Technological dimensions of security in Antarctica and the Southern Ocean – the Oceans, Space and Near Space

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The strategic importance of Antarctica and the Southern Ocean is becoming an issue for major power competition, particularly as a rising China expands its presence across the continent. Preserving the spirit and letter of the Antarctic Treaty System (ATS) through greater use of advanced air, maritime and space capabilities provides an opportunity for greater transparency of activities by all Antarctica Treaty System states, and in turn acts as a deterrent against any one state circumventing the treaty by exploiting grey zone activities.

Key words: Antarctica; space; near space; autonomous systems; maritime domain; unmanned satellite; AUKUS; ATS.

The 21st Century strategic environment is dominated by intensifying major power competition, and a growing risk that such competition could easily become military conflict. The period immediately following the end of the Cold War in 1991 saw hope for a peaceful and cooperative post-Cold war era emerge. This has been overtaken by a re-assertion of major power competition, particularly driven by a rapidly rising China and a revanchist Russia, with the latter launching a brutal war against Ukraine in February 2022 that has brought war back to Europe for the first time since 1945. In the Indo-Pacific, the rapid growth of China's military power and its activities in the South and East China Sea, and against Taiwan, are generating tensions and risks that existing major power competition could become military conflict in coming years. These two fundamental changes to the strategic environment suggests a future that looks full of menace and risk. That risk extends to outer space, into the deep oceans, and to the polar regions of our planet. Competition between major powers is already intense within the Arctic region, and there are worrying signs that such competition could emerge in the Antarctic in coming years. For Australia the potential for major power competition to emerge over the southern continent should be a cause for great concern, given the significant amount of landmass covered by the Australian Antarctic Territory (AAT).

Central to the non-militarisation of Antarctica is the Antarctic Treaty System (ATS).[1] It's vital to preserve the spirit and letter of ATS and maintain its role – to preserve a stable and cooperative status quo in Antarctica and to prevent the militarisation of the southern continent. The challenge to the current stability in Antarctica emerges from the risk that major powers, such as China, will choose to circumvent the ATS, by exploiting 'grey zone' actions that would gradually undermine or erode the ATS over time. In doing so, a creeping militarisation of Antarctica could occur in a manner that gives that state military advantages elsewhere, or allows it the opportunity to challenge the sovereignty of AAT in coming years. In the longer term, if the ATS were to be weakened that would increase the likelihood for major power competition to extract strategic resources from the continent in a manner that could raise the risk of actual conflict.

The solution to preventing this outcome is through preserving the ATS through both diplomatic and technological means. On-going diplomacy amongst all ATS participants, including making full use of the right for inspections of facilities and activities, is vital, and should be at the forefront of Australia's approach to Antarctic security matters. But that diplomatic path, backed by established legal and regulatory mechanisms must be backed up by better use of emerging technologies to monitor activities across the region, to ensure attribution of any violations of the ATS, and to deny opacity for a state that seeks to circumvent the ATS.

A range of new technologies, most of which are 'dual use' in nature, can be employed without 'militarising Antarctica' or violating Article I ('Antarctica shall be used for peaceful purposes only') to ensure greater awareness and transparency of states' activities. The huge scale of the AAT, and of Antarctica in general, as well as its harsh operational environment, demands a persistent ability to monitor activities through a mix of space-based sensors on low-earth orbit (LEO) based satellites as well as autonomous systems in the air - including at very high altitudes in 'near space', as well as on and under the sea, that are connected via resilient data networks, and supported where necessary by human presence. This 'system of systems' approach is not about employment of military capabilities in violation of the ATS nor is it a path towards 'militarising Antarctica.' The technology would be used purely for surveillance in open skies, in a manner similar to the employment of ground and space-based surveillance (also known as space domain awareness), for ensuring the stability and longevity of the ATS. The nature of the technology would allow it to be operated by civilian agencies, with minimal or even no involvement by

the Australian military. The reality of assured attribution and denial of an opportunity for another state to exploit a grey zone approach, reinforces deterrence against challenges to the ATS and strengthens the agreement.

Leveraging technology to support security and stability

The case for using such technologies starts with the reality that an absence of awareness of the activities of other states invites violations of the ATS, however gradual and subtle, that over time will erode the credibility and efficacy of the agreement. Certainly, the ATS provides an inspections regime, in which 'parties are obliged to inform each other of their activities in Antarctic and facilitate inspections by other parties of their facilities.' This process should be maintained as a cornerstone of the ATS, and broad area surveillance capabilities suggested would contribute to the success of the existing inspections regime by reducing the prospect of undeclared or undetected activities. The goal must be for no opacity and greater opportunity for inspections that are informed by enhanced situational awareness of every state's activities. The approach of using advanced space and near-space based surveillance should be shared amongst all ATS partners, so in practical terms, China would have as much right to employ satellites and fly high altitude UAVs as Australia or the United States.

Space-based intelligence, surveillance and reconnaissance (ISR) provided by commercially operated satellite constellations operate in a vacuum of sovereignty. There is a legal right for satellites to overfly terrestrial territory as there are no borders or designated airspace in low-earth orbit (LEO). The use of commercial imaging satellite technologies as well as other types of surveillance capabilities, such as electronic and signals intelligence (ELINT and SIGINT), from a polar or sun synchronous orbit (SSO) means that broad area surveillance can be provided on a daily or even hourly basis over focal areas to monitor the activities of other ATS members, and cue higher resolution persistent surveillance of any activities that could be seen to be a violation or circumvention of the ATS. That higher resolution could be achieved from LEO-based satellites, or from long-endurance 'near-space' based uncrewed autonomous vehicles (UAVs). Ultimately, information gathered from both of these types of technology can then support the case for a request for inspections as allowed under the ATS. The availability of commercial satellites for ISR is going to grow as satellite 'mega-constellations' begin to emerge, involving thousands of small satellites to provide not just overhead imagery but also digital connectivity. Likewise, new approaches to UAV systems are appearing, with very long-endurance platforms such as the Airbus 'Zephyr' UAV being powered by solar panels along its wings, and able to stay on station for months.[2] The ability to complement such stratospheric-based platforms with lower altitude UAVs operating as a networked sensor cloud contributes towards greater situational awareness of activities on the surface. These technologies can operate under trusted autonomy, with humans on, or even 'off the loop' that dispatch and control the UAVs via satellite links from distant ground facilities. That reduces further the physical footprint of such technologies over Antarctica.

The role of autonomy goes further from the air to the sea, with the development of uncrewed surface vessels (USVs) and uncrewed underwater vessels (UUVs) now emerging as a viable capability for maritime domain awareness. The Australian 'Bluebottle' USV are solar powered and can remain at sea for weeks or months to conduct autonomous maritime surveillance as part of a networked system.[3] Like the Zephyr UAV, systems like Ocius' Bluebottle USV allow long-term maritime surveillance of critical economic exclusion zones (EEZs) and territorial seas around Antarctica and in the Southern Ocean. In the same way as UAVs, USVs can provide a comprehensive and common operating picture of maritime activities through providing a platform for networks of sensors to maritime domain fusion centres ashore, even if those centres are located in Australia, and anywhere distant from the AAT.

The technology mentioned above is simply the means by which the ATS can be strengthened by providing greater situational awareness of states activities on and around the southern continent. From that greater situational awareness will emerge the basis for an ability to inspect other states activities across the continent, and to challenge any perceived violations in a manner consistent with the ATS.

There are clear parallels with the application of space domain awareness (SDA) under the 1967 Outer Space Treaty (OST). SDA is a crucial element of ensuring compliance with the OST, and occurs using both ground-based electro-optical sensors, as well as space-based optical sensors on satellites. Without an effective SDA capability, it would be impossible to detect violations of the OST or other irresponsible behaviour in orbit, and thus hold would-be violators to account. There is a norm of accepting SDA as a means to avoid misunderstanding and miscalculation that could then lead to weaponisation of space. The employment of satellites and autonomous systems over and around Antarctica should support a similar norm of responsible behaviour in a manner consistent with the ATS.

The risks to the ATS

The key risk to the ATS' Article I comes from the establishment of dual-use facilities by some states to support space activities. In particular, China is making moves to exploit Antarctic territory to establish facilities including ground stations for its *Beidou* global navigation satellite system, and ground-based space domain awareness facilities to monitor satellites in polar orbit.

The ground-station for Beidou in particular is a concern following China's test of a new fractional orbital bombardment system (FOBS) based hypersonic glide vehicle in July and August 2021. The nature of the two tests saw China launch a hypersonic glide vehicle that circled the globe over the South Pole before re-entering over the South China Sea. Unlike Cold War era FOBS systems developed and deployed by the Soviet Union between 1968 and 1983, the IISS' Timothy Wright

suggests that the Chinese system apparently 'takes this concept one step further by then providing operators with the capability to manoeuvre the warhead laterally and vertically towards its target…' once the glide vehicle re-enters the Earth's atmosphere.[4] Bowen and Hunter challenge the significance of the 'FOBS-HGV' test arguing that the tests '…does not usher in a new phase of American vulnerability to Chinese weapons" and note that in any case, "US missile defences have never been able to fully protect American cities from nuclear attack."[5] They argue that such a system would likely be cost ineffective, 'requiring an enormous logistical effort resulting in the building and fielding of hundreds of launchers, vehicles, warheads and munitions.'

The use of a ground station in Antarctica could enhance the accuracy of such systems and could complement one that now exists in Perth, and others being established through the southern hemisphere in Africa and South America.[6] In the same way that the US Global Positioning System (GPS) now exploits a Satellite-based Augmentation System (SBAS) that enhances the accuracy of GPS from metres down to centimetres, through both space and ground-based infrastructure, China can enhance its Beidou GNSS network. That in turn would enhance the military effectiveness of PLA air, naval and missile forces undertaking operations in the South China Sea or against Taiwan, including potentially against the Australian Defence Force and our allies. In crisis, its unlikely that Australia would permit China to operate the Perth ground station but shutting down a ground station in Antarctica is a more challenging matter. In this sense, a dual-use facility in Antarctica, such as the one established at the Zhongshan and the Great Wall facilities in 2010, and Kunlun in 2013 can support Beidou satellite navigation in a manner that could directly support PLA military operations in a crisis.[7]

It's important not to over-dramatise the potential for an Antarctic facility to give a decisive military advantage. Claire Young dismisses the significance of Beidou ground stations in Antarctica, but argues that 'we should make more use of aerial, remote, unmanned and satellite surveillance capabilities…already needed to meet our Southern Ocean Search and Rescue (SAR) responsibilities, [with] remote monitoring [providing] cover for more of the year than surface vessels do.'[8] She argues that space domain awareness from high altitude locations in Antarctica, such as 'Dome Argus' ('Dome A') 'would only contribute marginally to data easily available from telescopes and other equipment in other parts of the world.'[9] That's debatable given the growing number of satellite capabilities for defence and national security that occupy polar and sun synchronous orbits, that pass directly over Chinese facilities, allowing valuable intelligence gathering on the ground.

Yet, the combination of activities that are dual-role and the expansion of dual-use facilities over time by China has the effect of gradually eroding norms of non-militarisation as required by the ATS. This is a 'boiling frog' analogy that sees China gradually reshape the facts on the ground to suit its strategic interests, whilst eroding the security interests of others. An absence of situational awareness of Chinese (and Russian) activities inside the AAT, and a reliance purely on the ATS Inspections protocols, which depend on the cooperation of all parties to work, creates the risk that over time, grey zone actions allow a creeping militarisation. The introduction of new types of military capability, such as advanced hypersonic weapons, and the expansion of PLA power projection capabilities beyond the second island chain into far seas and far oceans in the South Pacific and Indian Oceans, makes the potential utility of Antarctica to support military activities – in a manner that circumvents the ATS – more likely.

Ultimately, it may not be possible to prevent states from employing dual-role technologies and dual-use facilities to circumvent the ATS, and even with enhanced use of space and near-space surveillance capabilities discussed above, a breakout from the ATS, or the use of Antarctic territory for purposes which challenge the spirit and letter of the ATS may become unavoidable. The potential for illegal resource extraction would be one possible scenario where greater situational awareness, beyond traditional means such as Antarctic survey vessels such as Australia's the Nuyina can be employed. Ship launched UAVs and USVs, as well as even UUVs to monitor activities underwater could be employed in concert with commercially operated satellites to monitor a broad range of activities across the AAT and beyond.

This approach would be consistent with the recent decision by the Quad to employ space surveillance of focal areas and to use satellites to cue maritime responses to detected illegal activities. Philip Citowicki highlights the role of satellite surveillance to watch for illegal fishing as part of the Quad Leaders Tokyo Summit's new 'Indo-Pacific Partnership for Maritime Domain Awareness (IPMDA)'.[10] The use of commercially operated civilian satellites operating in polar orbits would bring them over the Southern Ocean on a regular basis in a manner that could enhance Australian and allied ability to monitor commercial fishing fleets that regularly plunder these maritime regions, and which 'go dark' by switching off automatic identification systems (AIS).[11] McGee and Bergin make clear that 'maritime domain awareness for civilian purposes is a 'peaceful use'. The Antarctic Treaty inspection regime expressly allows for 'aerial inspection' of stations and ships in the treaty area. That might arguably include satellite inspection from space.'[12]

The IPMDA creates a golden opportunity to establish a broad area of maritime surveillance network comprising both satellites, which could be jointly developed and operated by all four Quad members as a common capability, as well as investing in high altitude long endurance UAVs that can provide cued persistent surveillance of targets of concern or suspicious activity. This in turn, can allow better employment of crewed platforms – be they maritime patrol aircraft or Antarctic survey vessels to track and monitor potential illegal fishing activity in the Southern ocean. Awareness of such activities occurring in territorial waters and economic exclusion zones (EEZs) would enhance the effectiveness of the ATS and reduce the ability of states to violate the

agreement or erode its effectiveness over time. Such an approach could be expanded over time to include a broader range of autonomous technologies such as USVs that can offer networked surveillance which is persistent and allows greater detail and granularity of activity in the region.

Australia is well placed to support such an enhanced surveillance system. In considering space capabilities, there is already substantial work underway under Defence Project DEF-799 Phase 2 for the Australian Geospatial Organisation (AGO) to acquire ISR satellites as early as 2026 which are likely to be based in LEO and 'medium earth orbit' (MEO) in a polar and sun synchronous attitude. These will be defence satellites, but it would not be impossible to consider an extension of the project to incorporate a commercial component that would be controlled by a civilian agency or, as noted above, as part of a multilateral grouping such as the Quad. The growth of commercial satellite megaconstellations, based around small satellite technologies, and the falling cost of space launch as a result of the emergence of reusable launch systems such as SpaceX's 'Falcon 9' booster, would make the development of a civil satellite network affordable, particularly if costs were shared by several different ATS members. The establishment of a launch site at Whaler's Way near Port Lincoln in South Australia, is the ideal location for launching such small satellite constellations into polar and sun-synchronous orbit, and the technology of small satellites means that a regular refresh of the constellation is the best way to sustain such a capability. This would contribute to additional opportunities for Australia's rapidly growing commercial space sector, much of it based in Adelaide.

The autonomous vehicle component of an ATS surveillance system would also be able to be developed locally. Once again, the ADF is pursuing a range of autonomous air vehicle projects, most notably with the acquisition of four to six MQ-4C Triton surveillance UAVs under RAAF Project AIR 7003. One path would be to extend this project to acquire additional MQ-4C Tritons which would be operated by a commercial partner and not as part of the RAAF. This would immediately negate any charge that Australia is 'militarising' Antarctica. Investment in very high altitude long-endurance UAVs such as the Airbus Zephyr, which sometimes is referred to as a 'psuedo-satellite' for its very high altitude and long endurance, could add to the system's effectiveness, either as a network 'gateway' between other UAVs and USVs, or to support space-based sensors. Finally, with USV projects such as the Ocius Bluebottle now in advanced testing for Navy and Defence Science and Technology Group (DST) a surface element to undertake maritime domain awareness is a capability that could be fielded reasonably quickly.

Australia has a choice. It can continue to rely on the existing ATS and hope that all parties honour the spirit and letter of the agreement, without any intention to circumvent and erode the efficacy of the agreement. Or, it can choose to strengthen the ATS by reinforcing situational awareness of activities happening on and around Antarctica using advanced technology solutions. The goal is not to militarise Antarctica but to strengthen the ability of all states to challenge any violations through the process laid out in the ATS. Technology gives us better awareness of such risks. Its time we began exploiting this opportunity before the ATS comes under real threat.

The Author

Dr. Malcolm Davis joined ASPI as a Senior Analyst in Defence Strategy and Capability in January 2016. Prior, he was a Post-Doctoral Research Fellow in China-Western Relations with the Faculty of Society and Design at Bond University, and retains an Honorary Assistant Professor position in the Faculty. He has worked with the Department of Defence, both in Navy Headquarters in the Strategy and Force Structure area, and with Strategic Policy Division in the Strategic Policy Guidance and Strategic External Relations and Education sections. Earlier, he was a Lecturer in Defence Studies with Kings College London at the Joint Services Command and Staff College, Shrivenham, UK. He holds a PhD in Strategic Studies from the University of Hull as well as Masters degrees in Strategic Studies from the Australian National University's Strategic and Defence Studies Centre. His main research focus is on defence strategy and capability development, military technology, and the future of warfare.

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