



## Insights into German polar research during POLARSTUNDE

Alexandra M. Zuhr<sup>1,2</sup>, Erik Loebel<sup>1,3</sup>, Marek Muchow<sup>1,4</sup>, Donovan Dennis<sup>1,5</sup>, Luisa von Albedyll<sup>1,6</sup>, Frigga Kruse<sup>7</sup>, Heidemarie Kassens<sup>8</sup>, Johanna Grabow<sup>1,9</sup>, Dieter Piepenburg<sup>6,7</sup>, Sören Brandt<sup>1,7</sup>, Rainer Lehmann<sup>10</sup>, Marlene Jessen<sup>11</sup>, Friederike Krüger<sup>12</sup>, Monika Kallfelz<sup>13</sup>, Andreas Preußner<sup>1,6</sup>, Matthias Braun<sup>14</sup>, Thorsten Seehaus<sup>14</sup>, Frank Lisker<sup>15</sup>, Daniela Röhnert<sup>15</sup>, and Mirko Scheinert<sup>3</sup>

<sup>1</sup>German National Committee of the Association of Polar Early Career Scientists (APECS Germany), Germany

<sup>2</sup>Alfred Wegener Institute, Helmholtz Center for Polar and Marine Research, Research Unit Potsdam, Potsdam, Germany

<sup>3</sup>Institut für Planetare Geodäsie, Technische Universität Dresden, Dresden, Germany

<sup>4</sup>School of Engineering, Department of Mechanical Engineering, Aalto University, P.O. Box 14100, 00076 Aalto, Finland

<sup>5</sup>German Research Center for Geosciences, GFZ, Telegrafenberg, Potsdam, Germany

<sup>6</sup>Alfred Wegener Institute, Helmholtz Center for Polar and Marine Research, Research Unit Bremerhaven, Bremerhaven, Germany

<sup>7</sup>Christian-Albrechts-Universität zu Kiel, Kiel, Germany

<sup>8</sup>GEOMAR, Helmholtz Centre for Ocean Research Kiel, Kiel, Germany

<sup>9</sup>Scientific Committee on Antarctic Research, Scott Polar Research Institute, University of Cambridge, Cambridge, UK

<sup>10</sup>Europa Universität Flensburg, Flensburg, Germany

<sup>11</sup>Elly-Heuss-Knapp-Schule, Neumünster, Germany

<sup>12</sup>IGS Bothfeld, Hintzehof 9, Hannover Germany

<sup>13</sup>Natural History Museum, Bad Dürkheim, Germany

<sup>14</sup>Institute of Geography, Friedrich-Alexander-Universität Erlangen-Nürnberg, Wetterkreuz 15, Erlangen, Germany

<sup>15</sup>Fachbereich Geowissenschaften der Universität Bremen, Bremen, Germany

**Correspondence:** Alexandra M. Zuhr (alexandra.zuhr@awi.de)

Received: 28 February 2023 – Revised: 14 August 2023 – Accepted: 28 August 2023 – Published: 26 October 2023

**Abstract.** Polar research is an interdisciplinary and multifaceted field of research ranging from history to geology and geophysics to social sciences and education. Thus, several different universities and institutions within Germany participate in polar research. The seminar series POLARSTUNDE, organized by the German Society for Polar Research (Deutsche Gesellschaft für Polarforschung) and the German National Committee of the Association of Polar Early Career Scientists (APECS Germany) regularly features different topics of German polar research. Although initially a “pandemic solution”, the seminar series has established itself as a valuable and highly successful part of the German polar research landscape. The seminar series was held in German and was aimed at both scientists and the general public. This article addresses the first season of POLARSTUNDE and provides (1) comprehensive summaries of the talks and (2) insight into the planning and execution from an organizational point of view.

### 1 Introduction

The origins of German polar research date back to the period between 1865 and 1875 with the efforts of the first German expedition to the North Pole (Krause, 1992; Murphy, 2002). In the 19th century, expeditions were mainly driven by the desire to discover and explore the polar regions. Until the end of the 20th century, expeditions were characterized by scientific curiosity and fascination. Later, the exploration of the cold and icy regions of the Earth increasingly became the focus of natural sciences. Nowadays, German polar research is highly multidisciplinary and goes far beyond the field of natural sciences, including, for example, but not limited to social sciences and history.

The polar research community mainly from Germany, Austria and Switzerland but also from other European countries, regularly meets at the International Polar Conference organized by the German Society for Polar Research (DGP),



**Figure 1.** Flyer for POLARSTUNDE, a public lecture series jointly organized by the German Society for Polar Research and APECS Germany.

which is held every two and a half years, to discuss current research and to initiate new collaborations. In 2020, the realization of this conference was prevented, like many other events, by the uncertain pandemic situation. Hence, the conference was postponed from October 2020 to May 2022. As a substitute and to bridge the time until in-person meetings were possible again, the DGP and the German National Committee of the Association of Polar Early Career Scientists (APECS Germany) together launched a virtual seminar series called POLARSTUNDE (Fig. 1).

On six Wednesdays from June 2021 to April 2022, POLARSTUNDE provided a look behind the scenes of German polar research. These six events, each dealing with a particular topic, not only fostered exchange between researchers from different disciplines but were also kept short, lively and approachable to reach the interested public. To have a greater reach than the scientific community, the entire seminar series was held in German – quite a unique setting. With up to 110 German-speaking participants per event, POLARSTUNDE was thus able to reach far beyond the academic audience and contribute to science education and public awareness.

Each individual seminar dealt with a particular research topic. For the selection of topics we initially reached out to the different working groups of the DGP (in German *Arbeitskreise*). Not all six talks were based on the working groups, but the selection of topics is still a reflection of the existing working groups within the DGP. These topics ranged from history, literature and education to biological processes, sea ice, glaciology and geology. Additionally, POLARSTUNDE was designed to contain presentations by invited speakers at different career stages – from students and early career scientists (ECSs) to established professors – with each event featuring at least one senior and one early career scientist. With this setup we aim to increase the visibility of early career scientists as this is one of the main goals of APECS.

This article has two main objectives. Firstly, in Sects. 2 to 7 we summarize each of the six seminars. These summaries include the main takeaways from these presentations but also supplementary information about the topic, the speakers, audience attendance and further resources. Secondly, in Sect. 8 we reflect on this first season of POLARSTUNDE from an organizational point of view to share what we have learned and why we think such events are important for the polar community.

## 2 “(Hi)Stories from the polar regions”

### Speakers:

Frigga Kruse, Christian-Albrechts-Universität, Kiel  
 Johanna Grabow, Scientific Committee on Antarctic Research, Cambridge

On 23 June 2021, Frigga Kruse (Christian-Albrechts-Universität, Kiel) and Johanna Grabow (SCAR (Scientific Committee on Antarctic Research) Standing Committee on the Humanities and Social Sciences member) opened the seminar series with talks about “(Hi)Stories from the polar regions”. The seminar started with polar archeology in the Arctic and lead us to learn about heroes and heroic misadventures in Antarctica and their descriptions in contemporary literature.

The first anthropogenic remains in the Arctic are thought to date from about 40 000 years ago (Pavlov et al., 2001). Although the region seems to us like a cold and harsh environment, early humans nonetheless moved here because of its abundant living resources. If you knew where to find them and how to exploit them, you could survive and even thrive here. Advanced methods are used by (polar) archeologists to investigate the everyday life of people at that time, which was dominated by the procurement and storage of food and

other raw materials (Sikora et al., 2019). As a polar historical archeologist at the Institute for Ecosystem Research, Frigga Kruse is currently leading the Timeless Arctic project (<https://timelessarctic.org/>, last access: 1 August 2023), in which she investigates the role of commercial hunting in the reconstruction of human impact in Svalbard with a specific focus on the recent developments in polar archeology (Kruse, 2016, 2017). Hence, it is through weapon-related injuries on, e.g., mammoth bones, rather than actual human-made artifacts or even human bones, that we see evidence of the earliest human presence above the polar circle (Pitulko et al., 2016).

On the other side of the Earth, it took much longer for humans to leave traces. About 31 500 years lie between the first findings in the Arctic and reports of humans in Antarctica (Pearson et al., 2020). Many documentations of the first legendary expeditions are nowadays found in contemporary literature. Johanna Grabow currently works as the Project Officer of SCAR in Cambridge, England. She loves to read about the Antarctic and Arctic and travels to both regions as a lecturer and expedition guide. This interest also brought her to her dissertation on the reception of Antarctica in contemporary British literature. The famous explorers Robert F. Scott, Roald Amundsen and Ernest Shackleton, amongst others, found their way into many books revisiting, retelling and deconstructing the stories of the golden age of Antarctic research from the end of the 19th century to the beginning of the early 1920s (Bainbridge, 2009; Ryan, 2009). The narratives of this period are full of manly endeavors. Amongst the first recorded women to visit Antarctica are Ingrid Christensen and Mathilde Wegger in 1931 (Blackadder, 2013; Manhire, 2004).

About 50 people interested in polar issues joined the first seminar, listened to stories from the polar regions and asked interested questions about living conditions on Svalbard and favorite polar books.

### 3 “Warming and sea-ice decline in the Arctic: what are the impacts of rapid climate change on marine life?”

Speakers:

Dieter Piepenburg, Alfred Wegener Institute, Helmholtz Center for Polar and Marine Research, Bremerhaven  
Sören Brandt, Christian-Albrechts-Universität, Kiel

On 18 August 2021, Dieter Piepenburg (Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven) and Sören Brandt (Christian-Albrechts-Universität, Kiel) gave an overview of the footprints of rapid climate change in marine life in the Arctic (Brandt et al., 2023).

In recent decades, the Arctic sea-ice extent has been declining more rapidly than predicted in climate models, with

significant consequences for the marine food webs due to the amplified impact of climate change at high latitudes. Sea ice is not only a habitat for organisms living on, in or under the ice, it also affects marine life in the water below the ice and even on the seafloor. This part was especially highlighted during the introduction to the key functions of Arctic marine ecosystems by Dieter Piepenburg. He is a marine biologist focusing on the impacts of climate change on marine ecosystems in polar regions.

With a change in sea-ice cover, the habitats and living conditions of many species are also changing. These changes were highlighted in the second talk by Sören Brandt, who has a bachelor’s degree in biology and a master’s degree in environmental management with a special focus on climate change in the Arctic Ocean and its effects on marine food webs. The distribution ranges of fish are, for example, shifting northwards due to ocean warming, which is especially severe for Arctic species because their distribution is quite narrow and often sea-ice-dependent, and they face pressures from invading sub-Arctic and boreal fish species. Besides, the lives of polar bears, which live mainly on the sea ice, are drastically changing as well. Their mobility on the sea ice is becoming increasingly difficult, forcing them to find other food sources, mostly on land. Furthermore, due to their changing living environment, polar bears increasingly often meet brown bears, leading to a more frequent mating between the two species. In conclusion, the ongoing sea-ice decline in Arctic seas profoundly affects marine food webs, and species and communities are forced to adapt very fast to new and challenging conditions.

The 65 participants listened with interest to both talks and asked exciting questions afterwards, especially about the best-known Arctic icon – the polar bear.

### 4 “From the classroom to the polar regions and vice versa”

Speakers:

Rainer Lehmann, geographer, lecturer and scientist at the Europa Universität Flensburg  
Marlene Jessen, student at the Elly-Heuss-Knapp-Schule in Neumünster  
Friederike Krüger, teacher for German and geography at the IGS Bothfeld in Hannover  
Monika Kallfelz, biologist, teacher for biology and chemistry, working at the Natural History Museum in Bad Dürkheim, Rhineland-Palatinate

The third edition of POLARSTUNDE was held on 13 October 2021, organized by the Arbeitskreis (AK) Polarlehrer (Work Group Polar Educators) and joined by 43 interested people. The hour was all about how to communicate polar science to school children and how to inspire the next generation of polar scientists.

The seminar started with an overview of the work of the AK Polarlehrer by Rainer Lehmann, a geographer working at the Europa Universität Flensburg and the head of the working group. The activities of educators include joining scientific expeditions to the polar regions to gain first-hand experience of scientific work (Pound et al., 2019) as well as providing the link between scientists, educators and children. The AK further gives talks at conferences, publishes in journals and distributes a regular newsletter (Lehmann and Rudolph, 2020; Lehmann and Kallfelz, 2019).

The AK Polarlehrer also provides school children with the opportunity to start their own experiments. Marlene Jessen, a student at the Elly-Heuss-Knapp-Schule (Neumünster) joined Frigga Kruse (Christian-Albrechts-Universität Kiel) for her project *Timeless Arctic 2022*, which was also part of the first POLARSTUNDE. During the seminar, Marlene shared how her long dream of going to the Arctic might come true in 2022 by introducing the audience to her first scientific expedition. She is currently focusing on the preparation for an expedition to the Arctic, where she will take soil and water samples to study the isolation of psychrophilic bacteria and the detection of glyphosate.

The audience also gained insights into the pedagogical perspective of an educator and possible projects for imparting knowledge. These were presented first by Friederike Krüger, who teaches German and geography at the IGS Bothfeld (Hanover) and was a member of the MOSAiC campaign in 2019. She spoke vividly about climate change and its consequences in the Arctic. The combination of having experienced the conditions on site and the daily work of a scientist as well as her educational background allows her to create appealing teaching materials tailored to different age groups (Krüger, 2021). Educators who have been in the field themselves have a better ability to communicate the subject and to motivate children enormously. In addition, Monika Kallfelz presented publication and exchange opportunities for educators and scientists. She is a biologist and used to work as a biology and chemistry teacher in Rhineland-Palatinate before she started her current job at the Natural History Museum (<https://www.pfalzmuseum.de/>, last access: 1 August 2023), where she develops programs and educational material for teachers and children. She highlights the importance of good communication between researchers and educators to translate complex scientific topics into content that is easy to understand. An important goal of her work is to connect the different disciplines and to provide experiments suitable for children, both in the museum and in schools (Kallfelz, 2021).

All presenters showed how educators are necessary additional disseminators of the outreach performed by researchers. To contact the AK Polarlehrer, please use the following e-mail address: [ak-polarlehrer@polarforschung.de](mailto:ak-polarlehrer@polarforschung.de).

## 5 “Where the ocean meets the atmosphere – the key role of sea ice in polar climate”

Speakers:

Andreas Preußner, Universität Trier and Alfred Wegener Institute Bremerhaven

Luisa von Albedyll, Alfred Wegener Institute Bremerhaven

The fourth POLARSTUNDE was all about sea ice in the Arctic Ocean. Andreas Preußner (Universität Trier) and Luisa von Albedyll (Alfred Wegener Institute Bremerhaven) introduced the role of sea ice in the polar climate, with 88 interested people following their presentations on the 15 December 2021.

Sea ice is a very diverse medium with tremendously changing conditions between the winter and the summer season. It is closely embedded in the complex climate system in the Arctic between the ocean and the overlying atmosphere. Arctic sea ice is not a completely closed and homogeneous cover on the Arctic Ocean – it is quite the opposite as pointed out by Andreas Preußner in his talk focusing on ice growth in thin-ice and open-water areas that are created by divergent ice motion. Sea-ice thickening is driven by two main processes. During thermodynamic growth, the seawater cools and once it reaches the freezing point, sea ice starts to form. Alternatively, sections of ice can be pushed on top of each other, forming rafted ice or ridges up to 20 m high. This process is also referred to as deformation-related or dynamic thickness change. Thus, sea ice contains various surface features such as polynyas (areas with thin ice and open water at roughly fixed locations), leads (cracks several meters to kilometers wide throughout the sea-ice cover) and pressure ridges.

Generally, sea ice in the Arctic is getting younger and therefore thinner (Meier et al., 2022). Following the warming trend of the Arctic, the freezing starts later in the year while the melting of the ice occurs earlier. This leaves less time for growing and decreases the survival rate of sea ice in the summer. At the same time, larger areas of thin ice promote increased volumes of thermodynamically grown ice during winter, which is especially noticeable on the shelf seas of the Siberian Arctic (Preußner et al., 2019; Ricker et al., 2021). However, the changes in the dynamic thickness change are not yet clear.

Luisa von Albedyll compared the contribution of deformation to the overall sea-ice thickness in two areas. She analyzed the closing of an unusual polynya in spring 2018 on the northeast coast of Greenland (Ludwig et al., 2019; von Albedyll et al., 2021). Strong convergence of the thin, newly formed ice had doubled the thermodynamically grown ice thickness to 2 m. This example underlines how important deformation can be for maintaining a thick ice cover. For the second area, she joined the MOSAiC campaign (Rex and Shupe, 2023) in 2020 to study the ice thickness changes due to deformation along the Transpolar Drift, the route of the re-

search vessel *Polarstern*. In addition to satellite data, she also used in situ measurements from an airborne electromagnetic sensor. The result of her current study (von Albedyll et al., 2022) is that new ice formation in leads created by deformation and subsequent ridging contributed 30 % to the sea-ice thickness.

Besides the characteristics of Arctic sea ice and its changes during the past 50 years, both Andreas Preußner and Luisa von Albedyll presented different ways of measuring the sea-ice extent and the thickness via satellite, airborne and in situ observations as well as sea-ice deformation and its effects on sea-ice growth and thickness. The central goal is to understand how the warming of the Arctic affects the numerous processes in leads, polynyas and pressure ridges. They will continue to use our “eyes in space”, i.e., satellite remote sensing, to develop a better understanding of those processes. They hope that this will help us to further map the role of sea ice in global climate models.

## 6 “Remote sensing of glaciers – how satellites help us to monitor ice mass changes”

Speakers:

Matthias Braun, Friedrich-Alexander-Universität Erlangen-Nürnberg

Thorsten Seehaus, Friedrich-Alexander-Universität Erlangen-Nürnberg

On the 16 February 2022, 113 participants listened to Matthias Braun and Thorsten Seehaus (Institute of Geography at the Friedrich-Alexander-Universität Erlangen-Nürnberg). In this fifth POLARSTUNDE, Matthias Braun provided an overview of the remote-sensing activities of his research group focusing entirely on the analysis of glaciers, with Thorsten Seehaus explaining the glacier changes on the Antarctic Peninsula.

Matthias Braun explains that the remote-sensing community experienced a boost after the Landsat data became public in 2008. These data were also of great importance for him and his group due to the coverage of polar areas and their potential for glaciological research. The Sentinel satellites as well as TerraSAR-X and TanDEM-X, two German radar satellites, are likewise important satellite missions with a continuously growing volume of data available. However, it is also important to combine remote-sensing data with field campaigns and observational data, especially for calibration and validation, and to have a feeling for the medium, which is otherwise only studied from a far distance.

Thorsten Seehaus talked about glacier changes in the Antarctic Peninsula and explained why this area, together with West Antarctica, is so special and why it is important to monitor it (Cook and Vaughan, 2010; The IMBIE Team, 2018). While the Antarctic Peninsula is only 3 % of the area of Antarctica, the overall mass loss from this small part ac-

counts for 15 %–40 % of the overall mass loss (The IMBIE Team, 2018). The reason for this behavior lies in the warming of the atmosphere and changes in ocean circulation, bringing warm deep water to the surface. Here, this water meets the ice shelves, causing them to retreat and melt. Such a feedback mechanism has been studied at the Larsen-A and Prince Gustav ice shelves where most likely surface melt influenced the stability of the ice shelves (Seehaus et al., 2015, 2016). After the breakup and disintegration events of the ice shelves in 1995, the tributary glacier fronts rapidly retreated. During this phase, the glacier flow accelerated dramatically and the glacier area decreased. After some years of increased flow speed, the glacier flow slowed down again and the calving fronts partly re-advanced.

Monitoring such events is important to understand glacier dynamics and to calculate the potential sea level contribution of former ice shelf tributaries. Thorsten Seehaus also visualized the importance of in situ observations, such as a permanent GPS station, for ground truthing of glacier flow rates at specific locations (Lippl et al., 2019).

Besides an improved understanding of glaciological phenomena, the research output of Braun’s group is used as input for glacier modeling as well as for risk assessments in high mountain areas. Focus areas of high importance are, for instance, the measurement of glacier surface velocities using Sentinel-1 data, the monitoring of supraglacial lakes in northeast Greenland, and elevation changes in glaciers from ICESat and ICESat-2 (Ice, Cloud and Land Elevation Satellite) as well as TerraSAR-X and TanDEM-X.

## 7 “Uplift of the Transantarctic Mountains and global climate change 34 Myr ago: a chicken or egg problem?”

Speakers:

Frank Lisker, Universität Bremen

Daniela Röhnert, Universität Bremen

In the sixth and last seminar of the POLARSTUNDE series on 13 April 2022, Frank Lisker and Daniela Röhnert (Universität Bremen) introduced 43 participants to the uplift of the Transantarctic Mountains about 35 Myr ago. Antarctica is not only a flat continent beneath the ice, as some might expect. On the contrary, parts of the Antarctic continent in the east lie (way) above sea level.

Different mechanisms are discussed as to how and when the Transantarctic Mountains were uplifted. Capped by a plateau surface, the Transantarctic Mountains are the most elevated areas of Antarctica with a length of more than 3500 km and a height of up to 5 km. Frank Lisker and Daniela Röhnert presented three mechanisms which potentially explain the uplift of the Transantarctic Mountains. The first hypothesis is mechanically driven uplift triggered by rifting and faulting. Further theories suggest thermal pro-

cesses as the cause or explain the mountains as a remnant of a Mesozoic Ross Sea highland. Beyond the cause and mechanism of uplift, the progression and timing of mountain uplift are also poorly known.

Daniela Röhnert uses radiometric methods to date the formation of the Transantarctic Mountains. Only 2 % of Antarctica is ice-free nowadays, which allows the study of its geological composition. Based on cooling histories of different minerals phases, she can reproduce and understand burial and exhumation processes that result from uplift and long-term landscape development. The combination of geological observation and the new thermochronological data indicates the existence of a long-living sedimentary basin along the margin of East Antarctica and the sudden uplift of the Transantarctic Mountains since 35 Ma. These processes rule out the existence of a Mesozoic Ross Sea highland.

However, the temporal coincidence of Transantarctic Mountain uplift and climatic change that caused the permanent glaciation of Antarctica is particularly striking. Climatic changes are controlling mechanisms on the global carbon cycle, with consequences for the amount of material with a terrestrial origin in the oceans. Changes in temperature have additionally influenced landscape evolution in polar regions, with erosional protection of low-relief landscapes and mountain peaks beneath cold glacial covers and substantially increased erosion in valleys hosting fast-moving glaciers. Moreover, temperature indirectly controls the amount of emitted long-wave radiation, with colder surfaces emitting less. Overall, it is still a challenge for the scientific community to disentangle the different feedback mechanisms and unravel the complex history of the Transantarctic Mountains.

## 8 Discussion and conclusions

With its six seminars between June 2021 and April 2022, POLARSTUNDE facilitated the exchange between German polar scientists and communication with the interested public during times in which in-person meetings were not possible. Furthermore, the seminars bridged the time until the 29th International Polar Conference, which was held in person in May 2022 in Potsdam. So what have we, as organizers, learned from almost a year of POLARSTUNDE?

1. Including at least one ECS speaker in each seminar was a key objective of the series, and this was very successfully realized. The involvement of ECSs as speakers is not only valuable to create an engaging dynamic during the seminar but is also essential to reflect who is conducting polar research as a whole. Additionally, POLARSTUNDE is a great place for ECSs to give presentations to a possibly different target audience than usual.
2. All seminars within POLARSTUNDE are held in German. Thus, the seminars enabled the communication of scientific topics without English being a barrier to a general audience. Of course, POLARSTUNDE was not the

only online seminar series which was developed during the pandemic, but it is the only German-speaking seminar series covering polar research that we are aware of. This is an important achievement of the German polar community and having outreach and science communication in native languages is highlighted as a goal in international guidelines such as the *APECS Handbook* (see, e.g., Sect. 3.3.1; APECS Executive Committee, 2021). Nevertheless, we also want to acknowledge that choosing German imposes a limitation on who can be invited as a speaker. However, there are many other online seminars for an English-speaking audience (e.g., IGS Global Seminar Series, <https://www.igsoc.org/events/igs-global-seminar-series>, last access: 1 August 2023).

3. Many students from different universities joined the seminar and therefore obtained an overview of the diversity of polar research within Germany. We argue that this is due (1) to the seminars being held in German as a lot of study programs are in German and (2) to POLARSTUNDE being free and accessible without travel.
4. It is impossible to cover the whole of German polar research with only six events. Although the various DPG working groups cover a range of topics, the events do not even come close to representing all relevant subjects. It will take more seasons to achieve this objective.
5. Related to this, there is a bias regarding the selection of speakers. Currently, they are invited by the organizing committee. Involving the audience in this process (e.g., through an open call) could be beneficial for the seminar series and the diversity of topics.

Due to the success of POLARSTUNDE, a second series with six talks has been organized from autumn 2022 to summer 2023 again as a cooperation between DGP and APECS Germany. We applied lessons learned from the first seasons. Thus, we kept the same structure and continued our commitment to involving ECSs. In addition, we are moving away from the fixed structure of the DGP working groups, allowing for a much more flexible organization of presentations and inclusion of topics not represented in the DGP because “polar research” is a big umbrella term which covers many disciplines. The second season was very successful and gained a steadily growing audience.

Despite being a “pandemic solution” initially, POLARSTUNDE has established itself as a valuable and easily accessible part of the German polar research landscape. The seminar series presented German polar research with its manifold achievements, covering a large variety of disciplines. It impressively demonstrated the importance of education and outreach, which are playing an increasingly important role alongside the publication of new scientific discoveries.

**Data availability.** No data sets were used in this article.

**Author contributions.** The idea for the seminar was developed by members of the DGP, especially FK and HK. MK was responsible for the technical details during the seminars and the communication with the audience. DD illustrated all flyers. AMZ mainly organized the seminars with the help of MM, MK, LvA and EL. JG, FK, DP, SB, RL, MJ, FK, MK, AP, LvA, MB, TS, FL and DR contributed through presentations during the seminar. AMZ summarized the six seminars and wrote the article with contributions from all co-authors. The revision of the article was done by MM and EL.

**Competing interests.** At least one of the (co-)authors is a member of the editorial board of *Polarforschung*. The peer-review process was guided by an independent editor, and the authors also have no other competing interests to declare.

**Disclaimer.** Publisher's note: Copernicus Publications remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

**Acknowledgements.** We would like to thank all attendees who made this seminar series a success. We thank Clara Burgard for her constructive comments which helped to improve the paper.

**Review statement.** This paper was edited by Lena Nicola and reviewed by Clara Burgard.

## References

- APECS Executive Committee: APECS Handbook, [https://apecs.is/images/Articles/Files/APECS\\_Handbook\\_Sept\\_2021.pdf](https://apecs.is/images/Articles/Files/APECS_Handbook_Sept_2021.pdf) (last access: 18 October 2023), 2021.
- Bainbridge, B.: *The Birthday Boys*, Abacus, London, ISBN-13 978-0349121567, 2009.
- Blackadder, J.: *Chasing the Light: A Novel of Antarctica*, Forth Estate, Sydney, ISBN-13 978-0732296049, 2013.
- Brandt, S., Wassmann, P., and Piepenburg, D.: Revisiting the footprints of climate change in Arctic marine food webs: An assessment of knowledge gained since 2010, *Front. Mar. Sci.*, 10, 1–17, <https://doi.org/10.3389/fmars.2023.1096222>, 2023.
- Cook, A. J. and Vaughan, D. G.: Overview of areal changes of the ice shelves on the Antarctic Peninsula over the past 50 years, *The Cryosphere*, 4, 77–98, <https://doi.org/10.5194/tc-4-77-2010>, 2010.
- Kallfelz, M.: Arctic Day – Ein Event für die ganze Schulgemeinschaft gestalten, *Biologie im naturwissenschaftlichen Unterricht* 5–10, 34, 32–35, 2021.
- Krause, R.: Die Gründungsphase deutscher Polarforschung, 1865–1875 The period of founding of the German polar research, 1865–1875, *Berichte zur Polarforschung (Reports on Polar Research)*, 114, 0–450, [https://doi.org/10.2312/BzP\\_0114\\_1992\\_1992](https://doi.org/10.2312/BzP_0114_1992_1992), 1992.
- Kruse, F.: Is Svalbard a pristine ecosystem? Reconstructing 420 years of human presence in an Arctic archipelago, *Polar Rec.*, 52, 518–534, <https://doi.org/10.1017/S0032247416000309>, 2016.
- Kruse, F.: Catching up: the state and potential of historical catch data from Svalbard in the European Arctic, *Polar Rec.*, 53, 520–533, <https://doi.org/10.1017/S0032247417000481>, 2017.
- Krüger, F.: Als Lehrerin auf Expedition in die Arktis: ein Tag auf dem Eis, *Biologie im naturwissenschaftlichen Unterricht* 5–10, 33, 36–39, 2021.
- Lehmann, R. and Kallfelz, M.: Die Polarlehrer – Coole Klassen an den Polen der Erde, *Biologie in unserer Zeit*, 49, 277–281, <https://doi.org/10.1002/biuz.201910682>, 2019.
- Lehmann, R. and Rudolph, E.: Polar Educators Germany, *ECO Magazine Polar Special Issue*, 124–125, <http://digital.ecomagazine.com/publication/?i=674747&ver=html5&p=124> (last access: 18 October 2023), 2020.
- Lipl, S., Friedl, P., Kittel, C., Marinsek, S., Seehaus, T. C., and Braun, M. H.: Spatial and Temporal Variability of Glacier Surface Velocities and Outlet Areas on James Ross Island, Northern Antarctic Peninsula, *Geosciences*, 9, 9, <https://doi.org/10.3390/geosciences9090374>, 2019.
- Ludwig, V., Spreen, G., Haas, C., Istomina, L., Kauker, F., and Murashkin, D.: The 2018 North Greenland polynya observed by a newly introduced merged optical and passive microwave sea-ice concentration dataset, *The Cryosphere*, 13, 2051–2073, <https://doi.org/10.5194/tc-13-2051-2019>, 2019.
- Manhire, B.: *The Wide White Page: Writers Imagine Antarctica*, Victoria University Press, Wellington, ISBN 978-0864734853, 2004.
- Meier, W., Petty, A., Hendricks, S., Perovich, D., Farrell, S., Webster, M., Divine, D., Gerland, S., Kaleschke, L., Ricker, R., and Tian-Kunze, X.: Arctic Report Card 2022: Sea Ice, NOAA technical report, <https://doi.org/10.25923/xyp2-vz45>, 2022.
- Murphy, D. T.: *German exploration of the Polar World: A history, 1870–1940*, U of Nebraska Press, ISBN 978-0803232051, 2002.
- Pavlov, P., Svendsen, J., and Indrelid, S.: Human presence in the European Arctic nearly 40,000 years ago, *Nature*, 413, 64–67, <https://doi.org/10.1038/35092552>, 2001.
- Pearson, M., Zarankin, A., and Salerno, M. A.: Chapter 14 - Exploring and exploiting Antarctica: The early human interactions, in: *Past Antarctica*, edited by: Oliva, M. and Ruiz-Fernández, J., 259–278, Academic Press, <https://doi.org/10.1016/B978-0-12-817925-3.00014-8>, 2020.
- Pitulko, V. V., Tikhonov, A. N., Pavlova, E. Y., Nikolskiy, P. A., Kuper, K. E., and Polozov, R. N.: Early human presence in the Arctic: Evidence from 45,000-year-old mammoth remains, *Science*, 351, 260–263, <https://doi.org/10.1126/science.aad0554>, 2016.
- Pound, K., Huffman, L., Hubbard, J., Cattadori, M., Dahlman, L., Dooley, J., Frisch-Gleason, R., Lehmann, R., and Trummel, B.: ANDRILL ARISE: A model for team-based field research immersion for educators, *Polar Rec.*, 55, 251–273, <https://doi.org/10.1017/S0032247419000056>, 2019.
- Preußner, A., Ohshima, K. I., Iwamoto, K., Willmes, S., and Heineemann, G.: Retrieval of Wintertime Sea Ice Production in Arctic Polynyas Using Thermal Infrared and Passive Microwave Remote Sensing Data, *J. Geophys. Res.-Oceans*, 124, 5503–5528, <https://doi.org/10.1029/2019JC014976>, 2019.

- Rex, M. and Shupe, M.: The Expedition PS122/4 of the Research Vessel POLARSTERN to the Arctic Ocean in 2020, edited by: Bornemann, H. and Amir Sawadkuhi, S., *Berichte zur Polar- und Meeresforschung, Reports on polar and marine research*, Bremerhaven, Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, 2023.
- Ricker, R., Kauker, F., Schweiger, A., Hendricks, S., Zhang, J., and Paul, S.: Evidence for an Increasing Role of Ocean Heat in Arctic Winter Sea Ice Growth, *J. Climate*, 34, 5215–5227, <https://doi.org/10.1175/JCLI-D-20-0848.1>, 2021.
- Ryan, R.: *Death of the Ice*, *Headline Review*, London, ISBN 978-0755348350, 2009.
- Seehaus, T., Marinsek, S., Helm, V., Skvarca, P., and Braun, M.: Changes in ice dynamics, elevation and mass discharge of Dinsmoor–Bombardier–Edgeworth glacier system, Antarctic Peninsula, *Earth Planet. Sc. Lett.*, 427, 125–135, <https://doi.org/10.1016/j.epsl.2015.06.047>, 2015.
- Seehaus, T. C., Marinsek, S., Skvarca, P., van Wessem, J. M., Reijmer, C. H., Seco, J. L., and Braun, M. H.: Dynamic Response of Sjøgren Inlet Glaciers, Antarctic Peninsula, to Ice Shelf Breakup Derived from Multi-Mission Remote Sensing Time Series, *Front. Earth Sci.*, 4, 66, <https://doi.org/10.3389/feart.2016.00066>, 2016.
- Sikora, M., Pitulko, V. V., Sousa, V. C., Allentoft, M. E., Vinner, L., Rasmussen, S., Margaryan, A., de Barros Damgaard, P., de la Fuente, C., Renaud, G., et al.: The population history of northeastern Siberia since the Pleistocene, *Nature*, 570, 182–188, <https://doi.org/10.1038/s41586-019-1279-z>, 2019.
- The IMBIE Team: Mass balance of the Antarctic Ice Sheet from 1992 to 2017, *Nature*, 558, 219–222, <https://doi.org/10.1038/s41586-018-0179-y>, 2018.
- von Albedyll, L., Haas, C., and Dierking, W.: Linking sea ice deformation to ice thickness redistribution using high-resolution satellite and airborne observations, *The Cryosphere*, 15, 2167–2186, <https://doi.org/10.5194/tc-15-2167-2021>, 2021.
- von Albedyll, L., Hendricks, S., Grodofzig, R., Krumpfen, T., Arndt, S., Belter, H. J., Birnbaum, G., Cheng, B., Hoppmann, M., Hutchings, J., Itkin, P., Lei, R., Nicolaus, M., Ricker, R., Rohde, J., Suhrhoff, M., Timofeeva, A., Watkins, D., Webster, M., and Haas, C.: Thermodynamic and dynamic contributions to seasonal Arctic sea ice thickness distributions from airborne observations, *Elementa: Science of the Anthropocene*, 10, 00074, <https://doi.org/10.1525/elementa.2021.00074>, 2022.