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1. Introduction

The Polar Regions are a key driver of both the Earth's climate and the functioning of the oceans. European research activities in the Polar Regions (Arctic and Antarctic) contribute significantly to the understanding of the global climate system and its direct impact on the European society and the environment. The magnitude and scope of the science that is undertaken at both polar regions includes many disciplines including oceanography, geosciences, physics, biology, space sciences and astronomy, environmental sciences, economics, social sciences and humanities.

Answering the full scale of research questions asked at the Polar Regions is beyond the capabilities of nations acting individually. Countries are increasingly looking for bi- and multilateral cooperation opportunities to overcome these challenges. There is often a need to obtain data at a variety of scales from the higher latitudes, which needs the implementation of complementary observational schemes for valid inter-comparisons.

International collaboration has a long and successful history in the Polar Regions. Expensive infrastructure is in many cases jointly operated on a cost-sharing basis e.g. the Concordia Station in the Antarctic, operated by France and Italy and the German-French AWIPEV station on Svalbard. Multi-national consortia, such as the Dome C observatory in Antarctica, or EISCAT radars on Svalbard including both Asian and European nations, successfully operate polar infrastructures. The international polar community has also shown an impressive willingness to cooperate in large-scale programmes, sharing results and data, as exemplified by both the International Geophysical Year 1957-58 and the International Polar Year (IPY) of 2007-2008. However, such large international activities are generally one-off, and the extensive cooperation generated tends to fade after the initiatives and their associated funding ends. EU-PolarNet intends to build a stable and sustainable process for international cooperation through encouraging and facilitating collaboration and exchange among existing networks and organisations for polar scientists, infrastructure providers and stakeholders, and by cooperating with all relevant global partners.

EU-PolarNet already supports the implementation of the Transatlantic Research Alliance launched by the EU, US and Canada with the Galway declaration of 24 May 2013 by assisting the project partners in cooperating with US and Canadian research organisations and networks. It supports the European Commission in the "Trilateral EU-US-Canada Working Group" which explores potential areas of trilateral scientific cooperation in Arctic Research.

The purpose of the D1.6 "International cooperation strategy" is to identify the relevant global partners to establish and secure a reliable cooperation for the benefit of European Polar Research. It identifies the important partners at a country level and not at an organisational level.

2. Importance of international cooperation

Due to the remoteness of the polar areas and the high costs associated with research there, polar scientists and infrastructure providers already have a long tradition of cooperating with each other on an international level. Nevertheless, to significantly improve the output and outcomes of polar research and the access to national infrastructures or territories, international cooperation needs to be further improved and new non-traditional partners on the international level need to be involved. Both the Polar Regions have recently produced recommendations for scientific questions to be answered in the near future – the ICARP III and AOS16 for the Arctic, and the Antarctic Horizon Scan and the Antarctic Roadmap Challenges.

The ICARP III and AOS16 recommendations of a Sustaining Arctic Observing Systems can only be achieved in close international cooperation. They recommend the implementation of robust, sustained, co-designed and participatory pan-Arctic Observing System with supporting regional and global observing initiatives. AOS16 also recommends the development of a strategy for international funding, ideally with a single application and review process and contributions of resources from all partner countries, along with established national support mechanisms. The full implementation of a pan-Arctic Observing System would require strong coordination of funding efforts to support a globally connected and internationally accessible network.

Also the Arctic Council is promoting stronger international cooperation in Arctic Research. The Arctic Council's Task Force on Scientific Cooperation recently concluded its ninth meeting. In a brief statement, the Task Force's Chairs, Vladimir Barbin (RU) and Evan Bloom (US), said:

"The Agreement on Enhancing International Arctic Scientific Cooperation was ad referendum agreed. Thus, participating countries are able to launch their needed inter-agency procedures so that this document can be approved for signature by foreign ministers at the upcoming Arctic Council Ministerial Meeting in spring 2017. A mood of cooperation dominated at the meeting and all the participants undertook their best efforts to achieve mutually acceptable results."

Co-Chair Evan Bloom of the United States described the agreement as follows:

"The new agreement, which will be the third legally-binding agreement under the auspices of the Arctic Council, will help facilitate cooperation on science in the Arctic, and remove obstacles to that cooperation."

Co-Chair Vladimir Barbin added:

"The uniqueness of the process of negotiating this document was that the PPs and the Observers were given an opportunity to take part in preparing concrete provisions of this pan-Arctic intergovernmental document. This shows once again that all Arctic states are committed to enhancing international cooperation in the Arctic and welcome the contributions from the other interested parties."

The SCAR Antarctic and Southern Ocean Horizon Scan identified the highest-priority scientific questions – all of which require increased international cooperation. Further the Antarctic Roadmap Challenges (ARC) project, which determines the necessary steps to enable the scientific community to conduct the research that will answer these critical questions, clearly states:

"The ARC project reaffirmed that no one country has the wherewithal to simultaneously pursue all aspects of the highest-priority Antarctic science. Continuing and enhanced co-operation in the spirit of the Antarctic Treaty remains a high priority and an ever increasing financial reality for national programmes."

There is much value to be gained for the European Polar Community from cooperating with so-called third countries:

- Sharing of knowledge and data,
- Coordination of logistics,
- Optimisation in the utilisation of infrastructure,
- Advancement in technologies,

International cooperation is thus indispensable to answer the high-priority questions in Polar Research.

Progressively more European scientists are looking for cooperation opportunities across national borders, in order to work with the best in their field and to get access to research infrastructures. At the same time, the scale of the problems scientific research tackles today, needs a bundling of infrastructure, resources and expertise. Such a consolidation and the resulting coordination across borders are especially useful for research and development, as they help to avoid duplication of resources and provide much stronger scientific results.

3. Current non-European cooperation partners

All EU-PolarNet consortium partners were asked to indicate the two most important non-European cooperation partners for both Arctic and Antarctic research for their respective country. Since EU-PolarNet comprises the majority of European polar actors, the results give a good overview on the present most important non-European cooperation partners. As it is difficult to quantify international cooperation, we have ranked the level of partnership according to the following criteria:

- with whom does your country share infrastructure?
- with whom do you carry out joint expeditions?
- with whom do your researchers publish most joint papers?

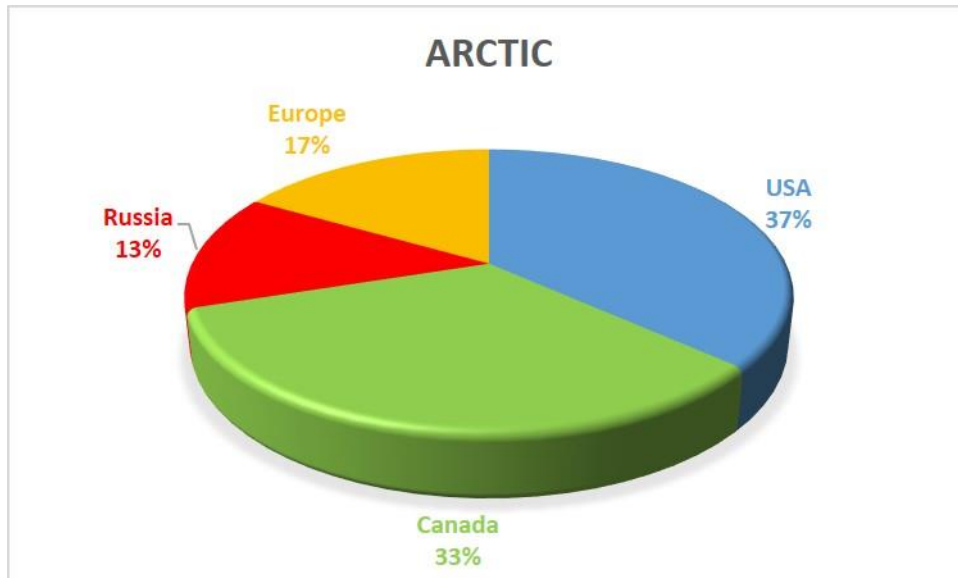
3.1 Arctic Cooperation Partners

The results of the survey on Arctic cooperation partners are quite homogenous. Cooperation partners for European countries in Arctic research are mainly the Arctic Rim nations – with the USA emerging as the most important partner. 37 % of the EU-PolarNet countries indicated the US as their main partner, closely followed by Canada, with 33 % of the consortium partners having a close cooperation. The ranking of this cooperation is clearly science based and builds on joint publications and joint expeditions. European nations are currently not sharing or jointly operating infrastructure in the Arctic with US and Canadian organisations.

Interestingly, only four European countries (13 %) indicated Russia as a main cooperation partner for Arctic research. Two European nations (Finland and Germany) are operating joint infrastructures with Russian institutes:

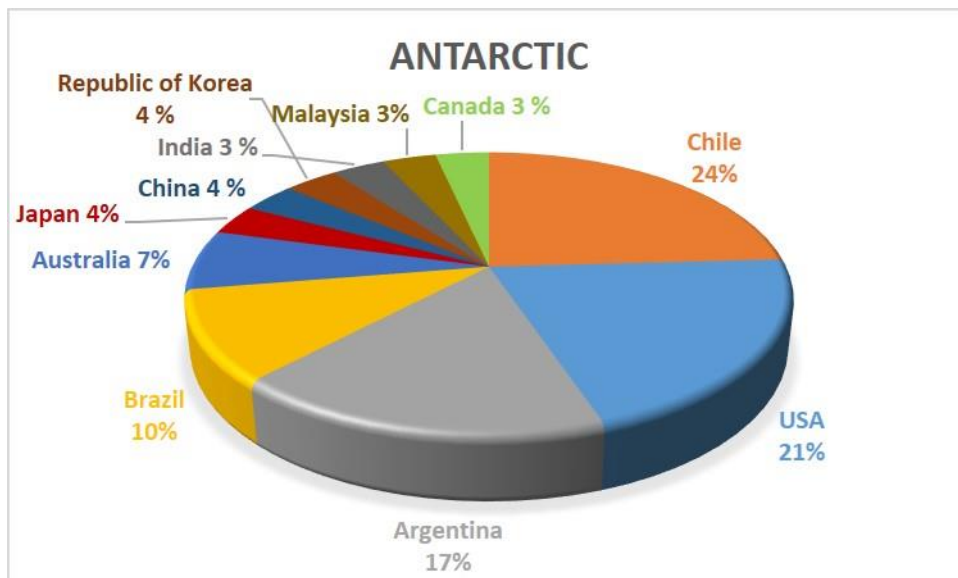
- The Finnish Meteorological Institute operates the Tiksi Hydrometeorological Observatory, which is located in the Russian Far East at 71.6 N, 128.9 E, jointly with the Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet).
- The Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, in Germany works in a close a partnership with Russian scientific institutes in the Siberian tundra since 1998. The joint Samoylov station is located on the southern coast of Samoylov Island (N 72°22', E 126°29') in the central Lena Delta. Since 2013, the island has been home to a modern research base operated by the Trofimuk Institute for Petroleum Geology and Geophysics, Siberian Branch, Russian Academy of Sciences. The new station is chiefly used by the Russian-German LENA research expeditions, which continue from spring to autumn every year. These trips are primarily organised by three institutes: the Alfred Wegener Institute, the Arctic and Antarctic Research Institute (St. Petersburg) and the Melnikov Permafrost Institute (Yakutsk).

Three of the 16 countries (Austria, Poland and Italy), cooperate only with other European partners in Arctic research.



3.2 Antarctic Cooperation Partners

The international cooperation in Antarctic research is much more heterogeneous than in the Arctic. The main cooperation partner of European countries in Antarctic research is Chile with 24 % of consortium partners maintaining cooperation projects. This is followed by the USA (21 %) and Argentina (17%), Brazil (10 %) and Australia (7 %). China, Japan, Malaysia, India and the Republic of Korea emerge as significant cooperation partners to single European countries.



Only Germany operates a joint infrastructure in Antarctica with an international partner. Since 1994 the German Alfred Wegener Institute and the Instituto Antártico Argentino jointly operate the Dallmann Laboratory (King George Island, South Shetland Islands, Antarctic Peninsula, Coordinates: 62°14'S, 58°40'W), where researchers from both nations work together in the Austral summer.

4. Discussion

4.1 Stronger cooperation with the Russian Federation in Arctic Research

In spite of its immense territory and a very long tradition in Arctic research, the Russian Federation has not emerged as the main cooperation partner for Europe in the Arctic. There are many technical and administrative barriers such as customs and visa issues, language barrier, and differences in administrative procedures of funding organisations, which complicate the scientific cooperation in practice. Western sanctions imposed on Russia because of the annexation of Crimea and the war in Ukraine are also severely hampering an intensification of the cooperation between European countries and Russia.

The Russian science and research policy is constantly in flux. The restructuring of the Russian Academy of Sciences, started a couple of years ago and is still underway; and what the final results will be, are still unclear. A reduction in the number of institutes of the Russian Academy of Sciences will most likely result in the loss of smaller institutions. The main Russian cooperation partner for polar research has been the Arctic and Antarctic Research Institute (AARI), a part of the Russian Federal Service on Hydrometeorology and Environmental Protection (Roshydromet). AARI is the oldest and the largest Russian research institution in the field of comprehensive studies of the Polar Regions. It operates numerous research stations in the Arctic and Antarctic, as well as research icebreakers, like e.g. the Akademik Fedorov.

The current restructuring of the Russian scientific landscape, aims at strengthening federal universities by assigning key research themes to them. The Northern (Arctic) Federal University (NARFU) in Archangelsk is one of these strong Federal Universities, which will play an important role in the Russian Arctic Research strategy in the future. NARFU's strategic tasks are closely linked with implementation of the national geopolitical interests in the Arctic. The University will add to both the experts and the expertise necessary to support industrial projects being launched in the polar region with personnel and technologies. This will address the current shortages of Russian experts and technologies for the development of its Arctic area, its continental shelf and infrastructure.

A Federal Research Centre for Integrated Studies of the Arctic (FRC ISArctic) is currently being founded in Archangelsk. This FRC is seen as a research and innovation nucleus for achieving a large-scale goal, as a kind of a technological platform. It aims to conduct research and develop and provide scientific support for the introduction of new methods, technologies and tools for addressing critical problems in the Arctic.

Russia has a strategy for the development of the Arctic Zone of the Russian Federation and National Security Efforts for the period up to 2020. It shows that Russia's ambition in the Arctic is primarily of an economic nature, mainly focussing on the development of natural resources expected to be found in the Arctic region, especially oil and gas. Russia also sees great potential in the opening up of an ice-free northern sea route between Europe and Asia across the Russian Arctic.

Other areas of development specified in the strategy include the improvement of the quality of life for their Arctic population and socio-economic activity in the Arctic. A further development of science and technology; a creation of an up-to-date information and telecommunication infrastructure; environmental safety; and international cooperation in the Arctic are also prominent topics in their strategy. Russia intends to maintain good neighbourly relations with other Arctic States both bilaterally and within regional organizations, including the Arctic Council and the Barents / Euro-Arctic Council.

Russia is currently going through significant socioeconomic changes with tremendous potential for creativity and technological development. With its well-trained scientists and its comprehensive infrastructure, Russia offers numerous opportunities for a successful cooperation and for achieving scientific goals together.

Recommendations

Russia, with its vast area in the Arctic and its high-level infrastructure, should be a key partner for Arctic research for European countries. The goal of a deepening European and Russian cooperation should be to build a stronger scientific collaboration in order to address common scientific problems in the Arctic and to build a constructive international partnership, serving as a good example of science diplomacy.

EU-PolarNet recommends to closely observe and follow new developments in the Russian science system, so that identification of new partners and new opportunities for collaboration with Russian institutes can easily take place when the need arises.

Widening of the Trans-Atlantic Research Alliance between the EU, US and Canada on Arctic research to include Russian participation would be a first step to improve the cooperation with Russia. Russian decision makers and researchers should be involved in the discussion on the definition of Arctic research themes to be supported in H2020 and on co-funding of successful projects. This could lead to a much stronger involvement of Russian scientists in H2020.

4.2 Emerging partners in Polar Research

As seen above, European nations are already very good in cooperating with the US in polar research as well as with Canada in Arctic research. In the Southern Hemisphere, the gateway countries to the Antarctic (Argentina, Chile, Australia, New Zealand and South Africa) are prominent collaboration partners of Europe. This cooperation is based on joint logistics for access this remote area.

The 1st SCAR Antarctic and Southern Ocean Science Horizon Scan assembled the world's leading Antarctic scientists, policy makers, leaders, and visionaries to identify the most important scientific questions that will or should be addressed by research in and from the southern Polar Regions over the next two decades. Answering these questions will require sustained and stable funding; access to all of Antarctica throughout the year; application of emerging technologies; strengthened protection of the region; growth in international cooperation; and improved communication among all interested parties. Wider international partnerships, more coordination of science and infrastructure funding and expanded knowledge sharing are essential to answer these important questions. Gateway countries to Antarctica are emerging as key players in Antarctic Research and will become progressively more important cooperation partners for European nations. This will also be reflected in an increase in joint scientific programming of these so-called Gateway countries with European partners.

Many Asian nations are currently not important collaborative partners for Europe, however, have very fast emerging Polar Programmes. We, therefore, provide a closer look on the Polar research capacities of the major Asian nations with emerging Polar programmes.

Polar Research in China

China has a strong National Polar Programme lead by the Chinese Arctic and Antarctic Administration (CAA). CAA organises polar expeditions and administers polar affairs on behalf of the State Oceanic Administration (SOA), P. R. China, to which it is affiliated. The Polar Research Institute of China (PRIC), also a subsidiary body of SOA, implements specific scientific research programmes, operates their Antarctic facilities and provides logistics support. PRIC operates the ice-strengthened research vessel M/V Xuelong and manages the Chinese polar stations.

It operates two year-round stations in Antarctica, the Great Wall Station located on King George Island, West Antarctica and the Zhongshan Station located in the Larsemann Hills, East Antarctica. It also operates a summer only, Kunlun station, located on “Dome A”, the highest place in Antarctica and the Taishan Camp, located in Princess Elizabeth Land, Antarctica.

The first Chinese Arctic station, the Yellow River station was established in 2004 in Ny-Alesund, Svalbard, and enables China to perform and widen its research and cooperation scope to the Arctic region. Additionally, CAA has successfully organised six marine Arctic expeditions on board of the ice strengthened research vessel M/V Xuelong.

China has not published any official Arctic strategy, policy or white paper yet. Nonetheless, statements by Chinese officials and China’s membership as a permanent observer in the Arctic Council have clarified China’s position on Arctic affairs and acknowledged China’s interests in the region. Scientific and climate considerations are primarily shaping China’s growing activity in the Arctic. Commercial interest in the petroleum, shipping and mineral sector, as well as diplomatic and legal concerns are additional drivers.

Polar Research in Japan

Japan runs a national Antarctic programme, the Japanese Antarctic Research Expedition (JARE), organised at the Ministry of Education, Culture, Sports, Science, and Technology (MEXT). The National Institute of Polar Research (NIPR) founded in 1973, is responsible for the management of JARE. NIPR has been pursuing cutting-edge studies in collaboration with research communities relating to the earth, the environment, life, space and other fields as well.

Japan has built four Antarctic stations, Syowa, Mizuho, Asuka and Dome Fuji, two of which are currently active. Syowa, built in 1957, the largest of the stations, can host up to 130 people in summer and approximately 30 in winter. Dome Fuji Station was built in 1995 for the purpose of the deep ice-core drilling program and for atmospheric observations.

In the Arctic, Japan operates the Ny-Ålesund Research Station on Spitsbergen in the Svalbard Archipelago. Here it conducts research on the Arctic environment across a variety of disciplines in cooperation with Japanese and oversea research institutes.

In 2015, Japan published its national Arctic policy, which strongly focusses on research and international cooperation. As a result of the Arctic policy, a national flagship project, called ArCS (Arctic Challenge for Sustainability), is funded by the Ministry of Education, Culture, Sports, Science and Technology. The National Institute of Polar Research (NIPR), the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and Hokkaido University play key roles in this project.

Polar Research in the Republic of Korea

The Republic of Korea shows strong interest in both Polar Regions. In 1987 it established the Korea Polar Research Institute (KOPRI), the operator of Korea's national polar programme. Being a government sponsored research institute dedicated to polar science and logistic support, it was established to contribute to the development of national science and technology capacities and to undertake scientific research programmes in cooperation with national and international partners.

Korea's King Sejong Antarctic station is located on King George Island, at the Antarctic Peninsula. The station has been in operation as a year-round research platform since its inauguration in 1988.

To enhance scientific capabilities of Korea and promote collaboration for the development of Antarctic sciences, the Korean Government built their second, Jang Bogo station in 2014, at Terra Nova bay. Jang Bogo station is operated year round as a continent-oriented research station in the field of meteorology, atmospheric chemistry, upper atmosphere physics, glaciology, geodesy and long-term monitoring.

Araon is Korea's icebreaking research vessel. The primary mission of Araon is to supply logistics to King Sejong and Jang Bogo Stations and to conduct scientific research in worldwide oceans, including both polar areas. Araon is committed to operate logistics and research activities for nearly 300 days a year in Arctic and Antarctic waters.

Korea's Arctic Station, the Dasan Station is situated in Ny-Alesund (78° 55' N, 11° 56' E), on the Svalbard Archipelago. The station, which supports mainly Earth and life scientists, is part of the international research community based at Ny Alesund.

Given its relatively recent entry into Arctic-related activities, South Korea has achieved a lot in its engagement in the Arctic. Similar to Japan, South Korea's polar activities have primarily centred on Antarctica, beginning in the late 1970s. It was only in 2002 that South Korea became a full member of IASC and opened its first research station in Svalbard.

In the policy arena, South Korea identified the Arctic as a priority before the Arctic Council's decision to grant it observer status in 2013. The current Integrated Arctic policy (2013-2017)¹ states strengthening international cooperation as one of its major goals.

Polar Research in India:

India began its National Antarctic Programme in 1981. It established a centre dedicated to Antarctic Expeditions, named as 'Antarctic Study Centre (ASC)' in Goa in 1988. The ASC was subsequently upgraded into an autonomous institute, the National Centre for Antarctic and Ocean Research (NCAOR). The main goals of the NCAOR are to plan, promote and execute polar sciences and logistic activities of the country in Antarctica, the Arctic and in the Southern Ocean. NCAOR is also responsible for construction on new research stations and maintenance of existing stations in Polar Regions.

The Indian year round Antarctic station, Maitri was built in 1989 on the Schirmacher Oasis in Queen Maud Land. India extended its Antarctic presence by building a new station in the Larsemann Hills

¹ http://library.arcticportal.org/1902/1/Arctic_Policy_of_the_Republic_of_Korea.pdf
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region about 3,000 km from Maitri. The new station is named Bharati and has been operational since March 2012.

India is the most recent Asian country to commence Arctic research, as it established its Arctic research station in 2008. Himadri is India's first research station located at Ny Ålesund in Svalbard, Norway. India's Arctic programme aims to contribute to the development, consolidation and dissemination of the current understanding of climate change, its impacts and adaptations in the Norwegian Arctic, Svalbard.

India is an observer in the Arctic Council since 2013. It has not published a national Arctic strategy yet.

Recommendations:

Asian nations are playing an increasingly important role in polar research; they have strong existing Antarctic programmes and logistics and fast emerging Arctic ones². They are very well equipped for research in the remote polar areas and nations like the Republic of Korea or China own excellent infrastructures, like the icebreaking research vessels Araon (Korea) and Xuelong (China), while others like India are in the process of acquiring one³. As stated in their national polar strategies or statements, all of these nations are very keen on cooperating with European partners, sharing infrastructure and jointly fund research programmes.

EU-PolarNet recommends to observe the Asian Polar Community in more detail and to identify the most important partners for European Polar Research. An agreement on science and technological cooperation between the European Community and the most interesting Asian partners should be anticipated which includes possibilities for the sharing of infrastructure and co-funding of scientific projects as e.g. H2020 funded EU-Projects.

² A comparison of Asian Arctic activity - <http://www.fni.no/pdf/FNI-R0313.pdf>

³ <http://moes.gov.in/programmes/construction-polar-research-vessel>