

Attachment A - Mapping SCAR research to the CEPs Climate Change Response Work Programme. See IP (par 6) for explanation of group acronyms

Climate related issue	Gaps/Needs	SCAR Group	Detail	Time frame for outputs	Outputs/upcoming developments
Enhanced potential for non-native species (NNS) introduction establishment	<ul style="list-style-type: none"> <li>• Framework for surveillance for non-native species establishments in marine, terrestrial and freshwater environment</li> <li>• Response strategy for suspected NNS introductions</li> <li>• Assessment of whether existing regimes for preventing NNS introductions and transfer are sufficient. Analyse management tools applied in other areas.</li> </ul>	AntEco	AntEco includes non-native species (NNS) amongst its human impacts priorities (AntEco Research Sector 5: Impacts, trends and conservation), and has a primary aim of ongoing policy evaluation and advising SCAR/ATS on conservation and management of Antarctic ecosystems.  <a href="http://www.biodiversity.aq">www.biodiversity.aq</a> and the register of Antarctic species is currently under development in the framework of antaBIS and can be used to store and exchange results of surveillance programs.	Medium-long-term  Long-term	Scientific publications. Submissions to the CEP. Evaluation of non-native species policy development and implementation within the Antarctic Treaty area.  Extensive databases, online portals and species registers
		AnT-ERA	Monitoring plankton in Potter Cove (South Shetland Islands)  Studies on near-shore marine communities including non-native species  AnT-ERA studies into the detailed attributes of NNS to help assess the risks and potential ranges associated with them	Medium-long-term	Scientific publications.
		SCATS	Monitoring biological invasion across the broader Antarctic: A baseline and indicator framework	Medium-long-term	Scientific publications and submissions to the CEP
	<ul style="list-style-type: none"> <li>• Improved understanding of risks associated with relocation of native terrestrial species</li> <li>• Assessment and mapping of Antarctic habitats at risk of invasion</li> <li>• Assessment of risks of introducing non-native marine species.</li> <li>• Techniques for eradication and control</li> </ul>	AntEco	Ongoing research on eradications and their effects, risk assessments of potential invaders  Towards an evidence based protection in terrestrial Antarctica – delineating Antarctic habitats	Ongoing  2016-2019	Scientific publications. SCAR Codes of Conduct ( <a href="http://www.scar.org/codes-of-conduct">http://www.scar.org/codes-of-conduct</a> ) also provide guidance for minimizing the introduction of non-native species  Scientific publication (late 2017), submission to 2018 CEP
		PAIS	PAIS is mapping the sea bed around Antarctica and is also sampling and investigating modern habitat on the sea bed and in the water column	Jan-Feb 2017	Cruise report and publications
		SCATS	Assessment of risk of continent wide establishment of non-native species	2012	Scientific publications and submission to the CEP.
<ul style="list-style-type: none"> <li>• Ongoing surveillance programme to identify</li> </ul>	ANTOS - AG	ANTOS aims to establish an observation system to document variations and changes in environmental conditions and biological systems around Antarctica.	Medium-long-term	Spatially and temporally explicit environmental data	

	status of NNS in light of climate change	AntEco	<a href="http://www.biodiversity.aq">www.biodiversity.aq</a> and the register of Antarctic species, currently being developed under the framework of antaBIS, can be used to store and exchange results of surveillance programs. This work is closely linked to activities of EG-ABI	Medium-long-term	Databases and species registers
		PAIS	PAIS is instrumental in identifying key areas where the impact of future climate change on the environment (including NNS) can be monitored	2016-2020	Publications after IODP expeditions 374 (Ross Sea, in 2018), 379 (in the Amundsen Sea, 2019), 373 (in George V Land in 2020)
Change to the terrestrial (incl. aquatic) biotic and abiotic environment due to climate change	<ul style="list-style-type: none"> <li>Understanding how terrestrial and freshwater biota will respond to a changing climate and the impacts of these changes</li> <li>Understanding as to how the abiotic terrestrial environment will change and the impacts of these changes</li> </ul>	Remote Sensing AG	Remote Sensing AG is conducting a repeated (long-term) monitoring of the distribution and abundance of key species (e.g. penguins) using remote sensing methods.	Medium-long-term	Distribution maps, abundance curves, reports, scientific publications, submissions to the CEP
		ANTOS Expert Group	The SCAR ANTOS Expert Group aims to foster and facilitate collection and sharing of long-term automated climate and associated environmental observations across Antarctica and national programmes. Terrestrial environments are one of the main targets of ANTOS.	Medium-long-term	ANTOS will provide guidance on the development of a long-term vision for observation systems to understand biological systems in a changing environment and on the adoption of a comprehensive continent-wide approach based on the collaboration of national programs and shared protocols.
		AnT-ERA	Several streams of research into this area, with a particular focus on the terrestrial Ross Sea region.	Until 2021	Scientific publications
		AntClim21	The main goal of AntClim21 is to promote research towards improving long-term projections of the physical Antarctic climate system to the year 2100 and beyond.  It is important to note therefore that near-term (decadal timescale) prediction is not central to AntClim objectives. However, a key activity is to help non-specialist researchers to independently access and evaluate Antarctic climate data by engagement across communities at workshops and meetings.	2012-2020	The results of AntClim21 research will be communicated over the next four years through (i) publication of papers, (ii) workshops to facilitate communication across disciplines and (iii) communication with broader stakeholders through contributions to ACCE updates, involvement in relevant IPCC activities, and submissions to the Antarctic Treaty System (and ATCM meetings) through SCATS.
		AntEco	Towards evidence based protection in terrestrial Antarctica – delineation of Antarctic habitats.	2016-2020	Publication due 2017, submission to 2018 CEP
		IPICS -EG	IPICS (particularly under the Antarctic 2k activity) provides the climatic context for assessing the climate changes these biota are undergoing – what has occurred and how unusual is it in the multi-centennial context?	Short-medium term	Paper describing patterns of temperature change over last 2000 years in 2017.
Change to marine near-shore abiotic and biotic environment	<ul style="list-style-type: none"> <li>Understanding and have the ability to predict near-shore</li> </ul>	BEPSII - AG	The BEPSII - AG supports and develops an international community on sea-ice biogeochemistry; stimulates the interaction between experimentalists and modellers working on this	2017-2021	BEPSII will provide consistent methodologies for sea-ice biogeochemical research, especially with developments towards large-scale, autonomous and high-frequency sampling of sea-ice

(excluding Ocean Acidification)	<p>marine changes and impacts of the change</p> <ul style="list-style-type: none"> <li>• Have a broader understanding of what monitoring data will be required to assess climate driven changes to the marine environment</li> </ul>		topic and helps the community articulate research priorities and identify optimized and cost-effective approaches and research platforms.		biogeochemical parameters, as well as effective sea-ice biogeochemical data archiving approaches and databases. BEPSII will also deliver an improved representation and evaluation of sea-ice biogeochemistry in regional and Earth System numerical models
		AntEco	<p>AntEco, specifically Research Sector 1 (Spatial Ecology) has a seafloor characterisation program in the nearshore marine environment, adjacent to Australia's Antarctic stations. Aims to provide fundamental baseline datasets for assessing future change, supporting a range of science end-users and leading to better informed environmental management.</p> <p>The Diversity and Structure of Antarctic Benthic Communities (DISTANTCOM) project will provide information on marine shallow benthic invertebrates regarding distribution, trends, biodiversity, abiotic and biotic environment.</p>	2016-2018	<p>AntEco will provide high resolution bathymetry and backscatter grids (1-2 m resolution), geomorphic and benthic habitat maps, sediment samples and composition information, underwater imagery and characterisation of benthic community composition.</p> <p>Scientific publications and reports</p>
		Ant-ERA	<p>Ant-ERA affiliated research groups have been collecting data since 1988 to follow benthic recovery from contamination of the seabed by McMurdo Station, but also from the impact of the B 15 iceberg that lodged at the entrance to McMurdo Sound in 2000-2005.</p> <p>Monitoring environmental variables in Potter Cove (South Shetland Islands) since the 90's; doing some experimental work and modelling to understand further effects of warming.</p> <p>Response of higher predators to climate change</p> <p>Response of near-shore marine communities to climate</p>	<p>1988-2014</p> <p>Medium-long</p>	<p>Scientific publications covering events over 2000-2014 are aimed to be written in 2017-2018.</p> <p>Scientific publications</p> <p>Scientific publications</p>
		ASPeCT	<p>ASPeCT – PIPERS (Polynyas, Ice Production and seasonal Evolution in the Ross Sea). Polynya openings and closings in response to atmospheric forcing: location of polynyas and changes related to interaction with ice shelf and glacier tongue changes). Antarctic Fast Ice Network provides sea ice and near-surface oceanography, monitoring changes in the response of fast ice climate driven changes.</p>	<p>PIPERS-2017-2019</p> <p>AFIN-long-term</p>	<p>A two month (April 15-June 15 2017) cruise into the Ross Sea on the US Icebreaker NB Palmer will be conducting an atmosphere-ice-ocean interaction experiment in the polynyas and sea ice regions of the western Ross Sea</p>

			Expedition to measure snowfall and sea surface salinity (and temperature) around Antarctica – to investigate whether/the extent to which ocean surface freshening may be contributing to observed change in sea ice coverage.  Observing the physical properties of sea ice-programme of buoy deployment.	2016-2017  Ongoing	Scientific publications  <a href="http://www.pangaea.de/PHP/CruiseReports.php?b=Polarstern">http://www.pangaea.de/PHP/CruiseReports.php?b=Polarstern</a>
		ANTOS-EG	The SCAR ANTOS Expert Group aims to foster and facilitate collection and sharing of long-term automated climate and associated environmental observations across Antarctica and national programmes. Terrestrial environments are one of the main targets of ANTOS.	Medium-long-term	ANTOS will provide guidance on the development of a long-term vision for observation systems to understand biological systems in a changing environment and on the adoption of a comprehensive continent-wide approach based on the collaboration of national programs and shared protocols.
		AntClim21	The main goal of AntClim21 is to promote research towards improving long-term projections of the physical Antarctic climate system to the year 2100 and beyond.  It is important to note therefore that near-term (decadal timescale) prediction is not central to AntClim21 objectives. However, a key activity is to help non-specialist researchers to independently access and evaluate Antarctic climate data by engagement across communities at workshops and meetings.	2012-2020	The results of AntClim21 research will be communicated over the next four years through (i) publication of papers, (ii) workshops to facilitate communication across disciplines and (iii) communication with broader stakeholders through contributions to ACCE updates, involvement in relevant IPCC activities, and links with the Antarctic Treaty System (and ATCM meetings) through SCATS.
		SOOS	SOOS Capability Working Group on ecosystem Essential Oceanic Variables (eEOV) is working on developing a set of variables which represents a defined biological or ecological quantity, is derived from field observations, and which contributes significantly to assessments of Southern Ocean ecosystems	Ongoing	Scientific publications and reports
		SORP	The CLIVAR/CLiC/SCAR Southern Ocean Region Panel was formed to serve as a forum for the discussion and communication of scientific advances in the understanding of climate variability and change in the Southern Ocean.	Ongoing	Advice to SCAR on progress, achievements, new opportunities and impediments in internationally-coordinated Southern Ocean research
Ecosystem change due to ocean acidification	Understanding of the impact of OA to marine biota and ecosystems	Ocean Acidificatio	The SCAR AG on OA has developed a report on Southern Ocean OA. This documents present rates and rationality of OA from observations and	2015-2018	SCAR Lecture 2015, report and associated publication mid-2017, submission to CEP in 2018

		n Expert Group	projections from climate models. Reviews of organism and ecosystem responses from experimentations and observations are reviewed and analysed.		
		ASPeCT	ASPeCT-PIPERS experiment will be measuring CO2 exchange in polynyas and unravelling the role of polynyas as sources or sinks of CO2 and their role in modulating or enhancing ocean acidification.	PIPERS-2017-19	Cruise planned for April 2017 – see also above.
		ANTOS-EG	ANTOS will provide information with which to document and detect change in coastal marine systems	Medium-long-term	Long-term environmental data
		PAIS	PAIS aims to reconstruct environmental changes during past glacial and interglacials by integrating fossil records with geochemical and other proxies, to understand the relationship between bio-productivity (terrestrial and marine), climate, ice sheet and ocean dynamics, including acidification.	2016-2020	Scientific publications
		ICED	ICED – ongoing work on the effects of ocean acidification on Southern Ocean ecosystems, including: -Assessing the synergy of OA with other anthropogenic environmental stressors; -Estimating the impact of OA on ocean resources and ecosystem services; -Developing the use of OA indicator species to consolidate their potential for a policy-management perspective	Ongoing	Recent relevant outputs: Publication on responses of pelagic food webs to increased acidification. ICED input to SCAR Ocean Acidification group. ICED input to the High CO2 Symposium, Hobart, May 2016
		SOOS	SOOS Capability Working Group on ecosystem Essential Oceanic Variables.(eEOV) is working on developing a set of variables which represents a defined biological or ecological quantity, is derived from field observations, and which contributes significantly to assessments of Southern Ocean ecosystems	Ongoing	Scientific publications and reports
		AnT-ERA	Research related to Ocean Acidification impacts on marine biota	Short-medium-term	Scientific publications
		SORP	The CLIVAR/CLIC/SCAR Southern Ocean Region Panel was formed to serve as a forum for the discussion and communication of scientific advances in the understanding of climate variability and change in the Southern Ocean.	Ongoing	Advice to SCAR on progress, achievements, new opportunities and impediments in internationally-coordinated Southern Ocean research
Climate change impact to the built	<ul style="list-style-type: none"> <li>Understanding how the abiotic terrestrial</li> </ul>	HASS-EG History-EG	HASS-EG undertakes research on Antarctic values, including heritage and environmental values	2013- 2019	Scientific publications, books, book chapters, submissions to the ATCM/CEP

(human) environment resulting in impacts on natural and heritage values	<p>environment will change and how this might impact result in impacts on environmental or heritage values</p> <ul style="list-style-type: none"> <li>• Understanding of effects of climate change on contaminated sites and implications for species/ecosystems (e.g. whether climate change will increase mobilization and exposure of species/ecosystems to contaminants and understanding how species/ecosystems will respond to exposure to such contaminants)</li> <li>• Understanding what conservation/remedial interventions might be applicable to counteract these impacts</li> </ul>		<p>NSF funded project on the history of the Dry Valleys including climatic changes. This project is linked to the Long Term Ecological Research (LTER) project and involves the collection and critical interpretation of historical data, their context and politics including on Antarctica, climate change, and the Anthropocene.</p> <p>Research on Antarctic heritage, especially with regard to Sweden's motivation to work out procedures on how to deal with heritage.</p> <p>Funding has just been obtained for a project on Antarctic heritage values and management. Aside from focussing on the values and meanings of Antarctic heritage, the political structures for managing heritage, this project will also explore the linkage between cultural heritage and environmental protection through a prism of values.</p>		<p>Planned outputs include a state-of-the-art edited volume on heritage; a series of academic papers; a report on the efficacy and value for current structures for the designation and management of heritage made available to SCAR; advice to the ATCM through a network of experts and SCATS.</p>
Marine and terrestrial species at risk due to climate change	<ul style="list-style-type: none"> <li>• Understand population status, trends, vulnerability and distribution of <i>key</i> Antarctic species</li> <li>• Improved understanding of effect on climate on species at risk, including critical thresholds that would give irreversible impacts</li> <li>• Framework for monitoring to ensure the effects on <i>key</i> species are identified</li> </ul>	ICED	<p>ICED is undertaking integrated circumpolar analyses to improve our understanding of change and the implications for Southern Ocean ecosystems and their management. Progress has been made in understanding the structure and functioning of ecosystems, modelling species and food webs, and with qualitative assessments of change. ICED are building on this to more comprehensively assess (and where possible quantify) key impacts of change on Southern Ocean ecosystems and to ensure this informs management and policy. This includes detailed work on key species and change, from Antarctic krill to whales</p>	Ongoing	<p>Scientific publications, research and papers (input and output) for the ICED International Conference on Assessing Status and Trends of Habitats, Key Species and Ecosystems in the Southern Ocean, Hobart, Australia, 2018</p>
		SOOS	<p>SOOS Capability Working Group on ecosystem Essential Oceanic Variables.(eEOV) is working on developing a set of variables which represents a defined biological or ecological quantity, is derived</p>	Ongoing	<p>Scientific publications and reports</p>

<ul style="list-style-type: none"> <li>Understand relationship between species and climate change impacts in important locations/areas</li> </ul>		from field observations, and which contributes significantly to assessments of Southern Ocean ecosystems.		
	AntEco	Terrestrial species vulnerability to climate assessments and terrestrial species distribution modelling under climate change.	2016-2019	Scientific publications, submission to the CEP
		Studies of the microbial diversity and microbial genomics, including comparative genomics, of microorganisms from the McMurdo Dry Valley region of Antarctica	Ongoing	Scientific publications
	SCATS	Priority Threat Management for terrestrial Antarctic species under climate change	2016-2019	Workshop to be held in Leuven 2017, Publication due 2018, results to 2018 CEP
	PAIS	By the integration of data and modelling PAIS aims to identify and analyse tipping points and spatio-temporal evolution of species (migrations due to climate change on various timescales)	2016-2020	Publications
	IPICS	IPICS (particularly under the Antarctic 2k activity) provides the climatic context for assessing the climate changes these biota are undergoing – what has occurred and how unusual is it in the multi-centennial context?	Medium-long-term	Paper describing patterns of temperature change over last 2000 years in 2017.
	BAMM-EG	The SCAR EG Birds and Marine Mammals project: Retrospective Analysis of Antarctic Tracking Datasets (RAATD) will identify the areas of ecological importance to a large number of top predator species to inform conservation planning (e.g. MPAs) purposes. The project also relates the habitat use at sea by predators with projected changes based on climatic scenarios.	EGBAMM 2010-2020	RAATD will produce several scientific articles including some in high-profile journals (first one planned for end of 2017), a data paper of the collated datasets, and R code to implement the tracking and modelling.
	Remote Sensing Action Group	The Remote Sensing AG is conducting a repeated (long-term) monitoring of the distribution and abundance of key species (e.g. penguin colonies) using remote sensing methods.	Medium-long-term	Distribution maps and abundance trends of key species, in the form of reports.
	ANTOS-EG	ANTOS will provide information useful for key Antarctic species, depending upon where the ANTOS sites are located	Medium-long-term	Environmental data on a range of biological and physical parameters.
AnT-ERA	Potter Cove research: modelling food web dynamics will contribute to understand the response of the system to perturbations  Other key research this field within AnT-ERA include; responses of marine biota, responses of higher predators, and responses of near-shore marine communities to climate change	Until 2021	Scientific publications	

<p>Marine, terrestrial and freshwater habitats at risk due to climate change</p> <ul style="list-style-type: none"> <li>• Understand habitat status, trends, vulnerability and distribution</li> <li>• Improved understanding of the effects of climate change on habitat, eg. sea ice extent and duration, snow cover, ground moisture, microclimate, changing melt flows and consequences to lake systems</li> <li>• Improved understanding of potential expansion of human presence in Antarctica as a result of changes resulting from climate change through e.g. changes in sea ice distribution; collapse of ice shelves; expansion of ice free area).</li> </ul>	<p>ICED</p> <p>ICED is undertaking integrated circumpolar analyses to improve our understanding of change and the implications for Southern Ocean ecosystems and their management.</p> <p>This includes detailed work on the effects of sea ice change and other physical drivers on Southern Ocean ecosystems. Interdisciplinary work in this area is currently exploring the use of climate models and data to develop scenarios and projections of change.</p>	<p>Ongoing</p>	<p>Recent outputs include ICED contribution (including papers) to the Joint CEP/SC-CAMLR Workshop, and ongoing input to CCAMLR's intersessional work on climate change impacts in the Southern Ocean.</p> <p>Forthcoming outputs will include:</p> <ul style="list-style-type: none"> <li>-A series of ICED community papers in 2016-18 on change in the Southern Ocean.</li> <li>-ICED-IMBER paper from 2016 workshop on "Integrated modelling to support assessment and management of marine social-ecological systems in the face of global change."</li> <li>- Joint ICED-CCAMLR workshop (2017) on Projections of Change.</li> </ul>
	<p>SOOS</p> <p>SOOS Capability Working Group on ecosystem Essential Oceanic Variables.(eEOV) is working on developing a set of variables which represents a defined biological or ecological quantity, is derived from field observations, and which contributes significantly to assessments of Southern Ocean ecosystems.</p>	<p>Ongoing</p>	<p>Scientific publications and reports</p>
	<p>AntEco</p> <p>Towards an evidence based protection in terrestrial Antarctica – delineating Antarctic habitats.</p> <p>The Diversity and Structure of Antarctic Benthic Communities (DISTANTCOM) project will provide information on marine shallow benthic invertebrates regarding distribution, trends, biodiversity, abiotic and biotic environment.</p> <p>Studies of the microbial diversity and microbial genomics, including comparative genomics, of microorganisms from the McMurdo Dry Valley region of Antarctica</p>	<p>2016-2020</p> <p>Ongoing</p>	<p>Scientific publications, submissions to the CEP</p> <p>Scientific publications</p>
	<p>PAIS</p> <p>Satellites analysis + mass balance study with models</p> <p>Projection of Antarctic evolution beyond IPCC timeframe—→ several millennia with climates and ice sheet models</p>	<p>2016-2020</p>	<p>Scientific publications</p>
	<p>ASPeCT</p> <p>ASPeCt-conducts process experiments in sea ice interiors, coastal polynyas and marginal ice zones relating to sea ice physical-chemical-biological-biogeochemical coupling.</p>	<p>2017-2022 (field programs)</p>	<p>A two-month (April 15-June 15 2017) cruise into the Ross Sea will be conducting an atmosphere-ice-ocean interaction experiment in the polynyas and sea ice regions of the western Ross Sea. Physical-biological sampling program at Davis (Oct-Nov 2015) by joint AU-NZ team</p>



		ANTOS-EG	ANTOS will be measuring many of these habitat characteristics	Medium-long-term	Medium-long term habitat data from a variety of locations
		AnT-ERA	AnT-ERA research relevant to this issue includes: climate effects on marine biota, development of research concepts, responses of near-shore marine communities.	Until 2021	Scientific publications, contributions to various fora for discussion
		HASS-EG History-EG	<p>HASSEG is undertaking social and political science research into human activities in Antarctic in areas that are recently ice-free or accessible due to ice changes.</p> <p>Research into the different understandings and views related to environmental change from historical, anthropological, cultural and political perspectives. This research provides valuable insights into why humans behave in certain ways, make certain decisions and why policies may or may not be agreed upon or work.</p> <p>Research on how science has influenced policy in the past including the history of environmental management in Antarctica and explorations of the relationship between climate change, Antarctic policy-making and science.</p>	2014-2020	<p>Peer reviewed research articles, book chapters and books. Information Papers presented to the ATCM/CEP</p> <p>The soon to be released <i>Handbook on the Politics of Antarctica</i> also contains several chapters addressing climate and environmental change in Antarctica from a historical, social scientific and humanities perspective.</p>
		SORP	The CLIVAR/CliC/SCAR Southern Ocean Region Panel was formed to serve as a forum for the discussion and communication of scientific advances in the understanding of climate variability and change in the Southern Ocean.	Ongoing	Advice to SCAR on progress, achievements, new opportunities and impediments in internationally-coordinated Southern Ocean research
		SERCE	Improved understanding of the effects of climate change on habitat, e.g. sea ice extent and duration, snow cover, ground moisture, microclimate, changing melt flows and consequences to lake systems, “shallow-water marine environments and bedrock uplift”	2016 -2020	Scientific publications