maintenance and research activities at the Norwegian Seismic Array (NORSAR), the Norwegian Regional Seismic Array (NORESS), the Arctic Regional Seismic Array (ARCESS) and the Spitsbergen Regional Array for the period 1 April - 30 September 1998. Statistics are also presented for additional seismic stations, which through cooperative agreements with institutions in the host countries provide continuous data to the NORSAR Data Processing Center (NPDC). These stations comprise the Finnish Regional Seismic Array (FINESS), the German Regional Seismic Array (GERESS), the Hagfors array in Sweden and the regional seismic array in Apatity, Russia.

The NORSAR Detection Processing system has been operated throughout the period with an average uptime of 99.77%. A total of 2049 seismic events have been reported in the NORSAR monthly seismic bulletin for April through September 1998. The performance of the continuous alarm system and the automatic bulletin transfer to AFTAC has been satisfactory. Processing of requests for full NORSAR and regional array data on magnetic tapes has progressed according to established schedules.

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

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

The operation of the regional arrays has proceeded normally in the period. Maintenance activities in the period comprise preventive/corrective maintenance in connection with all the NORSAR subarrays, NORESS and ARCESS. Other activities have involved repair of defective electronic equipment, cable splicing and work in connection with the small-aperture array in Spitsbergen.

Summaries of seven scientific and technical contributions are presented in Chapter 7 of this report.

Section 7.1 is entitled “Seismic monitoring of the Barents/Kara Sea region”. This paper, which was presented at the 20th Annual Seismic Research Symposium, is a joint effort between Kola Regional Seismological Centre and NORSAR. The paper demonstrates that the excellent capabilities of the IMS network for the Barents/Kara Sea region can be further improved by taking advantage of the regional seismic network in northern Europe. The paper presents analysis of several interesting seismic events occurring in the region in recent years, including the small (m_b=3.8) nuclear explosion on 26 August 1984 and the two small events on 16 August 1997. Case studies, some of which are discussed briefly in this paper, have demonstrated that traditional regional discriminants are not effective for separating between seismic source types at low event magnitudes in this region. In particular, the authors conclude that the P/S ratio, even at high frequencies, is rather unstable and should not be relied upon for regional event discrimina-

tion. The authors of this paper disagree with those scientists who have claimed that the 16 August 1997 events can be positively identified as earthquakes on the basis of seismological evidence. On the other hand, neither is there any seismological evidence to confidently classify these events as explosions. In the opinion of these authors, the source type of these two events remains unresolved.

Section 7.2 is entitled “Optimized Threshold Monitoring”, and contains excerpts of a paper presented at the 20th Annual Seismic Research Symposium. The objective of this work has been to improve the Threshold Monitoring (TM) algorithm for use in monitoring compliance with the Comprehensive Test Ban Treaty. In particular, we have investigated improvements associated with the use of station-specific travel-time and slowness/azimuth corrections, optimized bandpass filters for sites to be monitored, and integration of results with traditional detectors. The paper addresses the problem of automatically associating peaks in the threshold plots with possible interfering events from sites outside the target region, and gives examples to illustrate how such an approach might work in a practical application. Further work will focus on improving these automatic algorithms to “explain” as many as possible of the peaks not associated with the target area, so that the analysts’ efforts can be focused on those peaks which might be related to actual seismic events at the target site.

Section 7.3 is entitled “Norwegian Experience with IDC Metrics during GSETT-3”, and gives a summary of a presentation at the Workshop on Review and Definition of IDC Metrics in Vienna, 7-9 September 1998. The paper addresses previous studies undertaken on a variety of topics, including:

- Metrics for event size
- Metrics to define location accuracy
- Metrics for capability estimation
- Metrics for REB completeness
- Metrics for event screening

Some more recent studies are also included, including a demonstration of the usefulness of applying “high-frequency” filtering to regional recordings of long-period waves in order to enhance the extraction of surface waves in the presence of long-period coda from large teleseismic earthquakes. The paper focuses on issues and problems that are at the present time still not resolved, and gives suggestions for future improvements.

Section 7.4 describes a study of M_s:m_b based on surface waves recorded at the Apatity LP station. The paper notes that the current event screening procedure employed at the IDC focuses on two criteria: event focal depth and M_s:m_b, which are considered to be by far the most robust criteria currently available, but have the disadvantage that they are difficult to apply to small events or events recorded only by few stations. By focusing on regional recordings of surface waves, it would be possible to apply the M_s:m_b discriminant to low magnitude events, perhaps approaching m_b=3.0-3.5. This paper shows that APA surface wave recordings can provide a promising separation of earthquakes and explosions in the Barents region using the M_s:m_b discriminant in a wide frequency band (5-30 seconds period).

We note that this result gives promise for applying the M_s:m_b discriminants down to lower magnitudes than is possible using teleseismic recordings. Additional work is required in regionalization of the propagation paths to take into account the major tectonic features in the region. The body-wave magnitudes provided by the ISC are far from good enough for events in this region, and must be reassessed in order to make full use of the earthquake-explosion discrimination potential.

Section 7.5 is entitled "Tuning the automatic data processing for the Spitsbergen array (SPITS)". The Spitsbergen array (SPITS) usually reports a large number of detections, which can easily exceed several thousand per day. A detailed analysis shows that these detections are real seismic signals mostly caused by small sources located at close distances. These local sources are mining induced events from a coal mining area near Longyearbyen on Spitsbergen and so-called icequakes, which means active faults and fissures in the ice of nearby glaciers or step-wise movements of these glaciers. Because SPITS was not designed for optimized detection and analysis of such signals, they are not properly handled by the current automatic data processing and cause many erroneous results. In this study we have developed new processing recipes for automatic processing of SPITS array data.

The new recipes have been applied to 168 days of continuous data beginning 11 April 1998, and the results have been compared to the conventional processing. The new recipes clearly increase the quality of all estimated parameters. Starting from detection processing via signal analysis to the final location process, this paper shows the advantages of the new set of recipes for an automatic analysis of SPITS data. After implementing these new processing, SPITS onsets can now be included more easily in the GBF process for network phase association and event location and will most likely help to improve the event detection capability for the Arctic.

Section 7.6 is a study of the Indian nuclear explosions on 11 and 13 May 1998. Using observations of the 11 May 1998 explosion we have derived optimum Threshold Monitoring (TM) processing parameters for the eleven IMS stations assumed to have the best detection capability for the Indian test site. Our results, in terms of TM thresholds, can be summarized as follows:

- The magnitude threshold of the IMS primary network for the Indian test site is around m_b 2.9 during normal noise conditions. The stations of this network are located at teleseismic distances from the test site.
- During background noise conditions, regional data from the Nilore (NIL) station alone provides magnitude threshold of about m_b 2.4 for the Indian test site. Supplementing NIL data with data from the other teleseismic IMS stations does not lower the magnitude thresholds during normal noise conditions, but are important if interfering events occur.
- During background noise conditions, the IMS three-station detection capability vary around m_b 3.5, both with and without the use of NIL data. This illustrates that supplementing a network with one additional good station does not necessarily improve significantly the three-station detection capability of the network.

In particular, the paper applies the Threshold Monitoring method to assess the capabilities of the IMS primary and auxiliary networks during the reported time of the 13 May explosion, which was not detected by any known seismic station. The upper magnitude limit of any event which might have occurred at the time of this announced Indian nuclear test of 13 May 1998 is estimated at:

- m_b 2.4 using NIL data (distance 700 km) either alone or in combination with teleseismic IMS data
- m_b 2.9 using teleseismic IMS data only

Except for a small threshold peak caused by a P-phase at NIL from an m_b 4.5 event in Java, Indonesia, the upper magnitude limit stays below m_b 2.5 for several hours around the reported origin time of the 13 May 1998 event.

Section 7.7 summarizes the activities related to the GSETT-3 experiment and experience gained at the Norwegian NDC during the period 1 April - 30 September 1998. Norway has been contributing primary station data from the two arrays: ARCESS and NORSAR and auxiliary station data from the Spitsbergen array. Norway's NDC is also acting as a regional data center, forwarding data to the IDC from GSETT-3 primary and auxiliary stations in several countries. The work at the Norwegian NDC has continued to focus on operational aspects, like stable forwarding of data using the Alpha protocol, proper handling of outgoing and incoming messages, improvement to routines for dealing with failure of critical components, as well as implementation of other measures to ensure maximum reliability and robustness in providing data to the IDC. NOR_NDC will continue the efforts towards improvements and hardening of all critical data acquisition and data forwarding hardware and software components, so as to meet future requirements related to operation of IMS stations to the maximum extent possible.

The PrepCom has tasked its Working Group B with overseeing, coordinating and evaluating the GSETT-3 experiment until the end of 1998. The PrepCom has also encouraged states that operate IMS-designated stations to continue to do so on a voluntary basis and in the framework of the GSETT-experiment until such time that the stations have been certified for formal inclusion in IMS. In line with this, and provided that adequate funding is obtained, we envisage continuing the provision of data from Norwegian IMS-designated stations without interruption to the PIDC, and later on, following certification, to the IDC in Vienna, via the new global communications infrastructure currently being elaborated by the PrepCom.

Frode Ringdal

2 NORSAR Operation

2.1 Detection Processor (DP) operation

There was 1 break in the otherwise continuous operation of the NORSAR online system within the current 6-month reporting interval. The uptime percentage for the period is 99.77 as as it was for the previous period.

Fig. 2.1.1 and the accompanying Table 2.1.1 both show the daily DP downtime for the days between 1 April - 30 September 1998. The monthly recording times and percentages are given in Table 2.1.2.

The breaks can be grouped as follows:

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

The total downtime for the period was 10 hours and 16 minutes. The mean-time-between-failures (MBTF) was 93 days.

J. Torstveit

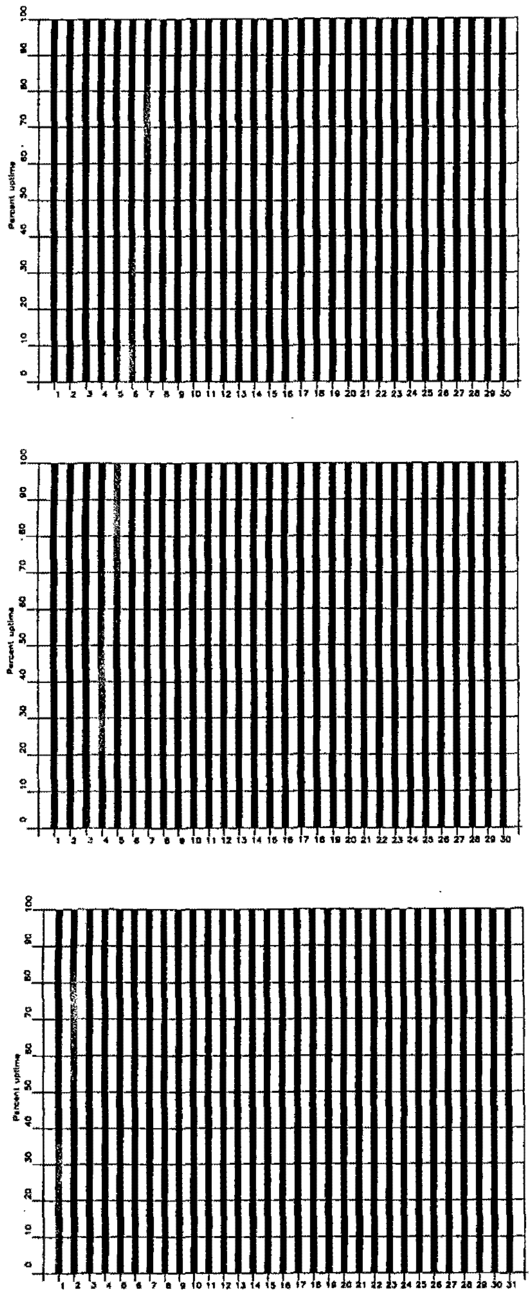


Fig. 2.1.1. Detection Processor uptime for April (top), May (middle) and June (bottom) 1998.

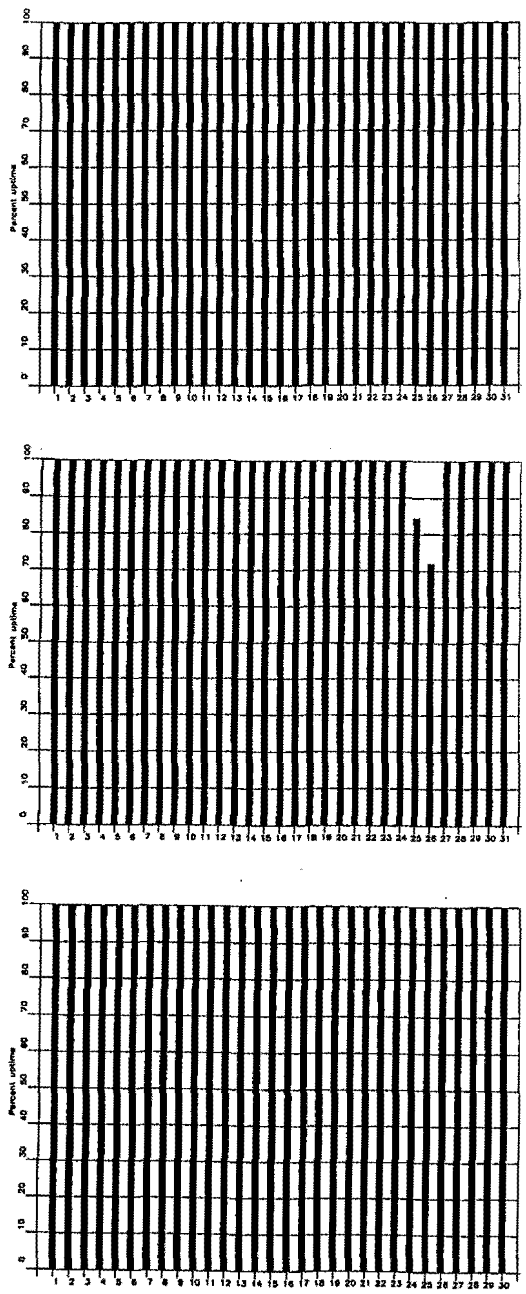


Fig. 2.1.1. Detection Processor uptime for July (top), August (middle) and September (bottom) 1998.

Date	Time	Cause
25 Aug	2014 -	Power failure
26 Aug	- 0621	
26 Aug	1914 - 1937	Power failure

Table 2.1.1. The major downtimes in the period 1 April - 30 September 1998.

Month	DP Uptime Hours	DP Uptime %	No. of DP Breaks	No. of Days with Breaks	DP MTBF* (days)
April	720.00	100	0	0	30.0
May	744.00	100	0	0	31.0
June	720.00	100	0	0	30.0
July	744.00	100	0	0	31.0
August	733.50	98.59	2	2	10.3
September	720.00	100	0	0	30.0
		99.77	2	2	

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

Table 2.1.2. Online system performance, 1 April - 30 September 1998.

2.2 Array Communications

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

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

From April - September 1998, there were 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
NORSAR Communication Status Report
Month: April 1998

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	-	-	-	-	-	-	-
Total hours normal operation	720	718.70	719	720	720	720	720
% normal operation	100	99.82	99.86	100	100	100	100

Legend:

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

Table 2.2.1
NORSAR Communication Status Report
Month: May 1998

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	720	744	744	744	744
% normal operation	100	100	96.77	100	100	100	100

Legend:

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

Table 2.2.1
NORSAR Communication Status Report
Month: June 1998

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	A	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	A	X
16	X	X	X	X	X	A	X
17	X	X	X	X	X	A	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	A	X	X	X	X
25	X	X	X	X	X	X	X
26	X	X	X	X	X	X	X
27	X	X	X	X	X	X	X
28	X	X	X	X	X	X	X
29	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X
31	-	-	-	-	-	-	-
Total hours normal operation	720	720	698	720	672	668	720
% normal operation	100	100	96.94	100	93.33	92.78	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
NORSAR Communication Status Report
Month: July 1998

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	743	744	744	744	743	695	744
% normal operation	99.87	100	100	100	99.87	93.41	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
NORSAR Communication Status Report
Month: August 1998

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	733.5	733.5	733.5	733.5	733.5	732.5	733.5
% normal operation	98.59	98.59	98.59	98.59	98.59	98.45	98.59

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
NORSAR Communication Status Report
Month: September 1998

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	-	-	-	-	-	-	-
Total hours normal operation	720	720	720	720	720	720	720
% normal operation	100	100	100	100	100	100	100

Legend:

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

2.3 NORSAR Event Detection operation

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

	Total DPX	Total EPX	Accepted events		Sum	Daily
			P-phases	Core Phases		
Apr 98	6815	787	249	66	315	10.5
May	4726	744	329	49	378	12.2
Jun	4935	725	301	43	344	11.5
Jul	6043	722	263	60	323	10.4
Aug	7202	775	302	47	349	11.3
Sep	6455	824	270	70	340	11.3
	36176	4577	1714	335	2049	11.2

Table 2.3.1. Detection and Event Processor statistics, 1 April - 30 September 1998.

NORSAR Detections

The number of detections (phases) reported by the NORSAR detector during day 091, 1998, through day 273, 1998, was 36,176, giving an average of 198 detections per processed day (183 days processed). Table 2.3.2 shows daily and hourly distribution of detections for NORSAR.

B. Paulsen

NOA .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
91	9	19	13	21	14	3	9	9	4	12	15	11	11	17	12	11	15	7	29	12	10	14	7	14	298	Apr 01 Wednesday
92	15	16	13	5	11	9	1	3	30	5	11	8	14	17	14	14	14	8	20	16	19	19	15	19	316	Apr 02 Thursday
93	10	12	14	13	15	6	9	11	20	1	12	1	24	18	14	12	9	9	18	11	12	10	28	10	299	Apr 03 Friday
94	12	23	18	16	18	18	18	13	22	4	18	6	10	8	19	11	22	13	19	21	19	16	15	22	381	Apr 04 Saturday
95	9	22	14	18	14	17	15	16	12	11	18	14	13	7	21	18	14	15	21	10	19	19	9	17	363	Apr 05 Sunday
96	41	13	23	15	12	10	7	14	5	5	10	12	5	8	6	5	9	4	6	10	7	4	12	10	253	Apr 06 Monday
97	22	8	9	17	9	6	0	2	4	2	4	9	13	24	9	10	10	12	18	18	23	18	15	23	285	Apr 07 Tuesday
98	10	14	20	13	16	8	8	12	5	19	7	18	12	12	11	26	15	23	28	28	29	12	28	21	395	Apr 08 Wednesday
99	17	18	18	14	10	22	16	10	24	15	38	17	16	21	11	13	16	19	23	14	14	13	22	28	429	Apr 09 Thursday
100	18	18	12	23	10	12	12	20	13	16	26	15	23	10	7	0	0	0	0	0	0	0	0	0	235	Apr 10 Friday
101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	21	23	16	22	23	116	Apr 11 Saturday
102	21	22	19	21	32	27	20	14	18	24	20	38	25	24	13	21	13	19	28	16	19	13	21	29	517	Apr 12 Sunday
103	13	18	17	16	14	21	17	16	16	11	11	19	17	16	19	23	24	9	20	15	20	20	13	14	399	Apr 13 Monday
104	23	13	22	15	15	7	4	9	8	4	7	7	16	14	11	8	5	5	10	12	17	12	11	15	270	Apr 14 Tuesday
105	14	16	10	9	13	9	1	16	1	4	0	3	11	17	29	16	10	2	4	1	10	7	8	5	216	Apr 15 Wednesday
106	10	16	9	24	7	6	0	4	5	9	5	6	20	8	9	8	10	17	7	8	12	13	8	12	233	Apr 16 Thursday
107	11	5	12	31	7	4	2	0	9	14	7	17	0	13	10	4	7	3	5	7	10	5	6	8	197	Apr 17 Friday
108	8	14	7	7	15	2	5	3	11	8	7	4	7	2	6	3	8	3	7	22	2	7	7	11	176	Apr 18 Saturday
109	8	1	22	20	4	3	7	0	0	8	2	1	12	0	5	5	9	2	6	0	13	0	6	7	141	Apr 19 Sunday
110	4	3	7	0	2	0	0	0	0	0	3	4	1	27	7	0	0	0	8	6	6	4	22	20	124	Apr 20 Monday
111	11	7	5	9	8	16	1	0	6	2	8	21	2	2	11	7	7	22	9	3	5	2	7	4	175	Apr 21 Tuesday
112	6	9	5	6	0	1	0	1	3	8	1	12	12	9	4	9	12	4	6	4	8	11	10	7	148	Apr 22 Wednesday
113	15	8	16	29	4	9	7	3	1	9	24	13	9	35	11	15	7	5	3	6	7	13	16	14	279	Apr 23 Thursday
114	8	8	16	14	6	14	2	5	0	11	20	3	16	0	12	3	3	9	2	1	7	3	10	2	175	Apr 24 Friday
115	4	4	4	3	11	14	11	1	6	9	2	16	6	4	2	5	2	3	0	3	1	3	8	13	135	Apr 25 Saturday
116	8	7	2	7	6	1	13	1	9	4	0	0	0	1	12	2	0	5	2	1	1	5	4	2	93	Apr 26 Sunday
117	3	2	2	2	3	4	1	8	2	2	0	1	13	11	4	0	11	5	6	4	0	1	2	0	87	Apr 27 Monday
118	8	2	0	3	5	0	0	9	0	2	11	11	7	22	6	30	8	49	14	4	3	1	3	3	201	Apr 28 Tuesday
119	2	1	0	6	5	6	8	2	8	7	6	12	15	16	6	5	18	11	0	11	2	3	3	7	160	Apr 29 Wednesday
120	1	0	3	0	2	4	0	2	6	0	18	17	10	9	7	0	1	4	0	0	0	7	2	0	93	Apr 30 Thursday
121	1	3	4	1	9	3	1	6	3	5	10	11	11	8	0	10	2	3	9	2	1	3	0	5	111	May 01 Friday
122	14	4	2	1	0	3	0	4	13	3	0	0	1	0	1	1	6	1	2	6	4	5	7	2	80	May 02 Saturday
123	9	7	27	3	12	7	8	9	4	8	5	3	2	5	1	4	2	6	3	0	5	3	2	9	144	May 03 Sunday
124	11	10	0	3	1	0	0	0	0	7	1	7	0	7	1	0	9	6	6	7	1	0	8	9	94	May 04 Monday
125	0	5	2	8	0	0	4	3	2	2	6	2	2	3	12	12	8	3	0	1	1	3	3	5	87	May 05 Tuesday
126	2	11	16	8	0	2	8	0	5	7	5	9	9	8	6	4	0	4	0	2	13	2	1	2	124	May 06 Wednesday
127	2	7	8	2	3	0	0	0	10	6	5	4	3	11	4	9	7	7	6	10	15	4	8	4	135	May 07 Thursday
128	5	6	16	6	6	10	3	4	12	7	1	9	4	3	2	5	6	11	3	2	9	3	6	0	139	May 08 Friday
129	4	6	6	3	5	9	1	5	1	0	4	6	0	15	0	14	13	14	2	3	2	7	2	4	126	May 09 Saturday
130	2	5	10	3	1	2	9	4	2	3	7	1	0	7	8	4	1	2	2	9	2	2	0	1	87	May 10 Sunday
131	1	3	5	1	8	4	0	0	1	7	14	10	9	5	2	2	4	3	3	2	0	4	4	0	92	May 11 Monday
132	7	4	4	2	0	2	2	2	0	5	9	14	25	9	0	8	0	16	1	0	1	4	2	1	118	May 12 Tuesday
133	6	1	1	0	0	0	1	0	6	8	3	8	8	21	2	0	13	1	0	4	3	0	5	20	111	May 13 Wednesday
134	3	0	0	2	2	1	9	16	12	7	7	25	14	4	1	13	4	0	1	15	10	0	3	5	154	May 14 Thursday
135	6	4	4	0	0	5	20	0	13	9	14	20	1	4	7	3	2	0	10	6	11	2	8	9	158	May 15 Friday
136	12	0	12	6	12	0	0	5	0	0	19	8	6	1	4	5	2	7	0	0	2	1	6	17	125	May 16 Saturday
137	1	0	0	7	0	9	0	7	0	0	0	0	1	8	2	4	3	3	0	0	2	0	1	0	48	May 17 Sunday
138	2	0	10	0	0	3	2	8	0	0	4	3	7	3	9	5	4	6	6	3	29	4	11	8	127	May 18 Monday
139	15	9	8	7	3	3	4	11	3	2	9	2	7	8	4	6	10	8	6	1	8	8	6	6	154	May 19 Tuesday
140	11	9	9	13	6	5	6	1	5	25	4	10	14	14	6	6	5	6	10	14	9	6	20	9	223	May 20 Wednesday
141	17	10	15	13	18	37	15	16	17	14	6	11	14	9	5	16	16	13	16	19	16	9	18	13	353	May 21 Thursday
142	12	15	13	10	3	12	5	3	5	10	3	1	2	14	13	8	8	2	6	6	9	6	2	4	172	May 22 Friday
143	8	4	4	4	22	5	3	5	3	4	9	3	6	2	15	2	8	15	12	6	10	13	6	10	179	May 23 Saturday
144	5	3	26	4	9	16	4	4	1	5	3	2	6	5	5	6	6	5	6	5	4	12	9	9	160	May 24 Sunday
145	18	6	22	7	6	3	2	2	4	1	2	8	3	20	6	7	14	9	7	11	8	12	10	17	205	May 25 Monday
146	19	17	24	11	13	6	4	4	0	11	5	2	31	6	4	15	5	4	2	7	14	16	14	12	246	May 26 Tuesday

Table 2.3.2 (Page 1 of 4)

NOA .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
147	19	31	7	23	10	1	4	0	4	10	16	14	21	1	5	16	12	1	0	1	24	14	5	12	251	May 27 Wednesday
148	13	13	5	0	4	31	0	6	1	10	21	19	24	24	0	6	16	9	15	3	16	14	7	5	262	May 28 Thursday
149	16	3	9	3	4	9	2	0	5	11	7	7	0	11	6	2	6	5	6	9	5	9	17	5	157	May 29 Friday
150	6	1	12	2	15	6	22	38	4	13	10	4	1	9	8	4	4	4	16	9	10	17	13	16	244	May 30 Saturday
151	9	7	20	21	12	13	10	11	7	8	27	13	10	18	12	14	10	11	10	15	12	16	8	23	317	May 31 Sunday
152	19	26	15	16	13	19	12	16	17	9	11	19	10	13	12	7	16	17	17	20	9	14	17	19	363	Jun 01 Monday
153	11	14	21	11	6	6	1	2	1	7	4	10	12	5	24	8	1	4	12	9	11	9	2	13	204	Jun 02 Tuesday
154	11	10	6	4	6	2	0	1	26	9	19	14	9	9	2	6	5	4	13	12	12	17	7	18	222	Jun 03 Wednesday
155	18	13	10	14	14	3	6	0	4	4	4	9	6	10	5	4	1	7	14	4	5	12	16	8	191	Jun 04 Thursday
156	13	3	13	1	6	1	2	5	3	2	12	3	10	7	14	3	2	9	1	2	9	13	10	3	147	Jun 05 Friday
157	11	6	7	8	5	2	6	4	7	5	3	15	3	16	12	8	5	15	6	7	5	7	13	4	180	Jun 06 Saturday
158	12	6	9	10	8	7	10	11	9	19	6	7	6	9	11	8	17	16	9	8	10	11	19	23	261	Jun 07 Sunday
159	12	10	13	6	6	5	4	2	3	4	13	14	10	18	6	7	5	8	11	6	19	12	11	11	216	Jun 08 Monday
160	10	9	18	10	2	4	6	10	2	8	15	17	1	14	5	18	12	5	14	16	8	5	9	9	227	Jun 09 Tuesday
161	13	10	9	28	6	1	5	8	26	10	4	11	10	11	10	8	13	11	10	10	24	9	13	17	277	Jun 10 Wednesday
162	14	6	12	8	2	13	2	8	4	1	8	5	12	15	6	13	10	4	10	8	10	8	9	14	202	Jun 11 Thursday
163	12	4	10	7	8	1	0	5	9	6	27	6	15	10	5	3	1	5	2	19	2	12	11	3	183	Jun 12 Friday
164	6	4	16	6	4	1	7	4	19	3	3	11	4	4	2	5	2	2	13	4	4	5	2	4	135	Jun 13 Saturday
165	14	5	5	1	3	7	5	2	1	4	6	17	1	9	9	3	0	7	2	0	2	3	6	0	112	Jun 14 Sunday
166	5	8	1	7	2	0	0	8	3	5	10	2	9	7	9	8	6	4	4	7	3	7	3	6	124	Jun 15 Monday
167	10	6	15	4	4	5	4	21	6	10	20	22	20	20	13	18	12	10	19	9	14	12	17	14	305	Jun 16 Tuesday
168	16	12	14	15	17	12	12	12	9	8	7	7	8	14	6	11	8	9	16	17	16	11	10	17	284	Jun 17 Wednesday
169	17	13	8	15	13	8	14	8	3	0	3	17	2	4	4	6	12	8	2	8	7	4	25	11	212	Jun 18 Thursday
170	7	9	5	5	11	17	1	1	2	8	8	14	1	10	1	4	0	2	2	8	5	3	2	12	138	Jun 19 Friday
171	1	6	9	0	6	3	2	0	0	6	3	14	3	1	6	4	9	0	1	2	7	6	8	5	102	Jun 20 Saturday
172	0	10	5	14	6	1	3	4	6	9	5	3	12	10	4	11	10	4	5	5	2	11	3	1	144	Jun 21 Sunday
173	9	3	2	4	3	0	0	9	9	3	8	5	5	7	15	18	1	0	2	5	13	2	0	1	124	Jun 22 Monday
174	0	5	3	4	6	0	0	6	4	0	6	13	2	10	14	18	5	1	7	0	11	3	6	9	133	Jun 23 Tuesday
175	0	1	2	1	6	1	0	0	7	6	3	14	18	9	20	9	7	6	5	0	2	4	2	1	124	Jun 24 Wednesday
176	3	2	15	5	1	5	18	3	2	0	2	9	4	17	10	9	0	0	8	0	0	8	1	5	127	Jun 25 Thursday
177	1	9	12	19	1	2	2	2	3	7	3	16	15	3	2	3	3	2	1	7	5	3	1	8	130	Jun 26 Friday
178	1	0	2	5	1	2	0	13	7	7	2	4	0	3	16	1	4	9	1	2	4	10	2	1	97	Jun 27 Saturday
179	7	4	14	3	16	3	1	3	3	1	0	0	6	1	1	0	3	0	2	0	0	11	1	6	86	Jun 28 Sunday
180	2	3	0	4	1	2	1	0	0	1	0	8	9	1	3	1	1	3	0	2	16	1	0	3	62	Jun 29 Monday
181	0	4	0	8	3	2	0	0	17	0	1	14	8	14	11	7	9	12	0	0	5	12	3	0	130	Jun 30 Tuesday
182	4	7	9	0	2	0	0	2	0	20	8	3	14	14	9	5	13	4	12	8	9	12	15	13	183	Jul 01 Wednesday
183	12	7	5	9	24	9	3	16	6	8	10	8	16	11	3	12	4	6	15	14	4	3	8	3	216	Jul 02 Thursday
184	8	3	10	5	2	14	12	3	6	1	2	6	6	5	14	5	10	2	3	14	3	7	3	7	151	Jul 03 Friday
185	8	8	17	7	10	9	3	2	4	8	4	7	11	4	13	4	7	11	11	12	12	11	11	17	211	Jul 04 Saturday
186	18	17	22	17	15	15	18	11	13	12	8	11	8	8	9	14	9	8	9	13	15	11	13	12	306	Jul 05 Sunday
187	9	11	18	27	15	9	9	4	10	8	9	4	5	3	8	15	14	17	10	11	15	16	6	8	261	Jul 06 Monday
188	14	11	56	52	66	52	12	2	6	6	2	18	13	11	14	12	11	14	16	5	10	20	8	14	445	Jul 07 Tuesday
189	13	9	13	12	9	0	1	1	5	2	3	1	12	8	2	14	7	2	8	9	10	11	3	25	180	Jul 08 Wednesday
190	10	12	11	4	1	7	7	4	5	7	10	2	3	10	15	11	16	12	5	20	14	11	7	8	212	Jul 09 Thursday
191	9	1	0	8	7	12	3	4	6	10	13	9	9	2	13	2	5	1	1	4	5	6	4	9	143	Jul 10 Friday
192	9	2	4	3	5	5	5	0	7	2	2	9	4	6	0	0	6	3	2	1	0	3	2	3	83	Jul 11 Saturday
193	16	6	16	7	9	19	6	19	8	4	4	9	5	2	2	8	3	2	6	5	4	11	8	6	185	Jul 12 Sunday
194	5	6	17	7	2	4	5	1	5	3	14	1	6	15	5	7	4	6	6	6	9	10	7	15	166	Jul 13 Monday
195	5	14	7	14	10	3	4	6	2	4	3	2	19	10	21	7	19	4	10	17	14	9	16	18	238	Jul 14 Tuesday
196	14	13	18	18	30	6	15	18	8	25	6	13	13	16	9	13	15	18	8	10	13	10	15	20	344	Jul 15 Wednesday
197	10	12	12	9	10	2	15	5	4	6	12	11	14	7	7	3	6	15	5	7	11	8	12	2	205	Jul 16 Thursday
198	2	3	12	4	7	6	2	0	8	32	2	12	18	0	3	10	3	2	9	3	7	11	24	9	189	Jul 17 Friday
199	7	7	5	4	15	4	16	10	6	26	1	7	8	8	11	11	13	12	7	3	5	5	4	16	211	Jul 18 Saturday
200	8	4	9	3	4	0	21	1	2	9	8	7	5	1	2	10	28	17	10	10	8	7	7	10	191	Jul 19 Sunday
201	9	23	11	9	6	1	1	0	2	3	1	5	8	3	11	8	9	9	12	12	11	5	3	7	169	Jul 20 Monday
202	3	11	8	17	9	7	4	3	4	16	27	13	15	10	18	14	7	11	1	5	5	6	7	3	224	Jul 21 Tuesday

Table 2.3.2. (Page 2 of 4)

NOA .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
203	4	8	10	13	6	3	6	12	8	5	6	1	5	4	5	7	8	5	11	10	18	14	5	10	184	Jul 22 Wednesday
204	8	6	6	12	6	6	4	9	11	3	4	14	15	3	6	4	7	5	4	5	3	4	5	5	155	Jul 23 Thursday
205	1	5	11	3	8	4	1	4	9	10	5	6	12	9	11	11	3	7	15	9	10	4	12	11	181	Jul 24 Friday
206	4	8	20	15	6	10	5	7	7	12	9	2	8	6	9	7	11	6	14	17	18	4	8	11	224	Jul 25 Saturday
207	12	6	8	9	7	10	5	6	5	6	3	4	8	12	20	1	8	9	4	12	8	1	5	5	174	Jul 26 Sunday
208	0	4	4	4	3	0	0	1	6	7	3	2	4	4	6	15	6	0	0	15	10	0	0	5	99	Jul 27 Monday
209	2	1	8	0	2	10	0	2	7	6	11	13	3	12	8	11	5	3	2	3	0	4	1	9	123	Jul 28 Tuesday
210	10	10	5	9	6	4	0	21	4	15	9	14	5	24	2	10	0	1	19	3	8	14	4	5	202	Jul 29 Wednesday
211	3	3	10	6	3	0	0	1	5	8	12	8	7	14	17	15	11	22	9	9	13	11	7	13	207	Jul 30 Thursday
212	11	8	8	12	12	5	8	3	9	12	1	5	3	22	11	16	25	18	12	12	12	13	14	19	271	Jul 31 Friday
213	16	9	15	14	11	11	12	19	17	11	11	11	4	14	13	11	10	10	8	11	19	11	13	20	301	Aug 01 Saturday
214	11	9	19	10	23	14	8	3	9	8	6	7	10	3	15	8	2	4	4	1	5	7	6	7	199	Aug 02 Sunday
215	3	10	8	5	4	6	3	2	5	2	22	20	2	5	2	16	5	23	3	7	12	14	9	10	198	Aug 03 Monday
216	9	13	17	11	8	8	12	3	3	6	3	25	14	3	7	11	10	12	6	15	11	17	10	12	246	Aug 04 Tuesday
217	10	14	10	19	21	4	6	9	3	18	20	8	7	18	25	6	16	9	8	12	6	19	16	15	299	Aug 05 Wednesday
218	12	12	21	12	7	1	4	11	10	8	3	22	25	72	41	10	12	10	11	8	4	9	10	13	348	Aug 06 Thursday
219	16	12	10	7	12	4	8	5	4	1	3	0	7	14	2	21	15	9	11	5	3	6	7	12	194	Aug 07 Friday
220	12	6	8	10	7	7	5	4	5	2	5	5	2	5	2	2	8	3	13	6	14	11	11	7	160	Aug 08 Saturday
221	19	12	11	8	19	14	7	10	6	24	13	11	14	8	7	13	11	1	8	1	6	10	5	8	246	Aug 09 Sunday
222	3	4	7	13	10	3	0	0	0	0	11	0	9	11	3	8	5	1	3	5	4	8	2	5	115	Aug 10 Monday
223	3	4	6	1	4	0	7	15	1	0	9	34	11	4	8	15	17	6	12	6	4	5	4	35	211	Aug 11 Tuesday
224	18	5	8	0	4	4	6	2	2	9	6	23	10	6	17	11	5	4	6	2	7	3	6	10	174	Aug 12 Wednesday
225	9	8	15	2	3	9	10	17	8	0	7	3	1	17	8	7	6	7	5	5	6	4	6	6	169	Aug 13 Thursday
226	2	13	14	6	2	4	6	0	6	14	1	7	8	13	12	13	17	8	3	11	10	8	9	23	210	Aug 14 Friday
227	8	10	14	15	8	18	5	16	7	6	9	9	8	6	8	16	20	20	16	12	16	12	14	16	289	Aug 15 Saturday
228	14	18	17	19	19	20	15	10	8	9	8	16	14	12	17	15	13	8	7	7	6	11	8	8	299	Aug 16 Sunday
229	7	17	14	8	10	5	9	5	7	3	12	14	7	12	10	6	7	10	13	11	29	8	6	13	243	Aug 17 Monday
230	4	11	15	10	22	15	10	12	13	7	9	5	7	10	10	7	14	10	22	11	20	6	14	9	273	Aug 18 Tuesday
231	20	11	20	15	10	9	4	9	7	7	10	21	18	12	6	12	7	12	5	11	7	11	14	16	274	Aug 19 Wednesday
232	7	16	6	9	4	9	16	7	4	8	5	9	9	7	3	39	16	15	6	19	12	10	9	10	255	Aug 20 Thursday
233	9	12	21	26	1	10	10	2	0	11	6	14	0	2	2	14	8	5	12	18	13	12	12	15	235	Aug 21 Friday
234	10	11	11	18	8	16	14	20	17	20	13	10	22	7	10	3	15	12	10	10	17	17	12	22	325	Aug 22 Saturday
235	19	20	12	11	16	28	21	23	32	21	12	16	14	15	22	10	11	10	13	16	15	9	7	10	383	Aug 23 Sunday
236	15	16	13	18	10	9	1	2	5	3	16	31	14	4	11	12	9	14	5	8	16	10	7	13	262	Aug 24 Monday
237	14	5	8	6	8	1	4	14	5	2	8	9	16	23	13	9	15	3	11	15	1	0	0	0	190	Aug 25 Tuesday
238	0	0	0	0	0	0	4	1	2	3	1	37	21	12	3	8	9	11	10	10	19	16	10	17	194	Aug 26 Wednesday
239	21	12	18	25	11	5	1	8	12	26	10	12	16	10	12	11	18	12	16	19	20	17	21	19	352	Aug 27 Thursday
240	18	14	16	15	16	14	5	3	9	10	7	14	45	15	11	18	18	9	5	9	11	16	29	24	351	Aug 28 Friday
241	13	14	10	12	11	7	8	7	13	4	5	9	5	10	2	7	10	10	6	4	12	5	11	13	208	Aug 29 Saturday
242	7	6	28	16	13	3	10	2	5	3	2	12	4	5	14	1	20	19	5	1	13	5	10	3	207	Aug 30 Sunday
243	6	3	27	24	6	4	0	0	0	0	9	2	5	10	27	2	11	11	1	8	5	6	2	16	185	Aug 31 Monday
244	5	14	6	6	14	1	0	4	0	17	10	12	10	6	11	2	5	2	9	5	8	1	3	12	163	Sep 01 Tuesday
245	10	10	14	7	7	2	1	0	18	11	6	0	11	8	14	4	23	12	3	11	18	9	3	10	212	Sep 02 Wednesday
246	15	5	12	7	6	1	15	6	11	2	17	12	7	21	4	1	7	11	16	13	8	8	5	21	231	Sep 03 Thursday
247	22	18	7	14	7	3	3	13	8	0	18	2	17	1	3	29	15	11	5	3	11	9	7	17	243	Sep 04 Friday
248	9	7	11	15	12	20	9	8	8	7	7	3	6	3	2	5	13	8	14	12	7	9	8	9	212	Sep 05 Saturday
249	20	6	12	6	7	9	6	6	4	5	6	0	5	16	7	2	4	5	6	6	13	14	7	6	178	Sep 06 Sunday
250	13	2	11	6	3	0	3	0	1	1	5	13	13	12	5	8	0	0	12	1	1	7	1	14	132	Sep 07 Monday
251	11	2	10	4	7	1	0	0	0	16	11	10	11	19	6	13	17	3	4	7	12	12	5	13	194	Sep 08 Tuesday
252	5	9	6	8	5	2	5	1	4	6	7	23	2	11	2	7	4	19	6	6	6	4	6	11	165	Sep 09 Wednesday
253	6	4	14	13	10	0	5	3	7	0	0	8	2	4	11	8	6	2	7	7	10	7	11	12	157	Sep 10 Thursday
254	8	9	7	8	7	7	14	5	6	13	6	5	5	2	6	6	8	8	2	3	5	7	7	16	170	Sep 11 Friday
255	6	9	3	12	4	7	7	6	2	9	25	5	3	7	8	11	14	10	8	8	14	11	7	13	209	Sep 12 Saturday
256	15	9	10	9	10	12	4	4	8	6	6	0	5	5	1	7	6	5	2	4	6	5	4	3	146	Sep 13 Sunday
257	6	6	5	2	6	11	2	4	11	4	3	12	17	7	9	9	3	6	12	4	5	3	5	9	161	Sep 14 Monday
258	6	7	4	8	5	4	4	7	12	10	9	7	17	1	4	5	20	11	10	6	8	9	15	19	208	Sep 15 Tuesday

Table 2.3.2. (Page 3 of 4)

NOA .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
259	14	15	15	5	10	5	8	16	8	3	22	12	13	2	10	6	2	6	3	7	8	13	10	21	234	Sep 16 Wednesday
260	17	17	17	20	18	12	9	6	15	9	10	8	10	10	29	16	13	17	13	32	32	18	25	11	384	Sep 17 Thursday
261	24	24	16	15	16	5	16	15	34	2	14	3	6	9	2	22	2	19	11	47	2	9	3	15	331	Sep 18 Friday
262	17	8	6	6	10	23	9	12	18	22	7	14	6	10	43	9	4	7	14	11	20	30	24	13	343	Sep 19 Saturday
263	24	21	19	21	25	12	24	22	16	11	8	5	3	2	12	9	15	6	15	18	19	38	22	13	380	Sep 20 Sunday
264	18	21	16	28	7	11	5	14	4	6	4	8	24	12	8	7	12	5	21	13	15	22	8	15	304	Sep 21 Monday
265	8	27	9	10	6	0	3	7	0	5	5	4	20	40	3	5	1	0	7	5	4	5	6	4	184	Sep 22 Tuesday
266	2	10	5	4	0	5	1	10	0	5	1	15	14	8	9	8	11	2	15	7	17	10	5	5	169	Sep 23 Wednesday
267	5	4	19	11	5	2	4	6	14	1	6	15	17	11	10	2	1	12	2	11	5	5	16	14	198	Sep 24 Thursday
268	5	6	7	13	10	8	4	4	1	6	7	9	9	9	3	6	18	6	7	9	9	19	4	13	192	Sep 25 Friday
269	12	7	9	13	7	18	8	13	7	12	12	12	8	14	6	13	4	11	14	10	3	10	8	7	238	Sep 26 Saturday
270	9	17	16	9	9	11	13	14	9	17	17	24	6	8	11	11	16	12	14	4	17	15	16	5	300	Sep 27 Sunday
271	8	11	15	8	17	11	7	2	1	6	6	13	2	46	13	2	3	11	6	14	6	14	7	7	236	Sep 28 Monday
272	15	15	13	10	5	5	3	6	7	15	8	10	19	5	14	10	14	17	14	17	12	12	24	15	285	Sep 29 Tuesday
273	13	16	29	28	9	11	13	6	1	14	15	8	15	8	10	8	12	11	5	11	24	10	8	14	299	Sep 30 Wednesday

NOA	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	1790	1662	2049	1822	1561	1331	1105	1199	1266	1396	1536	1809	1766	1880	1638	1614	1606	1475	1515	1551	1776	1634	1614	1939	38534	Total sum
183	10	9	11	10	9	7	6	7	7	8	8	10	10	10	9	9	9	8	8	8	10	9	9	11	211	Total average
125	9	9	11	10	8	6	5	5	6	7	8	10	11	11	9	9	9	8	8	9	10	9	9	11	204	Average workdays
58	10	9	12	10	10	11	9	9	9	9	8	9	7	8	9	8	9	8	9	8	9	10	9	10	218	Average weekends

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

3 Operation of Regional Arrays

3.1 Recording of NORESS data at NDPC, Kjeller

The average recording time was 97.46% as compared to 87.33% during the previous reporting period.

Table 3.1.1 lists the main outage times and reasons.

Date	Time			Cause
11 Apr	0222	-		Clock failure
15 Apr		-	0835	
26 Aug	0010	-	0629	Power failure

Table 3.1.1. Interruptions in recording of NORESS data at NDPC, 1 April - 30 September 1998.

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

April 98	:	85.79
May	:	99.99
June	:	100.00
July	:	99.94
August	:	99.07
September	:	99.98

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

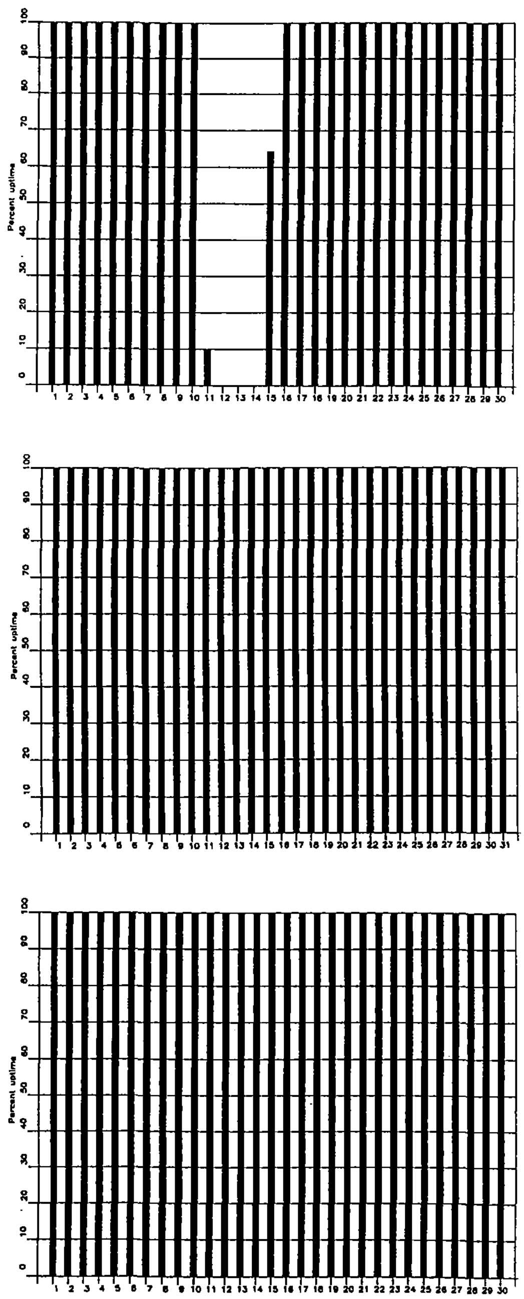


Fig. 3.1.1. NORESS data recording uptime for April (top), May (middle) and June (bottom) 1998.

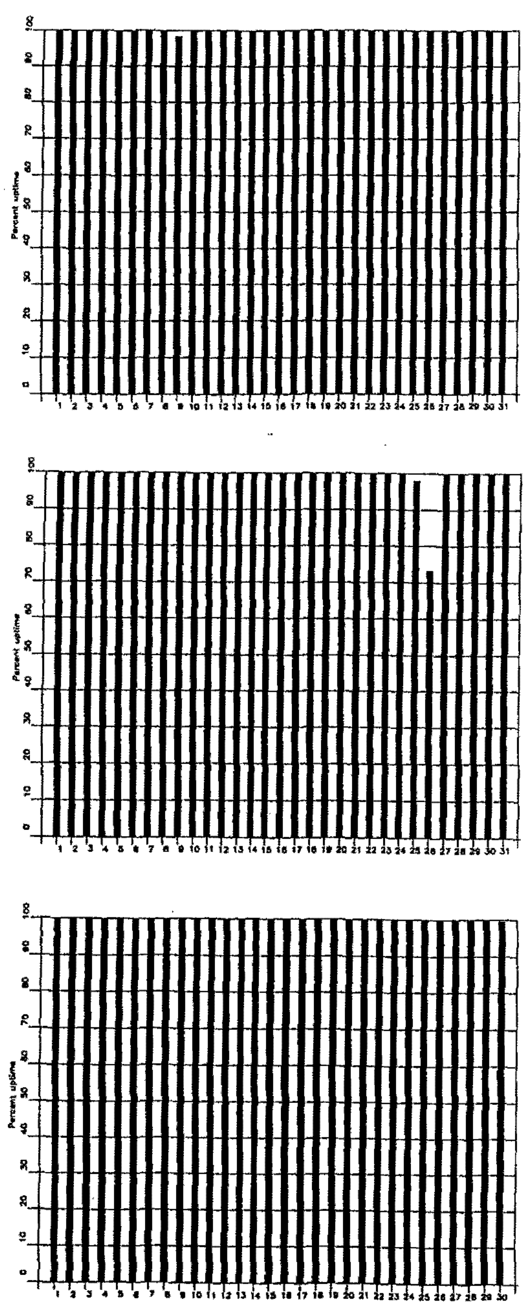


Fig. 3.1.1. (cont.) NORESS data recording uptime for July (top), August (middle) and September (bottom) 1998.

3.2 Recording of ARCESS data at NDPC, Kjeller

The average recording time was 99.72% as compared to 99.68% for the previous reporting period.

Table 3.2.1 lists the main outage times and reasons.

Date	Time	Cause
28 May	1455 - 1637	Power failure Hub
23 Aug	0113 - 0916	Hardware failure Hub

Table 3.2.1. The main interruptions in recording of ARCESS data at NDPC, 1 April - 30 September 1998.

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

April 98	:	99.93%
May	:	99.75%
June	:	99.92%
July	:	99.97%
August	:	98.74%
September	:	99.99%

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

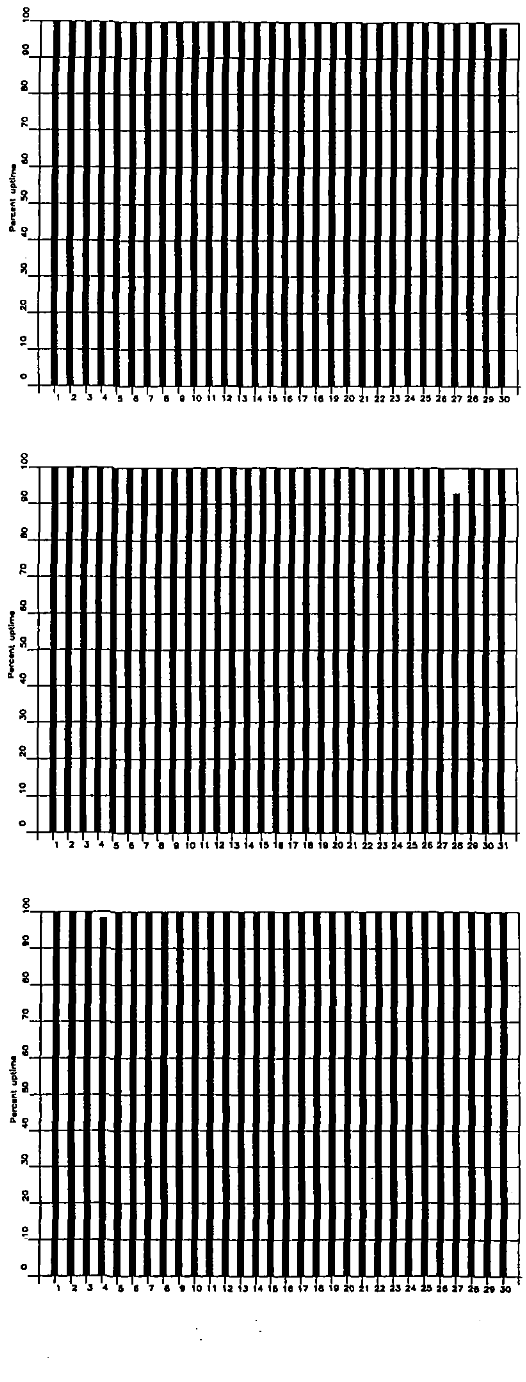


Fig. 3.2.1. ARCESS data recording uptime for April (top), May (middle) and June (bottom) 1998.

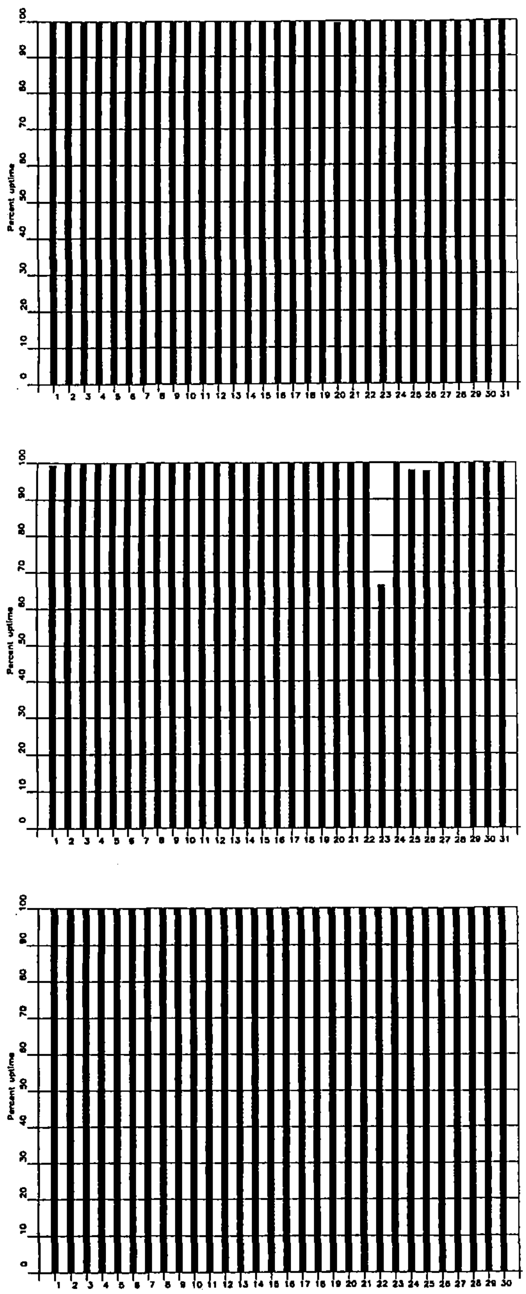


Fig. 3.2.1. (cont.) ARCESS data recording uptime for July (top), August (middle) and September (bottom) 1998.

3.3 Recording of FINESS data at NDPC, Kjeller

The average recording time was 97.71% as compared to 99.81% for the previous reporting period.

Date	Time			Cause
14 Apr	1538	-		Transmission line failure
15 Apr		-	0453	
01 May	1847	-		Problems in Helsinki
02 May		-	2015	
21 May	2320	-		Problems in Helsinki
22 May		-	0940	
28 May	2227	-		Problems in Helsinki
29 May		-	0440	
22 Jun	1813	-		Transmission line failure
23 Jun		-	1813	
01 Jul	1652	-	1728	Transmission line failure
15 Aug	0031	-	0956	Problems in Helsinki
10 Sep	1907	-	2218	Transmission line failure
11 Sep	0007	-	0358	Transmission line failure
16 Sep	1247	-	1441	Problems in Helsinki
17 Sep	0122	-	0524	Problems in Helsinki

Table 3.3.1. The main interruptions in recording of FINESS data at NDPC, 1 April - 30 September 1998.

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

April 98	:	98.16%
May	:	94.35%
June	:	96.67%
July	:	99.87%
August	:	98.92%
September	:	98.26%

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

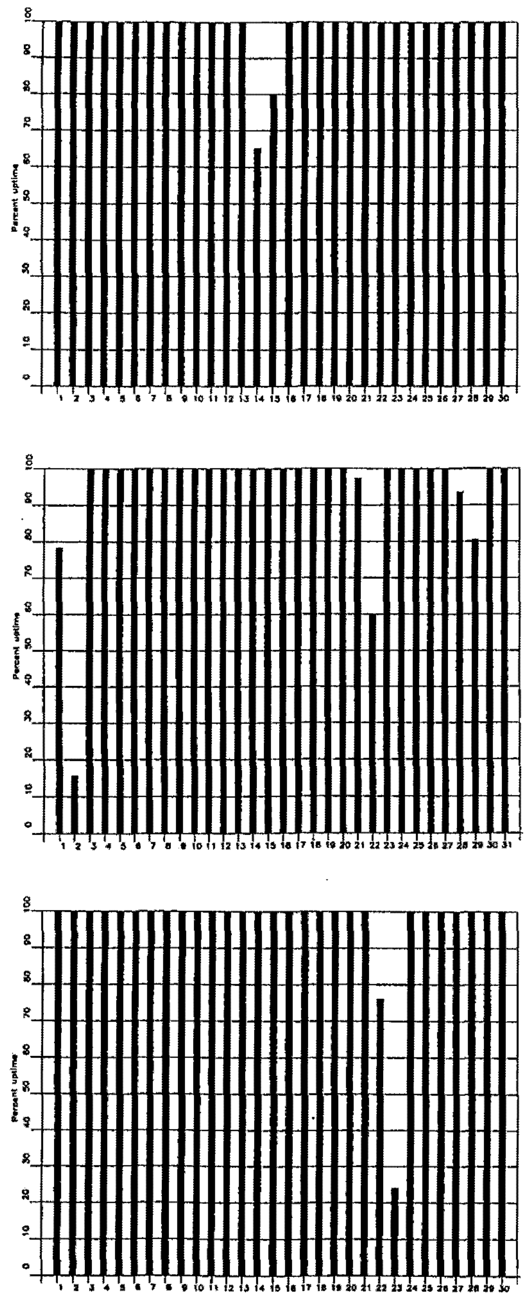


Fig. 3.3.1. FINESS data recording uptime for April (top), May (middle) and June (bottom) 1998.

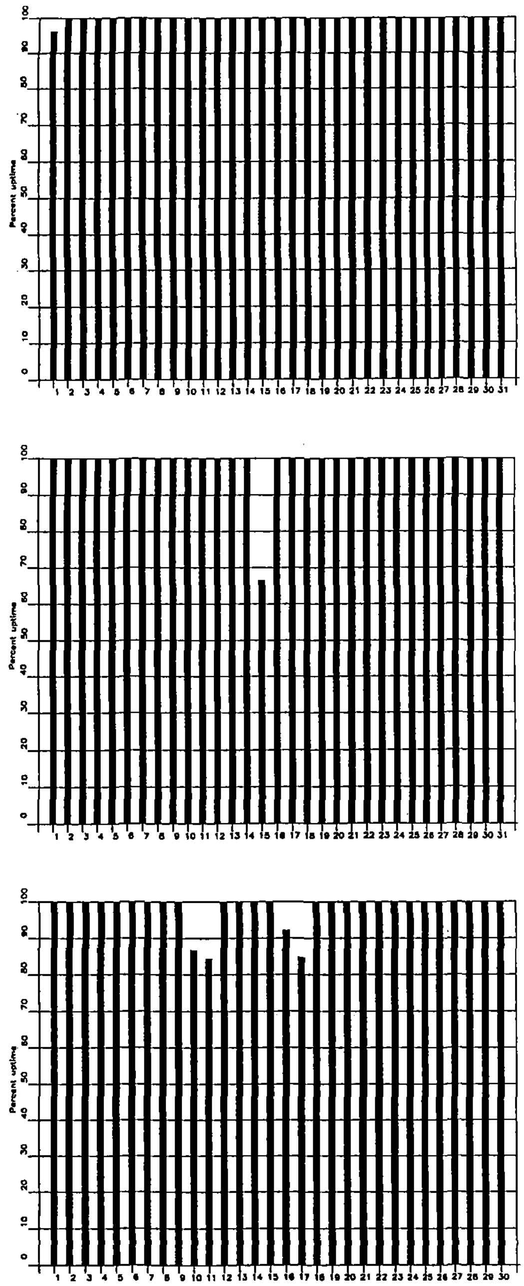


Fig. 3.3.1. (cont.) **FINESS** data recording uptime for July (top), August (middle) and September (bottom) 1998.

3.4 Recording of Spitsbergen data at NDPC, Kjeller

The average recording time was 99.07% as compared to 91.06% for the previous reporting period.

The main reasons for downtime follow:

Date	Time	Cause
04 May	2250 - 2339	Transmission line failure
05 Jun	0804 - 1002	Transmission line failure
21 Jun	1715 -	Transmission line failure
22 Jun	- 1047	
25 Aug	2014 -	Power failure NDC
26 Aug	- 0631	

Table 3.4.1. The main interruptions in recording of Spitsbergen data at NDPC, 1 April - 30 September 1998.

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

April 98	:	99.99%
May	:	99.81%
June	:	97.06%
July	:	99.85%
August	:	97.85%
September	:	99.87%

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

J. Torstveit

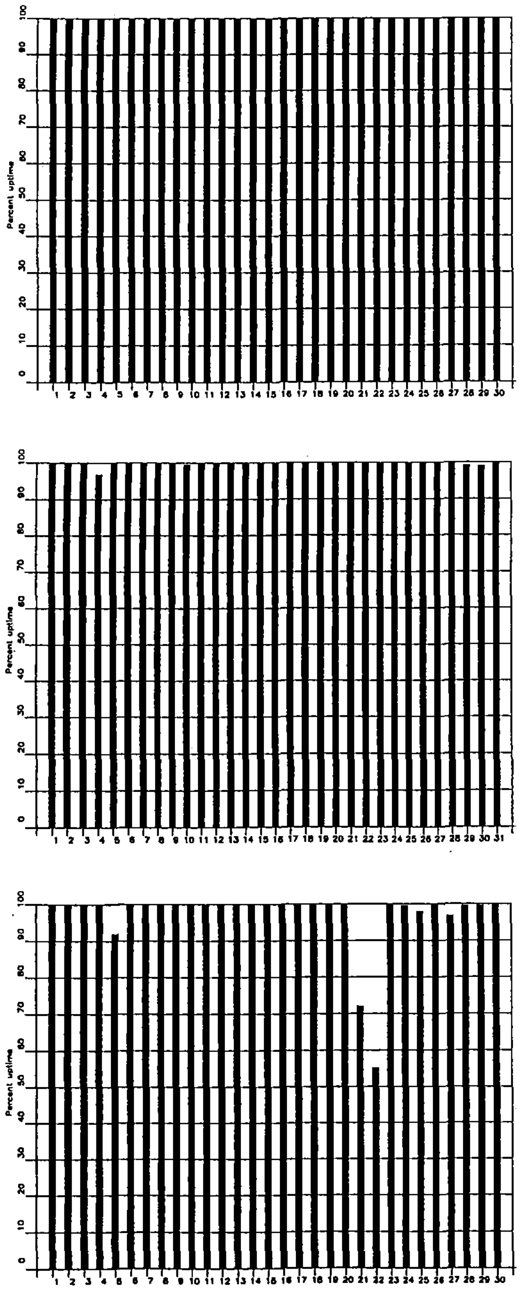


Fig. 3.4.1. Spitsbergen data recording uptime for April (top), May (middle) and June (bottom) 1998.

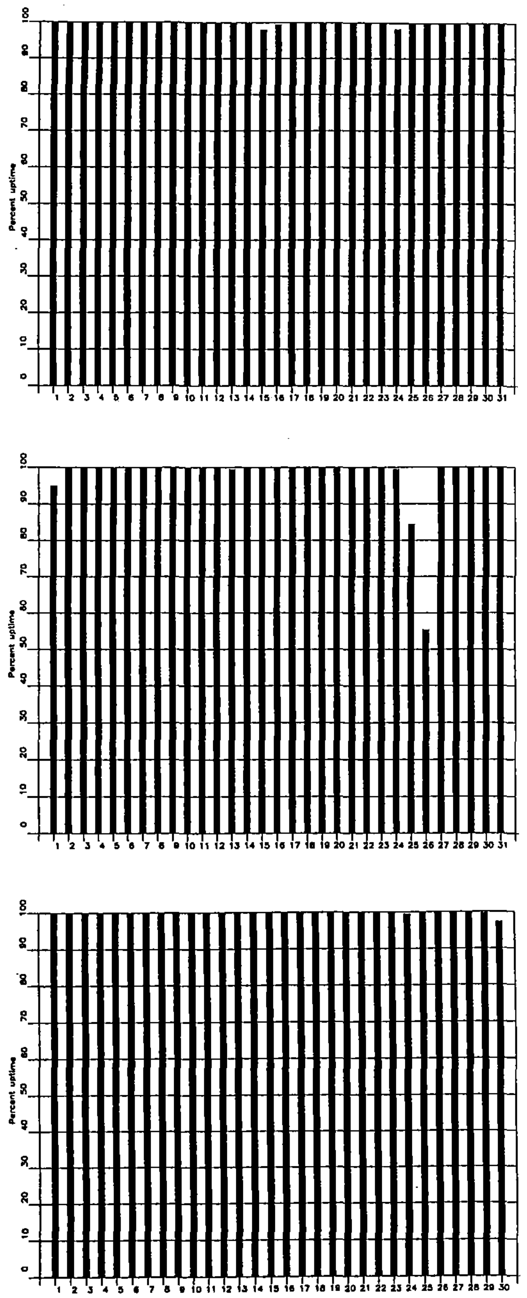


Fig. 3.4.1. (cont.) Spitsbergen data recording uptime for July (top), August (middle) and September (bottom) 1998.

3.5 Event detection operation

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

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

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

RMS results are reported in section 3.6.

NORESS detections

The number of detections (phases) reported from day 091, 1998, through day 273, 1998, was 49,871, giving an average of 277 detections per processed day (180 days processed).

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

Events automatically located by NORESS

During days 091, 1998, through 273, 1998, 2805 local and regional events were located by NORESS, based on automatic association of P- and S-type arrivals. This gives an average of 15.6 events per processed day (180 days processed). 56% of these events are within 300 km, and 81% of these events are within 1000 km.

ARCESS detections

The number of detections (phases) reported during day 091, 1998, through day 273, 1998, was 79,866, giving an average of 436 detections per processed day (183 days processed).

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

Events automatically located by ARCESS

During days 091, 1998, through 273, 1998, 5654 local and regional events were located by ARCESS, based on automatic association of P- and S-type arrivals. This gives an average of 30.9 events per processed day (183 days processed). 47% of these events are within 300 km, and 87% of these events are within 1000 km.

FINESS detections

The number of detections (phases) reported during day 091, 1998, through day 273, 1998, was 53,654, giving an average of 293 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 091, 1998, through 273, 1998, 3002 local and regional events were located by FINESS, based on automatic association of P- and S-type arrivals. This gives an average of 16.4 events per processed day (183 days processed). 68% of these events are within 300 km, and 86% of these events are within 1000 km.

GERESS detections

The number of detections (phases) reported from day 091, 1998, through day 273, 1998, was 42,918, giving an average of 235 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 091, 1998, through 273, 1998, 4563 local and regional events were located by GERESS, based on automatic association of P- and S-type arrivals. This gives an average of 24.9 events per processed day (181 days processed). 71% of these events are within 300 km, and 88% of these events are within 1000 km.

Apatity array detections

The number of detections (phases) reported from day 091, 1998, through day 273, 1998, was 86,973, giving an average of 475 detections per processed day (183 days processed).

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

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

Events automatically located by the Apatity array

During days 091, 19987, through 273, 1998, 1431 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 7.8 events per processed day (183 days processed). 37% of these events are within 300 km, and 67% of these events are within 1000 km.

Spitsbergen array detections

The number of detections (phases) reported from day 091, 1998, through day 273, 1998, was 149,399, giving an average of 816 detections per processed day (183 days processed).

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

Events automatically located by the Spitsbergen array

During days 091, 1998, through 273, 1998, 12,479 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 68.1 events per processed day (183 days processed). 49% of these events are within 300 km, and 75% of these events are within 1000 km.

Hagfors array detections

The number of detections (phases) reported from day 091, 1998, through day 273, 1998, was 59,996, giving an average of 333 detections per processed day (180 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 091, 1998, through 273, 1998, 2045 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 11.4 events per processed day (180 days processed). 35% of these events are within 300 km, and 77% of these events are within 1000 km

U. Baadshaug

NRS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
91	94	82	32	62	36	25	34	22	13	14	21	19	17	15	21	20	14	11	9	8	10	5	5	5	594	Apr 01 Wednesday
92	9	3	6	6	11	4	1	6	36	28	16	12	23	23	12	16	8	2	14	20	1	7	15	16	295	Apr 02 Thursday
93	14	10	9	5	6	6	4	16	19	5	12	14	29	10	17	19	13	5	48	71	27	50	38	24	471	Apr 03 Friday
94	35	44	32	34	26	36	27	15	32	27	15	15	57	43	51	29	34	40	7	18	8	5	4	8	642	Apr 04 Saturday
95	3	1	1	12	15	9	14	18	6	6	29	11	7	6	4	5	13	3	3	10	2	6	4	4	192	Apr 05 Sunday
96	29	30	37	16	8	10	7	7	8	6	9	80	54	16	10	29	12	24	43	39	83	48	32	21	658	Apr 06 Monday
97	18	10	30	18	44	13	30	34	38	24	40	21	20	16	10	32	55	11	23	26	32	27	11	36	619	Apr 07 Tuesday
98	18	98	72	85	38	16	13	5	8	13	11	7	13	18	11	17	12	8	12	8	8	105	94	123	813	Apr 08 Wednesday
99	125	134	115	115	111	136	103	126	123	14	24	28	95	46	8	86	94	98	94	101	73	43	80	68	2040	Apr 09 Thursday
100	107	105	29	29	86	98	113	64	34	10	13	18	16	12	6	20	14	25	9	9	11	17	23	50	918	Apr 10 Friday
101	42	35	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78	Apr 11 Saturday
102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 12 Sunday
103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 13 Monday
104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Apr 14 Tuesday
105	0	0	0	0	0	0	0	0	5	14	6	24	30	15	30	19	9	22	7	9	12	4	5	11	222	Apr 15 Wednesday
106	6	5	4	9	6	6	7	3	4	8	12	7	24	24	12	6	6	25	5	8	4	8	7	11	217	Apr 16 Thursday
107	15	2	6	23	4	7	9	8	11	10	9	26	11	14	26	10	17	7	7	30	13	9	6	13	293	Apr 17 Friday
108	3	13	13	11	32	12	10	11	12	14	14	17	16	7	10	5	10	29	8	15	6	4	7	9	288	Apr 18 Saturday
109	7	8	17	14	6	7	14	3	11	9	15	6	10	5	8	14	19	12	9	6	20	6	17	8	251	Apr 19 Sunday
110	7	4	11	20	4	5	8	4	9	5	9	7	12	22	13	5	19	18	22	12	19	14	29	17	295	Apr 20 Monday
111	6	11	10	21	12	11	11	11	7	5	18	33	16	17	23	9	19	33	16	6	16	17	11	9	348	Apr 21 Tuesday
112	8	5	9	13	2	7	4	8	15	14	12	17	27	21	17	14	33	16	12	18	7	9	13	15	316	Apr 22 Wednesday
113	7	12	7	16	7	10	4	7	5	6	22	9	24	38	69	44	18	36	23	56	43	39	35	19	556	Apr 23 Thursday
114	11	12	14	13	10	8	5	5	8	13	14	14	11	6	9	10	9	10	25	6	11	5	8	4	241	Apr 24 Friday
115	16	12	6	2	5	13	13	9	7	6	9	8	13	7	5	20	5	25	14	41	4	7	22	68	337	Apr 25 Saturday
116	112	56	22	11	67	69	77	78	70	72	34	25	31	35	21	37	57	73	54	55	53	88	60	45	1302	Apr 26 Sunday
117	18	20	35	28	19	27	30	78	10	9	6	6	14	21	3	5	20	11	5	11	2	4	3	2	387	Apr 27 Monday
118	9	3	1	6	2	3	0	10	4	2	12	12	20	16	9	31	10	44	23	5	3	2	2	3	232	Apr 28 Tuesday
119	2	4	2	7	2	3	5	1	6	4	9	7	7	6	9	8	12	5	11	7	6	5	3	8	139	Apr 29 Wednesday
120	3	5	0	0	5	5	3	1	3	2	11	12	17	7	6	4	9	12	6	7	7	9	5	9	148	Apr 30 Thursday
121	7	5	4	8	10	6	4	7	3	6	4	4	5	3	2	8	1	2	4	6	4	4	3	5	115	May 01 Friday
122	17	8	1	5	3	12	1	8	13	1	8	7	2	2	12	6	7	3	3	7	12	7	9	10	164	May 02 Saturday
123	10	6	13	8	9	9	4	5	3	3	11	4	3	5	3	4	7	7	4	2	2	2	4	12	140	May 03 Sunday
124	4	6	1	7	6	5	5	3	3	11	7	13	5	8	2	5	10	8	12	4	1	1	7	3	137	May 04 Monday
125	5	3	4	6	5	1	3	3	4	3	10	6	7	12	17	4	14	4	1	12	3	3	6	0	136	May 05 Tuesday
126	6	4	8	5	2	5	2	4	2	4	5	10	11	11	2	3	5	2	17	4	4	3	4	0	123	May 06 Wednesday
127	2	5	8	1	3	8	1	7	12	8	9	11	17	14	7	8	4	9	9	10	5	5	8	3	174	May 07 Thursday
128	7	0	7	7	8	4	4	5	8	8	10	6	10	4	2	1	1	8	3	11	2	3	1	2	122	May 08 Friday
129	2	10	1	9	6	11	8	4	2	2	5	4	2	7	10	15	7	7	4	1	6	3	7	6	139	May 09 Saturday
130	3	4	8	3	1	7	7	7	5	7	10	2	1	5	8	17	14	11	7	4	3	3	3	8	148	May 10 Sunday
131	4	4	9	5	9	4	2	7	4	6	17	8	16	9	4	6	11	8	11	4	3	4	6	5	166	May 11 Monday
132	5	6	4	4	0	5	6	3	2	10	5	16	26	8	4	6	10	19	2	3	0	5	7	5	161	May 12 Tuesday
133	8	2	0	5	4	3	4	3	12	13	9	7	25	22	6	8	8	7	4	6	6	4	3	8	177	May 13 Wednesday
134	4	2	1	3	2	5	6	10	8	6	4	19	18	6	7	15	18	4	13	10	12	3	3	8	187	May 14 Thursday
135	3	4	11	2	1	4	17	3	11	20	14	17	7	4	7	4	2	0	6	6	10	1	2	3	159	May 15 Friday
136	3	5	7	7	3	14	2	4	1	2	6	6	4	6	2	2	19	5	8	7	4	3	4	7	131	May 16 Saturday
137	3	5	0	6	5	4	3	6	4	3	4	2	3	7	4	6	7	2	5	3	4	3	5	5	99	May 17 Sunday
138	7	8	10	8	4	5	0	2	1	8	5	4	11	8	10	8	6	12	13	4	16	6	21	6	183	May 18 Monday
139	4	14	13	7	6	7	4	10	4	10	9	9	10	10	11	10	15	7	4	18	6	3	9	3	203	May 19 Tuesday
140	1	6	6	5	8	3	3	1	1	13	4	18	12	17	12	12	6	18	6	3	6	4	12	5	182	May 20 Wednesday
141	5	6	7	4	6	16	7	5	7	8	8	12	11	7	13	11	6	16	5	15	10	6	17	9	217	May 21 Thursday
142	14	14	14	9	9	6	2	5	3	15	7	6	14	13	21	8	14	20	25	27	13	18	27	26	330	May 22 Friday
143	20	16	15	10	17	8	8	3	1	6	7	1	5	4	16	7	7	16	20	9	7	12	7	1	223	May 23 Saturday
144	4	7	13	15	2	14	6	10	2	6	3	4	3	5	2	4	1	4	1	6	6	3	8	5	134	May 24 Sunday
145	15	1	6	7	7	5	3	1	4	1	7	7	9	19	15	4	10	15	4	6	4	2	8	2	162	May 25 Monday
146	5	9	5	3	5	3	8	6	7	18	8	8	30	10	6	10	11	6	9	6	6	5	5	5	194	May 26 Tuesday

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
147	6	10	3	8	9	6	5	4	6	10	24	12	27	3	9	11	7	8	25	8	14	8	5	5	233	May 27 Wednesday
148	11	3	5	6	0	16	3	7	20	16	20	20	22	21	15	12	15	18	7	5	8	17	4	5	276	May 28 Thursday
149	13	3	4	9	6	10	5	4	5	12	7	4	2	13	6	8	8	2	7	7	2	2	13	9	161	May 29 Friday
150	3	5	5	1	5	13	21	20	10	11	12	9	7	10	12	2	6	3	13	6	5	10	8	10	207	May 30 Saturday
151	2	9	12	8	3	10	5	2	2	1	11	8	9	20	5	6	11	7	9	8	19	6	6	12	191	May 31 Sunday
152	8	13	10	9	5	8	8	13	9	2	12	12	9	14	11	11	13	6	3	13	3	4	3	6	205	Jun 01 Monday
153	6	6	6	9	5	8	7	5	7	15	13	7	18	9	13	9	4	11	26	10	6	6	6	6	218	Jun 02 Tuesday
154	5	5	9	7	6	3	7	10	15	16	13	18	12	8	4	10	2	8	13	6	7	9	16	9	218	Jun 03 Wednesday
155	4	17	4	3	6	4	7	4	5	15	7	12	13	8	3	3	11	6	19	7	3	7	9	7	184	Jun 04 Thursday
156	2	9	8	5	5	2	2	8	4	4	19	2	6	9	7	3	3	7	5	23	8	6	6	4	157	Jun 05 Friday
157	4	5	4	6	12	9	2	2	3	4	8	8	3	11	23	6	1	3	1	3	0	4	9	5	136	Jun 06 Saturday
158	14	2	5	3	5	1	0	2	2	17	4	2	8	8	10	6	11	8	6	9	6	1	4	8	142	Jun 07 Sunday
159	8	2	6	3	6	1	6	2	2	3	5	17	15	17	5	10	12	8	11	3	15	32	5	1	195	Jun 08 Monday
160	2	2	4	3	3	6	4	11	1	16	12	15	15	20	10	12	8	14	4	10	6	5	3	5	191	Jun 09 Tuesday
161	10	2	4	16	8	1	1	9	18	6	11	9	2	15	11	2	13	9	7	9	11	6	9	4	193	Jun 10 Wednesday
162	6	5	8	6	2	9	8	22	9	7	14	8	17	20	8	28	11	4	5	7	3	1	11	6	225	Jun 11 Thursday
163	3	5	1	3	10	2	4	5	7	4	20	4	7	6	9	6	1	7	3	21	2	8	4	3	145	Jun 12 Friday
164	1	3	11	6	5	10	11	11	14	6	6	16	5	13	8	17	23	23	23	23	14	11	13	10	283	Jun 13 Saturday
165	14	13	11	14	17	21	18	8	7	5	4	12	2	11	6	7	19	19	12	5	4	5	3	8	245	Jun 14 Sunday
166	11	10	5	12	4	6	3	7	12	10	16	4	10	12	17	12	18	18	1	13	2	6	7	7	223	Jun 15 Monday
167	6	0	8	5	15	13	19	24	12	14	17	22	33	18	14	7	15	6	10	4	16	8	24	17	327	Jun 16 Tuesday
168	18	13	8	11	20	18	30	71	24	30	31	41	36	30	17	15	10	9	11	15	7	4	16	5	490	Jun 17 Wednesday
169	4	10	7	8	16	33	23	25	12	20	12	15	20	22	7	12	7	4	11	10	9	3	16	5	311	Jun 18 Thursday
170	10	5	7	3	10	36	40	20	5	11	33	17	31	19	14	10	4	1	6	10	8	7	7	10	324	Jun 19 Friday
171	5	9	12	6	11	9	14	23	7	8	8	39	21	6	12	20	7	7	7	9	11	8	7	1	267	Jun 20 Saturday
172	5	6	6	12	5	4	7	13	20	12	9	6	14	15	7	10	15	16	4	8	3	24	2	6	229	Jun 21 Sunday
173	7	3	8	7	6	3	8	9	7	13	13	16	35	18	12	12	11	3	12	14	19	12	14	11	273	Jun 22 Monday
174	1	4	2	1	8	27	28	22	14	23	14	20	32	20	12	11	9	11	2	8	4	7	10	12	302	Jun 23 Tuesday
175	21	25	21	10	23	20	59	46	49	62	40	38	55	54	21	15	9	14	16	8	10	18	12	14	660	Jun 24 Wednesday
176	19	6	21	11	12	55	35	53	20	36	21	24	23	30	31	27	7	10	14	7	5	6	9	26	508	Jun 25 Thursday
177	24	31	35	33	13	29	21	14	11	14	17	16	14	8	6	7	5	7	22	13	28	49	24	25	466	Jun 26 Friday
178	16	11	8	8	27	27	9	15	23	19	10	9	10	6	29	16	18	10	7	5	13	12	8	10	326	Jun 27 Saturday
179	25	9	11	4	5	5	0	7	14	25	19	3	4	8	2	5	5	12	10	2	3	14	2	6	200	Jun 28 Sunday
180	2	8	14	21	11	6	11	7	12	8	15	8	16	9	19	5	11	15	25	6	15	7	7	5	263	Jun 29 Monday
181	13	6	6	13	8	4	4	6	19	7	4	11	17	9	10	15	26	14	10	7	29	15	19	10	282	Jun 30 Tuesday
182	16	14	8	11	17	5	5	2	6	11	8	11	14	20	8	9	14	6	16	6	14	4	10	3	238	Jul 01 Wednesday
183	19	14	14	19	16	9	10	18	5	11	7	16	15	12	6	12	4	5	9	19	2	5	10	1	258	Jul 02 Thursday
184	8	8	15	14	5	9	18	7	5	15	18	9	8	3	14	8	11	10	20	16	24	8	14	5	272	Jul 03 Friday
185	18	19	22	12	31	33	17	11	9	13	22	18	21	14	18	6	18	14	9	13	7	3	0	4	352	Jul 04 Saturday
186	4	12	12	9	4	9	3	5	2	10	4	6	9	8	9	9	3	5	1	6	4	4	10	6	154	Jul 05 Sunday
187	2	4	3	3	3	0	15	10	12	10	6	9	17	12	8	8	8	13	10	4	5	6	11	8	187	Jul 06 Monday
188	15	15	15	6	1	10	3	7	3	3	7	11	18	8	15	10	13	15	6	5	6	6	4	2	204	Jul 07 Tuesday
189	11	8	4	10	6	5	5	6	5	6	10	6	22	11	4	7	7	21	7	3	1	3	5	10	183	Jul 08 Wednesday
190	4	4	1	3	5	11	5	9	5	12	14	8	12	6	7	15	15	10	13	9	7	4	4	5	188	Jul 09 Thursday
191	2	4	3	0	0	2	5	8	4	6	12	12	8	14	14	1	4	3	11	2	1	3	2	15	136	Jul 10 Friday
192	14	2	2	3	11	29	23	20	38	15	23	29	15	27	48	26	37	42	29	54	23	17	19	22	568	Jul 11 Saturday
193	39	24	21	14	33	47	7	13	22	18	9	18	8	13	7	46	15	5	18	5	2	11	7	2	404	Jul 12 Sunday
194	3	1	5	3	4	3	2	2	3	6	5	0	12	19	8	5	7	11	9	7	9	9	6	11	150	Jul 13 Monday
195	1	7	2	3	5	8	3	4	12	13	9	4	19	5	11	2	10	14	3	11	7	3	8	19	183	Jul 14 Tuesday
196	2	3	5	5	13	17	12	13	12	18	13	13	14	17	13	4	11	10	7	5	5	10	3	14	239	Jul 15 Wednesday
197	4	6	5	6	13	9	5	15	16	5	15	8	14	30	12	5	17	12	3	10	6	2	4	4	226	Jul 16 Thursday
198	2	2	4	3	9	8	3	2	16	18	4	8	14	0	7	22	9	10	7	5	6	11	27	5	202	Jul 17 Friday
199	5	12	9	8	12	17	9	5	3	11	6	9	7	7	6	0	12	8	3	4	10	3	7	4	177	Jul 18 Saturday
200	6	2	5	2	4	3	12	3	3	4	11	7	4	2	5	12	11	14	14	0	1	3	1	7	136	Jul 19 Sunday
201	0	17	3	12	3	6	1	9	4	15	4	7	8	6	17	4	9	14	3	2	3	5	1	4	157	Jul 20 Monday
202	1	5	5	5	4	12	7	17	5	10	9	9	6	8	7	7	7	6	7	4	5	0	6	34	186	Jul 21 Tuesday

Table 3.5.1 (Page 2 of 4)

NRS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
203	33	33	38	33	24	29	10	7	3	8	7	7	3	14	10	15	10	6	7	17	2	5	6	4	331	Jul 22 Wednesday
204	1	4	0	5	0	14	7	10	9	16	16	15	19	8	8	4	7	13	4	7	8	2	9	8	194	Jul 23 Thursday
205	4	5	0	0	3	7	3	4	6	9	10	11	13	26	15	21	14	9	9	2	10	19	11	18	229	Jul 24 Friday
206	14	17	13	14	16	23	30	18	10	22	20	11	17	27	38	19	21	18	24	21	19	26	22	19	479	Jul 25 Saturday
207	21	29	26	38	38	25	34	33	35	22	18	19	28	27	39	26	27	35	32	28	31	34	44	51	740	Jul 26 Sunday
208	51	54	56	38	39	25	13	9	8	10	8	12	11	9	9	7	6	11	4	14	9	6	9	13	431	Jul 27 Monday
209	9	7	6	10	14	13	5	6	9	10	15	19	3	18	11	9	16	19	13	16	18	12	16	22	296	Jul 28 Tuesday
210	5	6	9	3	3	5	17	18	15	19	12	13	14	21	11	37	29	21	33	3	17	13	3	3	330	Jul 29 Wednesday
211	2	2	0	3	1	4	22	24	42	13	26	19	25	19	14	16	5	16	14	5	8	9	4	11	304	Jul 30 Thursday
212	7	14	17	7	10	8	15	15	21	20	11	18	20	21	10	15	16	7	9	4	13	5	5	4	292	Jul 31 Friday
213	2	3	7	8	2	5	5	5	1	6	6	13	5	5	5	5	4	7	10	5	7	0	6	7	129	Aug 01 Saturday
214	9	5	5	4	6	11	17	8	5	6	7	0	6	8	3	7	11	2	4	6	10	2	8	4	154	Aug 02 Sunday
215	3	10	4	4	5	4	9	7	4	8	13	10	15	8	7	6	4	17	15	6	4	6	7	3	179	Aug 03 Monday
216	7	5	2	5	1	11	11	9	4	10	5	21	23	8	9	6	12	11	20	7	7	4	0	3	201	Aug 04 Tuesday
217	8	3	0	6	10	3	0	13	9	18	19	9	18	17	20	0	15	15	2	5	5	4	7	2	208	Aug 05 Wednesday
218	3	4	0	1	6	4	13	8	9	14	7	19	26	28	19	11	12	2	4	5	2	1	5	4	207	Aug 06 Thursday
219	1	1	1	7	7	5	7	7	3	9	13	7	5	9	0	9	6	11	15	4	11	3	10	1	152	Aug 07 Friday
220	4	2	7	0	6	9	4	5	10	3	6	12	31	7	10	18	18	9	10	8	9	4	3	2	197	Aug 08 Saturday
221	12	15	6	10	22	18	14	11	13	14	9	11	1	3	9	12	8	7	14	6	11	9	6	7	248	Aug 09 Sunday
222	4	10	9	6	5	4	3	2	10	4	9	10	15	5	10	12	6	10	5	11	6	14	8	19	197	Aug 10 Monday
223	11	9	11	5	3	5	4	14	4	2	12	30	16	14	6	12	10	11	19	9	0	7	1	15	230	Aug 11 Tuesday
224	11	4	3	9	6	7	2	6	3	9	16	16	16	6	15	4	6	11	3	2	6	5	4	3	173	Aug 12 Wednesday
225	1	2	4	3	4	6	6	10	6	10	8	1	2	10	6	2	2	13	5	8	8	0	0	3	120	Aug 13 Thursday
226	1	6	6	6	7	3	8	7	11	14	9	6	6	8	9	7	4	14	13	27	6	5	3	14	200	Aug 14 Friday
227	14	5	20	14	11	14	1	12	12	7	9	7	10	4	4	16	6	6	11	7	24	5	2	5	226	Aug 15 Saturday
228	4	4	5	1	5	3	10	14	12	3	3	23	15	13	9	12	8	5	7	7	0	3	3	3	172	Aug 16 Sunday
229	2	2	6	8	11	6	3	2	7	7	7	22	8	10	13	6	14	6	14	9	16	2	7	7	195	Aug 17 Monday
230	5	3	4	12	20	13	10	15	13	11	10	10	6	19	9	4	21	11	10	20	17	31	17	22	313	Aug 18 Tuesday
231	30	20	14	13	11	4	3	8	10	4	17	26	18	15	8	17	15	17	9	11	8	12	11	7	308	Aug 19 Wednesday
232	10	12	13	7	9	11	13	7	6	16	11	20	12	10	11	24	14	10	21	10	13	13	13	29	315	Aug 20 Thursday
233	14	15	12	20	7	23	8	1	3	14	9	9	2	2	19	35	9	30	16	9	8	24	17	10	316	Aug 21 Friday
234	2	2	4	4	4	13	9	6	8	7	5	10	6	4	19	13	10	36	18	8	32	26	41	24	311	Aug 22 Saturday
235	9	4	4	4	8	12	8	28	15	13	17	8	10	12	22	7	9	11	5	8	7	8	4	3	236	Aug 23 Sunday
236	6	7	5	32	17	5	3	8	11	7	9	21	10	5	4	16	20	20	29	14	9	8	19	21	306	Aug 24 Monday
237	40	32	64	54	46	28	13	10	6	18	13	12	18	19	10	6	11	14	15	38	16	5	23	19	530	Aug 25 Tuesday
238	1	0	0	0	0	0	7	0	4	11	7	30	24	9	22	9	10	6	20	7	23	13	11	7	221	Aug 26 Wednesday
239	6	0	7	2	5	3	0	4	10	27	13	9	20	15	12	9	18	5	33	22	5	6	24	23	278	Aug 27 Thursday
240	8	5	8	23	10	6	11	6	10	9	18	23	34	24	25	16	14	33	30	47	25	27	38	37	487	Aug 28 Friday
241	48	42	57	51	24	37	16	7	13	11	24	50	20	21	16	39	18	16	34	21	45	34	39	40	723	Aug 29 Saturday
242	18	15	29	23	17	9	23	13	25	15	12	20	13	9	14	11	19	20	2	16	5	7	21	7	363	Aug 30 Sunday
243	11	15	12	9	4	5	6	3	10	4	13	8	5	7	14	5	9	9	20	14	6	11	4	7	211	Aug 31 Monday
244	9	7	1	4	8	10	5	3	1	13	10	14	11	6	12	4	10	13	16	9	3	9	4	8	190	Sep 01 Tuesday
245	10	11	13	12	3	6	4	2	15	10	12	2	10	17	15	7	12	18	15	11	7	9	12	20	253	Sep 02 Wednesday
246	10	9	10	7	10	4	8	3	13	6	18	11	24	27	14	12	26	18	20	22	12	8	11	18	321	Sep 03 Thursday
247	17	21	11	21	9	3	7	12	18	20	42	22	19	17	8	19	15	11	24	22	12	10	10	13	383	Sep 04 Friday
248	5	7	13	15	19	12	11	6	5	11	8	17	14	12	15	15	15	29	16	18	24	16	18	16	337	Sep 05 Saturday
249	23	35	16	26	16	12	10	9	3	12	4	9	4	18	10	32	6	8	9	5	16	16	8	2	309	Sep 06 Sunday
250	8	19	23	29	11	8	11	12	14	20	8	6	12	14	8	8	6	10	12	13	6	20	13	17	308	Sep 07 Monday
251	13	40	19	12	8	7	5	9	5	13	14	16	10	24	11	21	16	1	16	9	2	6	1	4	282	Sep 08 Tuesday
252	5	4	5	9	9	6	4	5	3	8	9	12	6	14	3	5	12	16	14	3	4	0	1	6	163	Sep 09 Wednesday
253	3	5	8	5	3	7	1	2	4	3	12	7	2	7	14	10	6	12	9	4	4	3	5	8	144	Sep 10 Thursday
254	2	5	8	15	11	5	8	7	11	15	20	16	7	6	17	17	14	14	21	13	6	9	8	18	273	Sep 11 Friday
255	9	12	12	18	13	20	17	17	10	6	26	12	9	18	15	30	24	12	12	4	9	1	2	2	310	Sep 12 Saturday
256	4	4	3	1	4	5	8	4	2	4	4	3	3	1	0	1	3	2	5	4	1	4	2	1	73	Sep 13 Sunday
257	1	3	5	10	0	6	1	0	9	3	5	14	15	14	9	12	13	5	6	7	5	3	3	5	154	Sep 14 Monday
258	4	3	1	3	1	1	1	2	10	8	12	9	18	4	10	6	14	6	8	2	2	4	5	8	142	Sep 15 Tuesday

Table 3.5.1 (Page 3 of 4)

NRS .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
259	3	1	2	4	5	0	1	8	5	7	19	6	12	4	10	6	3	4	11	1	7	2	4	2	127	Sep 16 Wednesday
260	2	14	5	18	7	2	7	5	11	3	4	10	12	21	25	12	16	10	18	16	10	4	7	3	242	Sep 17 Thursday
261	10	10	6	9	5	3	9	8	20	3	9	9	6	11	3	20	2	9	21	20	12	7	4	1	217	Sep 18 Friday
262	1	2	0	3	2	10	2	9	14	14	3	6	9	7	15	8	1	5	5	3	9	11	10	13	162	Sep 19 Saturday
263	5	8	2	4	10	4	8	9	11	6	8	14	4	1	4	5	8	7	3	10	7	10	6	13	167	Sep 20 Sunday
264	18	26	16	17	5	3	1	6	4	4	4	10	16	9	8	8	15	11	7	7	5	11	6	13	230	Sep 21 Monday
265	8	20	12	5	2	4	3	4	6	9	16	6	16	35	10	7	8	14	6	5	1	6	7	9	219	Sep 22 Tuesday
266	5	6	3	23	7	1	3	9	1	8	14	14	11	17	8	15	14	5	27	2	11	3	6	6	219	Sep 23 Wednesday
267	3	6	19	17	16	9	9	6	13	7	14	18	19	14	14	6	2	13	4	9	3	0	6	5	232	Sep 24 Thursday
268	7	1	5	7	5	3	4	2	5	10	10	10	8	6	2	5	11	7	10	4	13	18	24	22	199	Sep 25 Friday
269	26	22	14	16	16	21	7	8	6	4	9	10	10	7	10	4	17	11	15	10	13	18	21	20	315	Sep 26 Saturday
270	27	22	17	29	17	13	9	11	7	12	6	12	4	8	1	8	7	7	8	9	10	9	4	13	270	Sep 27 Sunday
271	13	21	13	7	10	7	4	7	1	3	6	5	8	31	17	2	7	20	3	9	2	4	6	3	209	Sep 28 Monday
272	9	6	2	4	3	1	7	8	9	5	11	15	16	13	15	14	10	13	2	6	6	6	13	10	204	Sep 29 Tuesday
273	19	18	18	15	6	6	8	7	9	8	6	11	14	10	4	5	13	12	3	2	7	5	8	17	231	Sep 30 Wednesday

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		
180	12	12	11	11	11	11	10	11	11	11	12	13	15	13	12	12	12	13	12	11	10	10	11	11	277	Total average
124	9	10	10	11	8	8	8	10	9	11	12	13	16	14	12	11	11	12	12	11	9	10	10	11	259	Average workdays
56	17	16	13	13	15	18	15	14	13	10	11	12	12	11	12	14	14	15	12	12	12	11	12	13	316	Average weekends

Sum	2143	2043	2046	1979	1965	2311	2371	2141	2274	2061	1789	2043	
	2108	1935	1904	1857	1898	2137	2614	2105	2180	2209	1817	1941	49871 Total sum

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
91	15	13	11	15	15	18	18	24	14	20	19	31	30	15	20	9	10	8	32	10	13	17	11	17	405	Apr 01 Wednesday
92	18	8	11	11	11	6	9	12	32	28	34	27	13	17	17	9	15	9	18	16	4	24	12	16	377	Apr 02 Thursday
93	7	4	8	6	20	10	6	23	28	32	25	38	27	35	23	46	23	8	35	25	21	10	32	11	503	Apr 03 Friday
94	6	11	14	11	16	2	11	22	28	19	21	21	10	20	17	22	36	9	21	19	19	7	13	21	396	Apr 04 Saturday
95	8	2	14	4	15	6	11	9	4	9	7	8	4	8	11	10	7	5	3	11	6	9	10	17	198	Apr 05 Sunday
96	8	4	19	14	12	14	27	38	24	20	12	8	14	15	11	14	13	19	15	11	12	14	9	17	364	Apr 06 Monday
97	14	16	12	15	14	22	34	18	21	31	21	11	15	18	25	21	7	7	13	3	14	13	26	26	417	Apr 07 Tuesday
98	15	23	31	41	37	33	39	21	19	21	26	19	12	14	12	21	24	14	13	11	19	10	17	15	507	Apr 08 Wednesday
99	12	22	21	39	37	23	18	45	30	18	32	26	27	14	14	9	16	12	24	3	17	15	17	26	517	Apr 09 Thursday
100	5	4	8	2	7	4	11	6	5	12	22	28	11	10	13	18	19	22	11	15	18	8	21	12	292	Apr 10 Friday
101	15	21	7	26	11	21	31	25	12	19	14	16	12	7	14	13	5	10	16	10	12	6	28	26	377	Apr 11 Saturday
102	9	16	28	15	32	37	37	19	27	23	7	37	8	20	7	12	19	10	17	7	6	15	23	30	461	Apr 12 Sunday
103	21	24	32	36	47	46	33	60	27	37	12	22	9	19	23	16	24	13	17	20	21	16	13	8	596	Apr 13 Monday
104	12	12	7	19	19	16	13	17	18	23	21	12	30	14	23	11	10	9	18	10	9	14	18	23	378	Apr 14 Tuesday
105	8	7	7	12	18	9	23	20	19	14	27	32	11	20	19	17	18	12	9	11	15	18	8	14	368	Apr 15 Wednesday
106	10	10	16	27	26	10	16	27	20	9	17	26	17	14	8	14	17	18	22	13	18	5	18	30	408	Apr 16 Thursday
107	5	11	6	12	8	23	9	22	16	39	37	17	26	32	7	17	14	24	17	18	5	7	16	12	400	Apr 17 Friday
108	10	15	15	7	11	11	15	23	19	14	26	7	13	7	5	7	7	8	18	18	13	14	19	17	319	Apr 18 Saturday
109	7	9	15	13	7	6	8	10	9	15	16	16	13	9	15	7	21	9	18	10	16	12	11	28	300	Apr 19 Sunday
110	22	3	7	7	13	17	18	22	16	21	24	16	15	28	18	22	18	23	17	15	10	8	27	29	416	Apr 20 Monday
111	7	9	6	7	16	16	19	30	22	27	40	36	24	16	30	22	21	24	29	32	11	9	24	30	507	Apr 21 Tuesday
112	8	12	12	16	14	18	23	33	23	36	21	33	25	21	35	15	16	18	22	47	34	38	22	18	560	Apr 22 Wednesday
113	13	9	10	17	24	22	23	28	33	11	28	24	16	27	26	25	24	23	28	27	12	27	15	17	509	Apr 23 Thursday
114	6	12	20	18	11	52	50	36	52	33	23	34	36	36	42	25	13	61	61	47	43	7	12	22	752	Apr 24 Friday
115	8	6	13	6	3	10	18	45	34	26	13	47	11	14	16	10	12	18	23	17	11	16	28	15	420	Apr 25 Saturday
116	11	14	3	35	7	19	22	17	19	18	22	35	40	27	47	28	25	14	23	17	12	13	18	18	504	Apr 26 Sunday
117	2	7	18	9	15	5	14	18	18	29	18	17	13	16	30	19	12	17	17	10	18	19	22	23	386	Apr 27 Monday
118	18	11	12	7	10	15	17	48	60	66	26	24	26	22	13	30	24	42	25	16	26	28	30	35	631	Apr 28 Tuesday
119	36	20	19	25	25	22	34	29	40	34	22	11	18	16	17	10	16	28	30	40	26	19	18	33	588	Apr 29 Wednesday
120	21	15	22	14	21	16	19	33	21	27	48	36	35	25	36	40	53	12	23	21	17	26	32	27	640	Apr 30 Thursday
121	10	13	9	23	19	24	28	10	18	26	25	17	19	37	16	40	27	23	9	8	7	17	11	27	463	May 01 Friday
122	16	14	13	13	6	13	10	12	20	15	12	14	9	14	16	18	7	11	6	15	14	11	20	23	322	May 02 Saturday
123	11	9	14	4	5	8	3	18	46	13	6	20	12	13	11	14	12	11	15	5	7	28	13	27	325	May 03 Sunday
124	9	10	0	8	10	5	9	13	19	12	22	17	12	14	16	17	31	12	18	11	14	13	17	20	329	May 04 Monday
125	10	12	4	10	9	8	15	22	17	28	31	16	22	25	23	28	25	9	11	26	19	13	15	16	414	May 05 Tuesday
126	12	12	17	13	11	17	16	13	21	26	13	20	8	15	19	19	19	8	20	21	19	27	24	37	427	May 06 Wednesday
127	19	21	19	36	45	29	33	61	48	31	43	63	52	31	38	55	40	25	24	38	23	20	13	27	834	May 07 Thursday
128	10	15	19	11	8	6	15	12	7	16	38	13	15	11	16	14	6	32	18	10	13	27	18	27	377	May 08 Friday
129	6	9	10	10	17	11	18	12	22	24	10	21	8	17	7	7	20	11	6	6	4	6	10	18	290	May 09 Saturday
130	10	2	9	14	12	7	11	10	9	17	15	11	8	13	19	9	10	14	19	21	12	1	12	20	285	May 10 Sunday
131	10	8	14	5	10	10	17	12	12	14	32	25	17	16	23	24	21	10	19	12	14	11	6	14	356	May 11 Monday
132	7	11	8	3	6	11	10	11	16	13	36	22	28	14	9	23	22	14	15	10	22	7	19	10	347	May 12 Tuesday
133	3	6	8	11	4	8	22	10	18	13	21	17	21	26	7	13	15	12	9	7	5	22	8	28	314	May 13 Wednesday
134	11	10	11	14	16	9	15	28	10	27	29	28	20	25	17	29	9	14	11	14	24	13	20	28	432	May 14 Thursday
135	20	9	13	9	13	12	20	21	32	27	37	17	23	13	18	3	11	11	17	16	8	10	14	10	384	May 15 Friday
136	15	9	29	20	15	6	10	14	21	11	21	40	16	8	11	21	9	13	9	15	6	6	10	15	350	May 16 Saturday
137	7	9	2	9	12	6	10	17	8	15	19	20	12	14	13	15	5	8	15	19	23	25	20	25	328	May 17 Sunday
138	17	21	36	17	25	20	9	16	12	10	24	23	24	13	25	15	36	13	15	21	14	13	5	15	439	May 18 Monday
139	1	6	4	4	5	4	18	8	17	20	26	17	21	24	49	76	60	15	15	5	9	8	30	28	470	May 19 Tuesday
140	16	18	12	23	10	24	17	14	19	33	19	29	28	19	18	22	22	15	26	20	31	33	61	42	571	May 20 Wednesday
141	6	11	6	15	5	6	8	8	18	20	14	18	25	22	26	16	29	24	18	16	10	29	25	57	432	May 21 Thursday
142	10	46	5	5	15	7	19	22	21	36	42	44	23	14	14	11	16	15	14	7	10	9	4	33	442	May 22 Friday
143	61	53	14	8	15	3	7	0	16	23	20	17	12	8	12	13	15	11	6	9	8	12	62	104	509	May 23 Saturday
144	109	52	16	9	14	45	9	13	11	9	10	11	12	19	21	16	17	19	15	17	22	17	23	22	528	May 24 Sunday
145	13	12	18	21	31	55	38	38	32	34	26	26	16	33	25	17	19	12	6	9	7	11	23	14	536	May 25 Monday
146	5	18	10	5	10	7	14	24	23	23	23	18	19	25	14	18	23	23	16	6	17	15	17	16	389	May 26 Tuesday

Table 3.5.2 (Page 1 of 4)

ARC .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
147	6	14	10	14	13	10	19	34	11	28	25	34	24	15	33	35	19	14	13	13	29	17	19	30	479	May 27 Wednesday
148	14	25	15	5	14	23	5	21	28	17	40	46	18	20	21	0	6	21	28	6	25	22	25	28	473	May 28 Thursday
149	11	5	15	11	18	8	7	24	22	13	31	45	17	15	22	36	17	13	22	27	16	9	34	22	460	May 29 Friday
150	22	15	18	6	7	9	30	28	18	20	23	24	29	47	23	37	33	20	26	16	7	12	6	28	504	May 30 Saturday
151	5	6	8	11	6	16	4	5	10	18	21	13	7	18	15	10	7	13	7	7	23	12	20	11	273	May 31 Sunday
152	21	10	5	4	10	21	20	47	26	14	15	27	13	18	41	20	20	11	16	7	9	15	16	17	423	Jun 01 Monday
153	3	7	6	13	5	6	25	53	51	24	29	29	35	6	16	44	27	17	27	31	12	3	14	18	501	Jun 02 Tuesday
154	5	7	10	14	8	11	40	34	38	27	35	14	24	34	17	18	7	23	18	22	35	13	27	18	499	Jun 03 Wednesday
155	3	11	3	14	11	19	39	32	6	8	28	31	13	20	18	13	20	22	28	12	16	11	22	19	419	Jun 04 Thursday
156	14	7	14	14	19	20	42	43	33	38	33	42	58	24	21	23	21	15	24	10	12	29	15	14	585	Jun 05 Friday
157	6	12	19	9	18	16	15	28	23	10	30	37	10	12	15	14	19	9	15	6	3	10	16	16	368	Jun 06 Saturday
158	10	8	18	5	10	10	7	21	10	8	11	19	43	18	17	16	25	10	17	12	15	1	20	22	353	Jun 07 Sunday
159	13	8	8	9	11	2	17	44	43	22	26	34	10	31	9	30	40	20	44	59	53	81	79	75	768	Jun 08 Monday
160	74	63	21	14	16	15	41	44	24	23	18	24	31	25	21	43	53	26	20	21	13	3	18	8	659	Jun 09 Tuesday
161	13	11	6	14	21	7	26	48	30	31	22	41	16	25	21	21	17	16	18	17	13	8	17	13	472	Jun 10 Wednesday
162	13	3	6	8	12	15	8	17	15	22	32	17	16	20	16	18	37	23	33	32	17	19	6	8	413	Jun 11 Thursday
163	15	3	1	11	8	3	6	33	23	26	33	14	9	13	18	32	18	19	16	19	4	20	24	10	378	Jun 12 Friday
164	2	3	11	9	8	3	13	11	18	24	32	6	7	14	8	10	11	6	22	11	13	6	15	9	272	Jun 13 Saturday
165	7	3	17	7	5	2	12	12	17	17	15	28	13	12	13	20	8	24	29	8	8	5	9	14	305	Jun 14 Sunday
166	12	11	11	18	6	3	10	22	22	21	38	25	20	28	17	22	20	19	13	11	16	1	15	9	390	Jun 15 Monday
167	8	11	14	10	8	7	8	24	28	21	18	27	21	9	21	11	14	12	9	10	14	9	32	18	364	Jun 16 Tuesday
168	10	8	8	10	9	2	3	14	4	18	20	23	11	15	17	16	12	4	26	19	5	10	15	13	292	Jun 17 Wednesday
169	7	11	7	13	10	7	6	17	16	20	22	33	14	12	14	18	21	12	28	8	4	9	30	13	352	Jun 18 Thursday
170	7	6	13	3	23	12	23	18	41	31	35	43	74	40	13	9	9	15	12	16	9	9	9	21	491	Jun 19 Friday
171	12	5	5	6	11	9	8	19	26	33	32	27	12	28	18	12	16	13	16	10	32	14	23	13	400	Jun 20 Saturday
172	4	9	11	14	12	3	13	15	14	22	28	28	35	29	4	13	15	28	22	18	8	9	3	12	369	Jun 21 Sunday
173	6	9	2	4	6	10	31	27	12	17	30	21	32	17	25	22	14	32	21	9	15	8	10	16	396	Jun 22 Monday
174	6	10	3	2	6	9	2	12	14	17	40	64	37	23	35	39	23	15	27	13	15	8	8	31	459	Jun 23 Tuesday
175	7	15	12	8	6	10	32	38	29	27	33	36	18	26	11	16	15	14	20	15	13	7	14	8	430	Jun 24 Wednesday
176	10	13	8	7	12	6	24	19	35	61	30	40	27	39	18	22	28	5	31	11	4	17	10	9	486	Jun 25 Thursday
177	8	4	8	7	10	5	36	54	24	41	38	30	44	31	17	13	16	18	14	24	5	9	11	24	491	Jun 26 Friday
178	3	3	7	10	13	12	10	21	56	24	30	14	32	21	27	14	8	10	9	9	11	14	22	26	406	Jun 27 Saturday
179	10	10	19	16	5	10	9	7	13	6	17	22	25	19	26	28	35	33	44	29	20	10	3	14	430	Jun 28 Sunday
180	7	4	8	11	9	8	39	35	31	24	48	29	51	20	15	38	16	7	17	14	11	11	10	26	489	Jun 29 Monday
181	9	4	5	12	3	5	12	48	43	33	66	23	48	34	37	19	11	38	35	33	22	7	31	12	590	Jun 30 Tuesday
182	8	5	9	7	9	9	32	17	18	39	34	27	19	45	35	40	34	20	52	29	15	9	9	15	536	Jul 01 Wednesday
183	17	13	15	7	9	12	6	20	20	22	33	24	13	18	9	3	7	13	11	10	7	6	12	9	316	Jul 02 Thursday
184	8	5	11	4	16	11	29	37	23	36	26	26	59	33	0	20	24	34	15	7	5	18	8	7	462	Jul 03 Friday
185	4	13	14	22	15	1	24	25	11	26	27	33	15	16	16	6	6	19	7	13	6	4	1	7	331	Jul 04 Saturday
186	6	13	5	10	7	7	6	11	17	22	18	28	16	13	24	7	11	17	19	24	13	5	21	20	340	Jul 05 Sunday
187	7	20	25	36	34	26	23	43	23	48	48	41	36	18	19	23	18	15	35	19	17	10	12	16	612	Jul 06 Monday
188	7	14	16	11	11	19	50	38	31	37	47	39	40	23	34	27	24	20	26	41	51	25	23	26	680	Jul 07 Tuesday
189	8	20	11	17	10	16	49	46	20	22	34	33	33	29	32	38	15	18	27	25	30	18	23	23	597	Jul 08 Wednesday
190	10	15	24	11	9	11	29	24	27	35	41	35	36	27	39	36	18	29	26	14	19	14	14	24	567	Jul 09 Thursday
191	6	10	10	11	8	5	31	28	32	46	44	27	40	18	30	19	21	30	21	14	14	8	11	12	496	Jul 10 Friday
192	15	5	12	6	15	19	18	28	30	23	37	29	18	41	29	13	8	11	20	15	13	6	4	13	428	Jul 11 Saturday
193	10	10	11	20	12	15	7	18	31	26	31	26	26	13	8	12	16	19	29	25	19	27	17	11	439	Jul 12 Sunday
194	14	6	13	18	14	7	11	27	22	25	31	25	27	24	15	15	11	17	17	22	17	20	21	16	435	Jul 13 Monday
195	2	10	11	17	12	10	16	11	26	21	20	24	21	18	32	29	20	19	16	14	23	5	22	25	424	Jul 14 Tuesday
196	13	4	15	16	27	22	28	20	23	17	28	29	22	27	27	10	18	27	20	19	19	16	14	20	481	Jul 15 Wednesday
197	10	14	17	11	14	27	22	23	32	25	28	22	29	14	29	23	24	8	22	21	19	11	36	19	500	Jul 16 Thursday
198	9	11	13	6	22	25	28	22	38	63	46	49	30	41	40	15	20	34	40	34	28	16	30	21	681	Jul 17 Friday
199	8	14	8	10	27	8	12	25	47	62	43	37	25	40	35	49	41	33	34	27	29	16	13	18	661	Jul 18 Saturday
200	16	6	9	14	27	13	21	11	9	13	20	19	9	11	10	20	23	23	14	3	9	4	10	19	333	Jul 19 Sunday
201	3	16	6	27	12	14	15	30	26	15	23	14	14	21	12	24	29	17	33	7	15	19	17	16	425	Jul 20 Monday
202	16	7	16	21	12	2	27	31	35	21	26	18	5	11	25	11	17	18	9	10	7	5	10	10	370	Jul 21 Tuesday

Table 3.5.2 (Page 2 of 4)

ARC .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
203	6	9	15	6	10	9	23	29	28	22	34	10	24	23	15	19	7	12	24	14	14	15	24	21	413	Jul 22 Wednesday
204	9	3	12	6	14	5	24	20	17	21	19	43	18	12	20	32	18	19	19	21	21	10	18	11	412	Jul 23 Thursday
205	3	4	10	12	12	7	12	30	38	13	20	40	23	13	24	26	10	9	20	6	20	4	19	11	386	Jul 24 Friday
206	4	0	5	12	1	7	6	22	22	10	15	9	17	13	6	11	6	12	7	6	12	5	6	14	228	Jul 25 Saturday
207	5	6	5	9	6	19	11	6	27	46	9	18	23	22	20	6	7	10	14	23	20	27	11	14	364	Jul 26 Sunday
208	6	8	3	8	6	2	11	24	32	34	10	26	29	16	18	13	19	10	13	15	7	4	10	22	346	Jul 27 Monday
209	2	4	7	13	5	9	11	27	27	17	38	23	26	8	13	13	17	19	29	3	4	9	8	28	360	Jul 28 Tuesday
210	24	5	11	7	3	8	15	16	18	30	38	31	11	19	13	20	18	35	27	20	19	19	11	14	432	Jul 29 Wednesday
211	8	3	3	6	12	7	6	16	10	32	15	20	9	10	8	8	11	14	7	17	16	6	14	16	274	Jul 30 Thursday
212	11	13	5	4	10	5	15	23	31	38	43	31	24	27	20	20	19	14	24	13	13	12	12	15	442	Jul 31 Friday
213	12	17	4	9	9	4	2	21	20	20	32	31	7	4	6	25	27	17	23	18	10	19	21	22	380	Aug 01 Saturday
214	9	7	15	5	14	14	10	10	19	41	23	28	27	27	36	11	15	17	22	40	20	10	14	15	449	Aug 02 Sunday
215	8	16	8	1	8	22	8	5	26	27	22	40	16	13	11	24	24	14	10	20	14	8	5	17	367	Aug 03 Monday
216	2	5	9	4	7	7	26	37	35	23	37	31	20	16	14	19	9	13	27	13	8	31	7	25	425	Aug 04 Tuesday
217	5	10	9	12	5	12	17	28	19	47	43	28	16	22	13	17	16	22	29	17	14	11	19	11	442	Aug 05 Wednesday
218	14	4	7	2	4	10	16	55	53	46	33	29	20	33	23	26	27	19	10	29	10	5	13	15	503	Aug 06 Thursday
219	7	7	11	8	10	8	30	35	40	23	36	15	12	18	16	19	14	22	16	14	11	18	16	17	423	Aug 07 Friday
220	16	9	10	3	39	7	10	7	13	18	19	12	18	20	12	12	30	14	13	9	17	17	16	19	360	Aug 08 Saturday
221	21	6	9	8	10	15	3	12	11	16	26	27	7	10	10	11	24	24	47	12	10	5	12	11	347	Aug 09 Sunday
222	4	1	8	8	10	6	7	13	19	14	23	22	28	12	14	14	29	17	29	39	29	18	17	20	401	Aug 10 Monday
223	9	3	10	8	13	8	22	38	20	34	28	30	18	39	9	29	22	29	25	18	9	29	24	22	496	Aug 11 Tuesday
224	12	8	2	13	12	9	23	17	25	28	47	31	22	25	30	15	23	16	25	18	22	9	20	10	462	Aug 12 Wednesday
225	15	12	6	7	4	7	25	27	15	18	29	29	27	9	18	6	29	22	15	16	23	5	17	21	402	Aug 13 Thursday
226	6	4	12	8	17	8	34	44	27	28	20	42	32	36	10	14	18	12	26	4	12	8	15	13	450	Aug 14 Friday
227	9	7	12	5	7	25	17	42	10	7	26	12	17	17	17	5	26	12	31	2	12	10	8	11	347	Aug 15 Saturday
228	3	3	13	3	10	11	6	9	5	22	17	9	18	14	13	10	25	6	31	11	20	14	17	22	312	Aug 16 Sunday
229	4	4	5	4	4	4	8	20	42	21	13	26	20	17	8	22	31	22	18	19	19	7	10	13	361	Aug 17 Monday
230	7	1	3	6	10	12	33	37	48	25	27	20	16	13	10	20	17	20	27	13	15	14	18	35	447	Aug 18 Tuesday
231	16	11	13	6	12	11	21	24	30	28	28	53	39	23	24	22	18	18	18	34	10	7	19	25	510	Aug 19 Wednesday
232	13	3	4	11	7	29	21	49	36	23	21	9	29	22	33	35	41	23	27	19	26	9	21	27	538	Aug 20 Thursday
233	14	20	8	6	16	25	25	51	39	46	23	50	22	17	25	24	7	5	17	23	12	20	27	22	544	Aug 21 Friday
234	10	5	24	17	12	9	3	12	24	33	23	20	13	24	26	26	28	17	12	8	13	11	24	26	420	Aug 22 Saturday
235	13	1	0	0	0	0	0	0	0	21	3	25	28	49	86	36	28	30	39	44	19	16	15	32	485	Aug 23 Sunday
236	19	8	5	9	14	10	12	24	35	35	39	23	18	13	15	9	18	7	10	22	25	19	15	22	426	Aug 24 Monday
237	13	5	7	6	13	27	18	32	41	34	28	27	41	48	33	27	14	23	16	19	17	26	35	48	598	Aug 25 Tuesday
238	22	26	17	14	14	15	8	8	31	11	17	13	14	8	14	20	8	7	14	10	16	7	3	9	326	Aug 26 Wednesday
239	23	1	7	5	11	12	16	16	16	34	31	23	17	20	16	15	10	12	26	17	7	8	13	29	385	Aug 27 Thursday
240	6	13	7	13	13	12	10	9	27	38	24	24	33	31	16	12	16	15	11	20	10	8	40	17	425	Aug 28 Friday
241	6	10	16	5	4	7	11	17	32	17	26	17	6	7	11	14	20	17	10	10	7	17	28	16	331	Aug 29 Saturday
242	15	16	24	22	22	8	12	18	15	16	30	22	5	13	23	13	20	14	26	8	12	10	24	11	399	Aug 30 Sunday
243	10	21	20	17	17	12	13	26	17	12	28	31	17	27	18	13	29	38	32	21	16	21	6	16	478	Aug 31 Monday
244	9	9	6	9	23	17	22	34	23	39	29	24	41	15	29	21	9	26	24	22	10	11	14	9	475	Sep 01 Tuesday
245	11	10	9	8	21	11	21	21	26	33	31	19	21	14	13	19	14	12	24	21	24	11	17	16	427	Sep 02 Wednesday
246	14	3	5	8	17	17	21	9	22	27	62	19	20	12	38	31	25	12	28	22	21	24	17	21	495	Sep 03 Thursday
247	17	16	11	7	9	8	18	33	53	16	32	41	26	16	8	45	16	30	28	41	15	23	5	12	526	Sep 04 Friday
248	6	23	7	18	16	31	11	10	34	41	32	23	41	47	32	22	6	17	10	10	11	14	16	10	488	Sep 05 Saturday
249	9	12	8	5	11	5	4	18	8	10	13	6	9	5	18	9	18	30	12	11	8	10	15	13	267	Sep 06 Sunday
250	8	9	5	14	17	9	26	16	20	18	13	16	23	36	24	34	15	16	20	21	15	23	17	20	435	Sep 07 Monday
251	5	12	18	16	15	11	8	2	19	27	27	26	36	16	19	24	21	23	19	25	7	13	6	12	407	Sep 08 Tuesday
252	8	9	8	8	23	20	27	32	28	28	54	35	50	29	30	28	21	10	11	34	11	4	23	33	564	Sep 09 Wednesday
253	7	6	8	21	9	18	7	25	24	10	39	18	8	26	18	9	12	16	19	19	8	8	21	22	378	Sep 10 Thursday
254	5	7	7	11	12	19	16	14	20	25	19	22	24	14	12	20	5	9	10	9	9	6	17	24	336	Sep 11 Friday
255	6	12	10	11	9	6	7	1	7	9	22	14	8	11	20	9	14	20	12	11	17	14	10	22	282	Sep 12 Saturday
256	9	10	11	14	12	11	13	10	19	10	22	17	3	21	12	24	16	10	11	22	13	9	15	27	341	Sep 13 Sunday
257	11	1	5	7	10	14	18	14	20	12	28	20	16	11	23	44	8	34	29	17	19	16	14	33	424	Sep 14 Monday
258	16	19	15	23	16	25	29	19	39	31	39	24	21	23	32	32	30	13	13	12	12	13	19	20	535	Sep 15 Tuesday

Table 3.5.2 (Page 3 of 4)

ARC .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
259	9	13	7	3	16	9	17	27	28	12	23	27	31	19	23	14	25	16	23	10	13	20	13	21	419	Sep 16 Wednesday
260	13	8	10	12	15	7	16	19	40	19	19	27	13	12	14	11	16	20	20	15	12	19	10	15	382	Sep 17 Thursday
261	10	8	6	12	19	4	13	18	36	33	26	33	30	26	17	32	25	27	39	37	20	32	28	30	561	Sep 18 Friday
262	28	30	35	11	48	25	56	31	26	18	30	27	19	22	49	24	27	26	32	43	14	15	19	13	668	Sep 19 Saturday
263	14	1	11	17	24	7	15	18	20	10	14	6	4	17	12	7	24	10	17	10	13	14	18	15	318	Sep 20 Sunday
264	8	8	19	12	8	12	7	12	16	25	23	18	21	19	11	22	13	17	19	5	16	8	13	19	351	Sep 21 Monday
265	12	8	10	9	17	6	19	19	17	21	19	17	21	25	17	14	17	10	9	12	10	6	11	13	339	Sep 22 Tuesday
266	8	8	3	5	7	8	13	12	18	10	9	19	15	22	15	28	14	17	18	8	10	9	13	25	314	Sep 23 Wednesday
267	8	2	11	9	17	5	14	9	21	11	23	20	17	29	27	15	21	12	18	14	17	12	13	24	369	Sep 24 Thursday
268	13	9	13	6	6	18	8	17	23	31	26	25	23	15	20	26	18	13	22	23	11	11	18	15	410	Sep 25 Friday
269	13	11	7	21	11	15	9	14	11	12	4	15	19	8	15	21	8	16	9	14	18	9	23	11	314	Sep 26 Saturday
270	8	16	11	6	10	9	11	11	1	35	35	36	43	14	15	15	28	12	12	17	7	15	15	18	400	Sep 27 Sunday
271	7	11	7	25	17	15	14	10	16	21	25	9	15	45	11	43	29	14	36	18	20	17	21	13	459	Sep 28 Monday
272	12	18	13	11	11	38	22	11	25	16	23	33	22	44	25	35	13	20	19	19	11	8	30	15	494	Sep 29 Tuesday
273	15	11	13	13	13	7	21	22	33	21	49	39	23	30	36	33	35	30	29	11	29	13	15	31	572	Sep 30 Wednesday
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		2002		2142		2365		4198		4428		4652		3784		3740		3178		3141		2503		3696		
	2113		2068		2458		3267		4362		4889		3975		3671		3498		3737		2784		3215		79866	Total sum
183	12	11	11	12	13	13	18	23	24	24	27	25	22	21	20	20	19	17	20	17	15	14	18	20	436	Total average
125	11	11	11	11	13	13	20	25	26	26	29	27	24	22	20	22	20	18	21	18	16	14	18	20	458	Average workdays
58	13	12	13	12	14	12	13	18	19	20	21	21	17	18	19	16	18	16	18	15	13	12	16	20	385	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
91	6	12	6	5	8	4	11	6	12	21	20	13	10	16	13	11	12	19	21	11	17	15	24	30	323	Apr 01 Wednesday
92	24	21	47	15	27	43	44	15	20	17	10	12	21	15	15	12	13	9	16	12	11	19	23	15	476	Apr 02 Thursday
93	25	35	43	38	72	83	82	35	20	24	23	27	23	20	30	34	20	4	14	15	15	10	14	16	722	Apr 03 Friday
94	16	15	14	18	22	34	47	62	17	11	14	13	12	10	33	33	41	14	7	21	10	15	14	15	508	Apr 04 Saturday
95	15	14	20	19	23	45	63	70	14	4	13	8	17	25	45	48	42	23	22	18	24	20	27	14	633	Apr 05 Sunday
96	22	24	23	12	12	12	6	14	19	7	38	36	19	31	14	9	6	11	19	27	31	28	19	12	451	Apr 06 Monday
97	20	14	11	7	9	10	12	13	19	23	20	11	13	16	12	10	10	6	11	8	13	16	19	13	316	Apr 07 Tuesday
98	15	15	15	18	13	3	10	9	10	19	13	12	22	15	12	13	8	32	31	18	25	25	25	22	400	Apr 08 Wednesday
99	24	17	22	18	23	48	57	43	25	18	22	19	19	24	7	6	5	22	27	6	16	11	14	11	504	Apr 09 Thursday
100	9	18	20	17	30	88	93	57	8	17	17	40	37	27	3	13	15	22	17	39	41	33	19	10	690	Apr 10 Friday
101	7	17	9	5	9	7	14	27	30	33	15	6	10	9	7	6	1	8	26	26	17	14	16	15	334	Apr 11 Saturday
102	13	14	11	12	17	43	36	24	17	5	14	13	8	6	15	15	13	3	12	6	4	7	6	14	328	Apr 12 Sunday
103	6	11	10	7	9	8	9	14	16	25	33	28	33	42	33	30	33	32	25	37	39	35	34	29	578	Apr 13 Monday
104	30	34	29	16	4	10	11	9	17	9	12	14	14	10	20	5	0	0	0	0	0	0	0	0	244	Apr 14 Tuesday
105	0	0	0	0	2	12	4	9	8	21	22	9	9	9	23	21	5	9	9	15	11	37	12	5	252	Apr 15 Wednesday
106	7	12	5	10	12	1	14	7	15	11	19	20	23	30	17	9	11	7	9	4	11	11	17	25	307	Apr 16 Thursday
107	14	15	27	22	21	9	8	6	16	14	16	24	10	13	5	9	8	9	7	10	8	10	6	7	294	Apr 17 Friday
108	6	6	6	5	9	2	7	8	4	4	13	7	1	9	5	12	12	12	9	9	3	8	2	1	160	Apr 18 Saturday
109	0	1	9	7	0	6	3	0	4	7	4	2	9	2	9	9	9	6	4	6	10	8	11	11	137	Apr 19 Sunday
110	11	8	10	4	4	1	3	20	6	16	10	11	11	13	15	5	11	4	17	10	16	7	11	24	248	Apr 20 Monday
111	11	9	10	10	8	14	1	5	6	17	22	14	13	19	12	6	12	12	12	9	8	8	7	8	253	Apr 21 Tuesday
112	11	8	7	4	1	3	5	6	9	23	14	23	23	11	12	7	8	4	8	3	14	19	21	8	252	Apr 22 Wednesday
113	10	4	11	20	8	11	8	8	19	11	26	23	13	28	17	16	14	9	7	6	11	12	11	10	313	Apr 23 Thursday
114	14	12	7	9	3	9	8	10	16	19	12	15	4	7	8	8	6	14	13	6	19	10	11	15	255	Apr 24 Friday
115	14	7	13	4	8	10	4	4	13	6	7	10	7	1	3	6	6	7	5	2	5	11	5	10	168	Apr 25 Saturday
116	2	12	4	5	6	4	10	3	8	6	2	2	7	5	4	6	8	7	7	10	13	6	14	4	155	Apr 26 Sunday
117	7	2	2	1	0	0	7	6	11	7	18	10	7	12	5	5	7	3	14	7	6	4	6	6	153	Apr 27 Monday
118	7	7	4	6	2	3	3	9	13	7	26	15	15	11	13	19	15	26	4	5	12	7	8	11	248	Apr 28 Tuesday
119	19	5	8	10	3	4	8	11	24	16	15	22	14	7	5	9	5	7	10	5	14	9	9	9	248	Apr 29 Wednesday
120	12	6	8	6	6	5	10	11	12	13	23	8	10	23	12	18	5	11	17	13	10	16	11	11	277	Apr 30 Thursday
121	8	2	5	6	8	5	3	6	5	29	29	34	35	41	24	15	6	5	4	0	0	0	0	0	270	May 01 Friday
122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	12	10	4	33	May 02 Saturday
123	4	1	8	2	8	4	4	3	1	7	10	5	8	4	8	9	8	4	5	7	4	11	7	12	144	May 03 Sunday
124	24	9	8	2	3	0	5	8	9	4	12	15	12	13	8	5	14	9	9	4	3	2	10	9	197	May 04 Monday
125	9	4	6	7	0	5	4	11	14	12	18	12	18	16	8	13	3	9	2	5	11	5	6	2	200	May 05 Tuesday
126	5	6	14	1	1	9	3	9	10	14	10	13	11	13	8	6	5	3	4	6	7	3	5	0	166	May 06 Wednesday
127	6	7	6	2	0	2	3	5	7	21	15	20	17	8	11	10	5	5	5	2	1	2	2	5	167	May 07 Thursday
128	6	5	12	4	3	3	4	7	10	19	8	14	6	8	3	0	1	7	4	1	8	2	7	6	148	May 08 Friday
129	6	8	2	8	6	7	6	6	1	5	12	13	3	5	1	4	7	7	2	3	2	19	0	8	141	May 09 Saturday
130	17	3	6	3	2	4	7	3	9	5	7	5	6	1	6	8	6	16	6	6	5	7	6	4	148	May 10 Sunday
131	7	11	9	6	3	3	4	3	4	4	19	11	9	2	5	5	4	3	4	6	2	3	3	4	134	May 11 Monday
132	7	4	6	2	4	7	2	6	12	6	13	13	16	6	3	10	7	9	4	4	7	10	5	9	172	May 12 Tuesday
133	5	10	5	4	0	3	6	1	22	13	24	12	11	8	4	12	7	7	5	5	9	2	8	19	202	May 13 Wednesday
134	12	11	8	5	7	3	9	7	6	22	23	21	18	9	16	8	4	11	6	14	9	7	3	10	249	May 14 Thursday
135	12	10	6	4	1	7	15	5	11	11	22	22	16	13	7	4	5	2	11	6	6	5	9	12	222	May 15 Friday
136	4	5	17	8	9	1	3	5	4	1	12	12	3	8	17	5	4	1	6	13	3	1	3	8	153	May 16 Saturday
137	9	9	2	5	10	5	3	7	3	5	6	9	7	5	5	3	4	4	7	7	11	6	12	11	155	May 17 Sunday
138	9	7	8	6	3	2	5	2	10	20	15	18	22	5	11	4	7	7	13	6	21	4	7	3	215	May 18 Monday
139	3	4	4	1	4	2	7	3	7	7	10	15	11	5	8	4	6	8	2	4	5	4	6	4	134	May 19 Tuesday
140	2	5	5	7	1	2	18	6	10	32	8	12	10	6	6	3	5	4	6	4	2	1	7	13	175	May 20 Wednesday
141	6	4	4	4	2	8	7	6	5	13	14	7	12	15	0	6	3	9	12	14	12	7	7	1	178	May 21 Thursday
142	0	0	0	0	0	0	0	0	0	2	12	17	4	6	4	3	2	9	5	4	12	10	4	1	95	May 22 Friday
143	7	3	7	3	4	2	0	3	4	1	3	3	3	5	9	1	4	9	6	3	3	4	3	6	96	May 23 Saturday
144	2	5	13	4	0	7	6	4	4	3	3	2	4	6	5	1	2	1	3	5	1	4	6	8	99	May 24 Sunday
145	11	8	8	5	0	3	5	1	5	11	12	9	8	10	3	1	4	5	6	9	5	8	13	6	156	May 25 Monday
146	11	8	8	5	2	3	5	7	8	16	12	12	14	10	13	13	9	10	12	4	9	8	6	10	215	May 26 Tuesday

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
147	8	20	11	11	7	6	6	6	13	10	26	15	18	7	15	20	7	6	13	8	12	11	9	11	276	May 27 Wednesday
148	15	19	9	2	2	14	10	11	18	11	35	19	19	9	10	9	4	5	13	6	11	13	2	0	266	May 28 Thursday
149	0	0	0	0	2	8	6	7	18	23	12	20	9	10	8	8	1	6	10	5	5	4	10	4	176	May 29 Friday
150	3	3	7	2	7	3	17	13	4	8	6	7	4	8	4	6	7	6	18	7	4	10	6	6	166	May 30 Saturday
151	3	3	6	13	6	3	4	5	2	0	6	10	4	3	4	7	2	8	7	10	14	7	10	6	143	May 31 Sunday
152	9	10	5	10	5	9	8	11	19	9	14	21	7	8	11	7	6	7	6	3	0	6	5	4	200	Jun 01 Monday
153	3	7	7	16	1	1	2	5	7	13	8	23	18	4	7	9	6	7	11	8	11	10	4	3	191	Jun 02 Tuesday
154	8	11	4	3	3	1	1	8	18	8	16	10	10	5	8	8	5	13	11	3	6	8	6	4	178	Jun 03 Wednesday
155	6	7	8	5	26	2	2	7	7	20	14	14	10	9	6	3	6	5	3	8	4	11	10	5	198	Jun 04 Thursday
156	9	5	8	4	3	1	3	15	20	17	7	11	9	4	1	3	6	3	1	3	2	5	2	3	145	Jun 05 Friday
157	3	1	5	1	10	0	2	5	4	4	5	5	2	6	8	11	8	7	3	13	4	5	8	4	124	Jun 06 Saturday
158	7	2	8	0	7	2	2	6	2	4	9	4	20	8	12	6	12	8	6	12	7	8	10	9	171	Jun 07 Sunday
159	8	9	6	7	0	6	7	9	21	15	14	13	1	5	7	9	7	17	10	5	8	1	2	6	193	Jun 08 Monday
160	6	6	5	2	2	0	1	8	10	7	21	16	10	4	4	26	11	3	4	7	10	1	2	7	173	Jun 09 Tuesday
161	8	3	4	9	7	9	4	11	11	13	12	9	4	3	11	6	9	9	11	13	17	12	17	7	219	Jun 10 Wednesday
162	6	2	6	5	6	10	4	9	18	18	14	16	11	16	4	11	8	14	15	15	5	5	7	7	232	Jun 11 Thursday
163	8	2	6	7	0	2	3	10	13	16	8	18	11	10	12	16	16	12	20	17	9	19	16	8	259	Jun 12 Friday
164	1	7	11	4	4	4	5	6	10	4	2	14	2	1	4	5	9	6	5	9	2	2	7	8	132	Jun 13 Saturday
165	4	4	6	2	5	10	4	3	7	15	37	32	29	28	20	19	6	13	12	17	9	13	10	12	317	Jun 14 Sunday
166	8	7	16	10	2	9	3	9	6	24	19	11	10	9	0	10	9	2	4	22	18	5	8	4	225	Jun 15 Monday
167	11	6	9	4	5	4	6	11	13	14	27	9	18	15	13	6	6	6	4	5	8	4	11	6	221	Jun 16 Tuesday
168	8	4	7	7	5	6	5	4	7	11	19	12	9	10	14	10	7	5	11	8	4	2	9	5	189	Jun 17 Wednesday
169	4	10	3	3	9	7	6	15	16	11	12	11	6	1	7	6	6	6	5	11	5	5	7	9	181	Jun 18 Thursday
170	5	5	8	4	7	7	5	9	13	13	15	11	16	2	6	6	9	6	6	4	2	2	7	9	177	Jun 19 Friday
171	7	6	14	7	7	4	4	4	3	9	3	14	6	3	2	3	8	2	7	5	8	4	20	7	157	Jun 20 Saturday
172	2	6	3	7	10	18	22	5	2	6	11	5	7	6	4	13	8	7	4	14	11	10	8	4	193	Jun 21 Sunday
173	9	3	9	7	4	1	3	3	7	4	13	9	11	13	5	8	1	3	1	0	0	0	0	0	114	Jun 22 Monday
174	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	10	2	4	8	34	Jun 23 Tuesday
175	2	5	6	1	5	3	1	3	15	15	11	12	14	14	7	16	14	8	15	5	6	16	9	10	213	Jun 24 Wednesday
176	13	10	15	5	10	5	11	4	16	11	7	3	13	7	12	14	10	10	9	7	9	14	4	9	228	Jun 25 Thursday
177	9	12	7	8	3	5	3	4	20	24	13	17	23	11	6	7	8	8	9	13	11	8	9	4	242	Jun 26 Friday
178	9	4	12	4	8	4	8	12	16	21	23	27	25	35	23	37	29	52	32	23	15	12	2	12	445	Jun 27 Saturday
179	6	1	5	3	14	3	9	18	23	38	34	36	40	44	53	50	44	46	34	28	22	26	17	22	616	Jun 28 Sunday
180	9	11	8	9	7	5	13	15	15	10	11	10	21	7	9	10	6	13	8	7	21	10	13	9	257	Jun 29 Monday
181	13	6	10	9	1	5	3	8	8	10	16	20	23	26	29	37	31	27	13	11	20	7	12	7	352	Jun 30 Tuesday
182	9	10	10	8	1	3	6	11	10	21	17	14	16	22	22	18	24	4	42	21	10	9	16	2	326	Jul 01 Wednesday
183	14	6	7	8	5	9	9	8	15	7	20	10	10	10	11	11	7	3	13	9	7	8	15	3	225	Jul 02 Thursday
184	14	10	10	12	2	4	10	14	7	10	10	11	13	9	4	2	1	3	8	8	2	5	22	2	193	Jul 03 Friday
185	3	5	4	5	7	4	4	14	7	6	10	19	8	3	5	4	4	4	24	19	2	3	5	1	170	Jul 04 Saturday
186	3	3	1	4	5	4	4	2	8	13	9	5	8	6	3	7	3	6	10	9	7	9	12	8	149	Jul 05 Sunday
187	5	6	5	6	0	4	1	5	8	15	13	20	12	14	13	5	8	4	15	7	13	15	18	18	230	Jul 06 Monday
188	28	36	19	31	11	21	21	23	29	26	32	25	26	30	24	42	26	14	28	22	18	27	24	16	599	Jul 07 Tuesday
189	28	27	24	15	15	23	20	23	21	22	31	26	25	24	29	23	20	28	28	30	34	36	31	27	610	Jul 08 Wednesday
190	30	29	21	17	14	33	25	23	29	25	33	29	20	25	27	41	30	36	35	28	32	28	30	31	671	Jul 09 Thursday
191	19	8	56	12	12	37	57	34	7	10	12	20	13	13	15	11	16	16	13	16	22	21	13	24	477	Jul 10 Friday
192	17	16	14	16	17	14	21	17	20	10	15	17	16	18	30	34	29	42	28	45	13	20	30	22	521	Jul 11 Saturday
193	26	18	20	15	28	40	40	28	22	19	22	30	29	21	28	22	17	27	26	26	37	38	28	26	633	Jul 12 Sunday
194	26	23	27	40	34	30	16	12	18	13	15	15	16	16	17	22	18	24	20	21	19	28	25	27	522	Jul 13 Monday
195	32	26	18	26	29	22	16	12	20	26	21	17	22	25	22	16	35	26	17	25	22	22	27	38	562	Jul 14 Tuesday
196	24	29	26	11	24	14	12	20	28	25	16	20	15	20	22	14	24	28	38	23	22	24	37	36	552	Jul 15 Wednesday
197	31	20	17	19	14	16	18	8	5	23	13	17	18	19	16	16	23	12	8	12	14	16	29	18	402	Jul 16 Thursday
198	19	24	23	16	13	8	12	19	41	25	19	31	31	26	33	30	27	37	35	28	32	32	34	31	626	Jul 17 Friday
199	30	49	33	33	35	27	26	27	27	31	29	35	33	33	30	35	32	34	32	33	32	35	38	25	774	Jul 18 Saturday
200	31	24	29	23	27	27	26	23	23	34	32	29	33	31	33	29	36	31	32	19	28	22	30	25	677	Jul 19 Sunday
201	32	27	17	21	18	14	11	12	17	19	17	14	20	13	26	30	21	17	30	24	20	23	28	26	497	Jul 20 Monday
202	25	24	28	26	19	9	13	14	20	21	21	14	20	21	20	20	23	23	17	27	18	23	20	24	490	Jul 21 Tuesday

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
203	28	31	28	18	12	16	13	19	16	31	37	28	20	37	23	36	34	33	34	35	28	30	21	23	631	Jul 22 Wednesday
204	28	26	34	26	13	15	27	25	31	21	26	46	28	25	23	26	18	19	29	30	29	30	21	30	626	Jul 23 Thursday
205	27	24	28	20	16	19	18	17	33	32	26	31	27	23	36	28	31	37	38	30	37	38	28	36	680	Jul 24 Friday
206	32	36	42	40	34	28	31	27	26	36	30	30	24	32	29	38	32	32	27	30	30	33	28	29	756	Jul 25 Saturday
207	34	38	28	27	25	29	29	29	27	26	30	23	33	22	26	36	43	19	25	28	29	22	28	25	681	Jul 26 Sunday
208	27	25	28	22	19	11	10	26	25	23	20	22	14	18	18	14	14	13	24	23	25	24	26	31	502	Jul 27 Monday
209	29	27	26	20	16	16	13	24	15	12	29	30	33	27	36	32	38	30	30	34	37	31	36	27	648	Jul 28 Tuesday
210	36	27	26	16	29	13	7	26	17	10	17	36	18	15	8	9	8	9	7	4	3	5	6	5	357	Jul 29 Wednesday
211	4	0	5	5	16	8	11	12	14	21	25	14	24	24	13	17	17	17	15	11	20	17	20	15	345	Jul 30 Thursday
212	5	13	7	16	14	10	5	5	18	21	11	23	23	40	19	11	11	21	13	20	11	22	21	16	376	Jul 31 Friday
213	8	14	8	12	15	14	10	10	24	14	12	17	19	23	29	17	24	12	15	11	28	27	16	15	394	Aug 01 Saturday
214	5	11	15	21	20	16	10	17	15	20	22	22	31	11	20	18	18	25	20	26	27	26	23	27	466	Aug 02 Sunday
215	14	18	20	19	22	18	11	23	15	18	23	17	23	33	26	21	20	25	23	22	23	20	26	22	502	Aug 03 Monday
216	12	16	13	36	21	13	14	16	17	24	14	36	26	23	17	22	17	13	16	22	14	23	20	22	467	Aug 04 Tuesday
217	13	10	12	14	13	10	17	15	29	25	24	23	22	23	21	13	15	24	11	18	15	17	17	12	413	Aug 05 Wednesday
218	16	9	17	9	10	8	9	10	20	15	15	14	17	26	24	12	8	6	5	3	6	3	7	6	275	Aug 06 Thursday
219	10	9	9	13	8	6	2	12	13	15	17	29	14	12	5	13	10	10	10	9	7	8	8	9	258	Aug 07 Friday
220	5	17	29	8	6	16	6	7	9	11	7	4	8	13	20	7	7	10	11	8	5	4	4	1	223	Aug 08 Saturday
221	10	8	18	28	21	31	13	9	14	12	10	11	13	3	4	12	6	8	8	10	7	11	17	29	313	Aug 09 Sunday
222	6	4	8	12	9	4	14	11	6	13	11	15	6	9	17	8	3	5	10	4	8	15	8	6	212	Aug 10 Monday
223	3	2	12	8	3	7	4	12	16	9	9	17	14	24	8	12	12	11	16	5	3	6	8	19	240	Aug 11 Tuesday
224	15	7	10	5	2	5	13	10	12	17	14	16	13	14	24	7	9	9	11	7	8	6	6	12	252	Aug 12 Wednesday
225	10	11	10	6	4	10	14	7	14	13	5	20	6	11	6	6	11	17	11	10	21	7	13	11	254	Aug 13 Thursday
226	9	4	4	4	5	7	8	4	12	11	13	10	11	10	9	4	7	21	6	21	8	4	1	7	200	Aug 14 Friday
227	6	0	0	0	0	0	0	0	34	17	13	6	5	6	7	17	11	6	8	9	7	4	4	5	165	Aug 15 Saturday
228	4	19	18	8	6	23	14	12	4	23	8	12	7	4	7	8	20	22	4	8	5	6	8	6	256	Aug 16 Sunday
229	2	7	5	7	3	2	5	6	9	5	23	12	19	15	17	12	6	5	4	4	8	6	8	20	210	Aug 17 Monday
230	9	20	9	0	12	14	10	11	15	22	34	27	12	16	12	9	6	4	2	9	32	8	6	4	303	Aug 18 Tuesday
231	11	5	4	5	5	5	8	9	15	21	10	19	22	10	10	9	8	4	7	15	7	10	9	11	239	Aug 19 Wednesday
232	9	24	20	13	4	14	16	14	11	18	7	18	4	12	6	21	10	12	8	12	6	10	28	16	313	Aug 20 Thursday
233	5	12	8	6	3	4	17	26	7	18	7	15	12	1	8	6	1	4	8	4	8	4	6	7	197	Aug 21 Friday
234	6	4	5	8	6	6	10	6	8	7	5	8	9	5	5	11	8	5	4	5	5	4	17	8	165	Aug 22 Saturday
235	7	1	1	3	6	11	23	9	9	1	8	4	7	9	13	5	9	7	12	14	10	11	10	7	197	Aug 23 Sunday
236	15	30	16	21	12	5	3	4	3	11	12	21	16	8	12	8	4	12	1	8	7	3	9	11	252	Aug 24 Monday
237	6	18	17	21	8	7	0	12	14	13	15	24	16	12	21	19	5	11	6	11	5	6	14	11	292	Aug 25 Tuesday
238	9	7	16	39	30	24	8	11	20	15	7	23	18	5	4	13	7	4	4	2	2	6	6	8	288	Aug 26 Wednesday
239	18	26	37	21	17	10	7	13	10	20	19	18	8	10	14	10	9	6	4	7	1	8	11	7	311	Aug 27 Thursday
240	4	9	1	4	5	3	2	5	21	15	21	13	14	5	7	13	9	9	3	5	6	8	12	8	202	Aug 28 Friday
241	7	9	7	0	15	12	7	7	11	9	6	8	3	9	4	6	5	6	3	2	4	6	6	6	158	Aug 29 Saturday
242	4	2	16	11	7	4	15	3	3	7	7	11	6	3	7	10	15	6	13	2	8	6	7	18	191	Aug 30 Sunday
243	11	3	7	10	5	4	7	2	5	10	10	8	9	8	12	10	4	11	6	16	12	8	1	5	184	Aug 31 Monday
244	9	17	3	4	4	7	4	6	13	6	12	21	4	14	14	9	5	11	6	4	8	3	18	4	206	Sep 01 Tuesday
245	10	7	11	5	5	1	4	9	20	15	15	17	11	20	20	3	16	12	5	12	9	7	5	2	241	Sep 02 Wednesday
246	10	14	14	5	5	3	6	6	20	17	14	21	17	10	8	10	4	16	14	7	7	11	7	10	256	Sep 03 Thursday
247	10	9	13	6	3	5	5	8	11	16	17	9	11	6	10	11	16	7	7	1	5	7	6	6	205	Sep 04 Friday
248	19	14	11	8	9	11	4	7	4	4	6	2	8	24	5	9	5	10	5	6	3	3	2	7	186	Sep 05 Saturday
249	15	5	6	13	11	6	5	9	7	9	6	15	2	12	4	7	4	6	13	4	11	11	8	5	194	Sep 06 Sunday
250	9	11	16	3	3	1	2	10	4	16	16	15	13	12	19	14	9	11	7	11	5	6	12	15	240	Sep 07 Monday
251	17	11	8	6	6	5	6	9	7	18	19	16	13	15	16	4	2	12	4	8	11	16	5	8	242	Sep 08 Tuesday
252	4	11	11	6	3	2	8	1	18	16	14	14	12	9	5	7	14	3	4	6	7	4	2	4	185	Sep 09 Wednesday
253	7	5	4	9	6	8	6	10	4	13	12	16	7	14	8	4	7	4	7	1	0	0	22	21	195	Sep 10 Thursday
254	3	0	0	1	3	12	7	29	14	19	21	18	13	7	10	13	10	5	3	5	5	4	9	5	216	Sep 11 Friday
255	3	10	3	8	5	5	5	6	5	6	7	2	4	1	6	13	10	8	11	6	6	4	3	4	141	Sep 12 Saturday
256	5	4	3	4	2	4	4	6	2	4	6	5	2	6	6	10	7	11	7	7	9	6	14	35	169	Sep 13 Sunday
257	10	4	5	12	8	9	4	3	12	29	11	9	18	4	14	16	9	7	7	7	3	6	30	45	282	Sep 14 Monday
258	12	15	23	25	20	27	31	18	9	16	15	13	16	9	6	10	9	3	5	24	20	6	5	8	345	Sep 15 Tuesday

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
259	7	8	5	4	6	4	9	12	6	17	20	33	22	0	10	22	5	12	8	7	24	50	32	25	348	Sep 16 Wednesday
260	21	8	0	0	0	7	16	17	33	25	19	24	13	35	31	7	5	13	7	18	37	35	20	10	401	Sep 17 Thursday
261	21	16	15	18	29	38	34	27	28	33	26	11	24	24	16	16	10	16	16	41	18	12	8	6	503	Sep 18 Friday
262	9	2	7	2	6	16	21	7	21	24	19	7	5	14	11	10	4	9	16	11	4	11	7	4	247	Sep 19 Saturday
263	5	2	3	7	6	7	11	8	7	7	4	2	1	5	4	14	12	6	5	9	13	13	9	9	169	Sep 20 Sunday
264	6	3	5	9	2	4	4	13	8	15	9	11	15	11	19	2	6	8	19	33	18	6	3	8	237	Sep 21 Monday
265	3	10	7	2	2	2	5	3	4	21	33	12	11	22	8	10	33	13	5	10	12	10	9	9	256	Sep 22 Tuesday
266	7	4	5	18	17	3	7	4	11	14	19	23	22	15	18	13	4	5	6	8	13	8	5	11	260	Sep 23 Wednesday
267	6	4	15	9	1	11	3	14	25	21	21	25	7	17	22	12	10	7	5	10	3	6	6	2	262	Sep 24 Thursday
268	7	5	21	4	6	6	16	12	20	14	8	5	19	7	10	11	13	8	8	4	4	8	2	4	222	Sep 25 Friday
269	6	3	11	11	9	7	6	4	2	4	8	7	7	6	10	11	11	1	9	6	4	5	4	4	156	Sep 26 Saturday
270	3	8	2	2	1	1	4	4	2	20	6	15	8	7	4	5	5	1	8	3	7	8	3	5	132	Sep 27 Sunday
271	7	25	10	2	11	5	8	3	11	9	9	4	14	25	14	1	5	9	3	7	1	7	9	0	199	Sep 28 Monday
272	7	6	4	7	6	18	10	9	20	12	19	16	21	13	13	19	10	7	3	12	5	11	17	5	270	Sep 29 Tuesday
273	8	11	9	9	6	14	8	9	12	16	18	12	15	13	22	7	7	5	30	5	7	5	2	9	259	Sep 30 Wednesday

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	2042	2007	2136	1802	1693	1909	2035	2102	2414	2713	2864	2901	2593	2478	2403	2343	2085	2114	2180	2158	2169	2146	2239	2128	53654	Total sum
183	11	11	12	10	9	10	11	11	13	15	16	16	14	14	13	13	11	12	12	12	12	12	12	12	293	Total average
125	12	12	12	10	9	9	10	11	14	16	17	17	15	14	13	12	11	11	12	11	12	12	12	12	293	Average workdays
58	9	9	11	9	11	13	14	13	11	12	13	13	12	13	13	14	13	13	12	13	12	12	12	11	286	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
91	3	7	3	5	4	2	5	7	16	15	22	29	16	10	7	4	6	8	10	8	1	8	3	6	205	Apr 01 Wednesday
92	9	7	6	2	3	0	2	9	16	12	41	33	10	5	19	9	7	8	10	8	11	16	11	4	258	Apr 02 Thursday
93	7	6	7	8	9	5	2	20	23	11	22	14	8	10	5	8	5	7	8	11	6	2	11	3	218	Apr 03 Friday
94	4	1	8	6	5	2	3	5	4	11	4	6	5	5	6	1	3	0	4	6	3	2	3	5	102	Apr 04 Saturday
95	1	3	3	3	7	1	0	3	1	5	5	7	1	6	2	9	3	4	2	0	3	9	11	5	94	Apr 05 Sunday
96	11	8	6	5	1	6	3	9	18	15	14	13	6	10	21	2	7	0	5	8	4	5	1	2	180	Apr 06 Monday
97	8	11	9	4	3	6	5	18	18	7	24	19	16	23	13	20	10	11	16	9	8	16	8	9	291	Apr 07 Tuesday
98	7	2	8	7	13	14	18	7	31	19	19	28	24	20	17	15	5	5	4	4	7	12	4	1	291	Apr 08 Wednesday
99	5	4	10	6	2	12	9	14	24	23	37	23	26	17	13	6	5	2	4	7	6	4	5	5	269	Apr 09 Thursday
100	1	4	7	1	0	2	3	2	17	5	20	8	0	0	3	10	9	4	3	6	1	1	0	0	107	Apr 10 Friday
101	5	14	8	14	12	7	4	4	17	17	5	19	3	4	0	6	3	1	4	1	2	1	4	2	157	Apr 11 Saturday
102	5	7	2	4	5	4	0	1	12	9	12	73	49	25	19	12	10	23	13	22	12	12	21	20	372	Apr 12 Sunday
103	20	4	9	16	15	11	12	4	3	6	11	8	2	12	14	8	8	2	4	2	11	6	10	9	207	Apr 13 Monday
104	19	13	9	13	7	4	8	11	21	14	23	14	11	16	12	6	4	12	2	7	4	7	2	3	242	Apr 14 Tuesday
105	3	6	15	3	0	3	3	9	9	29	19	29	17	16	13	15	8	4	5	8	4	2	12	9	241	Apr 15 Wednesday
106	4	3	7	12	5	1	2	7	12	22	25	19	14	10	14	11	13	9	6	3	6	3	2	3	213	Apr 16 Thursday
107	12	4	9	16	3	8	7	17	17	30	37	16	10	14	9	7	6	2	8	6	0	4	10	0	252	Apr 17 Friday
108	4	14	11	6	12	11	3	3	6	4	10	8	7	1	3	2	4	3	5	4	7	6	6	6	146	Apr 18 Saturday
109	3	6	8	13	9	3	2	6	2	12	5	13	8	1	1	4	7	5	6	5	14	4	6	4	147	Apr 19 Sunday
110	7	10	2	4	5	1	10	10	17	19	23	38	17	5	11	8	3	5	8	8	1	10	5	8	235	Apr 20 Monday
111	4	3	13	11	4	8	6	7	6	31	52	22	27	14	18	9	12	11	7	0	7	6	1	3	282	Apr 21 Tuesday
112	3	9	6	1	7	3	10	15	21	23	25	34	24	14	7	9	4	2	8	2	19	7	1	9	263	Apr 22 Wednesday
113	2	6	11	12	0	2	14	12	22	16	42	23	20	16	13	3	16	7	0	4	5	15	4	7	272	Apr 23 Thursday
114	3	6	9	4	3	13	7	30	23	17	25	30	9	16	16	2	13	6	3	4	7	4	3	2	255	Apr 24 Friday
115	3	2	38	22	20	14	13	7	1	8	10	32	12	8	28	2	6	6	4	8	5	2	4	2	257	Apr 25 Saturday
116	1	10	7	1	2	4	1	1	9	0	9	6	7	6	3	1	3	9	2	2	6	14	0	2	106	Apr 26 Sunday
117	39	27	7	5	4	5	8	15	25	26	34	21	11	16	10	12	16	24	13	10	12	6	3	4	353	Apr 27 Monday
118	7	8	6	3	5	8	4	11	16	23	27	34	20	15	15	3	11	6	9	6	11	11	7	2	268	Apr 28 Tuesday
119	4	2	8	17	3	1	6	11	26	26	23	7	15	18	27	5	10	5	8	8	9	9	5	5	258	Apr 29 Wednesday
120	10	5	3	17	14	7	5	16	24	25	30	29	11	10	29	7	4	4	5	0	2	5	1	5	268	Apr 30 Thursday
121	9	7	0	1	8	9	3	4	4	7	5	10	5	6	3	7	3	6	4	1	0	2	1	5	110	May 01 Friday
122	6	8	7	2	7	10	37	16	16	23	20	30	23	23	15	7	5	1	0	6	3	1	9	1	276	May 02 Saturday
123	3	1	5	1	5	1	0	1	2	4	5	4	4	3	1	5	0	1	2	1	6	9	1	14	79	May 03 Sunday
124	11	6	11	6	5	8	10	16	25	17	21	22	13	11	9	16	11	12	11	4	6	3	2	2	258	May 04 Monday
125	4	4	3	10	2	2	11	9	16	26	33	24	17	15	21	12	6	9	4	6	15	10	6	5	270	May 05 Tuesday
126	4	11	17	4	5	4	7	16	15	25	23	15	21	11	10	2	6	1	2	2	6	2	4	4	217	May 06 Wednesday
127	8	3	16	12	1	2	7	11	16	18	27	26	14	5	17	12	8	9	5	8	5	6	10	13	259	May 07 Thursday
128	20	5	8	4	12	6	12	6	12	11	30	31	19	6	7	6	7	6	6	1	4	4	0	5	228	May 08 Friday
129	5	9	7	8	5	12	3	13	9	8	8	29	11	8	0	6	6	4	0	1	0	2	2	6	162	May 09 Saturday
130	0	3	4	7	1	1	7	2	1	16	3	1	8	9	4	7	2	2	6	8	5	12	14	11	134	May 10 Sunday
131	15	2	4	10	5	2	5	3	10	36	22	15	24	16	11	5	4	4	4	1	1	2	6	11	218	May 11 Monday
132	6	4	5	4	5	4	5	15	32	30	18	32	10	12	11	24	12	16	6	6	5	9	8	3	282	May 12 Tuesday
133	13	12	9	2	6	3	9	7	13	32	22	19	19	4	19	2	14	73	70	0	3	10	10	4	375	May 13 Wednesday
134	11	8	10	9	3	2	12	17	16	17	43	20	13	18	10	12	3	2	3	18	6	14	4	5	276	May 14 Thursday
135	6	4	11	2	2	5	9	11	22	21	21	27	14	11	18	9	3	9	3	0	10	10	2	6	236	May 15 Friday
136	2	6	10	10	7	18	10	16	2	3	9	17	29	7	6	3	7	3	6	5	7	1	1	11	196	May 16 Saturday
137	1	1	4	0	3	3	2	0	7	7	8	6	5	1	4	7	6	2	5	2	6	3	2	8	93	May 17 Sunday
138	3	8	10	9	3	4	4	14	21	20	25	22	10	10	15	13	12	6	10	3	13	6	5	0	246	May 18 Monday
139	3	6	10	0	2	5	7	14	20	23	17	16	29	18	22	0	8	6	3	11	1	8	2	8	239	May 19 Tuesday
140	4	3	4	4	11	8	19	5	13	21	23	36	19	8	15	5	4	6	5	10	4	1	14	2	244	May 20 Wednesday
141	5	2	9	0	4	12	9	4	18	19	8	50	19	18	18	6	5	5	3	6	4	3	9	10	246	May 21 Thursday
142	6	7	5	10	5	14	5	3	7	11	9	21	6	13	22	3	5	4	7	1	7	0	4	5	180	May 22 Friday
143	3	6	3	7	4	2	4	4	9	2	13	10	9	4	8	15	8	6	12	2	4	1	2	1	139	May 23 Saturday
144	1	3	7	6	2	1	0	4	1	3	6	6	2	3	3	1	0	6	1	3	5	3	1	6	74	May 24 Sunday
145	7	5	17	4	4	3	4	8	16	16	23	26	19	17	17	13	3	4	4	6	9	7	1	0	233	May 25 Monday
146	7	10	3	6	0	1	0	29	26	18	24	24	12	11	12	6	7	9	6	4	7	5	3	9	239	May 26 Tuesday

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
147	1	12	6	10	10	5	14	23	18	35	19	26	22	14	25	14	12	2	4	2	6	4	12	3	299	May 27 Wednesday
148	10	7	10	8	3	10	13	20	31	27	28	28	36	10	6	6	6	5	11	3	9	10	4	8	309	May 28 Thursday
149	5	12	17	13	4	4	12	17	12	24	22	26	2	4	15	3	1	5	5	2	4	13	12	3	237	May 29 Friday
150	4	4	5	7	3	0	8	12	10	10	4	8	2	6	3	2	8	8	12	4	2	1	8	5	136	May 30 Saturday
151	0	2	9	4	2	2	3	2	1	1	3	11	4	4	2	2	1	5	0	1	0	5	12	14	90	May 31 Sunday
152	8	5	5	5	6	10	7	3	15	10	15	16	3	15	14	5	1	3	3	8	2	5	2	7	173	Jun 01 Monday
153	9	36	13	45	13	4	3	16	39	18	29	16	21	3	14	6	5	7	12	9	14	8	4	11	355	Jun 02 Tuesday
154	4	7	7	27	11	5	8	12	16	7	31	19	6	18	6	5	7	5	12	5	3	5	1	0	227	Jun 03 Wednesday
155	9	5	2	7	5	0	1	13	5	12	31	18	9	11	12	10	11	7	9	2	2	16	6	7	210	Jun 04 Thursday
156	5	6	6	2	7	3	2	11	12	12	26	6	17	10	11	7	1	4	7	5	2	16	2	3	183	Jun 05 Friday
157	0	17	2	11	7	2	6	10	10	8	6	14	8	11	7	9	15	8	7	3	7	3	10	2	183	Jun 06 Saturday
158	12	6	0	4	4	0	3	1	1	7	5	1	1	7	2	4	10	6	2	5	10	5	12	21	129	Jun 07 Sunday
159	5	3	9	4	1	2	10	17	13	22	26	28	9	5	6	6	5	3	5	5	2	8	6	9	209	Jun 08 Monday
160	9	4	6	5	2	7	3	12	18	22	31	29	20	6	13	11	1	12	5	0	12	5	8	5	246	Jun 09 Tuesday
161	15	6	12	8	7	9	22	8	19	15	38	25	19	10	4	4	6	5	3	7	8	6	5	8	269	Jun 10 Wednesday
162	7	3	2	2	5	3	1	14	5	17	29	25	9	6	10	7	5	1	3	1	4	8	10	10	187	Jun 11 Thursday
163	15	5	4	8	10	1	1	11	12	21	28	21	11	1	4	14	8	5	6	9	1	6	7	2	211	Jun 12 Friday
164	1	3	6	8	3	2	2	1	7	1	11	5	7	4	3	1	2	2	4	0	6	5	4	3	91	Jun 13 Saturday
165	6	5	1	4	2	1	1	4	0	11	5	10	1	5	4	1	6	7	0	2	1	7	13	11	108	Jun 14 Sunday
166	7	8	10	7	8	11	5	19	12	29	29	20	23	11	11	6	2	3	2	10	2	5	1	1	242	Jun 15 Monday
167	4	2	2	4	0	6	7	13	18	21	22	33	34	28	22	23	4	7	8	4	5	4	3	2	276	Jun 16 Tuesday
168	4	9	7	6	2	4	12	12	20	8	17	24	18	26	8	3	8	9	6	5	1	2	7	3	221	Jun 17 Wednesday
169	13	16	3	4	13	1	7	9	17	29	24	26	19	7	20	6	11	9	0	5	5	3	0	6	253	Jun 18 Thursday
170	5	9	7	3	4	5	4	18	15	25	26	20	18	7	4	6	0	11	4	8	2	0	3	7	211	Jun 19 Friday
171	0	1	12	7	4	8	8	2	4	8	6	19	5	16	3	3	3	3	0	0	6	4	2	5	129	Jun 20 Saturday
172	2	2	1	2	2	3	1	2	5	3	8	3	6	5	0	4	7	1	0	0	5	5	7	9	83	Jun 21 Sunday
173	6	15	3	5	3	6	2	24	21	8	28	20	25	24	12	32	34	4	5	2	3	4	2	5	293	Jun 22 Monday
174	5	8	3	13	0	10	30	28	28	23	36	40	16	15	11	5	8	11	3	1	7	1	4	7	313	Jun 23 Tuesday
175	10	3	4	3	5	7	8	13	26	30	33	21	28	12	27	10	17	11	7	0	2	5	2	2	286	Jun 24 Wednesday
176	21	4	9	7	2	12	38	34	30	27	61	47	33	22	14	9	7	7	4	7	5	7	2	4	413	Jun 25 Thursday
177	2	5	7	14	2	3	7	12	20	26	30	15	19	6	4	3	2	1	5	33	96	18	6	4	340	Jun 26 Friday
178	1	8	2	5	2	4	4	9	8	16	11	11	10	10	19	2	6	6	2	3	5	6	5	21	176	Jun 27 Saturday
179	0	1	5	6	13	2	0	0	5	6	4	7	8	5	3	5	4	4	1	4	7	7	9	4	110	Jun 28 Sunday
180	3	3	6	2	12	8	8	14	12	17	46	23	24	14	11	5	5	10	6	3	4	1	6	51	294	Jun 29 Monday
181	5	3	3	17	1	4	8	28	25	20	40	22	15	17	13	7	4	8	6	7	11	4	8	5	281	Jun 30 Tuesday
182	3	8	15	4	3	5	3	13	15	23	22	20	20	10	12	10	6	2	2	5	11	27	32	2	273	Jul 01 Wednesday
183	6	9	9	9	4	11	7	13	27	15	21	29	14	9	16	8	6	7	5	7	11	2	5	2	252	Jul 02 Thursday
184	2	9	2	4	1	4	8	13	24	12	21	23	11	12	6	4	6	8	5	7	2	5	4	2	195	Jul 03 Friday
185	0	8	11	9	10	14	7	7	16	9	11	10	14	6	3	4	6	3	0	1	2	2	3	3	159	Jul 04 Saturday
186	2	2	7	3	5	3	5	10	12	15	14	3	9	2	8	5	7	1	0	0	1	6	5	7	132	Jul 05 Sunday
187	12	8	16	8	1	5	18	26	4	17	23	19	15	8	6	10	3	1	3	2	5	4	7	8	229	Jul 06 Monday
188	1	5	11	18	6	10	7	8	13	11	21	12	10	11	14	7	3	3	6	8	3	5	2	1	196	Jul 07 Tuesday
189	6	3	10	5	3	3	20	26	26	38	25	14	18	17	25	14	7	7	6	7	5	2	3	4	294	Jul 08 Wednesday
190	10	13	10	6	3	8	9	11	22	23	18	27	18	10	15	11	18	12	12	16	11	8	8	9	308	Jul 09 Thursday
191	11	7	8	6	1	10	5	16	9	18	23	14	8	12	12	6	3	1	2	11	3	2	2	1	191	Jul 10 Friday
192	1	3	0	0	0	0	0	11	17	14	12	8	7	14	9	12	16	5	0	0	2	7	5	4	147	Jul 11 Saturday
193	8	6	12	4	6	5	10	17	25	13	18	10	6	6	5	10	2	0	1	5	5	5	14	12	205	Jul 12 Sunday
194	1	6	5	9	2	8	11	5	28	22	36	24	18	22	5	5	1	10	8	4	10	9	9	10	268	Jul 13 Monday
195	2	19	11	4	5	10	7	9	36	34	73	32	43	29	13	6	1	8	4	10	3	10	7	6	382	Jul 14 Tuesday
196	5	0	5	7	14	19	16	21	22	35	32	25	26	8	12	2	10	6	4	13	0	5	3	1	291	Jul 15 Wednesday
197	1	8	12	8	6	9	17	26	24	31	16	52	20	20	38	19	7	7	7	11	6	6	9	7	367	Jul 16 Thursday
198	16	9	11	3	9	10	4	13	20	35	23	19	10	6	8	3	12	3	18	4	1	5	9	3	254	Jul 17 Friday
199	13	12	10	5	3	2	12	9	13	14	12	21	11	7	4	4	5	10	4	5	7	0	9	2	194	Jul 18 Saturday
200	4	5	2	1	4	1	9	9	6	11	9	5	3	3	3	2	9	10	6	0	4	7	6	17	136	Jul 19 Sunday
201	3	16	9	10	9	3	2	12	16	19	31	16	23	11	26	5	13	6	3	0	2	3	4	7	249	Jul 20 Monday
202	12	10	15	5	10	22	12	17	17	19	27	15	18	11	9	10	17	10	4	2	4	1	7	10	284	Jul 21 Tuesday

Table 3.5.4 (Page 2 of 4)

GER .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
203	5	1	6	4	6	16	8	18	26	11	27	23	22	27	6	7	7	2	8	17	3	7	10	65	332	Jul 22 Wednesday
204	13	2	7	7	2	12	14	17	24	27	26	9	14	18	25	5	4	1	7	3	6	53	6	11	313	Jul 23 Thursday
205	4	6	9	8	11	8	7	12	28	26	33	22	12	19	33	30	38	14	3	4	3	3	1	2	336	Jul 24 Friday
206	7	13	10	8	4	26	17	15	3	6	3	0	2	4	7	11	2	2	0	1	4	1	0	2	148	Jul 25 Saturday
207	0	4	2	6	8	2	2	3	1	6	1	5	10	7	4	7	3	7	2	2	2	7	5	5	101	Jul 26 Sunday
208	5	5	4	8	10	6	18	15	35	39	33	37	31	45	24	17	7	12	14	6	4	2	12	2	391	Jul 27 Monday
209	3	6	8	8	8	17	10	13	17	15	26	36	33	9	20	7	4	6	7	8	3	6	1	26	297	Jul 28 Tuesday
210	19	13	4	10	8	31	24	30	20	49	37	31	34	33	25	13	5	6	5	1	4	11	8	0	421	Jul 29 Wednesday
211	2	5	2	5	10	7	12	31	27	28	40	34	14	36	16	12	8	11	27	6	5	5	0	8	351	Jul 30 Thursday
212	4	27	12	14	10	17	11	18	20	33	28	23	11	17	30	8	9	7	4	5	2	1	9	5	325	Jul 31 Friday
213	0	3	4	5	3	1	2	0	0	5	9	8	4	6	6	8	3	11	81	6	4	60	70	28	327	Aug 01 Saturday
214	1	1	1	3	2	5	2	4	4	8	6	5	5	7	6	1	0	0	3	2	3	10	20	9	108	Aug 02 Sunday
215	15	5	13	12	8	7	6	17	16	14	8	29	6	4	19	6	1	1	4	3	8	6	6	25	239	Aug 03 Monday
216	48	21	10	4	10	7	24	15	23	15	29	41	17	11	29	11	31	11	6	13	4	6	7	4	397	Aug 04 Tuesday
217	2	11	3	4	4	8	5	8	13	36	27	32	23	19	16	10	17	14	8	8	5	6	15	2	296	Aug 05 Wednesday
218	3	12	6	37	9	4	10	11	20	27	23	32	14	14	15	10	20	10	5	9	7	2	8	7	315	Aug 06 Thursday
219	11	13	20	9	4	10	2	10	11	16	41	12	11	11	11	6	5	5	8	5	6	4	7	10	248	Aug 07 Friday
220	7	10	3	5	5	2	0	1	10	11	11	4	4	3	1	3	4	1	6	0	4	7	1	4	107	Aug 08 Saturday
221	4	8	2	6	3	7	3	2	2	13	18	4	2	10	8	4	10	1	9	2	7	10	7	6	148	Aug 09 Sunday
222	5	11	4	6	3	3	8	10	24	13	30	14	15	15	20	8	8	3	3	4	6	8	4	4	229	Aug 10 Monday
223	5	9	11	5	5	9	7	26	29	22	25	30	23	10	21	15	5	0	5	1	10	26	6	10	315	Aug 11 Tuesday
224	2	5	9	18	7	4	12	26	21	13	37	30	28	9	7	1	7	3	2	8	7	3	7	4	270	Aug 12 Wednesday
225	2	18	20	6	6	8	8	12	23	19	34	24	17	10	13	7	14	8	6	2	4	1	0	4	266	Aug 13 Thursday
226	8	5	8	9	4	4	4	7	12	17	39	26	12	17	6	12	7	4	5	0	3	0	4	1	214	Aug 14 Friday
227	9	3	3	9	0	7	2	7	8	6	6	11	1	7	0	6	11	3	8	1	4	0	0	4	116	Aug 15 Saturday
228	2	6	11	4	5	18	3	2	3	4	10	11	7	6	9	8	6	2	3	4	3	3	4	11	145	Aug 16 Sunday
229	5	13	5	20	3	6	14	23	23	7	23	23	15	11	10	11	2	3	3	4	3	4	7	6	244	Aug 17 Monday
230	6	4	6	25	7	12	18	25	22	14	26	16	33	14	13	2	4	7	4	8	4	5	1	4	280	Aug 18 Tuesday
231	8	3	7	7	2	9	7	21	33	24	25	18	12	15	11	11	4	3	6	6	2	3	1	5	243	Aug 19 Wednesday
232	3	8	7	2	5	4	8	8	25	35	15	21	21	11	9	17	5	8	5	3	3	3	3	7	236	Aug 20 Thursday
233	4	5	11	4	17	11	15	17	36	37	37	39	22	28	27	27	24	19	15	10	22	17	16	13	473	Aug 21 Friday
234	16	11	10	11	10	3	2	4	3	11	14	18	7	13	2	15	8	1	6	4	7	1	3	6	186	Aug 22 Saturday
235	5	3	5	3	10	13	5	7	18	9	15	11	8	14	15	6	4	3	6	4	1	4	10	14	193	Aug 23 Sunday
236	10	17	7	17	9	8	20	22	37	36	35	33	31	25	30	5	6	13	12	16	6	7	2	12	416	Aug 24 Monday
237	3	3	2	18	13	12	15	14	29	17	25	17	13	18	31	11	4	4	3	3	0	0	0	0	255	Aug 25 Tuesday
238	0	0	0	0	0	0	5	12	23	23	48	19	37	19	17	14	4	4	1	1	1	3	1	3	235	Aug 26 Wednesday
239	9	12	4	7	2	10	28	19	27	32	14	14	16	19	27	11	27	7	2	2	4	2	3	3	301	Aug 27 Thursday
240	1	9	6	17	11	4	13	10	21	11	34	15	12	14	6	5	10	6	5	8	5	0	11	7	241	Aug 28 Friday
241	7	12	3	7	2	0	8	1	11	9	5	3	4	5	2	9	3	1	6	6	3	2	4	1	114	Aug 29 Saturday
242	7	6	14	5	6	3	10	1	11	17	1	11	1	6	3	5	8	0	2	2	4	10	5	3	141	Aug 30 Sunday
243	3	11	14	14	1	14	17	14	28	21	13	16	15	24	16	10	3	7	10	4	4	5	4	2	270	Aug 31 Monday
244	11	14	4	1	11	9	14	15	29	24	27	25	19	22	17	13	12	8	6	8	11	2	3	5	310	Sep 01 Tuesday
245	3	6	10	6	6	3	6	15	17	21	19	22	29	9	23	8	6	4	8	16	15	7	4	2	265	Sep 02 Wednesday
246	15	6	3	4	18	10	24	20	34	17	26	42	17	21	18	9	24	10	12	6	4	6	4	24	374	Sep 03 Thursday
247	8	7	11	7	10	18	9	16	39	21	33	35	17	18	8	9	14	6	2	2	3	12	5	1	311	Sep 04 Friday
248	1	3	5	10	5	6	1	6	13	13	17	14	13	14	8	13	5	13	3	8	4	4	4	4	187	Sep 05 Saturday
249	4	2	3	7	1	4	3	2	3	5	4	10	6	4	4	4	4	13	4	6	6	10	2	5	116	Sep 06 Sunday
250	10	5	15	10	11	8	5	8	16	23	17	27	13	16	14	8	1	3	2	2	1	5	7	3	230	Sep 07 Monday
251	5	7	7	4	12	1	1	19	26	22	20	26	19	16	12	15	4	4	1	9	4	5	3	8	250	Sep 08 Tuesday
252	3	8	7	5	12	7	10	15	31	21	24	24	10	11	18	11	11	8	9	5	9	4	7	7	277	Sep 09 Wednesday
253	3	7	7	9	10	7	9	13	18	16	10	20	17	7	0	0	0	4	5	4	7	8	10	7	198	Sep 10 Thursday
254	1	6	5	10	8	10	12	7	25	20	11	19	5	21	6	6	9	3	7	0	3	3	5	5	207	Sep 11 Friday
255	5	1	2	10	13	4	5	1	10	19	13	15	7	8	13	13	8	15	10	11	9	4	17	13	226	Sep 12 Saturday
256	15	5	3	4	13	11	6	5	9	4	7	6	4	3	7	0	5	1	1	4	6	7	5	9	140	Sep 13 Sunday
257	12	6	13	24	9	22	16	31	22	30	21	22	26	15	33	15	19	34	32	26	24	23	18	20	513	Sep 14 Monday
258	20	21	19	32	29	33	25	25	43	45	31	34	43	31	30	22	17	14	20	16	19	10	18	18	615	Sep 15 Tuesday

Table 3.5.4 (Page 3 of 4)

GER .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
259	24	15	9	8	4	2	6	14	26	19	27	39	23	29	40	12	11	8	12	13	9	8	5	6	369	Sep 16 Wednesday
260	8	3	15	8	18	25	18	28	27	23	21	28	31	20	27	17	13	12	5	12	3	2	1	3	368	Sep 17 Thursday
261	8	6	3	3	26	7	19	14	14	16	17	19	18	8	12	9	5	2	3	2	5	3	4	1	224	Sep 18 Friday
262	2	8	2	2	4	3	7	2	10	6	7	5	7	3	8	12	1	2	1	2	2	5	7	1	109	Sep 19 Saturday
263	4	7	8	3	4	0	6	9	1	3	2	9	3	5	2	7	8	0	6	1	3	5	5	9	110	Sep 20 Sunday
264	3	30	29	7	10	7	11	16	20	9	11	25	14	17	17	9	7	5	1	3	4	8	2	1	266	Sep 21 Monday
265	0	9	6	9	8	3	9	19	14	21	12	20	11	16	11	15	12	2	4	8	3	3	0	0	215	Sep 22 Tuesday
266	0	0	0	0	0	0	5	3	12	19	18	26	5	17	12	7	0	4	10	2	5	1	5	2	153	Sep 23 Wednesday
267	0	1	8	10	10	2	5	17	16	16	19	26	0	10	2	0	0	0	0	9	6	0	4	4	165	Sep 24 Thursday
268	6	2	8	4	3	20	13	11	18	22	22	12	28	6	7	0	0	0	0	3	2	7	0	0	194	Sep 25 Friday
269	0	0	0	0	0	0	0	6	21	0	0	10	14	8	6	2	3	0	0	0	0	3	0	0	73	Sep 26 Saturday
270	0	0	0	0	0	0	0	2	14	10	4	10	5	0	1	0	0	0	0	0	0	0	0	0	46	Sep 27 Sunday
271	0	0	0	0	0	0	7	10	0	14	14	22	9	21	15	3	0	0	0	4	3	4	0	0	126	Sep 28 Monday
272	0	0	0	0	0	0	11	11	10	0	12	27	21	23	23	7	1	0	3	11	5	0	12	0	177	Sep 29 Tuesday
273	0	0	0	0	0	0	5	9	7	6	6	24	13	6	7	4	3	4	4	3	7	4	6	12	130	Sep 30 Wednesday
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	1164	1303	1358	1378	1099	1223	1519	2183	3033	3200	3842	3741	2690	2249	2268	1478	1333	1154	1151	986	1079	1165	1109	1213	42918	Total sum
183	6	7	7	8	6	7	8	12	17	17	21	20	15	12	12	8	7	6	6	5	6	6	6	7	235	Total average
125	7	8	8	8	6	7	10	15	20	21	26	24	18	14	15	9	8	7	7	6	6	7	6	6	271	Average workdays
58	4	5	6	6	5	5	5	5	8	9	9	12	8	7	6	6	5	4	5	4	4	6	7	7	150	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
91	3	12	7	9	7	18	24	10	8	19	14	23	15	7	6	16	6	2	15	4	1	4	3	7	240	Apr 01 Wednesday
92	9	1	3	1	4	4	4	3	9	9	8	8	11	8	2	7	4	3	3	8	7	2	7	3	128	Apr 02 Thursday
93	5	6	7	4	0	10	2	24	3	9	15	18	10	2	3	8	6	2	6	8	10	1	11	1	171	Apr 03 Friday
94	0	5	6	2	2	2	3	0	8	1	10	3	6	1	5	0	9	2	9	2	0	1	1	0	78	Apr 04 Saturday
95	1	0	0	1	11	3	7	1	5	1	10	5	1	6	8	5	10	5	7	4	6	9	7	3	116	Apr 05 Sunday
96	5	7	8	3	15	11	8	16	10	10	6	6	11	5	3	8	2	3	4	1	2	4	4	5	157	Apr 06 Monday
97	6	5	6	5	4	9	4	1	0	10	6	4	6	7	11	3	0	7	5	2	8	5	3	2	119	Apr 07 Tuesday
98	1	2	3	14	8	11	5	0	4	8	2	5	5	3	4	2	1	4	1	3	4	6	5	1	102	Apr 08 Wednesday
99	4	4	3	7	4	11	5	19	12	5	5	10	10	4	6	4	4	1	4	1	5	4	2	9	143	Apr 09 Thursday
100	2	2	5	4	5	9	12	4	4	13	18	33	11	10	3	13	14	9	2	2	8	1	11	2	197	Apr 10 Friday
101	0	4	0	4	3	0	4	14	2	14	15	4	2	0	4	3	2	1	4	5	1	1	1	1	89	Apr 11 Saturday
102	1	1	6	3	4	10	1	4	2	1	4	9	4	2	3	3	3	5	2	4	4	4	3	1	84	Apr 12 Sunday
103	3	11	15	8	6	6	7	0	8	6	4	6	7	6	9	2	2	4	1	10	6	1	2	1	131	Apr 13 Monday
104	2	2	2	11	11	7	0	7	3	3	2	8	11	7	2	1	2	1	1	8	5	3	5	0	104	Apr 14 Tuesday
105	1	6	7	4	3	6	16	10	9	6	12	8	6	6	12	12	6	7	0	5	10	0	0	4	156	Apr 15 Wednesday
106	2	0	5	4	12	8	4	11	8	16	19	19	11	3	10	6	2	5	1	14	2	3	5	2	172	Apr 16 Thursday
107	2	9	6	4	7	6	14	14	23	14	11	19	14	9	6	7	5	6	1	1	5	4	0	0	187	Apr 17 Friday
108	6	5	0	1	5	8	2	10	9	4	31	12	12	5	9	8	4	5	5	6	4	9	1	0	161	Apr 18 Saturday
109	0	0	12	2	4	4	3	3	1	0	0	1	13	2	4	2	8	2	1	4	4	0	0	1	71	Apr 19 Sunday
110	2	5	9	7	14	11	25	23	14	11	23	16	10	16	7	11	3	11	5	7	0	7	2	15	254	Apr 20 Monday
111	0	5	12	14	7	28	24	29	15	33	27	23	17	19	19	4	12	15	10	11	6	2	3	5	340	Apr 21 Tuesday
112	3	3	19	11	26	29	48	26	26	39	35	35	32	18	20	22	29	19	4	5	14	2	3	8	476	Apr 22 Wednesday
113	9	12	12	25	15	29	37	27	30	35	35	29	38	18	22	21	16	17	8	4	2	7	5	0	453	Apr 23 Thursday
114	2	8	18	12	12	28	42	43	20	37	24	34	45	21	20	15	16	9	13	6	8	5	5	0	443	Apr 24 Friday
115	1	4	9	10	18	20	17	20	11	23	19	2	14	11	15	9	11	17	7	9	1	0	7	6	261	Apr 25 Saturday
116	0	4	3	8	10	22	10	6	6	5	16	6	11	10	11	7	7	3	7	7	3	14	4	0	180	Apr 26 Sunday
117	5	8	15	10	34	29	43	34	36	32	38	15	30	18	11	15	15	19	14	7	7	1	4	3	443	Apr 27 Monday
118	2	4	14	32	24	50	83	73	34	58	72	27	12	29	25	33	22	11	29	16	13	5	17	10	695	Apr 28 Tuesday
119	9	8	18	32	16	39	32	32	11	22	10	3	13	0	3	4	12	17	10	9	9	6	4	13	332	Apr 29 Wednesday
120	8	7	15	11	20	14	13	16	13	18	18	22	12	1	13	14	1	13	7	18	6	9	2	3	274	Apr 30 Thursday
121	3	2	1	1	5	2	12	14	8	4	4	16	12	3	9	5	8	6	8	6	2	3	0	4	138	May 01 Friday
122	6	5	7	5	0	3	8	16	17	7	6	11	4	8	12	4	11	10	13	5	6	1	6	8	179	May 02 Saturday
123	13	10	9	8	3	8	14	13	14	9	7	13	16	11	8	6	19	7	14	7	6	2	5	14	236	May 03 Sunday
124	3	6	6	1	3	16	3	9	12	9	21	8	7	12	11	5	13	15	8	5	1	3	11	13	201	May 04 Monday
125	7	12	13	11	24	38	58	38	52	18	44	26	31	11	9	21	19	4	7	13	6	3	9	0	474	May 05 Tuesday
126	6	10	15	24	19	48	26	39	36	32	39	39	24	12	17	11	10	15	6	9	9	6	9	1	462	May 06 Wednesday
127	3	16	13	27	18	32	43	18	31	23	14	29	30	11	10	14	10	18	14	5	8	5	2	1	395	May 07 Thursday
128	3	8	11	13	16	15	35	27	28	25	32	27	11	15	17	8	11	8	19	11	16	16	8	3	383	May 08 Friday
129	9	5	2	6	2	6	6	20	7	2	3	28	6	10	8	8	12	4	1	4	3	7	2	0	161	May 09 Saturday
130	5	2	5	2	4	4	4	2	3	7	4	11	20	10	15	8	9	12	21	0	1	9	3	1	162	May 10 Sunday
131	4	6	9	6	26	11	5	14	15	9	9	6	3	11	4	11	19	13	11	11	7	10	10	5	235	May 11 Monday
132	1	3	10	11	6	19	42	30	33	15	23	32	26	23	17	8	12	16	12	16	1	9	3	4	372	May 12 Tuesday
133	2	6	26	31	18	35	31	25	24	39	32	17	49	25	35	30	16	19	8	8	11	13	5	4	509	May 13 Wednesday
134	0	11	13	25	14	46	29	36	27	15	30	36	25	24	21	20	9	25	3	11	7	5	1	4	437	May 14 Thursday
135	17	9	18	8	26	45	50	22	46	50	52	36	35	13	21	23	18	21	7	13	8	0	2	14	554	May 15 Friday
136	3	3	20	3	9	19	12	5	9	10	23	27	21	9	15	15	0	5	16	17	6	5	5	1	258	May 16 Saturday
137	6	7	8	5	8	7	9	8	15	5	6	9	8	27	6	8	3	13	15	16	5	8	11	1	214	May 17 Sunday
138	6	5	20	20	12	25	43	32	27	27	22	42	11	30	15	21	5	14	11	8	2	8	7	3	416	May 18 Monday
139	6	10	33	16	11	24	55	28	17	19	16	24	37	20	30	13	7	15	14	9	9	8	13	2	436	May 19 Tuesday
140	13	8	11	15	27	35	41	35	25	28	18	40	27	29	16	15	17	10	3	18	7	7	18	8	471	May 20 Wednesday
141	11	11	27	29	10	33	34	28	19	23	30	34	44	36	33	21	9	13	17	9	5	6	0	4	486	May 21 Thursday
142	9	19	12	33	24	40	26	23	33	33	50	35	27	23	18	21	15	7	10	22	1	0	4	6	491	May 22 Friday
143	7	3	6	3	8	7	6	15	8	16	22	11	20	18	24	7	16	8	17	5	10	9	6	5	257	May 23 Saturday
144	4	10	17	6	12	9	16	11	4	17	21	13	10	16	15	8	23	18	15	14	12	14	26	28	339	May 24 Sunday
145	18	20	26	20	29	22	27	18	22	18	17	26	18	26	17	14	22	27	12	8	7	11	4	3	432	May 25 Monday
146	1	4	10	23	15	32	34	19	33	23	21	29	32	33	18	22	23	15	17	10	5	2	12	10	443	May 26 Tuesday

Table 3.5.5 (Page 1 of 4)

APA .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
147	11	6	20	11	16	41	42	26	15	36	20	28	38	21	9	23	7	14	16	8	19	10	8	7	452	May 27 Wednesday
148	3	9	14	17	21	43	57	41	27	35	35	28	12	22	29	6	21	19	15	2	10	19	5	8	498	May 28 Thursday
149	0	10	22	23	23	35	44	31	38	24	32	41	25	33	18	26	2	9	14	11	8	13	10	5	497	May 29 Friday
150	8	4	11	5	4	10	18	10	12	19	21	8	16	24	16	9	5	15	12	3	6	2	7	5	250	May 30 Saturday
151	7	0	3	12	12	18	4	14	10	13	8	17	21	13	9	8	1	16	6	18	6	15	2	0	233	May 31 Sunday
152	6	13	17	14	8	28	32	50	30	17	22	36	26	27	39	6	10	5	12	8	16	16	4	2	444	Jun 01 Monday
153	4	12	19	20	20	28	52	53	34	31	26	37	14	18	14	24	19	16	10	7	11	7	8	0	484	Jun 02 Tuesday
154	5	14	23	21	12	32	48	35	30	19	18	46	18	13	28	15	2	12	3	21	11	4	5	0	435	Jun 03 Wednesday
155	4	16	20	19	22	41	42	35	31	27	30	27	17	36	13	14	18	12	16	7	1	6	31	26	511	Jun 04 Thursday
156	29	13	34	13	12	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	114	Jun 05 Friday
157	0	0	0	0	0	0	0	0	8	11	17	22	12	13	11	23	4	18	7	11	23	2	14	0	196	Jun 06 Saturday
158	4	1	19	14	4	0	11	6	10	5	9	3	3	7	4	10	5	18	10	13	15	4	3	13	191	Jun 07 Sunday
159	11	8	19	16	15	24	32	46	27	23	21	13	21	16	15	11	15	6	7	3	17	2	0	4	372	Jun 08 Monday
160	11	12	13	15	17	31	29	48	21	18	24	26	23	22	29	24	18	13	11	12	12	5	3	4	441	Jun 09 Tuesday
161	8	9	15	23	19	35	39	61	207	20	9	12	14	37	17	22	10	11	1	9	14	20	11	15	638	Jun 10 Wednesday
162	6	6	21	25	21	33	37	26	30	25	38	33	33	28	10	25	45	19	24	24	16	18	2	8	553	Jun 11 Thursday
163	5	14	3	14	10	8	18	29	19	17	1	39	10	7	5	12	7	16	14	7	4	40	17	1	317	Jun 12 Friday
164	11	3	6	7	6	17	13	29	19	14	15	7	8	13	24	17	9	8	40	11	11	5	7	6	306	Jun 13 Saturday
165	12	5	2	12	3	12	18	6	6	5	0	9	14	7	2	3	4	5	9	9	12	9	6	3	173	Jun 14 Sunday
166	3	11	14	12	16	24	37	43	39	7	48	24	16	27	16	30	17	14	7	8	13	8	5	6	445	Jun 15 Monday
167	2	6	18	5	24	27	37	45	19	41	37	26	22	31	12	22	12	13	10	14	14	2	4	8	451	Jun 16 Tuesday
168	4	7	7	22	20	30	36	38	23	37	29	32	36	22	19	23	9	8	18	13	3	15	7	0	458	Jun 17 Wednesday
169	8	23	14	22	25	37	35	37	27	24	30	33	25	31	28	15	15	27	19	7	8	2	6	4	502	Jun 18 Thursday
170	1	0	8	4	9	30	25	21	49	27	27	34	23	15	17	2	0	21	8	4	6	13	3	2	349	Jun 19 Friday
171	9	5	7	9	12	9	12	12	14	9	11	5	14	7	10	4	19	21	12	7	10	0	0	7	225	Jun 20 Saturday
172	7	1	11	12	2	9	1	3	6	8	9	6	4	15	11	6	7	11	12	6	6	7	4	4	168	Jun 21 Sunday
173	4	10	14	24	12	30	31	24	27	19	10	26	19	25	23	16	23	10	3	1	8	4	5	2	370	Jun 22 Monday
174	1	11	16	24	27	40	26	16	22	32	33	29	23	13	35	27	15	12	10	8	14	2	8	7	451	Jun 23 Tuesday
175	9	6	15	15	17	35	27	29	19	29	31	40	25	28	19	17	13	11	12	8	8	3	7	6	429	Jun 24 Wednesday
176	7	12	19	17	12	25	50	11	27	32	23	41	23	18	26	19	34	5	13	6	13	9	7	9	458	Jun 25 Thursday
177	3	14	24	8	19	25	44	43	24	46	33	35	37	19	14	4	14	14	19	10	6	0	10	9	474	Jun 26 Friday
178	8	1	4	2	9	13	7	10	32	10	25	13	16	18	28	12	8	4	21	4	4	2	10	4	265	Jun 27 Saturday
179	8	0	11	8	10	8	3	4	3	9	3	6	9	6	2	1	3	7	4	3	7	2	7	7	131	Jun 28 Sunday
180	7	6	20	11	6	33	49	41	16	17	17	12	7	18	13	10	21	6	4	8	9	4	1	9	345	Jun 29 Monday
181	8	10	14	27	11	36	37	41	39	30	25	27	31	34	8	20	18	15	10	21	30	14	3	6	515	Jun 30 Tuesday
182	6	12	20	19	14	35	22	11	28	22	18	14	16	29	20	15	14	8	20	21	9	17	9	13	412	Jul 01 Wednesday
183	9	3	14	16	18	37	34	38	24	23	33	28	23	12	16	27	6	28	25	10	7	8	3	4	446	Jul 02 Thursday
184	5	10	8	6	14	27	38	12	19	34	27	29	37	36	23	20	9	11	6	10	11	11	2	7	412	Jul 03 Friday
185	9	0	11	4	25	14	17	24	33	22	10	18	7	0	16	21	6	30	2	8	14	14	11	7	323	Jul 04 Saturday
186	4	18	17	10	8	19	6	14	7	6	8	14	12	1	10	1	13	8	8	7	11	8	0	9	219	Jul 05 Sunday
187	12	11	12	14	10	36	33	30	17	10	17	25	14	17	26	22	11	14	11	13	10	0	2	1	368	Jul 06 Monday
188	3	10	21	14	27	26	43	31	18	15	20	44	32	36	28	19	9	5	12	35	17	8	8	0	481	Jul 07 Tuesday
189	2	6	20	30	24	39	36	39	37	28	26	25	20	32	11	25	21	16	17	12	15	2	0	1	484	Jul 08 Wednesday
190	10	2	44	33	15	41	3	1	1	0	2	0	0	1	1	4	1	1	0	2	0	0	0	0	162	Jul 09 Thursday
191	0	0	0	0	0	0	1	2	6	3	0	1	0	1	0	1	0	0	0	0	0	1	0	1	17	Jul 10 Friday
192	0	0	0	0	0	6	36	66	56	54	67	39	25	26	17	14	17	6	4	27	10	15	0	3	488	Jul 11 Saturday
193	13	4	4	7	2	10	5	12	24	19	5	32	13	22	12	23	21	7	1	6	17	8	10	7	284	Jul 12 Sunday
194	11	30	30	22	32	68	51	47	50	45	43	34	32	33	18	31	18	30	12	10	7	8	6	23	691	Jul 13 Monday
195	12	38	31	49	37	58	37	21	26	32	48	32	46	13	40	31	20	23	8	13	19	6	1	2	643	Jul 14 Tuesday
196	9	11	26	13	12	22	23	21	29	24	44	38	31	27	19	10	9	26	6	6	3	7	1	10	427	Jul 15 Wednesday
197	7	13	22	26	24	37	39	36	53	31	40	26	53	37	22	22	19	42	8	8	9	5	7	5	591	Jul 16 Thursday
198	22	16	14	16	17	44	24	41	34	37	25	31	48	26	24	19	18	10	15	15	6	6	8	1	517	Jul 17 Friday
199	12	9	3	1	7	12	18	10	10	18	26	12	5	7	22	14	13	11	11	8	10	8	11	7	265	Jul 18 Saturday
200	13	0	14	8	9	13	8	7	9	7	11	10	6	8	18	13	22	20	17	6	2	19	10	1	251	Jul 19 Sunday
201	9	19	12	16	23	40	37	30	39	30	43	34	25	21	21	26	1	16	13	26	8	9	7	7	512	Jul 20 Monday
202	10	5	29	18	21	31	37	35	25	22	36	24	26	32	33	23	36	20	61	143	130	87	79	29	992	Jul 21 Tuesday

Table 3.5.5 (Page 2 of 4)

APA .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
203	14	9	40	40	24	39	54	23	25	14	38	34	36	14	17	22	16	17	2	0	5	6	5	11	505	Jul 22 Wednesday
204	1	7	24	12	26	43	41	32	30	33	35	27	20	17	26	23	20	13	25	8	6	8	10	4	491	Jul 23 Thursday
205	16	0	0	0	6	38	24	24	28	30	9	64	25	30	21	6	6	12	14	14	5	6	3	4	385	Jul 24 Friday
206	6	9	9	5	3	13	21	13	6	12	15	9	2	11	14	7	8	14	12	5	7	7	2	14	224	Jul 25 Saturday
207	0	6	10	11	4	8	6	2	11	9	11	5	25	30	13	5	8	7	5	7	9	5	0	13	210	Jul 26 Sunday
208	1	12	12	21	23	31	43	29	33	25	30	25	31	13	23	15	8	18	0	9	4	6	0	0	412	Jul 27 Monday
209	0	0	9	12	15	35	20	34	13	31	23	27	27	28	27	19	13	22	10	5	17	0	3	7	397	Jul 28 Tuesday
210	8	9	16	6	15	37	26	25	17	25	14	41	12	15	14	13	28	13	12	18	6	6	3	1	380	Jul 29 Wednesday
211	4	3	20	16	13	32	41	30	20	19	34	34	28	18	18	20	18	15	26	6	9	2	11	4	441	Jul 30 Thursday
212	4	11	15	18	39	29	18	27	39	28	30	39	28	36	16	19	14	17	9	13	6	0	4	1	460	Jul 31 Friday
213	3	18	9	0	14	14	9	10	13	16	9	4	9	6	10	14	20	8	8	0	0	6	9	2	211	Aug 01 Saturday
214	1	4	14	2	13	2	6	6	5	9	7	4	18	12	6	11	3	9	2	3	3	5	2	7	154	Aug 02 Sunday
215	8	7	13	20	21	30	49	27	23	21	12	27	32	17	7	17	17	18	11	4	13	6	14	0	414	Aug 03 Monday
216	0	3	16	15	22	22	28	30	39	43	20	20	28	36	17	20	13	12	13	23	0	9	1	1	431	Aug 04 Tuesday
217	16	11	16	14	11	27	23	27	13	35	52	44	15	27	17	4	20	7	10	8	15	7	6	10	435	Aug 05 Wednesday
218	2	9	13	21	22	44	35	48	29	29	29	33	13	17	24	16	13	13	7	13	4	2	5	6	447	Aug 06 Thursday
219	1	7	11	15	17	15	36	30	49	13	22	32	35	27	31	41	26	34	48	37	45	26	27	32	657	Aug 07 Friday
220	10	18	35	35	46	51	34	37	36	31	44	34	26	16	22	18	25	27	29	30	32	17	20	24	697	Aug 08 Saturday
221	26	8	5	18	26	17	20	7	10	4	18	25	9	15	5	8	6	11	7	10	17	21	17	6	316	Aug 09 Sunday
222	12	2	5	28	27	34	40	24	25	29	41	27	33	26	19	15	11	16	15	10	0	2	3	1	445	Aug 10 Monday
223	8	5	19	24	27	23	35	25	35	29	51	19	27	28	16	34	36	20	13	13	9	7	12	4	519	Aug 11 Tuesday
224	3	7	23	21	28	38	34	30	48	49	43	34	43	36	21	30	15	9	19	11	20	8	1	4	575	Aug 12 Wednesday
225	8	5	12	35	24	42	35	27	30	27	48	31	20	31	34	9	8	33	13	4	7	18	9	3	513	Aug 13 Thursday
226	1	6	11	0	8	36	35	36	20	31	46	53	19	27	33	10	25	19	14	19	0	6	2	8	465	Aug 14 Friday
227	7	4	6	1	1	0	27	23	15	8	14	12	6	25	5	12	13	11	1	1	5	18	0	8	223	Aug 15 Saturday
228	4	7	12	3	18	13	23	0	4	12	14	8	6	19	30	1	8	12	6	6	0	10	5	2	223	Aug 16 Sunday
229	0	8	16	18	15	40	51	53	34	3	17	28	50	25	34	22	11	17	12	4	17	3	2	1	481	Aug 17 Monday
230	9	0	13	35	20	28	43	38	22	13	20	43	42	38	21	25	22	26	21	9	23	0	0	2	513	Aug 18 Tuesday
231	2	9	21	23	37	47	40	24	46	18	40	31	42	38	32	30	15	11	10	14	1	0	5	6	542	Aug 19 Wednesday
232	0	5	25	37	22	59	45	38	86	58	39	70	32	49	52	30	11	18	38	17	15	39	15	11	811	Aug 20 Thursday
233	7	8	28	32	45	40	49	52	22	41	38	74	46	35	53	46	18	33	17	16	18	14	5	12	749	Aug 21 Friday
234	8	40	37	22	17	21	21	29	19	30	34	14	25	22	19	7	23	13	24	10	9	15	4	4	467	Aug 22 Saturday
235	8	3	21	10	13	14	21	8	6	19	7	13	8	18	30	32	18	17	18	10	4	8	10	9	325	Aug 23 Sunday
236	2	5	8	21	6	38	42	32	37	31	23	30	36	33	15	17	28	11	11	8	16	7	6	2	465	Aug 24 Monday
237	10	12	12	30	26	43	42	44	25	37	24	48	40	47	35	12	48	32	35	38	37	20	18	18	733	Aug 25 Tuesday
238	5	8	11	21	33	49	44	30	53	17	34	43	51	36	50	44	37	53	26	29	16	59	88	69	906	Aug 26 Wednesday
239	100	76	81	84	86	59	70	39	160	53	74	138	90	79	73	77	91	75	66	41	77	79	99	82	1949	Aug 27 Thursday
240	63	35	53	49	55	82	75	86	86	96	62	63	91	50	60	47	20	25	40	12	20	19	34	29	1252	Aug 28 Friday
241	15	22	32	25	31	31	36	59	42	44	61	53	55	53	63	35	12	20	17	5	7	20	9	6	753	Aug 29 Saturday
242	8	10	18	15	14	17	17	19	14	21	3	15	9	23	9	46	34	16	28	25	36	15	30	27	469	Aug 30 Sunday
243	40	36	37	31	82	97	76	73	35	42	36	6	59	46	65	73	54	41	59	49	33	43	27	43	1183	Aug 31 Monday
244	34	33	49	47	52	102	74	59	65	37	52	50	61	57	56	50	64	57	71	29	21	16	18	7	1161	Sep 01 Tuesday
245	7	14	43	80	71	82	73	80	79	79	91	0	0	24	60	47	53	18	19	18	28	22	34	36	1058	Sep 02 Wednesday
246	31	30	60	35	24	66	46	33	36	53	36	42	30	34	35	25	19	15	19	5	17	11	0	7	709	Sep 03 Thursday
247	1	10	21	31	24	20	21	12	38	16	37	25	17	32	22	14	14	31	8	22	5	9	6	9	445	Sep 04 Friday
248	4	27	30	67	27	43	27	54	39	38	66	47	58	58	48	38	43	60	42	41	17	28	34	29	965	Sep 05 Saturday
249	22	24	26	16	28	41	36	40	30	17	31	14	14	18	56	34	7	21	32	20	14	3	36	17	597	Sep 06 Sunday
250	50	15	26	19	30	31	39	54	51	19	48	38	31	63	30	29	32	25	19	16	12	9	9	23	718	Sep 07 Monday
251	27	16	23	34	32	38	40	32	33	19	32	51	17	23	22	35	42	23	34	22	3	4	5	1	608	Sep 08 Tuesday
252	3	14	22	13	27	28	22	18	28	28	39	40	33	47	49	28	17	16	17	24	29	9	15	18	584	Sep 09 Wednesday
253	11	19	21	38	38	55	34	45	48	40	71	57	46	19	26	16	34	24	29	11	2	15	8	4	711	Sep 10 Thursday
254	6	8	14	15	15	20	25	23	39	53	40	37	44	25	26	26	18	16	10	28	13	3	19	14	537	Sep 11 Friday
255	13	1	21	20	23	12	18	21	29	9	27	24	12	32	16	23	11	9	7	7	7	14	4	12	372	Sep 12 Saturday
256	8	8	35	23	17	23	18	31	24	35	14	16	4	9	20	21	8	35	15	25	19	8	17	7	440	Sep 13 Sunday
257	4	13	23	23	24	30	48	33	28	37	17	12	26	45	24	22	35	38	13	24	28	9	6	19	581	Sep 14 Monday
258	34	48	19	25	26	39	31	36	29	31	33	9	12	20	45	30	10	12	0	10	11	0	8	12	530	Sep 15 Tuesday

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
259	21	20	26	44	70	53	51	51	45	39	26	46	12	30	17	10	9	10	16	6	14	7	16	7	646	Sep 16 Wednesday
260	27	28	43	34	37	34	64	42	55	40	44	43	30	28	32	19	19	20	5	6	6	13	8	18	695	Sep 17 Thursday
261	17	22	32	82	53	80	113	93	74	116	80	98	82	86	64	79	54	57	58	89	3	0	0	0	1432	Sep 18 Friday
262	0	0	0	0	0	0	0	0	34	50	58	34	36	17	25	45	20	11	21	10	39	52	45	17	514	Sep 19 Saturday
263	24	30	23	53	30	45	42	44	26	27	24	48	42	50	49	60	44	53	24	10	15	15	47	17	842	Sep 20 Sunday
264	20	36	52	42	60	59	72	70	79	78	87	81	67	87	86	94	54	54	67	57	54	65	36	63	1520	Sep 21 Monday
265	57	55	84	101	79	102	106	81	49	33	39	51	60	65	39	44	64	48	71	68	64	61	63	35	1519	Sep 22 Tuesday
266	53	39	56	46	43	55	53	57	66	37	72	32	41	38	59	67	89	62	61	68	68	63	58	71	1354	Sep 23 Wednesday
267	65	59	60	76	66	72	69	79	94	38	100	100	106	88	69	76	39	73	90	41	51	27	21	28	1587	Sep 24 Thursday
268	12	28	25	43	37	29	40	27	45	80	50	52	65	80	58	49	81	89	70	47	64	54	54	30	1209	Sep 25 Friday
269	34	62	57	51	65	83	64	58	68	75	64	74	65	83	65	36	42	61	41	40	41	16	25	10	1280	Sep 26 Saturday
270	2	14	32	21	31	47	8	10	15	5	40	27	52	4	32	28	13	12	15	8	17	7	4	7	451	Sep 27 Sunday
271	2	10	11	33	41	48	62	71	52	45	61	45	24	53	57	42	30	17	17	29	32	13	13	3	811	Sep 28 Monday
272	10	27	57	88	79	88	96	74	54	90	74	67	86	66	77	62	30	53	39	27	18	49	46	53	1410	Sep 29 Tuesday
273	54	65	54	40	49	57	72	61	31	47	42	54	37	48	64	55	43	45	49	25	60	50	47	54	1203	Sep 30 Wednesday

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	1772	2102	3282	3534	3674	5364	5617	5168	5117	4626	5098	5084	4554	4331	4104	3663	3169	3212	2889	2551	2359	2034	1948	1721	86973	Total sum
183	10	11	18	19	20	29	31	28	28	25	28	28	25	24	22	20	17	18	16	14	13	11	11	9	475	Total average
125	11	13	20	23	24	36	38	34	34	30	32	33	29	27	25	23	20	19	17	16	14	12	11	10	549	Average workdays
58	7	8	13	11	12	15	15	17	16	15	19	17	16	16	17	14	12	14	13	10	10	9	9	7	312	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
91	45	50	41	49	33	56	43	35	26	24	30	16	19	26	25	12	25	23	37	23	13	23	19	31	724	Apr 01 Wednesday
92	29	46	6	15	15	28	34	46	36	23	53	20	29	16	13	32	39	23	46	22	19	35	45	52	722	Apr 02 Thursday
93	29	29	55	33	28	29	60	69	45	37	52	31	13	58	18	20	29	29	34	25	18	20	33	25	819	Apr 03 Friday
94	18	26	23	15	12	16	20	14	3	6	14	28	17	6	4	9	22	21	15	8	15	24	22	32	390	Apr 04 Saturday
95	11	21	24	22	19	16	8	21	31	18	14	18	10	9	13	16	18	29	46	16	46	46	34	34	540	Apr 05 Sunday
96	45	34	37	45	25	23	17	49	21	20	25	20	11	30	30	9	18	25	30	43	17	29	39	50	692	Apr 06 Monday
97	56	51	53	51	36	46	33	34	45	28	20	26	19	28	16	20	20	13	22	22	28	27	36	32	762	Apr 07 Tuesday
98	28	31	30	41	41	34	20	32	37	30	26	37	22	27	49	61	52	41	21	30	37	29	41	47	844	Apr 08 Wednesday
99	55	34	23	33	28	37	34	39	47	46	15	20	103	42	18	43	32	22	38	22	26	19	23	22	821	Apr 09 Thursday
100	31	28	23	35	34	34	27	33	34	11	16	19	28	36	26	40	38	55	34	25	34	16	21	33	711	Apr 10 Friday
101	38	52	20	29	53	27	36	28	25	36	37	41	40	33	42	38	40	30	34	21	16	23	43	27	809	Apr 11 Saturday
102	42	42	35	27	28	48	21	40	30	37	28	46	27	28	19	26	31	11	28	17	34	22	25	28	720	Apr 12 Sunday
103	25	32	46	34	34	24	33	53	30	42	17	26	36	20	50	34	49	26	21	19	32	28	38	25	774	Apr 13 Monday
104	21	36	43	35	22	3	24	32	25	23	22	41	29	32	42	23	17	26	56	56	28	13	30	36	715	Apr 14 Tuesday
105	27	11	21	22	27	14	46	64	32	44	35	43	24	13	25	47	44	56	24	38	41	32	20	25	775	Apr 15 Wednesday
106	22	31	18	28	43	42	34	48	21	17	43	31	16	37	29	24	42	40	20	43	43	36	27	23	758	Apr 16 Thursday
107	31	26	39	27	23	14	18	39	38	23	33	40	24	44	55	27	29	18	37	33	32	39	29	14	732	Apr 17 Friday
108	20	35	19	21	22	4	12	28	34	24	21	42	20	46	22	10	22	28	28	28	33	26	44	27	616	Apr 18 Saturday
109	38	32	29	25	26	38	30	36	25	27	31	38	50	24	32	31	40	34	32	32	32	36	99	53	870	Apr 19 Sunday
110	41	17	61	65	43	21	60	62	46	57	61	51	30	16	37	55	43	31	64	89	59	36	56	87	1188	Apr 20 Monday
111	38	63	67	72	33	26	32	69	51	21	56	32	28	29	30	23	34	25	24	38	30	16	52	84	973	Apr 21 Tuesday
112	41	54	80	79	56	38	49	60	28	44	32	46	20	27	59	72	49	34	61	42	25	75	38	47	1156	Apr 22 Wednesday
113	28	38	34	52	58	42	30	48	30	44	28	28	22	30	23	29	50	36	36	39	27	35	21	28	836	Apr 23 Thursday
114	26	35	47	44	25	34	41	47	23	14	15	34	14	45	68	61	80	74	105	33	44	34	39	19	1001	Apr 24 Friday
115	23	18	41	42	64	26	36	13	37	42	16	40	9	23	13	34	28	16	16	32	23	19	28	33	672	Apr 25 Saturday
116	30	44	21	28	16	20	28	27	21	26	13	16	8	25	16	18	23	30	38	26	24	29	27	31	585	Apr 26 Sunday
117	28	27	26	42	31	30	27	62	24	11	35	16	26	22	18	27	38	22	42	36	63	39	43	28	763	Apr 27 Monday
118	26	30	32	23	26	42	49	29	29	22	24	25	20	24	27	24	22	38	34	41	14	24	53	39	717	Apr 28 Tuesday
119	42	26	44	60	48	44	55	33	70	80	70	29	10	19	25	19	23	19	31	29	41	43	39	27	926	Apr 29 Wednesday
120	42	78	114	87	59	22	54	64	34	25	44	46	119	43	31	43	39	26	36	55	44	51	36	36	1228	Apr 30 Thursday
121	37	37	73	27	23	33	42	62	56	19	37	35	42	56	34	38	40	39	43	37	32	49	46	33	970	May 01 Friday
122	53	33	35	25	19	36	38	31	23	27	27	59	66	39	61	48	45	22	31	31	37	32	32	36	886	May 02 Saturday
123	25	27	37	33	15	18	11	34	34	32	55	24	14	21	48	38	13	20	9	22	22	44	45	35	676	May 03 Sunday
124	39	30	35	72	50	27	48	23	24	29	39	47	22	24	16	20	27	56	21	32	45	26	37	5	794	May 04 Monday
125	30	20	39	39	14	30	48	26	42	33	36	38	28	15	66	33	31	33	32	5	16	17	58	34	763	May 05 Tuesday
126	18	33	77	47	13	47	83	55	23	26	68	63	9	34	47	54	24	31	44	38	29	31	29	43	966	May 06 Wednesday
127	41	38	73	51	27	12	44	49	44	31	52	20	30	45	29	28	30	39	30	31	32	49	43	76	944	May 07 Thursday
128	67	20	75	49	18	23	23	43	27	14	44	45	20	27	41	28	63	63	39	24	6	20	16	19	814	May 08 Friday
129	36	33	19	35	29	20	16	32	21	3	23	27	24	15	21	24	26	43	21	32	29	29	32	21	611	May 09 Saturday
130	25	32	17	37	23	21	35	34	45	16	14	15	25	29	30	40	34	47	20	35	32	30	31	36	703	May 10 Sunday
131	26	8	19	31	33	48	62	46	13	29	46	35	44	23	38	33	23	26	25	39	52	48	24	32	803	May 11 Monday
132	39	36	39	22	17	24	70	38	16	24	22	27	42	31	41	24	24	33	25	23	36	58	61	48	820	May 12 Tuesday
133	51	40	25	40	25	31	55	43	38	28	40	48	8	21	39	14	20	18	39	21	10	18	10	51	733	May 13 Wednesday
134	26	21	20	46	19	44	24	26	20	28	26	68	26	32	32	41	36	20	57	40	54	23	40	28	797	May 14 Thursday
135	56	20	24	18	19	26	30	10	28	27	28	22	10	29	37	32	15	29	37	48	18	18	14	12	607	May 15 Friday
136	12	11	27	9	16	16	16	22	14	26	37	35	28	13	20	45	14	34	30	13	13	12	42	25	530	May 16 Saturday
137	21	38	18	16	22	13	12	12	14	15	11	15	25	24	22	17	23	24	8	35	53	17	35	32	522	May 17 Sunday
138	23	24	49	23	10	32	25	37	30	25	20	53	24	12	21	31	27	21	18	33	40	42	46	42	708	May 18 Monday
139	36	29	10	15	15	37	46	39	50	9	22	38	22	27	39	51	30	10	28	18	5	38	51	54	719	May 19 Tuesday
140	40	21	22	20	5	35	20	15	42	44	43	26	23	24	27	46	26	16	20	43	42	20	24	42	686	May 20 Wednesday
141	10	10	11	34	32	26	16	14	42	13	13	6	14	10	9	11	22	11	26	18	16	17	34	51	466	May 21 Thursday
142	25	6	26	38	30	8	19	33	18	7	24	47	14	23	28	19	34	15	21	26	12	21	28	17	539	May 22 Friday
143	22	14	10	21	14	20	21	8	15	20	16	29	7	26	35	20	27	36	27	34	20	9	24	52	527	May 23 Saturday
144	30	26	37	4	29	28	29	16	17	35	53	19	24	56	34	34	26	22	20	39	19	22	44	57	720	May 24 Sunday
145	27	34	84	64	49	30	60	44	34	35	61	59	45	70	81	48	21	21	45	55	37	18	31	43	1096	May 25 Monday
146	24	17	26	40	15	21	17	18	10	35	38	41	24	15	25	25	23	19	19	29	47	43	49	31	651	May 26 Tuesday

Table 3.5.6 (Page 1 of 4)

SPI .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
147	25	35	40	51	22	24	27	48	40	17	50	41	20	32	20	30	36	30	20	20	28	46	47	29	778	May 27 Wednesday
148	23	25	21	31	35	46	21	31	25	15	16	34	17	17	18	23	22	29	31	18	21	21	16	24	580	May 28 Thursday
149	29	17	34	38	37	25	24	28	32	38	22	12	47	25	27	44	35	17	62	46	29	21	30	21	740	May 29 Friday
150	29	51	31	49	24	14	24	38	16	42	25	14	8	14	16	17	7	10	23	23	27	22	37	25	586	May 30 Saturday
151	31	24	14	14	21	31	30	9	15	27	30	11	27	26	28	32	29	32	28	28	16	31	23	19	576	May 31 Sunday
152	9	31	17	19	26	22	14	24	25	29	39	37	21	23	18	35	30	11	10	37	18	22	14	25	556	Jun 01 Monday
153	15	24	24	13	17	17	19	13	9	23	28	37	11	20	21	19	14	25	30	11	20	38	41	24	513	Jun 02 Tuesday
154	36	13	38	73	39	21	34	53	26	37	40	54	37	25	40	43	23	39	46	28	41	53	47	10	896	Jun 03 Wednesday
155	23	29	28	52	55	24	39	38	37	30	56	37	40	19	43	26	22	32	29	15	18	28	39	24	783	Jun 04 Thursday
156	27	21	25	27	31	15	38	63	3	0	58	52	29	27	48	61	15	30	32	33	17	40	34	14	740	Jun 05 Friday
157	26	26	19	20	21	24	28	14	17	18	22	47	20	31	27	27	24	27	21	20	27	40	34	25	605	Jun 06 Saturday
158	37	17	11	19	29	29	17	27	14	24	22	9	18	29	22	18	25	15	24	14	28	36	56	70	610	Jun 07 Sunday
159	67	35	74	85	51	33	36	52	43	35	43	40	30	35	25	39	36	28	49	24	20	26	72	15	993	Jun 08 Monday
160	36	22	44	49	25	32	40	42	34	16	33	27	21	26	32	45	25	16	20	26	14	20	31	20	696	Jun 09 Tuesday
161	28	10	35	23	28	25	29	34	29	34	58	57	47	24	31	40	39	34	18	18	11	15	19	13	699	Jun 10 Wednesday
162	15	26	26	25	24	22	10	9	29	26	24	35	23	22	34	20	31	27	23	13	25	19	14	37	559	Jun 11 Thursday
163	27	43	32	34	15	38	45	41	50	35	44	31	18	34	14	11	18	12	10	15	16	21	18	16	638	Jun 12 Friday
164	14	26	14	16	22	20	28	26	45	32	22	25	23	15	22	19	23	8	24	19	14	9	23	17	506	Jun 13 Saturday
165	13	20	15	12	7	17	6	10	13	23	18	26	14	31	25	20	18	8	5	5	11	16	22	4	359	Jun 14 Sunday
166	9	27	19	9	12	14	25	24	25	28	47	46	32	18	31	9	31	24	19	18	15	18	13	17	530	Jun 15 Monday
167	13	13	12	23	19	10	22	20	21	28	15	25	26	26	30	19	27	21	27	18	11	12	14	22	474	Jun 16 Tuesday
168	25	14	8	21	12	26	38	26	31	19	36	25	27	35	26	48	20	19	24	35	30	12	24	14	595	Jun 17 Wednesday
169	15	36	22	26	37	32	30	46	45	42	39	39	32	24	51	59	25	24	38	41	28	16	16	27	790	Jun 18 Thursday
170	19	25	33	32	35	39	37	23	30	29	41	45	27	18	28	24	28	25	27	18	14	41	22	42	702	Jun 19 Friday
171	29	9	23	30	16	24	15	26	14	10	11	25	23	29	29	21	19	47	23	35	34	12	17	13	534	Jun 20 Saturday
172	13	14	15	19	24	10	18	16	31	35	28	28	26	39	42	35	37	6	0	0	0	0	0	0	436	Jun 21 Sunday
173	0	0	0	0	0	0	0	0	0	0	14	19	28	25	28	19	25	35	15	28	30	24	42	24	356	Jun 22 Monday
174	17	18	15	17	30	11	23	21	17	41	25	27	32	30	20	45	35	38	27	22	23	25	23	32	614	Jun 23 Tuesday
175	29	17	24	26	20	23	18	33	24	28	20	26	35	17	24	34	25	15	20	15	7	20	18	15	533	Jun 24 Wednesday
176	15	13	20	7	7	12	28	15	19	18	21	10	24	13	18	23	16	8	33	26	28	19	11	15	419	Jun 25 Thursday
177	6	29	19	18	15	9	19	13	36	40	27	46	34	25	35	34	23	23	32	31	27	29	26	27	623	Jun 26 Friday
178	36	16	24	22	26	30	39	46	73	38	27	30	27	34	37	26	28	36	36	39	51	20	21	31	793	Jun 27 Saturday
179	36	20	25	53	37	36	38	35	18	46	17	33	32	31	34	24	36	61	71	79	91	90	49	53	1045	Jun 28 Sunday
180	53	16	27	55	26	33	36	29	35	31	14	30	28	25	27	36	20	17	19	29	24	30	32	39	711	Jun 29 Monday
181	25	29	24	26	18	27	31	11	28	22	32	32	19	25	23	21	25	28	19	15	29	33	25	25	592	Jun 30 Tuesday
182	32	37	33	34	31	57	44	44	42	34	29	32	31	42	46	26	43	35	30	14	14	22	24	28	804	Jul 01 Wednesday
183	26	34	18	25	39	28	22	23	36	25	26	33	54	24	20	28	16	29	25	28	38	32	38	22	689	Jul 02 Thursday
184	23	23	39	41	28	31	35	19	19	33	27	26	29	17	15	20	19	27	29	37	14	25	12	17	605	Jul 03 Friday
185	17	36	25	32	20	14	17	19	21	28	25	13	30	28	35	27	24	19	17	26	10	13	32	9	537	Jul 04 Saturday
186	20	23	13	15	25	18	21	30	16	18	16	18	21	26	38	20	22	18	16	29	18	18	17	20	496	Jul 05 Sunday
187	24	17	10	21	16	18	18	17	24	26	15	38	14	21	14	14	16	17	22	17	8	23	23	28	461	Jul 06 Monday
188	19	31	22	42	17	23	22	37	42	27	30	36	37	63	83	45	49	40	36	26	44	20	37	24	852	Jul 07 Tuesday
189	31	24	61	47	33	33	57	26	43	27	26	38	47	36	37	36	48	28	43	31	41	57	63	80	993	Jul 08 Wednesday
190	61	60	47	47	28	32	31	44	47	44	39	30	27	29	24	43	31	18	24	21	26	25	32	19	829	Jul 09 Thursday
191	9	0	15	33	41	48	36	39	40	35	33	23	30	24	26	39	26	33	19	17	32	39	24	34	695	Jul 10 Friday
192	24	30	38	43	40	29	36	37	57	31	21	20	23	37	18	30	15	32	26	19	26	38	40	40	750	Jul 11 Saturday
193	35	27	26	32	55	58	45	45	48	28	24	47	34	38	20	32	43	42	27	34	30	36	51	40	897	Jul 12 Sunday
194	37	22	27	23	29	26	24	27	20	25	26	33	13	24	51	56	43	55	58	67	43	35	14	18	796	Jul 13 Monday
195	20	26	8	25	17	25	41	32	20	15	19	18	21	34	32	33	36	22	36	45	49	64	54	62	754	Jul 14 Tuesday
196	61	75	95	107	114	124	109	94	75	69	79	74	70	72	95	83	58	53	59	61	72	71	80	87	1937	Jul 15 Wednesday
197	94	90	87	80	78	102	102	61	69	65	63	47	31	31	30	36	34	29	22	12	18	30	34	26	1271	Jul 16 Thursday
198	49	32	46	42	31	48	23	23	29	41	22	40	39	33	35	40	26	32	26	34	42	57	45	29	864	Jul 17 Friday
199	44	43	44	51	49	59	61	37	36	37	32	38	17	24	19	31	25	35	42	29	27	44	35	37	896	Jul 18 Saturday
200	46	33	32	37	51	62	34	50	38	33	29	34	32	29	16	32	18	28	21	15	18	19	9	29	745	Jul 19 Sunday
201	37	27	24	24	38	15	12	7	14	11	23	11	14	10	5	5	20	3	19	30	6	24	21	21	421	Jul 20 Monday
202	15	12	17	18	13	22	35	50	30	39	62	73	89	75	56	57	55	63	38	31	59	118	137	70	1234	Jul 21 Tuesday

Table 3.5.6 (Page 2 of 4)

SPI .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
203	30	33	37	38	34	17	18	19	14	10	30	10	12	14	19	12	18	9	12	9	2	20	19	14	450	Jul 22 Wednesday
204	32	33	19	24	15	15	20	12	29	32	18	16	4	19	19	15	4	12	17	10	16	17	23	31	452	Jul 23 Thursday
205	20	25	23	22	16	21	12	26	13	22	17	13	9	10	9	6	11	1	20	11	35	30	43	77	492	Jul 24 Friday
206	81	47	36	12	21	14	16	15	27	18	10	3	4	1	8	16	3	14	7	22	17	25	34	33	484	Jul 25 Saturday
207	35	33	26	31	27	33	28	11	27	26	14	20	5	9	0	10	9	12	12	10	18	12	13	16	437	Jul 26 Sunday
208	26	28	16	32	29	14	19	14	20	12	18	28	7	13	16	20	6	11	3	15	10	16	7	19	399	Jul 27 Monday
209	22	14	28	18	18	16	12	13	9	7	11	25	5	30	5	9	7	14	10	23	3	23	18	19	359	Jul 28 Tuesday
210	33	36	24	21	19	20	12	22	11	16	7	25	6	15	11	3	4	13	16	27	18	25	21	25	430	Jul 29 Wednesday
211	26	37	30	26	30	16	14	19	19	21	15	18	12	10	23	6	15	19	8	11	14	10	20	40	459	Jul 30 Thursday
212	28	29	26	23	22	29	34	23	29	24	27	12	20	31	31	21	48	30	37	17	16	41	31	41	670	Jul 31 Friday
213	44	37	37	48	53	44	33	38	24	19	37	18	19	23	12	12	6	8	12	16	18	16	16	26	616	Aug 01 Saturday
214	24	23	40	21	30	20	26	23	16	7	10	11	8	24	14	13	16	7	13	27	26	34	33	29	495	Aug 02 Sunday
215	43	56	48	42	45	69	30	21	20	12	22	14	14	16	19	8	8	15	23	16	16	34	31	36	658	Aug 03 Monday
216	43	39	51	33	43	39	38	22	33	21	14	26	34	13	13	30	26	26	8	16	17	19	30	21	655	Aug 04 Tuesday
217	31	41	36	36	29	17	11	19	23	27	28	11	13	19	13	7	8	14	20	31	30	24	26	23	537	Aug 05 Wednesday
218	23	38	32	13	50	37	14	17	26	19	24	14	16	8	26	22	16	8	19	15	13	22	10	18	500	Aug 06 Thursday
219	26	32	25	37	40	14	32	25	44	14	17	11	12	5	20	20	27	27	13	17	19	20	20	18	535	Aug 07 Friday
220	30	26	37	51	34	31	55	20	20	12	20	13	34	9	18	16	23	17	24	34	31	17	36	32	640	Aug 08 Saturday
221	66	59	50	53	50	51	71	35	19	22	17	25	14	11	19	22	21	24	34	17	18	24	34	25	781	Aug 09 Sunday
222	36	32	44	47	28	41	47	36	29	25	47	23	25	14	19	19	16	18	12	21	35	33	39	28	714	Aug 10 Monday
223	41	67	69	41	51	34	62	59	27	27	27	22	15	13	22	5	12	10	16	29	36	32	16	49	782	Aug 11 Tuesday
224	44	34	43	53	68	39	32	19	14	26	25	44	9	6	11	21	15	30	36	27	18	37	32	19	702	Aug 12 Wednesday
225	30	18	24	31	18	15	29	37	24	9	16	17	10	19	9	15	14	20	8	24	18	41	30	33	509	Aug 13 Thursday
226	48	33	42	45	48	51	35	35	13	30	23	19	20	20	17	16	13	18	18	26	26	14	46	42	698	Aug 14 Friday
227	42	35	37	38	36	40	39	32	59	112	61	58	99	65	68	83	73	89	67	25	41	41	23	36	1299	Aug 15 Saturday
228	46	63	38	43	48	52	108	99	115	54	21	38	62	60	34	13	20	41	25	31	33	41	20	14	1119	Aug 16 Sunday
229	12	10	10	33	33	11	28	12	6	16	10	20	19	24	13	13	28	15	12	10	28	13	21	33	430	Aug 17 Monday
230	36	37	14	25	36	30	26	28	21	18	24	14	14	34	28	16	30	29	27	23	46	32	33	45	666	Aug 18 Tuesday
231	42	41	41	61	34	33	36	29	33	24	10	23	15	27	41	45	29	38	20	25	51	33	41	71	843	Aug 19 Wednesday
232	69	83	89	83	65	98	69	55	50	42	36	41	40	36	48	39	43	36	22	40	40	42	35	62	1263	Aug 20 Thursday
233	31	38	51	52	21	40	27	45	47	43	36	38	24	32	47	59	39	30	40	32	47	36	48	25	928	Aug 21 Friday
234	25	42	34	42	24	73	46	51	48	50	35	57	59	44	54	41	29	51	59	52	43	70	60	73	1162	Aug 22 Saturday
235	62	51	60	56	30	53	44	55	53	26	35	40	31	25	36	24	22	33	13	29	31	27	17	23	876	Aug 23 Sunday
236	23	29	29	17	34	17	24	42	13	23	28	24	22	12	24	22	18	8	62	54	36	24	23	42	650	Aug 24 Monday
237	32	41	44	24	15	19	13	12	12	11	18	13	15	19	17	30	26	21	26	36	3	0	0	0	447	Aug 25 Tuesday
238	0	0	0	0	0	0	8	18	8	0	0	21	55	59	70	81	70	64	48	33	27	39	66	48	715	Aug 26 Wednesday
239	55	52	74	72	50	34	40	42	27	34	30	43	38	36	37	51	31	37	35	26	37	103	122	116	1222	Aug 27 Thursday
240	108	110	115	30	61	63	69	41	44	48	30	29	31	27	18	28	43	53	37	29	31	29	40	55	1169	Aug 28 Friday
241	41	52	60	46	54	67	73	61	67	40	35	37	50	28	35	42	62	71	78	66	60	44	54	57	1280	Aug 29 Saturday
242	37	42	75	62	66	43	38	50	33	30	24	34	27	35	37	19	26	26	23	30	36	35	46	32	906	Aug 30 Sunday
243	32	47	46	46	38	53	26	18	40	15	26	9	15	13	18	14	20	12	70	37	20	4	25	24	668	Aug 31 Monday
244	11	19	16	21	31	29	25	19	32	28	30	15	48	30	16	50	23	37	38	32	34	46	38	52	720	Sep 01 Tuesday
245	82	74	66	60	67	64	40	46	55	58	48	55	40	63	58	51	68	53	71	67	55	48	43	46	1378	Sep 02 Wednesday
246	31	43	55	47	74	48	58	80	56	51	47	37	31	59	42	34	42	51	67	70	86	48	64	53	1274	Sep 03 Thursday
247	57	44	52	68	64	58	44	62	56	25	50	28	21	42	20	32	46	36	32	61	32	26	54	55	1065	Sep 04 Friday
248	75	68	73	66	61	65	43	75	70	71	55	60	45	33	44	60	48	46	33	52	42	55	51	38	1329	Sep 05 Saturday
249	39	35	44	38	45	50	45	62	40	57	45	61	45	61	67	49	44	47	70	54	49	50	47	62	1206	Sep 06 Sunday
250	72	76	94	76	85	57	54	53	43	62	39	24	81	71	85	66	62	86	124	155	130	89	95	116	1895	Sep 07 Monday
251	129	169	137	97	93	86	87	75	76	76	64	73	75	69	40	59	57	55	49	62	82	59	55	48	1872	Sep 08 Tuesday
252	51	67	61	70	64	60	79	31	41	55	42	37	25	28	22	31	45	60	55	57	26	75	77	74	1233	Sep 09 Wednesday
253	57	81	100	117	104	100	85	104	103	109	116	82	84	57	48	60	52	75	53	86	74	72	59	60	1938	Sep 10 Thursday
254	47	50	39	27	48	43	61	28	26	22	50	55	43	39	53	23	38	57	50	62	47	31	27	49	1015	Sep 11 Friday
255	38	29	36	63	78	89	45	29	45	52	61	51	78	46	51	88	89	68	68	60	92	67	70	48	1441	Sep 12 Saturday
256	54	48	53	40	53	65	60	51	52	37	70	66	23	48	68	47	44	54	64	47	17	54	67	62	1244	Sep 13 Sunday
257	29	44	67	43	63	44	50	41	52	45	50	81	72	77	52	63	69	47	55	60	68	36	60	50	1318	Sep 14 Monday
258	44	58	56	76	74	76	106	56	26	18	30	47	59	42	33	52	61	76	96	55	67	92	26	46	1372	Sep 15 Tuesday

Table 3.5.6 (Page 3 of 4)

SPI .FKX Hourly distribution of detections

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum	Date
259	36	64	114	39	21	42	49	51	56	43	67	43	49	52	37	45	56	57	43	51	56	36	52	57	1216	Sep 16 Wednesday
260	50	53	46	48	78	41	70	50	67	55	45	59	66	52	75	54	62	37	54	69	77	63	67	67	1405	Sep 17 Thursday
261	87	94	84	98	94	119	94	76	81	71	39	60	54	70	84	97	89	53	102	64	91	91	79	64	1935	Sep 18 Friday
262	76	89	95	71	109	60	82	78	61	61	37	30	40	39	34	51	48	45	41	45	46	31	31	29	1329	Sep 19 Saturday
263	39	27	57	53	44	52	83	54	52	87	50	40	55	66	74	65	36	48	36	45	53	30	39	28	1213	Sep 20 Sunday
264	70	29	42	50	26	19	39	30	33	23	42	36	35	15	14	19	18	18	23	15	23	23	31	20	693	Sep 21 Monday
265	18	20	16	21	47	19	19	29	12	21	19	10	12	31	23	39	25	28	35	21	26	41	26	12	570	Sep 22 Tuesday
266	31	33	25	32	24	26	43	55	32	17	14	34	37	31	46	37	36	48	68	60	53	40	36	39	897	Sep 23 Wednesday
267	41	45	25	21	28	28	22	35	40	26	44	82	65	71	69	66	53	68	50	67	58	41	49	28	1122	Sep 24 Thursday
268	50	49	63	72	37	32	41	25	27	24	49	30	44	35	33	52	44	32	31	48	54	41	35	48	996	Sep 25 Friday
269	50	37	30	48	48	33	42	32	34	54	56	45	44	38	47	47	40	20	18	33	50	21	29	32	928	Sep 26 Saturday
270	28	21	22	57	31	35	49	48	45	48	89	63	47	45	89	72	54	71	51	59	56	58	27	29	1194	Sep 27 Sunday
271	34	25	33	52	26	29	32	46	52	51	44	39	24	56	43	44	46	41	52	43	34	37	44	34	961	Sep 28 Monday
272	58	52	60	16	23	45	41	42	55	49	40	47	52	58	64	65	56	56	52	54	47	60	67	83	1242	Sep 29 Tuesday
273	58	80	72	33	65	70	52	33	30	39	43	58	26	52	59	50	32	50	45	38	71	65	58	71	1250	Sep 30 Wednesday

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 6485 7057 6307 6603 5683 6174 5633 6100 5733 6024 6146 6577
6496 7069 6433 6757 6117 6007 5517 6015 5774 6099 5959 6634 149399 Total sum

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	
183	35	35	39	39	35	34	37	36	33	31	33	34	30	31	33	33	32	31	33	33	33	34	36	36	816	Total average
125	36	36	41	41	35	34	38	37	33	30	34	35	30	31	33	34	32	31	35	34	33	35	37	37	831	Average workdays
58	34	33	33	34	34	34	35	35	35	33	29	31	31	31	31	32	30	32	30	30	31	30	34	33	776	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
91	3	6	0	0	3	8	2	5	4	10	12	8	7	16	14	10	11	22	18	24	28	60	61	89	421	Apr 01 Wednesday
92	91	114	130	130	55	16	22	14	40	18	17	19	29	35	17	11	14	31	34	43	62	61	78	65	1146	Apr 02 Thursday
93	82	114	99	98	111	39	19	24	23	11	20	8	27	7	7	5	16	16	20	43	39	42	64	39	973	Apr 03 Friday
94	57	81	48	20	9	3	14	5	17	2	6	9	8	3	14	6	14	8	15	22	1	9	5	8	384	Apr 04 Saturday
95	4	9	14	7	15	1	10	16	11	2	8	5	11	9	1	7	20	5	4	10	5	7	29	11	221	Apr 05 Sunday
96	27	20	24	30	19	22	8	18	2	5	12	7	3	9	3	9	5	6	1	7	6	9	9	14	275	Apr 06 Monday
97	14	7	3	10	2	5	5	3	3	12	3	15	2	16	12	8	3	2	6	2	1	7	4	4	149	Apr 07 Tuesday
98	1	1	6	2	1	2	2	0	2	6	6	14	7	8	6	12	10	8	0	3	8	7	2	10	124	Apr 08 Wednesday
99	9	12	8	30	24	6	2	3	9	7	8	9	6	2	5	4	4	1	9	1	2	3	11	10	185	Apr 09 Thursday
100	6	10	3	14	21	22	2	7	2	3	10	3	5	3	4	12	12	22	3	4	2	3	3	2	178	Apr 10 Friday
101	3	18	9	7	1	9	8	8	9	15	9	6	6	3	1	3	11	2	5	0	4	0	4	4	145	Apr 11 Saturday
102	3	3	2	5	15	8	5	7	5	8	16	14	2	5	4	15	4	2	19	6	1	5	13	13	180	Apr 12 Sunday
103	7	7	20	7	16	2	3	5	14	13	2	7	6	7	3	11	8	2	1	3	7	5	9	5	170	Apr 13 Monday
104	19	25	6	3	7	6	3	4	5	10	9	16	17	7	6	1	2	2	8	3	4	6	3	0	172	Apr 14 Tuesday
105	0	4	1	1	7	9	10	10	5	8	7	7	13	10	26	11	13	0	1	3	5	3	7	4	165	Apr 15 Wednesday
106	5	2	3	7	5	8	2	5	4	3	7	6	17	9	12	3	7	7	3	2	6	6	5	1	135	Apr 16 Thursday
107	3	5	6	15	6	10	3	4	2	17	9	16	3	7	31	13	5	5	2	3	6	3	6	2	182	Apr 17 Friday
108	3	11	3	0	5	6	10	5	14	9	15	6	10	2	4	9	6	2	4	15	3	3	7	10	162	Apr 18 Saturday
109	2	3	5	9	4	5	5	4	6	12	8	15	18	9	14	11	8	6	4	2	13	7	10	8	188	Apr 19 Sunday
110	7	3	11	9	4	5	11	1	9	0	13	4	14	12	12	2	5	4	7	3	4	5	14	16	175	Apr 20 Monday
111	5	20	5	4	5	7	5	2	5	10	4	26	10	9	14	3	10	9	9	1	9	0	3	2	177	Apr 21 Tuesday
112	3	2	2	3	3	6	0	2	9	6	2	14	16	16	18	17	13	0	5	1	6	11	7	2	164	Apr 22 Wednesday
113	5	3	4	18	2	6	7	16	1	20	28	16	12	25	11	9	7	5	11	4	6	9	13	1	239	Apr 23 Thursday
114	1	6	4	9	2	14	1	9	2	9	5	21	16	9	17	10	4	9	6	1	1	1	2	0	159	Apr 24 Friday
115	3	3	2	5	8	8	4	9	1	13	6	12	4	3	3	13	5	5	6	14	4	7	10	8	156	Apr 25 Saturday
116	3	9	9	6	5	5	10	6	4	1	7	3	1	4	8	8	6	12	3	1	4	4	4	2	125	Apr 26 Sunday
117	0	4	4	1	0	4	3	5	4	5	7	11	17	13	8	3	15	14	7	3	5	1	1	4	139	Apr 27 Monday
118	8	0	1	1	5	3	2	8	1	6	9	12	16	23	18	51	15	67	23	10	5	2	1	5	292	Apr 28 Tuesday
119	4	5	6	10	7	9	4	6	8	6	10	6	8	12	21	9	14	18	16	5	6	2	5	11	208	Apr 29 Wednesday
120	0	3	2	4	5	5	2	8	6	12	25	16	19	12	10	21	7	10	10	8	1	7	4	3	200	Apr 30 Thursday
121	5	0	6	2	11	4	0	9	7	19	13	16	8	16	12	17	4	13	6	2	1	6	2	15	194	May 01 Friday
122	16	6	2	8	1	10	10	6	16	11	6	8	5	5	16	9	7	6	8	9	7	12	15	17	216	May 02 Saturday
123	6	4	20	14	4	15	2	17	7	10	14	10	5	20	9	10	2	11	12	2	1	4	11	17	227	May 03 Sunday
124	5	4	5	9	5	4	5	1	4	11	2	17	5	17	11	11	9	10	12	11	1	1	2	1	163	May 04 Monday
125	2	3	4	7	2	9	3	2	7	6	18	5	14	8	17	5	18	8	1	5	5	2	6	7	164	May 05 Tuesday
126	0	0	8	8	4	8	10	9	3	11	4	13	19	4	3	9	12	0	9	5	9	0	7	6	161	May 06 Wednesday
127	5	3	5	10	9	10	3	18	21	12	6	6	17	14	10	17	11	7	11	8	2	4	0	1	210	May 07 Thursday
128	0	3	4	9	6	8	2	10	9	10	11	2	16	12	8	0	7	10	9	3	11	8	6	2	166	May 08 Friday
129	7	9	8	5	6	10	5	10	10	9	15	11	1	10	5	9	12	8	6	20	5	13	12	29	235	May 09 Saturday
130	13	5	23	4	2	7	9	1	15	13	18	18	3	10	10	16	12	17	11	22	2	1	4	5	241	May 10 Sunday
131	4	0	5	13	10	9	7	1	3	3	19	23	32	14	8	15	3	8	10	3	1	3	2	1	197	May 11 Monday
132	4	2	2	0	4	8	5	2	2	7	11	29	33	13	1	3	11	37	5	1	2	3	3	3	191	May 12 Tuesday
133	2	0	3	1	3	6	2	6	16	22	5	28	22	12	6	8	13	2	8	1	4	2	3	6	181	May 13 Wednesday
134	2	1	3	3	9	1	3	7	3	3	4	19	13	7	7	9	12	9	2	13	7	1	4	5	147	May 14 Thursday
135	4	6	2	1	1	8	21	1	11	12	13	7	4	4	18	3	4	6	11	4	8	5	6	9	169	May 15 Friday
136	4	8	8	6	7	2	8	11	14	19	11	14	10	10	11	6	0	1	14	2	7	2	6	28	209	May 16 Saturday
137	9	9	10	4	7	7	3	18	8	14	10	9	16	14	9	14	16	11	5	4	8	2	5	3	215	May 17 Sunday
138	2	1	9	1	1	4	3	28	29	5	9	5	9	12	19	4	5	56	41	2	13	2	2	6	268	May 18 Monday
139	8	15	4	4	1	2	5	54	16	4	4	6	6	7	9	15	13	11	51	33	7	5	7	7	294	May 19 Tuesday
140	12	9	5	12	6	8	4	49	4	16	6	22	18	14	16	13	11	5	12	7	14	3	11	4	281	May 20 Wednesday
141	14	4	7	7	22	9	3	8	4	8	12	11	15	14	8	10	4	9	4	12	5	6	5	4	205	May 21 Thursday
142	4	8	1	3	1	28	21	17	3	9	13	2	10	15	11	3	6	15	18	3	13	7	5	5	221	May 22 Friday
143	2	4	4	6	8	4	11	6	12	15	12	9	11	16	16	24	39	18	9	3	8	0	0	0	237	May 23 Saturday
144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 24 Sunday
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 25 Monday
146	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	May 26 Tuesday

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	
147	0	0	0	11	2	14	16	24	59	38	28	57	54	29	27	7	7	6	11	29	25	10	6	40	500	May 27	Wednesday
148	7	23	29	0	3	44	30	30	36	37	21	39	25	22	14	10	36	23	13	8	19	58	13	4	544	May 28	Thursday
149	13	38	25	19	14	23	19	31	37	18	6	5	6	6	14	6	8	8	8	14	4	1	10	3	336	May 29	Friday
150	6	5	6	4	8	4	40	41	9	26	16	21	25	26	21	11	14	16	27	23	10	9	14	18	400	May 30	Saturday
151	5	8	28	26	3	16	9	6	12	18	5	10	13	14	10	18	11	25	15	28	20	17	16	12	345	May 31	Sunday
152	4	11	10	13	3	4	3	7	15	3	17	22	14	26	18	15	9	7	11	6	7	4	11	21	261	Jun 01	Monday
153	7	11	11	5	23	15	2	8	8	12	14	8	16	9	23	5	5	14	14	9	5	8	1	6	239	Jun 02	Tuesday
154	4	16	5	6	5	1	2	3	11	6	17	15	10	20	5	6	10	2	6	9	3	11	30	7	210	Jun 03	Wednesday
155	2	5	3	4	6	3	3	2	14	20	5	13	10	6	6	11	8	18	25	7	8	4	7	5	195	Jun 04	Thursday
156	7	4	22	5	13	12	2	6	20	17	9	8	30	14	14	12	28	23	5	2	12	7	7	5	284	Jun 05	Friday
157	5	4	11	12	31	4	10	6	9	5	7	34	6	12	22	19	14	20	14	4	11	10	10	25	305	Jun 06	Saturday
158	15	7	18	19	24	10	5	7	10	20	20	25	15	11	12	9	24	32	23	20	8	7	7	15	363	Jun 07	Sunday
159	9	9	9	25	6	13	20	6	26	8	22	9	6	18	3	19	12	14	3	14	26	18	9	1	305	Jun 08	Monday
160	3	5	20	6	6	5	22	22	3	17	6	19	7	11	10	21	26	23	11	19	14	5	1	6	288	Jun 09	Tuesday
161	7	0	14	23	5	13	11	14	22	7	14	24	11	23	19	12	26	15	12	35	27	20	14	8	376	Jun 10	Wednesday
162	11	11	32	22	20	25	12	12	12	11	15	23	22	15	12	15	15	15	9	8	15	12	5	5	354	Jun 11	Thursday
163	7	1	4	30	22	2	10	16	10	7	30	16	17	21	14	21	16	33	15	25	4	8	7	3	339	Jun 12	Friday
164	5	5	23	18	9	4	14	5	18	11	13	24	5	11	10	5	11	10	18	15	16	7	5	14	276	Jun 13	Saturday
165	8	9	5	13	6	8	10	10	17	15	13	15	15	21	14	21	19	21	19	25	9	9	8	11	321	Jun 14	Sunday
166	7	7	3	36	27	12	23	17	10	17	8	19	33	27	18	9	20	25	13	13	16	6	2	3	371	Jun 15	Monday
167	3	4	9	6	7	17	16	23	15	19	22	57	38	25	22	38	23	35	22	15	26	14	9	12	477	Jun 16	Tuesday
168	16	4	14	3	8	13	8	6	12	23	25	8	20	27	13	25	13	16	7	10	19	3	6	2	301	Jun 17	Wednesday
169	0	0	0	0	0	0	0	0	109	446	493	470	542	379	0	0	9	26	16	12	14	11	11	8	2546	Jun 18	Thursday
170	8	3	9	5	7	17	6	12	24	26	16	24	25	26	23	12	12	20	4	14	15	13	26	11	358	Jun 19	Friday
171	8	12	6	4	9	4	2	14	10	17	23	44	35	23	32	18	34	19	24	18	32	22	1	3	414	Jun 20	Saturday
172	5	10	3	8	20	16	20	24	22	39	32	20	22	20	31	46	19	12	12	18	19	6	13	26	463	Jun 21	Sunday
173	13	19	25	6	5	9	15	28	18	20	25	10	9	17	18	35	19	21	20	18	50	6	7	18	431	Jun 22	Monday
174	18	23	9	9	17	21	10	9	25	26	8	19	14	11	34	27	25	13	10	32	30	23	10	6	429	Jun 23	Tuesday
175	4	8	10	17	17	10	11	14	16	20	12	33	18	14	39	38	38	27	25	12	6	4	4	17	414	Jun 24	Wednesday
176	5	5	5	19	9	12	17	8	30	9	21	23	14	16	27	44	23	31	14	9	5	7	4	16	373	Jun 25	Thursday
177	11	0	0	0	0	0	0	0	0	162	863	227	0	0	0	0	0	0	0	0	0	0	0	0	1263	Jun 26	Friday
178	0	0	0	0	0	0	0	0	0	0	0	0	4	0	114	0	0	0	0	0	0	1	0	0	119	Jun 27	Saturday
179	0	0	0	0	0	0	7	5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	14	Jun 28	Sunday
180	0	0	0	5	0	0	0	20	0	0	0	8	10	10	19	13	32	13	12	12	24	9	1	8	196	Jun 29	Monday
181	2	2	9	34	14	8	7	18	31	17	27	24	32	26	28	21	20	15	12	11	13	8	8	2	389	Jun 30	Tuesday
182	4	8	8	26	17	26	23	26	12	21	8	20	19	27	11	11	27	14	30	51	11	7	3	2	412	Jul 01	Wednesday
183	7	7	55	37	28	38	2	43	18	14	11	10	21	21	12	14	19	28	18	50	9	5	8	3	478	Jul 02	Thursday
184	4	1	4	11	27	12	7	9	5	11	13	13	14	11	18	15	11	28	9	10	7	13	4	4	261	Jul 03	Friday
185	5	11	11	9	10	14	7	9	21	35	18	18	12	20	28	15	10	15	11	9	5	11	2	5	311	Jul 04	Saturday
186	7	5	8	4	3	8	6	11	18	19	24	21	33	18	29	10	15	28	14	27	7	6	9	9	339	Jul 05	Sunday
187	3	21	7	14	6	7	7	7	5	10	4	6	18	10	20	28	23	24	12	17	15	6	1	4	275	Jul 06	Monday
188	16	13	11	3	6	7	8	1	3	5	8	10	13	10	31	16	27	21	25	10	9	2	1	4	260	Jul 07	Tuesday
189	8	8	4	6	6	0	12	9	7	2	5	4	19	15	17	11	7	18	9	9	3	1	4	14	198	Jul 08	Wednesday
190	2	9	2	0	7	14	16	2	22	21	16	19	21	10	15	9	21	6	6	6	2	1	9	4	240	Jul 09	Thursday
191	2	4	3	0	0	0	0	5	12	2	10	6	6	12	23	4	9	9	13	10	10	18	7	2	167	Jul 10	Friday
192	4	4	6	11	15	7	27	17	18	13	4	18	11	17	6	15	6	10	15	12	6	7	4	5	258	Jul 11	Saturday
193	10	3	15	3	3	15	10	15	15	19	12	15	20	19	16	8	4	12	10	4	5	11	7	1	252	Jul 12	Sunday
194	10	6	11	7	2	13	1	8	8	4	8	13	10	15	16	13	7	12	25	5	16	7	4	5	226	Jul 13	Monday
195	0	5	1	4	14	4	1	5	6	12	2	15	32	7	25	6	12	9	4	9	9	5	5	0	192	Jul 14	Tuesday
196	2	2	1	44	56	31	9	33	19	20	38	50	40	28	70	24	14	15	7	2	4	9	4	5	527	Jul 15	Wednesday
197	1	4	20	42	22	24	21	34	17	25	20	13	13	22	28	26	27	21	2	12	8	9	14	3	428	Jul 16	Thursday
198	2	3	18	23	50	33	18	26	17	21	20	20	16	18	54	25	17	6	6	12	9	13	17	11	455	Jul 17	Friday
199	7	10	4	5	12	12	14	6	9	20	18	30	6	24	11	4	18	26	10	10	3	23	13	5	300	Jul 18	Saturday
200	4	1	3	3	4	3	17	6	6	13	21	27	11	24	3	22	26	20	18	3	14	7	5	6	267	Jul 19	Sunday
201	7	21	8	53	37	14	30	40	37	13	13	18	20	12	26	23	11	12	15	12	12	3	4	3	444	Jul 20	Monday
202	2	6	15	67	29	23	7	12	19	13	17	18	17	20	24	22	15	18	17	17	9	11	15	3	416	Jul 21	Tuesday

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
203	5	5	4	51	39	25	26	35	21	19	20	13	15	13	19	15	8	15	10	14	5	15	4	9	405	Jul 22 Wednesday
204	0	0	8	77	46	13	27	22	18	22	21	30	26	20	18	34	22	16	13	11	21	10	3	4	482	Jul 23 Thursday
205	6	5	3	32	68	33	29	23	17	7	18	54	25	21	52	10	6	10	18	4	10	6	7	10	474	Jul 24 Friday
206	5	4	7	3	2	13	5	11	20	23	16	12	11	10	24	18	13	10	16	11	7	4	5	3	253	Jul 25 Saturday
207	1	6	3	12	6	15	23	13	25	33	26	10	24	16	16	9	18	36	8	11	14	4	5	2	336	Jul 26 Sunday
208	1	9	43	73	82	29	26	19	12	16	26	21	21	27	40	39	52	51	31	35	3	2	2	15	675	Jul 27 Monday
209	9	3	17	44	31	13	4	6	7	5	30	34	35	25	28	51	72	38	44	29	7	12	6	9	559	Jul 28 Tuesday
210	4	11	24	43	27	21	8	19	6	17	11	19	21	21	31	25	14	33	47	32	17	18	7	4	480	Jul 29 Wednesday
211	8	3	46	61	33	17	9	29	23	22	20	16	13	32	35	55	16	7	0	0	0	0	0	11	456	Jul 30 Thursday
212	5	1	140	423	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	569	Jul 31 Friday
213	0	0	0	0	0	0	0	0	0	4	40	28	16	12	12	7	9	14	13	10	5	4	10	11	195	Aug 01 Saturday
214	2	2	1	2	7	44	30	41	39	59	21	51	22	42	33	7	17	8	20	13	0	4	20	12	497	Aug 02 Sunday
215	14	82	62	62	44	34	22	8	25	3	25	31	16	11	37	44	22	55	18	2	9	1	16	4	647	Aug 03 Monday
216	1	2	39	42	3	15	23	19	26	16	16	23	30	16	33	38	32	23	31	33	11	6	21	10	509	Aug 04 Tuesday
217	15	26	41	42	15	17	21	15	16	15	13	29	17	25	31	17	19	57	22	5	9	8	13	21	509	Aug 05 Wednesday
218	12	1	38	70	147	255	243	280	347	110	10	26	26	77	33	16	32	48	16	12	7	41	58	11	1916	Aug 06 Thursday
219	3	64	42	67	20	19	18	23	28	17	10	24	13	20	43	38	33	9	9	3	6	6	10	3	528	Aug 07 Friday
220	8	11	3	3	7	23	24	22	7	10	19	13	19	15	9	19	24	19	11	26	25	16	27	17	377	Aug 08 Saturday
221	52	25	20	14	27	16	6	15	23	27	26	25	23	8	22	19	17	9	23	23	9	13	10	11	463	Aug 09 Sunday
222	6	7	26	39	15	19	10	21	26	8	32	9	25	25	42	23	19	19	35	27	29	13	17	48	540	Aug 10 Monday
223	11	4	10	23	20	20	15	15	18	15	24	44	25	18	51	28	14	12	25	18	6	9	6	16	447	Aug 11 Tuesday
224	6	4	9	34	26	19	2	8	5	13	21	33	7	7	14	21	26	25	9	5	6	2	4	39	345	Aug 12 Wednesday
225	4	3	5	31	7	6	11	14	21	21	7	13	3	24	24	26	6	3	9	4	9	14	13	3	281	Aug 13 Thursday
226	2	10	14	15	16	10	8	4	11	10	3	4	15	21	25	17	17	9	14	10	9	14	3	17	278	Aug 14 Friday
227	12	1	10	11	11	15	8	18	10	12	13	9	12	28	13	17	16	8	19	6	3	13	6	10	281	Aug 15 Saturday
228	19	9	18	18	9	6	5	4	12	23	15	11	7	13	50	39	35	15	12	19	11	4	5	8	367	Aug 16 Sunday
229	5	7	15	22	8	14	11	11	14	12	13	28	21	13	16	40	48	28	12	5	22	4	3	33	405	Aug 17 Monday
230	25	3	29	32	30	8	3	17	16	7	16	21	7	16	22	26	29	8	37	57	17	2	7	35	470	Aug 18 Tuesday
231	22	9	34	13	13	14	30	25	10	11	9	24	19	5	17	19	3	4	6	4	5	32	3	5	336	Aug 19 Wednesday
232	3	6	27	24	12	11	16	13	4	4	13	1	5	8	6	24	9	7	2	8	8	3	4	9	227	Aug 20 Thursday
233	4	6	12	12	3	9	6	1	4	7	5	9	5	3	5	6	3	5	10	4	7	4	2	0	132	Aug 21 Friday
234	4	2	8	8	3	8	3	8	6	8	11	26	9	1	12	4	5	6	0	4	2	3	5	6	152	Aug 22 Saturday
235	4	7	1	6	2	8	5	6	8	5	5	6	4	12	13	2	8	1	5	7	5	1	7	4	132	Aug 23 Sunday
236	1	13	21	13	8	3	2	5	4	9	13	17	19	12	12	18	11	12	4	4	8	0	3	3	215	Aug 24 Monday
237	1	37	9	17	19	5	3	26	14	17	11	27	11	25	22	6	21	16	4	2	0	14	8	13	328	Aug 25 Tuesday
238	21	4	8	10	15	13	17	4	10	19	35	303	207	248	127	101	66	41	53	30	25	30	26	22	1435	Aug 26 Wednesday
239	0	0	0	0	0	0	0	0	11	18	10	13	17	11	18	23	13	3	5	2	1	28	34	5	212	Aug 27 Thursday
240	3	7	4	15	16	6	4	7	10	14	21	12	16	7	8	12	14	2	5	4	4	6	13	10	220	Aug 28 Friday
241	4	4	6	4	3	5	7	2	12	8	8	12	14	17	5	10	8	0	6	7	8	5	7	3	165	Aug 29 Saturday
242	3	1	15	13	11	1	8	3	6	10	14	17	15	7	20	5	15	12	7	3	3	6	7	2	204	Aug 30 Sunday
243	2	2	11	24	8	16	12	7	12	8	22	11	14	9	20	11	14	19	4	20	5	6	3	14	274	Aug 31 Monday
244	0	8	9	28	18	10	3	6	11	15	13	12	24	13	21	8	21	11	19	16	13	3	1	4	287	Sep 01 Tuesday
245	3	4	5	13	20	8	9	16	25	13	10	14	14	19	22	5	22	20	11	24	24	10	2	5	318	Sep 02 Wednesday
246	12	4	21	20	16	11	19	14	22	8	20	14	16	27	14	8	18	30	42	27	27	4	10	19	423	Sep 03 Thursday
247	15	12	9	19	20	5	4	10	3	5	13	21	21	16	11	8	11	9	4	7	7	6	4	6	246	Sep 04 Friday
248	8	8	14	8	21	16	10	5	12	10	5	17	21	2	8	8	6	8	11	9	7	11	9	16	250	Sep 05 Saturday
249	7	1	9	16	9	18	12	11	8	16	11	18	17	18	11	6	12	8	19	9	8	10	11	6	271	Sep 06 Sunday
250	9	2	13	36	26	9	11	9	15	20	19	15	17	32	7	10	7	18	44	16	6	3	1	7	352	Sep 07 Monday
251	5	0	7	16	4	10	2	20	15	11	19	54	29	24	23	20	14	6	7	6	4	7	1	6	310	Sep 08 Tuesday
252	5	1	56	17	11	6	3	12	9	8	6	16	10	14	10	10	18	4	1	3	6	3	2	4	235	Sep 09 Wednesday
253	3	1	6	12	10	4	14	7	6	2	3	10	12	17	7	8	9	4	9	5	5	5	3	5	167	Sep 10 Thursday
254	1	1	2	6	8	20	31	10	11	29	8	9	3	8	9	16	9	6	10	3	8	1	2	5	216	Sep 11 Friday
255	4	1	5	7	1	9	11	5	3	10	26	9	8	5	10	2	29	7	10	4	8	3	1	6	184	Sep 12 Saturday
256	6	5	0	14	4	7	7	10	9	7	6	4	9	5	5	2	6	1	0	3	5	3	4	4	126	Sep 13 Sunday
257	3	2	3	13	9	21	10	8	16	11	12	15	18	14	19	11	10	14	14	8	7	3	4	8	253	Sep 14 Monday
258	3	6	4	14	15	10	21	20	29	18	17	6	28	14	16	10	20	21	17	2	1	7	14	12	325	Sep 15 Tuesday

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
259	3	3	11	16	13	17	15	13	12	13	36	15	17	10	11	15	27	20	15	10	7	4	6	4	313	Sep 16 Wednesday
260	2	11	4	2	17	13	18	7	14	12	14	24	21	13	37	22	13	7	6	23	24	2	9	0	315	Sep 17 Thursday
261	11	8	4	8	22	11	25	16	37	17	21	15	13	5	6	24	11	9	8	21	1	4	6	3	306	Sep 18 Friday
262	3	5	3	1	5	24	5	10	9	21	2	13	4	12	23	9	7	2	19	6	9	21	12	12	237	Sep 19 Saturday
263	9	2	7	8	25	2	13	18	17	13	4	10	10	4	8	6	4	2	7	12	6	11	1	5	204	Sep 20 Sunday
264	14	4	6	6	5	11	4	8	19	5	19	12	15	11	16	11	21	13	5	6	3	5	2	5	226	Sep 21 Monday
265	3	9	4	7	2	9	13	2	6	10	17	4	17	52	13	8	9	5	7	6	3	21	7	5	239	Sep 22 Tuesday
266	3	7	1	2	9	8	7	19	8	12	6	14	14	29	10	15	15	5	14	6	34	7	1	0	246	Sep 23 Wednesday
267	2	1	17	9	7	14	16	15	39	21	9	27	25	11	18	9	19	9	2	11	2	4	4	2	293	Sep 24 Thursday
268	3	3	2	5	11	27	15	9	8	6	10	12	6	5	0	10	11	5	3	11	9	10	8	0	189	Sep 25 Friday
269	2	6	5	5	5	14	4	4	7	3	12	7	9	7	9	5	9	5	13	5	4	3	4	7	154	Sep 26 Saturday
270	1	7	1	20	5	7	16	7	6	28	24	21	12	7	3	5	8	12	3	5	15	7	5	1	226	Sep 27 Sunday
271	4	5	12	10	18	7	5	3	2	2	4	5	6	28	16	3	4	5	8	13	3	11	6	7	187	Sep 28 Monday
272	13	8	6	4	1	7	11	6	10	5	7	15	20	17	20	23	8	13	11	2	3	6	10	3	229	Sep 29 Tuesday
273	4	4	18	10	4	4	7	7	10	10	10	10	8	11	8	15	9	10	2	3	9	4	4	10	191	Sep 30 Wednesday

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	1349	1615	2316	3283	2440	2295	2062	2450	2750	3034	3784	3939	3441	3291	3215	2711	2662	2564	2268	2052	1739	1536	1541	1659	59996	Total sum
180	7	9	13	18	14	13	11	14	15	17	21	22	19	18	18	15	15	14	13	11	10	9	9	9	333	Total average
123	7	9	14	22	15	14	12	15	17	18	24	25	22	21	19	16	16	16	13	12	10	9	9	9	366	Average workdays
57	8	7	9	9	9	9	9	10	11	14	13	15	12	12	15	11	12	11	11	10	7	7	8	9	248	Average weekends

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

3.6 Regional Monitoring System operation

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

A major data base crash near the end of the reporting period stopped the second version of RMS and also prevented the production of phase and event statistics. At the time of writing, a third version of RMS is being installed at NORSAR. It will consist of newer editions of all software modules and will use the GBF (Generalized Beamforming) program as a pre-processor. All GBF events fulfilling certain magnitude and location conditions will be available to the analyst along with all phase detections from all the arrays, including the NORSAR array.

U. Baadshaug

4 Improvements and Modifications

4.1 NORSAR

NORSAR instrumentation

No significant change in the NORSAR instrumentation has been effected in the reporting period.

A block diagram of the remote sensor site components can be found in NORSAR Sci. Rep. No. 1-95/96.

NORSAR data acquisition

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

NORSAR detection processing and feature extraction

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

Detection statistics for the NORSAR array are given in section 2. A description of the NORSAR beamforming techniques can be found in NORSAR Sci. Rep. 2-95/96.

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.

NOA processing at the PIDC

On 5 December 1997 the CCB report for including NOA in the GSETT-3 primary station network was reviewed and approved. Since 13 December 1997, the DFX has processed NOA data and arrivals have been associated and included in the REB. The performance of this process has been satisfactory, and has been verified by comparing to the results of our local detection/ event processing system at NORSAR.

NORSAR data retention

We have initiated a project to copy historic NORSAR data from the original 1/2 inch magnetic tapes to modern storage media (on-line disk files and tape backup). As of 1 October 1998, one full year (1974) of data retained for the large NORSAR array (22 subarray configuration) has been copied. This project will continue until the entire data set has been saved in this way.

J. Fyen

5 Maintenance Activities

Activities in the field and at the Maintenance Center

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

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

NORSAR

Visits to subarrays in connection with:

- Cable splicing
- Replacement of defective equipment
- Preventive maintenance of Central Terminal Vault (CTV) and Long Period Vault (LPV)

NORESS

- Replaced GPS synchronized clock

NMC

- Repair of defective electronic equipment

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

P.W. Larsen
K.A. Løken

Subarray/ area	Task	Date
	April 1998	
NORESS	Replaced GPS synchronized clock	April
NMC	Repair of defective electronic equipment.	April
	May 1998	
NORSAR		May
02B	Reset 48 VDC power supply	7/5
04C	Installed an SP seismometer i BB borehole for coherence tests with SP05	8/5
01A	Installed dc/dc converter card at SP01	13/5
01A	Cable splicing SP01	14-15/5
02B	Installed d/dc converter card at SP01	19/5
01B	Cable splicing at SP01	25-27/5
01A	Cable splicing at SP02	27/5
01B	Cable splicing at SP01	28-29/5
NMC	Repair of defective electronic equipment.	May
	June 1998	
NORSAR		June
01B	Cable splicing SP01 and SP05	2-5/6
04C	Installed an SP seismometer in the empty BB borehole for coherence tests with SP05 instrument	8/6
01A	Preventive maintenance in CTB and LTV	9/6
01B	Preventive maintenance in CTB and LTV	10/6
02C	Preventive maintenance in CTB and LTV	10/6
02B	Preventive maintenance in CTB and LTV	11/6
03C	Preventive maintenance in CTB and LTV	11/6

Subarray/ area	Task	Date
04C	Preventive maintenance CTV and LPV	12/6
06C	Preventive maintenance CTV and LPV	15/6
01B	Cable splicing SP02	29-30/6
NMC	Repair of defective electronic equipment.	June
	July 1998	
NORSAR		July
06C	Cable splicing SP03	1-2/7
06C	Polarity check of the KS-54000 seismometer	3/7
01B	Cable splicing SP02	8/7
01B	Cable splicing SP01	14/7
01B	Cable splicing SP05	20/7
04C	Cable splicing SP01	21/7
02B	AIM-24 digitizer at SP03 taken to NMC for repair	22/7
02B	Reinstallation of AIM-24 digitizer at remote site SP03	23/7
NMC	Repair of defective electronic equipment.	July
	August 1998	
NORSAR		August
01B	Cable splicing SP01	4-7/8
01B	Cable splicing SP05	10-11/8
01B	Reinstalled AIM-24 digitizer at remote sites SP01 and SP05. There are still problems with interference from a 50 Hz high voltage power line going parallel with our cable for some miles. The transmission of data from the remote sites was not running well, and both sites had to be disconnected	14/8
01B	Cable work SP01 and SP05	17/8
02C	Installed new vault lid at SP02	26/8

Subarray/ area	Task	Date
02C	Installed new vault lid at SP01	28/8
NMC	Repair of defective electronic equipment.	August
	September 1998	
NORSAR		Septem-ber
01B	Measuring of mismatch and attenuation in the transmission lines to SP01 and SP05	2/9
01B	Matching the modem impedance to the cable impedance for transmission lines going to SP01 and SP05. There are still problems with interference from the high voltage power line going parallel with our cable for some miles	4/9
NMC	Repair of defective electronic equipment	Septem-ber

Table 5.1. Activities in the field and the NORSAR Maintenance Center during 1 April - 30 September 1998.

6 Documentation Developed

Baadshaug, U., S. Mykkeltveit & J. Fyen (1998): Status report: Norway's participation in GSETT-3, Semiannual Tech. Summ. 1 April - 30 September 1998, NORSAR Sci. Rep. 1-98/99, Kjeller, Norway.

Kremenetskaya, E., V. Asming, Z. Jevtjugina & F. Ringdal (1998): Study of surface waves and M_s:m_b using Apatity LP recordings, Semiannual Tech. Summ. 1 April - 30 September 1998, NORSAR Sci. Rep. 1-98/99, Kjeller, Norway.

Kværna, T., F. Ringdal, J. Schweitzer & L. Taylor (1998): Optimized Threshold Monitoring, Semiannual Tech. Summ. 1 April - 30 September 1998, NORSAR Sci. Rep. 1-98/99, Kjeller, Norway.

Kværna, T., F. Ringdal, J. Schweitzer & L. Taylor (1998): Monitoring of the Indian underground nuclear tests of May 1998, Semiannual Tech. Summ. 1 April - 30 September 1998, NORSAR Sci. Rep. 1-98/99, Kjeller, Norway.

Ringdal, F. (1998): Norwegian experience with IDC metrics during GSETT-3, Semiannual Tech. Summ. 1 April - 30 September 1998, NORSAR Sci. Rep. 1-98/99, Kjeller, Norway.

Ringdal, F., E. Kremenetskaya, V. Asming, T. Kværna, J. Fyen & J. Schweitzer (1998): Seismic monitoring of the Barents/Kara sea region, Semiannual Tech. Summ. 1 April - 30 September 1998, NORSAR Sci. Rep. 1-98/99, Kjeller, Norway.

Schweitzer, J. (1998): Tuning the automatic data processing for the Spitsbergen array (SPITS), Semiannual Tech. Summ. 1 April - 30 September 1998, NORSAR Sci. Rep. 1-98/99, Kjeller, Norway.

Semiannual Technical Summary, 1 October 1997 - 31 March 19998 , NORSAR Sci. Rep. 2-97/98, Kjeller, Norway.

7 Summary of Technical Reports / Papers Published

7.1 Seismic monitoring of the Barents/Kara sea region

Paper presented at the 20th Annual Seismic Research Symposium, Contract F08650-96-C0001, Sponsored by DoD

Introduction

During the last decade, a network of sensitive regional arrays has been installed in northern Europe in preparation for the global seismic monitoring network under a comprehensive nuclear test ban treaty (CTBT). This regional network, which comprises stations in Fennoscandia, Spitsbergen and NW Russia, provides a detection capability for the Barents/Kara Sea region that is close to $m_b = 2.5$, using the generalized beamforming method for phase association and initial location estimates. Several low-magnitude seismic events have been detected and located during this period, including 31 December 1992 ($m_b = 2.7$), 13 June 1995 ($m_b = 3.5$), 13 January 1996 ($m_b = 2.4$) and 16 August 1997 (m_b=3.5 and 2.6). While this demonstrates that the detection and location capability of the regional network is outstanding, source classification of these events has proved very difficult. Thus, even for the $m_b = 3.5$ events in 1995 and 1997, we have been unable to provide a confident classification of the source as either an earthquake or an explosion using available discriminants. In particular, the seismic event near Novaya Zemlya on 16 August 1997 at 02:11 GMT has been the subject of extensive analysis in order to locate it reliably and to classify the source type. Some scientists have forwarded arguments that this event could be confidently classified as an earthquake, especially based on observed P/S ratios. In this paper we consider some of this evidence in light of other observations of earthquakes and explosions in the region, including NORSAR recordings of past underground nuclear explosions. We show that there is an apparent source scaling of the P/S ratio of Novaya Zemlya explosions recorded at NORSAR in such a way that the larger explosions have a relatively high P/S ratio. Such an effect would make a reliable comparison difficult between P/S ratios of small and large events. Furthermore, this amplitude ratio shows large variability for the same source type and similar propagation paths. This effect is most pronounced at far-regional distances and relatively low frequencies (typically 1-3 Hz), but it is also significant on closer recordings (around 10 degrees) and at higher frequencies.

Objective

This work represents a continued effort to study earthquakes and explosions in the Barents/Kara Sea region, which includes the Russian nuclear test site at Novaya Zemlya. The overall objective is to characterize the seismicity of this region, to investigate the detection and location capability of regional seismic networks and to study various methods for screening and identifying seismic events in order to improve monitoring of the Comprehensive Test Ban Treaty. In particular, the task includes investigating the possibilities and limitations of utilizing the P/S ratio to characterize seismic events at low magnitudes in this region.

Research accomplished

Detection and location capability of the regional network

Seismicity studies

NORSAR has for many years been cooperating with the Kola Regional Seismological Centre (KRSC) of the Russian Academy of Sciences in the continuous monitoring of seismic events in North-West Russia and adjacent sea areas.

KRSC began its seismic network processing in 1982. Initially, this was done primarily by processing data from the KRSC network of seismological stations, but in recent years the analysis has been supplemented with data from IRIS stations (KBS, LVZ, KEV, ARU, ALE, NRI, etc.) and the Scandinavian seismic arrays (ARCESS, SPITS, FINESS, HFS, NORESS) for analyzing of the most interesting events. NORSAR has carried out similar analyses based primarily on the Scandinavian arrays, but in recent years supplemented with data provided by KRSC.

The seismicity of the Barents/Kara sea region is quite low, as discussed by Ringdal (1997). This is illustrated in Fig. 7.1.1 which shows the epicenters in northern Europe and adjacent areas determined in the Revised Event Bulletin of the GSETT-3 IDC during 1995-1997. Because of the high-quality coverage of regional arrays in Fennoscandia, a large number of seismic events (mostly mining explosions) are detected in this region. The seismic event occurrence is also very high in the Spitsbergen area and offshore Norway (to the north and west). These events are presumably mostly earthquakes.

On the other hand, the figure shows that there are almost no recorded events in the region comprising the eastern part of the Barents sea, the Kara Sea, Novaya Zemlya and the northern part of Russia (excluding Kola). While the GSETT-3 network has a lower detection capability in this region compared to Fennoscandia, its capability is nevertheless around magnitude 3.0-3.5 and it is thus clear that seismic events of such magnitudes or larger occur rather infrequently in the region specified above. This is further illustrated in Fig. 7.1.2 which shows the low-magnitude events detected by the Barents regional array network since 1990. Only two additional events during 1995-97 have been located by this network.

Event location

The IASPEI-91 model is not suitable for the Barents region (Ringdal et al, 1997a), and it has therefore been necessary to study local travel-time curves using data from a set of strong explosions with known locations, including an underground calibration explosion carried out in the Khibiny Massif (29.09.1996, 350 ton), see Ringdal et al (1996).

We have attempted to fit a one-dimensional velocity model to agree with these results. This has resulted in the compilation of a model which is a combination of the NORSAR model for smaller depths (up to 200 km) and IASPEI-91 at greater depths. To validate the model we have relocated several large nuclear explosions at Novaya Zemlya, as well as the presumed earthquake on 1 August 1986 (see Asming et al, 1998). The study has shown that the locations by the regional network are within 5-10 km of the locations obtained by joint hypocentral determination (JHD) using world-wide data.

This documented consistency with precise global network locations is especially important since we are able to use the regional network to locate events far smaller than those which can be detected teleseismically. For example, the KRSC network was the only network with sufficient data to locate reliably the smallest recorded nuclear explosion on the Novaya Zemlya test site (m_b=3.8) on August 26, 1984 (Mikhailov et. al., 1996). The result is shown in Fig. 7.1.3. Our estimated epicentral coordinates of this explosion are 73.326 N, 54.763 E, thus placing the event (as expected) at the nuclear test site.

The table of low-magnitude events in Ringdal (1997) has been supplemented by more recent information as summarized in Table 7.1.1. The most important new information concerns the new location of the 26 August 1984 nuclear explosion mentioned above, a confirmation of the 25 August 1987 event as a 1 kiloton chemical explosion (Khristoforov, 1996), and the two seismic events on 16 August 1997, the second of which was located by Ringdal et al (1997b) (see also Richards and Kim, 1997).

Table 7.1.1. Low magnitude (mb<5.0) seismic events in the NZ region since 1980

Date/time	Location	m_b	Comment
26.08.84/ 03.30.00	73.326 N, 54.763 E	3.8	Located by Asming et al (1998)
01.08.86/ 13.56.38	72.945 N, 56.549 E	4.3	Earthquake according to Marshall et.al. (1989)
25.08.87 / 14.00.00	73.380 N, 54.780 E	3.2	Chemical explosion-974 ton (Khristoforov, 1996)
12.31.92/ 09.29.24	73.600 N, 55.200 E	2.7	Located by Scandinavian regional network
13.06.95/ 19.22.38	75.170 N, 56.740 E	3.5	Reported in REB, relocated by Ringdal (1997)
13.01.96/ 17.17.23	75.240 N, 56.660 E	2.4	Not in REB, located by Ringdal (1997)
16.08.97 02.11.00	72.510 N, 57.550 E	3.5	Reported in REB, relocated by Ringdal et al (1997b)
16.08.97 06.19.10	72.510 N, 57.550 E	2.6	Not in REB, located by Ringdal et al (1997b)

The smallest of the two events on 16 August 1997 was, as mentioned above, first reported by NORSAR, and represents a rather interesting example of low-level detection. Only one of the Fennoscandian stations (Spitsbergen) had an automatic detection of this event, and only the P-phase was detected. After analysis at NORSAR and KRSC, we quickly succeeded in locating this event on the basis of Spitsbergen P and S (visually detected, see Fig. 7.1.4), and a visual confirmation of both P and S at Kevo. Some weeks later, the Amderma data tapes became available, and the event could be further confirmed as being located at almost exactly the same point as the first event (Fig. 7.1.5 and 7.1.6). The SNR of both events as recorded by Amderma is remarkably high.

Study of P/S ratios observed at NORSAR

NORSAR recordings of Novaya Zemlya events

The NORSAR large array has an extensive database of recordings from events near Novaya Zemlya, including some nuclear explosions with magnitudes similar to those of the 16 August event and the nearby presumed earthquake of 1 August 1986 (Ringdal, 1997). It is therefore of interest to compare the P/S ratios for these events, as recorded by individual sensors in the array. In the following, we give some comments on these observations.

Figures 7.1.7 and 7.1.8 show recordings at the center seismometer of each of 5 NORSAR subarrays for the presumed earthquake of 1 Aug 1986 and the nuclear explosion of 9 Oct 1977. These events have similar magnitudes (4.3 and 4.5) and are also at similar epicentral distance (~20 degrees) and azimuth.The data have been filtered in the band 1.0-3.0 Hz. The following observations can be made:

- The P/S ratios show very large variability across the array for both events.
- For each sensor pair, the P/S ratios are quite similar, although P/S is slightly smaller on average for the presumed earthquake
- The variability in the P/S ratios is dominated by strong P-wave focusing effects across NORSAR

While it is seen that the P/S for the presumed earthquake is generally slightly smaller than for the explosion (as might be expected), it is in fact *larger* for one of the sensors (NBO00).

It may be concluded from these two figures that P/S in this frequency band is not a very powerful discriminant when using data recorded at a single array or station. Clearly, better performance might be expected if data from a large range of azimuths are available, but the overall performance of this discriminant is still questionable. Recent studies for Central Asia (Hartse et al, 1997), have shown that the P/S discriminant for that region appears to be effective at frequencies above 4 Hz, but performs poorly for frequencies below 4 Hz. At NORSAR, there is almost no significant S-wave energy above 4 Hz, so we are restricted to considering the lower frequencies for Novaya Zemlya events.

NORSAR recordings of a Kola nuclear explosion

In order to illustrate the behavior of the P/S discriminant at higher frequencies (3-5 Hz), we show in Fig. 7.1.9 the pattern of P/S ratios across the full NORSAR array (22 subarrays, center sensors) for the nuclear explosion in the Kola Peninsula on 4 September 1972. This explosion had an epicentral distance of only about 10 degrees, and consequently we see a fair amount of high-frequency energy both for the P and the S phase.

It is clear from this figure that the P/S ratio varies considerably across NORSAR even in the frequency range 3-5 Hz. Fig. 7.1.10 shows a comparison of the two neighboring subarrays 02C and 03C, situated less than 30 km apart. The relative difference in P/S ratio is about a factor of

4 between these two seismometers. Thus, any P/S ratio factor at a single station of 4 or less will not be sufficient to separate different seismic sources.

Source scaling of the P/S ratio

To our knowledge, only one station at a regional distance, the NORSAR array, has available digital recordings of both large and small nuclear explosions from Novaya Zemlya. It may be instructive to study the P/S pattern of these explosions as a function of the event size.

In order to accomplish this, we have used the one NORSAR sensor (01A01) that has dual gain recording (the usual high-gain channel and a channel that is attenuated by 30dB). The attenuated channel has been available since 1976, and therefore provides a good data base of unclipped short period recordings of Novaya Zemlya explosions.

Figure 7.1.11 shows a selection of nuclear explosions recorded at 01A01, with magnitudes ranging from 3.8 (26 August 1984) to 6.0 (10 August 1978). The data have been filtered in the band 1.0-3.0 Hz. There is a remarkable and systematic increase in the P/S ratio with increasing magnitude. This demonstrates that comparing the P/S ratios of large and small events could easily give misleading conclusions.

An illustration, in an expanded scale, for two of these explosions is shown in Figure 7.1.12. The difference between these two explosions is in fact rather similar to the differences seen for the Kevo recordings shown by Richards and Kim (1997), which likewise compares a large and a small seismic event. Admittedly, the Kevo recordings are in a higher frequency band, but there is clearly reason for caution in interpreting the Kevo plots based on the results discussed above.

Because of the large epicentral distance of NORSAR from the test site, there is no appreciable high-frequency energy in the NORSAR recordings. Consequently, we have not been able to assess the possible source scaling of the P/S ratio for frequencies of 3 Hz and above. It would seem reasonable that such a source scaling might in fact be present also at these higher frequencies, but this needs to be further studied.

Conclusions and recommendations

This paper demonstrates that the excellent capabilities of the IMS network for the Barents/Kara Sea region can be further improved by taking advantage of the regional seismic network in northern Europe. The paper presents analyses of some other interesting seismic events occurring in the region in recent years, including the small (m_b=3.8) nuclear explosion on 26 August 1984. Further work should be carried out, especially using data from the Amderma station, to obtain additional information on the seismicity of the Barents/Kara sea region at low event magnitudes.

Case studies, some of which are discussed briefly in this paper, have demonstrated that traditional regional discriminants are not effective for separating between seismic source types at low event magnitudes in this region. In particular, the authors conclude that the P/S ratio, even at high frequencies, is rather unstable and should not be relied upon for regional event discrimination. The authors of this paper disagree with those scientists who have claimed that the 16

August 1997 events can be positively identified as earthquakes on the basis of seismological evidence. On the other hand, neither is there any seismological evidence to confidently classify these events as explosions. In the opinion of these authors, the source type of these two events remains unresolved.

F. Ringdal, NORSAR
E. Kremenetskaya, KRSC, Apatity, Russia
V.Asming, KRSC, Apatity, Russia
T. Kværna, NORSAR
J. Fyen, NORSAR
J. Schweitzer, NORSAR

References

Asming, V., E. Kremenetskaya and F. Ringdal (1998). Monitoring seismic events in the Barents/Kara Sea region. *Semiannual Technical Summary 1 October 1997 - 31 March 1998*, NORSAR Sci. Rep. 2-97/98, Kjeller, Norway.

Hartse, H.E., S.R. Taylor, W.S. Phillips and G.E. Randall (1997). A preliminary study of regional seismic discrimination in Central Asia with emphasis on western China, *Bull. Seism. Soc. Am.* 87, 551-568.

Khristoforov, B. (1996): About the control of underwater and above water nuclear explosions by hydroacoustic methods, *Final Report for the Project SPC-95-4049*, Russian Academy of Sciences, Institute for Dynamics of the Geosphere, Moscow.

Kværna T. and F. Ringdal (1996). Generalized beamforming, phase association and threshold monitoring using a global seismic network. In: E.S.Husebye and A.M.Dainty (eds), *Monitoring a Comprehensive Test Ban Treaty.* 1996, 447-466. Kluwer Academic Publishers. Netherlands.

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

Mikhailov, V.N. et.al. (1996): USSR Nuclear Weapons Tests and Peaceful Nuclear Explosions, 1949 through 1990, RFNC - VNIIEF, Sarov, 1996, 63 pp.

Richards, P.G. and Won-Young Kim (1997). Test-ban Treaty monitoring tested, *Nature*, 389, 781-782.

Ringdal, F. (1997): Study of Low-Magnitude Seismic Events near the Novaya Zemlya Test Site, *Bull. Seism. Soc. Am. 87 No. 6,* 1563-1575.

Ringdal, F., E. Kremenetskaya, V. Asming and Y. Filatov (1997a). Study of seismic traveltime models for the Barents region. *Semiannual Technical Summary 1 October 1996 - 31 March 1997*, NORSAR Sci. Rep. 2-96/97, Kjeller, Norway.

Ringdal, F., T. Kværna, E. Kremenetskaya and V. Asming (1997). The seismic event near Novaya Zemlya on 16 August 1997. *Semiannual Technical Summary 1 April - 30 September 1997*, NORSAR Sci. Rep. 1-97/98, Kjeller, Norway.

Ringdal, F., Kremenetskaya E., V. Asming, I. Kuzmin, S. Evtuhin and V. Kovalenko (1996): Study of the calibration explosion on 29 September 1996 in the Khibiny Massif, Kola Peninsula. *Semiannual Technical Summary 1 April - 30 September 1996*, NORSAR Sci. Rep. 1-96/97, Kjeller, Norway.

GSETT-3 events 1995-1997

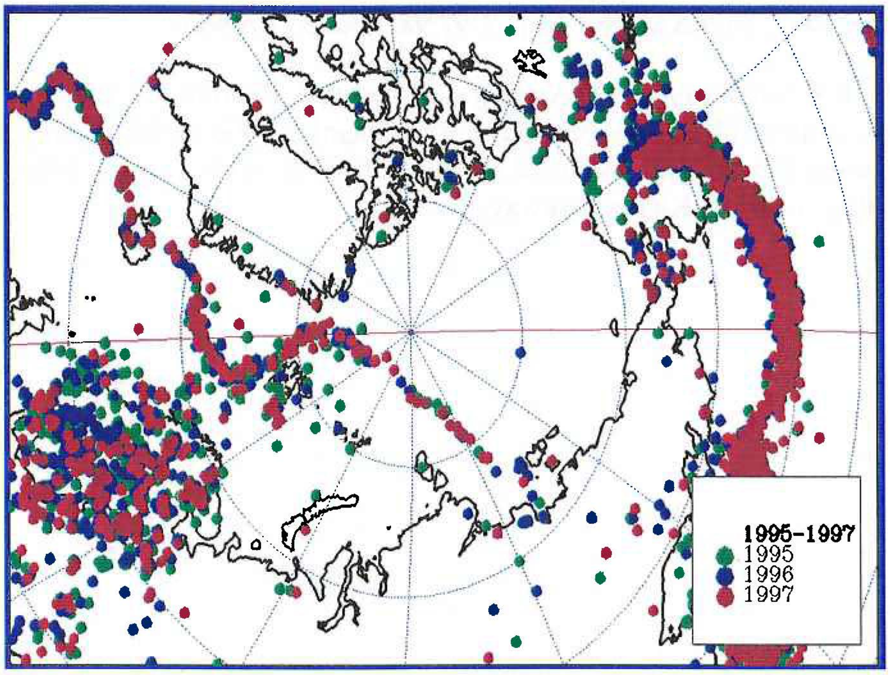


Fig. 7.1.1. Epicenters in northern Europe and adjacent areas determined in the Revised Event Bulletin of the GSETT-3 IDC during 1995-1997. Note the large number of seismic events (mostly mining explosions) in Fennoscandia and the high seismicity in the Spitsbergen area and offshore Norway (mostly earthquakes). Also note the low observed seismicity in the Barents/Kara sea region.

Recent Seismic Events near Novaya Zemlya

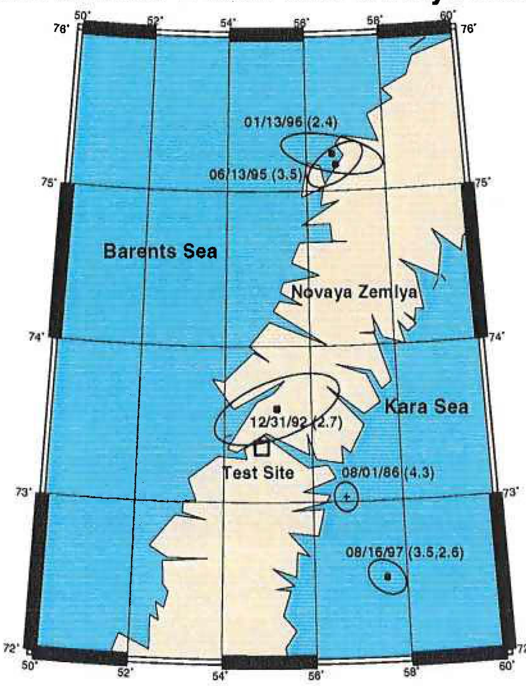


Fig. 7.1.2. Location of some recent low-magnitude seismic events near Novaya Zemlya using data from the stations in the regional array network in northern Europe.

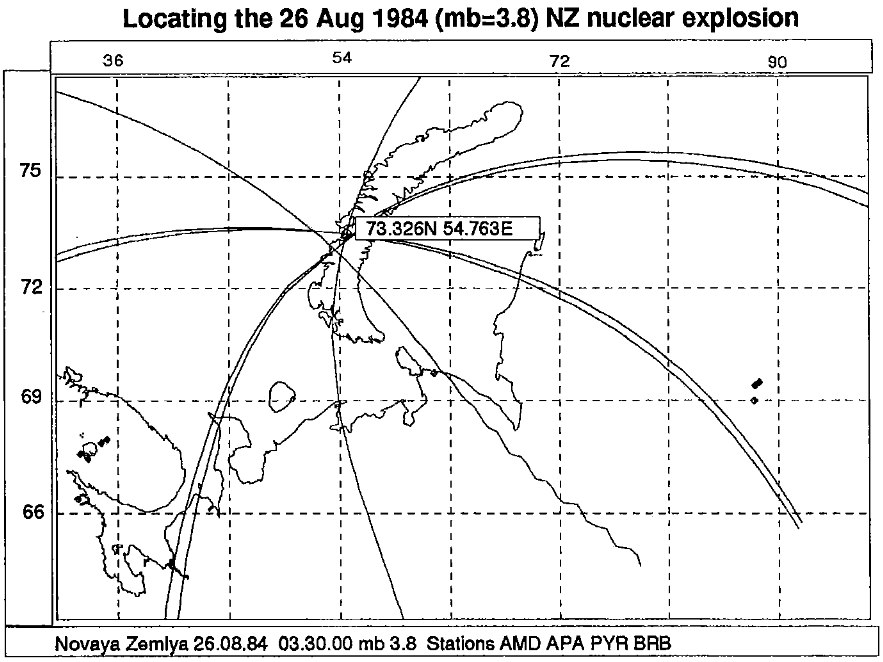


Fig. 7.1.3. Location of the smallest recorded Soviet nuclear explosion (26 August 1984, m_b=3.8) at Novaya Zemlya using data by the stations PYR, BRB, APA and AMD.

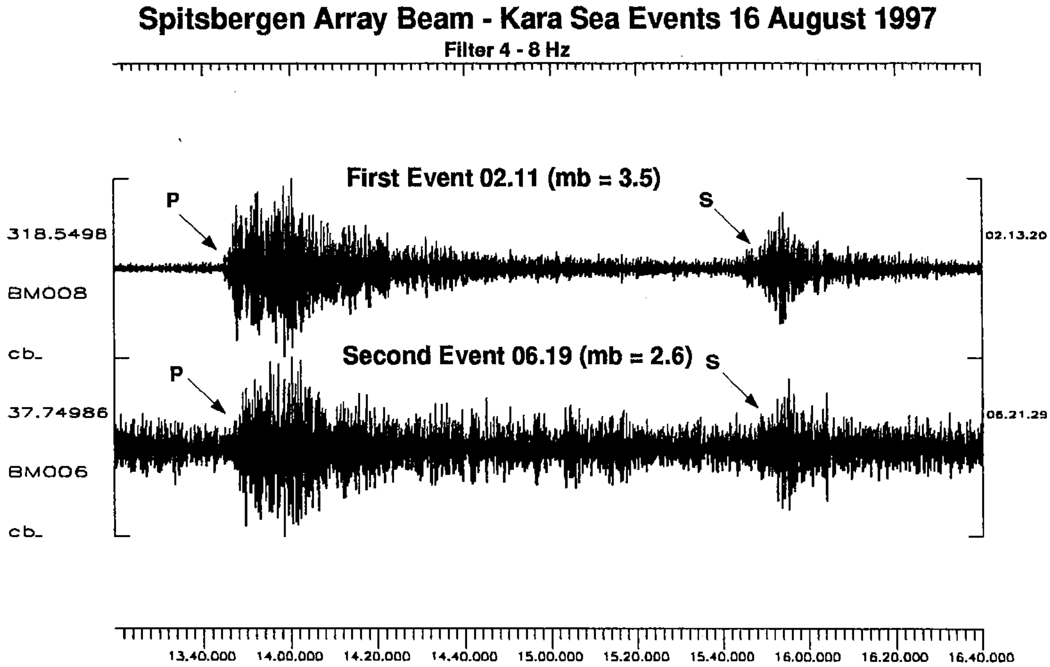


Fig. 7.1.4. Recordings by the Spitsbergen array of the two events on 16 August 1997. The traces are array beams steered towards the epicenter, and with an S-type apparent velocity in order to enhance the S-phase. The traces are filtered in the 4-8 Hz band. Note that the traces are very similar, although not identical. The scaling factor in front of each trace is indicative of the relative size of the two events.

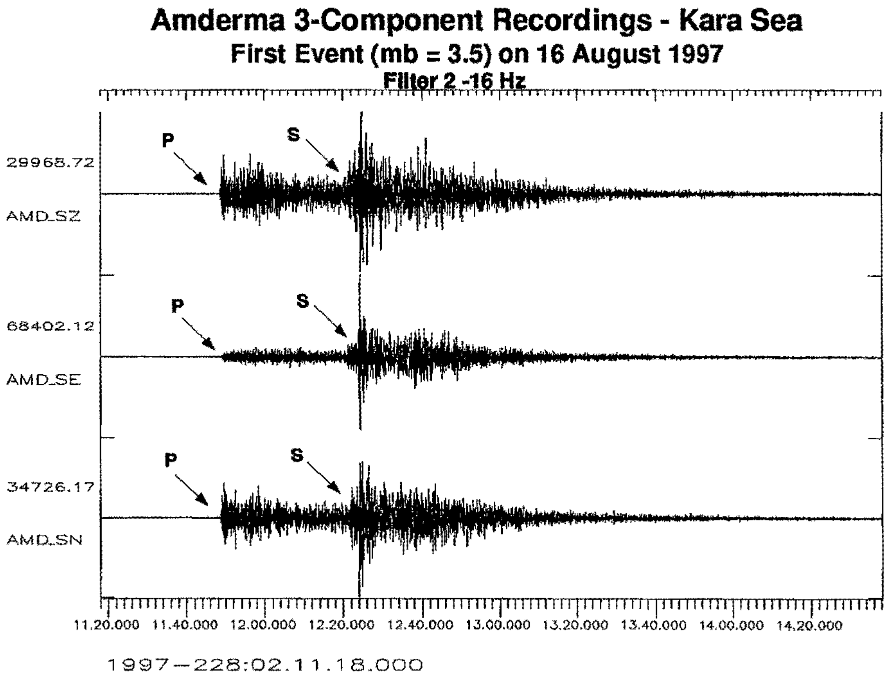


Fig 7.1.5. Recordings by the Amderma 3-component center station of the first seismic event on 16 August 1997. The traces are filtered in the 2-16 Hz band. The scaling factor in front of each trace is indicative of the event size.

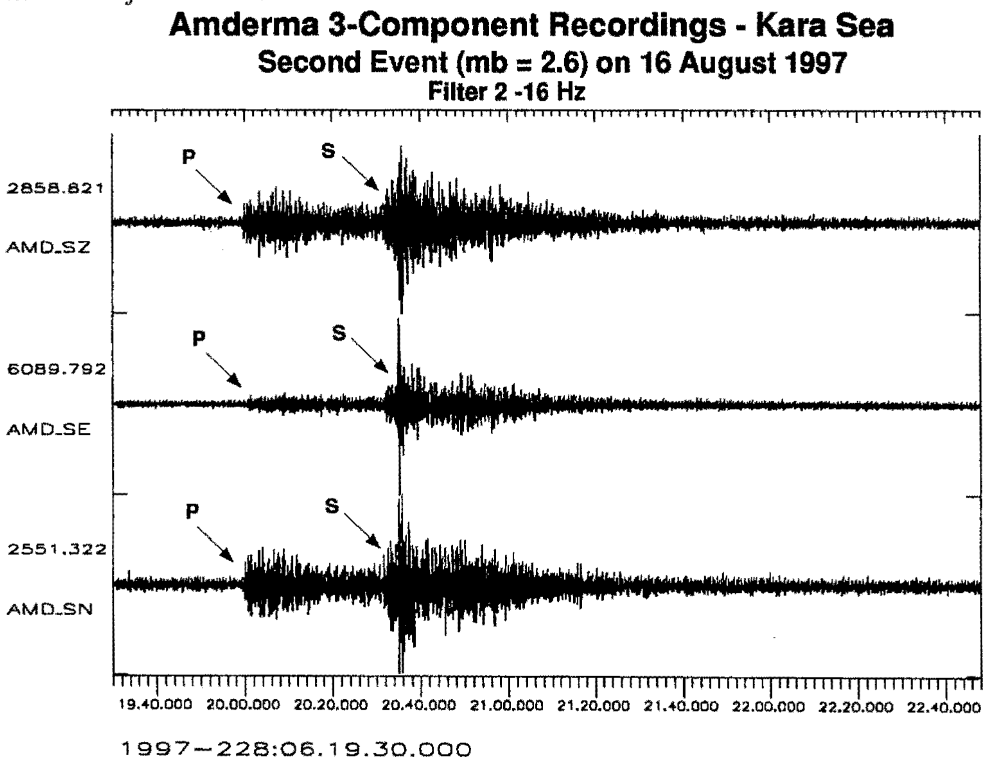


Fig 7.1.6. Recordings by the Amderma 3-component center station of the second seismic event on 16 August 1997. Note the high SNR even for this small (m_b=2.6) event.

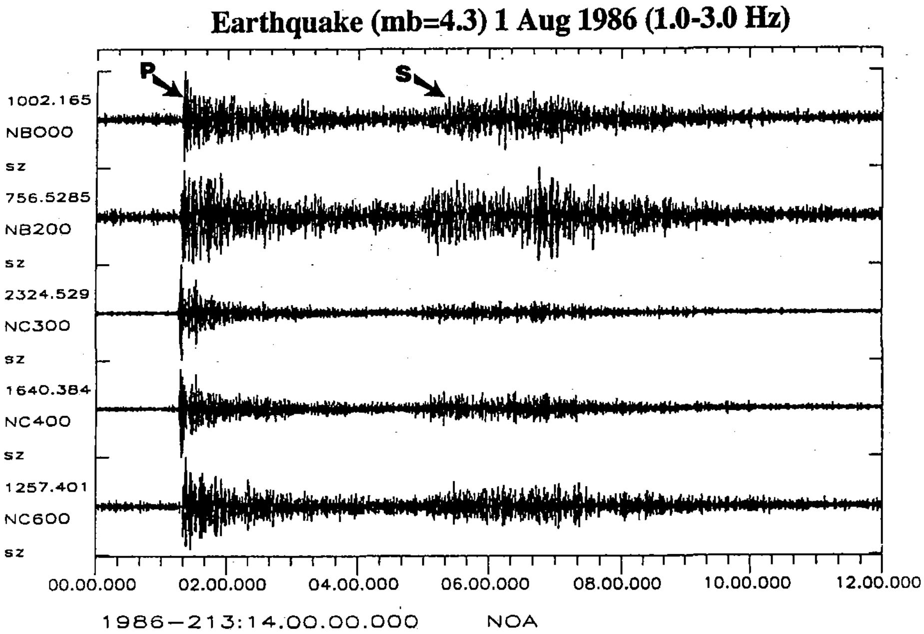


Fig. 7.1.7. Selected NORSAR SP seismometer recordings for the Novaya Zemlya presumed earthquake of 1 August 1986. Note the strong variation in relative strength of the P and S phases across the array.

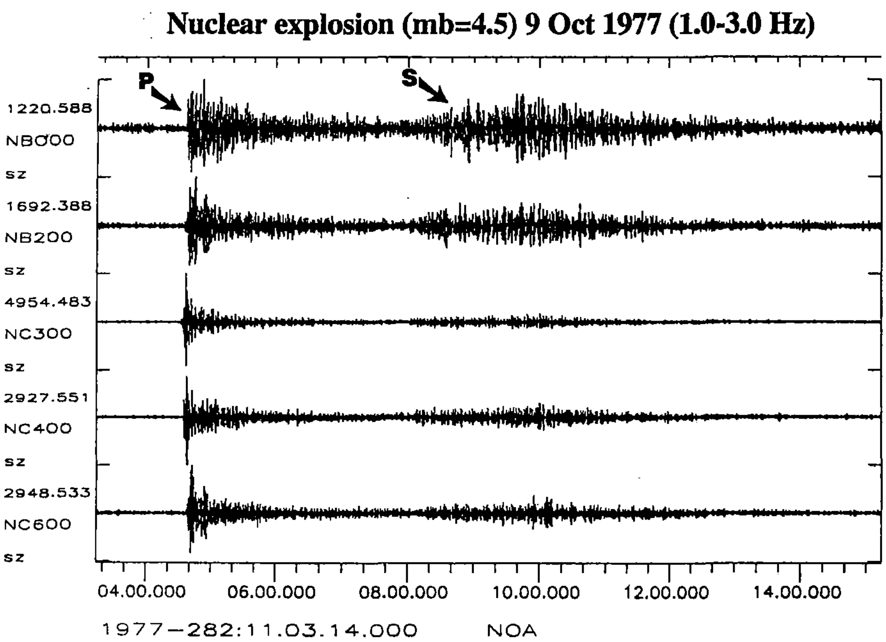
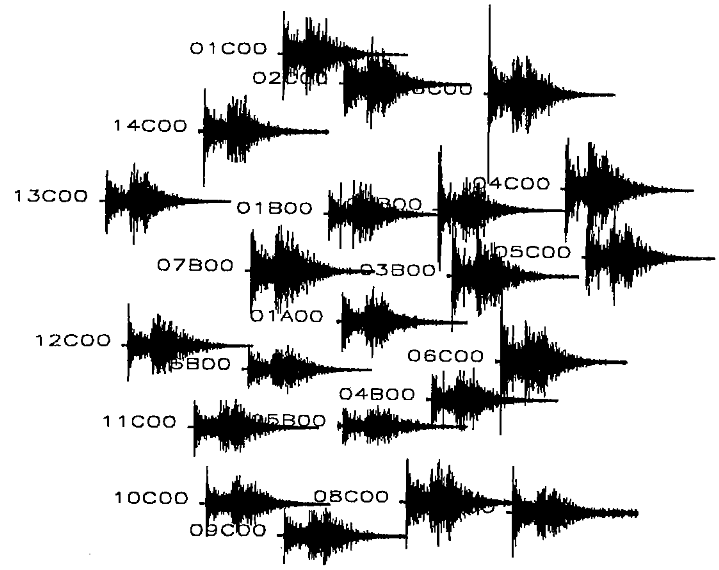


Fig. 7.1.8. Selected NORSAR SP seismometer recordings for the Novaya Zemlya nuclear explosion of 9 October 1977. Note the similarity to Fig. 7.1.7 as to the relative strength of P and S phases pair-wise for the same instruments, as well as the similarity in variation across the array.

NORSAR amplitude pattern



P and S waves (3.0-5.0 Hz)
Nuclear explosion in Kola (mb=4.5) 4 Sep 1972

Fig. 7.1.9. Amplitude pattern across NORSAR for the P and S phase of the Kola nuclear explosion on 4 September 1972 (distance 10 degrees). The data have been filtered in the 3-5 Hz band. Note the strong variation in P/S ratios.

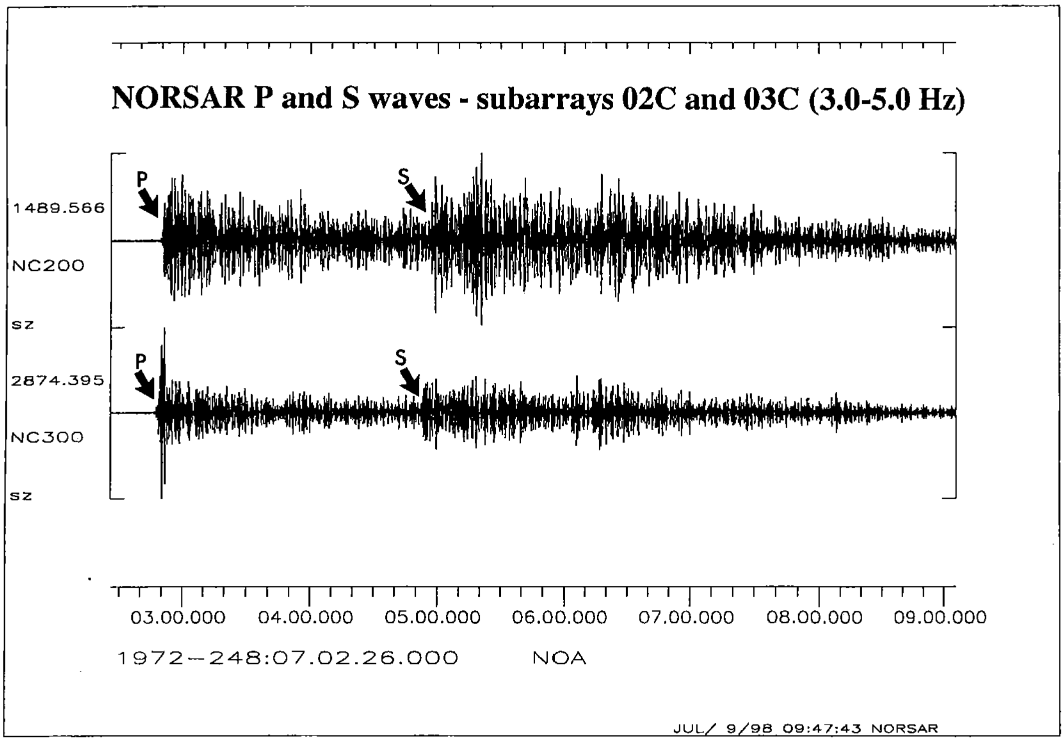


Fig. 7.1.10. NORSAR recordings at subarrays 02C and 03C (center sensors) of the Kola Peninsula nuclear explosion in Fig. 7.1.9 (filter band 3-5 Hz). The P/S ratios differ by a factor of 4.

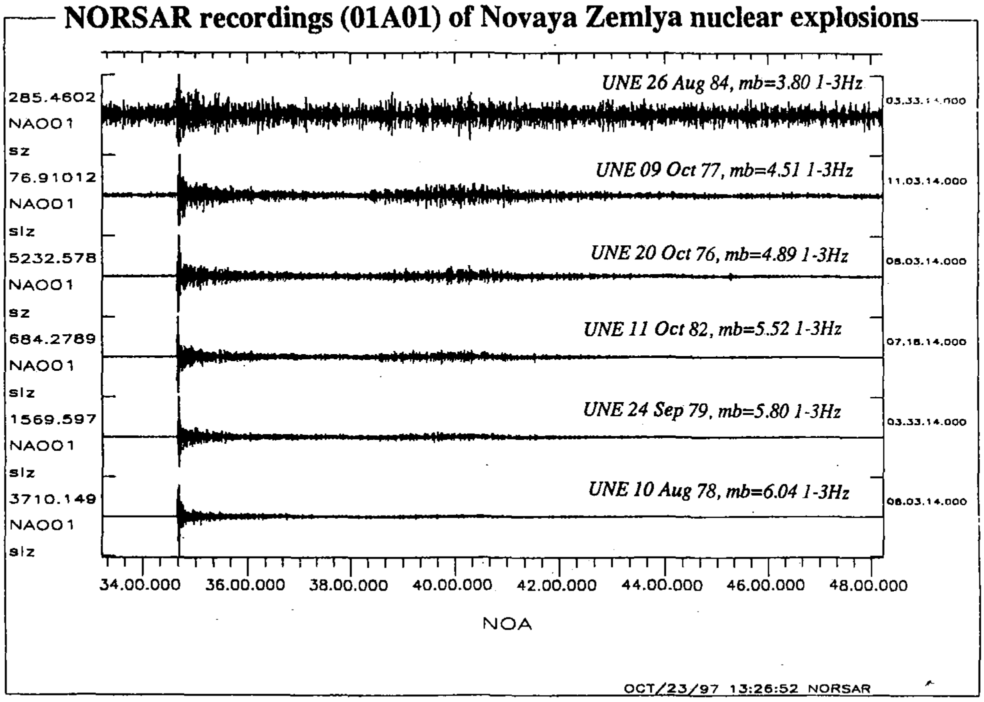


Fig. 7.1.11. NORSAR recordings (seismometer 01A01) of six Novaya Zemlya nuclear explosions of varying magnitudes. The data have been filtered in the 1-3 Hz band. Note the systematic increase in P/S ratio with increasing magnitude.

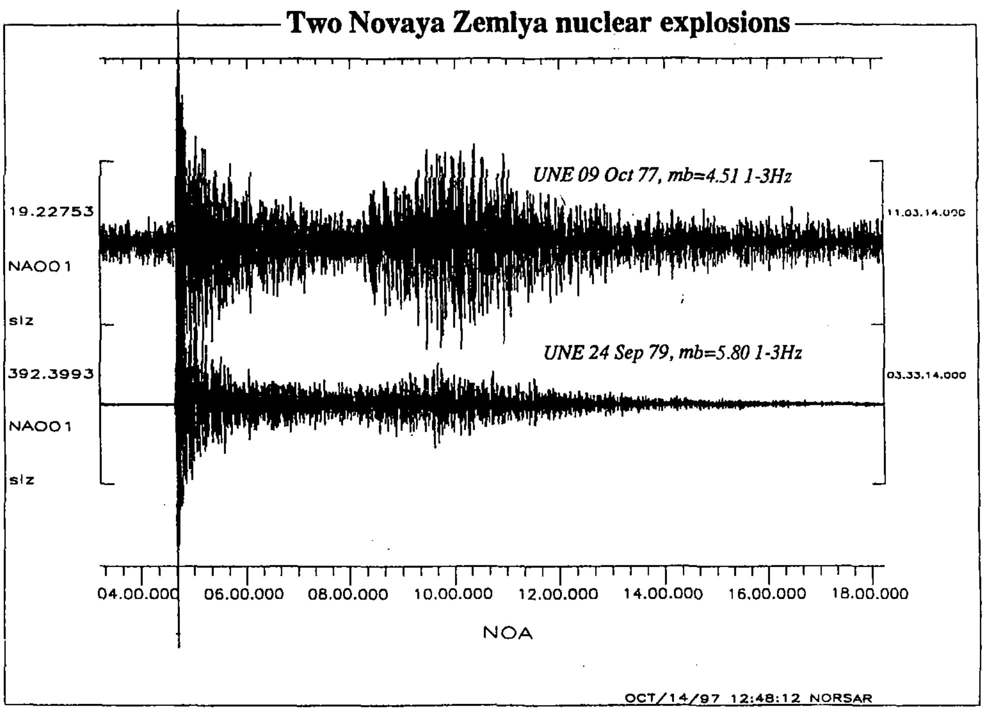


Fig. 7.1.12. NORSAR recordings (seismometer 01A01) of two of the Novaya Zemlya nuclear explosions shown in Fig. 7.1.11. The top trace shows a small explosion (m_b=4.5), whereas the bottom trace shows a large explosion (m_b=6.0). The vertical scale has been amplified to highlight the difference in P/S ratio between the two events.

7.2 Optimized Threshold Monitoring

Excerpt from paper presented at the 20th Annual Seismic Research Symposium
This work is conducted under contract DSWA01-97-C-0128

Summary

In order to enhance the automatic monitoring capability of particularly interesting areas, we have analyzed events from the region around the Novaya Zemlya (NZ) nuclear test site to come up with a set of optimized processing parameters for the arrays SPITS, ARCES, FINES, and NORES. From analysis of the tuning events we have derived values for beamforming steering delays, filter bands, STA lengths, phase travel-times, and amplitude-magnitude relationships for each array. By using these parameters for Threshold Monitoring (TM) of the NZ testing area, we obtain a monitoring capability varying between m_b 2.0 and 2.5 during normal noise conditions. The advantage of using a network, rather than a single station or array, for monitoring purposes becomes particularly evident during intervals with high global seismic activity (aftershock sequences), high seismic noise levels (wind, water waves, ice cracks) or station outages. For the time period November-December 1997, all time intervals with network magnitude thresholds exceeding m_b 2.5 were manually analyzed, and we found that all these threshold peaks could be explained by teleseismic, regional, or local signals from events outside the NZ testing area. We could therefore conclude at the 90% confidence level that no seismic event of magnitude exceeding 2.5 occurred at the Novaya Zemlya test site during this two-month time interval.

To obtain a fully automatic monitoring procedure, we have started to investigate the possibility of utilizing detector information for labelling the threshold peaks. Results so far indicate that the azimuth and slowness estimates of the detected phases at the individual arrays can be effectively used for such labelling. It is, however, important to identify azimuth and slowness estimates that are likely to be incorrect, *e.g.*, by introducing additional quality criteria.

Objective

The objective of this work has been to improve the Threshold Monitoring (TM) algorithm for use in monitoring compliance with the Comprehensive Test Ban Treaty. In particular, we have investigated improvements associated with the use of station-specific travel-time and slowness/azimuth corrections, optimized bandpass filters for sites to be monitored, and integration of results with traditional detectors.

Research accomplished

Experimental Threshold Monitoring of the Novaya Zemlya (NZ) Test Site

We have improved the monitoring capability of the NZ Test Site by deriving optimized processing parameters for the SPITS array (see Fig. 7.2.1). At ARCES, FINES, and NORES, the processing parameters have previously been derived from recordings of underground nuclear explosions at the test site, but at SPITS no such recordings are available. For the SPITS array we have analyzed recordings of other events located in the vicinity of the island of Novaya Zemlya to come up with estimates of the processing parameters to be used for the actual test site. Key events in this analysis have been the m_b 3.5 event of June 13, 1995, located about 200 km north of the test site, and the two events (m_b 3.5 and 2.6) of August 16, 1997 located in the Kara Sea about 140 km south-east of the test site. A summary of the processing parameters for the four arrays is given in Table 7.2.1.

In order to investigate the utility of the TM method in an operational environment, we have implemented continuous calculation of the threshold level for the NZ test site using the four arrays shown in Fig. 7.2.1. Plots are generated for each day processed, and currently we have results available for 8 months since November 1, 1997. Figs. 7.2.2 and 7.2.3 show results from the monitoring study, and we now have such figures available for 6 months since November 1, 1997. In each figure, the network trace (*i.e.*, the combined threshold trace, using P-phases for all arrays and S-phases for ARCES and SPITS) is shown on the top. The traces for each of the four stations (P-phases only) are shown below the network trace.

Table 7.2.1. TM processing parameters for the NZ Test Site

Station	Dis-tance (km)	Phase	Obs. slowness (s/deg)	Obs. back azimuth (s/deg)	Frequen-cy band (Hz)	STA length	Travel time	Mag. calib.	St. dev of calib.
ARCES	1108.6	P	11.2	62.2	3.0 - 5.0	5.0	147.5	2.84	0.3
-	-	S	23.2	64.3	3.0 - 5.0	3.0	254.2	2.99	0.3
SPITS	1154.2	P	14.8	109.6	3.0 - 5.0	5.0	152.6	2.95	0.3
-	-	S	23.0	97.6	3.0 - 5.0	3.0	263.0	3.11	0.4
FINES	1776.9	P	11.6	29.6	2.0 - 4.0	1.0	224.2	2.78	0.3
NORES	2267.3	P	10.9	33.6	1.5 - 3.5	1.0	281.4	2.68	0.3

The first part of Fig. 7.2.2 (5 December 1997) shows thresholds during typical "quiet" conditions where the upper magnitude thresholds for possible events at the NZ test site fluctuate around m_b 2.0. Around noon that day, a large (M_S 7.7) earthquake occurred near the E. coast of Kamchatka, followed by a very large aftershock sequence. We note that the individual arrays have large numbers of peaks corresponding to these aftershocks, whereas the network threshold trace is much less influenced by the aftershock sequence, ensuring a monitoring capability below m_b 2.5 for almost the entire time period. However, we should add that the situation would have been quite different if the sequence has taken place near the target area for the monitoring.

Fig. 7.2.3 shows a second example, which covers 16 December 1997. Two important features are illustrated in this figure. First, the key array SPITS happened to be out of operation, resulting in a general deterioration of the combined network capability. Second, there was an unusually large increase in the background noise level at the other key array, ARCES. This increase was caused by a very strong storm system moving through northern Norway at that time, producing increased microseismic noise at ARCES over the entire frequency spectrum. In spite of the coincidence of these two unfavorable factors, we note that the network threshold trace still, in general, remains below magnitude 2.5. There are about 10 peaks slightly exceeding 2.5 this day, but they can all be "explained" as resulting from interfering events.

During November and December, 1997, we found 90 peaks on the network threshold trace that exceeded m_b 2.5, of which 73 were caused by teleseismic earthquakes, and in particular the

Kamchatka aftershock sequence. The remaining 17 peaks were correlated with small earthquakes close to SPITS and some local events in Fennoscandia (mostly mining explosions).

During these two months, the continuous TM method was able to provide results that enabled monitoring of the NZ test site down to m_b 2.0 for most of the time period. All peaks exceeding mb 2.5 were correlated to events outside the target region, so we can therefore conclude at the 90% confidence level that no seismic event of magnitude exceeding 2.5 occurred at the NZ test site during the time period November - December, 1997.

Analyzing threshold traces using detector information

In an attempt to come up with an automatic analysis procedure for the Novaya Zemlya threshold traces, we have started to investigate the possibility of utilizing detector information for labelling the threshold peaks. The idea is to associate the peaks of the threshold traces with detected signals at the different arrays, and then use the signal measurements to characterize the signals as originating from sources **outside** the NZ test region.

In this initial study, we have focused on magnitude thresholds calculated from SPITS P-phases alone, but we could as well have used the network threshold trace as the basis. An example for the one hour time interval 19:00-20:00 on March 14, 1998, is shown in Fig. 7.2.4, and we refer to the figure text for details on the content of the different panels. During this one-hour interval we have found eight threshold peaks exceeding m_b 2.5, and two of these peaks reach the 3.5 level. Except for the detections associated with peak no. 7, all azimuth and slowness estimates differ by more than 18 s/deg from the predicted horizontal slowness of NZ P-phases. For the detections associated with peak no. 5, the differences are between 5 and 10 s/deg, which also is outside our area of interest. From manual analysis of the SPITS data we found that peak no. 7 was caused by a P-phase from an m_b 5.3 event located in northern Iran. The other peaks were all caused by events within 300 km of the SPITS array.

The most important conclusion from Fig. 7.2.4 is illustrated by the shaded region on the bottom panel. We note that none of the 8 peaks have slowness/azimuths near this shaded region, which corresponds to expected values for "real" NZ events. Thus it is possible to automatically explain all of the peaks as resulting from non-NZ events.

These results, and results from analysis of other time intervals, suggest that information provided by the automatic detection analysis can be effectively used to "explain" the peaks in the threshold trace calculated from a single array. We have so far only used the azimuth and slowness estimates, but additional measurements like frequency content, polarization attributes and estimates of the signal loss can also be considered. It is well known that automatic azimuth and slowness estimation in some cases produces erroneous results. This can be due to problems like wrong positioning of the analysis window, data errors, or low SNR. In addition, the array configuration limits the resolution of the slowness estimates. It will therefore be necessary to develop quality criteria for the azimuth and slowness estimates, so that we can recognize results that have a high likelihood of being wrong.

Conclusions and recommendations

For site-specific monitoring it is important to be aware that the main purpose of the threshold monitoring method is to call attention to any time instance when a given threshold is exceeded. This will enable analysts to focus their efforts on those events that are truly of interest in a monitoring situation. Other, traditional analysis tools will then be applied for detecting, locating and characterizing the source of the disturbance. We will, however, continue to develop the tools for automatic labelling the threshold peaks using information from the signal detector. In this way we hope to reduce the number of instances where manual analysis is needed for explaining the cause of the threshold peaks.

T. Kværna
F. Ringdal
J. Schweitzer
L. Taylor

References

Mykkeltveit, S. and F. Ringdal (1981). Phase identification and event location at regional distance using small-aperture array data.
In: Husebye, E.S. & Mykkeltveit, S. (eds.), 1981: Identification of seismic sources - earthquake or underground explosion. D. Reidel Publishing Company, 467 - 481.

Ringdal, F., 1977. P-Wave Amplitudes and Sources of Scattering in m_b-Observations. J. Geophys., 43, 611-622, 1977.

Ringdal, F., 1996. Study of low-magnitude seismic events near the Novaya Zemlya nuclear test site. Semiannual Tech. Summary, 1 Apr-30 Sep 96, NORSAR Sci. Rep. 1-96/97, NORSAR, Kjeller, Norway

Ringdal, F., 1997a. The seismic event near Novaya Zemlya on 16 August 1997. Semiannual Tech. Summary, 1 Apr-30 Sep 97, NORSAR Sci. Rep. 1-97/98, NORSAR, Kjeller, Norway

Ringdal, F., 1997b. P/S ratios for seismic events near Novaya Zemlya. Semiannual Tech. Summary, 1 Apr-30 Sep 97, NORSAR Sci. Rep. 1-97/98, NORSAR, Kjeller, Norway

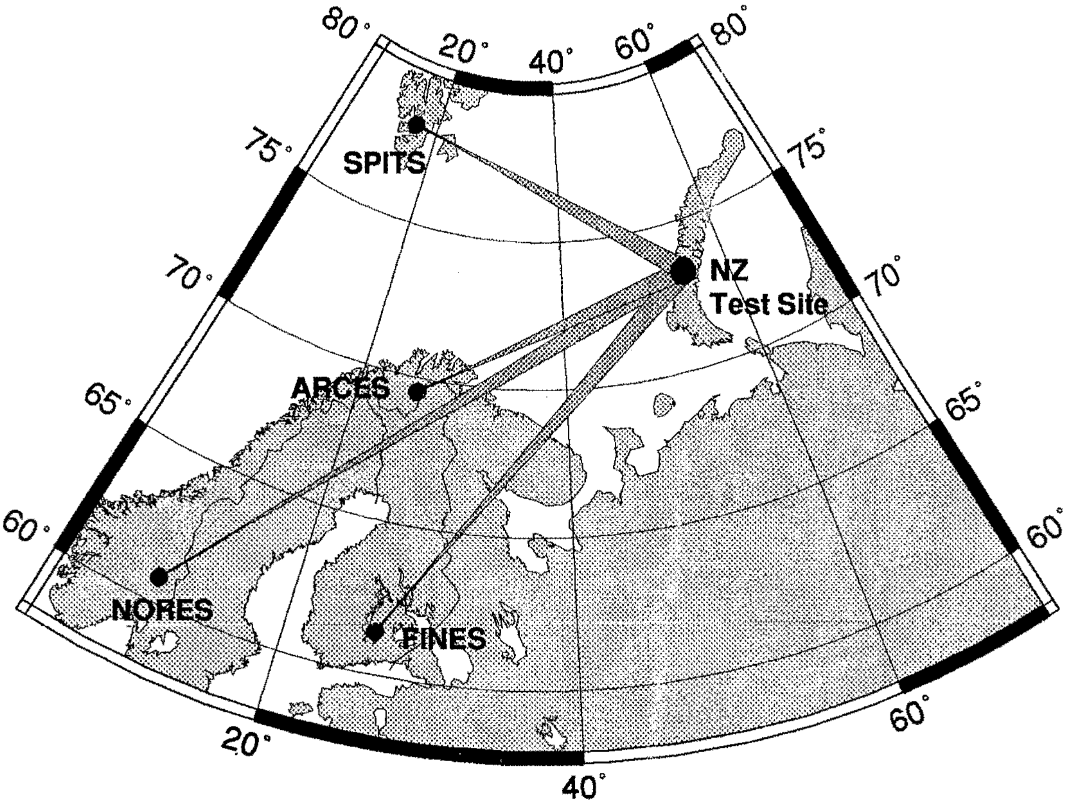


Fig. 7.2.1: Map of Novaya Zemlya and the locations of the four arrays (SPITS, ARCES, FINES, and NORES) used to monitor the region around the former underground nuclear test site.

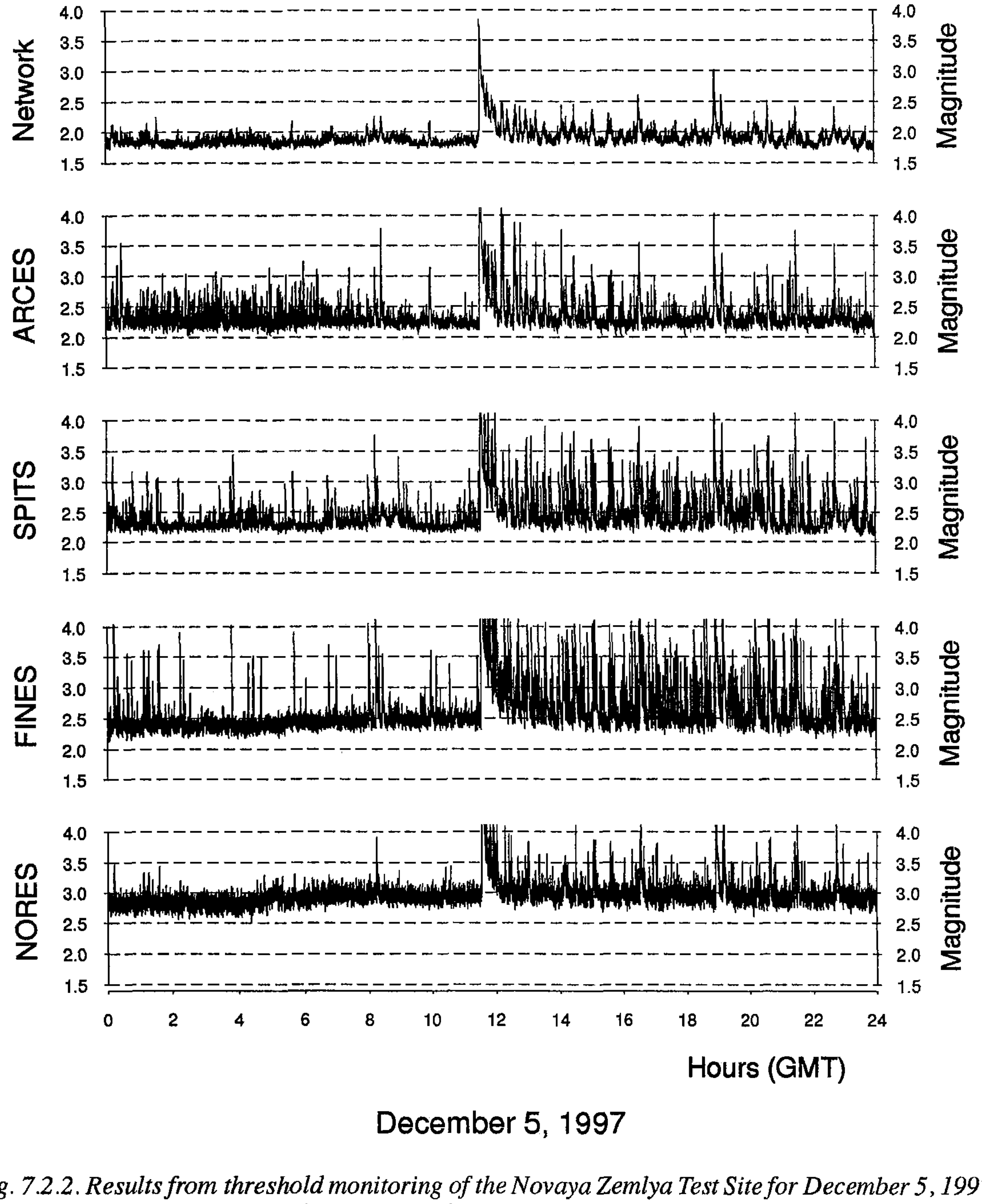


Fig. 7.2.2. Results from threshold monitoring of the Novaya Zemlya Test Site for December 5, 1997. The network trace on top is the combined threshold trace, using P phases for all arrays and in addition S phases for ARCES and SPITS. The traces for each of the four stations (P phases only) are shown below the network trace. The peaks starting around noon correspond to signals from a large (M_S 7.7) earthquake which occurred near the E. coast of Kamchatka, followed by a very large aftershock sequence. Notice that before the earthquake occurred there are no instances where the network threshold trace exceeds magnitude 2.5. Also notice that the individual arrays have large numbers of peaks corresponding to aftershocks, whereas the network threshold trace is much less influenced by the aftershock sequence.

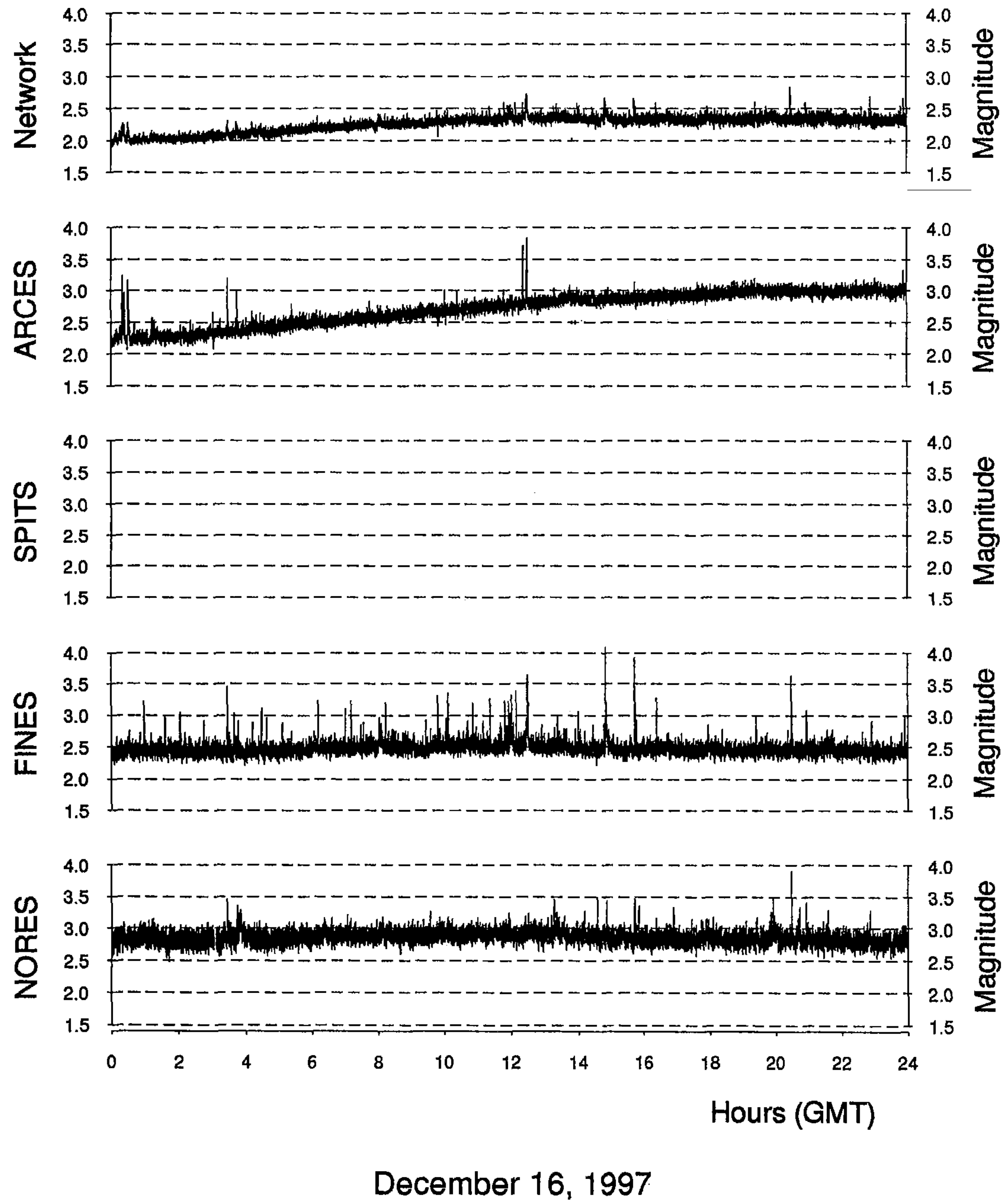


Fig. 7.2.3. Results from threshold monitoring of the Novaya Zemlya Test Site for December 16, 1997. Two important features are illustrated in this figure. First, the SPITS array happened to be out of operation, resulting in a general deterioration of the combined network capability. Second, there was an unusually large increase in the background noise level at the other key array, ARCES, caused by a very strong storm system moving through northern Norway at that time.

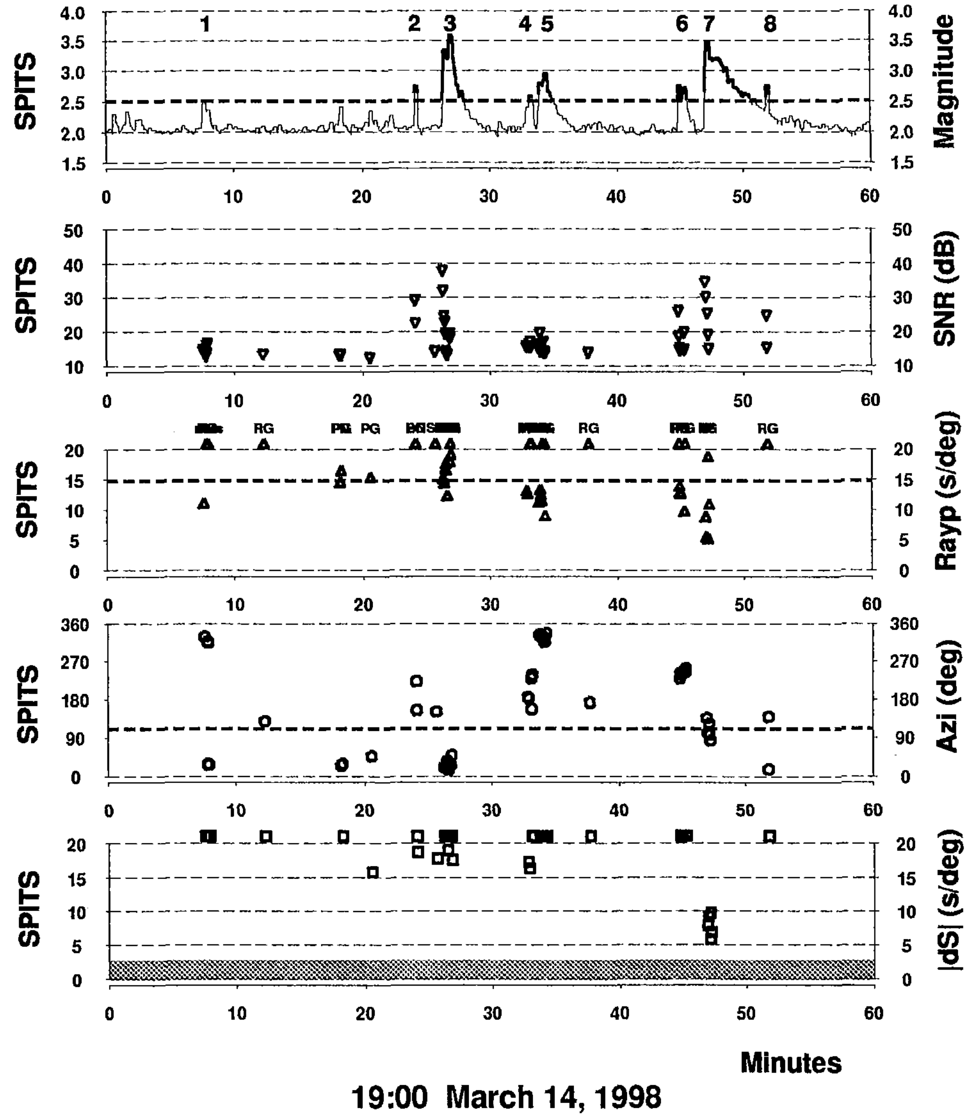


Fig. 7.2.4. Results from correlating NZ magnitude thresholds calculated from SPITS array data (P-phase only) with information from the signal detector. The upper panel shows the NZ magnitude thresholds for the one-hour interval 19:00-20:00 on March 14, 1998. Threshold peaks exceeding 2.5 are highlighted and labelled. The next four panels show different types of information from the signal detector.
Panel no. 2 shows the SNR (in dB) of the SPITS detections.
Panel no. 3 shows the estimated slownesses of the detections (in s/deg). Notice that slownesses exceeding 20 s/deg are plotted just above the 20 s/deg line. Local Rg phases at SPITS often have slownesses exceeding 70 s/deg. Phase type hypotheses based on the slowness estimates are plotted above the panel. The bold dashed line indicates the expected slowness of P-phases from events at the NZ test site (14.76 s/deg).
Panel no. 4 shows the estimated azimuths of the detections. The bold dashed line indicates the expected azimuth of P-phases from events at the NZ test site (109.6 deg).
Panel no. 5 shows the differences in horizontal slowness estimates between the detected signals and predicted P-phases from the NZ test site (in s/deg). Detections with differences exceeding 20 s/deg are plotted above the panel. The shaded region within 2.5 s/deg indicates the range of interest for NZ P-phases.

7.3 Norwegian Experience with IDC Metrics During GSETT-3

Paper presented at the Workshop on Review and Definition of IDC Metrics 7-9 Sep 98

Introduction

The Ad Hoc Group of Scientific Experts (GSE) Third Technical Test, GSETT-3, began full-scale operations on 1 January 1995. In 1997, the responsibility for GSETT-3 was transferred to PrepCom's Working Group on Verification, and the GSETT-3 system is now gradually evolving into the International Monitoring System for the CTBT.

Evaluation has been an essential component of and prerequisite for the success of GSETT-3. Numerous national studies have contributed to these evaluation studies, including a number of papers from Norway. With respect to IDC metrics, the Norwegian contributions have focused on issues such as

- Metrics for event size
- Metrics to define location accuracy
- Metrics for capability estimation
- Metrics for REB completeness
- Metrics for event screening

This presentation gives an overview of some of the main experiences by Norway during GSETT-3, with emphasis on PIDC processing and results. Some more recent studies are also included. The paper focuses on issues and problems that are at the present time still not resolved, and gives suggestions for future improvements.

Metrics for event size

a) Body-wave magnitude m_b

Body-wave magnitude m_b has traditionally been the most common measure of the "size" of a seismic event. While this quantity is in general easy to measure at any given station, it shows a large variability across a seismic network for any given event. For this reason, it has been common practice to calculate the average magnitude measured at the individual stations of a network, and use this network magnitude as a best estimate.

It has long been recognized that this method can create a significant bias at low and intermediate magnitudes, because the stations which do not detect the event (usually those stations with the smallest signals) are selectively excluded from the averaging procedure. Figure 7.3.1 illustrates how this problem affects the magnitude-frequency relationship measured by the ISC network, when compared to NORSAR array magnitudes. It might be worth mentioning that under reasonable assumption, a single station or array produces an unbiased slope in this relationship, since the inherent scatter in single-station magnitudes merely shifts the baseline without affecting the slope (Ringdal, 1975). A similar result is found for IDC magnitudes, where the recurrence relations shows a slope significantly greated than 1.0 (see the IDC Performance Reports).

Looking at the same problem for a different angle, we have compared the IDC magnitudes to NORSAR magnitudes for a sequence of earthquakes from Greece in 1995 (Ringdal, 1995). Figure 7.3.2 illustrates the magnitude-dependent bias in both IDC and PDE magnitudes as compared to the "unbiased" NORSAR m_b.

The maximum-likelihood method (Ringdal, 1976) offers a means to compensate for this bias, but it has not yet been operationally implemented at the IDC. Current efforts aimed at implementing this procedure should be intensified, at the same time as efforts are underway to incorporate new distance corrections to enable the computation of m_b at regional distance ranges. In implementing the maximum likelihood method, the most important consideration is a quality check to ensure that non-operational stations or stations with abnormally low gain are excluded from the calculations.

We believe that the slope of the magnitude-frequency relationship, for various regions and for specified time periods, would be a useful and simple metric to assess the consistency of the IDC magnitude estimates. The actual assessment could be made by comparing this IDC slope to the corresponding slope for the same regions and time intervals as obtained from selected array stations in the IMS network. Such array stations (*e.g.* NOA) must be able to independently provide approximate location estimates in order to ensure that the regions correspond well enough.

b) Surface wave magnitude M_S

The recommendation to introduce the maximum-likelihood approach applies to the computation of network M_S as well as network m_b. In addition, a similar approach should be made to estimate the upper limit of M_S for events for which no surface waves are detected. This provides important information for the M_s:m_b discriminant, in the form of "negative evidence" as has been addressed in many studies in the past.

Recent studies, as *e.g.* documented in Section 7.4 of this report, have shown that the measurement of surface wave magnitudes at regional distances holds significant promise of lowering the limit for applying the M_s:m_b criterion, and would be of particular importance for the event screening currently being implemented at the IDC. Furthermore, regional surface waves have significant energy at shorter periods (down to 5-10 seconds), and this could be exploited in extending the spectral range for useful M_s measurements.

In particular, measurement of such shorter period surface waves at regional distances could contribute to reducing the influence of coda from surface waves of large teleseismic earthquakes, which often mask ordinary surface waves from small events for hours. The reason is that these strong surface waves generally have a dominant period of 20 seconds or more, with far less energy in the shorter period bands. This is illustrated in Figs. 7.3.3. and 7.3.4, which show NORSAR LP beam recordings for two Novaya Zemlya nuclear explosions (m_b=5.8 and 4.5). In the latter case, the surface waves in the "standard" frequency band are masked by an interfering teleseismic earthquake, but by applying a filter around 10 sec, these surface waves can be clearly seen.

As a new metric, we propose regional surface wave magnitudes at a suite of signal periods, *e.g.* 5sec, 10sec, 15 sec, 20 sec, 25 sec. This would in effect amount to providing a "spectrum" for recorded regional surface waves. It would be important to include an indicator of whether the measured level corresponds to noise or signal ("noise" includes possible interfering energy from other seismic events).

Metrics to define location accuracy

The traditional metric for location accuracy is the 95% confidence ellipse around the estimated epicenter. This metric should certainly be retained, but its implementation in the current IDC needs to take into account more realistic uncertainties in the parameters used for location estimation. Studies for many countries (including Fennoscandia) have shown that the location ellipse too often does not encompass the true epicenter. Significant progress in this regard is, however, taking place at the present time.

Looking at the available methods for estimating location, it is widely recognized that regional calibration is a requirement for achieving significantly better accuracy than today. Again, efforts are underway to develop such calibrated procedures at the IDC. There are, however, some factors that are much more difficult to quantify, and that also play a large role in producing mislocations. The most obvious is inaccurate reading of onset time, most often due to emergent signals with low SNR, but in some cases also caused by questionable analyst picks. The IDC experience in comparing picks by two or more independent analysts illustrates this problem well enough. It would be difficult to define appropriate metrics for this type of erroneous reading, but it is necessary to take this possibility into account when defining the error ellipse for small events.

An interesting result obtained by NORSAR in analyzing a sequence of Kola mining explosions with known locations, is that the most accurate locations (in this case) were obtained by including only three stations at close distances and correspondingly high SNR (Kværna and Ringdal, 1994, Ringdal, Kværna and Hokland, 1993). Even though, in principle, the locations should be improved by adding more stations, this did not happen in practice. The obvious reason is the lack of calibration (which is more serious at larger distances) combined with difficulties in reading onset time accurately at remote stations with low SNR.

This result could be important in future evaluation and estimation procedures. For example, if stations at regional distances from a given seismic event have been well calibrated through *e.g.* small chemical explosions or refraction surveys, it may be possible to estimate quite accurate locations using these regional stations only. It is far from obvious that the location accuracy would improve by adding a large number of teleseismic stations, for which the calibration information might be less developed. This question needs to be investigated in the future.

Metrics for capability estimation

The traditional method of estimating network capability is based upon an average statistical assessment of the noise level, the required SNR for detection and the number and types of phases needed to define an event. Recent developments in Threshold Monitoring, documented *e.g.* by Kværna and Ringdal (1998), promise to significantly expand and improve metrics for estimating capabilities, both on a network and station level.

Basically, the two types of network capability estimation can be summarized as follows:

Detection capability:

- The *smallest* hypothetical event that could be *detected* (*e.g.* by three stations)

Threshold capability:

- The *largest* hypothetical event that could have *occurred*

The Threshold capability always gives lower magnitude levels than the Detection capability, with a typical difference of 0.5-1 unit. Among the advantages of the Threshold Monitoring approach is that it can provide estimates of *both* the detection capability and the threshold capability

- continuously
- in near real time
- using the actually observed seismic field

In addition, the Global Threshold Monitoring system, as currently implemented at the PIDC, provides regular (hourly) statistics on individual station performance of the primary network. These performance statistics can be used to monitor the seismic noise level, seismometer gain, data quality (*e.g.* statistics on spikes) and instrument outage.

The global TM maps also give immediate indications of any degradation in global detection performance caused *e.g.* by coda of large earthquakes, abnormal noise levels for certain regions or stations or outages of key stations in the IMS primary network.

While the TM data provides a vast amount of potentially useful information, it will be a challenge to develop appropriate "simple" metrics to extract and make use of the most essential parts of this information.

Metrics for REB completeness

This topic is closely tied to the metrics for detection capability discussed above, but addresses some important additional considerations. In particular, the completeness of the bulletin must be seen in relation to the estimates of "expected" capabilities. Thus, even if the system "theoretically" has a certain capability, given a number of assumptions, an obious question to be considered is whether the actual detection performance, as observed in the REB, matches these theoretical estimates.

The PIDC Performance Reports already address this question by comparing the REB to the PDE or NEIC bulletins, and highlights events that are close to the 90% detection threshold of the IMS network but are not reported in the REB. This procedure should be expanded, taking also into account national earthquake bulletins. However, it is mandatory to accompany such comparisons by a realistic assessment of the reference magnitudes used at these non-IMS agencies. Again, this is a considerable challenge for future evaluation work.

An entirely different aspect of this problem is whether the IDC event definition criteria are appropriate for the purposes of the global system. As discussed earlier, there is a significant "gap" between even the theoretical detection capability of the network and the actual "threshold" at which we can monitor the upper limit of the magnitudes of possible occurring events. The current event definition criteria for the REB calls for P-detection at 3 or more primary stations. Obviously, many events could be (and are being) detected and located that do not satisfy this criterion, and consequently are not listed in the REB.

A particularly interesting example, in terms of CTBT monitoring, is the seismic event near Novaya Zemlya on 13 January 1996. This event was well detected (with P and S phases and azimuth estimates) by both the primary array ARCES and the auxiliary array SPITS (see Fig. 7.3.5). In fact ARCES was by itself able to detect and locate this event with reasonable accuracy, and the event thus fulfils the requirement that it should be "detected and located by the primary network". With the inclusion of SPITS, the location estimate could be further refined, as demonstrated by Ringdal (1997).

It will be an important task to develop metrics to assess the completeness of the REB, and to provide improved event definition criteria to enhance the completeness of this bulletin. Such new event definition criteria must carefully consider the tradeoff between achieving improved detectability and the desire to avoid overloading the REB with numerous small local events seen only at one or two IMS stations.

Metrics for event screening

The current event screening procedure employed at the PIDC focus on two criteria: event focal depth and M_s:m_b. These are considered to be by far the most robust criteria currently available, but have the disadvantage that they are difficult to apply to small events or events recorded only by few stations. Section 7.4 of this report describes some recent advances in studying regional recordings of surface waves, and the preliminary results indicate that it would be possible to apply the M_s:m_b discriminant to low magnitude events, perhaps approaching m_b=3.0-3.5 using regional data.

Other criteria, such as the high-frequency P/S ratio, hold the promise of being applicable at much lower event magnitudes. We have carried out extensive studies of this criterion for the Barents/Kara Sea region, and have concluded that at present, the P/S ratio is not sufficiently well understood to be routinely applied in event screening at the IDC (see the study described in Section 7.1 of this report).

In order to further develop the metrics for screening, it is necessary to study extensive historical recordings of nuclear explosions in various tectonic regions. Fortunately, many of the IMS stations have retained such recordings, but nevertheless the majority of IMS stations were not established at the time when the majority of nuclear explosions were conducted. The screening criteria must therefore be developed based to a large extent on non-IMS data. An excellent example is the historical data base of regional (analog) LP recordings retained in Apatity, Kola Peninsula (see Section 7.4).

Furthermore, since event magnitudes are important in most of the envisaged criteria, the problem of computing magnitudes of pre-GSETT-3 events in a way compatible with the current magnitude calculations must be addressed. This question is now being studied by many scientists, but again, we emphasize the need to avoid excessive reliance on past PDE, ISC or NEIC magnitude estimates, because of the potential magnitude-dependent bias discussed earlier in this paper.

Concluding remarks

Although the seismological procedures currently implemented at the PIDC are by now considered mature, there is still room for significant improvement, both in the calculation procedures and in the metrics designed to evaluate the IDC products and services. This includes event location, where improvements are needed both in regional calibration and estimation of arrival times at low SNR as well as improvement of metrics to measure location accuracy. Event magnitude is still not measured by maximum likelihood, and upper limits on non-detected surface waves should be included. Threshold monitoring promises to improve significantly the capability estimation, and will also provide metrics for characterizing station performance.

The completeness of the REB needs to be reassessed, with special view to the event definition criteria. In fact, with the current 3-primary station requirement, there are areas where the IMS can detect and locate events an order of magnitude smaller than the current REB threshold. Such a reassessment must, however, be carefully weighted against the undesired effect of including large number of small mining explosions and small aftershocks in the REB.

As detailed in this paper, there are many statistics and results currently forming part of the IDC processing which could give rise to useful metrics for evaluation purposes. An important future challenge will be to compress and synthesize these data to obtain metrics that represent the essence of the performance in a simple and easily understandable way. Furthermore, in the absence of "absolute" criteria against which to evaluate the system, the metrics will need to be assessed in a "relative" sense. Thus it is important to develop metrics which will provide a continuous assessment of the improvements, relative to previous practice, in the IMS and IDC processing as the development progresses in the years to come.

F. Ringdal

References

Kværna, T. and F. Ringdal (1994). Intelligent post-processing of seismic events, *Ann. Geofis.* XXXVII, 309-322.

Kværna, T. and F. Ringdal (1998). Seismic threshold monitoring for continuous assessment of global detection capability. *Semiannual Technical Summary 1 October 1997 - 31 March 1998*, NORSAR Sci. Rep. 2-97/98, Kjeller, Norway.

Ringdal, F. (1975). On the estimation of seismic detection thresholds, *Bull. Seism. Soc. Am.* 65, 1631-1642.

Ringdal, F. (1976). Maximum-likelihood estimation of seismic magnitude, *Bull. Seism. Soc. Am.* 66, 789-802.

Ringdal, F. (1986). Study of magnitudes, seismicity and earthquake detectability using a global network, *Bull. Seism. Soc. Am.* 76, 1641-1659.

Ringdal, F. (1995). Magnitude estimation at the IDC - a case study. *Semiannual Technical Summary 1 April - 30 September 1995*, NORSAR Sci. Rep. 1-95/96, Kjeller, Norway.

Ringdal, F. (1997): Study of Low-Magnitude Seismic Events near the Novaya Zemlya Test Site, *Bull. Seism. Soc. Am. 87 No. 6,* 1563-1575.

Ringdal, F., T. Kværna and B.K. Hokland (1993). Onset time estimation and location of events in the Khibiny Massif, Kola Peninsula, using the Analyst Review Station. *Semiannual Technical Summary 1 April - 30 September 1993*, NORSAR Sci. Rep. 1-93/94, Kjeller, Norway.

Ringdal, F. and E.S. Husebye (1982). Application of arrays in the detection, location and identification of seismic events, *Bull. Seism. Soc. Am.* 72, S201-S224.

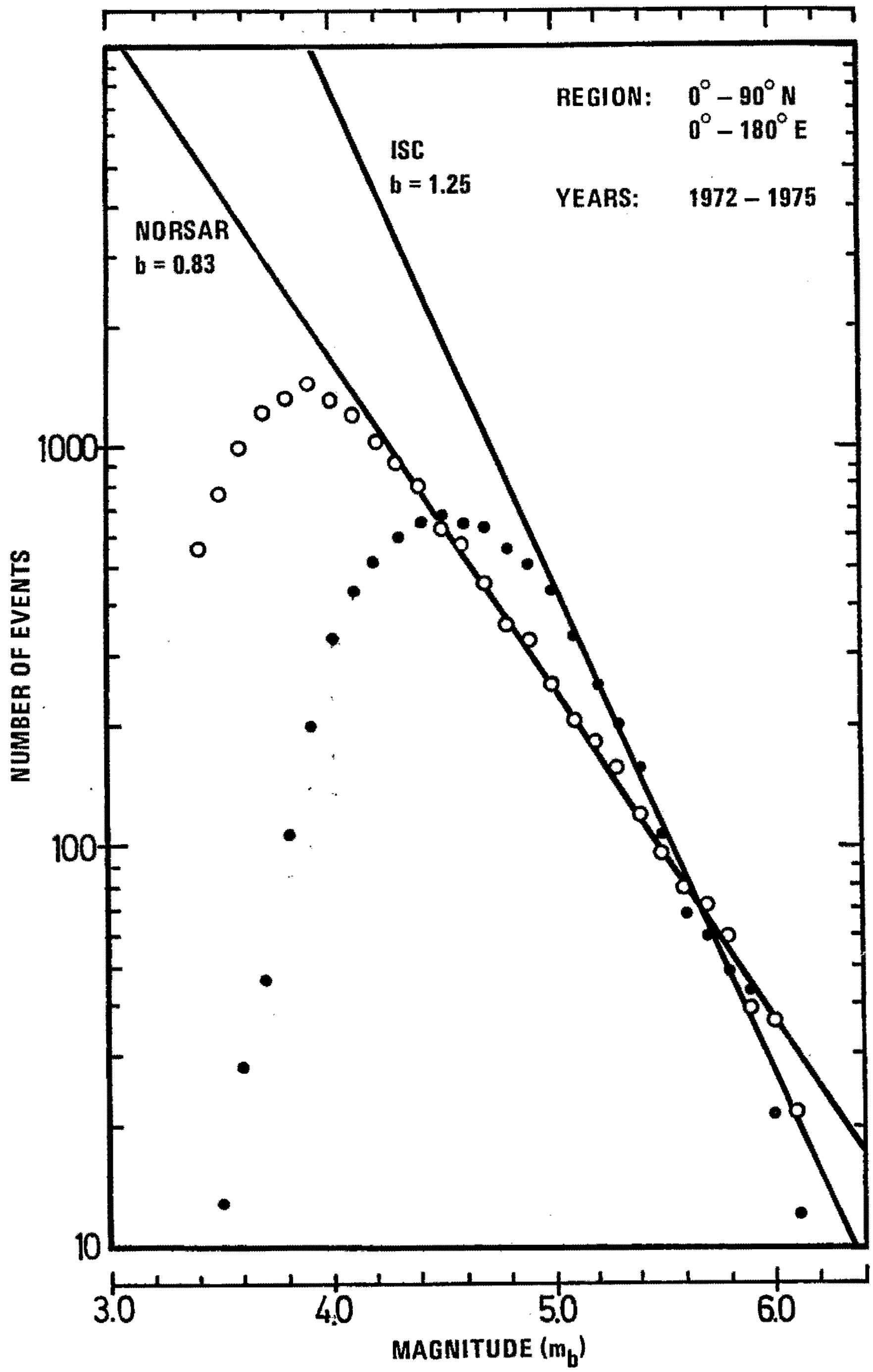


Fig. 7.3.1. ISC and NORSAR magnitude-frequency statistics for seismic events in the region 0-90 degrees North, 0-180 degrees East over the four year period 1972-1975. The filled circles (ISC) and open circles (NORSAR) correspond to incremental number of reported events at m_b intervals of 0.1 unit. Note the significant difference in the apparent slope of the respective recurrence relations. (After Ringdal and Husebye, 1982).

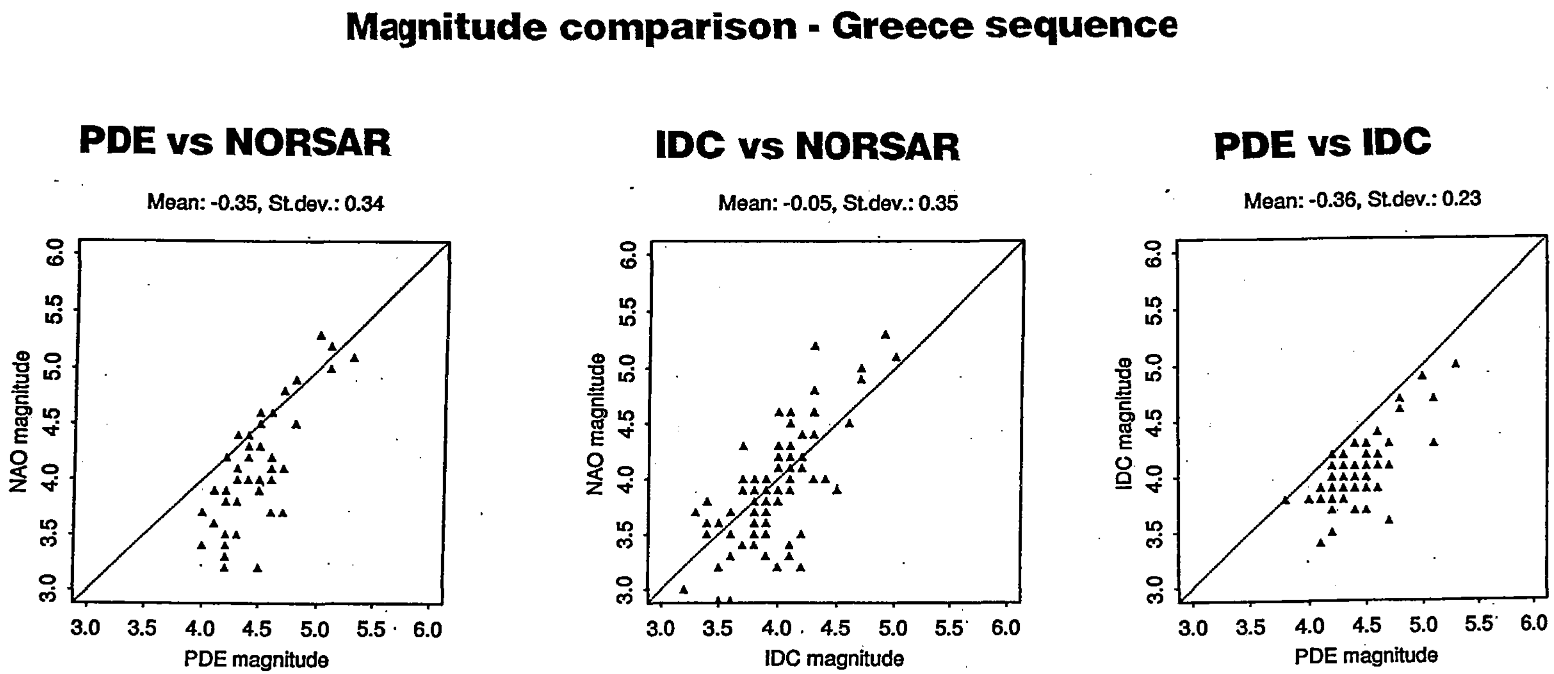


Fig. 7.3.2. Magnitude comparisons for various reporting agencies for an earthquake sequence in Greece during 1995. Note the network magnitude bias, which is particularly pronounced in the comparison of PDE and NORSAR magnitude. Note also the negative bias in IDC magnitudes compared to PDE. (After Ringdal, 1995).

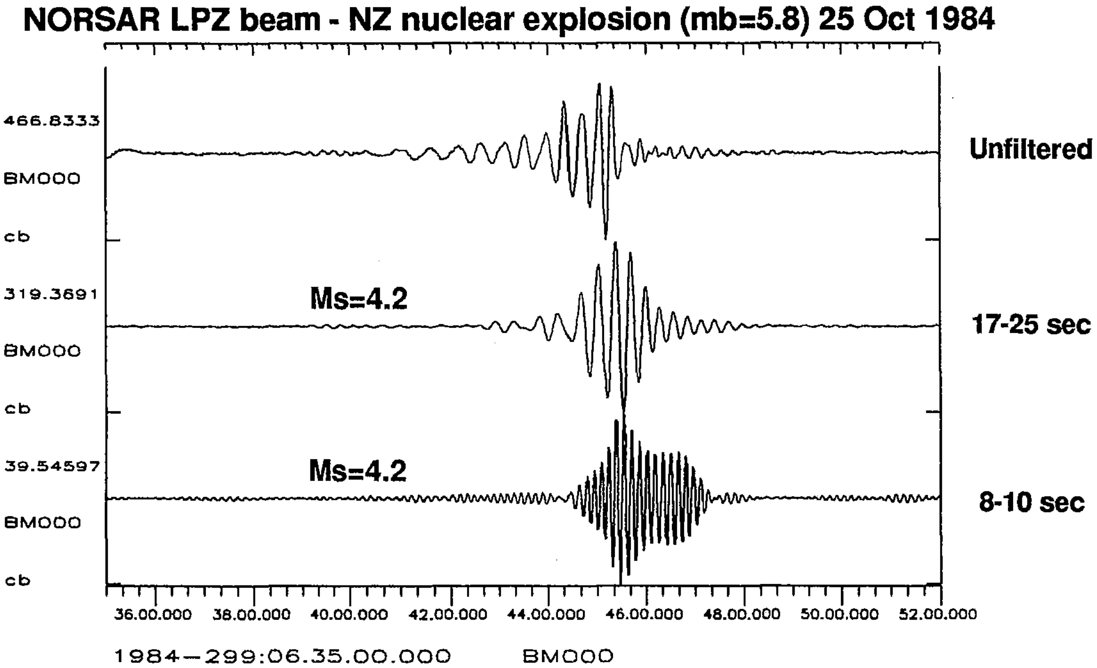


Fig. 7.3.3. NORSAR LPZ array beam recordings of a nuclear explosion (m_b=5.8) at Novaya Zemlya on 25 October 1984. An unfiltered beam is shown together with the beam filtered in the "standard" 17-25 seconds band and a "high-frequency" 8-10 seconds band. Note the high SNR of this regional recording (distance =20 degrees) even at the higher frequencies.

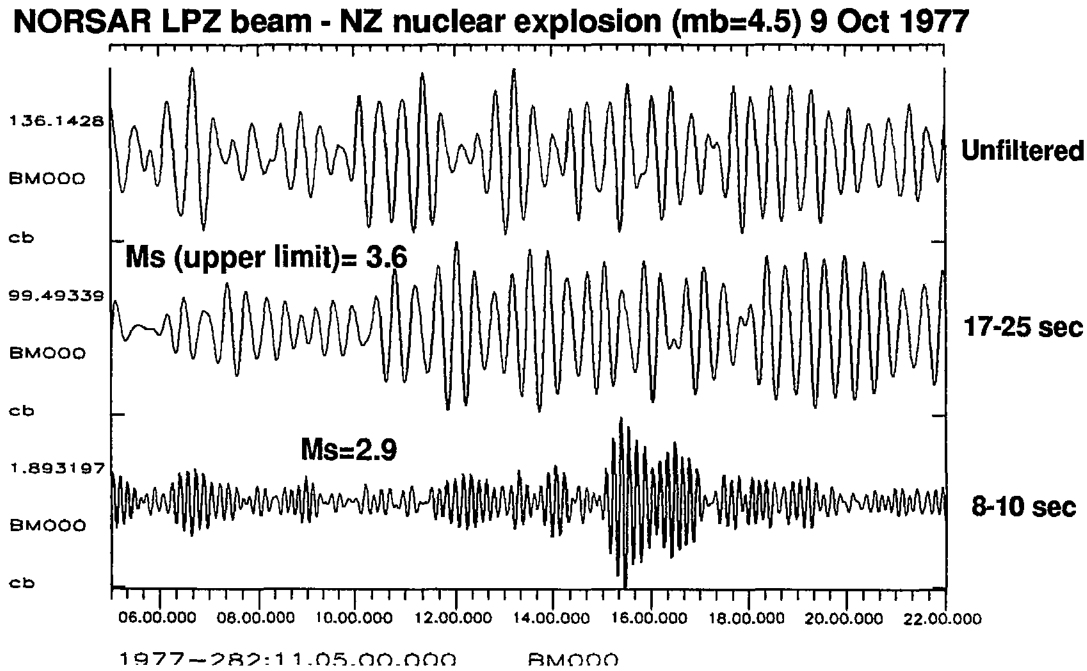


Fig. 7.3.4. NORSAR LPZ array beam recordings of a nuclear explosion (m_b=4.5) at Novaya Zemlya on 9 October 1977. An unfiltered beam is shown together with the beam filtered in the "standard" 17-25 seconds band and a "high-frequency" 8-10 seconds band. Note that an interfering event masks the explosion surface waves in the 17-25 seconds band, whereas the explosion signal is clearly seen in the 8-10 seconds band.

Seismic event near Novaya Zemlya 13 January 1996

Filter 3 - 5 Hz

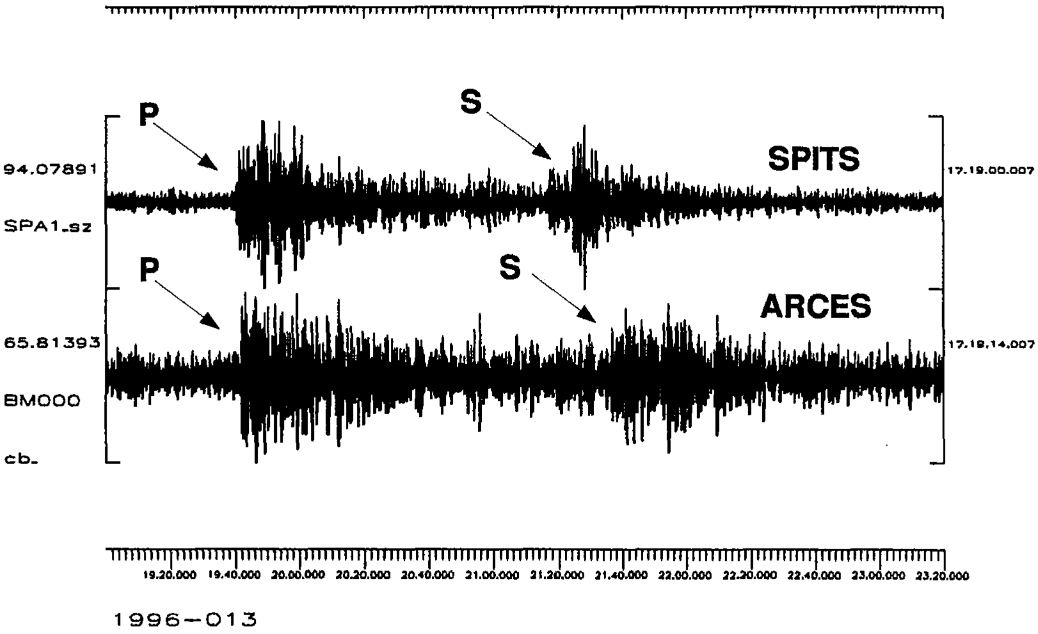


Fig. 7.3.5. SPITS and ARCES recordings of a small seismic event (m_b=2.4) near Novaya Zemlya on 13 January 1996. This event is about 1 magnitude unit smaller than the REB reporting threshold for this region, but can nevertheless be reliably detected and located using these two IMS stations.

7.4 Study of surface waves and M_s:m_b using Apatity LP recordings

Introduction

As part of a project aimed at improving seismic monitoring capabilities for the Arctic region, NORSAR and Kola Regional Seismological Centre (KRSC) are conducting a comprehensive study of seismicity, seismic wave propagation and seismic event characterization in the Barents region. This work is particularly relevant to the development of event screening criteria, which is one of the main tasks of the expert work conducted by the Vienna Working Group B (verification).

The current event screening procedure employed at the IDC focuses on two criteria: event focal depth and M_s:m_b. These are considered to be by far the most robust criteria currently available, but have the disadvantage that they are difficult to apply to small events or events recorded only by few stations. Other criteria, such as the high-frequency P/S ratio, hold the promise of being applicable at much lower event magnitudes, but are currently not proven to be sufficiently reliable (see the study described in Section 7.1 of this report).

By focusing on regional recordings of surface waves, it would be possible to apply the M_s:m_b discriminant to low magnitude events, perhaps approaching m_b=3.0-3.5. This is the motivation for the present study. As is well known, accurate discrimination of seismic events with a regional network requires detailed knowledge of the propagation characteristics of seismic waves in the region. At present, these propagation characteristics are reasonably well known for P-waves in the Barents region, but much work remains to be done regarding surface wave propagation and magnitude estimation. In the following, we describe some initial results obtained for this region.

Station network

The regional seismic network operated by the Kola Recional Seismological Center currently comprises a combination of digital and analog stations. Several stations of the analog type have been in operation for many years (see Fig. 7.4.1), whereas the digital stations in this network have only a few years of available recordings (Asming et al, 1998).

In order to assess surface wave propagation, and in particular to evaluate the M_s:m_b discriminant, it is necessary to take advantage of the historic analog recordings. The station APA in Apatity forms a unique source of such data. This station has had high-quality LP recordings since 1969, and thus a data base is available of regional earthquakes and nuclear explosions dating back almost 30 years.

Data

We have initiated a project to digitize surface waves of selected regional events in the APA data base of LP recordings. The digitization method is illustrated in Fig. 7.4.2, and is based on a semi-automated algorithm. The original seismograms are amplified by photocopying and scanned into an image on a PC. An automatic algorithm calculates the midpoint of each trace for a given time interval, and thus creates an initial digital record. The analyst can interactively verify the output and make corrections as necessary (for example when lines on the seismogram cross each other). Finally, the record is resampled with an equidistant sampling rate.

We have checked this method by comparing digitized analog LP recordings to the digital recordings of a co-located broadband station in order to verify the response characteristics and the quality of the digitization process. This comparison can only be made for the most recent years, during which a co-located broadband Guralp 3-component seismometer has been in operation in Apatity.

An illustration of such a comparison for an earthquake in 1998 near Spitsbergen is shown in Figures 7.4.3 and 7.4.4. It is seen that the quality of the digitized records are excellent, and can be used over a spectral band ranging from 5 seconds to at least 30 seconds period. In fact, the recordings in the various filter band are almost identical, except that for the lowest filter band (0.03-0.04 Hz or 25-33 seconds) the broad-band recordings have slightly more ringing of the signal than the digitized LP recordings. We attribute this difference to the different response characteristics of the seismometers at these frequencies.

Results

We have initially applied this digitization to about 30 seismic events at regional distances and various azimuths from the APA station. About half are nuclear explosions (mostly from the Novaya Zemlya test site) and the remainder are intermediate and low magnitude earthquakes (typical magnitude range 4.0-5.0). All of the earthquakes have continental propagation paths. While the earthquakes (by necessity) are at azimuths different from the explosions, we consider that the variations in azimuths and propagation paths are sufficient to provide a representative sample of the characteristics of the seismic source and propagation effects.

An example of digitized data for two nuclear explosions (separated in time by 12 years) is shown in Fig. 7.4.5 and 7.4.6. We note that the LP signals are very similar across all the frequency bands considered, with about a factor of 2 in amplitude difference. In particular, it is interesting to note the strong signals even at the highest frequency band considered (0.1-0.2 Hz or 5-10 seconds period).

Fig. 7.4.7 shows a map of the propagation paths (to the left) and a comparison of the corrected surface wave spectra (to the right). These corrected spectra have been obtained by calculating the log amplitude of the filtered surface waves in each frequency band, making a distance correction equal to 1.66*log(Delta(deg)) and subtracting the m_b value for each event. Although somewhat simplified, this diagram can be seen as a frequency-dependent M_s:m_b plot, and the separation is quite good at all frequencies considered.

We may add that we also digitized surface wave recordings from a suite of earthquakes in the oceanic part of the Norwegian Sea (very close to the oceanic/continental margin), and compared them to the explosion population. While not shown in a figure, it turned out that they were closer to the explosions than the "continental" earthquakes. This is likely at least partly due to attenuation along the oceanic/continental margin, and confirms that such major tectonic features must be corrected for when carrying out discrimination studies.

One interesting observation in Fig. 7.4.7 is the 1 August 1986 event near Novaya Zemlya. This event, which is traditionally classified as an earthquake (see Marshall et.al., 1989) seems to fall very close to the explosion population. We should note, however, that this is to some extent a consequence of our not having available reliable m_b values for this (or most other) events in the data base. It is therefore premature to use these results to state anything about the nature of the source for the 1 August 1986 event.

The lack of reliable m_b estimates for events in this region is in fact a source of concern, and prevents us at present from carrying out the M_s:m_b study in more detail. As an example, the ISC m_b can at occasions be biased high by one full magnitude unit, *e.g.* when only one or two high-amplitude teleseismic stations have detected a given event. On the other hand, most of the Novaya Zemlya events have a reasonably accurate magnitude estimate (Ringdal, 1997). We plan to carry out a more comprehensive evaluation of m_b , perhaps by using a maximum-likelihood formulation similar to that of Ringdal (1986), in order to obtain more consistent estimates for the events in the data base.

Conclusions

We have demonstrated the capabilities of the APA surface wave recordings to provide a promising separation of earthquakes and explosions in the Barents region using the M_s:m_b discriminant. We have shown that separation between the earthquake and explosion populations can be achieved in a wide frequency band (5-30 seconds period). We note that this gives promise for applying the M_s:m_b discriminants down to lower magnitudes than is possible using teleseismic recordings.

Additional work is required in regionalization of the propagation paths to take into account the major tectonic features in the region. The body-wave magnitudes provided by the ISC are far from good enough for events in this region, and must be reassessed in order to make full use of the earthquake-explosion discrimination potential.

E. Kremenetskaya, KRSC, Apatity, Russia
V. Asming, KRSC, Apatity, Russia
Z. Jevtjugina, KRSC, Apatity, Russia
F. Ringdal, NORSAR

References

Asming, V., E. Kremenetskaya and F. Ringdal (1998). Monitoring seismic events in the Barents/Kara Sea region. *Semiannual Technical Summary 1 October 1997 - 31 March 1998*, NORSAR Sci. Rep. 2-97/98, Kjeller, Norway.

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

Ringdal, F. (1986). Study of magnitudes, seismicity and earthquake detectability using a global network, *Bull. Seism. Soc. Am.* 76, 1641-1659.

Ringdal, F. (1997): Study of Low-Magnitude Seismic Events near the Novaya Zemlya Test Site, *Bull. Seism. Soc. Am. 87 No. 6,* 1563-1575.

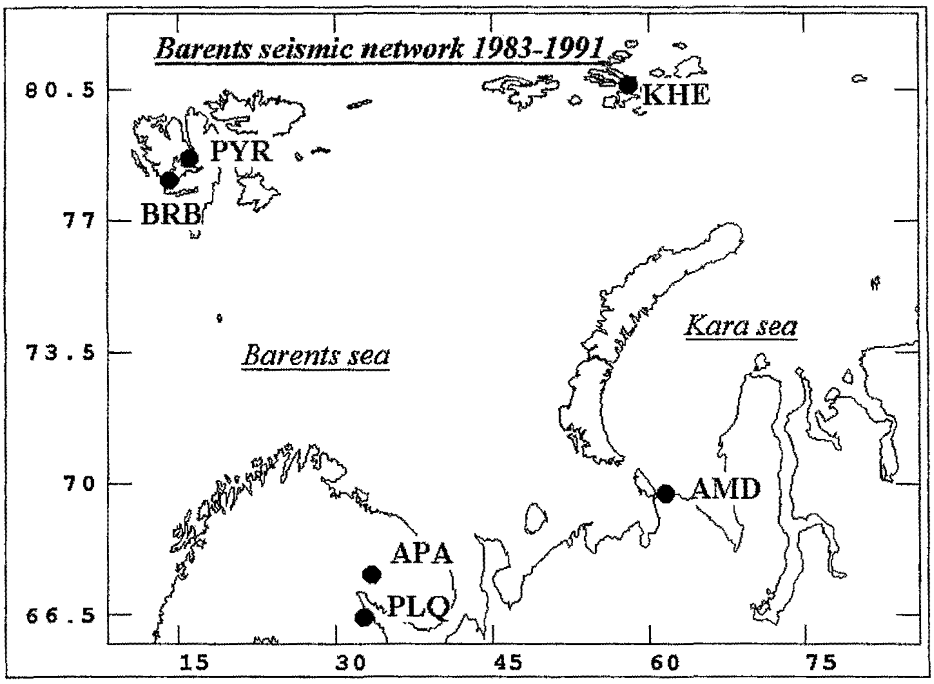


Fig. 7.4.1 Stations in the Barents seismic network operated by KRSC. The station APA, which has both 3-component SP and LP seismometers, has the longest period of operation, from 1969 until present. APA has in addition a Guralp BB digital seismometer, which has been operational since 1991.

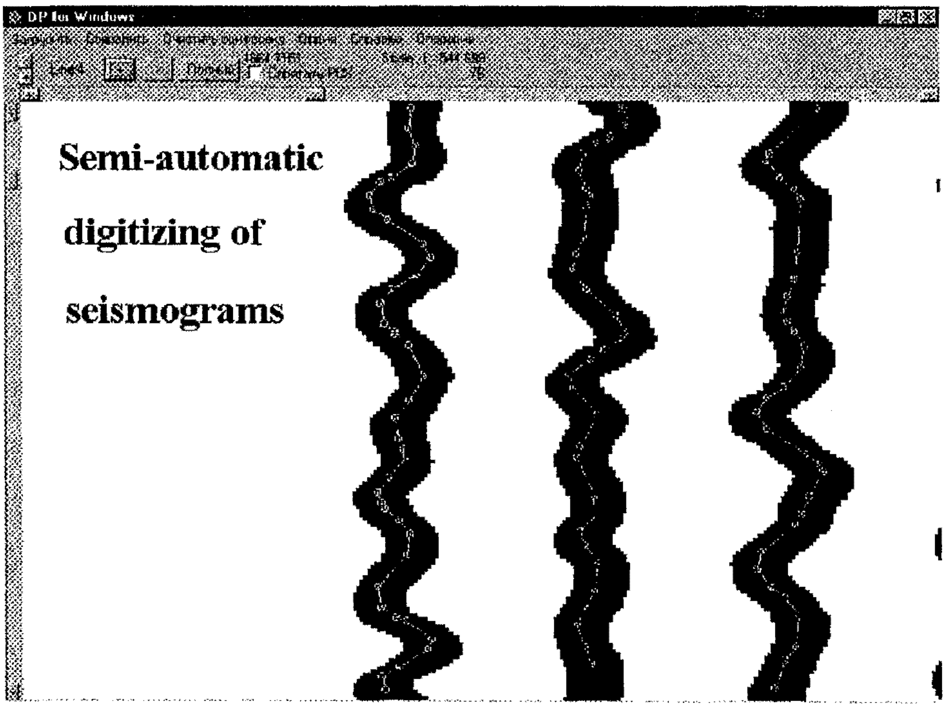


Fig. 7.4.2..Illustration of the semi-automatic method of digitization of analog LP seismograms applied to the APA data base. See text for details.

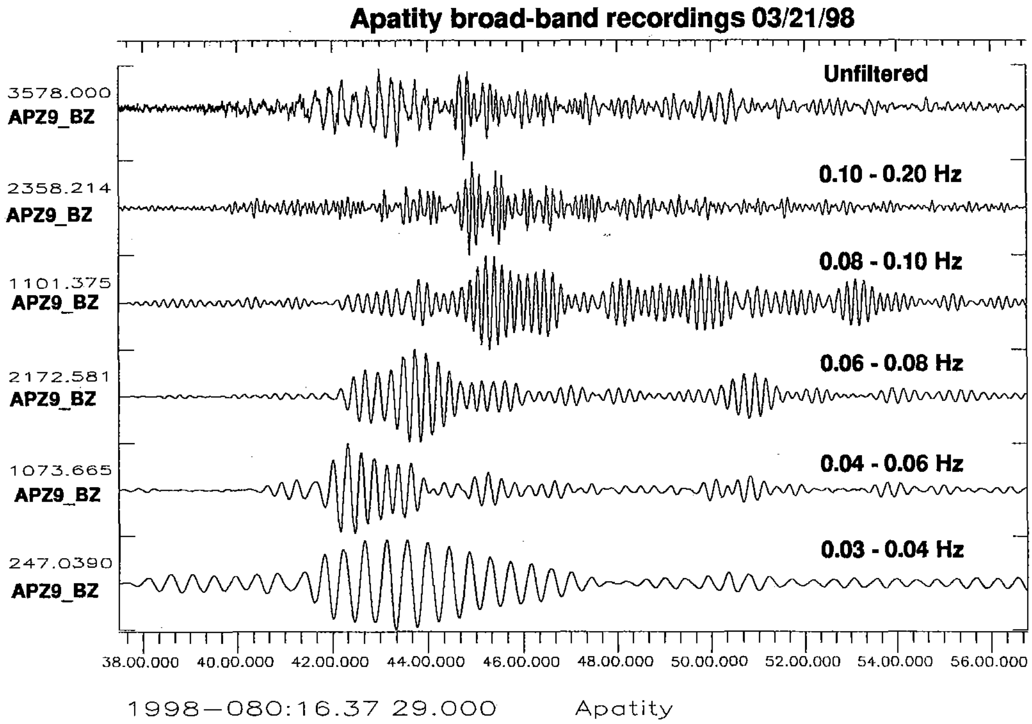


Fig. 7.4.3. Digital recording by the broad-band Guralp vertical seismometer in Apatity for an earthquake near Spitsbergen on 21 March 1998. The unfiltered data are shown in the top trace, with the other traces showing a suite of narrow-band filters applied to the recording.

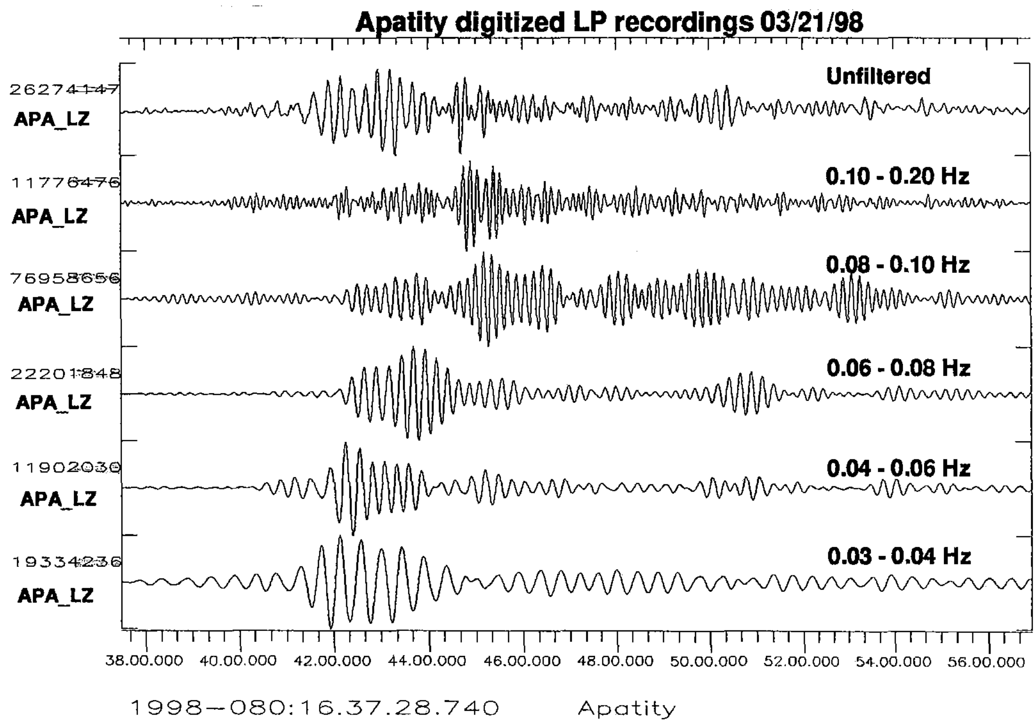


Fig. 7.4.4. Digitized recordings based on the APA LP vertical component co-located with the Guralp BB seismometer for the same event shown in Fig. 7.4.3. Note the close correspondence of the data shown in the two figures.

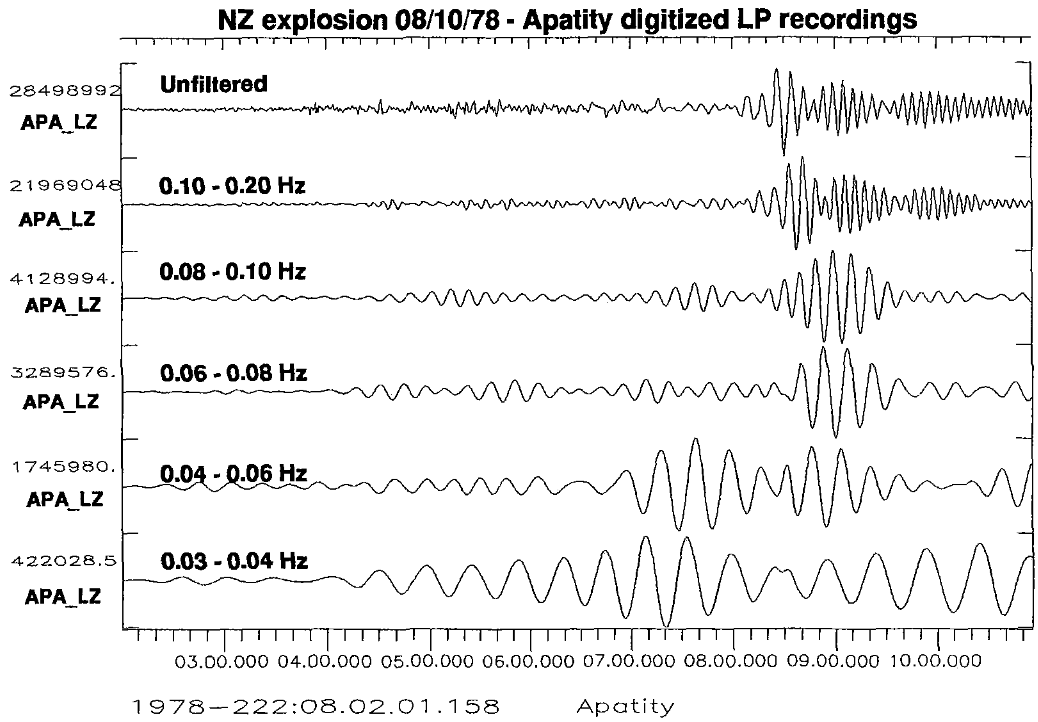


Fig. 7.4.5. Digitized recordings based on the APA LP vertical component seismometer for the nuclear explosion at Novaya Zemlya on 10 August 1978. Note the high SNR in all the filter bands.

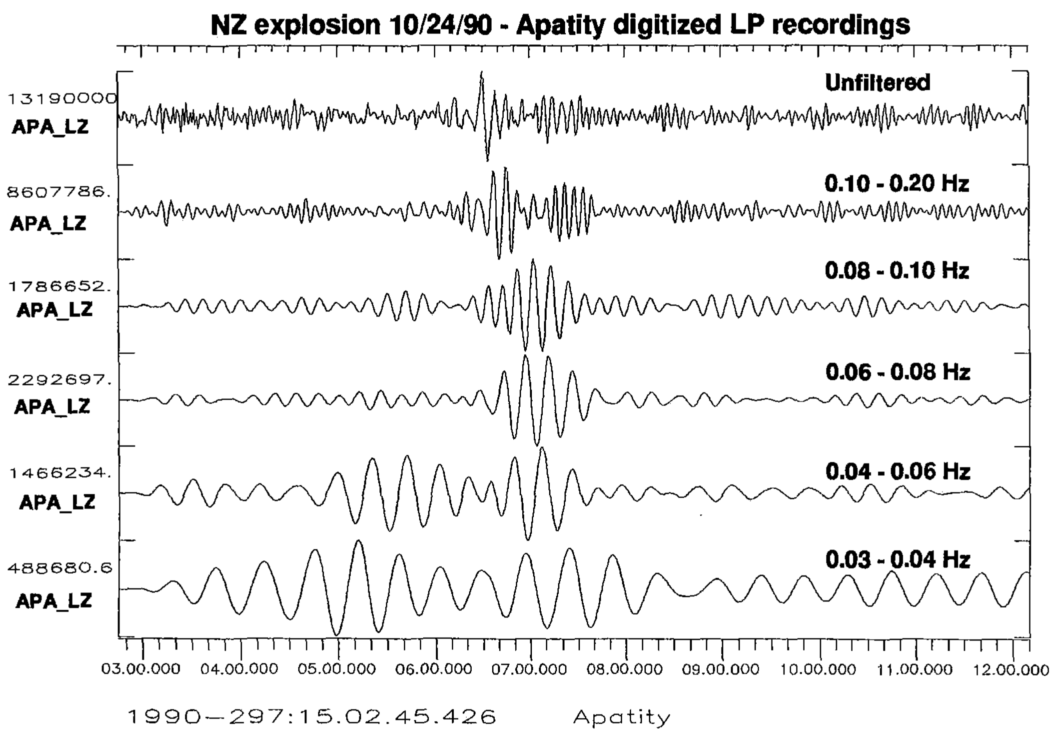


Fig. 7.4.6. Digitized recordings based on the APA LP vertical component seismometer for the nuclear explosion at Novaya Zemlya on 24 October 1990. Note the similarity to the explosion shown in Fig. 7.4.5.

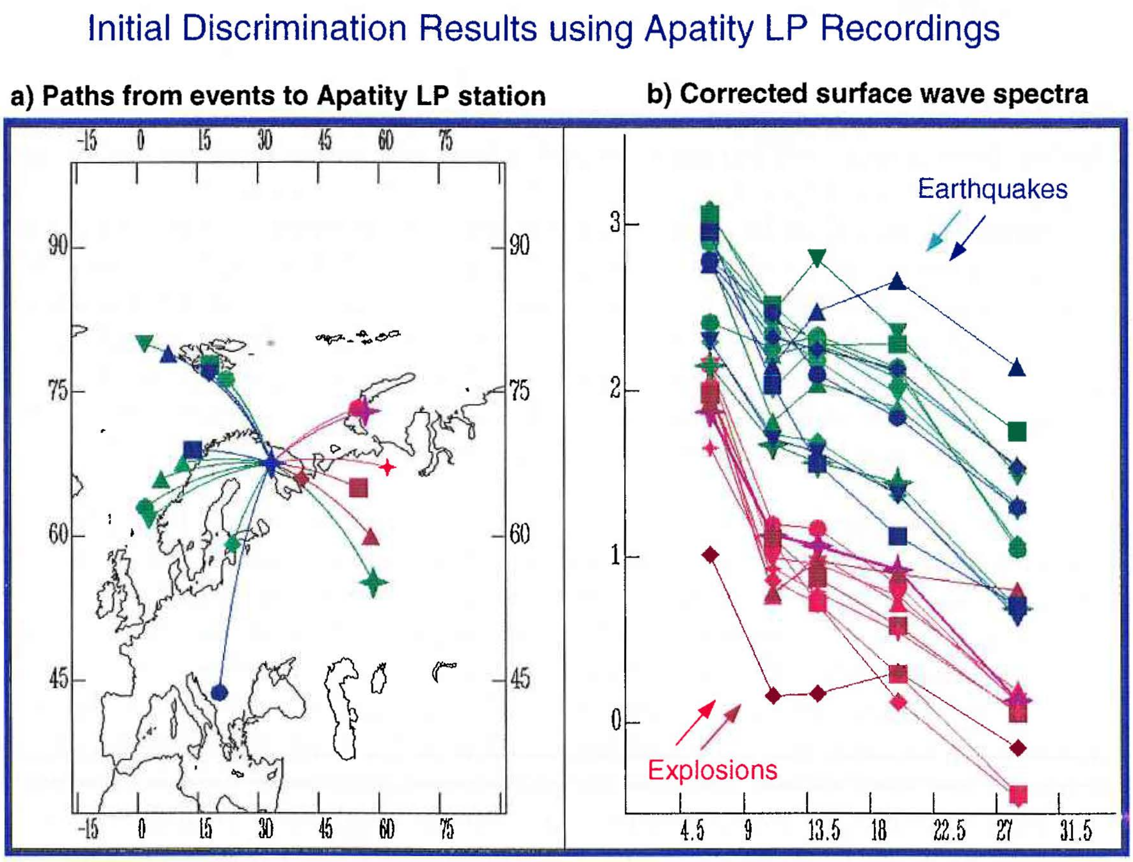


Fig. 7.4.7. Initial discrimination results using regional M_s:m_b for a data base of earthquakes and nuclear explosions with continental travel paths to the APA LP station. The left part shows the events and the travel paths to APA, whereas the right part shows surface wave spectral levels ranging from 5 to 30 second period. The spectral levels have been corrected for distance and body-wave magnitude as described in the text.

7.5 Tuning the automatic data processing for the Spitsbergen array (SPITS)

Introduction

The Spitsbergen array (SPITS) usually reports a large number of detections, which can easily exceed several thousand per day. A detailed analysis shows that these detections are real seismic signals mostly caused by small sources located at close distances. These local sources are mining induced events from a coal mining area near Longyearbyen on Spitsbergen and so-called icequakes, which means active faults and fissures in the ice of nearby glaciers or stepwise movements of these glaciers (*e.g.* Górski, 1997). Because SPITS was not designed for optimized detection and analysis of such signals, they are not properly handled by the current automatic data processing and cause many erroneous results. In this study we have developed new processing recipes for SPITS that make the automatic results more reliable.

The numerous local events (Fig. 7.5.2) typically show P onsets, no well defined S onsets, and dominant Rg onsets. Because of the short epicentral distances of these events (most of them can be located within 15 km of SPITS) the travel-time difference between P and Rg onsets is only a few seconds. The current automatic processing for SPITS data has difficulty separating these onsets and locating the events, because the time windows necessary for analyzing the onsets often contain a mixture of signals with different apparent velocities (Pg, Sg, and Rg). Additionally, the array was not designed to detect local Rg phases or to estimate the slowness vector for very slow arrivals. Using the known equations to calculate the array transfer function (*e.g.* Harjes and Henger, 1973) one can estimate the design limits of an array; *e.g.*, to measure the slowness vector of an Rg phase with an apparent velocity of 1.8 km/s and a dominant frequency of about 4 Hz, an array with a minimum distance between its single sites of 0.225 km would be needed. The distances between the A-ring sites of SPITS are of this order, but not the B-ring sites (Fig. 7.5.1). To analyze these data by using only the four A-ring sites would be possible, but this would clearly decrease the stability and resolution of the slowness-vector measurements. Some of these local events are so close that the concept of a plane wave crossing an array can no longer be used, and the single sites behave as a seismic network. With these local signals, SPITS is at the edge of its resolution and the automatic f-k analysis of onsets from such events can be influenced by aliasing effects due to the side-lobes of the array transfer function.

These problems lead to many unpredictable and erroneous results for an automatic parameter extraction of SPITS detections. The most critical parameters in this context are measurements of apparent velocity and azimuth, which are used to define the phase type and are needed during the association process to define seismic events. A high error rate in f-k results leads to a high rate of erroneous or artificial events and many unassociated onsets. This problem is the main reason why SPITS onsets are not yet implemented in the Generalized Beamforming (GBF, Ringdal and Kværna, 1989) processing at NORSAR, although SPITS data would be very helpful for identifying and locating seismic events north of Fennoscandia, in the Arctic Ocean, and especially in the Barents Sea.

A New Beam Set to Improve the Detection Process

SPITS is located on Mesozoic sediments, which are about 3 to 4 km thick in this part of Spitsbergen (Winsnes, 1988). The seismic velocities in these layers are much lower than below the well known arrays in Fennoscandia, and consequently the observed apparent velocities for onsets of local events are relatively low (*e.g.*, the observed apparent velocities for local Rg phases become as small as 1.5 km/s). Therefore, the beam deployment must be expanded to lower velocities. Before beamforming, all traces are prefiltered with a Butterworth band-pass filter between 0.4 and 18.0 Hz to reduce the influence of the microseisms, which often have high amplitudes so close to the open ocean. The beam parameters (apparent velocity and azimuth) were chosen such that the whole slowness space of interest is equally covered. After beamforming, the beams are filtered with different Butterworth band-pass filters to detect the signals in the frequency range with the highest signal-to-noise ratio (SNR). Table 7.5.1 shows the parameters of the new beamset for SPITS, which contains 254 different beams.

Some beams (SG01 - SG36 and SM01 - SM36) were designed to detect the Rg onsets from local events. Identification of these numerous onsets at an early stage helps to extract detections from more "interesting" ones. Therefore the update rate for calculating the SNR was minimized to detect these high amplitude Rg phases separately from their leading Pg onsets. This also results in a increased number of detections in the coda of "normal" onsets; however, this can be handled during the following association and location process.

Because SPITS is the Norwegian array located closest to the former nuclear test sites on Novaya Zemlya, a special set of beams optimized for this source region was also implemented (SN01 - SN10).

In Fig. 7.5.4 we compare the density distribution of SNR values for detections using the old and the new processing recipes. Only Sn values smaller than 20 are shown in the figure. The data interval spans 159 days from 11 April to 16 September 1998. The original detector had a total of 118852 detections during this time period, with 113039 below SNR = 20. The new detector had a total of 179440 detections with 159289 below SNR = 20. The improvement is particularly evident for lower SNR values. Although the new beam deployment uses a higher detection threshold and no incoherent beams, the number of detected onsets is significantly increased.

A still unsolved problem at SPITS is the large number of high SNR P detections from regional events without any corresponding detection of an S phase. Without a detected S phase, these events cannot be associated and located with RONAPP (Mykkeltveit and Bungum, 1984). Fig. 7.5.3 shows seismograms observed at the 3C site SPB4 of SPITS from an earthquake located at the Knipovich Ridge northwest of Svalbard at an epicentral distance of about 3°. In addition to the original horizontal components, the rotated radial and transverse components are also shown (at the bottom). The S onset has a low SNR and the signal is particularly weak for SV energy, which should be visible on the radial and vertical components.

Just detecting this S phase on one horizontal component would not help, because the corresponding SNR on the vertical components, which has to be used for an f-k analysis, is very low and therefore the f-k results become unreliable. Additionally, at all sites of SPITS we observe spikes in the data stream, such that a detector only running on one trace will have a relatively high false alarm rate. The best way to reduce the problem of these undetected S phases would be to install more horizontal components, so that horizontal beams could be calculated. The advantages of such beams have previously been demonstrated for other small aperture arrays like ARCESS, NORESS, and GERESS (Schweitzer, 1994).

Improving the f-k Analysis of Detected Phases

The problems discussed above influence the results from the automatic f-k analysis. We will in the following describe procedures for reducing the effect of these problems.

As mentioned above, we observe spikes which often cause false detections or disturbances of detected onsets. Most of these spikes are detected and automatically removed by the installed quality control system. However, not all spikes are detected and then they produce signal-like onsets with the pulse form of the response of the band pass filter used. The traces with the filtered spikes usually show much higher amplitudes than the undisturbed traces. Therefore, the data of all channels are checked for large amplitude deviations in the time window around the detected signal (*i.e.*, from 10 s before to 3 s after the detected onset time). If a maximum amplitude deviates more than a factor of 2.5 (smaller or larger) from the mean maximum amplitude, the data of this channel will not be used (masked) during the subsequent analysis of the detection.

Fig. 7.5.2 shows that the original amplitudes can vary by a factor of 3 between the single sites. Such amplitude variations also influence the f-k analysis. To reduce the influence of amplitude variations at the different sites, all traces are normalized to a common maximum amplitude in the time window used for the f-k analysis. However, the beam to measure the signal amplitude, dominant frequency, and onset time is calculated from non-normalized traces.

The positioning and length of the time window used for f-k analysis of the detected onset influences the f-k results and must be carefully selected. As described by Schweitzer (1994 and 1997), the optimum length of the time window can be estimated from the signal frequency band, the aperture of the array, and the largest slowness to be resolved. For SPITS the largest slowness SMAX is:

$$SMAX = \frac{1.666}{FK1}$$

when FK1 the lowest frequency used in the f-k analysis.

The time window for the f-k analysis should include the whole pulse form of the onset at all array sites. Because the onset time is given relative to the reference site of SPITS (SPA0), we need to introduce a lead time TN before the onset as the start time of the f-k analysis window. This is done to ensure that even for the arrivals with the largest slowness (smallest apparent velocity) the f-k analysis window includes the start of the signal at all array sites. For SPITS we get the relation:

$$TN = \frac{1}{2 \cdot SMAX}$$

The pulse length is initially set to 3 times the dominant period of the detected signal. For onsets detected on beams used with an apparent velocity below the local S velocity, this time length is set to 6 times the dominant period. The f-k window length is then estimated by adding this pulse length to TN. The final f-k window length is restricted to the range between 1.5 and 5 s, which are numbers derived from manual analysis of numerous signals.

Broadband f-k analysis usually provides quite stable results. However, the detection process sometimes needs narrow band filters to detect a signal. As shown for the Matsushiro array (Schweitzer, 1997) f-k analysis results can be improved by widening the frequency range as far as possible. Therefore, a systematic search for the widest frequency range with a usable SNR was implemented.

Prior to f-k analysis in the now broader frequency range, the data are band pass filtered in a pass band slightly wider than the frequency range to be used for f-k analysis (Schweitzer, 1994). After normalizing the amplitudes, defining the smallest resolvable apparent velocity, the length of the time window, and the best frequency band, all parameters for the following f-k analysis are now set.

Although the maximum elevation difference between the single sites of SPITS is only 140 m, the corresponding travel-time differences for waves with nearly vertical incidence can be in the same order as the travel-time differences caused by the horizontal distances between the sites. The reason for this is the low seismic velocities in the sediments below SPITS. To correct for this effect during the f-k analysis, we have to know the local velocity below the array. Therefore, the best local velocities for P and S waves were estimated by comparing the f-k results for a large number of onsets with a wide range of apparent velocities after correcting with different local velocities. Assuming that the result with the highest relative f-k power is the best one for a given onset, we found that the best velocity to correct for the elevation effect is 4.75 km/s for P waves and 3 km/s for S waves. For P and S phases from local events, similar apparent velocities are observed, *i.e.*, we observe at SPITS an overlap of observable apparent velocities of regional Sn onsets and local Pg onsets, which are different from what we observe on the European continent. The slowest local Pg phases observed at regional arrays in Europe have apparent velocities between 5.5 and 6.0 km/s and observed short-period Sn phases have apparent velocities below 5.0 km/s. To resolve this ambiguity for SPITS data, all f-k analyses are done twice: once using the P phase and once the S phase local velocity to correct for the elevation effect. If the measured apparent velocity of the onset is between 4.75 and 6.0 km/s, we choose the result with the highest relative f-k power: If this was obtained using the P velocity, the phase is assumed to be a local Pg, and if this was obtained using the S velocity, the phase is assumed to be an Sn phase. If in the latter case we obtain an apparent velocity higher than the local P velocity, the phase is labeled as "Spg", to indicate that this phase is presumably an Sn, and not a local Pg.

As mentioned above, SPITS detects numerous local Rg phases which have often been misinterpreted during the automatic processing. This is primarily due to the mixture of onsets with different apparent velocities and the mentioned aliasing effect. Since an onset time estimated from the detecting beam may not be the best reference time to identify such an Rg onset, the f-k analysis is repeated for a total of six time windows. These begin TN seconds prior to the following reference times:

1) estimated onset time from the detecting beam
2) detection time from detection process
3) 0.5 s after the detection time from the detecting beam
4) 1 s earlier than the detection time from the detecting beam
5) reestimated time when the SNR reaches its threshold value
6) time when the SNR has its maximum
7) a fixed time window of +/- 1.5 s around the detection time from the detecting beam

The analysis yielding the maximum relative f-k power is preferred, excluding any for which an apparent velocity below 3 km/s (*i.e.* Rg) with a relative f-k power larger than 0.35 was found.

We will in the following compare the results from the automatic data analysis of SPITS data using the new and the old recipes. The time interval processed is the 169 day period from 11 April through 26 September 1998.

Table 7.5.2 gives the number of the different phases detected and analyzed in this time period. Except for a more detailed phase naming convention in the new recipes, the major difference is that the old recipes produce a large amount of phases with a measured apparent velocity lower than 3 km/s. These phases are called "noise" and are not further used. In the new recipes, most of these onsets are now identified as Rg. The new recipes declare as "noise" phases with an apparent velocity lower than 1.3 km/s. As mentioned, Sn phases with apparent velocities larger than the local P velocity are called Spg. They are now separated from the local Pg onsets, and can both be used to locate events. The distribution of estimated apparent velocities in Fig. 7.5.5 shows a similar result. The peak at 1 km/s disappears, and a new peak around 5 km/s represents local Pg phases, which can be used to locate these local events if a corresponding Rg (or Sg) is also observed.

The source of many of the Rg onsets (*i.e.* apparent velocities below 3 km/s) can be explained with Fig. 7.5.6, where the azimuthal distribution of these Rg phases is plotted in a rose diagram on a local map of SPITS at the position of the array. Clearly seen are distinct directions with more (longer bars) or less (shorter bars) Rg observations. To get a readable figure, the bars to the southwest in direction to the coal mine area at about 8 km distance (blue star) are truncated at about half of their lengths. We observe a strong correlation between the number of Rg phases and the azimuth at nearby glaciers (grey-blue areas). The distance to the closest glacier is about 3 km to the south.

The relative f-k power measures the coherency of the signal and is therefore a measurement of the quality of the f-k results. Fig. 7.5.7 compares the relative f-k power of body wave onsets for both sets of recipes. With the new recipes the phases with low f-k power below 0.2 are removed, and the new additional phase detections usually have high f-k power, providing well defined onsets. In Fig. 7.5.8 the relative f-k power results for the Rg phases are compared. Again, the large number of onsets with low f-k power disappear and the increased number of Rg observations for the new recipes in most cases have a relative f-k power larger than 0.35.

Conclusions

In conclusion, the new recipes for automatic analysis of SPITS data clearly increase the quality of all estimated parameters. That these new parameters are also useful as input for the automatic location processing (RONAPP) is demonstrated with the last two figures. Fig. 7.5.9 shows a map with all events automatically located with the results from processing with the old recipes during the 169 day period from 11 April through 26 September 1998. Notice the large number of events scattered all over the map. In addition, more than 12% of the 11638 located events were located outside the borders of this map. After slight modifications of the RONAPP recipes to handle the results from the new signal processing recipes, a parallel event association and location process was also installed. Fig. 7.5.10 shows a map with 12175 located events using the new results. The decrease in the scatter is obvious, only 2% of all located events fall outside of the map and the well know seismicity pattern around and on Svalbard (*e.g.* Lindholm (1995) or Górski (1997)) is reproduced.

Starting from detection over signal analysis to the final location process, this paper shows the advantages of the new set of recipes for an automatic analysis of SPITS data. After implementing these new processing, SPITS onsets can now be included more easily in the GBF process for network phase association and event location and will most likely help to improve the event detection capability for the Arctic.

J. Schweitzer

References

Górski, M. (1997): Seismicity of the Hornsund region, Spitsbergen: icebreaks and earthquakes. Publications of the Institute of Geophysics, Polish Academy of Sciences **B-20(308)**, 76 pp.

Harjes, H.-P. and M. Henger (1973). Array-Seismologie. Zeitschrift für Geophysik **39**, 865-905.

Lindholm, C. (1995): Analysis of data recorded at the Spitsbergen array. In: NORSAR Semiannual Tech. Summ. 1 April - 30 September 1995, NORSAR Sci. Rep. **1-95/96**, Kjeller, Norway, 79-88.

Mykkeltveit, S. and Bungum, H. (1984): Processing of regional seismic events using data from small-aperture arrays. Bull. Seism. Soc. Amer. **79**, 1927-1940.

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

Schweitzer, J. (1994). Some improvements of the detector / SigPro - system at NORSAR. In: NORSAR Semiannual Tech. Summ. 1 October 1993 - 31 March 1994, NORSAR Sci. Rep. **2-93/94**, Kjeller, Norway, 158-163.

Schweitzer, J. (1997). Recommendations for improvements in the PIDC processing of Matsushiro (MJAR) array data. In: NORSAR Semiannual Tech. Summ. 1 April - 30 September 1997, NORSAR Sci. Rep. **1-97/98**, Kjeller, Norway, 128-141.

Winsnes, T. (1988): Bedrock map of Svalbard and Jan Mayen, Norsk Polarinstitutt, **Temakart Nr. 3**.

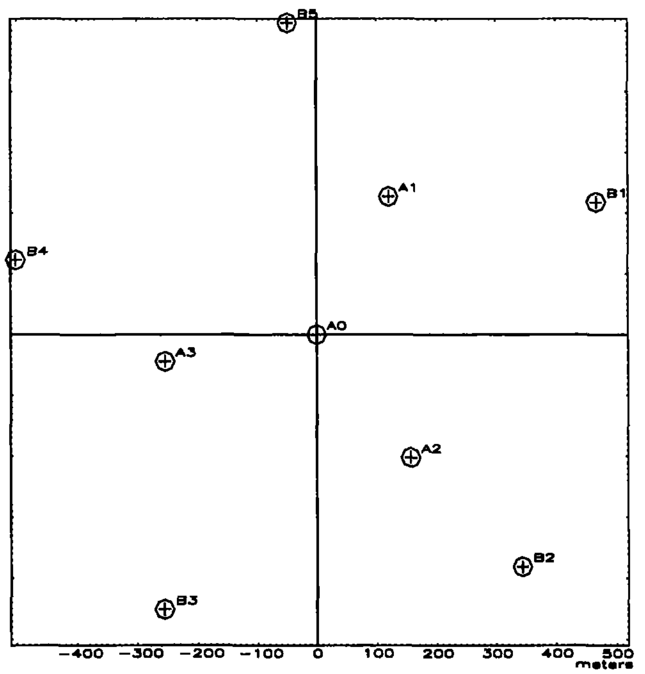
TABLE 7.5.1. The new beamset for the SPITS array. THR is the SNR threshold used to define a detection and "all" means that the whole SPITS array (SPA0, SPA1, SPA2, SPB1, SPB2, SPB3, SPB4, and SPB5) is used to form this beam.

BEAM NAMES	VELOCITY [km/s]	AZIMUTH [°]	Filter		THR	SITES (*verticals only*)
			bandwidth [Hz]	order		
S001	99999.9	0.0	0.8 - 2.0	4	4.5	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
S002	99999.9	0.0	0.8 - 2.0	4	4.5	all
S003	99999.9	0.0	1.0 - 3.0	3	4.5	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
S004	99999.9	0.0	1.0 - 3.0	3	4.5	all
S005	99999.9	0.0	2.0 - 4.0	3	4.0	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
S006	99999.9	0.0	2.0 - 4.0	3	4.0	all
S007	99999.9	0.0	3.0 - 5.0	3	4.0	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
S008	99999.9	0.0	3.0 - 5.0	3	4.0	all
S009	99999.9	0.0	0.9 - 3.5	4	4.5	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
S010	99999.9	0.0	0.9 - 3.5	4	4.5	all
S011	99999.9	0.0	1.0 - 4.0	3	4.5	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
S012	99999.9	0.0	1.0 - 4.0	3	4.5	all
SA01 - SA04	10.0	0 90 180 270	1.0 - 3.0	3	4.5	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
SA05 - SA08	10.0	45 135 225 315	1.0 - 3.0	3	4.5	all
SA09 - SA12	10.0	0 90 180 270	2.5 - 4.5	3	4.0	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
SA13 - SA16	10.0	45 135 225 315	2.5 - 4.5	3	4.0	all
SA17 - SA20	10.0	0 90 180 270	4.0 - 8.0	3	4.0	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
SA21 - SA24	10.0	45 135 225 315	4.0 - 8.0	3	4.0	all
SA25 - SA28	10.0	0 90 180 270	3.0 - 6.0	3	4.0	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
SA29 - SA32	10.0	45 135 225 315	3.0 - 6.0	3	4.0	all
SB01 - SB04	7.0	0 90 180 270	1.0 - 4.0	3	4.5	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
SB05 - SB08	7.0	45 135 225 315	1.0 - 4.0	3	4.5	all
SB09 - SB12	7.0	0 90 180 270	3.0 - 6.0	3	4.0	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
SB13 - SB16	7.0	45 135 225 315	3.0 - 6.0	3	4.0	all
SB17 - SB20	7.0	0 90 180 270	5.0 - 10.0	3	4.0	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
SB21 - SB24	7.0	45 135 225 315	5.0 - 10.0	3	4.0	all
SC01 - SC04	5.0	0 90 180 270	1.0 - 4.0	3	4.5	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
SC05 - SC08	5.0	45 135 225 315	1.0 - 4.0	3	4.5	all
SC09 - SC12	5.0	0 90 180 270	3.5 - 5.5	3	4.0	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
SC13 - SC16	5.0	45 135 225 315	3.5 - 5.5	3	4.0	all
SC17 - SC20	5.0	0 90 180 270	5.0 - 10.0	3	4.0	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
SC21 - SC24	5.0	45 135 225 315	5.0 - 10.0	3	4.0	all
SC25 - SC28	5.0	0 90 180 270	8.0 - 16.0	3	4.0	SPA0 SPB1 SPB2 SPB3 SPB4 SPB5
SC29 - SC32	5.0	45 135 225 315	8.0 - 16.0	3	4.0	all
SD01 - SC08	4.0	0 45 90 135 180 225 270 315	0.9 - 3.5	4	4.5	all
SD09 - SC16	4.0	0 45 90 135 180 225 270 315	3.0 - 6.0	3	4.0	all

BEAM NAMES	VELOCITY [km/s]	AZIMUTH [°]	Filter		THR	SITES (verticals only)
			bandwidth [Hz]	order		
SD17 - SC24	4.0	0 45 90 135 180 225 270 315	4.0 - 8.0	3	4.0	all
SE01 - SE08	3.3	0 45 90 135 180 225 270 315	1.5 - 3.5	3	4.5	all
SE09 - SE16	3.3	0 45 90 135 180 225 270 315	3.0 - 6.0	3	4.0	all
SE17 - SE24	3.3	0 45 90 135 180 225 270 315	5.0 - 10.0	3	4.0	all
SF01 - SF08	2.5	0 45 90 135 180 225 270 315	1.0 - 4.0	3	4.5	all
SF09 - SF16	2.5	0 45 90 135 180 225 270 315	2.0 - 4.0	3	4.0	all
SF17 - SF24	2.5	0 45 90 135 180 225 270 315	3.0 - 5.0	3	4.0	all
SN01	8.4	97.6	2.0 - 4.0	3	3.7	all
SN02	8.4	97.6	3.0 - 5.0	3	3.7	all
SN03	8.4	97.6	4.0 - 8.0	3	3.7	all
SN04	8.4	97.6	6.0 - 12.0	3	3.7	all
SN05	8.4	97.6	8.0 - 16.0	3	3.7	all
SN06	4.7	97.6	2.0 - 4.0	3	3.7	all
SN07	4.7	97.6	3.0 - 5.0	3	3.7	all
SN08	4.7	97.6	4.0 - 8.0	3	3.7	all
SN09	4.7	97.6	6.0 - 12.0	3	3.7	all
SN10	4.7	97.6	8.0 - 16.0	3	3.7	all
SG01 - SG12	2.0	0 30 60 90 120 150 180 210 240 270 300 330	1.5 - 3.5	3	4.5	all
SG13 - SG24	2.0	0 30 60 90 120 150 180 210 240 270 300 330	2.5 - 4.5	3	4.0	all
SG25 - SG36	2.0	0 30 60 90 120 150 180 210 240 270 300 330	3.5 - 5.5	3	4.0	all
SM01 - SM12	1.7	0 30 60 90 120 150 180 210 240 270 300 330	1.0 - 3.0	3	4.5	all
SM13 - SM24	1.7	0 30 60 90 120 150 180 210 240 270 300 330	2.0 - 4.0	3	4.0	all
SM25 - SM36	1.7	0 30 60 90 120 150 180 210 240 270 300 330	3.0 - 6.0	3	4.0	all

TABLE 7.5.2. Number of onsets analyzed by the old and the new signal processing recipes during the compared time period (DOY 101 - DOY 269, 1998).

PHASE	OLD	NEW
all data	137 963	193 923
PKP	-	574
P	19 497	12 279
Pn	-	6 773
Pgn	57 333	25 360
Pg	-	38 985
S / Sn	11 691	5 208
Spg	-	4 449
Sg (Lg)	-	8 772
Rg	-	87 557
"noise"	49 442	3 965



Site	X east	Y north	Z height
SPLA0_sz	0	0	323
SPLA1_sz	120	227	320
SPLA2_sz	157	−202	250
SPLA3_sz	−254	−44	339
SPLB1_sz	467	218	301
SPLB2_sz	344	−381	200
SPLB3_sz	−255	−451	234
SPLB4_sz	−501	123	340
SPLB5_sz	−49	513	295

Fig. 7.5.1. Configuration of the Spitsbergen array (SPITS). The horizontal distances are measured in [meters] with respect to the reference site SPA0 and the elevations are given in [meters] above the sea level.

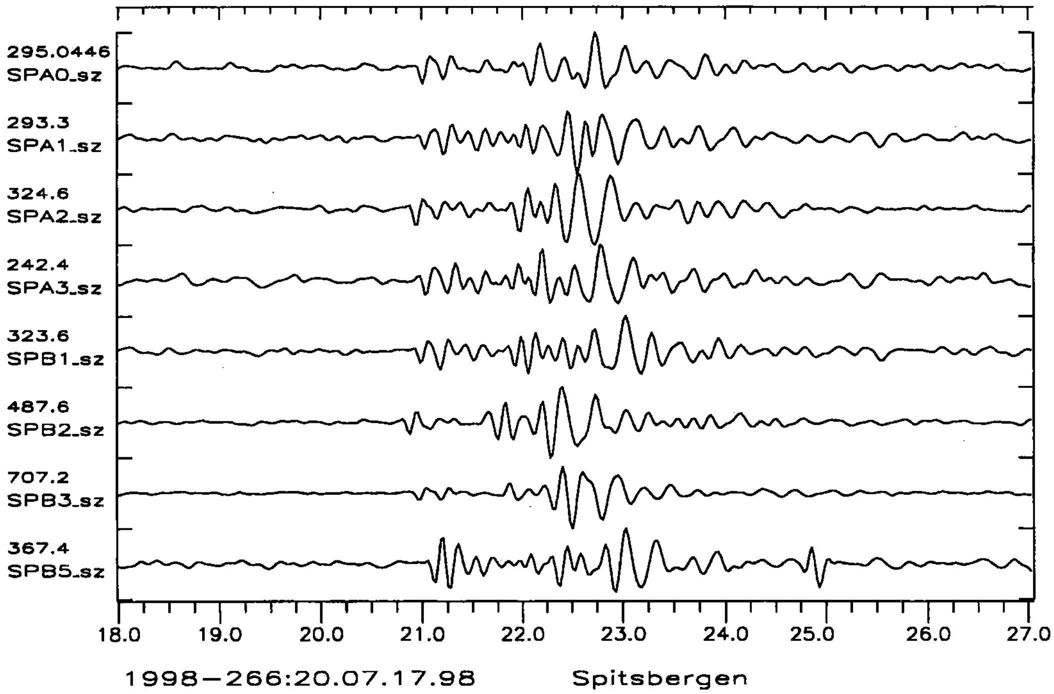


Fig. 7.5.2. Example of an "icequake" observed at SPITS and located in the glacier Gløttfjellbreen (azimuth = 141°, Δ = 4 km). Shown are band pass (3 - 8 Hz) filtered vertical seismograms.

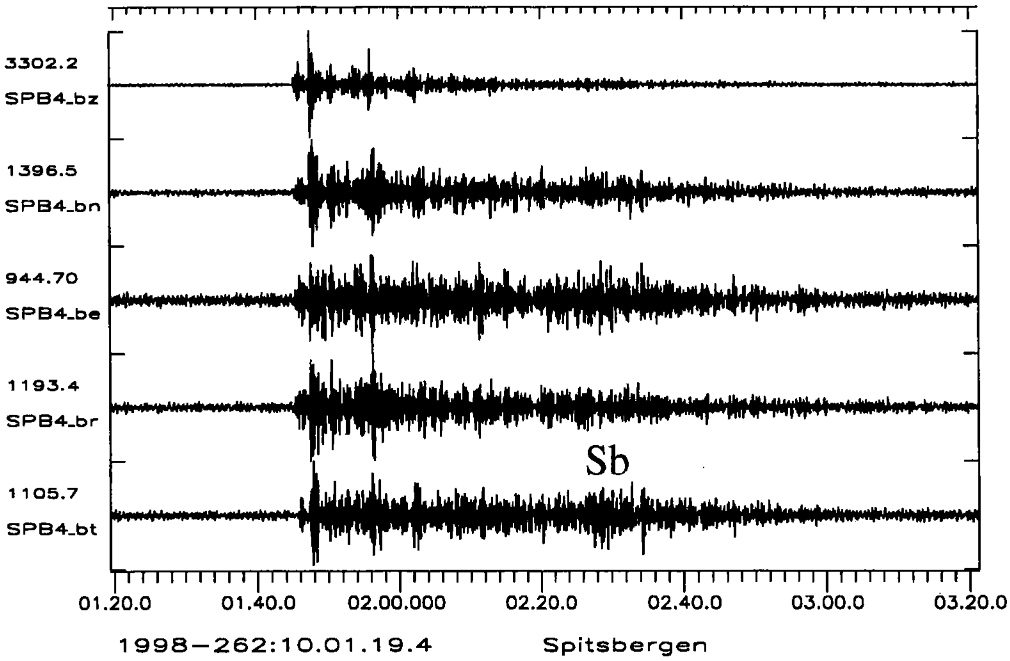


Fig. 7.5.3. Seismograms of a regional event observed with the broadband 3C site SPB4. Note the increased SNR for the Sb onsets on the transverse component (SPB4_bt). The data were band pass filtered (3 - 6 Hz); the azimuth to rotate the horizontals was 312°.

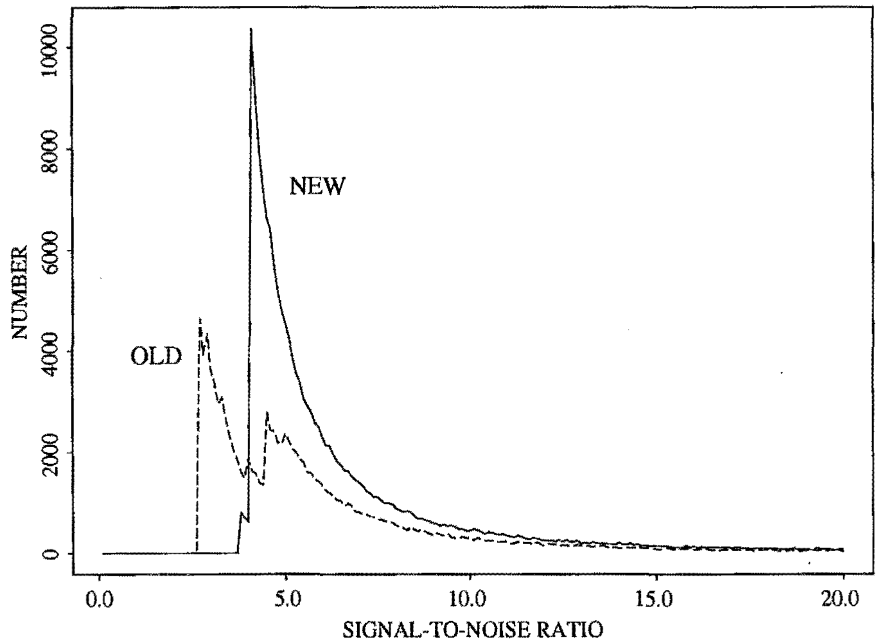


Fig. 7.5.4. Distribution of observed SNR values (SNR < 20) for the old (broken line) and the new SPITS beam deployment.

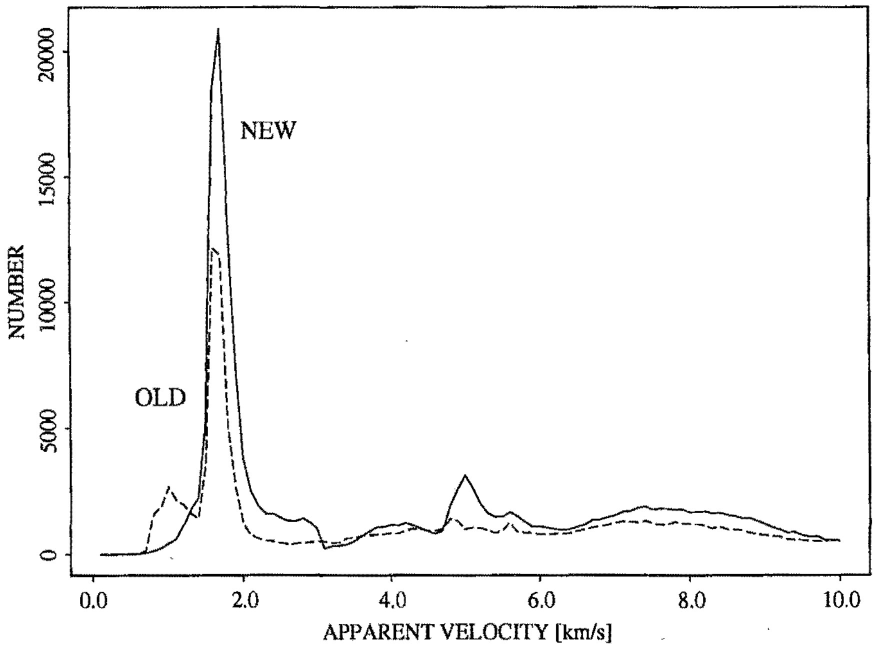


Fig. 7.5.5. Distribution of observed apparent velocities for local and regional phases for the old (broken line) and new SPITS analysis recipes.

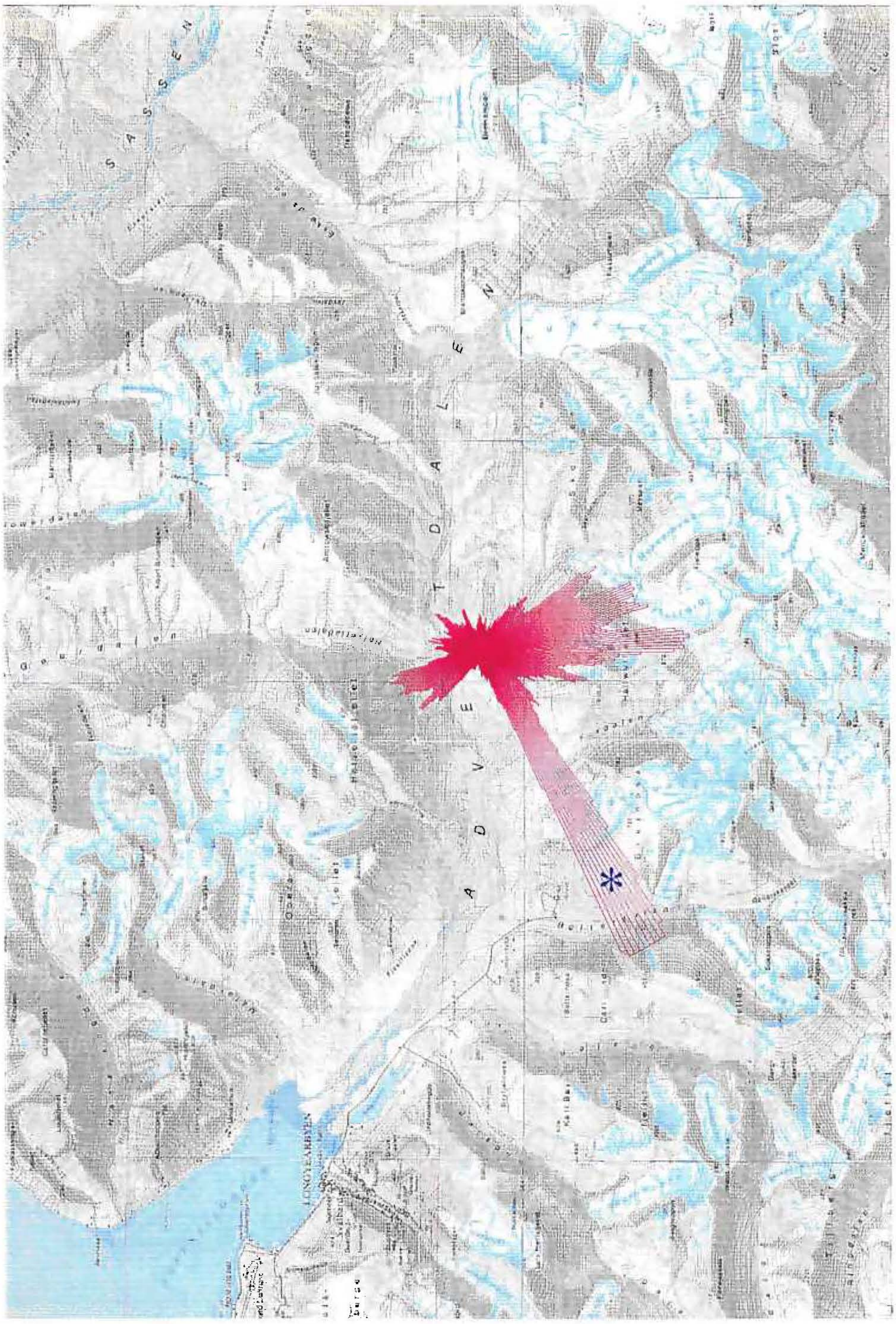


Fig. 7.5.6. Map with the area around SPITS and a rose diagram for 90228 observed local phases (apparent velocity < 3 km/s, DOY 101 to DOY 269, 1998) to show the relative azimuth distribution of these onsets. The center of the rose diagram is plotted at the center of the array. The graph for the large amount of phase observations from mining induced events (blue star) in the southwest direction was truncated at about half of its length. Note: the shorter the distance to a glacier (grey areas), the larger the number of observed Rg phases. The scale of the map is approximately 1 : 220 500.

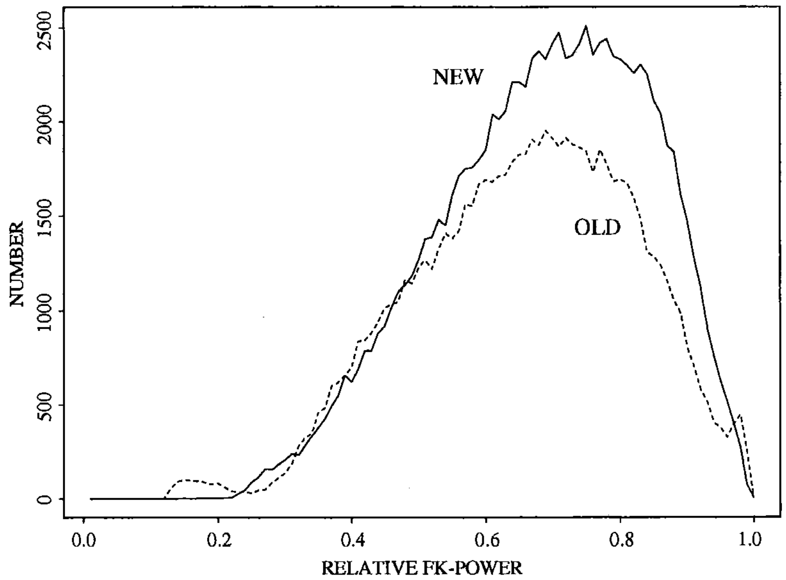


Fig. 7.5.7. Distribution of relative f-k power results for the old (broken line) and the new recipes for onsets with an apparent velocity > 3.0 km/s.

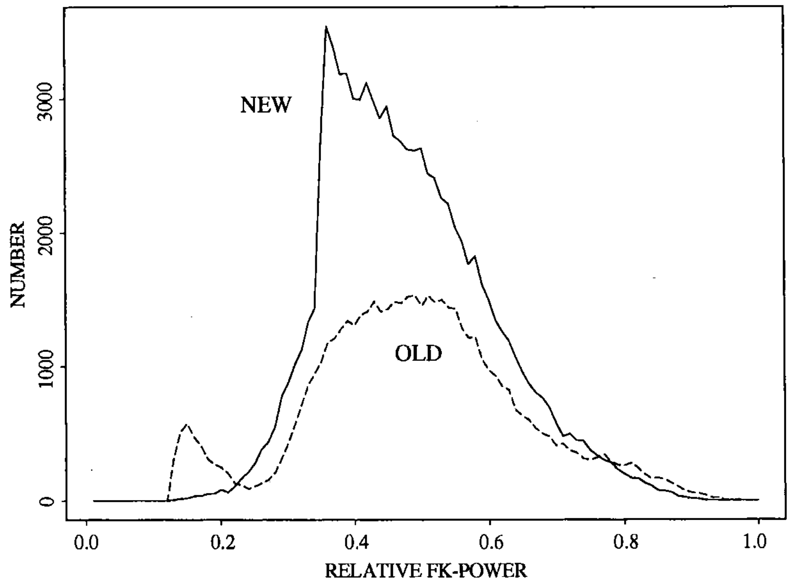


Fig. 7.5.8. Distribution of relative f-k power results for the old (broken line) and the new recipes for onsets with an apparent velocity <= 3.0 km/s.

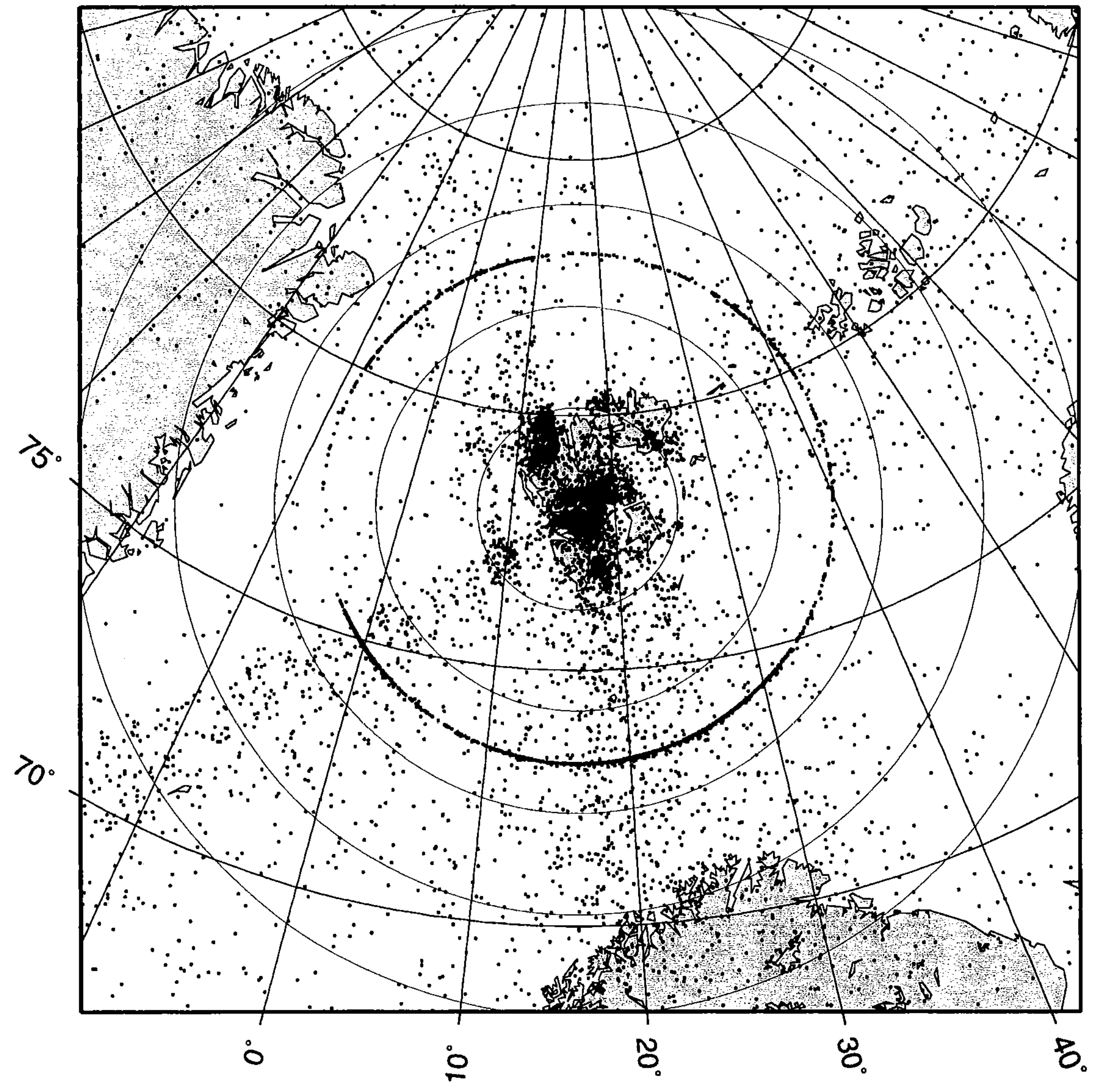


Fig. 7.5.9. SPITS single array located events using the old recipes during the 169 day period from 11 April through 26 September 1998. From the altogether 11 638 located events more than 12% were located outside this map. The circles around SPITS are at 2°, 4°, 6°, 8°, and 10° epicentral distances. The circle of events at about 5° is an artifact of an error in the old recipes.

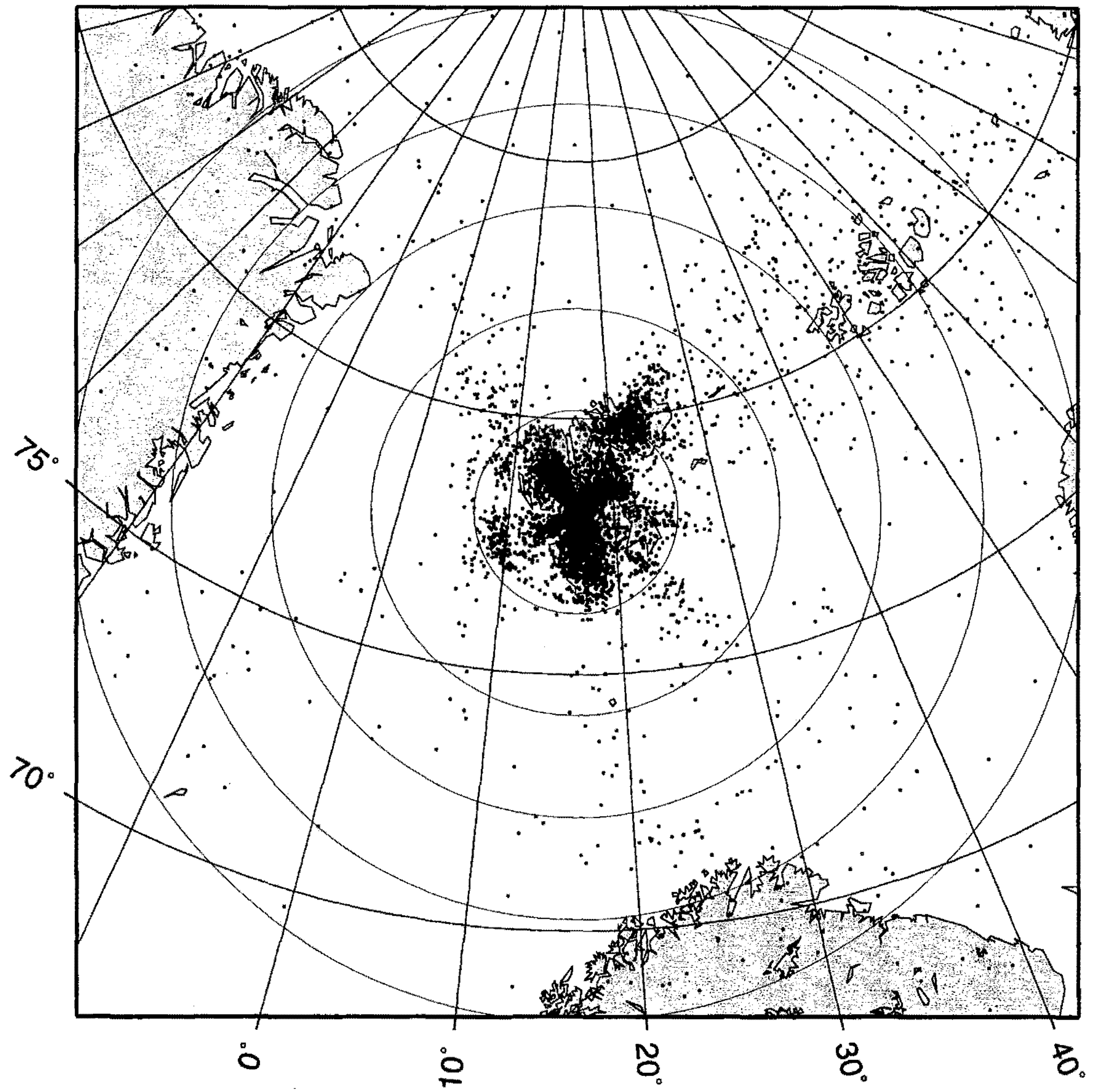


Fig. 7.5.10. SPITS single array located events using the new recipes during the 169 day period from 11 April through 26 September 1998. From the altogether 12 175 located events less than 2% were located outside this map. The circles around SPITS are at 2°, 4°, 6°, 8°, and 10° epicentral distances.

7.6 Monitoring of the Indian underground nuclear tests of May 1998

This work is conducted under contract DSWA01-97-C-0128

We have investigated the capability of the International Monitoring System (IMS) to monitor the Indian nuclear test site. Our approach has been to use the IMS stations with the best detection capability for this region which, in practice, determine the monitoring capability of the full IMS network. We have therefore based our investigation on data from the eleven IMS stations shown in Fig.7.6.1, which all had high SNRs for the 11 May 1998 Indian underground nuclear test. The IMS location of this event is given in Table 7.6.1.

Table 7.6.1. Event information from the REB

Origin time	Lat	Lon	Depth	m_b	Nsta	Region
1998/05/11 10:13:44.2	27.0716	71.7612	0.0	5.0	50	India-Pakistan Border Reg.

The IMS auxiliary station in Nilore, Pakistan (NIL), located 6.7 degrees away from the Indian test site, provided the P-phase with the highest SNR (937.4) for this event. NIL was the only IMS station located within regional distances, and the vertical-component recording of the Indian test is shown in Fig. 7.6.2. The highest SNR relative to the background noise level was found between 1 and 2 Hz for both the P and the Lg phase, and this filter was used prior to the calculation of STA traces. A 1.5 second STA length was used for P, and for the longer duration Lg phase an STA length of 8 seconds was used.

The remaining 10 stations used for monitoring were all located at teleseismic distances, and only P-phases were considered for calculation of the magnitude thresholds. The list of stations, and the TM processing parameters derived from the recordings of the 11 May 1998 explosion are given in Table 7.6.2.

Table 7.6.2. TM Processing Parameters Derived from the Recordings of the 11 May 1998 Indian Nuclear Test

Station	Distance (deg)	Phase	SNR in REB	Theo. ray parameter (s/deg)	Obs. slowness (s/deg)	Obs. back azimuth (s/deg)	Freq. band (Hz)	STA length	Travel time	Mag. calib.	St. dev of calib.
NIL	6.68	P	937.4	13.73	-	-	1.0 - 2.0	1.5	102.1	1.67	0.15
-	-	Lg	(3.8)	33.04	-	-	1.0 - 2.0	8.0	223.2	2.20	0.15
NRIS	43.05	P	191.1	8.10	-	-	2.0 - 4.0	3.0	482.0	3.90	0.15
FINES	45.87	P	80.3	7.90	7.34	120.37	2.0 - 4.0	3.0	505.3	3.73	0.15
GERES	49.39	P	43.3	7.65	6.95	95.05	1.0 - 2.0	1.5	532.4	4.16	0.15
ARCES	50.16	P	182.6	7.59	7.53	125.88	2.0 - 4.0	3.0	538.9	3.51	0.15
HFS	51.10	P	56.0	7.52	5.83	121.7	2.0 - 4.0	2.0	544.7	3.70	0.15
BGCA	55.19	P	174.0	7.23	-	-	1.5 - 3.5	2.0	576.1	3.87	0.15
SPITS	56.81	P	190.0	7.11	9.38	124.59	2.5 - 5.0	2.5	587.8	3.98	0.15
ASAR	78.39	P	199.3	5.53	5.67	307.3	1.0 - 3.0	2.5	724.6	4.03	0.15
ILAR	83.65	P	157.0	5.12	3.93	323.11	1.0 - 3.0	2.5	750.8	3.98	0.15
YKA	90.60	P	238.0	4.65	5.02	349.59	1.5 - 3.0	2.5	785.8	4.94	0.15

Fig. 7.6.3 shows the results from site-specific threshold monitoring of a five-hour time interval around the 11 May 1998 Indian nuclear test, using the processing parameters derived from the nuclear test itself. The top trace shows the combined network thresholds, and the following seven traces show the thresholds derived from each of seven selected stations (P-phase only). Notice the enhanced monitoring capability when NIL data are available.

The time tolerances were set to accommodate a target area with a radius of 25 km around the explosion site. Several distinct peaks are seen on the threshold traces for the individual arrays, but for the network trace the only significant peak corresponds to the nuclear test. With available NIL data, the 90% magnitude thresholds during noise conditions vary around m_b 2.4. For time intervals without available NIL data, the magnitude thresholds increase to about m_b 2.9. We would also like to emphasize that the peak on the network threshold trace caused by the nuclear test has a value that is slightly lower than the actual event magnitude. In cases when an event occurs in the target region, the threshold calculations should be replaced by the maximum likelihood estimate of the event magnitude.

According to the Indian authorities, two explosions of 0.5 and 0.3 kt took place on 13 May 1998, with origin time 06:51 GMT. No signals were detected by the IMS stations, and we have calculated the magnitude threshold (90% upper magnitude limit) of the reported event, using the processing parameters derived from the Indian test of 11 May 1998.

Fig. 7.6.4 shows magnitude thresholds for a four-hour time interval around the announced nuclear test, using different combinations of stations. The middle trace shows the magnitude threshold calculated from all the stations listed in Table 7.6.2. From this trace we read that the reported event had an upper magnitude limit of m_b 2.4. Except for a small peak at 07:08, caused by a P-phase at NIL from an m_b 4.5 event in Java, Indonesia, the upper magnitude limit stays below m_b 2.5 for a long time interval around the reported origin time.

The magnitude thresholds calculated from NIL data only are shown in the upper trace of Fig. 7.6.4. When comparing this trace to the magnitude thresholds calculated from all stations, shown in the middle trace, we see practically no lowering of the magnitude thresholds. This implies that during background noise conditions, NIL data alone can effectively be used to place an upper magnitude limit on possible events located at the Indian test site. However, if interfering events occur, especially local events near NIL, but at sites different from the target site, the remaining stations will provide important contributions to lowering the thresholds.

The lower trace of Fig. 7.6.4 shows the magnitude thresholds calculated without using data from NIL. With this teleseismic station configuration, an upper magnitude limit of m_b 2.9 can be placed on the reported event.

The TM processing parameters derived from the 11 May 1998 Indian nuclear test can also be used for continuous assessment of the detection capability of the network. For the same four-hour interval around the announced Indian test of 13 May 1998, we have estimated the three-station detection capability of the network. An SNR of 4 was required for detection, and the capabilities were estimated at the 90% probability level.

The upper trace of Fig. 7.6.5 shows the detection capability of all stations listed in Table 7.6.2, and we find for the four-hour interval values slightly below m_b 3.5. The detection capability without the use of NIL data (teleseismic data only) is shown in the lower trace, and we find values slightly above m_b 3.5. This small difference is not surprising, since the three-station detection capability is effectively dependent on the 3rd best station. One additional good station may not make much difference.

Conclusions

From observations of the 11 May 1998 Indian nuclear test we have derived optimum processing parameters for the eleven IMS stations assumed to have the best detection capability for the Indian test site. Our results can be summarized as follows:

- The magnitude threshold of the current IMS primary network for the Indian test site is around m_b 2.9 during normal noise conditions. The stations of this network are located at teleseismic distances from the test site.
- During background noise conditions, regional data from the Nilore (NIL) station alone provides magnitude threshold of about m_b 2.4 for the Indian test site. Supplementing NIL data with data from the other teleseismic IMS stations does not lower the magnitude thresholds during normal noise conditions, but is important if interfering events occur.
- During background noise conditions, the IMS three-station detection capability vary around m_b 3.5, both with and without the use of NIL data. This illustrates that supplementing a network with one additional good station does not necessarily improve significantly the three-station detection capability of the network.

The upper magnitude limit of the announced Indian nuclear test of 13 May 1998 is estimated at:

- m_b 2.4 using NIL data (distance 700 km) either alone or in combination with teleseismic IMS data
- m_b 2.9 using teleseismic IMS data only

Except for a small threshold peak caused by a P-phase at NIL from an m_b 4.5 event in Java, Indonesia, the upper magnitude limit stays below m_b 2.5 for several hours around the reported origin time of the 13 May 1998 event.

T. Kværna
F. Ringdal
J. Schweitzer
L. Taylor

References

Schweitzer, J. F. Ringdal and J. Fyen, 1998. The Indian nuclear explosions of 11 and 13 May 1998. *Semiannual Technical Summary 1 October 1997 - 31 March 1998*, NORSAR Sci. Rep. 2 -97-98, Kjeller, Norway.

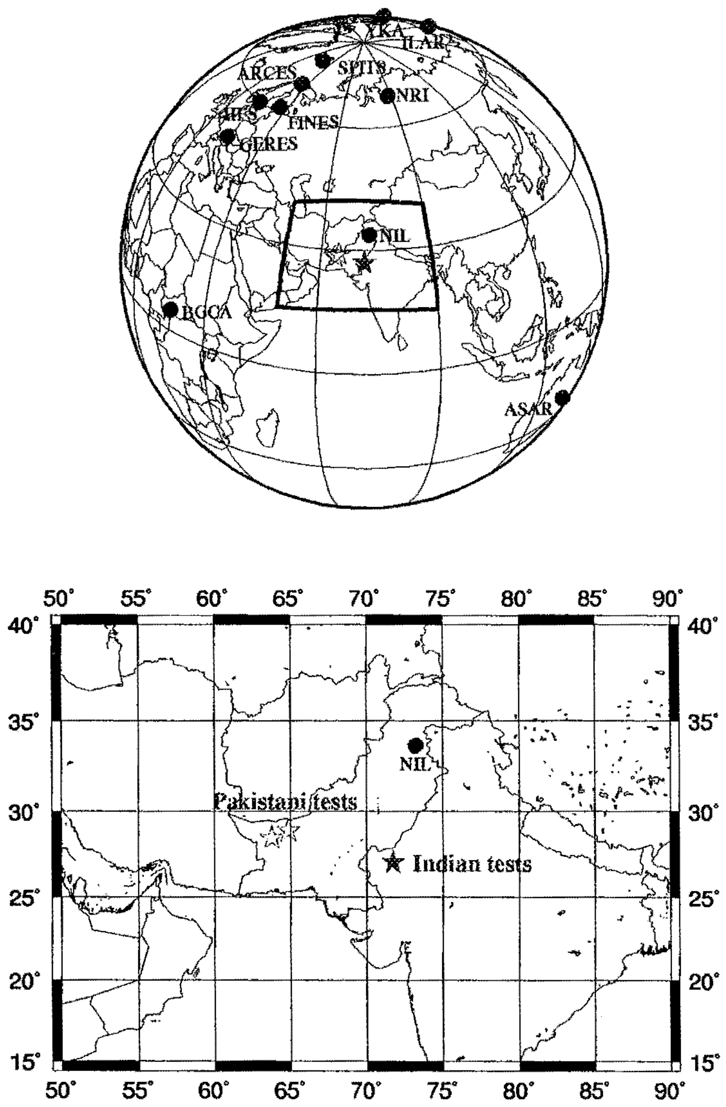


Fig. 7.6.1. The upper map shows the locations of the stations used for threshold monitoring of the Indian nuclear test site. The area within the rectangle is expanded in the lower map, where the filled star indicates the location of the Indian explosions, and the open stars indicate the location of the Pakistani explosions of 28 May and 30 May 1998.

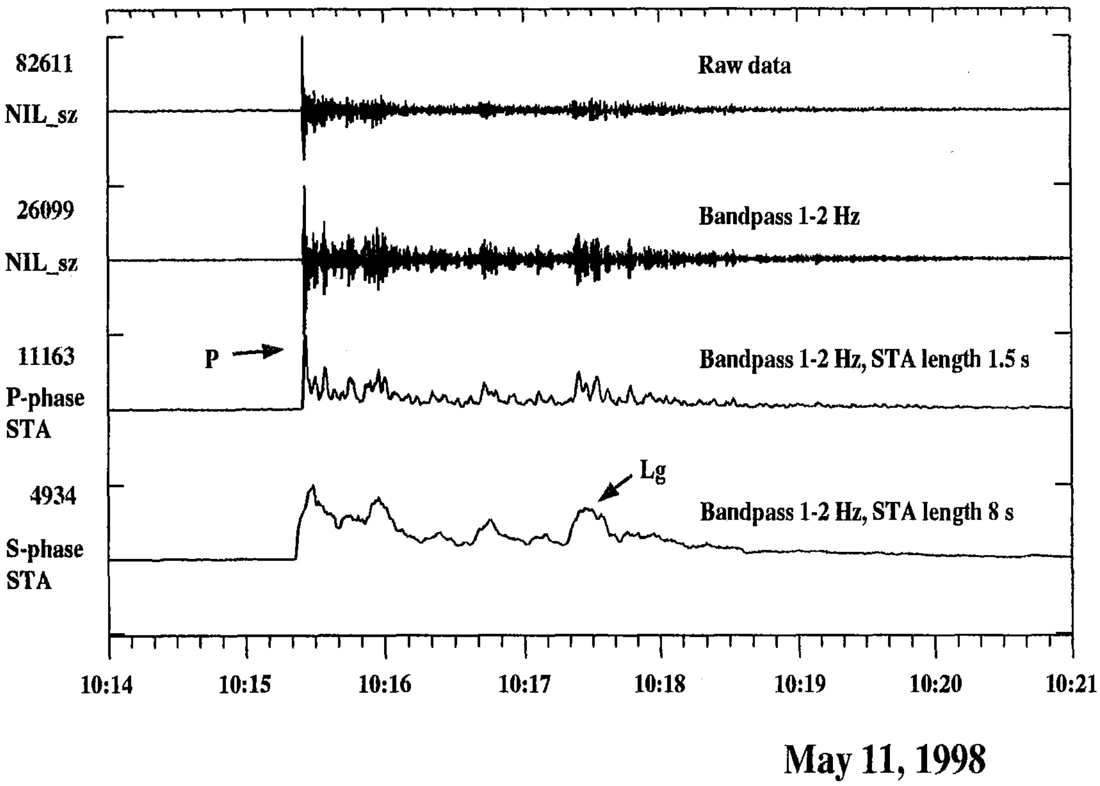


Fig. 7.6.2. Panel showing Nilore recording of the Indian nuclear test of 11 May 1998. The upper trace shows the raw data of the vertical-component sensor, and the second trace shows the same data filtered in the band 1-2 Hz. The two lower traces show the STA traces used for representing the amplitudes of the P and Lg phases. Notice that different STA lengths were used for P and Lg.

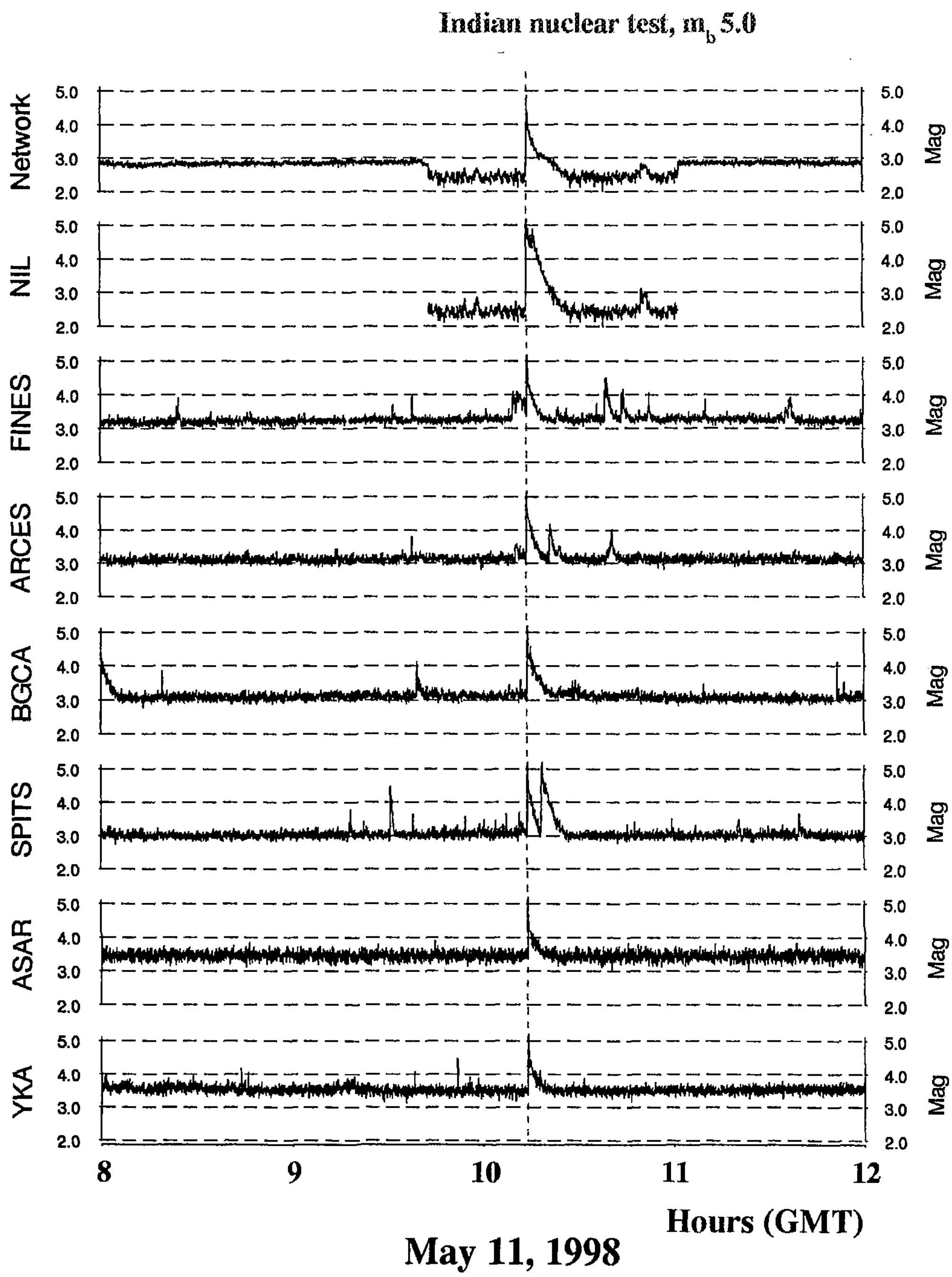


Fig. 7.6.3. Site-specific Threshold Monitoring of a 5-hour time interval around the Indian nuclear test, using the processing parameters given in Table 7.6.2. The plot shows the individual P-phases (STA traces) for 7 selected stations, with the combined network threshold trace on top. The time tolerances were set to accommodate a target area with a radius of 25 km around the explosion site. Notice the improved monitoring capability when NIL data are available. The only significant peak on the network threshold trace corresponds to the nuclear test.

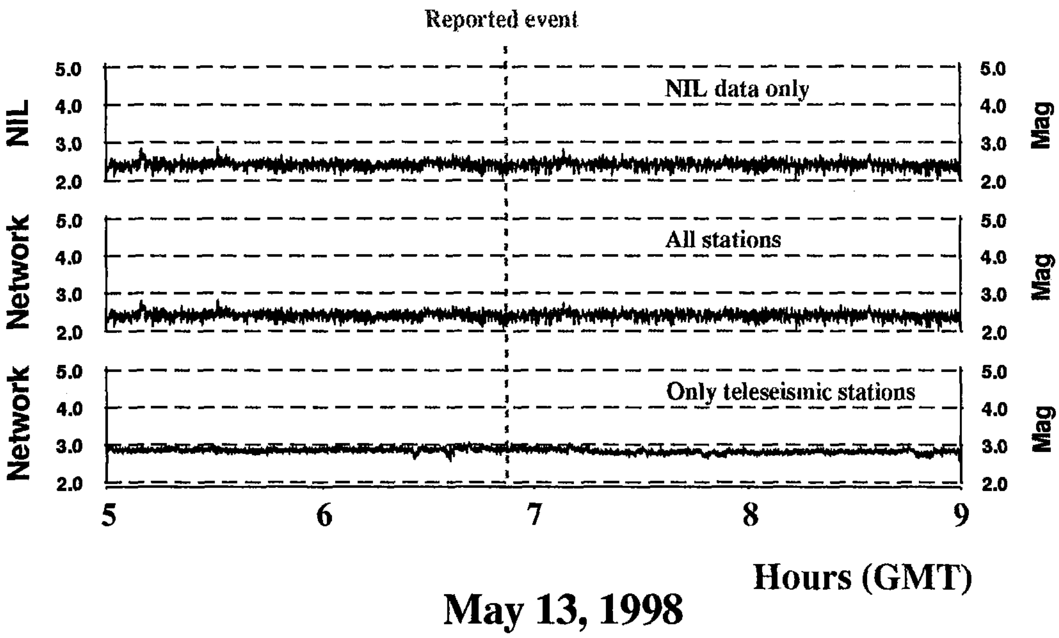


Fig. 7.6.4. The plot shows magnitude thresholds for a four-hour time interval around the announced Indian nuclear test of 13 May 1998. The upper trace shows the magnitude threshold calculated from NIL data only, using the P and Lg processing parameters derived from the 11 May event. The middle trace shows the magnitude threshold calculated from all stations listed in Table 7.6.2. The lower trace shows the magnitude threshold calculated without using data from NIL (i.e., teleseismic stations only).

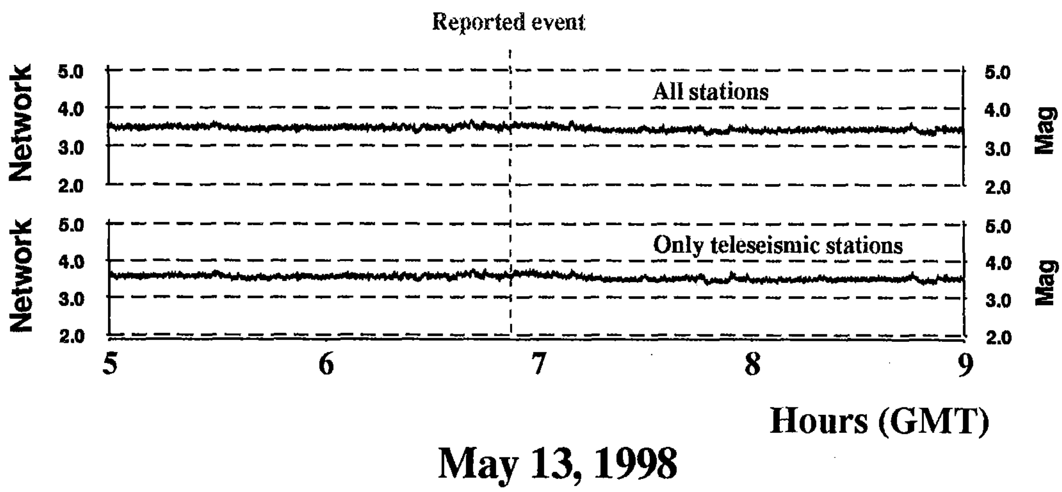


Fig. 7.6.5. The plot shows the three-station detection capability at the 90% level for a four-hour time interval around the announced Indian nuclear test of 13 May 1998. An SNR of 4 was required for detection. The upper trace shows the detection capability of all stations listed in Table 7.6.2, whereas the lower trace shows the detection capability estimated without the use of NIL data (teleseismic data only).

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

Introduction

This contribution is a report for the period April - September 1998 on activities associated with Norway's participation in the GSETT-3 experiment, which is now being coordinated by PrepCom's Working Group B. This report represents an update of contributions that can be found in the previous five editions of NORSAR's Semiannual Technical Summary.

Norwegian GSETT-3 stations and communications arrangements

During the reporting interval 1 April - 30 September 1998, Norway has provided data to the GSETT-3 experiment from the three seismic stations shown in Fig. 7.7.1. The NORSAR array (station code NOA) is a 60 km aperture teleseismic array, comprised of 7 subarrays, each containing six vertical short period sensors and a three-component broadband instrument. ARCES is a 25-element regional array with an aperture of 3 km, whereas the Sptisbergen array (station code SPITS) has 9 elements within a 1-km aperture. ARCES and SPITS both 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 NOA data are transmitted using dedicated land lines, whereas data from the other two arrays are transmitted via satellite links of capacity 64 Kbits/s and 19.2 Kbits/s for the ARCES and SPITS arrays, respectively. From the NOR_NDC, relevant data (see below) are forwarded to the prototype IDC (PIDC) in Arlington, Virginia, USA, via a dedicated fiber optical 256 Kbits/s link between the two centers.

The NOA and ARCES arrays are primary stations in the GSETT-3 network, which implies that data from these stations are transmitted continuously to the PIDC with a delay not exceeding 5 minutes. The SPITS array is an auxiliary station in GSETT-3, and the SPITS data are available to the PIDC on a request basis via use of the AutoDRM protocol (Kradolfer, 1993; Kradolfer, 1996). The Norwegian stations are thus participating in GSETT-3 with the same status (primary/auxiliary seismic stations) they have in the International Monitoring System (IMS) defined in the protocol to the Comprehensive Nuclear Test-Ban Treaty.

Uptimes and data availability

Figs. 7.7.2 - 7.7.3 show the monthly uptimes for the Norwegian GSETT-3 primary stations ARCESS and NOA, respectively, for the period 1 April - 30 September 1998, given as the hatched (taller) bars in these figures. These barplots reflect the percentage of the waveform data that are available in the NOR_NDC tape archives for these two arrays. The downtimes inferred from these figures thus represent the cumulative effect of field equipment outages, station site to NOR_NDC communication outage, and NOR_NDC data acquisition outages.

Figs. 7.7.2-7.7.3 also give the data availability for these two stations as reported by the PIDC in the PIDC Station Status reports. The main reason for the discrepancies between the NOR_NDC and PIDC data availabilities as observed from these figures is the difference in the ways the two data centers report data availability for arrays: Whereas NOR_NDC reports an array station to be up and available if at least one channel produces useful data, the PIDC uses weights where the reported availability (capability) is based on the number of actually operating channels.

Experience with the AutoDRM protocol

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

The PIDC started actively and routinely using NOR_NDC's AutoDRM service after SPITS changed its station status from primary to auxiliary on 1 October 1996. For the month of October 1996, the NOR_NDC AutoDRM responded to 12338 requests for SPITS waveforms from two different accounts at the PIDC: 9555 response messages were sent to the "pipeline" account and 2783 to "testbed". Following this initial burst of activity, the number of "pipeline" requests stabilized at a level between 5000 and 7000 per month. Requests from the "testbed" account show large variations.

The monthly number of requests for SPITS data for the period April - September 1998 is shown in Fig. 7.7.4.

NDC automatic processing and data analysis

These tasks have proceeded in accordance with the descriptions given in Mykkeltveit and Baadshaug (1996). For the period April - September 1998, NOR_NDC derived information on 491 supplementary events in northern Europe and submitted this information to the Finnish NDC as the NOR_NDC contribution to the joint Nordic Supplementary (Gamma) Bulletin, which in turn is forwarded to the PIDC. These events are plotted in Fig. 7.7.5.

Data forwarding for GSETT-3 stations in other countries

NOR_NDC continues to forward data to the PIDC from GSETT-3 primary stations in several countries. These currently include FINESS (Finland), GERESS (Germany) and Sonseca (Spain). In addition, communications for the GSETT-3 auxiliary station at Nilore, Pakistan, are provided through a VSAT satellite link between NOR_NDC and Pakistan's NDC in Nilore. The PIDC obtains data from the Hagfors array (HFS) in Sweden through requests to the AutoDRM server at NOR_NDC (in the same way requests for Spitsbergen array data are handled, see above). Fig. 7.7.6 shows the monthly number of requests for HFS data from the two PIDC accounts "pipeline" and "testbed".

Future plans

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

The PrepCom has tasked its Working Group B with overseeing, coordinating, and evaluating the GSETT-3 experiment until the end of 1998. The PrepCom has also encouraged states that operate IMS-designated stations to continue to do so on a voluntary basis and in the framework of the GSETT-experiment until such time that the stations have been certified for formal inclusion in IMS. In line with this, and provided that adequate funding is obtained, we envisage continuing the provision of data from Norwegian IMS-designated stations without interruption to the PIDC, and later on, following certification, to the IDC in Vienna, via the new global communications infrastructure currently being elaborated by the PrepCom.

The certification process for NOA was initiated by an overview station inspection visit by a PTS (Provisional Technical Secretariat of the PrepCom) team in mid-June 1998. We are currently (1 October 1998) awaiting the PTS report on their findings during this visit.

U. Baadshaug
S. Mykkeltveit
J. Fyen

References

Kradolfer, U. (1993): Automating the exchange of earthquake information. *EOS, Trans., AGU*, 74, 442.

Kradolfer, U. (1996): AutoDRM — The first five years, *Seism. Res. Lett.*, 67, 4, 30-33.

Mykkeltveit, S. & U. Baadshaug (1996): Norway's NDC: Experience from the first eighteen months of the full-scale phase of GSETT-3. *Semiann. Tech. Summ., 1 October 1995 - 31 March 1996*, NORSAR Sci. Rep. No. 2-95/96, Kjeller, Norway.

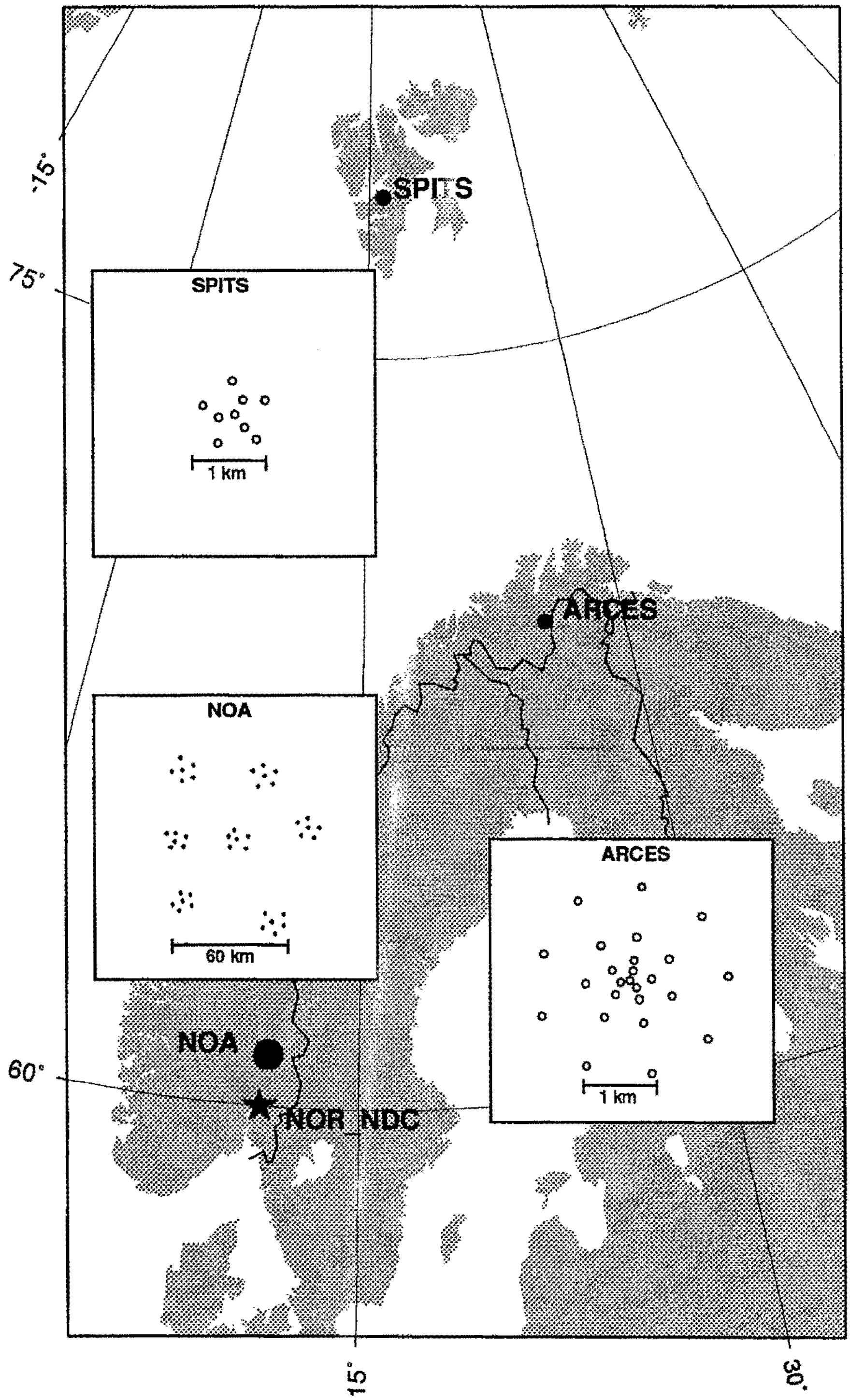


Fig. 7.7.1. The figure shows the locations and configurations of the three Norwegian seismic array stations that have provided data to the GSETT-3 experiment during the period 1 April - 30 September 1998. The data from these stations are transmitted continuously and in real time to the Norwegian NDC (NOR_NDC). The stations NOA and ARCES have participated in GSETT-3 as primary stations, whereas SPITS has contributed as an auxiliary station.

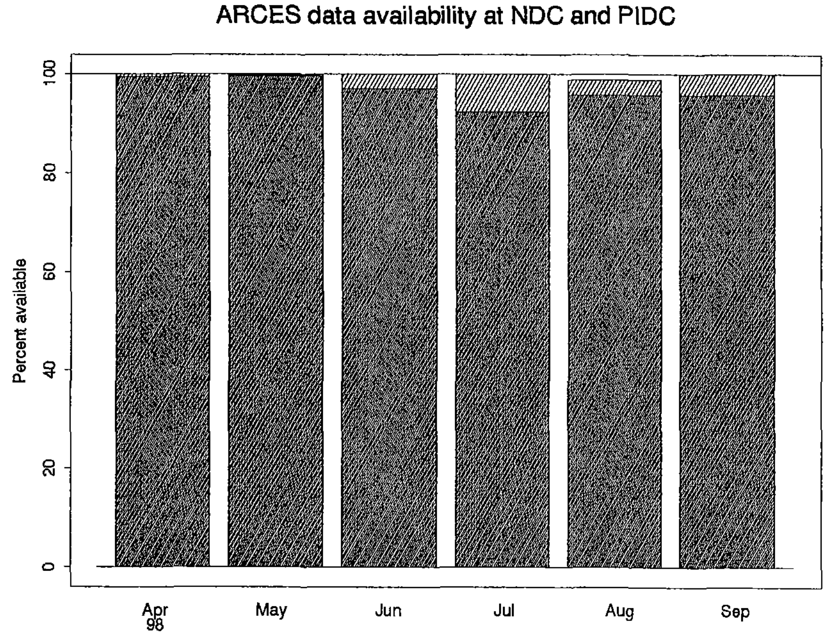


Fig. 7.7.2. The figure shows the monthly availability of ARCESS array data for the period April - September 1998 at NOR_NDC and the PIDC. See the text for explanation of differences in definition of the term "data availability" between the two centers. The higher values (hatched bars) represent the NOR_NDC data availability.

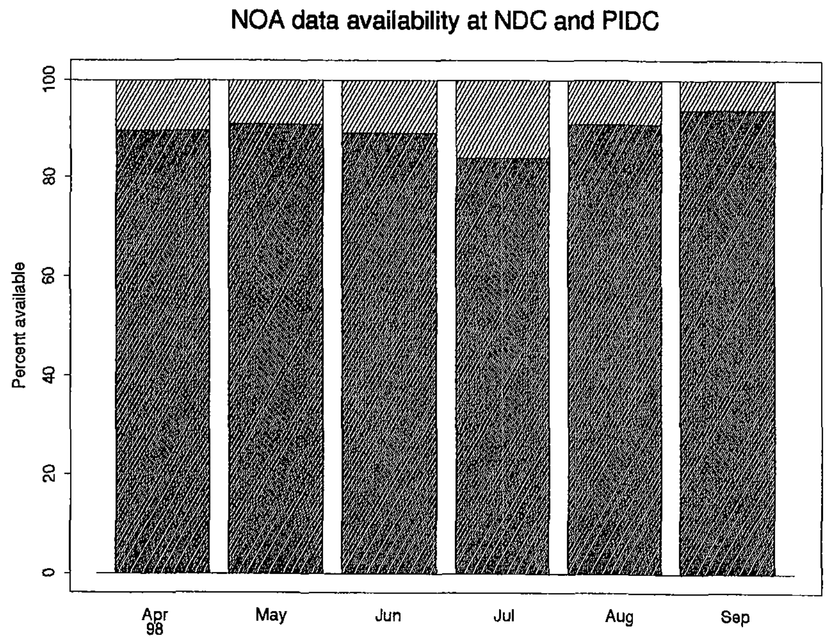


Fig. 7.7.3. The figure shows the monthly availability of NORSAR array data for the period April - September 1998 at NOR_NDC and the PIDC. See the text for explanation of differences in definition of the term "data availability" between the two centers. The higher values (hatched bars) represent the NOR_NDC data availability.

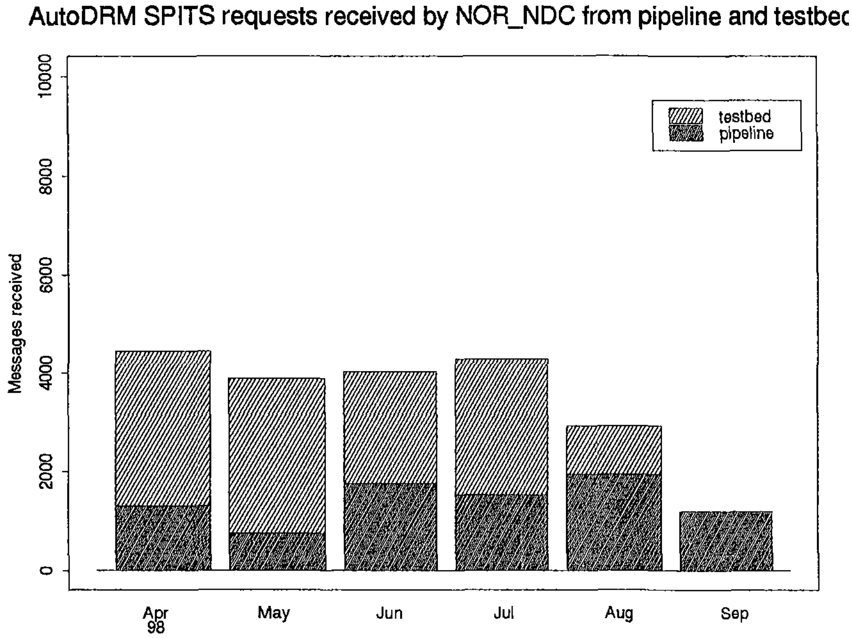


Fig. 7.7.4. The figure shows the monthly number of requests received by NOR_NDC from the PIDC for SPITS waveform segments during April - September 1998.

Reviewed Supplementary events

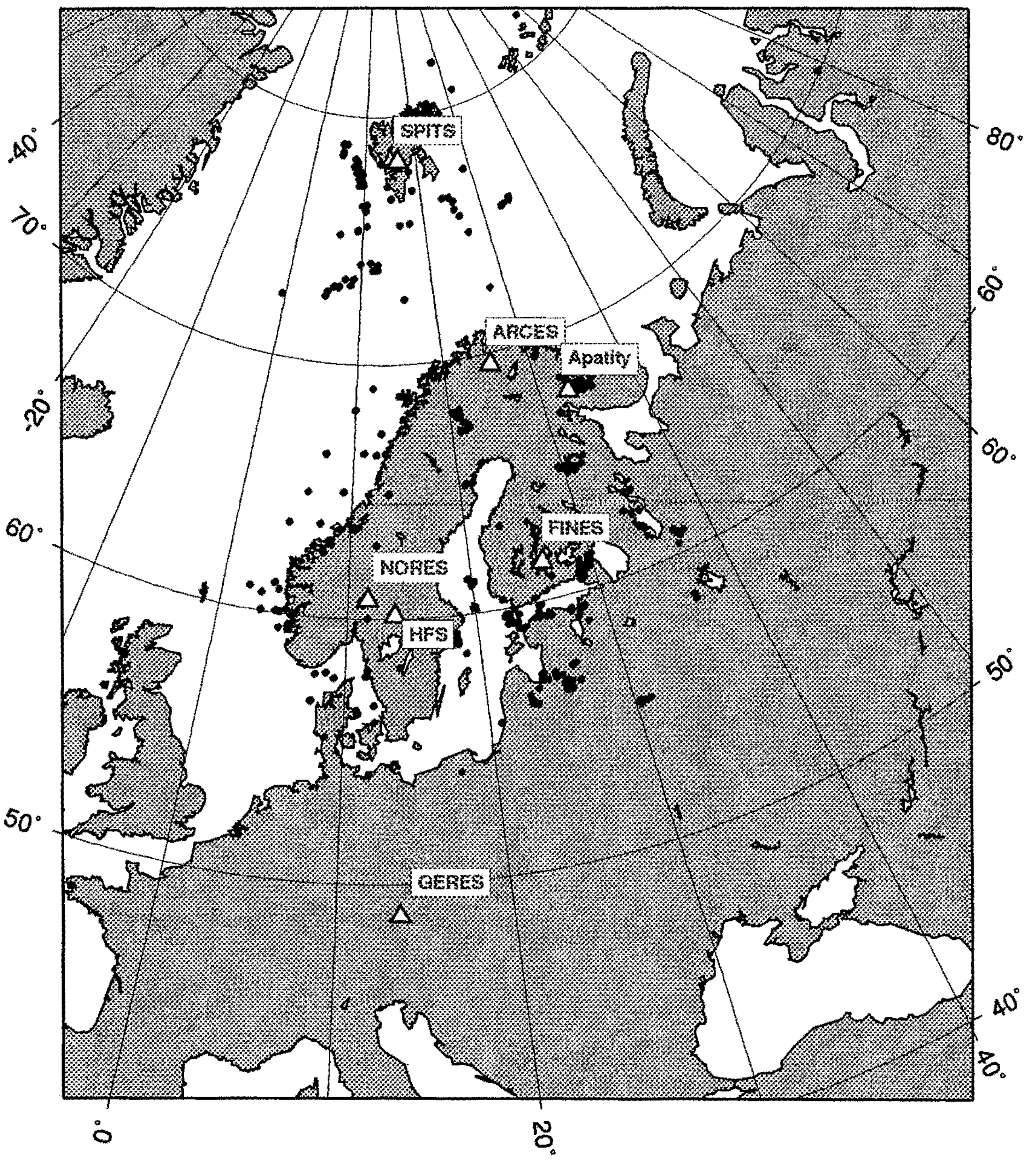


Fig. 7.7.5. The map shows the 491 events in and around Norway contributed by NOR_NDC during April - September 1998 as Supplementary (Gamma) data to the PIDC, as part of the Nordic Supplementary data compiled by the Finnish NDC. The map also shows the seismic stations used in the data analysis to define these events.

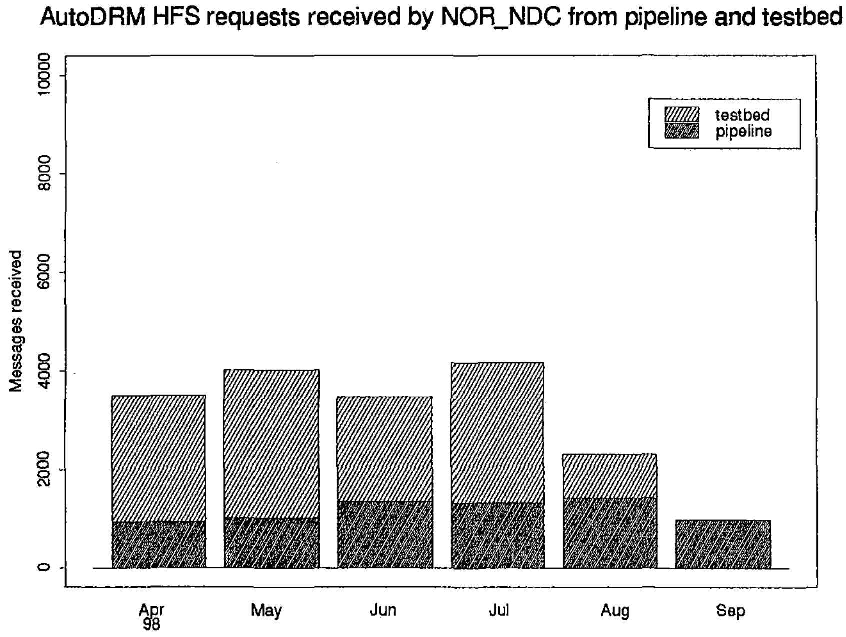


Fig. 7.7.6. The figure shows the monthly number of requests received by NOR_NDC from the PIDC for HFS waveform segments during April - September 1998.