



Royal Netherlands
Meteorological Institute
*Ministry of Infrastructure
and Water Management*

Space weather and its impact on resilience

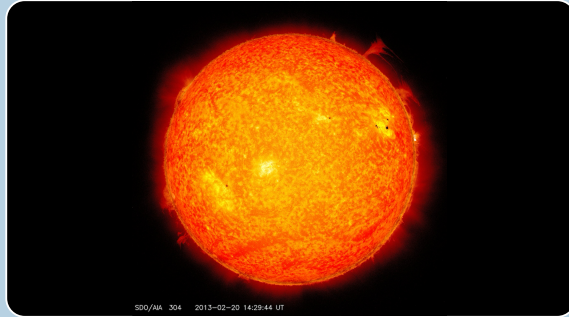
ENISA Telecom and Digital Infrastructure
Security Forum, Amsterdam, 20 March 2025

Kasper van Dam
Bert van den Oord





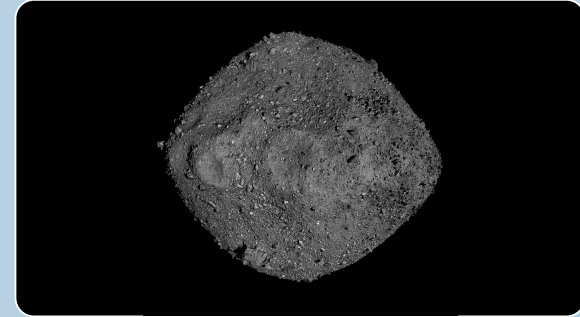
Space Situational Awareness (SSA)



Space Weather
SWE



Space Surveillance and Tracking
(Including space debris)
SST



Near Earth Objects
(asteroids)
NEO

Satellite services

(Space) Weather at Earth:

Magnetosphere, Ionosphere

(Upper) Atmosphere

Vital sectors

Continuous
Electromagnetic

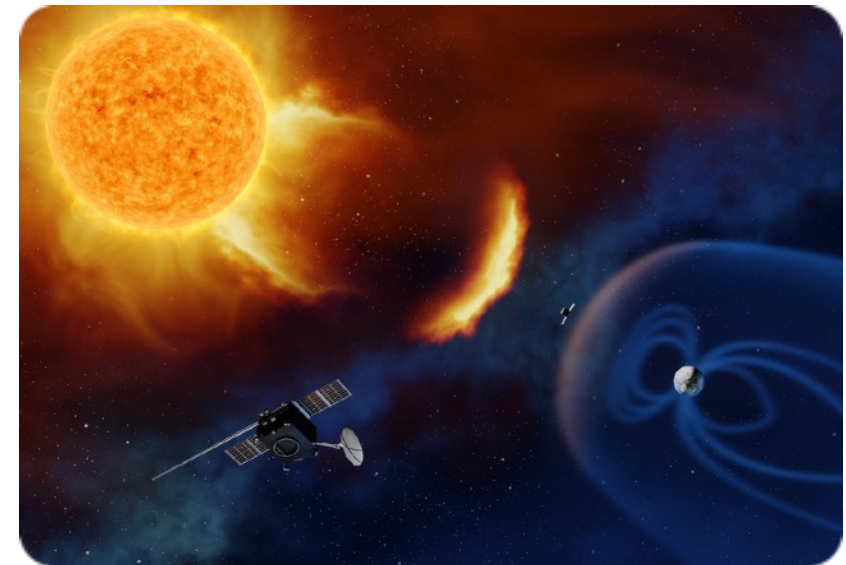
Infrastructure

Incidental
Kinetic



What is space weather and how can it impact resilience?

- › Magnetic energy release on the Sun can have an impact on Earth
 - › Increased **particle radiation for aviation, satellites, astronauts**
 - › Disturbed upper atmosphere (ionosphere and thermosphere)
 - › **Satellite services** (e.g. GNSS, SATCOM), **long-distance radio communication** (HF)
 - › Ground induced currents can impact **power grids**
 - › Increased atmospheric drag on satellites (**orbit lifetime**)
 - › **Solar radio bursts drowning out other radio signals** (e.g. GNSS, secondary air traffic control radar)





A recent example of severe space weather: May 2024 storm

- > Largest geomagnetic storm since “Halloween” storm of October 2003
 - > Occurrence: **1 in 12.5 years** (strength of event) and 1 in 41 years (duration of event)
- > Effects:
 - > HF communication problems in aviation
 - > Two outages in power grids in North-Eastern Europe
 - > GNSS augmentation systems affected (EGNOS, WAAS)
 - > 'Mass migration' of satellites in low Earth orbit (dropping altitude)

Powerful solar storms are a nightmare for farmers. 'Our tractors acted like they were demon possessed'

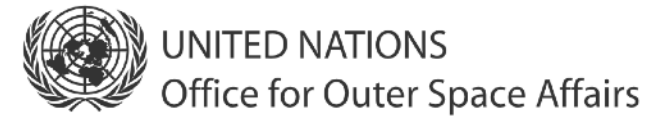
News By Daisy Dobrijevic published December 11, 2024

When the sun's fury disrupts high-tech farming, precision turns to chaos.



International playing field

- > On UN level space weather is on the agenda of:
 - > COPUOS: Committee on Peaceful Use of Outer Space
 - > WMO: World Meteorological Organisation
 - > ICAO: International Civil Aviation Organisation (**four operational centres**)
 - > ITU/WRC: International Telecommunication Union, World Radio Conference
- > On a European level:
 - > European Commission: DG DEFIS (Defence Industry and Space)
 - > ESA: Space Safety programme
- > International organisations for scientific coordination:
 - > COSPAR (Committee on Space Research)
 - > IAGA (International Association of Geomagnetism and Aeronomy)





Activities in the Netherlands

- › Royal Netherlands Meteorological Institute (KNMI) hosts the national space weather service that provides 24/7 alerts to vital sectors (e.g. power grid operators, telecom companies)
- › Tasks: provide **alerts**, create **awareness**, make space weather part of **Business Continuity Plans**
 - › Example: Dutch study (2016) on importance of PNT (GNSS). Important reason for one of our telecom companies to **introduce an additional atomic clock based timing system** for the synchronisation of their cellphone tower network.
 - › Another example: White Rabbit protocol for precise timing over the internet (5 nanosecond precision). Done by VSL National Metrology Institute, Nikhef, etc. (CERN technology).
- › KNMI participates in one of the four ICAO centres that issue advisories for aviation



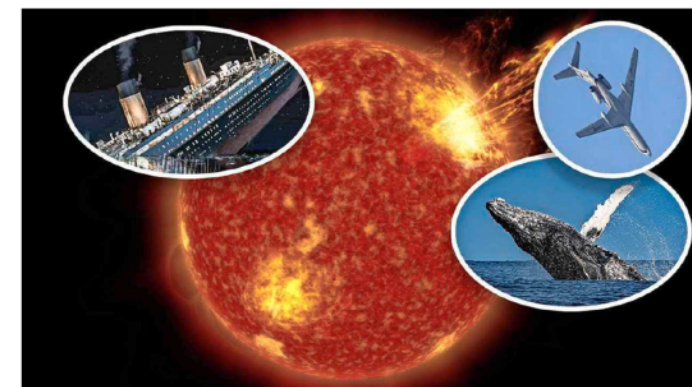
Current developments

- › European 'trend' to establish **national space operations centres** (SPOCs)
 - › **Important role for defence** but also in close collaboration with civilian space weather centres (UK, Finland, NL ongoing).
- › The impact of an **EMP** in space (what to learn from space weather)
- › Importance of **correct information in public media** domain
 - › Often alarmist messaging whereas the situation is much more nuanced.
 - › Our field is very complicated and perhaps prone to over-exaggeration
 - › Important to rely on trusted sources for accurate information

*Massive Solar Storm Expected
by the End of the Year: Risk of
Weeks-Long Internet Outage*

Eind dit jaar enorme zonnestormen verwacht: kans op wekenlang geen internet

AMSTERDAM - Kans op wekenlang geen internet, een aangetaste energie-infrastructuur en zelfs gevaar voor dieren. Die kunnen gedesoriënteerd raken. Het einde van de zonnecyclus, ook wel Solar maximum genoemd, komt eerder dan verwacht.

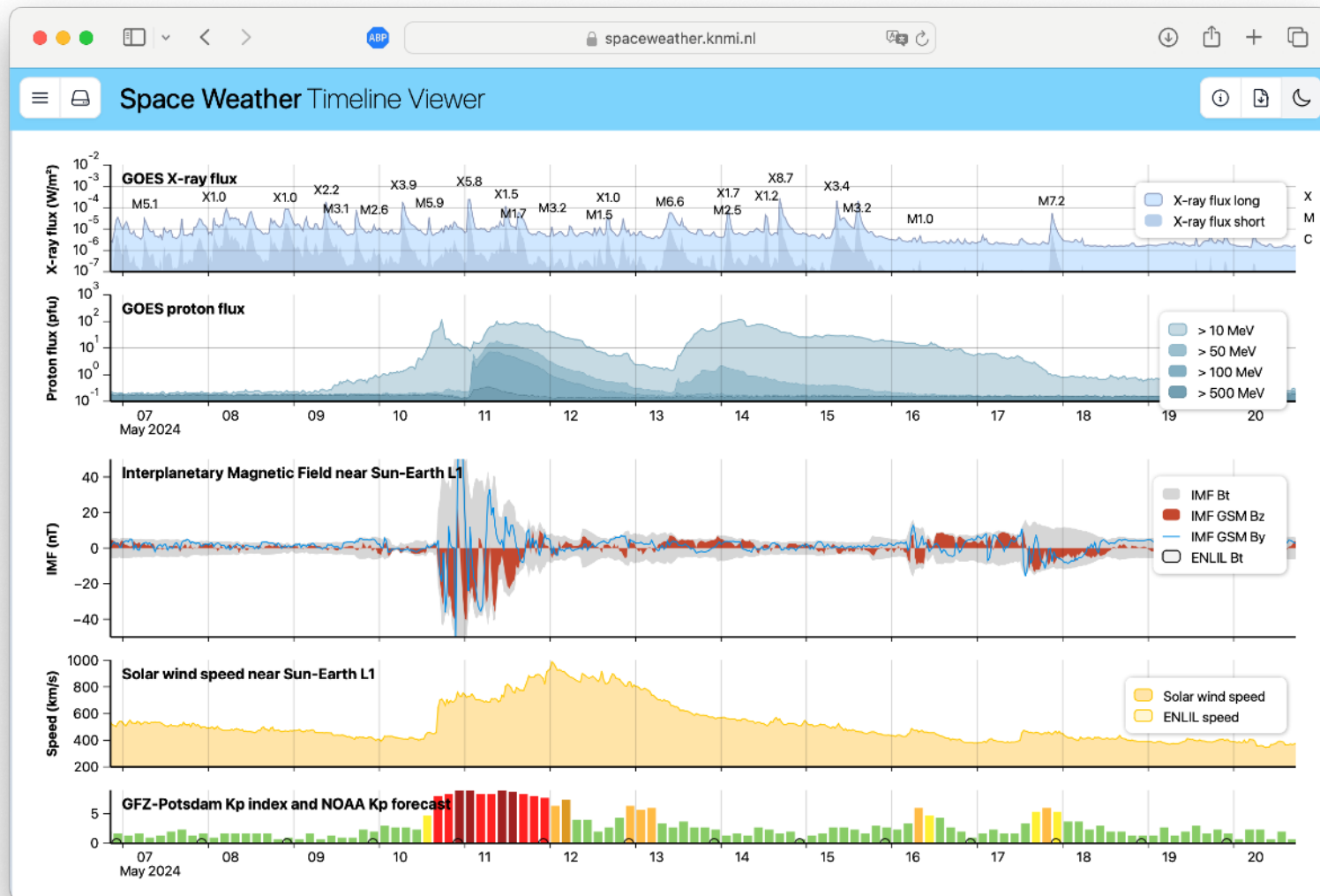


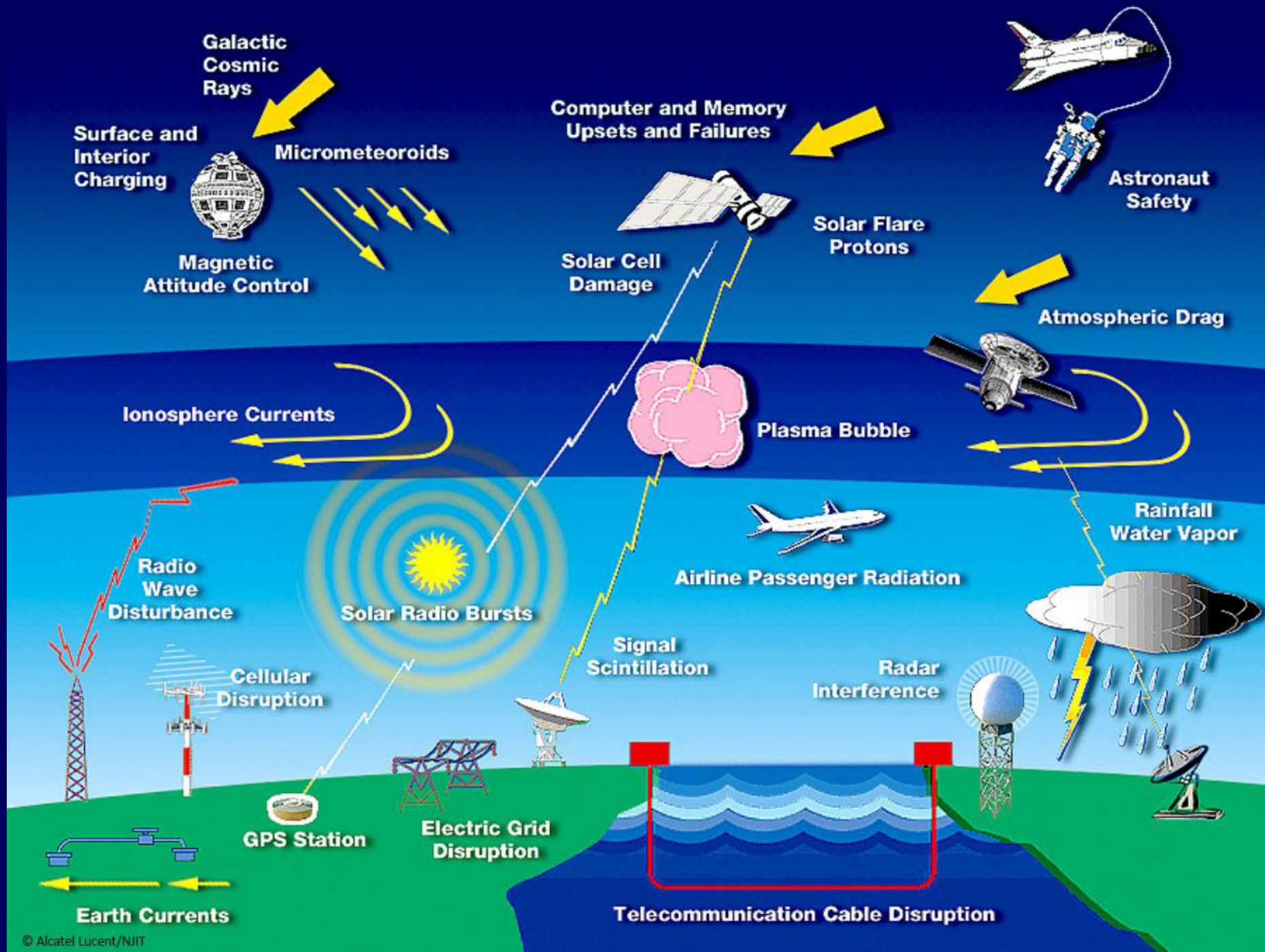
Telegraaf



Track space weather yourself:

- > KNMI has developed the space weather timeline viewer
- > Made by Eelco Doornbos
- > Available on: <https://spaceweather.knmi.nl/viewer/>





A photograph of the Northern Lights (Aurora Borealis) at Schiphol Airport. The aurora is visible as a vibrant green and yellow glow in the night sky. In the foreground, the yellow and white structure of the airport's control tower is visible on the left. The airport buildings and lights are visible at the bottom of the frame.

Northern Lights at Schiphol Airport, 10 May 2024

Photo by Rene van Aken, KNMI

Thank you for your attention

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