

PCAS 14 Syndicate Project

Carbon Emissions in Antarctica

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Abstract

In this report we consider (i) how National Programmes should respond to the challenge of reducing fuel consumption and carbon emissions and (ii) how National Programmes balance environmental values with other values associated with Antarctica.

The rate of carbon emissions from activities undertaken in Antarctica, the impact of climate change in Antarctica and globally, and the role of the Antarctic in climate change science are all reasons why the reduction of carbon emissions should be important to National Programmes.

National Programmes are obliged to follow the framework provided by the Antarctic Treaty System and COMNAP guidelines. However, analysis of the current practices of a sample of three National Programmes shows that their approach to reducing fuel consumption and carbon emissions is varied. In light of this, we recommend further initiatives that could be undertaken by National Programmes to enhance their efforts to reduce fuel consumption and carbon emissions.

Any activity undertaken in Antarctica will have an environmental impact. In order to balance the conflict between environmental and other values National Programmes need to:

- Factor in the environmental impact of their activities; and
- Aim to minimise this impact.

Glossary of Terms

ANZ	Antarctica New Zealand
ATS	Antarctic Treaty System
ATCM	Antarctic Treaty Consultative Meeting
ATME	Antarctic Treaty Meetings of Experts
CEMARS	Certified Emissions Management and Reduction Scheme
CEP	Committee for Environmental Protection
COMNAP	The Council of Managers of National Antarctic Programs
DROMLAN/DRONSHIP	The Dronning Maud Land Air/Ships Network
EIA	Environmental Impact Assessment
GHG	Green House Gas
INARCH	Instituto Antartico Chileno
IPCC	Intergovernmental Panel on Climate Change
NARE	Norwegian Antarctic Research Expeditions
National Programme	National Antarctic Programme for each country with operations in Antarctica
PEP	Protocol on Environmental Protection to the Antarctic Treaty 1991
RAPAL	Latin American Antarctic Program Administrator
USAP	United States Antarctic Programme
WAIS	West Antarctic Ice Sheets

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1 Introduction

In this section we describe the topic and the questions that are addressed in this report.

Topic

The National Antarctic Programme (National Programme) of each country that is a signatory to the Antarctic Treaty 1959 has responsibility for managing the support of scientific research in the Antarctic Treaty Area on behalf of its government and in the spirit of the Antarctic Treaty.

The Council of Managers of National Antarctic Programs (COMNAP) is a body comprised of representatives from the 29 National Programmes with operations in Antarctica. The purpose of COMNAP is to develop and promote best practice in managing the support of scientific research in Antarctica.

The Antarctic Treaty Meeting of Experts (ATME) provides advice to the Consultative Parties to the Antarctic Treaty. The Consultative Parties are responsible for the governance of the Antarctic Treaty.

In a recent report on the implications of Climate Change for Antarctic Management and Governance, the ATME make the following recommendation¹:

“Recognizing the importance of emission cuts in Antarctica and their symbolic value in the global context, the ATME recommends that the ATCM encourage COMNAP to work with national programmes to use consistent methods to quantify and publish savings made by energy efficiencies, and which contribute to both (a) reducing carbon footprint, and (b) reducing fuel consumption and operating costs.”

In light of this recommendation the following questions are addressed in this report:

- To what extent should National Programmes respond to what appears to be a symbolic gesture?
- How do National Programmes balance environmental values with other key Antarctic values (scientific value for example) and the need to operate safely and efficiently in a hostile environment?

We have taken a broad approach to these questions; considering not only the issue of quantifying and publishing energy savings but also recommending practical steps that National Programmes could take to reducing carbon emissions.

Content of this Report

In addressing the first question posed above, we consider the following:

- The significance of carbon emissions for National Programmes (Section 2).
- The legal requirements applicable to National Programmes under the Antarctic Treaty System (ATS) and guidelines issued by COMNAP (Section 3).

¹ ATME FR1, 2010

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- Current practices with regards to carbon emissions for a sample of three National Programmes (Section 4).
- Our view of the actions that National Programmes could be undertaking to reduce their fuel consumption and carbon emissions (Section 6).

Finally, we address the question of the balance between environmental and other key Antarctic values in Section 5.

2 Carbon Emissions

In this section we consider the significance of carbon emissions in Antarctica to National Programmes.

The Significance of Carbon Emissions

The Intergovernmental Panel on Climate Change (IPCC) has formed the view that increases in global air and ocean temperatures, widespread melting of snow and ice and rising sea levels provide unequivocal evidence that changes in the climate are occurring².

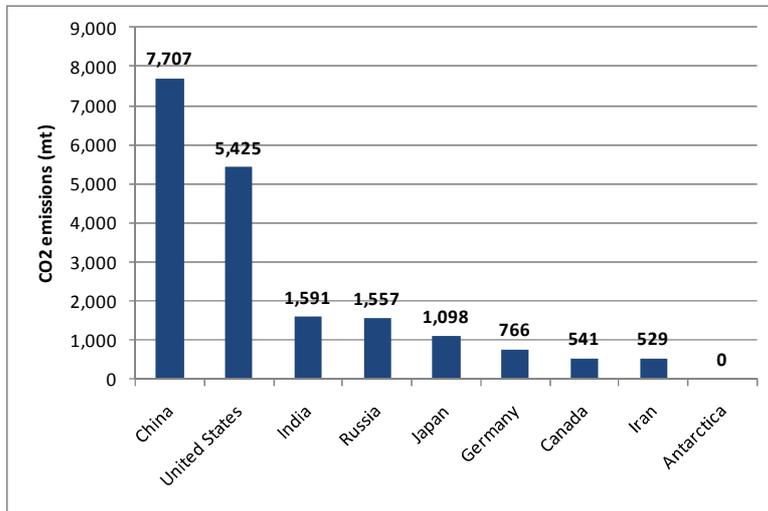
The changes in the climate are linked to increases in Green House Gas (GHG) emissions as a result of human activities. The IPCC estimate that GHG emissions have increased by 70% between 1970 and 2004. Carbon dioxide is the most important GHG. Annual carbon dioxide emissions have grown by about 80% between 1970 and 2004 and represent approximately 77% of total GHG emissions in 2004.

The IPCC conclude that most of the global warming over the past 50 years is very likely to be due to increases in GHG's.

Carbon Emissions in Antarctica

In its report on climate change, the ATME acknowledges that activities in Antarctica are not a major cause of climate change³. Figure 1 compares the carbon emissions for the eight largest emitters of carbon to the total carbon emissions for Antarctica in 2009. Figure 2 presents the same data on a per capita basis⁴.

Figure 1: Total Carbon Emissions in 2009

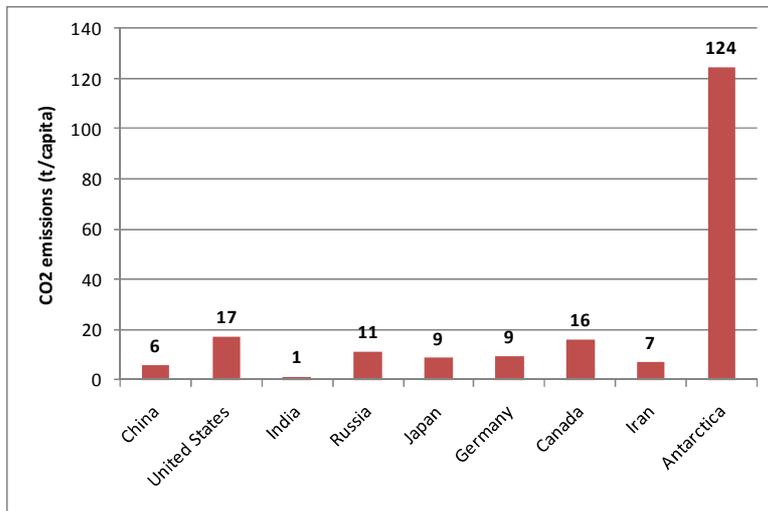


² Pachauri, R.K. and Reisinger, A., 2007

³ ATME FR1, 2010

⁴ For the purpose of this calculation, the population of National Programme personnel in Antarctica is assumed to be 2,500. This is calculated as the average number of National Programme personnel in the summer of 4,000 and 1,000 people in the winter as reported by the ATME (ATME, 2010).

Figure 2: Carbon Emissions Per Capita



Source: Energy Information Administration

Source: Energy Information Administration

The following observations are noted:

- The total Antarctic carbon emissions (0.31 CO₂ mt) are insignificant compared to the countries with the largest carbon emissions in 2009.
- Antarctica has the highest rate per of carbon emissions per capita compared to the sample of countries.

While the nominal carbon emissions in Antarctica are relatively low, the rate of carbon emissions from activities undertaken in Antarctica is very high.

The Significance of Carbon Emissions to National Programmes

There are a number of reasons why the consequences of carbon emissions should be of concern to National Programmes:

- Antarctica has a high rate of carbon emissions per capita compared to other countries.
- Climate change will have an impact on Antarctica. A report prepared by SCAR⁵ predicts that changes are occurring, and will continue to occur, in the Antarctic air temperature, ocean temperature, snowfall, sea ice and sea levels. These changes are likely to have implications for the maintenance and operation of existing and future infrastructure used by the National Programmes.
- The effects of climate change on Antarctica will have an impact on the rest of the world. Initial findings from the ANDRILL project suggest that even a slight rise in

⁵ Turner J. et al, 2009

atmospheric concentrations of carbon dioxide will have an effect on the stability of the West Antarctic Ice Sheet (WAIS). The WAIS covers the Antarctic continent on the Pacific side of the Transantarctic Mountains. Any substantial melting of the WAIS would cause a rise in global sea levels⁶.

- Antarctic science has a leading role in climate change research. Increasing levels of research into the causes and effect of climate change will impose additional demands on the facilities, infrastructure and operations of the National Programmes.
- There is a “symbolic” value as a result of reducing carbon emissions in one of the most challenging operating environments. Reducing fuel consumption and carbon emissions in Antarctica, clearly demonstrates that similar achievements can be accomplished in other parts of the world.

⁶ Nature 19 March

3 Legal Requirements of National Programmes

The National Programmes are required to operate within the framework of the Antarctic Treaty.

Legal Requirements for Antarctic activities and operations

Operating in Antarctica comes with obligations. All the parties to the ATS have signed a binding document, which states what conditions they have to operate under. There have been several instruments added to the Antarctic Treaty since 1959, making it an Antarctic Treaty System, which regulates the international cooperation and preserves both land and sea.

Under the Protocol on Environmental Protection (PEP) the parties “commit themselves to the comprehensive protection of the Antarctic environment...”⁷ and all activity in the Antarctic Treaty area is done within this framework of obligations.

Article 3 of the PEP states that the protection of the Antarctic environment and the values of Antarctica, intrinsic, wilderness, aesthetic, but also scientific must be a fundamental consideration in the planning and conducting activities in the Antarctic Treaty area⁸

The PEP sets demands on how the National Programmes operate by:

- Protecting the environment
- Protecting the Antarctic values
- Initiating assessments
- Initiating monitoring
- Recognising and mitigating human impact

The need for safety is key in Antarctica, both for human and environmental operations. From the results of “regular and effective monitoring (...) of ongoing activities” to assess impacts and verify predicted impacts,⁹ it may be necessary to modify operating procedures.¹⁰

By co-operating in the planning and conduct of activities in the Antarctic Treaty area and sharing helpful information National Programmes can prevent adverse environmental impacts.¹¹ COMNAP has taken a leadership role in this area by developing and promoting best practice guidelines.

In addition to operating within these guidelines, the National Programmes have to include appropriate monitoring of key environmental indicators to minimise and mitigate impacts that their activities have on the Antarctic Treaty area¹².

In summary, the PEP regulates all activity done within the Antarctic treaty area and sets requirements for the National Programmes to follow to reduce the impact humans have on the Antarctic environment and its values.

⁷ PEP Article 2

⁸ PEP Article 3

⁹ PEP Article 3

¹⁰ PEP Article 3

¹¹ PEP Article 6

¹² PEP, Annex I, Article 5

Environmental Guidelines

National Programmes are provided with environmental guidelines by both the Committee for Environmental Protection (CEP) and the COMNAP.

Committee for Environmental Protection (CEP)

The CEP is established under Article 11 of the PEP. Article 12 of the PEP states that the CEP is to “provide advice and formulate recommendations to the Parties in connection with the implementation of this Protocol, including the operation of its Annexes, for consideration at Antarctic Treaty Consultative Meetings.”

Following on from this, Article 3 states:

“activities in the Antarctic Treaty Area shall be planned and conducted on the basis of information sufficient to allow prior assessments of, and informed judgements about, their possible impacts on the Antarctic environment and dependant and associated ecosystems and on the value of Antarctica for the conduct of scientific research.”

Article 8 of the PEP requires all Treaty Parties to complete an Environmental Impact Assessment (EIA), to determine whether technology and procedures are available to allow for environmentally safe operations. Procedures for this are covered in Annex I¹³. The environmental impact of an activity will determine the size and depth of the final document. If the activity causes less than minor to transitory impact it may proceed, if the activity is likely to have a minor or transitory impact then an Initial Environmental Evaluation (IEE) is to be completed. Should an activity be deemed to have more than a transitory impact, a Comprehensive Environmental Evaluation (CEE) must be prepared. Note that the assessment scale is based on environmental impact and not the size or complexity of the activity.

Within the Environmental Impact Assessment Guidelines, section 3.2 ‘Considering the Environment’ illustrates points to consider; these include:

- “aspects of the environment which have changed, or may be changing as the result of other current or previous activities.”
- “recognition of management action taken/required to address or minimise the cumulative impacts of past and present activities.”

These points recognise that (i) the effect of carbon emissions as a result of past and present activities that are damaging to the environment, and (ii) National Programmes need to establish measures to reduce and monitor these.

Council of Managers of National Antarctic Programmes

COMNAP was created in 1988 and was ‘responsible for planning and conducting National Programmes’ presence in the Antarctic on behalf of their respective governments’. Following its 20th anniversary in 2008, the purpose of COMNAP was changed ‘to

¹³ PEP Articles 2 & 3

developing and promoting best practice in managing the support of scientific research in Antarctica' achieved by:

- Serving as a forum to develop practices that improve effectiveness of activities in an environmentally responsible manner;
- Facilitating and promoting international partnerships;
- Providing opportunities and systems for information exchange; and
- Providing the Antarctic Treaty System with objective and practical, technical and non-political advice drawn from the National Antarctic Programs' pool of expertise.'

In January 2005, COMNAP produced a document on Practical Guidelines for Developing and Designing Environmental Monitoring Programmes in Antarctica. This originated from the Antarctic Environmental Officers Network (AEON) workshop concentrating on facilitating and discussing environmental monitoring of science and operational activities in Antarctica.

These guidelines provide a three step approach on how to carry out environmental monitoring:

- Scoping out the Monitoring Programme: identifying your objectives, doing some background research, considering available resources and baseline monitoring.
- Defining the Monitoring Programme: deciding what to monitor including prioritising, relevant indicators, and what parameters to measure to detect changes in the indicators¹⁴.
- Implementing the monitoring programme: a pilot project, baseline monitoring, data handling, reporting and publishing and programme review.

The Practical Guidelines provide examples of each step such as an example of Baseline Monitoring of a hypothetical National Programme. This simple generic document with detailed explanations provides a common approach for National Programmes that are: either new to the PEP, or reviewing long term monitoring programmes or establishing new ones for specific activities. It accounts for people of a non-science background and can be utilised within a National Programme's available resources.

COMNAP has produced many publications which are regularly updated and can be accessed via their website. Amongst these are a Waste Management Workshop Report (2006), COMNAP Fuel Manual from April (2008) and a Best Practice for Energy Management – Guidance and Recommendations (2007).

¹⁴ Indicators measure the key elements of the environment whether they be physical, chemical, biological or socio-economic which capture information on the environment for management, monitoring and reporting. Upon selection of indicators parameters need to be set (SCAR/COMNAP 1996). The Environmental Manager uses an Impact Rating to choose which monitoring will be carried out usually the one with the highest impact considering the available resources.

Best Practice for Energy Management – Guidance and recommendations 2007 COMNAP

This report was presented to ATCM XXX, that highlights the benefits of reducing fuel use as:

- saving operating costs;
- lowering the impact of fuel spills;
- reducing pollutants from engine exhaust; and
- lowering carbon emissions.

The document provides practical advice on how to action this from a technical and operational perspective as well as acknowledging the achievement of educational measures having a saving with less cost on implementation. It advises best practice as identifying where and how energy is being used within your National Programme, implementing an education programme to appreciate the need for saving and encouraging personnel to implement and to maintain energy savings.

Other best practice guidelines involve:

- Replacing inefficient buildings or installing enhanced insulation to reduce heat loss;
- Replacement of power and lighting systems with energy efficient equipment,
- Controllers to be tightly monitoring their equipment ensuring that equipment is only powered when there is an operational need;
- Researching and installing renewable energy systems is mentioned to reduce the dependency on fossil based fuel and making use of heat recovery systems; and
- Focus of best practice is also given to where possible and reducing operational activities.

Acceptance that fossil fuels will still be used at a level is illustrated recognising that energy saving and management are one aspect of reducing environmental impacts in Antarctica.

Setting these guidelines as a framework for operations and activities in Antarctica, in the next section we look at how the National Programmes have responded to the recommendations on reducing carbon emissions.

4 Current Practices of National Programmes

In this section we present the current policies and practices with respect to carbon emissions for three National Programmes operating bases in Antarctica.

This analysis has been prepared from publicly available information. However, the quantity (and quality) of data varies across the National Programmes analysed. This is a limitation on the scope of this report.

New Zealand

New Zealand has operated Scott Base, located on Ross Island in the Ross Dependency, since 1957.

Description of New Zealand's Operations

Antarctica New Zealand (ANZ) is responsible for developing, managing and administering New Zealand's activities in Antarctica and the Southern Ocean. The key activities which ANZ undertakes include:

- supporting scientific research;
- conserving the intrinsic values of Antarctica and the Southern Ocean; and
- raising public awareness of the international significance of the continent.

ANZ is also responsible for managing Scott Base. The base provides services and accommodation for the researchers and groups that visit Antarctica. Scott Base operates year round and has 85 beds in the summer and 14 beds over the winter season.

ANZ works closely with the Italian Antarctic Programme and the US Antarctic Programme (USAP) for the sharing of logistical resources in the Ross Dependency region. As a result, New Zealand is dependent on its relationship with the USAP for much of its air and cargo transport requirements.

New Zealand's Approach to Carbon Emissions

Protection of the Antarctic environment is a goal that forms part of ANZ's strategic framework. ANZ aims to achieve this goal by operating Scott Base as a leading environmentally sustainable small research base by:

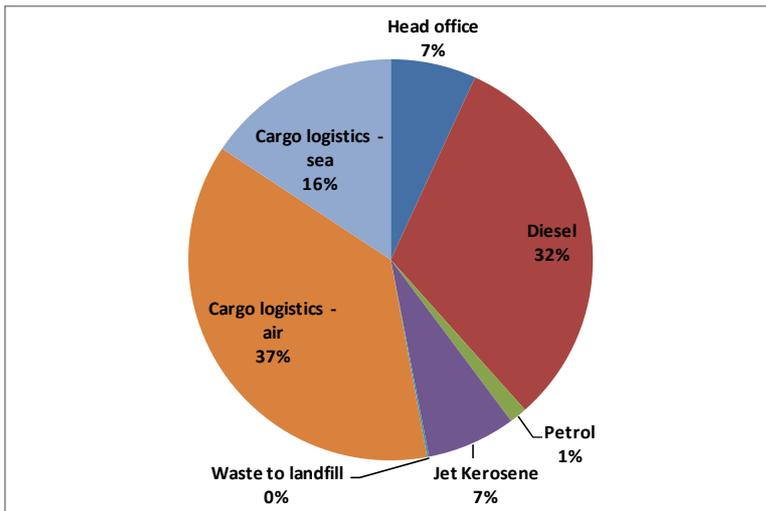
- Using more renewable energy;
- Reducing the amount of energy and materials used; and
- Reducing and recycling waste.

Since 2009, ANZ has participated in the Certified Emissions Management and Reduction Scheme (CEMARS). CEMARS independently certifies organisations' measurements of Green House Gas emissions and their plans to reduce emissions. The scheme has been developed for large organisations where offsetting emissions is not a viable option or they wish to take a measured approach and further gauge the costs and benefits of moving to the goal of being carbon neutral.

Other organisations that participate in the CEMARS programme include the University of Canterbury, Meridian Energy Limited, Contact Energy Limited and Westpac New Zealand Ltd.

In 2009, ANZ estimated its annual carbon emissions to be approximately 3,500 t. Figure 3 below presents an overview of the source of carbon emissions by ANZ activities in 2009.

Figure 3: Source of New Zealand Antarctic Programme 2009 Emissions



Source: Antarctica New Zealand Emissions Management and Reduction Plan

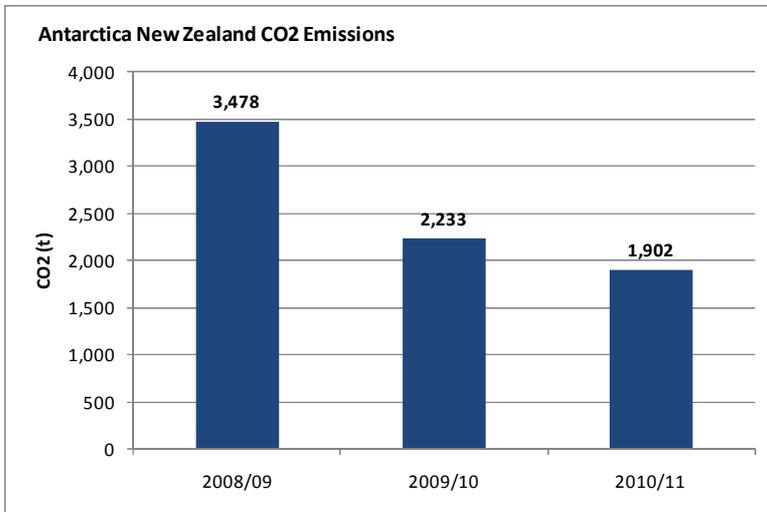
The following observations are noted:

- Over 50% of ANZ's 2009 emissions relate to sea and air logistics for Scott Base. Air cargo logistics (37% of total emissions) is the largest contributor to ANZ's total emissions.
- Emissions from diesel fired electricity generation at Scott Base accounts for 32% of ANZ's total emissions.
- Helicopters operating from Scott Base use Jet Kerosene and vehicles use petrol. The emissions from operating helicopters and vehicles from Scott Base account for approximately 8% of total ANZ emissions.
- ANZ's administrative operations in Christchurch contribute to 7% of its total emissions.

An Emissions Management and Reduction Plan (EMRP) was developed with the goal of reducing carbon emissions by 20%. Meeting the EMRP annual targets form part of the annual Key Performance Measures that ANZ uses to benchmark its performance.

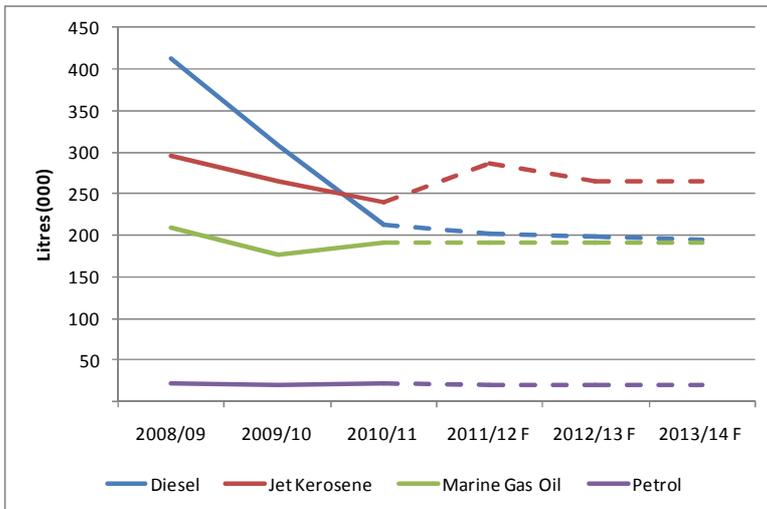
Figure 4 presents ANZ's annual carbon emissions and Figure 5 presents the change in key sources of ANZ carbon emissions since 2009.

Figure 4: ANZ Carbon Emissions



Source: Antarctica New Zealand Emissions Management and Reduction Plan

Figure 5: Changes in Sources of Carbon Emissions



Source: Antarctica New Zealand Emissions Management and Reduction Plan

The key targets and reductions in emissions are set out in Table 1

Table 1: Key Targets and Achievements

Target	Achievement
Scott Base building performance improvements	In 2009 a building management system was installed at Scott Base to measure energy flows and consumption. Control equipment is being installed over the next 12 months to improve management of the electricity load at Scott Base. In addition a programme has been undertaken at Scott Base to increase awareness of energy wastage among staff and visitors.
Optimise the use of wind energy	Three Enercon wind turbines with an installed capacity of 0.99MW were commissioned in February 2010. The turbines currently generate around 3.2GWh per year. Electricity generated from the turbines is distributed to Scott Base and McMurdo Base (a US base located within 3km for Scott Base). The turbines are expected to reduce the amount of diesel used for power generation and cut carbon emissions by approximately 1,200 tonnes per year.
Scott Base vehicle fleet reduction and management	A vehicle was removed from the Scott Base fleet in 2009. This has resulted in a reduction in diesel of 1,147 litres per year.
Investigate more renewable energy supply options for Scott Base, field camps, and field huts	No information was noted on this target.
Reduce air cargo to Scott Base	Air cargo volume has decreased since 2009. In 2009 261,000 lb of cargo was transported to Scott Base by air. By 2011 this figure was 186,000 lb. However, cargo volume will vary by the amount of activity undertaken each season.
Use of a more energy efficient helicopter at Scott Base.	The helicopter was upgraded in 2010 and improvements have been made to scheduling of helicopter movements.

The New Zealand Antarctic Programme faces the following constraints on further reductions in carbon emissions:

- ANZ is dependent on the USAP for the provision of cargo space on US aircraft. Other than reducing its volume of cargo, ANZ has little other scope to influence the

rate of emissions generated from the air-cargo flights (i.e. efficiency of scheduling, optimisation of cargo loads and fuel mix etc). Air transport is the greatest source of carbon emissions for ANZ.

- There is a trade off between the level of activity at Scott Base and carbon emissions. For example, the volume of cargo transported to Scott Base is primarily influenced by the number and nature of activities and science projects undertaken in a year.

Nevertheless, ANZ has set a longer term goal of being carbon neutral. However, in order to become carbon neutral it is likely that ANZ will incur the cost of acquiring carbon credits to offset residual carbon emissions.

The New Zealand Government has fixed the price of New Zealand Units (carbon credits issued under New Zealand's Emission Trading Scheme) at \$25 / CO₂t until December 2012. After December 2012, the price for NZU's is expected to be linked to the international market price for carbon.

Assuming that:

- The current price of NZU's is representative of the price after December 2012; and
- 2011 carbon emissions are indicative of the future level of ANZ's net carbon emissions.

The New Zealand Antarctic Programme could face a cost of up to approximately \$50,000 per year to become carbon neutral. This is a significant additional cost in terms of an annual operating budget of \$12 million.

Norway

Norway operates the Troll station, situated on Dronning Maud Land approximately 4,300 km from Cape Town. The station was built in 1989/90 as a summer station and was rebuilt into a permanent station in 2005.

Description of Norway's Operations

The Norwegian Polar Institute is in charge of the Norwegian operations in the Arctic and the Antarctic. Most of the Institute's activity is undertaken in the Arctic, due to its close proximity. However, since 2005 all-year research has been done in the Antarctic as well.

The key activities undertaken in Antarctica by the Norwegian programme are:

- Research on climate change; and
- Operating the TROLLSAT, a satellite download station.

The Norwegian Antarctic Research Expeditions (NARE) operates all Norwegian activities in Antarctica. Troll Station and Tor Station (refuge) has a wintering crew of 6 to 8 people, it can accommodate up to 30 people in the summer and it is the smallest station in Dronning Maud Land (DML).

Norway works closely with Belgium, Sweden, Finland, Germany, India, Japan, the Netherlands, Russia, South Africa and the United Kingdom as part of two logistic projects DROMLAN and DROMSHIP that provide logistics and transportation of personnel and cargo.

Norway's Approach to Carbon Emissions

The recent upgrades to Troll Station have resulted in several measures being taken to reduce the impact the station has on the environment. These include better land use, energy management, waste management, fuel handling and improved guidelines/procedures.

Regular environmental monitoring of base operations was introduced in 2009 and as a result of this several measures to reduce emissions have been taken.

Nordic Waste Management Guidelines require that all waste, with the exception of grey water and some human waste generated in field camps, is removed from Antarctica for proper disposal.

A new food waste management system was installed in 2009, grinding up food waste reducing it by 97%, reducing the volume shipped back to Cape Town.

The station relies on two 260 kW generators installed in 2005 to produce power, heat and melting water. To reduce carbon emissions excess heat from the generators is used to melt water and the heating water from the generator is distributed around the base for heating.

Research has been undertaken on installing wind turbines, which could decrease the use of fuel by up to 15% according to the research reports¹⁵. However, this project has yet to be completed as the current generators, installed in 2005, would need to be replaced.

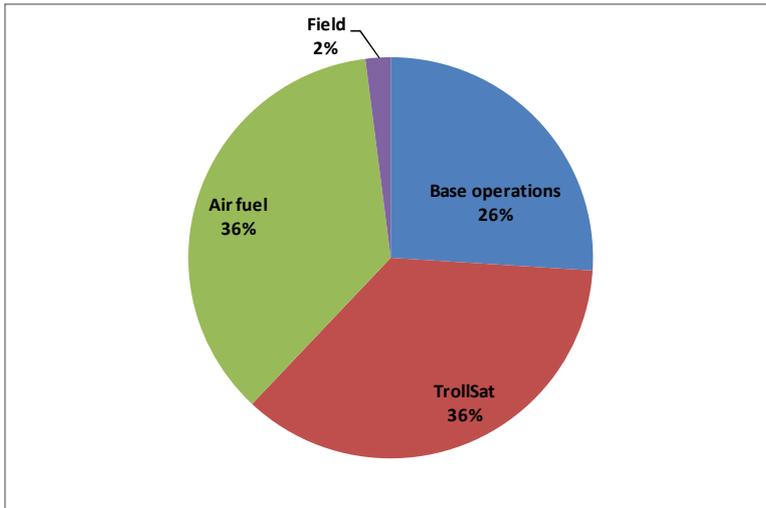
All lighting has been replaced by LED and other energy saving options.

The most effective other measure has been to educate the base staff to change their behaviour in reducing emissions. This measure has already reduced emissions in winter operations by 40%.

Figure 6 below presents the composition of the total annual carbon emissions (960 tonnes CO₂).

¹⁵ www.npolar.no

Figure 6: Source of Norwegian Carbon Emissions



The following observations are noted:

- Over 36% of emissions are from air operations
- The operation of TROLLSAT accounts for 36%
- Operating the station is 26% of the emissions.
- Emissions from the science and research facilities is only 4%

The two biggest sources of emissions are from air operations and running the TROLLSAT system.

Table 2 presents achievements made by the Norwegian programme to reduce their carbon emissions and fuel consumption.

Table 2: Key Targets and Achievements

Target	Achievement
Troll Station building performance improvements	The station was turned into an all-year station in 2005, using new technology making the new buildings more environmental friendly. More improvements are planned for the future.
Looking into use of wind energy	Preliminary measurements have been conducted.
Troll Station vehicle renewal	The snow machine park will be upgraded over the next few years and more cost-effective machines that require less fuel (approx. half the amount) will replace the existing machines.

Monitoring and control systems	A new monitoring system was put in place in 2009 which allows assessments and modifications to be done continuously.
Air cargo and cooperation of flight logistics	The opening of the Troll Air Field in 2005 and initiating the DROMLAN project to coordinate and promote better air services for the national operators in DML, reducing the cost of fuel and logistics.
Cooperating on shipping logistics	Initiated the DROMSHIP, contracting vessels on behalf of the national Antarctic operators in Norway, Germany, Belgium, Sweden and Finland, to bring in supplies to the respective countries' stations in DML

The NARE has identified the following opportunities for further reductions in carbon emissions:

- Evaluate the monitoring reports and make modifications on the operation.
- Working towards using renewable resources
- Further reduction in fuel consumption
- Increasing efficiency because of their size

Given the relatively smaller size of the station compared to other bases it is not unreasonable to expect a higher rate of emissions. The NARE would need more funding to be able to reduce emissions and modify their operation even more.

Chile

Chile did not make a claim to the Antarctic continent until 1940 and their first base, Aurton Prat, was established in 1947. Chile's claim overlaps with the claims of Argentina and Britain.

Description of Chile's Operations

INACH is the Chilean Antarctic Institute which operates from Punta Arenas. However, Chilean bases are either operated by INACH, the Chilean Army, Navy or Air Force. Chile has a mix of 15 permanent and seasonal bases, and emergency shelters which are all located along the border of their territorial claim.

We describe the permanent bases operated by Chile below.

- The Professore Escudero Base is controlled by INACH and is the main science research facility in Antarctica and located on King George Island.
- Frei Montalva base is a logistical centre for eight other countries that have scientific bases on King George Island. Frei Montalva operates an airport on King George Island and is part of the village of Villa Las Estrellas which includes a town

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hall, hotel, day-care centre, school, scientific equipment, hospital, post office and bank.

- O'Higgins Station is a permanent station located on Puerto Covadonga in the Antarctic Peninsula. The base has operated since 1948 and is considered to be the official capital of the territory claimed by Chile.
- Captain Arturo Prat Base is the oldest Chilean base, established by the Navy in 1947 on Greenwich Island for research purposes. Today the base is operated as a summer facility focussing on ionospheric and meteorological research. Intentions are to make it permanent again.

On the 15th January, 2012 President Pinero of Chile announced plans to renovate Arturo Prat which would increase the number of researchers from two to ten and doubling the lab area, and to significantly increase the Esudero base.

We describe the seasonal bases operated by Chile in the table below:

Base	Where	Operator	Activities
Dr Guillermo Mann Base	Livingston Island	Summer base of INACH	Weather and ecological research and archaeological research on sealers
Dr Guillermo Mann Base	Pen Palmer	Ruins	
Luis Risopatron Base	Robert Island	Chilean Navy	Geodetic, geophysical and biological research
Teniente Parodi Base	Mts in Ellsworth Land	Semi-permanent by INACH and Airforce	Glaciology, meteorology, geology and mapping since 1996
Julio Ripamondi Base	Ardley Island (next to Frei Montalva Station and Escurdo Base)	Summer station INACH	Cartography from 1997, terrestrial biology from 1988 and penguins studies from 1988

Gonzalez Videla Base	Waterboat Point, Paradise Bay	Chilean air force on Antarctica mainland	“inactive” with emergency supplies. Used in 2011 by INACH
Teniente Carvajal Base		Chilean Air Force (transferred from BAS between 1984 as a summer facility)	Chilean Navy visits regularly to ensure good order, used 2011 by INACH

No information was found on the remaining bases operated by Chile.

On the 15 January 2012, President Pinera also announced a new policy for Chile with respect to Antarctica. The policy is based around the following four pillars:

- The establishment of a small inland base to increase Chile’s presence in Antarctica.
- Promote Punta Arenas and Puerto Williams as gateways to Antarctica.
- Updating Chilean legislation concerning Antarctica (which is currently dispersed over 67 legal statutes) by creating a single Act that will consolidate it, to work with the Antarctic Treaty System.
- Developing Punta Arenas and the Magallanes region as a centre for tourism.

This demonstrates that Chile is active in maintaining its interests in Antarctica.

Chile’s Approach to Carbon Emissions

We noted the following from a review of the INACH website:

- There is evidence of environmental monitoring. However, it is not clear what type of monitoring takes place.
- INACH’s obligations to the Antarctic Treaty System and the Protocol on Environmental Protection are clearly stated.
- No evidence of environmental management planning was noted (e.g. a carbon emissions plan).
- A lot of references are made to international collaboration projects providing logistical and scientific cooperation. Some of these include joint projects undertaken with:
 - Czech Republic
 - Alfred Wegener Institute (Germany)

- Climate Change Institute (CCI, USA)
- Deutsches Luft-und Raumfahrtzentrum (DLR, Germany)
- KORDI (Korea)
- British Antarctic Survey (BAS, UK)
- Academy of Sciences (Malaysia)

The Latin American Antarctic Program Administrators (RAPAL) is a group for the coordination of Latin American scientific, logistical and environmental operations in the Antarctic. Their mandate is to ‘invigorate’ South American activity in the Antarctic, ‘encourage, promote & coordinate’ scientists and technicians in the region, exploiting the regions capabilities in science and the exchange of information between countries of the Antarctic region. RAPAL has made many environmental recommendations since 1997. However, we have not found any evidence to identify whether these recommendations have been adopted.

Antarctica as a hostile environment paradoxically “has a fragile future with more global responsibility than an opportunity for the national domain.”¹⁶

Summary

The table below presents a summary of the key points for the sample of National Programmes:

	Chile	Norway	New Zealand
National Programme	INACH	Norwegian Polar Institute	Antarctic New Zealand
No. of Bases	15 (although this figure includes a number of refuges)	1 and 1 refuge	1
No. of Beds Summer / Winter	Not reported	20 / 8	85 / 14
Evidence of Environmental Monitoring	Yes	Yes	Yes
Evidence of collaboration with other programmes	Yes. Part of RAPAL	Yes. Air and sea cargo collaboration with 10 other programmes	Yes. Joint logistics pool with US and Italy

¹⁶ Salazar

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Evidence of a emissions management programme	No	No programme. However, there is monitoring and assessment of emissions.	Yes. ANZ is involved in the CEMARS programme.
CO2 emissions	No data	920 tonnes	1,902 tonnes

5 Values

In this section we address the question of how National Programmes balance the conflict between a desire to undertake activities in Antarctica and the consequential impact to the environment.

Balancing Conflicting Antarctic Values

Competing Interests in Antarctica

People place different values on Antarctica and have differing views on how these values should be prioritised.

The following values are recognised in the PEP as “fundamental considerations” in the planning and conduct of all activities in Antarctica:

- The value of Antarctica as an area to conduct scientific research; and
- Protection of the environment and protection of the intrinsic value of Antarctica, including wilderness and aesthetic value in particular

However, the PEP states that the value of Antarctica as an area to conduct scientific research, including research essential to understanding the global environment, should have priority.

There are other values that people place on Antarctica; these include safety, education, historical, resource, symbolic, economic and other values. These values represent the competing interests on the frozen continent.

Environmental Impact of Activities undertaken in Antarctica

By undertaking research and other activities in Antarctica, we have a direct impact on the Antarctic environment.

There is a balance between the extent of the activities that we undertake in Antarctica and the direct environmental impact. The greater level of activities that we undertake, the greater the environmental impact on the continent.

However, even if we were not to undertake any activities at all in the Antarctic, humanity has an indirect impact on the Antarctic environment (i.e. carbon emissions from other countries, the ozone hole).

Therefore, the question becomes:

- What level of environmental impact is acceptable?; and
- For an accepted level of environmental impact, how are the competing interests in Antarctica to be balanced?

Under the PEP, the value of Antarctica for scientific research has a priority. But there is a need to accommodate other values. Antarctic National Programmes balance these values by:

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- Factoring the environmental impact into all the activities that they undertake; and
- Minimising the environmental impact of these activities.

By accounting for and minimising the environmental cost of all activities undertaken, National Programmes are able to accommodate other activities which are linked to different values.

We provide examples of the methods National Programmes use to balance the competing interests below:

- All activities under taken in Antarctica have to produce an Environmental Impact Assessment (EIA) which documents the expected impacted that each activity will have on the environment.
- National operations regard safety as a key value in all activities that they undertake.
- Introducing new technologies like “green power” promotes environmental value, but may have an impact on the other values like wilderness and aesthetics.¹⁷
- Operating procedures at the bases and stations have been modified to reduce “messy” areas, enhancing the aesthetic value.¹⁸
- When expanding operations and stations, design is carefully considered and planned to cause as little impact as possible, giving the surrounding wilderness priority.

We provide our recommendations on the ways that National Programmes can to reduce the environmental impact of their activities in the next section.

¹⁷ Green power as in putting up windmills and huge solar panels.

¹⁸ Troll Station changed their handling of discarded fuel drums.

6 Recommendations for National Programmes

In this section we set out our views on how National Programmes should respond to Recommendation 5 of the ATME report on the implications of Climate Change for Antarctic Management and Governance.

National Programme Response

National Programmes should consider the following approaches to managing carbon emissions and fuel consumption as part of the activities they undertake in Antarctica.

Reporting emissions and fuel consumption

Public reporting of carbon emissions and energy consumption from each National Programme's activities in Antarctica. Reporting emissions and fuel consumption will better inform all stakeholders of the environmental impact of activities undertaken in Antarctica and may provide an incentive for National Programmes to achieve reductions in fuel consumption and emissions. For this to occur a common approach to measuring energy consumption and carbon emissions would need to be agreed by the National Programmes.

Working collaboratively to develop common approaches to common challenges

Identification of best practices for emission reduction and technologies should be shared among National Programmes. This would give National Programmes that are not as advanced in their environmental practices the opportunity to 'catch up' to those National Programmes that are.

Sharing experience outside the continent

Some National Programmes (e.g. New Zealand, Australia, Belgium) have extensive experience in reducing carbon emissions and generating of energy from renewable sources in Antarctica. However this experience is not often distributed outside the National Programmes (Tin T. et al, 2009). The remoteness of Antarctic stations makes them similar to other isolated rural areas. Information and experience from the National Programmes could be used to reduce emissions and fuel consumption in other parts of the world.

Increase co-ordination and co-operation of transport and logistics

Emissions from transport to and from Antarctica are the largest contributor to total Antarctic carbon emissions. There are already examples of some National Programmes working together to reduce the cost and impact of transportation to and from Antarctica (e.g. Italy/New Zealand/United States). However, co-ordination of logistical operations needs to be taken further. National Programmes should consider regional pooling of logistics, especially with regard to sea and air transport. The overriding objective should be the most efficient use of resources while minimising environmental cost.

Minimum building standards

Developing a minimum set of building standards for facilities that are constructed in Antarctica and establishing a timeframe for existing structures to become compliant. Belgium's Princess Elisabeth station provides an example of the standards that can be

achieved. The station opened in 2009 and can accommodate up to 48 people in the summer season. The building design, installation of solar panels and use of nine wind turbines means that the station operates entirely on renewable energy sources with diesel generators only used as a back-up.¹⁹

Educating staff

A simple and effective way to reduce emissions and fuel consumption is to educate staff working at Antarctic bases on the best practices in terms of conserving energy. For example new staff members at the Australian stations are required to undergo training programmes how their behaviour impacts energy consumption while at working at Antarctic stations and the cost of the energy consumed²⁰.

Changes in approach to the undertaking of science

Scientific research has a priority in Antarctica. However, science projects need to be held accountable not just for the dollar cost of research but also the environmental cost of their activities in Antarctica. We recommend:

- Revisiting the selection process for science projects that get undertaken on Antarctica. Questions with regard to the “quality” of some the science that is undertaken in Antarctica were raised on occasions throughout the PCAS course. Projects need to demonstrate and be held accountable for a “return” on the costs incurred (both environmental and financial) to undertake the project; and
- Promoting the use of less intrusive research techniques (such as remote sensing) which would reduce the need for travel to Antarctica.

There are a number of reasons why the Programmes may not have implemented these recommendations to date:

- The economic cost of implementing the recommendations
- The flow on impact of these recommendations within their own nation (i.e. there might demands for similar measures to be implemented outside of Antarctica).
- The Programme may consider that it can achieve these outcomes without collaborating with other National Programmes.

Broader Issues

The scope of this paper is limited to the response of National Programmes to the impact of climate change in Antarctica. However, it should not just be the responsibility of National Programmes to deal with the implications of climate change for Antarctica.

The parties to the ATS could be working to develop a broader regulatory framework for carbon emissions under the ATS. This could involve:

¹⁹ Tin T. et al, 2009

²⁰ *ibid*

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- Capping of Carbon Emissions: agreeing a declining threshold for total annual carbon emissions for the continent; and/or
- A Carbon Trading Regime for the Antarctic: introducing an emissions trading scheme for carbon emitted on the continent.

Antarctica is unique in that it is the only continent managed collectively under the ATS. If a regulatory regime could be agreed between parties to the ATS, this could be a reference point from which a broader agreement for management of carbon emissions for the rest of the world could be developed.

7 Conclusion

In this section we summarise our answers to the questions posed in Section 1.

To what extent should National Programmes respond to what appears to be a symbolic gesture?

Should National Programmes respond?

Carbon emissions are important to National Programmes for the following reasons:

- Antarctica has a high rate of carbon emissions per capita compared to other countries.
- Climate change is likely to have implications for the maintenance and operation of existing and future infrastructure used by the National Programmes
- The effects of climate change on Antarctica will have an impact on the rest of the world (especially rising sea levels).
- Antarctic science has a leading role in climate change research.
- There is a “symbolic gesture” value as a result of reducing carbon emissions in one of the most challenging operating environments.

These reasons should be strong incentives for National Programmes to respond to the ATME’s recommendation and more broadly on the issue of climate change.

How should National Programmes respond?

We have taken a broad approach to these questions; considering not only the issue of quantifying and publishing energy savings but also recommending the following practical steps that National Programmes could take to reducing carbon emissions.

Our recommendations are summarised below:

- Public reporting emissions and fuel consumption for each National Programme
- Working collaboratively to develop common approaches to common challenges
- Sharing experience outside the continent
- Increase co-ordination and co-operation of transport and logistics
- Establishing minimum building standards
- Setting standards for the educating staff and visitors
- Changes in approach to undertaking science

How do National Programmes balance environmental values with other key Antarctic values (scientific value for example) and the need to operate safely and efficiently in a hostile environment?

Competing Interests in Antarctica

People place different values on Antarctica and have differing views on how these values should be prioritised. However, the PEP states that the value of Antarctica as an area to conduct scientific research, including research essential to understanding the global environment, should have priority.

Balancing the Environmental Impact of Activities undertaken in Antarctica

By undertaking research and other activities in Antarctica, we have a direct impact on the Antarctic environment. There is a conflict between undertaking these activities and the extent of the environmental impact.

In order to balance the conflict between environmental and other values National Programmes need to:

- Factor in the environmental impact of their activities; and
- Aim to minimise this impact.

8 Bibliography

Antarctica New Zealand Statement of Intent 2011 - 2014 (2011).

Antarctica New Zealand Emissions Management Reduction Plan. (2011). Independently reviewed by CEMARS and the carboNZero programme.

Antarctica New Zealand Greenhouse Gas Emissions Inventory Report. (2011). Independently reviewed by CEMARS and the carboNZero programme. Independently reviewed by CEMARS and the carboNZero programme.

CIA World Factbook. Data retrieved December 2011, from www.cia.gov.

ATME FR1 (2010) *Co-Chairs' Report from Antarctic Treaty Meeting of Experts on Implications of Climate Change for Antarctic Management and Governance*. Antarctic Treaty Meeting of Experts, 6 to 9 April 2010, Svolvær, Norway.

Energy Information Administration (EIA) (2011). *Total Carbon Dioxide Emissions from the Consumption of Energy 2005 – 2009*. International Energy Statistics. <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=90&pid=44&aid=8>

Pachauri, R.K. and Reisinger, A. (2007). *Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC, Geneva, Switzerland.

Tin T, et al. (2009). *Energy efficiency and renewable energy under extreme conditions: Case studies from Antarctica*. *Renewable Energy*, doi:10.1016/j.renene.2009.10.020

Turner, J., Bindschadler, R., Convey, P., di Prisco, G., Fahrbach, E., Gutt, J., Hodgson, D., Mayewski, P. and Summerhayes, C. (2009). *Antarctic climate change and the environment*. SCAR, Cambridge UK.

Council of Managers of National Antarctic Programs, COMNAP (2005). *Practical Guidelines for Developing and Designing Environmental Monitoring Programmes in Antarctica* retrieved 14th January 2012 <http://www.comnap.aq>

Council of Managers of National Antarctic Programs, COMNAP (2007). *Best Practice for Energy Management – Guidance and Recommendations*. retrieved 14th January 2012 <http://www.comnap.aq>

Council of Managers of National Antarctic Programs COMNAP (2010). *Council of Managers of National Antarctic Programs (COMNAP) Report to ATCM XXXIII* retrieved 14th January 2012, www.comnap.aq

Antarctic Treaty, retrieved 14th January 2012, www.ats.aq

The Protocol on Environmental Protection, retrieved 15th January 2012. www.ats.aq

Norwegian Polar Institute, retrieved 15th January 2012, www.npolar.no

Salazar (2011) *Picturing Antarctica; Emerging Agendas for Cultural Research in Antarctica*. Retrieved 13 January 2012 www.uws.edu.au