

## OPINION

## Empowering ECRs: Bridging the educational gap for polar regions

Hugo R. Guimarães<sup>1,2\*</sup>, Joana Fragão<sup>1,2</sup>, José Abreu<sup>1,2</sup>, Connor Rettinger<sup>3</sup>, José P. Queirós<sup>1,2</sup>

**1** Marine and Environmental Sciences Centre, Department of Life Sciences, University of Coimbra, Coimbra, Portugal, **2** British Antarctic Survey, Natural Environment Research Council, Cambridge, United Kingdom, **3** Department of Geography, Environment, and Geomatics, University of Ottawa, Ottawa, Canada

\* [h.r.g@hotmail.com](mailto:h.r.g@hotmail.com)



The polar regions are crucial to regulate global climate. However, both regions are quickly changing due to climate change [1]. With environmental changes succeeding at a fast pace, there is an increasing need for public awareness and action to tackle these complex and interdisciplinary challenges. The importance of education and outreach to raise awareness among civil society was recently highlighted during the Paris Call for Glaciers and Poles signed in Paris [2]. In this opinion piece, we highlight the importance of Early Career Researchers (ECRs) as emerging professionals working in several disciplines. ECRs are an essential role regarding the enhancement of environmental education and outreach activities about polar regions, bridging the gap between the traditionally complex scientific language and the public.

Climate change has its epicenter in the polar regions, where immediate consequences of warming, acidification, freshening, changes in circulation patterns, among others, have been documented [3, 4]. For example, from March to September 2023, the Arctic ice coverage decreased from its maximum extent of 14.62 million km<sup>2</sup> to just 4.23 million km<sup>2</sup> (below the 1981–2010 average minimum), representing a loss of an area equivalent to the entire continental territory of the United States of America [5]. This has prompted a surge in human activities (e.g. mining, tourism, military presence) in the Arctic, leading to increasing geopolitical tensions in the area [6, 7]. Similarly, 2023 hit a new record low of sea ice in Antarctica [8, 9]. The lower sea ice extent not only has profound impacts on climate with changes in the albedo, increasing the heat absorption by the ice free ocean, but also impacts animals that highly depend on the sea ice. For example, the low extent and early break of the sea ice in 2022 lead to an unprecedented breeding failure of the iconic species of emperor penguins (*Aptenodytes forsteri*) in the Bellingshausen Sea region [10]. Constant negative records and climate extreme events in both polar regions leave little room for optimism. Nevertheless, the complex scientific language and acronym usage are often associated with polar science has, in many cases, limited comprehension by the public, being an obstacle to effective communication and policy advocacy.

In this context, ECRs emerge as a well-positioned group to bridge the gap between science and the public. ECRs are professionals recently graduated in their respective disciplines and represent the new generation of scientists that not only conduct critical research but also have a unique talent for translating complex scientific concepts into simple and compelling stories. Leadership, networking, and education and outreach are examples that became essential in addition to our field-specific knowledge. Defining an ECR can be complex because different thresholds can be used. Here, we considered every researcher up to 5 years after concluding their last degree. They are a critical part of the scientific community that stand out among peers by gaining both specialized expertise and transferable “soft skills”. Several characteristics

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of ECRs make them some of the best to raise awareness for the threats of polar regions. First and foremost ECRs are usually fully dedicated to science so incorporating some hours to education and outreach activities is easier than for scientists in advanced career stages that have lecturing duties, coordinate institutes, among others. Also, ECRs usually have a closer age to students in schools. The absence of a significant generational gap makes building rapport amongst scientists and audiences easier. Furthermore, ECRs are more prone to use digital platforms and social media to disseminate knowledge about polar regions and engage with a wider, diverse audience. In these platforms, it is possible to reach thousands of people in seconds. Through stunning photographs or videos of polar landscapes and wildlife, they can bring the distant polar regions closer and with that, also the urgency of conservation efforts. But it is in educational initiatives that ECRs have a more fruitful impact. We can bring polar science directly to the public through participation in workshops, conferences and public talks. Education and outreach can also promote inclusivity and diversity in Science, Technology, Engineering and Mathematics (STEM). For example, integrating and collaborating with indigenous communities, who have a deep connection to polar environments, adds a unique perspective to these educational efforts. Initiatives like “Women in Polar Science” that aim to connect and support women studying in the polar regions, or even the “International Polar Weeks” that aims to take scientists to schools to ensure that the younger generation is educated about the polar regions (e.g., held twice a year at the equinoxes, uninterrupted, since 2012, and happen all over the world) [11]. These events are brought to fruition by the Association of Polar Early Career Scientists (APECS) platform where ERCs share their work in social media and in schools teaching students from several ages (and also teachers) about the importance of polar regions (Fig 1) [The individual(s) pictured in Fig 1 has provided written informed consent (as outlined in PLOS consent form) to publish their image alongside the manuscript]. Also, ECRs work very closely with the educators and professors (e.g., Polar Educators International—PEI) bringing polar education to the national education programs. For example, creating new didactic ways to bring polar science to classrooms such as the “Open Science”, an APECS Portugal rubric that consists in creating one page summary of scientific papers so it becomes accessible to non-scientists [12]; or even the “The Polar Resource Book”, an initiative by PEI with the support of ECRs through APECS to support education and outreach activities. An updated version is on its way with ECRs having, again, an important role [13].

Organizations dedicated to ECRs, such as APECS, Polar Science Early Career Community Office (PSECCO), or the Permafrost Young Researchers Network (PYRN), are platforms that offer a global and inclusive stage for collaboration. ECRs can share knowledge and develop educational initiatives that can amplify their impact in polar education. By working together, ECRs can develop global strategies for effective polar education and outreach, enhancing the exchange of scientific knowledge and paving the way for innovative solutions to the challenges faced by polar regions.

Scientific literacy and climate change awareness are extremely important, and ECRs are emerging as drivers of change. They are making polar education more accessible, engaging, diverse and inclusive through their dedication and innovative approaches. Future generations will have the tools to face the several challenges of these vulnerable regions. Perhaps, for being on the vanguard of polar education and outreach, ECRs have a commitment to bridge the educational gap for polar regions. The groundwork for a more informed, connected, and environmentally conscious society is on its way and for that, we believe that ECRs should not just have a voice but be at the forefront. Therefore, policymakers and society should actively seek out and listen to the voices of ECRs, as they hold the key to a more environmentally conscious world, one that will rise to the challenge of protecting our precious polar environments for generations to come.



**Fig 1. Scientists and students engage in experiments, fostering a deeper understanding of the polar regions.**

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## Author Contributions

**Conceptualization:** Hugo R. Guímaro, José P. Queirós.

**Writing – original draft:** Hugo R. Guímaro.

**Writing – review & editing:** Hugo R. Guímaro, Joana Fragão, José Abreu, Connor Rettinger, José P. Queirós.

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