



Regional Provision of Space Weather Information in support of International Air Navigation

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Presented by: Dr Lee-Anne McKinnell

Managing Director Space Science

South African National Space Agency





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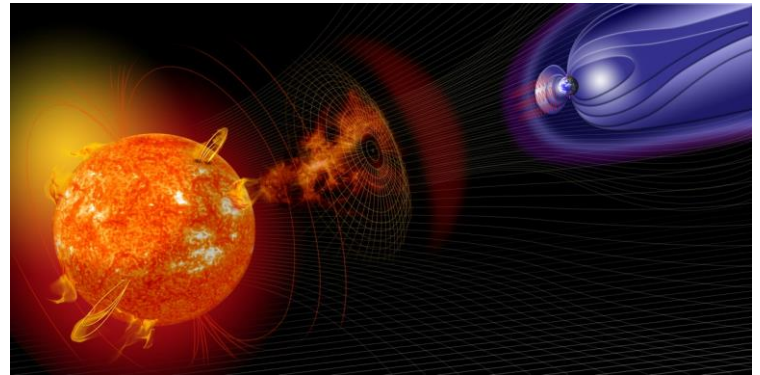
- What is Space Weather?
- Why should we care?
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What is Space Weather?

Space Weather refers to **conditions on the Sun** and in the solar wind, magnetosphere, ionosphere, and thermosphere that can **influence the performance and reliability** of space-borne and ground-based technological systems.

Space weather is a consequence of the behaviour of the sun, the nature of Earth's magnetic field and atmosphere, and our location in the solar system.





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WHY SHOULD WE CARE?

- Technology continues to play an ever-increasing role in our society and the potential for space weather to impact our daily lives is also growing – especially as we move into the 4IR.
- Technological infrastructure, including the power grid, satellites used for communication and navigation, and the “Internet of Things” are vulnerable to space weather effects caused by the Sun's variability.



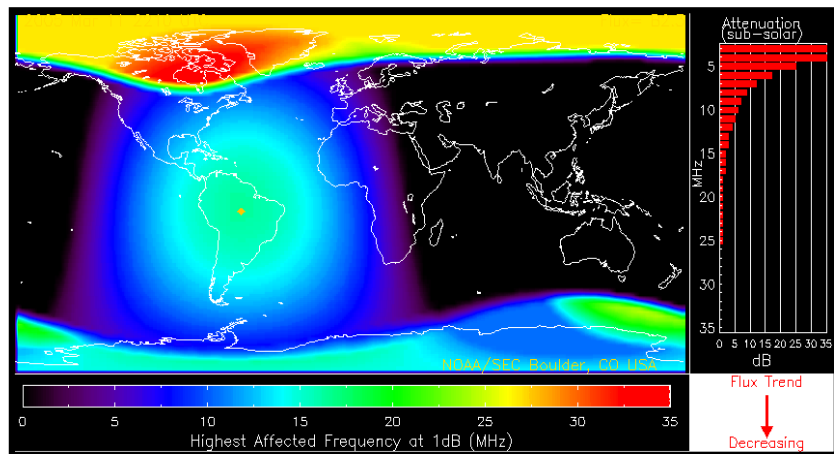
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- In the 4IR technology continues to play an ever-increasing role in our society and the potential for space weather storms from the Sun to impact our daily lives is also growing.
- Technological infrastructure, including the power grid, GPS and satellites used for communication and navigation, are vulnerable to space weather effects caused by the Sun.



IMPACT ON AVIATION



- Airline communication (HF & Satellites)
- Airline Navigation
- Radiation doses (particularly for polar routes)

For 15 and 11-hour periods in Oct 2003, the vertical error limit (50 meters), was exceeded.

Commercial aircraft were unable to use WAAS for precision approaches.



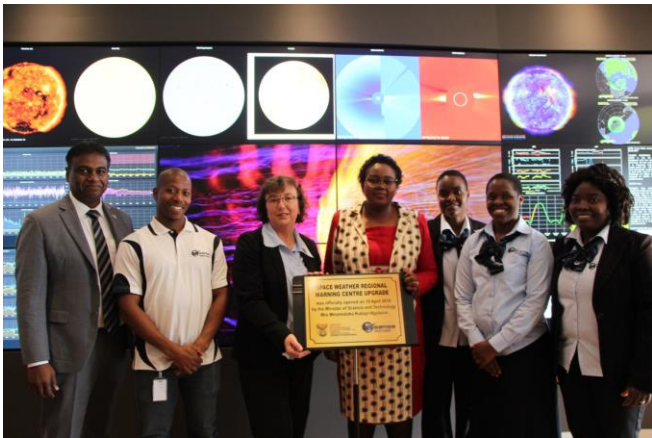
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Space weather events that affect Aviation sector

| SOLAR EVENT | Solar Flare | | | | CME | | Solar Wind | Galactic Cosmic Rays | |
|--------------------------|--|--------------------------|--------------|--------------------------------|---------------------|--------------------------------|--------------------------|----------------------|---------------------------|
| | X-Ray Emissions | Ultraviolet emissions | Radio Bursts | Solar Energetic Protons (SEPs) | Plasma | Solar Energetic Protons (SEPs) | Enhances Radiation Belts | | |
| | Increase Ionosphere Density | Ionospheric disturbances | | | Geo-magnetic Storms | | Aurora | Radiation | Ionospheric Scintillation |
| AVIATION-RELATED SYSTEMS | Passengers/Crew (Biological) | | | X | X | X | | X | |
| | Avionics | | | X | | X | | X | |
| | HF Communication | X | X | | X | X | | | |
| | GPS/WAAS | X | X | X | X | X | X | | X |
| | Satellites (Navigation, Communication) | X | X | X | X | X | X | X | X |
| | Low Frequency Communication | X | | X | | X | | | |
| | ATC facilities | | X | | | X | | | |
| | NextGen | X | X | X | X | X | X | X | X |



SANSA SPACE WEATHER CENTRE



Space Weather Centre launched
in December 2010
Re-launched after upgrade in
April 2018

Provide the *right*
information...
in the *right* format...
at the *right* time... to the
right people...
to enable and facilitate
the *right* decisions!



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Summary of Amendments

→ States were given the opportunity to apply to be **Regional Provider States** for space weather information

→ Provider States need to be able to

- A) **monitor** relevant ground-based, airborne and space-based observations to detect, and predict when possible, the existence and extent of space weather conditions that have an impact in 4 identified areas
- B) **Issue** advisory information
- C) **Supply** the advisory information to appropriate aviation channels
- D) **Maintain** a 24 hour watch
- E) **Ensure** active collaboration with other regional centres and global centres to ensure a continuity of information



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Space Weather Information for Aviation

- Space weather phenomenon relevant to the whole flight route has been added to the information to be provided to operators and flight crew members.
- **SANSA has received designation as a Regional Centre for Space Weather Information Provision from the International Civil Aviation Organisation (ICAO)**
- Space weather advisory information will include one or more of the following effects:

- high frequency (HF) radio communications;
- Satellite communications
- GNSS-based navigation and surveillance; and
- radiation exposure at flight levels;





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Policy Briefs



Executive Summary

This policy brief addresses the need to raise awareness of the impacts caused by space weather on the aviation sector. The main recommendation put forward is that South Africa should sign itself with international standards for the provision and access to space weather information in order to meet the International Civil Aviation Organisation (ICAO) recommendations by 2017, and to protect the vulnerable areas within the aviation sector. An additional seven recommendations are included which would assist South Africa in developing capabilities, strategies and action plans around space weather and its impact on the aviation sector in South Africa.

Space weather refers to the conditions in space, on the Sun and in the solar wind, magnetosphere, ionosphere, and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems. Continuous monitoring of the space environment allows for early warning, forecasting and prediction of space weather events that could lead to technological and infrastructure failure. Due to the increasingly interconnected and interdependent technological systems of modern society space weather can negatively impact

numerous sectors, leading to a cascade of operational failures. Research has shown that the defence, communications, navigation, aviation, and energy sectors are most vulnerable to space weather effects. The South African National Space Agency (SANSa) operates the Space Weather Regional Warning Centre for Africa, under the International Space Environment Service (ISES), which aims to coordinate global space weather activities. The SANSa Space Weather Centre was established in 2010 with the mandate to (i) develop space weather capabilities within South Africa, (ii) improve the understanding and awareness of space weather within Africa, and (iii) provide a space weather operational service to government, industry and the public. It is important to note that space weather is a global phenomenon with regional impact.

Ground based support and aircraft are vulnerable to space weather impacts, primarily in four key areas: communication, navigation, aircraft avionics and radiation exposure. ICAO has recognised the need for the adoption of procedures related to mitigating space weather impacts. During the 2014 Montreal Meeting of the ICAO Meteorology Division a recommendation was passed for



Executive Summary

This policy brief addresses the need to raise awareness of the economic impacts that can arise from space weather events and the national risk that space weather presents to South Africa. The main recommendation put forward is that South Africa should identify extreme space weather events as a potential risk to the economy and critical infrastructure, and therefore appropriate recognition, understanding and capability development is required in order to ensure adequate preparedness. Nine recommendations are included which would assist South Africa in developing capabilities, strategies, action and mitigation plans in order to manage the national risk presented by the space environment.

Due to the increasingly interconnected and interdependent technological systems of modern society space weather can negatively impact numerous sectors, leading to a cascade of operational failures. Research has shown that the defence, communications, navigation, aviation, and energy sectors are most vulnerable to space weather effects. Research has also shown that space weather is a global phenomenon with regional impact. The South African National Space Agency (SANSa) operates the

Space Weather Regional Warning Centre for Africa, under the International Space Environment Service (ISES), which aims to coordinate global space weather activities. The SANSa Space Weather Centre was established in 2010 with the mandate to (i) develop space weather capabilities within South Africa, (ii) improve the understanding and awareness of space weather within Africa, and (iii) provide a space weather operational service to government, industry and the public.

The field of space weather is growing rapidly, with new discoveries and continuous developments in forecasting and prediction capabilities which improve almost daily. There are still many unknowns and a rigorous assessment of the economic impact resulting from a severe solar storm is a work in progress. Some analysis has been done on the impacts resulting from Geomagnetically Induced Currents (GICs), however, to a large extent the evidence is still anecdotal. This policy brief describes the possible economic impacts, and presents likely scenarios as well as discussion points around the risk that South Africa may be exposed to from space weather.



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IMPORTANT POINTS

- Space Weather events can create **vulnerabilities** within our technology dependencies, and is a risk to the 4IR
- Space Weather affects **safety of live principles** for aviation operations, and compliance with ICAO is now a requirement
- SANSA is addressing **operational capability** for Space Weather information provision as a service to the African region
- SANSA will continue to utilize its existing capability and global networks to ensure that the most optimum solution for dealing with the **threat of Space Weather** is developed for the continent
- SANSA will continue to **partner** with various role players to ensure an adequate readiness level for provider & user of space weather information





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ACTION BY THE MEETING

The meeting is invited to:

- a) Take note of the information contained in this working paper including State Letter AN10/1-17/41, dated 7 April 2017, and the designation of SANSA as the Regional Centre for Space Weather Information provision.
- b) Consider the implications of space weather requirements for AFI States regulatory authorities, ANSP's and operators' operational policies.
- c) Urge States to work with the Regional Space Weather Centre (SANSA) to develop action plans to meet the implementation requirements as defined in State Letter AN10/1-17/41, dated 7 April 2017, and to participate in arranged information sessions to ensure adequate awareness and understanding.





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DRAFT CONCLUSION/DECISION

Development of action plans to meet the Space Weather implementation requirements

That;

- a) States consider the implications of Annex 3 space weather requirements for AFI States' regulatory authorities, ANSPs and operators' operational policies;
- a) the Secretariat, with the support of the designated Regional Space Weather Centre (SANSA), take appropriate actions to assist States to meet the space weather implementation requirements.



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