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State of the Early Career Profession in Space Physics and Aeronomy: Climatological Survey Results

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Key Points:

- A climatological survey of 140 early career space physicists was conducted
- Current demographics and climate indicators, including current satisfactions and concerns, are presented
- Findings and recommendations are provided to help maintain and grow a healthy space physics workforce

Supporting Information:

Supporting Information may be found in the online version of this article.

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Abstract The American Geophysical Union (AGU) Space Physics & Aeronomy (SPA) section comprises scientists who study the Sun, solar wind, and planetary magnetospheres, ionospheres, and thermospheric/mesospheric systems along with their interconnections. In order to better understand the needs and perspectives of the early career community within the section (defined as being 10 years or less after obtaining a doctoral degree), the SPA executive committee established the SPA early career leadership advisory committee (EC-LAC), which is composed of 15 members. Striving to better understand the make-up of the SPA early career community and its current climate, the EC-LAC conducted a survey of early career SPA members. This survey, conducted between 2025 15 July and 2025 1 September, had 140 respondents and provides a snapshot of the early career SPA community at this time. This paper outlines aggregated results from the survey and provides findings and recommendations that may be of use to various agencies and groups.

1. Introduction and Motivation

The American Geophysical Union (AGU) is a professional society encompassing many scientific disciplines within the Geosciences (Fleming, 1943). Among these is the Space Physics & Aeronomy (SPA) section, which focuses on the science of the Sun, solar wind, magnetospheres, and ionospheres within our solar system. This includes multiple divisions within the National Aeronautics and Space Administration (NASA) Science Mission Directorate (SMD), including all of the "Heliophysics" division and portions of the "Planetary Science" division, related to magnetospheres of other planets, planetary aeronomy, and space weather impacts and interactions with planetary bodies. SPA is also largely encompassed within the National Science Foundation (NSF) Directorate for Geosciences and includes aspects of the Directorate for Mathematical and Physical Sciences. Applications of SPA science fall well within the National Oceanic and Atmospheric Administration (NOAA) Office of Space Weather Observations and the Space Weather Prediction Center (SWPC), part of the NOAA National Weather Service. Space weather has implications not only for industry but also for National Defense application, such as space domain awareness, especially in aeronomy with drag, radar and Global Positioning Satellite (GPS) interference (scintillation), and orbital debris, which are of direct relevance to the military through the Air Force Office of Scientific Research (AFOSR) and Office of Naval Research (ONR). As membership in SPA is also international, agencies such as the European Space Agency (ESA), Japan Aerospace Exploration Agency (JAXA), Brazilian Space Agency (AEB), Canadian Space Agency (CSA), China National Space Administration (CNSA), and many others impact the members of SPA. Work done within SPA is also of direct relevance to several space weather prediction services outside of the United States, such as the United Kingdom Met Office and the ESA Space Weather Office.

Established in 2022, the Early Career Leadership Advisory Committee (EC-LAC) of the SPA section is tasked with representing the needs of early career members within the section, and advising the SPA Executive Committee on matters impacting early career members. Understanding the needs of this scientific community has historically occurred through climate surveys (e.g., Jones & Maute, 2022; O'Brien et al., 2024), although there has not recently been a survey spanning all of the sub-disciplines and sub-communities within SPA, nor has there been a survey specifically focusing on early career space physicists (defined as within 10 years of obtaining a Ph. D.). In order to better serve and understand the community that the EC-LAC represents, such a survey was constructed with the primary objectives of establishing a current measure of the state of the profession and collecting demographic information on early career space physicists within SPA. This includes measures of current satisfaction within the career path and information on aspects that may impact work-life balance. A secondary objective is to investigate potential correlations between satisfaction and various workplace factors, such as proposal workload, compensation, and access to conferences. The ultimate goal is to better understand the current early career community in SPA and to provide recommendations to improve the current state of the profession, while also helping employers more effectively attract and retain talent by aligning hiring practices with the priorities and values of early career researchers.

Historically, space physics has been a profession composed primarily of white men (e.g., Bagenal, 2023). Various initiatives have since been developed, including the NASA PI Launchpad Workshop (Hamden et al., 2022), with the stated goal of increasing diversity within the community and specifically within rungs of leadership. Additionally, the SPA Nomination Task Force (NTF) has focused on ensuring the recognition of traditionally marginalized groups in AGU awards (Keesee et al., 2022). A potential result of such initiatives is to help the "leaky pipeline" issue (e.g., Berhe et al., 2022; Wynn-Grant, 2019) within the field by enabling underrepresented groups to see people like themselves succeeding within SPA. Addressing this pipeline problem is essential to ensuring that the field retains high talent individuals, irrespective of personal circumstance. Assessing the current constituency of early career SPA members may therefore provide insight into the impact of these initiatives and help better understand where such "leaks" may reside and what potential barriers to entry into the field may exist.

For context, it should be noted that the survey was conducted during a particularly tumultuous period for federal research funding in the United States of America. It followed the release of the Fiscal Year 2026 Presidential Budget Request (PBR; https://www.whitehouse.gov/omb/information-resources/budget/the-presidents-fy-2026-discretionary-budget-request/) to Congress but preceded the release of either the House of Representatives or Senate committee draft appropriations bills. The PBR called for a \$6 billion cut to NASA overall and a ∼47% decrease to the NASA SMD. Beyond the sharp decrease in funding to the NASA science portfolio, the PBR also called for ending several prolific missions, such as the Magnetospheric Multiscale (MMS) mission (Burch et al., 2016), New Horizons (Stern, 2008), and Juno (Bolton et al., 2017), and severely curtailing others such as NASA's contributions to the Solar Orbiter mission (Müller et al., 2020) and Parker Solar Probe (Fox et al., 2016). The survey was also conducted after NASA released their annual Research Opportunities in Space and Earth Science (ROSES) solicitations, about 5 months later than normal and with significantly fewer programs than typical across all divisions. Beyond NASA, the PBR also called for a reduction of ∼56% to NSF, which would affect both research and analysis (R&A) programs and funding for critical observation facilities. As such, the survey was conducted at a time when funding prospects, both for R&A programs and missions/facilities within the United States of America, were under threat of severe reductions or cancellations. These conditions have particular impact for early career scientists by decreasing the number of postdoctoral positions available, posing the potential inability to secure full salary support, and their overall career outlook.

As such, this survey provides a snapshot of the early career SPA population at a unique time, shortly after the COVID-19 global pandemic and at a moment of major upheaval in the typical funding agencies of the community. The aim of this study, then, is to better understand the demographics, climate, and needs of the current population and to provide findings and recommendations to improve the state of the early career SPA profession.

2. Methodology

The target population of the survey was early career space physicists in the AGU SPA section. Following AGU's definition, "Early Career" is defined as within 10 years of obtaining a Ph.D., with all respondents being of the age of majority (i.e., of legal adult age). Recruitment was conducted through community email newsletters (specifically, AGU SPA; American Astronomical Society (AAS) Solar Physics Division (SPD); SolarNews; Heliosphere News; Coupling, Energetics, and Dynamics of Atmospheric Regions (CEDAR); Geospace Environment Modeling (GEM); European Heliophysics Community; Latin American Geophysical Society; and African Geophysical Society newsletters). Combined, these newsletters largely span the entirety of SPA and are the most often used modes of communication within the discipline. The survey was open for responses from 2025 15 July to 2025 1 September and collected 140 unique responses. Reminders were issued to these newsletters with each release spanning the entirety of the survey period with additional requests for SPA members to spread the poll through word-of-mouth efforts. As the EC-LAC did not have access to the individual emails on the list, and that we did not collect identifying information including email address in the survey, the primary mode of soliciting participation was through these newsletters. Note that due to rounding, some percentages reported in this paper may not sum up exactly to 100%.

At the end of 2024, there were about 1010 "active" early career members of SPA according to AGU records, suggesting that this survey covered 14% of early career SPA members, which would be considered a low response rate for online surveys (Wu et al., 2022). However, the number of "active" members may also be an overestimate of the number of members actually active in the field. For example, the 2025 annual AGU meeting only received 1,847 abstracts over all career stages with some authors submitting multiple abstracts, compared to the estimated 4,220 "active" members for all of SPA according to AGU. As such, the actual number of early career SPA members active in the field may be significantly lower than in AGU's records, making the response rate higher. Instead, if conservatively it was assumed that 24% (the percentage SPA members that are early career according to AGU membership records) of abstracts were early career and that all members only submitted one abstract, making this an upper bound of membership, then the true population size of active early career members would be estimated at 443, giving a response rate of 32%. So, the estimated response rate is likely somewhere between 14% and 32%.

To estimate the amount of random sampling error in the survey results, calculated margin of errors are reported. Margin of error is computed using $MOE = Z_{95\%}\sqrt{p(1-p)/n}$ where $Z_{95\%}$ is the z-score for the 95% confidence interval, p is the sample proportion for a comparison that is nearest 50% (which has the largest margin of error and therefor is the conservative estimate), and n is the sample size of the comparison. For all percentage comparisons, the margin of error is given in the Supporting Information S1 tables or within figure captions for comparisons without an associated table. For further comparisons of populations, this study uses the Welch's unequal variances *t*-test with Poisson error to test the null hypothesis that two populations have equal means.

One of the goals of this survey was to collect demographic information on early career SPA members. This was done through questions asking the respondent to identify themselves in the following areas:

1. Race,
2. Gender,
3. Sexual orientation,
4. Region of employment,
5. Region of origin,
6. Years since Ph.D.,
7. AGU primary section,
8. AGU secondary section, and
9. Whether they were the first member of their family to obtain a college degree or Ph.D.

The wording of each question and its corresponding response options are provided in the Dataset S1. All demographic-related questions allowed the option of "prefer not to answer." As the demographic information collected by the survey is potentially sensitive, only aggregates of results are shown in this study and data collection was fully anonymous (i.e., without email addresses, IP addresses, or location information being associated with the responses).

Satisfaction of various aspects of respondents' careers and compensation was based on the 5-point Likert scale (Likert, 1932). This rating scale asks respondents to gauge their satisfaction on a 5-point scale that ranges from strongly dissatisfied, dissatisfied, neutral, satisfied, to strongly satisfied. The use of the Likert scale here allows for a better understanding of community sentiment.

The survey also allowed for a free response section for respondents to provide additional thoughts or comments for the EC-LAC. While these comments were considered when interpreting these results and to understand where anxieties may lie, they are not provided here to maintain anonymity and to keep results aggregated, in accordance with our Institutional Review Board (IRB) waiver.

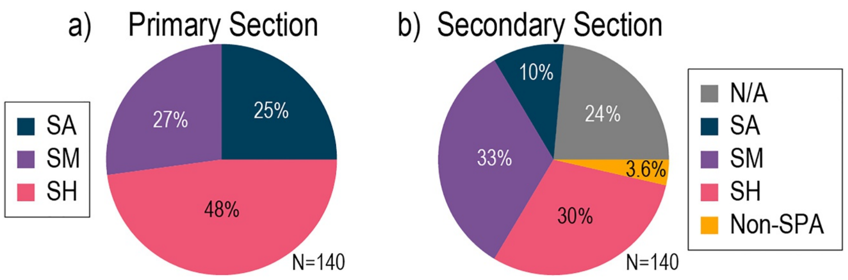

Figure 1. (a) Breakdown of survey respondents by primary SPA subsection affiliation and (b) secondary section/subsection affiliations, where N shows the total number of respondents. For both panels, SA is Aeronomy, SM is Magnetospheric physics, and SH is Solar and Heliospheric physics. Margin of errors are 8.2% and 7.7% for panels (a, b), respectively.

3. Demographics

The SPA section consists of three subsections. Of the survey respondents, 48% identified as primarily members of the SPA-Solar and Heliospheric physics (SH) subsection, 27% were from the SPA-Magnetospheric physics (SM) subsection, and 25% were from the SPA-Aeronomy (SA) subsection (Figure 1a). As the research topics within SPA often connect to other subsections, respondents were further asked if they identified with a secondary SPA subsection or other AGU section. As shown in Figure 1b, 243% did not identify with a secondary section while 10%, 33%, and 30% identified SA, SM, and SH as a secondary subsection, respectively. As a result, this suggests that 78% of early career scientists who responded to the survey conduct some degree of research on the Sun and/or solar wind (SH), 60% conduct some degree of research on magnetospheric systems (SM), and 35% study ionosphere/mesosphere/thermosphere regions. An additional 3.6% of respondents identified a non-SPA section as a secondary section (e.g., planetary sciences, non-linear geophysics, or education).

Regarding gender, SPA has traditionally largely skewed toward being mostly male (e.g., Bagenal, 2023). Of early career respondents, 58% identified as male, 32% identified as female, 3.6% identified as either non-binary or gender-queer, and 6.4% preferred not to answer (Figure 2a). This general composition is fairly consistent between the SPA subsections within statistical uncertainties, with SH potentially being slightly more male and SM being slightly more female (Figure 2b, with $t = 4.1$ and $p = 0.0004$). While this distribution is not representative of the global population, it is a significant improvement from previous surveys within SPA. Bagenal (2023) reported an 83%–17% male-female split for the field of Heliophysics, where Heliophysics is used in their study as a general name for the scientific community that encompasses the disciplines of SPA. While SPA membership demographics show a higher percentage of female members (25% vs. 17%) from those reported by Bagenal (2023), the early career population is also more gender diverse than the SPA population as a whole (outer ring of Figure 2a). This improvement could suggest that efforts to increase gender diversity are having an impact in correcting the disproportion and removing potential non-meritorious barriers to entry.

Comparing these findings by subsection to those of the National Science Foundation (NSF)-supported community workshops provides an additional recent comparison point. The SPA SA subsection generally overlaps the NSF-funded Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) community. Jones and Maute (2022) reported that the portion of CEDAR, across all career stages, that identified as male (female) was 58% (28%) and 57% (27%) in 2021 and 2022, respectively, which is consistent with the results of this survey. However, when separating out only early career registrants (defined in their study as less than 5 years from Ph.D.), Jones and Maute (2022) reported gender identities for male (female) being 66% (45%) and 80% (18%), for 2021 and 2022, respectively, which is notably skewed more male than the findings of this survey for the SA subsection. As noted in Jones and Maute (2022), the results based on the 2022 CEDAR workshop registrants may have been impacted by that meeting being the first CEDAR workshop to resume in-person attendance since the COVID-19 global pandemic and, as such, may have impacted genders to differing degrees.

The SPA SM subsection largely overlaps with the NSF supported Geospace Environment Modeling (GEM) community. A survey of GEM workshop attendees from 2023 found that 59% (29%) of respondents identified as male (female) when including all career stages (O'Brien et al., 2024). This is slightly more male-dominated than the reported SPA-wide SM subsection, but with EC-LAC survey having a stronger representation of female

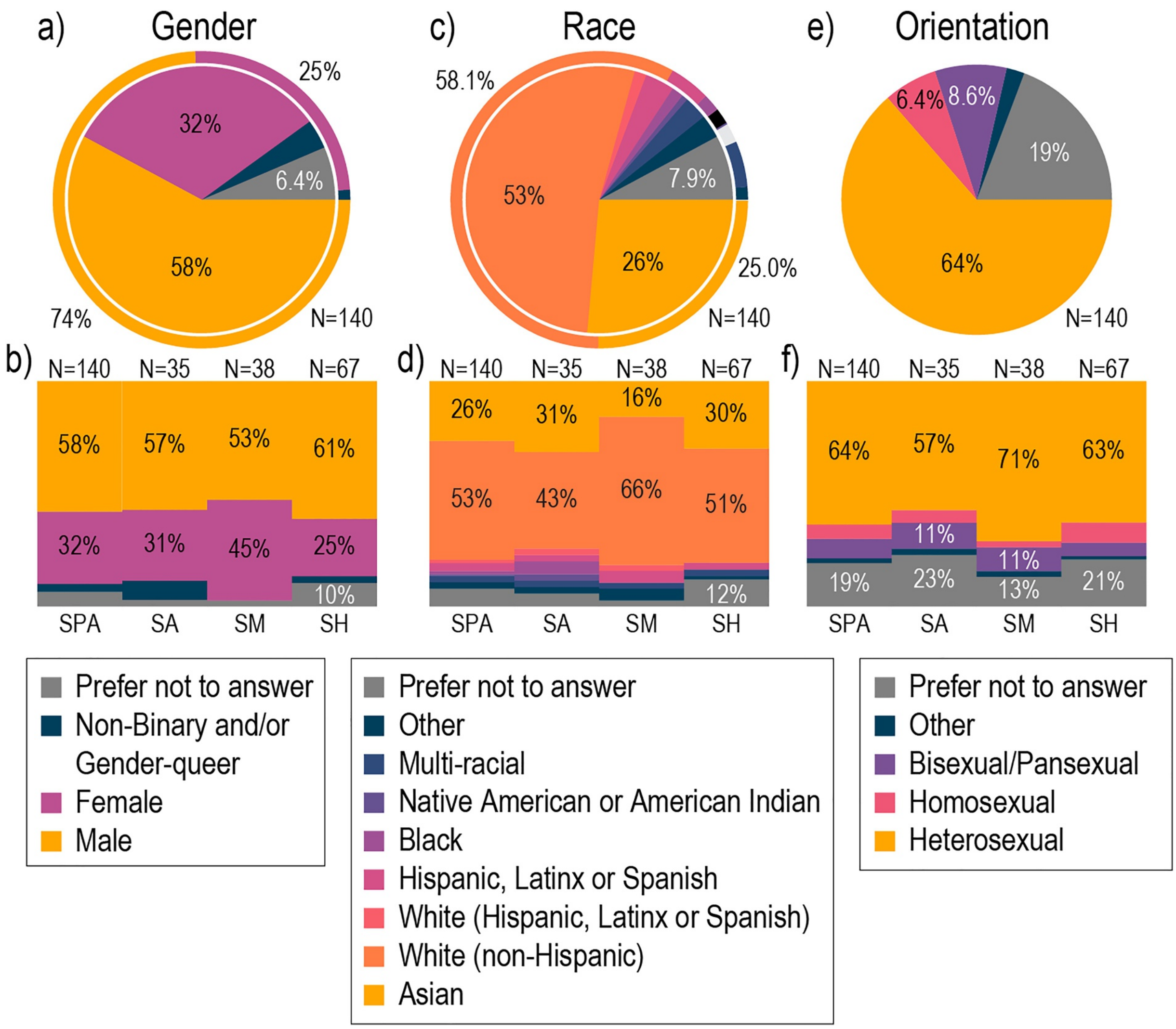

Figure 2. Demographic information for early career survey respondents including gender (a, b), race (c, d), and orientation (e, f). The top row are shown in pie-charts for SPA as a whole, whereas the middle row shows these percentages for SPA as a whole as well as the SA, SM, and SH subsections. The bottom row provides legends for each column. The percentages shown as an outer ring in panels (a, c) indicate the distribution of all SPA members as of December 2024, including all career stages. The black and light gray percentile grouping in the outer ring of panel c represent those who identified as "Middle Eastern or North African" and "Native of Indian subcontinent" on their SPA membership, respectively, but which were not categories in the early career researcher survey. To aid readability, only a subset of percentage values are shown; all percentage values and margins of error can be seen in Tables S1–S3 of Supporting Information S1.

identifying respondents. While SPA SH subsection overlaps the NSF funding Solar Heliospheric and INTerplanetary Environment (SHINE) community, there has not been a recent SHINE climatological survey published.

SPA has historically been largely composed of people who identify as white. However, the early career survey respondents identified as 26% Asian, 53% white (non-Hispanic), 1.4% white (Hispanic, Latinx, Spanish), 2.6% non-white (Hispanic, Latinx, Spanish), 1.4% Black, 0.7% Native American or American Indian, 2.9% Multi-racial, 2.9% Other, and 7.9% who preferred not to answer (Figure 2c). While there is a general consistency between the subsections (Figure 2d), the SM subsection respondents had a higher percentage of those that identified as white (non-Hispanic), with $t = 4.9$ and $p = 0.00001$. As in the case of gender diversity, while still majority white, the composition of the SPA early career body is more diverse than previous studies of the field as a whole (i.e., 82% white as reported in Bagenal (2023)). Similar to gender, the overall SPA membership has become more racially diverse since the values reported in Bagenal (2023), and the early career population is slightly more racially diverse than the general SPA membership.

The CEDAR climatological survey in Jones and Maute (2022) reported a general (i.e., all career stages) composition in 2021 (2022) that identified as 56% (54%) white, 35% (34%) Asian or Middle Eastern, 3% (6%) non-white Hispanic, 2% (4%) Black, 3% (1%) African, and 1% (1%) American Indian, Native Hawaiian, Alaskan Native, or Pacific Islander. Similar to gender, the racial distribution of SPA-wide SA subsection is closer to the general CEDAR composition than it is to only early career CEDAR respondents in 2021, which was 41% white, 53% Asian, 4.0% non-white Hispanic, 2.4% African, 0.8% Black, and 0.8% American Indian, Native Hawaiian, Alaskan Native, or Pacific Islander (the 2022 demographics were not broken down by career stage).

While the GEM survey results did not report racial demographics by career stage, there are notable differences between the general GEM demographics and the early career SPA SM subsection in this survey. O'Brien et al. (2024) reported that the general GEM community identified as 55% white, 28% Asian, 5.3% Hispanic, 2.6% Black, 2.6% Middle Eastern or Northern African, 0.7% Indigenous Descent/American Indian/Native American/Alaska Native/First Nations, 0.7% Native Hawaiian/Polynesian/Pacific Islander, and 0.7% other. In comparison the early career SM subsection respondents had a higher percentage identifying as white, and a smaller percentage identifying as Asian (Figure 2d). It is not clear if this difference is due to changes in demographics among career stages, or if this indicates different demographics between the GEM and SPA SM communities (e.g., the SPA survey may have a higher percentage of respondents from outside the United States of America than the GEM survey).

The distribution of sexual orientations for early career respondents was 64% heterosexual, 6.4% homosexual (combining gay and lesbian selection categories for statistics), 8.6% bisexual or pansexual, 2.1% other, and 19% prefer not to answer (Figure 2e). This distribution is fairly consistent among the subsections, but the high response rate of "prefer not to answer" limits further interpretation. Of the NSF sub-community surveys, only the GEM survey reported orientation demographics. O'Brien et al. (2024) reported that GEM in general (all career stages) identified as 66% heterosexual, 4.6% homosexual (combining gay and lesbian categories for comparison), and 13% bisexual or pansexual. It is not clear whether the differences in orientation demographics between the GEM study and this survey are due to a higher percentage of SM respondents in this survey who prefer not to respond (13% in this survey vs. 5.3% in the GEM survey), changing demographics with career stage, or differences in community overlap.

Another aspect of interest is the percent of the early career SPA population that are the first in their family to obtain either a 4-year degree and/or a doctoral degree (Ph.D.) to understand potential barriers to entry into the discipline. Of the respondents, 31% were the first in their families to obtain a 4 year college degree (Figure 3a). Between the SPA subsections (Figure 3b), SA has the smallest percentage of members who are the first in their family with a college degree, with SH having the highest percentage (with the comparison of SA (SM) to SH yielding a $t = -4.3$ ($t = -2.7$) and $p = 0.001$ ($p = 0.02$)). Further, 80% of respondents were the first in their families to obtain a Ph.D. (Figure 3c), with SA having the smallest percentage and SM having the highest percentage of members who are the first in their families with a Ph.D. (Figure 3d). This suggests that the population of SPA early career respondents does, in fact, come from various backgrounds beyond those of families already within academia and that the fields of physics that SPA represents are a pathway for families to advance into these levels of education. However, additional and more focused surveys would be required to further understand potential impacts of socioeconomic background and exposure to educational resources on the accessibility of the profession.

While the AGU organization is based, and holds its annual meeting, in the United States, its members work and are from countries all over the globe. Of the early career respondents, 70% work in North America, 15% work in Europe, 4.3% in Central and South America, 8.6% in Asia, and 2.1% in Africa (Figure 4a). As expected, this is very similar to the geographic distribution of SPA members over all career stages (outer ring in Figure 4a). Note, however that the SPA membership region questions are different than used in the early career survey (see Table S6 in Supporting Information S1). When further separating by SPA subsection (Figure 4), SA was the only subsection with respondents working in Africa, while SH had a higher percentage of respondents working in Asia, and SM had the largest contingent working in Central & South America.

As expected, regions of origin are more diverse, with only 36% from North America, 0.7% from Oceania, 22% from Europe, 7.9% from Central and South America, 30% from Asia, and 2.9% from Africa (Figure 4c). The distribution of region of origin has clear variations between the SPA subsections (Figure 4d). Respondents with a primary affiliation of SA were predominantly from North America (46%) or Asia (31%). Additionally, the SA

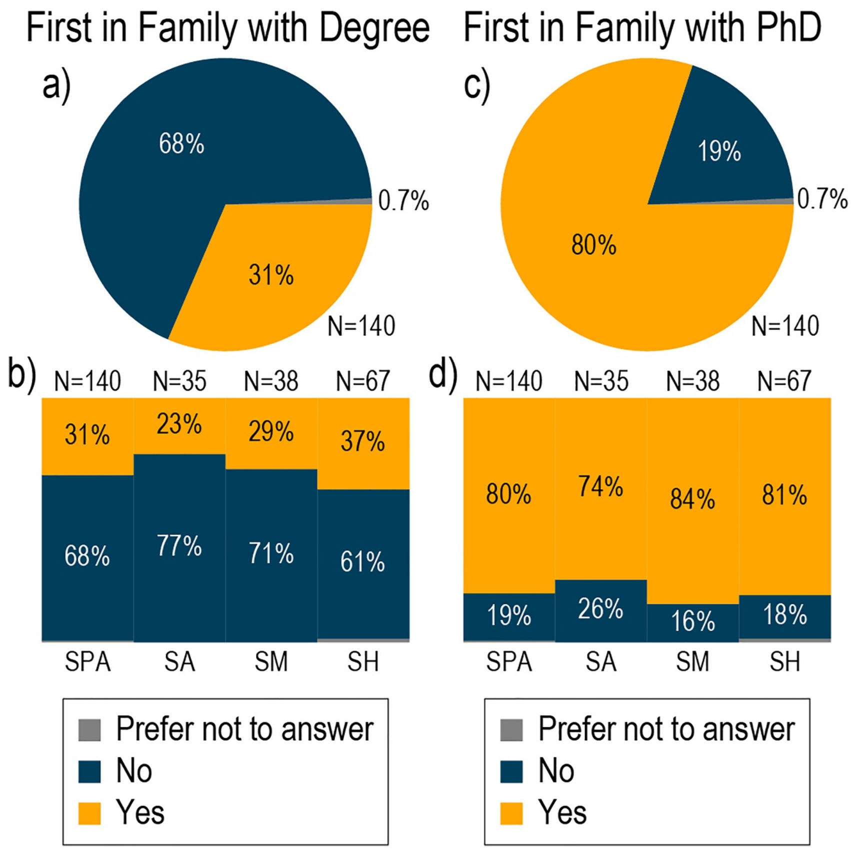

Figure 3. Distribution of the early career SPA community who are the first in their family with a college degree (panels a, b) and the first in their family with a Ph.D. (panels c, d). These are shown in the same format as Figure 2. To aid readability, only a subset of percentage values are shown in panels (b, d); all percentage values and margins of error can be seen in Tables S4 and S5 of Supporting Information S1.

section had the highest percentage of respondents originating from Africa (8.6%) and the lowest percentage from Europe (2.9%). Conversely, SH respondents were only 28% from North America, with a much higher relative concentration from Europe (33%). The SM subsection was the closest of the three to the SPA-wide distribution.

Another aspect of the demographic survey is the type of positions held by early career SPA members. Of the respondents, 44% are in research or research faculty positions, 39% are in postdoctoral positions, 8.6% are tenure-track faculty, 5.0% are scientists in industry, 1.4% are in non-tenure-track positions, and 2.9% designated themselves in the "other" category (Figure 5a). Among the sections, SH has the highest percentage of postdoctoral members, with SM having the fewest (Figure 5b, with $t = -7.7$ and $p = 0.000001$), though SM does have the largest percentage of members in research or research faculty positions (with SM to SH being $t = 3.0$ and $p = 0.005$). Notably, the results of these two survey questions suggest that the vast majority of early career SPA members are in soft-money positions rather than in positions that may offer some departmental support for teaching obligations (i.e., tenure-track positions).

While the GEM climatological survey did not break down positions by career stage, after removing student categories O'Brien et al. (2024) reported 22% postdoctoral researcher, 39% research scientist, 22% tenure or tenure-track university faculty, 7.5% non-tenured/non-tenure-track university research faculty, and 8.5% government employee. The significantly large percentage of research/research faculty in this survey for SM (50% compared to 39% in O'Brien et al. (2024)) may suggest that more early career magnetospheric scientists are finding themselves in the research scientist/research faculty category compared to tenure-track positions (11% in this study compared to 22% in the GEM study), which could indicate that tenure-track opportunities have not recently been as available. This may be of interest to future studies if a shift toward soft-money funding (i.e., relying on securing external grants and contracts) is occurring within the SM subsection, and perhaps other parts

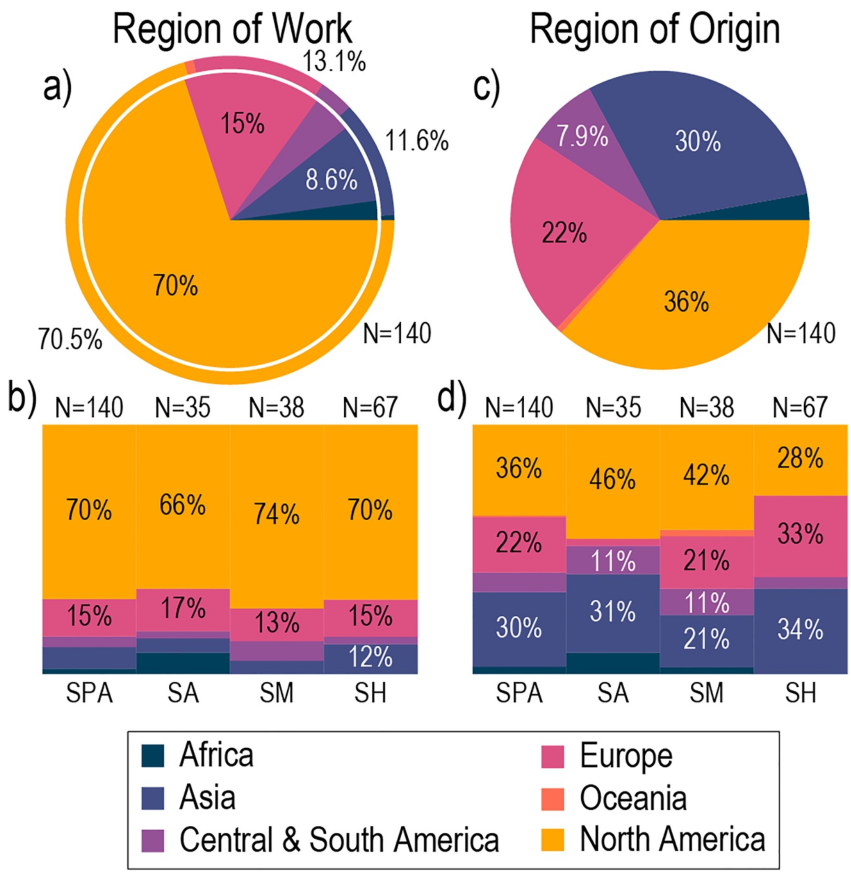

Figure 4. Distribution of where SPA early career members work (panels a, b) and originate from (panels c, d). These are shown in the same format as Figure 2. To aid readability, only a subset of percentage values are shown; all percentage values and margins of error can be seen in Tables S6 and S7 of Supporting Information S1.

of SPA. Such a shift in support may result in the field being more vulnerable to fluctuations in federal research funding.

Regarding the types of institutions early career SPA members work at (Figure 5c), 50% work in academic university/college settings, 19% work for a government agency, national laboratory, or Federally Funded Research and Development Center (FFRDC), 16% work for a research non-profit, 9.3% work for a University Affiliated Research Center (UARC), 3.6% work for industry, and 2.1% identified as an independent researcher (in between jobs). Of the subsections, SA was the only subsection with early career researchers who identified themselves as being between jobs and the highest percentage of members at government agencies, national labs, or FFRDCs (comparing SA to SM (SH) yields $t = 3.3$ ($t = 3.4$) and $p = 0.008$ ($p = 0.007$)), with the smallest percentage at research non-profits (Figure 5d, although possibly not significantly significant with the comparison of SA to SM (SH) yields $t = -1.9$ ($t = -2.2$) and $p = 0.1$ ($p = 0.08$)). The SM subsection has the lowest percentage of early career members at government agencies, national labs, or FFRDCs (while statistically significant compared to SA as noted above, this may not be significant compared to SH with $t = -1.0$ and $p = 0.3$). SM also has the highest percentage in academic universities/colleges (Figure 5d, with SM compared to SA (SH) yielding $t = 3.9$ ($t = 3.0$) and $p = 0.0004$ ($p = 0.004$)). Notably, the SH subsection has the largest percentage of members at UARCs, compared to the other subsections (Figure 5c, although possibly not statistically significant with SH compared to SA (SM) yielding $t = 2.1$ ($t = 1.5$) and $p = 0.2$ ($p = 0.3$)).

4. Aspects of the Career Path

An important aspect of becoming a successful early career researcher is learning how to acquire funding. One metric of this skill is the selection of proposals in which the scientist was the primary investigator (PI; Figure 6a).

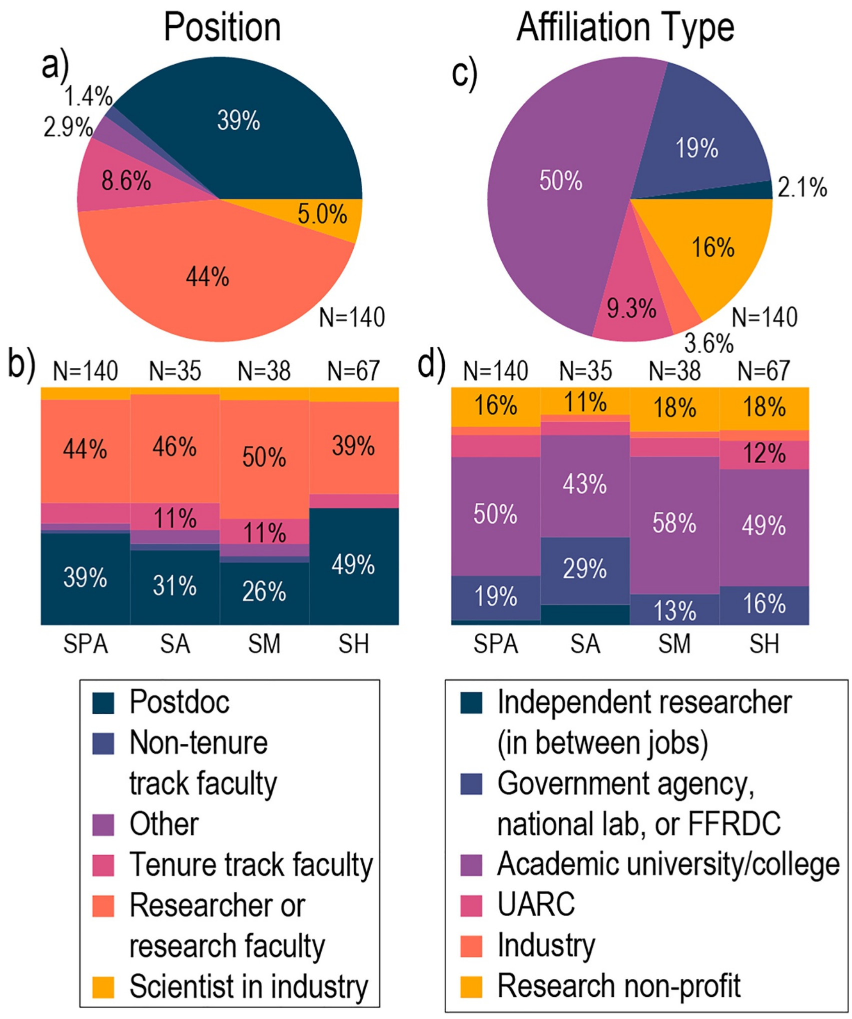

Figure 5. Distributions of the different positions early career SPA members hold (panels a, b) and the type of organization in which they work (panels c, d). These are shown in the same format as Figure 2. To aid readability, only a subset of percentage values are shown; all percentage values and margins of error can be seen in Tables S8 and S9 of Supporting Information S1.

The distribution of early career PI selection rates, when only including respondents that indicated an average of at least one PI proposal per year, was fairly consistent among the subsections. The exclusion of respondents who indicated an average of zero PI proposals per year was done to remove potential respondents who have yet to propose, which could possibly skew the results. SM has the highest percentage of members with a selection rate above 50% (with SM compared to SA (SH) yielding $t = 6.1$ ($t = 5.7$) and $p = 0.0007$ ($p = 0.00003$)), SA has the highest percentage with selection rates from 40% to 50% (with SA compared to SM (SH) yielding $t = 6.9$ ($t = 5.9$) and $p = 0.002$ ($p = 0.00003$), while SH is more evenly distributed once above 10% (Figure 6b).

Pertaining to funding, respondents were asked if they would prefer a lower selection rate with a higher award amount, or a higher selection rate for a lower award amount. Of the SPA early career respondents 74% wanted a higher selection rate for a lower award amount, while 26% preferred a lower selection rate with a higher award amount (Figure 6c). Between the subsections, the opinions of SM and SH members were identical, while SA subsection members had a relatively larger percentage of members who preferred a lower selection rate with a higher award amount (with comparing SA to SM (SH) yielding $t = -5.8$ ($t = -6.8$) and $p = 0.0000008$ ($p = 0.0000001$); however, the majority of early career SA members still preferred a higher selection rate with a lower award amount (Figure 6d). Note that this question was asked as a general comparison of two options and not as a comparison to current selection rates or funding levels.

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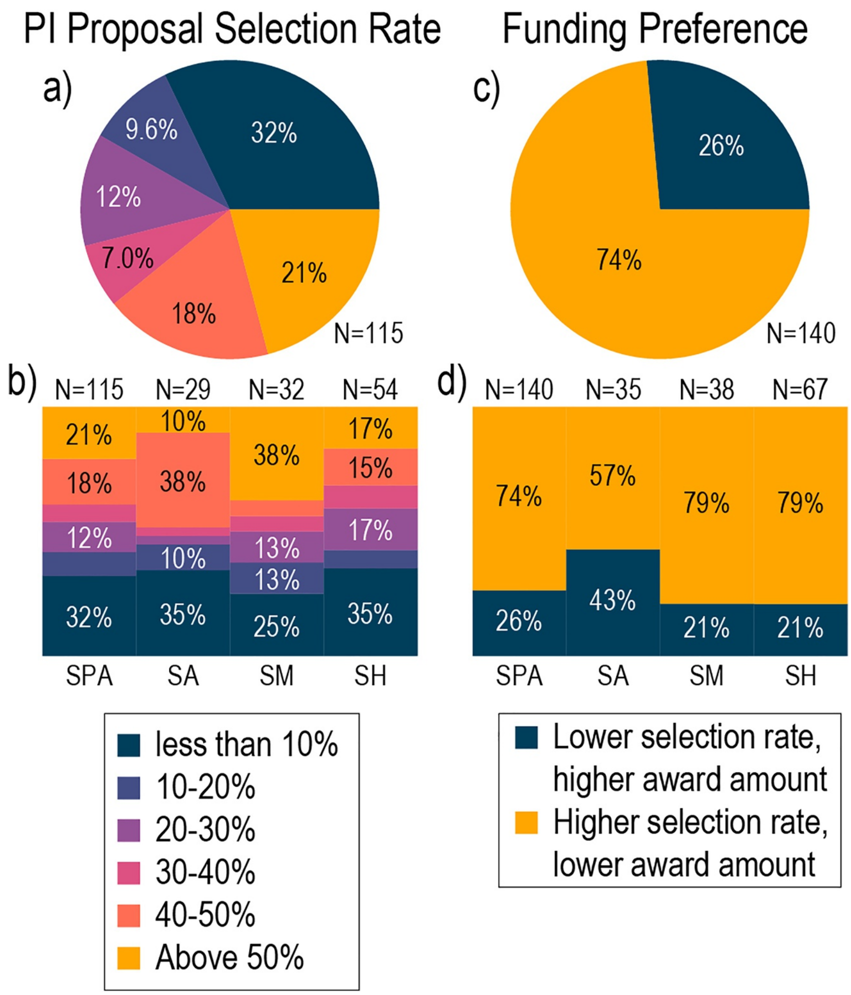

Figure 6. Distribution of early career SPA PI proposal selection rates for respondents with an average of 1 or more PI proposals per year (panels a, b) and funding preferences for all respondents (panels c, d). These are shown in the same format as Figure 2. To aid readability, only a subset of percentage values are shown in panel b; all percentage values and margins of error can be seen in Tables S10 and S11 of Supporting Information S1.

To better assess the proposal workload placed on early career SPA members, the number of proposals submitted as either PI or co-investigator (Co-I) was collected (Figure 7). The majority of early career respondents reported authoring one to two PI proposals per year (33% and 31%, respectively), followed by zero and three proposals per year (18% and 11%, respectively). Very few respondents indicated authoring four or more proposals per year. This general qualitative distribution was seen for Co-I proposals, but with a broader distribution (i.e., less peaked at one to two proposals per year).

As most of the members of the SPA early career body are likely in soft-money positions (see Figure 5a), understanding the PI proposal selection rate is an important consideration. Notably, when only including respondents with an average of at least 1 PI proposal per year, 32% reported having a selection rate less than 10%, 9.6% of respondents were between a 10%–20% selection rate, 12% reported selection rates between 20% and 30%, 7.0% of respondents were between 30% and 40% successful, 18% fell in the 40%–50% range, and 21% reported a selection rate over 50% (Figure 7). The distribution, which appears to have two peaks, one below 10% and one above 40%, is curious and may be related to respondents with only one or two submitted proposals, but more statistics and information are needed to further explore this.

As the number of original scientific publications is often used as a metric of scientific output, Figure 7 illustrates the distribution of the average number of first-authored publications per year for early career respondents. The majority publish one first-authored paper on average per year (63%), followed, with decreasing percentage, by

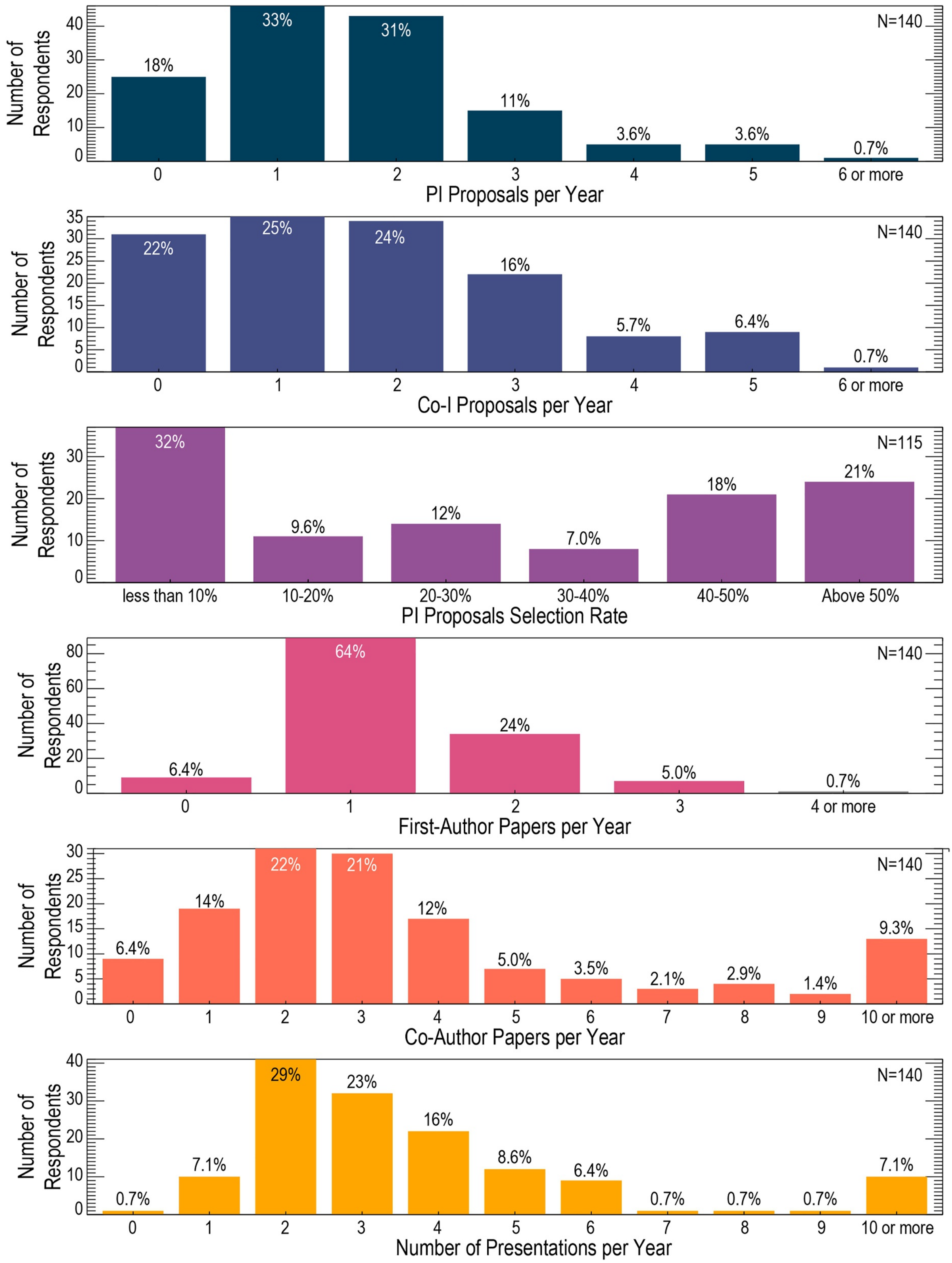

Figure 7. Distributions of (from top to bottom) average PI proposals per year, average Co-I proposals per year, PI proposal selection rate for respondents with an average of 1 or more PI proposals per year, average number of first-author and co-authored papers per year, and the number of presentations given per year. Margins of error from top to bottom are 7.8%, 7.2%, 8.5%, 7.9%, 6.9%, and 7.5%, respectively.

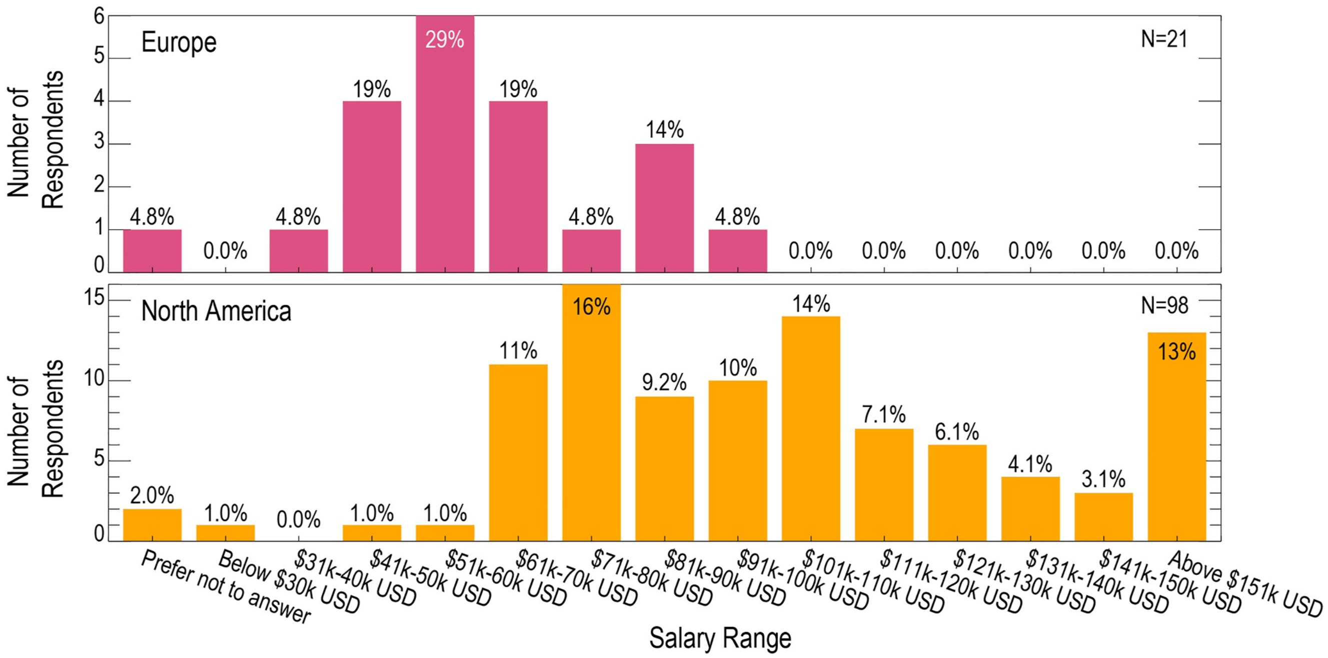

Figure 8. Salary distributions for early career SPA members working in Europe (top) and North America (bottom). Other regions are excluded due to limited statistics. Margins of error are 19% and 7.3%, respectively.

two, zero, three, and four or more publications per year (Figure 7). While not shown, the general distribution of first-authored publications per year did not statistically vary between the different regions of work, as expected.

The distribution of the average number of co-authored publications per year for early career SPA members is peaked between two and three papers per year (22% and 21%, respectively, Figure 7), although the distribution is fairly broad, with a secondary peak at "10 or more." Similarly, the number of presentations per year, a metric of community exposure to their work, is highest for two to three presentations per year (29% and 23%, respectively) and has a secondary peak at "10 or more" (Figure 7).

5. Distribution of Salaries

To better understand the distribution and dependencies of various factors on the salary of early career SPA members, the survey included an optional question to report their salary range. This ranged in increments of $10,000 from "below $30k" up to "above $151k." Due to the limited number of respondents outside of North America and Europe, only these two regions are compared. This is both a result of the difficulty in determining true distributions for other regions and to protect this sensitive information (i.e., only including results that are appropriately aggregated to avoid identification of the respondent). Respondents were asked to report salaries in US dollars (USD).

When comparing the salary of the respondents between Europe and North America (Figure 8), there is a clear dependence of salary on region of employment. Respondents employed in Europe were more likely to be paid in the range of $40k–$70k with no respondents above $101k. Meanwhile, North America-based early career SPA members have a broader distribution of salaries, mostly ranging from $60k to over $151k. It should be noted that while there is a clear pay discrepancy between the continents, other factors of a complete compensation package, such as benefits or paid time off, are not reported here and may factor into someone's perception of better or worse total compensation. Additionally, other external factors, such as cost of living (including healthcare and daycare costs), are not considered here, and as such this comparison is not intended to weigh wealth disparities.

Another important consideration is how salary ranges compare between genders. Due to the difference in salary by region discussed above, gender pay disparity is only investigated for North America, which had the highest number of responses. Also due to the number of respondents, only those identifying as male or female are compared here. There is not a significant difference between salary levels by gender in North America (Figure 9).

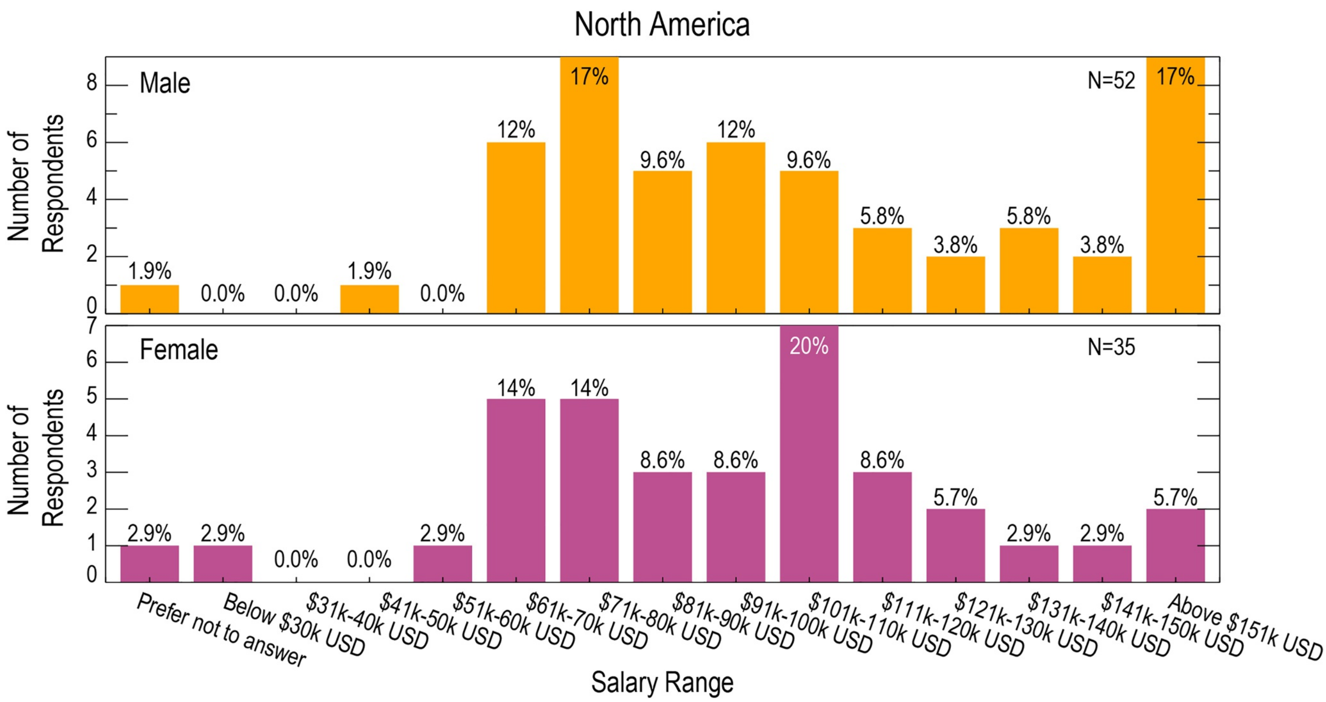

Figure 9. Salary distributions of early career SPA members for both male (top) and female (bottom) identifying respondents who work in North America. Due to limited statistics, non-binary and/or gender-queer respondents are not included. Margins of error are 10% and 13%, respectively.

Constructing the Welch's unequal variances t-test to compare the means, Z-statistic to compare medians, and F-statistic to compare variances results in significance values of 0.19, 0.15, and 0.62, respectively. These statistical tests were conducted using the median value of each bin, with $25k for the "below $30k" bin and $155k for the "above $151k" bin. This suggests that, statistically, the means, medians, and variances are the same between both populations, and as such that the take-home compensation between genders in North America is similar. It should be noted that this does not necessarily imply that every employer has pay parity, but it suggests North American institutions, as a field, have similar compensation packages for male and female early career space physicists. Despite the absence of a general statistical difference in the two salary distributions, it should be noted that the percent of respondents in the "above $151k USD" range is higher for males than females. Future surveys may benefit from including salary ranges up to higher maximum pay levels to better understand any potential significance of this.

As the early career designation spans a portion of one's career with many changes in job classification, understanding how job position may impact the distribution of salary may be important. Figure 10 illustrates the salary distributions for North America-based respondents who classified themselves as postdoctoral researchers, tenure-track faculty members, researchers or research faculty members, or scientists in industry. As before, this analysis is limited to respondents working in North America to remove regional biases in salary ranges and to focus on the region with the most respondents. North American postdoctoral fellows mostly earn between $61k and $110k. The distribution of early career tenure-track faculty largely falls between $111k and $140k but with limited statistics. Early career researchers and research faculty have the largest distribution, spanning from $61k to above $151k, with local maxima at both $101–$110k and above $151k. Lastly, early career scientists in industry have limited statistics, with salaries clustered between both $101k–$120k and $141k to above $151k.

As expected, the job category with the lowest salaries is postdoctoral fellow, as this is typically the position of scientists who have just obtained their Ph.D. and therefore have fewer experience and less years of work in the field. While both the "researcher and research faculty" and "scientist in industry" categories are the only ones to have respondents earning over $151k, it should be noted that the limited statistics for tenure-track positions may result in a biased comparison. While the distribution of salaries for the "researcher and research faculty" positions is the broadest, it also has the largest number of respondents. In general, however, the local maximum for

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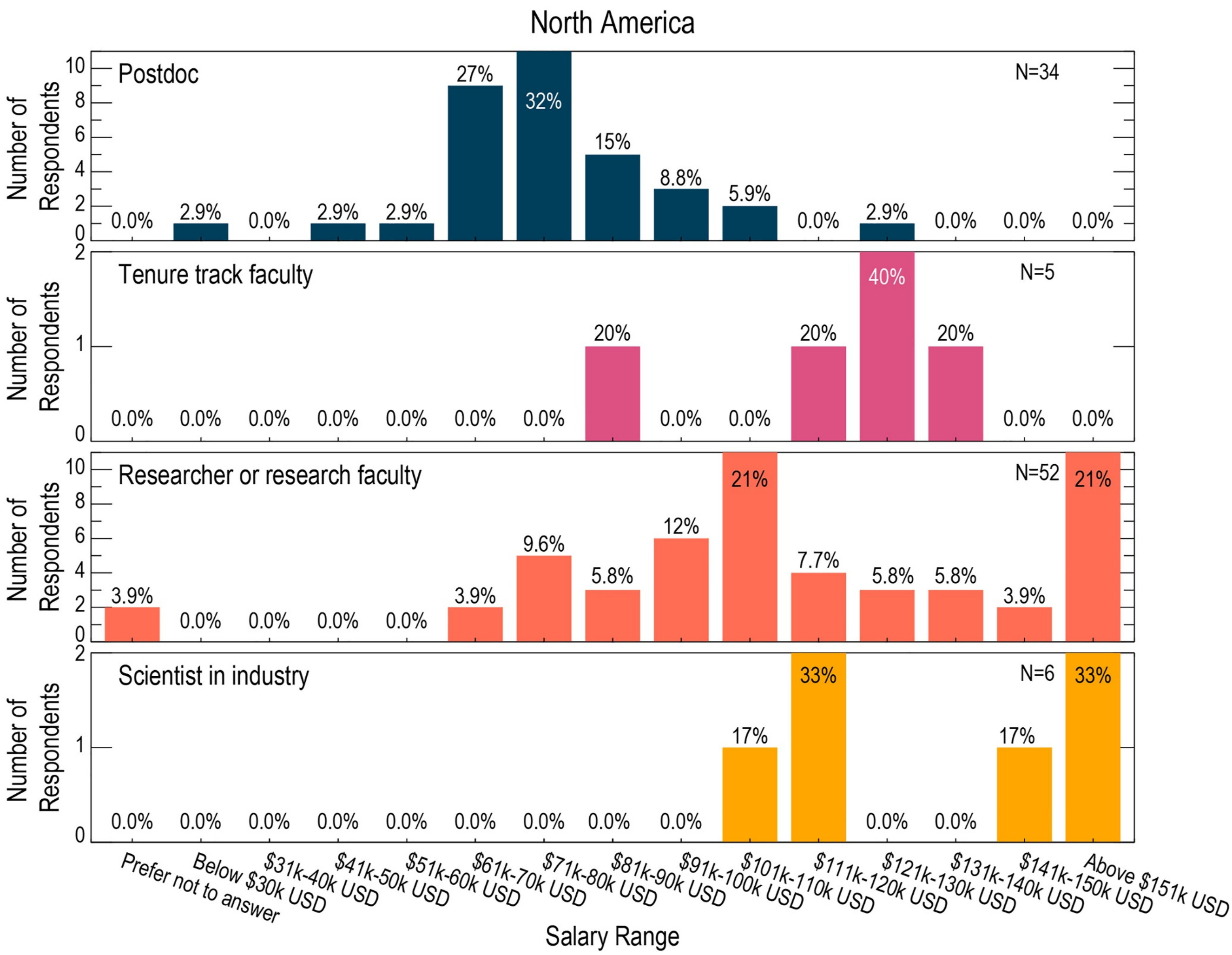

Figure 10. Distribution of SPA early career salaries by job type (top to bottom) for postdoctoral positions, tenure-track faculty positions, researcher or research faculty positions, and scientists in industry working within North America. Responses from "non-tenure-track faculty" and "other" are not included due to limited statistics. Margins of error are 16%, 43%, 11%, and 38%, respectively.

researchers and research faculty at $101k–110k is below the maximum of tenure-track salaries, which may suggest different starting salaries for these categories. However, the second maximum at salaries above $151k for researchers and research faculty suggests this career path may allow for salaries that exceed those of tenure-track faculty within the early career time range (less than 10 years from Ph.D.).

Lastly, beyond the position held, the type of institution at which a scientist works may impact salary. To investigate this, Figure 11 presents the distributions of North American salaries by type of employer. There are not a sufficient number of responses to mutually subdivide the data for region, job type, and affiliation type, so this representation includes all job types. Generally, academic universities and colleges have a large distribution of salaries with a peak around the postdoctoral researcher range ($60k to $80k, see Figure 10) and a long tail to higher salaries, including the top category of above $151k. Meanwhile, government agencies, national laboratories, and FFRDCs peak in the range of $101k – $120k, with a top salary in the $131k – $140k range. Research non-profits have two peaks, one in the $71k to $110k range, which may include postdoctoral fellows, and another peak (with the highest percentage of the ranges at 24%) at above $151k. Salaries at UARCs are varied, ranging from a low in the range of $51k – $60k and a peak at above $151k. However, as the "above $151k" range is an inequality, this higher salary peak may become lower if the survey included $10k bins of salary above $151k. The limited number of respondents working in industry settings reported salaries ranging from $101k to above $151k (not shown), but the limited number of respondents does not allow for a distribution to be discerned.

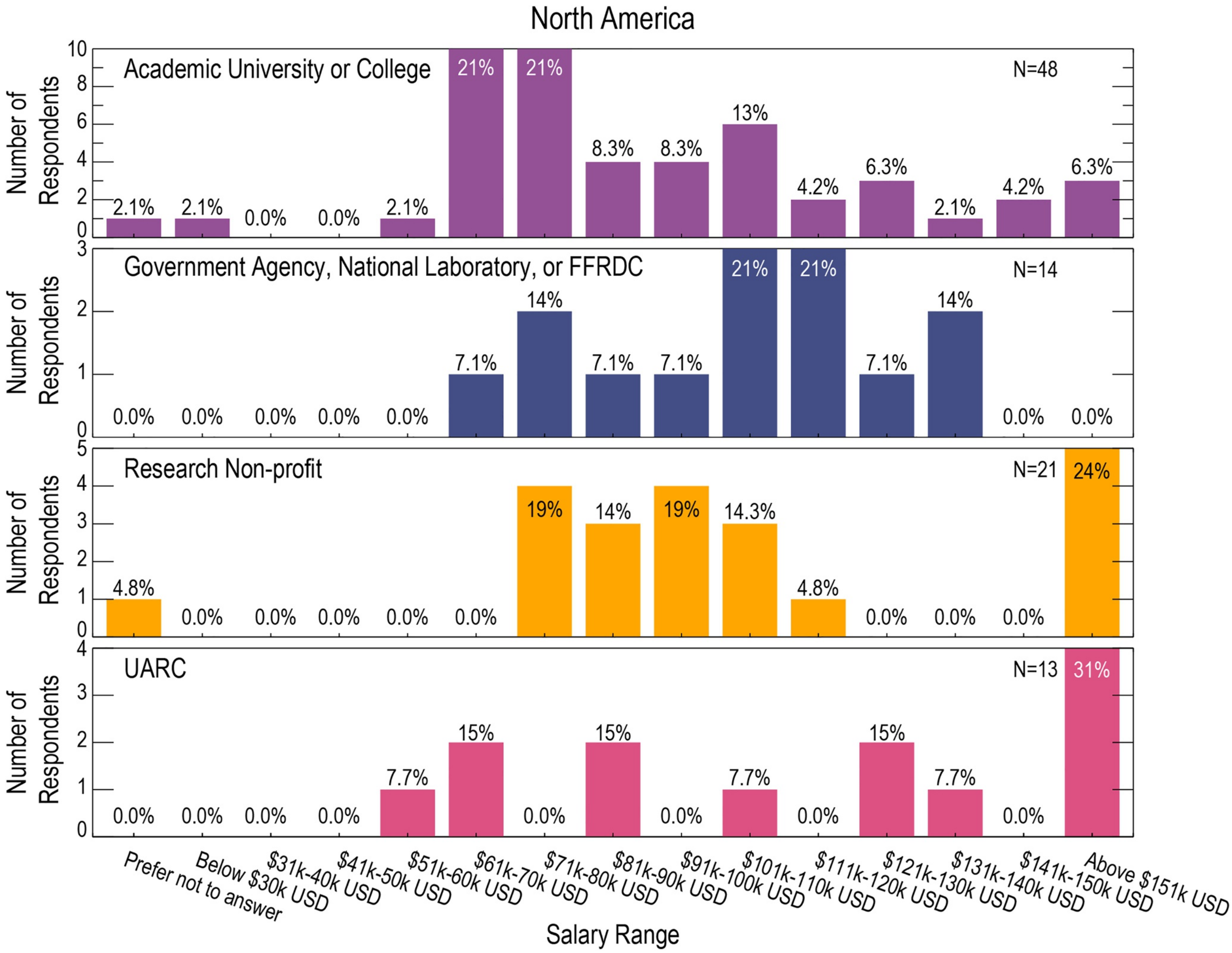

Figure 11. Salaries of early career SPA members working in North America by affiliation types. The categories of "Independent researcher (in between jobs)" and "Industry" are not included due to limited statistics. Margins of error are 12%, 21%, 18%, and 25%, respectively.

Beyond salary, another important compensation for early career scientists is paid maternity and family leave, as many early career scientists may be within their child bearing years. Typically, maternity leave is paid leave for the birthing parent, while family (or parental) leave is paid leave that can be used by the birthing parent and/or the non-birthing guardian. Due to the limited number of respondents in most regions, Figure 12 illustrates the distribution of responses for those working within North America. While factors such as salary were compared between North America and Europe-based scientists, many European countries have government-mandated paid leave requirements, unlike the United States. Figure 12 therefore contains scientists in the United States, Canada (with 15 weeks of mandated maternity leave and 40 weeks of shared parental leave), and Mexico (with 12 weeks paid maternity and 5 days paid parental leave). While the survey only collected information on region, rather than country, the majority of SPA members within North America work in the United States. Consistent with the assumption that the majority of North American respondents work within the United States, the majority of responses with leave are below that required in Canada and Mexico (Figure 12). Not including responses of "Don't know/prefer not to answer", the most common response was no paid maternity or family leave. This was followed by a broad peak in responses ranging from 5 to 11 weeks of paid maternity leave and 5–8 weeks of family leave. Only 2% of respondents reported over 12 weeks of maternity leave and an additional 2% reported some but less than 2 weeks of paid maternity leave.

For comparison of paid maternity leave, as of 2018 the United Kingdom mandated 39 weeks of paid leave; Hungary mandated 24 weeks; Italy mandated 21.7 weeks; Australia, Chile, Denmark, and New Zealand mandated

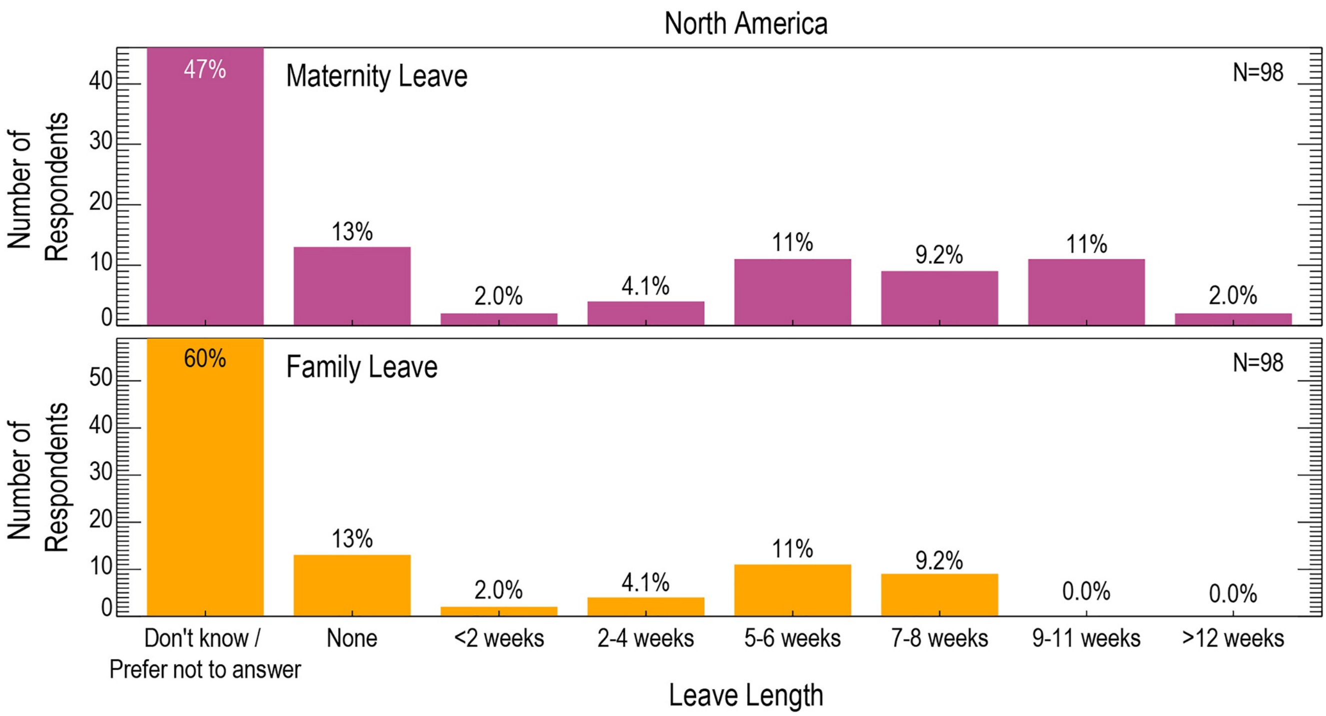

Figure 12. Distribution of North American responses to the length of their paid maternity (top) and family (bottom) leave compensation from their employer. Margins of error are 9.9% and 9.7%, respectively.

18 weeks of paid leave; Austria, Canada, France, Latvia, Netherlands, Spain, and Turkey mandated 16 weeks of paid leave; Belgium mandated 15 weeks; and Japan, Germany, and Switzerland mandated 14 weeks (Khan, 2020). Similarly, mandated paid parental leave has been expanding in many regions of the world including 5 weeks mandated in Portugal; 3 weeks mandated in Finland; and 2 weeks paid leave in Australia, Belgium, Denmark, Estonia, France, Ireland, Luxembourg, Poland, and the United Kingdom (Khan, 2020). Additionally, Sweden offers up to 480 days of paid parental leave to be shared between parents up until the child is age 12 (Heshmati et al., 2025). As such, The North American respondents report relatively lower levels of paid maternity leave than countries with mandates, but some respondents report longer durations of paid family leave than mandated by other countries.

6. Workforce Retention

To gauge workforce retention, the respondents were asked if they were considering leaving the field. Figure 13 presents the results for respondents in North America (left) and those in Europe (right). As with other survey questions, there were not enough responses from other regions to include in this comparison. Of these, early career space physicists in Europe (Figure 13c) were more likely to intend to stay in the field (38% compared to 24% in North America, with $t = 3.0$ and $p = 0.02$). A majority of North America-based early career scientists (57%, Figure 13a) indicated that they would prefer to stay in the field but that lack of funding may force them to leave, while a plurality of Europe-based respondents (43%) selected this response. A smaller number of respondents in North America and Europe (12% and 9.5%, respectively) responded that they would like to stay in the field but are being driven away by the climate/culture. Lastly, 7.1% of respondents working in North America and 4.8% in Europe responded that they are actively searching for a new position outside the field.

Breaking this out by subsection, North American respondents in SM and SH were mostly consistent with each other and with the general SPA early career population. SA members in North America have a higher percentage of those intending to stay in the field and fewer, but still majority, responding with funding being a potential cause for leaving the field (Figure 13b). Of respondents working in Europe, both SA and SH affiliated early career scientists had a 50% response rate for intending to remain in the field with ~30% of respondents stating that lack of funding may force them to leave. Meanwhile 17% (20%) of European SA (SM) respondents reported that the

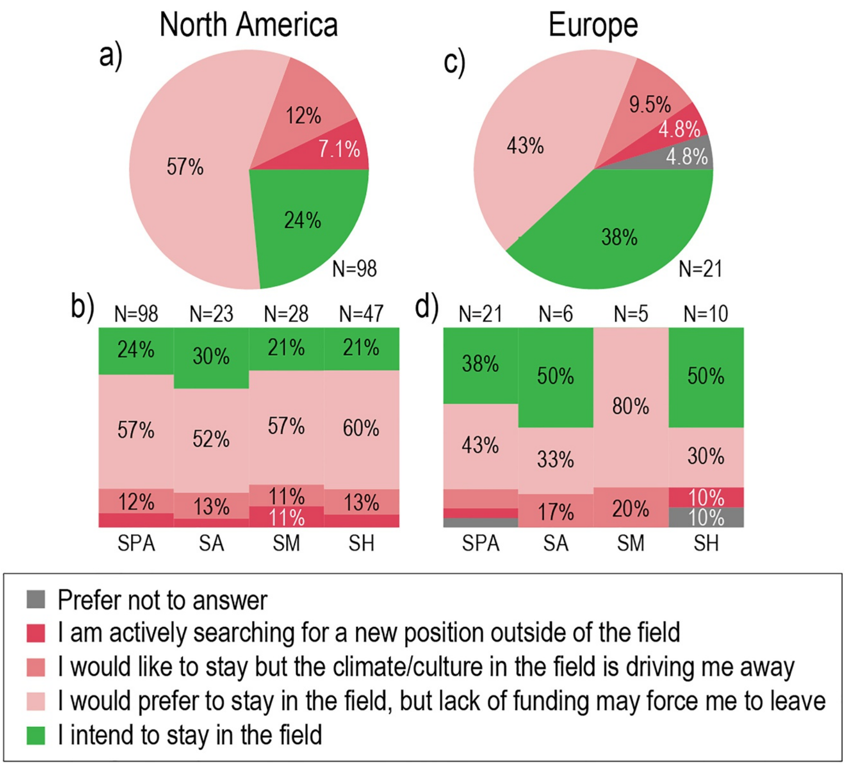

Figure 13. Responses from early career SPA members in North America (panels a, b) and Europe (panels c, d) on consideration of leaving the field. These are shown in the same format as Figure 2. To aid readability, only a subset of percentage values are shown; all percentage values and margins of error can be seen in Tables S12 and S13 of Supporting Information S1.

climate/culture may force them to leave and 10% of European SH respondents indicated that they are actively searching for work outside the field. Notably, however, no European respondent in the SM subsection indicated that they intend to stay in the field, a potential sign of a lack of optimism for the magnetospheric physics sub-field, although the limited response rate limits interpretation of this finding. Instead, 80% of European SM respondents indicated that funding may force them out of the field, which could be due to the ending of the Cluster mission (Escoubet et al., 2001) and uncertainty about the potential selection of Plasma Observatory as a European Space Agency (ESA) M7 mission (Retinò et al., 2022).

Generally, with the exception of the European SM respondents, early career scientists in North America are far more likely to fear having to leave the field due to lack of funding. Meanwhile, the combined response of either actively searching for work outside the field or potentially leaving due to climate/culture is roughly the same across all subsections and regions, with the potential outlier of European SH respondents, who also had a larger percentage who did not answer the question.

7. Satisfaction Assessment

To further assess work-related satisfaction, respondents were asked to rate how satisfied they were with various aspects of work, work-life balance, and workplace compensation on a five-point Likert scale (Likert, 1932) (Figure 14). Since some of these aspects, such as family leave and insurance, are known to be different between North America and Europe, the ratings of satisfaction are separated into these two workplace regions. There are not sufficient responses from other workplace regions for a statistical and aggregate investigation of satisfaction elsewhere. Further, it is noted that while the North America workplace region includes Canada and Mexico, it is expected to be largely composed of members working in the United States, as AGU SPA membership as a whole is reported as being 71% United States and 3.4% "Americas." For this reason, many of the North American satisfaction will be interpreted as reflecting United States satisfaction, but with the understanding that some small subset of respondents are likely working in Canada and Mexico.

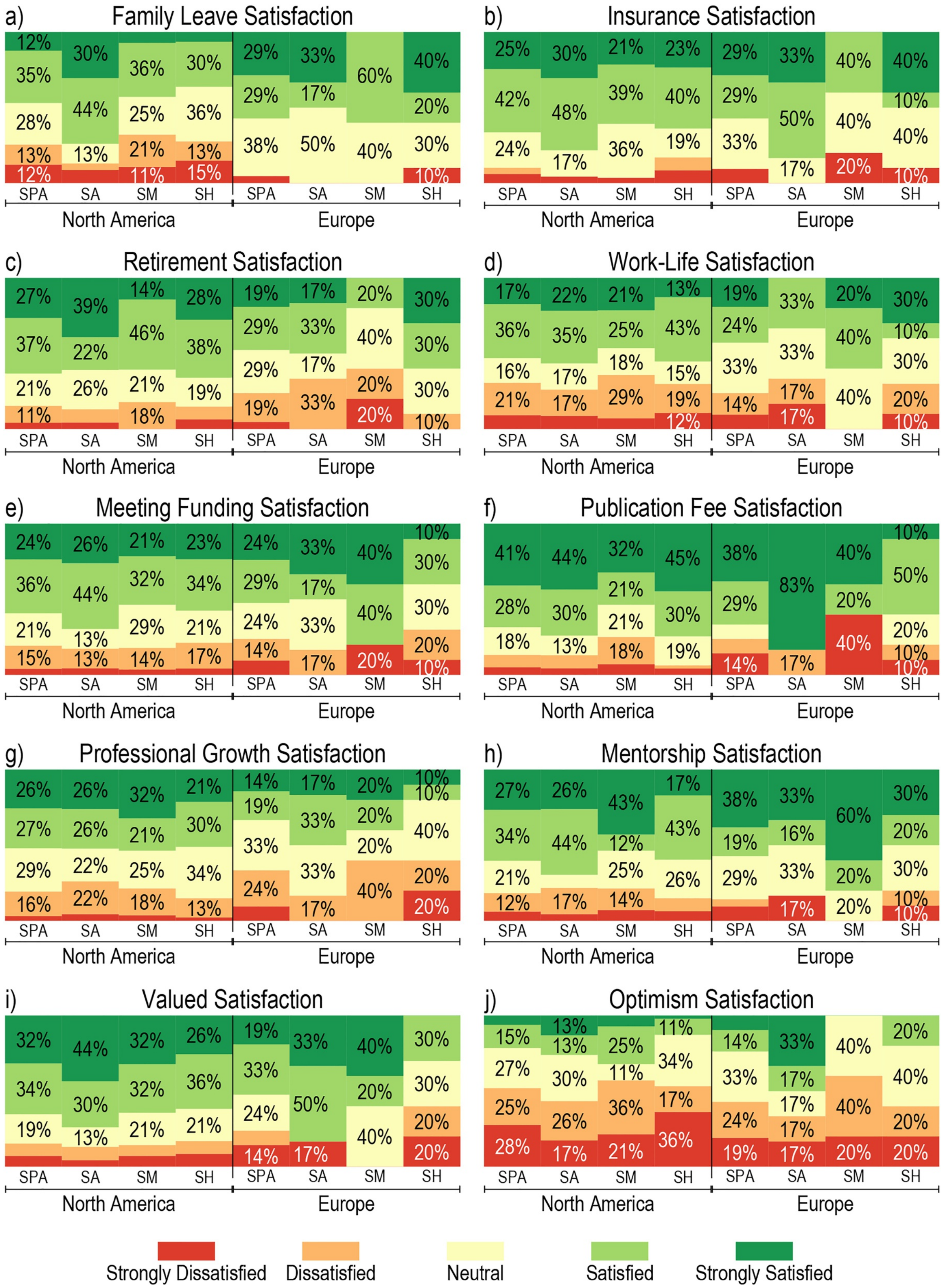

Figure 14. Distributions of satisfaction on a 5-point Likert scale (Likert, 1932) for various compensation and workplace elements for respondents from North America (predominantly the United States, left panels) and Europe (right panels). The of responses (N) from North America and Europe is the same as given in Figures 13a and 13b, respectively. To aid readability, only a subset of percentage values are shown; all percentage values and margins of error can be seen in Table S14 of Supporting Information S1 through Table S23 of Supporting Information S1.

Regarding satisfaction with compensation packages, respondents were asked to rate their satisfaction with their family leave policy, insurance plans, and retirement plans. Family leave satisfaction is on average higher in Europe than in North America (Figure 14a), likely due to government mandated leave requirements being higher in Europe than in the United States. Interestingly, though, in North America the number of respondents who are either "satisfied" or "strongly satisfied" (green shades) is still larger than the percentage who are "dissatisfied" or "strongly dissatisfied" (orange and red) SPA early career members across all subsections, with North American SA members generally being the most satisfied. While not able to be explored with the responses of this survey, Canada does have an extensive ground based network of imagers, magnetometers, radars, and other remote sensing instrumentation for upper atmospheric and ionospheric investigations. As such the North American SA respondents may have a higher contribution from those working in Canada than the other subsections in North America. This is relevant as Canada mandates paid parental leave, whereas the United States only mandates a minimum of unpaid leave time.

Satisfaction with insurance plans (Figure 14b) was also high for both regions, with satisfied responses outweighing dissatisfied responses for all subsections. Satisfaction with insurance plans was also generally higher than satisfaction with family leave in North America. However, European dissatisfaction was higher for insurance plans than for family leave.

Retirement plan satisfaction in North America (Figure 14c) was similar to that of insurance satisfaction, with satisfied ratings strongly outweighing dissatisfied ratings, although the percent dissatisfied with retirement plans was larger than for insurance plans. One marked difference, however, is that Europe-based early career SPA members were notably more dissatisfied in their retirement plans compared to the other compensation-based satisfaction questions. Additionally, of the compensation-related satisfaction measures, this is the only one in which dissatisfaction in Europe was larger than that in North America. It is not clear whether this may be related to the lower relative salaries in Europe compared to North America (Figure 8) impacting perception of preparedness for retirement of early career members, or whether this reflects some other factor (e.g., employer matching of retirement/pension savings).

Another often discussed metric of well-being surrounding work is a "work-life balance", which is different for each individual. When asked about the satisfaction of the respondents with their work-life balance, a majority (53%) of early career North American SPA members responded with some degree of satisfaction while only 31% responded with some degree of dissatisfaction compared to only a plurality (43%) and a minority (24%) responding with satisfaction or dissatisfaction, respectively, in Europe (Figure 14d). Generally, there are no clear statistical variations between the subsections.

Respondents were generally favorable to the amount of funding available to attend professional meetings (Figure 14e), with satisfaction (59% in North America and 52% in Europe) exceeding dissatisfaction (19% in North America and 24% in Europe), and with little variation between subsections. Similarly, respondents had more favorable views on funding for publications fees (Figure 14f), with satisfaction (68% in North America and 67% in Europe) higher than dissatisfaction (13% in North America and 24% in Europe). Generally, satisfaction with funding for meeting travel and publications is high, though there is more satisfaction (and a higher degree of satisfaction) with funding to cover publication costs than for attending meetings (Figures 14e and 14f).

When asked about satisfaction with opportunities for professional growth within their research group, a majority (52%) of early career North American SPA members responded with some degree of satisfaction and only a small percentage (19%) indicating some degree of dissatisfaction, with little variation between the subsections (Figure 14g). Comparatively, professional growth satisfaction was lower for Europe-based members, with one third of respondents being satisfied, one third being neutral, and one third being dissatisfied. Between the subsections, dissatisfaction was relatively highest for SA members in North America, while satisfaction was relatively highest for SA members in Europe. Satisfaction for early career SM and SH members was noticeably different between those working in North America and Europe, with higher rates of satisfaction noted for those in North America.

Another metric for how well the community is cultivating early career scientists is satisfaction with the guidance and career advice early career members receive from their mentors (Figure 14h). Mentorship satisfaction was higher than that for professional growth, with a majority (60% in North America and 57% in Europe) reporting some degree of satisfaction and only a small contingent (18% in North America and 14% in Europe) reporting some degree of dissatisfaction.

When asked to rate their satisfaction with how valued they feel within their research group (Figure 14i), the majority of both North America-based and Europe-based respondents answered with satisfaction (65% and 52%, respectively). Between the subsections in both regions, SA respondents were the most satisfied with the value they perceived having in their research group, followed by SM and lastly SH. While all subsections in North America were primarily satisfied, only the SA and SM subsections in Europe had more respondents reporting being more satisfied than unsatisfied, with European SH subsection respondents being more dissatisfied (40% dissatisfied to 30% satisfied).

Of all rankings of satisfaction, the highest degree of dissatisfaction was recorded when respondents were asked how optimistic they felt about their long-term career prospects in the field of space physics (Figure 14j). Of all respondents based in North America, only 21% indicated optimism, while 52% were dissatisfied. Meanwhile, respondents working in Europe had a slightly more optimistic perception of their future prospects, with 24% being optimistic and 43% being pessimistic. While the Europe-based respondents were slightly more optimistic when combining the degrees of satisfaction, the disparity was also reflected in the difference between strongly satisfied (6.1% and 9.5% for North America and Europe, respectively) and strongly dissatisfied (28% and 19% for North America and Europe, respectively). As such, in general, North America is found to be more pessimistic about the future than Europe-based researchers. One notable exception is for European SM early career scientists, who are mostly pessimistic, with no respondents indicating satisfaction. However, European SM response rates were also low, which increases uncertainty in this comparison. As optimism was markedly lower than satisfaction for other aspects of the career, this is interpreted as being due to external factors, such as funding and policy decisions, rather than factors within the workplace, consistent with Section 6.

8. Correlations Between Responses

A correlation matrix was constructed to further explore potential correlations between responses (Figure 15). To construct this matrix for quantities that were categorical rather than numerical (e.g., region of work), all response types were assigned numerical values. To do this, funding preferences, regions of work and origin, section affiliations, gender, race, orientation, first with degree and Ph.D., position type, and affiliation type were all given numerical values in the same order shown by the legends Figure 1 through Figures 6 and 13. For example, funding preference was given a value of 0 (lower selection, higher award), or 1 (higher selection, lower award) whereas regions of work and origin were ordered by their GDP per capita (nominal) according to the International Monetary Fund (2025 estimate, IMF Data Mapper, International Monetary Fund, Retrieved 15 November 2025). For quantities that were numerical in nature, the value of the entry was used, though in the case of salary ranges the median value of each range was used (e.g., using $15k for "below $30k", $85k for "$81-90k", and $160k for "above $151k"). Due to the number of correlations computed for Figure 15, this paper will primarily focus on the main correlations and notable non-correlations, rather than discussing every possible combination; however, all are provided for completeness and potential future comparisons.

Generally, and to varying degrees, all metrics of satisfaction are positively correlated with other metrics of satisfaction. The highest correlations are between insurance satisfaction and retirement satisfaction, the three-way combination of professional growth, mentorship, and being valued, and travel funding and publication fee satisfaction. While optimism is well correlated with feeling valued, mentorship, work-life balance, and professional growth, it is less well correlated (but still slightly correlated) with compensation-related satisfactions.

The strongest correlation for the question regarding workforce retention (Figure 13) is with optimism for future prospects. Notably, salary, prolificness in proposals, publications, or presentations, proposal selection rate, or years since Ph.D. do not correlate well with whether the respondent is considering leaving the field. This suggests that optimism and concern over funding are similarly impacting all stages and competencies of early career space scientists.

There is an interesting positive correlation between gender and race, gender and orientation, and race and orientation. However, there are not sufficient statistics to further explore this trend, and as such any interpretation may be misleading or misconstrued. Additionally, while a positive correlation exists between a respondent being the first within their family with a university/college degree and being the first in their family with a Ph.D., these

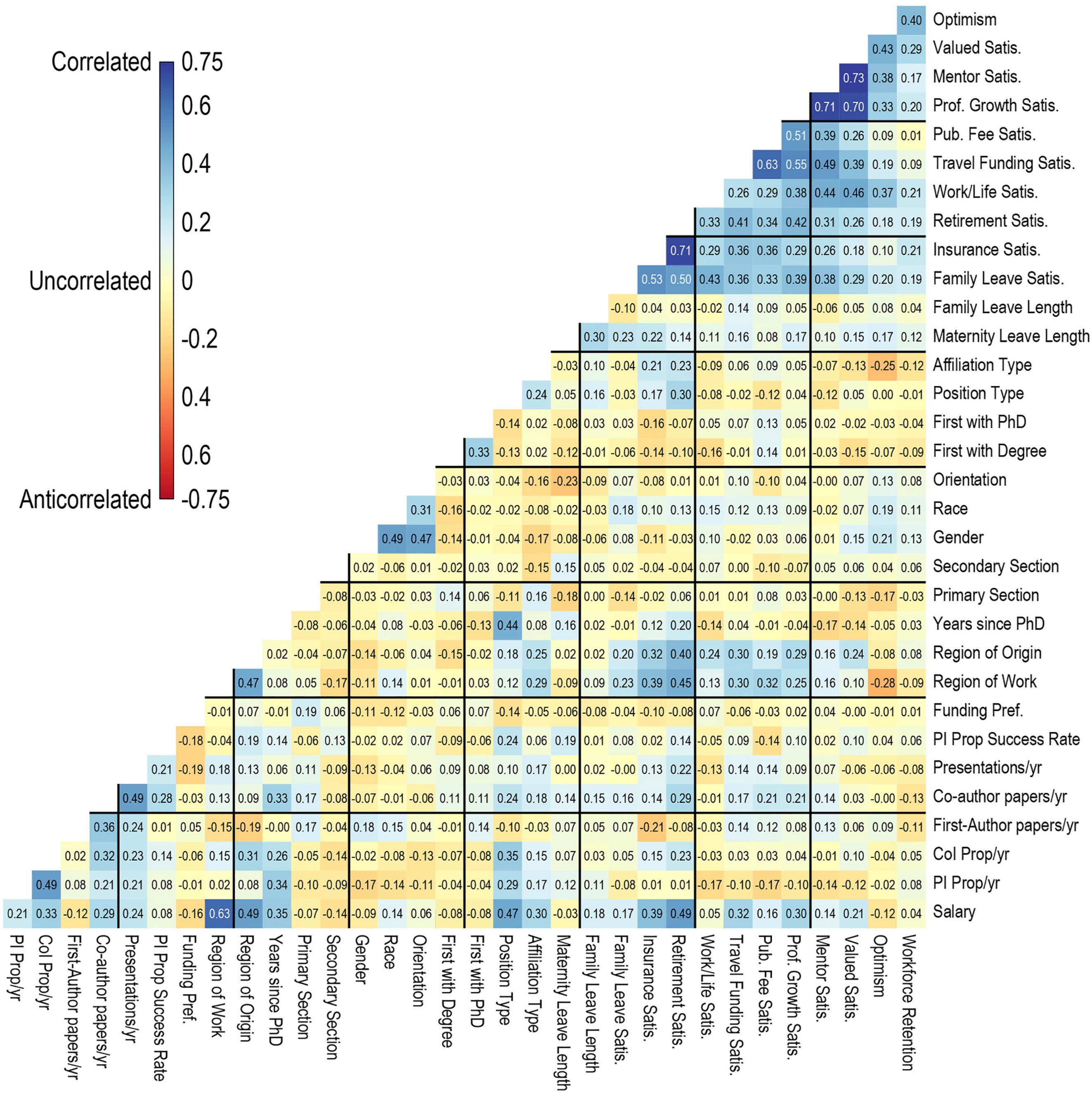

Figure 15. Correlation matrix between survey question responses.

two responses are not entirely independent. Should a respondent be the first in their family with a college degree of any type, then they would also likely be the first in their family with a Ph.D., and as result, this correlation is expected. Additionally, not unexpectedly, a respondent's PI proposal selection rate is slightly anti-correlated with their funding preference, suggesting that those with a high selection rate would prioritize award amount over selection rates, while those with a lower selection rate would prioritize higher general selection rates.

Related to the discussion of Figure 14j, there is an anti-correlation between the region of work and optimism (Figure 15). This suggests that those working in higher GDP per capita (nominal) countries have less optimism than those working in lower GDP per capita countries. This is potentially related to real and perceived reductions in funding and career opportunities in high GDP countries (e.g., the United States of America). There is a similar anti-correlation between affiliation type and optimism, suggesting that early career members working within government or some portions of academia feel more optimistic than those at non-profits, industry, or UARCs. This affiliation dependence of optimism could also be a result of regional dependencies in the types of institutions scientists work within and factors within that region impacting optimism. For example, UARCs are inherently a United States construct, and work within research non-profits is primarily within the United States, while government positions also exist within Europe. As such, the correlations between region and optimism may be the fundamental correlation.

The positive correlation between region of origin and region of employment may suggest both that early career members, to some degree, work in the regions they are from, and that early career scientists from high GDP per capita (nominal) countries are more likely to remain in high GDP per capita countries rather than take employment in a lower GDP per capita country. This may suggest that where mobility is observed, it is either between similarly high GDP countries, or from low GDP per capita countries to higher GDP per capita countries. While this survey does not contain sufficient numbers to fully explore this in an aggregated way, this may be a topic for future surveys to explore more pointedly.

While the number of PI proposals, Co-I proposals, and co-authored papers per year are positively correlated with the number of years since Ph.D., the number of first-authored papers or presentations per year is not. This may be due to two causes. As an early career scientist progresses in their career, they may be increasingly expected to obtain coverage for others (e.g., students and postdoctoral fellows), which may increase proposal pressure but also allow opportunities for mentorship roles that would lead to an increase in the number of co-authorships. Additionally, the experience of a scientist may increase throughout their career and spawn additional collaborative groups, leading to increasing numbers of co-authored papers. However, in both of these cases, the number of first-authored papers may remain unchanged, likely near the average rate of one or two papers per year (Figure 7), and the number of presentations per year may plateau at the number of meetings the scientist can support (nominally two or three per year, Figure 7).

Both position type and affiliation type have notable relationships with the number of proposals per year (both PI or Co-I), co-authored publications per year, and proposal selection rates. The correlation between position type and number of proposals per year (both PI and Co-I) may in part be an indication of increasing proposal pressure throughout a scientist's career, with expectations of submitting and winning proposals being lowest in their postdoctoral years. Additionally, this may indicate higher proposal pressure for purely “soft-funded” positions such as researcher and research faculty, compared to those who also have a teaching component to their funding sources (i.e., tenure-track faculty). This may also factor into the smaller but still significant correlation between affiliation type and proposals per year (both PI and Co-I), with government agencies, national labs, and FFRDCs having less proposal pressure than those at non-profits, industry, and UARCs. Interestingly, there is an apparent slight anti-correlation between position type and the number of first-authored papers per year, which may be due to those with less proposal pressure having more time for original scientific publications. However, the number of co-authored publications per year is again positively correlated with both position type and affiliation type, which could be related to the general positive correlations between the number of co-authored papers per year and number of proposals per year. While it is not possible from this survey alone to determine the cause, this may suggest that the teams formed during the proposal process, and perhaps participation on multiple grant teams, may then increase the number of collaborations and thus co-authored papers. Additionally, there is an interesting slight correlation between position type and presentation per year, but a stronger correlation is seen between the number of co-authored publications and presentations per year.

Lastly, there are many interesting correlations, anti-correlations, and lack of correlations with salary. As discussed before, the strongest correlation with salary is the region of work. This is followed by region of origin, which is also correlated with region work. There are strong positive correlations between salary and years since Ph.D., position type, and affiliation type. Generally, early career SPA scientists with a higher salary also have a higher rate of proposals per year rate (both PI and Co-I), a higher number of co-authored publications per year, and a higher number of presentations per year. This suggests that those with a high salary may face additional proposal pressure, but also be active in more collaborations. This added proposal pressure may also come at the cost of first-authored publications, which is lower for high salary respondents. While high salary respondents propose more, there is a negligible correlation with selection rates. Additionally, there are negligible correlations between salary and SPA subsection, gender, orientation, and being the first in their family to obtain either a college or doctoral degrees.

With regards to benefits and satisfaction, high-salary respondents had a negligible correlation with maternity leave length but a very slight positive correlation with family leave length. Generally, there is a positive correlation between salary and the respondents' satisfaction with their insurance, retirement, travel funding, publication fee funding, professional growth, and feeling of value. However, there is effectively no correlation between the respondents' salary and their satisfaction with their work/life balance or their considerations of remaining in the field.

9. Discussion

The AGU SPA EC-LAC conducted a survey of early career (less than 10 years since Ph.D.) space physicists to conduct a climatological study of the field, yielding 140 unique respondents. In general, the gender and racial demographics of the early career respondents were more diverse than the broader SPA membership, suggesting that the early career workforce has further diversified from previous generations. While continued progress is required to reach a point in which the workforce mirrors the general population, as would be expected if the only barriers to entry were merit-based rather than broader structural or cultural barriers, this improvement suggests that efforts such as the SPA NTF and PI Launchpad are yielding results and should at minimum be continued.

Notably, the SPA early career male-female divide (∼58%:32%) is smaller than the 80%:20% ratio among Physics Ph.D. in 2019 within the United States (Mulvey et al., 2021), further suggesting that these efforts are having an impact. The absence of a statistically significant difference in male and female salaries is very positive and follows other recent studies showing that there is not a statistical difference in the number of citations for papers first-authored by men or women (Moldwin & Liemohn, 2018). While these metrics indicate appropriate compensation and scientific appreciation (through citation-based metrics) are being given, this survey is not able to investigate barriers to entry occurring prior to Ph.D. which may then be where the largest limitations are for entry into the field exist. Additionally, as this survey is limited to only early career (within 10 years of Ph.D.), it may not be able to reveal gradual pay differences developing from disparities in raises, which would become more notable in the mid-to late-career stages.

The distribution of respondent's primary and secondary subsections may provide an interesting reflection of the importance of robust mission investment by government agencies to maintain a continuous and thriving workforce in space physics. Currently, a plurality of respondents (48%) listed SH as their primary subsection with another (30%) listing SH as a secondary subsection. This is followed in numbers by 27% (33%) of respondents indicating SM as a primary (secondary) subsection, with SA being the least subscribed (25% primary and 10% secondary affiliation). The resulting cumulative distribution of early career researchers working on topics within each of the respective subsections also mirrors the total number of abstracts submitted to each subsection for the 2025 AGU annual meeting (784 abstracts to SH, 626 abstracts to SM, and 437 abstracts to SA). Assuming scientists working in more than one subsection submit an abstract to both, the survey results would predict a breakdown in abstracts of 20% SA, 35% SM, and 45% SH compared to 2025 AGU meeting numbers of 24% SA, 34% SM, and 42% SH. As such, the early career subsection distribution seems to follow the general trend in the community.

This distribution of subsection membership could be a result of SH currently having the most expansive and newest mission portfolios across multiple countries. This includes Solar Orbiter (ESA Medium-class (M-class), with NASA contributions, launched in 2020 and currently in prime mission cycle; Müller et al., 2020), Parker Solar Probe (NASA-Living with a Star (LWS), launched in 2018 and currently in extended mission cycle; Fox et al., 2016), the Interstellar Mapping and Acceleration Probe (IMAP, NASA-Solar Terrestrial Probes (STP), launched in 2025 and currently in commissioning phase; McComas et al., 2018), and Polarimeter to Unify the Corona and Heliosphere (PUNCH, NASA-Small Explorer (SMEX), launched in 2025 and currently in prime mission phase DeForest et al., 2022, 2026) missions, as well as the NSF-funded Daniel K. Inouye Solar Telescope (DKIST, in operation since 2022; Rimmele et al., 2020). This collection of recent missions at higher funding levels, in addition to other relevant assets, provides the means to maintain a robust workforce, skill sets, and expertise within SH.

Meanwhile, the SM community has several missions supporting their work, including the Magnetospheric MultiScale mission (MMS, NASA-STP, launched in 2015 and currently in extended mission cycle; Burch et al., 2016), Tandem Reconnection and Cusp Electrodynamics Reconnaissance Satellites (TRACERS, NASA-

SMEX, launched in 2025 and currently in commissioning phase; Miles et al., 2025), Juno (NASA-New Frontiers, launched in 2011 and in extended mission phase; Bolton et al., 2017), Time History of Events and Macroscale Interactions during Substorms (THEMIS, NASA Medium-Class Explorers (MIDEX), launched in 2007 and in extended mission phase; Angelopoulos, 2008), and until recently the highly successful Cluster mission (ESA, launched in 2000 with decommissioning and deorbiting in progress; Escoubet et al., 2001). Compared to the SH subsection, SM currently has a smaller fleet of missions to support the workforce, especially with the end of the NASA-LWS Van Allen Probes mission in 2019 (Stratton et al., 2013).

The SA subsection, however, has a more limited portfolio of large satellite missions like Solar Orbiter for the SH subsection or MMS for SM subsection. Along with the Swarm mission (ESA-Earth Explorer, launched in 2013 and currently in extended mission cycle; Friis-Christensen et al., 2008), those in the SA subsection primarily have several smaller NASA Mission of Opportunities (MoOs). These include Global-scale Observations of the Limb and Disk (GOLD, NASA-MoO, launched in 2018 and currently in extended mission phase; Eastes et al., 2020) and Electrojet Zeeman Imaging Explorer (EZIE, NASA-MoO, launched in 2025 and currently in commissioning phase; Yee et al., 2024), as well as NSF and international ground-based facilities (e.g., Active Magnetosphere and Planetary Electrodynamics Response Experiment (AMPERE; Anderson et al., 2021, 2002), Super Dual Auroral Radar Network (SuperDARN; Greenwald et al., 1995), SuperMag (Gjerloev, 2012), and the European Incoherent Scatter (EISCAT; Baron, 1984) radars). While smaller, lower-cost ground-based instrumentation and rocket campaigns have long supported individual research groups, especially in academic settings, the SA subsection notably has the lowest level of large mission support of the subsections, especially within the United States. That may potentially be a contributing factor for the SA subsection being the least subscribed of the SPA subsections.

It should be noted that beyond these more recent and higher budget missions, all subsections have additional, highly successful older missions/facilities with significantly reduced budgets (e.g., Wind (Acuña et al., 1995); Advanced Composition Explorer (ACE; Stone et al., 1998); Solar Terrestrial Relations Observatory (STEREO; Kaiser et al., 2008); THEMIS (Angelopoulos, 2008); Thermosphere-Ionosphere-Mesosphere Energetics and Dynamics (TIMED; Yee et al., 1999);). While the continued operation of these valuable facilities remains critical to future scientific advancement, these missions no longer have the financial means to support as robust an early career workforce as they once could. As result, there is a clear indication that gaps in large-scale mission/facility investment winnow away at the early career workforce in a area of scientific inquiry, which could later create issues of deteriorating expertise. Also of interest is that the R&A programs, whether from NASA or NSF, are not historically designed to favor one sub-field over another, however these programs have been unable to robustly support the workforce of sub-fields without adequate mission/facility funding. Additionally, R&A programs typically do not provide longer-term funding stability, since they're usually 2 to 5-year awards. This suggests that R&A programs cannot counter the significant impact of mission support on workforce retention and on maintaining knowledge and skill sets for the future.

From these results, it is apparent that the science support from active missions and facilities may be critical in maintaining/building an early career base to become the future generation of scientists. This motivates not only maintaining a strong cadence of missions to cultivate and preserve the workforce, but also cautions against the planned movement to begin reclassifying missions from extended mission to "infrastructure" that entails a reduction in science support of the mission/facility. Maintaining operational mission funding is also consistent with recommendations from both the Planetary Science and Astrobiology Decadal Survey (National Academies of Sciences & Medicine, 2023) and Decadal Survey for Solar and Space Physics (National Academies of Sciences & Medicine, 2025). This also supports the recommendation from the Decadal Survey for Solar and Space Physics to create a new Heliophysics Large Explorer (HeLEX)-class of Explorer missions, a PI-led explorer-class mission with roughly twice the cost cap of current Medium-class Explorers (MIDEXs) (National Academies of Sciences & Medicine, 2025).

An added consequence of reduced mission/facility funding is that increased reliance on R&A programs will increase proposal pressure on space physicists. From the correlative analysis (Figure 15 and discussed in Section 8), this increase in proposal pressure may lead to a reduction in scientific output through a reduction in publication rates. As such, moving to a system in which scientists spend more time writing proposals to compete for funding may slow discovery.

Early career space physicists typically rely on purely soft-money (i.e., very few hold tenure or tenure-track positions), making them incredibly vulnerable to changes in federal research spending. This places great importance on stability in funding from relevant government agencies, and highlights the risk of sudden budgetary cuts. Additionally, the efforts from NSF programs such as the Faculty Early Career Development Program (CAREER) and Faculty Development in geoSpace Science (FDSS) become more valuable and important, as stable funding of these programs could increase the number of faculty positions for space physicists and aid in mitigating this vulnerability in the field.

In general, there currently exists great anxiety among early career SPA members, especially in North America. This is likely related to pessimism in the field generated by several policy and agency actions in the United States. First, the survey took place between the release of the PBR, which requested significantly reduced funding for NASA SMD and NSF, and the congressional subcommittee reports on the FY2026 budget. Additionally, the survey occurred after the release of the delayed NASA SMD 2025 ROSES solicitation, which featured a large reduction in programs offered (e.g., initially Heliophysics reduced the number of research programs from 21 to 4 and Planetary Science from 26 to 10). The 2025 ROSES solicitation also featured a dramatic consolidation of many disparate programs into single—more competitive and all-encompassing—programs, such as moving multiple programs into the Solar System Science solicitation within Planetary Science. This has greatly increased concern among early career scientists regarding their future funding prospects and potential exclusion of several science sub-communities, as the prior separate research elements safeguarded a certain level of funding for various sub-fields. For example, consolidating solicitations that were more favorable for studies of the magnetospheres of outer planets (e.g., the Cassini Data Analysis Program) into one call with a massively expanded scope could potentially result in less funding going to this specific subcommunity. The ROSES 2025 solicitation initially also removed entire lines of instrument development, such as in Heliophsyiscs, initially cutting off a generation of researchers from being able to participate in efforts leading to future mission development, and so effectively removing a pipeline for the next generation of instrument PIs. While Heliophysics did bring back the Heliophysics Technology and Instrument Development for Science program in January 2026, its initial removal from ROSES 2025 generated anxiety within the field, which would have been present during the time of the survey. All of these factors culminated in a majority of North America-based respondents feeling that they would prefer to remain in the field, but fear that lack of funding may force them out of the profession (Figure 13a).

While this survey provides a more in-depth state of the early career profession in space physics, points of comparison were either limited to sub-community surveys with more targeted scopes or to field-specific surveys without a career stage element. Conducting regular climatological surveys every few years (i.e., every 4–5 years), perhaps expanding to include other career stages while maintaining career stage information, would allow for better monitoring of changes in the field and identify potential issues in pipelines or career satisfaction early. The repeated cadence would also enable an understanding of baseline satisfactions and sentiments in the community to understand how different policy actions or community initiatives impact the field.

10. Conclusions and Recommendations

Based on survey results from 140 respondents (equating to somewhere between 14% and 32% of SPA Early Career members, see Section 2) and the above discussion, the following conclusions and subsequent recommendations are suggested by the SPA EC-LAC:

1. *Finding*: There is indication that efforts to reduce barriers to entry and improve access to all aspiring and talented students are having an impact in increasing the diversity of early career SPA members compared to the section as a whole (Figure 2 and Sections 3 and 9). However, the current composition does not yet reflect the general population, suggesting that additional efforts may be required.
   - *Recommendation*: Continue current efforts such as the PI Launchpad and the AGU SPA NTF.
   - *Recommendation*: Continue to study possible “leaks” in the workforce pipeline that may prevent access for talented students and postdoctoral researchers, to either augment current efforts or to motivate new initiatives.
   - *Recommendation*: More effort is needed to understand the 12% (9.5%) of respondents in North America (Europe) who would like to stay in the field but are being driven away due to the climate/culture in the field.
2. *Finding*: There is an apparent correlation between the number and scope of current, well-funded missions and the number of early career scientists working within a given subsection of SPA, regardless of the distribution of R&A funding or facilities (Figure 1 and Sections 3 and 9).

   - *Recommendation*: While the SH subsection currently has the largest number, internationally, of prime-phase or recently into extended mission spacecraft, leading to a healthy community of SH subsection early career researchers, these mission-associated funding lines need to be maintained to ensure a robust workforce can survive and continue to thrive.
   - *Recommendation*: As the SM subsection may be shrinking due to an aging active mission portfolio in the United States and due to the end of the highly successful Cluster mission in Europe, this places more demand on continuous, healthy funding for current missions (e.g., MMS, Juno, TRACERS) until a new set of magnetospheric missions are launched and operating. Additionally, the SM community would highly benefit from the selection of the Plasma Observatory mission concept, especially in Europe.
   - *Recommendation*: The SA subsection needs GDC/Dynamic, as recommended in the Decadal Survey for Solar and Space Physics (National Academies of Sciences & Medicine, 2025), along with continued support for active missions (e.g., ICON, GOLD, Swarm) and more robust and secure funding of facilities (e.g., AMPERE, SuperDARN).
   - *Recommendation*: NASA should reconsider plans to accelerate the decrease in funding to extended mission assets through the removal of science support by classifying the missions as "infrastructure." This will have the likely effect of deteriorating the workforce and undermining NASA priorities and the national workforce.
   - *Recommendation*: In addition to maintaining current mission funding levels, NASA should execute the recommendation from the Decadal Survey for Solar and Space Physics (National Academies of Sciences & Medicine, 2025) to establish a higher-cost cap explorer line of "HELIX-class" missions to both advance science and maintain an actively engaged workforce.
   - *Recommendation*: NSF should ensure adequate funding levels to active and future faculties to enable graduate, postdoctoral, and early career development, to maintain and expand upon necessary skill sets within the workforce.
3. *Finding*: Most early career space physicists hold soft-money positions, rather than tenure or tenure-track positions, making them more vulnerable to changes in federal spending (Figure 5 and Sections 3 and 9).
   - *Recommendation*: NSF should continue to prioritize funding for workforce development, including student and early career funding connected to facilities. Especially with the low percentage of early career scientists in tenure-track positions, NSF should continue, and expand, programs such as CAREER and FDSS.
4. *Finding*: Recent changes to funding elements within the NASA SMD ROSES may have added to funding anxiety within the early career workforce, which may reduce participation and negatively impact scientific competency within a generation of researchers (Figures 13 and 14 and Sections 6 and 9).
   - *Recommendation*: Revert the number of program elements back to the ROSES 2024 element offerings. Particularly, bring back a consistent and maintaining announcements of opportunity for instrument development and low-cost access to space (LCAS) solicitations for both Heliophysics and for non-lunar-focused Planetary Science development to ensure a generation of instrumentalists is not lost and that progress can continue on lower size, weight, and power and/or higher performance instrumentation.
   - *Recommendation*: Unconsolidate program elements in NASA ROSES to maintain funding transparency and safeguard funding lines across the many sub-disciplines. Particularly, unconsolidation of the Solar System Science program back to previous protected funding elements would reduce anxiety within the early career work force by providing stability and transparency. Further consolidation of additional program elements is not recommended.
5. *Finding*: Funding anxieties within the early career profession (Figures 13 and 14) may be motivating a desire for higher selection rates over larger award amounts (Figure 6), while larger proposal pressure may decrease scientific output (Figure 15 and Sections 8 and 9).
   - *Recommendation*: Funding agencies should ensure healthy selection rates for solicitations while maintaining awards at viable levels.
6. *Finding*: There is extreme value in a regular cadence of climatological surveys to gauge changes in the community and impacts of policy, cultural, and funding related changes (Section 9).
   - *Recommendation*: AGU SPA and the American Astronomical Society-Solar Physics Division (AAS-SPD) should conduct regular (i.e., every 5 years) climatological surveys of their members to identify variations in the field over time. Value may be added if this were expanded to all career stages to allow consistent categories for comparisons at the same moment in time. Such a longitudinal survey effort would benefit

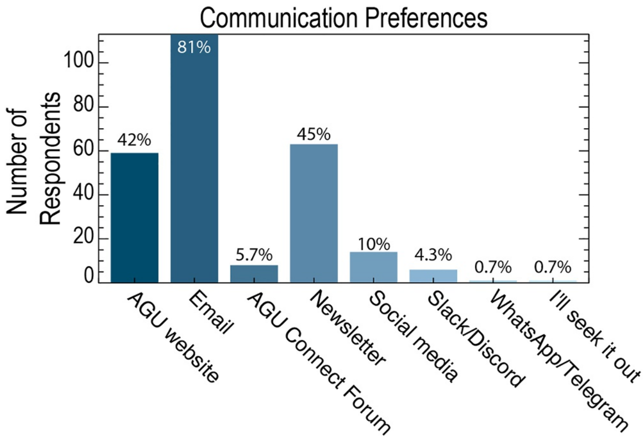

Figure A1. Early career SPA member communication preferences for professional communication from AGU. Percentages will sum to over 100%, as respondents could select more than one communication mode.

from consultation with professional sociologists both for the formulation of survey questions as well as in improving methods to increase participation.

Appendix A: Preferred Mode of Communication

The survey also included a question on the preferred modes of professional communication from AGU. This question allowed the respondent to select as many options as they preferred, so the percentages will not add to 100%. Overwhelmingly, 81% of the SPA early career community prefers professional communication from AGU to be sent through email. The next highest category (at 45%) was for communication to come through community newsletters, with information being disseminated through the AGU website being third highest, at 42% (Figure A1). All other modes of communication were seldom preferred, with social media, the AGU Connect Forum, Slack/Discord, and WhatsApp/Telegram only receiving 10%, 5.7%, 4.3%, and 0.7%, respectively. Additionally, 0.7% would prefer to seek information on their own rather than through one of the other modes of communication.

These preferences indicate that rather than investing in "new communication" methods to reach early career scientists (e.g., AGU Connect Forum, social media, Slack/Discored, WhatsApp/Telegram), the AGU organization should instead focus on more "traditional" modes of communication such as informative email construction, use of newsletters, and robust website development. While some of the "new communication" modes are likely helpful and well situated for communication to the general public for outreach, they are not the preference of early career scientists for professional communication. This information may also be of use for potential agency representatives wanting to communicate with the early career science community.

Conflict of Interest

The authors declare no conflicts of interest relevant to this study.

Availability Statement

This study only reports aggregated data from the public survey conducted as described in the manuscript. The treatment of these data is pursuant to the Institutional Review Board (IRB) exemption Granted by Advarra (registered with OHRP and FDA under IRB#00000971) under Protocol Pro00088138. The exemption determination was based on the Department of Health and Human Services regulations found at 45 CFR 46.104(d) (2).

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