



# Promoting Space Sustainability

## Implementation of the Guidelines for the Long-term Sustainability (LTS) of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space

### Operational Case Studies

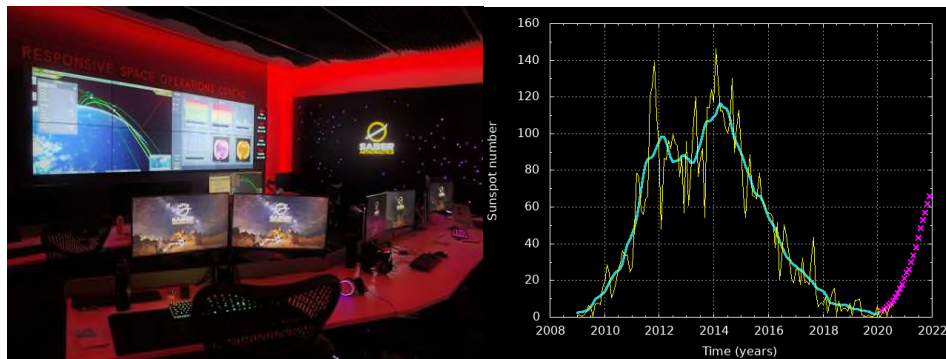
#### I. Short description of the outer space activity

Space weather is intrinsically linked to the long-term sustainability of operations in space and is recognised in the LTS guidelines through two guidelines specific to space weather. Australia undertakes a range of activities towards the implementation of these guidelines including supporting satellite operations within the mission control centre funded by the Australian Space Agency, participating in the delivery and exchange of space weather forecasts and information for the International Civil Aviation Organisation (ICAO), and participating in a number of international organisations promoting the international exchange and coordination of space weather information.

##### **A: Contributing to the safe and efficient operation of satellites using real-time space weather information.**

Australia recognises that space weather is an inherent influence on the longevity of a satellite's life. Australia contributes to the safe and efficient operation of satellites by providing alerts and warnings through the Australian Bureau of Meteorology's Space Weather Service (SWS). The real time space weather information provided to the Australian space industry, supports satellite operator's ability to anticipate and mitigate the impacts of space weather. In January 2021, the Bureau of Meteorology formed an agreement with Saber Astronautics to provide space weather data to the new Mission Control Centre, funded through the Australian Space Agency, named the Responsive Space Operations Centre (RSOC). Through this partnership, real-time space weather information is ingested into the RSOC, and integrated into Saber's visualisation software to aid space situational awareness to satellite customers. This awareness contributes to Australia's goal of being a responsible user of space. In addition to directly supporting space operators, the RSOC will be able to be viewed by the public, which helps to increase the community's awareness of space sustainability and the impact of space weather.

Moving towards the next solar maximum, and the potential for more frequent solar events Australia's investment in space weather activities is timely. This investment will not only increase the general public's knowledge of space weather, but it will increase Australia's ability to be a resilient and sustainable space faring nation through the improved safety of satellites and satellite operations.



LEFT: Saber Astronautics Responsive Space Operations Centre™ (RSOC) in Adelaide Australia (Credit: Saber Astronautics), RIGHT: Monthly sunspot number (yellow) during the previous solar cycle and predicted monthly sunspot number (magenta) during the beginning of Cycle 25 (Credit: Bureau of Meteorology).

## **B: Delivering space weather services to the aviation industry through international cooperation**

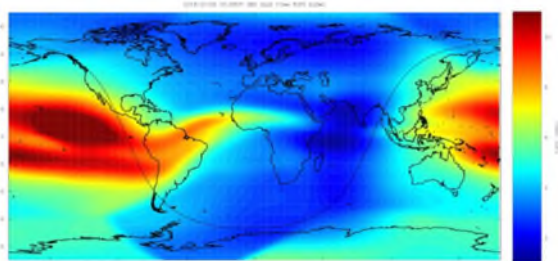
Space weather poses a risk to the safety and efficiency of international aviation operations causing disruptions to communications, navigation and surveillance systems. Severe space weather can also lead to exposure to harmful levels of radiation for passengers and flight crew at high latitudes. Access to globally standardised and globally consistent space weather advisories is critical for the aviation industry to effectively manage the risk of space weather. Space weather advice must remain consistent across multiple flight information regions and be available on a 24/7 basis requiring a high level of global coordination.

To meet these requirements, Australia participates in the International Civil Aviation Organization (ICAO) established a global space weather information service, which commenced operations in November 2019. Australia's Bureau of Meteorology delivers these services to the aviation industry through the ICAO space weather service as a leading partner in the Australia-Canada-France-Japan (ACFJ) consortium, one of four global space weather centres designated by ICAO. The other three centres comprise the European PECASUS consortium, the US Space Weather Prediction Centre and the recently designated China-Russia consortium. The centres operate as the On Duty centre for two-week periods, providing all space weather advisories to aviation on a global scale on a 24/7 basis, with other centres acting in operational backup roles.

The aviation industry monitor for ICAO advisories and activate operational procedures as required. These actions may include use of modified or alternate routes, or delayed flights to avoid affected areas; use of alternate means of communication; increased spacing between aircraft in congested

airspace; or use of alternate technology supporting navigation and positioning in the event of potential space weather impacts.

The global service is governed by international agreements between member states and relies on effective operational coordination between the space weather centres to deliver a globally harmonised service.



Global map of maximum useable frequency for HF Radio users.  
Photo: Bureau of Meteorology



### **C: Promoting international cooperation and exchange of space weather data**

Severe space weather has the potential to significantly impact both space and ground-based critical infrastructure. With an increasingly connected and technology-reliant society, these impacts would be felt on a global scale. Australia contributes to the international efforts towards improved coordination and exchange of space weather information to help mitigate this threat.

As an active member of the UN Committee on the Peaceful Uses of Outer Space (COPUOS) Scientific and Technical Subcommittee's Expert Group on Space Weather, Australia has helped to coordinate and analyse surveys of COPUOS Member States' progress towards the LTS space weather guidelines. The analysis assessed the level of space weather event preparedness among the international community, provided information on planned future activities, and outlined the requirements within Member States for improved space weather impact mitigation. The results of the analysis highlighted the need for improved coordination among member states and international organisations and will provide a focus for the future coordination of space weather activities.

In addition to its involvement in UN COPUOS, Australia actively participates in a wide range of other international collaboration activities with the International Space Environment Service (ISES), the World Meteorological Organization (WMO) expert working group on space weather, the Committee on Space Research (COPSAR) Panel on Space Weather, and the inter-governmental Group on Earth Observations (GEO).

Australia also supports the international exchange of space weather data by providing open access to its observations, forecasts, warnings, and alerts through SWS. The exception is when data products are designed or tailored for the special needs of commercial customers.

Australia also operates a World Data Centre for Space Weather through the SWS as an international resource. Additionally, Australia participates in international organisations progressing the development of the standards for data exchange of space weather information such as the Space Physics

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Archive Search and Extract (SPASE) consortium. SPASE is an international community of scientists, specialists, information engineers and system designers who are endeavouring to create a standard and service to enable to open exchange of Heliophysics data. Australia's SWS has been contributing to this activity since 2017.

## II. Connection with the LTS Guidelines

Australia undertakes a range of activities towards the implementation of aspects of the LTS Guidelines, and shows strong links to:

**Guideline B.6:** Share operational space weather data and forecasts

**Guideline B.7:** Develop space weather models and tools and collect established practices on the mitigation of space weather effects

**Guideline C.1:** Promote and facilitate international cooperation in support of the long-term sustainability of outer space activities

LTS Guideline **B.6** addresses sharing operational space weather data and forecasts. In particular, the guideline suggests that organisations should share and disseminate space weather data and forecasts, in real-time if possible, to enhance the long-term sustainability of outer space activities.

The Bureau of Meteorology's agreement with Saber Astronautics to integrate real-time space weather information into a Mission Control supports the longevity of satellites in orbit and is therefore closely connected with the implementation of guideline **B.6**. The Bureau also openly shares much of its space weather data, which is available via its website. In addition, the Bureau has numerous data sharing agreements in place with international organisations, such as the ACFJ consortium, to assist with monitoring and forecasting space weather conditions that can have impacts in space and on Earth.

Australia has expertise in the development of space weather models and tools which support key industry's ability to establish sound management strategies to mitigate the impacts of a space weather impact. This action supports guideline **B.7**. The Bureau of Meteorology focuses this output around bespoke products and services that supports the coordination of space weather data, which also strengthens Australia's ability to help support the establishment and coordination of responses to extreme space weather threats.

As an active participant in numerous international collaboration activities, particularly the UN COPUOS Expert Group on Space Weather, Australia also implements guideline **C.1**: promoting and facilitating international cooperation in support of the long-term sustainability of out space activities. Australia successfully coordinates its activities through the Bureau of Meteorology and its collaboration with the Australian Space Agency.

## III. Lessons learned

1. International participation in international coordinated bodies builds on the strengths of all parties involved. Australia sees participation in such forums as essential for achieving a global approach to space weather that is both meaningful and effective. For Australia, involvement in such multi-

international forums has additional benefits through the reciprocal access to information which helps to create pathways for further innovation and the operationalisation of space weather data for the benefit of key industries.

2. Participation in international coordinating bodies improves the global community's understanding on space weather issues and it maximises the global effort to manage and mitigate space weather impacts. Being part of such group allows Australia to share their experiences and learn from others. For example, being a part of the ICAO global service has enhanced our skills and knowledge that we can share with others. It is also a valuable contribution to safety and security of industries.
3. The establishment of a standardised data format will facilitate the sharing of data across organisations. Australia's Bureau of Meteorology has taken steps to incorporate the SPASE approach to data and see that this approach will enhance learning, increase knowledge, and will improve the opportunities for more effective services, which will benefit the space industry and the broader community.
4. Australia sees values in working closely with the space industry to increase awareness of space weather impacts. It also see that data sharing agreements with industry provide the opportunity to scale-up the impact and value of space weather information for specific industry needs, and will contribute to the sustainable use of space in an operational capacity.