SPACE WEATHER INTRODUCTORY COURSE

Collaboration of

Solar-Terrestrial Centre of Excellence

Koninklijke luchtmacht

Koninklijk Nederlands
Meteorologisch Instituut
Ministerie van Infrastructuur en Milieu

Space Weather into practice – SIDC/RWC & URSIgram

Jan Janssens

SIDC/RWC & URSIgram - Contents

- SIDC/RWC
- SWx alerts
- Exercises

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- SIDC/RWC
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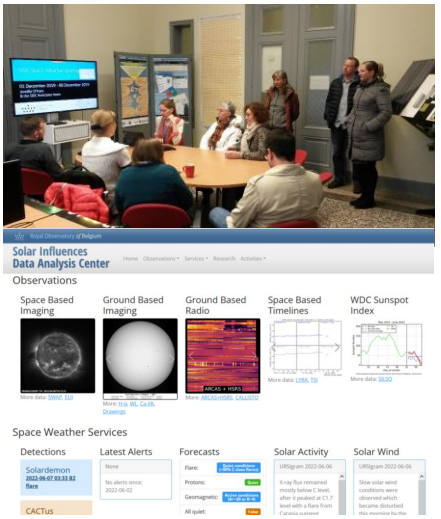
The SIDC / RWC
Regional Warning Centre Brussels

- Team of +/- 8 SWx forecasters
  - Scientists
    - Cumul job
    - Experts
  - Weekly tour of duty
    - 7/7, 14/24
    - Back-up by automated services and tools
  - IT supported
    - Previweb
      - Interface
    - Web page
    - Mailing service
  - Regular meetings
  - ICAO support: PECASUS
    - HF COM, radiation, GNSS



SIDC: Solar Influences Data analysis Center – ICAO: International Civil Aviation Organization - HF: High Frequency – GNSS: Global Navigation Satellite System ; PECASUS: Pan-European Consortium for Aviation Space weather User Services

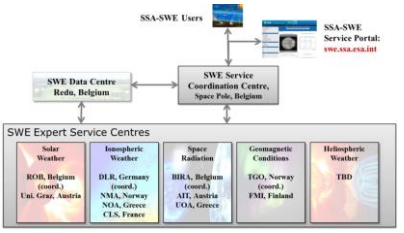
International Space Environment Service

ISES (International Space Environment Services): international network
● ROB/SIDC is RWC (Regional Warning centre) since 2000
● endorsement by national government
● Services delivered to SWE network developed under ESA SSA (Space Situational Awareness) program (cfr. presentation by MK). Expert Group coordinating the Expert Service Centre “Solar Weather”

ICAO: International Civil Aviation Organization
PECASUS: Pan-European Consortium for Aviation Space weather User Services

The SIDC / RWC
Regional Warning Centre Brussels

- International context
  - ISES
    - International Space Environment Service
  - ESA / SSCC
    - SSA Space Weather Coordination Centre
    - Services and expertise
  - World Meteorological Org.
  - ICAO / PECASUS
    - International Civil Aviation Organization



SSA: Space Situational Awareness

International Space Environment Service
http://www.spaceweather.org/

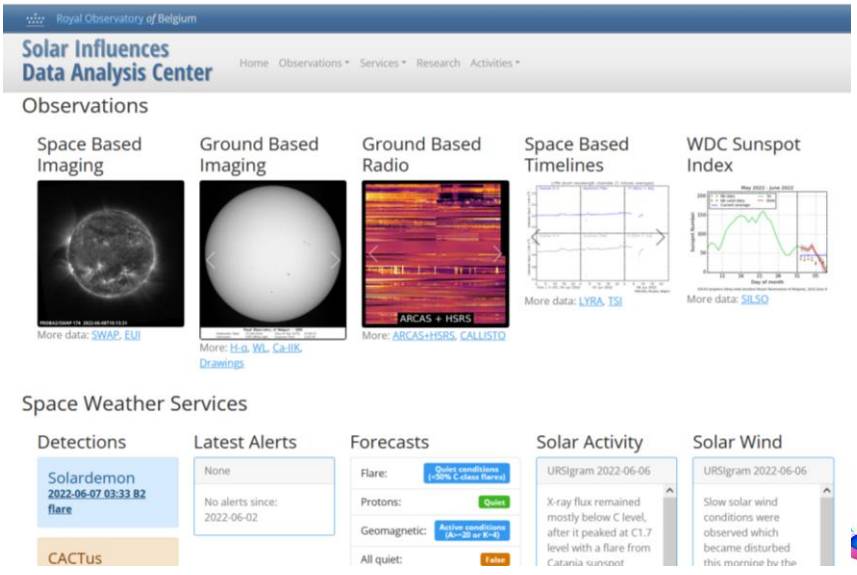
ISES (International Space Environment Services):
international network
- ROB/SIDC is RWC (Regional Warning Centre) since 2000
- endorsement by national government
- Services delivered to SWE network developed under ESA SSA (Space Situational Awareness) program (cfr. presentation by MK). Expert Group coordinating the Expert Service Centre “Solar Weather”

WMO: WMO: ICTWS: 4-year → plan for consolidation of SWx services in WMO.
ICTSW: Interprogramme Coordination Team on Space Weather
WMO: World Meteorological Organization

ICAO: International Civil Aviation Organization
PECASUS: : Pan-European Consortium for Aviation Space weather User Services

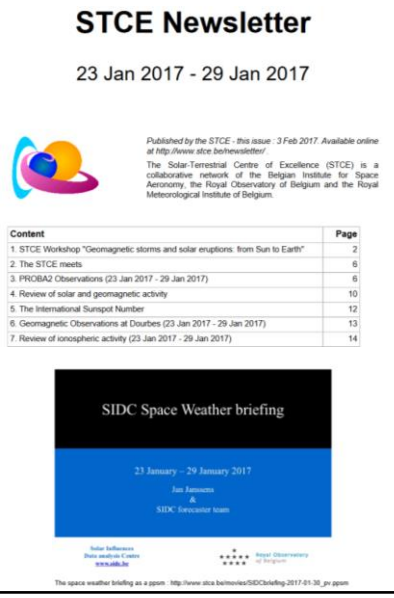
URSIgram

https://www.sidc.be/



The weekly bulletin

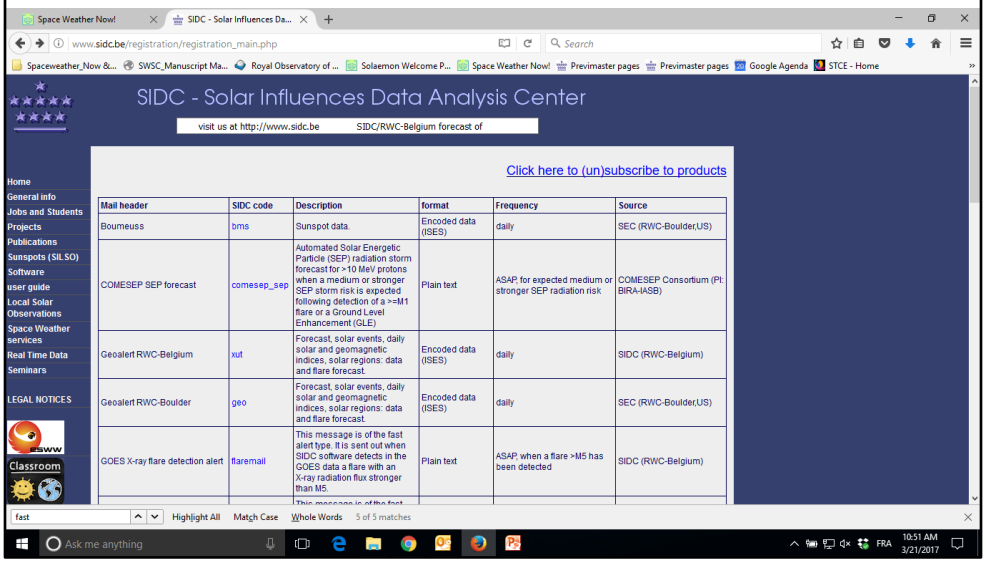
```
:Issued: 2017 Jan 30 1406 UTC
:Product: documentation at http://www.sidc.be/products/bul
#-----------------------------------------------------------------------#
# SIDC Weekly bulletin on Solar and Geomagnetic activity                #
#-----------------------------------------------------------------------#
WEEK 839 from 2017 Jan 23
SOLAR ACTIVITY
---------------
Solar activity was very low to low, with a single C-class flare produced by spotless
active region NOAA 2627 near the west limb on 28 January (C2 flare peaking at
21:09UT). A new region, NOAA 2629, developed quickly on 24 January and was
responsible for most of the B-class flaring on 24-26 January. The other regions were
mostly quiet and decaying. No earth-directed coronal mass ejections (CMEs) were
observed in available coronagraphic imagery. The greater than 10MeV proton flux was
at nominal levels. A small positive equatorial coronal hole (CH) started its transit
of the central meridian on 23 January, and a negative trans-equatorial CH was
transiting the central meridian (CM) by the end of the period.
GEOMAGNETIC ACTIVITY
--------------------
Solar wind conditions near Earth were determined by the high speed stream (HSS) from
the small positive coronal hole (CH). The co-rotating interaction region (CIR) that
preceded it, drove a small shock on 26 January at 07:12UT. The proper HSS arrived a
few hours later around 13:45UT of the same day, with solar wind speed gradually
increasing from an initial 375 km/s up to values near 670 km/s around 06UT on 27
January. Bz oscillated wildly between -12 nT and +13 nT, preventing the development
of a strong geomagnetic disturbance. As a result, only active geomagnetic conditions
were observed on 26 and 27 January, while the rest of the week was at quiet levels
with an occasional unsettled episode.
-------------------------------------------------------------------------------
DAILY INDICES
DATE          RC   EISN  10CM   Ak   BKG    M   X
2017 Jan 23   ///    057   084   006   B1.0   0   0
2017 Jan 24   053    042   082   003   B1.0   0   0
2017 Jan 25   064    046   085   005   B1.4   0   0
2017 Jan 26   053    039   083   012   B1.1   0   0
2017 Jan 27   033    028   080   021   A9.1   0   0
2017 Jan 28   ///    029   079   010   A8.5   0   0
2017 Jan 29   ///    032   077   007   A8.2   0   0
-------------------------------------------------------------------------------
# RC   : Sunspot index (Wolf Number) from Catania Observatory (Italy)
# EISN : Estimated International Sunspot Number
# 10cm : 10.7 cm  radioflux (DRAO, Canada)
# Ak   : Ak Index Wingst (Germany)
# BKG  : Background GOES X-ray level (NOAA, USA)
# M,X  : Number of X-ray flares in M and X class, see below (NOAA, USA)
-------------------------------------------------------------------------------

NOTICEABLE EVENTS SUMMARY
DAY BEGIN MAX  END  LOC    XRAY OP  10CM Catania/NOAA RADIO_BURST_TYPES
NONE
```



https://www.stce.be/
https://www.stce.be/newsletter/newsletter.php

SIDC products – Free online

https://www.sidc.be/registration/



SIDC/RWC & URSIgram - Contents

- SIDC/RWC
- SWx alerts
- Exercises

Fast alerts: automatic detection by SIDC software

Flare > M5
SIDC in GOES X-ray

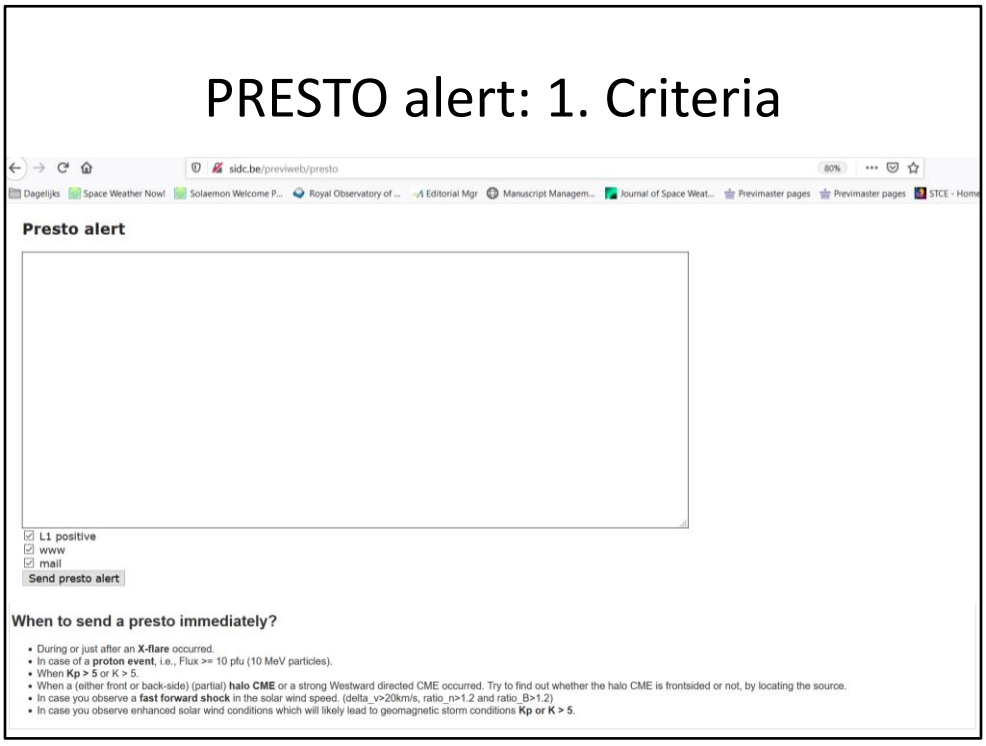
```
:Issued: 2016 Jul 24 0516 UTC
:Product: documentation at http://www.sidc.be/products/flaremail
#-----------------------------------------------------------------------#
# Large flare alerts from the SIDC (RWC-Belgium), detected in GOES      #
# X-ray data                                                            #
#-----------------------------------------------------------------------#
A class M5.5 solar X-ray flare occurred on 2016/07/23 with peak time 05:31UT
#-----------------------------------------------------------------------#
# Solar Influences Data analysis Center - RWC Belgium                   #
# Royal Observatory of Belgium                                          #
# Fax : 32 (0) 2 373 0 224                                              #
# Tel.: 32 (0) 2 373 0 491                                              #
#                                                                       #
# For more information, see http://www.sidc.be.  Please do not reply    #
# directly to this message, but send comments and suggestions to        #
# 'sidctech@oma.be'. If you are unable to use that address, use         #
# 'rvdlinden@spd.aas.org' instead.                                      #
# To unsubscribe, visit http://sidc.be/registration/unsub.php           #
#                                                                       #
# Legal notices:                                                        #
# - Intellectual Property Rights:                                       #
#   http://www.astro.oma.be/common/internet/en/data-policy-en.pdf       #
# - Liability Disclaimer:                                               #
#   http://www.astro.oma.be/common/internet/en/disclaimer-en.pdf        #
# - Use and processing of your personal information:                    #
#   http://www.astro.oma.be/common/internet/en/privacy-policy-en.pdf    #
#-----------------------------------------------------------------------#
```

Halo CME (width > 150°)
CACTus in SOHO/LASCO

```
:Issued: 2016 Nov 05 1349 UTC
:Product: documentation at http://www.sidc.be/products/cactus
#-------------------------------------------------------------------------------#
# HALO CME ALERTS from the SIDC (RWC-Belgium), generated by CACTUS              #
#-------------------------------------------------------------------------------#
  A halo or partial-halo CME was detected with the following
characteristics:

            t0      | dt0| pa | da |  v  |  dv | minv| maxv|
005|2016/11/05 04:24| 03 | 338| 178| 0297| 0048| 0200| 0452

Details can be found here:
http://www.sidc.oma.be/cactus/out/latestCMEs.html

      t0: onset time, earliest indication of liftoff
     dt0: duration of liftoff (hours)
      pa: principal angle, counterclockwise from North (degrees)
      da: angular width of the CME (degrees),
       v: median velocity (km/s)
      dv: variation (1 sigma) of velocity over the width of the CME
   mindv: lowest velocity detected within the CME
   maxdv: highest velocity detected within the CME


  This message is sent whenever a CME wider than 150 degrees is detected by
cactus.
*-------------------------------------------------------------------------------*
```

SOHO: Solar and Heiospheric Observatory
CACTus: Computer Aided CME Tracking
LASCO: Large Angle and Spectrometric Coronagraph

PRESTO alert: 1. Criteria

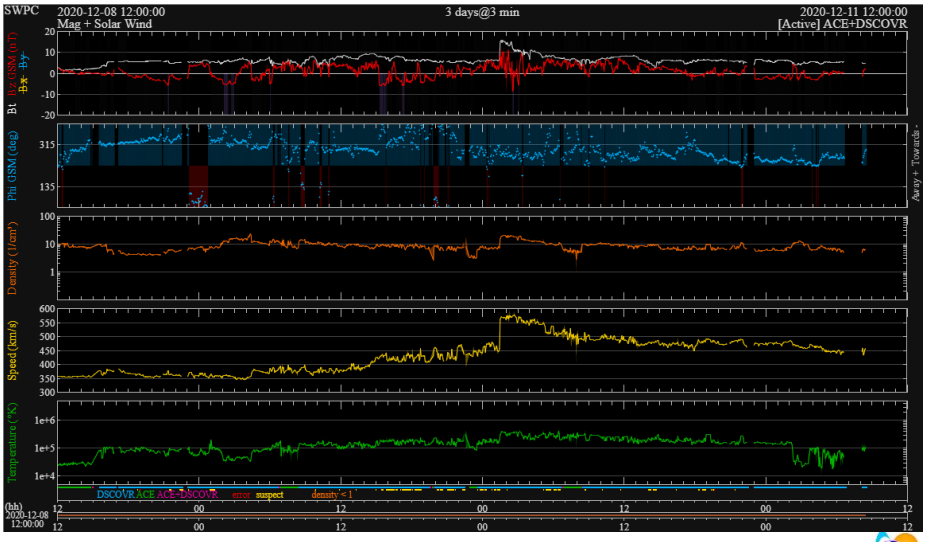


A shock is considered to have the following criteria, calculated using a 10 min average before and after the shock:

- A 20+ % increase in B, N (density), and T
- A 20+ km/s increase in V (speed)

From: Interplanetary shock database (S. Nikbakhsh, PhD thesis)
https://helda.helsinki.fi/bitstream/handle/10138/45227/Thesis.pdf

PRESTO alert: 2. Detection



PRESTO alert: 3. Send

PRESTO ALERT

Message 14 of 1168

From: Solar Influences Data analysis Center
To: jan.janssens@oma.be
Reply-To: no-reply-sidc@oma.be
Date: 10.12.2020 08:30

```
:Issued: 2020 Dec 10 0727 UTC
:Product: documentation at http://www.sidc.be/products/presto
#-----------------------------------------------------------------------#
# FAST WARNING 'PRESTO' MESSAGE  from the SIDC (RWC-Belgium)            #
#-----------------------------------------------------------------------#
A shock was seen in the solar wind at 01:34 UT marking the arrival of the CME from 7 December. The speed jumped from 450 km/s to 560 km/s and the magnetic field from 6 nT
to 16 nT. It did not have long lasting negative Bz embedded in it, therefore only unsettled conditions were seen locally (K Dourbes =3) and active at planetary levels (Kp
= 4).
#-----------------------------------------------------------------------#
# Solar Influences Data analysis Center - RWC Belgium                   #
# Royal Observatory of Belgium                                          #
#                                                                       #
# Website          http://www.sidc.be.                                  #
# E-mail           sidc-support@oma.be                                  #
# To unsubscribe   http://www.sidc.be/registration/unsub.php            #
#                                                                       #
# Legal notices:                                                        #
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# - Use and processing of your personal information:                    #
#   http://www.astro.oma.be/common/internet/en/privacy-policy-en.pdf    #
#-----------------------------------------------------------------------#
```
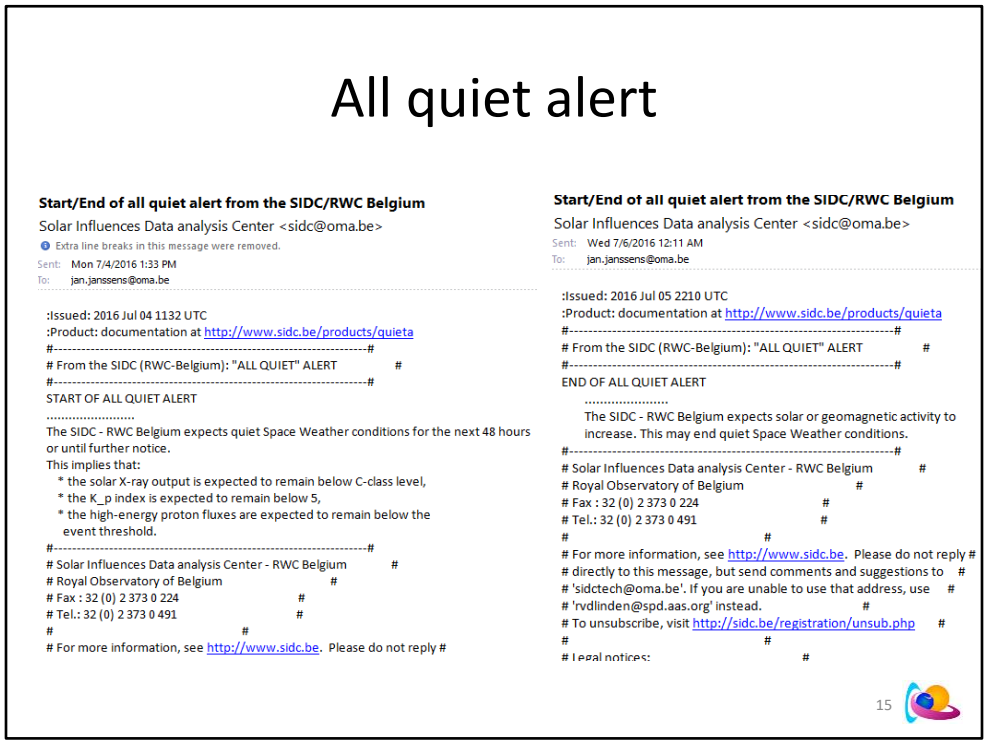


All quiet alert



Start/End of all quiet alert from the SIDC/RWC Belgium

Solar Influences Data analysis Center <sidc@oma.be>

Extra line breaks in this message were removed.

Sent: Mon 7/4/2016 1:33 PM

To: jan.janssens@oma.be

:Issued: 2016 Jul 04 1132 UTC
:Product: documentation at http://www.sidc.be/products/quieta
#---#
From the SIDC (RWC-Belgium): "ALL QUIET" ALERT
#---#
START OF ALL QUIET ALERT
.....
The SIDC - RWC Belgium expects quiet Space Weather conditions for the next 48 hours or until further notice.
This implies that:
* the solar X-ray output is expected to remain below C-class level,
* the K_p index is expected to remain below 5,
* the high-energy proton fluxes are expected to remain below the event threshold.
#---#
Solar Influences Data analysis Center - RWC Belgium
Royal Observatory of Belgium
Fax : 32 (0) 2 373 0 224
Tel.: 32 (0) 2 373 0 491
# #
For more information, see http://www.sidc.be. Please do not reply

Start/End of all quiet alert from the SIDC/RWC Belgium

Solar Influences Data analysis Center <sidc@oma.be>

Sent: Wed 7/6/2016 12:11 AM

To: jan.janssens@oma.be

:Issued: 2016 Jul 05 2210 UTC
:Product: documentation at http://www.sidc.be/products/quieta
#---#
From the SIDC (RWC-Belgium): "ALL QUIET" ALERT
#---#
END OF ALL QUIET ALERT
.....
The SIDC - RWC Belgium expects solar or geomagnetic activity to increase. This may end quiet Space Weather conditions.
#---#
Solar Influences Data analysis Center - RWC Belgium
Royal Observatory of Belgium
Fax : 32 (0) 2 373 0 224
Tel.: 32 (0) 2 373 0 491
# #
For more information, see http://www.sidc.be. Please do not reply
directly to this message, but send comments and suggestions to
'sidctech@oma.be'. If you are unable to use that address, use
'rvdlinden@spd.aas.org' instead.
To unsubscribe, visit http://sidc.be/registration/unsub.php
# #
Legal notices:

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This message is of the fast alert type. It is sent when quiet Space Weather conditions are expected for the next 48 hours or until further notice. This implies that:

- * the solar X-ray output is expected to remain below C-class level,
- * the K_p index is expected to remain below 5,
- * the high-energy proton fluxes are expected to remain below the event threshold.

All quiet alerts are send by the SWx forecaster, both to begin and to end the period.

The all quiet period is seldomly send during the solar cycle maximum, as new groups may quickly develop on disk or may round the east limb, or there may be filaments on disk that may result in flare/proton events.
The all quiet alert is also seldomly send during the ascending and declining phase as in view of the persistent high speed streams from coronal holes, as well as transients in the solar wind.

The criteria for the all quiet alerts are under debate.

PECASUS advisories

GNSS, Radiation, HF COM

FNXX02 EFKL 070850
SWX ADVISORY
DTG: 20220907/0851Z
SWXC: PECASUS
ADVISORY NR: 2022/73
NR RPLC: 2022/72
SWX EFFECT: HF COM MOD
OBS SWX: 07/0837Z HNH MNH W150 - E030
FCST SWX +6 HR: 07/1500Z NOT AVBL
FCST SWX +12 HR: 07/2100Z NOT AVBL
FCST SWX +18 HR: 08/0300Z NOT AVBL
FCST SWX +24 HR: 08/0900Z NOT AVBL
RMK: SPACE WEATHER EVENT (MAXIMUM USABLE FREQUENCY DEPRESSION) IS IN PROGRESS. IMPACT ON HIGHER HF COM FREQUENCY BANDS EXPECTED. LOWER FREQUENCY BANDS MAY BE LESS IMPACTED.
NXT ADVISORY: WILL BE ISSUED BY 20220907/1437Z=

SWX ADVISORY
DTG: 20221003/1445Z
SWXC: PECASUS
ADVISORY NR: 2022/50
SWX EFFECT: GNSS MOD
OBS SWX: 03/1342Z EQN E070 - E130
FCST SWX +6 HR: 03/2000Z NOT AVBL
FCST SWX +12 HR: 04/0200Z NOT AVBL
FCST SWX +18 HR: 04/0800Z NOT AVBL
FCST SWX +24 HR: 04/1400Z NOT AVBL
RMK: SPACE WEATHER EVENT (IONOSPHERIC DISTURBANCE) IN PROGRESS. IMPACT ON GNSS PERFORMANCE POSSIBLY LEADING TO LOSS OF GNSS SIGNALS AND/OR DEGRADATION OF TIMING AND POSITIONING PERFORMANCE.
NXT ADVISORY: WILL BE ISSUED BY 20221003/2042Z

PECASUS: Pan-European Consortium for Aviation Space weather User Services ;
GNSS: Global Navigation Satellite System ; HF COM: High Frequency Communication

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Latest advisories (last 24 hours are available on the dedicated PECASUS website (https://pecasus.eu/)
https://www.ilmailusaa.fi/warnings.html#top=0#id=swx#select-area=4#FMILang=en

Exercise: URSIgram

- Which of the following topics is usually <u>not</u> mentioned in the daily URSIgram?
  a. Visibility of the aurora
  b. The flux of high energetic (<u>≥</u> 2 MeV) electrons
  c. Ionospheric scintillation

Latest issue

```
:Issued: 2021 Feb 16 1230 UTC
:Product: documentation at http://www.sidc.be/products/meu
#-----------------------------------------------------------------------#
# DAILY BULLETIN ON SOLAR AND GEOMAGNETIC ACTIVITY from the SIDC        #
# (RWC Belgium)                                                         #
#-----------------------------------------------------------------------#
SIDC URSIGRAM 10216
SIDC SOLAR BULLETIN 16 Feb 2021, 1230UT
SIDC FORECAST (valid from 1230UT, 16 Feb 2021 until 18 Feb 2021)
SOLAR FLARES  : Quiet conditions (<50% probability of C-class flares)
GEOMAGNETISM  : Active conditions expected (A>=20 or K=4)
SOLAR PROTONS : Quiet
PREDICTIONS FOR 16 Feb 2021  10CM FLUX: 070 / AP: 014
PREDICTIONS FOR 17 Feb 2021  10CM FLUX: 070 / AP: 012
PREDICTIONS FOR 18 Feb 2021  10CM FLUX: 070 / AP: 012
COMMENT: The solar activity has been quiet over the past 24 hours. The
visible solar disc is spotless and the X-ray flux is below B-level. The
solar activity is expected to remain at low levels over the next 24 hours.

No Earth-directed coronal mass ejections (CMEs) was observed in the
available coronagraph imagery.

The greater than 10 MeV proton flux was at nominal levels in the past 24
hours and is expected to remain so in the next 24 hours. The greater than
2MeV electron flux remained under the 1000 pfu threshold and is expected to
remain so in the next 24 hours.

Over the past 24 hours the solar wind speed remained slow between 320 km/s
and 375 km/s, the total magnetic field slowly increased up 10 nT and the Bz
component ranged between -8.6 nT and 7.8 nT being mostly negative since
February 16 at 02:00 UTC. The solar wind parameters indicate that the solar
wind is slightly compressed ahead of the expected high-speed streams
associated with the extension of the northern polar coronal hole (positive
polarity, and facing Earth on February 13). The enhancements of the solar
wind conditions are expected to persist with the speed increasing .

The geomagnetic conditions over the past 24 hours were active in response
to the enhanced interplanetary magnetic field and the prolonged period of
southward directed Bz component. Unsettled conditions are expected for the
next 24 hours with possible active periods due to the enhancement of the
solar wind parameters as long as Earth remains under the influence of the
coronal hole wind speed.

TODAY'S ESTIMATED ISN  : 000, BASED ON 17 STATIONS.

SOLAR INDICES FOR 15 Feb 2021
WOLF NUMBER CATANIA    : 000
10CM SOLAR FLUX        : 070
AK CHAMBON LA FORET    : 017
AK WINGST              : ///
ESTIMATED AP           : 008
ESTIMATED ISN          : 000, BASED ON 16 STATIONS.

NOTICEABLE EVENTS SUMMARY
DAY BEGIN MAX  END  LOC    XRAY OP  10CM Catania/NOAA RADIO_BURST_TYPES
NONE
END
```

Space Weather into practice – URSIgram exercises

Jan Janssens

SIDC URSIGRAM 30515
SIDC SOLAR BULLETIN 15 May 2013, 1205UT
SIDC FORECAST (valid from 1230UT, 15 May 2013 until 17 May 2013)
SOLAR FLARES : Major flares expected (X-class flares expected, probability >=50%)
GEOMAGNETISM : Active conditions expected (A>=20 or K=4)
SOLAR PROTONS : Proton event expected (10 pfu at >10 MeV)
PREDICTIONS FOR 15 May 2013 10CM FLUX: 150 / AP: 017
PREDICTIONS FOR 16 May 2013 10CM FLUX: 152 / AP: 014
PREDICTIONS FOR 17 May 2013 10CM FLUX: 153 / AP: 011

COMMENT:A class X1.2 solar flare occurred today with peak time 01:48 UT, from NOAA AR 1748 which has a beta-gamma-delta magnetic configuration. It was associated with radio bursts and an increase of GOES proton flux levels, now at 5 protons/cm2-s-sr, the threshold of 10 protons/cm2-s-sr will likely be reached soon (at >=10 MeV). The increases in proton flux likely come from the CME driven shock. If the strong flares from this AR continue, the proton increases will likely be more abrupt when the magnetic connection between the flare site and the Earth is better (i.e. when the AR is in the western hemisphere). A CME was associated with the event, a shock and glancing blow can probably be expected at the Earth late on May 16 (CME speed 1700 km/s in LASCO C2).

Geomagnetic conditions are quiet, but ACE data shows a disturbance starting this morning, with currently magnetic intensity close to 15 nT (northwards, so no geomagnetic effect). There is not enough data yet to discern clearly its cause, but it is likely related to the CME on May 12 (and possibly those from the two previous days related to X-flares from NOAA AR 1748). Geomagnetic conditions are expected to be unsettled to active, with possible isolated minor storm periods.

TODAY'S ESTIMATED ISN : 099, BASED ON 11 STATIONS.

SOLAR INDICES FOR 14 May 2013
WOLF NUMBER CATANIA : 176
10CM SOLAR FLUX : 148
AK CHAMBON LA FORET : 012
AK WINGST : 009
ESTIMATED AP : 008
ESTIMATED ISN : 102, BASED ON 14 STATIONS.

NOTICEABLE EVENTS SUMMARY

DAY	BEGIN	MAX	END	LOC	XRAY	OP	10CM	RADIO BURST TYPES	Catania	NOAA	NOTE
15	0125	0148	0158	N12E64	X1.2	2N		IV/2II/1		1748	

END

URSIgram – Exercise 1

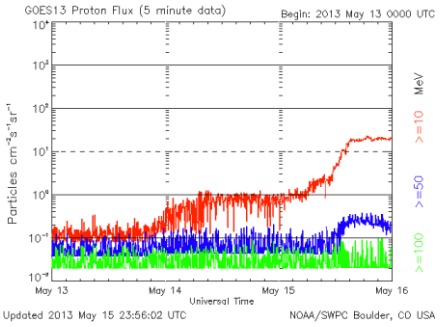
- **Setting**
  - You have received the above URSIgram. It is now 18:00UT on 15 May 2013. You have to brief your SWx colleagues.
- **Questions – Part 1 of 2: Reading-Comprehension questions**
  - Was the X1.2 flare: a) a strong flare (which class)? b) a long duration event (LDE)?
  - What kind of radio burst (SRB) is type «IV/2II/1 »?
  - 'Active geomagnetic conditions' correspond to which NOAA scale?
  - ' protons/cm2-s-sr ' : This is the unit for which parameter? What is the short notation for this unit?
  - Despite the relatively strong magnetic field strength of 15 nT, no strong geomagnetic effects were recorded from this CME. Why?
  - ' Beta-Gamma-Delta ': What's the name of the corresponding active region classification scheme? What is the simplest type possible?
  - For the geomagnetic prediction of 15 May, why is A >= 20 while Ap=17?
  - What is being evaluated under the column « OP »?

URSIgram – Exercise 1

- **Setting**
  - You have received the above URSIgram. It is now 18:00UT on 15 May 2013. You have to brief your SWx colleagues.
- **Questions – Part 2 of 2: SWx impact questions**
  - Has the >10MeV proton event threshold been reached? If yes, what would be your communications advice concerning a Dutch fregate operating north of Iceland?
  - You received a report from Gilze-Rijen Air Base (The Netherlands) about HF radio communication problems around 01:45UT. Do you think they were related to the X1.2 flare?
  - With the LASCO/C2 data now fully available, do you agree (part of) the CME is headed for Earth? Why (not)?
  - Was the X1.2 event a Tenflare? Do you think the 10.7 cm radio flux of 20:00UT will be affected?
  - « … possible isolated minor storm periods. » Do you expect important satellite communications problems?

URSIgram – Exercise 1

- Question 1:
  - Has the >10MeV proton event threshold been reached? If yes, what would be your communications advice concerning a Dutch submarine operating north of Iceland?



S 4	Severe	**Biological:** Unavoidable radiation hazard to astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. **Satellite operations:** May experience memory device problems and noise on imaging systems; star-tracker problems may cause orientation problems, and solar panel efficiency can be degraded. **Other systems:** Blackout of HF radio communications through the polar regions and increased navigation errors over several days are likely.
S 3	Strong	**Biological:** Radiation hazard avoidance recommended for astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. **Satellite operations:** Single-event upsets, noise in imaging systems, and slight reduction of efficiency in solar panel are likely. **Other systems:** Degraded HF radio propagation through the polar regions and navigation position errors likely.
S 2	Moderate	**Biological:** Passengers and crew in high-flying aircraft at high latitudes may be exposed to elevated radiation risk. **Satellite operations:** Infrequent single-event upsets possible. **Other systems:** Small effects on HF propagation through the polar regions and navigation at polar cap locations possibly affected.
S 1	Minor	**Biological:** None. **Satellite operations:** None. **Other systems:** Minor impacts on HF radio in the polar regions.

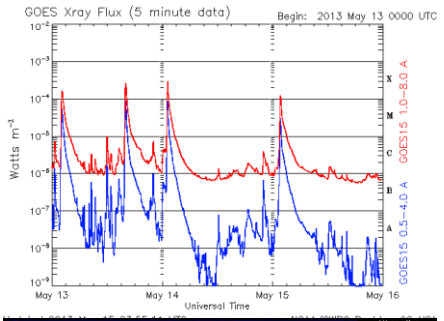
Real-time: https://www.swpc.noaa.gov/products/goes-proton-flux

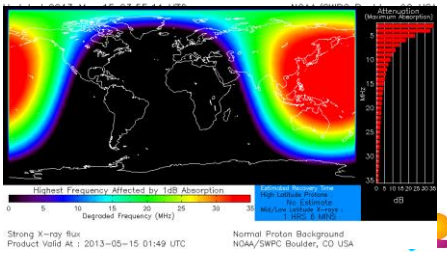
Nowcast e.g. COMESEP: https://swe.ssa.esa.int/bira-comesep-federated
Nowcast e.g. D-RAP: https://www.swpc.noaa.gov/products/d-region-absorption-predictions-d-rap

Archive at ftp://ftp.swpc.noaa.gov/pub/warehouse/

URSIgram – Exercise 1

- Question 2:
  - You received a report from Gilze-Rijen Air Base (The Netherlands) about HF radio communication problems on 15 May around 01:45UT. Do you think they were related to the X1.2 flare?





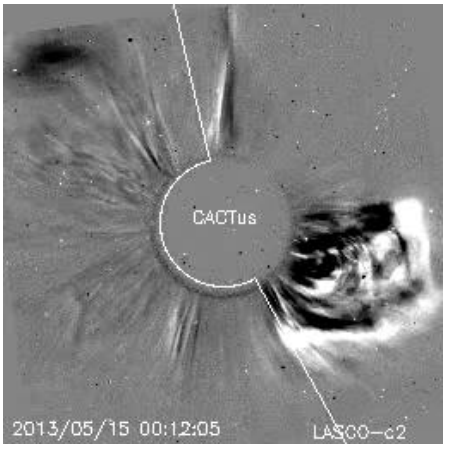
Real-time: https://www.swpc.noaa.gov/products/goes-x-ray-flux

Nowcast e.g. D-RAP: https://www.swpc.noaa.gov/products/d-region-absorption-predictions-d-rap

Archive at ftp://ftp.swpc.noaa.gov/pub/warehouse/

URSIgram – Exercise 1

- Question 3:
  - With the LASCO/C2 data now fully available, do you agree (part of) the CME is headed for Earth? Why (not)?



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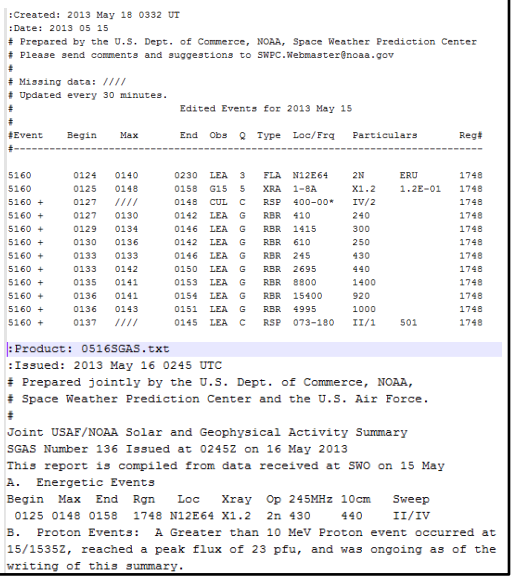
Real-time data at https://www.sidc.be/cactus/out/latestCMEs.html

Archive at https://www.sidc.be/cactus/catalog.php

Movie of this event at https://www.sidc.be/cactus/catalog/LASCO/2_5_0/2013/05/CME0079/CME.html

URSIgram – Exercise 1

- Question 4:
  - Was the X1.2 event a Tenflare? Do you think the 10.7 cm radio flux of 20:00UT will be affected?



```
:Created: 2013 May 18 0332 UT
:Date: 2013 05 15
# Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center
# Please send comments and suggestions to SWPC.Webmaster@noaa.gov
#
# Missing data: ////
# Updated every 30 minutes.
#                          Edited Events for 2013 May 15
#
#Event    Begin    Max      End  Obs  Q  Type  Loc/Frq   Particulars      Reg#
#-------------------------------------------------------------------------------

5160       0124   0140     0230  LEA  3   FLA  N12E64    2N      ERU      1748
5160       0125   0148     0158  G15  S   XRA  1-8A      X1.2    1.2E-01  1748
5160 +     0127   ////     0148  CUL  C   RSP  400-00*   IV/2             1748
5160 +     0127   0130     0142  LEA  G   RBR  410       240              1748
5160 +     0129   0134     0146  LEA  G   RBR  1415      300              1748
5160 +     0130   0136     0142  LEA  G   RBR  610       250              1748
5160 +     0133   0133     0146  LEA  G   RBR  245       430              1748
5160 +     0133   0142     0150  LEA  G   RBR  2695      440              1748
5160 +     0135   0141     0153  LEA  G   RBR  8800      1400             1748
5160 +     0136   0141     0154  LEA  G   RBR  15400     920              1748
5160 +     0136   0143     0151  LEA  G   RBR  4995      1000             1748
5160 +     0137   ////     0145  LEA  C   RSP  073-180   II/1    501      1748

:Product: 0516SGAS.txt
:Issued: 2013 May 16 0245 UTC
# Prepared jointly by the U.S. Dept. of Commerce, NOAA,
# Space Weather Prediction Center and the U.S. Air Force.
#
Joint USAF/NOAA Solar and Geophysical Activity Summary
SGAS Number 136 Issued at 0245Z on 16 May 2013
This report is compiled from data received at SWO on 15 May
A.  Energetic Events
Begin  Max  End  Rgn   Loc   Xray  Op 245MHz 10cm   Sweep
 0125 0148 0158  1748 N12E64 X1.2  2n 430    440    II/IV
B.  Proton Events:  A Greater than 10 MeV Proton event occurred at
15/1535Z, reached a peak flux of 23 pfu, and was ongoing as of the
writing of this summary.
```

Real-time at https://www.swpc.noaa.gov/products/solar-and-geophysical-event-reports

Summary at https://www.swpc.noaa.gov/products/solar-and-geophysical-activity-summary

Archive at ftp://ftp.swpc.noaa.gov/pub/warehouse/

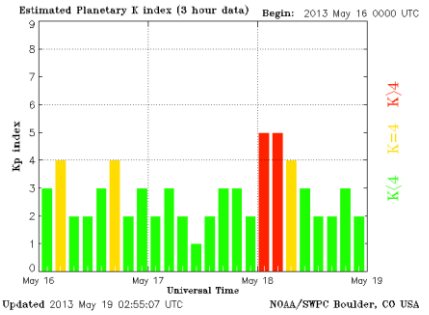
The daily values for the 10.7cm radio flux can be found at
Penticton: https://www.spaceweather.ca/forecast-prevision/solar-solaire/solarflux/sx-4a-en.php
SWPC/NOAA: ftp://ftp.swpc.noaa.gov/pub/lists/radio/rad.txt

For 14 & 15 May, the Penticton values were as follows:

Date	Time	Julian day	Carr. Rot.	**Observed Flux**	Adjusted Flux	URSI Flux
2013-05-14	17:00:00	2456427.197	2136.996	**148.1**	151.4	136.2
2013-05-14	20:00:00	2456427.322	2137.001	**147.9**	151.1	136.0
2013-05-14	23:00:00	2456427.447	2137.005	**147.8**	151.0	135.9
2013-05-15	17:00:00	2456428.197	2137.033	**141.8**	144.9	130.4
2013-05-15	20:00:00	2456428.322	2137.037	**145.6**	148.8	133.9
2013-05-15	23:00:00	2456428.447	2137.042	**148.7**	152.0	136.8

URSIgram – Exercise 1

- Question 5:
  - « … possible isolated minor storm periods. » Do you expect important satellite communications problems?



G 3	Strong	**Power systems:** Voltage corrections may be required, false alarms triggered on some protection devices. **Spacecraft operations:** Surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems. **Other systems:** Intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.).
G 2	Moderate	**Power systems:** High-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage. **Spacecraft operations:** Corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions. **Other systems:** HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.).
G 1	Minor	**Power systems:** Weak power grid fluctuations can occur. **Spacecraft operations:** Minor impact on satellite operations possible. **Other systems:** Migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine).

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Real-time:
NOAA Kp: https://www.swpc.noaa.gov/products/planetary-k-index
K Dourbes, K BEL: http://ionosphere.meteo.be/geomagnetism/K_BEL/
Dst: http://wdc.kugi.kyoto-u.ac.jp/dst_realtime/presentmonth/index.html
DSCOVR: https://www.swpc.noaa.gov/products/real-time-solar-wind
TEC (DLR, ROB/GNSS): https://impc.dlr.de/products ; http://gnss.be/Atmospheric_Maps/ionospheric_maps.php

Archive at ftp://ftp.swpc.noaa.gov/pub/warehouse/

SIDC URSIGRAM 50623
SIDC SOLAR BULLETIN 23 Jun 2015, 1242UT
SIDC FORECAST (valid from 1230UT, 23 Jun 2015 until 25 Jun 2015)
SOLAR FLARES : M-class flares expected (probability >=50%)
GEOMAGNETISM : Major magstorm expected (A>=50 or K>=6)
SOLAR PROTONS : Proton event in progress (>10 MeV)
PREDICTIONS FOR 23 Jun 2015 10CM FLUX: 135 / AP: 038
PREDICTIONS FOR 24 Jun 2015 10CM FLUX: 130 / AP: 038
PREDICTIONS FOR 25 Jun 2015 10CM FLUX: 125 / AP: 018
COMMENT: NOAA active region 2371 produced an M6.5 flare, peaking at 18:23 UT on June 22. An associated full halo CME erupted, with first measurement in LASCO C2 at 18:36 UT on June 22 and has a projected speed around 1000 km/s . A few filament eruptions were recorded in the Northwest quadrant, first a small one around 22:00 UT and then an extended one starting near 4:24 UT. Coronagraphic data indicate the occurrence of (mainly westward) CMEs, but incomplete data currently prohibit full analysis.

Proton levels have descended from the peak of 1070 pfu (19UT), despite some smaller peaks and are around 30 pfu at the moment. NOAA AR 2367 is now close to the West limb and could, in case of further eruptions, elevate the proton levels again. The proton levels might also be enhanced at the expected June 22 CME arrival. Flares at the M-level are expected, with some chance (15%) for a flare at the X-level.

A shock arrived to the ACE spacecraft at 18:01 UT on June 22, marking the expected arrival of the June 21 CME. The interplanetary magnetic field (IMF) magnitude jumped to 42 nT, with long periods of negative Bz down to -39 nT. Solar wind speeds reached values between 600 and 780 km/s. The IMF magnitude has declined to a current value of 12 nT.

Minor to severe geomagnetic conditions were recorded, with severe levels between 18 and 21 UT (on June 22) and between 3 and 6 UT (on June 23). The local K at Dourbes reached K=8 at 22 UT (on June 22). A decline to unsettled levels is expected for the coming hours. Further minor to major storm levels are expected, following the expected arrival of June 22 CME around 12:00 UT on June 24.

TODAY'S ESTIMATED ISN : 042, BASED ON 14 STATIONS.

SOLAR INDICES FOR 22 Jun 2015
WOLF NUMBER CATANIA : 083
10CM SOLAR FLUX : 135
AK CHAMBON LA FORET : 108
AK WINGST : ///
ESTIMATED AP : 073
ESTIMATED ISN : 047, BASED ON 23 STATIONS.

NOTICEABLE EVENTS SUMMARY
DAY BEGIN MAX END LOC XRAY OP 10CM Catania/NOAA RADIO_BURST_TYPES
22 1739 1823 1851 N12W08 M6.5 2B 1000 92/2371 II/1
END

URSIgram – Exercise 2

- **Setting**
  - You have received the above URSIgram (23 June 2015 – 12:42UT). You have to brief your SWx colleagues.
- **Questions**
  - Where on the solar surface did the M6 flare take place?
  - How would you characterize the solar activity level (very low, … , very high) over the last 24 hours?
  - Did the M6 flare affect the daily 10.7cm radio flux of 22 June?
  - A proton event is in progress.
    - Do you (still) expect a GLE?
    - What would you recommend concerning arctic polar flights?
  - In terms of Dst, how strong would you expect this event to be (Quiet, … , Extreme)?
  - Based on the description of the geomagnetic storm:
    - Would you expect major satellite problems from deep di-electric charging?
    - Would you expect degradation of GNSS applications (WAAS,…)?

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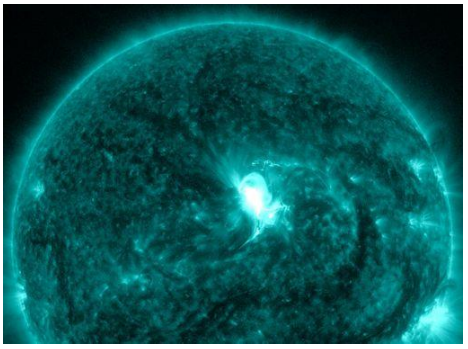
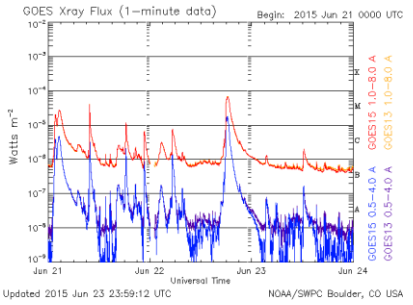
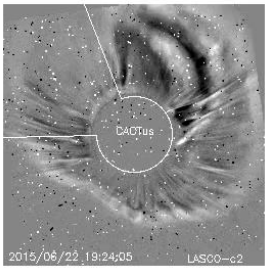
URSIgram – Exercise 2

- Where on the solar surface did the M6 flare take place?







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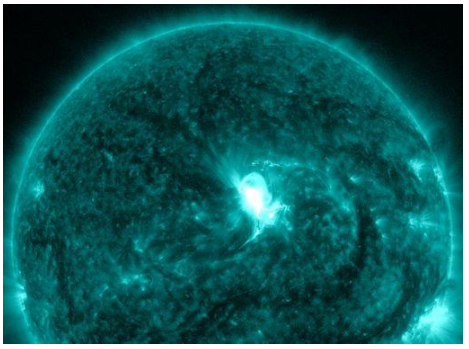
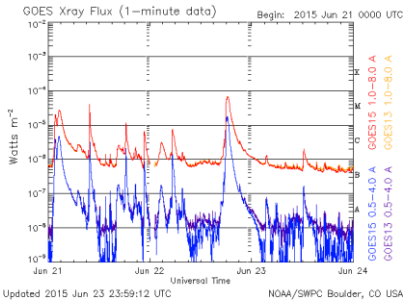
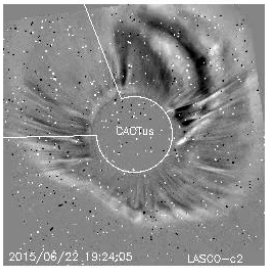
URSIgram – Exercise 2

- How would you characterize the solar activity level (very low, … , very high) over the last 24 hours?







URSIgram – Exercise 2

- Did the M6 flare affect the daily 10.7cm radio flux of 22 June?

TODAY'S ESTIMATED ISN : 042, BASED ON 14 STATIONS.

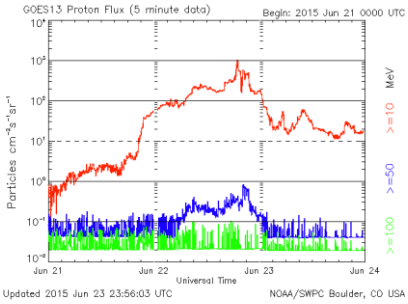
SOLAR INDICES FOR 22 Jun 2015
WOLF NUMBER CATANIA : 083
10CM SOLAR FLUX :
AK CHAMBON LA FORET : 108
AK WINGST : ///
ESTIMATED AP : 073
ESTIMATED ISN : 047, BASED ON 23 STATIONS.

NOTICEABLE EVENTS SUMMARY
DAY BEGIN MAX END LOC XRAY OP 10CM Catania/NOAA RADIO_BURST_TYPES
22 1739 1823 1851 N12W08 M6.5 2B 1000 92/2371 II/1

Date	Time	Julian day	Carrington rotation	Observed Flux	Adjusted Flux	URSI Flux
2015-06-20	17:00:00	2457194.197	2165.117	134.4	138.8	124.9
2015-06-20	20:00:00	2457194.322	2165.121	135.4	139.8	125.8
2015-06-20	23:00:00	2457194.447	2165.126	134.0	138.4	124.5
2015-06-21	17:00:00	2457195.197	2165.153	133.0	137.4	123.6
2015-06-21	20:00:00	2457195.322	2165.158	131.7	136.0	122.4
2015-06-21	23:00:00	2457195.447	2165.163	128.6	132.8	119.5
2015-06-22	17:00:00	2457196.197	2165.190	130.1	134.3	120.9
2015-06-22	20:00:00	2457196.322	2165.195	246.9	255.0	229.5
2015-06-22	23:00:00	2457196.447	2165.199	127.2	131.3	118.2
2015-06-23	17:00:00	2457197.197	2165.227	116.5	120.3	108.3
2015-06-23	20:00:00	2457197.322	2165.231	116.1	119.9	107.9
2015-06-23	23:00:00	2457197.447	2165.236	116.6	120.4	108.4

URSIgram – Exercise 2

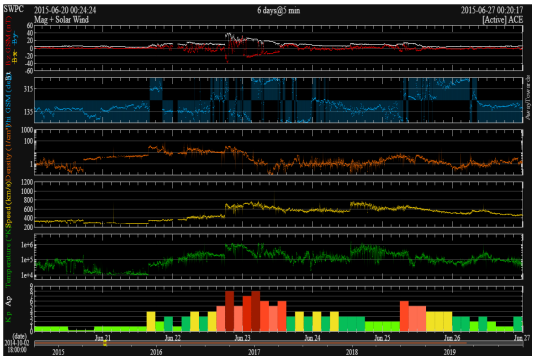
- A proton event is in progress.
  - Do you (still) expect a GLE?
  - What would you recommend concerning arctic polar flights?

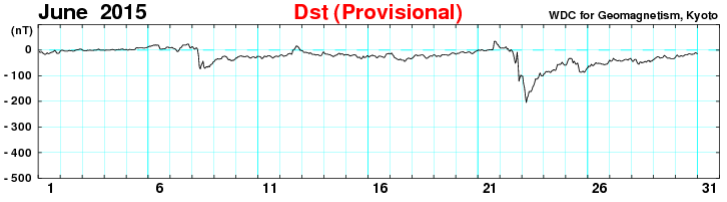


S 4	Severe	**Biological:** Unavoidable radiation hazard to astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. **Satellite operations:** May experience memory device problems and noise on imaging systems; star-tracker problems may cause orientation problems, and solar panel efficiency can be degraded. **Other systems:** Blackout of HF radio communications through the polar regions and increased navigation errors over several days are likely.
S 3	Strong	**Biological:** Radiation hazard avoidance recommended for astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. **Satellite operations:** Single-event upsets, noise in imaging systems, and slight reduction of efficiency in solar panel are likely. **Other systems:** Degraded HF radio propagation through the polar regions and navigation position errors likely.
S 2	Moderate	**Biological:** Passengers and crew in high-flying aircraft at high latitudes may be exposed to elevated radiation risk. **Satellite operations:** Infrequent single-event upsets possible. **Other systems:** Small effects on HF propagation through the polar regions and navigation at polar cap locations possibly affected.
S 1	Minor	**Biological:** None. **Satellite operations:** None. **Other systems:** Minor impacts on HF radio in the polar regions.

URSIgram – Exercise 2

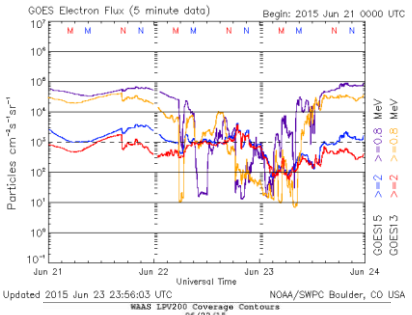
- In terms of Dst, how strong would you expect this event to be (Quiet, … , Extreme)?

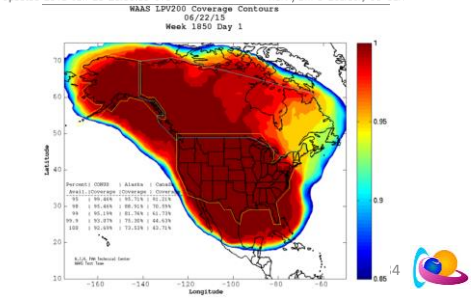




URSIgram – Exercise 2

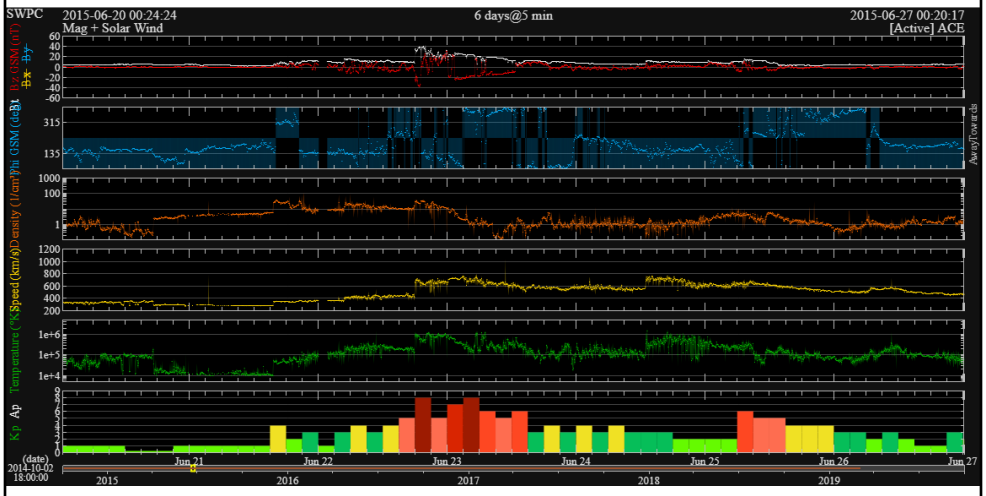
- Based on the description of the geomagnetic storm:
  - Would you expect major satellite problems from deep di-electric charging?
  - Would you expect degradation of GNSS applications (WAAS,…)?





https://www.sciencedirect.com/topics/engineering/augmentation-system

URSIgram – Exercise 2



SIDC URSIGRAM 30424
SIDC SOLAR BULLETIN 24 Apr 2023, 1236UT
SIDC FORECAST (valid from 1230UT, 24 Apr 2023 until 26 Apr 2023)
SOLAR FLARES : C-class flares expected, (probability >=50%)
GEOMAGNETISM : Minor storm expected (A>=30 or K=5)
SOLAR PROTONS : Quiet
PREDICTIONS FOR 24 Apr 2023 10CM FLUX: 133 / AP: 051
PREDICTIONS FOR 25 Apr 2023 10CM FLUX: 140 / AP: 018
PREDICTIONS FOR 26 Apr 2023 10CM FLUX: 145 / AP: 010
COMMENT: Solar flaring activity was low and infrequent during the last 24 hours. Three C-class flares were detected, all from NOAA Active Region (AR) 3282 (magnetic type Beta-Gamma, Catania group 61). Further C-class activity is likely in the next 24 hours, either from NOAA AR 3282 or NOAA AR 3285 (magnetic type Beta, Catania group 65).

No Earth-directed Coronal Mass Ejections (CME) were observed in the last 24 hours.

The greater than 10 MeV proton flux exceeded the 10 pfu level yesterday between 18:15 and 18:40 UT and stayed at nominal levels for the rest of the past 24 hours. In the next 24 hours it is expected to remain below the 10 pfu level. The greater than 2 MeV electron flux remained below the 1000 pfu alert threshold and is expected to remain below this threshold during the next 24 hours. The 24h electron fluence was at nominal levels and is expected to remain so.

A small equatorial coronal hole of negative polarity started crossing the central meridian today. An associated high speed stream in in-situ solar wind measurements is expected for 28 April.

The Solar Wind (SW) conditions are strongly affected by the arrival of a Coronal Mass Ejection (CME) as previously forecasted. The SW speed increased from 340 km/s before the arrival of the CME to 650 km/s by today 01:00 UT. The total interplanetary magnetic field (Btot) increased to 35 nT yesterday at 17:00 UT, while its North-South component (Bz) dropped as low as -33 nT. The interplanetary magnetic field phi angle was predominantly directed towards the Sun over the last 24 hours. For the next 24 hours the SW speed and the Btot are expected to remain high, however the Bz has already increased above zero and is not expected to drop to such low values in the next 24 hours.

Geomagnetic conditions reached globally severe storm (Kp 8 between 18:00-21:00 UT yesterday and 03:00-06:00 UT today, Kp 8- between 21:00-00:00 yesterday) and strong storm (Kp 7 between 00:00-03:00 and Kp 7- between 06:00-09:00 today), while the rest of the time they were at minor to moderate storm levels. Locally the situation was rather similar, with K BEL at storm level (K BEL 5 or more) since yesterday 21:00 UT. Storm levels are expected for the next several hours and a significant decrease for the rest of the next 24 hours, both globally and locally.

TODAY'S ESTIMATED ISN : 077, BASED ON 09 STATIONS.

SOLAR INDICES FOR 23 Apr 2023
WOLF NUMBER CATANIA : ///
10CM SOLAR FLUX : 135
AK CHAMBON LA FORET : 103
AK WINGST : 062
ESTIMATED AP : 055
ESTIMATED ISN : 087, BASED ON 16 STATIONS.

NOTICEABLE EVENTS SUMMARY
DAY BEGIN MAX END LOC XRAY OP 10CM Catania/NOAA RADIO_BURST_TYPES
NONE
END

URSIgram – Exercise 3

- **Setting**
  - You have received the above URSIgram (24 April 2023 – 12:36UT). You have to brief your SWx colleagues.
- **Questions**
  - Do you agree with the SWx forecasters prognosis of solar flare activity (C-class flares expected)? Why (not)?
  - Around 14:15UT, the Humain solar radio observatory detects a disturbance in the radio-spectrogram. What type of solar radio-burst is this?
  - In terms of Dst, how strong would you expect this event to be (Quiet, … , Extreme)? Do you expect any drag effects?
  - Based on the description of the geomagnetic storm, would you expect degradation of GNSS applications (WAAS,…)?
  - Do you still expect there will be advisories (warning messages) for the International civil aviation to be send? If yes, in which domains (GNSS, Radiation, HF Com)?

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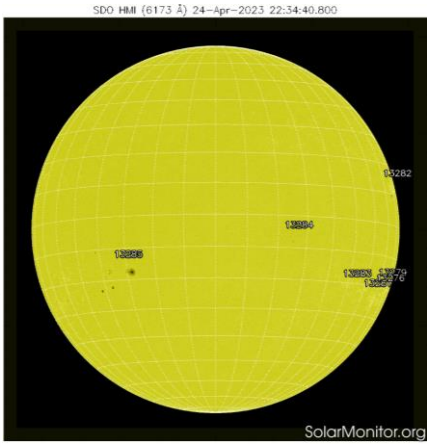
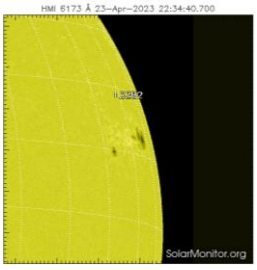
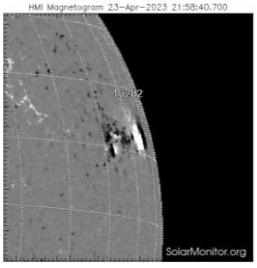
URSIgram – Exercise 3

- Do you agree with the SWx forecasters prognosis of solar flare activity (C-class flares expected)? Why (not)?

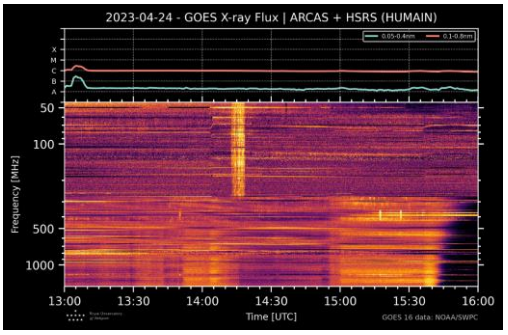






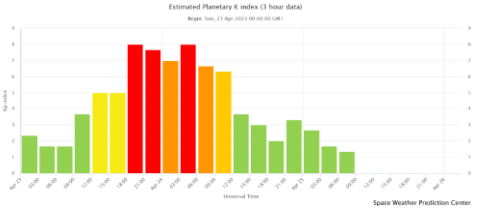
URSIgram – Exercise 3

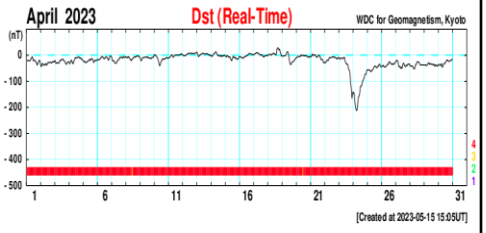
- Around 14:15UT, the Humain solar radio observatory detects a disturbance in the radio-spectrogram. What type of solar radio-burst is this?

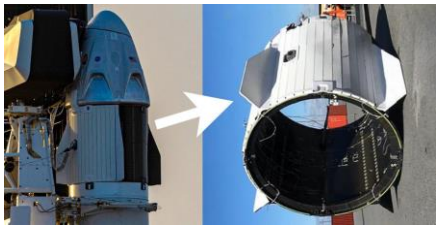


URSIgram – Exercise 3

- In terms of Dst, how strong would you expect this event to be (Quiet, … , Extreme)?
- Do you expect any drag effects?

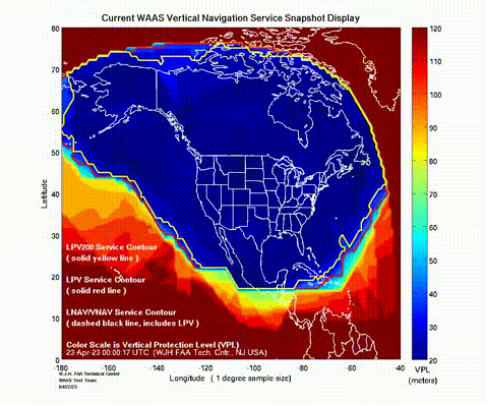






URSIgram – Exercise 3

- Based on the description of the geomagnetic storm, would you expect degradation of GNSS applications (WAAS,…)?



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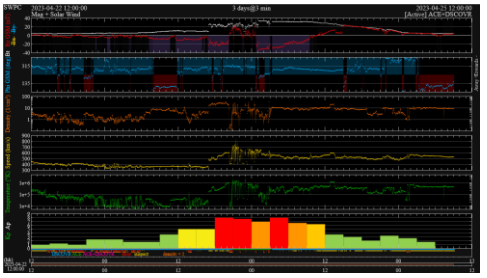
https://www.stce.be/news/642/welcome.html

URSIgram – Exercise 3

- Do you still expect there will be advisories (warning messages) for the International civil aviation to be send? If yes, in which domains (GNSS, Radiation, HF Com)?



PECASUS DASHBOARD on 2023-04-24 12:00 UTC

GNSS	Moderate	Severe	Time UTC	Values	Status	Alert	Max-3h values	Max-3h status
Amplitude Scintillation	0.5	0.8	2023-04-24 12:00	0.38	QUIET		0.38	QUIET
Phase Scintillation	0.4	0.7	2023-04-24 12:00	0.30	QUIET		0.33	QUIET
Vertical TEC	125	175	2023-04-24 12:00	162.59	QUIET		162.83	MODERATE

RADIATION	Moderate	Severe	Time UTC	Flags	Status	Alert	Max-3h flags	Max-3h status
Effective Dose FL ≤ 460	30	80	2023-04-24 12:00	0	QUIET		0	QUIET
Effective Dose FL > 460	/	80	2023-04-24 12:00	0	QUIET		0	QUIET

HF COM	Moderate	Severe	Time UTC	Values/Flags	Status	Alert	Max-3h values	Max-3h status
Auroral Absorption (AA)	8	9	2023-04-24 12:00	5.0	QUIET		6.3	WARNING
Polar Cap Absorption (PCA)	2	5	2023-04-24 12:00	0.06	QUIET		0.19	QUIET
Shortwave Fadeout (SWF)	x1.0	x10.0	2023-04-24 12:00	< M5 flare	QUIET		< M5 flare	QUIET
Post-Storm Depression (PSD)	30%	50%	2023-04-24 12:00	2	SEVERE		2	SEVERE

PECASUS DASHBOARD on 2023-04-25 00:00 UTC

GNSS	Moderate	Severe	Time UTC	Values	Status	Alert	Max-3h values	Max-3h status
Amplitude Scintillation	0.5	0.8	2023-04-25 00:00	0.38	QUIET		0.47	QUIET
Phase Scintillation	0.4	0.7	2023-04-25 00:00	0.22	QUIET		0.26	QUIET
Vertical TEC	125	175	2023-04-25 00:00	156.28	QUIET		157.32	MODERATE

RADIATION	Moderate	Severe	Time UTC	Flags	Status	Alert	Max-3h flags	Max-3h status
Effective Dose FL ≤ 460	30	80	2023-04-25 00:00	0	QUIET		0	QUIET
Effective Dose FL > 460	/	80	2023-04-25 00:00	0	QUIET		0	QUIET

HF COM	Moderate	Severe	Time UTC	Values/Flags	Status	Alert	Max-3h values	Max-3h status
Auroral Absorption (AA)	8	9	2023-04-25 00:00	3.0	QUIET		4.0	QUIET
Polar Cap Absorption (PCA)	2	5	2023-04-25 00:00	0.09	QUIET		0.12	QUIET
Shortwave Fadeout (SWF)	x1.0	x10.0	2023-04-25 00:00	< M5 flare	QUIET		< M5 flare	QUIET
Post-Storm Depression (PSD)	30%	50%	2023-04-25 00:00	2	SEVERE		2	SEVERE

SIDC/RWC & URSIgram - Summary

- SIDC/RWC
- SWx alerts issued by the SIDC
- Exercises