



Australian Academy of Science

SUBMISSION TO THE REVIEW OF THE BUREAU OF METEOROLOGY'S SPACE WEATHER SERVICES

FROM THE AUSTRALIAN ACADEMY OF SCIENCE / JULY 2014

Submission to the review of the Bureau of Meteorology's Space Weather Services

Key points

- **The Bureau's Space Weather Services provides a broad range of data and expertise, and is fundamental to the security of vital national infrastructure.**
- **The Bureau's integrated network of sensors covering an eighth of the globe is a valuable scientific resource that must be supported.**
- **Participation in international science activities requires reciprocal collection and distribution of data, and the introduction of cost recovery charges may prompt reciprocal charges from others and lead to diminished use of data sets.**
- **The Bureau's Space Weather Services provides a vital service and research platform for Australia, and support for the service should be continued, and at a level commensurate with its expected growth in demand for its services.**
- **Moves to reduce the Bureau's Space Weather Services functions or increase cost recovery would be counterproductive and detrimental to the national interest, and any moves to privatise, outsource or remove the service should be avoided.**

Introduction

The term 'space weather' describes effects on technological systems and human enterprise of natural phenomena in the upper and ionised part of the atmosphere, including near-Earth space. Monitoring and research activities are necessary to better understand and predict these processes. The Academy welcomes the release of the Review Discussion Paper, which provides a well-considered overview of the significance of some of these effects and the associated activities of the Bureau of Meteorology's Space Weather Services ('Bureau Service').

Policy context

Space weather operates over a range of time constants and interconnected physical systems. While extremely severe space weather events are rare, more frequent moderate events can disrupt or degrade a range of critical services such as communications via radio or undersea cable, GPS accuracy, power grids and gas, oil and other pipelines (Jensen et al 2000). The Bureau Service provides a broad range of data and associated expertise that supports the defence, navigation, aviation, resource exploitation and other industry sectors. This is a fundamental contribution to the security of national infrastructure, and such activities clearly fall within the ambit of the Bureau's mission and of the *Meteorology Act 1955*. The monitoring and related-research activities of the Bureau Service clearly support the advancement and application of science in this area, supporting Australia's interests nationally and internationally.

Benchmarking

The governments of many developed countries recognise space weather risks, in some cases formally on a national risk register, and operate centralised space weather prediction agencies to help mitigate these risks. The Bureau Service is a centralised agency and has a long and successful history of customer coordination and engagement at a national level. It is regarded internationally as an innovative and senior space weather centre, is a member agency and Regional Warning Centre for the International Space Environment Service of the World Meteorological Organization's Interprogramme Space Weather Coordination Team. The Bureau Service is also a network member

of the International Council of Science World Data System, operating the World Data Centre for Solar-Terrestrial Science through which it provides data from its sensor network and from other Australian observatories to the international community.

Meeting user needs

Like weather in the lower atmosphere, understanding and prediction of space weather requires data and expertise contributed by many member countries, but with regional focus. Space weather effects and impacts vary with local time and latitude, and with the nature of the technology and infrastructure assets. For example, the magnitude of pipe-to-soil potentials in long gas pipelines and ground induced currents in electricity grids depend on the local ground geology and the pattern of current systems in the overhead ionosphere as well as the global level of magnetic disturbance. Long conductors are therefore vulnerable to severe space weather events and cumulative degradation from moderate events. Another important example of space weather effects concerns the formation of irregularities in the low latitude ionosphere which degrade the performance of global navigation satellite systems. Understanding all these effects requires monitoring and research activities informed by user needs and local knowledge.

To perform its functions the Bureau Service has developed an integrated network of sensors that covers about an eighth of the globe, consistent with Australia's sphere of interest. In addition to its own sources, it accesses and builds on data from other organisations including Geoscience Australia, the Australian Antarctic Division, universities and international agencies. This is a unique and valuable central scientific resource. Long term monitoring and data maintenance are essential for understanding complex environmental processes such as space weather, and the Academy acknowledges the valuable work of the Bureau Service in this regard. Australia's credibility and our participation in international science activities requires collection and distribution of such data, and cost recovery may prompt reciprocal charges from others and diminish the use of data sets (Office of the Federal Coordinator for Meteorological Services and Supporting Research 2013). The result would be counterproductive (Houghton 2011).

The Bureau Service provides national corporate knowledge of space weather. It is a logical focal point for space-weather related monitoring and prediction activities; it would be inefficient and unrealistic for such interests to be met on a needs basis by various agencies with narrower space weather interests.

Strategic outlook

In recent years there has been enormous growth and increasing reliance on an array of services and networks which are vulnerable to space weather. These include communications networks (e.g. radio), data channels (e.g. satellite-ground), precise position and timing systems (e.g. GPS), surveillance systems (e.g. HF radar) and resource distribution networks (e.g. electricity and gas). These sectors will continue to grow, with future requirements for space weather monitoring and prediction also expanding. Furthermore, there is accumulating evidence that space weather through particle precipitation from the radiation belts affects atmospheric events, including ozone, NO_x and OH concentrations at least in the polar regions (Rodger et al 2010).

In addition, the Bureau Service undertakes research, initiated through its own endeavours and in collaboration with other organisations, to improve understanding and hence prediction and amelioration of space weather effects. For example, scientists with the Bureau Service have published papers in international peer-reviewed literature on measured effects and consequent space weather hazards to long pipelines and electricity networks in Australia (e.g. Marshall et al. 2010; Marshall et al 2011) and on causes of GPS irregularities at low latitudes (e.g. Carter et al.

2014), and are engaged with university academics on applied research aimed at developing models that improve the capacity to predict geo-effective solar eruptions and induced currents in long conductors (e.g. Cairns and Neudegg 2013; Waters et al 2013). The Academy commends the Bureau Service for its efforts in this direction.

Summary and recommendation

The Bureau of Meteorology's Space Weather Services provides a vital service and research platform for Australia. Its sensor network, prediction service and focused research safeguard Australia's critical infrastructure, and user demand for this will grow in the future. Such operations fit logically within the Bureau's remit, both in terms of its mission and Act, and by international benchmarks. The Bureau Service has a strong international reputation and is a key contributor to international programs aimed at better understanding and mitigating space weather hazards.

The Academy is of the strong view that moves to reduce the Bureau Service's functions or increase cost recovery would be counterproductive and detrimental to the national interest, and recommends that the Space Weather Services not be privatised, outsourced or otherwise removed from the Bureau.

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