Assessing the Impact of an Online Climate Science Community: The Early Career Climate Forum

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ABSTRACT: Online science communities can serve as powerful platforms for advancing scientific knowledge, capacity, and outreach by increasing collaboration and information sharing among geographically distant peers, practitioners, and the public. Here, we examine the value and role of the Early Career Climate Forum (ECCF), a climate-focused online science community that is based in the United States and is dedicated to training and providing support to the next generation of climate scientists. In a survey of community users and contributors, we find that the ECCF played a unique role in providing users access to career resources as well as climate-related research and insights. Respondents also indicated that the ECCF provides them with a strong sense of community and a sense of hope for the future of climate science research. These findings highlight the importance of online science communities in shaping and supporting the next generation of scientists and practitioners working at the science–management interface on climate change issues.

KEYWORDS: Social Science; Communications/decision making; Education; Climate change

1. Introduction

The emergence and growth of online science-related platforms that host blogs and science communities have coincided with the ever-expanding role scientists are expected to play in sharing their research and actively engaging with diverse audiences. This is particularly evident among scientists working at the science–management interface on climate change and climate adaptation issues. In this domain, increasing emphasis has been placed on interdisciplinary and transdisciplinary research (Moss et al. 2010), the coproduction of knowledge alongside stakeholders (Jasanoff 2004; Meadow et al. 2015), generating actionable science for decision-makers (Dilling and Lemos 2011), building collaborative cross-sectoral and institutional networks (Stein et al. 2013), and being able to effectively communicate one's science to diverse nontechnical audiences (Greenwood and Riordan 2001; Nisbet and Scheufele 2009).

These aforementioned endeavors are intended to advance scientific research, inform better decision-making, and increase public engagement with science; however, they are also contributing to rapid changes in expectations regarding scientists' responsibilities to both science and public outreach activities. Navigating the changing landscape of research and outreach presents a new and particularly salient challenge for early career scientists studying climate change (Dike et al. 2018; Jørgensen et al. 2019), one of the most multifaceted and polarizing problems currently facing society (Pachauri et al. 2014; McCright and Dunlap 2011).

As the norms and practices around science and information dissemination continue to evolve, providing early career scientists with the requisite skills, resources, and experiences to grow into these expanding roles is paramount. Early career initiatives have emerged to address the lack of opportunities for training and development in key skills and competency areas. Scientific societies (e.g., American Geological Association and World Meteorological Organization) and bottom-up initiatives (e.g., Young Earth Systems Scientists) have recently begun to offer development training and opportunities for diverse and disadvantaged early career researchers (e.g., Nikaj et al. 2018). These programs hold the potential to shape the future of interdisciplinary research by creating greater opportunities for collaboration, communication and, ultimately, helping early career scientists ascend the professional ladder (Bridle et al. 2013; Jørgensen et al. 2019; Langendijk et al. 2019). To further support the development of the next generation of scientists, the Early Career Climate Forum (ECCF) emerged as a centralized online science community for early career professionals and students engaged in climate-related science and outreach to interact, discuss topics, and find climate-relevant resources. Specifically, the ECCF supported early career climate scientists associated with the U.S. Department of Interior Climate Adaptation Science Centers, whose work on climate change rests within the science–management

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interface. Here, we discuss the changing social, political, and institutional contexts that early career climate scientists are navigating and highlight the role of online science communities in training and providing support to the next generation of climate scientists, in part, by examining the history and use of the ECCF.

a. Climate change and an evolving social, political, and institutional context

For decades, scientists have primarily communicated their results through peer-reviewed technical papers and at scientific conferences. Success in scientific research has largely been measured in terms of pursuing such activities, as underscored by the ''publish or perish'' valuation system (Abbott et al. 2010). As a result, the training of graduate and postgraduate scientists often started and ended in the field and laboratory. While this culture and reward system continues to persist in academia, successfully solving the increasingly complex and multifaceted problems facing society and putting science into practice requires communicating and engaging with policy makers, relevant stakeholders, and the general public. Climate change, in particular, poses significant challenges for decision-makers and policy makers that requires coordination and action across scales, disciplines, and stakeholders who often represent different needs, values, and motivations (Pachauri et al. 2014). Increased recognition of the connections between science and society (Jasonoff 2004) has led to the emergence and expansion of new models of science, including ones that integrate and couple traditional expert-oriented exploration and analysis with more applied approaches that increasingly involve stakeholders as collaborators in the development and pursuit of scientific questions (i.e., knowledge coproduction) as well as approaches that span multiple disciplines and sectors (e.g., transdisciplinary scholarship; Djenontin and Meadow 2018; Jasanoff 2004). These approaches fill a critical need in producing actionable science to solve real-world problems and informing management decisions (Kirchhoff et al. 2013; Lemos et al. 2012), while engaging the public in the process (Moser and Dilling 2011). The notion of science continues to evolve from the discovery of ''pure'' knowledge to the pursuit of problem-driven, scientifically grounded solutions (Kirchhoff et al. 2013).

As a result, early career scientists face challenges not only in terms of honing their skills as researchers but also in developing the ability to explain and engage various audiences with science, as well as effectively advocating for the value of their science to policy makers, the general public, and their peers (Lach et al. 2003; Langendijk et al. 2019; Nisbet and Scheufele 2009). These endeavors and new models of science are particularly complicated with respect to climate change in part because the issue has become less about science and more about what the issue—causes, impacts, and solutions—means for society and disparate groups (e.g., Kahan et al. 2012). Indeed, much attention has been paid to the public's lack of engagement and the significant heterogeneity that exists among Americans (and others) with respect to their beliefs about whether climate change is happening and is anthropogenic (Leiserowitz et al. 2016; Pew Research Center 2016). This stands in stark contrast to the strong consensus within the climate science community (Cook et al. 2016).

In recognition of the gap between public and scientists' perceptions, climate scientists and others have begun stepping into the public domain to redirect the narrative of how their science is communicated to the public, increase awareness, and as a means to restoring public trust (Nisbet and Scheufele 2009). To do so effectively, however, scientists must balance the challenges of explaining a scientifically complex issue and related uncertainties to nonscientists (Markowitz and Guckian 2018; Moser 2010, 2016), while disentangling the social and political meanings attached to it (Kahan et al. 2012; McCright and Dunlap 2011). Moreover, scientists must balance traditional markers of career success (i.e., research, publishing), which do not entirely align with the necessary collaborations, pursuits, and outcomes surrounding the production of actionable science or community engagement. Developing the requisite skills to communicate effectively to diverse technical and nontechnical audiences will in part rely on understanding and integrating insights from the social sciences, including psychology, communications, and judgment and decision-making, all of which are fields that fall outside a traditional (climate) scientist's training (Nisbet and Scheufele 2009).

In many ways, being a young scientist in today's society pervades almost all aspects of life, including the social, political, and professional domains. These broadening responsibilities and expectations concerning scientists' role in society are reflected in the academic and professional arena as scientists are now asked about their public engagement plans and outreach activities when applying for research funding (Pearson 2001). Early career scientists and professionals are also experiencing an evolving academic and social context. Calls to transition the norms, practices, and implicit biases surrounding equity, diversity, and inclusion have received increased attention both within and outside of academia (e.g., Dike et al. 2018; Martinez-Acosta and Favero 2018). On the one hand, science has received fair criticism for a history of exploiting and/or excluding historically marginalized groups in the pursuit of knowledge (Dennis 1995; Kaijser and Kronsell 2014). On the other hand, efforts are needed to address persistent inequities, pressures, and systemic biases that underrepresented scientists face as they pursue their education and career (e.g., Handley et al. 2015). Indeed, women and racial minorities in science, technology, engineering, and mathematics (STEM) are particularly vulnerable to antiquated guidelines for tenure and career promotion. This stems from a confluence of factors, including the lack of professional networks and mentors (e.g., representation), gender and racial stereotyping, financial burdens, and work–life imbalance (Ceci et al. 2014; Dike et al. 2018; Eaton et al. 2020). For instance, research demonstrates how women and racial minorities receive significantly lower and unfavorable assessments in teaching evaluations, tenure decisions, and job application reviews, which disproportionality prevent these groups from advancing in STEM fields (e.g., Eaton et al. 2020; Handley et al. 2015; Moss-Racusin et al. 2012). Thus, learning how to effectively support more equitable participation and opportunity in science is critical in effectively addressing society's challenges (e.g., Hong and Page 2004;

Østergaard et al. 2011), including enhancing researchers' recognition and understanding of how implicit biases and power structures promote or inhibit the production of science and advancement of traditionally underrepresented scientists as well as comprehension of the scope of power relations and justice within communities most vulnerable to climate impacts (Kaijser and Kronsell 2014).

Collectively, these issues have transcended the expectations and roles surrounding scientists' responsibilities not only as researchers in the field but also as important civic actors in pursuit of societal and ecological progress. Given the increasing need for stakeholder outreach, public engagement, knowledge coproduction, and diversity inclusion, it is perhaps surprising that there has been relatively little formalized and widely accessible training to support scientists' preparation for such activities and systemic changes (Bankston and McDowell 2018; Brownell et al. 2013; Nisbet and Scheufele 2009), though programs offered by groups such as the American Association for the Advancement of Science (AAAS) and Alan Alda Center do aim to fill this critical gap. The manner in which early career scientists are prepared and trained to meet these changing roles and responsibilities requires new opportunities that build and hone relevant skills to communicate with nontechnical and diverse audiences. Without structured opportunities, early career climate scientists may be understandably concerned or anxious about feeling capable of fulfilling these expanding expectations and sociocultural challenges.

On the positive side, training and experiential offerings to prepare early career climate scientists for their roles within and outside of research are becoming more common in the United States and internationally, including activities hosted and promoted by professional societies such as the American Geophysical Union, Ecological Society of America, American Meteorological Society, American Fisheries Society, International Science Council, World Meteorological Organization, and African Climate Change Network. Additionally, several bottom-up initiatives, including Young Earth Systems Scientists (YESS) and the Association for Polar Early Career Scientists, have worked to create and support discussion and development among early career scientists from around the world (Jørgensen et al. 2019; Rauser et al. 2017).

b. *Online science communities*

Online platforms may act as an important social and professional space for early career scientists to practice communicating their science to broad audiences, find access to career-related resources, and interact with peers, thus offering a potentially powerful way to help train the next generation of climate scientists and practitioners (e.g., Rauser et al. 2015). Indeed, digital forms of communication—including blogs, social media (e.g., Facebook and Twitter), and listservs—are playing an increasingly important role in generating and expanding discussions about science, networking, increasing capacity, and in circulating relevant resources among communities of practice (Bonetta 2007; Borgman 2007). Perhaps the most popular of these online endeavors involves the rise of science communication blogs, which serve as a platform for scientists to distill and share their work with the general public (Brumfiel 2009; Trench 2012; Wilcox et al. 2016). While this nontechnical outreach format plays an important part in enabling researchers to practice communicating their science with nonexpert audiences, blogging platforms—including science community blogs—also provide scientists with the opportunity to share and engage directly with their peers (Shiffman 2018). Science community blogs also address important issues including "the culture and process of science, offer advice to early-career scientists, discuss academic writing and publishing, [and] consider issues of methodology" (Saunders et al. 2017).

To that end, online science communities offer enriched learning environments by providing users with centralized directories of relevant research, career- and communication-related resources, as well as a way to share and learn about the trials and tribulations of life as a researcher across various disciplines, methodological approaches, and geographical locations (e.g., Marcek 2020). Operating in these contexts can provide early career scientists, and particularly graduate students, unique opportunities, such as identifying and starting new collaborations (Batts et al. 2008), finding inspiration for new research ideas, and receiving feedback on one's research (Butler 2005; Tola 2008). Tola (2008) goes so far as to suggest that "it is really difficult to imagine why a scientist, especially a young one at the beginning of her own career, should not feel like entering this collective conversation." While there are many suggested benefits of engaging within these communities, few studies have evaluated how online science communities have served early career researchers and students in their growth and development as scientists and communicators (Liang et al. 2014; Mahrt and Puschmann 2014; Saunders et al. 2017). Thus, the present study begins to explore this question and examines the reach, functionality, and value of one such community—the ECCF—from the perspective of its users and contributors.

c. *The Early Career Climate Forum*

The ECCF was originally conceived in 2012 during a weeklong workshop known as the Northwest Climate Science Bootcamp, sponsored by the burgeoning U.S. Department of the Interior (DOI) Climate Adaptation Science Centers (CASC) and held at the H.J. Andrews Experimental Forest in Blue River, Oregon. Students from across the national CASC network converged to learn more about climate change, climate adaption, and science communication. As a small but growing network, many of the participating early career students and postdocs sought a means to stay connected and practice the skills they obtained at the training after they went back to their disparate and isolated laboratories at their respective institutions. Through the grassroots desire and collectively identified need for community and a platform for exchanging ideas, the ECCF emerged with a mission to provide users with resources revolving around three core themes aiming to address the expanding roles of scientists in today's society: 1) science communication, 2) career development, and 3) science and research. In late 2012–early 2013, the ECCF Editorial Board was formed and a pilot website was launched. In 2015, with dedicated funding secured from the Northeast CASC, the ECCF website was redesigned, relaunched, and

expanded with additional resource pages and the establishment of the ECCF electronic mailing list (i.e., listserv).[1]

The resulting platform provided a web-based resource to facilitate and increase information sharing, networking, and effective interdisciplinary science communication for early career scholars across the DOI CASCs, affiliates, and stakeholders. The ECCF consisted of a publicly accessible website (earlycareerclimate.org) that featured a regular blog written in nontechnical language appropriate for a broad range of audiences. A small six-person editorial board (i.e., editor-in-chief and editors) maintained the network's multiple platforms, including curating information on the resource pages. Additional responsibilities included writing blog posts as well as soliciting and editing blog contributions from professionals both within and beyond the listserv network, which maintained approximately 220 subscribers at its height in 2017 and when the survey described below was conducted. Blog topics have been diverse, including summaries of individuals' research, discussions of emerging methodologies, and insights on science communication, to issues pertaining to diversity in STEM and maintaining a work–life balance. Writers for the blog have been just as diverse, representing all regions of the United States, and myriad fields of expertise, such as communication, ecology, geography, and climate modeling. Between 2015 and 2019, the website hosted roughly 125 blogs, authored by more than five dozen authors representing a wide range of professional (e.g., graduate students, university professors, and communication specialists), academic (e.g., climatology, ecology, applied science, and social science), and sociocultural backgrounds from regions across the United States. The website also provided a central directory of resource pages that highlighted relevant fellowships, job boards and listservs; writing and communication tools; and diversity in STEM, such as information on recognizing microaggressions. A publications page served as a database of peer-reviewed articles written by early career CASC members (primarily between 2013 and 2017). The ECCF email listserv disseminated information on early career research, opportunities, and resources in the field of climate change science and adaptation.

d. ECCF community survey objectives and recruitment

To examine users' attitudes and perceptions toward the ECCF and its resources, in 2017 the ECCF Editorial Board conducted a community survey to solicit feedback on the quality and utility of existing ECCF products as well as to identify future opportunities for how to best provide access to climate-related resources and insights of interest to early career researchers across the CASC network. The primary goals of this survey were to examine the reach of the ECCF in targeting the desired audience (e.g., early career researchers), evaluate the utility of ECCF resources, and to assess the broader impacts of the ECCF on early career scientists' learning and development. We developed a variety of topic-specific items and measures to capture distinct aspects of users' interactions with and assessments of the ECCF. The following is a summary of the survey results, as well as relevant website metrics (e.g., pageviews and demographics) gleaned from Google Analytics. Recruitment for the survey occurred via a blog on the ECCF website, CASC network distribution lists, the ECCF listserv, and the community's social media platforms (e.g., Facebook and Twitter). A total of 37 individuals completed the survey over a 1-month response period.

2. Results

a. Demographics

The survey collected demographics that included gender, position/occupation, affiliated organization/region, and field of research. When compared with the user demographics for the website domain, "eccforum.org"[2] collected via Google Analytics from June 2015 to January 2019, the ratios of age, gender, and location appear to be similar to those surveyed (Clifton 2012). About 51% of survey respondents were female, and 46% were male (nondisclosure: $n = 1$). Comparatively, about 46% of the total number of website sessions were identified with female users, and about 54% were identified with male users. A session is defined by Google Analytics as any collection of page visits by one IP address until the user reaches 30 min of inactivity or until the clock resets at midnight (Clifton 2012). The age range of website users, according to Google Analytics, primarily consisted of the following: 18–24 (28%), 25–34 (34%), and 35–44 (16%). These age ranges made up 78% of total sessions, and aligned well with the ECCF's target audience, namely, early career researchers, including graduate students.

Respondents indicated a diverse range of career stages and positions, including Ph.D. students ($n = 10$), followed by postdoctoral researchers ($n = 9$), master's students ($n = 2$), and early career professors ($n = 2$), with the remaining respondents falling into other categories, including staff ($n = 8$), senior researcher/scientist ($n = 1$), and other ($n = 5$). Regionally, all of the respondents identified with a U.S. organization, with more respondents from the Northeast CASC region ($n = 7$), the South Central CASC region ($n = 6$), and the National Climate Adaptation Science Center (NCCWSC; $n = 6$). Other regions accounted for three or fewer of the respondents each. Comparatively, Google Analytics reported that 78% of sessions occurred in the United States. The remaining 22% could include international site users (primarily from Canada, India, the United Kingdom, France, and Germany), scans from automated website scanners, or individuals using a virtual private network (VPN) service. In looking more closely at regional representation in the United States, it is seen that website users were from Amherst, Massachusetts, at 8% and Northampton, Massachusetts, at 3% (Northeast CASC region); Reston, Virginia, at 4% (NCCWSC office region); Raleigh, North Carolina, at 4% (Southeast CASC region); and Norman, Oklahoma, at 3%

[1] In 2020, the ECCF underwent a name change, updated the platform design, and relaunched as the Early Career Climate Network (https://earlycareerclimate.org/).

[2] As of 2021, the website can be found at https://earlycareerclimate.org/.

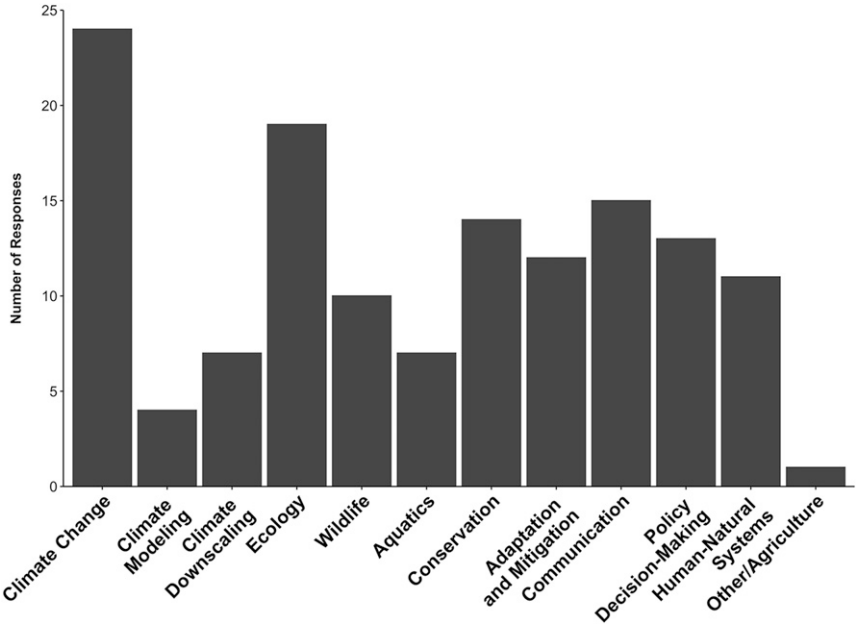

FIG. 1. Field of study and research categories of respondents (n = 35). Respondents were able to select more than one field of study, because much of the work conducted by the CASCs and affiliated researchers intersects multiple fields.

(South Central CASC region). Major cities in the other CASC regions were represented at ≤3% of sessions each. Parallels can therefore be drawn from a comparison of gender, relative age, and region to conclude that the survey likely represented site users proportionally. In addition to the abovementioned demographics, survey respondents also indicated their respective field of study and research categories, which are summarized in Fig. 1. These categories represent a broad range of fields, including climate modeling, ecology, conservation, adaptation/mitigation, communication, policy, and human–natural systems.

b. *Discovery of the ECCF*

The majority (55.3%) of respondents first learned about the ECCF through a CASC. This finding suggests that the promotion of the website was most successful via the CASC networks and fits the ECCF mission to target and provide support to CASC-affiliated early career researchers. Furthermore, 23.7% of respondents first heard of the ECCF via a friend, coworker, or fellow student, suggesting that word of mouth also played a strong role in spreading awareness about the website. A minority of respondents indicated first learning about the ECCF via an event or presentation (7.9%) or a forwarded email (5.3%). The social media platforms Twitter (0%) and Facebook (2.6%) did not contribute strongly to how survey participants learned about the ECCF. None of the survey participants found out about the ECCF by either conducting a web search or learning about it from an advisor or professor.

c. *General assessment and perceptions of the ECCF website*

At a broad level, the survey gauged respondents' general satisfaction with the ECCF (i.e., "Generally speaking, how satisfied are you with the ECCF?"). Survey participants expressed high levels of satisfaction with the ECCF. On a 7-point scale, 92.1% of respondents reported feeling either "fairly," "very," or "extremely" satisfied (5, 6 or 7 on the scale, respectively). Only a minority of participants (7.9%) reported feeling either "not very" or "a little" satisfied (2 and 3 on the scale, respectively), and no respondents indicated that they were "not at all satisfied."

The website is the main platform through which the ECCF provides support and resources to the community of users. Based on survey results, respondents tended to visit the ECCF website most often when new content was released (44.7%) or otherwise once per week (5.3%), once per month (18.4%), less than once per month (15.8%), or not at all (15.8%). Provided the ECCF maintains multiple platforms including a website, listserv, and several social media outlets, it is possible that some members may interact with the ECCF on only one (or more) of its mediums. Thus, only respondents who indicated visiting the website answered additional items about the utility of the website. During the period of evaluation, new blogs were posted on average once every two weeks and were announced via the listserv and social media platforms. Other additions to resources pages (e.g., publications and fellowships) were posted as needed, though these appeared less frequently than new blogs. When asked about the usefulness of these pages, respondents indicated that the job board resources page, fellowship resources page, and communication tools page were most useful. The publications page, one of the most recent additions to the website and containing more than 60 papers published by researchers supported by the CASCs between 2013 and 2017, was also popular (Fig. 2). Additions to the publications page were made available when

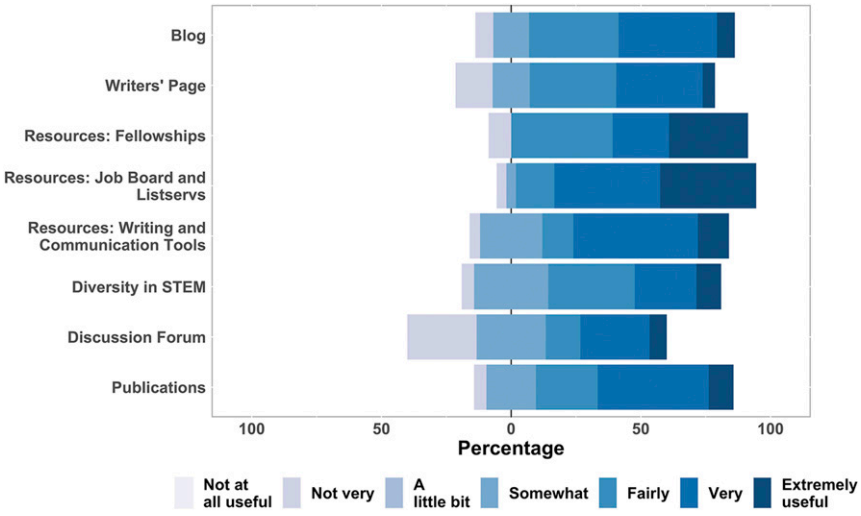

FIG. 2. Perceived utility of ECCF website pages assessed on a 7-point scale (from 1 = not at all useful to 7 = extremely useful; $n = 31$).

new CASC-affiliated material was published and submitted to the ECCF Editorial Board. The discussion forum was ranked as the least useful, possibly because users were required to log in before posting comments.

The blog was the main feature of the ECCF and was updated regularly with broad-ranging topics, including research summaries, challenges associated with conducting early career research, communication-related topics, and those that offer viewpoints on conventional institutional practices and inequities. Respondents were asked which categories were most interesting, and results were consistently positive, with slightly higher interest levels in science communication tools and insights, current events or developments in policy and research, and early career development perspectives and lessons learned (Fig. 3). Ranked as less interesting—although still fairly highly rated—were climate modeling and research troubleshooting. The breadth of topics appeared useful as early career professionals prepare for careers in an ever-growing, transdisciplinary field.

d. *Social media*

Between June 2015 and January 2019, the ECCF managed active social media accounts on Facebook (e.g., www.facebook.com/ecclimatenetwork) and Twitter (e.g., @ECClimate) as a way to engage with and amplify website material and topic-relevant resources to community members. As of 2019, the ECCF Twitter account maintained 275 followers and tweeted over 700 times with content pertaining to new blogs, science communication, jobs, and publications. The Facebook page offered another avenue for community members to engage with ECCF content. Facebook posts reached around 250 people on average and toward the end of 2018, blog posts were reaching over 650 individuals. From survey results, about one-half of respondents reported following at least one of the ECCF's social media accounts and have referred at least one individual to follow the ECCF on social media. Furthermore, most respondents (55%) who reported following the social media accounts indicated that the amount of content generated on social media should remain "about the same" (4 on 7-point scale), while the rest of respondents wanted to see more (44.5%; 5 or above on 7-point scale). When asked about their interest in generating content-related discussions on Facebook posts, the majority of respondents were indifferent (e.g., "somewhat interested") about engaging.

e. *Career development*

One of the core themes of the ECCF mission is to help early career climate scientists navigate the academic and professional arena. Through blog posts and dedicated website material, the ECCF helped young researchers gain relevant perspectives on career development and challenges by providing a space to share and learn from others' experiences, as well as to have access to an evolving list of resources with regard to writing, science communication, fellowships, and diversity in STEM. Thus, a primary aim of the survey was to learn how and to what extent the ECCF had supported early career researchers' career development efforts and fostered a sense of community and hope for climate science in the future.

When asked about the general usefulness of ECCF in supporting their career development (i.e., "How useful do you find the ECCF in supporting your career development?") the majority of respondents indicated that the ECCF was "fairly" or "very" useful (54%; 5 or more on 7-point scale). Respondents also indicated the extent to which the ECCF had supported different elements of their career development (e.g., "Networking with other early career climate scientists or students"; see Fig. 4). Importantly, results suggest that the ECCF served early career researchers by providing both a unique space for community building as well as a sense of hope for the future of climate science. Respondents indicated to their agreement or disagreement with the following statements: "Being a part of the ECCF community gives me a sense of

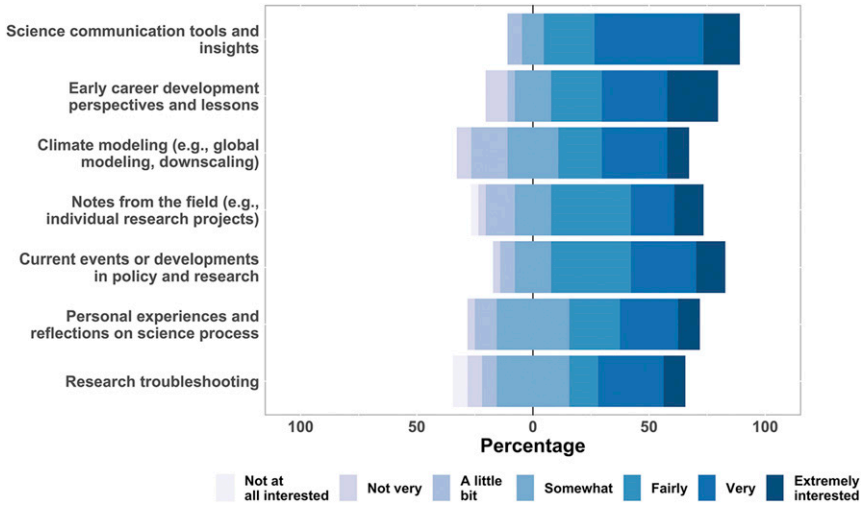

FIG. 3. Interest level in ECCF blog categories assessed on a 7-point scale (from 1 = not at all interested to 7 = extremely interested; $n = 32$).

hope for the future of climate science''; ''The ECCF provides me with a sense of community with other early career scientists'' (1 = strongly disagree; 7 = strongly agree). Figure 5 displays the results for these items. These results are encouraging, as a collective sense of efficacy, hope, and belonging are important but often overlooked psychological and social resources that students and early career scientists can draw on as they attempt to navigate a socially and politically divisive field of study.

3. Discussion and future directions

The ECCF emerged as a platform primarily focused on serving early career scientists associated with the CASCs, a young and small network of federal, academic, and tribal organizations that work at the science–management interface on climate change issues. The number of CASC students and postdocs located nationally across the network grew from approximately 50 to 250 between 2012 and 2017. The present study sought to evaluate the utility and value of the ECCF in satisfying the needs of the community's users during this time period. The results of this exploratory survey suggest that respondents were generally satisfied with the content and resources maintained by the ECCF as well as with the various platforms and community services offered. This parallels the success and growth the ECCF experienced since the relaunch of the website and subsequent platforms (e.g., listserv, Facebook, and Twitter) in 2015.

Between and 2015 and 2018, the ECCF published 125 blog entries, contributed from over 65 different writers representing all eight regional CASCs, the National CASC, and multiple partner organizations (e.g., U.S. Fish and Wildlife Service and U.S. Department of Agriculture partners). The three most accessed blogs were viewed more than 550 times each (as of September 2018) and represent the ECCF's core topical themes, including ''Targeting 2 Degrees Celsius in Paris, #COP21,''

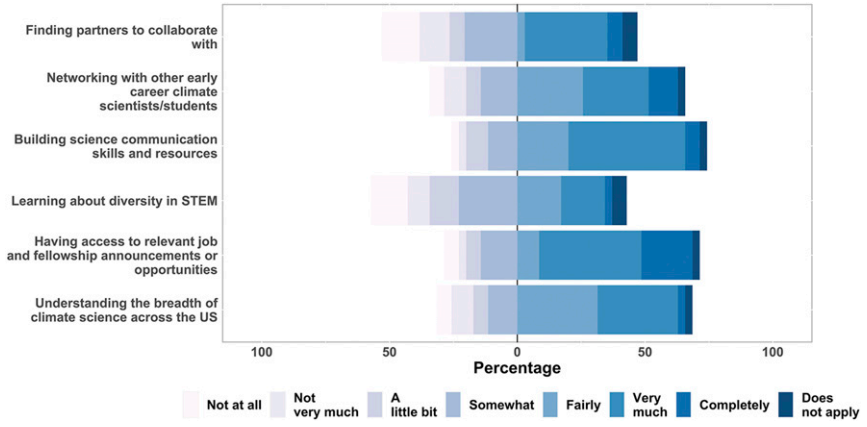

FIG. 4. How the ECCF supports career development assessed on an 8-point scale (from 1 = not at all to 7 = completely, with 8 = does not apply; $n = 35$).

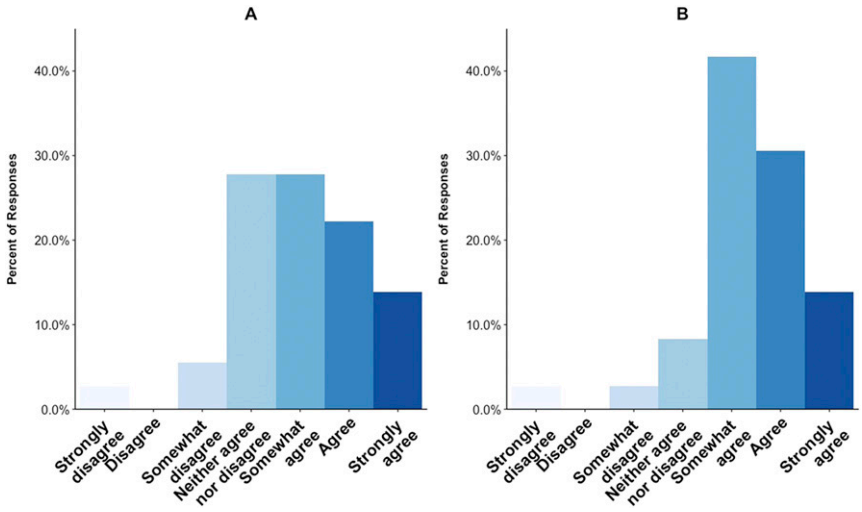

FIG. 5. (a) Respondents' sense of hope for the future of climate science (n = 36), and (b) participants' responses relative to ECCF providing a sense of community among early career scientists (from 1 = strongly disagree to 7 = strongly agree; n = 36).

"From Scarcity to Inclusion: The Continued Need for Women in Science," and "The Importance of Philosophy in Responding to Climate Change." Furthermore, users of the website spanned the continental United States as well as potential international audiences from more than 25 countries worldwide. Several contributing writers of blogs were international students and could, as such, represent conduits into broader international engagement in the future. Memberships to the ECCF listserv grew to a total of 230 subscribers. The ECCF also had 275 followers on Twitter, and the Facebook page reached 250–650 individuals with each post.

Perhaps one of the more interesting and important findings from the survey was respondents expressing that the ECCF provides them with a sense of community and hope for science in the future. This highlights the unique and supporting role that the ECCF—and other platforms like it—play for this particular community of practice. This may, in part, be explained by the deliberate scope and focus of the ECCF to the CASC network. One of the primary motives for forming the ECCF was to provide early career scholars associated with the CASCs a positive space in which to engage, network, build skills, and discover a sense of personal and collective efficacy as they seek to bring about positive social and ecological change through their research and outreach. The website's limited open access (e.g., commenting on blog posts) helped to create a safe space and encouraged positive interactions and discussion among early careers within the network. As a result, some of the most important benefits of the platform may have been less tangible and further reflect the importance of cultivating a shared understanding among peers navigating similar issues in their own career, outreach, and research efforts. The ECCF's primary focus on a concentrated subset of early career climate scientists (e.g., CASC affiliates) raises important questions about how and to what extent the platform could be expanded without compromising the sense of community and hope provided by a relatively small network of practice.

The results of the survey highlight the extant appetite for online communities that provide a wide variety of services and opportunities to their members. In concert with the more social–psychological benefits of engaging with the community (e.g., elevated feelings of hope, collective efficacy), respondents indicated that the ECCF provided them with access to a range of relevant resources, and further supported their career development via insights on science communication and exposure to the breadth of climate-related work and relevant methodologies leveraged by others. This may be particularly important when considering the role of science community blogs as compared with science communication blogs. The former, such as the ECCF, offer a broader, more diverse platform for users to engage with and learn from peer researchers, while also providing a space to practice communicating one's research to diverse audiences including the public. The burgeoning of online science communities, mostly spearheaded by bottom-up initiatives, including the formation of the ECCF, suggests that extracurricular arenas for conversation, career-related development and social–psychological support are necessary and worthwhile endeavors (Batts et al. 2008; Saunders et al. 2017). More recently, the COVID-19 pandemic and resulting lockdowns have further highlighted the opportunities online science communities may provide early career scientists to communicate and build both scientific and personal connections within a digital environment (Bottanelli et al. 2020). Future studies could evaluate the continuity and longevity of these platforms after the pandemic has ended or, more generally, over the long term.

Science community blogs may fulfill an important role by providing resources and opportunities that expand traditional learning environments and enable early career scientists to share with and learn from individuals with whom they might not have otherwise interacted. Moreover, the popularity of posts related to nontechnical issues—including diversity, inclusion, and philosophy of (climate) science—highlights a rapidly

expanding awareness of and interest in better understanding the broader ecosystem within which early career climate scientists are operating (including issues related to the science–society relationship). Thus, online science communities may provide a range of resources and content of sincere interest to users that falls beyond the scope of traditional training and education graduates receive in the field and laboratory. Although each online science community should be uniquely structured to address the needs of its audience, an exploratory assessment of the ECCF suggests that maintaining multiple platforms (e.g., listservs, social media) as well as promoting topically diverse and timely content enhanced community member's experience. While the results of the survey add to the nascent literature examining the utility of online science communities (e.g., Saunders et al. 2017), broad inferences should be made with considerable caution, as the survey presents results from a relatively small and highly concentrated network of early career scientists. Nonetheless, our goal was to detail the evolving demands of early career climate scientists and to examine the value of online science communities in addressing these challenges in the specific context of the ECCF.

In recognition of the community's growth and recent survey results, there is room for improvement and increasing engagement with the ECCF. One potential strategy for increasing CASC awareness of the ECCF would be to increase the promotion and circulation of ECCF products to and by consortium institution affiliates. In a world of information overload, messages are regularly overlooked; thus, there is a greater need to be consistent and persistent in advertising what an online community like the ECCF can provide for early career researchers, particularly when new content is produced. Furthermore, the survey responses stressed the importance of maintaining multiple digital platforms for reaching different community members; circulating content through different, yet related networks appear to be critical in building an engaged and diverse community of scholars. Integrating emerging digital communication platforms, such as Slack (e.g., FuturePISlack), could further enhance the communication and collaboration opportunities available to early career scientists (Perkel 2017).

The ECCF relied largely on CASC newsletters (e.g., Climate Adaptation Insights, formerly called BioClimate), listservs, and social media platforms to announce and bring attention to new content. As the ECCF enters its next phase as the Early Career Climate Network, an obvious next step would be to broaden its reach by actively engaging non-CASC climate and adaptation networks [such as the U.S. Department of Agriculture Climate Hubs and the National Oceanic and Atmospheric Administration Regional Integrated Sciences and Assessments (RISA) programs], early career chapters of scientific societies, and other organizations (including on an international scale) with early career and science communication missions (e.g., American Geophysical Union and AAAS) and continually increasing the social diversity of its network to promote a community of inclusiveness and equity. However, funding and capacity are familiar challenges that must be confronted when deciding what a relatively small and highly focused network can realistically accomplish.

4. Conclusions

Early career scientists and practitioners have the potential to become vanguards for progressing institutional norms in the valuation of inclusion, research, and practice and overall advancement of deeper dialogues between science and policy arenas, particularly in the climate change domain. Thus, providing this sector with a platform through which they can share and learn from their peers as well as access a centralized directory of relevant career- and climate-related resources is critical. Online science communities, such as the ECCF, offer enriched learning and networking environments for the next generation of early career scientists to engage with science and each other that moves beyond the traditional technical bounds of the classroom and/or laboratory. For the individual scientists, engaging with others' lived experiences as researchers, individuals and students can provide a simple, yet critical form of social proof, reaffirming that one's peers are similarly navigating the complexities and challenges of scientific research and outreach in an evolving social, political, and institutional context. Amidst the urgency of the climate crisis facing society, online science communities may play a critical role for early career scientists trying to cope with and create change within their everyday personal and professional environments. Indeed, assessment of the ECCF found that early career researchers are benefitting not only in terms of gaining access to relevant resources but also, and perhaps more importantly, by gaining a sense of community; an expanded view of diversity, equity, and inclusion in STEM; and hope about the future of climate science.

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Data availability statement. Data, including the survey instrument, can be accessed online (https://osf.io/8wgj7/).

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