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# **The Scientific Committee on Antarctic Research (SCAR)**

## **Selected Science Highlights for 2015/16**



# The Scientific Committee on Antarctic Research (SCAR) Selected Science Highlights for 2015/16

## 1. Background

This Background Paper highlights some recent key science papers published since the last Treaty meeting and should be read in conjunction with the Information Paper “The Scientific Committee on Antarctic Research (SCAR) Annual Report for 2015/16”. Although not highlighted below, the latest ACCE update (see Information Paper) should also be consulted as it contains reference to recent studies on climate change in the Antarctic and Southern Ocean region. It should also be noted that this is not a complete list (there have been many highly significant papers published over the last year) but represents some of the key science papers highlighted by SCAR groups.

## 2. Selected Antarctic and Southern Ocean Science Highlights (2015/16)

### Ice sheet mass balance, sea level, and past climate and earth sciences:

During the last two years, the Marine Ice Sheet Instability (MISI) was incorporated in simulations of ice sheet models allowing the investigation of the impact of global warming on ice dynamics. Several articles proposed projections of the contribution of Antarctica to sea level rise on the century to millennial time scales focusing on various aspects. Cornford et al. (2015) highlighted the importance of initial conditions, Gomez et al. (2015) showed that the sea level feedback has a stabilizing influence and (Ritz et al., 2015) used an ensemble method and a statistical approach constrained by observation to assess probability distribution of sea level contribution due to MISI.

- Cornford, S. L., Martin, D. F., Payne, et al. (2015). *Century-scale simulations of the response of the West Antarctic Ice Sheet to a warming climate. The Cryosphere. doi:10.5194/tc-9-1579-2015.*
- Gomez, N., Pollard, D. and Holland, D. (2015). *Sea-level feedback lowers projections of future Antarctic ice-sheet mass loss. Nature Communications. doi:10.1038/ncomms9798.*
- Ritz, C., Edwards, T. L., Durand, G., Payne, A. J., Peyaud, V., and Hindmarsh, R. C. A. (2015). *Potential sea-level rise from Antarctic ice-sheet instability constrained by observations. Nature. doi:10.1038/nature16147.*

Other simulations aimed at assessing the role of backstresses exerted by ice shelves in this instability. For instance, (Fürst et al., 2016) delineated the vulnerable regions and (Mengel et al., 2015) indicated that the response of the Weddel sea sector is almost linear and does not display a strong MISI feedback. Recent improvements on ice sheet modelling highlighted the dramatic processes linked to hydrofracturing and ice cliff failure (Pollard et al. 2015a).

- Fürst, J.J., Durand, G., Gillet-Chaulet, F., et al. (2016). *The safety band of Antarctic ice shelves. Nature Climate Change. https://dx.doi.org/10.1038/nclimate2912.*
- Mengel, M., Feldmann, J. and Levermann, A. (2015). *Linear sea-level response to abrupt ocean warming of major West Antarctic ice basin. Nature Climate Change, doi:10.1038/nclimate2808.*
- Pollard, D., DeConto, R. M. and Alley, R.B. (2015a). *Potential Antarctic Ice Sheet retreat driven by hydrofracturing and ice cliff failure. Earth Plan. Sci. Lett.. doi:10.1016/j.epsl.2014.12.035.*

Agosta et al. (2015) evaluate the current climate in 41 climate CMIP5 models with the aim of regional modelling of the Antarctic surface mass balance. Trusel et al. (2015) assess the twenty-first-century evolution of surface melt across Antarctica under intermediate and high emissions climate scenarios and show that under the high emissions pathway by 2100, melt on several ice shelves approaches or surpasses intensities that have historically been associated with ice shelf collapse.

- *Agosta, C., Fettweis, X. and Datta, R. (2015). Evaluation of the CMIP5 models in the aim of regional modelling of the Antarctic surface mass balance. The Cryosphere. doi:10.5194/tc-9-2311-2015.*
- *Trusel, L. D., Frey, K. E., Das, S. B., et al. (2015). Divergent trajectories of Antarctic surface melt under two twenty-first-century climate scenarios. Nature Geoscience. doi:10.1038/ngeo2563.*

A new, highly detailed ice core retrieved by researchers with the National Science Foundation (NSF)-funded West Antarctic Ice Sheet (WAIS) Divide project revealed a consistent pattern of climate changes that started in the Arctic and spread across the globe to the Antarctic during planet Earth's last glacial period, tens of thousands of years ago. Representing more than 68,000 years of climate history, data extracted from the core - a cylinder of ice that represents a cross-section of the ice sheet - is helping scientists understand past, rapid climate fluctuations between warm and cool periods that are known as Dansgaard-Oeschger events. Published in the journal *Nature*, the new research illustrates how sudden climate changes that began in the North Atlantic around Greenland circulated southward, appearing in the Antarctic approximately 200 years later. Further, the new findings show how ocean currents were largely responsible for redistributing the heat between the Northern and Southern hemispheres in a process called the bipolar seesaw.

- *WAIS Divide Project Members. (2015). Precise inter-polar phasing of abrupt climate change during the last ice age. Nature. doi:10.1038/nature14401.*

Sea-level rise in the next century will become increasingly dominated by glacier and ice sheet contributions, and threshold behaviour could bring unwelcome surprises. Of particular concern is the 'marine ice sheet instability', where initial retreat of an ice margin into a deepening valley leads to progressive, unstable ice loss. This study used results from Beryllium-10 dating to show that Mackay Glacier, an outlet of the East Antarctic Ice Sheet, underwent rapid thinning around 7,000 years ago, in a climate similar to present. This is the first study to unambiguously link geological evidence of rapid ice surface lowering to the marine ice sheet instability. It also shows that glacier thinning events, similar to those observed by satellites in rapidly changing parts of Antarctica today, may continue unabated for centuries.

- *Jones, R. S., Mackintosh, A. N., Norton, K. P., et al. (2015). Rapid Holocene thinning of an East Antarctic outlet glacier driven by marine ice sheet instability. Nature Communications. doi:10.1038/ncomms9910.*

New information from the ANDRILL-2A drill core and a complementary ice sheet modelling study show that polar climate and Antarctic ice sheet (AIS) margins were highly dynamic during the early to mid-Miocene. Changes in extent of the AIS inferred by these studies suggest that high southern latitudes were sensitive to relatively small changes in atmospheric CO<sub>2</sub> (between 280 and 500 ppm). Importantly, reconstructions through intervals of peak warm temperatures indicate that the AIS retreated beyond its terrestrial margin under atmospheric CO<sub>2</sub> conditions that were similar to those projected for the coming centuries.

- *Levy, R., Harwood, D., Florindo, F., et al. (2016). Antarctic ice sheet sensitivity to atmospheric CO<sub>2</sub> variations in the early to mid-Miocene. PNAS. doi:10.1073/pnas.1516030113.*

Atmospheric concentrations of carbon dioxide are projected to exceed 500 ppm in the coming decades. It is likely that the last time such levels of atmospheric CO<sub>2</sub> were reached was during the Miocene, for which there is geologic data for large-scale advance and retreat of the Antarctic ice sheet. Simulating Antarctic ice sheet retreat is something that ice sheet models have struggled to achieve because of a strong hysteresis effect. Here, a number of developments in modelling approaches allowed the authors to simulate large-scale variability of the Antarctic ice sheet for the first time. These results are also consistent with a recently recovered sedimentological record from the Ross Sea at ANDRILL-2A site, presented in the above article.

- *Gasson, E., DeConto, R., Pollard, D. and Levy, R. (2016). Dynamic Antarctic ice sheet during the early to mid-Miocene. PNAS. doi:10.1073/pnas.1516130113.*

A special issue of the journal *Global and Planetary Change*, edited by Maldonado et al. (2015), presents new

works that summarize significant recent research results and synthesize the current state of knowledge for the Scotia Arc. The Scotia Arc, situated between South America and Antarctica, is one of the Earth's most important ocean gateways and former land bridges. Understanding its structure and development is critical for the knowledge of tectonic, paleoenvironmental and biological processes in the southern oceans and Antarctica. As the basins opened, formation of first shallow sea ways and then deep ocean connections controlled the initiation and development of the Antarctic Circumpolar Current, which is widely thought to have been important in providing the climatic conditions for formation of the polar ice sheets. The evolution of the Scotia Arc is therefore of global palaeoclimatic significance. The Scotia Arc has been the focus of increasing international research interest. Many recent studies have stressed the links and interactions between the solid Earth, oceanographic, paleoenvironmental and biological processes in the area. This special issue contains 17 papers from many authors of different countries, and provides an updated view of the knowledge of this region.

- *Maldonado, A., Dalziel, I. W. D. and Leat, Ph. (Eds). (2015). Special Issue of Global and Planetary Change, 123-125, A1–A8.*

### Ecology and Biology:

#### *Marine:*

Ground counts during 1959-1968 compared with counts using high-resolution satellite imagery during 2008-2012 indicated many fewer Weddell seals (*Leptonychotes weddellii*) at two major moulting areas in the western Ross Sea. This reduction is consistent with an altered food web, the reasons for which are complex. In the context of a recent industrial fishery targeting a seal prey species, the authors suggest a large-scale seal monitoring programme is required to increase understanding of seal population changes.

- *Ainley, D. G., Larue, M. A., Stirling, I., Stammerjohn, S. and Siniff, D. B. (2015). An apparent population decrease, or change in distribution, of Weddell seals along the Victoria Land coast. Marine Mammal Science 10.1111/mms.12220.*

Bost et al. (2015) tracked breeding king penguins (*Aptenodytes patagonicus*) from Crozet islands (South Indian Ocean) for 16 years and monitored their population and change in breeding success. They found that changes associated with an increased sea surface temperature of just 1°C pushed the polar front southward, and significantly increased both the distances penguins travelled to forage and the depths to which they dived to find food. Population numbers also decreased. Climate models predict that the polar front will continue to shift southwards, which may threaten king penguins and other predators in the region.

- *Bost, C. A., Cotté, C., Terray, P., et al. (2015). Large-scale climatic anomalies affect marine predator foraging behaviour and demography. Nature Communications. doi:0.1038/ncomms9220.*

Using conventional and isotopic measures of dietary overlap, this study showed that the trophic structure of the Antarctic seabird community was unaffected by annual changes in availability of different types of prey, including Antarctic krill. Even though resource abundance changed, the various seabird species maintained roughly the same position in the food web.

- *Moreno, R., Stowasser, G., McGill, R. A. R., Bearhop, S., and Phillips, R. A. (2016). Assessing the structure and temporal dynamics of seabird communities: the challenge of capturing marine ecosystem complexity. Journal of Animal Ecology. doi: 10.1111/1365-2656.12434.*

A catch-based macrobenthos study and a sea-bed imaging survey on ascidians were carried out off the tip of the Antarctic Peninsula, an area with steep natural gradients in the environment and in climate-induced changes. The multidisciplinary analyses showed large-scale faunistic differences between the Drake Passage, Bransfield Strait and western Weddell Sea. They can partially be explained by differences in sea-ice, primary production, water depth, water masses and bottom rugosity. A possible reason for difficult to explain intermediate-scales patterns might be a high between-station heterogeneity and high small-scale

variability in ascidian composition. This high species turnover shaped by unknown biological interactions may mask existing intermediate-scale physical and chemical drivers.

- Gutt, J., Alvaro, M. C., Barco, A. Böhmer, A., et al. (2015). *Macro-epibenthic communities at the tip of the Antarctic Peninsula, an ecological survey at different spatial scales. Polar Biology.* doi:10.1007/s00300-015-1797-6

The most recent knowledge on the cold limit to adaptation of marine species was comprehensively reviewed in an opinion paper by Peck (2016). It seems likely that problems with protein synthesis or protein folding are important in the slowing of rates of a wide range of physiological processes beyond the expected effects of temperature on biological systems.

- Peck, L. S. (2016). *A cold limit to Adaptation in the Sea. Trends in Ecology and Evolution.* doi:10.1016/j.tree.2015.09.014

Xavier et al. (2016) evaluates the habitats and distributions of Southern Ocean cephalopods (octopuses, squid, cuttlefish and nautilus), which may be commercially exploited in the future. They used net-catch data to develop habitat suitability models for 15 of the most common species in the Southern Ocean. The individual habitat suitability models were overlaid to generate a “hotspot” index of species richness, which showed higher numbers of squid species associated with various fronts of the Antarctic circumpolar current.

- Xavier, J. C., Raymond, B., Jones, D. C. and Griffiths, H. (2016). *Biogeography of cephalopods in the Southern Ocean using habitat suitability prediction models. Ecosystems.* doi:10.1007/s10021-015-9926-1.

The uptake of anthropogenic CO<sub>2</sub> is altering the carbonate chemistry and pH of the world’s oceans with changes for the polar oceans predicted to be amongst the most severe. This study carried out ocean acidification (OA) manipulations of natural Arctic and Southern Ocean pelagic communities. A key finding was that all copepod species preferentially grazed on dinoflagellates, compared to other phytoplankton species, when in elevated pCO<sub>2</sub> conditions. This demonstrates that changes in food quality and altered grazing selectivity may be a major consequence of the predicted chemical changes to the polar oceans. Such altered trophodynamic interactions will impact how carbon is channelled through polar food webs, and the extent to which future anthropogenic CO<sub>2</sub> emissions can be absorbed.

- Tarling G, Peck, V., Ward, P., et al. (2016). *Response of polar pelagic food-webs to predicted changes in ocean chemistry. Deep-Sea Research II.* doi: 10.1016/j.dsr2.2016.02.008.

Understanding the key drivers of population connectivity is essential for effective management of natural marine resources. Here, a seascape genetics approach, combining oceanographic modelling and microsatellite analyses, was used to understand the influences on the population genetic structure of two Antarctic fishes with contrasting life histories. Inter-annual variability in oceanographic currents strongly influenced the projected genetic structure, suggesting that shifts in circulation patterns due to climate change are likely to impact future genetic connectivity and opportunities for local adaptation, resilience and recovery from perturbations.

- Young, E. F., Belchier, M., Hauser, L., et al. (2015). *Oceanography and life history predict contrasting genetic population structure in two Antarctic fish species. Evolutionary Applications.* doi: 10.1111/eva.12259.

Quantifying the strength of biological feedbacks in Southern Ocean air-sea CO<sub>2</sub> flux is an important aspect of understanding the effects of a changing climate. This study compared a number of global biogeochemical models under different climate change scenarios projected to the end of this century, focusing on vertical carbon flux and changes in plankton community structure. The models agreed that the biological carbon pump may be responsible for increased CO<sub>2</sub> uptake in a future more acidic ocean.

- Hauck, J., Völker, C., Wolf-Gladrow, D., et al. (2015). On the Southern Ocean CO<sub>2</sub> uptake and the role of the biological carbon pump in the 21st century. *Global Biogeochemical Cycles*. doi:10.1002/2015GB005140.

#### Terrestrial:

The Antarctic Peninsula is one of three regions of the planet that have experienced the highest rates of climate warming over recent decades. Based on a comprehensive large-scale resurvey, allowing comparison of new (2009) and historical data (1960s), these authors show that the two native Antarctic vascular plant species have exhibited significant increases in number of occupied sites and percent cover since the 1960s: *Deschampsia Antarctica* increasing in coverage by 191% and in number of sites by 104%. *Colobanthus quitensis* increasing in coverage by 208% and number of sites by 35%. These changes likely occurred in response to increases of 1.2°C in summer air temperature over the same time period.

- Cannone, N., Guglielmin, M., Convey, P., Worland, M. R., and Longo, S. F. (2016). Vascular plant changes in extreme environments: effects of multiple drivers. *Climatic Change*. doi:10.1007/s10584-015-1551-7.

The role of aerial dispersal in shaping patterns of biodiversity remains poorly understood, mainly due to a lack of coordinated efforts in gathering data at appropriate temporal and spatial scales. It has been long known that the rate of dispersal to an ecosystem can significantly influence ecosystem dynamics, and that aerial transport has been identified as an important source of biological input to remote locations. With the considerable effort devoted in recent decades to understanding atmospheric circulation in the south polar region, a unique opportunity has emerged to investigate the atmospheric ecology of Antarctica, from regional to continental scales. SCAR has facilitated the bringing together of a consortium of polar aerobiologists with a common interest in the airborne dispersion of microbes and other propagules in the Antarctic, with opportunities for comparative studies in the Arctic.

- Pearce, D. A., Alekhina, I. A., Terauds, A., et al. (2016). Aerobiology Over Antarctica - A New Initiative for Atmospheric Ecology. *Frontiers in Microbiology*. doi:10.3389/fmicb.2016.00016.

Human activity in Antarctica has the potential to cause disturbance to wildlife. In some cases, human disturbance to wildlife can cause declines in breeding success, physical harm and even sometimes, direct mortality. Human disturbance can also induce physiological stress responses, which can manifest as behavioural responses like increased vigilance or fleeing behaviour, or avoidance of disturbed areas. The meta-analysis undertaken in this study highlights that human disturbance effects vary in response to a range of extrinsic factors such as the type of disturbance, its form, magnitude and frequency. It also shows that different species, and even different populations of the same species can show widely differing responses to human disturbance. This variability means that generalisations of the impact of human disturbance to Antarctic wildlife cannot yet be made.

- Coetzee, B. W., and Chown, S. L. (2015). A meta-analysis of human disturbance impacts on Antarctic wildlife. *Biological Reviews*. doi:10.1111/brv.12184.

Biological invasion is one of the key threats to the conservation of the broader Antarctic region. This study provides an evidence-based assessment of the status of biological invasion in the region as a basis for future monitoring and management. The authors adapted the indicator framework for global biological invasion monitoring by collating information on (i) numbers of alien species and those invasive species impacting biodiversity (ii) trends in the extinction risks of native species impacted by invasive species and (iii) trends in relevant agreements, management intention and species eradications. The Antarctic Biological Invasions Indicator (ABII) provides a system for information exchange across the region and a vehicle for targeted monitoring and surveillance. It also enables inclusion of the region in global efforts to track both invasive alien species and interventions for managing the threat.

- *McGeoch, M. A., Shaw, J. D., Terauds, A., Lee, J. E., and Chown, S. L. (2015). Monitoring biological invasion across the broader Antarctic: A baseline and indicator framework. Global Environmental Change-Human and Policy Dimensions. doi:10.1016/j.gloenvcha.2014.12.012.*

### Conservation and Management:

The prohibition of commercial mineral resource extraction through the Antarctic Treaty System has removed one significant source of potential damage to Antarctica's geological and geomorphological values. However, given the ongoing increase in Antarctic tourism and scientific footprint, some high-quality geological features may be vulnerable to human impact, such as damage due to the construction of infrastructure, unregulated collection of geological specimens or oversampling for scientific purposes. These authors suggest that further implementation of existing management tools may be required to protect the diverse range of vulnerabilities, qualities and spatial scales represented in the geology and geomorphology of the continent. At sites where high-quality mineralogical or palaeontological specimens exist in limited quantities, considerations of how best to prevent oversampling and manage access to remaining material may be supported by assessment of cumulative impacts.

- *Hughes, K. A., Lopez-Martinez, J., Francis, J., et al. (2016). Antarctic geoconservation: a review of current systems and practices. Environmental Conservation. doi:10.1017/S0376892915000387.*

Vegetation is sparsely distributed over Antarctica's ice-free ground, and distinct plant communities are present in each of the continent's 15 recently identified Antarctic Conservation Biogeographic Regions (ACBRs). With rapidly increasing human activity in Antarctica, terrestrial plant communities are at risk of damage or destruction by a range of factors. Using remote sensing to assess vegetation in Antarctic Specially Protected Areas, these authors suggest that there are large omissions in the protection of Antarctic botanical diversity.

- *Hughes, K. A., Ireland, L. C., Convey, P. and Fleming, A. H. (2016). Assessing the effectiveness of specially protected areas for conservation of Antarctica's botanical diversity. Conservation Biology. doi:10.1111/cobi.12592.*

Antarctic krill fishing vessels can collect acoustic data that could be used in future management of the commercial fishery. With increasing costs and demands on time, the use of research vessels to undertake regular Antarctic krill biomass surveys is becoming more difficult to justify. Here we describe the work undertaken by CCAMLR to assess how Antarctic krill fishing vessels may be used to collect more extensive scientific data sets. Through a 'proof of concept' study started in 2013, trial data have now been received from half the fishing fleet and protocols are being developed to enable Antarctic krill fishing vessels to collect quantitative acoustic data along transects. The willingness of the fishing industry to participate in this process has already been demonstrated by several fishing companies, and Norwegian- and Chinese-flagged vessels are undertaking krill biomass surveys in two key fishery areas in the South Atlantic sector of the Southern Ocean.

- *Watkins, J. L., Reid, K., Ramm, D., et al. (2015). The use of fishing vessels to provide acoustic data on the distribution and abundance of Antarctic krill and other pelagic species. Fisheries Research. doi:10.1016/j.fishres.2015.07.013.*

The Arctic and Antarctic polar regions are subject to multiple environmental threats, arising from both local and ex-situ human activities. This study reviews the major threats to polar ecosystems including the principal stressor, climate change, which interacts with and exacerbates other threats such as pollution, fisheries overexploitation, and the establishment and spread of invasive species. Given the lack of progress in reducing global atmospheric greenhouse-gas emissions, the authors suggest that managing the threats that interact synergistically with climate change, and that are potentially more tractable, is all the more important in the short to medium term for polar conservation. They show how evidence-based lessons learned from scientific research can be shared between the poles on topics such as contaminant mitigation, biosecurity protocols to reduce species invasions, and the regulation of fisheries and marine environments. They suggest

that applying these trans-polar lessons in tandem with expansion of international cooperation could substantially improve environmental management in both the Arctic and Antarctic.

- *Bennett, J. R., Shaw, J. D., Terauds, et al. (2015). Polar lessons learned: long-term management based on shared threats in Arctic and Antarctic environments. Frontiers in Ecology and the Environment. doi:10.1890/140315.*

Do krill fisheries compete with macaroni penguins? Management of the krill fishery at South Georgia includes a closed season during the summer to minimise spatial overlap of predators during the breeding season. It opens in winter on the assumption that predators disperse away from the island and overlap will be minimal, but this remains untested. We equipped macaroni penguins on Bird Island with geolocators and tracked their winter distribution. They dispersed widely across the Southern Ocean, with some feeding hotspots associated with oceanic fronts. During this time, the krill fisheries were concentrated on three small areas of shelf break off South Georgia, South Orkneys and South Shetlands and spatial overlap of fishery catches and penguin foraging was minimal. We conclude that competition under current management is low and recommend our methods are extended to other species on South Georgia that forage closer to the island and to other krill fisheries that remain open during the breeding season.

- *Ratcliffe, N., Hill, S. L., Staniland, I. J., Brown, R., Adlard, S., Horswill, C. A., and Trathan, P. N. (2015). Diversity and Distributions. doi:10.1111/ddi.12366.*

This 10-year synthesis reconstructs population trajectories and assesses the recovery status of all Southern Hemisphere humpback whale populations. It also details methodological advances and the significant challenges overcome during the assessment and identifies key data gaps and avenues for future work. Southern Hemisphere humpback whales are now at roughly 70% of pre-exploitation abundance, but recovery levels vary substantially between oceans, with strong recovery in the Indian Ocean but still low recovery in the southwest Atlantic and Oceania.

- *Jackson, J. A., Ross-Gillespie, A., Butterworth, D., et al. (2015). Synthesis review of the status of Southern Hemisphere humpback whales. 67th Annual Meeting of the International Whaling Commission (IWC). Document SC/66a/SH3 submitted to the IWC Scientific Committee.*

### **Astronomy and Astrophysics:**

In August 2015, the IceCube Collaboration announced a new observation of high-energy neutrinos that originated beyond our solar system. This study, which looked for neutrinos coming from the Northern Hemisphere (i.e. neutrinos that reached the detector after passing all the way through the Earth), confirms their cosmic origin as well as the presence of extragalactic neutrinos. The first evidence for astrophysical neutrinos was announced by the collaboration in November 2013. This new, independent observation confirms that the detection rate of astrophysical neutrinos is close to the maximum rate based on potential cosmic ray sources. The intensity of this flux shows that cosmic ray sources are also efficient generators of neutrinos and, therefore, that these tiny particles are further endorsed as the perfect tools to explore the extreme universe.

- *Aartsen, M. G., Abraham, K., Ackermann, M. (2015). Evidence for Astrophysical Muon Neutrinos from the Northern Sky with IceCube. Phys. Rev. Lett. doi:10.1103/PhysRevLett.115.081102.*

The direct detection of gas clouds in our Galaxy via observations of carbon was made using the HEAT telescope at Ridge A in Antarctica. Ridge A is the driest location on the Earth, allowing routine study of the universe at terahertz frequencies through atmospheric windows not accessible from warmer locations. One third of the molecular gas along the sightline studied was estimated to be in "dark" form, a form of cold gas that can only be traced by observation of the carbon atoms by terahertz instruments such as HEAT.

- *Burton, M. G., Ashley, M. C. B., Braiding, C., et al. (2015). Extended Carbon Line Emission in the Galaxy: Searching for Dark Molecular Gas along the G328 Sightline. The Astrophysical Journal. doi:10.1088/0004-637X/811/1/13.*

Magnetic monopoles are thought to have been created during the early stages of the universe. These monopoles would have been accelerated by intergalactic magnetic fields and could reach relativistic velocities, i.e. velocities near the speed of light ( $c$ ). Similar to electrically charged particles, magnetic monopoles produce Cherenkov light when traveling through ice at such high speeds. IceCube, with its large instrumented volume, is an excellent detector for searches for exotic particles. The IceCube Collaboration presented a search for relativistic ( $>0.75c$ ) and mildly relativistic ( $>0.51c$ ) monopoles using two years of data. No monopole candidate was observed, allowing IceCube to set very stringent limits for the abundance of such particles in the range of velocities studied.

- Aartsen, M. G., Abraham, K., Ackermann, M. (2016). *Searches for relativistic magnetic monopoles in IceCube*. *Eur. Phys. J. C*. doi:10.1140/epjc/s10052-016-3953-8.

### **History, Humanities, Social Sciences and Multidisciplinary:**

A new multi-disciplinary book catering to students and those who want to have a more critical look behind the scenes of Antarctic science has recently been published. This book takes a systems approach to providing insights into Antarctic ecosystems and the geophysical environment. Further, the book links these insights to a discussion of current issues, such as climate change, bio prospecting, environmental management and Antarctic politics. It is written and edited by experienced Antarctic researchers and scientists from a wide range of disciplines. Academic references are included for those who wish to delve deeper into the topics discussed in the book.

- Liggett, D., Storey, B., Cook, Y. and Meduna, V. (Eds.) (2016). *Exploring the Last Continent: An Introduction to Antarctica*. Springer. 597p. doi:10.1007/978-3-319-18947-5.

A recent publication on the environmental history of both polar regions, covering both the Arctic and Antarctic over the long durée, makes an important argument for the links between physical geography, culture, and politics. The book builds on the author's many years of study of Antarctic politics, including pioneering studies of British and Latin American Antarctic research in the mid-20<sup>th</sup> century.

- Howkins, A. (2016). *The Polar Regions: An Environmental History*. Cambridge: Polity Press.

*Climate Terror* brings a critical geopolitics perspective to climate change debates. The authors argue that the geographical politics of global warming are highly differentiated. They critique the way in which climate change has been framed as a challenge for and threat to the West, neglecting the perspective of and impact on the global South. They ask: "Can climate, as a set of discourses, be utilized for emancipatory ends or, ultimately, is the climate story ... a discourse now captured by the affluent North to control the development of the global South?" This important and timely book is relevant to international policy makers as well as researchers from a wide range of disciplines.

- Chaturvedi, S. and T. Doyle. (2015). *Climate Terror: A Critical Geopolitics of Climate Change*. Houndsmills, Basingstoke; New York: Palgrave Macmillan. doi:10.1057/9781137318954.

Deary and Tin (2015) offer a thoughtful and well-informed review of the Antarctic Treaty Parties' engagement with the concept of wilderness in Antarctica and the governance of wilderness areas. Comparing different Parties' domestic wilderness legislation and their level of engagement with Antarctic wilderness protection leads the authors to conclude that Parties' engagement with issues around the governance of Antarctic wilderness is more closely aligned with their overall patterns of engagement within the Antarctic Treaty System than with the extent to which they have put in place legislation protecting wilderness areas in their domestic territories.

- Deary, H. and Tin, T. (2015). *Antarctic Treaty Consultative Parties' engagement in wilderness protection at home and in Antarctica*. *The Polar Journal*. doi:10.1080/2154896X.2015.1068537.

The product of the fruitful collaboration within the SCAR Humanities and Social Sciences Expert Group

(HASSEG), this paper illustrates the challenges arising from the presence and practice of nationalism in the Antarctic. The authors suggest that nationalism in Antarctica is present in a form that is different to what is typically understood as nationalism in the rest of the world – it may play out in a virtual realm or may be mediated through social or cultural habits, events, celebrations, or even through the diverse sets of human activities in the Antarctic themselves. As Hemmings et al. (2015) argue, “[I]n Antarctica, the intersection of nationalism with resources poses a particular challenge to the regional order and its commitments to shareable public goods such as scientific research and environmental protection”.

- *Hemmings, A. D., Chaturvedi, S., Leane, E., Liggett, D., and Salazar, J. F. (2015). Nationalism in Today's Antarctic. The Yearbook of Polar Law. doi:10.1163/2211-6427\_020.*

Shibata (2015) offers an astute analysis of the legal order in both polar regions and concludes that, despite a multitude of geographical, socio-cultural and physical differences, some fundamental principles determining the legal order and the process of creating legal order in the Arctic and the Antarctic are very similar. These core foundational principles upon which the making of legal order rests have been applied differently in the two polar regions, highlighting that the same core principles can lead to different end projects. Shibata points out, for example, that an analysis of the core foundational principles of legal order-making does not necessarily and unambiguously support the creation of an Arctic Treaty System. However, such an analysis does enable the identification of important interactions between the Arctic and Antarctic regimes and emphasizes the opportunity for processes enabling the sharing of experiences and mutual learning between these regimes.

- *Shibata, A. (2015). Japan and 100 Years of Antarctic Legal Order: Any Lessons for the Arctic? The Yearbook of Polar Law. doi:10.1163/2211-6427\_002.*