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# Preparing for Emergency Response in the Remote Southern Ocean

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**Abstract**

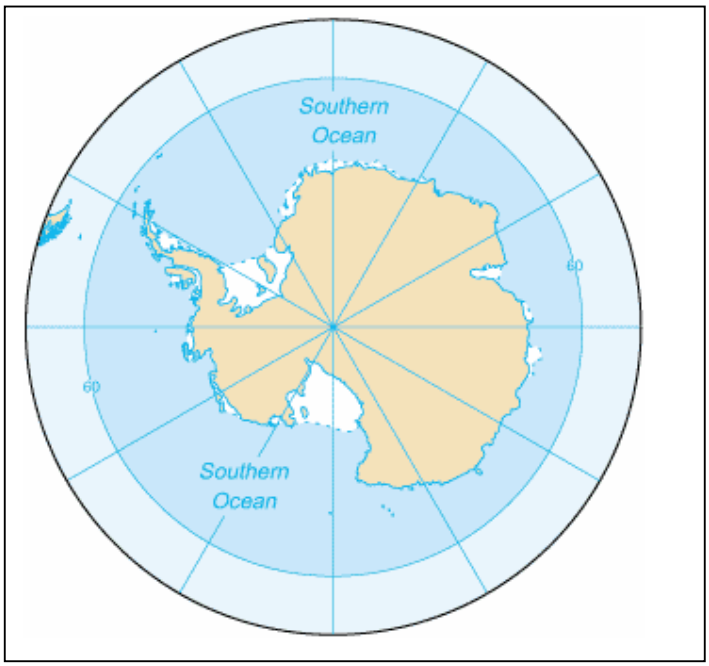
*This paper explores the challenges associated with Emergency Response operations in the Southern Ocean. Emergency response includes search and rescue (SAR), pollution response and emergency towing service operations. The paper explores current arrangements for these operations, the challenges and opportunities and possibly identify areas for future cooperation between countries with an interest in the Southern Ocean. To understand the challenges for emergency response services in this region the paper briefly mentions the nature of operations in the Southern Ocean including those operating to, from and in Antarctica. These include: commercial fishing, whaling and counter whaling operations, scientific surveys, tourism and adventure craft as well as Antarctic logistic operations by air and sea. Antarctic operations are subject to a number of Conventions, Protocols and operational guidelines established by international bodies as well as national governments. These help shape the nature of Southern Ocean operations.*

**Acknowledgement**
Recognition needs to be make of Colin Barr and David McBrien as the authors of this paper

**Southern Ocean – a definition**

Whilst the term Southern Ocean has been traditional among mariners for many years, it was not until 2000 that the International Hydrographic Organization defined the fourth largest ocean.[1] It is regarded as the body of water encircling the continent of Antarctica extending south from Latitude 60 degrees South. It is oceanographically defined as the ocean connected with the Antarctic Circumpolar Current, which circulates around Antarctica. It includes Amundsen Sea, Bellingshausen Sea, part of the Drake Passage, Ross Sea, a small part of the Scotia Sea, and Weddell Sea.

It should be noted that this definition is not accepted by all. In Australia the Southern Ocean is defined as described above but also includes the entire body of water between Antarctica and the south coasts of Australia and New Zealand.




For the purposes of this paper, the IHO definition is suitable as we seek to draw out the complications of emergency response in remote and difficult conditions.

[1] http://en.wikipedia.org/wiki/Southern_Ocean

**Southern Ocean Climate and Geography**

The Polar front or Antarctic Convergence is the best natural definition of the northern extent of the Southern Ocean. It is a distinct region at the middle of the Antarctic Circumpolar Current that separates the very cold polar surface waters to the south from the warmer waters to the north. The front and the current extend entirely around Antarctica reaching south of 60 degrees south near New Zealand and near 48 degrees south in the far South Atlantic coinciding with the path of the maximum westerly winds.[2] The Antarctic Circumpolar Current moves perpetually eastward and is the largest ocean current.

Sea temperatures vary from about –2 to 10 degrees C. Cyclonic storms travel eastward around the continent and frequently are intense due to the temperature contrast between ice and open ocean. The area from about Latitude 40 South to the Antarctic circle has the strongest average winds anywhere on earth. In winter the ocean freezes out to 65 degrees in the Pacific sector and 55 degrees in the Atlantic, lowering temperatures well below $0^{o}$ C.

The Southern Ocean is deep at 4,000 to 5,000 metres over most of its extent with limited areas of shallow water. The Antarctic continental shelf is generally narrow and unusually deep. The ice pack grows from an average minimum of 2.6 million square kilometres in March to about 18.8 million square kilometres in September, more than a sevenfold increase.

**Natural Hazards**

Natural hazards include: huge icebergs; smaller icebergs and iceberg fragments; sea ice about 0.5 to 1 metre thick with large variations; deep continental shelf floored by glacial deposits varying widely over short distances; high winds and large waves for much of the year; and ship icing; especially May-October. Most of the region is remote from emergency response facilities.

**Conventions, Protocols and operational guidelines**

There are a number of International Conventions and associated coordinating bodies as well as an industry association that seek to guide and control behaviours in and around Antarctica. They include:

- The Antarctic Treaty System (see Annex A for more details), its Secretariat and Antarctic Treaty Consultative Meetings, which to date have adopted over 300 measures.
- The Council of Managers of National Antarctic Programs (COMNAP) which brings together the agencies tasked by their government to implement and manage their national activities in Antarctica. Most activities focus upon scientific research but they also contribute to the governance and environmental protection of the Antarctic region. COMNAP works closely with:
    - The Antarctic Treaty Secretariat;
    - The Antarctic Treaty's Committee for Environmental Protection (CEP);
    - The Scientific Committee on Antarctic Research (SCAR); and
    - The Hydrographic Committee on Antarctica (HCA).

[2] Ibid.

- International Association of Antarctic Tour Operators (IAATO) IAATO was founded in 1991 to promote and practice safe and environmentally responsible private-sector travel to Antarctica. IAATO provides guidance for those organising and conducting tourism and non-governmental activities in the Antarctic.

**Who might need emergency response in the Southern Ocean?**

The national Antarctic programs of many nations have been active in Antarctic and sub-Antarctic regions for many years. These programs have conducted, and continue to conduct, research and other activities that are the key to protecting this region due to its global importance. Over the last three decades a growing number of non-governmental expeditions have visited the Antarctic and a wide range of tourist and adventure activities have been conducted as well. Such activities have allowed many people who would not otherwise have had the opportunity to experience the wonders and understand the importance of this unique part of the world.[3]

The Southern Ocean is used for fishing, whaling and counter whaling operations, scientific research, merchant trade on great circle routes, tourism to Antarctica and logistic support operations to Antarctica, round the world yacht races and other yachting trips and adventure trips. The Southern Ocean is overflown by a number of airlines employing great circle routing. These operations represent the potential customers for emergency response.

Fisheries land about 120,000 metric tons a year, of which about 85% is krill and 14% Patagonian tooth-fish. Until recently illegal, unreported and unregulated fishing of Patagonian tooth-fish was five or six times the regulated catch.

**Preventative Measures and Operational Guidelines**

Through the Antarctic Treaty System and its associated bodies and IAATO, significant progress has been made in putting into place guidance and preventative measures to mitigate the risks of an emergency occurring. There is an appropriate emphasis upon prevention as the challenges for response agencies are so great.

Preventative measures include the production of guidelines for ships operating in ice-covered waters. The ATCM has requested the International Maritime Organization (IMO) to revise MSC/Circ.1056 to include reference to Antarctica as well as the Arctic ice-covered waters. These guidelines have been developed to mitigate the additional risks imposed on shipping due to the harsh environmental and climate conditions existing in ice covered waters.

The IMO also has guidance for passenger ships operating in remote areas under development but it may be better for vessels operating in ice-covered waters to be treated differently because of the more challenging environment.

IAATO already has guidelines for tour operators and these are in the process of being upgraded to an accreditation system which will be trialled in the 2005-2006 season.

[3] Adapted from 'going south' on AAD web site: www.aad.gov.au/

ATCM XXVIII (June 2005) decided to request the IMO to examine mechanisms for restricting the use of Heavy Fuel Oil (defining HFO in accordance with MARPOL Regulation 13 H definition of Heavy Grade Oil as all fuels of higher number than Intermediate Fuel Oil 180 (IFO-180)) in Antarctic waters. This is because of the relatively high risk of fuel release in the Antarctic Treaty Area due to navigation hazards such as icebergs, sea-ice, and uncharted waters; and the high potential for environmental impact associated with a spill.

**Australian Guidelines for Ship Safety and Marine Pollution in the Antarctic**

In Australia, the Australian Maritime Safety Authority (AMSA) warns mariners by Marine Notice of the dangers and extreme risks of operating in Antarctic and sub-Antarctic waters. Mariners are warned about:

- poorly surveyed areas with uncharted dangers;
- the need for Sea Area A4 radio equipment;
- rapid changes to meteorological conditions;
- limited weather forecasts;
- strong winds, reduced visibility;
- icebergs and pack ice; and
- remoteness and sparse or non-existent SAR and other emergency response facilities.

AMSA strongly recommends that no vessel proceed into the Antarctic Treaty Area unless the master and navigator have training in high latitude navigation and ice operations. Alternatively, an ice pilot with relevant experience should be engaged. Adequate hydrographic and meteorological information is required for the voyage and watchkeeping procedures should be appropriate to the conditions.

Ship owners should ensure that:

- the vessel is properly strengthened for ice operations, preferably has a double hull below the waterline for the full length of the vessel;
- no bunker fuel is adjacent to the vessel's outer hull;
- the vessel has IMO Special Purpose Ships (SPS) classification and adequate water tight compartments;
- all the ship's lifeboats and liferafts are fully enclosed, suitable for cold climate use, surveyed and operational;
- there are sufficient thermal protective survival suits for all on board;
- there are adequate arrangements to handle medical emergencies that may arise in the course of the voyage;
- reserves of food, fresh water, fuel and spares for critical equipment are carried;
- marine pollution mitigation arrangements are also in place including a Shipboard Pollution Emergency Plan; and
- vessels are also encouraged to report to the Australian Ship Reporting system (AUSREP) during their voyage through the Australian search and rescue region.

Measures such as these will reduce the chances of an emergency response operation but authorities are still challenged to respond if an emergency does occur.

**Tourist Operations**

Beech 200 King Air operated by Victory Adventure Expeditions landing at President Frei Station.

During the 2004-05 season, it is estimated that that the total number of people entering the Antarctic Treaty area was over 43,000. This number includes personnel involved in national programs, crew of vessels and aircraft and tourists. The International Association of Antarctic Tour Operators (IAATO) reported that at least 30,232 tourists visited the Antarctica area including seaborne (with landings), seaborne (with no landings), air (with land-based activities) and air (overflights only). The vast majority (about 95%) of all tourist activity is in the Antarctic Peninsula area.

The Antarctic Treaty Consultative Meeting mechanism sets the procedures for all tourism activities to the Antarctic area. IAATO is recognised as an international organisation under Article III(2) of the Antarctic Treaty. A list of members of IAATO can be found at: www.iaato.org.

A breakdown of figures for 2004-05 show 22,297 seaborne tourists landed in the Antarctic on 29 commercially organized expeditions vessels; 5,027 seaborne passengers visited the area but did not step foot on Antarctica; 878 tourists flew to Antarctica and skied, climbed, camped or simply participated in day or overnight trips; and 2,030 tourists flew to Antarctica with no landing. Looking more closely at the 5,027 seaborne passengers that did not land, most of these were passengers in large cruise ships. The activity pattern and number of visiting yachts is less clear and IAATO cannot provide exact numbers. In the 2003/04 season, Australia estimates that 23 yachts (some with expedition parties on board) visited Antarctica from Australia. Not all of these activities were formal tourist operations under IAATO guidelines.

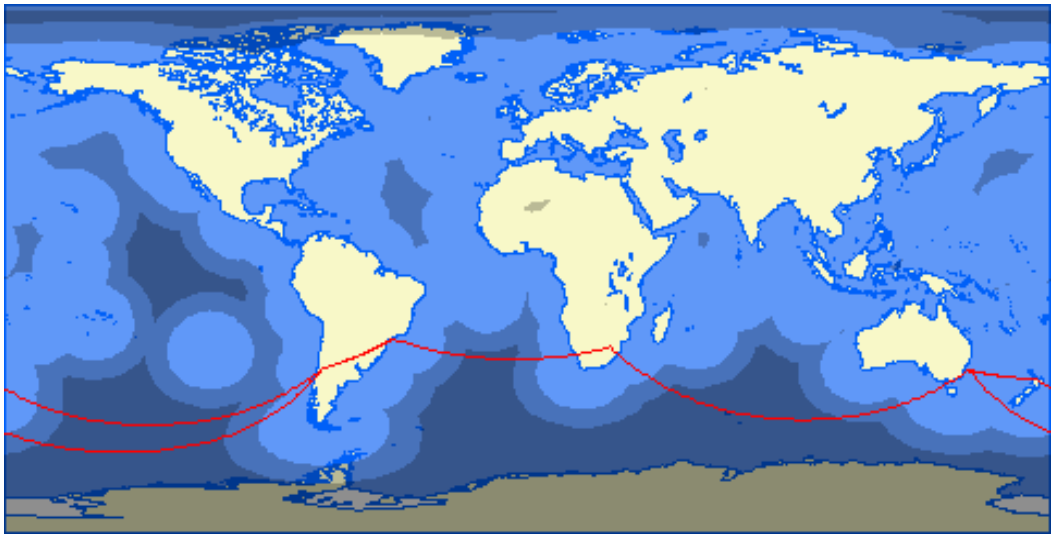
IAATO predicts that Antarctic Tourism will continue to grow both in seaborne and, to a lesser degree, land-based activities. The IAATO prediction for the 2005-06 season is 34,713 which represents an annual growth of 14.8%.

Antarctic Logistics and Expeditions (which also purchased Adventure Network International in 2003) is a major provider of tourist and adventure holidays to Antarctica offering a combination of flying, passenger vessel or sailing ship transfers to the Antarctic Peninsula (camping or vessel based accommodation) and fly/ski holidays to the geographic South Pole. Refer to: http://www.antarctic-logistics.com/index.html. Other major providers are Victory Cruises and Adventure Expeditions (http://www.victory-cruises.com/); and Scan Tours (http://www.scantours.com/).

**Aviation Operations**

The International Civil Aviation Organisation (ICAO) has no Standards or Recommended Procedures that apply specifically to the Southern Ocean or Antarctica.

Aircraft operations are common in the Southern Ocean region. Large commercial trans-continental flights take advantage of the shorter great circle routes and favourable meteorological conditions when available to transit the oceanic spaces between Africa, Australasia and South America. The aircraft operate down to about 65°S. Given the ranges from suitable alternative airfields and the distances to be covered, the commercial trans-continental routes operating via the Southern Ocean routes are serviced by large four-engine aircraft (ie Boeing 747-400 and Airbus A340).



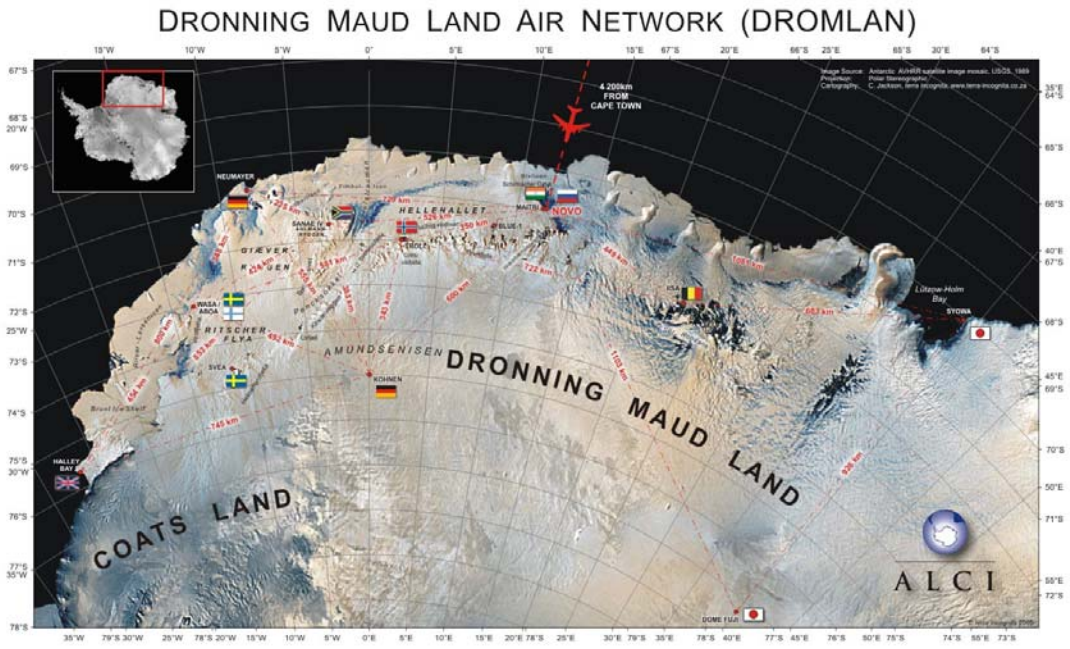
The great circle routes regularly flown by large commercial aircraft in the Southern Ocean region are shown in red. The circles represent the standard 120 minutes (light blue) and 180 minutes (blue) distances that generally apply to operations by appropriately certified twin-engine aircraft. Within the dark blue, these operations must be conducted by appropriately certified four-engine aircraft.[4]

Looking specifically at Antarctica, a range of fixed-wing aircraft and helicopters fly to the Antarctic or are carried on vessels. These aircraft may be as part of national programs (people transfer, logistics support, search and rescue, aerial survey and so forth) or used to transport tourists or adventurers. The majority of land-based Antarctic air activity occurs from South America to points South via the Antarctic Peninsula. There are some notable exceptions being inter-continental flights from South Africa, Australia and New Zealand.

Eleven national programs that have stations or operations in Dronning Maud Land have formed a consortium to transport scientists and equipment from South Africa to Antarctica. The service is called the Dronning Maud Land Air Network and it is provided under contract by the Antarctic Logistics Centre International (ALCI). See http://www.aci.info/home.html. ALCI operate Ilyushin 76TD (with the occasional C130) aircraft from Cape Town to Novo

[4] Map generated by Great Circle Mapper- copyright © Karl L. Swartz.

Air Base, which is close to the Russian Novolazarevskaya Station. Once the aircraft has landed there, passengers and cargo for other locations are transferred either by smaller aircraft operated by ALCI or the respective national program. It is understood that due to the Novo runway often experiencing surface melting during the season that an alternative runway is being prepared near the Norwegian Troll Station which will become the major hub. Some tourists sponsored by national programs have been known to travel on ALCI services.




The Droning Land Air Network provides an air bridge for
11 national programs in the Antarctic

Over the last two seasons, Australia has transited two CASA C-212 aircraft from Hobart to the Australian Antarctic Base at Casey for national program activities. Also, a blue ice runway is in the final stages of prepared for larger intercontinental flights with the runway being 70 km from Casey. The Australian Antarctic Division have an Airbus A 319 on charter and will condict test flights between Hobart and Casey before commencing on a regular basis later in the 2007/08 season. Also Croydon Travel operates a number of tourist flights from Sydney and/or Melbourne each year which transit to Antarctica and overfly the Antarctic before returning to Australia.

Regular flights from Christchurch, New Zealand are carried out by the US and NZ military aircraft to the US McMurdo Station. The US military operates regular C-17 Globemaster flights in support of its national program and positioning flights for LC-130 Hercules (ski-equipped) aircraft which are used for transfers within Antarctica. There are very occasional C-5 Galaxy flights. The New Zealand military operate occasional C-130 Hercules flights.

COMNAP publishes the Antarctic Flight Information Manual (AFIM). This publication includes details of all established landing sites for fixed and rotary wing aircraft in Antarctica including information on navigation aids, meteorological services, and

communications frequencies. The AFIM indicates that the Chilean Air Force and Civil Aeronautic Authority (DGAC) have at Lt Marsh Aerodrome located on the Antarctic Peninsula one Twin Otter DHC-6 and Eurocopters BO-105 helicopters for search and rescue year round. They also have access to distress beacon alerts via the ground station in Puntas Arenas in Southern Chile. The Argentina Air Force maintains a Search and Rescue (SAR) Rescue Sub-Centre (RSC) at Marambio Base located on the Antarctic Peninsula. The RSC has access to Twin Otter (year round) and helicopters (in summer). A number of national programs also indicate that their helicopters carried on ship may be made available for SAR purposes but these would be limited to a very local area.

Aircraft (with potential crew and passenger numbers for comparative purposes although some of these aircraft mainly carry freight) supporting scientific stations in Antarctica include Antonov 2 Mielec (10), Basler BT-67 (19 - 24), Dornier 228 (21), Twin Otter (22), CASA 212 (28), LC and C-130 Hercules (60), Ilyushin IL76 (80+),C-17 Globemaster (150), and C-5 Galaxy (80 plus 250 tonnes of freight). Tourist aircraft types (with potential crew and passenger numbers for comparative purposes) operating into the area include Beech 200 King Air (17), Twin Otter (22), De Havilland Canada Dash 7 (50), Boeing 737-200 (60 – overflight only), Ilyushin IL76 (80+) and Boeing 747-400 (540 - overflight only).

*US Air National Guard LC-130 unloading fuel and supplies at Amundsen-Scott Base at the geographic South Pole.*

**SAR regions in the Southern Ocean**

The chart at Annex F shows the delimitations of the maritime search and rescue regions (SRRs) in the Southern Ocean. The maritime SRRs extend to the Antarctic coast whilst the equivalent aviation SRRs extend to the South Pole. Argentina, Australia, Chile, New Zealand and South Africa have responsibility for the maritime and aviation SAR regions in the Southern Ocean. Land SAR responsibility in Antarctica has not been defined but has traditionally been the job of the national expeditions deployed to bases located in Antarctica. Expeditions are expected to be self sufficient with respect to emergency response. It is also traditional that national facilities help each other in emergencies with the best placed assets providing emergency response.

Whilst Argentina and Chile have undertaken combined Antarctic Naval Patrols since 1998/1999 in the peninsula region of the Antarctic Treaty area, the other nations with SRRs extending to the Antarctic continent have rarely deployed SAR or counter pollution assets to this region. Certainly in Australia's case there are few emergency response facilities capable of operating in the harsh environment. During the annual combined Argentina and Chile Naval Patrols a vessel is kept on station with SAR capacity and equipment to control and combat pollution. Indeed, during the 2001/2002 patrol support and counter pollution measures were provided when the Danish vessel *Anne Boye* ran aground in Catete Ardley. As a precautionary measure an anti-oil boom was deployed. Fortunately, there was no hull damage.

The increased number of tourists traveling in ships not designed for the Antarctic ice, even in summer, raises the possibility of accidents with dire consequences for the tourists as well as the environment. In the past few years there have been several cases of ships in trouble requiring assistance from either Chilean or Argentine ice-hardened ships and ice-breakers designed for the environment: in June 2002 a German transport, which was carrying Russian scientists, got stuck in the ice and had to be rescued by helicopters from South Africa, assisted by an Argentine Navy ice-breaker. A few months later the cruise ship Clipper Adventurer had to be rescued by Chileans after grounding.[5]

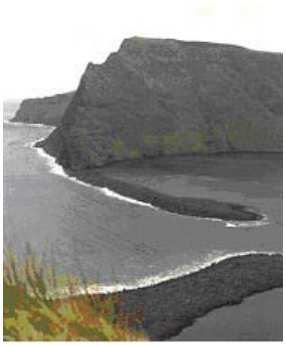
**The Australian SAR Experience**

The following are brief examples of Australian SAR incidents in the Southern Ocean in recent times.

*1995- BOC Challenge Race*

Isabelle Autissier – yacht dismasted, 850 NM Southwest of Hobart. – RAAF P3 used to locate yacht. A Sea Rescue Kit including liferafts was dropped. Other RAAF P3 aircraft provided top cover, until rescue completed by a helicopter from HMAS Adelaide. HMAS Adelaide had sailed from Stirling Naval base Western Australia.

*1995 - Japanese Fishing Vessel*



A Japanese fishing vessel ran aground on the steep western shore of St Paul Island (pictured) in the southern Indian Ocean (1900 NM South West of Perth).

The 22 crew got safely ashore. However, the island was uninhabited and they required food until a rescue ship could arrive. An RAAF C130 proceeded to Mauritius from Perth (3200 NM) and then flew a number of supply drop missions to St Paul (1500 NM SE of Mauritius). A French vessel from Reunion later rescued the fishermen.

*1996-1997 - Vendee Globe Race*

In December 1997, Rafael Dinelli's yacht capsized and was sinking. A RAAF P3 located the yacht and further aircraft provided top cover until rescue arrived. A radio was dropped for communications purposes. Rafael was rescued by another competitor, Pete Goss, who had to turn back during the storm to provide assistance.

Thierry Dubios and Tony Bullimore both capsized and inverted their yachts in an area 1300 NM South South West of Perth in January 1997. A RAAF P3 located Dubois and dropped a Sea Rescue Kit

[5] http://en.wikipedia.org/wiki/Antarctic_South_American_Geopolitics_recent_developments

including a liferaft. Dubois abandoned his yacht and swam to the liferaft. He was subsequently rescued by a helicopter from HMAS Adelaide. A RAAF P3 located Bullimore's upturned yacht the *Exide Challenger*. He was rescued by a zodiac from HMAS Adelaide. HMAS Adelaide had put to sea to respond to these incidents from Stirling Naval Base in Western Australia. Support was provided by HMAS Westralia including fuel for the return journey. In both rescues the RAAF provided top cover with aircraft overhead the yachts during daylight hours.

A Zodiac rescue from the hull of the Exide Challenger.

*1998- Aurora Australis*

Supply ship for Australian Antarctic Division reported being 1300 NM South of Hobart. The ship had 79 people on board and was disabled by fire. The nearest ship was five days away. After 60 hours of being disabled, sufficient repairs were completed for the ship to move off under its own power.

*1999 - Around Alone Race*

Isabelle Autissier, - yacht 'PRB' again in trouble South of Hobart. However, she was able to make it to Hobart.

Subsequently the yacht capsized and sank between New Zealand and Chile. Isabelle was recued by another competitor, Giovanni Soldini. 2001 - Yacht "Spirit of Sydney"


A yacht with 10 people on board was on a commercial voyage to Antarctica.

Notification was received that the yacht had lost steering and was trapped in pack ice and in gale force winds 1500 NM South of Hobart. At this time the vessel did not require immediate assistance. The MV L'Astrolabe enroute to Dumont D'urville was made aware of the situation. Subsequently, the yacht activated it 406 MHz EPIRB because it had drifted between two icebergs and those on board were concerned for their safety.

With the possibility of having to drop survival equipment to the yacht, the AAD provided severe climate supplies which were flown from Hobart to Richmond (near Sydney). These were held at this location for a RAAF C130 drop should it be required. The yacht was able to make repairs and break free of the ice.

*2004 - Yacht 'Beam 7'*


In February 2004, initial notification was from a 406 MHz EPIRB distress alert. Through the Japan MRCC the yacht was identified and confirmed to be on a voyage in the Southern Ocean with one person on board. As there were no military assets available, a merchant vessel CSK Radiance diverted with a transit of 25.5 hours to the distress position. The position was 1800 NM South West of Perth.


A civil Bombardier Global Express jet aircraft was tasked from Essendon (near Melbourne) and re-fuelled at Perth before proceeding to locate and identify the yacht. Once contacted, the skipper advised he had been badly injured and required rescue. He was subsequently taken onboard the CSK Radiance, which continued its voyage to Capetown.

**Pollution response – an Australian perspective**

Australia has a comprehensive national marine pollution response arrangement entitled the National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances. It relies on mutual cooperation between Australian State and Federal Governments, oil and exploration industry and emergency service organisations to ensure that Australia is well placed to respond to marine pollution incidents around the coastline.

Responding to a pollution incident on land or from a vessel in the Southern Ocean or in the vicinity of Antarctica is exacerbated by the tyranny of distance. Countries that have marine spill containment, recovery, and storage equipment suitable for a major or prolonged response in this region are hampered by the limited transport resources available to provide a quick and adequate response. Additionally, difficulties arise with the logistics support

required to feed, cloth and accommodate the large number of response personnel required for a major pollution incident.

Although there is a limited amount of oil spill equipment held by the various countries that have bases in Antarctica, appropriate equipment is carried on most logistics ships engaged in resupply activities in the region. However, this equipment is not suitable for countering large spills and other vessels equipment not be quickly available or compatible.

Low ambient and sea temperatures in the region also complicate the containment and recovery of spilt oil and limit the response options available to the affected agencies. Low temperatures affect the oil by increasing its viscosity while the recovery of oil that has been trapped under ice or become frozen within ice must be undertaken using specialist equipment.

For a response to a major ship sourced oil spill in the region to be effective, it would take the cooperation of the countries that operate bases within Antarctica and the support of both Government and merchant vessels engaged in resupply, exploration and other activities in the area, to work together to effect a first strike response before additional resources are able to be transported to the spill site.

Protocols currently exist for cooperation between countries under the OPRC 1990 framework.

In the past, joint oil spill response exercises have been conducted by a number of countries including Germany and the United Kingdom in the Southern Ocean/Antarctic region. However, these have been limited to small quantity scenarios and no large scale exercises have taken place.

Therefore, realistically the focus should be on the prevention of an oil pollution incident. The implementation of sound engineering designs in both vessels and land based storage facilities, and effective operational procedures that attempt to prevent the loss of oil and other noxious and hazardous substances, coupled with the use of lighter or alternative fuel sources will ensure that the requirement for pollution response is minimised.

**The Nella Dan Pollution Incident**

*Nella Dan* was a 2,186 DWT Australian-chartered Antarctic supply vessel that was used to resupply the Australian bases at Macquarie Island and Antarctica.
On 3 December 1987 it dragged its anchor in strong winds and ran aground in Buckle Bay, Macquarie Island.

*Nella Dan* grounding, 3 December 1987

It wasn't until 13 December that a suitable towage vessel with salvage and pollution response equipment was able to reach the site. Divers assessed

the damage to the hull which at first seemed repairable. Work started to remove the remaining fuel oil from the double bottom tanks. On 20 December the vessel was manoeuvered in preparation for a next day refloat. Following the refloat a further dive inspection revealed that the hull damage was worse than first thought . A decision was made to scuttle the vessel.

During the 22 day period following the vessels grounding, approximalty 120 tonnes of Antartic grade diesel oil and 5 tonnes of lubrication oil escaped into Buckle bay. Fortunately, due to wind and tide conditions, the majority of the oil was washed out to sea with only minimal shoreline damage.

**Australian Emergency Towage Vessels (ETV) and Powers of Intervention (POI)**

As part of its National Maritime Emergency Response Arrangements (NMERA), Australia is in the process of introducing a minimal level of emergency towage capability in strategic regions around its coastline. This capability will be contracted to AMSA and available for tasking during a maritime incident that has the potential to significantly impact on Australia's marine environment.

The low levels of shipping traffic in the Southern Ocean and the Antarctic region, and therefore the risk of an incident occurring which has the potential to impact on Australia's maritime environment, means that the cost of providing an emergency towage capacity in the region would be prohibitive and so no contracted emergency towage capability will be available in that area under the NMERA.

However, under the Protection of the Sea (Powers of Intervention) Act 1981, as amended, AMSA will have the ability to direct an appropriate vessel of opportunity, which is within its Exclusive Economic Zone (EEZ), in the area of a maritime incident, to provide assistance when there is a 'risk of pollution' from a ship. However on the high seas, that is the remaining seas outside the Australian EEZ, Australian POI can only be used to direct a vessel to provide assistance when there is a 'grave and imminent' risk of pollution affecting Australia's interests.

If there were to be a maritime incident in the Southern Ocean and Antarctic region, Australian maritime authorities would be seeking cooperation from other countries in mounting a response to assist a vessel experiencing difficulties.

**Lessons from the Australian Experience**

From a review of the recent emergency response activity involving Australian assets and coordination it is clear that emergency response authorities are challenged to respond in the harsh environment of the Southern Ocean. There are long-range assets within the Australian Defence Force (ADF) and civil community that can enter the region but very few are suited to the low temperatures and ice conditions.

**So who owns the best response assets for the Antarctic region?**

The point to make here is that it may not be the countries with search and rescue regions adjoining the Antarctic region that have the best Southern

Ocean emergency response assets. These may be owned and operated by other countries with bases in Antarctica. These countries include: USA, UK, Japan, Russia, France, China, Germany and other COMNAP nations. (Refer to Annex G). These nations can be expected to have access to and operate polar capable vessels and aircraft meeting the requirements and guidelines for operating safely in the challenging conditions. It is most likely these vessels and aircraft which will need to be called upon to respond to a rescue operation in ice covered waters or on the Antarctic continent.

Argentina and Chile regularly operate vessels and aircraft into the Antarctic Peninsula region and Argentina maintains a military base at Esperanza. However, Australia, New Zealand and South Africa have limited emergency response assets capable of operating in the Southern Ocean.

**Potential for Future Cooperation**

Argentine icebreaker Almirante Irizar rescues the Magdalena Oldendorff July 2002

<u>Improving National Relationships</u>

There seems to be scope to improve relationships and arrangements on two fronts: national and multilateral. Firstly, there is scope for the nations responsible for search and rescue regions in the Southern Ocean to improve relationships with their own national Antarctic programs. In Australia this involves AMSA and the Australian Antarctic Division (AAD).

AMSA has been developing its relationship with the AAD (which is the administering authority for the Australian national program) over recent years. A draft Memorandum of Understanding (MOU) has been developed to ensure that individual responsibilities of both Government agencies are well understood by each other. It is proposed to conduct a SAR and environmental protection table-top exercise in mid-2006 to further develop an understanding of the inter-relationships between the two agencies during emergency response operations.

<u>Improving Multilateral Relationships</u>

The second possibility is to improve mulilateral arrangements to promote more cooperation and understanding between the nations responsible for search and rescue regions in the Southern Ocean and COMNAP countries.

There seems to be potential to improve communications, vessel and aircraft tracking, and coordinated response arrangements.

There may be a need for aviation and maritime SAR authorities and other emergency response agencies responsible for the Southern Ocean region to gain a better understanding of their counterparts through specific meetings or forums. Some emergency response authorities, for example Argentina and Chile, are already an integral part of their national Antarctic programs. Other countries, such as Australia, New Zealand and South Africa, currently have less involvement in their national Antarctic programs.

AMSA has had limited contact with the COMNAP Secretariat over recent years. Liaison was established when the Antarctic web-based ship reporting system was being set up by COMNAP in 2001 and access to the system was provided to RCC Australia. Unfortunately, few vessels have taken up the option of reporting their positions to the system and it has not been as useful as hoped. This system has the potential to provide valuable information about vessels in the Antarctic region to SAR authorities. However, some nations are reluctant to make their vessel movements known. Similarly, tourist vessels do not always wish to report their positions and sometimes communicate with each other only to ensure they do not cross paths to preserve the feeling of isolation for their passengers.

Reinvigorate Antarctic Vessel Tracking

A reinvigorated Antarctic vessel reporting system with full participation would be an excellent asset for emergency response. This is one potential area of cooperation between COMNAP and the search and rescue nations. As all the countries with search and rescue regions in the Southern Ocean are also COMNAP members, there seems to be ample scope to progress some coordinated action through this forum.

The database that goes with the ship reporting system could also be improved with the addition of more vessel details including comments on capabilities and communications equipment and contact number details.

LRIT in the Southern Ocean

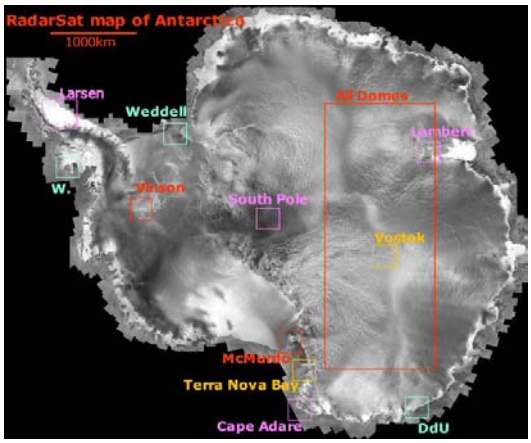
Another approach with regard vessel tracking is to make Long Range Identification and Tracking (LRIT), currently under consideration in IMO, mandatory for vessels operating in the Antarctic Treaty Area.

Sharing Knowledge about Adventure Craft

After the Southern Ocean rescues of 1996/1997 steps were taken within the yachting community to improve liaison between Southern Ocean nations and the organisers of around the world events using the Southern Ocean. The organisers of the Volvo and Vendee Globe races, for example, now actively liaise with RCC Australia and have introduced waypoints to keep competing yachts closer to potential rescue assets.

The same active liaison needs to be promoted for adventure craft using the Southern Ocean or proceeding to Antarctica. In these cases the recently published IMO MSC Circular 1174 on oceanic voyages by non-regulated craft is relevant. A maritime administration that becomes aware that a non-regulated craft is setting out on such a voyage without meeting the basic safety requirements should ensure that all rescue coordination centres are aware if a craft will be passing through their area.

Sharing of knowledge about services/systems




Another area of potential cooperation is the effective sharing of knowledge about services useful to emergency response planning. This could be facilitated by the COMNAP forum or directly between nations. The types of systems and services might include:

- Weather models such as the Fifth-generation Mesoscale Model used in polar regions (referred to as the Polar MM5). The model is also used by forecasters as part of the National Science Foundation sponsored Antarctic Mesoscale Prediction System to meet the operational and logistic needs of the United States Antarctic Program.[6]
- RADARSAT, SAR on ERS and ASAR on ENVISAT can be used to provide ice imagery and reports for safe marine vessel navigation and ship icebreaking activities. These services can provide data independent of daytime and cloud cover.
- Individual nations may provide ice prediction services.

SAR Procedures Development with COMNAP

COMNAP sponsors the Standing Committee on Antarctic Logistics and Operations (SCALOP). This committee provides COMNAP with technical advice on Antarctic logistics and operations. Every second year, in conjunction with the combined meetings of SCAR and COMNAP a SCALOP Symposium is held.

The 12th Symposium on Antarctic Logistics and Operations, "Going Forward Together, Efficiently and Safely", will be held in Hobart, Tasmania, Australia on Thursday 13 July 2006. It is interesting to note that the Symposium has two key themes: new technology and safety. The safety topics are planned to include:

- Field-based collaboration
- Search And Rescue (systems, processes or technologies)
- Emergency Response
- Contingency Planning
- Management of Antarctic Air Operations

It certainly seems that emergency response and safety are topical in the COMNAP forums and there seems to be potential for some coordination and input from the search and rescue and other emergency response authorities.

[6] http://box.mmm.ucar.edu/rt/mm5/amps/

**Conclusion**

The Southern Ocean and the Antarctic region are remote and challenging environments in which to operate. Ships and aircraft operating into this region must make special provisions and abide by certain protocols if they are to stay out of trouble and prevent an incident requiring an emergency response.

Argentina, Australia, Chile, New Zealand and South Africa have responsibility for the SRRs in the Southern Ocean. Apart from Argentina and Chile, who regularly operate emergency response facilities in the Antarctic Peninsula region, the experience and capability of the responsible nations is limited.

Each of the nations that are responsible for emergency response in the Southern Ocean also run a national Antarctic program. There appears to be scope for more cooperation between national emergency response authorities and national Antarctic programs. If national Antarctic programs have a better understanding of safety and emergency response issues then these have a better chance of better informing the Antarctic Treaty consultative mechanisms.

Similarly, there is scope for more cooperation between emergency response nations and COMNAP. This should be readily achievable as each emergency response nation is also a member of COMNAP. In particular, a reinvigoration of the Antarctic vessel tracking system would be a very positive step for potential emergency response. This would go a long way towards tracking the potential victims of an emergency as well as tracking the potential response assets capable of working in the environment.

Other areas for future cooperation include:

- sharing knowledge about Antarctic services and systems, especially those that would be useful in planning an emergency response; and
- cooperative action at IMO to promote more robust guidelines for operations in ice-covered waters including the compulsory use of LRIT in the Antarctic Treaty Area.

**AMSA**
**September 2007**

**Annexes**:

A. Antarctic Treaty.
B. Protocol on Environmental Protection to the Antarctic Treaty.
C. COMNAP in brief.
D. International Association of Antarctica Tour Operators (IAATO).
E. Characteristics of ice-strengthened ships and Ice Breakers.
F. Southern Ocean SAR Regions.
G. Antarctic Region (showing national program locations)

# ANTARCTIC TREATY[7]

## INTRODUCTION

The Antarctic Treaty was signed in Washington on 1 December 1959 by the twelve countries whose scientists had been active in Antarctica during the International Geophysical Year (IGY) of 1957-58. The experience of this multinational research program had shown that it was possible to establish bases on Antarctica and engage in scientific cooperation without getting into conflict about the different, sometimes overlapping, claims of sovereignty over the continent. The original signatories consisted of the seven countries with claims over parts of Antarctica - Argentina, Australia, Chile, France, New Zealand, Norway and the United Kingdom - and five other countries with Antarctic activities, namely Belgium, Japan, South Africa, the Soviet Union and the United States.
The Antarctic Treaty, which came into effect on 23 June 1961, has been joined since that time by 33 other countries and now has 45 parties in all, 28 of which are Consultative Parties.

Important provisions of the Treaty are:
"Antarctica shall be used for peaceful purposes only." (Art. I)
"Freedom of scientific investigation in Antarctica and cooperation toward that end ... shall continue" (Art. II)

As for the sovereignty issue, the status quo of 1959 with regard to claims or their recognition is maintained. "No acts or activities taking place while the present Treaty is in force shall constitute a basis for assenting, supporting or denying a claim to territorial sovereignty in Antarctica or create any rights of sovereignty in Antarctica." (Art. IV)

To guarantee the peaceful status of Antarctica, "All areas of Antarctica, including all stations, installations and equipment within those areas ... shall be open at all times to inspection ..." (Art. VII).

The Antarctic Treaty System which has grown up around the original treaty now consists of the following agreements in addition to the treaty itself:

- The Convention for the Conservation of Antarctic Seals (CCAS), signed in London on 1 June 1972
- The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), signed in Canberra on 20 May 1980
- The Protocol on Environmental Protection to the Antarctic Treaty, signed in Madrid on 4 October 1991

In addition there are some 300 measures adopted by the Antarctic Treaty Consultative Meeting (ATCM), which meets annually.

[7] Antarctic Treaty Secretariat website: http://www.ats.aq/top

# M E M B E R S H I P

**INTRODUCTION**

The original Signatories to the Treaty are the twelve countries that were active in Antarctica during the International Geophysical Year of 1957-58 and then accepted the invitation of the Government of the United States of America to participate in the diplomatic conference at which the Treaty was negotiated in Washington in 1959. These Parties have the right to participate in the meetings provided for in Article IX of the Treaty (Antarctic Treaty Consultative Meetings, ATCM). Since 1959, thirty-three other countries have acceded to the Treaty. According to Art. IX.2, they are entitled to participate in the Consultative Meetings during such times as they demonstrate their interest in Antarctica by "conducting substantial research activity there". Sixteen of the acceding countries have had their activities in Antarctica recognized according to this provision, and consequently there are now twenty-eight Consultative Parties in all. The other seventeen Non-Consultative Parties are invited to attend the Consultative Meetings but do not participate in the decision-making.

## List of Signatories

| # | State | Date | Status | Date when Acceding State became Consultative Party |
|---|---|---|---|---|
| 1 | United Kingdom | 31 May 1960 | OS/CP | |
| 2 | South Africa | 21 June 1960 | OS/CP | |
| 3 | Belgium | 26 July 1960 | OS/CP | |
| 4 | Japan | 4 August 1960 | OS/CP | |
| 5 | United States of America | 18 August 1960 | OS/CP | |
| 6 | Norway | 24 August 1960 | OS/CP | |
| 7 | France | 16 September 1960 | OS/CP | |
| 8 | New Zealand | 1 November 1960 | OS/CP | |
| 9 | Russia [1] | 2 November 1960 | OS/CP | |
| 10 | Poland | 8 June 1961 | AS/CP | 29 July 1977 |
| 11 | Argentina | 23 June 1961 | OS/CP | |
| 12 | Australia | 23 June 1961 | OS/CP | |
| 13 | Chile | 23 June 1961 | OS/CP | |
| 14 | Czech Republic [2] | 14 June 1962 | AS | |
| 15 | Slovak Republic [2] | 14 June 1962 | AS | |
| 16 | Denmark | 20 May 1965 | AS | |
| 17 | Netherlands | 30 March 1967 | AS/CP | 19 November 1990 |
| 18 | Romania | 15 September 1971 | AS | |
| | German Democratic Republic [3] | 19 November 1974 | AS/CP | 5 October 1987 |
| 19 | Brazil | 16 May 1975 | AS/CP | 12 September 1983 |
| 20 | Bulgaria | 11 September 1978 | AS/CP | 25 May 1998 |
| 21 | Germany, Federal Republic of | 5 February 1979 | AS/CP | 3 March 1981 |

| | | | | |
|---|---|---|---|---|
| 22 | Uruguay | 11 January 1980 | AS/CP | 7 October 1985 |
| 23 | Papua New Guinea [4] | 16 March 1981 | AS | |
| 24 | Italy | 18 March 1981 | AS/CP | 5 October 1987 |
| 25 | Peru | 10 April 1981 | AS/CP | 9 October 1989 |
| 26 | Spain | 31 March 1982 | AS/CP | 21 September 1988 |
| 27 | China, People's Republic of | 8 June 1983 | AS/CP | 7 October 1985 |
| 28 | India | 19 August 1983 | AS/CP | 12 September 1983 |
| 29 | Hungary | 27 January 1984 | AS | |
| 30 | Sweden | 24 April 1984 | AS/CP | 21 September 1988 |
| 31 | Finland | 15 May 1984 | AS/CP | 9 October 1989 |
| 32 | Cuba | 16 August 1984 | AS | |
| 33 | Korea, Republic of | 28 November 1986 | AS/CP | 9 October 1989 |
| 34 | Greece | 8 January 1987 | AS | |
| 35 | Korea, Democratic People's Republic of | 21 January 1987 | AS | |
| 36 | Austria | 25 August 1987 | AS | |
| 37 | Ecuador | 15 September 1987 | AS/CP | 19 November 1990 |
| 38 | Canada | 4 May 1988 | AS | |
| 39 | Colombia | 31 January 1989 | AS | |
| 40 | Switzerland | 15 November 1990 | AS | |
| 41 | Guatemala | 31 July 1991 | AS | |
| 42 | Ukraine | 28 October 1992 | AS/CP | 27 May 2004 |
| 43 | Turkey | 25 January 1996 | AS | |
| 44 | Venezuela | 24 May 1999 | AS | |
| 45 | Estonia | 17 May 2001 | AS | |

top^

## References

OS = Original Signatory
CP = Consultative party
AS = Acceding State
Dates = the dates of ratification of the Treaty by the original signatories or the dates of accession or succession by other states.

## Notes

1 Known as the Soviet Union until December 1990.
2 Succeeded to the Treaty as part of Czechoslovakia which separated into two republics on 1 January 1993.
3 Became united with Federal Republic of Germany on 3 October 1990 (now known as Germany).
4 Succeeded to the Treaty after independence from Australia.

# PROTOCOL ON ENVIRONMENTAL PROTECTION TO THE ANTARCTIC TREATY[8]

**Introduction**
In the 1980s the Consultative Parties to the Antarctic Treaty developed the Convention on the Regulation of Antarctic Mineral Resource Activities, which was concluded in 1988 in Wellington. However, before any country had ratified it, the Consultative Parties changed course and decided instead to expand their existing environmental measures into a comprehensive system for the protection of the Antarctic environment.

The outcome of this process was the Protocol on Environmental Protection to the Antarctic Treaty, signed in Madrid on October 4, 1991. The Protocol designates Antarctica as a "natural reserve, devoted to peace and science", and sets forth basic principles and detailed, mandatory rules applicable to human activities in Antarctica, including obligations to accord priority to scientific research. The Protocol prohibits all activities relating to Antarctic mineral resources, except for scientific research, and provides that this prohibition cannot be amended by less than unanimous agreement for at least fifty years following entry into force of the Protocol.

The Environment Protocol has six Annexes. Annex I, *Environmental Impact Assessment*, Annex II, *Conservation of Antarctic Fauna and Flora*, Annex III, *Waste Disposal and Waste Management*, and Annex IV, *Prevention of Marine Pollution*, were adopted together with the Protocol itself. The Protocol and the first four annexes entered into force on January 14, 1998. Annex V on *Area Protection and Management* was adopted by the 16th Antarctic Treaty Consultative Meeting in Bonn on 17 October 1991 and entered into force on 24 May 2002. An annex on liability, which had been foreseen in Article 16 of the Protocol, was adopted as Annex VI, *Liability Arising From Environmental Emergencies*, by the 28th ATCM in Stockholm on June 14, 2005 and is being ratified by the Consultative Parties.

The Protocol established the Committee for Environmental Protection (CEP) as an expert advisory body to provide advice and formulate recommendations to the Antarctic Treaty Consultative Meetings in connection with the implementation of the Protocol. The CEP meets every year at the same time as the Antarctic Treaty Consultative Meeting.

[8] http://www.ats.aq/protocol.php

# COMNAP in brief[9]

**COMNAP**, the **"Council of Managers of National Antarctic Programs"**, brings together the agencies tasked by their government to implement and manage their national activities in Antarctica, including organising expeditions. While most of these activities focus on the support of scientific research, they do also contribute to the governance and environmental protection of the Antarctic region under the auspices of the Antarctic Treaty.
The **National Antarctic Programs** have their foundation in the early expeditions sent to explore, map and study Antarctica in the 19th and 20th centuries and **COMNAP** has its roots in the long-standing, ongoing tradition of international collaboration in the conduct of Antarctic expeditions.
**COMNAP**'s primary function and activities are related to the exchange of practical, operational information with a view to improving the way all National Programs can fulfill their various missions, together or independently. That includes mutual support in the design, ongoing improvement and operation of Antarctic facilities and transport infrastructure.
**COMNAP**, in addition to supporting its members, works with the other Antarctic bodies to support effective, sustainable Antarctic expeditions and the success of the *Antarctic Treaty System*. In particular, it works closely with:

- the Antarctic Treaty Secretariat - www.ats.aq
- the Antarctic Treaty's Committee for Environmental Protection (CEP) - www.cep.aq
- the Scientific Committee on Antarctic Research (SCAR) - www.scar.org
- the Hydrographic Committee on Antarctica (HCA), a Registered Hydrographic Commission of the International Hydrographic Organisation (IHO) - www.iho.shom.fr

[9] Adapted from the COMNAP website: http://www.comnap.aq/comnap/comnap.nsf

# IAATO[10]

**IAATO is a member organization founded in 1991 to advocate, promote and practice safe and environmentally responsible private-sector travel to the Antarctic.**

Since the beginning of the modern Antarctic tourism industry in 1969, the number of tourists in Antarctica has grown from a few hundred to more than 20,000 each year. Recognizing the potential environmental impacts that such growing numbers of tourism could cause, seven private tour operators conducting excursions in Antarctica joined together in 1991 to practice and promote the highest possible standards of travel in this remote, wild and delicate region of the world.

In 2005, 69 Antarctica-bound outfitters are voluntary members of our organization, the International Association of Antarctica Tour Operators (IAATO). Together we have established extensive procedures and guidelines that ensure appropriate, safe and environmentally sound private-sector travel to the Antarctic: regulations and restrictions on numbers of people ashore; staff-to-passenger ratios; site-specific and activity guidelines; wildlife watching; pre- and post-visit activity reporting; passenger, crew and staff briefings; previous Antarctic experience for tour staff; contingency and emergency medical evacuation plans; and more.

IAATO is an industry group that has resolved to set the highest possible tourism operating standards in its effort to protect Antarctica. This effort is unique, and the challenge to maintain environmentally responsible tourism exists to this extent in no other region of the world. Our membership comprises ship operators, land-based operators, ship agents, travel agents, one government office and travel companies that charter ships and airplanes from existing operators.

Most of our members also operate expeditions to environmentally sensitive areas such as the Arctic and the Amazon, as well as educational excursions to all seven continents. The experience and awareness these tour operators have gained through their membership in IAATO has allowed the spirit of environmentally safe and responsible travel to extend to nearly every remote region of the world.

IAATO meets at least once a year, during which policies, procedures, challenges and tasks are agreed to by at least a two-thirds majority vote. The Executive, Finance, Membership, Marine, Bylaws and Site Guidelines committees actively participate throughout the year when decisions are at hand. When these decisions are made or changes occur, an extensive and effective e-mail network allows all of our members to be updated quickly. IAATO provides an unparalleled service to all of its members, and we are proud of our achievements.

Working in close cooperation with governments and scientific foundations, IAATO's capable representatives attend all relevant Antarctic Treaty Consultative Meetings and other pertinent international conferences throughout each year.

[10] Adapted from IAATO web site: http://www.iaato.org/

**Characteristics of ice-strengthened ships and Ice Breakers**[11]

**Characteristics of ice-strengthened ships**

Most of the ships that supply Antarctic bases are ice strengthened rather than full blown ice breakers

- Double hull, with a gap between them, the gap may be air or filled with water ballast. If the outer hull is punctured the inner will hopefully not be.
- Flat hull shape with a rounded rather than pointed bow. This allows the front of the ship to drive forwards, rise above the ice and then let the weight of the ship break the ice.
- Specially formulated hull polymer paints for strength and also low friction when in contact with ice.
- Special engine cooling arrangements so that the inlet for water taken on board to cool the engine doesn't get blocked with ice - likewise the water outlet.
- No stabilizers or any other kind of hull protuberance that might get ripped off by ice
- Helicopter, for scientific work, but also for spotting leads and open water in the ice to guide the ship.
- Rudder and propeller protected by the shape of the hull, so that ice moving backwards is less likely to cause damage.
- Thicker than normal steel, particularly at the bow and at the level of the water-line
- Reinforced "ice belt" that typically extends about 1m above and below the water line. This is where the hull has thicker steel and also has extra internal ribs to help the stiffening. These are usually twice as many of these ribs than in a comparable "normal" ship.
- Powerful bow and stern thrusters to help manoeuvring in tight spaces such as pack ice.

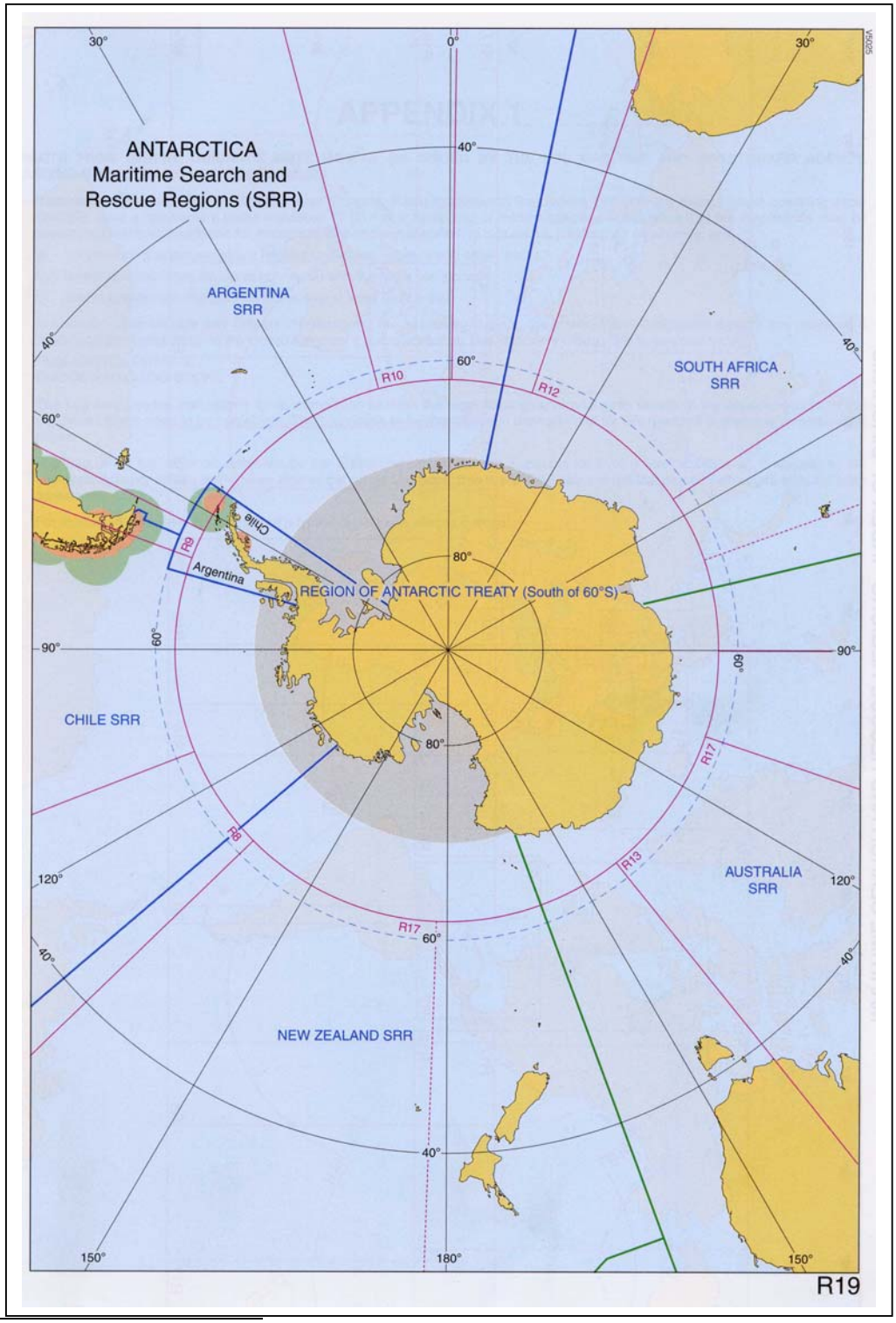
[11] http://www.coolantarctica.com/

**Characteristics of Ice Breakers**

Ice breakers have the features of ice strengthened ships and then some of their own too

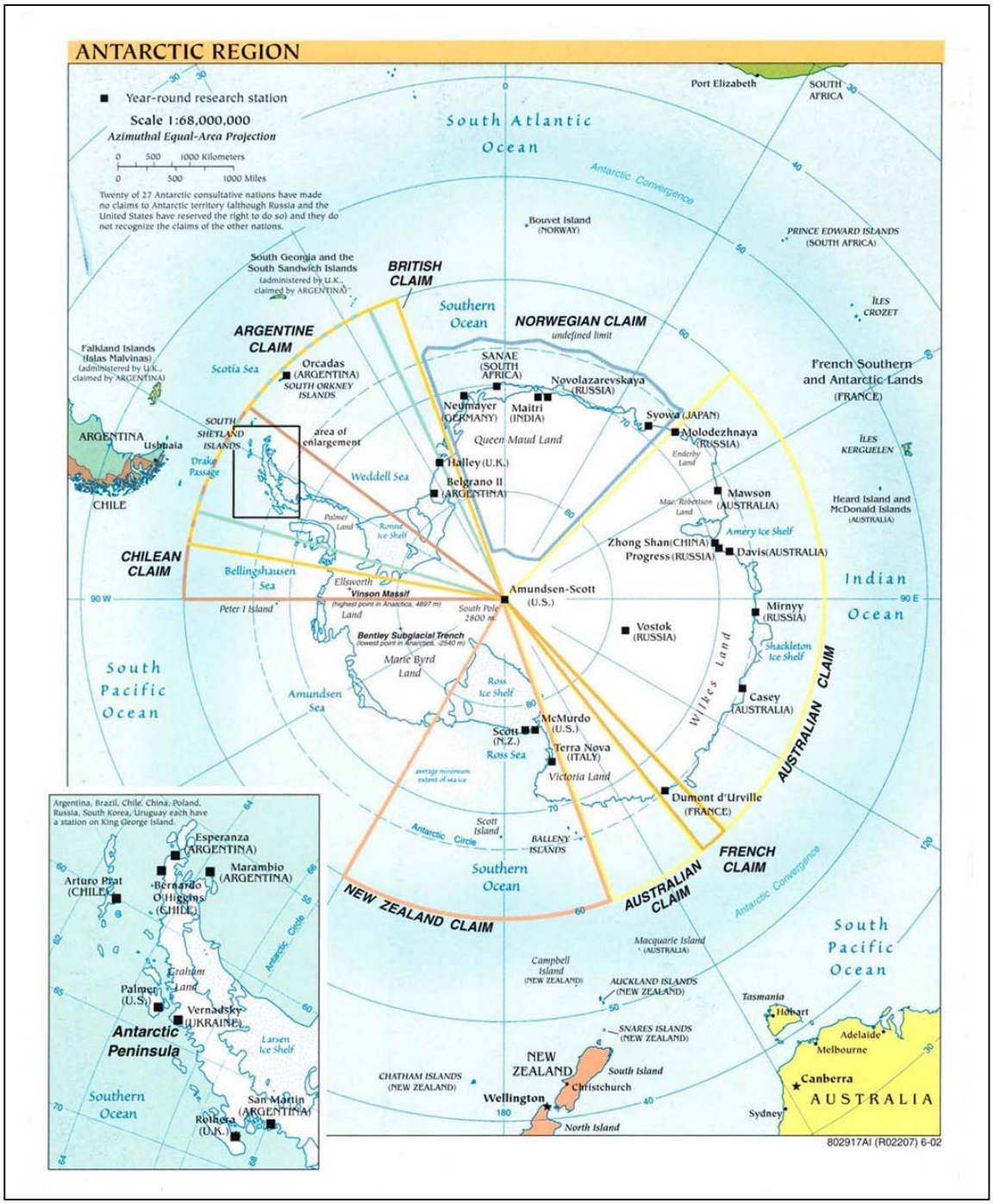
- Heavy for their size, to make them more effective at breaking through ice when they are pushed up above it by their engines.
- Very gradual upwards slope at the bow, particularly at the water line to allow the bow to ride up over ice before the weight breaks through.
- Hull made from special steels designed for optimum strength at low temperatures
- Extra thick steel at the bow, the stern and at the waterline.
- An "ice horn" to protect the rudder and propeller when in reverse, and an "ice knife" in front to protect it when in forwards motion.
- Electric propulsion to the propellers. Electric motors can apply torque when not actually turning or when only turning slowly, so hitting a large piece of ice will not stop the engine.
- Extra strong propellers with replaceable blades. There may also be a propeller inspection well to examine them in operation and the facility to change blades while at sea.
- **Very** powerful engines. The engine may be diesel possibly with extra power supplied by gas turbines for ice breaking or be nuclear powered.
- Air bubbling systems to assist ice-breaking. Air is forced under pressure from 2m or so below the water line where ice is met, helping to break it and move it out of the way.
- Heated water jets below the waterline to help when breaking through ice.
- Ability to rapidly move large amounts of water ballast within the ship to shift the weight when needing to break ice.
- Hull divided by bulkheads into a series of watertight compartments in case the hull is holed.
- Powerful searchlights for use in dark winter conditions.

## ANTARCTICA MARITIME SEARCH AND RESCUE REGIONS[12]




[12] Source: UK Hydrographic Office ALRS Vol 5

## ANTARTIC REGION (POLITICAL) MAP[13]




[13] Source: http://www.lib.utexas.edu/maps/polar.html