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EDITED BY
Xu-Zhi Zhou,
Peking University, China

REVIEWED BY
Ying Zou,
University of Alabama in Huntsville, United States
Christine Gabrielse,
The Aerospace Corporation, United States

*CORRESPONDENCE
McArthur Jones Jr.,
mcarthur.jones@nrl.navy.mil

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Assessing the demographics of the 2021 and 2022 CEDAR workshop

McArthur Jones, Jr.[1]* and Astrid Maute[2]

[1]Space Science Division, U.S. Naval Research Laboratory, Washington, DC, United States, [2]High Altitude Observatory, National Center for Atmospheric Research, Boulder, CO, United States

The Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) community is made of engineers, scientists, physicists, and students with a mission to understand the fundamental properties and predictability of the space-atmosphere interaction region, including the mesosphere, thermosphere, ionosphere, and inner magnetosphere. At the 2020 CEDAR annual workshop, community-wide feedback received on diversity, equity, and inclusion (DEI) in CEDAR warranted a grassroots effort focused on addressing the DEI issues raised. This led to the creation of the CEDAR DEI task force, whose goals were to 1) Assess and formalize DEI efforts in CEDAR; 2) Establish and normalize a DEI presence in the CEDAR community; and 3) Foster improvement in CEDAR through implementation of actionable initiatives that promote diversity, equity, and inclusion. Of these actionable items collecting demographic information on those participating in the Annual CEDAR Workshop was identified as the top priority. This paper therefore, reports the demographic information obtained from CEDAR registrants for the virtual workshop in 2021 and in-person workshop in 2022. In general, the demographics of CEDAR are consistent with those in broader science, technology, engineering, and mathematics (STEM) fields, that is, most participants identify as male, White, and or Asian/Middle Eastern. On average, women and historically underrepresented races and ethnicities in STEM fields make up roughly 30% and 10%, respectively, of all 2021 and 2022 CEDAR Workshop registrants over the past 2 years. We further discuss the demographics of CEDAR relative to reports published in recent years by other organizations, where possible.

KEYWORDS

heliophysics, aeronomy, diversity, equity, inclusion, CEDAR, demographics

1 Introduction and motivation

All of us who work in the astronomical and space sciences are first and foremost people, whose different lived experiences, both consciously and unconsciously inform the way we do science. In our continued pursuit to understand how the Sun and atmosphere impact our everyday lives, we cannot lose sight of this people first perspective. This people first perspective is essential to the vitality of the

astronomical and space sciences fields now, and into the future. As such, it is well established that when a person feels accepted, safe, and valued at work they can perform at their peak ability (e.g., Cho and Barak, 2008; Halkos and Bousinakis, 2010; Østergaard et al., 2011; AlShebli et al., 2018; Way et al., 2019; Haacker et al., 2022). The opposite is true as well, that is, hostile and unsafe educational and work environments cause people, especially women and people of color, to leave the scientific enterprise (e.g., Price, 2010; Gayles and Ampaw, 2014; Bradforth et al., 2015; Thiry et al., 2019; Watson, 2019; Marín-Spiotta et al., 2020; Donovan, 2021). It is also well established that diverse groups are more innovative and produce better science (e.g., McLeod et al., 1996; National Research Council, 2015; Lerback et al., 2020). Currently, there are several different efforts to reduce barriers associated with implicit and explicit bias in the scientific enterprise, but it can be difficult to understand the current landscape, set goals, make changes, and assess progress without ample and consistent demographic data (e.g., Else and Perkel, 2022; National Academies of Sciences, Engineering, and Medicine, 2022). Without data, scientific organizations, policymakers, programs, and stakeholders have had difficulty implementing structural interventions (e.g., Pendergrass et al., 2019) that could be the catalyst for promoting a more people first mentality in astronomical and space sciences.

Diversity, equity, and inclusion (DEI) became of greater public interest in America in late spring of 2020, which lead to a broader push to acknowledge and address structural inequities in the scientific enterprise (e.g., Subbaraman, 2020). Following this broader interest, a workshop session entitled "DEI in CEDAR" was held at its Virtual Workshop in June 2020. The CEDAR workshop is funded by the US National Science Foundation. CEDAR's scientific community consists of students, faculty members, researchers in academia and industry from various fields such as engineering, physics, computational science, atmospheric science, etc. Whose mission is to understand the fundamental properties of the space-atmosphere interaction region, including the middle and upper atmosphere, ionosphere, magentosphere, and the geospace environment.

In the "DEI in CEDAR" session community members raised a number of issues and suggested practices regarding diversity, equity, inclusion, and accessibility in CEDAR. From the received feedback by session participants, the conveners and the CEDAR Science Steering Committee deduced that a grassroots effort focusing on addressing the raised DEI issues could lead to real progress within CEDAR and the broader Heliophysics communities. A first step was the creation of a permanent, community based CEDAR DEI Task Force with the following goals 1) Assess and formalize DEI efforts in CEDAR; 2) Establish and normalize a DEI presence in the CEDAR community; and 3) Foster improvement in CEDAR through implementation of actionable initiatives that promote diversity, equity, and inclusion.

Of the actionable items suggested by different stakeholders in CEDAR, the top priority was to include questions on the CEDAR Workshop registration to obtain demographic information, including, career stage, race/ethnicity, gender identity, and association with the LGBTQ+ (lesbian, gay, bisexual, transgender, queer (or sometimes questioning), and others) community. Demonstrating current and future progress on DEI related initiatives in CEDAR requires data. Therefore, this short paper seeks to report the demographic information voluntarily obtained from willing CEDAR registrants for the 2021 virtual workshop and the 2022 in-person workshop. This paper also attempts to place CEDAR demographics in the context of other demographic information within the atmospheric and space sciences reported by the American Geophysical Union (2018), National Center for Science and Engineering Statistics (2021), and National Academies of Sciences, Engineering, and Medicine (2022). Our findings are generally consistent with the findings of these other studies and indicate that the majority of CEDAR registrants in 2021 and 2022 identify as male, White, and or Asian/Middle Eastern, across all career stages.

2 Collection of demographic information and methodology

Starting in 2021, optional demographic questions were included in the registration form for the annual CEDAR Workshop. Please see the CEDAR website for information. The CEDAR workshop provides an opportunity for the community to self-organize and exchange ideas in the form of breakout workshops, poster session(s) with a student competition, science lectures, and a student day. All CEDAR registrants, either in-person or virtual were asked to provide an answer to a series of questions about their career stage, race/ethnicity, gender identity, and association with the LGBTQIA+ (lesbian, gay, bisexual, transgender, queer (or sometimes questioning), intersex, asexual, and others) community.

For career stage the following categories were used:

- Students (including both undergraduate and graduate students)
- Early Career (0–5 years after your terminal degree)
- Mid-Career (6–15 years after your terminal degree)
- Senior Career (>15 years after your terminal degree)
- Non-scientist (Citizen Scientist, DEI Experts, Experts outside the CEDAR Community)

For race/ethnicity the following question was asked, "What race(s) and/or ethnicities do you identify with? Select all that apply." The following options were listed:

- White (Hispanic, Latinx or Spanish)
- White (Not Hispanic, Latinx or Spanish)
- Non-white Hispanic, Latinx or Spanish
- Asian or Middle Eastern
- Black or African American
- African
- American Indian or Alaska Native
- Native Hawaiian or Pacific Islander
- Not listed, please specify
- Prefer not to answer

Note the above races and ethnicities were slightly different in 2021 and 2022, as a result of feedback from CEDAR registrants in 2021. All the races and ethnicities listed above were on the CEDAR Workshop registration for both years, but some options may have been listed separately in 2021, whereas they were combined in 2022 (e.g., Asian or Middle Eastern).

For gender identity, the following question was asked, "To which gender do you most identify with?" The following options were listed:

- Female (she,her,hers)
- Male (he,his,him)
- Nonbinary (they, them)
- Not listed, please specify
- Prefer not to answer

These demographic data were collected by workshop organizers and shared with the authors. The survey results depicted and discussed in the subsequent section highlight the participants' responses to the career stage, race/ethnicity, and gender identity listed above. Note that any special processing of these demographic data will be provided in the discussion of the figures shown in **Section 3**.

3 Results and discussion

We first illustrate demographic data on the career stage and gender identity of the 2021 and 2022 CEDAR Workshop registrants. Specifically, **Figure 1A** depicts the career stage distribution, **Figure 1B** the gender distribution, and **Figure 1C** shows the gender distribution as a function of career stage of the 2021 and 2022 CEDAR Workshop registrants. Participation in 2021 CEDAR Workshop was much larger than in 2022 with a total registration of 839 in 2021 and 324 in 2022. This increased registration in 2021 is most likely the result of a fully virtual workshop with no registration fee, whereas the 2022 CEDAR Workshop was a hybrid (i.e., in-person and virtual plenary and select small sessions) workshop with a registration fee (i.e., for both in-person and virtual participants). **Figure 1A** shows the career stage distribution of CEDAR registrants is generally consistent between the 2 years, with the student population approximately equaling those that identify as senior career/experienced.

Figures 1B,C illustrate that the majority of CEDAR registrants for the annual workshop identify as male, outnumbering those that identify as female or non-binary colleagues by a 2-to-1 ratio. The overall percentage of the different gender identities that registered for the past two CEDAR Workshops, was fairly consistent, including those that chose 'no-answer' to this question. Further analysis of the gender distribution of CEDAR registrants as a function of career stage (**Figure 1C**), shows that in general female registrants make up between ∼30–40% of all CEDAR Workshop registrants, with a few exceptions. Most notably is the stark drop-off between female participation in the early-career category during the 2021 virtual workshop from 45.2% to 17.9% during the 2022 hybrid workshop. Also note that those registrants that identified as non-binary were either students or early in their career.

The gender identity demographics of those that attended the annual CEDAR workshop in 2021 and 2022 are broadly consistent with those reported by several other studies including American Geophysical Union (2018), National Center for Science and Engineering Statistics (2021), and National Academies of Sciences, Engineering, and Medicine (2022). These studies generally show that those identifying as female represent ∼30% (±10%) of the student and professional population in the Space Physics and Aeronomy (SPA) Section of the American Geophysical Union (AGU), doctorate-holding non-faculty researchers in the atmospheric sciences, and serve as principal or co-investigators in Heliophyiscs research and analysis proposals submitted to the NASA Solicitation and Proposal Integrated Review and Evaluation System between 2014 and 2020. However, comparing CEDAR gender identity demographics, especially as a function career stage is quite difficult given the lack of consistent demographic collection across the geosciences and heliophysics. This is demonstrated in the above cited reports, including the variance in the types of demographic information collected and how it is qualitatively categorized by different prominent professional societies and funding agencies, CEDAR community members typically participate in and receive funding from.

Figure 2 illustrates the race and ethnicity demographics from the CEDAR 2021 and 2022 Workshop registrants. Registrants could select multiple race/ethnicities which we counted separately and therefore the total percentage by career stage in **Figure 2B** can be larger than 100%.Note that **Figure 2B** only depicts race and ethnicity demographics as a function of career stage from 2021 CEDAR Workshop, as the 2022 CEDAR Workshop race/ethnicity demographics as a function of career stage are very similar. The 2022 CEDAR Workshop race/ethnicity demographics as a function of career stage are included as **Supplementary Material**.

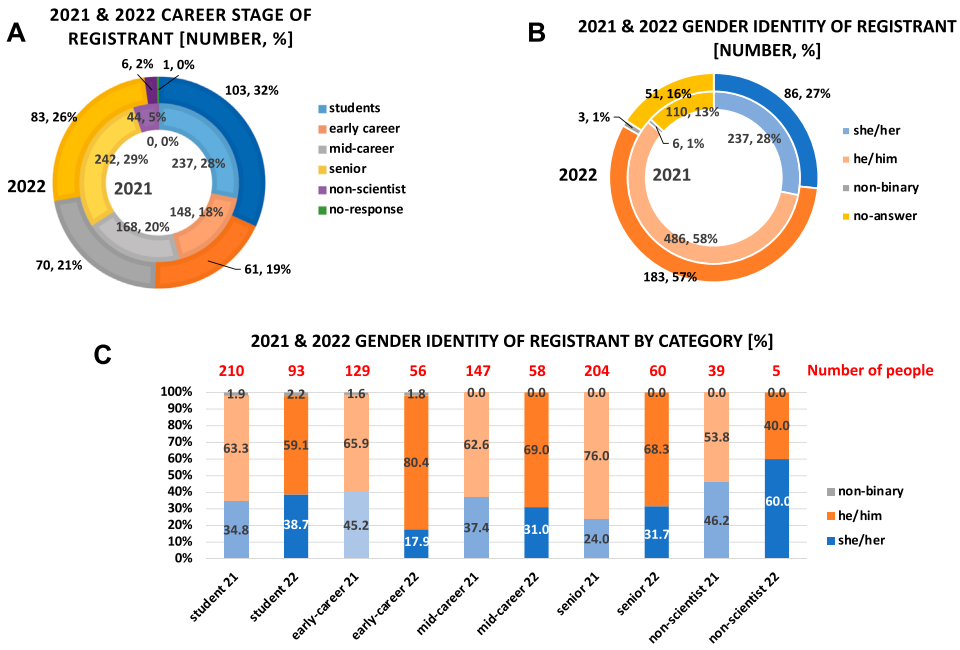

FIGURE 1
(A) Career stage distribution of the 2021 (inner ring) and 2022 (outer ring) registrants for the Annual CEDAR Workshop in both total number and percentage; **(B)** Gender identity distribution of the 2021 and 2022 Annual CEDAR Workshop registrants in both total number and percentage; **(C)** Gender identity distribution as a function of career stage of the 2021 and 2022 Annual CEDAR Workshop, excluding those of whom declined to answer. Shown are the percentages in black or white text and the total number of people in each category in red text.

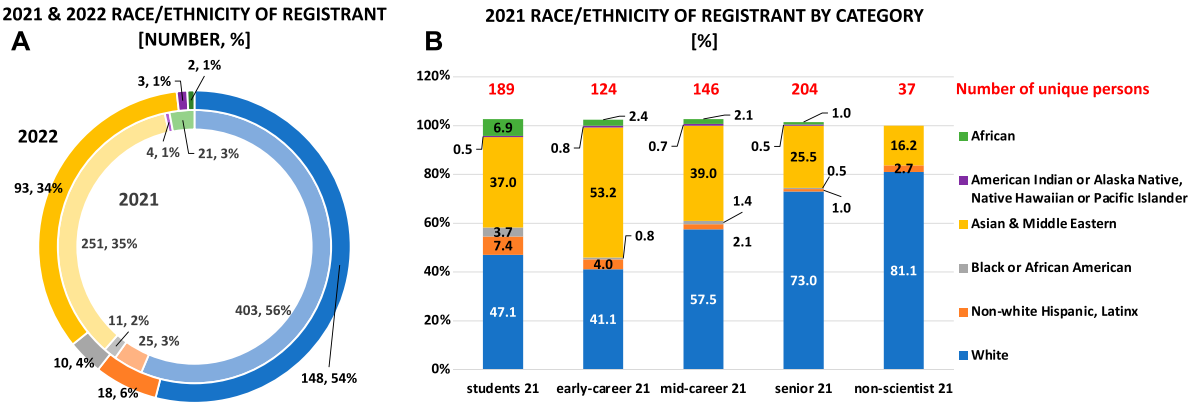

FIGURE 2
(A) Race/ethnicity distribution of the 2021 and 2022 registrants for the Annual CEDAR Workshop in both total number and percentage. Note that multiple races/ethnicities were counted. **(B)** Race/ethnicity distribution of the 2021 Annual CEDAR Workshop registrants in both total number and percentage. Note that multiple races/ethnicities were counted, and the number of unique persons are shown in red text.

Figure 2A indicates that the race and ethnicity distribution of CEDAR Workshop registrants fairly consistent for these 2 years, with those identifying as White and/or Asian and Middle Eastern representing ~90% of all CEDAR Workshop registrants in both years. In total for both years all other races and ethnicities of CEDAR Workshop registrants that are historically underrepresented in science, technology, engineering, and mathematics (STEM) fields as described by the NSF (e.g., National Center for Science and Engineering Statistics, 2021)—Black people, Hispanics, and American Indians or Alaska Natives or Pacific Islanders–represent 9–12% of all registrants. Also note that

no individual historically minoritized community in STEM represents more than 6% of the CEDAR Workshop registrants in either year.

Figure 2B generally shows that earlier career (e.g., students and early-career participants) CEDAR registrants tend to be slightly more diverse than those at mid- and senior career levels. Specifically, historically minoritized communities in STEM for student registrants for the 2021 CEDAR Workshop represent slightly greater than 15% of all student registrants, which research (e.g., Cain and Leahey, 2014) cites as an important benchmark for realizing the benefits of diversity in groups. In 2021, for no other career stage do historically minoritized communities in STEM represent more than ∼8% of all CEDAR Workshop registrants. In 2022, participation by historically underrepresented minorities in STEM at the CEDAR Workshop was slightly improved, as just over 10% of registrants at early and mid-career stages identified as Black, Hispanic, and American Indian or Alaska Native or Pacific Islander. However, this still falls short of the benchmark set forth by Cain and Leahey (2014).

Similar to the gender identity demographics of CEDAR Workshop participants, race and ethnicity demographics of CEDAR Workshop participants are broadly consistent with the demographics reported by several other organizations including, American Geophysical Union (2018), National Center for Science and Engineering Statistics (2021), and National Academies of Sciences, Engineering, and Medicine (2022). Also like gender identity demographics it is quite difficult to compare CEDAR race and ethnicity demographics against other available STEM data sets due to different categorizations. However, it is clear from **Figure 2B** that the student population of CEDAR is more diverse than any other career stage. National Academies of Sciences, Engineering, and Medicine (2022) describes that the low retention rate (∼11%) in space science disciplines during undergraduate (but also graduate) schooling, and racial/ethnic disparity of a factor of ∼3 thereof (i.e., 4% retention rate among African American, Hispanic American, and Native American, Alaska Native and Native Hawaiian students), significantly limits representation and restricts diversity of future NASA science and mission leadership. Thus, it is suggested that the CEDAR DEI Task Force focus efforts on incorporating evidence-based practices aimed at retaining its diverse student population, with the hope of increasing diversity in CEDAR, unlike the lack thereof in the geosciences over the last 40 years (e.g., see Bernard and Cooperdock, 2018).

4 Summary, challenges, and lessons learned

This paper reports on the gender identity, race, and ethnicity demographics of the registrants of the 2021 and 2022 CEDAR Workshops. Collecting and analyzing CEDAR participant demographic information presented herein is a first step to acknowledging CEDAR's lack of diversity and implementing structural interventions to make CEDAR a more diverse, equitable, inclusive, and accessible community to all people. Although this is just a first step, it is an important step, because demonstrating progress on DEI-related initiatives in the CEDAR community requires data. Further, retaining, sharing, and continuing to consistently collect demographics on the CEDAR community over an extended period of time provides a means to measure the impact of the CEDAR DEI Task Force and other DEI-related initiatives, while also creating accountability (Pendergrass et al., 2019) for all people in the CEDAR community.

Also, it is important to reflect on some of the lessons learned throughout this process. The authors of this report are classically trained scientists and physicists, and while having a relatively good understanding of mathematics and statistical techniques, employing such expertise on demographic information presented some challenges. These challenges included 1) attempting to use the same demographic categories across organizations to provide the best inter-comparison, and 2) the amount of time and effort which goes into careful data processing, which should not be underestimated. To really affect change in DEI there needs to be accountability, equitable funding from major agencies, and guidance/support to do such work. As Pendergrass et al. (2019) states, transparency in equity and inclusion work is key, and it is our hope that funding and guidance from major funding agencies would provide a means to openly share data and assessments with them and the wider STEM community, about our future DEI successes and failures in CEDAR.

Data availability statement

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding authors.

Author contributions

MJ lead the conceptualization and drafting of the this manuscript. AM lead data collection and the production of figures. Both authors contributed to manuscript citations, editing, revisions, reading, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fspas.2022.1074460/full#supplementary-material

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