



Athens Neutron Monitor Data Processing Center
National and Kapodistrian University of Athens,
Physics Department, Nuclear and Particle Physics Section

GLE Alert Infrastructure in Athens

Data Collection, Processing, Alert Production

Software Infrastructure Description

GLE Alert Method

Alert Notification methods

13_12_06 GLE Alert

Old Data analysis

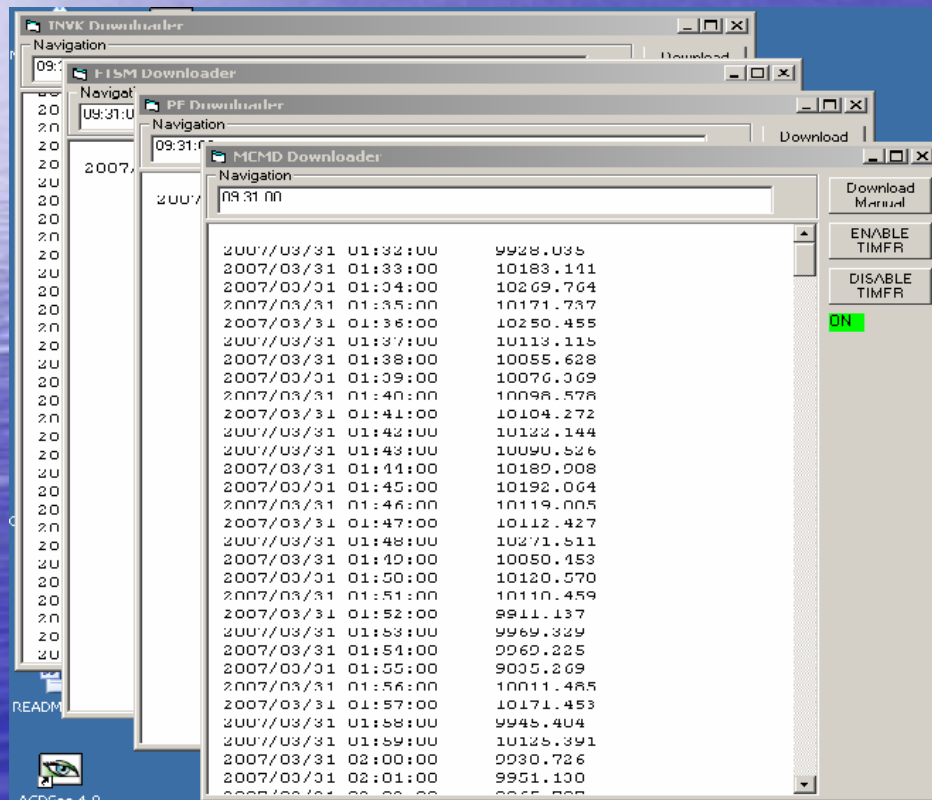
Software Infrastructure Description

The Downloaders

Multiple independent parallel downloaders.

One Downloader for every station

Problems with one station don't effect the others



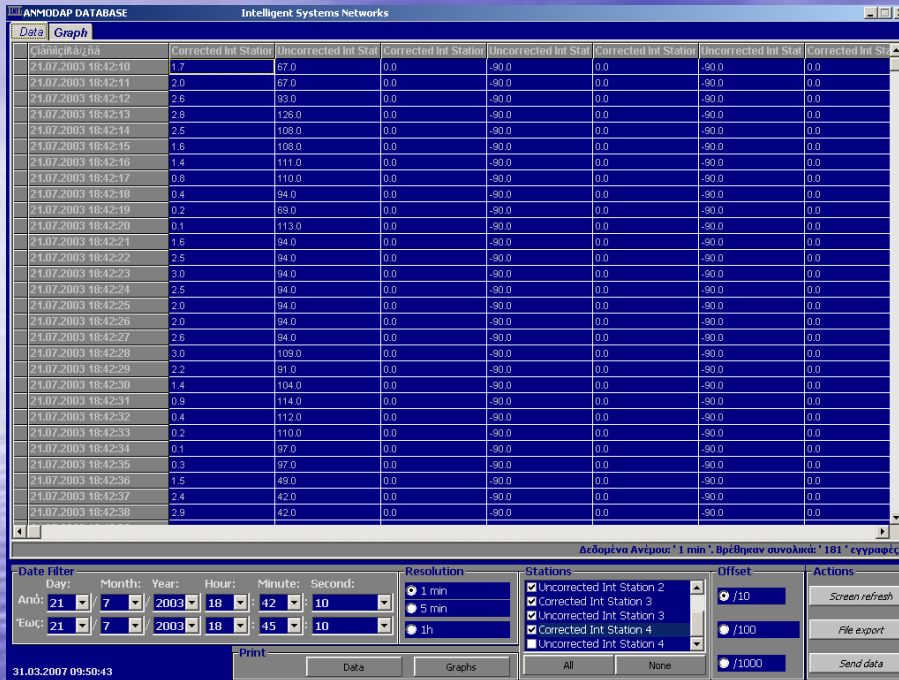
Different types of downloaders. Depending on different Station Infrastructures

Ftp Downloading

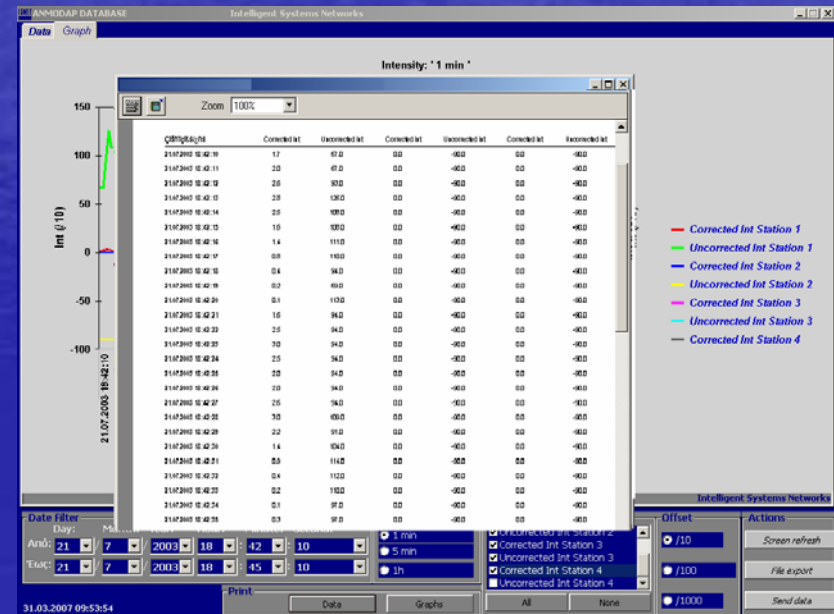
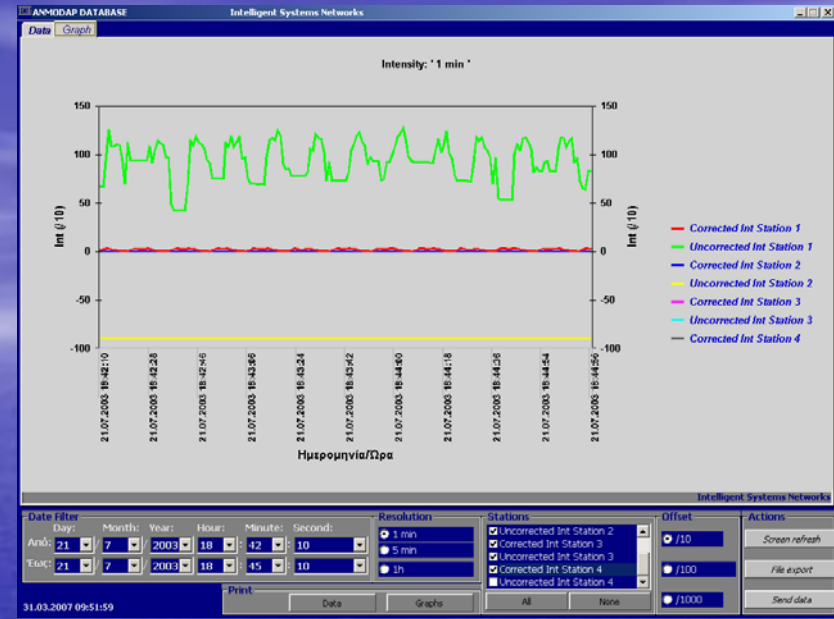
Http Downloading

ASP Downloading

Local Database



Data Storage
Data exporting
Graphical representation
Text Reports



Software Infrastructure Description

For every station there is a program named [station]_GLE_alert.exe
This program every minute calculates in real time the mean value of the last 60 minutely measurements and the value of a moving threshold that is $N \cdot \text{Sigma}$

The screenshot displays five overlapping windows, each representing a different station's GLE SEARCH interface. The windows are titled 'INVK GLE SEARCH', 'NAIN GLE SEARCH', 'PE GLE SEARCH', 'MCMD GLE SEARCH', and 'FTSM GLE SEARCH'. Each window contains a table with columns for Station, Longitude, Latitude, Rigidity, and Threshold Multiplier. The FTSM window also includes a table for MEAN, ST DEVIATION, EARLIEST VALUE, and REPETITION, along with buttons for 'Manual' and 'Auto 1min', and a 'LAST ALERT' field.

Station	Longitude	Latitude	Rigidity	Threshold Multiplier
INVK	168.4 NORTH	133.7 WEST	reg	2
NAIN	56.55 NORTH	61.68 WEST	reg	2
PE	54.98 NORTH	85.44 WEST	reg	2
MCMD	77.9 SOWTH	166.6 EAST	reg	2
FTSM	60.02 NORTH	111.93 WEST	reg	2

MEAN	ST DEVIATION	EARLIEST VALUE	REPETITION
7813	105	7925	399

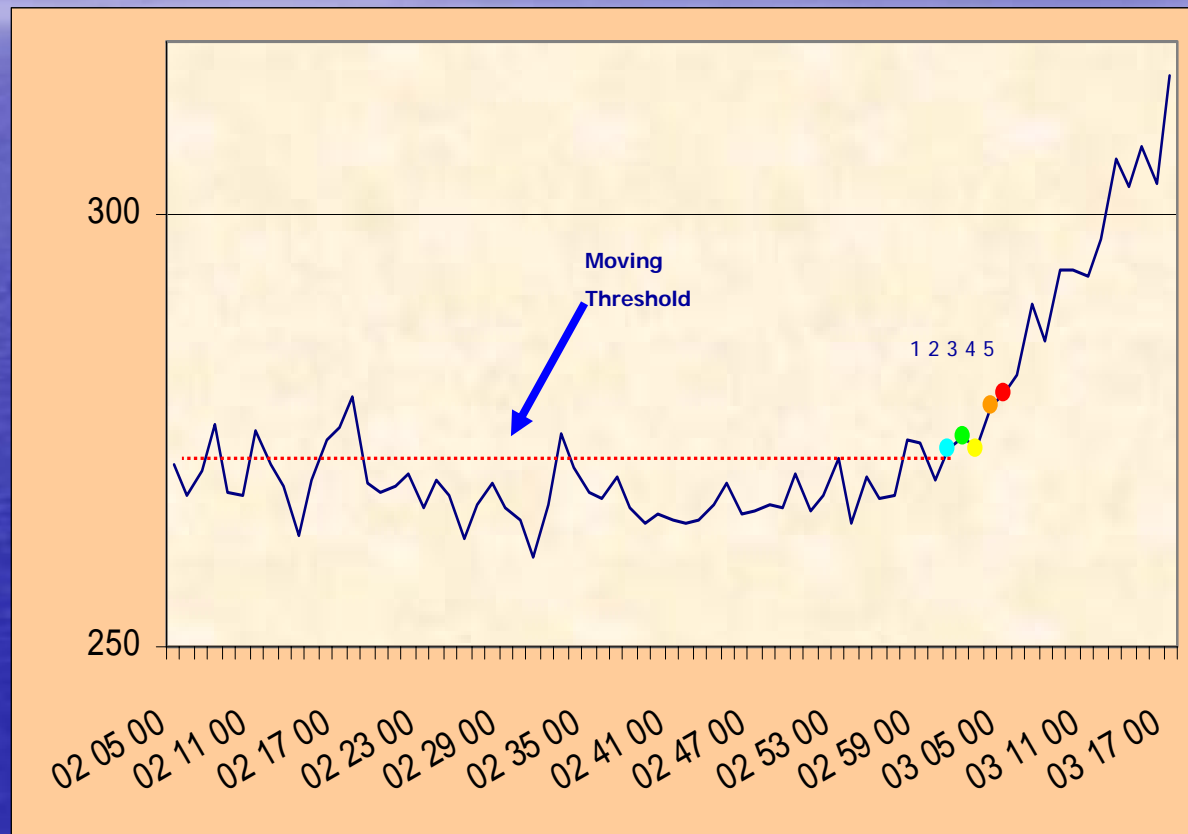
Manual
Auto 1min

LAST ALERT: FTSM 2 UP 2007/02/26 13:30:00 7857 UT REAL TIME 2007.02.26 13:40:08

The threshold multiplier N has been defined for every station as the value, for which for the past 10 years GLE alerts, we see the maximum number of true alerts with the minimum number of false.

When we produce a Station GLE Alert ?

- If the last measurement exceeds the moving threshold, the program writes down a pre-alert point
- If we have 5 pre-alert points in succession we define a Station Alert



When we produce General GLE Alert ?

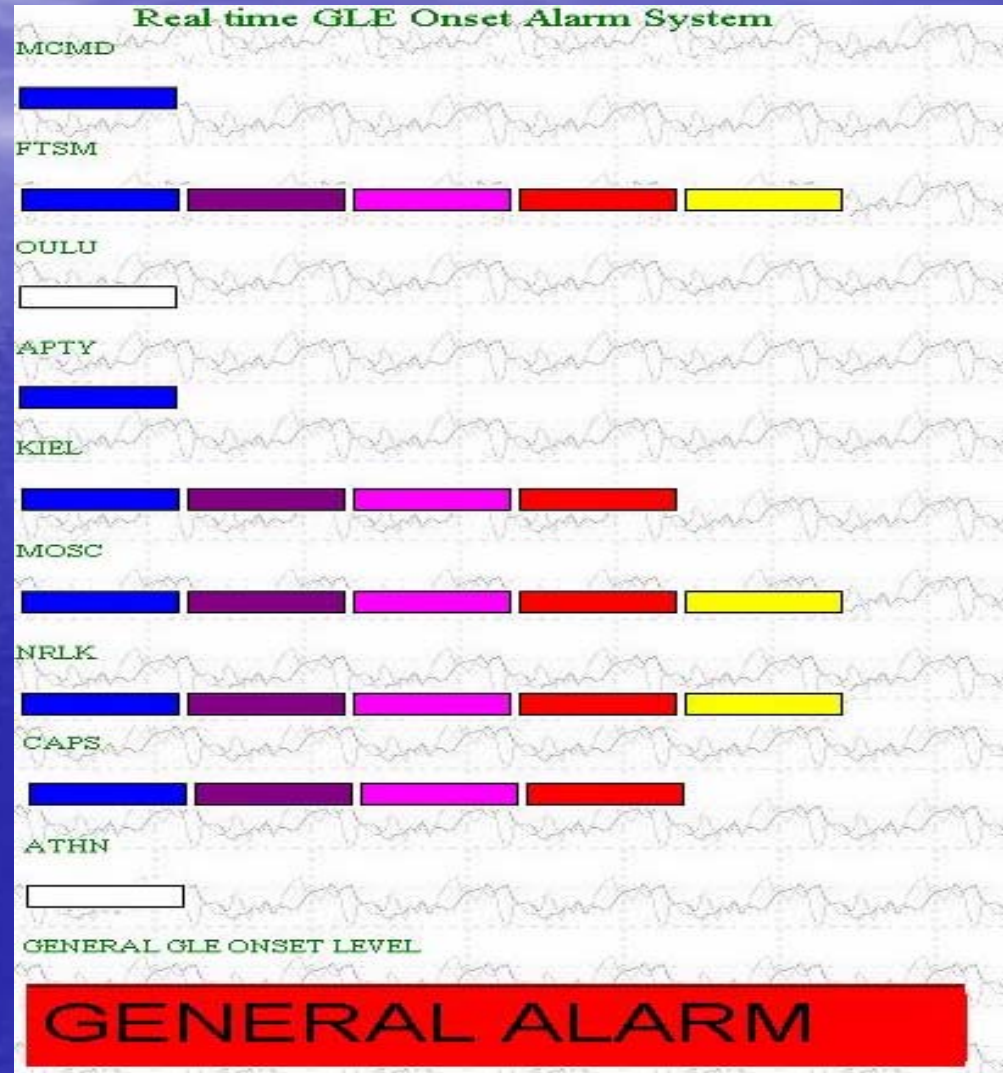
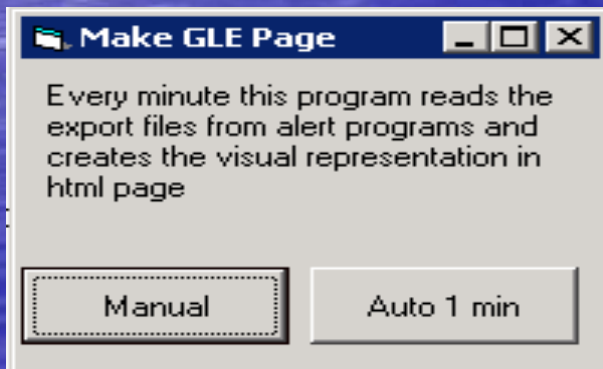
- A Supervision program named Check_For_alert checks every minute the status of every station.
- If this program detects at least three stations in "station alert mode" then produces a General GLE Alert Signal



Network Presentation of Alert evolution

The network presentation of the GLE alert is created with a program named **Make_Page** this program every minute creates a web page that describes the status of every station that participates the GLE alert network

Every colored bar presents a pre-alert point





Alarm Notification



e-mail notification



GSM Phone Notification

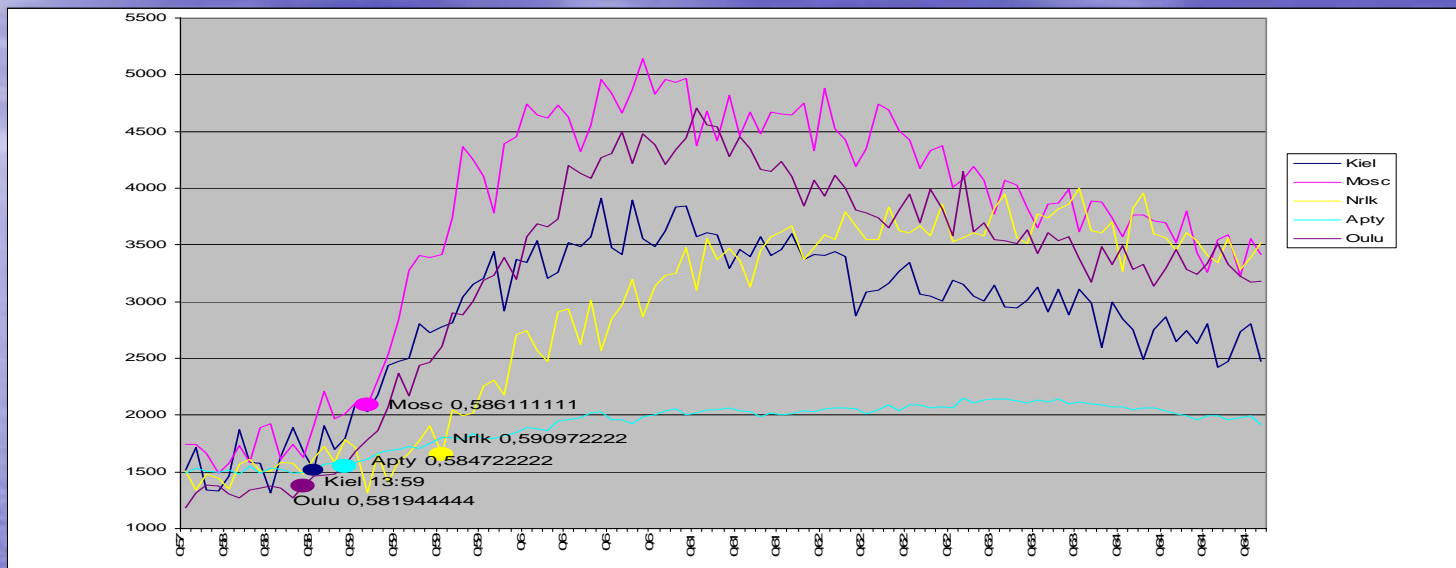


Phone Call Notification



GLE Alert Example

15/04/01 non real time data results



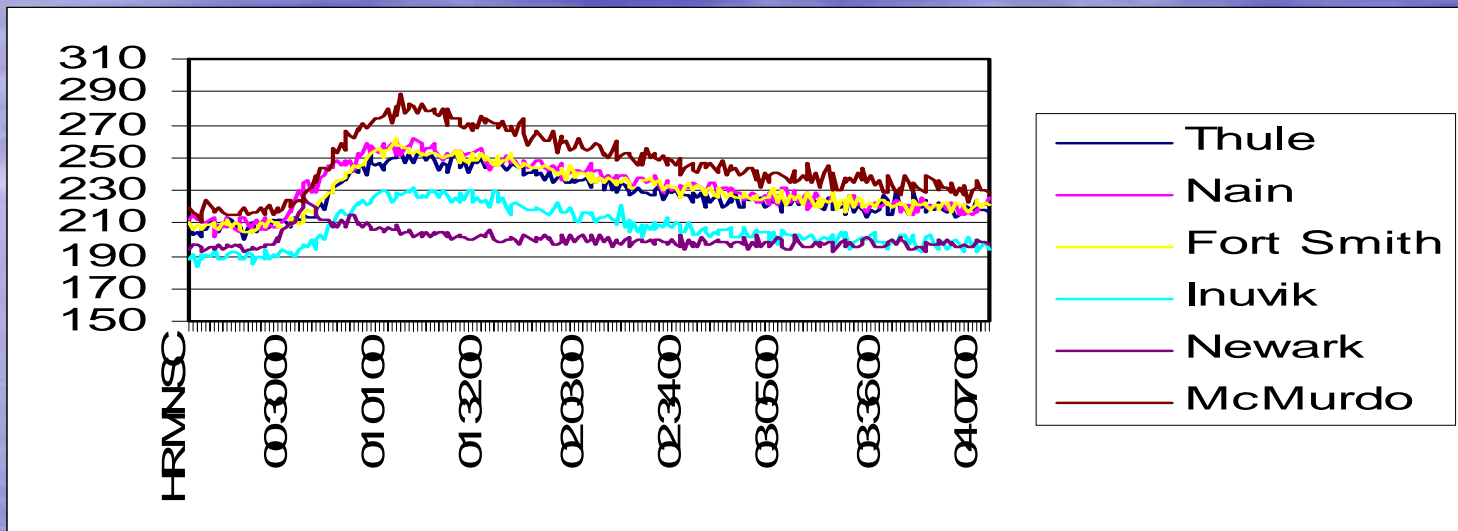
15/04/2001	station alert time	counts	first trigger
oulu	14:03	5841	13:58
Kiel	14:04	9531	13:59
Apty	14:07	1701	14:02
Mosc	14:09	13611	14:04
Nrsk	14:16	7110	14:11

GLE Alert Precedes
Earliest SEC proton
alert 14min

13/12/2006

First Real time GLE Alert Notification in Athens

13/12/2006 First Real time GLE Alert Notification in Athens



13_12_2006			
station	1s	2s	3s
LMNSK	2:55	2:57	2:58
THUL	03:13	03:13	03:15
NAIN	03:02	03:03	03:05
FSMTH	03:08	03:08	03:11
INVK	03:15	03:30	NO GLE
NWRK	02:56	03:01	03:01
McMD	03:05	03:08	03:09

Alert Time 03:05
Onset Time 02:51

4 station in GLE alert system that day
 Three stations in alert

Alerts Issued by SEC in 13 Dec

Time



Space Weather Message Code: ALTXMF Serial Number: 137 Issue Time: 2006 Dec 13 0225 UTC	ALERT: X-Ray Flux exceeded M5 Threshold Reached: 2006 Dec 13 0224 UTC NOAA Scale: R2 - Moderate
Space Weather Message Code: ALTPP2 Serial Number: 682 Issue Time: 2006 Dec 13 0253 UTC	ALERT: Type II Radio Emission Begin Time: 2006 Dec 13 0226 UTC Estimated Velocity: 1534 km/s
Space Weather Message Code: WARPC0 Serial Number: 39 Issue Time: 2006 Dec 13 0301 UTC	WARNING: Proton 100MeV Integral Flux above 1pfu expected Valid From: 2006 Dec 13 0301 UTC Valid To: 2006 Dec 13 2359 UTC Warning Condition: Onset
Space Weather Message Code: WARPX1 Serial Number: 297 Issue Time: 2006 Dec 13 0310 UTC	WARNING: Proton 10MeV Integral Flux above 10pfu expected Valid From: 2006 Dec 13 0310 UTC Valid To: 2006 Dec 13 2359 UTC Warning Condition: Onset Predicted NOAA Scale: S2 - Moderate
Space Weather Message Code: ALTPC0 Serial Number: 27 Issue Time: 2006 Dec 13 0312 UTC	ALERT: Proton Event 100MeV Integral Flux exceeded 1pfu Begin Time: 2006 Dec 13 0300 UTC
Space Weather Message Code: ALTPX1 Serial Number: 273 Issue Time: 2006 Dec 13 0324 UTC	ALERT: Proton Event 10MeV Integral Flux exceeded 10pfu Begin Time: 2006 Dec 13 0310 UTC NOAA Scale: S1 - Minor
Space Weather Message Code: SUMX01 Serial Number: 63 Issue Time: 2006 Dec 13 0333 UTC	SUMMARY: X-ray Event exceeded X1 Begin Time: 2006 Dec 13 0214 UTC Maximum Time: 2006 Dec 13 0240 UTC End Time: 2006 Dec 13 0257 UTC X-ray Class: X3.4 Optical Class: 4b Location: S05W23 NOAA Scale: R3 - Strong
Space Weather Message Code: ALTPX2 Serial Number: 45 Issue Time: 2006 Dec 13 0406 UTC	ALERT: Proton Event 10MeV Integral Flux exceeded 100pfu Begin Time: 2006 Dec 13 0345 UTC NOAA Scale: S2 - Moderate

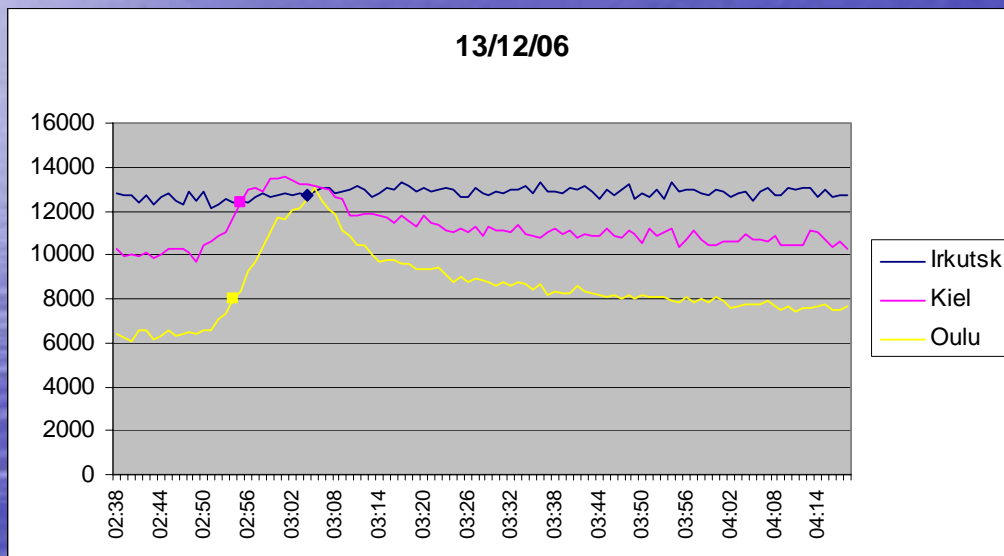
Comparison With GOES

- GLE Alert Precedes 7 minutes the earliest SEC Proton Alert

GLE Alarm Evolution in Web Page

Non Real time Analysis With three Stations

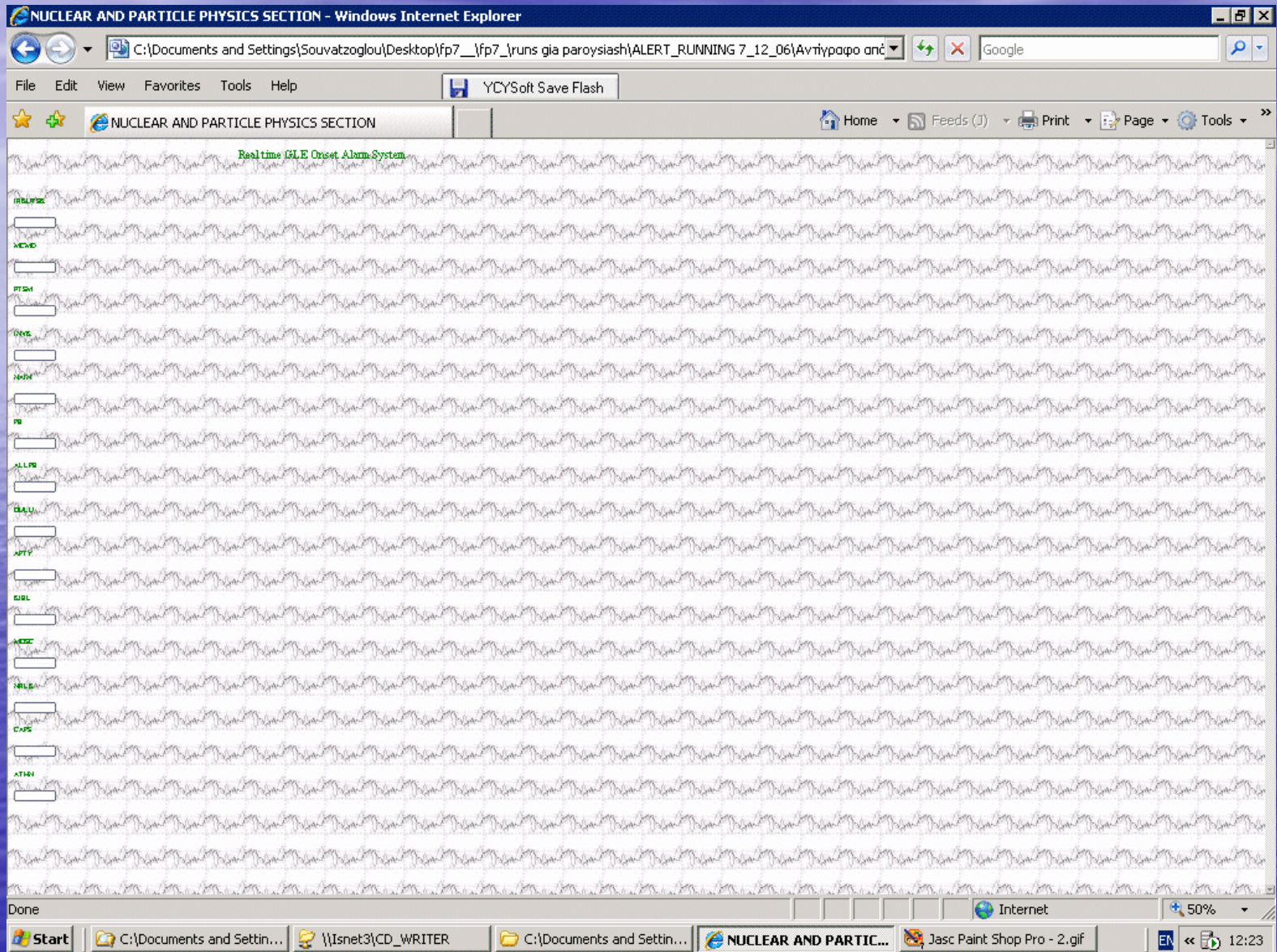
13/12/2006	station alert time	counts	first trigger
Oulu	02:54	8005	02:49
Kiel	02:55	12339	02:50
Irkutsk	03.04	12723	02:59



Alert Time 03:04

Onset Time 02:49

GLE Alarm Evolution in Web Page



- We have run the GLE alarm System For the last 10 GLE

Past Data Analysis

	STATION GLE Alert		GOES ALERT		GLE ALERT Precedes earliest SEC Proton Alert (min)
	time HH:MM	Counts	10MeV Integral Flux exceeded 10pfu	100MeV Integral Flux exceeded 1pfu	
15/4/2001					
Oulu	14:03	5841			
Kiel	14:04	9531			
Apty	14:07	1701			
Mosc	14:09	13611			
NrIk	14:16	7110			
General Alert	14:07		14:26	14:21	14
18/4/2001					
Mosc	2:44	12735			
Oulu	2:45	6083			
Kiel	2:51	9650			
NrIk	2:56	6822			
Apty	3:01	1512			
General Alert	2:51		3:43	3:11	20
26/12/2001					
APT Y	6:11	1708			
nrIk	6:12	7025			
OULU	6:05	6200			
General Alert	6:12		6:24	6:14	2
24/8/2002					
apty	1:27	1602			
mosc	1:44	12294			
OULU	1:32	5849			
General Alert	1:44		1:56	1:48	4
28/10/2003					
Apty	11:04	1516			
NrIk	11:18	7469			
Mosc	11:18	9146			
Kiel	11:25	9670			
Oulu	11:49	5961			
General Alert	11:18		12:23	11:51	33

	STATION GLE Alert		GOES ALERT		GLE ALERT Precedes earliest SEC Proton Alert (min)
	time HH:MM	Counts	10MeV Integral Flux exceeded 10pfu	100MeV Integral Flux exceeded 1pfu	
29/10/2003					
Kiel	21:08	7832			
NrIk	21:09	6029			
mosc	-	no data			
Apty	10:04	1475			
Oulu	18:01	4502			
General Alert	not enough data	close			
2/11/2003					
mosc	17:40	7967			
nrIk	17:43	6143			
Oulu	17:46	5309			
Apty	17:52	1464			
kiel	18:00	8577			
General Alert	17:46			17:56	10
20/1/2005					
KIEL	6:56	13072			
oulu	6:55	20,2881944			
NR2K	6:35	9252			
nvsbrsk	7:00	11004			
MOSC	6:53	10363			
CAP2S	7:01	9794			
APT Y	6:55	10339			
General Alert	6:56			7:04	8
17/1/2005					
General Alert	NO		no	no	
13/12/2006					
Oulu	2:54	8005			
kiel	2:55	12339			
Irkutsk	3:04	12723			
General Alert	3:04		3:24	3:12	8

The background is a smooth blue gradient, transitioning from a lighter blue at the top to a darker blue at the bottom. A bright sun flare is visible on the left side, creating a horizontal glow across the middle of the image.

The system can be improved

We need more stations with 1min data updated in the network every minute

- It is very critical to have minutely data updated every minute in order to give the alarm in time
- Many stations give minutely data every 1 Hour or every Five Minutes
- In order to develop and run the GLE alert system we use their data every minute with time window in the past but we can not use them in real time

About the time synchronization

- The GLE alert system uses the time of local server in order to analyze the intensities of the stations every minute and is independent from the differences of time stamp between stations of the Network for the same minute.

But

- For the past data analysis we assume that the data from different stations are well synchronized

As a conclusion.....



GLE forecasting using 1min real time NM Data is working

We have to work together in order to improve the real time data collection Network and to achieve even better results

- **1min Data** and **1min network refreshing** rate
- **common reference time** (Internet time synchronization is enough)

THANK YOU