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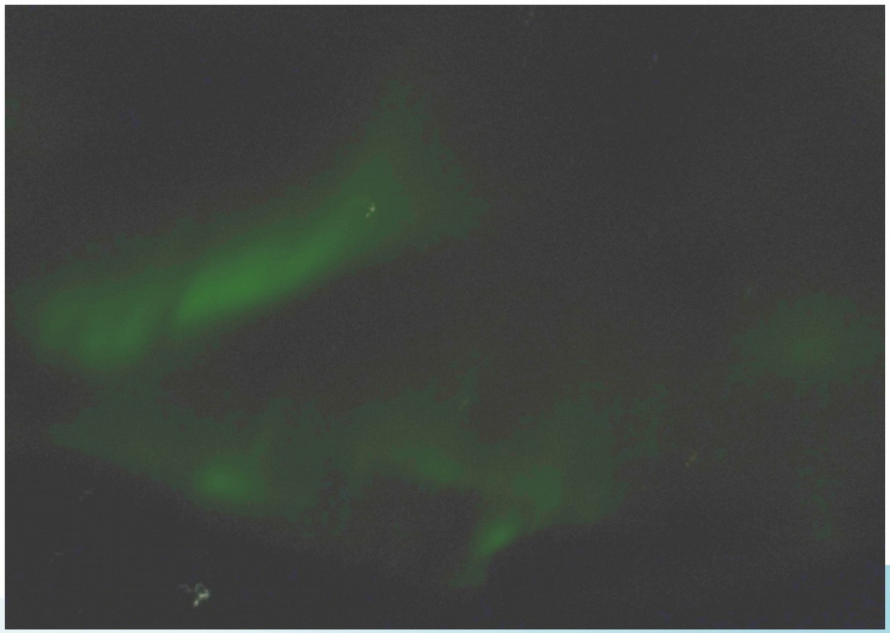
Space Weather :

the aviation relevance

Cpt. Klaus Sievers
European Cockpit Association

11/2013



Aurora.....bands of moving light, seen from the cockpit

IFALPA
The Global Voice of Pilots

Medical Briefing Leaflet

13MEDBL01 — 12 November 2012

- Flight personnel with an effective dose of more than 1 mSv/y should be recognised as occupationally exposed to ionizing radiation. Those who are liable to receive an effective dose greater than 6 mSv per year should be classified as Category A workers.
- All aircraft with a maximum operating altitude of more than 8,000m (approx. 26,000ft) operating in polar/sub polar regions, especially long-range aircraft, should be equipped with a warning device to detect sudden increases in dose rate. During flight, the cockpit crew should have the display of the warning function plainly visible to allow timely response to suddenly increased levels of dose rates.
- IFALPA recommends that an ICAO sponsored multi-party task force be formed to address all issues associated with an ionizing radiation event and the possible subsequent emergency descent of a large number of aircraft.

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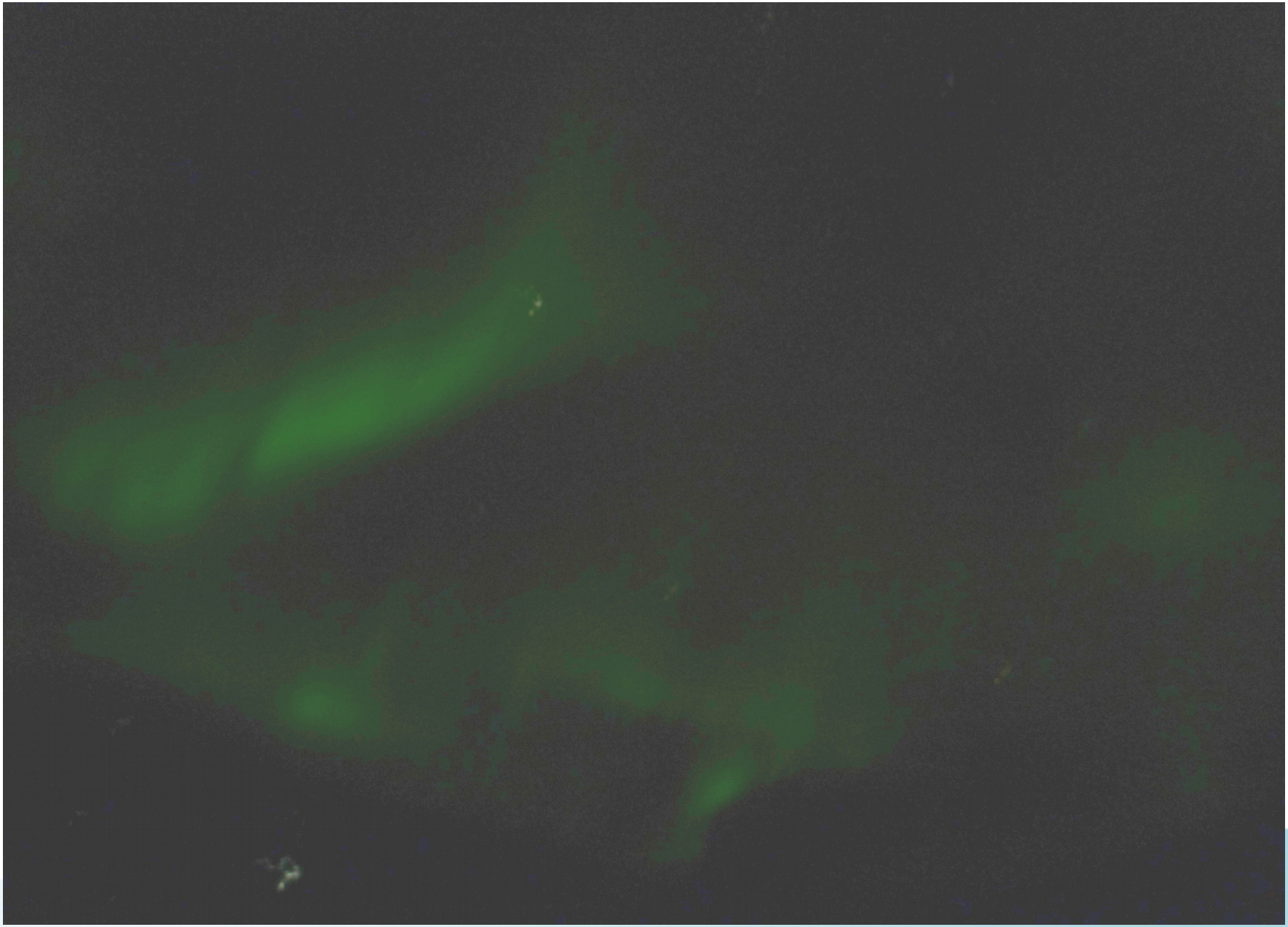
Statement by a pilot after considering space weather:

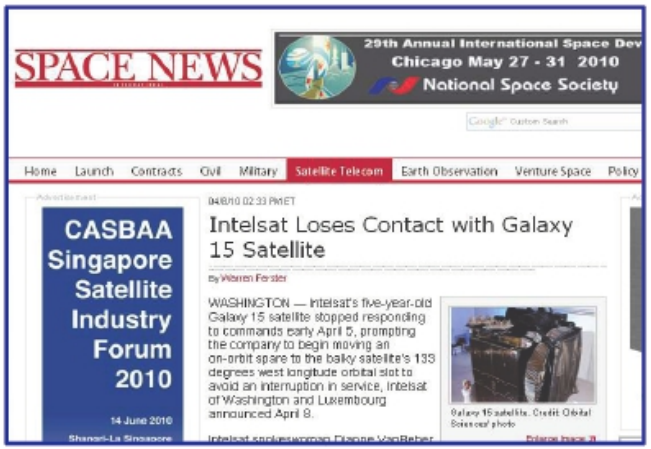
I NEED

an OFF – flag !



Aurora.....bands of moving light, seen from the cockpit

Background (1 of 2)
Galaxy 15 Satellite Anomaly - Impacts

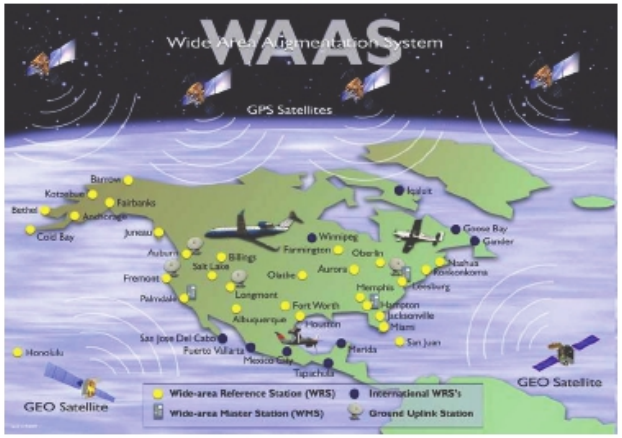


08 Apr 2010 – Intelsat reports that the Galaxy 15 stopped responding to ground commands (Anomaly time: 05 April @ 09:48 UTC)

10 Apr 2010 – FAA predicts erosion of WAAS capability due to Galaxy 15 failure

20 Apr 2010 – Orbital attributes the loss of Galaxy 15 to space weather

30 Apr 2010 – Intel reports Galaxy 15 still adrift and threatens nearby satellites (i.e. frequency interference)



Navigation: how does aviation deal with failure of EGNOS / WAAS satellites due to Space Weather ?

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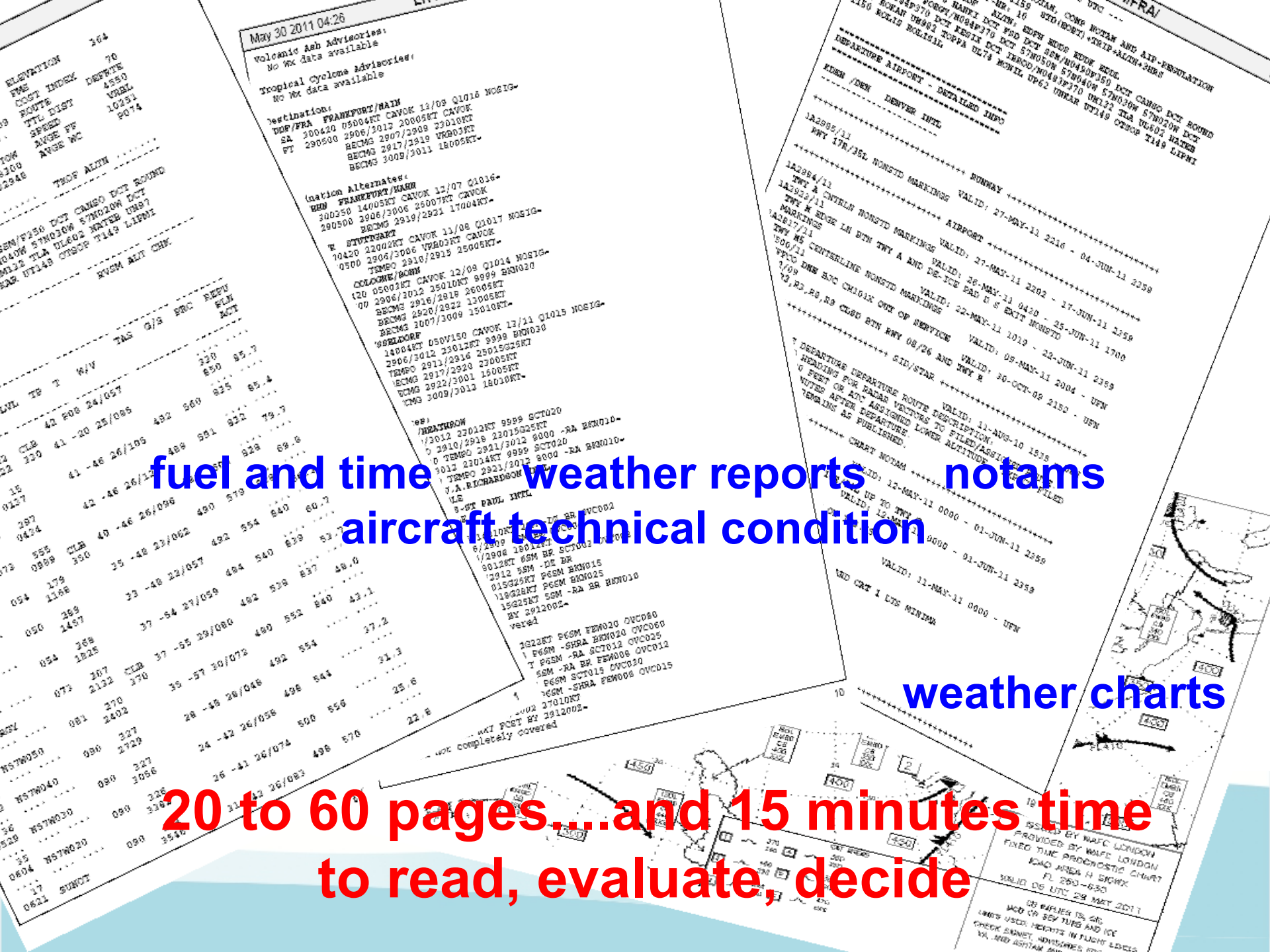
What do pilots need , what does aviation need ?

* mesaurements of Space Weather ?
* forecasts in standardized form,from planning to landing ?
* distribution of forecasts, via ICAO / WMO system ?
* backup procedures and systems to cover strong space-weather events ?
* Space Weather training for pilots, dispatchers and air traffic controllers ?


fuel and time
weather reports
notams
aircraft technical condition
weather charts
20 to 60 pages....and 15 minutes time
to read, evaluate, decide

from Belgium :

:Issued: 2012 Oct 23 0827 UTC
:Product: documentation at http://www.sidc.be/products/presto
#---#
FAST WARNING 'PRESTO' MESSAGE from the SIDC (RWC-Belgium)
#---#
NOAA Active Region 1598 produced an M5.0 flare on Oct 22, peaking at 18:51UT and an X1.8 flare on Oct 23, peaking at 03:17UT. There is a time gap for SOHO/LASCO images between Oct 22, 20:36UT and Oct 23, 06:00UT. STEREO A/COR2 images are missing between Oct 22, 15:24UT and Oct 23, 03:54UT, STEREO B/COR2 images are missing from Oct 22, 16:55UT. There is no coronographic evidence for an associated plasma eruption before 20:36UT. The proton fluxes did not increase.

#---#
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
#---#

Available: warning,yes, but too long and complicated.

from the USA:

Space Weather Message Code: ALTXMF
Serial Number: 182
Issue Time: 2012 Oct 22 1852 UTC

ALERT: X-Ray Flux exceeded M5
Threshold Reached: 2012 Oct 22 1851 UTC
NOAA Scale: R2 - Moderate

NOAA Space Weather Scale descriptions can be found at
www.swpc.noaa.gov/NOAAscales

Potential Impacts: Area of impact centered on sub-solar point on the sunlit side of Earth. Extent of blackout of HF (high frequency) radio communication dependent upon current X-ray Flux intensity. For real-time information on affected area and expected duration please see http://www.swpc.noaa.gov/drap/index.html.

Thank you for using the Product Subscription Service. If you would like to remove a produc t subscription or update the personal information in your account, go to the
Please do not use the from address for correspondence, as it is
not monitored. For comments or help, please contact

SWPC Help

Available: warning,yes, but too long and complicated.

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Medical Briefing Leaflet

13MEDBL01

12 November 2012

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VEREINIGUNG COCKPIT

SOLAR FLARES NEWSLETTER

Sehr geehrte Kolleginnen und Kollegen,

am gestrigen 15.03. hat sich auf der Sonne ein koronaler Massenauswurf der Klasse M1 ereignet.

Aus strahlenschutztechnischer Sicht hat dieser keine besondere Relevanz.
Fliegerisch könnte sich der geomagnetische Sturm heute und morgen jedoch durch HF-Störungen und
Polarlichter sowie möglicherweise Satellitensignalstörungen bemerkbar machen.

Weitere Informationen und Hintergründe zum Thema finden Sie auf der VC-Homepage unter Berufspolitik/Strahlenschutz.

Wir beobachten seit 6 Uhr heute morgen die Sonne ganz besonders genau und hoffen, Ihnen mit dies
Service behilflich zu sein.

Mit freundlichen Grüßen
Ihre AG Strahlenschutz

> e-mail alerts , primarily based on SWPC, Boulder, Co.

> maintained by VC Working Group Radiation Protection

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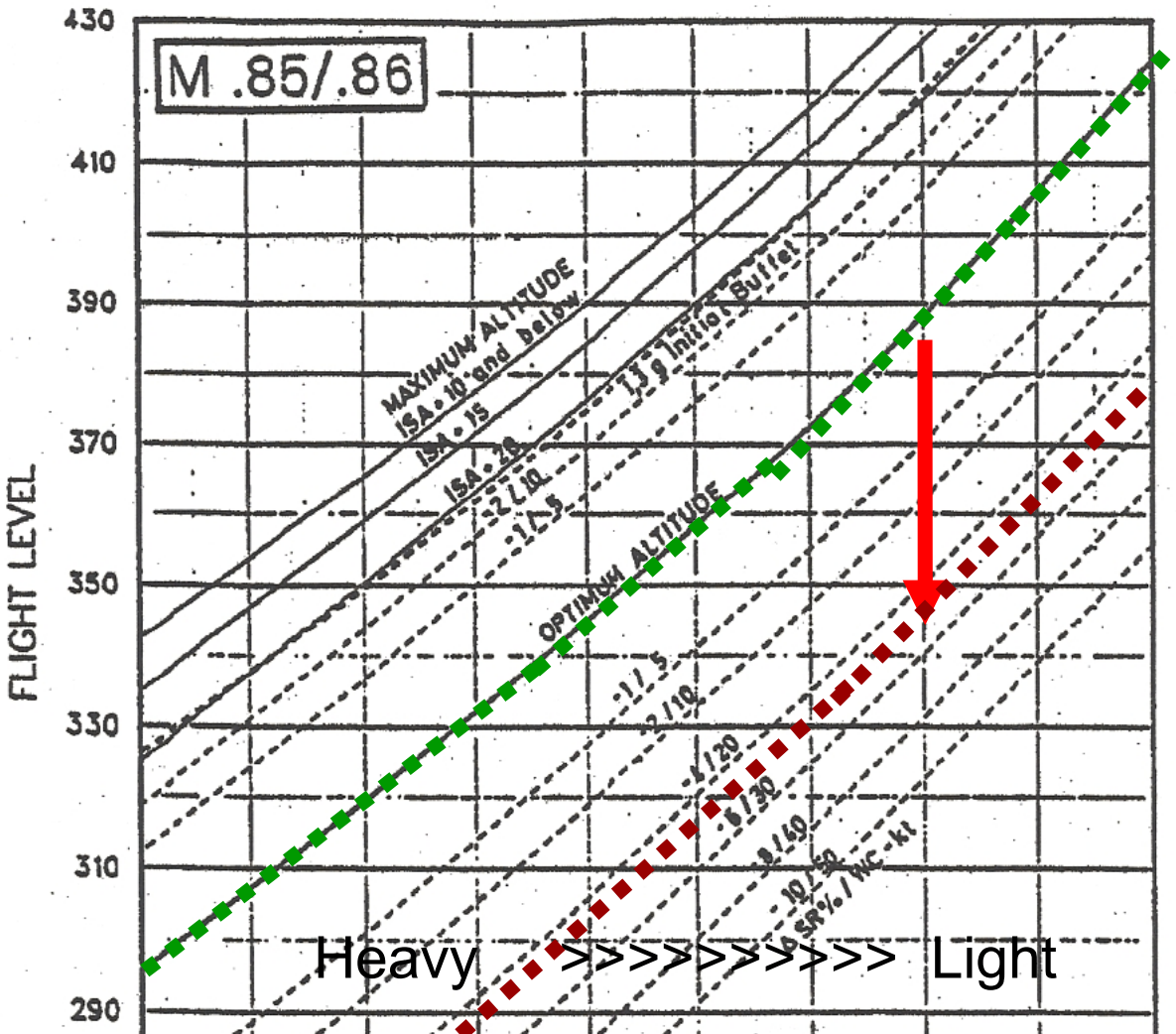
Radiation dose reduction by flying at a lower altitude.



5% more fuel =

5000 ft
below optimum =

? % dose reduction

BUT ATC ?

International Civil Aviation Organization

IAVWOPSG/7-WP/20
30/1/13

WORKING PAPER

INTERNATIONAL AIRWAYS VOLCANO WATCH OPERATIONS GROUP (IAVWOPSG)

SEVENTH MEETING

Bangkok, Thailand, 18 to 22 March 2013

Agenda Item 8: Matters related to the assessment of the need to provide information on solar radiation storms and other bio-hazards

FOLLOW-UP ON CONCLUSION 6/31 D) — STANDARDS AND RECOMMENDED PRACTICES FOR SPACE WEATHER INFORMATION

(Presented by Australia, New Zealand, the United States and IATA)

SUMMARY

This working paper presents a proposal for amendment of Annex 3 related to space weather information. Action by the IAVWOPSG is in paragraph 4.

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What do pilots need , what does aviation need ?

* **measurements of Space Weather !**
* **forecasts in standardized form,from planning to landing !**
* **distribution of forecasts, via ICAO / WMO system !**
* backup procedures and systems to cover strong space-weather events ?
* Space Weather training for pilots, dispatchers and air traffic controllers ?

Space Weather for Aviation Service Providers

NOAA National Weather Service Space Weather Prediction Center

24 hour Forecast issued Oct 01 0300 UTC, Geophysical Alert Message

```
Solar-terrestrial indices for 30 September follow.
Solar flux 136 and estimated planetary A-index 10.
The estimated planetary K-index at 0300 UTC on 01 October was 7.

Space weather for the past 24 hours has been strong.
Geomagnetic storms reaching the G3 level occurred.
Radio blackouts reaching the R1 level occurred.

Space weather for the next 24 hours is predicted to be strong.
Geomagnetic storms reaching the G3 level are expected.
```

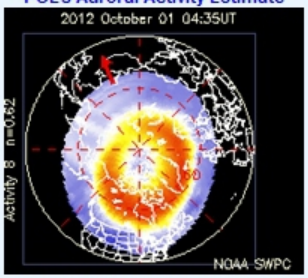
Latest 3-day Solar Weather Forecast

NOAA Scales Activity

NOAA Scale	Past 24 hours	Current
Geomagnetic Storms	G3	G3
Solar Radiation Storms	none	none
Radio Blackouts	none	none

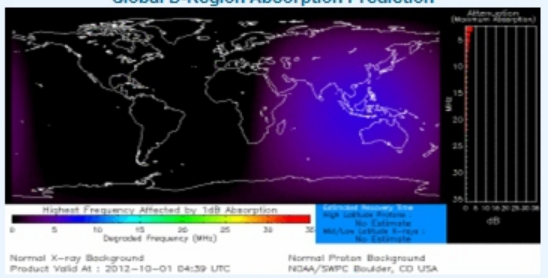
Info is nice to know, good to have, but what action is expected ?

POES Auroral Activity Estimate



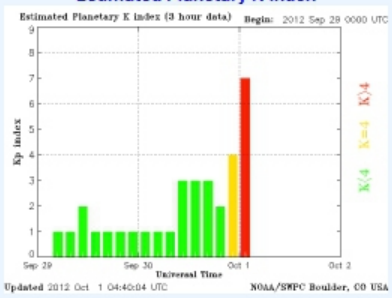
Effects: HF Radio propagation, Aurora boundaries

Global D-Region Absorption Prediction

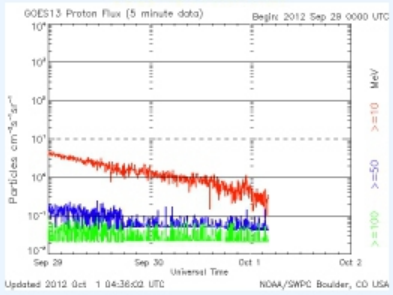


Effects: HF Radio communications

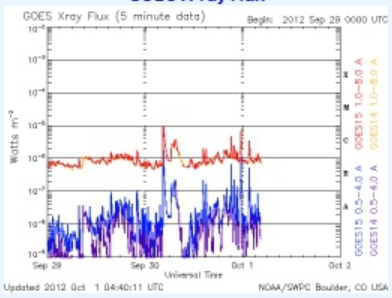
Estimated Planetary K-index



GOES-15 Proton Flux



GOES X-ray Flux



Website made for aviation: Information use needs to be defined.

Solar Radiation Storms (Excerpt from NOAA Scale)			Flux level of ≥ 10 MeV particles (ions)*
S 5	Extreme	Biological: unavoidable high radiation hazard to astronauts on EVA (extra-vehicular activity); passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. *** Satellite operations: satellites may be rendered useless, memory impacts can cause loss of control, may cause serious noise in image data, star-trackers may be unable to locate sources; permanent damage to solar panels possible. Other systems: complete blackout of HF (high frequency) communications possible through the polar regions, and position errors make navigation operations extremely difficult.	10^5
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.	10^4
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.	10^3

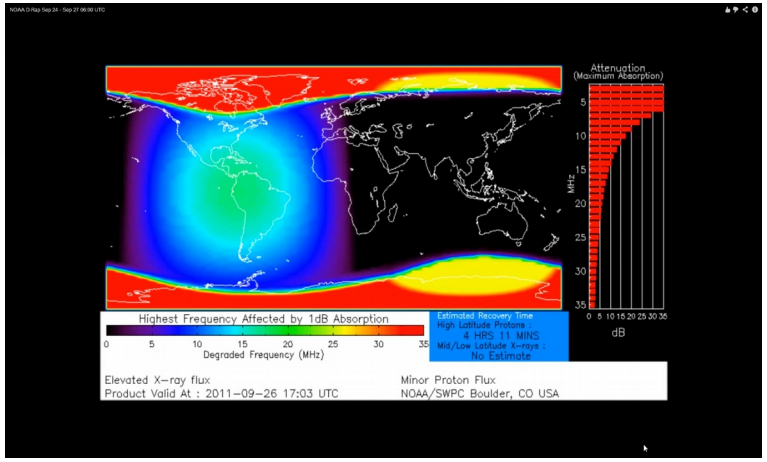
Health : passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk

Navigation: S4 :blackout of HF radio communication through the polar region and increasd navigation errors over several days

Can I depend on using satellite-navigation for approach and landing ?

SWPC: Issue Time: 2011 Sep 26 1708 UTC

WARNING: Geomagnetic K-index of 7 or greater expected
Valid From: 2011 Sep 26 1715 UTC Valid To: 2011 Sep 26 2100 UTC
Warning Condition: Onset NOAA Scale: G3 or greater - Strong to Extreme



Air Traffic Control System Command Center (´´Network Manager´´) :

ATCSCC ADVZY 059 DCC 09/XX/2011 WAAS FYI
DUE TO SOLAR FLARE ACTIVITY; WAAS SIGNALS ARE DEEMED UNRELIABLE: AS A RESULT; RNP CAT 1 ARRIVAL PROCEDURES WITHIN THE U.S. ARE ALSO DEEMED UNRELIABLE. 261930 – 271059 11/09/XX 20:30 DCCOPS

Not quite a NOTAM, but close.

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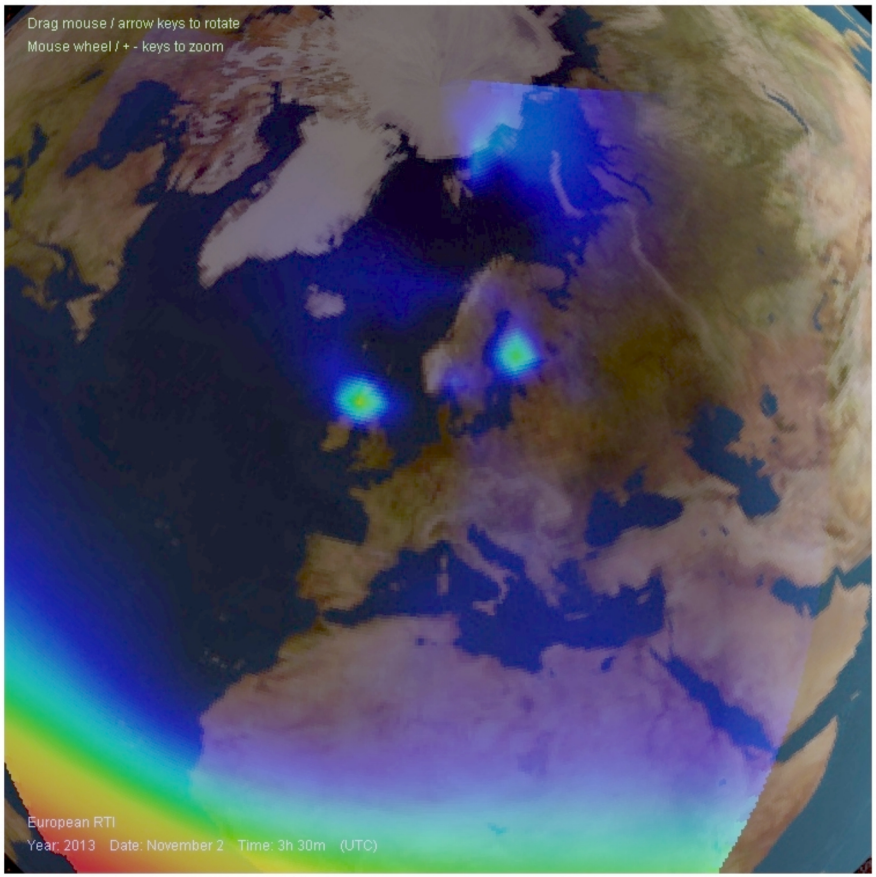
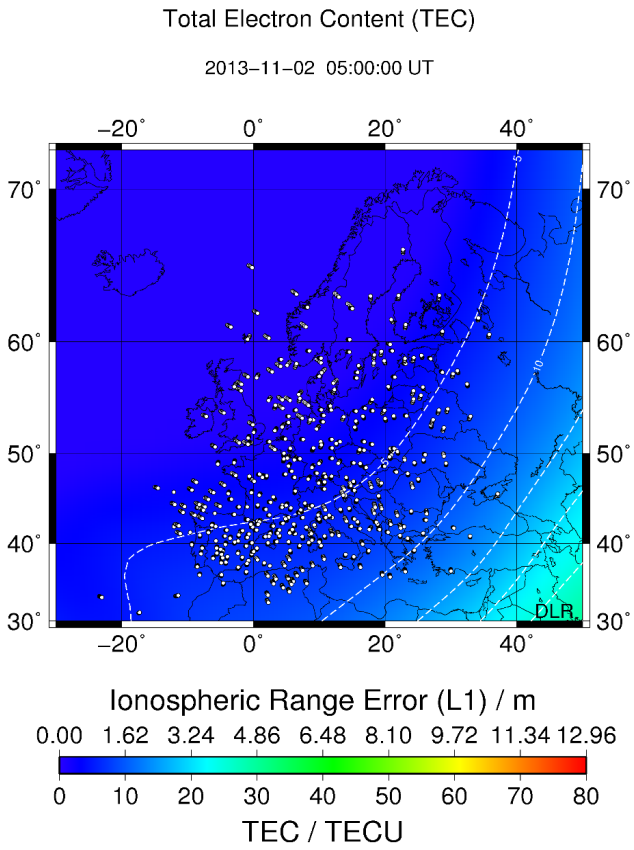
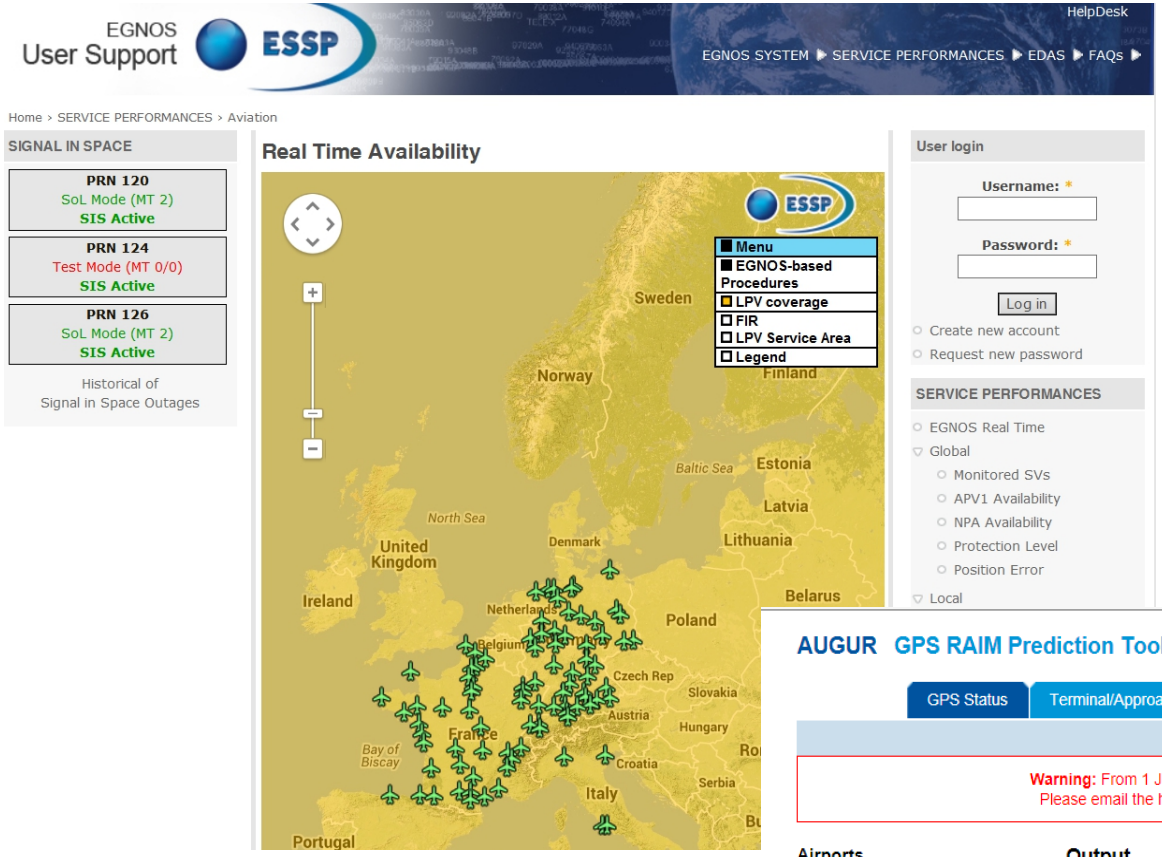
Online-tools for scientist show the state of the ionosphere, not directly it´s influence on satellite navigation. Go / No Go desicion ?

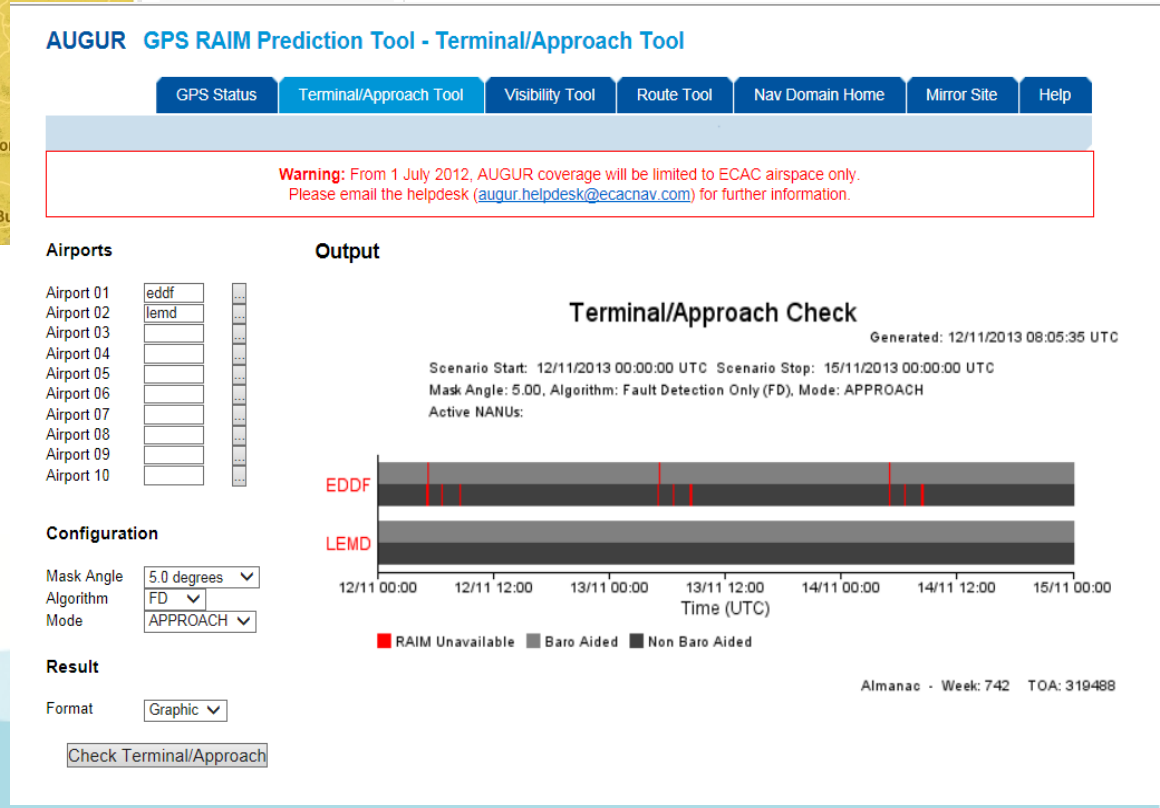


TEC from Univ. of Bath



TEC from ESA / DLR, diff. day





Online-tools for aviation consider the signal, the satellite availability only.

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```
++++++++++++++++++++++++++++++ AIRPORT ++++++++++++++++++++++++++++
1V230/10 VALID: 1004142230 - 1004152236
GPS RAIM UNAVAILABLE FOR APPROACH AND DEPARTURE PROCEDURES
04142230 TIL 04142240
04152226 TIL 04152236
```

Navigation: Aviation - standard GPS-RAIM u/s notam

Covering only satellite satellite visibility

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GBAS-Approaches:

NO PROBLEM ??

Long-Term Ionospheric Anomaly Monitoring for Ground-Based Augmentation Systems (GBAS)

Jiyun Lee*† and Sam Pullen

Tetra Tech AMT*

KAIST†

Stanford University

1st Ionospheric Studies Task Force
ICAO APANPIRG

Tokyo, Japan
27 February 2012

ICAO...
SESAR..

consider,
study,
work on
mitigations
for space WX

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Statement by a pilot after considering space weather:

I NEED

an OFF – flag !

Solar Radiation Storms

How often : 5-20 days / year !

Is it serious ? More so, than recent experience suggests: No strong GLE recently.

Last updated at NGDC: 24 Oct 2013

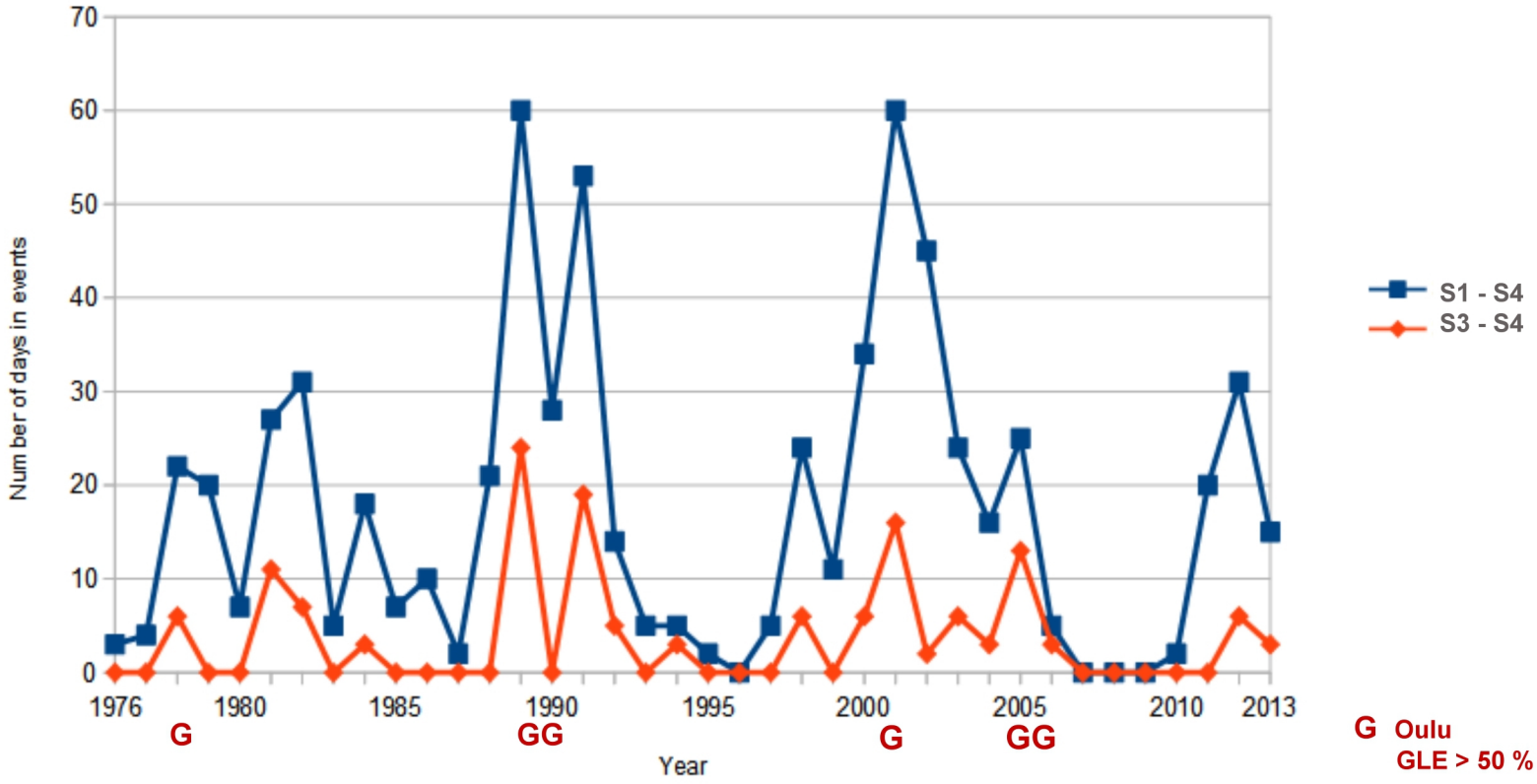
Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center

Solar Proton Events Affecting the Earth Environment

January 1976 - Present

Event days NOAA Scale S1 - S4

(pfu @ > 10 MeV)



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What do pilots need , what does aviation need ?

* continuous mesaurements of Space Weather, so warnings can be given with high priority when threshold levels of radiation, communication and navigation disturbance are exceeded.

* forecasts, measurements and warnings in standardized form, for the whole flight, from planning to landing.

* distribution of forecasts, measurements and warnings analoguos to the present ICAO / WMO weather reports and sigmet-system.

* backup procedures and systems to cover strong space-weather events, covering: severe radiation-dose events, degraded enroute and approach navigation accuracy, non-availability of GNSS-based navigation aids, degraded communications

* Space Weather training for pilots, dispatchers and air traffic controllers

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Thank you for your attention !

Cpt. Klaus Sievers
European Cockpit Association

11/2013