



Where are they now? – A case study of the impact of international travel support for early career Arctic researchers



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ABSTRACT

Supporting and training the next generation of researchers is crucial to continuous knowledge and leadership in Arctic research. An increasing number of Arctic organizations have developed initiatives to provide travel support for Early Career Researchers (ECRs) to participate in workshops, conferences and meetings and to network with internationally renowned scientific leaders. However, there has been little evaluation of the effectiveness of these initiatives. As a contribution to the 3rd International Conference on Arctic Research Planning, a study was conducted to analyze the career paths of ECRs who received travel funding from the International Arctic Science Committee between the start of the International Polar Year (2007–2008) and 2013. Two surveys were used: one sent to ECRs who received IASC travel support and one as a specific event study to those unsuccessfully applied for IASC travel support to the IPY 2010 Conference. The results of the surveys indicate that travel support was beneficial to both the research and careers of the respondents, especially if the ECR was engaged with a task or responsibility at the event. Survey responses also included suggestions on how funds could be better used to support the next generation of Arctic researchers.

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1. Introduction

Over the last ten years, the involvement of Early Career Researchers (ECRs) in international polar research processes (conferences, workshops, projects, etc.) has been increasingly prioritized (Baeseman and Pope, 2011; Provencher et al., 2012). Various sponsors have made travel support available for ECRs to attend meetings, and ECR participation has become an important factor in event planning.

The fourth International Polar Year (IPY – 2007–2008) was one of the first efforts to make significant improvements in the participation of ECRs in international polar research (Baeseman

et al., 2011). It was the largest scientific program focused on polar science to date, covering both the Arctic and Antarctic, and was co-sponsored by the International Council for Science (ICSU) and the World Meteorological Organization (WMO) (Krupnik et al., 2011). The IPY included over 200 projects and more than 50,000 participants from all over the world working to examine physical, biological, and social research questions related to both poles (Krupnik et al., 2011). During the early days of the IPY, ECRs created the Association of Polar Early Career Scientists (APECS) as a platform to push for the active engagement of fellow young scientists in both planning and participating in the activities of IPY (Baeseman et al., 2011; Provencher et al., 2011; Salmon et al., 2011). Prior to APECS, sustained support of ECRs was standard practice only at a few polar-related organizations.

The International Arctic Science Committee (IASC) is one of the many polar organizations helping ECRs take part in international

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conferences, workshops, meetings, research programs and science planning activities. IASC is a non-governmental organization which aims to “encourage, facilitate and promote cooperation in all aspects of Arctic research, in all countries engaged in Arctic research, and in all areas of the Arctic region” (IASC, n.d.). IASC has adapted practices recognizing that it is important to involve young researchers. Before IPY and the formation of APECS, IASC only supported a handful of early career scientists per year. A more organized approach to sustained financial support for ECRs has emerged since then; between 2007/2008 and 2013, IASC provided 313 travel stipends for 287 ECRs to participate in Arctic and Arctic-related research events. These range from the large interdisciplinary conferences of the IPY with thousands of participants to disciplinarily-focused workshops and field courses (e.g. Workshop on Genetic Monitoring in the Polar Regions in 2011) and IASC-related initiatives and group meetings (e.g., Arctic in Rapid Transition executive committee meeting in 2013) (see Appendix, IASC Database, 2014). Travel support was available for workshops and conferences that were scientifically relevant to IASC and were led by or related to the five IASC working groups and for the Arctic Science Summit Week, IASC’s annual meeting where all IASC working groups come together. Close cooperation between IASC and APECS has also influenced for which events IASC provided travel support. Together IASC and APECS have worked to ensure a welcoming atmosphere for travel support recipients through networking events, dedicated ECR workshops, and mentoring opportunities scheduled around the main event. These side events are a unique supplement to traditional travel support programs supporting ECRs.

Over the years IASC has offered travel support to ECRs, the goals for the funding have evolved with the field. The primary aims have been to improve the knowledge, networks, and soft skills of the ECRs attending the events, and this way to increase ECR retention in polar sciences, and to support ECRs as productive members of the Arctic scientific community. As the profile of ECRs in polar science has increased with time, an additional focus to increase representation and involvement of early career researchers in all bodies of the Arctic research community and organizations has been developed. This is in support of “the need for a continuum of leadership in polar research” as stated in the Memorandum of Understanding between IASC and APECS (IASC, n.d.).

The importance of supporting and involving young scientists is widely acknowledged as they will be the scientific leaders of tomorrow (Friesenhahn and Beaudry, 2014). However, available literature on this topic is scarce. With the Global State of Young Scientist project, Friesenhahn and Beaudry (2014) provided an extensive review combined with empirical data from 650 survey respondents with 45 semi-structured interviews of young scholars to explore the global state of young scientists and identify their opportunities and concerns. Results of this report demonstrate the incomplete and geographically biased knowledge (primarily produced in Europe and North America) on the state of ECRs. The report identified needs in the following areas: mentoring and support structures, focused training, transparency and fairness, working conditions, and cultivating values. The report provides a list of recommendations at the policy and institutional level, in which the lack of funding for early career scientists across regions of the world was noted. Evaluation of the career benefits of early career participation in international conferences and meetings or the impacts of travel support was not included in Friesenhahn and Beaudry (2014).

In 2014 and 2015, the 3rd International Conference on Arctic Research Planning provided APECS, the Climate and Cryosphere (CliC) Project of the World Climate Research Programme (WCRP) and IASC with an opportunity to evaluate the benefit of initiatives

to support young scientists’ participation in international conferences, workshops and meetings. The three organizations used the IASC travel funding available for ECRs as a case study to make this assessment. This evaluation was conducted with regard to the stated goals of IASC support for ECRs (see above) and considered whether supporting young researchers resulted in an increase in their knowledge and networking skills, allowed them to become productive members of the Arctic scientific community, created more opportunities to engage in quality science, and made it possible to apply knowledge gained from Arctic research to other professional and personal activities. The scenario where an ECR leaves science and does not use their Arctic knowledge in any respect is considered a failure. A survey was sent to the ECRs who were awarded IASC travel support between the start of the last IPY (2007/2008) and 2013, asking them about the impact of the IASC travel support on their careers. A second survey was sent to a group of ECRs who were not successful in their applications for travel support to the IPY 2010 Conference in Oslo, Norway. Answers to the two different surveys were compared, and analyses were conducted to evaluate the impact of travel support provided to. The necessity of understanding what makes ECRs succeed and how the community can best promote them is very timely in the light of the increasingly global context: young researchers are more mobile and international than ever before (Friesenhahn and Beaudry, 2014; Wardell et al., 2008).

2. Methods and data

2.1. Survey design

Both 42-question surveys were developed in-house using questions (see example in Table 1) derived from conversations with fellow scientists. With 17 open-ended and 25 constrained-choice questions, the survey could be completed in approximately 15 min. The surveys were posted on-line using Google forms. The answers to both surveys were used for the purpose of this study only and the identities of the respondents were kept confidential.

Survey 1 (sent to ECRs who received travel support) started with a set of demographic questions that were used for statistical purposes. The survey was then divided into two parts – one for those who remain in an Arctic-related career (either in academia, policy, education and outreach or management etc.), and another section for those no longer working in an Arctic-related career. The survey was designed to assess ECRs’ experiences and satisfaction in the following areas: participation in an IASC-funded activity/event; responsibilities attached to the funding; benefits of participation in the event; involvement in IASC activities prior to/after receiving the funding; benefits from the support received, and professional development (including involvement in Arctic organizations, career goals and challenges).

Survey 2 was constructed similarly to Survey 1 with additional options for ECRs who participated in the 2010 IPY Conference without IASC funding and for those who did not participate at all. Survey 2 included additional open-ended questions to allow non-funded participants to describe their participation in the event. Analyses of these responses were conducted to evaluate how their career challenges differed from the ones identified by those who did receive funding.

2.2. Participants

Travel support provided by IASC to selected events is subject to several requirements: the recipient has to conduct Arctic research, be within 5 years of having finished their PhD, and be located at a scientific institution/organization in one of the 19 IASC member

Table 1
Example questions and answer options of the survey design.

Question	Answer options
Was there some kind of responsibility/job attached to receiving the funding?	Session Chair; Reporter; Event Organizer; Volunteer/Helper; Presenter; no (multiple choice)
How much did you know about IASC before being funded? Please rank on a scale from 1 to 5.	Rank from 1 to 5, where 1 – nothing, 5 – a lot.
In general, has attending international meetings/conferences, like the one you received IASC funding for, been beneficial to your RESEARCH? Please rank on a scale from 1 to 5.	Rank from 1 to 5, where 1 – not at all, 5 – significantly.
Please explain why it has or has not been beneficial to your RESEARCH?	Open-ended.
Have you been involved with IASC since the activity/event you were funded to attend?	No; I get their newsletter; I have attended other IASC events/activities; I have a leadership role within IASC activity (multiple choice)
Do you plan to continue working with Arctic Issues?	Yes, for as long as I can; Probably; No, I'm looking for a new area to concentrate on
Explain why you have decided this about your Arctic future?	Open-ended.

countries (IASC 2013, as of 2016 that number has increased to 23 member countries). 15 of the IASC member countries are non-Arctic countries, and ECRs from these nations are well-represented. Geographical distribution and gender balance are also taken into consideration in decisions about funding recipients for a given event. The application procedure and selection depended on the nature of the event; public open calls were announced for larger international conferences while for some of the smaller, more disciplinary meetings the announcement was distributed via supervisors who were engaged in IASC activities. ECRs can only receive IASC travel support once every 18 months. ECRs are required to submit an expenditure and summary report to IASC within 6 weeks following the event that includes a 1–2 page description of what they learned at the meeting. In these reports, participants were asked to describe what they expected to get out of the workshop, what they actually got out of it, and how the workshop enhanced their research goals.

Survey 1 was sent to the 287 ECRs who met the above criteria and received the 313 IASC travel awards given out between the beginning of the last IPY (2007/2008) through 2013 to participate in 55 different workshops, symposia and conferences (see [Appendix](#)). Out of this group, 54 received funding to participate in the 2010 IPY Conference in Norway. This conference was the event with the highest number of IASC travel awards given out to ECRs and was therefore used as a special case study for **Survey 2**, sent to a group of 209 Arctic ECRs who unsuccessfully applied for IASC travel support to participate in the Conference.

2.3. Procedure and data collection

In August 2014, an e-mail invitation was sent to the Survey 1 group. The invitation to fill out Survey 2 was sent out by e-mail in February 2015. All participants were invited to complete the online survey and were provided with a link to the web-based form. A reminder e-mail was also sent to each group of participants a week before the survey closed. Each survey was available online for approximately four weeks.

In addition, the authors analyzed 253 post-event reports by IASC funded recipients submitted as part of their travel claim to IASC.

2.4. Analysis

The analyses focused on whether the responses were significantly different between the two surveys (received travel funding or not), between respondents still active in Arctic work or not, between ages, nationalities, gender, whether other funding was received for event participation, and whether the ECR's supervisor was involved in IASC. T-test and Mann Whitney U-test (when data was not normally distributed) analyses were used to evaluate the comparisons. For the analyses, the survey answers were used as

variables (translated to dummy variables 1, 2, 3 etc.). The study also considered whether the survey responses were significantly divided into *a priori* groups on two factors, i) Survey 1 versus Survey 2 responders and ii) those who were funded to participate 2010 IPY Conference in Norway versus those who participated without IASC travel support. The group analysis was conducted using principal coordinate analysis (PCO) and following generalized discriminant analysis based on distances (CAP; [Anderson and Robinson, 2003](#); [Anderson and Willis, 2003](#)), with Bray-Curtis dissimilarity as a distance measure. The CAP program determined the appropriate number of dimensions (m) included in the principal coordinate and discriminant analyses. Word matrices (tables with counts of specific words/phrases used in text) were used for analysis of the open-ended questions from the surveys and the text of the post-event reports. From the text of all responses for each question, a word matrix was developed to represent the topics included in the responses and then the frequency of semantically significant terms was calculated as a rough measure for e.g. what was most helpful for an ECR's career. Terms included, for example, "networking", "discussions", "presenting", "internationality", and "connections for future jobs". A "Check all that apply" method was used to capture the full response. Individual word matrices were created by each of the authors and an additional person external to the project to limit uncertainty due to the interpretation of the answers.

In addition to the word matrix, the following information was collected from the reports: gender, degree/position, country of residence, discipline, whether the funded event was an ECR's first conference, whether they mentioned specific people, whether they described the experience as having broadened perspectives, and their level of involvement in the events (chairman/breakout group leader, presenting summary, writing report, etc.). The two-sample proportion test was used to compare word matrices from the event reports to Survey 1 and to evaluate differences between reports from different kinds of events (i.e., conferences versus workshop).

3. Results

3.1. Survey 1 & 2

Of the 287 ECRs who received the IASC travel funding and therefore an invitation to participate in the first survey, 134 participants completed the survey, equivalent to a response rate of 47%, which is well within the range of an acceptable rate (between 25 and 75%) allowing for conclusions to be drawn from the survey responses ([Biersdorff, 2009](#)). Of the ECRs who were sent surveys, email-delivery failures accounted for 29 due to outdated or incorrect email addresses and a lack of alternative contact information.

Of the 209 ECRs who were sent an invitation to participate in Survey 2, 24 individuals completed the survey, for a response rate of

12%. 58 delivery failures and two notices of maternity leave were received. The low response rate limits the conclusions that can be drawn from this group. Because Survey 2 targeted those who did not receive IASC funding support, there are several possible explanations for the low response rate including a lack of concern due to an unsuccessful IASC funding application or a feeling that the survey was not relevant to them since they might have left the Arctic research fields (which approximately 42% of the respondents in Survey 2 reported).

Despite the low response rate for Survey 2, the results of this study gives an indication as clear differences of the responses could be identified between the surveys (Fig. 1A). In addition, there was a significant difference between the respondents who received IASC funding to attend 2010 IPY Conference in Norway (in Survey 1) and the respondents who did not receive IASC funding but still attended the conference (66% of respondents, Survey 2) (Fig. 1B). Questions related to the benefit of travel funding on career and research, and ECR's knowledge of IASC had high or moderate correlation with those who had received funding. The respondents who did not receive funding were less likely to have a current academic position and reported less Arctic-related and IASC involvement (Fig. 1B) than those who did. Recipients of the travel support reported their participation in the 2010 IPY Conference in Norway more beneficial than those who did not receive the travel support but still attended.

3.1.1. Core questions

The respondents represented genders equally, with 50% men and 50% women responding to Survey 1 and 46% men and 54% women responding to Survey 2 (Table 2; Fig. 2). The mean age of Survey 1 respondents was 34.9 ± 5.2 years old, with the ages ranging from 26 to 58. The mean age of Survey 2 respondents was 38 ± 5.4 with the pool ranging from 30 to 49 (Table 2). Men were slightly older than women (35.9 ± 4.6 versus 34.6 ± 5.8 years). The mean age at the time the travel support was received (based on the recipients own memory) was 31.1 ± 5.0 years old. Age did not show any significant impacts on any of the questions asked in either of the surveys ($p > 0.05$).

Respondents' gender did seem to have an impact on career outcomes. While 72% of the respondents in Survey 1 and 88% in Survey 2 had already earned a PhD when they applied for the

funding, and 66% and 79% respectively reported their PhD to be related to Arctic issues, more men reported higher degrees in an Arctic-related field ($p = 0.02$) than women in Survey 1. Men also reported more Arctic-related peer-reviewed publications ($p = 0.02$) and other Arctic-related publications ($p = 0.03$) than women, even though there was no statistical difference in the number of years they had worked with Arctic issues ($p > 0.05$).

25 nationalities were represented among those who received the funding, and 26 represented by the survey respondents; USA, UK, Russia, Norway, Germany and Canada were the most represented in both the funding awards and the survey responses. No significant difference was found between the breakdown of nationalities of those who received IASC travel support and those who participated to Survey 1 ($p > 0.05$) or between Survey 1 and Survey 2 ($p > 0.05$).

3.1.2. Participation and travel support

The majority of Survey 1 respondents (74%) had already attended other Arctic conferences/workshops prior to receiving IASC support; for 18%, the IASC-funded meeting was their first Arctic-related conference or workshop and for 8% it was a first international conference or workshop. In Survey 1, approximately half (49%) of the respondents stated that they would have not participated in the event without IASC funding while 41% had additional funding through other sources to participate. In Survey 2 (those who did not receive IASC funding for 2010 IPY Conference), more than half of the respondents who did not get IASC travel support still participated in the conference (66%). For 12% of them it was the first international science meeting they had participated in. Those who attended the conference without support from IASC funded their participation and travel with project funds (50%) or other travel awards (33%). 75% of the respondents who did not report participating in IPY 2010 in Survey 2 listed the lack of funding as the main reason for not attending.

Using gender as a criterion for analysis in Survey 1, a difference between responses provided by men and women emerged. The event for which IASC funding was received was more likely to be the first scientific meeting attended by women than for men ($p = 0.01$). The male respondents stated that they would have been less likely to have participated in the event without the IASC

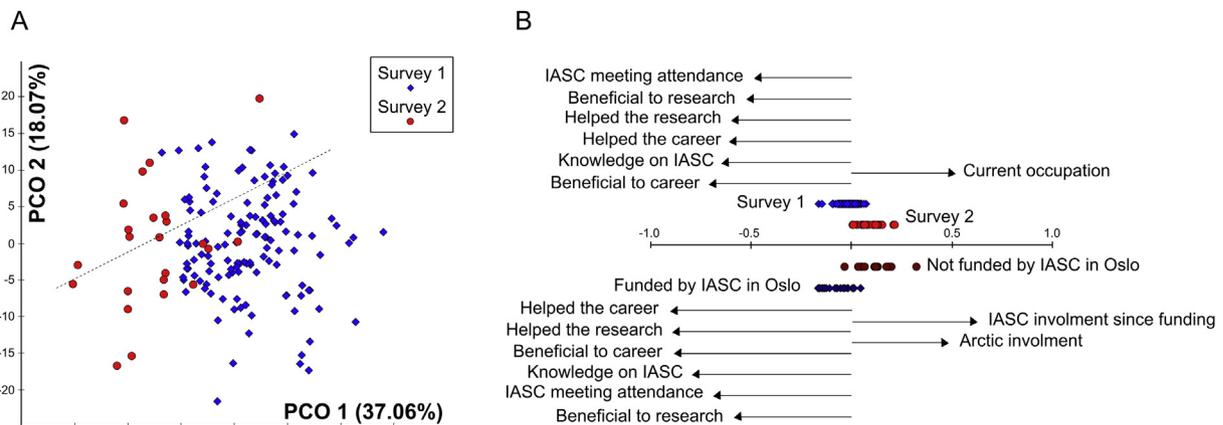


Fig. 1. A - The principal coordinate analysis clearly separated the surveys. B - Upper panel. According to the following discriminant analysis, there was a significant difference between the surveys ($\delta^2_1 = 0.502$, $t_2 = 0.502$, $p < 0.001$, 9999 permutations, mis-classification error 7%). B - Lower panel. In addition, there was a significant difference between the respondents who received IASC funding to attend 2010 IPY Conference in Norway and the respondents who did not receive IASC funding but attended the conference ($\delta^2_1 = 0.612$, $t_2 = 0.612$, $p < 0.001$, 9999 permutations, mis-classification error 9%). The questions which had strong or moderate correlation (>0.4) with the canonical axis and which explained the differences are listed for both discriminant analyses. According to the answers, IASC funding benefitted the career and research of the respondents as well as their knowledge on IASC and increased their IASC meeting attendance. The respondents who did not receive funding had less academic current occupations as well as lower Arctic and IASC involvement.

Table 2
Results of the core questions in the Survey 1 and 2.

	Survey 1	Survey 2
Number who received survey	313	209
Number who completed the survey	134	24
Response rate	47%	12%
Number of different nationalities	25	13
Average age of respondent	34.9 (26–58; min–max)	38.0 (30–49; min–max)
Gender rate	50% men/50% women	46% men/54% women
% earning a PhD	72	88
% earning a PhD in the field of Arctic issues	66	79
% who has participated in more than one IASC event	31	17
% have not been involved in IASC activities	38	83
% who know nothing or very little about IASC now	13	70
% still involved and working with Arctic issues either in academia, policy, education, and outreach or management, etc.	90	58
% who have been working with Arctic issues for more than five years	68	56
% who had 1 to 5 Arctic related peer-reviewed publications	52	42
% who had more than 5 other Arctic related publications	64	*
% who had no Arctic related peer-reviewed publications	10	25
% who are no longer working with Arctic issues	10	42
	–40% stopped working on this topic 1 year or less ago	–40% stopped working on this topic 1 year or less ago
% who have left Arctic issues for personal reasons	28	30
% who changed topic due to lack of funding	24	30
% of those who have quit but would like to continue working with Arctic issues	43% yes 50% maybe	50% yes 40% maybe

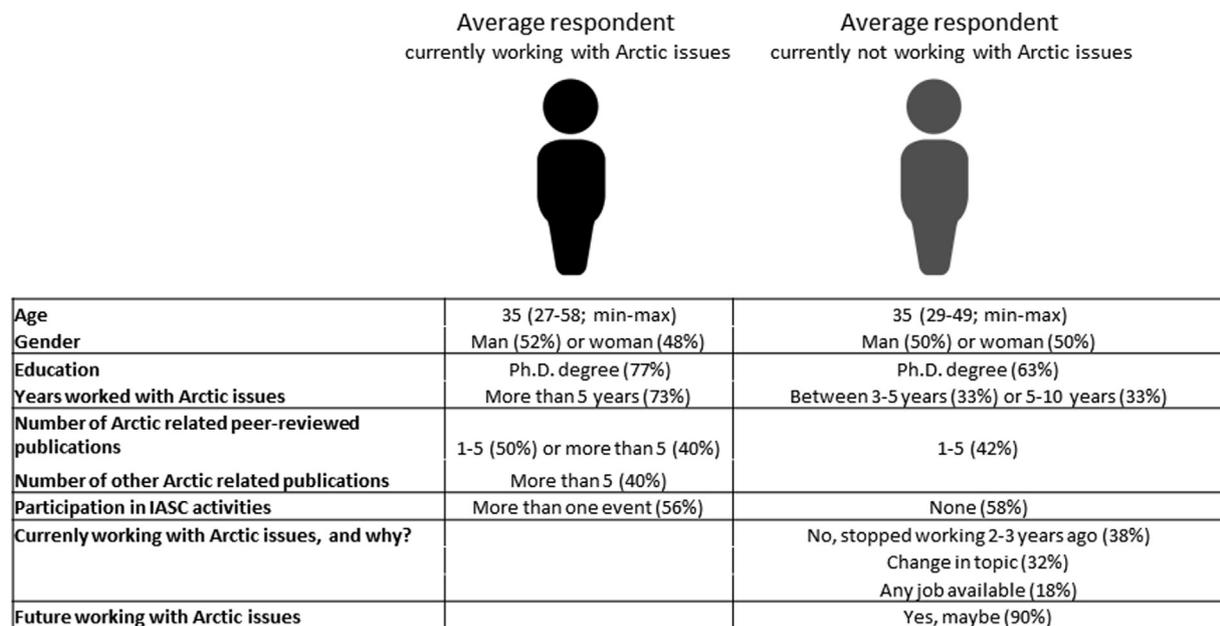


Fig. 2. Average respondent currently working and not working with Arctic issues compiled from Survey 1 and 2 responses.

funding ($p = 0.02$), even though men and women had similar numbers of additional funding sources to attend the event ($p > 0.05$). The most often reported sources of additional funding were ECR's university, graduate school, or department programs and project budgets.

The majority of respondents in Survey 1 had received IASC travel support only once (75%), whereas 7% had received it more than 3 times. No statistical differences in responses were found when comparing those who had received travel support once or multiple times ($p > 0.05$). Travel support was mostly received to participate in a certain workshop (37%) or conference (48%). All but 3 respondents in Survey 1 remembered the year and the event for which they received the travel support. 63% of Survey 1

respondents received their travel support through a formal application process while 16% indicated that they did not have to go through a selection process and that the support was awarded directly to them. The latter can be explained by their advisors' involvement in IASC, which was acknowledged by 14% of the respondents. No statistical difference was present in Survey 1 responses regarding career outcomes between those who had to go through an official application processes or whether the advisor/committee member was involved in IASC ($p > 0.05$).

In response to the question of whether funding recipients had to fulfill an official role or task at the event besides presenting their research results, about a quarter of travel funds were received without any additional responsibility attached while 39% of the

recipients indicated that there were responsibilities linked to the funding. In Survey 2, 69% of those who attended the IPY 2010 Conference without IASC funding presented at the conference, and one volunteered to help the organizers, but 31% did not have any responsibility at the event.

Survey 1 revealed some interesting results in regards to when ECRs received the travel stipends and their future in Arctic research. For those who were no longer working in Arctic research in 2014, it was more likely that the IASC-funded meeting was their first conference or workshop ever ($p = 0.03$). Those still working in Arctic-related fields were more likely to have had additional support to participate in the event ($p = 0.01$) and had attended one or more IASC workshops or working group meetings ($p = 0.01$).

3.1.3. Career and research benefits

Respondents in both surveys reported that attending international meetings had a beneficial or significantly beneficial impact on their careers (70%) and research (76%) (Fig. 3). Only a small percentage did not see any benefits to their career (12%) or research (6%). On a scale ranging from 1 (meaning not being beneficial) and 5 (being significantly beneficial), both survey participants rated the impact of the meetings on their research at an average of 4.1 ± 1.0 (mean \pm SD) and for their career 4.0 ± 1.1 . No particular type of event (conference versus workshop) was found more beneficial than the others ($p > 0.05$). Respondents who received IASC travel support saw more benefits for their career ($p = 0.001$) and research ($p = 0.01$) coming from attending international meetings or conferences than those who did not receive funding, even though some of the latter attended the IPY 2010 Conference (Fig. 1b) and likely other meetings as well. The participants still working in Arctic-related fields considered that, in general, attending international meetings and conferences had been more beneficial to their career ($p = 0.001$) and their research ($p = 0.007$) than those who had left the field.

3.1.4. Knowledge about IASC and participation in IASC activities

The surveys considered whether receiving the travel funding from IASC had improved ECRs' knowledge about the organization or increased their participation in IASC activities. 38% of the participants in Survey 1 and 83% in Survey 2 had not attended any IASC events including workshops, business or working group meetings, or larger conferences (Table 2). 59% of the Survey 1 participants reported that they knew nothing or very little about IASC prior to receiving travel funding, whereas only 13% knew nothing or very little about it after receiving the funding (Fig. 3). Almost half of Survey 1 participants (43%) said that they did not get involved in IASC after receiving the funding, but 37% report receiving the IASC News emails as of 2014. Only 6% stated they now have a leadership role within IASC (e.g. Member of IASC working group, Council/Executive committee member in an IASC initiative). Still, participants who received IASC travel support (Survey 1) knew more about IASC as of 2014 ($p = 0.0001$) and had attended more IASC events than those who did not receive the support (Survey 2) for the IPY conference in 2010 ($p = 0.0003$). When asked if the survey respondents considered attending IASC events as beneficial to their career, 61% (Survey 1) and 22% (Survey 2) of those who reported participating at least in one IASC meeting reported that it has helped their career significantly, while 22% (Survey 1) and 44% (Survey 2) indicated that these events had not had any effect on their career. Similarly, 55% (Survey 1) and 22% (Survey 2) reported that at least one IASC meeting has helped their research significantly, while 17% (Survey 1) and 44% (Survey 2) indicated that these events had not had any effect on their research.

Additional levels of participation beyond attending and presenting research at a meeting seemed to make a difference in ECR's

knowledge of IASC and whether they saw the meetings they attended as beneficial to their careers. When there was a responsibility or task attached to the funding (e.g. as rapporteurs), respondents indicated that they were more familiar with IASC ($p = 0.01$). For those who reported having additional tasks at the meetings, attending international meetings was considered more useful ($p = 0.02$), and attending at least one IASC meeting was reported as having helped both their career ($p = 0.03$) and research ($p = 0.03$). As would be expected, the more events an ECR had participated in, the more involved in IASC activities they were ($p = 0.001$). Respondents who, as of the survey in 2014, were still working with Arctic issues knew more about IASC ($p = 0.0002$) and had attended more IASC workshops/meetings ($p = 0.03$) than those who were no longer in Arctic-related fields, even when controlling for the number of times they received IASC travel funding.

3.1.5. Current involvement in Arctic issues and future career plans

Capacity building efforts, including early career travel funding for science events, ultimately aim to train the next generation of researchers in the field. The surveys asked respondents' current career and future plans in Arctic research. In 2014, more than 90% of those who responded to Survey 1 and 58% of those who responded to Survey 2 were working with Arctic issues in career paths in academia, policy, education and outreach, and management, among others. There was no statistical significant difference ($p > 0.05$) in whether the participants were still involved in Arctic-related work using the criteria gender, age, current occupation and the highest degree completed.

Survey responses on the length of involvement in Arctic research and number of published peer-reviewed publications reflect the still-early career status of the participants. While more than half of all respondents (68% and 56% in Survey 1 and 2 respectively) have been involved in Arctic issues for more than 5 years, they are just building their publication records: 52% in Survey 1 and 42% in Survey 2 reported having between 1 and 5 Arctic peer-reviewed publications; 10% (Survey 1) and 25% (Survey 2) reported not having any Arctic-related peer-reviewed publications. ECRs still working in Arctic-related fields reported having worked more years in Arctic-related fields ($p = 0.0002$) as well as having more Arctic-related peer-reviewed publications ($p = 0.007$) and higher degree completed ($p = 0.04$) than those who had left, which is directly connected to career success in academia.

Those who left Arctic research had various reasons to do so: in the open-ended answers, 28% and 30% stated personal reasons in Survey 1 and 2 respectively while 24% and 30% cited lack of funding and 48% and 40% change of topic reasons for leaving Arctic work.

Survey participants were asked to list their long-term career goals at the time of the survey; nine themes emerged in the responses. The most common responses were staying in academia (49% and 60% in Survey 1 and 2 respectively) and doing relevant research while making an impact on society (33% in both surveys). Less than a fifth of respondents (17% and 14%) were not yet clear about their career goals at the time of the survey. The biggest challenges reported in achieving those career goals were limited sources of funding (35% and 13% in Survey 1 and 2 respectively) and limited numbers of positions (15% and 25%). Lack of time, high workloads, and challenging work-family life balance were also noted in numerous responses, all of which were also cited by the Global State of Young Scientist project (Friesenhahn and Beaudry, 2014). These responses were consistent between those still in the field and those who had left. Only 4% of all respondents (both surveys combined) indicated on the survey that even though they would have the option to continue in Arctic-related work, they were not planning on doing so. The rest would either definitely like to (72%) or would consider (24%) continuing in Arctic-related work.

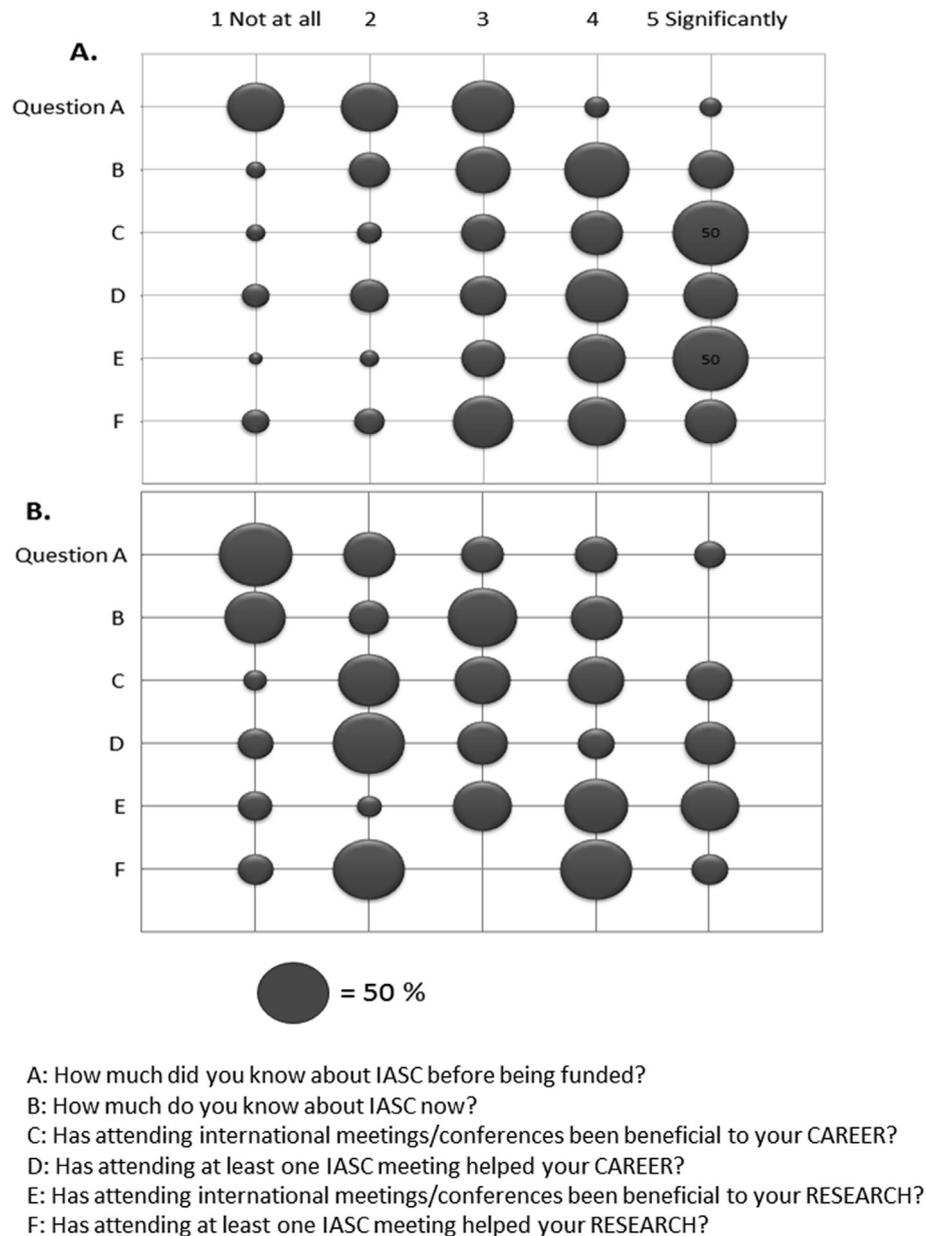


Fig. 3. Responses to questions related to knowledge on IASC and benefits of participating international conferences/meetings and IASC events in the scale of 1 = not at all to 5 = significantly. A - responses of those ECRs currently working with Arctic issues and B - responses of those ECRs currently not working with Arctic issues. Note: only the respondents who had participated at least to one IASC event were included into D and F.

Respondents who were still working in Arctic-related fields were more likely planning to keep doing so in the near future ($p = 0.03$), however 50% of those not currently working in Arctic-related fields reported that they were planning on doing so again in the future. As expected, those who had received IASC travel support were more likely to still be working in Arctic-related fields than those who did not ($p = 0.0006$).

3.2. Case study IPY 2010 conference

Of the 134 ECRs who received the IASC travel funding and completed the Survey 1, 28 had received travel support to participate IPY 2010 conference. 16 respondents from Survey 2 participated in the conference despite not receiving IASC travel support (Table 3). Those who had received the travel support reported

having participated in more IASC activities and as a consequence knew more about IASC as an organization. They were also more likely to still be working in Arctic-related fields, and the great majority had been working in the field for more than 5 years (85%, due to having been in Arctic research before the IPY conference and remaining in the field through 2014). The majority of the both groups had between 1 and 5 peer-reviewed Arctic-related publications, though among those who did not receive funding, 25% had zero. Those who received travel funding reported that participation in the 2010 IPY meeting had helped their career and research more highly than those who were not funded.

3.3. Reports

ECRs who received travel funding were usually required to

submit a summary report. The 253 reports analyzed (138 from conferences and 115 from workshops) varied greatly in length and level of detail. 49% were written by women and 46% by men. Many of the reports did not provide much background information on the author: 51% did not report their career status at the time of the report.

The reports showed that the authors were generally satisfied with the events. The aspects of meetings most often listed as helpful were discussions at the event (51% of authors), networking (47%), and opportunities for collaboration (43%) (Table 4). About 21% included details in the report about the new opportunities that the event led to. ECRs indicated that the things most beneficial to their research were new knowledge (54%), feedback on presentations (26%), gaining new collaborations (25%), and getting new ideas for projects (24%). The most common answers in the three categories (most helpful, beneficial for career and beneficial for research) did not vary significantly between workshops and conferences, even though some differences in specifics between the two kinds of events were noticeable (Fig. 4).

There is no record of what participants were initially hoping to get out of the workshops, as they did not have to submit this information prior to the event. However the reimbursement reporting template used in some years asked ECRs to list what they expected to get out of the meeting and if the event met their expectations. A majority of the ECRs who participated in meetings with IASC travel funding reported that the event met or exceeded their expectations and many commented on the events' positive atmospheres. Unfulfilled expectations typically had to do with lack of focus on certain disciplines or inadequate information/communication regarding event organization.

3.4. Reports and Survey 1 – word matrix comparison

The ranking of the most popular answers changed little between the word matrices generated from the reports and from Survey 1 in the “most helpful”, “beneficial for career” and “beneficial for research” categories, despite significant differences (Table 4).

Table 4

Comparison of word matrices from reports and Survey 1. Statistically significant differences between reports and Survey 1: * - $p < 0.1$; ** - $p < 0.05$; *** - $p < 0.001$.

Survey 1	%	Reports	%
Most helpful			
Networking**	33.6	Discussions***	51.0
Discussions***	17.9	Networking**	46.6
Collaborating oportunities***	10.4	Collaborating oportunities***	43.1
Career development/mentoring	7.5	Senior reseachers***	24.9
Presenting***	6.7	Presenting***	20.9
Connections for future jobs	6.0	Writing a paper*	9.1
Hands on experiences	3.7	Hands on experiences	6.3
Writing a paper*	3.7	Connections for future jobs	5.9
Senior reseachers***	1.5	Career development/mentoring	5.5
Speaking English	0.7	Internationality**	4.0
Internationality**	0.0	Speaking English	1.2
Beneficial for career			
Networking***	73.9	Networking***	45.5
Follow up oportunities***	23.1	New oportunities***	20.9
Presenting	10.4	Interdisciplinarity***	15.4
Boost my CV***	9.7	Presenting	14.2
Remotivated***	6.7	Follow up oportunities***	13.4
International	5.2	International	6.7
New oportunities***	5.2	Communication skills	4.3
Communication skills	3.7	Hands on experience	4.0
Interdisciplinarity***	3.0	Boost my CV***	0.4
Hands on experience	1.5	Remotivated***	0.4
Beneficial for research			
New collaborators***	38.8	New knowledge***	54.2
New knowledge***	28.4	Feedback	25.7
Feedback	22.4	New collaborators***	25.3
New ideas	19.4	New ideas	24.1
New insights	11.2	New methods	11.9
Confidence***	9.7	Motivation	8.7
Motivation	9.7	New insights	7.1
New methods	7.5	Interdisciplinarity	5.5
Interdisciplinarity	6.0	New data	2.0
New data	4.5	New fieldsites	2.0
New fieldsites	2.2	Confidence***	1.6

Table 3

Results of the core questions for those who received travel support to participate IPY 2010 Conference in the Survey 1 and for those who did not receive the funding but did participate anyway in Survey 2. * indicates different scale: 1–5 in Survey 1 (a lot or significantly being 4 and 5) and 1–3 in Survey 2 (a lot or significantly being 3).

	Received funding	Did not receive funding
Number who completed the survey	28	16
Number of different nationalities	15	9
Average age of respondent	36.2 (29–52; min–max)	35.5 (30–45; min–max)
Gender rate	63% men/37% women	31% men/68% women
% earning a PhD	89	81
% earning a PhD in the field of Arctic issues	85	81
% who has participated at least in one IASC event	59	19
% who know nothing or very little about IASC now	4	63
% still involved and working with Arctic issues either in academia, policy, education, and outreach or management, etc.	89	69
% who have been working with Arctic issues for more than five years	85	56
% who had 1 to 5 Arctic related peer-reviewed publications	41	44
% who had no Arctic related peer-reviewed publications	4	25
% who thinks attending international meetings/conference has helped their CAREER a lot or significantly *	93	50
% who thinks attending international meetings/conference has NOT helped their CAREER*	0	13
% who thinks attending international meetings/conference has helped their RESEARCH a lot or significantly	78	63
% who thinks attending international meetings/conference has NOT helped their RESEARCH	0	13
% who are no longer working with Arctic issues	11	31
% who have stopped working on this topic 1 year or less ago	–33% stopped working on this topic 1 year or less ago	–60% stopped working on this topic 1 year or less ago
% who have left Arctic issues for personal reasons	33	0
% who changed topic due to lack of funding	0	40

Discussions, networking, and opportunities for collaborations were aspects of meetings most frequently described as helpful. Networking was the most popular word associated with benefit to

career both in the reports and in Survey 1. Interdisciplinarity, which was the third most popular word in the reports, was not as frequently mentioned in Survey 1. New knowledge, new

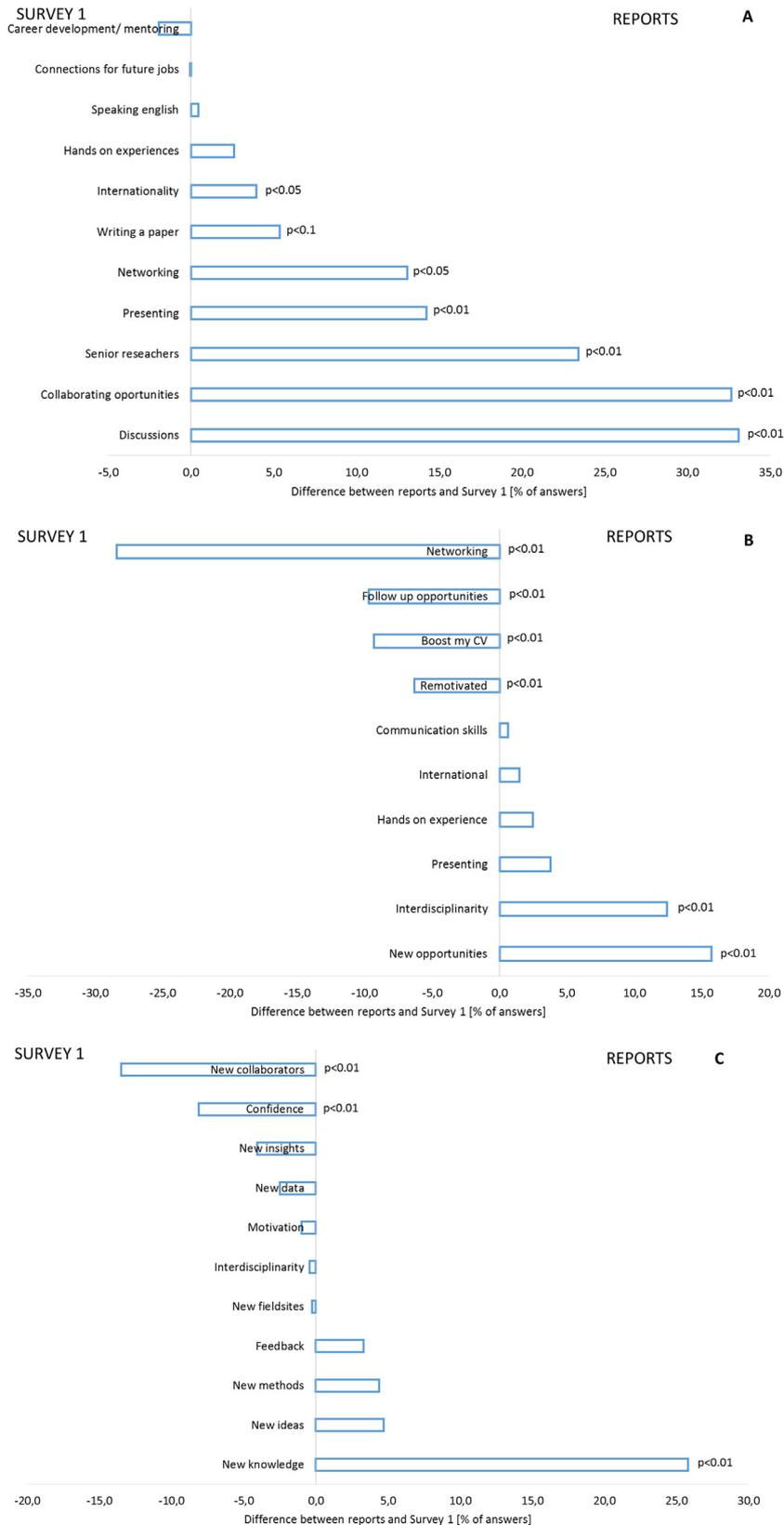


Fig. 4. Comparison of differences between word matrices from the reports and Survey 1. A - most helpful; B – beneficial for career; C – beneficial for research.

collaboration, and feedback were the most common answers associated with the benefits to research.

4. Interpretations and discussion

Based on the statistical analysis of the data used in this study, it is possible to highlight several interesting trends despite the low response rate for Survey 2.

4.1. Age and early career status

The average age of the survey respondents in Surveys 1 and 2, and the average age at which they received IASC funding, show that respondents are still relatively young. In most cases they are still within the typical definitions of early career researcher, considering that polar scientists have to finish their PhD and then usually undertake one or more post-doctoral positions before pursuing an academic career. The average of four years between receiving IASC support and the follow-up survey can be considered long enough to assess the impact of funding on career opportunities and development but short enough that ECRs actually remember the event they attended and what opportunities or benefits may have come out of it. Survey 1 and 2 are therefore appropriate for the analyses discussed in this paper.

Early career researchers rarely have their own project funding, and rely on advisors and fellowships for support instead. Universities and departments sometimes provide additional funding for conference travel, often in the form of matching grants. In these cases, IASC travel funding could increase the likelihood of securing additional funding for international meetings. Dedicated programs for supporting ECR travel and meeting registrations is critical to their participation in conferences and workshops.

4.2. Gender

Genders were equally represented among respondents in both surveys, though differed from the percentages of the ECRs who received travel support from IASC (63% women and 37% men). Equal representation meant that there were sufficient respondents of each gender to identify some general themes related to gender issues. Since a slightly higher percentage of women received funding but genders were equally represented in survey responses, a larger portion of women who received funding did not fill out the survey. Survey 1 results showed that men have on average higher degrees in an Arctic-related field and more Arctic-related peer-reviewed publications than women, even though they had been in the field for equal lengths of time. Considering the age of the respondents, it can be assumed that some ECRs have children which may explain why women reported fewer publications and fewer degrees, as well as their relatively-lower response rate.

Women were more likely to have received IASC funding for their first conference or workshop. Women were more likely to have reported that they still would have participated in the event without the IASC funding even though men and women reported having similar additional funding sources available. The Global State of Young Scientists' report stated that young women and ECRs with children seek networks more locally among colleagues, young men try to build more international networks via participation on international conferences (Friesenhahn and Beaudry, 2014). The majority of IASC travel support recipients were female (63%), which suggests that the GSYS report's findings may not hold for polar scientists, or that women are more likely to request travel funding. Women who responded to Survey 1 were slightly younger on average than men which adds context to the fact that it was more likely to be their first conference or workshop. It might be

that men had more access to opportunities for funding and were therefore less likely to seek IASC funding, though the survey responses do not address this. APECS sees particularly high rates of participation from female ECRs both in the general membership (60%) and particularly in their leadership since establishing a formal leadership structure in 2007 (64%) (APECS Member Database, 2015). The disparity between career outcomes as measured by degrees and publications, despite the participation of women in early career organizations and receipt of travel funding awards, underlines the need for continued support of young women in the field.

4.3. Involvement in Arctic research

The overwhelming majority in Survey 1 (90%) and over half in Survey 2 (58%) stated that they are still doing Arctic-related work in various sectors including academia, policy, education and outreach, or management and have been for at least 5 years. Respondents are therefore familiar with the field and have a good understanding of the Arctic. More than one third have moved on from the PhD student or postdoctoral stage into more longer-term or permanent positions. These positions include professors or lecturers (11% in Survey 1; 25% in Survey 2) and researchers in Arctic sciences (25% in Survey 1; 20% in Survey 2). Other surveys conducted to follow the career paths of graduates from STEM PhD programs show that while only about 65% of US PhD-holders continue on to a postdoc, only 15–20% of those move into tenure-track academic posts (Powell, 2015). The situation in Europe is even more competitive — in the UK, for example, only 4% of science doctorates find permanent research positions at universities (Powell, 2015). The proportion of science PhDs successfully pursuing non-traditional career paths is likely to keep increasing with increasing numbers of PhDs being trained (Cyranski et al., 2011) given the limited positions and funding available in academia. Earlier reports show that 43% of STEM PhD's were employed full-time in non-academic settings (Stephan, 2012). In this study, 11% of Survey 1 and 28% in Survey 2 respondents were already working in non-academic fields in policy, education and outreach, management, or in other not-identified fields. With 36% of the respondents of Survey 1 and 25% in Survey 2 still at the postdoctoral research stage, it remains to be seen if they will move into more permanent positions in academia as their careers progress.

The surveys indicated that even those who were no longer working in Arctic-related fields remained highly interested in Arctic issues and were considering returning to the field sometime in the future. Some even remained engaged in the Arctic-related projects in addition to other full-time employment, hoping to later receive funding for projects in the field. This highlights the special connection many ECRs have to their work with the Arctic and the Arctic research community, a sense of personal responsibility that goes beyond the available funding and jobs. One of the respondents said, "*I plan to work with Arctic issues as long as I can because first, it's a deep passion and second, it is an area of great concerns in terms of climatic change*" [sic]. ECRs who have left Arctic research have received a strong education in Arctic research and have expert knowledge of polar science. By sharing that knowledge they can help to improve the public understanding of Arctic issues, raising public education, awareness, and engagement (see more elaborate discussion on public engagement in Salmon et al., 2015).

ECRs who did not receive IASC funding were more likely to report having earned a PhD (Table 2), especially in Arctic-related fields (see Table 3 for the special case study). The small sample size of ECRs who did not receive IASC funding must be taken into account when considering these results. Those who did not receive

funding were less likely to participate in an IASC event or have been involved in IASC activities. IASC travel support therefore appears to encourage successful applicants to remain associated with IASC, participate in IASC activities, and stay in Arctic-related work. Survey results show that two of the goals of the IASC travel support program are fulfilled by supporting ECR travel to international meetings. Travel support did not appear to have a direct impact on the overall career success of potential academics in this study; those who did not receive funding and did not become as connected with IASC appear to have a similar chance of earning a PhD and thus remaining in academia, though not necessarily in Arctic research. Survey 2 respondents were more likely to report wanting to stay in academia and expressed less concern about funding challenges. Thus, survey results indicate that those who are currently working outside of Arctic research are more optimistic about an academic career than those who stayed in, which may be a result of access to more funding and employment opportunities. It is important to note that the survey was conducted on average 4 years after the funded events, and for many who applied for travel funding for a meeting early in their career, it is too soon to judge their career outcomes in terms of permanent positions. A follow-up study after 10 years' time could yield different results.

4.4. Importance of networking and training

Forging international and interdisciplinary connections early on can be critical to an ECR's success in the competitive academic and research environment (Weiler, 2007). In both the surveys and the reports analyzed for this study, the opportunity to network with senior researchers and fellow ECRs had the highest impact on career development and opportunities for ECRs following the funded meetings. *"I met co-advisor, who ... really supported me in finishing my PhD thesis; also she invited me to the Laboratory ... I've got fellowship for support of my visit"* [sic] was one of the open-answer responses describing networking possibilities as critical to career success. Mutual support among colleagues and collaboration networks were identified among the eight top factors that contribute to a successful career in academia by ECRs around the world (Friesenhahn and Beaudry, 2014). The importance of networking and forging connections with new collaborators is evident when comparing the answers from the post-event reports and Survey 1. Although networking opportunities were not always cited by travel award recipients immediately after the event, they acknowledge the benefits of the connections several years afterwards (Table 4). Considering that 75% of Survey 1 respondents received funding only once, this shows how effective one-time travel support can be if used properly. Survey results confirm that attending several conferences and having additional funding led to better career outcomes than attending only one event and being funded only through IASC: attending multiple conferences allows for more exposure and more time to build a network.

Effective communication is the cornerstone of interdisciplinary work (Weiler, 2007). A successful academic career in Arctic research requires scientists to collaborate on large, international projects with multiple players. The skills developed for research collaborations are also crucial for communicating beyond the research community with educators, the media, stakeholders, and policy makers. Conferences and workshops bring specialists together, sharing new knowledge and providing a forum to maintain collegial relationships. However, these gatherings are sometimes so large or specialized that it is difficult to initiate new connections, especially for someone just entering the field. While some institutions provide some integrative activities and professional training for students and postdocs, the majority could use more training and mentorship (Weiler, 2007). At global level, the

lack of mentoring was listed among the top four obstacles ECRs encounter during the early stages of their career (Friesenhahn and Beaudry, 2014).

Support for a young researcher can range from sharing experience, informal advice, encouragement to accept new challenges, and feedback, to including young scholars into the network of more senior colleagues (Friesenhahn and Beaudry, 2014). Since the IPY, organizations like IASC, APECS and the Permafrost Young Researchers Network (PYRN) and other international partners have significantly increased the number of resources and training available to young researchers in the polar sciences. These organizations have put effort into ensuring that those participants who have received travel support find the meetings a welcoming and useful experience, in part through hosting early-career focused side events at larger meetings. Examples of these activities include speed-dating-style meet-and-greet events and organized mentorship opportunities where ECRs and senior scientists can meet in informal atmosphere. Those who received funding to participate in the IPY 2010 conference reported more benefit to their career and research from the event than those who did not receive the travel support. This difference may be in part due to the expectation that those who received funding participate in ECR community side events at the conference. The open-ended questions to the surveys confirmed that the participation in a meeting was most beneficial if there was a preparatory phase before the event, some sort of active involvement during, and follow-up work afterwards. For example, specific tasks or training during the event (e.g., being rapporteur or session chair), provide networking and communication opportunities, and expose ECRs to administration skills necessary for their careers. To ensure a welcoming atmosphere for travel support recipients, the authors recommend travel support programs include roles in which the ECRs are actively included in the meeting and specific side events for ECRs (e.g., networking events, dedicated ECR workshops, mentorship opportunities).

The IASC Fellowship Program (IASC, n.d.) provides an example of an ongoing program aimed to foster ECRs with a focus on longer-term commitments. The fellowship program is a new type of travel support for ECRs: while funding fewer total ECRs, it provides a more meaningful experience to those who receive support. The program requires selected ECRs to be involved in scientific activities with one of the IASC Working Groups over one to two years. In doing so, ECRs build an international network of contacts and develop science management skills. The Fellows receive travel support to attend two consecutive Arctic Science Summit Weeks where the annual working group meetings are held. This program was developed to provide young researchers the opportunities and soft-skills training they need to launch successful careers in academia. As of 2015, 19 ECRs from nine countries have received the fellowships in the first three years of the program. A follow-up study to analyze the career impacts of this program relative to previous event-based funding will be necessary in the future.

5. Conclusions

The results of this study show that the preparation and retention of ECRs, a necessary priority for the Polar science community, is achievable through four key areas: 1) continuing to invest in travel support for ECRs to attend international meetings, 2) creating more training opportunities for ECRs, especially in-person learning through specific responsibilities (e.g., session chair, reporter etc.) attached to the travel support and ECR-focused side events, 3) focused mentoring efforts and follow-up work engagement, and 4) meaningfully involving ECRs in international research communities as contributing members to research teams, projects, working groups, and organizations.

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Appendix. List of events for which IASC offered travel support for early career researchers**Year Meeting**

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- 2009 3'd International Conference and Workshop Arctic Palaeoclimate and Its Extremes -Beyond the Frontier (APEX), Copenhagen, March/April 2009
 Arctic in Rapid Transition Initiation Workshop, Fairbanks, November 2009
 Arctic Science Summit Week (ASSW), Bergen, March 2009
 Arctic System Model Workshop III (ASM), Montreal, July 2009
 Network on Arctic Glaciology annual Meeting (NAG), Canada, February 2009
- 2010 Arctic in Rapid Transition Implementation Plan Workshop, Winnipeg, October 2010
 Arctic Social Indicators (ASI-II), Roskilde, June 2010
 Circum-Boreal Vegetation Mapping Workshop, Helsinki, March 2010
 Future of Arctic Humanities and Social Sciences, Oslo, June 2010
 iAOS Workshop, Woods Hole, October 2010
 International Polar Year Conference (IPY), Oslo, June 2010
 Network on Arctic Glaciology annual Meeting (NAG), Obergurgl, March 2010
 Second International Symposium on the Arctic Research "Arctic System in a Changing Earth" (ISAR-2), Tokyo, December 2010
 Summer School, Fairbanks, June 2010
 Third International Conference and Workshop, Arctic paleoclimate and its extremes (APEX), Iceland, May 2010
- 2011 7th International Arctic Social Science Congress (ICASS VII), Akureyri, June 2011
 Arctic in Rapid Transition (ART), Polarstern Draft EC meeting, Copenhagen, November 2011
 Arctic Science Summit Week (ASSW), Seoul, March/April 2011
 Atmospheric Investigations on a Drifting observatory over the Arctic Ocean (AIDA), Kick-Off meeting, Potsdam, September 2011
 Conference on Life in Extreme Environments (CAREX), Dublin, October 2011
 Distributed Biological Observatory Data Workshop (DBO), Victoria, November 2011
 Global Terrestrial Network for Permafrost (GTN-P), Potsdam, November 2011
 International Glacier and Ice Cap Working Group (GIC), Winter Park, June 2011
 Network for Arctic Glaciology workshop on the dynamics and mass budget of Arctic glaciers, Colorado, February 2011
 Overcoming Barriers to Arctic Ocean Scientific Drilling: The site survey challenge, Copenhagen, November 2011
 Polar Archaeology Network (PAN) Workshop, Norway, February 2011
 Shrubring Synthesis Workshop, Davos, September 2011
 Workshop on Genetic Monitoring in the Polar Regions, Cambridge, April 2011
 Workshop on the use of automatic measuring systems on glaciers, Switzerland, March 2011
- 2012 Arctic Climate System Network (ACSNet), Montreal, April 2012
 ART-APECS Workshop, Sopot, October 2012
 Atmosphere-Ice-Ocean Boundary Layer Processes and Their Role in Polar Change, Boulder, June 2012
 Circum-Arctic Lithosphere Evolution (CALE), Vienna, April 2012
 CircumArctic Rangifer Monitoring and Assessment Workshop on the global status of migratory tundra Rangifer (CARMA), Vancouver, December 2012
 Field Workshop on Studies of Tidewater Glaciers, Svalbard, August 2012
 Global Terrestrial Network for Permafrost (GTN-P), Hamburg, November 2012
 International Polar Year Conference (IPY), Montreal, April 2012
 Network on Arctic Glaciology annual Meeting (NAG), Poland, January 2012
 Vulnerability on Permafrost Carbon, Florida, May 2012
- 2013 19th Northern Research Basins International Symposium and Workshop (NRB), Alaska, August 2013
 3rd International Symposium for Arctic Research (ISAR-3), Tokyo, January 2013
 Arctic in Rapid Transition EC Meeting (ART), Copenhagen, November 2013
 Arctic Science Summit Week (ASSW), Krakow, April 2013
 Arctic Vegetation Archive Workshop (AVA) at Arctic Science Summit Week (ASSW), Krakow, April 2013
 Atmospheric Chemistry Workshop Session at American Geophysical Union Fall Meeting (AGU): Local Sources of Arctic Pollution and their Impacts, San Fransisco, December 2013
 Circum-Arctic Lithosphere Evolution annual Workshop (CALE) Workshop at American Geophysical Union Fall Meeting (AGU), San Fransisco, December 2013
 CliC Sea Ice Modeling and Observing Workshop, Tromsø, June 2013
 Distributed Biological Observatory Data Workshop (DBO), Seattle, February/March 2013
 Gordon Research Conference (GRC), Ventura, April 2013
 International Science Initiative in the Russian Arctic (ISIRA) Meeting at Arctic Science Summit Week (ASSW), Krakow, April 2013
 Northern Hemisphere Polar Jet Stream links with Arctic Climate Change, Reykjavik, November 2013
 Shaping Forces of Biodiversity in the Arctic, Reykjavik, January 2013
 The International Tundra Experiment (ITEX) – an International Conference and Synthesis Workshop, Bergün, September 2013
 Workshop on Arctic Data Rescue, Citizen-Science and Collaborative Research, Reykjavik, November 2013
 Workshop on the Dynamics and Mass budget of Arctic Glaciers & IASC Network on Arctic Glaciology Annual Meeting (NAG), Obergurgl, February 2013
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