Australian Academy of Science

Submission to the 20 Year Australian Antarctic Strategic Plan

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Summary: Science is the currency of Antarctica

Antarctica, a continent set aside for 'peace and science', lies within a complex geopolitical environment of territorial claims, and the Antarctic Treaty signed by 50 nations (28 of which are Consultative Parties), is underpinned by long-standing consensus. However, despite so many nations' involvement, it is the 12 original Treaty signatories, including Australia, that are most influential in setting the political agenda and, of most significance, produce most of the science. This later point is critical, as participation as a Consultative Party is dependent on demonstration of a substantial scientific program. Actively pursuing our role as a major Consultative Party ensures that Australia's Antarctic interests are not diminished. Regardless of what path or direction Australian investment in Antarctica takes in the next 20 years, it is of fundamental importance to demonstrate that we have a credible, competitive scientific program that is producing high quality, scientific outputs and delivering high quality scientific outcomes.

Adopting the following nine fundamental requirements into the 20 Year Australian Antarctic Strategic Plan, as essential deliverables that can be tracked as key measures of success, will meet the minimum requirements needed for Australia to deliver an internationally credible Antarctic scientific program. Such a program is essential to maintain our sovereign moral claims, and our leading role in the Antarctic Treaty System.

Fundamental requirements

1) Reliable access to Antarctica and the Sub-Antarctic islands that allow science projects to have at least two to six weeks on-ground research time.
2) Travel time for scientists to Antarctica of two weeks or less.
3) Reliable annual access (in different seasons) of at least 60 days ship time for Antarctic and Southern Ocean marine science voyages. Within the sea-ice zone a Class 1 Icebreaker will be required, where as open-ocean, Southern Ocean work does not require an icebreaker.
4) Reliable and adequate funding to annually support at least 100 high-quality, competitive science projects spanning the physical, chemical, atmospheric, cryospheric and space sciences, and biosciences.
5) Sufficient accommodation on stations or ships to support 100 science projects and adequate resourcing of associated transport and logistics – small boats, helicopters, over-ice vehicles, support personnel, and other capabilities such as modular laboratories.
6) Increased capacity for deep field access via long-range helicopters and/or fixed wing light aircraft, use of ships as a remote-location science platforms and ground traverse capabilities.
7) Increased capacity for science focus on long-term observing systems on land, ice and at sea and continued support for existing systems to maximise the value of the existing long-term data sets. Continued and improved access to key satellite remote sensing data and products.
8) Better remote sensing and mapping capabilities and real time data exchange between Antarctica and Australia (and hence greater capacity data storage and sharing).
9) Flexible funding structures suited to facilitate both national and international collaboration.

1 The strategic importance of Australia's Antarctic interest

1.1 Assess Australia's strategic national Antarctic interests.

Australia currently makes claim to 43% of the Antarctic continent, and has indisputably the strongest claim of any claimant state given its geographic proximity and history of exploration, discovery and activity in Antarctica. In addition, Australia has responsibility for a large ocean area off east Antarctica and two of the six Sub-Antarctic islands groups. The perception of relative strength of claims by any nation is dependent to a large extent on a nation's current activities and current interests in the continent. Inactivity or reduced activity within the Australian Antarctic Territory runs the risk of eroding Australia's long term goals, interests, and our capacity to influence the long standing stability of the region. Therefore it is strategically important for Australia to ensure that it remains active in the region, and uses this moral claim to influence the cooperation of other nations based in Antarctica.

The most significant part of this activity currently comes from Australia's highly respected science leadership and research effort. This science has, and will, continue to be of national and global significance. Our scientific endeavours ensure that Australia is seen as active in the region, but also helps forge mutually beneficial cooperation with other nations as scientists collaborate on projects of joint interest and global importance. The result of this science diplomacy is a strengthening of Australia's position in Antarctica, and assists Australia in taking a leading role in setting environmental management standards, securing the protection of Antarctic ecosystems, and contributing to addressing global science problems. In the past Australia has consistently been one of the top three nations in terms of producing working papers to submit to the Antarctic Treaty, along with the UK and New Zealand. Furthermore, between 1992 and 2010 Australia produced the fourth highest number of scientific publications after the US, UK and Germany. When this is normalised to gross domestic product Australia was second only to New Zealand[1].

However Australia's role in Antarctic science has shrunk. The number of science projects being supported by the Australian Antarctic Program has dropped from a peak of 142 in 1997–98 to just 62 this year. The ratio of scientists to other personnel going to Antarctica has dropped from a peak of 50% in 1989/90 to just 20%. This diminishing activity has resulted in decreased scientific output, as indicated by the number of peer review publications dropping from around 200 annually (1999–2006) to less than 100. The reduction in recent expenditure in the sector is having a real impact in terms of measurable outputs. As science is the currency in Antarctica, this impacts on the strength of Australia's claim over the Australian Antarctic Territory and it impacts on its role as an influential Consultative Party to the Treaty.

Antarctica is a significant location for Antarctic science, with much Antarctic science needing to be undertaken in Antarctica itself rather than remotely. This science is of strategic importance to Australia's future well-being and includes science such as:

- Investigations into improved conservation of Antarctic and Southern Ocean ecosystems
- Understanding Australia's and Antarctica's past, present and future climate systems, the drivers within the Southern Ocean, as well as the process and impacts of natural and anthropogenic climate change
- Development of effective response to the impact of human activities in Antarctica

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[1] Dudeney, J.R. & Walton, D.W.H (2012) 'Leadership in politics and science within the Antarctic Treaty'. *Polar Research*, 31, 11075, DOI: 10.3402/polar.v31i0.11075

- Sun-Earth coupling and associated changes in the atmosphere, ionosphere, and climate.

Antarctica is of strategic importance to Australian science because its unique environment, location and relatively undisturbed landscape provide opportunities to undertake research that cannot be replicated elsewhere. For example, Antarctica and the Southern Ocean are significant elements in Earth system science, and increasing our knowledge in this area is vital to present and growing future strategic interests, particularly with respect to matters of sustainability and security. Many global processes, such as ocean acidification, are likely to affect polar ecosystems earliest, so are most readily detected in polar waters. Similarly, research into Antarctic microbial ecosystems provides insight into evolutionary adaptations to extreme environments, and can lead to significant biotechnological outcomes, and these are just a few examples.

Furthermore, the best sites for undertaking astronomy in Antarctica all lie within the Australian Antarctic Territory, and this, combined with Australia's strong international reputation for astronomy, can provide Australia with a strategic advantage for international collaboration opportunities.

1.2 Consider whole-of-Government coordination of Australia's Antarctic interests and Government institutional arrangements for their delivery

The current mixed-model approach to the coordination of Australia's Antarctic interest is highly effective. This approach is led by a government agency (Australian Antarctic Division), but with participation from other Australian government agencies, universities, and overseas institutions. The success of this model is demonstrated in that 60% of Antarctic science is being conducted by external agencies and institutions and as such, spreads the participatory load across a range of sectors.

The current structure of the Australian Antarctic Division, whereby science, policy and logistics are coordinated by one organisation, is seen as effective and efficient within the sector. This allows for the key delivery of science into international forums and the management of the territory. Other nations where delivery of Antarctic science is separated from delivery of logistics or policy development are not as effective or cohesive as Australia in delivery of the entire 'Antarctic package'.

1.3 The funding required for implementing the 20 Year Strategic Plan for Australia's Antarctic engagement

The current Antarctic funding arrangements are chronically underinvested to maintain the current operations and undertake the strategically designed science program. Australia's Antarctic research and resupply flagship, the *Aurora Australis,* has reached the end of its effective lifespan. Australia's basic infrastructure is reaching the point where it is rapidly ageing, and insufficient funding prevents adequate support for both land and marine based science. Current funding levels mean that the science program has no resilience for incidents such as the recent loss of helicopter capacity due to an accident or unusual heavy sea-ice conditions.

Furthermore, our Antarctic infrastructure is limited in crucial discipline areas: the *Aurora Australis* has very little geoscience capability and it is vital to ensure its successor is fully geoscience-capable, particularly regarding marine-bed mapping and assessment.

Australia is rapidly falling behind developing nations that are taking an increasingly high interest in the Australian Antarctic Territory, particularly China, Russia and India. The interests of these countries are varied but do include resource identification. If Australia wants to shape the future of Antarctic activities and Antarctic science, and so protect its strategic interest, it needs to be present and active. This means we need to maintain a physical presence, and take responsibility for activities not only along the coastal regions, but inland as well. This includes mapping (onshore and offshore) and the implementation of management regimes and activities such as the remediation of Wilkes, in addition to running an active, comprehensive science program. Inadequate investment means a lack of participation in these activities, and this will lead to other nations setting the dominant agenda within Antarctica, and so diminishing Australia's international leadership and strategic position.

2 Expanding the role of Tasmania as the gateway for Antarctic expeditions and scientific research

2.1 Recommend options to build on and further stimulate economic, social, research and policy benefits deriving from Tasmania's status as an Antarctic gateway

The presence of the Australian Antarctic Division, CSIRO, the University of Tasmania (UTAS), CAMLR (the Commission for the Conservation of Antarctic Marine Living Resources) and ACAP (Agreement on the Conservation of Albatrosses and Petrels) ensures that there is a world-class, critical mass of Antarctic science interests within Hobart. This is further strengthened by the presence of French Antarctic Program activities based in Hobart, as well as the activities of the Tasmanian Polar Network. The ongoing, growth and support of both national and international networks should be encouraged as they are of significant importance to the Tasmanian economy.

There are a number of ways in which further economic benefits can be generated for Tasmania through this presence. The fit-out of the new icebreaker could be located in Hobart, generating employment opportunities. Teaching of Antarctic science at UTAS to international students could be expanded. There is also the opportunity to develop procurement, biosecurity and logistic capabilities and partnership for other nations, such as China, India and Korea, to enhance Tasmania's place as the gateway to Antarctica.

One of the critical areas developing in Antarctic science is the need for increased capacity for obtaining real-time, remote measurements from the challenging Antarctic environments including the ice-covered ocean environment, using state-of-the-art autonomous platforms (aerial and underwater). As such, these needs are embedded in the current Antarctic 10-year Science Plan. International observing systems are initiating (e.g. SCAR's Antarctic Nearshore and Terrestrial Observing Systems ANTOS) and one, SOOS (Southern Ocean Observing System) already has its secretariat established in Hobart. Policy to develop this capacity in Hobart through joint initiatives would ensure this need is met in a timely matter and enhance an already burgeoning ITC sector.

2.2 Building efficient, effective and internationally integrated partnerships including among Hobart-based Antarctic research institutions

International partnerships among Hobart-based Antarctic research institutions are now well developed and should be encouraged to continue and expand. Similarly, building national collaboration with other Australian research institutions outside of Tasmania will build Australia's national scientific capabilities. In addition such collaborative networking will bring to bear on Antarctic and Southern Ocean science complementary capabilities in areas such as geology, geophysics, genetics, microbiology, biotechnology, and other areas that may be well-developed in other Australian science hubs.

Hobart has more scientists per capita than any other capital city in Australia and a large majority are Southern Ocean or Antarctic focussed (65% of the Australia's Antarctic and Southern Oceans research scientists[2]). Development of virtual institutes relying on National Broadband Network (NBN) investment in the state and creating abilities for large data storage and fast data sharing should be encouraged. Extensive use of the virtual world is a cost-effective pathway for partnership development and integration. Achieving a more integrated science program will require attention to Australian Antarctic science processes to ensure facilitation of collaboration and merit-based support for projects.

3 Ensuring robust and reliable access to the Australian Antarctic Territory

3.1 Assess the Australian Antarctic Division's current operational capabilities and the future (short, medium and long-term) options to meet Australia's requirements to access the Australian Antarctic Territory and other parts of Antarctica, principally via:

- options to modernise and streamline Australia's intercontinental aviation capability
- options to derive maximum benefit from Australia's new icebreaking capability
- options for enhanced operational collaborations with other nations.

The current access arrangements to the Australian Antarctic Territory and the Sub-Antarctic islands are woefully inadequate. The age and condition of the *Aurora Australis* and inadequate funding to support scientific research hamper researcher access to the Australian Antarctic Territory. This was highlighted by the 2013–14 summer in which the *Aurora Australis* was stuck in sea-ice for several weeks off Davis station and the sea ice was too extensive for effective resupply at Mawson station, requiring expensive oversea ice resupply. Such hindrances have substantially compromised the capacity to support science, with many science projects being cancelled. Furthermore, the age and condition of Casey Station has meant that new beds are not available until infrastructure and station services can match the capacity of the station. Other nations such as Poland, Chile, Japan, Russia, China and Belgium continue to have more reliable access to Antarctica than Australia.

Replacement of the *Aurora Australis* with a new ice-breaker will significantly improve this situation and provide confidence in future access arrangements for the Australian Antarctic Territory. The Icebreaker should be equipped with state-of-the-art facilities and instrumentation and have the ability to carry out world-leading, cross-disciplinary scientific research in the Southern Ocean environment (ice-covered and non ice-covered) at different times of the year.

In addition to a new icebreaker, Australia needs to establish and maintain an ongoing and operational sea-ice analysis and forecasting program, coupled with an associated high-resolution atmospheric forecasting and seasonal outlook services, to improve ship navigation in ice-covered waters and minimise the chance of ships becoming icebound. This is essential to minimise delays/cancellations in logistical resupplies and scientific operations, and to optimise field planning of experiments in the sea-ice zone.

Physical access to Antarctica has been a bottleneck that inhibits scientists from making research trips. It was anticipated that increased availability of flights to Antarctica would improve access, particularly for senior scientists, and reduce travel time, but unfortunately this does not seem to have occurred. Although air access has improved travel time, it has not delivered reliable access or greater access for science and scientists. Air access has also shortened the season available to complete science, due to its expense. Although air access has proven to be a viable concept, two ships operating in the past were far more reliable and allowed greater access for both marine science and terrestrial science. Expansion of the use of the ship *Investigator* may reduce the science-versus-

[2] http://www.hobartcity.com.au/Business/Economic_Development_Priorities/Growing_the_Research_Sector

logistics tension, but only in areas with no or limited ice cover. While we recognise that rejecting or enhancing an operating model (i.e. air transport) is a difficult task, we recommend that in the assessment for the 20 Year Plan, a comprehensive evaluation of the return on investment is considered for a range of models such as:

a) One ship, intercontinental airlink, and fixed-wing intra-continental transport.
b) Two ships plus long-range-helicopters.
c) Two ships, intercontinental airlink, long-range-helicopters and fixed-wing intracontinental transport.
d) Other combinations including expanded operational collaborations with other nations.

Support for improved mapping and hydrography of the Australian Antarctic Territory, support for improved communications to/from and across Antarctica, and support for collaborative activities between the Australian Antarctic Division, Geoscience Australia (the lead Australian agency for Antarctic geoscience), and the Australian Navy in data gathering will also improve access capability to Antarctica. Likewise investment in data capturing by the Australian Antarctic Data Centre and data cubes being developed by Geoscience Australia in conjunction with the Australian Antarctic Division will secure these data assets and make them available for use.

Space based systems may also make a significant contribution to these needs. Australia might consider collaboration and partnering arrangements with the Canadian RadarSAT program, which aims to address similar information needs in the Canadian Arctic, in order to gain ready access to the Canadian sensor data in support of Antarctic movements. Australia might also consider a space-based high bandwidth data and voice communications system for Antarctica, with preliminary R&D already achieved under the recent Australian Space Research Program.

Finally, the Australian Antarctic program would benefit from developing flexible capacity to be able to respond quickly and launch scientific field studies when, and where extraordinary and unexpected events/phenomena occur with relatively little lead-in time, in order to gauge the resultant change. Examples of such events include the calving of a major glacier tongue or ice shelf, and its effect on regional sea ice conditions and physical, biological and biogeochemical processes. Such capacity allows quantum leaps to be made in Earth system sciences.

4 Extending Australia's reach across the Australian Antarctic Territory

4.1 Assess the practical and strategic considerations underpinning Australia's physical presence in Antarctica, including Australia's sovereign interests

As expressed in section 1.1, critical to ensuring that Australia's strategic Antarctic interest are not diminished, Australia must maintain and expand its current undertaking and leading of globally significant science in Antarctica.

A clear policy position is needed regarding our capacity to complete independent core non-science and science activities in Antarctica. Currently Australia cannot complete core scientific activities without other nations. We are reliant on the US to begin our summer season and other nations for core science, and we are also aware of the significant efforts that are required in trading for access with other nations. Such time-consuming activities come at significant opportunity and monetary costs, costs that could be diverted into improving access for scientists and facilitating greater scientific efforts.

Continued support for Australia to actively participate in such large-scale scientific endeavours further enhances our strategic interests and position within the Antarctic Treaty. Australian scientists have a good track record of leveraging international engagement in 'big science' in Antarctica. It is in the national interest to continue to do so. Antarctic science is relatively expensive, but encouraging countries that are active in the Australian Antarctic Territory to participate in big relevant science, such as the search for a one-million-year-old ice core, exploration of remote areas for biodiversity, or building a multinational telescope, defines our leadership, yet shares the expense across nations.

On the ground, an additional effective way to extend Australia's reach would be through conducting remote science throughout the Australian Antarctic Territory. Whilst remote science cannot replace the need for some science to be physically undertaken on site, it can provide an effective mechanism for research, particularly in areas such as biodiversity and climate science. This would be particularly effective if a network of automatic sensor stations supported it and would contribute to the development of long-term observing systems.

In addition to improving access to and movement through Antarctica, Australia's reach is facilitated by the presence of flexible, reliable communications that are capable of relaying large quantities of data back to either central nodes in Antarctica or back to Australia. Sustaining these communications for decades to come – possibly by means of the space-based capabilities referred to above – should remain firmly entrenched in forward planning. From a science perspective, they should be considered as part of the national research infrastructure.

4.2 Provide recommendations on options for Australia's future presence in Antarctica, including through:

4.2.1 Research facilities

The stations in the Australian Antarctic Territory and on Macquarie Island are very old and require a high level of maintenance just to keep them operational. The capacity to accommodate scientists is extremely low and without effective funding it is likely that this will continue to be the case. Investment to increase the number of beds utilised by scientists in Antarctica is drastically needed over the next 20 years. Australia needs to progress towards effective but low-footprint stations that have excellent research facilities, as well as redevelopment of mobile capability access to all areas of the Australian Antarctic Territory.

Furthermore, a combination of refurbishment of current Australian research facilities, forging collaborations and making use of the new equipment being deployed by other nations will prove most effective. For example Box 1 lists the astronomical facilities that are set to be developed in the next 20 years, and these hold great potential for Australian involvement.

- KDUST: a new Chinese 2.5 metre optical/infrared telescope at Dome A
- DATE-5: a new Chinese 5-metre THz telescope at Dome A
- New US cryogenic THz telescope and interferometers at Ridge A
- A 2-metre infrared telescope at Dome Fuji
- A possible China-France-Australia 0.5 metre optical telescope at Dome C
- The US IceCube neutrino experiment
- The US Askaryan Radio Array
- US balloon-borne experiments launched from McMurdo.

In addition, collaboration with the US, UK, China, and other nations on magnetometers, atmospheric and ionospheric lidars and related instruments, radars, and energetic particle detectors is important for space science and atmospheric research, as well as space weather detection, operations, and predictions.

Box 1. Planned Astronomical Facilities in Antarctica over the next 10 years.

4.2.2 Intra-continental transport, including aviation and traverse capabilities

Two forms of intra-continental transport have proven to be effective in recent years for both logistic and scientific placement in the Australian Antarctic Territory – long-range helicopters and fixed wing aircraft, specifically Twin otters and the Basler BT 67. We would recommend continued use of such platforms.

Due to sustained funding cuts, Australia has lost the capability for deep field traverses. This was highlighted by the need to access French deep field traverse support during summer 2013–14 to access the Aurora Basin for a vital ice-coring project. Improved deep field access, either through on the ground traverse and/or by small fixed-wing aircraft or long-range-helicopters, or by use of icebreakers as research platforms will underpin Australia's presence and increase valuable science outputs. This again highlights the need for improved mapping of the Australian Antarctic Territory. GPS-supported mapping has shown that existing maps have errors in the location and height of some mountains in the Australian Antarctic Territory.

4.3 Provide recommendations on Australia's interests and presence in the Sub-Antarctic

The Sub-Antarctic islands are valuable research areas. They form the outer extent of the Antarctic region and are also the resting and breeding ground for much of the Antarctic's wildlife in a readily accessible location. Many species that are listed under Convention on the Conservation of Antarctic Marine Living Resources, International Union for Conservation of Nature, Environment Protection and Biodiversity Conservation Act 1999, and the Agreement on the Conservation of Albatrosses and Petrels as species of international and national interest or concern, and as such Australia is responsible and has agreed to their population monitoring management and to ensure their continued recovery and survival.

These islands have distinct value as they are home to some of the rarest ecosystems on the planet. They offer an ideal location in terms of sensing change (such as through Bureau of Meteorology (BOM) activities and the ARPANSA project) and help us to understand the impact of climate change, island biogeography and the application of conservation measures. As such, a continued presence of a station on Macquarie Island is needed, along with predictable access to Heard Island on a three to five-year access pattern.

5 Committing to undertaking nationally and globally significant science

5.1 Scope the future high priority research for Australia in Antarctica and the Southern Ocean, and its delivery through the Australian Antarctic Science Strategic Plan.

The Australian Antarctic Science Strategic Plan 2011–2012 to 2020–2021 sets the direction and determines funding priorities for science activities supported by the Australian Antarctic Division. The Plan focuses effort into four thematic areas:

- Climate processes and change
- Terrestrial and nearshore ecosystems: environment change and conservation
- Southern Ocean ecosystems; environment change and conservation
- Frontier science.

The development of the Plan was a major undertaking and should act as an important building block for the 20-year strategic plan for Antarctica.

A key driver of the Science Plan was to help determine the level of research support and effort across universities and other national and international agencies. This Plan is only three years old, and as such these areas continue to be of high priority. A mid-term review of the Plan is scheduled to occur in 2016, which will allow for a timely check on its outcome trajectories.

The science designed under this plan is highly effective and strategically focused and will deliver a strong cross-disciplinary program that serves Australia well, in addition to influencing international activity in areas of national significance. For example, within Earth system science, it does this through many internationally leading science organisations and agencies, including SCAR (Scientific Committee on Antarctic Research, SCOR (Scientific Committee on Oceanic Research), IGBP (International Geosphere-Biosphere Program), CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources) and the newly formed Future Earth initiative.

Space science projects are supported under the Frontier Science theme. Antarctica is recognised as the best location on Earth to undertake some areas of astronomical and space research. Furthermore, it is important to note that environmental themes rely heavily on space capabilities and as such continued and improved access to key satellite remote sensing data and products is essential. Access to such data will become increasingly expensive unless Australia combines efforts with other nations. For example, this could be facilitated by Australia becoming signatory to an international space program such as the European Space Agency.

In the next iteration of the Science Plan consideration of additional and emerging science could be considered, for example:

- One of Australia's few R&D-intensive manufacturing and distribution industries is the pharmaceutical industry. Consideration of the capacity to develop bio-prospecting in Antarctica, in an effective policy framework should be considered
- The environmental thematic areas currently do not properly recognise that the neutral atmosphere is connected to the ionised upper atmosphere and magnetosphere, and that some drivers of chemical atmospheric processes may come from Earth's radiation belts and solar activity. This is a current area of international research and requires a global approach. In addition to this, polar field lines map from the ground into large volumes of space, incorporating the regions where solar wind most directly encounters geospace. Antarctic space physics measurements are therefore vital to international science, and Australia provides important capability in support of specific research programs. Three examples

include the poleward-looking over-the-horizon research radars located in Tasmania, South Australia and New Zealand that are elements of the global SuperDARN consortium, LIDAR measurements of the mesosphere, and ground measurements that complement in situ observations by spacecraft missions such as Cluster and THEMIS
- Space-based technologies are ideally suited to provide rapid centimetre-level positioning and imaging accuracy across vast, sparsely populated areas such as Antarctica. This detailed information will help foster innovation in Antarctic science. The nature, fidelity and ease with which research can occur will be dictated in a large part by access to appropriate data. Space-based remote sensing, particularly interferometric SAR, has the ability to map and monitor the volume and movement of snow, ice and glaciers over extended regions and time periods without requiring substantial in situ personnel. Such a capability might be provided by international collaboration and access to international space-based systems. Space-based systems still require field access for ground truth and calibration. For example, space-based estimates of ice sheet mass balance change must correct for past changes that have taken place over tens of thousands of years, so require remote GPS uplift measurements and geological field work
- Given the advantages of high-latitude regions for observing and tracking near-Earth objects, Australia might consider the development of a passive space telescope or active surveillance radar for Antarctica (potentially dual use with a satellite ground station), as part of improving its contribution to the global need for securing and protecting critical space assets.

5.2 Consider Australia's role in driving and participating in international collaborations on science of global significance

Strong emphasis should be placed on international engagement in the 20-year strategic plan. Existing international partnerships are working well and deliver substantial and leveraged benefits to Australian Antarctic science. However, there are always new and exciting opportunities for further collaboration that can deliver both scientific and strategic benefits to Australia, as well as cost sharing across nations of internationally relevant science. Australian Antarctic science programs, projects and individual science teams are usually working with up to 30 nations in any one year. Improved international collaboration to facilitate shared or multi-ship or land-based operations, personnel and intellectual exchange, closer coordination and linking of national Antarctic science strategic plans is the way forward to optimise our Antarctic science and logistics investments.

There are a number of well developed paths of driving and participating in international collaborations on science of global significance, including bilateral and multilateral agreements, driving science informed-policy at through the Antarctic Treaty system including CCAMLR and the Committee for Environmental Protection (CEP), targeted scientific participation in international bodies such as SCAR, SCOR and the WCRP, and participation in international processes such as the International Panel on Climate Change (IPCC). Continued strategic investment is such activities offers guaranteed significant benefits and results.

Furthermore creation or investment in individual international science programs such as the Australian PLATO (PLATeau Observatory) can lead to substantial opportunities. A number of developing countries with rapidly emerging economies are taking an increased interest in Antarctica. China is rapidly expanding its footprint in Antarctica, and will be second only to the US in science expenditure. Some Australian research collaborations in Antarctica with China are in an excellent position for further expansion and have demonstrated a useful model that could be emulated.

Australia's stewardship of a large proportion of Antarctic land mass provides opportunities to host such ground station facilities and ground-based calibration, validation, and verification activities, providing valuable contributions to the international community as well as opportunities for international collaborations.

6 Committing to exercising influence in the region through the Antarctic Treaty system

Australia has considerable influence in Antarctica, and with appropriate funding and leadership it can continue to lead international research programs. Australia has strengths and international leadership capability in areas such as human impacts and management, conservation and biodiversity, climate science, oceanography, upper atmospheric and magnetospheric physics, solar activity, space weather prediction, astronomy, sea ice science, ice-core science, fishery science and climate science, and actively participates in areas such as ice sheet dynamics, and Earth sciences.

6.1 Recommending future priorities for Australia's engagement in Antarctic affairs, including the Antarctic Treaty system and related international forums

Engaging in science in the Antarctic is of strategic importance to Australia's future. As the Australian Strategic Policy Institute points out, 'science is the currency of influence in the Antarctic Treaty System'[3].

Australia should continue its active participation in SCAR, SCORE, CCAMLR and ATCM and strategically targeted associated activities.

6.2 Consider options for building Australia's international influence in Antarctic affairs, including through increased policy engagement in the Antarctic Treaty system, and relationships with key partners

As stated above, Australia has well developed paths for engagement both at a policy and scientific level. Defining areas of policy engagement is beyond the remit of the Academy of Science.

7 Strategy recommendations

The Academy of Science puts forward the following recommendations for consideration in the formulation of the 20 Year Australian Antarctic Strategic Plan:

Adopting of the following nine fundamental requirements into the 20 Year Australian Antarctic Strategic Plan, as essential deliverables that can be tracked as key measures of success, will meet the minimum requirements needed for Australia to deliver an internationally credible Antarctic scientific program. Such a program is essential to maintain our sovereign moral claims, and our leading role in the Antarctic Treaty System.

7.1 Fundamental requirements

1) Reliable access to Antarctica and the Sub-Antarctic islands that allow science projects to have at least two to six weeks on-ground research time.
2) Travel time for scientists to Antarctica of two weeks or less.
3) Reliable annual access (in different seasons) of at least 60 days ship time for Antarctic and Southern Ocean marine science voyages. Within the sea-ice zone a Class 1 Icebreaker will be required, where as open-ocean, Southern Ocean work does not require an icebreaker.

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[3] Australian Strategic Policy Institute (2013) Cold Calculations – Australia's Antarctic Challenges

4) Reliable and adequate funding to annually support at least 100 high-quality, competitive science projects spanning the physical, chemical, atmospheric, cryospheric and space sciences, and biosciences.
5) Sufficient accommodation on stations or ships to support 100 science projects and adequate resourcing of associated transport and logistics – small boats, helicopters, over-ice vehicles, support personnel, and other capabilities such as modular laboratories.
6) Increased capacity for deep field access via long-range helicopters and/or fixed wing light aircraft, use of ships as a remote-location science platforms and ground traverse capabilities.
7) Increased capacity for science focus on long-term observing systems on land, ice and at sea and continued support for existing systems to maximise the value of the existing long-term data sets. Continued and improved access to key satellite remote sensing data and products.
8) Better remote sensing and mapping capabilities and real time data exchange between Antarctica and Australia (and hence greater capacity data storage and sharing).
9) Flexible funding structures suited to facilitate both national and international collaboration.

7.2 Additional recommendations:

a) Substantial repair to the Antarctic budget and the associated loss of opportunity.
b) Rapid replacement of the *Aurora Australis* with a high capacity Class 1 ice-breaker with science capabilities across the full range of physical, chemical, geological, and biological disciplines .
c) The establishment and maintenance of an ongoing and operational sea-ice analysis and forecasting program, and associated high-resolution atmospheric forecasting and seasonal outlook services, to improve ship navigation in ice-covered waters and minimise the chance of ships becoming icebound. This is essential to minimise delays/cancellations in logistical resupplies and scientific operations, and to optimise field planning of experiments in the sea-ice zone.
d) A return-on-investment examination of logistic possibilities.
e) Expansion of the use of the RV *Investigato*r in Southern Ocean marine science.
f) Increased support for improved mapping and hydrography of the Australian Antarctic Territory, and support for collaborative activities between the Australian Antarctic Division, Geoscience Australia, and the Australian Navy in data gathering to improve access capability to Antarctica.
g) Rejuvenation of Australia's rundown stations in order to develop effective but low-footprint stations that have excellent research facilities.
h) Redevelopment of Australia's traverse and remote access capabilities to all areas of the Australian Antarctic Territory.
i) A clear policy position with regard to Australia's capacity to complete independently its core logistic and scientific activities in Antarctica.
j) Consideration in the next iteration of the Antarctic Science Plan of the balance between policy-driven science and other science areas of demonstrable national and international significance.
k) Better operational and financial support for current and future Australian instruments located in Antarctica.
l) Consider the development of a Satellite Ground Station in Antarctica to provide download opportunities for foreign and future domestic satellites and thereby increase Australia's access to that data for both Antarctic and domestic use.
m) Provide high bandwidth inter- and intra-continental communication to Antarctica, from and across Antarctica, potentially via a space-based system.

n) Better capacity to develop joint science funding and logistical support arrangements with national agencies (e.g. ARC) and international agencies (e.g. NSF) such that support is coordinated and synchronised among national and international programs, through mechanisms such as joint calls for proposals.