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Space Weather & Aviation:

Understanding the Risk, Managing the Impact

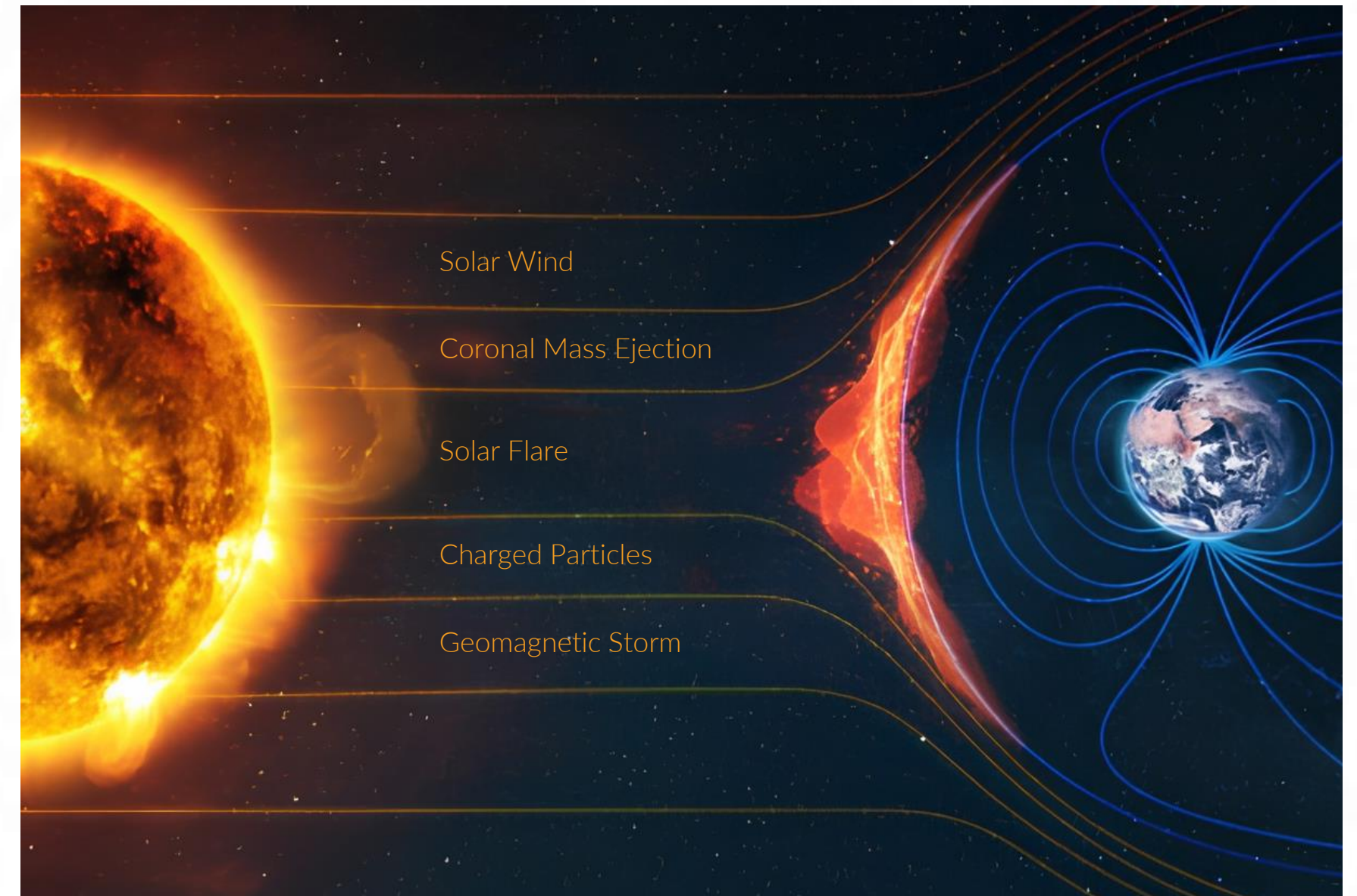
Dr Mpho Tshisaphungo
Space Weather Manager,
South African National Space Agency



What is space weather?



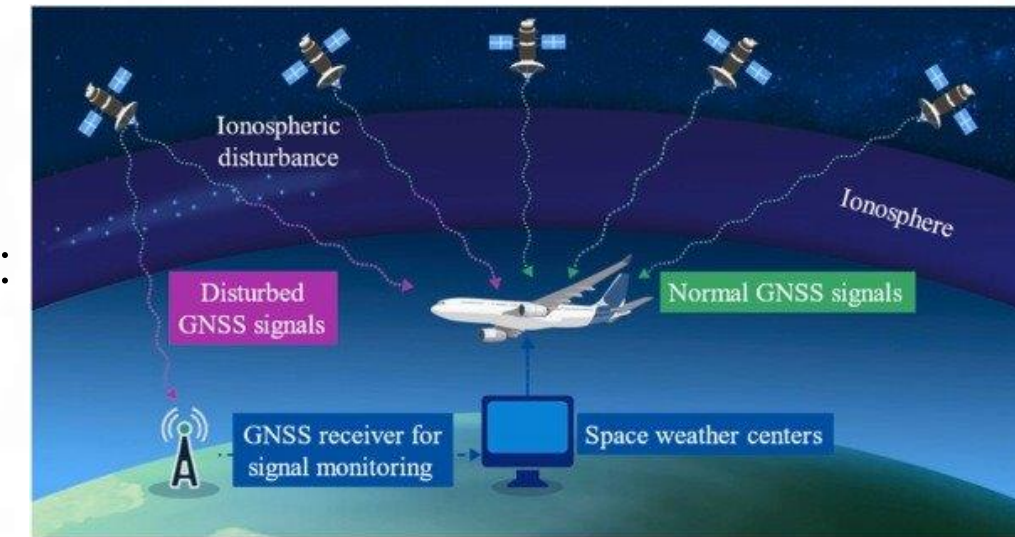
- Space weather is the **study of how the Sun** and events in space **impact the near-Earth environment**.
- These events release bursts of radiation and charged particles that travel through space and **interact with Earth's magnetic field and upper atmosphere**.
- Many of the technologies used in aviation rely on stable space environment conditions in these areas for **radio communication, navigation** and **satellite services**.
- While invisible to passengers and crew, space weather can **disrupt the systems that modern aviation depends on**.



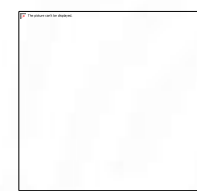


How space weather impacts African aviation

For commercial airlines, space weather carries **operational, commercial** and **reputational risk**:



High-frequency (HF) radio used for long-range communications can be weakened or lost during solar events.



Satellite navigation systems (GNSS), which are crucial for routing and positioning decisions, can become less accurate.



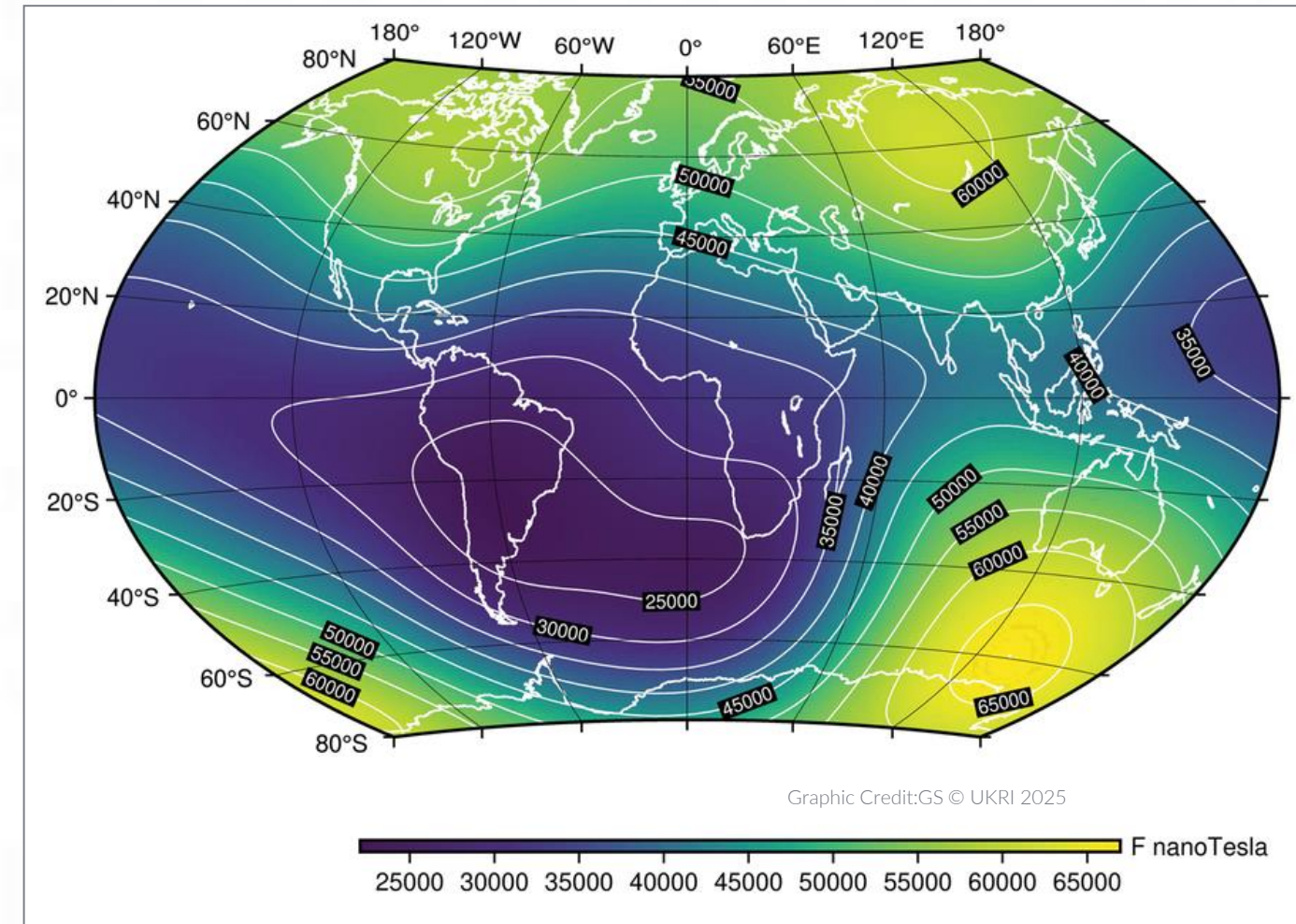
Crews and frequent flyers may be exposed to higher levels of radiation at cruising altitude.



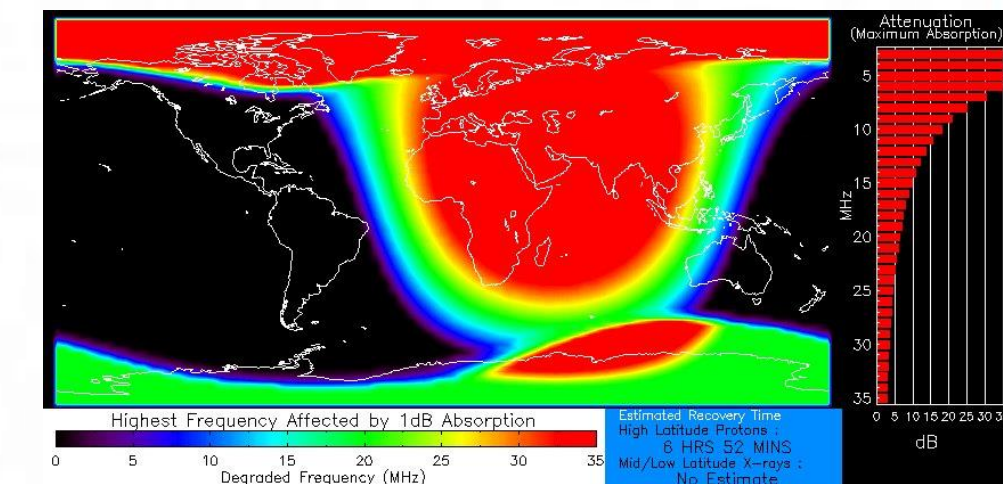
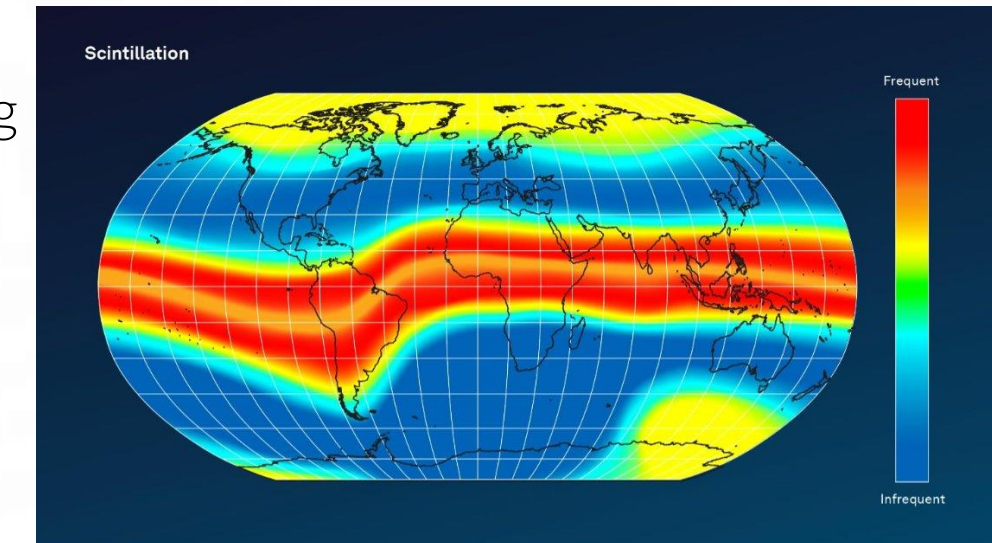
Sensitive **avionics and onboard computer systems** can be degraded.



This is a global issue – that's becoming relevant for Africa



- **A weak** point in the Earth's magnetic field is emerging in the south Atlantic, offshore of South Africa.
- This weakens Africa's portion of Earth's natural protection against solar radiation, allowing stronger space weather effects to **reach deeper into the continent**.
- Meanwhile...
More people are choosing to travel by air
More long-haul / trans-oceanic routes are opening up
More modern aircraft are coming into service



Strong X-ray flux
Product Valid At : 2024-05-15 08:37 UTC

Minor Proton Flux
NOAA/SWPC Boulder, CO USA



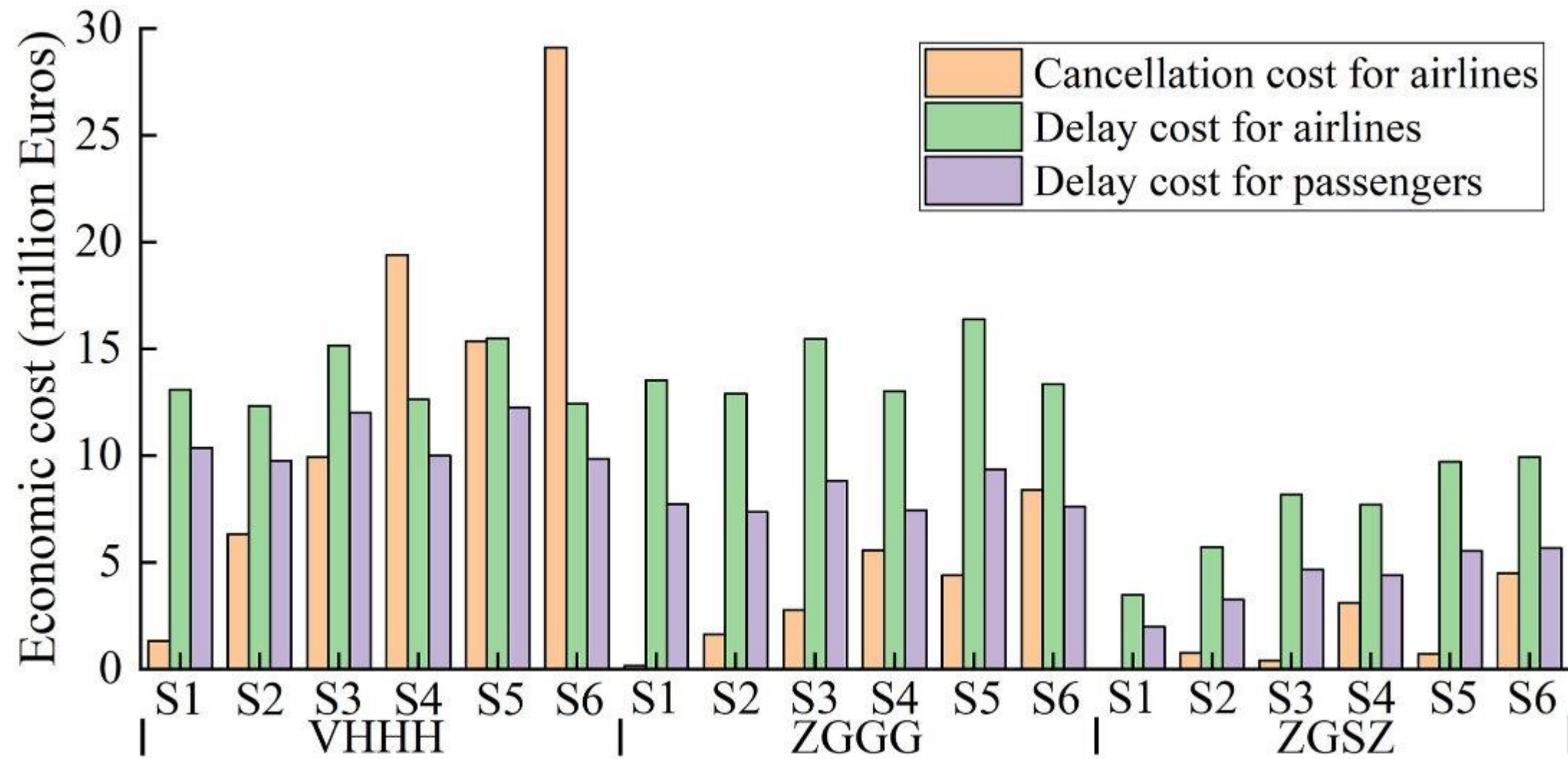
The potential cost of space weather



These factors combine to increase the continent's vulnerability to major space weather events, with implications for:

- **Flight safety**, especially on long-haul and remote routes that depend heavily on satellite navigation and long-range communications.
- **Flight schedules**, as airlines may need to reroute, delay or cancel flights during major solar storms.
- **Aircraft availability and maintenance**, if planes need additional checks after disruptions to onboard systems.
- **Crew rotations**, particularly as airlines pay closer attention to radiation exposure for pilots and cabin crew who fly frequently.
- **Airline finances**, as disruptions can lead to grounded aircraft, stranded crews, lost revenue, higher fuel costs, missed connections and reputational damage.
- **For airlines already operating on tight margins**, even a short period of disruption can have a noticeable impact on operations and profitability.

The potential cost of space weather



Results of **flight cancellation costs** and **flight delay costs for airlines**, and **flight delay costs for passengers** in different scenarios.

Source: <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2023SW003678>

Table 1: Economic benefits and estimated loss of GNSS services for various sectors [66]

Sector	Economic benefits (per annum)	Economic loss (7 days' disruption)
Road	£5.7bn	£1.6bn
Rail	£19.5m	£140m
Aviation	£188m	£4m
Maritime	£568m	£1.5bn
Emergency and justice services	£5.8bn	£3.5bn
Agriculture	£524m	£224m
Finance	£1.7m	-
Surveying	£127m	£526m ³
Location-based services	£210m	£1.6m
Other applications ⁴	£504m	£55m

Example for UK study



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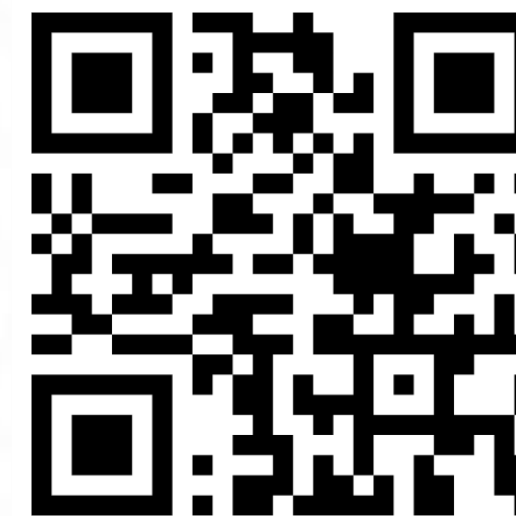
Examples of Space Weather Impacts



*Theme: Resilient African Aviation: Partnerships –
Empowerment – Profitability*



Importantly, this is not theoretical... November 2025



NEWS GHANA

Home > Science > Strongest Solar Storm in Decades Threatens Satellite Systems

Science

Strongest Solar Storm in Decades Threatens Satellite Systems

By News Ghana - January 20, 2026

[f](#) [x](#) [p](#) [w](#)

Le Monde

ECONOMY • TRANSPORT

Airbus grounds 6,000 A320s, disrupting air travel worldwide

The aircraft manufacturer ordered an emergency software update for the flight control systems on these planes, resulting in widespread delays and flight cancellations across the globe.


By Guy Duthell

Published on November 29, 2025, at 12:20 pm (Paris), updated on November 29, 2025, at 12:22 pm · 3 min read · [Lire en français](#)

AVIATIONWEEK
& SPACE TECHNOLOGY

EASA Orders Immediate Airbus A320 Flight Control Software Changes

Sean Broderick November 30, 2025



Credit: Airbus

NASA

Geomagnetic Storm Causes Satellite Loss

Released Monday, December 11, 2023
Visualizations by: [AJ Christensen](#) | Scientific consulting by: [Slava Merkin](#)

In February 2022, a Coronal Mass Ejection led to 38 commercial satellites being lost. Solar plasma from a geomagnetic storm heated the atmosphere, causing denser gases to expand into the satellites' orbit, which increased atmospheric drag on the satellites and caused them to de-orbit. Johns Hopkins APL-led Center for Geospace Storms (CGS) is building a Multiscale Atmosphere-Geospace Environment (MAGE) supercomputer model to predict space weather. The physics-based MAGE simulation reproduced the storm-time atmospheric density enhancement much better than empirical or standalone ionosphere-thermosphere models, emphasizing the need for fully-coupled whole-of-geospace models for predicting space weather events.

BBC

Bit flips: How cosmic rays grounded a fleet of aircraft

1 December 2025

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Chris Baraniuk

- In November 2025, Airbus and European regulators ordered **urgent software updates** across thousands of A320-family aircraft after investigators linked a flight-control issue to **intense solar radiation exposure**.
- Airbus later said **charged particles** from solar activity **corrupted data** inside one of the aircraft's flight-control computers.





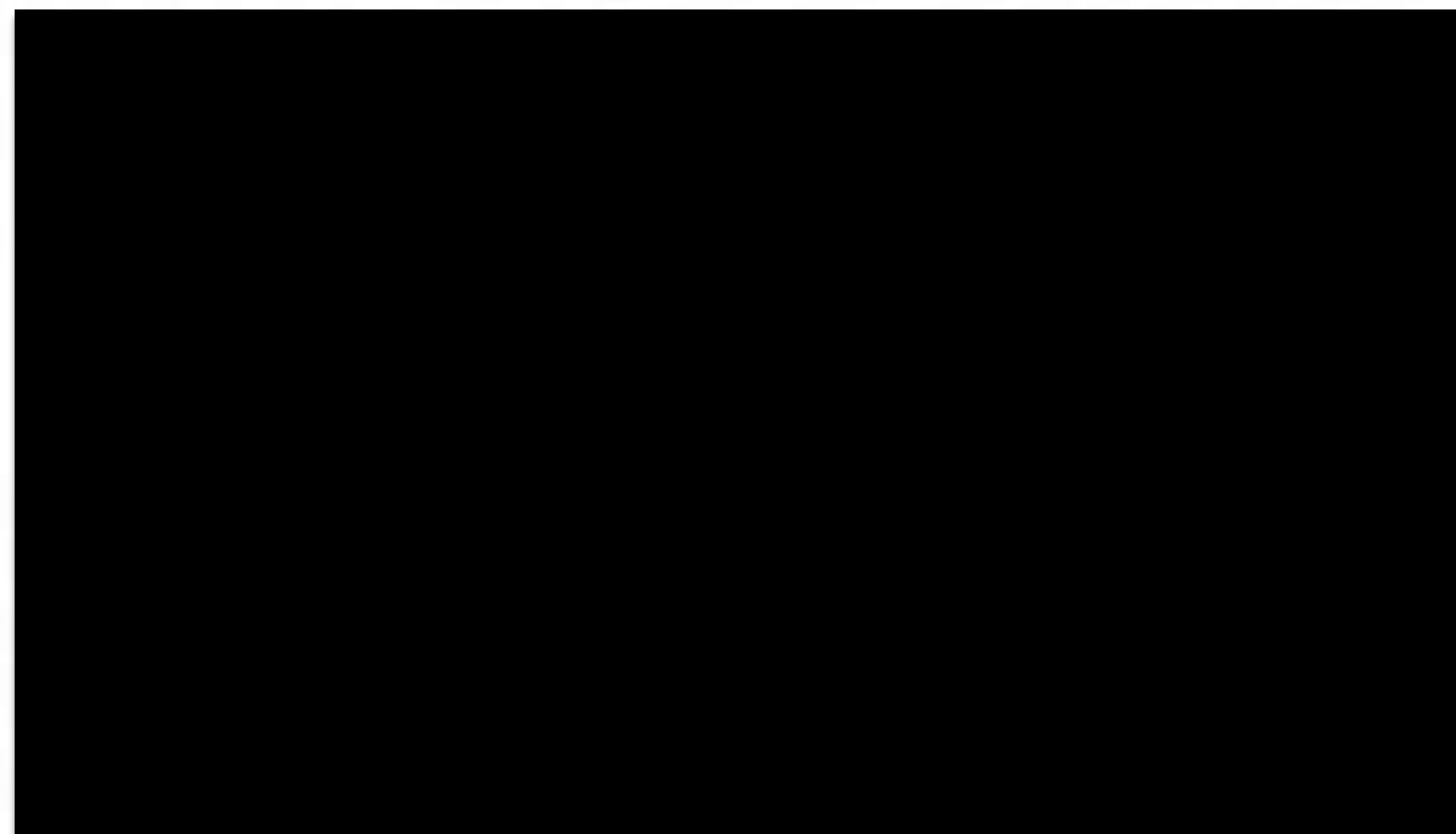
Example: Red Bull Air Race – October 2024

- In October 2024, a powerful **geomagnetic storm** disrupted GPS and satellite navigation systems during the Red Bull Air Race competition qualifying rounds.
- Between 6-12 October 2024, **multiple coronal mass ejections (CMEs)** from the Sun struck Earth and geomagnetic conditions reached **severe storm levels**.
- During the storm, South Africa's Team 77 experienced **GPS signal disruptions** linked to the severe geomagnetic activity.
- The incident highlighted how **vulnerable GNSS-dependent systems** can be during major space weather events. For aviation, this is significant because modern aircraft increasingly rely on satellite navigation for routing, tracking, timing and operational efficiency.





Watch our case study with Red Bull

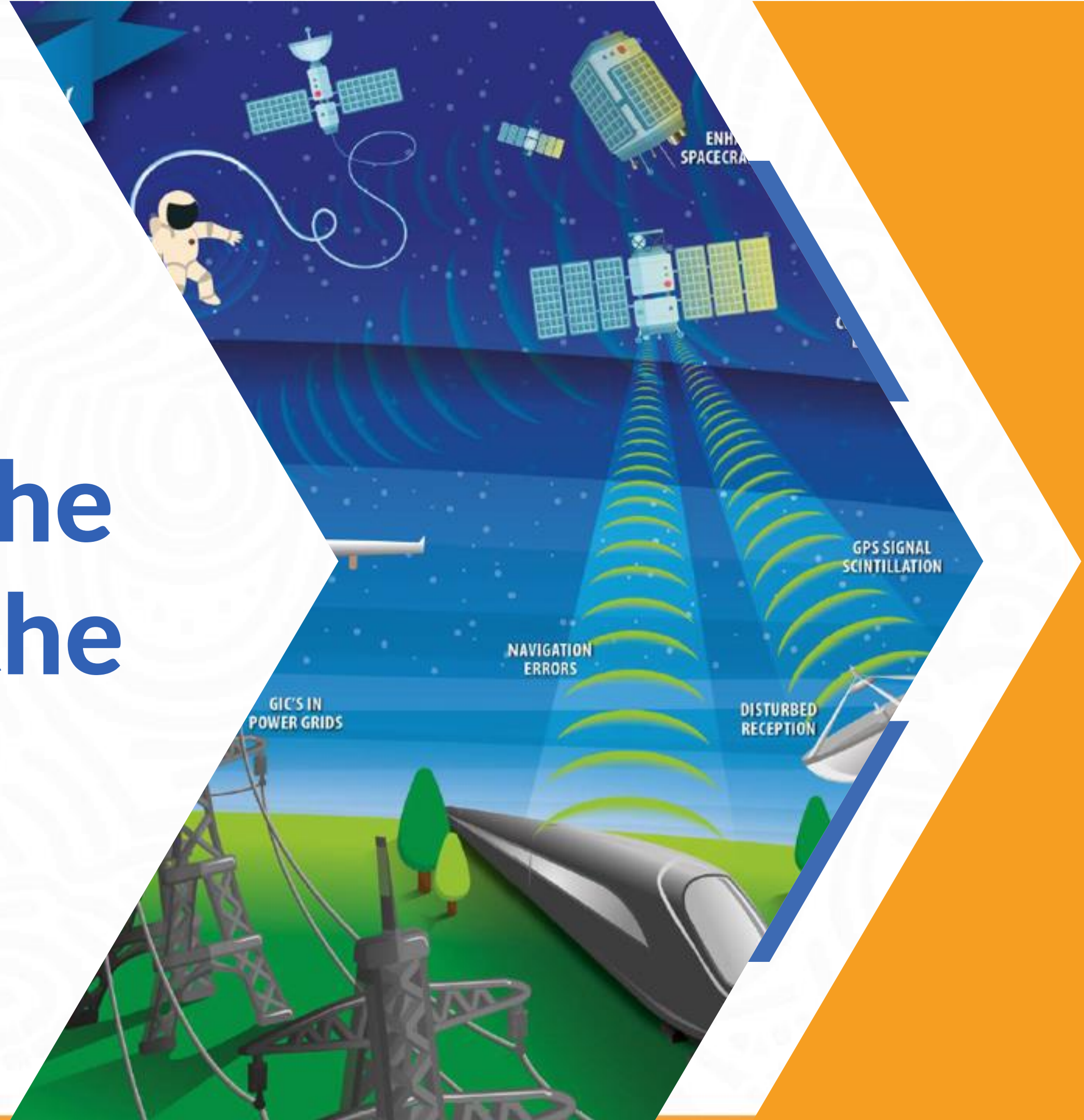




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AIRPORTS COMPANY OF SOUTH AFRICA

Understanding the Risk, Managing the Impact

*Theme: Resilient African Aviation: Partnerships –
Empowerment – Profitability*





How airlines can manage space weather risks

- **Awareness** – Making pilots and flight planners aware that they receive space weather information and alerts through SWIS bulletins issued by SANSA.
- **Training** – Space weather information can be highly technical, so airlines need practical guidance on what alerts mean operationally and what actions may be required. Turning scientific data into clear operational decision-making is a critical part of building resilience.
- **Planning** – Airlines need clear response plans for severe space weather events, including how they conduct impact assessments, explain the issue to customers and crew, reroute flights, recover from delays, schedule maintenance, etc.



How SANSA supports the African aviation industry



- SANSA is home to a **24/7 Space Weather Centre** that provides real time geophysical data on the near-Earth space environment as well as forecasts and early warnings of adverse space weather.

- SANSA is the International Civil Aviation Organization's (ICAO) **designated regional space weather centre**; fully integrated into global centres in November 2025 and is responsible for supporting global centres through co-operation and provision of regional space weather information.

How SANSA supports the African aviation industry



✓ Establishment of **Met Project 3** in 2021 with **AFI Region** to ensure the provision of the space weather service information.

NATIONAL PARTNERS - Aviation

- ✓ Air Traffic and Navigation Services (ATNS)
- ✓ South African Weather Services (SAWS)
- ✓ Department of Transport



transport

Department:
Transport
REPUBLIC OF SOUTH AFRICA



- ✓ SANSA is an ICAO Regional Space Weather Service Provider supporting 4 Global Centres.
- ✓ SANSA African Instrumentation Network Deployment with African Continent.
- ✓ Regional ICAO MET Project for implementation of Space Weather within the African Region.
- ✓ Partnership with National, Regional and International stakeholders
- ✓ In partnership with ATNS – SWx Training Curriculum.



Instrumentation in Africa

Current Partners:

Zimbabwe Zimbabwe National Geospatial and Space Agency (ZNGISA)	Namibia Ministry of Mines and Energy (MME)
Nigeria University of Lagos (UNILAG)	Uganda Busekwa University (BU)
Ethiopia SISG & EORC	Kenya Pwani University (PU) Kenyan Space Agency (KSA)
South Africa South African National Space Agency (SANSA) National Geospatial Information (NGI) TRIGANT	Gabon L'Agence Gabonaise d'Etudes et d'Observations Spatiales (AGEOS)
Zambia Kusenshi Ninyemah University (KNU)	Botswana Botswana International University of Science and Technology (BIUST)

More to come!

Focus is currently on the SADC region (SBAS + SWx) and the magnetic equator (SWx)
Focus is currently on the deployment of GNSS stations, as the cost and infrastructure requirements offer the best value in terms of the outputs gained

Conclusion



- Space weather is the **study of how the Sun** and events in space **impact the near-Earth environment**.
- For aviation, the risks include **degraded HF radio communications, GNSS inaccuracies, damage to avionics**, and the potential for increased **radiation exposure**.
- The aviation industry can manage these risks through raising **awareness, training** crews on how to respond, and **planning** for disruption.
- The South African National Space Agency (SANSA) supports the sector through space weather **information, monitoring, alerts and training**, and is **on-hand to assist** the African aviation industry.

Invitation:

Join SANSA and ICAO at our upcoming space weather roundtable in June

For more information, please contact:

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TO SPEED UP CONTEMPORARY AVIATION
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Understanding the Risk,
Managing the Impact

