

Letter

Keywords:

inclusivity, diversity, accessibility, field work

Author for correspondence:

M.S. Karplus,
E-mail: mkarplus@utep.edu

Strategies to build a positive and inclusive Antarctic field work environment

Marianne S. Karplus,¹ Tun Jan Young,^{2,3} Sridhar Anandakrishnan,⁴ Jeremy N. Bassis,⁵ Elizabeth H. Case,^{6,7} Anna J. Crawford,⁸ Anne Gold,⁹ Leilani Henry,¹⁰ Jonathan Kingslake,^{6,7} Asmara A. Lehrmann,¹¹ Patricia A. Montaña,^{22,33} Erin C. Pettit,⁴⁴ Ted A. Scambos,²² Elizabeth M. Sheffield,²² Emma C. Smith,⁵⁵ Margie Turrin,⁷ and Julia S. Wellner⁶⁶

¹Department of Geological Sciences, University of Texas at El Paso, El Paso, TX, U.S.A.

²Department of Geography and Sustainable Development, University of St. Andrews, St. Andrews, United Kingdom

³Scott Polar Research Institute, University of Cambridge, Cambridge, United Kingdom

⁴Department of Geosciences, Pennsylvania State University, University Park, PA, U.S.A.

⁵Department of Atmospheric, Oceanic and Space Sciences, University of Michigan, Ann Arbor, MI, U.S.A.

⁶Department of Earth and Environmental Sciences, Columbia University, New York, NY, U.S.A.

⁷Lamont-Doherty Earth Observatory, Palisades, NY, U.S.A.

⁸School of Geosciences, University of Edinburgh, Edinburgh, United Kingdom

⁹Cooperative Institute for Research in Environmental Sciences, Boulder, CO

¹⁰Being & Living Enterprises, LTD Conifer, CO, U.S.A.

¹¹Department of Geological Sciences, University of Alabama, Tuscaloosa, AL, U.S.A.

²²Cooperative Institute for Research in the Environmental Sciences, University of Colorado Boulder, Boulder, CO, U.S.A.

³³National Center for Atmospheric Research, Boulder, CO

⁴⁴College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis, OR, U.S.A.

⁵⁵School of Earth and Environment, University of Leeds, Leeds, United Kingdom

⁶⁶Department of Earth and Atmospheric Sciences, University of Houston, Houston, TX, U.S.A.

Abstract

To increase inclusivity, diversity, equity, and accessibility in Antarctic science, we must build more positive and inclusive Antarctic field work environments. The International Thwaites Glacier Collaboration (ITGC) has engaged in efforts to contribute to that goal through a variety of activities since 2018, including creating an open-access “Field and Ship Best Practices” guide, engaging in pre-field season team dynamics meetings, and surveying post-field season reflections and experiences. We report specific actions taken by ITGC and their outcomes. We found that strong and supported early career researchers brought new and important perspectives regarding strategies for transforming culture, and that engaged and involved senior leadership was also critical for expanding participation and securing funding to support efforts. Pre-field discussions involving all field team members were particularly helpful for setting expectations, improving sense of belonging, describing field work best practices, and co-creating a positive work culture.

1. Introduction and motivation

The geosciences is one of the least diverse scientific fields, with demographics of PhD recipients changing little over the last forty years (Huntoon and others, 2015; Bernard and Cooperdock, 2018; Dutt, 2020; Dowey and others, 2021). Some progress has been made on the number of geoscience undergraduate degree recipients from marginalised racial groups, mostly from Minority-Serving Institutions (MSIs) in the U.S. (Beane and others, 2021) or through demographically-targeted programs and pipelines (Carrick and others, 2016). The number of women earning PhDs and working in the geosciences and polar sciences has increased in recent years (e.g. Bernard and Cooperdock, 2018; Case and others, 2019; Hulbe and others, 2010), however, the proportion of women in geoscience academia progressively decreases with advancing career stage (for the European Union and Switzerland: Piccolo and Guidobaldi, 2021; for the U.S.: Ranganathan and others, 2021). Although the polar science community lacks comprehensive demographic data, limited surveys indicate that it is even less diverse than geosciences as a whole (e.g. Case and others, 2019; Frater, 2021). On average, professorial appointments in scientific disciplines are biased towards those from socioeconomically privileged backgrounds (Morgan and others, 2022) and are further skewed in race, (dis)ability, and sexuality, with white able-bodied heterosexual men receiving better treatment and rewards, leading to systemic career advancement (Cech, 2022). In contrast, scientists from underrepresented racial, ethnic, and other minoritised groups face temporally-cumulative disadvantages from national and international foundations in winning grant funding (Chen and others, 2022; Wild, 2022), as well as structural bias and a “hostile obstacle course” in their

scientific workplaces (Marín-Spiotta and others, 2020; Berhe and others, 2022). Inadequate support and allyship within the geoscience community, particularly from senior researchers and faculty, results in suppressed visibility, lower retention, and underrepresentation of LGBTQ postgraduate students (Ulrich, 2021; Downen and Olcott, 2022). Numerous physical as well as logistical and bureaucratic barriers also prevent researchers with disabilities from engaging in lab, ship, or field work (Carabajal and others, 2017; Marshall and Thatcher, 2019).

Building inclusive and equitable geoscience workplaces requires the identification and removal of these structural barriers. This remediation is urgently needed to encourage and nurture diverse perspectives in polar science (Berhe and others, 2022; Griffiths and others, 2021). However, there is no one-size-fits-all solution. Applying an intersectionality lens (Crenshaw, 1989) to any approach recognises that individuals' experiences cannot be reduced to one identity (e.g. Núñez and others, 2019; Cech, 2022). Diverse identities can include race, ethnicity, gender identity, sexuality, socioeconomic status, language, and ability.

In recognition of the need for Inclusivity, Diversity, Equity, and Accessibility (IDEA) efforts in Antarctic Science, members of the International Thwaites Glacier Collaboration (ITGC) formed an IDEA Council during summer 2020 (Figure 2). The ITGC is a large, multi-disciplinary program funded since 2018 by the U.S. National Science Foundation (NSF) and the U.K. Natural Environment Research Council (NERC) to investigate Thwaites Glacier in West Antarctica. ITGC projects cross scientific disciplines to understand the glacier's flow dynamics and project its ice mass loss and potential contributions to sea-level rise. The ITGC IDEA Council includes principal investigators (PIs), postdoctoral researchers, students, program logisticians, and outreach specialists who meet twice monthly in order to foster IDEA within each project team, across the ITGC, and across the wider Antarctic Science community.

The ITGC community is broadly representative of the lack of diversity in polar sciences and geosciences. The gender distribution within ITGC is skewed towards those identifying as male (57%) over those identifying as female (41%) (Figure 1). Additionally, similar to the ratios seen in similar communities such as the U.K. Science, Technology, Engineering, and Mathematics (STEM) community (Advance HE, 2022), the ITGC community has a higher proportion of White/Caucasian (84%) and those identifying as straight/heterosexual (84%) compared to the U.K. and U.S. national averages (Figure 1). The lack of diversity within ITGC is even more evident among more senior researchers. Across the nine ITGC projects, there are a total of 65 PIs and co-PIs representing 40 total institutions (70% U.S., 27% U.K., and 3% other countries). Of the 28 U.S. institutions represented, 4 are Hispanic-serving institutions. 77% of PIs and co-PIs identify as male and 23% identify as female, and 92% of PIs and co-PIs are white. ITGC early career researchers are significantly more diverse than the PI and co-PI group. For example, approximately 50% of ITGC's early-career scientists identify as women. We acknowledge that this community has a long way to go to achieve demographics

representative of our broader U.S. and U.K. communities.

ITGC and other Antarctic scientists operate in and across many different types of workspaces, including offices and laboratories, universities, classrooms, institutes, professional conferences and workshops, research ships, Antarctic research stations, and remote Antarctic field camps. Six of eight ITGC projects incorporate significant Antarctic field work for ship-based and/or ice-based data acquisition. ITGC teams have deployed to Thwaites Glacier and its surroundings through the British Antarctic Survey (BAS) and the U.S. Antarctic Program (USAP), as well as on board U.S. and Korean scientific ships. There are both opportunities and challenges in working across this variety of spaces. Opportunities include cultural and environmental diversity, but challenges can arise from different codes of conduct, avenues for accountability, and power dynamics across the many dimensions of the ITGC.

Inclusive field experiences are important for retaining scientists with marginalised identities in scientific disciplines that rely significantly on field data collection, and exclusive or hostile field experiences are both actively harmful and cause people to leave scientific research fields (Nelson and others, 2017; Núñez and others, 2019; Nash, 2021; Giles and others, 2020). Geoscientific fieldwork in polar regions has historical androcentric, colonialist, and sexist foundations (e.g. Church, 2013; Nash, 2021), from which a legacy persists that obstructs and discourages the participation of those with underrepresented and marginalised identities (Giles and others, 2020; Vila-Concejo and others, 2018; Núñez and others, 2021). Discrimination, bullying, sexual harassment, stalking, and assault occur in field environments, and are predominantly experienced by early career researchers (Clancy and others, 2014; National Science Foundation, 2022; Nash and others, 2019) predominantly from more senior professional colleagues within their own research teams (Clancy and others, 2014). Improving communication, raising awareness of how to report incidents, and enacting policies emphasising safety, inclusivity, and collegiality can be effective at improving field experiences (Clancy and others, 2014; National Science Foundation, 2022).

In light of the importance of field experiences to the ITGC program, community members - including our IDEA Council - have led a number of efforts to try to build and promote a positive and inclusive field work culture within ITGC that have been viewed positively by the community. Through these efforts, we highlight further directions for improvement and change. Below, we describe the journey and trajectory our IDEA Council and community have taken over the past several years attempting to build a more positive and inclusive Antarctic field work environment, including the specific actions taken and the outcomes of those actions. Through these reflections and observations, we aim to inspire continuing transformation of Antarctic field team cultures to become more positive and inclusive of diverse individuals in order to improve support and retention of those individuals in Antarctic science.

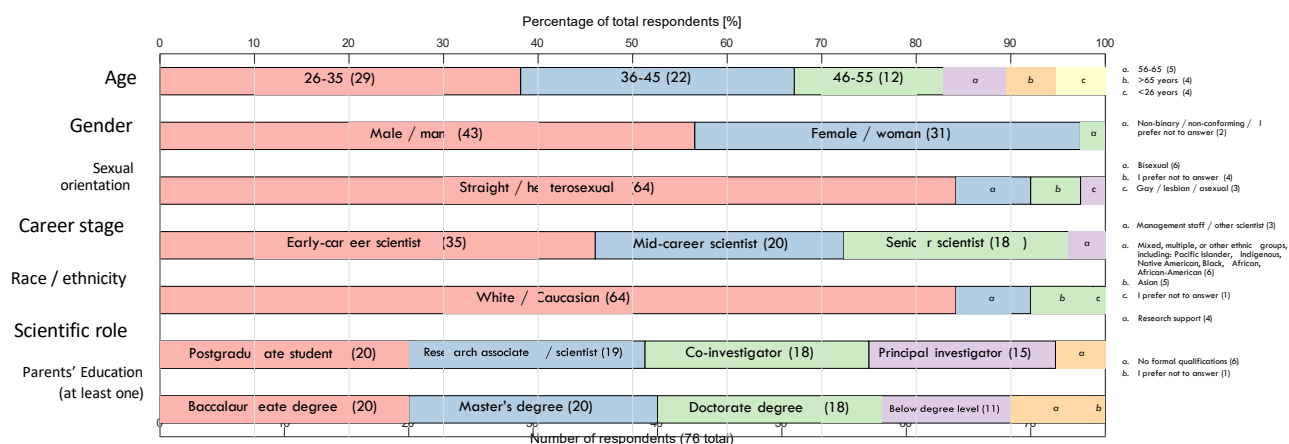


Fig. 1. Demographics of the International Thwaites Glacier Collaboration (ITGC) membership from an anonymous online survey conducted in March 2023. The survey received 76 responses, comprising 55% of the ITGC membership. Colour assignments across all responses and questions are arbitrary.

2. Timeline and description of activities

At the start of the ITGC during April 2018, all of the eight individual science projects as well as the Science Coordination Office (SCO) had plans within their projects to broaden participation in Antarctic Science and to impact society through research, outreach, and education. During the following years, the ITGC developed an IDEA Council to engage the whole community and provide a framework of professional development and growth opportunities that would inspire positive change. The Council was managed by the SCO, and leaders within the group came from various projects. The SCO successfully sought supplemental funding to support a range of efforts to increase IDEA within ITGC.

Several of the eighteen ITGC PIs brought up the need for concerted efforts in diversity, equity, and inclusion during the April 2018 kick off meeting, which set the tone and generated buy-in from the ITGC leadership. A pivotal group discussion occurred in September 2018 at the West Antarctic Ice Sheet (WAIS) Workshop and first all-hands ITGC meeting in Stony Point, NY, USA, with an evening of informal discussion on inclusivity, diversity, and code of conduct. These discussions continued at the second ITGC meeting in October 2019 in Oxford, UK, with a plenary group discussion on ITGC culture and values. A “Community Norms and Values” document (<https://thwaitesglacier.org/about/diversity/norms-and-values>) was published in July 2020 to set expectations for behaviour and scientific ethics within the ITGC.

Discussions of IDEA among ITGC leadership and ECRs during summer 2020 were inspired in part by the Black Lives Matter movement, and the ITGC Science Coordination Office and PIs posted a statement online supporting the Black Lives Matter movement and acknowledging a history of racism in Antarctic science. In September 2020, with recognition of the lack of diversity in ITGC and the need for cultural change, ITGC early career researchers (ECRs) formed an IDEA task force and compiled recommendations for ITGC, building on connections formed during an ITGC ECR retreat in Cambridge, UK in August 2019. The ECR IDEA task force

brought to the forefront the importance of including diverse voices in the ITGC science community as well as recommendations for warmly welcoming newcomers to the community. These recommendations inspired the formation of the ITGC IDEA Council in October 2020 and the hiring of an external diversity consultant, Leilani Henry, in January 2021, to guide the ITGC IDEA efforts. Because IDEA-related efforts often fall on ECRs and scientists of color (Guillaume and Apodaca, 2022; Kent and others, 2022), the ITGC leadership required participation from ITGC PIs and co-PIs to balance the Council, to encourage participation and commitment across the program, and to secure funds to support IDEA efforts. In these situations, strong ECR voices combined with listening and support from mid-career and senior community members helped to create the ITGC IDEA Council and precipitate positive changes.

The ITGC IDEA Council has met regularly—typically twice per month—since October 2020, to discuss, plan, and take action on IDEA topics. We have emphasised reaching more individuals from diverse backgrounds (including race, gender, sexual orientation, disability, socioeconomic status, and more) by creating a more positive and inclusive work culture, evaluating our biases, and growing our awareness. We have organised numerous ITGC-wide activities, some being field-focused while others were broader in scope (Figure 2). For example, in March 2021, we sponsored a showing of the film *Picture a Scientist* (Shattuck and Cheney, 2020) for the entire ITGC community and hosted a virtual follow-up conversation with over 100 participants, to encourage participants to critically examine their awareness of gender bias in their work places, and to identify potential ways to address this bias through personal actions and collective policies. In the summer of 2021, our consultant organised an immersive, 2.5-hour-long inclusive leader workshop (jointly with Ten Thousand Feet, LLC), with over 100 participants, that identified inclusive behaviours at work, engaged participants in problem-solving with custom scenarios, and provided an app for individuals to identify inclusive actions to take to sustain

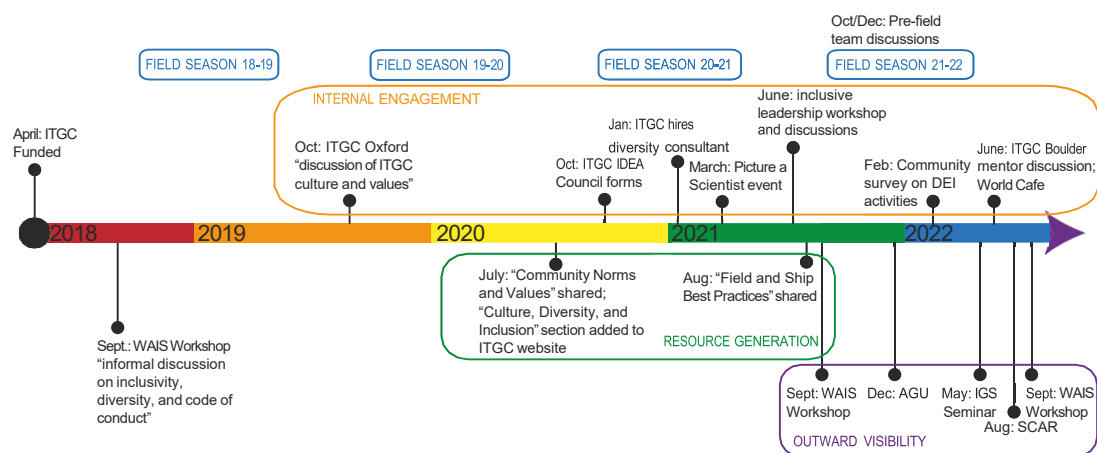


Fig. 2. Timeline showing key milestones and events of our International Thwaites Glacier Collaboration (ITGC) Inclusivity, Diversity, Equity, and Accessibility (IDEA) activities. Activities are grouped into categories of Internal Engagement, Resource Generation, and Outward Visibility. Due to COVID-19, Field Season 20-21 did not include any ITGC scientists. WAIS: West Antarctic Ice Sheet; AGU: American Geophysical Union; IGS: International Glaciological Society; SCAR: Scientific Committee on Antarctic Research; DEI: Diversity, Equity, and Inclusion.

the learning. Almost all of the ITGC project PIs participated. Feedback surveys following the event suggested participants enjoyed the game-oriented activities and opportunities for small group discussion, and they identified actions they could take to contribute to a more inclusive environment. Our consultant also had individually-tailored leadership conversations with the lead ITGC project PIs to determine their personal strengths and challenges in leadership and teamwork. These efforts were designed to encourage project leaders to set the tone and foster an inclusive environment.

In February of 2022, responses to an ITGC IDEA Council community survey highlighted interest in training on mentoring and communicating science to a non-science audience. In response, ITGC members hosted a discussion about mentoring at the June 2022 ITGC conference in Boulder, CO, and held online workshops on communicating with the media in September 2022. At the same conference, the IDEA Council also organised an interactive exercise inviting participants to envision an inclusive, positive working culture and what personal actions and organisational opportunities are needed to move in that direction. As our IDEA Council built momentum and experience from our community efforts, we increased our outward visibility by presenting our IDEA-related activities, efforts, and outcomes at conferences and community events (Figure 2). ITGC has communicated and discussed the importance of IDEA with representatives from NSF, NERC, USAP, BAS, and we have received feedback that our efforts have had a positive influence in those communities.

3. Field and Ship Best Practices

In Summer 2021, a subset of the IDEA Council compiled and distributed a “Field and Ship Best Practices” document (International Thwaites Glacier Collaboration IDEA Council, 2022) in response to recommendations following the 2019-20 field season to improve inclusion and team dynamics. Although there exists considerable knowledge and experience within ITGC

and the larger polar science community to effectively foster inclusive field and ship-based science experiences, this knowledge was not ubiquitous and the application of these inclusive practices varied between team leaders. Some examples of codes of conduct and standards for professional behavior include the Polar Code of Conduct (National Science Foundation, 2018) and the National Oceanic and Atmospheric Administration’s (NOAA’s) Shipboard Civility modules (National Oceanic and Atmospheric Administration, 2019). We identified a need to compile and present a best practices guide summarising community knowledge and experience in a format more directly relevant and applicable to ITGC science teams.

Given that the nature of field work varies greatly between ITGC projects, with team sizes ranging from 2 to 42 with continuous deployment periods from a few days to several months, this document was written to be easily adapted to the particularities of each deployment, with further intention to be a useful reference to the wider geoscience community. Over-arching goals of these recommendations included encouraging diversity of teams and ensuring a safe and welcoming culture for all members, particularly those from groups that have been historically marginalised in field- and ship-based science. Additionally, the document aims to clearly define expectations for good collaborative behaviour through identifying procedures and recommendations for preventing, identifying, addressing, and reporting potential misconduct before deployment.

Importantly, we emphasise that these best practices ideally extend to both before and after the actual deployment period. Engaging the field team prior to deployment can be an effective way to improve team morale and communication during deployment (King, 2008) and to establish communal agreed-upon goals, standards, and responsibilities. This is particularly important for those who have less experience and exposure to fieldwork, so as to reduce anxiety associated with uncertain or unclear expectations. We similarly promote the importance of a post-season debrief to reflect and give feedback on what has and has not worked. This is not only to continually improve

on efforts to foster a safe and inclusive field culture, but also to provide an opportunity to further discuss and address any concerns.

During deployment, we emphasise the importance of having multiple forms of contact both inside and outside the field team. Ideally, key members within each field team would listen compassionately, empathise, and ultimately address issues and disputes; however, small team sizes and inherent power dynamics mean this is not always the case. Trusted contacts outside of the field team, therefore, offer an additional or alternative resource. Multiple avenues of communication are critical for preventing and addressing misconduct as well as providing support for individuals.

The “Field and Ship Best Practices” document is hosted on *github*, a web-based platform for code development and version control. As such, it is a living, open-access document, and we encourage comments and feedback. The ability to continually refine and improve this document through public review demonstrates ITGC’s ongoing commitment to improving the work culture within Antarctic field and ship work.

At the time of publication, the document is written from the perspective of working with Antarctic programs of the U.S. and U.K. even though our collaboration involves additional national programs. While there are obvious scientific, societal, and cultural benefits to collaborating internationally in field and ship work, different legal and liability structures across national science programs, as well as home institutions of each team member, make it difficult to establish universal procedures in leadership and liability. This issue raises a concern of inadequate accountability in the case of significant misconduct or harassment, as clearly identified in the recent USAP Sexual Assault/ Harassment Prevention and Response report (National Science Foundation, 2022). For example, BAS and USAP have different human resources and management reporting structures as well as different confidential welfare personnel (U.K. Research and Innovation) or sexual assault advocates (USAP). ITGC endeavours to work with universities, institutions, and national programs towards an internationally recognised framework to address issues of harassment in polar field work and other scientific workplaces, and we hope to make future modifications to the “Field and Ship Best Practices” document to include broader perspectives beyond just the U.S. and U.K. national programs.

4. Field Work Culture and Experiences

4.1 Pre-season team meetings

Members comprising a field team often span a wide range of experience, personalities, backgrounds, and perspectives, and sometimes those who are early-career and/or external to the project have limited or even no engagement with other team members prior to deployment. As such, the ITGC IDEA Council recommended that each field team engage in inclusive team discussions prior to deployment to start the process of relationship-building among team members as well as improve understanding of how every team member can contribute towards a safe, welcoming, and inclusive field culture (Figure 3).

This recommendation also directly addressed the call to engage in inclusive activities prior to deployment, as outlined in the “Field and Ship Best Practices” document. These meetings were facilitated by Leilani Henry, ITGC’s diversity consultant, and incorporated social interaction tools to promote personal and introspective discussions between team members with respect to work-life balance, conflict recognition and resolution, and prospective roles and hierarchies in the field. Specifically, the meetings aimed to establish (Figure 3)

- key teamwork values and how we can best communicate questions and concerns with each other,
- the importance of communicating realistic expectations and roles for all field participants,
- how to understand each other’s unique responses to the many various issues that we will inevitably be faced with in the field,
- how to utilise our team’s diversity (on multiple fronts) to be open-minded and inclusive to various viewpoints,
- how to ensure each team member feels valued and respected as a member of the team given their career stage, technical knowledge, experience
- the flow of a typical work day that includes check-ins not only from a logistical standpoint, but also to keep track of everyone’s physical and mental well-being, and
- various avenues to seek help, whether it be within our field team or other contacts at home via satellite communications.



Fig. 3. Visual representation of important topics covered during the ITGC facilitated pre-field season conversations to build a positive and inclusive field work culture.

In the 2021–2022 season, four field teams engaged in online inclusive team discussions, with teams of smaller sizes (4–6 persons) reporting a more positive experience than the largest team of more than 40 members. We have learned from several experiences that discussions with smaller groups online have better outcomes. We also learned that field teams would often interact with many people who didn’t attend the pre-field

meetings (e.g., ship crew members, station and camp staff). Managed isolation and quarantine experiences may have also impacted perceptions of the online discussions, which took place during pre-deployment quarantines. For 2022-23, we hosted discussions for smaller groups (no larger than 25), and we focused more on direct discussions of team dynamics. Initial informal feedback suggests that these facilitated discussions lay the groundwork for creating a positive and healthy team work culture emphasising individual and team well-being.

Notably, regarding demographics, three out of four ITGC field teams in the 2022-23 season were led by women. Two of those teams working in deep field camps on Thwaites Glacier were majority women (75% and 89% women).

4.2 Post-season surveys

In 2019-20, the SCO decided to conduct structured post-field work surveys designed to identify ways to better understand the field team participants' field experiences, highlight issues in field planning and team dynamics, and improve the experience and positive field work culture of the ITGC field teams in future seasons. The full survey is included as Supplementary Material S1. The SCO contracted Patricia A. Montañó (who at the time worked at the Education and Outreach Group at the Cooperative Institute for Research in Environmental Science (CIRES)) to create and conduct the surveys. Irfanul Alam (CIRES) also collaborated on the 2021-22 survey. ITGC post-field season surveys were reviewed and approved by the University of Colorado Institutional Review Board (IRB) under Protocol 20-0222 as human subjects research. In 2019-20, the survey had a 47% response rate, and in 2021-22, the survey had a 60% response rate, with a mix of team member roles including scientists (students, PIs, technicians, etc.) as well as field safety guides and field support working directly within field-based teams. In 2019-20, 41% of respondents identified as PI/ Co-PI/ field team lead. In 2021-22, 25% of respondents identified as PI/ Co-PI/ field team leads. Team members generally reported that their colleagues created a positive living and work environment. Specifically, 83% (2019-20) and 78% (2021-22) of respondents reported that their colleagues created a positive *living* environment, and 76% (2019-20) of respondents and 75% (2021-22) of respondents reported that their colleagues created a positive *work* environment.

The surveys helped identify some issues that needed further attention in each of the field seasons. One example of this can be seen in word clouds describing perceptions of field team work culture that were created from the post-field surveys (Figure 4), which illustrate both positive and negative experiences as well as variability in the experiences across the groups. The size of a word in the word cloud is proportional to the number of times the word appears in the input text from the surveys. Positive descriptions of work culture used by many survey respondents included 'collaborative', 'supportive', 'dedicated', and 'fun'. Less positive descriptions of work culture that emerged included 'disorganised', 'stressful', and 'cliquey'. In both seasons, some respondents used concerning words including 'punitive', 'top down', 'segregated', 'chaotic', 'marginalising', indicating

negative experiences of some individuals. The feedback was shared with the ITGC community during our annual ITGC meetings, with opportunity for discussion about individual and organisational actions that could improve the environment. The survey results were also shared with the supporting agencies, including NSF, NERC, USAP, and BAS. The survey results also prompted more explicit pre-field discussions regarding how to mitigate negative or concerning elements of team work culture.

Notably, team members reported more stress during 2021-22, with 9% in 2019-20 reporting that stress from their job made them less productive compared to 53% in 2021-22. There are a number of possible reasons for the increase in stress level, including pandemic-related delays, logistical constraints, quarantines, and other personal impacts.

The surveys also highlighted the importance of (i) pre-field science planning, (ii) an organised work plan that extends across the projects in every case where any resources are shared, (iii) regular means of communications between logistics personnel, contractors, and scientists, which can assist with improving experiences and science outcomes, and (iv) the "Community Norms and Values" and "Field and Ship Best Practices" documents. When asked how supporting agencies can improve future field seasons, team members gave answers such as 'better communication', 'improve coordination between co-leaders', 'additional meetings for team building', and 'explain the role of different agencies involved.'

5. Lessons Learned and Future Directions

The primary lessons learned towards our goal of creating an inclusive and equitable culture across ITGC include:

- Leadership sets the tone and culture for all interactions. This means that senior leadership's willingness to listen, share goals, and support efforts from the beginning of a project is critical to creating the time and funding for ideas from everyone on the team to be implemented and progress assessed.
- Strong and supported ECR groups bring new perspectives and can shine light on actions that are likely to be effective in ways senior leadership does not always see. ECR groups play a critical role in effecting change.
- Discussion and agreement on field team dynamics and camp management in pre-field meetings, and reviewing these agreements in the field can lead to valuing and respecting each team member's contributions and ultimately to better sense of belonging for all participants.
- Post-season surveys are effective at capturing the general attitudes and emotions on a field team so that changes can be made to improve future team dynamics. This emphasis on the general state of the teams as a whole is critical to accepting that field team issues are the responsibility of the leadership and the entire team.
- Discussion of expectations and roles as well as participation in pre-field planning for all field team members leads to better work environments and better science outcomes.



Fig. 4. Word clouds describing perceptions of field team work culture from ITGC post-field season surveys reflecting the (a) 2019–20 and (b) 2021–22 seasons. The size of a word in the word cloud is proportional to the number of times the word appears in the input text from the surveys.

The ITGC community is aware the project functions within a global environment where sexual harassment, assault, and stalking remain pervasive. As such, our efforts remain focused on creating safe and inclusive environments. Our attempts to highlight challenges and aspirations through facilitated conversation, workshops, team agreements, and pre-field meetings are contributions toward building a positive culture. This work requires self-awareness and conflict management skills, as well as conscious design of systems and processes to support positive work culture. While these are important steps, ITGC will continue to move forward to engage the larger Antarctic Science community to collectively transform the culture of polar science.

Specifically, we hope to leverage our ITGC community efforts to reach more individuals from diverse and underrepresented backgrounds, including race, ethnicity, gender, sexuality, ability, socio-economics, and language of our team members. Given the exclusionary nature of fieldwork towards those from historically excluded and underrepresented groups (Griffiths and others, 2021), it is critical for ITGC to build safe and inclusive spaces not only in Antarctic fieldwork but also in other work spaces of Antarctic-oriented research groups and institutions. To do so, one of the things we need to do is to enhance engagement with underrepresented groups by offering interactive discussions and activities about polar science experiences and discoveries to undergraduates at Minority-Serving Institutions as well as pre-university children and teenagers. We also need to offer evidence-based programming and professional development on topics such as effective mentoring practices, team dynamics, unconscious bias, and cultural safety to ensure that those new to Antarctic Science are welcomed into an inclusive learning and work culture.

Numerous groups throughout the geoscience community are now engaging with topics of inclusion, diversity, equity, accessibility and safety. Our ITGC community has initiated links with organisations and groups that are undertaking similar efforts (e.g., the International Glaciological Society, CryoCommunity, Center for Oldest Ice Exploration) and is striving to amplify the voices of community groups such as Po-

lar Impact and Polar Pride. Given the complex problems of glacier science and their global impact, we aim to engage and strengthen our links with the broader community. We see this as important for enhancing our collective learning and evolution while together we foster a research and field work culture that welcomes scientists from diverse backgrounds.

6. Supplementary Material

The supplementary material for this article/letter can be found at ...

Acknowledgement

This work is from the Inclusivity, Diversity, Equity, and Accessibility (IDEA) Council of the International Thwaites Glacier Collaboration (ITGC). Support from National Science Foundation (NSF: Grants 1738913, 1738896, 1738942, 1738992, 1738896, 1738934) and Natural Environment Research Council (NERC: Grants NE/S006788/1, NE/S006605/1, NE/S00677X/1). Logistics provided by NSF-U.S. Antarctic Program and NERC-British Antarctic Survey. ITGC Contribution No. ITGC-084. The post-field surveys were created by Patricia A. Montaña for the SCO during P. Montaña's term at Education and Outreach within the University of Colorado CIRES. We thank Irfanul Alam (graduate research assistant, CIRES) who also contributed to analysis of the 2021–22 survey. We thank all members of the ITGC IDEA Council for productive conversations on these topics.

References

- Advance HE (2022) Equality in higher education: statistical reports 2022. Technical report, Advance Higher Education (HE)
- Beane RJ, Baer EMD, Lockwood R, Macdonald RH, McDaris JR, Morris VR, Villalobos IJ and White LD (2021) Uneven increases in racial diversity of US geoscience undergraduates. *Nature Communications Earth & Environment*, 2(126), 1–4 (doi: 10.1038/s43247-021-00196-6)
- Berhe AA, Barnes RT, Hastings MG, Mattheis A, Schneider B, Williams BM and Marín-Spiotta E (2022) Scientists from historically excluded groups face a hostile obstacle course. *Nature Geoscience*, 11, 292–295 (doi: 10.1038/s41561-021-00868-0)
- Bernard RE and Cooperdock EHG (2018) No progress on diversity in 40 years. *Nature Geoscience*, 11, 292–295 (doi: 10.1038/s41561-018-0116-6)

- Carabajal IG, Marshall AM and Atchison CL (2017) A Synthesis of Instructional Strategies in Geoscience Education Literature That Address Barriers to Inclusion for Students With Disabilities. *Journal of Geoscience Education*, **65**(4), 531–541 (doi: 10.5408/16-211.1)
- Carrick TL, Miller KC, Hagedorn EA, Smith-Konter BR and Velasco AA (2016) Pathways to the Geosciences Summer High School Program: A Ten-Year Evaluation. *Journal of Geoscience Education*, **64**(1), 87–97 (doi: 10.5408/15-088.1)
- Case EH, Coulon V and Isaacs F (2019) Bridging the crevasse: working toward gender equity in the cryosphere
- Cech EA (2022) The intersectional privilege of white able-bodied heterosexual men in STEM. *Science Advances*, **8**, eabo1558 (doi: 10.1126/sciadv.abo1558)
- Chen CY, Kahanamoku SS, Tripathi A, Alegado RA, Morris VR, Andrade K and Hosbey J (2022) Meta-Research: Systemic racial disparities in funding rates at the National Science Foundation. *eLife*, **11**, e83071 (doi: 10.7554/eLife.83071)
- Church M (2013) Refocusing geomorphology: Field work in four acts. *Geomorphology*, **200**, 184–192 (doi: 10.1016/j.geomorph.2013.01.014)
- Clancy KBH, Nelson RG, Rutherford JN and Hinde K (2014) Survey of Academic Field Experiences (SAFE): trainee report harassment and assault. *PLoS ONE*, **9**, e102172 (doi: 10.1371/journal.pone.0102172)
- Crenshaw K (1989) Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics. *University of Chicago Legal Forum*, **1**, 139–167
- Dowey N, Barclay J, Fernando B, Giles S, Houghton J, Jackson C, Khatwa A, Lawrence A, Mills K, Newton A, Rogers S and Williams R (2021) A UK perspective on tackling the geoscience racial diversity crisis in the Global North. *Nature Geoscience*, **14**, 256–259 (doi: 10.1038/s41561-021-00737-w)
- Downen MR and Olcott AN (2022) Supporting LGBTQ geoscientists, in and out of the classroom. *Journal of Geoscience Education* (doi: 10.1080/1089999.5.2022.2116205)
- Dutt K (2020) Race and racism in the geosciences. *Nature Geoscience*, **13**, 2–3 (doi: 10.1038/s41561-019-0519-z)
- Frater D (2021) *Diversity in UK Polar Science Initiative Race Impact Survey Report*. British Antarctic Survey
- Giles S, Jackson C and Stephen N (2020) Barriers to fieldwork in undergraduate geoscience degrees. *Nature Reviews Earth & Environment*, **1**, 77–78 (doi: 10.1038/s43017-020-0022-5)
- Griffiths HJ, Muschitiello P, Hough G, Logan-Park N, Frater D, Hendry KR and Schlarb-Ridley B (2021) Diversity in polar science: promoting inclusion through our daily words and actions. *Antarctic Science*, **33**, 573–574 (doi: 10.1017/S0954102021000584)
- Guillaume R and Apodaca E (2022) Early career faculty of color and promotion and tenure: the intersection of advancement in the academy and cultural taxation. *Race Ethnicity and Education*, **25**, 546–563 (doi: 10.1080/1361332.4.2020.1718084)
- Hulbe CL, Wang W and Ommanney S (2010) Women in glaciology, a historical perspective. *Journal of Glaciology*, **56**, 944–964 (doi: 10.3189/002214311796406202)
- Huntoon JE, Tanenbaum C and Hodges J (2015) Increasing diversity in the geosciences. *EOS*, **96**, 441–457 (doi: 10.1029/2015EO025897)
- International Thwaites Glacier Collaboration IDEA Council (2022) Itge field and ship best practices (version 1.0) (doi: <https://doi.org/10.5281/zenodo.5789786>)
- Kent C, Holman C, Amoako E, Antonietti A, Azam J and Ballhausen ea H (2022) Recommendations for empowering early career researchers to improve research culture and practice. *PLoS Biol*, **20**, e3001680 (doi: 10.1371/journal.pbio.3001680)
- King C (2008) Geoscience education: an overview. *Studies in Science Education*, **44**, 187–222 (doi: 10.1080/03057260802264289)
- Marshall AM and Thatcher S (2019) Creating Spaces for Geoscientists with Disabilities to Thrive. *EOS*, **100** (doi: 10.1029/2019EO136434)
- Marin-Spiotta E, Barnes RT, Berhe AA, Hastings MG, Mattheis A, Schnieder B and Williams BM (2020) Hostile climates are barriers to diversifying the geosciences. *Advances in Geosciences*, **53**, 117–127 (doi: 10.1029/2015EO025897)
- Morgan AC, LaBerge N, Larremore DB, Galesic M, Brand JE and Clauset A (2022) Socioeconomic roots of academic faculty. *Nature Human Behaviour* (doi: 10.1038/s41562-022-01425-4)
- Nash M (2021) National Antarctic Program responses to fieldwork sexual harassment. *Antarctic Science*, **33**, 560–571 (doi: 10.1017/S0954102021000432)
- Nash M, Nielsen HE, Shaw J, King M, Lea MA and Bax N (2019) Antarctica just has this heroic factor...: gendered barriers to Australian Antarctic research and remote fieldwork. *PLoS One*, **14**, e0209983 (doi: 10.1371/journal.pone.0209983)
- National Oceanic and Atmospheric Administration (2019) Shipboard civility. Technical report, National Oceanic and Atmospheric Administration
- National Science Foundation (2018) Polar code of conduct, version 1. Technical report, National Science Foundation
- National Science Foundation (2022) Sexual assault/harassment prevention and response: final report. Technical report, National Science Foundation
- Nelson RG, Rutherford JN, Hinde K and Clancy KBH (2017) Signaling safety: characterizing fieldwork experiences and their implications for career trajectories. *American Anthropologist*, **119**, 710–722 (doi: 10.1111/aman.12929)
- Núñez AM, Rivera J and Hallmark T (2019) Applying an intersectionality lens to expand equity in the geosciences. *Journal of Geoscience Education*, **68**, 97–114 (doi: 10.1080/10899995.2019.1675131)
- Núñez AM, Posselt JR, Hallmark T, Rivera J and Southern D (2021) The organization of learning in geoscience fieldwork and implications for inclusion. *Journal of Women and Minorities in Science and Engineering*, **27**, 33–60 (doi: 10.1615/JWomenMinorScienEng.2021031264)
- Piccolo F and Guidobaldi G (2021) A report on gender diversity and equality in the geosciences: an analysis of the Swiss Geoscience Meetings from 2003 to 2019. *Swiss Journal of Geosciences*, **114**, 1–12 (doi: 10.1186/s00015-020-00379-x)
- Ranganathan M, Lalk E, Freese LM, Freilich MA, Wilcots J, Duffy ML and Shivamoggi R (2021) Trends in the representation of women among US geoscience faculty from 1999 to 2020: the long road towards gender parity. *AGU Advances*, **2**, 1–14 (doi: 10.1029/2021AV000436)
- Shattuck S and Cheney I (2020) Picture a scientist
- Ulrich RN (2021) Queer geoscientists need more than visibility. *Nature Reviews Earth & Environment*, **2**, 567–557 (doi: 10.1038/s43017-021-00188-2)
- Vila-Concejo A, Gallop SL, Hamylton SM, Esteves LS, Bryan KR, Delgado-Fernandez I, Guisado-Pintado E, Joshi S, Miot da Silva G, Ruiz de Alegria-Arzaburu A, Power HE, Senechal N and Splinter K (2018) Steps to improve gender diversity in coastal geoscience and engineering. *Humanities & Social Sciences Communications*, **4**, 1–9 (doi: 10.1057/s41599-018-0154-0)
- Wild S (2022) Wellcome says it has perpetuated “systemic racism” in science. *Nature*, **609**, 233 (doi: 10.1038/d41586-022-02299-2)