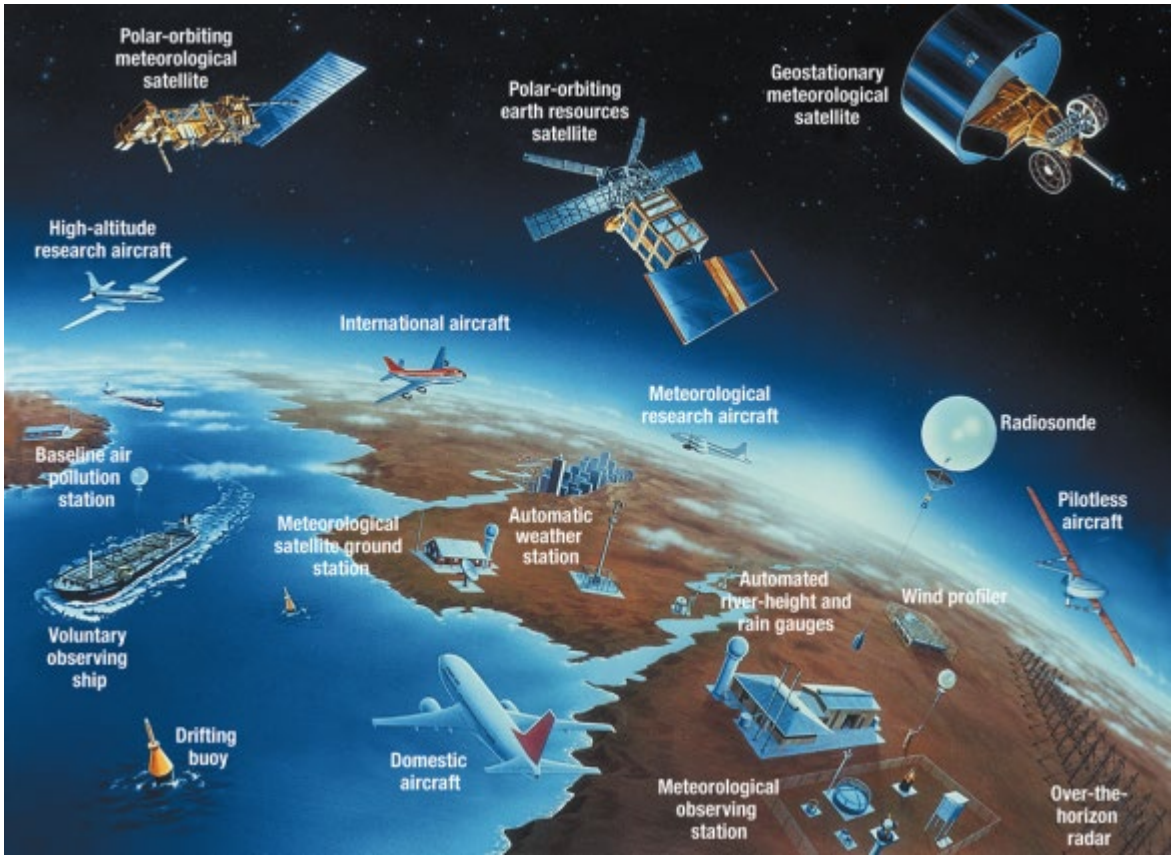
The Bureau of Meteorology

Bureau of Meteorology Submission to the Australian Communications and Media Authority (ACMA)

Draft Five-year spectrum outlook 2023–28 (FYSO)

May 2023



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1. About the Bureau of Meteorology

The Bureau of Meteorology (the Bureau) is Australia's national weather, climate and water agency, providing a wide range of products and services to support informed decision-making by governments, emergency services, industry and the community.

The Bureau operates under the authority of the *Meteorology Act 1955* (Cth) and the *Water Act 2007* (Cth), which together provide the legal basis for its activities. The Bureau must also fulfil Australia's international obligations under the Convention of the World Meteorological Organization (WMO) and related international meteorological treaties and agreements.

The Bureau is an Executive Agency under the *Public Service Act 1999* (Cth), and a non-corporate Commonwealth entity under the *Public Governance, Performance and Accountability Act 2013* (Cth). The Bureau operates under the Climate Change, Energy, the Environment and Water portfolio and reports to the Minister for the Environment and Water generally, and to the Minister for Emergency Management on emergency management matters.

The Bureau's products and services include a range of observations, forecasts, warnings, analyses and advice covering Australia's atmosphere, water, ocean and space environments. Its expertise and services assist Australians to manage and live safely and productively within their natural environment.

The Bureau welcomes the opportunity to provide feedback to the *Draft Five-year spectrum outlook 2023–28*, and to work with ACMA on optimising the use of the radiofrequency spectrum for the benefit of the Australian community.

2. The Bureau's use of spectrum

The Bureau is the third-largest frequency spectrum user in Australia, with licenced frequency spectrum from 2 MHz to 100 GHz to support a range of observing systems including active and passive sensors, fixed and mobile systems, and terrestrial to satellite services.

To meet the requirements of the different sectors of the meteorological services, reliable access to the radio frequency spectrum is critical for all Bureau sensors and communication links. The Bureau asks ACMA to consider the following recommendations in its five-year spectrum outlook (FYSO) plan.

2.1. Satellite earth observations

The Bureau uses satellites to access critical environmental data on drought, floods, fires, and thunderstorms, for direct use in products and warnings. It also incorporates massive amounts of satellite data into its weather, ocean, water and air quality forecasts. This results in dramatic improvements in forecast accuracy and directly translates into economic benefit through improved decision making and support for the activities of Australian industry and other stakeholders.

There are constraints on the spectrum appropriate for satellite earth observations data based on physics and the (requirements of) foreign satellite operators. A lack of access to dedicated spectrum for these applications will interfere with the maintenance and development of space capability to meet obligations of the Meteorology Act and to meet our customers' needs. The choice of radiofrequency spectrum for these applications is determined by environmental physics and foreign satellite operators.

Various entities in earth observation compete for allocation of spectrum due to their commercial interests. In addition, in metropolitan areas, commercial services (including fixed and mobile telephony) are often given preference, which forces the relocation of earth stations to locations that are a large distance from hubs and centres. This adds to costs and has associated security risks.

Considering the benefits to the Australian community the Bureau recommends that meteorological-satellite bands are retained and protected from future interference from commercial users sharing the same or adjacent bands.

2.1.1. Protection of passive and active bands used for earth observations

The Bureau uses data from around 30 earth observations satellites in its operational weather, ocean and land/hydrology models, and in the forecasts and warnings delivered to the Australian community.

Earth observation data is essential for monitoring and predicting climate change, for disaster prediction, monitoring and mitigation, for increasing the understanding, modelling and verification of all aspects of climate change, and for related policy making.

Earth observation satellites use passive and active technologies to observe the atmosphere and Earth. **Passive** sensing is the measurement of naturally occurring radiation, usually of very low power levels, which provides essential information on physical processes.

The relevant frequency bands are determined by *fixed* physical properties (molecular resonance) that cannot be changed or ignored, nor can these physical properties to be duplicated in other bands. Therefore, these frequency bands are an important natural resource. Even low-level interference can be problematic as it is difficult to detect and remove. In most cases passive sensors cannot discriminate between natural and man-made radiation.

Where passive sensing bands are shared with **active** services, the situation is becoming critical because the increased density of terrestrial active devices are causing serious cases of interference.

The Bureau recommends a new subheading and section under 'The policy environment and regulatory reform' section:

Passive and active bands for satellite Earth observation

Over 95% of the observations used by the Bureau of Meteorology in its weather forecast models are from satellites. Satellite observations also support our understanding of climate processes, and are used for monitoring drought and land degradation, sea surface temperatures, and the quality of inland water bodies.

Many meteorological satellites use passive sensing techniques that measure the very low-power microwave radiances naturally emitted from the atmosphere and the Earth's surface. These passive techniques are the most vulnerable to interference from new technologies.

Meteorological satellites use different frequencies across a wide range of frequency bands. As an example, a frequency around 1.4 GHz is best for ocean salinity and measurements, around 6 GHz offers the best sensitivity to sea surface temperature. Similarly, measurement in 17–19 GHz region offers optimal performance for ocean-surface emissivity, while atmospheric total water content is best measured around 24 GHz, with liquid clouds best measured at 36 GHz.

The Bureau has already seen evidence of radio frequency interference in the L (~1.4 GHz), C (~6.9 GHz), X (~10.7 GHz) and K (~18.7 GHz) frequency bands, notably on the European SMOS instrument and the Japanese AMSR2 instrument. Loss of these and other bands due to radiofrequency interference would have a catastrophic effect on the quality of the Bureau's forecasts and warnings.

New applications (e.g. 5/6G) outside the field of meteorology are interested in higher frequencies, such as in bands adjacent to 24 GHz and 50 GHz, which are crucial for obtaining accurate estimates of water vapour and temperature. We need to ensure protection is in place to limit the level of out-of-band emissions from active systems operating in neighbouring bands (e.g. emissions from the 5G band between 24.25 GHz and 27.5 GHz affecting the passive band 23.6–24.0 GHz).

Without satellite Earth observations, the Bureau cannot predict weather, climate and water-related hazards and protect the lives and property of all Australians with the degree of accuracy that we have come to expect. Lower accuracy

forecasts result in less timely warnings of severe weather, and potential significant economic costs and harm to people and property.

The Bureau seeks protection of frequencies that are vital to weather forecasts and warnings.

- Protection from out-of-band and spurious radiofrequency emissions that could affect frequencies near 7, 10, 18, 89, 231–247 (ice cloud sensing).
- Bands 239.2–242.2 GHz and 244.2–247.2 GHz and band 231.5–252 GHz for planned and future passive microwave sensors for ice cloud measurements.
- Bands 6425–7025 MHz and 7075−7250 MHz or to find, if possible, complementary frequency resources for sea surface temperature observations to compensate for the increased interference potential due to the identification of the band for International Mobile Telecommunications (IMT) 5G mobile in WRC agenda item 1.2
- Protection of the band 1695−1710 MHz (used for low earth orbit direct broadcast to user stations) from planned new frequency usage by commercial satellite systems or from possible high-altitude platform stations as IMT base stations (HIBS) in the neighbouring band.

Given that satellite Earth observations are vital to the Bureau's role in protecting life and property, the Bureau recommends that this is highlighted on page 6: Suggested new text (refer to red underlined text)

…facilitates the use of the spectrum for:

- commercial purposes
- defence purposes, national security purposes, weather warnings and forecasts, and other non-commercial purposes (including public safety and community purposes)…

2.1.2. Threat from 5G/6G

The Bureau is concerned about the impact of 5G/6G technology on the microwave bands. It is well recognised that satellites that observe the Earth in the microwave spectrum have the greatest impact on forecast accuracy. Degradation of the microwave bands could have a significant negative impact on weather-dependent sectors such as aviation, shipping, agricultural meteorology and warning of extreme events, as well as our ability to monitor climate change in the future.

The Bureau does not object to the rollout of new telecommunication technologies such as 5G, but recommends that these technologies should not be allowed to cause harmful interference (noting that low-level signals can cause harmful interference) on the frequencies used by life-saving services such as weather forecasts and warnings.

2.2. Downlink of satellite Earth observations

The FYSO should consider current and future requirements for downlink of satellite Earth observations data that are critical for the Bureau's operational forecast models. The Bureau relies on S-band and X-band frequencies for near-real-time reception of satellite observations from low

earth orbit satellites operated by the National Oceanic and Atmospheric Administration (US), European Space Agency and European Organisation for the Exploitation of Meteorological Satellites.

These data streams are received by the Bureau's antenna network across Australia and the Antarctic. The Bureau has also commenced early planning for a future Australian weather satellite capability, which will require these downlink frequencies, and therefore recommends that these frequencies are protected.

The Bureau also recognises that optical communications is an emerging technology for downlinking large data volumes, but this is not mentioned in the FYSO.

2.3. Coordination between 2.5 GHz band transmitters and S-band radiodetermination stations operated by the Bureau

The Bureau relies on weather radars to produce accurate and reliable observations, even in extreme weather conditions. In this regard, long-range radars in the Bureau's fleet are those operating in S-band (2700−2900 MHz).

The Bureau manages a network of S-band radars distributed around the country, which are required to co-exist with other spectrum users including 2500 MHz Mobile services transmitters (2500−2570 MHz and 2620−2690 MHz). In some cases, the two systems are only few hundred meters apart.

To ensure an interference-free co-existence, the Bureau recommends including a topic on revising technical parameters in licencing 2500 MHz band transmitters to coordinate between the Bureau's S-band radars and new 2500 MHz transmitters.

2.4. Protection of radioastronomy facility at Learmonth Solar Observatory

Learmonth Solar Observatory (LSO) is located at 22°13'09.4"S 114°06'11.0"E in Western Australia and is jointly operated by the Bureau and the United States Air Force. The facility monitors the variability of the sun with highly sensitive receivers, and the data is distributed to customers in Australia and the United States.

To ensure smooth operation and future extension of the observatory, the Bureau recommends including a topic on the protection of Learmonth Solar Observatory, including the observatory in the AUS87 footnote, which identifies radio astronomy facilities within Australia for greater visibility to other spectrum users.

The Bureau also recommends that the observatory is included in RALI MS31 so that the Bureau is notified in a timely manner of new transmitters in the area, to mitigate the impact of potential interference that might undermine data quality.

2.5. Peak of the solar cycle

The Bureau notes that ACMA's spectrum planning options framework considers environmental factors, including technical issues. As we approach the solar cycle peak in 2025, the expected frequency and severity of space weather events is likely to increase. Statistically, high impact events are also more likely in the year or two following the peak of the cycle (2025-2028). The Sun can emit radio signals that can interfere across a wide range of frequencies, primarily from HF (3-30 MHz) through to L-band (1-2GHz) for some extreme events. Interference is more likely below 180 MHz. Consequently, the Learmonth Solar Observatory monitors this part of the spectrum closely for solar activity.

The Bureau recommends that the increased likelihood of space weather interference across lower frequency bands being used by Emergency Management, aviation, and Defence be noted for awareness and planning purposes. In addition, the operators of ground segment of space-based (satellite) systems could be impacted by significant space weather events.