

Australia's Antarctic National Air Power Futures

Peter Layton Travis Hallen Lauren Bishop



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Foreword

In being at the end of the earth, Antarctica is almost the definition of geographical remoteness. At times it seems this is matched by the lack of interest in Antarctic air operations shown by airpower thinkers and strategists. This neglect may need to change. The frozen continent is steadily becoming less distant from national concerns. New countries are establishing Antarctica bases while long-term resident states are refurbishing old Cold War era facilities and embracing new grand ambitions.

In many respects this rekindled interest amongst countries in undertaking significant national scientific research projects in Antarctica represents humanity's best: the desire to seek out new knowledge for the good of all. There is though an element of nations getting better prepared for a distant future when perhaps Antarctica's marine, genetic and mineral resources might be available for exploitation. Only time will tell if this transpires.

In the meantime Antarctica is re-emerging as an area of some significance. This is especially for Australians because as we all know Australia asserts sovereignty over almost half of continental Antarctica. This deep abiding interest is reflected in the Australian government's 2016 instigation of an ambitious Antarctic strategy and action plan that will see significant resources invested into a revitalised long-term national research program. In this program, national air power – the prudent combination of civilian and military aviation - plays an important supporting role.

The time is thus opportune for Australian airpower thinkers and strategists to look afresh at Antarctica. Dr Layton, Squadron Leader Bishop and Wing Commander Hallen have done just that in a forward looking paper that moves from today to beyond 2035 through using the ADF's Future Operating Environment's alternative futures. The paper suggests how new technologies and concepts could contribute to Australia's Antarctic involvement in the inherently uncertain future. Some of these ideas could well have wider applicability.

The paper will hopefully arouse interest, stimulate thinking and promote innovation. However, it is well to remember that in being both dominated by harsh seasonal weather conditions, and far distant from Australian shores, nothing happens quickly in Antarctica. Change in the frozen continent is a case of making haste slowly.

GPCAPT Andrew Gilbert DAPDC July 2019

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WING COMMANDER TRAVIS HALLEN

Wing Commander Travis Hallen is the Air Staff Officer Plans and Operations, Officer of the Air Attaché, Australian Embassy, Washington DC. He joined the RAAF as a Direct Entry Navigator in 2000, and upon completion of Basic Navigator Course in 2002 he was posted to No 11 Squadron where he completed his first tour as the AP-3C Orion. More recently, he was Executive Officer (Maritime) at No 10 Squadron. In 2007, Wing Commander Hallen was selected as the Chief of Defence Force Fellow and was posted to the Air Power Development Centre to conduct research into the future of airborne ISR in the ADF. Following his Fellowship year, he completed staff tours at the Directorate of Personnel-Air Force, and the Air and Space Operations Centre. Prior to taking on his current role, he was Deputy Director of Air Power Development at the Air Power Development Centre. Wing Commander Hallen is a graduate of the US Air Force School of Advanced Air and Space Studies.

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INTRODUCTION

Antarctica is changing. Not just physically as climate change inexorably impacts but also in how countries and people perceive and act in the world's last uninhabited continent. More and more states are becoming engaged in Antarctic issues including through establishing research bases there. Given this, the future of Antarctica is now becoming increasingly uncertain. This deeply involves Australia for whom Antarctica is its closest southern neighbour and which asserts sovereignty over almost half the frozen continent, a territorial declaration to an area equal to some 80% of Australia itself.¹

Australia's claim and those of six other nations have however been deliberately set aside. This has created the unusual situation that in a contemporary intentional system apparently completely divided into individual sovereign states Antarctica is not deemed anyone's territory. Antarctica is instead 'ruled' multilaterally through international committees based on mutually decided treaties and agreements. An increasing number of states now want to influence these treaties and agreements.

Literally at the end of the earth, Antarctica's isolation and inhospitableness have allowed it to remain largely unaffected by humans. The resulting pristine natural environment makes Antarctica an ideal laboratory for a range of scientific activities and has led to science becoming the defining feature of contemporary Antarctica operations. In turn, this primacy has shaped the strategic arrangements that guide interactions between the interested states.

¹ Antarctica covers some 14.2 million km²; Australia some 7.6 million km². Australia's Antarctic claim is 6.0 million km².

The hallmarks of the Antarctic Treaty System (ATS) that has developed over the last 60 years have become science, environmental protection, and avoiding militarisation. The ATS regulates activities south of the 60° South latitude and within which the Antarctica land mass, associated islands and significant ice shelves lie.² The four agreements that comprise the ATS and their supporting institutions have been instrumental in maintaining a stable rules-based order in the Antarctica despite multiple geo-strategic changes elsewhere. It is considered to be an "unprecedented success in international law and diplomacy".³

The central institutional pillar of the ATS is the Antarctic Treaty, signed by 12 states in Washington at the height of the Cold War on December 1959. Today, there are 54 parties to the Antarctic Treaty made up of 29 Consultative Parties, those states conducting 'substantial research activity' in Antarctica and with decision-making rights within the system, and 25 non-Consultative Parties, states which are invited to observe but do not have decision-making rights. The Antarctic Treaty is unique because it is "a peace treaty not to stop hostilities but to prevent them."⁴

Three particular articles establish the ATS's key features. Article I opens with a clear statement of intent: "Antarctica shall be used for peaceful purposes only." The article goes on to prohibit the "measures of a military nature" but not the use of military forces for peaceful

² *The Antarctic Treaty* 1959, Article VI, Convention on the Conservation of Antarctic Marine Living Resources 1980, Article I.

³ Ellie Fogarty (2011), *Antarctica: Assessing and Protecting Australia's Interests*, Lowy Institute for International Policy, Sydney, p. 15, https://www.lowyinstitute. org/publications/antarctica-assessing-and-protecting-australias-national-interests [Accessed 16 April 2018].

⁴ Anthony Bergin, et al. (2013), *Cold Calculations: Australia's Antarctic Challenges*, Australian Strategic Policy Institute, Canberra, p.5, https://www.aspi.org.au/ report/strategic-insights-66-cold-calculations-australias-antarctic-challenges, [Accessed 18 April 2018]

purposes. This is an important distinction as military support is vital to a number of national Antarctic science programs.

Article II establishes the principle of scientific freedom and cooperation, which remains the cornerstone of international involvement in the region.

Article IV freezes disputes over territorial claims. The treaty acknowledges that some states have laid claim to Antarctic territory, but neither supports nor denies them. Further, it prohibits the making of new claims to territory. This article of the treaty has proved resilient in the face of growing interest in Antarctica. There are only seven states with Antarctic claims, but 29 states operate research bases on the continent.

Not all 54 Antarctic Treaty parties have signed the other three agreements that comprise the ATS: the 1972 Convention for the Conservation of Antarctic Seals, the 1980 Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) and the 1991 Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol). However, despite the smaller number of parties being formally bound by these three agreements they are generally abided with.

The two agreements of concern to Australia's Antarctica interests are the CCAMLR and the Madrid Protocol. The CCAMLR is the primary mechanism for managing the Southern Ocean's underexploited fishery resources, in particular the krill, toothfish and ice fish populations. As the name suggests, the CCAMLR is a conservation agreement, but it acknowledges that exploitation of Southern Ocean fisheries should not be prohibited if conducted sustainably. Accordingly, a range of conservation measures have been adopted by the CCAMLR that cover both contracting and non-parties to the Convention.

In contrast, the Madrid Protocol designates "Antarctica as a natural reserve, devoted to peace and science." The key clause, Article 7 states: "Any activity relating to mineral resources, other than scientific research, shall be prohibited." If at sea, sustainable fishing is allowed, onshore exploitation is banned. Crucially the Madrid Protocol puts off even debating changing Antarctica's resource exploitation regime until 2048.

This paper looks out to 2035 and beyond. By that time states, commercial companies and non-government organisations may be operating in Antarctica in ways different to today – or they may not be. The future of Antarctic is uncertain but seems to lie within definable boundaries; particular alternative futures are discernible. This is important because force structure changes in large organisations like the Australian Defence Force (ADF) and the Royal Australian Air Force (RAAF) take time. It is advantageous to think about Antarctica's future now so that changes can be gradually made that will prepare the ADF for whichever future eventuates. This approach is nowhere more important than in that most technical of the fighting arms: air power.

This paper focuses on national air power: the ability of a nation to achieve its objectives through the air domain and encompassing elements of civilian and military aviation.⁵ The scientific endeavours of all the participating Antarctic states make extensive use of a judicious mix of military and commercial air transport assets. Australia is notable in this use of national air power in Antarctica albeit on a small-scale. Sizeable investments have and are being made to create an effective and efficient modern air logistic network however in looking to the future new possibilities beckon.

This paper initially examines Antarctica today including noting some recent Chinese, Indian and Russian activities in the East Antarctic region Australia claims. In the second section the paper focuses on Australia's contemporary national interests, objectives, current operations and development plans. The third section looks well-forward to develop four Antarctic alternative futures linked to the ADF's 2035 Future Operating Environment's alternative futures. The fourth section then uses these futures to devise a range of possible strategic options in terms of both potential air power planning approaches and possible force structure changes.

⁵ Air Power Development Centre (2013), *The Air Power Manual, Sixth Edition*, AAP 1000–D, Department of Defence: Canberra, p.32

Antarctica Today

Antarctica is getting busier. The big wave of accession by states to the Antarctica Treaty was in the 1980s during the late Cold War with more gradually joining in the decades after that. Over the last fifteen or so years however, many nations have moved beyond simply attending international meetings to building and maintaining bases on the continent.

Old, refurbished and new Antarctic bases are now seen as allowing the participating states to be much better able to influence the development of the future rules governing Antarctica. For many of these states the bases have a further perceived benefit in ensuring their countries are well positioned to undertake marine, genetic and mineral resource exploitation when and if this happens. Lastly, for a small group of states there is the intangible lure of national prestige, a factor most attractive to the new great powers like China, India and Brazil. There are now some 80 separate facilities open in Antarctica, with more under construction.

Brazil is an example of these interlocking factors. Since the middle 2000s Antarctica has steadily gained prominence within Brazil's risingpower national strategy. Antarctica now features as an important element within Brazil's South Atlantic defence policy given Argentina's territorial claim to the Antarctic Peninsula generates concerns about future freedom of Brazilian navigation through the Drake Passage chokepoint. Engaging in cooperative Antarctic operations further provides a means for Brazil to enhance its strategic relationships with other South American states. More broadly, being an active player in the ATS allows Brazil to participate directly in the rules-based order, allowing it to influence global debates. Finally, Antarctic research is considered useful for boosting Brazilian science capabilities, improving national economic development and competitiveness.⁶

The newer Antarctic states have been actively assisted by the longer established states. In the 1980s for example, the Australian Antarctic research program hosted the first Chinese scientists to visit Antarctica, one of who now leads the Chinese National Antarctic Research agency. Australia has also donated one of its small summer-research facilities to Romania giving the country its first Antarctic base. In more recent years Russia has been particularly active in assisting China, India and Belarus establish new bases in East Antarctica. In this, Russia has made good use of geographically well-placed but aging Soviet-era facilities. Of note is that Russia's old Novo airbase in Queen Maud Land just outside of Australia's East Antarctic claim has returned to life as a major airhead used by some eleven nations.

Some perhaps unexpected nations have joined the ATS and established facilities. For example, Turkey an ATS member since 1996 has recently mounted some small Antarctic expeditions and this year erected a temporary science facility. The Ukraine, an ATS member since 1992, uses an old gifted British facility that is now being significantly modernised.

East Antarctic Countries

Within the territory that Australia claims there are several bases operated by various countries. Romania's small involvement has been noted however, the most active new participant in East Antarctica base development is China.

⁶ Adriana Erthal Abdenur & Danilo Marcondes Neto (2014) 'Rising powers and Antarctica: Brazil's changing interests', *The Polar Journal*, Vol. 4, Iss. 1, pp.12-27.

China

China is deeply involved in the ATS. The country joined in 1983, became a Consultative Party in 1985, signed the Madrid Protocol in 1998 and agreed to the CCAMLR in 2007. Today China has undertaken some 34 national Antarctic expeditions and runs four research stations in Antarctica with a fifth station planned to be completed in 2022.

In 2005 China's top polar scientist advocated his country should become a 'polar great power', that is a power strong in military, scientific, and economic terms in both the North and South Polar regions. President Xi Jinping first publically embraced this idea when visiting Hobart in 2014, giving the 'polar great power' expression his imprimatur and consequently wide Chinese public usage. The President further outlined that the guiding principles for Chinese Polar activities should be "understand, protect, and use".

In this, the ATS has some real advantages for great powers. Any country with the requisite economic strength can have unfettered access across the whole of the Antarctic landmass and littoral without having to consider other nations' rights. With such access these countries can assess the continent's resources, locate important natural assets and develop the latent capabilities to extract them if circumstances change. In a carefully considered assessment in 2017, Chinese Vice Premier Zhang Gaoli noted there was a "need for a proper balance between the protection and utilization of Antarctica in order to achieve green and sustainable development of the continent and unleash its potential and value..."⁷

In the Chinese political system polar affairs are part of maritime affairs, thus becoming a polar great power falls within the ambit

^{7 &#}x27;China urges balanced, sustainable development in Antarctica', Agencia EFE, 23 May 2017, https://www.efe.com/efe/english/world/china-urges-balancedsustainable-development-in-antarctica/50000262-3274279 [Accessed 13 May 2019].

of China's maritime strategy. The State Oceanic Administration published China's first Antarctic White Paper in May 2017 during the 40th Antarctic Treaty Consultative Meeting in Beijing. The White Paper noted that China has made "significant progress in its Antarctic activities in terms of integrated logistic support."⁸

In the last ten years, China has worked to extend its presence over a fairly narrow sector of East Antarctica. Three of China's Antarctic bases, three of its airfields, and two field camps are in this area. The Zhongshan base opened in 1989 near Russia's older Progress facility and the small Romanian base. Zhongshan has doubled in size in recent years and is now a medium size, all-season base that acts as both a research facility and a coastal support base for activities further inland.

Inland Taishan was opened in 2014 and is a small, summer-only base that supports both the much further inland Kunlun facility and expeditions into the nearby Grove Mountains. Kunlun opened in 2009 and is the second-southernmost research base in Antarctica, behind only the US's South Pole Station. Kunlun is a small, summer-only base but in being high altitude (some 4000m) and remote has excellent clear air and dark sky qualities perfect for imaging telescopes used for astronomical observations and space debris monitoring. Both Taishan and Kunlun have 600m ice runways.

China's base expansion has led to two specific concerns. Firstly, China has developed the BeiDou multi-satellite navigation system, broadly similar in function to the US Global Positioning System (GPS), the European Galileo and the Russian GLONASS. BeiDou ground receiving and reference stations have been installed at Zhongshan and Kunlun and while very useful for Antarctic operations will apparently also improve the overall global performance of the system, particularly

⁸ Nengye Liu (2019), 'The rise of China and the Antarctic Treaty System?', *Australian Journal of Maritime & Ocean Affairs*, Published online: 5 Mar 2019 p. 3.

in terms of locational accuracy. The dual-use nature of BeiDou has led to worries over the militarisation of Antarctica. Similar concerns were raised when Norway built the Trollsat satellite ground station at its Antarctic station. Trollsat supports Galileo and is Norway's main contribution to this major European project.

Secondly, concerns have been raised over China's proposal for a new Antarctic Specially Managed Area (ASMA) at Kunlun. ASMAs assist cooperation in busy areas and are managed by a single country or group of countries. There are several AMSAs across Antarctica including at the US's South Pole Station. Some see geopolitics behind China's proposal with the University of Canterbury's Anne-Marie Brady believing the ASMA is seen by China as a "soft presence...[a] subtle way for [the] state to control territory."⁹ Lacking an international endorsement for its AMSA proposal, China has now commenced negotiations on a code of conduct for the area.

Chinese Air Operations. While previously using the nearby Russian airfield, China is now gradually developing its own air hub near the Zhongshan base. In 2014 it built an ice runway and then in 2016 operated its first fixed wing aircraft from there. China now plans to build a more permanent 1500m airstrip of compacted snow on a glacier some 30km from Zhongshan.

The runway is short so initially the only aircraft based there will be China's sole Basler BT-67, a turbo-prop powered DC-3 specially modified in Canada for Antarctic research operations. Renamed as the Xue Ying 601 (Snow Eagle), the BT-67 is operated by Kenn Borek Air (a Canadian company) and used for summer air operations supporting the two inland bases and various research expeditions within 1300km

⁹ Anne-Marie Brady, China's Expanding Antarctic Interests: Implications For New Zealand, SSANSE: Small States and the New Security Environment, Policy Brief No. 2, 3 June 2017, https://www.canterbury.ac.nz/media/documents/research/ China's-expanding-Antarctic-interests.pdf [Accessed 13 May 2019].

of Zhongshan. The BT-67 deploys in summer to Zhongshan through South America and a multi-base hop across Antarctica. China's BT-67 is sometimes leased by Australia for air logistic tasks; when so tasked it is flown by Kenn Borek Air crews supplemented with a Chinese national.

The new airfield will take a few years to become operational but will give China experience in a polar airfield's construction and maintenance, ground support, airspace management and navigation aids. China's official Science and Technology Daily notes that the airbase "will provide a foundation for operating large aircraft, creating multiplane services, and building an Antarctic air traffic network in the future...and [allow] China [to] have a say in the international management of Antarctic air space."¹⁰

Beyond fixed wing aircraft, for a decade the Chinese National Antarctic Research Expedition (CHINARE) has operated Kamov Ka-32A11BC helicopters, mainly from ships. The co-axial design Ka-32 is a commercial version of the military Ka-27. In 2011 a CHINARE Ka-32 crashed at Zhongshan Station after an in-flight emergency. More recently CHINARE has also operated a Eurocopter AS365 Dauphin in Antarctica.

Russia

While many bases closed after the Soviet Union's collapse, Russia has recently embarked on a reconstruction and reconstitution program. In East Antarctica Russia now operates two small summeronly bases (Druzhnaya 4 and Molodezhnaya) a small all-seasons base (Vostok), a medium-sized all-seasons base (Progress 2) and a large all-seasons base (Mirny).

¹⁰ Liu Zhen, 'China to begin building first permanent airfield in Antarctica', South China Morning Post, 29 October 2018, https://www.scmp.com/news/china/ diplomacy/article/2170735/china-begin-building-first-permanent-airfieldantarctica [Accessed 13 May 2019].

Mirny is by a significant margin the largest base of any nation in East Antarctica. Vostock is well-inland whereas the others are coastal facilities. Progress has a wheel and ski aircraft capable 2500m airfield, with Druzhnaya 4 and Vostock having ski runways. Kenn Borek Air BT-76 aircraft and Avialift Vladivostok Ka-32 helicopters operate into the airfields during the summer.

Two concerns have been raised over Russia's bases. The first relates to Russia's seeming deep interest in resource exploitation. Russia's new ten-year Antarctic Strategy aims to "strengthen the economic capacity of Russia... through complex investigations of the Antarctic mineral, hydrocarbon, and other natural resources."¹¹ The second is again the issue of navigation satellite systems with Russia installing GLONASS equipment at Progress and Mirny.

Other Notable Facilities

India. Bharati, a medium-size, all-season coastal base and India's second active Antarctic research facility, was established in 2012 near Russia's Progress base. Air operations are by Kenn Borek Air BT-76 aircraft and shipboard helicopters (Ka-32 and Squirrels).

France/Italy. The Concordia Research Station opened in 2005 and is a medium-size all-seasons facility established – like China's Kunlun and Russia's Vostock - well inland on the Antarctic Plateau. Concordia has a 1500m ice runway that takes Kenn Borek Air BT-76 and Twin Otter aircraft.

United States. Just outside East Antarctica at the geographic South Pole, the US maintains a very large, all-season facility that dates back to 1957. The Amundsen-Scott South Pole Station has a surrounding AMSA and includes the Jack F. Paulus Skiway, a 3500m snow runway.

¹¹ Alan Boyd, 'Cold war chill settles over Antarctica', *AsiaTimes*, 7 March 2019, https://www.asiatimes.com/2019/03/article/cold-war-chill-settles-over-antarctica/ [Accessed 13 May 2019].

The main users are USAF's ski-equipped LC-130 aircraft together with Kenn Borek Air BT-76 and Twin Otter aircraft.

Australia's Antarctica

The UK first claimed territory in Antarctic in 1841. In time these claims were transferred to Australia with the 1933 Australian Antarctic Territory Acceptance Act declaring:

"That part of the territory in the Antarctic seas which comprises all the islands and territories, other than Adelie Land, situated south of the 60th degree south latitude and lying between the 160th degree east longitude and the 45th degree east longitude, is hereby declared to be accepted by the Commonwealth as a Territory under the authority of the Commonwealth, by the name of the Australian Antarctic Territory."¹²

In 1947, Britain further transferred Heard Island and McDonald Islands to the Australian Antarctic Territory. In 1954, Australia's first continental research facility, Mawson Station, was established; it is now the longest continuously operating station south of the Antarctic Circle of any nation.

Since then Australia has built another two permanent scientific research stations in the Australian Antarctic Territory that all contribute to an internationally significant ongoing scientific research program. The Department of the Environment, through its Australian Antarctic Division (AAD) in Hobart leads, coordinates and delivers

¹² Australian Antarctic Territory Acceptance Act 1933, (2000), Attorney-General's Department, Canberra, https://www.legislation.gov.au/Details/C2004C00416 [Accessed 14 May 2019].

the Australian Antarctic programme and administers the Australian Antarctic Territory, Heard Island and McDonald Islands.

Five years ago the Australian Government commissioned a former AAD Head, Anthony Press, to provide recommendations concerning future national Antarctic policies. The resulting Press Report warned that: "Australia's standing in Antarctic affairs is eroding because of historical under-investment at a time when new players are emerging in Antarctica."¹³ Acting on this, and after considering recommendations of a Senate inquiry, the Australian Government in 2016 released the Australian Antarctic Strategy and 20 Action Year Plan.¹⁴ This document sets the vision and the policy intentions for Australia's future engagement with Antarctica. Australia's declared national interests in Antarctica are:

- 1. maintain Antarctica's freedom from strategic and/or political confrontation;
- 2. preserve our sovereignty over the Australian Antarctic Territory, including our sovereign rights over adjacent offshore areas;
- 3. support a strong and effective Antarctic Treaty System;
- 4. conduct world-class scientific research consistent with national priorities;
- 5. protect the Antarctic environment, having regard to its special qualities and effects on our region;

¹³ A.J. Press (2014), *20 Year Australian Antarctic Strategic Plan*, p.2, http://www. antarctica.gov.au/__data/assets/pdf_file/0008/178595/20-Year-Plan_Press-Report. pdf [Accessed 20 May 2019].

¹⁴ Australian Government (2016), *Australian Antarctic Strategy and 20 Year Action Plan*, http://www.antarctica.gov.au/__data/assets/pdf_ file/0008/180827/20YearStrategy_final.pdf [Accessed 14 May 2019]

- 6. be informed about and able to influence developments in a region geographically proximate to Australia; and
- 7. foster economic opportunities arising from Antarctica and the Southern Ocean, consistent with our Antarctic Treaty system obligations, including the ban on mining and oil drilling.

There may appear some seeming incompatibilities between these various interests especially that between preserving Australian sovereignty and supporting the ATS. The ATS sets aside Australia's claim so it does not preserve Australia's sovereignty but instead disregards it. The counter argument however is that while the ATS continues no nation can make a counter-claim to Australia's. Under this perspective, the ATS keeps Australia's claim safe and crucially achieves another key Australian objective: keeping Antarctica free from strategic conflict.

Supporting this position is that in 2019 the ATS is sixty years old. It has succeeded in not just constraining geostrategic tensions in Antarctica but in also encouraging rivals – such as the US and the USSR during the Cold War – to collaborate in scientific research. The ATS has provided a durable framework for cooperative internationalism, allowing governments including Australia's to advance their primary Antarctic objective of gaining scientific knowledge that is made available to all.

To achieve the various interlocking policy objectives, Australia has made considerable investments in Antarctic bases, supporting infrastructure and ongoing activities.

Australia's East Antarctic Operations

Australia has three medium-sized, all-season bases spread out along the East Antarctic coast and principally supported logistically and administratively from Hobart. *Table 1* compares the various nations' East Antarctic bases and reveals that Australia's three bases are a significant presence relatively speaking, particularly as they are all-season. There is though an obvious sharp distinction between the coastal stations and the inland, high altitude facilities built on the ice covered Antarctic plateau with its average elevation of some 3000m. Australia is reacquiring an Antarctic overland traverse capability but has no inland bases as China, Russia, France and Italians do albeit some are summer-only facilities. See also *figure 1* opposite.

Station Name	Country	Altitude	Airfield	Opened	Average Winter Manning	Peak Summer Manning
Vechernyaya	Belarus	40m		2016	0	10
Bharati	India	35m		2012	24	47
Casey	Australia	30 m	ski	1969	20	70
Concordia	France & Italy	3220 m	ski	1997	15	60
Davis	Australia	15 m	ski	1957	22	70
Druzhnaya 4	Russia	20 m		1987	0	50
Kunlun	China	4087 m	ski	2009	0	28
Law Racovita	Romania	65 m		2006	0	13
Mawson	Australia	5 m	ski	1954	20	60
Mirny	Russia	40 m		1956	60	169
Molodezhnaya	Russia	42 m	wheel & ski	1962	0	15
Progress 2	Russia	15 m		1989	20	77
Taishan	China	2621 m	ski	2014	0	20
Vostok	Russia	3500 m	ski	1957	13	25
Zhongshan	China	10 m	ski planned	1989	25	60
				Total	219	774

Table 1: East Antarctic Bases¹⁵

¹⁵ This table uses several sources particularly including: 'Antarctic Stations - Bases - Currently Occupied', *Cool Antarctica*, https://www.coolantarctica.com/ Community/antarctic_bases.php [Accessed 20 May 2019].



Map of East Antarctica indicating the locations of various stations

Note this is a 2013 map and Belarus has now built its base.

The Australian bases are logistically supported using air and sea transport. In this, shipping provides the logistic backbone of the Australian Antarctic programme. The current Aurora Australis, an 8400 tonnes multi-purpose research and resupply ship, was built in Newcastle (Australia) and came into service in 1990. The icebreaker provides essential fuel and supplies to the three Australian stations, undertakes personnel transfer and is used for marine scientific research. Its Romanian-built replacement, the Nuyina, at 25500 tonnes displacement is significantly larger than the Aurora Australis and has much greater cargo and fuel carrying capacity. The Nuyina will have space for four AS350 Squirrel helicopters or two medium-sized helicopters similar to Sikorsky S92s.

Air operations have become increasingly important especially for personnel movement. Mawson has a summer ski runway constructed either on nearby sea ice if present, or more often inland about 10kms from Mawson at Rumdoodle. Davis station in the ice-free Vestfold Hills uses a ski runway on the Davis Plateau some 40km from the station and reconstructed each year on snow.

Casey's principal airfield is Wilkins, some 70km inland and sited 700m above sea level. The Wilkins runway has a foundation of natural glacial ice, which after annual surface grooming can accept large wheeled transport aircraft as well as smaller ski-equipped aircraft. Wilkins is open between October and March each year but closes for about six weeks in the middle of summer as warmer temperatures cause sub-surface melting that undermines runway strength and creates blisters. This mid-summer melt issue is likely to get worse as global warming worsens.

Air operations can be usefully divided into inter- and intra-continental.

Intercontinental Air Operations

Since 2007 the AAD has operated an air link using wheeled A319CJ passenger jet aircraft flying between Hobart and Wilkins airfield carrying personnel and high-priority, lighter-weight cargo. The intercontinental flight typically takes some 4½ hours with the aircraft spending two hours on the ground in Antarctica before returning to Hobart. The flights carry up to 38 passengers with some 20 flights undertaken each summer season. Importantly, the Airbus A319 service can also provide a rapid medical evacuation capability.

The A319CJ aircraft are leased from and operated by Skytraders, a Melbourne-based company. For Antarctic flights the aircraft are normally fitted with four auxiliary fuel tanks termed Additional Center Tanks (ACT) in the cargo hold. With the four ACTs the A319CJ can fly for some 11 hours with adequate holding, reserve and single-engine out fuel requirements. In recent years the Skytraders aircraft have also operated charter services from Cape Town (South Africa) and Christchurch to Antarctica airfields other than Wilkins.

Since 2016 RAAF C-17A heavy-lift aircraft have also flown into Wilkins. These flights allow delivery of high-priority, outsize cargo unsuitable for A319CJ transport but which need quick turnaround times not possible using shipping. In addition to personnel, the C-17A flights can carry up to 20 tonnes of cargo into Wilkins, accommodating loads such as helicopters, machinery, vehicles, food and stores.

In September 2017 a C-17A, flying out of Melbourne and refuelled enroute by a KC-30A, air-dropped 15 pallets onto the sea ice near Davis station delivering some nine tonnes of fresh food and supplies. Having such a capability allows delivery of essential supplies and equipment to Antarctica year-round, including outside the typical summer operating period between October and March. The airdrop capability can also support science projects operating inland where resupply is difficult. Pre-positioning equipment and supplies before the summer season start means research activities and other projects can commence as soon as personnel arrive from Australia.

Intra-continental Air Operations

Most airfields in Antarctica are suitable only for ski-equipped aircraft or helicopters. Since 2010, the AAD has contracted to Kenn Borek Air for intra-continental services using Basler BT-67 (a turboprop engined DC-3) and DHC-6 Twin Otter aircraft, and to Tasmanian company Helicopter Resources for Squirrel helicopter support. The fixed wing aircraft provide services from the Wilkins entry point to the other Australian stations of Mawson and Davis as well as supporting distant inland expeditions. The BT-67s and Twin Otters are normally operated by a crew of two pilots and one engineer. Kenn Borek Air based in Calgary, Canada provides air services for several nations across East Antarctica; it deploys multiple aircraft to the Antarctic each summer season through South America.

The Squirrels are sea and land-based. In operating from the Aurora Australis, the helicopters undertake ice reconnaissance (to assist ship navigation through pack ice), ship-to-shore carriage of expeditioners and cargo, and ship based support of marine science and field based operations in Antarctica, Heard and Macquarie Island. Two or three Squirrels are also typically land-based at Davis during December to February supporting numerous scientific programmes and deploying, supporting and retrieving field parties. Importantly, the helicopters also support the Basler and Twin-Otter transport services providing the optimum link between the Davis station and the Davis Plateau ski landing area, 40km away.

Runway Developments

The 2016 Strategy and Action Plan announced an intention to develop a paved all-seasons runway near the Davis station. The current Wilkins airfield near Casey is only usable during the summer season with a break midsummer due to glacial melt. There are currently no paved runways in East Antarctica although there is a paved C-130 capable airfield in the west on Seymour Island at the northernmost tip of the Antarctica Peninsula operated by Argentina.

In considering East Antarctica, an extensive survey process has determined that on balance the best location is in the ice-free Vestfold Hills about six kilometres from the Davis station. The new runway is envisaged as being some 2700m long, allowing landings by large passenger jets such as a Boeing 777 or an A330. The runway has gained initial government agreement with a detailed business case now being developed. The difficulties in building in Antarctica however mean the airfield may not be operational until the 2030s.

In being paved the new runway will be much easier and quicker to make ready when air traffic is forecast. Today's ice and snow runways require considerable work at the start of each season to get ready and then constant grooming and levelling to maintain the surface to the required operating standards.

In this, the paved runway offers new opportunities to rethink the Antarctic air logistic support model in terms of being seasonal only. The new Davis runway's location is in a relatively favourable climatic area and being on the coast at about 68° South never experiences complete darkness during winter days. It may be possible to conduct winter air operations giving all-year access to the Davis research station. The US base at McMurdo Sound at 77° South already operates on this basis using USAF night air transport operations.

The new Davis runway's capabilities to support easier intercontinental access will mean that other nations across East Antarctica are likely to use it also. In particular, the nearby Chinese, Russian, Indian and Romanian bases may find it logistically most efficacious.

Air Logistics Support in Today's Antarctica

Lauren Bishop



Antarctica is a vast continent. Undertaking research and science programs there requires timely and efficient transport and logistical capabilities. Although some may believe that a logistician's fundamental task is to move stores from A to B, when you consider the remoteness of the Antarctic supply chain, this becomes too simplistic. Logistics is a fundamental component of military capability and a critical enabler of air power. Ensuring efficiency in a supply chain that stretches 3500kms across the Southern Ocean to the coldest, windiest and driest continent on earth, brings many complex challenges.

Traditional doctrinal approaches describe the requirement to establish and sustain a remote 'hub and spoke' delivery model supported by air logistic support missions. The C-17A Globemaster provides the Australian Government with an unprecedented capacity for strategic airlift however, the lack of air base logistics support in the Antarctic makes C-17A air operations demanding.

Air Logistic Support and Aviation Refuelling

The C-17A is the Australian Government's exemplar of the employment of advanced military assets for peaceful purposes, serving as a key enabler in the remote Antarctic supply chain. The heavy airlift capability provides remarkable reach and air logistics support, effectively bridging lengthy inter-continental freighting challenges as previously experienced with shipping and smaller passenger aircraft alone. The C-17A has the ability to deliver cargo and personnel integral to a number of national Antarctic Science Programs directly into the ice-runway at Wilkins Airfield and to provide aerial delivery via air drop into remote deep field locations. The 2018/19 season included a 'proof of concept' 20ft container move and an aerial delivery of critical parts required to prepare the runway for the first flight of summer.

Despite the recent successes in air cargo delivery, the lack of air base logistics support creates real challenges. In the absence of an aviation refuelling capability at Wilkins airfield the C-17A relies on KC-30A air to air refuelling missions and payload restrictions to optimise fuel consumption in transit. The commercial A319-115LT was also selected for passenger transfer, partly because it has sufficient range for a return trip from Hobart to Wilkins Airfield without refuelling in Antarctica.¹ This avoids a myriad of conceivable environmental risks associated with the transport, handling and storage of large volumes of jet fuel. With potential for the C-130J to be utilised for ski-way landings, future logistics support concepts must be cognisant of these environmental considerations when supporting airbase

¹ Australian Antarctic Program's station environment: Operation indicators, 2016, https:// soe.environment.gov.au/theme/antarctic-environment/topic/2016/australian-antarcticprograms-station-environment-operation [Accessed 26 May 2019]

operations. Furthermore, without an aviation refuelling capability, the Australian Antarctic Program will continue to underutilise the C-17A for both south and northbound missions due to the requirement for reduced payloads.

A temperature sensitive supply chain

Supporting remote field operations is not a new concept for logistics planners, however the uniqueness of the harsh Antarctic environment adds new complexities. Sensitive scientific equipment requires the establishment of a 'warm chain' and scientific samples require a 'cold chain' to keep essential equipment from alternately freezing or melting during transfer while being transported. In the 4.5 hr flight south during the summer season, temperatures can vary from 30C+ degrees in Hobart, to -25C degrees at Wilkins Airfield; the reverse applies on return. Such a sharp temperature change can jeopardise years of dedicated scientific research. Today's supply chain prohibits timely delivery and repair of equipment affected by temperature and there are currently no effective or sustainable warm/cold chain solutions in place.

During the Austral Summer 18/19 period, the Australian Antarctic Program supported a world-first science research mission involving a deep field traverse to retrieve ice cores at depths of some 300m. To maintain integrity of ice core samples temperatures of -23 degrees Celsius had to be maintained, from deep field Antarctica to the USA. The Royal Australian Air Force (through the Heavy Airlift Systems Program Office) provided a responsive engineering solution, which allowed for a commercial chest freezer to plug into the C-17A electrical system while palletised during flight. An engineering solution was provided for a logistics problem, demonstrating the RAAF's ability to operate in a unique environment and

adapt to changing circumstances. In the future, we may see this lead to unmanned aerial vehicles collecting samples from the field to deliver for storage in reliable, on-station facilities, thereby ensuring the integrity of scientific samples.

Intra-continental aviation and fuel caching

The Wilkins airfield Forward Operating Base (FOB) near Casey Station struggles as a reliable in-theatre hub for storage and distribution. Significant air transport payload restrictions, infrequent flights and extreme weather, coupled with inadequate warehousing and storage at the FOB, results in regular delays moving passengers and cargo into deep field.

With aviation resources so constrained, the Australian Antarctic Program relies on using a nascent traverse capability to transport fuel caches to remote inland bases. These fuel caches allow smaller fixed and rotary wing aircraft to be refuelled at these distant bases allowing their reach to be significantly extended. Future efforts will focus on building up these fuel caches further to support longer-range air operations. Whilst there will continue to be deep field traverse in Antarctica for the delivery of large heavy cargo, fuel caches enhance the supply chain's overall capabilities. The more remote inland bases can now have air delivered to them lighter items which is particularly beneficial for spare parts and emergency resupply.

Conclusion

Timely and efficient transport and logistical capabilities are critical for the success of science in Antarctica. As the Australian government continues to provide regular access into the region through employing military platforms, dependency on airbase logistics support increases. Development of an aviation refuelling capability and the establishment of a temperature controlled supply chain will reduce platform vulnerability, increase reach and provide reliable air logistics support between the Australian point of departure and the Wilkins air field FOB.

Australia's Antarctic National Air Power Futures

The Antarctic Region in 2035

Intuitively we know the future is always uncertain. Our predictions may or may not eventuate. This inherent uncertainty however creates problems when developing large complicated organisations like the RAAF. An air force takes decades to build but by the time it is finally available for operations it may be completely inappropriate to the needs of the time. Much effort and significant resources may be expended but it is inherently uncertain today what tomorrow's strategic circumstances will demand. And the longer it takes to build an air force, the more intractable force planning becomes.

A way around this dilemma is through using an alternative futures approach. This approach tries to make use of the certainty of uncertainty, initially by being more specific about what uncertainty is. The type of uncertainty encountered in a problem may be classified in a conceptual sense as follows:¹⁶

- **1. Level One.** The residual uncertainty is irrelevant to making strategic decisions as analysis shows only a single possible future with change linear and evolutionary.
- **2. Level Two.** The future will be one of two or three discrete scenarios. While analysis cannot identify which particular outcome will eventuate, it may help establish probabilities.
- **3.** Level Three. While there is only a few uncertain dimensions, the future cannot be reduced to a few discrete scenarios. A range

¹⁶ Hugh Courtney (2001), 20/20 Foresight: Crafting Strategy in an Uncertain World, Harvard Business School Press: Boston, pp. 15-38.

of futures along a continuum for each identified dimension can be identified. Uncertainty is bounded.

4. Level Four. The numerous dimensions of uncertainty interact, making it impossible to determine a range of potential outcomes or scenarios, or identify the relevant variables that will define the future. The uncertainty is unbounded.

In applying these various uncertainty levels to issues such as the future of Antarctica it is apparent that Level One is too simplistic as there are many possible futures, not just one. Level Two is similarly afflicted in that the future, being non-linear and subject to 'butterfly' effects, cannot be reduced to only two or three tightly scripted alternatives. However, the chaotic vision of Level Four also seems inappropriate, as there are certain dimensions or parameters from the present that carry on into the future. The future will build on the past; it is not totally unbounded

Level Three uncertainty seems the preferred type of uncertainty when considering how Antarctica may change. This particular level of uncertainty means little can be accurately predicted on the basis of past events, but it is possible to examine the present and discern important existing trends and emerging drivers. A bounded range of possible futures can be determined, although which specific scenario will eventuate is unable to be ascertained.

Antarctic's Uncertainties

In broad terms there seem some fundamental uncertainties when thinking about Antarctica's future. Antarctic does not exist in a political void. The 29 states deeply involved in Antarctica bring their national ambitions and international relationships with them.

In 2016, ADF planners imagined four alternative future international systems and published these in the Future Operating

Environment 2035 (FOE 2035) document.¹⁷ The four alternative future worlds were derived based on two broad uncertainties: firstly, states in the future may have more or less power in the international system and secondly, states in the future may be cooperative or competitive towards each other.¹⁸ These uncertainties lead to four possible worlds labelled: multilateral, networked, multilateral and fragmented.¹⁹

The FOE 2035 construct is a useful one in which to situate Antarctica's specific and particular uncertainties. The FOE 2035 alternative futures then become the background environment within which the Antarctic alternative futures can be nested.

Future uncertainties are important but they are not the whole picture. In thinking about Antarctica's future distinct continuities, strong trends and certain assumptions appear evident. In terms of continuities, in the future Antarctic will still remain a tough place to get to, work in and survive in, especially during the winter. Decisions relating to human engagement in Antarctica will take time to be implemented. In general most activities can only happen during summer months, slowing progress down. Such activities are moreover costly making decision-making to fund them usually prudently protracted.

Considering trends, the dominant one in the current era is climate change. In this there is no uncertainty; Antarctica will be impacted

¹⁷ Future Operating Environment: 2035, Canberra: Department of Defence, 2016, https://www.cove.org.au/wp-content/uploads/2017/03/Future-Operating-Environment-2035.pdf [accessed 23 May 2018].

¹⁸ These worlds were originally devised to provide strategic insights for the Netherlands Armed Forces policy development. See: *Future Policy Survey: A new foundation for the Netherlands Armed Forces*, Netherlands Ministry of Defence, 2010.

¹⁹ These worlds are explored in some detail in Peter Layton (2018), *Tomorrow's Wars: Insights From Our Four Alternative Futures*, Air Power Development Centre: Canberra.

by climate change in all alternative futures. Access for large vessels that are not ice-strengthened is likely to become easier albeit sea ice movements may be less predictable and more frequently trap ships. The easier access combined with a longer summer season will allow more time to undertake scientific research or tourism albeit Antarctica's unique flora and fauna will be waning as other species move in.

More broadly, across the globe beyond 2035 there will be a significant increase in wild weather events. Food production will be becoming more difficult through longer droughts and changed temperature patterns. There may be associated population movements, wars and epidemics. Accordingly, some states may shift their interest and research funding away from costly Antarctic science with its the slow rate of return towards more pressing, greater payoff initiatives. The Antarctic may become less important to states to invest in as climate change deepens.

Lastly considering the future, some reasonable assumptions can be made. The key one is that the information technology revolution ongoing for several decades will continue. This assumption means that the thrust towards autonomous systems, artificial intelligence, robotics, big data, the fourth industrial revolution and space 2.0 will continue. Such technologies will be found in all future worlds.

Alternative Antarctic Futures

The various uncertainties, continuities, trends and assumptions can be usefully combined using the scenario matrix planning methodology. This uses two selected key uncertainties to derive four quadrants, each an alternative future qualitatively different from the others in a logical, non-random way. Such an endeavour was undertaken recently in a New Zealand study about Antarctica futures.²⁰ This study used as the key uncertainties "the level of human engagement with Antarctica, and the strength of Antarctic governance through the Antarctic Treaty System." These uncertainties were translated into a quadrant diagram with an x-axis ranging from states being individualistic or collaborative and the y-axis considering Antarctica's resources and ranging from conservationist to exploitative.

The four alternative futures derived from the study have been mapped across onto the FOE 2035. Figure 2 illustrates this with the FOE 2035 multilateral, networked, multilateral and fragmented alternative futures towards the diagram's centre and within the inner shaded area. The all-in, groundhog day, wild west and buy now alternative futures are how the FOE 2035 worlds might play out in Antarctica.²¹

Importantly no world is considered more likely than the others. The worlds are so developed to allow the differences between them to be explored.

Groundhog Day

This alternative future world is today but better. The global importance of Antarctic science is increasingly publicly recognized, leading governments to invest more on national and international research initiatives. Sustainable marine resource exploitation continues with krill and finfish off-takes maintained within CCAMLR targets; a series of Marine Protected Areas are established across the Southern Ocean. A mature relationship develops with the tourism

²⁰ Daniela Liggett, Bob Frame, Neil Gilbert and Fraser Morgan (2017), 'Is it all going south? Four future scenarios for Antarctica', *Polar Record*, Vol.53, Iss.5, pp. 459–478

²¹ The four worlds come from *ibid*, pp. 472-474. This paper is indebted to this study.

COOPERATIVE



Figure 2: Antarctic Alternative Futures

industry enhancing research opportunities and including citizen science activities. Tourism focuses on sustainability, peaks around 2030 and gradually declines.

All-In

This future world envisages states, commercial entities and non-state actors shifting to a more utilitarian perspective. Marine exploitation is expanding on broadly sustainable terms, with diversification into marine bioprospecting and aquaculture. Research activities are increasingly moving to developing the technology appropriate to sustainable resource exploitation. The international association, the Council of Managers of National Antarctic Program, adjusts its focus from coordinating scientific research towards providing education to new commercially oriented operators together with coordinating safety management and Search and Rescue activities. Tourism is in decline as the wilderness aspects of Antarctica are dwindling albeit some niche and extreme tourism remains.

Buy Now

In this alternative future there is a lack of political and financial investment in Antarctica, with increasingly divergent views over its future. States are making bilateral agreements about exploiting mutually beneficial commercial opportunities. States are now focusing on their own individual national interests and are supporting private ventures and privately owned facilities in the competition for resources. The main research thrust is now into technology for better resource exploitation. The public interest in Antarctica has also become focused on the commercial benefits possible and a range of new entrepreneurial ventures has emerged. Tourism reflects this with a less regulated, more competitive industry that has diversified into land-based hotels and visitor experience facilities.

Wild West

This future world envisages Antarctica and Antarctic science becoming increasingly irrelevant to governments globally. There is a reduced public awareness of Antarctic issues as the media lose interest and political commitment to the region becomes largely symbolic. Reducing funding means international collaboration becomes hard to achieve. Science projects are now small-scale, short-term and disparate, with many states encouraging national Antarctic programmes to seek private investment to support their research. State-owned Antarctic research bases struggle to justify their continuance, become more commercially focused and are complemented or replaced by private facilities investigating resource exploitation options. Harvesting of Southern Ocean resources continues but diminishing international cooperation means the level of illegal, unreported and unregulated fishing is significantly increasing. As regulation has evaporated tourism has moved into land-based facilities offering niche opportunities.

Conclusion

The four worlds are all different in particular ways. An important aspect of using alternative futures is that no single world is more likely than another; planning should consider all equally. Even so, it is interesting to speculate that the world could be moving from our contemporary groundhog day towards the buy now world as globalisation seemingly fragments and a multi-polar world emerges. Some sensing the rise of China and the relative decline of the US might be tempted to seize on this perspective.

More worryingly, as climate change problems become larger and more challenging it seems possible that interest in expensive, long payoff Antarctica science could decline. The wild west world might then arrive. Perhaps Antarctic's future will follow a progression from groundhog day to buy now to wild west?

ANTARCTIC AIR POWER FUTURE DIRECTIONS

The medium-term future of Antarctica is arguably less uncertain than many other regions where the volatility is inherently much higher. Nevertheless, investments in future Antarctic capabilities need to be both cautious and judicious given Antarctica is not the most important or most pressing challenge Australia faces.

In such a circumstance there are three big three strategic-level questions $^{\rm 22}$ that need addressing:

- 1. Should Australia shape the strategic environment or instead adapt to it as it changes,
- 2. Should investment in new capabilities be made now or later, and
- 3. Should spending be narrowly focused on particular aspects or diversified more widely?

The answers to these questions are influenced by Antarctica's future being a Level 3 uncertainty issue.

²² This section draws heavily on Hugh Courtney (2001), *20/20 Foresight: Crafting Strategy in an Uncertain World*, Harvard Business School Press: Boston, pp. 38-113.

Shape or adapt?

In considering either shaping or adapting to the emerging situation there are two broad options. The first is the option of being proactive and developing a shaping strategy that aims to set the direction and tone of how others will operate in Antarctica. This means becoming a first-mover that others will follow either willingly or by force of circumstances.

The second option involves being ready regardless of what the future holds. In a Level 3 uncertainty future however, this can be costly as a broad range of capabilities are necessary. A better approach may be to undertake a program of continuous experimentation that constantly probes the strategic environment. This combined with increased monitoring of the emerging environment should ensure that a strategic warning is received in sufficient time to convert one or more of the experiments into a robust capability appropriate to the now better defined and understood situation.

In the Antarctica case, the second option appears preferable but perhaps only by a narrow margin. In East Antarctica the other participants range from small states like Belarus and Romania to economically-constrained countries like Russia to friendly powers like France and Italy through to rising great power China. Australia only needs to shape the environment and be a first mover relative to China. In this Australia is geographically close to Antarctica whereas China is very distant. China though is investing heavily to make itself a polar great power; Australia may not wish to make comparable resource investments in people, money and material.

The second option seems achievable however detecting the key signals of when it is necessary to move from experimentation into full capability development is not easy. Signals are easy to miss. The danger in this approach is that Australia will always lag and never regain the initiative. In considering the strengths and weaknesses of both options, Australia's Antarctica situation may be unusual in being a case where undertaking both in a limited way might be worth considering. This would depend though if the costs of being a first mover can be contained to acceptable levels.

Invest Now or later?

The question of acting now or later can be reduced to doing nothing now or instead doing something. There are several possibilities what that 'something' might involve. Even in Level 3 uncertainty there may be investments that will be useful regardless of which future eventuates. These are termed no-regrets investments as they are always appropriate. In contrast are big-bets, immediate, full-scale commitments that are really important in some possible futures but of little use in others.

Between no-regrets and big-bets are so-called real options. This approach suggests postponing, phasing or making flexible investments or commitments in a manner that manages the risks involved. Such risk management envisages the options implemented reducing the losses suffered to an acceptable level if the anticipated worst case scenarios emerge. These might include small-scale capital equipment investments, developing appropriate alliances and relationships or developing intangible assets i.e. enhancing national soft power as relates to the issues of concern.

In considering the Antarctic issue, the no-regrets choice might be considered depending on the opportunity costs incurred. The funding of a new Davis runway is an example of a no-regrets choice in that it will be useful regardless which future eventuates. Big-bets might not be appropriate given the relative strategic priority of Antarctica issues. The final alternative of real options seems attractive but presents issues. Determining which specific real options to invest in first needs the level of loss that is acceptable to be ascertained and this is problematic.

Focus or Diversify?

In deciding whether to focus or diversify, there is some relationship between focusing, shaping, no regrets and big bets. If there is a no regrets investment that will shape the strategic environment then focussing may be sensible. On the other hand, choosing to focus using a big bet may be imprudent as large losses may be incurred if the alternative future that the big bet is appropriate for does not eventuate.

In general in a Level 3 uncertainty environment 'classic' diversification is preferred. Classic diversification makes several independent strategic investments that have uncorrelated payoff structures and risks: some may fail, some may succeed but overall the organisational capabilities developed will be acceptable if not outstanding. The alternative of hedging is not really appropriate as this assumes that if one investment fails, the other will accordingly succeed i.e. a negatively correlated payoff structure.

The Antarctic case suggests classic diversification with a series of wide ranging small investments or real options spread across the four alternative futures. The problem with small investments is that they may only bring a limited return on investment as gains are balanced out by losses. Diversifying using real options may bring larger gains.

Overall

The three questions suggest a range of different approaches. Introducing time can assist determining which are the best to embrace. A useful concept to help such thinking is the three horizons model. The first horizon is today's way of doing business and which forms the foundation for the future, the second is the medium term that builds from today and represents achievable change while the third is longer term and envisions a new and different future.²³

In the Antarctic case, in reaching for the second horizon Australia might build on and exploit current plans and capability development programs aiming to both shape and adapt to the changing strategic environment. This would involve a blend of modest no-regrets moves and real options development. This would need combining with enhanced monitoring of the Antarctic strategic environment. Overlapping this may be a push towards the third horizon using a classic diversification approach involving an experimentation program.

PROJECT POSSIBILITIES

Moving from abstract concepts to practical possibilities requires considering specific projects. There are an array of possibilities from exploiting existing plans and projects to blue sky concepts that would take considerable effort to realise. A number of possibilities are described below to stimulate discussion and suggest what could be achievable. The possibilities noted are deliberately restricted to air operations. Many land, sea and sub-surface projects are conceivable however these are outside the scope of this paper.

East Antarctic Air Network

The typical Antarctic air logistic network is an inter-continental airhead where large wheeled transport and passenger aircraft deliver freight and people. From this airhead a feeder service then operates taking cargo and people out to distant bases that only have skiequipped aircraft capable runways. Helicopters are used for close-in

^{23 &#}x27;Enduring Ideas: The three horizons of growth', *McKinsey Quarterly*, December 2009, https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/enduring-ideas-the-three-horizons-of-growth [Accessed 3 June 2019]

transport tasks. Such a network has developed around the Wilkins field and is becoming more international with its users now including China, France and Italy.

Australia's variation on the Antarctic air logistic support model uses for intercontinental movements Melbourne-based Skytraders A319CJ passenger aircraft and RAAF C-17A heavy lift transport aircraft, for intra-continental movements Calgary-based Kenn Borek Air BT-76 (a turbo-prop DC-3) and Twin Otter ski-equipped aircraft, and for the final step Hobart-based Helicopter Resources Squirrel helicopters. Australia's approach is an interesting small-scale example of national air power: the ability to achieve national objectives through the air domain by using civilian and military aviation elements.

The forthcoming Davis airfield offers the potential for a major expansion of the small Wilkins network into a proper East Antarctica Air Network. Near Davis are Russian, Indian, Romania and Chinese bases as well as Australia's Mawson facility; near Wilkins is the French/ Italian deep inland base. In developing such a regional air network, Australia would strengthen its position as an international leader in Antarctica and become the logistics collaborator of choice for East Antarctica. Both objectives articulated in the 2016 Strategy and Action Plan.

Such a network already exists in the Norwegian claimed Queen Maud Land west of East Antarctica. The Dronning Maud Land Air Network (DROMLAN) has been operating for some two decades and involves Belgium, Finland, Germany, India, Japan, Norway, Russia, South Africa, Sweden, The Netherlands, and the UK. DROMLAN uses services provided by the South African company Antarctic Logistics Center International for the intercontinental link from Capetown (II-76 aircraft) and Kenn Borek Air (ski-equipped aircraft) operating into and from Russia's Novo ice runaway airfield. The DROMLAN organisation may be a useful template for Australia to apply albeit suitably modified to meet East Antarctic circumstances. Making the new Davis airfield into a major regional transport hub will though mean having adequate hangar space to store items before they shipped out using the intra-continental air transport services. In that regard, while Australia provides much of the Wilkins hub air services, the importance of Kenn Borek Air in providing connecting intra-continental air transport is obvious.

Kenn Borek Air replaced Skytraders in providing these services in 2010; at that time Skytraders used ski-equipped C-212-400 aircraft for intra-Antarctica services. Kenn Borek Air is a highly competent, very experienced operator chartered every year by many nations across Antarctica.²⁴ Nevertheless, the need for air logistics is steadily growing across Antarctica as more nations establish and extend their bases.

It may be advantageous for AAD to gradually develop an Australian service provider for some intra-continental air transport tasks from the Wilkins and new Davis airfields. This would take some time but would provide a sovereign capability to complement the redoubtable Kenn Borek Air, be a backup if needs be and support achieving the goal of Australia being the logistics collaborator of choice for East Antarctica.

Cargo Drones

In recent decades there has been a proliferation in unmanned air vehicles, colloquially termed drones. Small drones have already been used in Antarctica from land and on board ships, mainly for reconnaissance and mapping tasks. Drone employment will probably expand further into scientific research tasks carrying sensors and

²⁴ In 2017 a Kenn Borek Airline Twin Otter crew won both an Aviation Week and Space Technology Laureate for Heroism and a Smithsonian National Air and Space Museum Trophy for a medivac mission to the US South Pole station in mid-winter. The mission well illustrates some of the challenges in Antarctic flying: Douglas Fox (2016), 'Flight Crew Tells of Harrowing Rescue to the South Pole', *National Geographic*, 8 July, https://www.nationalgeographic.com/adventure/ destinations/antarctica/antarctic-pilots-tell-of-rescue-flight/ [Accessed 17 May 2019]

instruments aloft. With further development drones could also be of use in short-range cargo carrying operations operating out of the existing Wilkins and planned Davis airheads.

The technology of cargo drones is still quite immature but advances are being made with work underway internationally.²⁵ An example is the Elroy Air Chaparral concept intended to be available in the early 2020s. The hybrid-powered drone is envisaged to have a range of up to 500km and be able to autonomously pickup and deliver a cargo pod with a 100-225kg payload capacity.²⁶ Separately, Sabrewing has signed an agreement with the Aleut Community of St. Paul Island off the Alaskan coast for drone cargo services starting in 2023 using 10 hybrid VTOL aircraft of two types, one carrying 350kg and the other 2000kg over ranges of several hundred kilometres.²⁷

In Australia, the Defence Innovation Hub is exploring drone technologies that could undertake land force resupply missions; prototype demonstrations are planned.²⁸ Two notable Australian concepts are Vertiia's battery powered, VTOL drone that could

²⁵ Jeremy Bogaisky (2019), 'Before Amazon Drops Packages On Your House From The Air, Drones May Start To Transform Air Cargo', *Forbes*, https://www.forbes. com/sites/jeremybogaisky/2019/02/13/before-amazon-drops-packages-on-yourhouse-from-the-air-drones-may-start-to-transform-bulk-air-cargo/#d60773a72fa0 [Accessed 17 May 2019]

²⁶ Vishnu Rajamanickam (2019), 'Autonomous cargo aircraft are bringing in same day delivery to remote areas', *Freight Waves*, 14 February, https://www. freightwaves.com/news/technology/autonomous-cargo-aircraft-are-bringing-insame-day-delivery-to-remote-areas [Accessed 19 May 2019].

²⁷ Woodrow Bellamy (2019), 'Sabrewing Finds First Customer for Cargo EVTOLs in Alaska', Avionics International, March 21, https://www.aviationtoday. com/2019/03/21/sabrewing-finds-first-customer-cargo-evtols-alaska/ [Accessed 18 May 2019].

²⁸ Keirin Joyce (2019), #SelfSustain – Breaking the (recent) paradigm, *The Central Blue*, http://centralblue.williamsfoundation.org.au/selfsustain-breaking-the-recent-paradigm-keirin-joyce/ [Accessed 22 May 2019].

potentially carry 150kg about 250km, and Amatek Design's hybrid fuel cell and battery powered, VTOL drone intended to deliver up to 200kg out to about 100kms.

The Antarctica environment is a harsh one for all forms of aviation but also eases some of the problems normally associated with cargo drones such as dangers presented to the communities over which they fly, crowded airspace and delivery risks. In Antarctica drone flight paths could be readily established and flown without concerns about causing damage to people or facilities if they crashed.

Antarctica is in the main empty except for near to the relatively few bases. This opens up further possibilities. Automated drones flying pre-programmed routes can fly as easily at night as during the day. Cargo drones could operate at times manned aircraft do not including potentially during the winter months.

Today manned aircraft only operate in Antarctica in winter *in extremis* for operations such as medivacs. The conditions are not just difficult but the risks are high with rescue of the crew of a crashed manned aircraft improbable. The Davis facility though will be an all-seasons airfield and with development could possibly operate cargo drones across a close-in network servicing Davis and the nearby Russian, Chinese and Indian winter bases, all within about 110km. Drones can be hazarded in situations manned aircraft cannot be. Even so the number of days drones could be operated in winter would be constrained as the weather can sometimes be poor with high winds.

Close-in cargo transfer is today the easiest application to develop but in 25+ years time large cargo drones operating from Hobart to Davis during winter would seem a plausible technological possibility. Again this is an empty air route flying over empty seas; the dangers to others would be minimal across such a drone flight path. However, while the engineering is within current capabilities, the drone cargo development costs would be considerable.

From an Australian perspective, developing cargo drones for short-range Antarctic operations would provide a unique capability supporting the logistics collaborator of choice objective. Beyond this though, cargo drones have great application outside of Antarctica. Antarctica might allow cargo drones to be developed, tested, certified and proven in a safe environment devoid of humans before being flown in and over inhabited areas and cities. Antarctic cargo drones would thus be dual use offsetting their high development costs.

Drones in Search and Rescue Operations (SAR)

SAR operations in the Antarctic are especially difficult given the large distances involved, the activities being undertaken in widely scattered locations and the poorly developed infrastructure. Handling an emergency is on a self-help basis although in practice all nations assist willingly. Some nations however have responsibility under various international agreements to coordinate SAR operations within designated regions.

The Australian Search and Rescue Region (SRR) covers about two thirds of East Antarctica with the reminder (including the Mawson base) within the South African SSR. The coordination of aviation and maritime SAR in the Australian SSR is undertaken by the Australian Maritime Safety Authority working through the Joint Rescue Coordination Centre in Canberra.

Antarctic SAR has the potential to be revolutionised by the application of advanced and emerging drone technology. Air Force is acquiring the MQ-4 Triton long range, long endurance maritime surveillance unmanned air vehicle. To be based at RAAF Edinburgh near Adelaide, the overall Triton system will for the first time allow surveillance missions to be mounted from Australia directly into the Antarctica region to accurately locate those involved in an emergency situation. Moreover, with its long endurance and SATCOM links, the Triton could in some circumstances remain overhead a SAR event in an on-scene commander role coordinating recovery operations.

In the longer term, cargo drones like those mooted earlier could then be deployed to drop supplies to those in need that Triton has geo-located. Beyond this, the USAF is running a competition to develop a drone that could be air delivered to survivors of an emergency and able to fly them to safety.²⁹ Such a capability could be very useful in Antarctic SAR operations.

Drone Maritime Surveillance

The Triton acquisition also provides an impressive new capability for maritime surveillance to detect and monitor unauthorised fishing activities in Antarctic waters. In waters within Australian jurisdiction and as noted, Triton air vehicles could then remain overhead to coordinate interception of the illegal fishing vessels by surface ships. The Air Force however is only getting a limited number of Triton air vehicles, demand for their services will be high and they are expensive to operate. Using them for fisheries patrol is possible but probably restricted only to very specific circumstances.

Electric Aircraft

There is significant work underway globally into electric aircraft. In considering Antarctica air operations there would be advantages in being non-polluting in a pristine environment but most importantly in sharply reducing fuel requirements. The burden of transporting large stocks of aviation fuel into and around Antarctica is significant. Ideally, the electricity needed to recharge the batteries of electric aircraft could be generated using renewable means such as solar, wind or geothermal.

Current expectations are that electric aircraft advances will mean that by 2022, small nine-seater passenger aircraft could be doing short-haul (500-1,000km) flights. Late in the decade, small-to-medium

²⁹ Joseph Trevithick (2019), 'Shot Down? The USAF Now Wants To Air-Drop An Air Taxi To Fly You Out To Safety', *The Drive*, 14 May, https://www.thedrive.com/ the-war-zone/27998/shot-down-the-usaf-now-wants-to-air-drop-you-an-air-taxito-fly-you-out-to-safety [Accessed 17 May 2019].

150-seat planes could be flying up to 500 kilometres. Short-range (100-250 km) VTOL aircraft could also become viable in the 2020s possibly replacing helicopters in certain roles.³⁰ In 2020 Australian company magniX will re-engine a Harbour Air DHC-2 Beaver floatplane in Vancouver as part of a joint-company demonstration of electric aircraft potential.³¹

Shared Network

As the information technology revolution continues, there is a new emphasis on the Internet of Things (IoT) where small remote sensors send data to distant processing facilities that turn thousands of inputs into useful information. Much Antarctica research could be done remotely but scientists currently need to undertake fieldwork as there is no reliable internet backbone to transfer data from emplaced sensors back to distant laboratories. If there were, fewer personnel would be needed in Antarctica and the skill balance would shift away from scientists towards technicians and maintainers.

Such an approach would require two fundamental building blocks. Firstly, the development of IoT systems able to both survive the Antarctic rigours – including perhaps during winter - and be readily customisable to perform a wide range of functions as scientific research required. Within this are hard issues of power supply and wireless data transmission. Secondly, a wide area communications network would need to be in place to receive the data from the thousands of IoTs that might be deployed. This seems achievable using

³⁰ Jake Whitehead and Michael Kane (2019), 'Get set for take-off in electric aircraft, the next transport disruption', *The Conversation*, 24 April, https://theconversation.com/get-set-for-take-off-in-electric-aircraft-the-next-transport-disruption-114178 [Accessed 17 May 2019]

³¹ Umair Irfan (2019), Aircraft fuel is notoriously dirty. This airline is betting on clean electricity', *Vox*, 14 May, https://www.vox.com/2019/5/14/18535971/ electric-airplane-aircraft-aviation-clean-energy [Accessed 17 May 2019].

space-based technology although this would require careful orbital selection and may require multiple satellites. The overall system costs would be lower than earlier times given Space 2.0 technology advances but launches still remain expensive.

Such a network would be a unique asset and make Australia a leader in Antarctica research. As importantly, the network could be shared with other East Antarctic nations reinforcing and strengthening longterm relationships. Such a network would markedly assist Antarctica SAR capabilities. The technology behind such a network would also be inherently dual-use in being able to be used elsewhere in different environments.

A Way Ahead

There are several possibilities but to be considered as a whole they need relating to the key strategic level questions, the envisaged Antarctic alternative futures and time.

Combining these aspects suggests reaching for the second horizon through a blend of modest no-regrets moves and real options development. The main thrusts would be in the East Antarctic Air Network, the Triton unmanned air system (UAS) and enhanced monitoring of the Antarctic strategic environment. Overlapping these second horizon initiatives would be a push towards the third horizon using a classic diversification approach involving an experimentation program.

Second Horizon Initiatives

An East Antarctic Air Network. Australia's current plans to build the new Davis paved, all-seasons runway is a first-mover step that could set the direction and tone of how others will operate in Antarctica. This runway could form the hub of air operations across Antarctica from which the spokes, the intra-continental ski-equipped transport aircraft, emanate from. In particular Davis is very well placed to support China's burgeoning coastal and inland base structure.

Making such a concept real though depends on exploiting the possibilities Davis offers and further modest investment. Firstly, all nations operating in East Antarctica would need to be brought into an air logistic support organisation that undertook network usage planning and operation. Such a multinational organisation would be necessary to give all involved a stake in using the network and confidence in the network's durability. The 11 nation Dronning Maud Land Air Network is an obvious model to consider. Given the Davis runway is more than a decade away such an organisation could be initially established based around the existing Wilkins airhead.

Secondly, C-17 aircraft could use the paved Davis runway to bring stores in early in the season so as to be ready to commence intracontinental distribution once the ski-equipped aircraft arrive and the ski runways open. This is an approach that the US has followed in McMurdo to get the most research accomplished in each season. To do this though would require Davis to be developed to have an efficient warehousing capability involving significant all-weather storage space.

The hub and spoke concept supports Australia strengthening its position as an international leader in Antarctica and being the logistics collaborator of choice for East Antarctica as the 2016 Strategy and Action Plan sets out. However those objectives are mainly important in only two futures: groundhog day and all-in.

In the other two alternative futures, developing Davis airfield to be a regional hub might be an overinvestment for limited additional return. In the buy now and wild west futures such airfield improvements would be useful but perhaps not essential.

Countering this is that investing in developing Davis airfield into a regional hub could significantly help move the future towards the groundhog day and all-in futures. These are the more desirable futures for Australia and most in harmony with the 2016 Strategy and Action Plan. Within this first-mover initiative there may be value gained from considering investing in a real option. Canadian company Kenn Borek Air is currently contracted to provide intra-continental ski-equipped air transport services. An Australian service provider could be used instead (as was before 2010) although this would take time to develop and may not be as cost-effective as continuing with Kenn Borek Air. The company dominates the Antarctic intra-continental air transport service provision market achieving significant economies of scale and can leverage off the North American market for ski-equipped aircraft during the off-season.

Moving to an Australian company would require suitable smallscale supplementary funding albeit ongoing. Such an investment though is most useful in the groundhog day and buy now futures. In the all-in and wild west futures, retaining Kenn Borek Air might be more efficacious. How long such a real option was continued with might depend on which future actually eventuates.

Triton UAS. The new Triton maritime surveillance unmanned air system offers advanced capabilities potentially very useful for SAR and fisheries patrol across the Antarctic littoral. Making Triton's Antarctic potential real though requires some investment and taking a real options approach.

The RAAF's Triton capability is limited in scale and will have many competing demands placed on it. Making it useful for Antarctic roles will take time. Initially, across the next decade some small trials and experiments could be undertaken to develop the embryonic procedures for using Triton for SAR and fisheries patrol. These would then help inform if there is a need to acquire additional Triton air vehicles to allow regular Antarctic use, any new sensor or communication equipment necessary to enhance Antarctic operations and the need for additional system manning.

Developing Triton procedures would be useful across all four alternative futures but the further investment seems more valuable in

the buy now and wild west futures. Decisions about such additional investment might be guided by which future appears eventuating.

Enhanced Situational Monitoring. A key element of the various proposals discussed is that they need to be undertaken in conjunction with an enhanced monitoring of the Antarctic strategic environment. The intent of this is to ensure that a strategic warning is received and acted upon in sufficient time to convert the real options into robust capabilities appropriate to the now better-defined and understood situation. Indeed, the money spent creating real options may be wasted if the critical time to move into a deployable capability is missed.

In an organisation as complicated and multifaceted as the Australian Defence Organisation who and where should undertake such enhanced monitoring is not easy to determine. In constraining the debate to just airpower, establishing a dedicated position within Air Force Headquarters may be an option. This individual could build relationships within the Australian Antarctic Division allowing the defence and civilian perspectives on Antarctica air power to be integrated while remaining abreast of relevant commercial developments and opportunities.

Longer Term Third Horizon Initiatives

In moving towards the third horizon the classic diversification approach seems appropriate. This approach envisages making several independent strategic investments that even if some fail will overall enhance Antarctic capabilities. The aim would be to undertake a program of continuous experimentation that constantly probed the technological possibilities. Limited investments would be made across a broad field, investigating ideas until they were determined worth funding for acquisition or not. In the emerging fourth industrial revolution this process is becoming considerably easier and effective.³²

Of the ideas earlier discussed, the cargo drones, electric aircraft, specialised SAR drones and shared network are all potential candidates. The cargo drones are useful across all futures albeit perhaps an excessive capability for the wild west future where states are trying to withdraw from involvement in Antarctic. For this future remaining with helicopters would be adequate. A small cargo drone experimentation program could readily begin in the near term aiming to transfer cargo from Wilkins to Casey, a short 40km trip but difficult overland.

Similar considerations apply to the electric aircraft and specialised SAR drones concepts. They would be useful in all futures but in the wild west future be of lesser import.

The shared network idea is different in being a high payoff/ high-risk notion. It has the potential to markedly disrupt the current approach to scientific research in Antarctica by allowing scientists to mostly remain in Australia. With reducing manning needs, Antarctic bases could shrink with consequential logistic support reductions. The concept though at first sight looks expensive and most applicable in only the groundhog day and all-in alternative futures. An experimentation program would need to stay modest until confidence was gained in the technology and the costs, and the utility in the specific future emerging could be gauged.

³² Peter Layton (2019), *Prototype Warfare and the Fourth Industrial Age*, Air Power Development Centre: Canberra.

Australia's Antarctic National Air Power Futures

CONCLUSION

The Australian Antarctic Territory is getting busier as more nations build and operate research bases there. This reawakening of interest in Antarctica in recent years is not accidental rather reflecting geoeconomic and geostrategic shifts in the broader international system.

Maintaining bases in Antarctica for the long haul is an inherently expensive undertaking not done on a whim. Nations need to be relatively wealthy to afford such involvement. The 29 nations who have built bases appear driven by a mix of rationale including scientific research, ensuring a say in the rules governing Antarctica's future, being well-positioned to exploit Antarctica's resources when that is allowed, geostrategic signalling and national prestige.

All Antarctic nations rely heavily upon aviation to support their bases and research activities. A type of Antarctic air logistic support model has become commonplace. An airhead is established around an ice or compacted snow runway into which large wheeled passenger and transport aircraft can operate into from distant countries. These intercontinental air operations deliver personnel and material to Antarctica that is then dispersed around the continent using ski-equipped twinengined transport aircraft. If further logistic movement beyond the remote ski runways is necessary, helicopters are used.

This air transport network model uses a mix of civilian commercial operators and military assets, trying to get the best overall system from a careful blend of the two. In that regard the Antarctic air logistic support model is an interesting small-scale example of national air power: the ability of a nation to achieve its objectives through the air domain and encompassing elements of civilian and military aviation. Australia's variation on the Antarctic air logistic support model uses for intercontinental movements Melbourne-based Skytraders A319CJ passenger aircraft and RAAF C-17A heavy lift transport aircraft, for intra-continental movements, Canadian Kenn Borek Air BT-76 (a turbo-prop DC-3) and Twin Otter ski-equipped aircraft, and for the final step Tasmanian-based Helicopter Resources Squirrel helicopters. Changes are however afoot with the biggest being the intention to develop a paved runway near the Davis research station. This will allow air operations to move beyond being summer only, becoming potentially all-seasons. At the moment even in summer inter-continental air operations have problems as the ice and snow runway melts and is unavailable for about six weeks mid-summer. More prosaically, today's ice and snow runways need to be remade after every winter unlike a paved runway.

In looking out across the next two or three decades other capability developments and innovations are possible that could noticeably improve Australia's Antarctic national air power employment. While efficiency gains are always helpful, the 2016 Australian Antarctic Strategy and Action Plan set some specific objectives that national air power improvements should aim to address. The important two are that Australia aims to strengthen its position as an international leader in Antarctica and seeks to become the logistics collaborator of choice for East Antarctica.

National air power improvements can be divided into two elements: medium-term adaptations and long-term visionary disruptive innovations. The first extend present plans and current capability acquisitions while the second create new capabilities that might displace today's ways of doing business.

In the first case a blend of modest no-regrets moves and real options development seem appropriate. Three broad programs fall into this category: the East Antarctic Air Network, the Triton UAS and an enhanced situational monitoring.

Australia's current plans to build the new Davis paved, all-seasons day/night capable runway is a first-mover step that could set the direction and tone of how others will operate in Antarctica. This runway could form the hub of air operations across Antarctica from which the spokes, the intra-continental ski-equipped transport aircraft, emanate from.

Making such a concept real though depends on exploiting the possibilities Davis offers and this may require further investment. Firstly, all nations operating in East Antarctica might be brought into an air logistic support organisation similar to the existing 11 nation Dronning Maud Land Air Network. Davis is more than a decade away from being operational but there is no reason that such a multinational organisation could not be established now using the existing Wilkins airhead.

Secondly, C-17 aircraft could use the paved Davis runway to bring stores in early in the season so as to be ready to commence intra-continental distribution once the ski-equipped aircraft arrive and the ski runways open. To do this though would require Davis to be developed to have an efficient warehousing capability involving significant all-weather storage space.

The second program is the new Triton UAS. Realising its potential for Antarctic air operations will require some investment and taking a real options approach. Initially, across the next decade some small trials and experiments could be undertaken to develop the embryonic procedures for using Triton for SAR and fisheries patrol. These would then help inform if there is a need to acquire additional Triton air vehicles to allow regular Antarctic use, any new sensor or communication equipment required to enhance Antarctic operations and the need for additional system manning.

The final program is enhanced situational monitoring. The intent of this is to ensure that a strategic warning is noticed in sufficient time to convert the real options into robust capabilities appropriate to the now better-defined and understood situation. In thinking solely about air power, establishing a dedicated position within Air Force Headquarters may be an option.

Considering longer-term visionary innovations the preferred approach envisages making several independent strategic investments that even if some fail will overall enhance Antarctic capabilities. The aim would be to undertake a program of continuous experimentation that constantly probed the technological possibilities. In the emerging fourth industrial revolution this process is becoming considerably easier and effective. Cargo drones, electric aircraft, specialised SAR drones and a shared network are all potential candidates.

Reflecting changes in the broader international system, more nations are becoming concerned about Antarctica, sensing that new opportunities may emerge and building bases in preparation. In response the way Australia is involved in the Antarctic is changing with new capabilities being introduced and new ideas being embraced. Amongst this backdrop of change though Antarctic is still a tough place to get to, work in and survive in, especially during the winter. Most activities can generally only happen during summer, slowing progress down. Antarctic is getting much busier drawing attention and concern but it remains a case of making haste slowly.

Australia's Antarctic National Air Power Futures

Antarctica is changing. Not just physically as climate change inexorably impacts but also in how countries and people perceive and act in the world's last uninhabited continent. More and more states are becoming engaged in Antarctic issues and establishing research bases there.

The scientific endeavours of all the participating Antarctic states use a judicious mix of military and commercial air transport assets. Australia is notable in this use of national air power in Antarctica albeit on a small-scale. Sizeable investments have and are being made to create an effective and efficient air logistic network. In looking to the future however, exciting new possibilities beckon.

This paper initially examines Antarctica today including recent Chinese, Indian and Russian activities in the East Antarctic region that Australia asserts sovereignty over. In the second section, the paper focuses on Australia's national interests, current air operations and development intentions. The third section looks two decades forward to develop four alternative futures both appropriate to Antarctic air operations and linked to the ADF's 2035 Future Operating Environment's alternative futures. The fourth section applies these futures to devise a range of strategic options in terms of potential Australian Antarctic national air power approaches and possible force structure changes.

