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ANTARCTIC SCIENCE AS A BASIS FOR GLOBAL ACTION ON CLIMATE CHANGE

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ANTARCTIC SCIENCE AS A BASIS
FOR GLOBAL ACTION ON CLIMATE CHANGE

Summary

The Antarctic and Southern Ocean Coalition (ASOC) prepares detailed information papers on climate change for the annual Antarctic Treaty Consultative Meeting (ATCM) and the Commission on the Conservation of Antarctic Marine Living Resources (CCAMLR). In 2009 it submitted two papers for these meetings, which are incorporated into this background paper for Copenhagen.

CCAMLR adopted a Resolution on Climate Change that supports urgent action to reduce the rate and extent of climate change and confirms the commitment of CCAMLR Members to actively contribute to reaching an adequate outcome at the UNFCCC's 15th Conference of the Parties in Copenhagen in December 2009. That Resolution is attached as Appendix 1.

ASOC urges that governments attending the Copenhagen negotiation utilize the profound scientific results about climate change coming from Antarctica as a basis for taking appropriate global action in Copenhagen and beyond.

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Policy Implications Arising from SCAR's Report: Antarctic Climate Change and the Environment

Policy Implications Arising from SCAR's Report:

Antarctic Climate Change and the Environment

Summary
Complementing the publication of the Executive Summary of SCAR's report "Antarctic Climate Change and the Environment," ASOC presents key policy implications that, in its view, arise from the science reviewed by the report. . ASOC urges Treaty Parties to consider the policy implications arising from the ACCE report in earnest and take action accordingly. Concrete local and regional-level action in Antarctica would contribute to mitigate the effects of Antarctic climate change:
1) **Support global reductions in carbon emissions and an equitable, effective, and science-based agreement at the United Nations Climate Change Conference in Copenhagen in December 2009.**
2) **Put in place consistently strong measures to prevent the establishment of invasive species;** and
3) **Apply a precautionary approach to the conservation of marine living resources through the use of Marine Protected Areas and reductions in non-climate stresses, such as exploitation, invasive species, and pollution.**
Scientific research in Antarctica will continue to be a major contributor to our understanding of the Earth's climate system. Antarctic research and logistics have a unique role to play in the promotion of solutions for climate change. They can serve as an example for the rest of the world in the deployment of energy efficiency and renewable energy technologies with the highest possible environmental standards, contributing to the global understanding of the physical basis and impacts of climate change, and sharing experience on mitigation techniques.

1. Introduction

The Antarctic Climate Change and the Environment (ACCE) project is an initiative of the Scientific Committee on Antarctic Research (SCAR), which aims to provide an up-to-date assessment of the climatic changes that have taken place on the continent and across the Southern Ocean, give improved estimates of how the climate may transform over the next century and examine the possible impact on the biota and other aspects of the environment.

The final report of the ACCE project follows on from the Arctic Climate Impact Assessment (ACIA), published in 2005 by the Arctic Council and the International Arctic Science Committee and the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), published in 2007. While the IPCC's Assessment Report was a tremendous initiative that provided a major advance in our understanding of natural climate variability, the role of anthropogenic factors in recent climate change and the best projections yet for how climate may evolve over the next century, its scope was global and there was limited space to consider the Antarctic. The ACCE review shares similar goals with the ACIA to provide a detailed regional review of past and possible future climate in a climatically sensitive region.

The ACCE review does not formulate any policy recommendations from the vast body of information that it contains. Like the IPCC Assessment Reports and the ACIA, the information contained in the ACCE review has significant implications for how the human society should respond to climate change, as well as management of natural resources on regional and global levels. In ASOC's view, the ACCE review not only has the potential to make an important contribution to our understanding of the role of the Antarctic in the global climate system, it is also one of the best available resources on which to base effective, equitable, and science-based management and policy decisions regionally and globally.

ASOC would like to take this opportunity to complement the publication of the ACCE Executive Summary by SCAR by highlighting some key policy implications that, in ASOC's view, arise from the science covered by the review. ASOC urges Treaty Parties to consider the policy implications arising from the ACCE review in earnest and take action accordingly. Concrete local and regional-level action in Antarctica would contribute to mitigate the effects of Antarctic climate change:

2. Policy implications arising from the ACCE review

In ASOC's view, the science reviewed in the ACCE document supports the following policy implications that should be considered in earnest by Treaty Parties:

1) Support global reductions in carbon emission

<u>According to the ACCE:</u>
Antarctica and the Southern Ocean play a critical role in driving, modifying, and regulating global climate. The Antarctic Circumpolar Current (ACC) – the largest of the world's ocean currents - flows around the Antarctic continent and connects the Pacific, Indian and Atlantic Ocean basins. The resulting global circulation redistributes heat, salt, freshwater and other climatically and ecologically important elements. It has a global impact on patterns of temperature, rainfall and ecosystem functioning. In recent decades, the ACC has shifted southward and its waters have warmed more rapidly than the global ocean as a whole. These changes in the ACC have arisen in response to changes in the atmospheric circulation. Changes in ozone in the Antarctic stratosphere and greenhouse warming have led to a shift in the Southern Hemisphere Annular Mode – a pronounced climate cycle in the high southern latitudes – to the positive phase, resulting in increased westerly winds over the Southern Ocean that have driven the observed changes in the ACC. In the next 100 years, as a result of continued greenhouse warming, computer models forecast the Southern Ocean to become warmer, fresher and windier and the ACC to continue to shift southward.

<u>*Implications:*</u>
Changes in the world's largest ocean current will have profound and complex repercussions on Earth's climate and ecosystems in patterns that we do not fully understand. Allowing carbon emissions to rise unabated commits all the planet's inhabitants and their future generations in an uncontrolled and unpredictable global experiment.

<u>According to the ACCE:</u>
There has been an overall reduction in total ice shelf area on the Antarctic Peninsula by 27,000 km^2 in the last 50 years. Some ice shelves, such as the Wordie (>1000 km^2), Larsen (>6500 km^2), Prince Gustav (2000 km^2) and the Wilkins (14000 km^2) Ice Shelves underwent rapid and sometimes catastrophic disintegrations. Recent observations have shown that the Amundsen Sea sector – holding approximately one third of the ice of the entire West Antarctic Ice Sheet - is currently the most rapidly changing region of the entire Antarctic. The attribution of ice loss on the Antarctic Peninsula to human-driven warming is now strong and, although not yet proved conclusively, there is a strong hypothesis that a similar case can be made for an even greater portion of West Antarctica. Continued increase of atmospheric greenhouse gases is expected over the next century, if they continue to rise at the current rate, will be remarkably rapid. Even if only changes no greater than those already observed were to continue through the 21st century, it is expected that the Antarctic Peninsula and the Amundsen Sea sector of West Antarctica would continue to lose land-based ice, offsetting any slow growth that may take place in East Antarctica. More disturbing is the possibility, albeit impossible to quantify at this time, of a number of climate influences that could amplify loss of Antarctic ice and accelerate future sea level rise. Until improved predictive capability is available, a reasonable upper bound of Antarctica's potential contribution to global sea level would lead to a 6m sea level rise by 2100. Even a significant fraction of such a contribution would come at great human and environmental cost.

<u>*Implications:*</u>

The Amundsen Sea embayment contains enough ice to raise sea level by ~1.5 m and a reasonable upper bound of Antarctica's potential contribution to global sea level would lead to a 6m rise by 2100. Even a *significant fraction of such a contribution would come at great human and environmental cost. While the contribution of sea level rise from Antarctic ice sheets may take place over decadal time scales, in the meantime, the more immediate effects of greenhouse warming, including changes in temperature, precipitation, extreme weather events, etc., are likely to result in significant impacts on physical and biological systems as well as human livelihoods and well-being[1].*

ASOC urges a resolution from the Treaty Parties calling for an equitable, effective, and science-based agreement to reduce carbon emissions at the United Nations Climate Change Conference in Copenhagen in December 2009.

2) Put in place consistently strong measures to prevent the establishment of invasive species

According to the ACCE:
Over the past 50 years, there has been significant warming across the Antarctic Peninsula and West Antarctica but little change across the rest of the continent. Although significant surface warming over Antarctica is projected over the 21st century, the temperature of the interior will remain well below the freezing point. As a result of their adaptations for the specific existing climatic conditions in Antarctica, terrestrial biota have a reduced ability to adapt to change. That makes them vulnerable to the impact of colonization by better competitors that may be more advantaged under warmer climatic conditions around the edges of the continent. The combination of increased human visitation across the entire Antarctic region and the lowering of dispersal and establishment barriers implicit through climate warming on the Antarctic Peninsula are expected to act synergistically and result in a greater frequency of transfers, possibly leading to successful establishment of non-indigenous species. Similarly, the potential for non-indigenous species to arrive and affect Southern Ocean biodiversity in the coming century is considerable. This is due to 1) historic Southern Ocean isolation and its domination by endemic species, 2) the lack so far of non-indigenous species, 3) the slow response time of native organisms because of their inherent, cold-adapted long generation turnover times, 4) the lack of durophagus predators (predators that eat hard food, such as molluscs), and 5) accelerating transport opportunities for non-indigenous species in a region of intense warming.

Implications:

Through the relatively limited number (in absolute terms) of access routes, vessels and journeys to Antarctica, it is among the most practicable of continents on which to apply control measures to minimize this risk in order to maintain its unique terrestrial and marine ecosystems. Possible measures include stringent procedures to ensure rodent-free status of ships and aircraft, logistical planning to minimize the risk of intra-regional and local transfer of propagules, control of visitor numbers and access to more sensitive including pristine sites, and cleaning/sterilization of high risk transport locations for aliens, such as cargo surfaces, foodstuffs and clothing (important in both inter- and intra-regional contexts)[2,3,4,5]. Measures to prevent the establishment of invasive species should be applied consistently by all Antarctic operators.

ASOC encourages the ATCPs to implement a comprehensive set of biosecurity management tools throughout the Antarctic. These practices should include precautions that reduce the risk of non-native species introductions to the Antarctic as well as plans to immediately and thoroughly remove accidental introductions should they occur.

[1] United Nations Intergovernmental Panel on Climate Change. 2007. Climate Change 2007 – Synthesis Report.
[2] Tin, T., Fleming, Z.L., Hughes, K.A., Ainley, D.G., Convey, P., Moreno, C.A., Pfeiffer, S., Scott, J. and Snape, I. 2009. Impacts of local human activities on the Antarctic environment. Antarctic Science 21(1), 3-33. Summary available as IP xx.
[3] Whinam, J., Chilcott, N. and Bergstrom, D.M. 2004. Subantarctic hitchhikers: expeditioners as vectors for the introduction of alien organisms. Biological Conservation, 121, 207–219.
[4] Frenot, Y., Chown, S.L., Whinam, J., Selkirk, P., Convey, P. and Skotnicki, M. and Bergstrom, D. 2005. Biological invasions in the Antarctic: extent, impacts and implications. Biological Reviews, 80, 45–72.
[5] DePoorter, M., Gilbert, N., Storey, B. And Rogan-Finnemore, M. 2006. Final report of the non-native species in the Antarctic workshop. Christchurch: Gateway Antarctica, 40 pp.

3) Apply a precautionary approach to the conservation of marine living resources

According to the ACCE:

Over the next 100 years, as a result of continued greenhouse warming, computer models forecast the Southern Ocean to become warmer, fresher and windier and the ACC to continue to shift southward. The Southern Ocean is projected to increase its absorption of CO_2 from the atmosphere, thereby increasing the acidity of its waters.-Computer models project with strong confidence Antarctic-wide decreases of sea ice extent and continued but accelerated retreat off the Western Antarctic Peninsula. Over the 21st century, all components of the ecosystem closely related to sea ice are expected to retract in response to the predicted 33% reduction of sea ice extent. In areas with an originally high krill population size the population is likely to stabilize at a low level. The implication is that there will be a significant limitation on the food supplies of the large whale stocks using the Southern Ocean as feeding grounds, and of other krill consumers, such as seals, penguins and fish. Mammals and birds having the highest energetic life styles will be affected most.

Implications:

The loss of sea ice and the southward migration of the ACC will alter the middle trophic-level 'forager species' and extend the migratory routes of predators. This could increase the costs of movement of migratory species that feed in the Southern Ocean and reduce the duration of their main feeding season[6]. Longer migrations, less food, fishery depletion, and ocean acidification will increase stress on the ecosystems.

In view of the high-level of uncertainty and potentially significant implications, a precautionary approach should be applied in the conservation of marine resources in face of greenhouse warming. Marine protected areas, including open and closed areas, should be used to conserve healthy ecosystems and maintain biodiversity banks. Non-climate stresses, such as exploitation, invasive species and pollution, must be reduced in order to give ecosystems more "breathing space" to adapt to the stresses arising from climate change.

3. Antarctica's continuing contribution to climate change solutions

Scientific research in Antarctica will continue to be a major contributor to our understanding of the Earth's climate system. The deployment of energy efficient and renewable energy technology is also becoming more feasible and attractive in Antarctica as a result of recent advances and the high price and negative environmental impacts of fossil fuels. In ASOC's view, Antarctic research and logistics have a unique role to play in the promotion of solutions for climate change. These include:

- Improving our understanding of the global climate and how the Earth's physical and biological systems respond to climate change. This is particularly important because in certain, but limited portions of Antarctica the impact of climate change on biological systems can be studied without the complicating factors of direct human interventions and pressures;
- Being an example for the rest of the world in the deployment of energy efficiency and renewable energy technologies with the highest possible environmental standards;
- Making research results and information on best practices available to the non-Antarctic community, feeding into the next round of IPCC Assessment Reports, thereby contributing to the global understanding of the physical basis and impacts of climate change, and sharing experience on mitigation techniques.

[6] Tynan, C.T. and Russell, J.L. 2008. Assessing the impacts of future 2°C global warming on Southern Ocean cetaceans. International Whaling Commission, Scientific Committee document SC/60/E3.

COMMISSION FOR THE CONSERVATION
OF ANTARCTIC MARINE LIVING RESOURCES

КОМИССИЯ ПО СОХРАНЕНИЮ
МОРСКИХ ЖИВЫХ РЕСУРСОВ АНТАРКТИКИ

CCAMLR

COMMISSION POUR LA CONSERVATION
DE LA FAUNE ET LA FLORE MARINES
DE L'ANTARCTIQUE

COMISIÓN PARA LA CONSERVACIÓN DE
LOS RECURSOS VIVOS MARINOS
ANTÁRTICOS

COMMISSION

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THE NEED FOR GLOBAL AND REGIONAL RESPONSES TO CLIMATE CHANGE

Submitted by ASOC

The Need for Global and Regional Responses to Climate Change

Summary

Scientific literature reviewed by SCAR's Antarctic Climate Change and the Environment report[1] and the Southern Ocean Sentinel (SOS) workshop[2] indicates that Southern Ocean marine ecosystems are already showing changes due to a warming climate. The effects are likely to be exacerbated with the further evolution of climate change. Last year the Commission agreed that "climate change is a very important issue and that it looked forward to continuing to receive reports from the Scientific Committee and its working groups" (CCAMLR XXVII, 4.62). ASOC urges CCAMLR Parties to accept their responsibility as managers of the Southern Ocean's marine living resources and address climate change on both global and regional levels. ASOC urges that CCAMLR:

(1) Adopt a Resolution on Climate Change that supports urgent action to reduce the rate and extent of climate change and confirms the commitment of CCAMLR Members to actively contribute to reaching an adequate outcome at the UNFCCC 15th Conference of the Parties (CoP15) in Copenhagen in December 2009.

(2) Continue to build climate change considerations, and impact of ocean acidification, into CCAMLR's management decisions with urgency following the Commission's endorsement last year.[3] This should include reducing non-climate stresses, establishing a series of marine protected areas of ecologically significant size to increase the resilience of the ecosystem to cope with the stresses of climate change, applying further precaution in the establishment of TACs, especially where it is known that ocean climate is changing rapidly (Area 48 and Area 88, the axes of the Southern Annular Mode/Antarctic Di-Pole), and to use flexible, adaptive approaches to management that maximize the choices for the future.

I. Impacts of Climate Change on Southern Ocean Marine Ecosystems

During the past few CCAMLR and Antarctic Treaty meetings ASOC collated and presented the latest scientific findings on the impacts of climate change on the Southern Ocean to inform delegates. This year, SCAR will be completing its comprehensive review on this subject and the full report of the Southern Ocean Sentinel Workshop will be provided to the Scientific Committee.

In this paper ASOC's intention is to present a summary of their work, while more details can be found in SCAR's Antarctic Climate Change and the Environment report and the SOS Workshop report.

Changes in the Southern Ocean over the past 50 years include:

- *Rising air temperatures; changes in atmospheric circulation, including increasing winds, changing snowfall patterns, and modified frequency and intensity of storms*. Antarctic circumpolar deep waters have warmed at a pace more rapid than the mean global ocean as a whole. The change is consistent with a southward shift of the Southern boundary of the Antarctic Circumpolar Current in response to increasing westerly winds driven by enhanced greenhouse forcing and the Antarctic ozone hole.[4]

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[1] SCAR's Antarctic Climate Change and the Environment (ACCE) Review Report. IP 5. ATCM XXXII, April 6-17, 2009. Baltimore, USA.

[2] Southern Ocean Sentinel Workshop. Hobart 20-24 April 2009. Conclusions.

[3] See CCAMLR XXVII Report, 4.61.

[4] IPCC. 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (S. Solomon, D. Qin, M. Manning, Z. C hen, M. Marquis, K.B. Avery, M. Tignor and H.L. Miller, editors.). Cambridge University Press, Cambridge, UK, and New York, NY, USA, 996 pp; Russell, J.L., K.W. Dixon, A. Gnanadesikan, R.J. Stouffer and J.R. Toggweiler. 2006. The Southern Hemisphere westerlies in a warming world: propping open the door to the deep ocean. Journal of Climate **19**:6382-6390; Thompson, D.W.J. and S. Solomon. 2002. Interpretation of recent Southern Hemisphere climate change. Science **296**:895-899.

- *Changes in ocean state, e.g., increased acidity, increased temperature and decreased salinity at different depths.*[5]

- *An antipodal change in sea ice extent, decreasing on the western side of the Antarctic Peninsula and increasing in the Ross Sea sector, as well as widespread thinning of sea ice*. With the warmer water and reduction in sea-ice in the Peninsula region, there has been an alteration of phytoplankton dynamics, a southward contraction in the distribution of the key forage fish, *Pleuragramma antarcticum,* and a decline in Antarctic krill, both of whose reproduction is associated with sea ice.[6]

Predictions of future temperature rises by the UN Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4)[7] are within the range that will potentially have substantive impacts on Southern Ocean ecosystem components.

- The observed mid-depth warming and freshening of the Southern Ocean is projected to continue. Climate models suggest that the annual average total sea-ice area will decrease by 2.6×10^6 km^2, or 30% by 2100.[8] Most of the retreat is expected to be in winter and spring, so decreasing the amplitude of the seasonal cycle of sea ice area. With continued decrease in sea-ice cover, marine ice algae will decrease with reduction in the extent of the marginal ice zone, which in turn may cause a cascade through higher trophic levels. Emperor and Adélie penguins and other ice-dependent species, fish, including Antarctic toothfish, Antarctic krill, seals and whales, depend on the sea-ice habitat to complete their life cycle. A significant decline in sea ice is likely to affect their populations, and may lead to true Antarctic species being displaced by southward shifting sub-Antarctic species.[9]

- Increased warming is expected to lead to more ice shelf disintegrations along the east and west coasts of the Antarctic Peninsula. Most critical is the reduction in the Pine Island Glacier, one of the largest ice streams on Earth, draining much of West Antarctica, and largely responsible thus far in the detected freshening of coastal West Antarctic waters. When ice shelves collapse, the changes from a unique ice-shelf-covered ecosystem to a typical sea-ice covered Antarctic continental shelf ecosystem, with high primary production during a short summer, are among the largest ecosystem changes on the planet.

- If surface ocean acidity levels become more acidic by 0.2 to 0.3 units by 2100 thinning is likely to happen on the aragonite skeletons of the pteropods that are important grazers of *Phaeocystis* at the base of the food chain in many coastal areas.[10] The Southern Ocean is at higher risk from this than

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[5] Jacobs, S.S. 2006. Observations of change in the Southern Ocean. Philosophical Transactions of the Royal Society, A, doi:10.1098/rsta.2006.1794, published online

[6] Stammerjohn, S.E., D.G. Martinson, R.C. Smith, X. Yuan and D. Rind. 2008. Trends in Antarctic annual sea ice retreat and advance and their relation to El Niño–Southern Oscillation and Southern Annular Mode variability. Journal of Geophysical Research **113**, C03S90, doi:10.1029/2007JC004269; Atkinson, A., V. Siegel, E. Pakhomov, and P. Rothery. 2004. Long-term decline in krill stock and increase in salps within the Southern Ocean. Nature **432**:100–103: Ducklow, H.W., K. Baker, D.G. Martinson, L.B. Quetin, R.M. Ross, R.C. Smith, S.E. Stammerjohn, M. Vernet and W.R. Fraser. 2007. Marine pelagic ecosystems: the West Antarctic Peninsula. Philosophical Transactions of the Royal Society B **362**:67–94 doi:10.1098/rstb.2006.1955; Martin Montes-Hugo, M., S.C. Doney, H.W. Ducklow, W. Fraser, D. Martinson, S.E. Stammerjohn, O. Schofield. 2009. Recent Changes in Phytoplankton Communities Associated with Rapid Regional Climate Change Along the Western Antarctic Peninsula. Science 323: 1470-1473

[7] IPCC. 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (S. Solomon, D. Qin, M. Manning, Z. C hen, M. Marquis, K.B. Avery, M. Tignor and H.L. Miller, editors.). Cambridge University Press, Cambridge, UK, and New York, NY, USA, 996 pp

[8] Mayewski, P. A., et al. 2009. State of the Antarctic and Southern Ocean climate system. *Reviews in Geophysics*, 47, RG1003, doi:10.1029/2007RG000231.

[9] Cheung, W.W. L., V.W.Y. Lam and D. Pauly. 2008. Modelling present and climate-shifted distribution of marine fishes and invertebrates. University of British Columbia, Fisheries Centre Research Reports 16(3). 72 pp; Ainley, D.G., J. Russell, S. Jenouvrier, E. Woehler, P. O'b. Lyver, W.R. Fraser, G.L. Kooyman. 2009. Antarctic penguin response to habitat change as earth's troposphere reaches 2°C above pre-industrial levels. Ecology, in press.

[10] Orr, J.C., Fabry, V.J. et al. 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. *Nature* **437**, 681-686 | doi:10.1038/nature04095

other oceans owing to its colder temperatures and low saturation levels of calcium carbonate. The effect of ocean acidification caused by elevated carbon dioxide levels is predicted to affect the Ross Sea first. "The ability of marine animals, most importantly pteropod molluscs, foraminifera, and some benthic invertebrates to produce calcareous skeletal structures is directly affected by seawater CO_2 chemistry."[11]

- Given the slow rates of growth and high degree of endemism in Antarctic species, continued ocean warming and expanded tourism and scientific activity may lead to the wider establishment of non-indigenous species by 2100, and consequent reduction or extinction of some local species.

II. The Need for Global and Regional Responses

There is international consensus on the urgent need to take action to address climate change, but so far insufficient action. Most nations and regions are adopting targets for acceptable increased levels of greenhouse gases. The international climate change response is led by the UN Framework Convention on Climate Change (UNFCCC). It will culminate in the 15th Conference of the Parties (CoP15) in Copenhagen in December 2009, whose mission is to provide clarity on four key issues before the existing legally binding agreement governing greenhouse gas emissions (the Kyoto Protocol) expires in 2012:

- Ambitious emission reduction targets for developed countries
- Nationally appropriate mitigation actions of developing countries
- Scaling up financial and technological support for both adaptation and mitigation
- An effective institutional framework with governance structures that address the needs of developing countries

Mitigation and adaptation are the two central approaches to addressing climate change:

- Mitigation involves human interventions to reduce the emissions of greenhouse gases. Carbon dioxide is the largest contributing gas to the anthropogenic greenhouse effect. In the 200 years since 1800, levels have risen by over 30%. Since levels of greenhouse gases are currently rising even more steeply, leading to the most dramatic change in the atmosphere's composition in at least 650,000 years, international action on mitigation is urgently required.

- Adaptation refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or effects, which moderates harm or exploits beneficial opportunities. According to the UN Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4), there is high confidence that the ability of many ecosystems to adapt naturally will be exceeded this century, and that neither adaptation nor mitigation alone can compensate for climate change impacts. Therefore, adaptation and mitigation are needed to complement each other, and together can significantly reduce the risks of climate change.[12]

CCAMLR, in its special role as the international body overseeing the management of the marine living resources of the Southern Ocean, is in a unique position to take leadership to promulgate responses to climate change on both global and regional levels.

A. Global Response: Mitigation

According to IPCC AR4, mitigation efforts over the next two to three decades will have critical impact on whether or not lower levels of greenhouse gases in the atmosphere can be achieved to instigate a lesser degree of climate change. Many impacts can be avoided, reduced or delayed by mitigation.

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[11] Fabry, V.J., Seibel, B.A., Feely, R.A., and Orr, J.C. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes. – ICES Journal of Marine Science, 65: 414–432.

[12] UNFCCC Fachsheets: The need for mitigation. The need for adaptation. Copenhagen – why is a deal so important? Available at: http://unfccc.int/press/fact_sheets/items/4991.php.

Article II, section c) of the Convention gives CCAMLR the responsibility to manage the ecosystems of the Southern Ocean, including its management in the face of environmental change. Effective mitigation of climate change will substantially reduce the scale of future management actions that CCAMLR will have to adopt in order to address the impacts of climate change. Therefore CCAMLR has the responsibility to communicate to international and national bodies that are leading efforts on climate change mitigation on the need for effective mitigation.

To this end, ASOC urges that CCAMLR Parties adopt a Resolution on climate change that:

1. Encourages continued and increased consideration within CCAMLR working groups and the Scientific Committee of climate change impacts to inform management decisions in relation to protecting and preserving Southern Ocean ecosystems.

2. Endorses the establishment of the Southern Ocean Sentinel program with clear monitoring objectives reflective of the information required to inform management actions towards protecting and preserving Southern Ocean biodiversity.

3. Supports the urgent need for an effective global response that will address the challenge of climate change.

4. Appeals to all Contracting Governments to take urgent action to reduce the rate and extent of climate change.

5. Confirms the commitment of all CCAMLR Members to actively contribute to reaching an adequate agreed outcome at the UNFCCC 15th Conference of the Parties (CoP15) in Copenhagen in December 2009.

6. Requests the Secretariat to forward this resolution and the Southern Ocean Sentinel workshop report to relevant bodies and meetings including the UNFCCC and the IPCC in time for upcoming meetings.[13]

B. Regional Response: Adaptation or Climate-smart Management

CCAMLR has recognized the need to consider climate change in the course of its management conservation mandate for Antarctic and Southern Ocean marine living resources. This has been done through tasking its working groups with taking climate change into consideration when providing advice on stock assessments, future population responses and recruitment levels, and to examine and invest in improved monitoring of climate change impacts, and to evaluate the success of the convention in addressing climate change.[14]

Although these are good initial steps, a long way still remains until CCAMLR can be congratulated for incorporating climate change effects into specific management decisions. CCAMLR's Performance Review Panel highlighted the need for CCAMLR to work more intensively on this issue in several of its recommendations.[15]

ASOC urges CCAMLR to follow the recommendations of the Review Panel on climate change and increase its efforts to apply a truly precautionary approach to management. This implies anticipating the combined effects of increased fishing pressure and climate change in order to develop management responses before irreversible impact occurs. In order to facilitate adaptive management responses, a more comprehensive and consistent monitoring program for marine living resources in the CCAMLR Area should be developed.

[13] A proposed draft Resolution is attached as Annex 1.
[14] CCAMLR XXVII Report 4.61.
[15] See CCAMLR Performance Review Panel Report – Sections 3.1.2; 3.1.3; 3.1.4; 3.5.2.

Adaptation, or climate-smart management, is becoming a vigorous field of science in other parts of the world. The following broad principles may be of particular relevance in the Southern Ocean context:[16]

Protect Adequate and Appropriate Space

As a result of climate change, many species are changing *where* they feed, grow, or breed, and *when* they engage in key life history behaviors such as reproduction and migration. The predicted effect of ocean acidification in the Southern Ocean especially when levels reach 450ppm will add further stress to species relying on calcium carbonate skeletons and shells and threaten them with extinction.[17] Existing conservation methods that employ spatial restrictions may not adequately protect the resources and ecosystems for which they were designed. In the face of climate change, spatial management strategies will need to incorporate such features as buffer zones and connectivity to accommodate uncertainty and range shifts. Identifying and protecting refugia, or areas less likely to change, is another important criterion for climate-smart spatial management.

Reduce non-climate stresses

Climate change is not the only threat faced by marine ecosystems. Pollution, habitat destruction, over-exploitation, invasive species, and more are already challenging us. Reducing non-climate stressors in general is thought to increase overall ecosystem resilience; when it comes to climate change adaptation, the key is to focus on those stressors that will interact negatively with climate change or its effects. Rates of harvest that have been viewed as 'sustainable' in the past will become unsustainable if climate change alters population growth rates or leads to miss-matches between life history patterns and the environmental signals to which they evolved, resulting also in dissolving skeletons and shells of marine organisms. The precautionary principle suggests that we add “insurance factors” to regulations governing a variety of non-climate stressors to minimize the risk of marine systems we care about flipping to alternative stable states.

Manage for Uncertainty

Climatic variability is a fact of life, but the long-term directional climate change we are currently experiencing is different. Ocean acidification is a direct result of increased carbon dioxide levels and will deteriorate over centuries even if carbon dioxide levels are stabilized at current levels.[18] While not unprecedented in the history of the world, it is unprecedented in the history of modern humans, and there are therefore a great many unknowns as we look towards the future. To remain effective, management systems must be able to incorporate uncertainty and to respond to new information and unforeseen circumstances in a timely fashion. Adaptive management, including deepened precaution and scenario planning provide frameworks for how to address this.

Using such flexible, responsive approaches to management will be particularly important in the Southern Ocean, given that the high degree of is already and clearly underway. The precautionary principle dictates that decision-makers for the Southern Ocean assess the full range of plausible scenarios, including potential tipping points, and look for management options that maximize the choices for the future.

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[16] Hoffman, 2009. Southern Ocean Ecosystems and Climate Change: Options for Adapting Conservation and Management.

[17] McNeil, B.I. and Matear, R.J. 2008. Southern Ocean acidification: A tipping point at 450-ppm atmospheric CO2. Proc. Natl. Acad. Sci. 105 (48): 18860–18864, www.pnas.org/cgi/doi/10.1073/pnas.0806318105

[18] Caldera,K. 2007. What corals are dying to tell us and CO2 and ocean acidification. Oceanography 20: 188-195.

ANNEX 1

DRAFT RESOLUTION xx/XXVIII

Resolution on Climate Change

The Commission,

Recalling the principles of conservation in Article II of the Convention and in particular the maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources and the prevention of changes or minimisation of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades, taking into account the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources;

Conscious of the importance of safeguarding the environment and protecting the integrity of the ecosystem of the seas surrounding Antarctica in the face of the effects of climate change;

Acknowledging that the Commission has endorsed three areas of work in relation to developing management responses to the impacts of climate change including examining the robustness of the Scientific Committee's advice and working group stock assessments in the face of increasing uncertainty accompanying climate change, particularly in relation to predictions of future population responses and recruitment levels; the need for, and implement as appropriate, improvements to current monitoring programs of harvested, dependent and related species so as to provide robust and timely indicators of climate change impacts and whether CCAMLR's management objectives and performance indicators require modification to remain appropriate in the face of climate change uncertainty;[19]

Recognizing human induced global climate change as one of the greatest challenges facing the Southern Ocean;

Concerned that escalating rates of warming of the Antarctic could have far-reaching consequences for the rest of the world;

Bearing in mind the findings of the 2009 SCAR Antarctic Climate Change and the Environment (ACCE) Review Report and the recommendations from the United Nations Intergovernmental Panel on Climate Change (UN IPCC) Fourth Assessment Report;

Noting that management action aimed at increasing adaptation and resilience capability is important and required to preserve and protect the unique Southern Ocean environment against potentially irreversible impacts of anthropogenic climate change;

However, recognizing that ultimately the preservation and protection of Southern Ocean ecosystems depends primarily on mitigation action that substantially reduces global emissions of CO2 and other greenhouse gases;

Acknowledging that the United Nations Framework Convention on Climate Change is the is the appropriate international body to deliver an adequate mitigation response the threat of climate change and impact of increasing greenhouse gas emissions.

1. Encourages continued and increased consideration within CCAMLR working groups and the Scientific Committee of climate change impacts to inform management decisions in relation to protecting and preserving Southern Ocean ecosystems;

[19] CCAMLR XXVII Final Report, para 4.61

2. Endorses the establishment of the Southern Ocean Sentinel program with clear monitoring objectives reflective of the information required to inform management actions towards protecting and preserving Southern Ocean biodiversity;

3. Supports the urgent need for an effective global response that will address the challenge of climate change;

4. Appeals to all Contracting Governments to take urgent action to reduce the rate and extent of climate change;

5. Confirms the commitment of all CCAMLR Members to actively contribute to reaching an adequate agreed outcome at the UNFCCC 15th Conference of the Parties (CoP15) in Copenhagen in December 2009; and

6. Requests the Secretariat to forward this resolution and the Southern Ocean Sentinel workshop report to relevant bodies and meetings including the UNFCCC and the IPCC in time for upcoming meetings.

November 5, 2009

Convention on the Conservation of Antarctic Marine Living Resources
Resolution 30/XXVIII on Climate Change

The Commission,

Recognising that global climate change is one of the greatest challenges facing the Southern Ocean;

Understanding that the Southern Ocean will continue to warm over this century and believing that the Southern Ocean will experience increased acidification with possible impacts on its marine ecosystems;

Concerned about the effects of climate change in Antarctica on Antarctic marine living resources;

Recalling Article II of the Convention, which provides inter alia that any harvesting and associated activities shall be conducted in accordance with provisions of this Convention and with the following principles of conservation:

- prevention of decrease in the size of any harvested population to levels below those which ensure its stable recruitment;
- maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources;
- prevention of changes or minimisation of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades;
- taking into account the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources;

Conscious of the need to safeguard the environment and protect the integrity of marine ecosystems in the seas surrounding Antarctica in the face of climate change effects;

Noting that management action can help build resilience and protect the unique Southern Ocean environment against potentially irreversible impacts of climate change, and ensure the continued conservation and rational use of the Antarctic marine living resources;

Recalling that the Commission has previously endorsed the work of the Scientific Committee (CCAMLR XXVII Report, para. 4.61) in relation to the impacts of climate change;

1. Urges increased consideration of climate change impacts in the Southern Ocean to better inform CCAMLR management decisions;

2. Encourages the commitment of all CCAMLR Parties to actively contribute towards relevant science initiatives, such as the *Integrating Climate and Ecosystem Dynamics* science programme, and the *Southern Ocean Sentinel* program, which will contribute information needed to improve CCAMLR management actions;

3. Encourages wide dissemination of the Scientific Committee on Antarctic Research's report on Antarctic Climate Change and the Environment (ACCE) when it is published at the end of November 2009, including among delegations to the United Nations Framework Convention on Climate Change (UNFCCC) 15th Conference of the Parties (CoP15) in Copenhagen in December 2009; and

4. Requests that the Chairman of the Commission writes to the President of the Conference of the Parties of the UNFCCC, to express that the CCAMLR Commission considers that an effective global response by the UNFCCC is urgently needed to address the challenge of climate change in order to protect and preserve the Southern Ocean ecosystems and their biodiversity.