Journal of Geological Resource and Engineering 4 (2014) 217-221
doi:10.17265/2328-2193/2014.04.004

# Education and Polar Research: Bringing Polar Science into the Classroom

Inga Beck[1], Louise Tolle Huffman[4], Jose Carlos Caetano Xavier[2, 3] and David Winston Harris Walton[3]

1. *Alfred-Wegener-Institut, Telegrafenberg A43, Potsdam 14473, Germany*

2. *Institute of Marine Research, University of Coimbra, Coimbra 3001-401, Portugal*

3. *British Antarctic Survey, NERC, Madingley Road, Cambridge CB3 0ET, UK*

4. *PEI (Polar Educators International), ARCUS, Fairbanks, AK 99709-3710, USA*

**Abstract:** The Polar Regions play an important role in the global processes of our planet, from climate change to sea level rise, protection from UV (ultraviolet) radiation to uptake of carbon dioxide. In addition, their scientific importance, extraordinary beauty and adventurous history provide perfect ingredients for both education and public outreach.Polar examples provide an excellent way to transmit basic concepts about a wide range of STEM (science, technology, engineering and mathematics) disciplines. The IPY (International Polar Year) brought educators and scientists together and provided the incentive for the formation of the PEI (Polar Educators International), an organization encouraging the exchange of ideas between educators and researchers and enhancement of the profile of polar education on the international scene. Educators must be adequately informed about current scientific polar research and have the confidenceto teach it to students. Scientists have the knowledge and data to explain these complexities, but may lack the communication skills to make the subject accessible to non-technical audiences. The development of this new network between polar educators and scientists has the potential to break down walls that restrict international collaboration and understanding, provide educators with topical and reliable information and share best practices internationally in an effective way.

**Key words:** Professional development, climate change science, scientist involvement, classroom-ready resources, hands-on, polar science, science communication.

## 1. Introduction

The Polar Regions are the cornerstones of the global ecosystem, barometers of the health of the planet, and the places where global processes connect across the planet [1, 2]. Issues such as sea level rise, climate change, ocean acidification, ozone destruction and global ocean circulation are of paramount importance to billions of people worldwide with much of the key science being conducted in the Arctic and Antarctic [3-8]. Furthermore, the Polar Regions also continue to spark our curiosity and imagination, coupled with a sense of adventure and fear of the unknown, providing perfect ingredients for both education and public outreach.

The IPY (International Polar Year), an international, multidisciplinary program focusing on the Polar Regions was carried out between 2007 and 2010, and encompassed more than 50,000 people from more than 60 countries worldwide, including scientists, teachers and educators [9]. IPY provided a perfect context not only to perform high quality science on an international basis but also to develop associated education and outreach with the objective of examining environmental and societal processes in the Arctic and Antarctic in a global perspective [10].This opportunity to consolidate research in those countries already active at the poles and attract new participants from other countries offered a unique chance to bring science and education together across frontiers and disciplines.

Polar examples can be an excellent way to transmit basic concepts about a wide range of STEM (science,

**Corresponding author:** Inga Beck, research scientist, research field: geosciences. E-mail: inga.may@awi.de.

technology, engineering and mathematics) disciplines. Indeed, numerous countries conducted their education and outreach programs within IPY focusing on a wide range of disciplines while sharing knowledge about the importance of the Polar Regions [11]. Due to an excellent interaction between scientists, educators (including teachers from primary, secondary and tertiary levels as well as public relation specialists) and students globally in the beginning of IPY, it has been a success in various polar and non polar countries, including Portugal and Malaysia [12-14], and a major boost for new ideas on science communication [11, 15]. Changes in requirements from government funding agencies in many countries now require scientists to not only recognize but also participate in the communication of science as an important aspect of their careers [5]. There is a pressing need now for polar educators to be organized in such a way that they can effectively utilize this interest from the scientific community to communicate their science.

A large gathering of educators and scientists during the last IPY conference in Montreal 2012, provided the incentive for the formation of the PEI (Polar Educators International), a new forum for bringing polar educators together to encourage the exchange of ideas, the development of co-operative projects and tools, and the enhancement of the profile of polar education on the international scene [16]. Major scientific polar organizations such as the SCAR (Scientific Committee on Antarctic Research) and IASC (International Arctic Science Council), along with the APECS (Association of Polar Early Career Scientists), have already realized the valuable role of education and outreach and are working with PEI to develop this new initiative. More recently it has been recognized that there is an additional high level international policy perspective, which may be best addressed through the consultative parties at the annual ATCM (Antarctic Treaty Consultative Meetings).

Now (2014), two years after the IPY Montreal teachers and educators workshop, PEI is actively developing their relationships with scientists in many countries. At present, there are two major issues that teachers, educators and scientists must address together to successfully bring important knowledge to their students and these are by no means specific to the Polar Regions.

First, educators need to be adequately informed not only about the relevance of the latest scientific research but also to be confident in explaining it to students. Yet, educators often do not have sufficient background knowledge about the complexities of the science subjects to proficiently teach them. Even worse, when teachers feel they are lacking background knowledge or understanding, this saps confidence and they often avoid teaching subjects (e.g., climate change) they feel may be controversial [17].

Second, whilst scientists have the knowledge and data to explain these complexities, they may lack the communication skills to make the subject accessible to non-technical audiences. Partnering scientists and teachers in a professional development experience thus benefits both groups [18, 19].

To address these issues, polar educators needed to work together with polar scientists to promote information-sharing. This is a non-trivial task especially where the questions are multidisciplinary and the results may have important social, cultural or economic impacts. Even to utilize polar exemplars for some of the basic STEM concepts will require significant interaction and development to provide soundly-based science in a package that can be used across schools in different educational systems and using different languages.

## 2. Developing the Methodology

An initial way forward in bridging the gap between researchers and educators is to develop a suite of simple activities for student participation that highlights important polar processes. An early development in information-sharing and good practice documentation has been to initiate international

workshops with lectures from polar scientists representing a wide range of disciplines who were experienced in communicating science, such as the recent international workshop in Portugal [18]. Scientists used accessible language appropriate for the audience of educators and addressed current scientific issues related both to current media trends and school curricula. By providing the science and its explanation on subjects that educators and their students have heard about in the media, scientists helped these audiences to begin to identify fact from opinion, understand the reliability of data and discuss how to deal with areas inadequately documented. These science talks provided valuable general information from many different research areas related to the Polar Regions. The scientists paid attention to using suitable non-technical language, improving their own communication skills to general audiences, and making it straightforward for all participants to understand the scientific concepts. The speakers made an effort to relate their presentations to the most recent scientific developments and demonstrated how scientists need to connect their findings and provide context and background to what their audiences are hearing in the media. These lectures were available to be downloaded by the educators and queries were answered either at the workshop, or later on, by email by the scientists [16].

For their part, the educators tried out several classroom approaches to see how easy it would be to share materials and approaches across countries and languages, whilst asking the scientists if there were other ways in which this information could be delivered at various educational levels.

## 3. Results and Discussion

In order to stimulate the interest of polar scientists in education and to encourage them to improve their communication skills, PEI and APECS have worked with IPY, SCAR and IASC, at their international conferences, to have education and outreach sessions, along with educators' workshops (e.g., IPY Montreal 2012, SCAR Portland 2013, AGU 2013). In addition, support material has been created for polar scientists to learn how to communicate in schools and provide the first steps to science communication outside their specialized conferences [11]. However, at present these materials are generally in English which is much too limiting, so future work will involve translating the most useful materials into other languages. One of the greatest successes of the polar educational community so far has been making strong connections within the educational, scientific and diplomatic communities, by engaging in common worldwide activities. Antarctica Day (which occurs every year on the 1st of December) and Polar Weeks (one in March and another in September/October) are excellent examples where polar scientists and schools work together in promoting science and education [20].

## 4. Conclusions

Much education worldwide is tightly controlled for political reasons either by local school boards or by central government through prescriptive curricula. In a global world, this is inhibiting and also runs counter to the increasingly free movement of people and goods. Whilst there are clearly national needs in eachcountry, which involve language, history and culture, there are also global needs especially in science where data and outcomes need to be shared and are part of our global heritage. The Polar Regions are major drivers of change in our present world and understanding their role and the likely impacts should be important to everyone, regardless of country or ethnicity. The development of the networks between educators and scientists has the potential to break some of the present walls that restrict international collaboration and understanding, provide educators with topical and reliable information and share best practice internationally in an efficient and effective way. Motivating and educating future generations in the value of polar science is a primary objective of PEI.

## Acknowledgements

These discussions came from an international workshop, held in Coimbra (Portugal), with funding from the SCAR-CBET (Scientific Committee for Antarctic Research Capacity Building, Education and Training Committee), SCAR-AnT-ERA (Scientific Rresearch Programme Antarctic Thresholds-Ecosystem resilience and adaptation), Museum of Science of the University of Coimbra, IMAR-CMA, SoI (Students on Ice) and Ciencia Viva. We are grateful to Filipa Oliveira from the Museum of Science in Coimbra for preparing the venue for the demonstrations and presentations, and to Alcides Pereira, Director of Earth Sciences Department of the University of Coimbra and his staff for the facilities for the hands-on educational activities.

## References

[1] IPCC. 2007. *Climate Change 2007: Synthesis report.* IPCC, Geneva, Switzerland.

[2] IPCC. 2013. "Summary for Policymakers". In *Climate Change 2013: The Physical Science Basis*, edited by Stocker, T.F., and Qin, D. H. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

[3] Anisimov, O. A., and Blair, F. 2007. "Polar Regions (Arctic and Antarctic)." In *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*,edited by Parry, M. L., Canziani, O. F., Palutikof, J. P., van der Linden, P. J., and Hanson, C. E. Cambridge: Cambridge University Press.

[4] Orr, J. C., Fabry, V. J., Aumont, O., Bopp, L., Doney, S. C., Feely, R. A., Gnanadesikan, A., Gruber, N., Ishida, A., Joos, F., Key, R. M., Lindsay, K., Maier-Reimer, E., Matear, R., Monfray, P., Mouchet, A., Najjar, R. G., Plattner, G-K., Rodgers, K. B., Sabine, C. L., Sarmiento, J. L., Schlitzer, R., Slater, R. D., Totterdell, I. J., Weirig, M-F., Yamanaka, Y., and Yool, A. 2005. "Anthropogenic Ocean Acidification over the Twenty-First Century and Its Impact on Calcifying Organisms." *Nature* 437 (7059): 681-6.

[5] Pace, M. L, Hampton, S., Limburg, K. E., Bennett, E. M., Cook, D., Davis, A., Grove, J. M., Kaneshiro, K., LaDeau, S. L., Likens, G. E., McKnight, D. M., Richardson, D. C., and Strayer, D. L. 2010. "Communicating with the Public: Opportunities and Rewards for Individual Ecologists." *Frontiers in Ecology and the Environment* 8: 292-8.

[6] Smetacek, V., and Nicol, S. 2005. "Polar Ocean Ecosystems in a Changing World."*Nature* 437: 362-8.

[7] Peter, C., Bindschadler, R., Di Prisco, G., Fahrbach, E., Gutt, J., Hodgson, D. A., Paul, A. M., Summerhayes, C. P. Turner, J., and ACCE Consortium 2009. *Antarctic Climate Change and the Environment.* Cambridge, UK: Scientific Committee for Antarctic Research.

[8] Walton, D. 2013. *Antarctica: Global Science from a Frozen Continent*. Cambridge: Cambridge University Press.

[9] Allison, I., and Béland, M. 2009. *The State of Polar Research.* Geneva: World Meteorological Organization.

[10] Carlson, D. 2009. "International Polar Year: Something Special, or More of the Same?" *Environ. Geol.* 56: 1735-8.

[11] Kaiser, B., Zicus, S., and Allen, B. 2010. *Polar Science and Global Climate: An International Resource for Education & Outreach*.Boston:Pearson Custom Publishing.

[12] Schiermeier, Q. 2009. "In from the Cold." *Nature* 457: 1072-7.

[13] Xavier, J. C., Barbosa, A., Agusti, S., Alonso-Sáez, L., Alvito, P., Ameneiro, J., Avila, C., Baeta, A., Canário, A., Carmona, R., Catry, P., Ceia, F., Clark, M.S., Cristobo, F. J., Cruz, B., Duarte, C. M., Figuerola, B., Gili, J-M., Gonçalves, A. R., Gordillo, F. J. L., Granadeiro, J. P., Guerreiro, M., Isla, E., Jiménez, C., López-González, P. J., Lourenço, S., Marques, J. C., Moreira, E., Mota, A. M., Nogueira, M., Núñez-Pons, L., Orejas, C., Paiva, V. H., Palanques, A., Pearson, G. A., Pedrós-Alió, C., Peña Cantero, A. L., Power, D. M., Ramos, J. A., Rossi, S., Seco, J., Saňe, E., Serrão, E. A., Taboada, S., Tavares, S., Teixidó, N., Vaqué, D., Valente, T., Vázquez, E., and Vieira, R., and Viñegla, B. V. 2013. "Polar Marine Biology Science in Portugal and Spain: Recent Advances and Future Perspectives." *Journal of Sea Research*. (in press).

[14] Xavier, J. C., Vieira, G. T., and Canário, A. 2006. *Portuguese Science Strategy for the International Polar Year*. Centre of Marine Sciences, University of Algarve: CCMAR and CEG.

[15] May, I., Carlson, D., Ardyna, M., Geoffroy, M., and Heikkilä, M. 2012. "Letter-to-the-Editor: Making Science Animations: New Possibilities for Making Science Accessible to the Public." *Polar Research* 30 (December): 15315.

[16] Walton, D., Xavier, J. C., May, I., and Huffman, L. 2013. "Polar Educators International—A New Initiative for Schools." *Antarctic Science* 25 (4): 473.

[17] Beatty, A. 2012. *Climate Change Education in Formal Settings, K-14: A Workshop Summary*. Washington, D.C.: The National Academies Press.

[18] AAAS. 2007. *Communicating and Learning About*

*Global Climate Change*. Washington, DC: Lonnie Thompson.

[19] Wise, S. B. 2010. "Climate Change in the Classroom: Patterns, Motivations, and Barriers to Instruction among Colorado Science Teachers." *J. Geoscience Education* 58 (5): 297-309.

[20] Krupnik, I., Allison, I., Bell, R., Cutler, P., Hik, D., López-Martínez, J., Rachold, V., Sarukhanian, E., and Summerhayes, C. 2011. *Year 2007-2008: University of the Arctic*. Rovaniemi, Finland: CCI Press.