SCAR Scientific Research Programme

External Performance Review

Antarctic Thresholds - Ecosystem Resilience and Adaptation (AnT-ERA)

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AnT-ERA
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Introduction

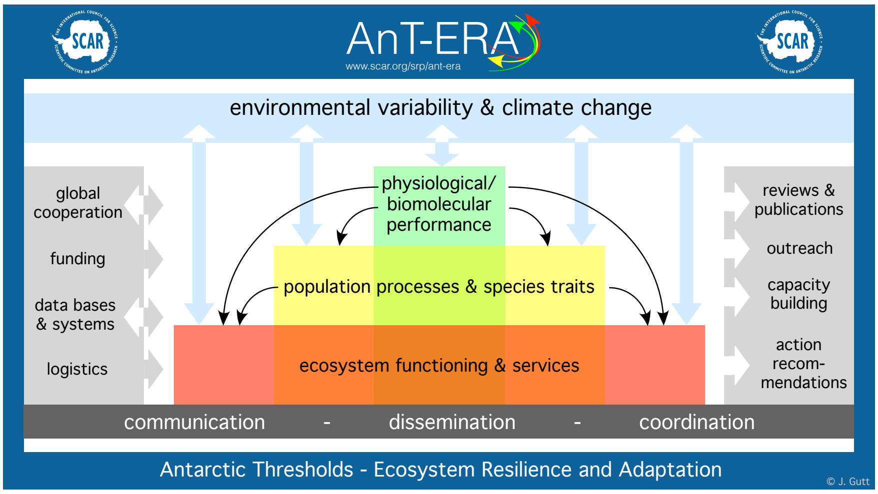
The Paris Agreement of the UNFCCC COP21 recognized that "climate change represents an urgent and potentially irreversible threat to human societies and the planet...". The objective of AnT-ERA is to facilitate the science required to determine the vulnerability and resilience of Antarctic biological systems to environmental change. Areas along the Antarctic Peninsula are warming fast, whilst in other locations temperatures are relatively unchanged. Thus, it is pressing that we learn what vulnerabilities of organisms and ecosystems exist and where the tipping points are so that, within the next 2-6 years, we can inform global climate-change policy.

With this background AnT-ERA is focusing on current biological ***processes*** that may reflect a cascade of responses to environmental forcing through three levels of biological organization (see cartoon below):

(1) Molecular and physiological performance

(2) Population processes

(3) Ecosystem functions and services.



Research activities carried out under the umbrella of AnT-ERA did not deviate considerably from the original implementation plan. Actions to inform stakeholders and support cross-disciplinary discussions even exceeded our plans.

AnT-ERA is community-driven and has an active Scientific Steering Committee: 13 members from 12 countries and 6 continents incl. APECS representatives and liaison officers (appendix I); male:female ratio 11:8. Since AnT-ERA is open for all scientists and other interested people, no membership is required. The mailing list comprises 520 members (Feb '16). For abbreviations used in this report see appendix II.

Deliverables and Milestones

I. Up to five key achievements

1. **Scientific output** is one of its most important products since AnT-ERA is fundamentally a science program. It contributed considerably to major advances in the knowledge on climate-change impacted Antarctic biological processes since mid-2013. One advance was a general identification of ecosystem components (systematic groups, trophic levels, regionally defined

communities), which are assumed to be stenoecious "losers" with a low resilience (self-repair capacity) or "winners" due to unexpected organism plasticity. Such conclusions result from topical environmental change studies and increase in fundamental biological knowledge. The 17 members of the core-SC published >150 peer-reviewed papers in highly ranked journals within 2.5 years (appendix III). Concerning interactions between the atmosphere and ocean on the one side and the terrestrial and marine biosphere on the other we are now much better informed in where to look for a comprehensive and detailed assessment of the impact of climate change. This advance is mainly based on interdisciplinary and cross-program exchange of information.

An example of a review paper, which had not been published without AnT-ERA support is Gutt et al. 2015 (GCB 21: 1434-1453) providing a new analytic approach of climate-change induced by multiple stressors of Antarctic marine ecosystems, published as a product of AnT-ERA topics 2 & 3 in cooperation with ACCE and AntClim[21]. A special volume of *Biodiversity* based on an AnT-ERA workshop in Napoli in 2014 (see below) will highlight advances at the biomolecular and physiological level. A special volume of *Polar Biology* will reflect results of a post-expedition AnT-ERA workshop in Dijon, France in 2015 (chairs: J. Gutt and B. David) based on an interdisciplinary survey to the Peninsula area (*Polarstern 81*) in 2013. This area is under high environmental stress and comprises extreme natural environmental gradients, e.g. in sea-ice cover, primary production and pelagic as well as benthic functional diversity. Both special volumes are to be published in 2016. The most recent knowledge on the cold limit to adaptation of marine species is comprehensively reviewed within a novel analysis in the opinion paper by Peck (2016).

2. **Capacity building**. Two major events with discussions of cutting edge issues in ecosystem- and climate-relevant research organized by AnT-ERA were:

- Workshop on *Molecular and Genetic Advances to Understanding Evolution and Biodiversity in the Polar Regions: the legacy of EBA*, 2014, Napoli (chairs: di Prisco, Verde et al)
- Interdisciplinary SCAR Cross-Program Workshop *Interactions between Biological and Environmental Processes*, 2015, Barcelona (chairs: Gutt, Isla et al).

3. **Dissemination** of AnT-ERA relevant knowledge to other scientific experts, the public and other stakeholders especially through:

- the AnT-ERA web-site, e.g. "Scientific and Other Highlights",
- updates of the ACCE report being publicly available and reported to ATCM,
- contributions in the Antarctic Environments Portal (AEP) in a CEP context,
- chairing sessions and mini-symposia of SCAR symposia and conferences,
- chairing and membership of International Steering Committees and International Organizing Committees of SCAR conferences and symposia,
- the AnT-ERA mailing list,
- contributions to the SCAR report to ATCM.

For additional stakeholders see "III. Major reports...".

4. **Support of early-career scientists**: a total of more than 20 mini-grants for young scientists, with particular emphasis on visiting meetings, SCAR conferences, symposia and workshops. Mini-grants also were awarded in support of attending APECS events and other workshops targeted at early-career scientists. In exceptional cases research activities were supported.

5. **Research projects** in the context of AnT-ERA being represented by field work were expeditions under the leadership, or with major contributions of their working groups, of SC-members. E.g. E. Isla, with his working group, studied biogeochemical processes at the climate-sensitive Filchner Outflow System in

the Southern Weddell Sea (***Polarstern, 96***). J. Xavier and his working group investigated during expedition ***James Clarke Ross 15004*** the dynamics of zooplankton and krill in the South Orkney Island region. V. Cummings was part of the 2015/16 ***Cape Adare Expedition*** – a pilot project for a long-term observation to understand and detect the impact of environmental change propagating into Antarctica from the Southern Ocean. G. di Prisco has been a member of the planning committee of the ***TUNU Euro-Arctic Marine Fishes (TEAM-Fish)*** long-term international and multidisciplinary program. He participated in all three cruises. This program represents an outstanding example for polar comparative (Antarctic-Arctic) cooperation. The ***McMurdo Dry Valley Water Pulse and Press Project*** is a field experiment that examines the resilience of soil biodiversity and biogeochemical processes (D. Wall). ***FjordEco*** cruise on board *RV L.M. Gould*, Nov – Dec '15 to study fjord ecosystem dynamics and climate change along the west Antarctic Peninsula, involving scientists from five countries including C. Smith.

II. Primary publications in peer-reviewed journals

More than 150 AnT-ERA relevant publications on biological processes were published by SC members, supported by national programs (see appendix III).

III. Major reports, including linkages to major SCAR activities

(Contributions of AnT-ERA SC members indicated)

- ACCE report updates (yearly to ATCM): major contributions
- Antarctic Environments Portal: writing two web-articles (2015/16)
- 1st SCAR Antarctic and Southern Ocean Horizon Scan: major contributions to the output and steering committee by 5 AnT-ERA SC members
- IPBES: reviewing
- COMNAP Antarctic Research Challenges (ARC) Project: reviewing
- EU-PolarNet (EPB): J. Gutt being member of the *General Assembly*
- UN-World Ocean Assessment: J. Gutt being member of the *Pool of Experts*

IV. Other reports and grey literature (see also appendix III)

- *SCAR Biogeography Atlas*, co-edited by J. Gutt and many scientific contributions
- The *Global Soil Biodiversity Atlas* to be published in 2016 by the *Global Soil Biodiversity Initiative* chaired by D. Wall
- MPA initiative (Weddell Sea): Major contributions to working papers (Gutt & Isla)
- Additional important "grey" publications by SC members are listed in appendix III.

V. Workshops and other key meetings organized and activities associated to major SCAR meetings

- SCAR OSC Kuala Lumpur, 2016. Co-convener of conference: I. Schloss; co-convener of mini-symposium 2, session 27 & member of ISOC: J. Gutt; co-convener of session 26: C. Smith & A. Takahashi; co-convener of mini-symposium 3: J. Xavier
- UNFCCC COP21 conference, Paris, 2015. Talks in side events *Irreversible Thresholds* and *Species Conservation in a Changing Climate*: J. Gutt.
- SCAR-EXCOM meeting, Tromsö, Norway. J. Gutt
- PEI workshop, Hannover, 2015. co-convener: J. Xavier.
- APECS World Summit, Bulgaria, 2015. Co-convenor: J. Xavier
- VII Portuguese Polar Conference, Évora, 2015. Co-convener: J. Xavier.
- ANTOS-workshop, Hamilton, NZ, 2015. Co-convener: V. Cummings.
- Antarctic Earth Science Meeting, Loveland, USA, 2015. Co-convener: B. Adams.

- Gordon Research Conference on Polar Marine Science, Lucca, Italy, 2015. Invited presentation: A. Takahashi
- SCAR OSC Auckland, 2014. ISOC: J. Gutt, session chairs: J. Gutt, V. Cummings, E. Isla, C. Verde, I. Schloss, C. Suckling, G. di Prisco, C. Verde, J. Xavier
- 1st SCAR Antarctic and Southern Ocean Horizon Scan, 2014. AnT-ERA participants and discussion leaders of retreat (members of Horizon Scan steering group underlined): J. Gutt, L. Peck, I. Schloss, D. Wall, J. Xavier.
- INTERACT workshop, Auckland, NZ, 2014. Co-convener: V. Cummings.
- AntEco workshop, Auckland, NZ, 2014. Participants: J. Gutt, D. Wall, B. Adams.
- ACCE workshop, Auckland, NZ, 2014. Co-convener: J. Gutt, G. di Prisco.
- VI Portuguese Polar Conference, Oporto, 2014. Co-convener: J. Xavier.
- Ecsite annual conference. The Hague, NL, 2014, Co-convener: J. Xavier.
- Ocean Acidification meeting, Auckland, NZ, 2014, Co-convener: C. Suckling.
- SCAR Biology Symposium, Barcelona, ES, 2013. ISOC: J. Gutt.
- World Congress of Malacology, Azores, PT, 2013. Co-convenor: J. Xavier
- ANTOS workshop, Barcelona ES, 2013. Participants: B. Adams, D. Wall, V. Cummings.

VI. Capacity building and education outreach activities

Capacity building was a major task of workshops and similar events organized and supported by AnT-ERA (see section V, above). Another objective was the supervision of many students by SC-members and the wider AnT-ERA community.

The involvement of established experts in AnT-ERA issues was successful. We continuously try to get new groups involved, e.g. the SCOR sea-ice group BEPSII.

The inclusion of newly emerging programs demands intensive communication over longer periods to identify common ideas and develop joint actions. It is a medium-term issue for AnT-ERA to meet this challenge and would significantly benefit from support by the national delegates.

Several AnT-ERA SC members are active in the SCAR Capacity Building, Education and Training Advisory Group (CBET), particularly in reviewing SCAR fellowships proposals annually.

VII. New data and/or meta-data (including plans for archiving)

Primary data, with their metadata, are publicly available since they are uploaded to repositories, such as *ANTABIF* (biogeographic and some ecological data), *GenBank* (genetic sequence information), and *PANGAEA* (primarily environmental data). Additional data bases for biomolecular information are *Polar Data Centre* (BAS) and *NCBI SRA* (Bethesta, Maryland, USA). When such primary data were analyzed, results were published in peer-reviewed scientific journals.

VIII. Communication activities and how these contribute to the promotion of SCAR and its mission.

The AnT-ERA webpage is the central tool for the program's outreach. It is considered and used as a modern and dynamic newsletter. Since 2014 30 web-articles have been written and uploaded, reflecting ***Scientific and Other Highlights***. Since September 2015 other interesting news such as important management issues or workshop reports are also considered. The total number of visits is approx. 30 000 (Feb. '16). The web-page also comprises ***News*** providing regularly updated information on events and opportunities for jobs, expeditions, courses etc. The webmaster is happy about any further contribution, which might be interesting to the AnT-ERA community, a wider group of colleagues interested in Antarctic biology research, the public and other stakeholders.

Outreach activities of SC members are numerous. Ten's of broadcast and TV interviews, ten's of popular articles in print media and on webpages, as well as a similar amount of popular presentation in a non-scientific context, contributed to a lively outreach of AnT-ERA.

A limited amount of merchandizing articles, including a brochure, stickers with a self-developed logo and pens have been produced and distributed to promote Ant-ERA in the SCAR context. Printed matter of this kind is also available on the AnT-ERA webpage, together with other documents, such as the mission statement, the implementation plan and reports.

J. Gutt is a member of the writing team of the new SCAR Strategic Plan.

IX. Linkages to other SCAR groups, international programmes and other activities

Major contributions have been made by four AnT-ERA SC members to the 1st SCAR Antarctic and Southern Ocean Horizon Scan.

The interdisciplinary SCAR Cross-Program Workshop in 2015 in Barcelona, Spain, planned and organized primarily by the AnT-ERA SC members J. Gutt and E. Isla linked a number of SCAR and other initiatives. These comprised: AntEco, AntClim[21], ICED, BEPSII, PAIS, EGBAMM, and IPCC.

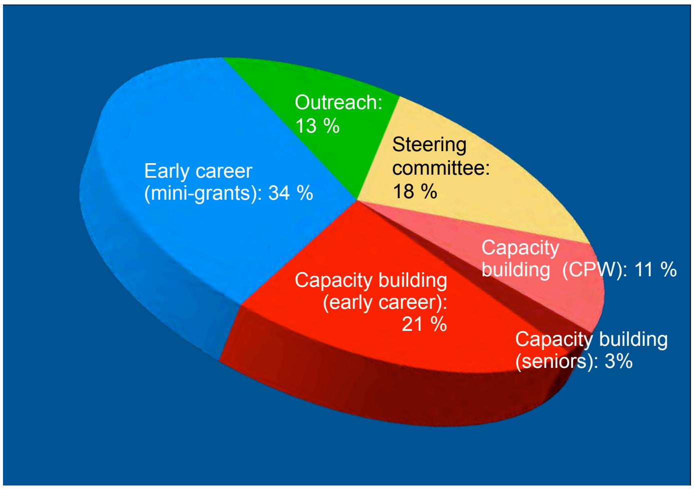
Any AnT-ERA activities are closely linked to the SCAR Life Sciences SSG. For many other events with major AnT-ERA cooperation see Section V (above).

Session 26 of the 2014 OSC in Auckland *Impact of climate change on Antarctic biota* lead by J. Gutt was a successful joint AnT-ERA/AntClim[21]/ICED session.

AnT-ERA representatives supported the *Interdisciplinary Antarctic Earth Sciences Meeting and Shackleton Camp Planning Workshop* on research to understand Transantarctic Mountain ecosystem responses to climate driven changes.

L.S. Peck was awarded the Plymouth Marine Science and Education Foundation silver medal for marine biology in 2015.

X. Expenditure on project activities and plans for unspent funds



Funding is decided by a financial committee, which comprises four AnT-ERA SC members. The expenditure of a total of US $66,000 since 2013 (incl. 6,000 carryover from EBA) can be classified according to the main categories: (1) capacity building, (2) early career scientists, (3) SC members, (4) outreach. See pie chart (right) for clustered budget (as of Jan 2016). Capacity building (red) is split into expenses for early career scientists, the AnT-ERA contribution to the SCAR Cross-Program workshop (CPW) and general expenses.

In the completed financial periods there were no unspent funds. The same is expected for 2015, considering the option to carryover money from 2015 to 2016.

Future Plans

AnT-ERA will remain thoroughly inclusive and community driven. This refers to early career and experienced scientists, gender, emerging and traditional SCAR countries, smaller and larger national programs and contributions from any SCAR member as well as from any continent. Major decisions on AnT-ERA activities, initiatives, financial support and important changes in the implementation plan (www.scar.org/scar_media/documents/science/antera/AnTERA_ImplPlan_140209.pdf) are made democratically within the SC. The SCAR/AnT-ERA funds are to be spent in the future similarly as in the past with highest priority for capacity building, early career scientists and emerging programs, with all approaches demanding high scientific quality. An interdisciplinary (capacity building) key event originally planned for 2016 was already realized in 2015. Thus, our foci for the next years will be dissemination of results, review of scientific key findings, and the development of new concepts:

- Initiation of discussions on **new interdisciplinary concepts**, as a continuation of the Barcelona Cross-Program workshop. The next step will be the mini-workshop *"Time for changes after COP21?"* attached to the OSC, August 2016, Malaysia. Most important seems to be a strategy to identify important biological parameters, measured or surveyed to detect significant biological response to climate and other environmental change and publish these.
- Focussed **capacity building** events, to support **early career scientists** and preferably in focused event(s). An APECS workshop to be held in Brasilia, Brazil, summer 2016, is already in an advanced stage of planning with major contributions by J. Xavier. An AnT-ERA specific option -to be elaborated during the OSC in Kuala Lumpur- is a summer school or workshop on the *Impact of climate change on Antarctic ecosystem services* in Coimbra, Portugal, in 2018.
- Improved inclusion of **emerging national programs** supported by the national representatives or delegates. The idea to hold a topical workshop in a country or on a continent with emerging or small Antarctic program(s) is to be presented at the Meeting of Delegates in Kuala Lumpur, August 2016.
- **Wrap-up of scientific knowledge** since 2013 being relevant in the AnT-ERA context and its conversion to public "products", e.g. summary paper and/or fact sheets. Presentation of these at a final symposium and via an international press release.
- Based on an official request AnT-ERA offered to contribute to an **IPCC "Special Report".**
- Develop **ideas for a new SCAR biology program** "Lessons learned – Implications for the future", in a brainstorming event in N.-America or Europe.
- Contribution to interdisciplinary, national and international **expeditions and similar research activities**, e.g. to the area of ice-shelf disintegration (Gutt & Isla) or focussing on penguins and seal research in East Antarctica (Takahashi).
- AnT-ERA scientists, especially SC-members will accept the challenge **to raise funds for AnT-ERA projects**. Critical for this purpose is the information, which funding agencies generally supporting such fully international initiatives.
- Strengthening an **Arctic-Antarctic scientific dialogue** in anticipation of the IASC-SCAR OSC, Davos, 2018 supported by the new liaison officer M. Kędra.

Appendix I - Membership

Scientific Steering Committee

Name	Affiliation	Country	Email	Gender	Term	Position
Gutt, Julian	AWI	GER	julian.guttlawi.de	m	perm	Prof
Peck, Lloyd	BAS	UK	lspe@bas.ac.uk	m	perm	Prof
Verde, Cinzia	IBBR-CNR	IT	cinzia.verde@ibbr.cnr.it	f	perm	senior
Adams, Byron	Brigham Univ.	USA	Byron_adams@byu.edu	m	perm	senior
Wall, Diana	Col. State University	USA	Diana.Wall@ColoState.EDU	f	perm	Prof
Takahashi Akinori	NIPR	JP	atak@nipr.ac.jp	m	perm	senior
Cummings Vonda	NIWA	NZ	vonda.cummings@niwa.co.nz	f	perm	senior
Smith, Craig R.	University of Hawaii	USA	craigsmi@hawaii.edu	m	perm	Prof
Isla, Enrique	ICM-CSIC	ESP	isla@icm.csic.es	m	perm	senior
Schloss, Irene	Dirección Nacional d. Antartico & Rimouski University	ARG CN	irene_schloss@uqar.ca	f	perm	Prof
Xavier, José	University of Coimbra & BAS	POR UK	jxavier@zoo.uc.pt	m	contr	Post-doc
Suckling, Coleen	Bangor University	UK	coleenclaire@yahoo.co.uk	f	contr	Post-doc
McIntyre, Trevor	University of Pretoria	South Africa	tmcintyre@zoology.up.ac.za	m	contr	Post-doc
new since '14						
Ott, Sieglinde	Univ of Düsseldorf	GER	otts@uni-duesseldorf.de	f	perm	Prof
Hogg, Ian	University of Waikato	NZ	hogg@waikato.ac.nz	m	perm	Prof
Ahn, In-Young	KOPRI	South Korea	iahn@kopri.re.kr	f	perm	Prof
di Prisco, Guido	CNR	IT	guido.diprisco@ibbr.cnr.it	m	ret	Prof
Liaison officers to ICED, IASC, AntClim21, AntEco						
Murphy, Eugene	BAS	UK	e.murphy@bas.ac.uk	m	perm	Prof
Kędra, Monika	Institute of Oceanology, PAS	POL	kedra@iopan.gda.pl	f	perm	Post-doc
Bracegirdle, Thomas	BAS	UK	tjbra@bas.ac.uk	m	perm	senior
Cowan, Don	Univ. of Pretoria	South Africa	Don.Cowan@up.ac.za	m	perm	Prof
Contact person at SCADAM						
Raymond, Ben	ACE CRC, Hobart	AUS	Ben.Raymond@aad.gov.au	m	perm	Prof

perm: permanent; contr: on contract; ret: retired; m: male; f: female

Members

AnT-ERA is open for any scientists and interested people. No membership is required. The mailing list comprising the AnT-ERA community has approx. 520 members.

Appendix II - Abbreviations

ACCE: Antarctic Climate Change and the Environment (SCAR advisory group)
ACE CRC: Antarctic Climate & Ecosystems Cooperative Research Centre
AEP: Antarctic Environments Portal
ANTABIF: Antarctic Biodiversity Information Facility
AntClim[21]: Antarctic Climate Change in the 21st Century
AntEco: State of the Antarctic Ecosystem
AnT-ERA: Antarctic Thresholds – Ecosystem Resilience and Adaptation
ANTOS: Antarctic Near-shore and Terrestrial Observing System (SCAR)
APECS: Association of Polar Early Career Scientists
ARC: Antarctic Research Challenges (COMNAP)
ATCM: Antarctic Treaty Consultative Meeting
AWI: Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research
BAS: British Antarctic Survey
BEPSII: Biogeochemical Exchange Process at Sea-Ice Interfaces (SCOR)
CBET: Capacity Building and Training, SCAR advisory group
CEP: Committee for Environmental Protection (Antarctic Treaty)
CNR: Consiglio Nazionale delle Richerche (National Research Council)
COMNAP: Council of Managers of National Antarctic Programs
COP21: Conference of the Parties 21, Paris, 2015 (UNFCCC)
CPW: Cross-Program Workshop, Barcelona, 2015
EBA: Evolution and Biodiversity in the Antarctic (former SCAR biology program)
EGBAMM: Expert Group an Birds and Marine Mammals (SCAR)
EPB: European Polar Board
EXCOM: Executive Committee (SCAR)
GCB: Global Change Biology (journal)
IASC: International Arctic Science Committee
IBBR-CNR: Institute of Biosciences and Bioresources - Italian National Council of Research
ICED: Integrating Climate and Ecosystem Dynamics
ICM-CSIC: Institute of Marine Sciences - Spanish National Research Council
IPBES: Intergovernmental Platform on Biodiversity & Ecosystem Services
IPCC: Intergovernmental Panel on Climate Change (UN)
IPE: International Polar Educators
ISOC: International Scientific Organizing Committee
KOPRI: Korean Polar Research Institute
MPA: Marine Protected Area
NCBI SRA: National Center for Biotechnology Information Sequence Read Archive
NIPR: National Institute of Polar Research
NIWA: National Institute of Water and Atmospheric Research
OSC: Open Science Conference
PAIS: Past Antarctic Ice Sheet Dynamics
PAS: Polish Academy of Sciences
PEI: Polar Educators International
SC: Scientific Steering Committee
SCAR: Scientific Committee on Antarctic Reserach
SSG: Standing Scientific Group
SCOR: Scientific Committee on Oceanic Research
UNFCCC: United Nations Framework Convention on Climate Change

Appendix III - References

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SCAR Scientific Research Programme

External Performance Review

Evaluation Form

for

SCAR Scientific Research Programmes (SRPs)

Note to reviewers:
When reviewing an SRP's capabilities, activities and outputs, please keep in mind that SRPs are managed by volunteers from the SCAR community and that they receive between 20,000 to 25,000 USD per year to facilitate/coordinate the activities that will allow them to fulfil their goals. Please also be aware that your reviews will be shared with the SRP chairs and the SCAR Delegates, and be made public on the SCAR website after September 2016. Your name will be kept confidential, unless you specify otherwise.

Reviewers should complete this page, expanding the text boxes where necessary, but should be kept to 3 A4 pages max. Reviews will be made public.

Name of SRP: Antarctic Thresholds – Ecosystem Resilience and Adaptation (AnT-ERA)

Name of Reviewer (optional):

Science quality. Recognising that the national/international science on which the research was based has already been peer-reviewed, do the scientific highlights and published papers indicate that the internationally collaborative research stimulated by the programme has produced science that is excellent, good, or fair? (please provide a brief justification for your choice).

The science of AnT-ERA is very sound; its clear articulation of the three levels of biological organization for study is commendable. The individual science papers coming from AnT-ERA are generally of a high quality though, interestingly, outputs focusing expressly on the program's themes are best found on the website. Without examining every paper in detail it is not easy for a reviewer to assess the extent to which the authorship includes international collaborators in a field as large as biology, though in some instances it is clear that research is internationally collaborative.

It is disappointing to this reviewer that the papers listed are those only of members of the steering committee, including their students, post-docs etc. Is there no wider research community? Or is there no mechanism to capture it? (Also, it would have been sensible if the list had been better scrutinised before submission; I can see no obvious relevance to the themes of AnT-ERA of papers on physical geography, or on the diet of Cape clawless otters.) Can the Steering Committee be confident there is no AnT-ERA work being conducted by people, other than themselves and their collaborators?

It would help future reviewers if the impact factor of the journals carrying the AnT-ERA work could be given alongside each paper listed, as well as a few words to indicate how the paper aligns with the program's themes. International collaborators could be identified in some typographical manner. In this way the SCAR Executive would be better able to compare rationally the performance of different programs.

While many of the papers listed are published in the top international journals, the majority is published in middling, or even low-impact journals. This raises the oft-debated issue of whether the Antarctic research community should have as its publication focus its own community, or whether it should be trying to demonstrate the relevance and theoretical applicability of Antarctic research to the vast community of biologists interested in vulnerability and resilience of biological systems to environmental change, irrespective of which biological system they are studying. Papers aimed at both communities are listed, but the balance appears to be with the local community.

Because the papers listed appear to be limited to a group of Antarctic biologists, it is necessary to ask if the group producing them is sufficiently representative of a) the whole research community, and b) is sufficiently cognitive of the requirements of the Strategic Plan. Ten countries are involved; three representatives each from UK and USA. Two representatives from Germany, Italy, and New Zealand, and one representative from Japan, Spain, Argentina, Portugal, republic of South Africa, and South Korea. It is surprising to this reviewer that China, India, Brazil, France, Malaysia, Scandinavian countries and Australia are not represented. These last listed countries involve established and emerging Antarctic nations. I am aware of the manner in which scientific representational committees are established and am not wishing to be critical of AnT-ERA, but if SCAR is to become the leading scientific body it aspires to be it will need to take a far more strategic approach to building its steering committees, and will actively canvass nominations from newer programs. It could discuss with ICSU how best to build its biological programs, rather than letting them grow organically based on the personal interests of scientists who regularly attend its meetings.

Science importance/relevance/timeliness. Has the work advanced scientific understanding and been in accordance with the SCAR Strategic Plan (http://www.scar.org/about/futureplans/)? (Yes or no; please provide a brief explanation for your choice). Are there important gaps currently not considered by the SRP? (If yes, please provide a brief description)

Broadly speaking, the work of AnT-ERA is aligned with SCAR's strategic plan. Most of the elements of the plan, set out on p6 (2010-2016 plan) are presented in the report. Curiously absent in the report is any mention of CCAMLR and CEP, and SCAR's provision of advice to those bodies. This could be because the matter was simply overlooked when the report was assembled, or it could be that SCAR is not asked to provide advice. Or it could be that as there are so many active CCAMLR scientists involved in AnT-ERA that the program has no institutional role to play over and above that of individual scientists. Whatever the reason it is important that SCAR's Strategic Plan does not put a significant piece of its biological research outside AnT-ERA's reach. A naive outsider looking at AnT-ERA's work *as presented in this report*, and knowing that marine science underpins the work of CCAMLR, would find it hard to understand why SCAR continues to support a biological program if it is not required by CCAMLR. A similar argument could be mounted with respect to CEP. I am personally familiar with how CCAMLR's scientific committee was established a quarter of a century ago and know of the traditional links with SCAR, but I feel that SCAR must do more in its strategic plan to make it acceptable for AnT-ERA to *not* provide scientific advice to the international body charged with the protection of marine Antarctic environments, or – if the report is to be read literally – to *not* provide advice to CEP. Alternatively, it must reassess the role of biological science in the chain of advice to ATCM and its associated bodies. Because of my background knowledge I know that SCAR provides much advice to ATCM, but this does not come out in the report.

Data archival and access. Is the programme adequately addressing the issues of data archiving and data access, and are its data accessible to the wider community? (Yes or no; please provide a brief explanation of your choice).

Biology is fortunate in having a number of well-known and well-run data archiving organisations. It is pleasing that most AnT-ERA data are archived into those databases. Funding for international databases comes and goes according to national priorities and there can be no guarantee that every databse we have today will still be around in two or three decades. Doubtless SCAR is maintaining a careful watch on these issues. Generally funding is seldom switched off overnight giving the user community time to adjust. In the very long term SCAR needs to have contingency plans for maintaining data in the event that current funding decisions are reversed.

Communication activities. Are the communication activities of the SRP contributing to the promotion of SCAR and its mission? (Yes or no; please provide a brief explanation of your choice).

AnT-ERA is very successful at promoting its agenda among its members, and in so doing raising SCAR's visibility internationally. The section "Future Plans" speaks about activities coming up in Brazil and Malaysia, admirably involving APECS. There are other initiatives listed that will raise AnT-ERA's profile including 'wrap-up of scientific knowledge since 2013'. Unless AnT-ERA hires good, professional Media agents with experience of gaining

international exposure, or unless SCAR does so for all its programs, such activities are unlikely to reach the sort of wide audiences it wishes to reach. AnT-ERA's website is good and well-presented. The number of hits reported is encouraging, but not exceptional. It would be interesting to know how many hits are unique and how many are redirections from elsewhere. SCAR could do well to issue an analysis of the number of hits to each of its scientific program websites, and to use this as a comparative metric of how it is getting its message out to the wider world. The web articles are particularly successful and address AnT-ERA's objectives very closely. They need wider promotion.
Education. Is the work contributing to education about Antarctic science? (Yes or no; please provide a brief explanation of your choice). The web articles are excellent and factual and contribute to education about Antarctica. The relatively modest hit-rate suggests more needs to be done if SCAR wishes to reach a wider audience. Is there a program of releases being made on Facebook? No mention of social media is made in the report. I have the feeling AnT-ERA is doing great work but is failing to adequately make a commensurate educational impact.
Building capacity across all SCAR Member countries. Has the programme contributed to building the capacity of countries with less well developed Antarctic programmes and/or early career scientists a lot, modestly, little, or not at all? Keeping in mind that there are various difficulties in this area, e.g. depending on the current interest of science topics in certain countries, please provide a brief explanation of your choice. Because the list of papers presented is that of the SC members only and their students, groups etc., it is very difficult to answer the question about capacity building. My general feeling is that there is little evidence in the list of much collaboration with less well developed Antarctic programs, but without current knowledge of who is working in established or emerging programs I may be wrong. That's not to say that it is not going on; it is only to say that the selection of papers listed relates to a certain group of individual researchers and appears not designed to be fully inclusive. AnT-ERA is well connected to other SCAR programs and other international initiatives. The financial emphasis being placed on early-career scientsis, through mini-grants and capacity building is highly commendable and should afford some continuity into the future.
Value for Money. Considering that SCAR is only able to invest ~20,000-25,000 USD per year in each SRP, do the results indicate excellent/good/fair/poor value for money (please provide a brief justification for your choice)? The great value of SCAR's small contribution is that it provides some incentive funds for bringing scientists together for scientific liaison meetings. It is essential that this be continued, and increased to the extent possible – few sources of national funding allow for it to occur and every practising scientist knows that face-to-face discussions are what gives rise to new collaborations and initiatives. In my view SCAR gets excellent value for the money it invests in AnT-ERA.
Terms of Reference. To what extent do you feel the SRP has met the Terms of Reference (provided on the following page). Generally the SRP has met most of the ToRs, as far as I can judge from the report. I have pointed out above where I believe gaps exist. AnT-ERA has liaison officers with various SCAR bodies but no evidence of formal liaisons with Antarcic Treaty bodies. Liaison with IASC is excellent and I expect to see interesting and valuable collaborative and comparative research with Arctic colleagues in the future.

Reviewers should complete this page, expanding the text boxes where necessary, but should be kept to 3 A4 pages max. Reviews will be made public.

Name of SRP: _Antarctic Thresholds – Ecosystem Resilience and Adaptation (AnT-ERA)

Name of Reviewer (optional): ____

Science quality. Recognising that the national/international science on which the research was based has already been peer-reviewed, do the scientific highlights and published papers indicate that the internationally collaborative research stimulated by the programme has produced science that is excellent, good, or fair? (please provide a brief justification for your choice).

The science that has been produced has been excellent, there have been a number of papers in high profile journals written by the AnT-ERA team with a strong interdisciplinary flavour to these papers.ie the GCB 2015 review paper and Peck 2016 paper. There are also several special journal issues in process that will present the work of AnT-ERA.

Science importance/relevance/timeliness. Has the work advanced scientific understanding and been in accordance with the SCAR Strategic Plan (http://www.scar.org/about/futureplans/)? (Yes or no; please provide a brief explanation for your choice). Are there important gaps currently not considered by the SRP? (If yes, please provide a brief description)

Yes, AnT-ERA has addressed a number of the keys goals of SCAR relevant to the programme very effectively for example,

- encouraging excellence in Antarctic and Southern Ocean research by developing transformational scientific programmes
- that address issues of regional and global importance;
- promoting an interdisciplinary philosophy and eliminating barriers to cross-
- fertilization of ideas;
- providing venues for presentation of the latest research results, exchange of up-to-
- the-minute scientific findings, and promotion of cross- and interdisciplinary
- communication (e.g., Science Conferences, Symposia, workshops, reviews, assessments, and syntheses)
- developing the capacity of students and early career scientists (e.g., Association of
- Early Career Scientists); encouraging emerging national Antarctic programmes;

Data archival and access. Is the programme adequately addressing the issues of data archiving and data access, and are its data accessible to the wider community? (Yes or no; please provide a brief explanation of your choice).

Yes, with the wide use of relevant international databases such as ANTBIF, PAGAEA, GenBank.

Communication activities. Are the communication activities of the SRP contributing to the promotion of SCAR and its mission? (Yes or no; please provide a brief explanation of your choice).

Yes, the AnT-ERA website is a primary communication tool, providing a window on the science undertaken by the group, links to upcoming activities and a platform for co ordination amongst research groups involved in AnT-ERA.
The group have also been active in outreach activities with a significant number of interviews and popular articles.

Education. Is the work contributing to education about Antarctic science? (Yes or no; please provide a brief explanation of your choice).

Yes, the active inclusion of students and early career scientist in the activities of AnT-ERA has contributed significantly to the outreach and education from the group.

Building capacity across all SCAR Member countries. Has the programme contributed to building the capacity of countries with less well developed Antarctic programmes and/or early career scientists a lot, modestly, little, or not at all? Keeping in mind that there are various difficulties in this area, e.g. depending on the current interest of science topics in certain countries, please provide a brief explanation of your choice.

There has been significant expenditure by the SRP on building capacity of early career scientists with 55% of the funds available spent supporting early career scientists. It is not clear from the report or website what % of the funds has been spent on scientist from countries with less well developed Antarctic programmes.

Value for Money. Considering that SCAR is only able to invest ~20,000-25,000 USD per year in each SRP, do the results indicate excellent/good/fair/poor value for money (please provide a brief justification for your choice)?

Excellent, AnT-ERA has a well-focused programme that has contributed significantly to SCAR in terms of excellent science being conducted and promoted, the promotion of capacity building for early career scientists and the promotion of interdisciplinary research through a range of activities including very effective interdisciplinary workshops. These have resulted in high quality research that would not have been undertaken and papers that would not have been written without the activities of AnT-ERA.

Terms of Reference. To what extent do you feel the SRP has met the Terms of Reference (provided on the following page).

The terms of Reference I am able to comment on have been effectively meet. I am not able to comment on AnT-ERA response to requests for expert advice/support from the SCAR Executive Committee in a timely and effective manner, or their ability to advise the SCAR Executive Committee and Delegates on progress and on the use of funds.

Reviewers should complete this page, expanding the text boxes where necessary, but should be kept to 3 A4 pages max. Reviews will be made public.

Name of SRP: Antarctic Thresholds – Ecosystem Resilience and Adaptation (Ant-ERA)

Name of Reviewer (optional): Michael Klages

Science quality. Recognising that the national/international science on which the research was based has already been peer-reviewed, do the scientific highlights and published papers indicate that the internationally collaborative research stimulated by the programme has produced science that is excellent, good, or fair? (please provide a brief justification for your choice).

EXCELLENT

The Ant-ERA consortium has not only contributed to a wealth of peer-reviewed publications but also to review papers and special volumes with foresight articles providing key information and tools how to address future cutting-edge research on climate-change impacted Antarctic biological processes. The Ant-ERA project is driven both by several scientists that belongs to the best in their fields of expertise and also by individuals with the ability to integrate different research directions into a more comprehensive approach. Thus, the entire Ant-ERA should be considered as a light-house project within the SCAR SRP initiative.

Science importance/relevance/timeliness. Has the work advanced scientific understanding and been in accordance with the SCAR Strategic Plan (http://www.scar.org/about/futureplans/)? (Yes or no; please provide a brief explanation for your choice). Are there important gaps currently not considered by the SRP? (If yes, please provide a brief description)

YES

By just citing the articles published by Gutt et al. in *Global Change Biology* (2015), Kennicutt et al. in *Antarctic Science* (2015) and Peck in *Trends in Ecology and Evolution* (2016) it is more than evident that Ant-ERA has significantly advanced scientific understanding. A good example of being well in accordance with the SCAR strategic plan is the inspiring synthesis paper published by Kennicutt et al (*loc. cit.*) summarizing the outcome of the SCAR horizon scan with regard to Antarctic and Southern Ocean research. Several leading Ant-ERA scientists contributed to this paper addressing the detailed and ambitious decadal roadmap that will require a co-ordinated portfolio of international scientific efforts to realize the potential offered by science in the southern polar regions.
I don't see any important gaps currently not considered by Ant-ERA.

Data archival and access. Is the programme adequately addressing the issues of data archiving and data access, and are its data accessible to the wider community? (Yes or no; please provide a brief explanation of your choice).

YES

The Ant-ERA consortium utilizes existing World Data Centres like PANGAEA to ensure long-term archiving and open access to primary and metadata. Over the past ten years a tremendous shift in understanding and acceptance of the need of long-term archiving of data has happened in the polar research community. With the implementation of digital object identifiers (doi) the value of archived data sets has gained an intrinsic value for scientists involved in the generation of such data sets. The variety of data repositories used by Ant-ERA is remarkable.

Communication activities. Are the communication activities of the SRP contributing to the promotion of SCAR and its mission? (Yes or no; please provide a brief explanation of your choice).

YES

The communication activities are well developed (webpage, broadcast and TV interviews, print media, merchandizing articles, etc). The authors of the report refer to their webpage as the central tool for the program's outreach. However, the structure of the webpage could be certainly optimized since there is so much information on the first page that you have to scroll down endlessly to find eventually news you are looking for. However, other SRPs webpages don't provide as much information or look even worse as Ant-ERA. There are certainly many more or other dissemination tools Ant-ERA could use (e.g. video-streaming via the Internet of workshops or symposia of particular interest for either scientists or the public), but this is kind of trivial and can be stated to any project.

Education. Is the work contributing to education about Antarctic science? (Yes or no; please provide a brief explanation of your choice).

YES

The support for early-career scientists is especially worth mentioning. It is amazing to see that the steering group is actively supporting the attendance of young scientists at SCAR conferences, symposia and workshops. The supervision of students by SC members and the wider Ant-ERA community together with their active participation in SCAR CBET is definitely also a significant contribution to education about Antarctic science.

Building capacity across all SCAR Member countries. Has the programme contributed to building the capacity of countries with less well developed Antarctic programmes and/or early career scientists a lot, modestly, little, or not at all? Keeping in mind that there are various difficulties in this area, e.g. depending on the current interest of science topics in certain countries, please provide a brief explanation of your choice.

Modestly / a lot

This is the most difficult to answer question. The report gives some examples of such activities, for example the "improved inclusion of emerging national programmes" and "the idea to hold a topical workshop in a country or on a continent with emerging or small Antarctic programs(s)". In context of capacity building events to support early career scientists the authors report about an Ant-ERA led summer school or workshop on the *Impact of climate change on Antarctic ecosystem services* in Coimbra, Portugal in 2018. These selected examples indicate that the SC is dealing with this issue. Taking their limited amount of funds into account, SCAR cannot expect excellence in all areas of activities.

Value for Money. Considering that SCAR is only able to invest ~20,000-25,000 USD per year in each SRP, do the results indicate excellent/good/fair/poor value for money (please provide a brief justification for your choice)?

EXCELLENT

As stated above I would classify this programme as a "light-house" project within the framework of SRPs. The total number of publications is impressive, the active organization and/or participation in SCAR meetings and other relevant international conferences is remarkable, outreach and capacity building efforts are very good. The cross-connection and linkages to other SCAR groups is well established and the future plans of Ant-ERA are promising, straight forward and well embedded into the outcomes of the SCAR horizon scan.

Terms of Reference. To what extent do you feel the SRP has met the Terms of Reference (provided on the following page).

Ant-ERA meets the Terms of Reference to full extent.

SCAR Scientific Research Programme

External Performance Review Summary and Recommendations

Antarctic Thresholds - Ecosystem Resilience and Adaptation (AnT-ERA)

The Ant-ERA Scientific Research Programme has not only contributed to a wealth of peer-reviewed publications but also to review papers and special volumes with foresight articles providing key information and tools how to address future cutting-edge research on climate-change impacted Antarctic biological processes. The Ant-ERA project is driven both by several scientists that are best in their fields but also by individuals with the ability to integrate different research directions into a more comprehensive approach and is well connected to other SCAR programmes and international initiatives, including Arctic connections. Thus, the entire Ant-ERA should be considered as an example project within the SCAR SRP initiative.

The science that has been produced has been excellent! There have been a number of papers in high profile journals written by the AnT-ERA team with a strong interdisciplinary flavour. However, curiously absent in the report is any mention of the contribution of Ant-ERA to CCAMLR, CEP, and other policy bodies which we know has been substantial.

The financial emphasis being placed on early career scientists, through mini-grants and capacity building is highly commendable and should continue.

The Ant-ERA consortium utilizes existing World Data Centres like PANGAEA to ensure long-term archiving and open access to primary and metadata, and this diversity of repositories is commendable.

The communication activities are well developed (webpage, broadcast and TV interviews, print media, merchandizing articles, etc), however the webpage is buried under layers in the SCAR website structure, greatly diminishing the impact of the SRP outreach efforts.

AnT-ERA Recommendations:

- An effort should be made to not only present the publications of the members of the steering committee, including their students and post-docs, but also relevant publications of the wider group of members.
- The group should consider broadening the steering committee to include additional nations.
- A more detailed explanation of the contributions from Ant-ERA to SCAR's policy-related activities should be provided, especially contributions for CCAMLR, CEP, and the Antarctic Environments Portal.
- AnT-ERA's report noted that a significant amount of funds has been spent to support early career researchers; they should also consider adding information on funds spent on scientists from countries with less well developed Antarctic programmes.
- AnT-ERA might consider other dissemination tools (i.e. webinars, videos, webcasting meetings) to help spread the great work they are doing.
- Ant-ERA should recommended to members to mention in their publications that the paper is a contribution to the SCAR AnT-ERA SRP.

SCAR Scientific Research Programme

External Performance Review Summary and Recommendations

Recommendations for all SRPs and/or SCAR

The following are recommendations arising from the 2016 SRP External Review Process that apply to all SRPs and/or SCAR as a whole:

- Given that SRPs are intended to be finite in duration, it would be useful to identify some key outputs that can be put forward to summarize progress achieved, for example "We now have sufficient information on x to support robust conservation and management of this component of the Antarctic.ecosystem. Document y assembles all the relevant information. SCAR can now focus on other priorities". Along this line, all SRPs should consider putting an emphasis on synthesis of the information collected thus far and have such a paper/product result in the completion of their programme.

- All SRPs should consider assessing the impact of their research by having some additional summary statistics, such as a list of paper citations, or impact factors of the journals where publications have been accepted which could be a useful metric to assess science quality in future reviews.

- All the SRPs should recommend to their members to mention in their publications that the paper is a contribution to the SCAR xxxxx SRP.

- All SRPs should somehow document which of their achievements are directly resulting from the SRP and would not have happened otherwise.

- All SRPs should improve their engagement with scientists from less well-developed Antarctic programmes. Collaborations in Asia, Scandinavia, Africa and South American are particularly important to increase. To help assess current engagement, SRPs should create a graph of the distribution of people involved from various SCAR member countries.

- It is recognized that the SRPs establishment was prior to the SCAR Science Horizon Scan. However, SRPs might want to consider mapping their activities to Horizon Scan questions and including this information on their websites and make sure it is included in all Horizon Scan follow-ups/accomplishment reports.

- Support for early career scientists should involve some kind of 'feed-back' to their home countries, the larger early career and science community and/or other 'outreach' efforts. This could include a presentation to their home department when they return, a report to their National Committee, a webinar, or another activity to share their experience with the wider community

- The SRPs are encouraged to contribute to reinforce the linkages of SCAR with the IPCC and the future Special Reports.

- The SCAR Social Sciences groups could potentially consider doing case studies detailing how the science community was coordinated through the SRPs, if goals were met, what lessons might be learned, and detail examples of management/policy outcomes that were based on work arising from the SRP.

- SCAR should do better at showcasing the results of the SRPs and recognizing the amazing voluntary efforts of their many participants and the amount of in-kind contributions from participating institutions.

- SCAR as a whole, should have a real communication strategy for major publications and scientific outputs, including the outputs of the SRPs. This includes a more standardized format for the SRPs that meet the needs of the programmes and help to showcase their efforts. Including metrics of hits for various programmes on webpages and social media channels would be useful to assessing reach of content.

- All SCAR groups, including the SRPs, should be reminded that acknowledging SCAR in publications is important. SCAR may wish to develop a standard statement that groups could use to help showcase publications that would not be possible without SCAR support. In a similar vein, when groups report publications they should highlight how papers advance the objectives of the programme, or listing them under the objectives to which they are targeted may also be useful for tracking progress.

- SCAR needs to define how publications can be attributed to a SCAR SRP, and which publications would have not been possible without SCAR involvement/endorsement. In the same vein, SCAR should set up a reference collection 'facility' to showcase all publications attributed to SCAR activities. This should also include non-technical publications.

- SCAR may wish to have a more detailed list of where all its data are stored and a contingency plan for maintaining the data in case current funding decisions are reversed.

- There is great value in SCAR's small contribution to these SRPs, which can often provide incentive funds to bring scientists together and it is essential that this be continued. SCAR Members are asked to continue to advocate for the support of SCAR efforts, particularly because few national funding sources allow for international collaborations such as those offered through SCAR activities.

Scientific Research Programmes Antarctic data management evaluation

General comments

The Antarctic Treaty System offers a clear statement on data. "*Scientific observations and results from Antarctica shall be exchanged and made freely available* (Art. III)."
Even at the level of ICSU the need for free and open access is becoming increasingly recognized. See "Open data in a big Data world". SCAR through the Standing Committee on Antarctic Data management has developed the SCAR Data and Information Management Strategy (DIMS). A principal component of this is the Antarctic Data Management System (ADMS) which is composed of The Antarctic Master Directory (AMD) and The National Antarctic Data Centres (NADCs). The Antarctic Master Directory is part of NASA's GCMD.

While overall the different research programs show good intent on making data and metadata available (through the AMD), this is not achieved in a consistent manner. Showing ample room from improvement.
It is clear all SRP's could be more aware of the SCADM and the ADMS. In regards to the overall reporting on data activities It would be good to have a more detailed description of how data feeds into the AMD as well as an overview of the records that belong to a specific SRP. This is a task that needs to be addressed by the SRP's and SCADM in collaboration.

For this purpose it would be good if all SRP could interact with SCADM during the upcoming SCAR OSC conference in Kuala Lumpur.
The SCADM joint meeting takes place on the 19th and 20th August. SRP's are invited to participate in this meeting (the 20th is probably of most interest). The meeting is open but notification of who will participate is mandatory. For this the SCADM Chief Officer can be contacte (avandeputte@naturalsciences.be or antonarctica@gmail.com). We believe that aprticipation to this meeting would held SRP's better understand SCAR DIMS and how to use it for improving the visibility of the research and data of their SRP.

Evaluation of the individual reports.

SERCE (score: B)

No section on data management, no mention of the AMD. Nevertheless Data archiving & exchange is mentioned for instance in a 2015 workshop.

PAIS (score: A)

PAIS has a section on data management and they provide an overview of a number of domain specific data repositories. Metadata is not always put into the AMD directly by these repositories (Pangaea, IODP). But for instance IPEV IMAGES is part of GCMD and will as such feed into the GCMD. No concrete overview of which metadata was made available and national repositories are just briefly mentioned.

AntarcticClimate21 (score: *A)*

AntClim21 has a section on data management. It seems metadata and data is not yet made available but would be in future. No Mention of the AMD specifically but they would be using SOCCOM. SOCCOM contributes to SOOS (which is a SCAR data product), and as such this also to the AMD.

AntEco (score: A)

AntEco has a section on data and metadata, no mention of the AMD specifically, but data is fed into the biodiversity.aq, a SCAR data product that feeds into the AMD. However there is no outlined protocol. Some specific contributions are listed.

AnT-ERA (score: A)

AnT-ERA has a section on data management and they provide an overview of a number of domain specific data repositories. Not all of these feed into the AMD though.

Kind Regards

Dr Anton P. Van de Putte On behalf of SCADM

Response of AnT-ERA to the 2016 reviews, recommendations by SCAR and data management evaluation

Julian Gutt (CO) and members of the AnT-ERA Steering Committee, 10 June 2016

Preface

We thank the reviewers and the SCAR EXCOM for their evaluation, constructive criticism and recommendations. We would like to emphasize that the SCAR funds are often used as important seed-money for further research activities or products. We are happy that we could successfully support in this past years many scientists and events, with special focus on early career scientists. We are and we will remain open to everyone, we are inclusive and community driven. We stick to our implementation plan (www.scar.org/scar_media/documents/science/antera/AnTERA_ImplPlan_160127.pdf).

In addition, most SC members and unofficial members of the AnT-ERA community have primarily to follow a national research strategy. As a consequence, AnT-ERA did not, and could not "grow organically based on the personal interests of scientists" (reviewer #1). The scientific focus of AnT-ERA is a product of the key issues identified by the scientific community, and SCAR's agreed strategy to focus in on biological processes, mainly related to climate change. The "pieces" that we "leave out" are well covered by the other biological SRP AntEco. We therefore disagree with the concern of reviewer #1 that "SCAR's Strategic Plan does not put a significant piece of its biological research outside AnT-ERA's reach, and that we do not provide advice (or the scientific basis for this advice), to bodies such as CCAMLR or CEP (see below). However, we would like to emphasize that according to the new SCAR Strategic Plan (draft) such scientific advice must be independent. We are not an executing agency for other international initiatives. We also would like to highlight here that some expectations raised by the reviewers exceed our opportunities. To produce field work based and SCAR-specific Nature and Science papers our budget would have to be enormously multiplied.

On request we provide here a list of papers of the national programs, which fell into the AnT-ERA scientific scope. However, we do not analyse and evaluate this list because we are not authorised to evaluate the foci and output of the national programs. We would support an initiative for SCAR to run a publication data base, and to analyse the items according to countries, disciplines and sub-disciplines, gender, early career, seniors etc. ,However, this is outside the scope of AnT-ERA and is not included in our implementation plan.

<u>In essence:</u> For the money we receive from SCAR we would like to strengthen in the future our stand alone features, comprising mainly high-end scientific communication in a diverse community, and skip administrative issues to the benefit of the first.

Response to the AnT-ERA specific recommendations.

<u>Recommendation:</u> **An effort should be made to not only present the publications of the members of the steering committee, including their students and post-docs, but also relevant publications of the wider group of members.**

<u>SC Comment:</u> The best way to demonstrate the success of AnT-ERA is to highlight its unique achievements. A list of all publications, which fell into the scope of AnT-ERA rather represents the efficiency of the national programs providing research funds for all the work behind the publications. AnT-ERA does not feel authorised to evaluate the national programs and their publications. Such a list also mirrors how wide or narrow an SRP is. However, the width of an SRP is determined in its implementation plan and not a measure of its quality. Such a list can also not be used for comparisons (and, thus, for a comparative evaluation) as long as the criteria for the selection (quality of the paper, number of co-authors, citizenship of co-authors?) are not defined. In our report we applied the only feasible definition for a selection and listed a representative number of papers, where SC-members are authors.

<u>Action:</u> Nevertheless, we provide an additional list of approx. 360 references, which fell into the scientific scope of AnT-ERA but are not co-authored by SC-members and could partially serve as examples of the progress of AnT-ERA relevant work. Criteria of the selection were applied according to our implementation plan. To provide a complete list and analyses would demand additional sources.

<u>Recommendation:</u> **The group should consider broadening the steering committee to include additional nations.**

<u>Comment:</u> 14 countries and 6 continents are represented by the 13 members of the SC: Argentina, Canada, Germany, Italy, Japan, Mexico, New Zealand, Poland, Portugal, South Africa, South Korea, Spain, UK, USA (dual citizenships included). We consider this as a high diversity of countries and good representation of continents. We are aware that this representation is not perfect. The AnT-ERA CO and SC put a lot of efforts into this issue. At the start of AnT-ERA the CO gave 3 presentations in 3 different towns within 4 days in a non-traditional SCAR country to promote AnT-ERA and offered a seat in the AnT-ERA SC without any response. For the cross-disciplinary workshop in 2015 we recognised an uneven representation of nationalities. We asked SCAR decision makers how to get access to underrepresented national programs and their representatives also for a longer perspective of cooperation. The resulting participation of one additional scientist from an underrepresented country/continent was a singular success but in general we were unable to extend the number of national programs considerably despite these efforts. AnT-ERA is community-driven. We depend on the contributions of the national programs. If countries and their representatives are interested to be represented in an active SCAR community they should recognise the value of the SCAR AnT-ERA SRP especially in the context of climate change ecosystem response and related scientific communication.

<u>Action:</u> During the 2016 biennale SCAR meeting the AnT-ERA CO will consider the delegates as the main "interface" between AnT-ERA and the scientists at the working level of all SCAR countries. He will promote AnT-ERA as a valuable tool for scientific communication etc. He will encourage all SCAR countries, but especially underrepresented national programs to contribute to AnT-ERA and benefit from its

services. If AnT-ERA will be funded for a next 4 year period the composition of the SC including the position of the CO is to be reconsidered.

Recommendation: Ant-ERA should contribute to SCAR's policy-related activities, especially to CCAMLR, CEP, and the Antarctic Environments Portal.

Comment: We listed several contributions to "policy bodies" in our report. We consider these as a major output of AnT-ERA. These even belong to the products, which would not at all, have been produced without the existence of AnT-ERA support. We would like to emphasize that we stick to our implementation plan, which has a specific scientific focus and does not include all scientific issues, as expected by referee #1, instead it covers some very important aspects, e.g. climate change impact (not nature conservation). The AnT-ERA contributions to policy bodies, listed in our report (!), take this focus into account:

- updates of the ACCE report being publicly available and reported to ATCM,
- contributions to the Antarctic Environments Portal (AEP) in a CEP context,
- UNFCCC COP21 conference, Paris, 2015. Talks in side events *Irreversible Thresholds* and *Species Conservation in a Changing Climate*: J. Gutt.
- MPA initiative (Weddell Sea): Major contributions to working papers (Gutt & Isla)

Reviewer #1 also missed these products, despite two of them being listed twice in our report! We are sorry that we forgot to mention CCAML as the body being in charge of MPAs, however, as mentioned above and despite the contribution of AnT-ERA scientists to this area, MPAs are not the major focus of AnT-ERA. Contrary to the statement of reviewer #1, climate change research issues were in the past efficiently separated between SCAR and CCAMLR, especially in the phase when the ACCE report was prepared and published.

Other contributions to "policy bodies", listed in our report (!), were:

- IPBES: reviewing
- EU-PolarNet (EPB): J. Gutt being member of the *General Assembly*
- UN-World Ocean Assessment: J. Gutt being member of the *Pool of Experts*
- AnT-ERA offered to contribute to an IPCC "Special Report".
- Also our planned mini-workshop *"Time for changes after COP21*?" in KL will contribute to a policy related discussion.

Action: We will continue to provide these and similar products. J. Gutt had been nominated as a candidate for the IPBES work program by SCAR/IOC after our report was submitted. The AnT-ERA SC started already a discussion around whether more liaison officers, e.g. to CCAMLR, IPCC could help to improve efficient relationships.

Recommendation: AnT-ERA's report noted that a significant amount of funds has been spent to support early career researchers; they should consider adding information on funds spent on scientists from countries with less well developed Antarctic programmes.

Comment: We think "less well developed Antarctic programmes" should be consistently defined before we can apply these criteria to an evaluation.

Action: Here we provide a map of all countries supported by AnT-ERA funds.

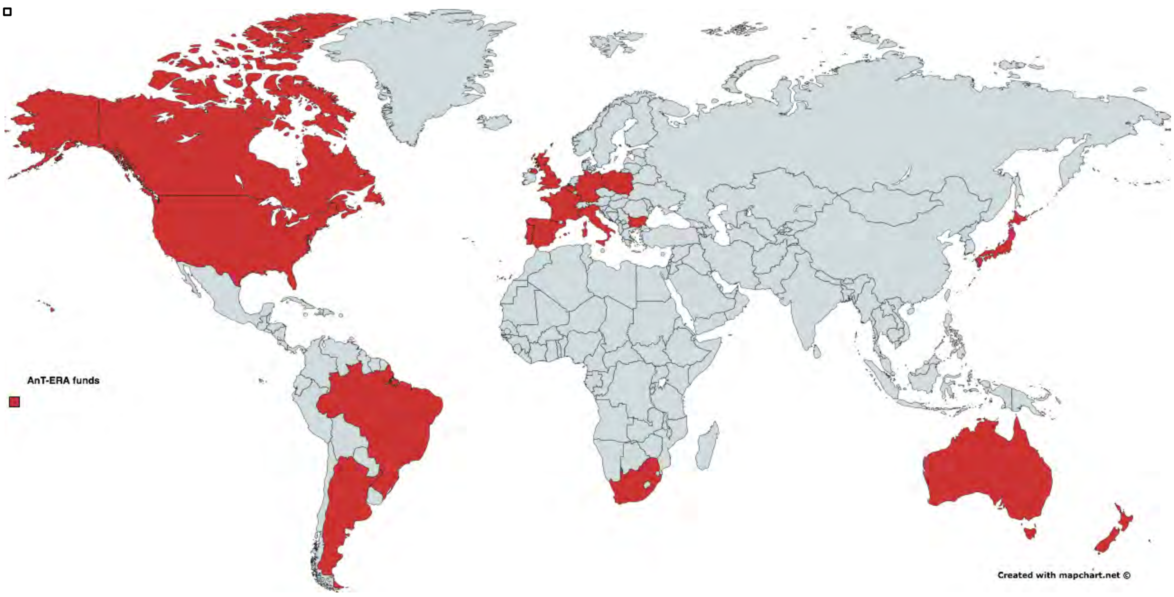

Fig. 1: Map of all countries supported by AnT-ERA mini-grants.

<u>Recommendation:</u> AnT-ERA might consider other dissemination tools to help spread the great work they are doing.

<u>Comment:</u> Our main dissemination tool is the low-budget AnT-ERA webpage on the SCAR website. We do not recommend to compare the hits of different SRPs because they provide only a poor measure for the success of a web-page. A detailed statistical evaluation of the AnT-ERA page hits is not possible for the webmaster due to his limited rights. A less spectacular but maybe better measure of our webpage-based outreach efficiency, not mentioned in our report, is the increase of hits immediately after announcements through the AnT-ERA mailing list. If new web-articles are announced more than 90% of the 520 list members, which comprise the AnT-ERA and a major proportion of the SCAR biology community, visit the AnT-ERA webpage.

<u>Action:</u> (1) We will ask SC members to be in charge of additional dissemination tools or try to hire an external dissemination expert since the capacities of the CO and the SC members are limited. We could apply for additional SCAR funds and other support, e.g. advanced training, to establish such tools. We agree with referee #1 that a professional E&O program would increase our visibility. However, we do not plan to modify our implementation plan in a way that professional E&O work will be financed to the disadvantage of scientific mini-grants. (2) Stimulated by comments of reviewer #3, we added "/more..." to the appetizers of all 35 web-articles and enlarged "TOP!" at their end for a better orientation of the user. (3) The AnT-ERA SC will discuss how to increase the visibility of the webpage based on our successful amateur performance.

<u>Recommendation:</u> Ant-ERA should recommended to members to mention in their publications that the paper is a contribution to the SCAR AnT-ERA SRP.

<u>Action:</u> We will ask the community members to mention in publications, which fall into the scientific scope of AnT-ERA that the paper contributes to the SCAR AnT-ERA SRP.

Response to the "Recommendations for all SRPs and/or SCAR"

Key output

Comment: We provided summary information in the 1st paragraph of our report as requested: "*It (AnT-ERA) contributed considerably to major advances in the knowledge on climate-change impacted Antarctic biological processes since mid-2013. One advance was a general identification of ecosystem components (systematic groups, trophic levels, regionally defined communities), which are assumed to be stenoecious "losers" with a low resilience (self-repair capacity) or "winners" due to unexpected organism plasticity. Such conclusions result from topical environmental change studies and increase in fundamental biological knowledge. .... Concerning interactions between the atmosphere and ocean on the one side and the terrestrial and marine biosphere on the other we are now much better informed in where to look for a comprehensive and detailed assessment of the impact of climate change. This advance is mainly based on interdisciplinary and cross-program exchange of information*." 'Technical' output (workshops, contributions to conferences, special issues) is emphasized in the next paragraphs of our report.

Action: An overarching synthesis of AnT-ERA related research topics is planned for the 2nd half of a possible 2nd funding period, but the format is still to be discussed because it depends on the availability of funds and resources. If AnT-ERA ends at the end of the 1st funding period in 2017 a report must be provided soon after its end.

Evaluating research impact

Comment: The requested metrics and detailed statistical analyses for several hundreds of publications can only be provided when additional funds or work capacities are made available. We must use our regular AnT-ERA funds according to our implementation plan. Additional person power on a volunteer basis is not available. If such analyses can be realised criteria for the statistics must be standardised and transparent. The metrics must finally be selected with respect to the aims of the implementation plan.

Action: It should be discussed during the next SCAR biennale meetings, how much effort/money should be spent for such statistics and how much these contribute to assessing the success of an SPR.

Acknowledging SCAR on publications

See above

Direct achievements

Comment: We appreciate the differentiation between products, which would/would not have been produced without SCAR support. We think, the quantity and quality of such direct achievements are the best measure to evaluate the success of an SRP.

Action: Here we list events/products from our report of which we are convinced would not have happened without AnT-ERA support:

1. Two special volumes (this can mean that some papers had not been published at all, but some others had maybe been published elsewhere without AnT-ERA support).
2. One cross-program and interdisciplinary review paper, a second is in preparation. We must mention here that the writing of papers can generally not be financed by AnT-ERA due to the limited funds. However, on the one hand a very small contribution of maybe

5% SCAR support could be essential for a paper. This was the case for the review mentioned above. On the other hand also a big contribution of >50%, not only for a paper but also for an event, could theoretically also be taken over by other funding agencies and the product could have been produced without SCAR support.
3. The EBA/AnT-ERA workshop (Napoli)
4. The cross-program workshop organised and initiated by AnT-ERA (Barcelona)
5. AnT-ERA website (scientific highlights, news, job and funding opportunities
6. major contributions to the ACCE updates
7. major contribution to the Antarctic Environments Portal
8. Support mainly of early career scientists through mini-grants
9. Presentations during UNFCCC COP21, Paris, 2015
10. The communication within the SCAR community to which AnT-ERA contributes significantly, is the basis to get involved in major SCAR events, e.g. conferences, symposia, 1st Southern Ocean and Antarctic Horizon Scan. However, we cannot assess to which degree such engagement would also have been possible without AnT-ERA.

"Less well-developed Antarctic programs

Comment: AnT-ERA was from its beginning open to all countries, was inclusive and supported a variety of different countries. The actual representation of SCAR countries in AnT-ERA events (in a broad sense) represents this open mindedness and is a compromise of (1) the pressure to provide high-end scientific results, (2) the willingness of the national programs and individual researchers to contribute, (3) the access of the AnT-ERA leaders to the scientific working level in various SCAR countries, (4) the overlap/non-overlap between the AnT-ERA main research issues and those of the national programs.

Action: Here we provide a graph of the events per persons per citizenship/country being involved in single events, which would not have been possible without AnT-ERA support.

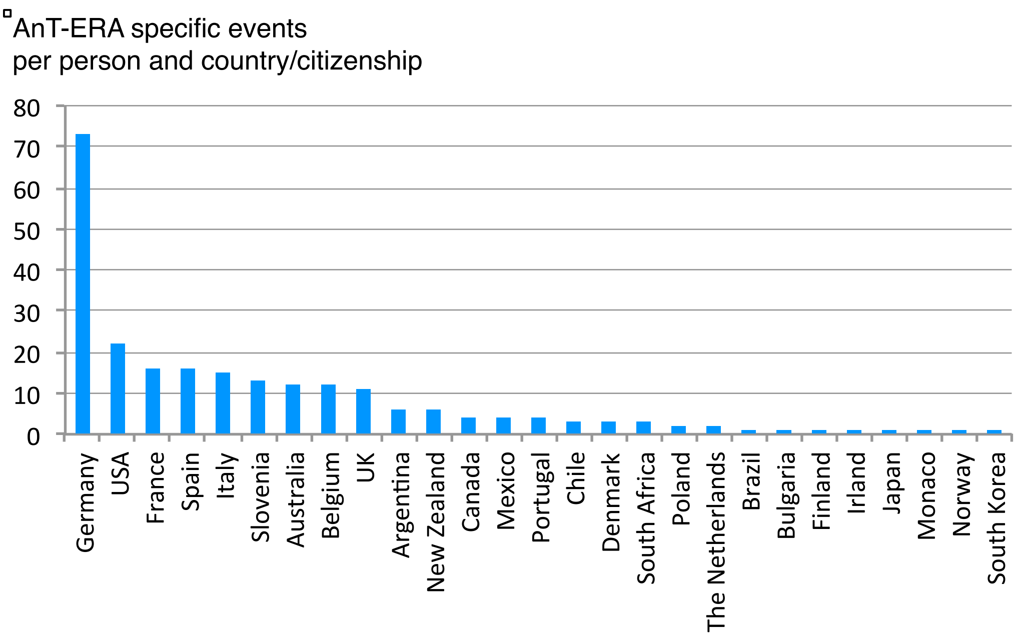

Fig. 2: Abundance of AnT-ERA specific events per person and per country/citizenship. Papers that contributed to the ACCE updates not considered, concerning the webpage only authorships of "highlight"-articles were counted, involvement in conference organisation not counted. The exceptional high abundance of German events is due to the fact that the CO is German and as such maybe the most active SC member.

During the 2016 biennale SCAR meeting the AnT-ERA CO will consider the delegates as the main "interface" between AnT-ERA and the scientists at the working level of all SCAR countries. He will promote AnT-ERA as a valuable tool for scientific communication etc. He will encourage all SCAR countries, but especially underrepresented national programs to contribute to AnT-ERA and benefit from its services. If AnT-ERA will be funded for a next 4 year period the composition of the SC including the position of the CO can be reconsidered.

Horizon Scan

Action: We provide a list of cross-linkages between the 1st Southern Ocean and Antarctic Horizon Scan and major AnT-ERA research issues mentioned in our implementation plan. A manuscript on details of this topic based on the AnT-ERA brainstorming workshop in Barcelona in 2015, is in preparation. Its finalisation however, is delayed due to more urgent SCAR obligations.

Table 1: Crosslinkages between 1st Southern Ocean and Antarctic Horizon Scan and AnT-ERA. Key words, which demonstrate the overlap between both initiatives and which are explicitly mentioned in the AnT-ERA implementation plan in bold.

1st Southern Ocean and Antarctic Horizon Scan questions "Antarctic life at the precipice" and "Human presence in the Antarctic".	AnT-ERA issues
43. What is the genomic basis of adaptation in Antarctic and Southern Ocean organisms and communities?	**Adaptation** is a major scientific issue of Theme 1: "Physiological limits, biomolecular processes, and thresholds" and part of AnT-ERA's name.
44. How fast are mutation rates and how extensive is gene flow in the Antarctic and the Southern Ocean?	**Mutation** is a major scientific issue of Theme 1
48. Which ecosystems and food webs are most vulnerable in the Antarctic and Southern Ocean, and which organisms are most likely to go extinct?	**Vulnerability** is a major general issue mentioned in the "Introduction" and "Background". Species **extinction** is an issue of Theme 2 "Population processes" and Theme 3 "Ecosystem functioning and services"
49. How will threshold transitions vary over different spatial and temporal scales, and how will they impact ecosystem functioning under future environmental conditions?	**Thresholds** are an issue of all three themes and are part of AnT-ERA's name. The impact of environmental change is THE overarching issue of AnT-ERA. Ecosystem functioning is part of the title of theme 3.
50. What are the synergistic effects of multiple stressors and environmental change drivers on Antarctic and Southern Ocean biota?	The impact of **environmental change** is THE overarching issue of AnT-ERA. **Multiple stressors** were a major topic of our cross-program Barcelona workshop and the AnT-ERA specific review paper
51. How will organism and ecosystems respond to a changing soundscape in the Southern Ocean?'	The impact of environmental **change** is THE overarching issue of AnT-ERA.
53. What is the exposure and response of Antarctic organisms and ecosystems to atmospheric contaminants (e.g. black carbon, mercury, sulfur, etc.), and are the sources and distributions of these contaminants changing?	The impact of environmental **change** is THE overarching issue of AnT-ERA.
54. How will the sources and mechanisms of dispersal of propagules into and around the Antarctic and Southern Ocean change in the future?	The impact of environmental **change** is THE overarching issue of AnT-ERA. **Dispersal** is recognised as one major driver for population (theme 2) ecosystem processes (theme 3)
56. How will climate change affect the risk of spreading emerging infectious diseases in Antarctica?	The impact of environmental **change** is THE overarching issue of AnT-ERA.

1st Southern Ocean and Antarctic Horizon Scan questions "Antarctic life at the precipice" and "Human presence in the Antarctic" (continued).	AnT-ERA issues (continued)
58. How will climate change affect existing and future Southern Ocean fisheries, especially krill stocks?	Ecosystem services under **ecosystem change** scenarios, explicitly **krill** is a major issue of theme 3
59. How will linkages between marine and terrestrial systems change in the future?	The impact of environmental **change** is THE overarching issue of AnT-ERA.
60. What are the impacts of changing seasonality and transitional events on Antarctic and Southern Ocean marine ecology, biogeochemistry and energy flow?	The impact of environmental **change** is THE overarching issue of AnT-ERA. The pronounced **seasonality** and potential changes are an important background for our implementation plan. **Ecosystem functioning** (theme 1), **biogeochemistry** (theme 3) and **energy transfer** (theme 3) must be considered at least partly a "current biological process", which is the main focus of AnT-ERA.
61. How will increased marine resource harvesting impact Southern Ocean biogeochemical cycles?	Ecosystem services in relation to **biogeochemical cycles** shape theme 3
62. How will deep sea ecosystems respond to modifications of deep water formation, and how will deep sea species interact with shallow water ecosystems as the environment changes?	AnT-ERA covery all ecosystems/habitats. **Population performance and species interactions** is a major issue of theme 2. The impact of environmental **change** is THE overarching issue of AnT-ERA.
63. How can changes in the form and frequency of extreme events be used to improve biological understanding and forecasting?	**Environmental extremes** or **extreme events** are a major issue of theme 1 and 3
64. How can temporal and spatial 'omic-level' analyses of Antarctic and Southern Ocean biodiversity inform ecological forecasting?	The largest proportion of theme 1 is dedicated to process orientated **"omics"** in an ecological context: **proteomic, metagenomic, next generation genomic, transcriptomic**
65. What will key marine species tell us about trophic interactions and their oceanographic drivers such as future shifts in frontal dynamics and stratification?	Amplification of population processes in lower **trophic** levels through food webs are a major issue of theme 2. Ecosystem boundaries such as **fronts** are considered a main **driver** in theme 3.
74. How can natural and human-induced environmental changes be distinguished, and how will this knowledge affect Antarctic governance?	**Human impacts** are an overarching issue of AnT-ERA
75. What will be the impacts of large-scale, direct human modification of the Antarctic environment?	**Human impacts** and **environmental** change are overarching issues of AnT-ERA
79. What is the current and potential value of Antarctic ecosystem services?	**Ecosystem services** is a major issue of theme 3
80. How will humans, diseases and pathogens change, impact and adapt to the extreme Antarctic environment?	**Adaptation** of biota is an overarching issue, it is even part of AnT-ERA's name

Feed-back/outreach of early career support

Comment: The effort to be expected from AnT-ERA awardees must be in a fair balance to the usual amount of US $ 1500 per mini-grant. Alternatively we could expect more than so far, e.g. to organise a webinar or a second presentation in their home countries. However, this would increase the amount of money being needed for one grant. Our implementation plan had to be modified accordingly to the disadvantage of the number of awardees, the variety of research issues and national programs to be supported.

Action: Occasionally we asked colleagues to write a web-article on the issue supported by AnT-ERA, but this cannot be applied to all awardees. We will continue with this approach, which is on a volunteer basis.

Linkages with IPCC

Comment: Linkages between SCAR and IPCC had been recognised in the past as not very well developed or communicated. This was discussed in the Life Sciences meeting and ACCE group several years ago.

Action: AnT-ERA recently offered to contribute significantly to an IPCC special issue.

Coordination through SRPs to be assessed by Social Sciences groups

Comment: We appreciate this initiative.

Action: If requested we will practically support this initiative

Showcasing results by SCAR

Comment: We appreciate this initiative.

Action: We will provide information if demanded. Much information can already now be directly accessed from our webpage.

SCAR communication strategy

Comment: We appreciate this initiative but remind the decision makers that funds must be provided to fulfil the requirements.

Acknowledging SCAR

See above

Publication reference collection

Comment: Wouldn't the development of a standardised search tool or definitions of search and filtering instructions when using existing bibliographic databases be more efficient and cheaper?

Details of data storage

Comment: SCAR can use data of national programs but we do not know about (biological) data owned by SCAR. We do not need more repositories for data and metadata or portals, see also above for bibliographic data. We need a manageable number of user-friendly repositories and easy and free access to the data through efficient portals.

New national funding sources

Comment: We look forward to the new fund raising opportunities! Which funding agency provides the calls?

Action: As soon as the calls are published and the funding guidelines fall into our scientific scope we will apply for them.

Response to the data management evaluation

Data management follows primarily national rules of the countries of the data "owners" to be harmonised with international SCAR rules. A broad variety of AnT-ERA science issues also demand a variety of data repositories. This is also the reason, why we emphasize above the need of a clear structure of different data management networks.

<u>Annex to:</u> Response of AnT-ERA to the 2016 reviews, recommendations by SCAR and data management evaluation

Selected publications (2013-2016) related to the SCAR Scientific Research Programme *AnT-ERA* with authors that are not related to the Steering Committee.

To be cited or used for other purposes only in aggreement with J. Gutt

Abakumov, E., and N. Mukhametova. 2014. Microbial biomass and basal respiration of selected Sub-Antarctic and Antarctic soils in the areas of some Russian polar stations. Solid Earth **5**:705-712.

Acosta, M. C., P. Mathiasen, and A. C. Premoli. 2014. Retracing the evolutionary history of Nothofagus in its geo-climatic context: new developments in the emerging field of phylogeology. Geobiology **12**:497-510.

Aguera, A., M. Collard, Q. Jossart, C. Moreau, and B. Danis. 2015. Parameter Estimations of Dynamic Energy Budget (DEB) Model over the Life History of a Key Antarctic Species: The Antarctic Sea Star Odontaster validus Koehler, 1906. Plos One **10**.

Alcaino, J., V. Cifuentes, and M. Baeza. 2015. Physiological adaptations of yeasts living in cold environments and their potential applications. World Journal of Microbiology & Biotechnology **31**:1467-1473.

Allende, L., and G. Mataloni. 2013. Short-term analysis of the phytoplankton structure and dynamics in two ponds with distinct trophic states from Cierva Point (maritime Antarctica). Polar Biology **36**:629-644.

Almroth, B. C., N. Asker, B. Wassmur, M. Rosengren, F. Jutfelt, A. Grans, K. Sundell, M. Axelsson, and J. Sturve. 2015. Warmer water temperature results in oxidative damage in an Antarctic fish, the bald notothen. Journal of Experimental Marine Biology and Ecology **468**:130-137.

Archer, S. D. J., I. R. McDonald, C. W. Herbold, C. K. Lee, and C. S. Cary. 2015. Benthic microbial communities of coastal terrestrial and ice shelf Antarctic meltwater ponds. Frontiers in Microbiology **6**.

Aronson, R.B., K. E. Smith, S. C. Vos, J. B. McClintock, M. O. Amsler, P.-O. Moksnes, D. S. Ellis, J. Kaeli, H. Singh, J. W. Bailey, J. C. Schiferl, R. van Woesik, M. A. Martin, B. V. Steffel, M. E. Deal, S. M. Lazarus, J. N. Havenhand, R. Swalethorp, S. Kjellerup, and S. Thatje. 2015. No barrier to emergence of bathyal king crabs on the Antarctic shelf. Proc. Natl. Acad. Sci. U. S. A. **112** (42), 12997–13002.

Arrigo, K. R. 2014. Sea Ice Ecosystems. Annual Review of Marine Science, **6**, 439–67.

Arthur, B., M. Hindell, M. N. Bester, W. C. Oosthuizen, M. Wege, and M. A. Lea. 2016. South for the winter? Within-dive foraging effort reveals the trade-offs between divergent foraging strategies in a free-ranging predator. Functional Ecology, DOI: 10.1111/1365-2435.12636

Assmy, P., B. Cisewski, J. Henjes, C. Klaas, M. Montresor, and V. Smetacek. 2014. Response of the protozooplankton assemblage during the European Iron Fertilization Experiment (EIFEX) in the Antarctic circumpolar current. Journal of Plankton Research **36**:1175-1189.

Auerswald, L., B. Meyer, M. Teschke, W. Hagen, and S. Kawaguchi. 2015. Physiological response of adult Antarctic krill, Euphausia superba, to long-term starvation. Polar Biology **38**:763-780.

Baird, H. P., and J. S. Stark. 2014. Spatial and temporal heterogeneity in the distribution of an Antarctic amphipod and relationship with the sediment. Marine Ecology Progress Series **502**:169-183.

Bajerski, F., and D. Wagner. 2013. Bacterial succession in Antarctic soils of two glacier forefields on Larsemann Hills, East Antarctica. Fems Microbiology Ecology **85**:128-142.

Balarinova, K., M. Bartak, J. Hazdrova, J. Hajek, and J. Jilkova. 2014. Changes in photosynthesis, pigment composition and glutathione contents in two Antarctic lichens during a light stress and recovery. Photosynthetica **52**:538-547.

Ball, B. A., and J. Levy. 2015. The role of water tracks in altering biotic and abiotic soil properties and processes in a polar desert in Antarctica. Journal of Geophysical Research-Biogeosciences **120**:270-279.

Ball, B. A., and R. A. Virginia. 2014. The ecological role of moss in a polar desert: implications for aboveground-belowground and terrestrial-aquatic linkages. Polar Biology **37**:651-664.

Barker, J. D., A. Dubnick, W. B. Lyons, and Y. P. Chin. 2013. Changes in Dissolved Organic Matter (DOM) Fluorescence in Proglacial Antarctic Streams. Arctic Antarctic and Alpine Research **45**:305-317.

Barnes, D.K.A., M. Fenton, A. Cordingley. 2014. Climate-linked iceberg activity massively reduces spatial competition in Antarctic shallow waters. Curr. Biol. **24** (12), R553–R554.

Barria, C., M. Malecki, and C. M. Arraiano 2013. Bacterial adaptation to cold. Microbiology, **159**, 2437–2443.

Baylis, A. M. M., R. A. Orben, P. Pistorius, P. Brickle, I. Staniland, and N. Ratcliffe. 2015. Winter foraging site fidelity of king penguins breeding at the Falkland Islands. Marine Biology **162**:99-110.

Beaulieu, M., A. M. Thierry, D. Gonzalez-Acuna, and M. J. Polito. 2013. Integrating oxidative ecology into conservation physiology. Conservation Physiology **1**.

Belchier, M., and J. Lawson. 2013. An analysis of temporal variability in abundance, diversity and growth rates within the coastal ichthyoplankton assemblage of South Georgia (sub-Antarctic). Polar Biology **36**:969-983.

Benoit-Bird, K. J., and G. L. Lawson. 2016. Ecological Insights from Pelagic Habitats Acquired Using Active Acoustic Techniques. Pages 463-490 *in* C. A. Carlson and S. J. Giovannoni, editors. Annual Review of Marine Science, Vol 8.

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Bestley, DS., I.D. Jonsen, M.A. Hindell; R.G. Harcourt, and N.J. Gales. 2015. Taking animal tracking to new depths: synthesiting horizontal-vertical movement relationships for four marine predators. Ecology **96**:417-427.

Bissett, A., M. V. Brown, S. D. Siciliano, and P. H. Thrall. 2013. Microbial community responses to anthropogenically induced environmental change: towards a systems approach. Ecology Letters **16**:128-139.

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