



‘Space Weather Service Network Development and Operation  
Part 1 – SWESNET’

*ESOC Contract 4000134036/21/D/MRP*

Space Radiation Service Center-R-ESC

National and Kapodistrian University of Athens  
Athens Neutron Monitor Station  
Physics Department / Cosmic Ray Expert Group



‘A new GLE Alert was issued in real-time by the  
Athens Neutron Monitor Alert System operated  
in ESA R-ESC SPACE WEATHER SERVICE NETWORK –  
SWESNET’

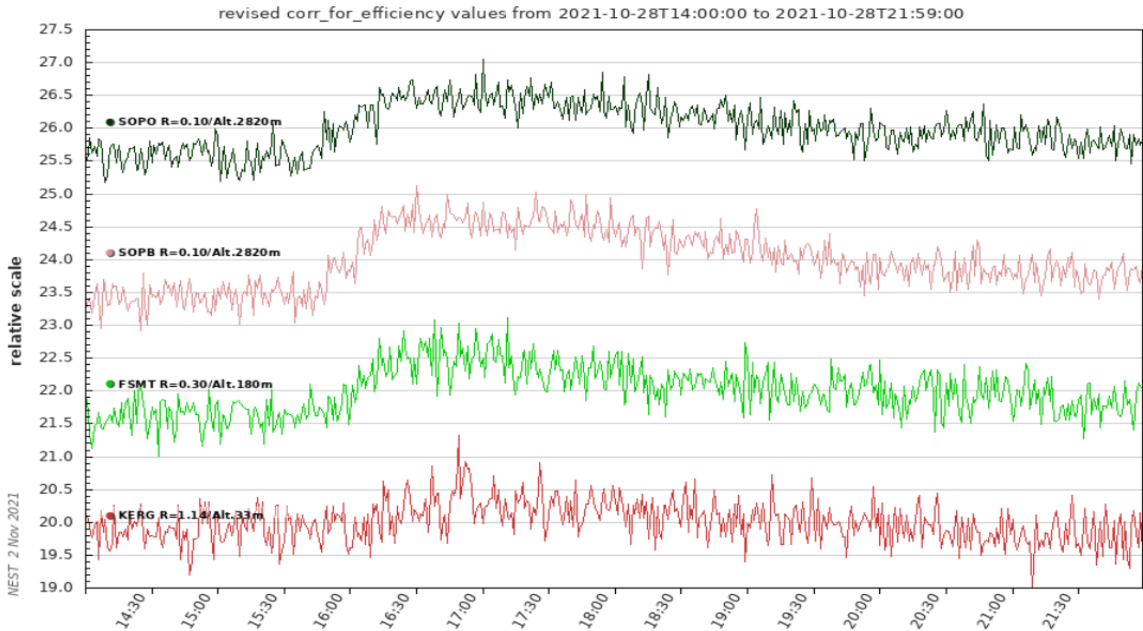
**Athens, 28 October 2021**

## **A Short Description**

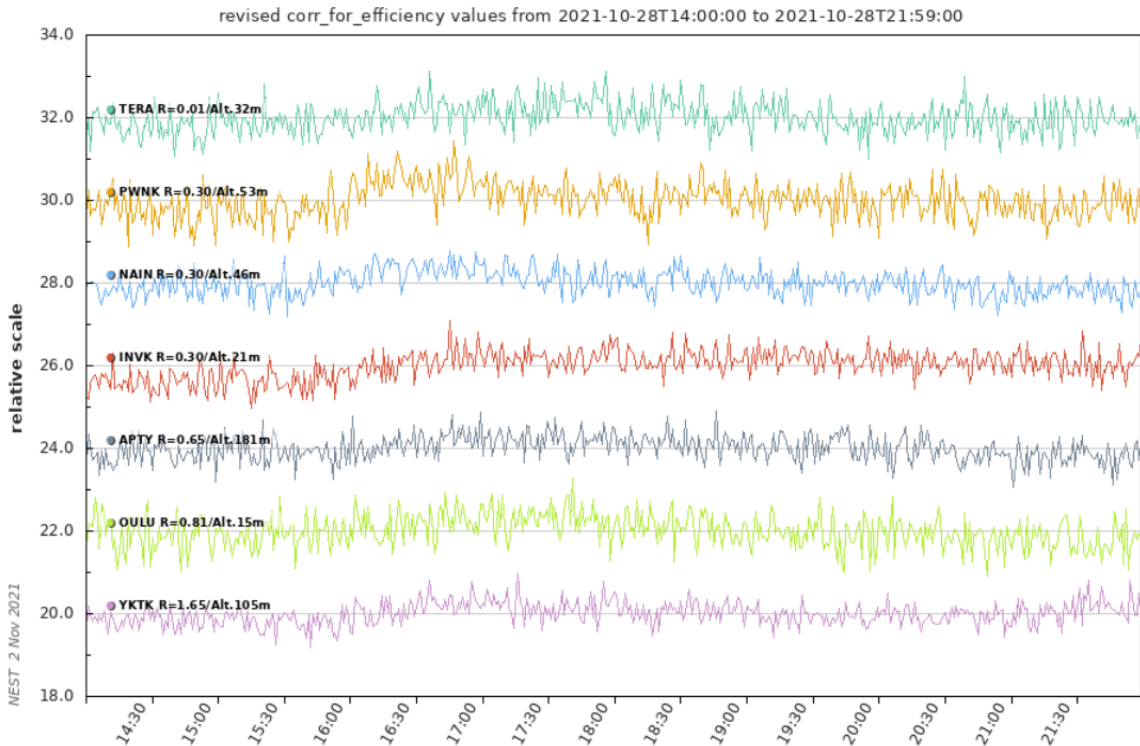
On October 28, 2021 a ground level enhancement (GLE) of the cosmic ray intensity, identified as GLE73, was recorded by several stations of the worldwide neutron monitor network provided by the high-resolution Neutron Monitor Database (NMDB). The solar proton event that resulted to this GLE was associated with the active region AR12887, which on October 28, 2021 at 15:34 UT (peak time) produced an X1.0 solar flare on the S26W07 part of the solar disk. This flare accompanied by an asymmetric halo Coronal Mass Ejection (CME) with a linear speed around 1100 km/s. Solar Energetic Particles were recorded by GOES, ACE and Stereo.

This GLE event was successfully detected in real time by the GLE Alert plus and also by the updated GLE Alert ++ System of the Athens Neutron Monitor Station (A.NeMoS). Firstly, the South Pole B (SOPB) Neutron Monitor status at 15:55 UT was on alert mode, followed by South Pole Neutron Monitor (SOPO) at 16:05 UT and by Fort Smith Neutron Monitor (FSMT) at 16:06 UT. Later and while the status of these three NMs was again on “quiet”, the Kerguelen Neutron Monitor (KERG) was on alert mode at 16:54 UT .

It is noted that the post event analysis showed that others also neutron monitor stations detected the GLE73 with smaller amplitude, such as Yakutsk (YKTK), Oulu (OULU), Apatity (APTY), Inuvik (INVK), Nain (NAIN), Peawanuck (PWNK) and Terre-Adelie NM (TERA).



*Cosmic ray intensity by the Neutron Monitor Stations that detected in real time the GLE73 by the ANeMoS GLE Alert Systems.*



*Neutron Monitor Stations that detected the GLE 73 with small amplitude and not giving alert signal in the ANeMoS GLE Alert Systems.*

**The GLE Alert++ system of the Athens Neutron Monitor Station (ANeMoS) of the Physics Department at the National and Kapodistrian University of Athens (NKUA) produced a real-time Alert on October 28 at 16:06 UT based on the NM stations FSMT, SOPB and SOPO.**



*A Notification via e-mail was sent on October 28, 2021 at 16:09UT to the subscribed users*

Federated products from the NKUA Cosmic Ray Group (NKUA)

## Welcome to the European Neutron Monitor Service

**THURSDAY, 28 OCTOBER 2021, 18:02:31 UTC**

**STATUS NOW:** QUIET

Ground Level Enhancement (GLE) Alerts  
A real-time service providing GLE Alerts

### General Alert Status

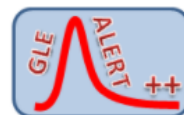
Time (UTC)	Number of stations in Alert mode
16:10 - 16:15	3
16:15 - 16:20	3
16:20 - 16:25	3
16:25 - 16:30	1
16:30 - 16:35	0
16:35 - 16:40	0
16:40 - 16:45	0
16:45 - 16:50	0
16:50 - 16:55	1
16:55 - 17:00	1
17:00 - 17:05	1
17:05 - 17:10	1
17:10 - 17:15	0
17:15 - 17:20	0
17:20 - 17:25	0
17:25 - 17:30	0
17:30 - 17:35	0
17:35 - 17:40	0
17:40 - 17:45	0
17:45 - 17:50	0
17:50 - 17:55	0
17:55 - 18:00	0

<http://swe.ssa.esa.int/web/guest/space-radiation>

# The GLE Alert++ system in Alert status!



**A.Ne.MoS**  
Athens Neutron Monitor Station (A.Ne.MoS)

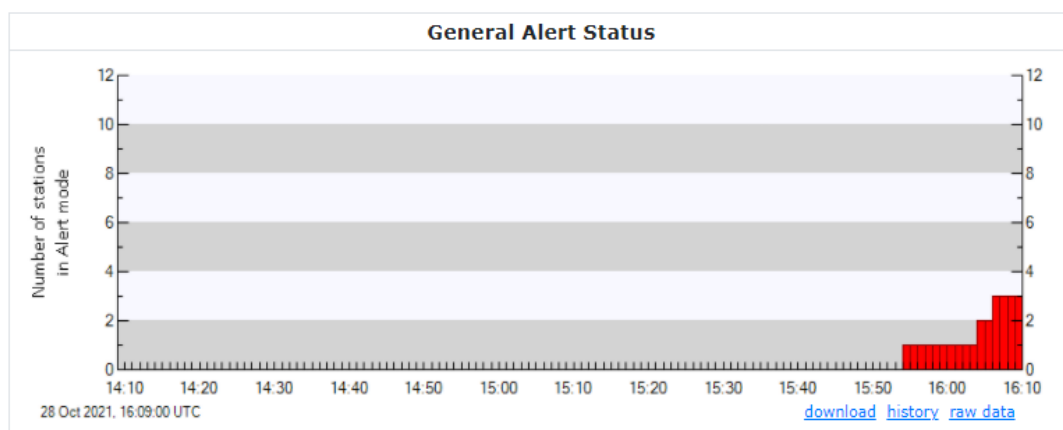


[Home](#) [Description](#) [Database](#) [Archived GLEs](#) [Acknowledgements](#) [Registration](#)

Year: 
 Month: 
 Day: 
 Hour: 
 Minute:

*THU, 28 OCT 2021, 16:09:00 UTC*

**STATUS: ALERT**



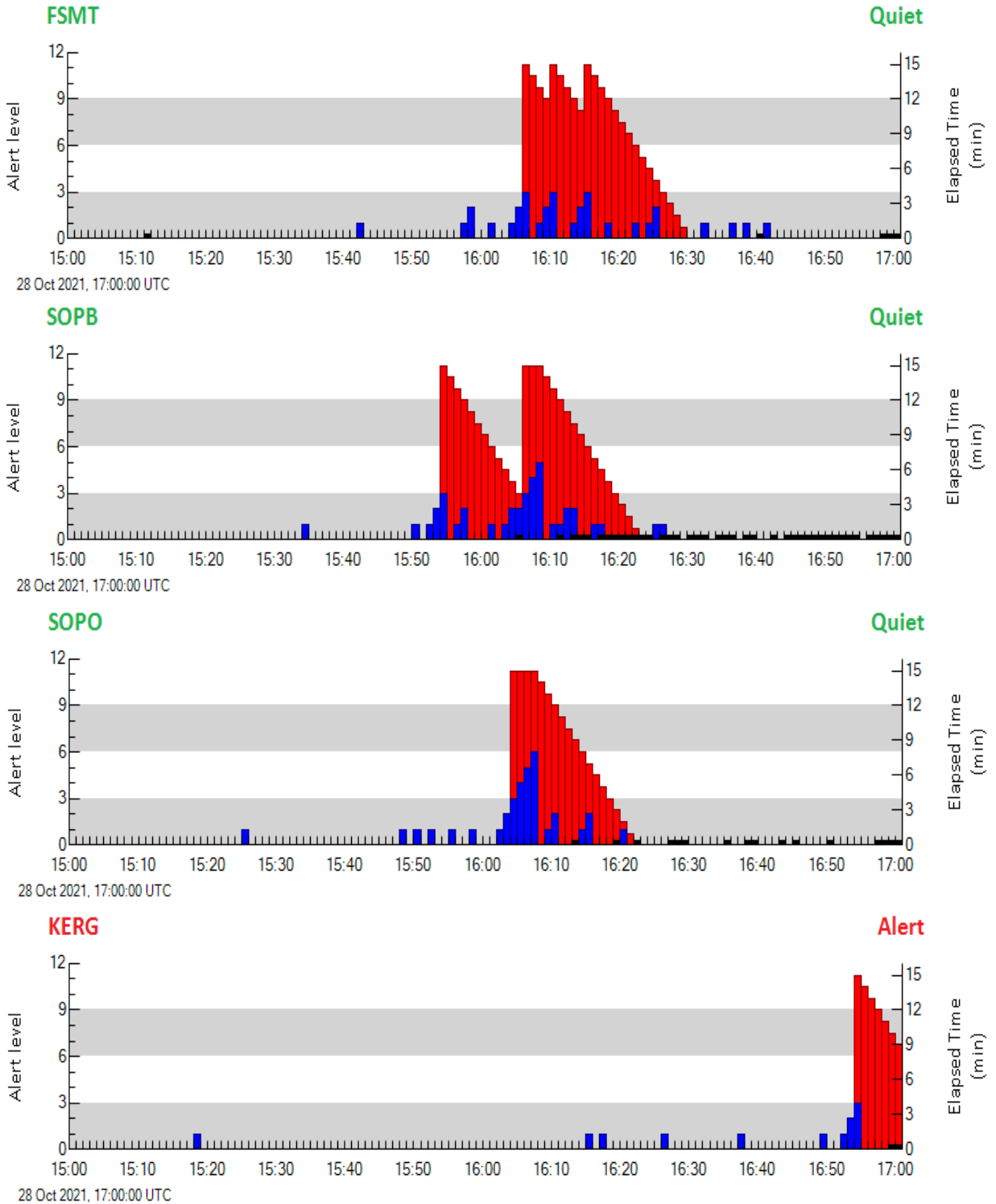
Station Status				
<input type="checkbox"/> ● AATB	<input type="checkbox"/> ● APTY	<input type="checkbox"/> ● ATHN	<input type="checkbox"/> ● BKSJ	<input type="checkbox"/> ● BURE
<input type="checkbox"/> ● CALM	<input type="checkbox"/> ● ESOI	<input type="checkbox"/> ● FSMT	<input type="checkbox"/> ● INVK	<input type="checkbox"/> ● IRK2
<input type="checkbox"/> ● IRK3	<input type="checkbox"/> ● IRKT	<input type="checkbox"/> ● JUNG	<input type="checkbox"/> ● JUNG1	<input type="checkbox"/> ● KERG
<input type="checkbox"/> ● KIEL2	<input type="checkbox"/> ● LMKS	<input type="checkbox"/> ● MCMU	<input type="checkbox"/> ● MCRL	<input type="checkbox"/> ● MGDN
<input type="checkbox"/> ● MOSC	<input type="checkbox"/> ● MRNY	<input type="checkbox"/> ● NAIN	<input type="checkbox"/> ● NEWK	<input type="checkbox"/> ● NVBK
<input type="checkbox"/> ● OULU	<input type="checkbox"/> ● PWNK	<input type="checkbox"/> ● ROME	<input type="checkbox"/> ● SOPB	<input type="checkbox"/> ● SOPO
<input type="checkbox"/> ● TERA	<input type="checkbox"/> ● THUL	<input type="checkbox"/> ● TXBY	<input type="checkbox"/> ● YKTK	

Summary		
<input type="checkbox"/>	Total	[34]
<input type="checkbox"/>	Alert	[3]
<input type="checkbox"/>	Warning	[0]
<input type="checkbox"/>	Watch	[0]
<input type="checkbox"/>	Quiet	[18]
<input type="checkbox"/>	Delayed	[1]
<input type="checkbox"/>	Offline	[12]

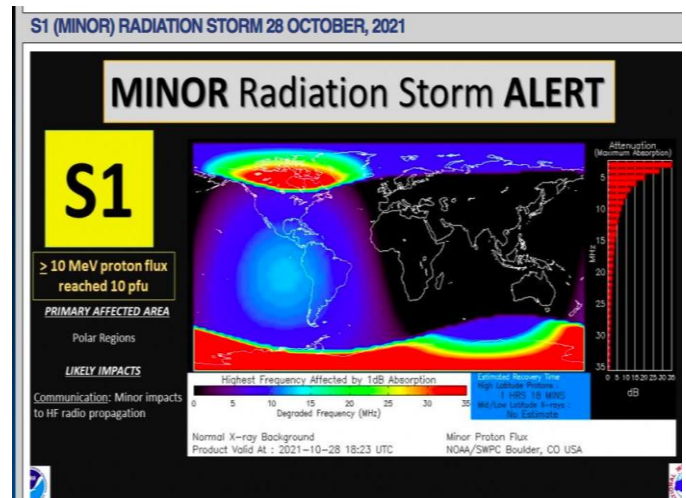
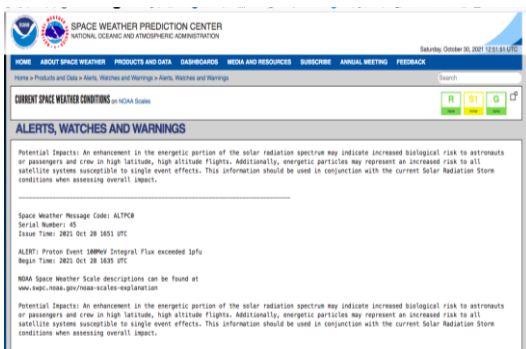
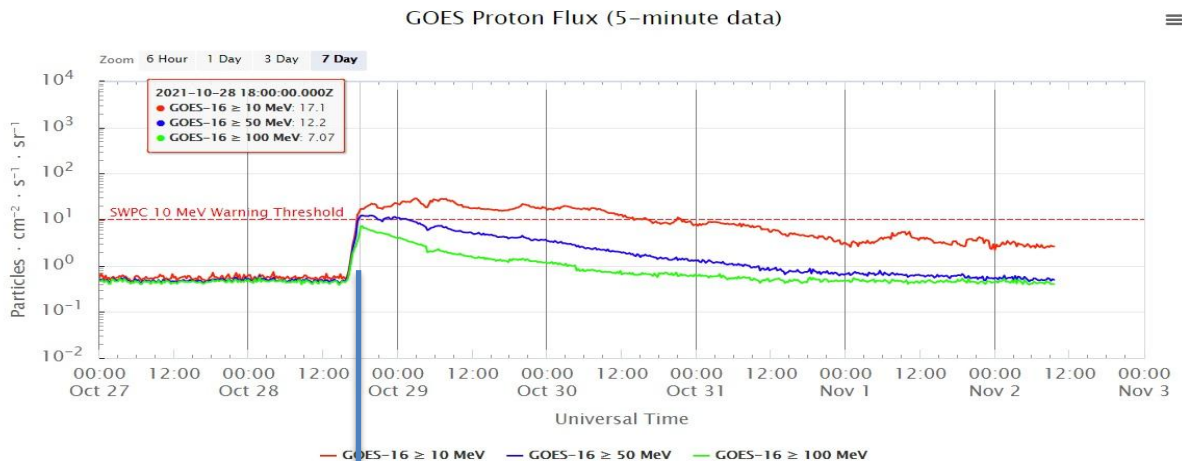
<http://glealertplus.phys.uoa.gr/glealertplus2>

*The GLE Alert++ website of the ANeMoS / NKUA at the time of the GLE event recording. The stations FSMT, SOPB, and SOPO which triggered the alert are marked with red color in the Station Status table.*

# Screenshots of the GLE Alert ++ system on October 28, 2021 during the GLE73. The stations SOPB, SOPO, FRTM and later KERG in Alert mode.



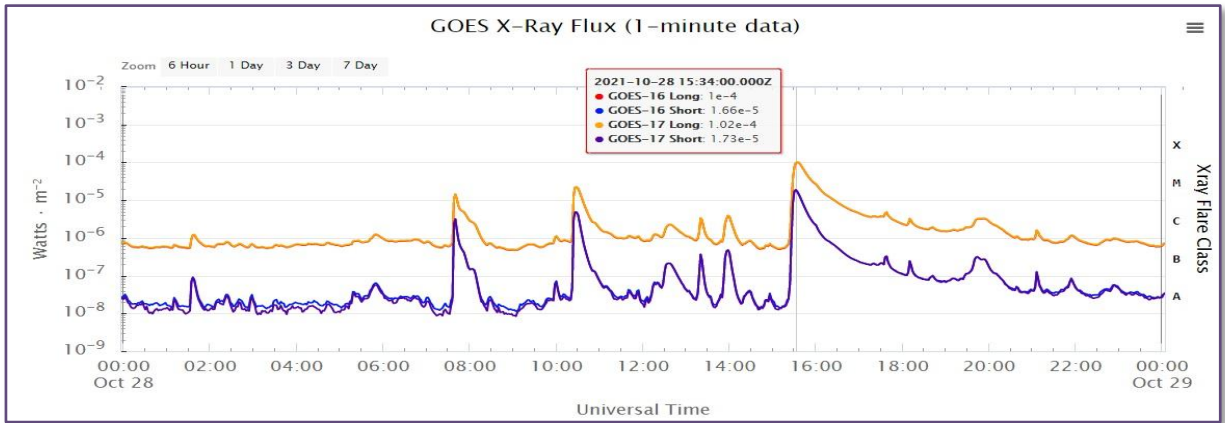
# The relevant Alert of >100 MeV protons and flux > 1pfu from GOES was issued in real-time by NOAA, on October 28, 2021 at 16:51 UT



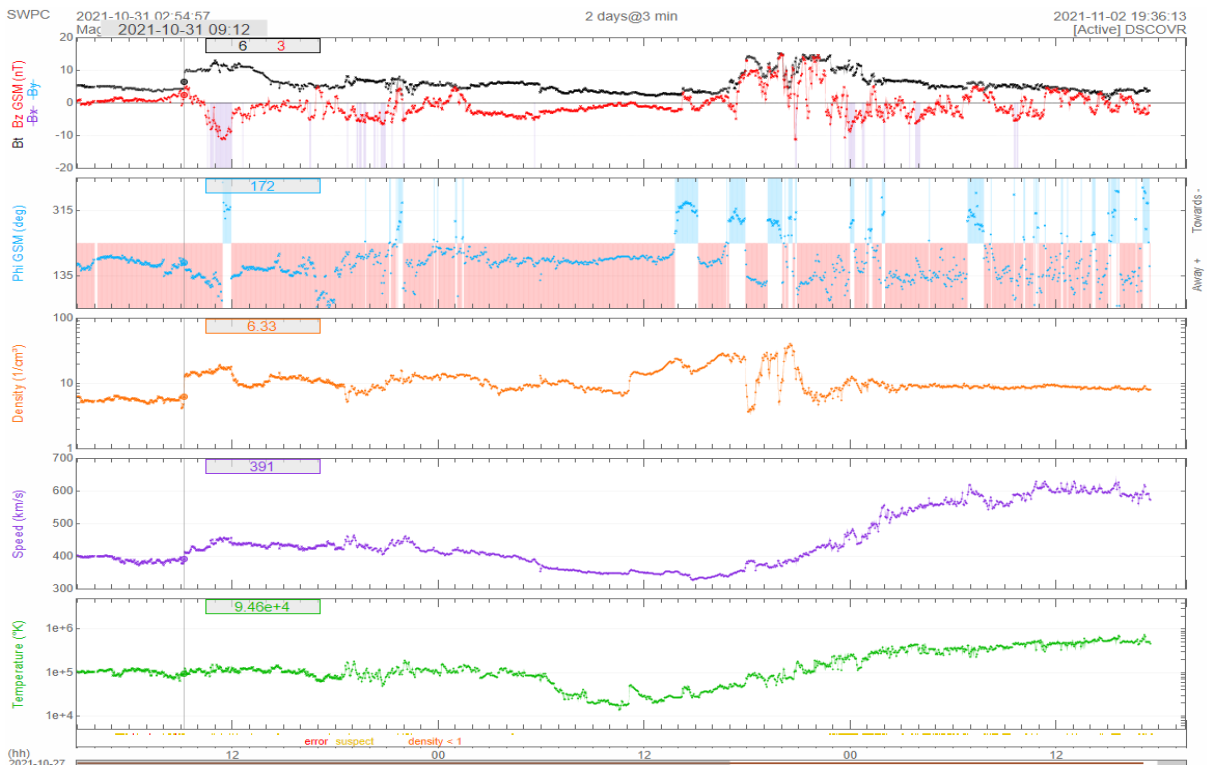
*The increase of the GOES proton flux (upper panel) triggered a solar radiation storm of S1 category according to NOAA scales. Alert signal issued by Space Weather Prediction Center \_SWPC of NOAA*

**The GLE Alert ++ signal by NKUA/ANeMoS was issued 45 min earlier than the one issued by GOES!!!**

# Flare and CME



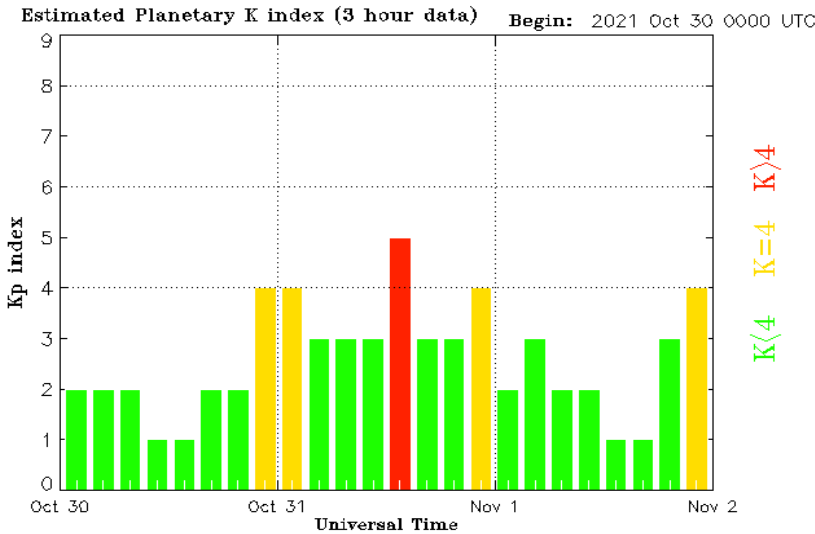
*The X1.0 solar flare as observed by the GOES satellites.*



*The associated CME with the X1.0 flare finally arrived at Earth on October 31 at approximately 09:12 UT (vertical grey line). Solar wind and plasma data are provided by DSCOVR spacecraft.*



# Space Weather Reports by the Athens Space Weather Forecasting Center at the ANeMoS / NKUA



Updated 2021 Nov 2 00:30:08 UTC

NOAA/SWPC Boulder, CO USA

\*\*\*\*\*  
 Product: Daily Forecast of Geomagnetic Activity  
 Issued: 2021 October 31 08:58UTC  
 Prepared by the Athens Space Weather Forecasting Center  
 \*\*\*\*\*

1. Solar activity  
 Solar activity was increasing during the past 24 hours.  
 Solar Flux (10.7 cm) measured on 30.10.2021 at 20:00 UTC was 107 sfu.  
 The background X-Ray flux is at the class B4.4 level.  
 The geomagnetic field was at quiet to active levels on October 30.  
 AR2887 erupted on Oct 28 producing 2 M-class (M1.4, M2.2) and 1 X-class (X1.0 15:35UT) solar flares. All these flares produced radio blackouts (of R1 and R3 levels) and the X1.0 solar flare is responsible for a solar radiation storm (S1) and a new GLE which recorded by the GLE Alert system of the ANeMoS/NKUA system. The associated halo CME is Earth directed and according the EAM predictions is expected to reach Earth between Oct 30 12:26 and Oct 31 04:51. On Oct 29 another solar flare of M1.6 class was produced by AR2887 at 02:40. The Kp index now is at unsettled levels with Kp=3.

2. Solar Wind Geomagnetic Activity  
 Solar Wind speed from ACE: 390 km/s.  
 Solar Wind speed from STEREO A: 410 km/s.  
 Solar Wind speed from STEREO B: --- km/s.  
 The southward component Bz is: 2 nT north.

3. Solar Energetic Particle Events  
 Protons and electrons are quiet.

4. Coronal Holes  
 No obvious coronal holes are currently in the visible solar disk.

5. Geophysical Activity Forecast  
 The geomagnetic field is expected to be at unsettled to strong geomagnetic storm (G3) levels on Oct 31 due to the arrival of Oct 28 CME, at quiet to minor storm (G1) levels on Nov 1 and at quiet to unsettled levels on Nov. 2.

Date	Estimated Ap index	Expected geom. storm
2021.10.31	36	G1 - G3
2021.11.01	25	G1
2021.11.02	10	-

\*\*\*\*\*  
 Athens Space Weather Forecasting Center  
 Physics Department, National & Kapodistrian University of Athens  
 Athens Neutron Monitor Station A.NE.MO.S  
 Tel.: +30 210 727 6901  
 email: spaceweather@phys.uoa.gr  
 URL: http://spaceweather.phys.uoa.gr  
 \*\*\*\*\*

*Note: A minor geomagnetic storm of G1 category was triggered in contrast to the forecasts where the most probable case was a storm of G3 category. The possible explanation is that the major part of the CME traveled below the Sun-Earth line due to the asymmetric shape of the CME.*

# Space Weather Reports by the Athens Space Weather Forecasting Center at the ANeMoS / NKUA

```
*****
% Compiled module: EAM
*****
Most pr. speed = 1109.0 km/sec
The EAM version you are running is: v3
Utilizing the upgraded version EAM_v3 [Paouris et al. 2021]
u_r =      647.787
Acceleration:      0.200029
Duration in seconds:      219532.20
Duration in days:      2.5408819
t2 is negative
*****
Acceleration of the CME:      0.20 m/s^2
Velocity of the CME at 1 AU:      691.7 km/s
Expected date and time for the arrival of the CME: 31/10/2021 Time: 04:51 UT
*****
```

*The arrival of the CME was successfully forecasted and reported. In particular, the predictions for the Time-of-Arrival of the CME were performed by the last version of the Effective Acceleration Model .*

***According to the EAMv3, the CME should arrive on October 31 at 04:51 UT and the CME finally arrived just 4 hours and 20 minutes later.***

## References

- Mavromichalaki, H., Gerontidou, M., Paschalis, P., Paouris, P., Tezari, A., Sgouropoulos, C., Crosby, N., Dierckxsens, M. (2018). Real-Time Detection of the Ground Level Enhancement on 10 September 2017 by A.Ne.Mo.S.: System Report . Space Weather, 16(11), 1797-1805.
- Paouris, E., & Mavromichalaki, H. (2017). Effective acceleration model for the arrival time of interplanetary shocks driven by coronal mass ejections. Solar Physics, 292(12), 1-11.