nature portfolio

https://doi.org/10.1038/s41893-021-00823-2

Supplementary information

Conference demographics and footprint changed by virtual platforms

In the format provided by the authors and unedited

Supplementary Information

Conference demographics and footprint changed by virtual platforms

Matthew Skiles[1], Euijin Yang[1], Orad Reshef[2], Diego Robalino Muñoz[1], Diana Cintron[3], Mary Laura Lind[4], Alexander Rush[5], Patricia Perez Calleja[6], Robert Nerenberg[6], Andrea Armani[7,*], Kasey Faust[1,*], Manish Kumar[1,*]

[1]Department of Civil, Architectural and Environmental Engineering, University of Texas at Austin, Austin, Texas, USA
[2]Department of Physics, University of Ottawa, Ottawa, Ontario, Canada
[3]Department of Chemical Engineering, University of Texas at Austin, Austin, Texas, USA
[4]School for Engineering of Matter, Transport and Energy, Arizona State University, Tempe, Arizona, USA
[5]Department of Computer Science, Cornell University, Ithaca, New York, USA
[6]Department of Civil and Environmental Engineering and Earth Sciences, University of Notre Dame, Notre Dame, Indiana, USA
[7]Department of Chemical Engineering and Material Science, University of Southern California, Los Angeles, California, USA

[*]Corresponding authors, email: armani@usc.edu, faustk@utexas.edu, manish.kumar@utexas.edu

Environmental Impact

The carbon footprints of IPCs were defined as the warming potential in CO_2e of the sum total of GHG emitted by the hotel stays and air travel of all conference participants. This value was dominated by air travel emissions and has increased over time (**Figure S2 and Table S7)**. However, as expected, carbon footprints were practically negligible for VCs.

As shown in **Figure S2**, the carbon footprint for a single international attendee to the most recent IPCs (2019) is comparable to the median global per capita carbon budget (3.26 tonnes CO_2e) for the entire year of 2030 in a collection of proposed decarbonization pathways designed to limit global warming to 1.5° C with a small overshoot[1]. Additionally, the average carbon footprint for all attendees to the most recent IPCs (2019) is comparable to the median global per capita carbon budget (0.72 tonnes CO_2e) for the entire year of 2050 in a collection of proposed decarbonization pathways[1]. Therefore, the carbon footprint of a single attendee to an IPC is a substantial fraction of the recommended per capita annual carbon budgets, and many attendees attend multiple international events per year. For further context, the ~2.5 tons of CO_2e emissions caused by an international attendee to one of these IPCs is roughly equivalent to the footprint of an average US passenger vehicle traveling ~10,000 km[2].

Conference Content and Dissemination

Changes in content and dissemination efficiency between IPCs and VCs are an important consideration and could be impacted by a variety of factors. Presenters may be less comfortable presenting unpublished work via a virtual format due to concerns about unsanctioned recording. VC organizers have tailored the format of their platforms in anticipation of this factor[3]. A response to the 2020 NAMS VC survey question asking what attendees foresaw as challenges with the online format confirmed that attendees have privacy concerns related to sharing content virtually:

> "[A challenge that I foresee with the online format is] limited data sharing, as presenters will be less likely (understandably) to report unpublished data." – NAMS survey respondent

While some survey responses indicated that there might be hesitancy to present new materials, the ratio of invited to submitted speakers at VCs remained similar to at IPCs according to the organizers. Overall, approximately 50% of oral session presenters at the 2020 NAMS VC and 100% of presenters at the 2020 ICLR, 2020 IWA, and 2021 POM VCs agreed to be recorded. The portion of AAS presenters that agreed to be recorded is not known. While some responses to open-ended survey questions indicated that attendees felt that presented material had a noticeable lack of works in progress, these comments were isolated. Generally, attendees were satisfied with the content delivery aspect of VCs.

Another important factor to consider when comparing content and dissemination between IPCs and VCs is the length of the conference. Analyzed conferences generally took place over the same number of days after they transitioned from an in-person to a virtual format, but the length of the event in hours varied. While IPCs tended to have more scheduled hours of events on each conference day compared to VCs, the length of the VCs in hours was not easy to define. Content at VCs including posters and recorded talks were posted on the platforms and available for consumption for days to months around the time of the scheduled event. For example, platform data demonstrated that attendees were continuing to view content for months after

ICLR ended (**Figure S14**). Thus, depending on how long participants choose to engage with the virtual platform, content dissemination could be limited or enhanced by the virtual format.

Demographic Impact

Opinions on specific conference components and the participant experience were interrogated with surveys distributed to conference attendees, as described in the methods. Survey responses indicated that reduction in cost and travel burdens such as documentation and time away from home were primary factors in the increase in attendance from underrepresented countries:

> "[The online format] saves money and it makes it possible to attend without giving up on other professional & private duties. I might haven't attended a conference as I live in India far away from the venue. It takes a lot of time for the visa process. As a research scholar, it's tough to get a travel accommodation budget for it. It was time-saving too." -POM 2 survey respondent

Survey respondents also pointed specifically to alleviation of concerns about childcare, a burden that disproportionately affects women[4], as a driver of social equity at VCs:

> "[The online conference format is] Environmentally friendly, allows people with caring [responsibilities] to attend, the opportunity for a far more diverse speaker pool and delegates." -POM 2 survey respondent

Additionally, responses to surveys distributed to 2020 NAMS VC attendees indicated that increased student participation was a direct result of the reduction in the cost of attendance:

> "I think this format was also great for allowing additional student participation and I had more students attend online than were going to come in person due to the financial differences." -NAMS survey respondent

Oral Sessions

Oral sessions for analyzed conferences were either livestreamed or pre-recorded and all released at a specified time. POM 2 oral presentations were livestreamed via a single Webex session at 20 – 30 minutes intervals. While audience members could not share audio or video, they could submit questions via the zoom messenger feature. The speaker answered as many questions as possible at the end of the talk via zoom video stream, and then addressed the remaining questions via direct message to the question-asker. The format lacked a conversational element between the speaker and the audience, but was time efficient and averted technical difficulties. 2020 NAMS and AAS VC talks were similarly livestreamed via zoom webinars. The NAMS talks took place at 20-minute intervals in five parallel zoom room sessions with a 20-minute midday break and no buffer time between talks. 2020 NAMS VC webinar attendance data indicated that generally only between 50% and 70% of registrants were attending the sessions at any given time and clear drops in attendance at 20-minute intervals showed that attendees were transitioning to other sessions between talks (**Figure S11**). Attendance in two rooms was disproportionately high relative to other rooms at some points, and the rates of transition between specific rooms were relatively high at other times, indicating the importance

of not scheduling popular sessions in parallel. Some respondents to surveys distributed to 2020 NAMS VC participants after the conference requested a longer conference with fewer parallel sessions to alleviate this issue. Conversely, the rate of transitions between rooms was spread evenly on the final day of the conference, indicating well balanced sessions. Attendance was relatively low for speakers that immediately followed the lunch break, indicating that the attendees needed a longer break. As the sessions were paced quickly and held in the middle of the day US time, it ensured that the talks took place at reasonable times for most other global attendees. However, the pace was difficult to maintain at times and parallel sessions occasionally failed to meet the tight schedule and were not in sync. Consequently, audience members felt at times that they could not take advantage of easy transitions to attend different talks. "Oral Session Scheduling" comments were the second most common response type to a post-conference survey question asking about areas of improvement for the NAMS VC:

> "It might be better if the schedule is loosened up with some buffer time of 5 minutes between talks, giving more time for questions and for people to switch between sessions. Whenever a session went a bit long, after switching to another session the next talk may have already started. Alternately, you would have to leave early to be on time to the other session. Also, the break time between morning and afternoon sessions of only 20 minutes should probably be increased, so people planning to attend oral sessions at every time slot (for the whole day) have more time to eat lunch or organize their notes and prepare for the afternoon sessions." – NAMS survey respondent

2020 NAMS VC oral session audience members could not share audio or video, but could submit questions throughout the presentation via the zoom messenger, or could utilize the "raise hand" feature within zoom to indicate that they had a question. At the end of the talk, the question-askers were "promoted" and given video and audio sharing capabilities to ask and discuss their question with the presenter via the video livestream. This Q&A format inevitably introduced some delays and technical issues, but facilitated discussion. Oral sessions were generally successful, and were the most common answer to the survey question of "what worked well" at the 2020 NAMS VC:

> "Oral presentation to broader audience is quite achievable through remote audio video connection. It is also very easy to switch rooms between each parallel session to listen interested talks, which is not that much possible for in-person conference. Presenter's voice and slides are better heard and viewed through online meeting." – NAMS survey respondent

The 2020 ICLR VC pre-recorded oral sessions and released the videos at the start of the conference on their virtual platform. A live Q&A session was held for each keynote speaker after the video had been available for some time, where a moderator asked the speaker questions that were collected and up-voted via a messenger feature throughout the conference. Live Q&A session attendees could also "raise their hand" to ask and discuss questions live via the video stream. This oral session format averted technical difficulties with live-streaming talks while maintaining a discussion-oriented atmosphere during the Q&A session. The live Q&A sessions were recorded and made available indefinitely along with the pre-recorded presentations, eliciting persistent viewing after the conference ended.

Virtual oral session were popular with attendees, as surveys distributed to 2020 NAMS and POM 2 VC participants indicated that large portions of the virtual delegations preferred virtual oral sessions to in-person oral sessions (**Figure S12 and S13).**

Posters

Virtual platforms were successful at delivering poster content to viewers, but creating an interactive virtual poster experience remains a challenge. POM 1 & 2 hosted twitter poster sessions where authors filled out a provided poster template and published the finished posters on twitter. Presenters could then discuss content and answer questions from poster viewers via comment sections. This format effectively expanded the typical poster audience, with the posters remaining available indefinitely, and some POM 1 posters reaching 4000 views[3]. While in-person interaction was not accommodated, the social media environment allowed attendees to continue engaging in the week following the conference, and allowed some to form lasting networks:

"The twitter poster session is a great initiative to grow the photonics community on twitter. I feel it also creates a long-lasting network between the people who presented posters as they can immediately form a connection." – POM 2 survey respondent

However, some POM survey respondents indicated that it would have been beneficial to have provided a central page with a listing of posters for more efficient browsing. POM 2 also experimented with hosting Mozilla Hubs Virtual Reality Poster Sessions (MHVRPS), for up to 15 participants. In MHVRPS, participants used an avatar to move through a virtual room with posters projected on the walls. Participants could speak with other avatars using an audio stream, with the volume of avatar voices proportional to the distance between the avatars to simulate a real-life experience. The format was effective at simulating a conversational environment but was only applied for a small number of posters and people, and would need to be scaled to fully meet the needs of a conference. NAMS and AAS employed the iPoster platform to host virtual posters filled out by participants using a distributed template. The NAMS posters were made available for viewing from a few days before the conference and up to a week after the conference. Live NAMS poster sessions were scheduled where poster viewers could interact with the poster presenters using either the iPoster messaging feature or by entering the zoom room assigned to each poster for face-to-face interaction with the presenter. The iPoster format expanded the typical audience for NAMS posters, with posters logging on average 142 views, and several posters logging over 700 views (**Figure S15**). Additionally, survey respondents indicated that this format was effective at distributing content:

> "Interacting with the posters themselves was very user-friendly. I spent more time looking at posters than I normally would at a conference and it was easier to find ones I was interested in." – NAMS survey respondent

Despite the high view counts, the virtual environment did not give presenters a sense of how many attendees were viewing their posters. Survey respondents indicated that some presenters felt discouraged and thought the virtual poster session was not effective at facilitating social interaction, leaving many presenters feeling isolated. This highlights a pervasive issue

with virtual poster sessions, as the conversational nature of in-person poster sessions is difficult to recreate in a virtual environment.

> "…the interactivity during the live sessions didn't work at all. I had precisely zero chats, messages, or visits to my poster (I was not part of the competition), and am not sure whether it got any visibility to the attendees. It may work better if attendees can schedule appointments with poster authors in advance. That way the authors aren't stuck in empty Zoom rooms missing out on networking." – NAMS survey respondent

ICLR replaced posters with 5-minute pre-recorded presentations that were posted along with an abstract, paper, code, and reviews on a single page. Authors were also available for live video chat during two separate Q&A sessions scheduled to accommodate participants from different time zones. The 5-minute video presentations were high quality and the format was effective at conveying the main message of the paper to the viewer. However, many poster presenters felt isolated and did not know how many attendees were viewing their presentations. Additionally, participants were reluctant to enter live Q&A sessions as they felt the need to be well informed on the material should they be the only participant in the room with the presenter [5].

Overall, virtual poster sessions environments are less developed than virtual oral session environments and will be a primary target of future innovation. Virtual posters were less popular with conference participants as only 15% of NAMS survey respondents and 57% of POM 2 survey respondents indicated that they preferred virtual poster sessions to in-person poster sessions (**Figure S12 and S13**).

Networking

VC platforms struggle to facilitate spontaneous social interaction and networking, but significant attention is being devoted to innovative new strategies for addressing this deficiency. While the incorporation of twitter in POMs instigated a significant amount of informal interaction, survey respondents indicated feelings of isolation:

> "I have not talked to a single participant of the POMs – making new connections is not straightforward. I don't even know who is there, other than the speakers." – POM 2 survey respondent

The 2020 NAMS VC attempted to facilitate the need for casual social interaction with "Virtual Hallways", which comprised several zoom rooms that attendees could join to interact with other participants outside of the scheduled oral and poster sessions. Virtual Hallways were moderated by volunteers who could place groups of attendees in breakout rooms upon request. The virtual hallways were popular among some survey respondents who indicated having meaningful interactions via this networking option. However, surveys indicated that participants thought these interactions could feel inauthentic:

> "One of the biggest consequences of being remote was the inability to casually chat with new people. Every interaction had to be directly organize, or in a large group (the large rooms)." -NAMS survey respondent

To address this issue, many survey respondents recommended that organizers provide full attendee lists as well as a platform "map" to indicate where particular attendees are located within the virtual environment at a particular time. Survey respondents also requested a central messaging feature and the ability to form their own breakout rooms for private interaction. The 2020 ICLR VC utilized a central chat feature and successfully encouraged participants to organize and host virtual meetups, resulting in 29 socials throughout the conference. However, the geographic reach of the socials was limited and the range of topics covered by the socials was narrow[5]. Future conferences should strive to make these socials more global and inclusive.

Despite efforts by organizers, current methods for facilitating virtual networking are inadequate and will require further development and testing with future virtual events. Previous efforts show promise but were unpopular with attendees as only 4% of NAMS survey respondents and 25% of POM 2 survey respondents indicated that they preferred virtual networking to in-person networking (**Figure S12 and S13**).

Innovations/Platforms

The COVID-19 pandemic has given rise to a burgeoning economy of commercial and open-source technology designed to deliver VCs. Many of these options have been employed to host 2020 VCs. Organizers of the 2020 ICLR VC conducted their conference using MiniConf, a VC platform that they built themselves. MiniConf is designed to manage papers, schedules, and speakers for a virtual academic conference[6] and is available for public use here: *http://mini-conf.org*. Since the 2020 ICLR VC, MiniConf has been used to host academic conferences covering a variety of fields. The Neuromatch conference used a virtual platform to facilitate 15-minute one-on-one networking sessions between attendees by algorithmically matching key words from their research abstracts[7]. Organizers have also experimented with schedule designs to better accommodate global communities. The 2020 ICLR VC followed an asynchronous schedule that could be engaged at a time that suited each participant. Pre-recorded presentations accommodated all time zones, and several live Q&A sessions were scheduled at different times for each presentation, so as to facilitate live interaction for participants from all regions. POM accommodated its global community by scheduling separate synchronous events, with POM 1 taking place during the day in North America and POM 2 occurring during hours that were convenient for Europe and the East. POM 1, which took place prior to the pandemic, also incorporated numerous hubs around the globe, where scientists could congregate for in-person interaction with local participants, while still engaging with the global community.

Organizational Recommendations

Cost of attendance to IPCs is more expensive for international participants and is especially restrictive to scientists from countries with less spending power. Consequently, conferences should consider assigning region-specific registration fees to accommodate scientists from historically marginalized countries. Organizers could also consider holding conferences in places such as Africa, as the cost of attendance would be lower and more inclusive of African scientists. However, the increased international travel created by forcing the large American contingent to travel overseas makes these events far less environmentally sustainable. This was demonstrated by the hypothetical 2020 ICLR IPC in Ethiopia, which would have had an average attendee footprint of 3.39 tonnes CO_2e, far greater than the historical average attendee footprint of historical ICLR IPCs held in North America (1.49 tonnes CO_2e).

One viable organizational strategy that has been proposed to address conference carbon footprints is for attendees to buy carbon offsets to negate emissions associated with conference attendance[8]. Conference organizers could potentially incorporate this cost in the registration fee, thus guaranteeing a carbon neutral experience for all IPC attendees. The high cost of attendance to IPCs also excludes persons from non-research-intensive institutions. To address this, conference organizers could also offer lower registration fees to attendees who are paying out-of-pocket instead of with grants. Organizers should also consider adopting a hybrid conference format such as that employed for POM 1. The hybrid format, comprised of numerous regional hubs spread around the globe participating in virtual sessions, maintains the advantages of both the VC and IPC formats. Attendees have the option to avoid extensive travel and interact in-person with local community members, while consuming scientific content from the global community through virtual platforms that have proven effective at disseminating scientific knowledge. Alternatively, participants could still have the option to travel to an on-site location for a fully IPC experience at a greater cost.

Virtual environments are most effective at delivering oral content, and less effective at facilitating poster sessions and social networking. Consequently, it is recommended that organizers employ oral presentations as much as possible. Conference organizers and respondents to the 2020 NAMS VC surveys agree that the plenary session on the first day was enjoyable and that convening the VC for a plenary talk at the start each day of a multi-day conference would make the event more cohesive. Plenary presenters would also be easy to recruit considering the large audiences that VCs attract. It is also important to ensure that presenters are familiar with the conference platform so as to avoid technical difficulties during the event. Live presenters should be required to attend a practice session prior to the VC to ensure that they can successfully use the platform to present their work. If oral presentations are held live at scheduled times, it is especially important that the sessions strictly follow the schedule. Conference participants state that the ability to seamlessly move between parallel sessions is a major advantage of the virtual format, but this advantage is negated if the talks do not take place at the scheduled timeslots. Survey attendees also requested more than the one 20-min lunch break scheduled during the 2020 NAMS VC, and attendance was low immediately following the lunch break, indicating the importance of allowing enough time during this midday break. Buffer time should also be scheduled between sessions and individual talks to allow flexibility, such as potentially leaving an open slot at the end of each session for a talk that had to be aborted due to technical difficulties. It could also be beneficial to instead use a virtual platform to release pre-recorded presentations and then hold live Q&A sessions after the recordings have been released. Chat features are a more efficient method for collecting and asking questions during a Q&A session, but asking questions via video chat does more to facilitate discussion.

While virtual posters can effectively deliver large amounts of content to broad audiences, interactive poster sessions are challenging to administer virtually. Organizers could consider replacing in-person poster sessions with pre-recorded oral presentations and then scheduling live Q&A sessions for questions collected via a chat feature throughout the conference or asked live by participants.

Facilitating networking is also challenging with a virtual environment, although significant attention is being devoted to developing software and virtual reality technology to address this shortcoming. A central messaging feature as well as a list of participants and their current locations within the virtual environment could help to accommodate informal social

interaction. Giving attendees the ability to form their own breakout rooms would also be helpful, as informal social interaction is difficult via video chat in large groups. Most importantly, scientific communities should continue to develop and test innovative VC solutions and share their findings, so VCs can continue to get better for everyone.

New Areas of Investigation

The findings of this study motivate several new areas of research. First, a major drawback of VCs identified by this study is the poor performance of virtual networking features. Future conferences should strive to implement innovative new methods of facilitating virtual networking and document their performance. These tactics will contribute to the development of virtual networking features and improve these tools for future use. Second, further investigation is warranted into how travel requirements impact participation from different organizations (small vs. large business, domestic vs. global). Better understanding of how IPCs or VCs may be more or less inclusive to different types of organizations will better inform communities on what conference options are the best for them. Third, the findings of this study indicate that IPCs and VCs each have attributes that benefit certain participants. These findings and future research could be used by technical/scientific societies, funding agencies, and universities to tailor fiscal and organization policy related to conference attendance that specifically benefit the members of their community. Finally, this study highlights the need for future research on the relationship between work-related travel and career progression. Attendance at conferences has been shown to be important for career advancement, but further understanding of this relationship could further highlight the importance of making conferences equitable and inclusive.

Table S1 | Average cost of attendance per person calculated by converting one-way flight costs to round trip costs using either a factor of 2 or 1.5 for historical ICLR, AAS, and NAMS IPCs, hypothetical 2020 ICLR, AAS, and NAMS IPCs and 2020 ICLR, AAS, and NAMS VCs.

Average Cost per Person (USD)	Round trip cost = one-way cost * 2			Round trip cost = one-way cost * 1.5		
	ICLR	AAS	NAMS	ICLR	AAS	NAMS
2015	-	-	$2,183	-	-	$1,947
2016	-	$1,973	$2,774	-	$1,789	$2,436
2017	-	$1,820	-	-	$1,639	-
2018	$3,224	$1,883	$1,895	$2,909	$1,715	$1,671
2019	$2,466	$1,857	$2,122	$2,126	$1,677	$1,899
Hypothetical 2020 In-person	$3,445	$1,879	$2,219	$2,838	$1,678	$1,934
2020 Virtual	$74	$162	$72	$74	$162	$72
Historical Average	$2,795	$1,885	$2,215	$2,466	$1,707	$1,965
Percent Change in Virtual Conference Cost vs. Previous Historical Conferences	-97%	-91%	-97%	-97%	-91%	-96%
2020 Virtual Conference Cost as Percent of Hypothetical 2020 In-person Conference Cost	2.1%	8.6%	3.2%	2.6%	9.6%	3.7%

Table S2 | Average attendee travel, registration, hotel and food expenses for analyzed IPCs-turned-VCs.

Conference	Expense	Average Attendee Expenses						
		2015	2016	2017	2018	2019	IPC Avg	2020 VC
ICLR	Travel	-	-	-	$1,257	$1,358	$1,308	$0
	Registration	-	-	-	$525	$517	$521	$74
	Hotel	-	-	-	$974	$393	$683	$0
	Food	-	-	-	$468	$198	$333	$0
	Total	-	-	-	$3,224	$2,466	$2,845	$74
AAS	Travel	-	$734	$727	$671	$721	$713	$0
	Registration	-	$432	$432	$432	$432	$432	$162
	Hotel	-	$567	$466	$555	$468	$514	$0
	Food	-	$241	$195	$225	$236	$224	$0
	Total	-	$1,973	$1,820	$1,883	$1,857	$1,883	$162
NAMS	Travel	$945	$1,353	-	$893	$894	$1,021	$0
	Registration	$455	$507	-	$427	$512	$475	$72
	Hotel	$575	$672	-	$411	$545	$551	$0
	Food	$209	$242	-	$163	$172	$196	$0
	Total	$2,183	$2,774	-	$1,895	$2,122	$2,244	$72

Table S3 | Total number of attendees, average cost of attendance, and percent difference in cost of attendance versus the United States for each region at historical NAMS IPCs and a hypothetical 2020 NAMS IPC at the originally planned on-site location with the 2020 NAMS VC delegation. *Regions do not add up to total as some attendee origins are unknown and not included as a subsection in this table.

Region	Data	2015	2016	2018	2019	2020 VC	IPC Average
Africa	Number of Attendees	2	1	0	2	0	1.25
	Average Attendee Cost (USD)	3995	6418	-	4692	-	4758
	% Cost Diff vs. USA	131%	179%	-	182%	-	174%
Asia	Number of Attendees	38	49	39	44	16	42.5
	Average Attendee Cost (USD)	4439	4139	4036	4414	4178	4254
	% Cost Diff vs. USA	157%	80%	193%	166%	125%	145%
Europe	Number of Attendees	22	17	26	42	54	26.75
	Average Attendee Cost (USD)	3112	4074	3130	3290	3535	3339
	% Cost Diff vs. USA	80%	77%	128%	98%	90%	92%
Middle East	Number of Attendees	28	20	21	15	37	21
	Average Attendee Cost (USD)	3884	4308	3713	3849	4231	3936
	% Cost Diff vs. USA	125%	88%	170%	132%	127%	127%
Oceania	Number of Attendees	2	4	3	5	4	3.5
	Average Attendee Cost (USD)	4924	4701	5451	5709	4022	5253
	% Cost Diff vs. USA	185%	105%	296%	244%	116%	203%
Other Americas	Number of Attendees	10	9	16	45	24	20
	Average Attendee Cost (USD)	1974	2137	1878	1775	2009	1861
	% Cost Diff vs. USA	14%	-7%	36%	7%	8%	7%
USA	Number of Attendees	345	257	310	394	500	326.5
	Average Attendee Cost (USD)	1726	2297	1376	1661	1860	1736
	% Cost Diff vs. USA	-	-	-	-	-	-
Total	Number of Attendees	456	362	428	553	635	450
	Average Attendee Cost (USD)	2183	2774	1895	2122	2219	2215
	% Cost Diff vs. USA	27%	21%	38%	28%	19%	28%

Table S4 | Regional average cost of attendance as a percent of attendee country's GDP per capita for analyzed historical IPCs.

Conference	Region	Regional Average Cost / Regional Per Capita GDP					
		2015	2016	2017	2018	2019	IPC Average
ICLR	Other Americas	-	-	-	5.8%	4.8%	5.3%
	USA	-	-	-	4.1%	2.9%	3.5%
	Asia	-	-	-	17.0%	15.2%	16.1%
	Europe	-	-	-	9.1%	7.2%	8.1%
	Middle East	-	-	-	12.0%	9.6%	10.8%
	Africa	-	-	-	101.3%	214.1%	157.7%
	Oceania	-	-	-	8.4%	8.0%	8.2%
	Unknown	-	-	-	-	-	-
AAS	Other Americas	-	7.4%	5.7%	6.8%	5.0%	6.2%
	USA	-	2.9%	2.7%	2.8%	2.7%	2.8%
	Asia	-	13.9%	18.7%	11.0%	14.8%	14.6%
	Europe	-	6.7%	7.7%	7.7%	6.3%	7.1%
	Middle East	-	4.9%	-	-	72.8%	38.9%
	Africa	-	494.1%	74.5%	151.8%	-	240.1%
	Oceania	-	7.0%	7.5%	7.8%	6.4%	7.2%
	Unknown	-	3.2%	2.9%	3.5%	3.4%	3.2%
NAMS	Other Americas	4.8%	4.3%	-	4.5%	3.9%	4.4%
	USA	2.7%	3.6%	-	2.2%	2.6%	2.8%
	Asia	13.0%	14.2%	-	14.1%	13.3%	13.7%
	Europe	6.2%	8.8%	-	7.1%	7.0%	7.3%
	Middle East	14.5%	15.6%	-	13.8%	11.5%	13.8%
	Africa	80.0%	100.0%	-	-	73.1%	84.4%
	Oceania	8.0%	7.7%	-	8.9%	9.3%	8.5%
	Unknown	3.2%	3.9%	-	2.8%	3.3%	3.3%

Table S5 | Number of countries represented, total attendees, and total attendees from the conference region at analyzed historically IPCs-turned-VCs. Conference region for historically IPCs is defined as the United States for AAS and NAMS (All AAS and NAMS IPCs were held in the United States) and North America for ICLR (All ICLR IPCs were held in United States or Canada).

Conference	Conference Attendance			Number of Countries Represented		
	ICLR	AAS	NAMS	ICLR	AAS	NAMS
2015	-	-	456	-	-	23
2016	-	727	362	-	20	19
2017	-	615	-	-	20	-
2018	1985	740	428	39	18	24
2019	2584	753	553	51	18	27
2020 Virtual	4980	1399	635	86	36	23
Historical In-person Conference Average	2284.5	708.8	449.8	45.0	19.0	23.3
2015-2018 Conference Average	1985.0	694.0	415.3	39.0	19.3	22.0
2020 Virtual Conference Attendance Percent Change vs. Historical Average	118%	97%	41%	91%	89%	-1%
Historical In-person Conference Average Attendance from Conference Region	1488.0	607.8	326.5	-	-	-
Historical In-person Conference Average Attendance from Conference Region as Percent of Total Attendance	65%	86%	73%	-	-	-

Table S6 | Number of NI>10 countries and scientists from NI>10 countries in attendance at analyzed historical IPCs.

NI>10 Type	Conference	2015	2016	2017	2018	2019	2020 VC	IPC Average	IPC Standard Deviation
NI>10 Countries	ICLR	-	-	-	29	41	76	35	8.49
	AAS	-	10	11	9	8	26	9.5	1.29
	NAMS	13	10	-	14	17	13	13.5	2.89
NI>10 Attendees	ICLR	-	-	-	207	201	955	204	-
	AAS	-	12	11	13	8	64	11	2.16
	NAMS	52	41	-	48	60	65	50.25	7.93

Table S7 | Total carbon footprint of analyzed historically IPCs-turned-VCs presented as the total greenhouse gas footprint converted to CO_2 equivalents (CO_2e).

Conference Footprint (tonnes CO_2e)	ICLR	AAS	NAMS	Total
2015	-	-	520	520
2016	-	653	561	1213
2017	-	525	-	525
2018	2904	565	471	3940
2019	3915	625	624	5163
Hypothetical 2020 In-person	16858	1304	858	19021
2020 Virtual	0.80	0.17	0.10	1.07
Historical Average	3410	592	544	4545
Percent Change Most Recent In-person (2019) vs. Previous Historical Conferences	35%	8%	21%	-
2020 Virtual Conference Footprint as Percent of Hypothetical 2020 In-person Conference Footprint	0.005%	0.013%	0.012%	-

Table S8 | NAMS attendee gender as determined by a Gender API or through manual designation via author familiarity with community members or internet search of attendee name.

Type	Category	2015	2016	2018	2019	2020 VC	IPC Avg
Manual	female	118	87	107	152	193	116.0
	male	302	251	310	391	423	313.5
	unknown	36	24	11	10	19	20.3
	total	456	362	428	553	635	449.8
	female %	25.9%	24.0%	25.0%	27.5%	30.4%	25.8%
	male %	66.2%	69.3%	72.4%	70.7%	66.6%	69.7%
	unknown %	7.9%	6.6%	2.6%	1.8%	3.0%	4.5%
API	female	122	80	102	146	184	112.5
	male	325	272	316	388	425	325.3
	unknown	9	10	10	19	26	12.0
	total	456	362	428	553	635	449.8
	female %	26.8%	22.1%	23.8%	26.4%	29.0%	25.0%
	male %	71.3%	75.1%	73.8%	70.2%	66.9%	72.3%
	unknown %	2.0%	2.8%	2.3%	3.4%	4.1%	2.7%

Table S9 | Effect of cost of attendance and non-cost related travel burden on attendance to 2020 NAMS VC and historical NAMS IPCs. (~50 % completion for each gender)

Gender	Response	Was the reduction in cost an important factor in your decision to attend the Virtual NAMS 2020?	Was the cost of attendance to past in-person NAMS conferences ever an important factor in your decision to not attend?	Was the reduction in non-cost related travel burden (i.e. time away from home-life responsibilities) an important factor in your decision to attend the Virtual NAMS 2020?	Was the non-cost related travel burden (i.e. time away from home-life responsibilities) for past in-person NAMS conferences ever an important factor in your decision to not attend?
Female	Yes	67.78%	46.07%	65.93%	46.07%
	No	32.22%	53.93%	34.07%	53.93%
	Sample Size	90	89	91	89
Male	Yes	43.93%	29.44%	47.91%	37.85%
	No	56.07%	70.56%	52.09%	62.15%
	Sample Size	214	214	215	214

Table S10 | Attendance by gender to analyzed historically IPCs-turned-VCs.

Conference	Gender	2015	2016	2017	2018	2019	IPC Avg	2020 VC
ICLR	Female	-	-	-	183	335	259	914
	Male	-	-	-	1429	1897	1663	3671
	Other	-	-	-	-	1	1	6
	Trans	-	-	-	0	0	0	2
	Gender Queer	-	-	-	0	2	1	8
	Prefer not to answer	-	-	-	29	33	31	67
	Unknown	-	-	-	0	0	0	0
AAS	Female	-	223	205	275	222	231.25	508
	Male	-	497	404	456	525	470.5	879
	Other	-	-	-	-	-	-	-
	Trans	-	-	-	-	-	-	-
	Gender Queer	-	-	-	-	-	-	-
	Prefer not to answer	-	-	-	-	-	-	-
	Unknown	7	6	-	9	6	7	12
NAMS	Female	118	87	-	107	152	116	193
	Male	302	251	-	310	391	313.5	423
	Other	-	-	-	-	-	-	-
	Trans	-	-	-	-	-	-	-
	Gender Queer	-	-	-	-	-	-	-
	Prefer not to answer	-	-	-	-	-	-	-
	Unknown	36	24	-	11	10	20.25	19

Table S11 | Percent of attendees that were female at analyzed historically IPCs-turned-VCs.

Conference	2015	2016	2017	2018	2019	IPC Avg	2020 VC
ICLR	-	-	-	11.2%	14.8%	13.0%	19.6%
AAS	-	30.7%	33.3%	37.2%	29.5%	32.7%	36.3%
NAMS	25.9%	24.0%	-	25.0%	27.5%	25.6%	30.4%

Table S12 | Percent women in natural science and engineering fields for the countries represented in the delegations of historical ICLR IPCs.

Country	Conference	Value	2018	2019	2018 Estimated Women	2019 Estimated Women
Argentina	ICLR	33.07%	2	0	0.66	0.00
Australia	ICLR	33.07%	8	12	2.65	3.97
Austria	ICLR	33.07%	3	5	0.99	1.65
Belgium	ICLR	33.07%	2	9	0.66	2.98
Brazil	ICLR	33.07%	4	1	1.32	0.33
Burkina Faso	ICLR	20.82%	0	1	0.00	0.21
Burundi	ICLR	14.10%	0	1	0.00	0.14
Canada	ICLR	33.07%	320	205	105.84	67.80
Chile	ICLR	30.45%	0	3	0.00	0.91
China	ICLR	33.07%	71	76	23.48	25.14
Colombia	ICLR	35.38%	0	1	0.00	0.35
Czech Republic	ICLR	20.78%	3	3	0.62	0.62
Denmark	ICLR	33.07%	4	5	1.32	1.65
Estonia	ICLR	40.91%	0	1	0.00	0.41
Ethiopia	ICLR	15.41%	0	1	0.00	0.15
Finland	ICLR	33.07%	8	6	2.65	1.98
France	ICLR	33.07%	41	59	13.56	19.51
Germany	ICLR	33.07%	48	75	15.88	24.81
Ghana	ICLR	14.92%	0	1	0.00	0.15
Hungary	ICLR	23.71%	0	5	0.00	1.19
India	ICLR	11.92%	16	11	1.91	1.31
Iran	ICLR	29.72%	1	0	0.30	0.00
Ireland	ICLR	33.07%	0	1	0.00	0.33
Israel	ICLR	33.07%	31	26	10.25	8.60
Italy	ICLR	33.07%	6	5	1.98	1.65
Japan	ICLR	33.07%	64	62	21.17	20.51
Latvia	ICLR	46.44%	0	1	0.00	0.46
Lebanon	ICLR	33.07%	1	0	0.33	0.00
Luxembourg	ICLR	29.01%	0	1	0.00	0.29
Morocco	ICLR	40.61%	0	1	0.00	0.41
Netherlands	ICLR	24.09%	25	28	6.02	6.75
Nigeria	ICLR	33.07%	0	1	0.00	0.33
North Korea	ICLR	33.07%	1	1	0.33	0.33
Norway	ICLR	33.07%	3	9	0.99	2.98
Poland	ICLR	31.67%	3	7	0.95	2.22

Portugal	ICLR	39.70%	1	4	0.40	1.59
Qatar	ICLR	26.20%	2	1	0.52	0.26
Romania	ICLR	45.90%	1	0	0.46	0.00
Russia	ICLR	33.07%	26	18	8.60	5.95
Rwanda	ICLR	21.36%	0	1	0.00	0.21
Saudi Arabia	ICLR	33.07%	2	2	0.66	0.66
Singapore	ICLR	33.07%	7	8	2.32	2.65
South Africa	ICLR	33.07%	5	1	1.65	0.33
South Korea	ICLR	33.07%	65	103	21.50	34.07
Spain	ICLR	33.07%	17	4	5.62	1.32
Swaziland	ICLR	33.07%	1	0	0.33	0.00
Sweden	ICLR	33.07%	11	6	3.64	1.98
Switzerland	ICLR	33.07%	34	38	11.25	12.57
Taiwan	ICLR	33.07%	18	11	5.95	3.64
Turkey	ICLR	30.69%	2	1	0.61	0.31
Uganda	ICLR	24.66%	0	3	0.00	0.74
Ukraine	ICLR	40.68%	0	4	0.00	1.63
United Arab Emirates	ICLR	33.07%	1	0	0.33	0.00
United Kingdom	ICLR	33.07%	169	260	55.90	85.99
Uruguay	ICLR	47.18%	0	1	0.00	0.47
USA	ICLR	34.28%	958	1493	328.37	511.75
Vietnam	ICLR	33.07%	0	1	0.00	0.33
				Women as % of Attendees Conference	33.35%	33.54%

Table S13 | Percent women in natural science and engineering fields for the countries represented in the delegations of historical AAS IPCs.

Country	Conference	Value	2016	2017	2018	2019	2016 Estimated Women	2017 Estimated Women	2018 Estimated Women	2019 Estimated Women
Australia	AAS	33.07%	3	1	2	3	1	0	1	1
Austria	AAS	33.07%	1	0	0	0	0	0	0	0
Belgium	AAS	33.07%	0	1	0	1	0	0	0	0
Canada	AAS	33.07%	4	7	5	6	1	2	2	2
Chile	AAS	30.45%	1	1	1	0	0	0	0	0
China	AAS	33.07%	3	7	0	4	1	2	0	1
Colombia	AAS	35.38%	0	1	1	1	0	0	0	0
Ethiopia	AAS	15.41%	1	0	1	0	0	0	0	0
Finland	AAS	33.07%	1	1	0	0	0	0	0	0

France	AAS	33.07%	2	3	1	1	1	1	0	0
Germany	AAS	33.07%	5	4	6	5	2	1	2	2
Ghana	AAS	14.92%	0	0	1	0	0	0	0	0
Holy See (Vatican City)	AAS	33.07%	0	0	0	1	0	0	0	0
Hungary	AAS	23.71%	0	1	1	0	0	0	0	0
Iceland	AAS	33.07%	1	0	0	0	0	0	0	0
India	AAS	11.92%	0	0	0	1	0	0	0	0
Iraq	AAS	43.06%	0	0	0	1	0	0	0	0
Israel	AAS	33.07%	1	0	0	0	0	0	0	0
Italy	AAS	33.07%	1	0	1	0	0	0	0	0
Japan	AAS	33.07%	1	1	2	3	0	0	1	1
Mexico	AAS	33.07%	2	0	0	1	1	0	0	0
Netherlands	AAS	24.09%	2	1	4	1	0	0	1	0
Russia	AAS	33.07%	0	0	2	1	0	0	1	0
Slovakia	AAS	33.54%	0	1	0	0	0	0	0	0
South Africa	AAS	33.07%	0	1	1	0	0	0	0	0
South Korea	AAS	33.07%	6	5	3	6	2	2	1	2
Spain	AAS	33.07%	0	1	0	0	0	0	0	0
Switzerland	AAS	33.07%	4	0	2	1	1	0	1	0
Taiwan	AAS	33.07%	1	1	0	0	0	0	0	0
United Kingdom	AAS	33.07%	5	4	5	10	2	1	2	3
Unknown	AAS	33.07%	63	50	54	63	21	17	18	21
Uruguay	AAS	47.18%	0	1	0	0	0	0	0	0
USA	AAS	34.28%	619	522	647	643	212	179	222	220
						Women as % of Attendees Conference	34.05%	34.09%	34.02%	34.08%

Table S14 | Percent women in natural science and engineering fields for the countries represented in the delegations of historical NAMS IPCs.

Country	Conference	Value	2015	2016	2018	2019	2015 Estimated Women	2016 Estimated Women	2018 Estimated Women	2019 Estimated Women
Argentina	NAMS	33.07%	0	0	0	1	0	0	0	0
Australia	NAMS	33.07%	2	4	3	5	1	1	1	2
Austria	NAMS	33.07%	0	1	1	3	0	0	0	1
Belgium	NAMS	33.07%	0	1	0	4	0	0	0	1
Brazil	NAMS	33.07%	2	0	3	3	1	0	1	1

Canada	NAMS	33.07%	8	9	13	41	3	3	4	14
China	NAMS	33.07%	10	20	11	10	3	7	4	3
Czech Republic	NAMS	20.78%	0	2	3	0	0	0	1	0
Denmark	NAMS	33.07%	0	2	0	1	0	1	0	0
France	NAMS	33.07%	1	2	3	3	0	1	1	1
Germany	NAMS	33.07%	8	0	3	7	3	0	1	2
Hungary	NAMS	23.71%	0	0	0	1	0	0	0	0
India	NAMS	11.92%	0	0	1	0	0	0	0	0
Israel	NAMS	33.07%	6	6	6	8	2	2	2	3
Italy	NAMS	33.07%	4	3	4	4	1	1	1	1
Japan	NAMS	33.07%	3	5	6	9	1	2	2	3
Netherlands	NAMS	24.09%	2	0	3	6	0	0	1	1
Norway	NAMS	33.07%	1	0	1	2	0	0	0	1
Portugal	NAMS	39.70%	0	0	1	0	0	0	0	0
Russia	NAMS	33.07%	0	0	0	2	0	0	0	1
Saudi Arabia	NAMS	33.07%	19	14	14	6	6	5	5	2
Singapore	NAMS	33.07%	11	10	5	11	4	3	2	4
South Africa	NAMS	33.07%	1	1	0	2	0	0	0	1
South Korea	NAMS	33.07%	14	14	14	10	5	5	5	3
Spain	NAMS	33.07%	1	1	3	1	0	0	1	0
Sweden	NAMS	33.07%	1	0	0	0	0	0	0	0
Switzerland	NAMS	33.07%	2	2	2	2	1	1	1	1
Taiwan	NAMS	33.07%	0	0	2	4	0	0	1	1
Tunisia	NAMS	33.07%	1	0	0	0	0	0	0	0
Turkey	NAMS	30.69%	1	0	1	0	0	0	0	0
United Arab Emirates	NAMS	33.07%	2	0	0	1	1	0	0	0
United Kingdom	NAMS	33.07%	2	3	2	6	1	1	1	2
Unknown	NAMS	33.07%	9	5	13	6	3	2	4	2
USA	NAMS	34.28%	345	257	310	394	118	88	106	135
						Women as % of Attendees Conference	33.94%	33.86%	33.76%	33.82%

Table S15 | Number attendees by job type and percent of all attendees that were each job type at historical NAMS IPCs.

Job Type	Number of Attendees				Percent of Attendees			
	2015	2016	2018	2019	2015	2016	2018	2019
Undergrad Student	2	2	1	13	0%	1%	0%	2%
Grad Student	131	101	132	161	29%	28%	31%	29%
Postdoc	20	11	21	44	4%	3%	5%	8%
Academic Scientist	114	103	144	151	25%	28%	34%	27%
Industry Personnel	180	132	118	176	39%	36%	28%	32%
Unknown/Other	9	13	12	8	2%	4%	3%	1%

Table S16 | Percent of attendees that were students and postdocs at analyzed historical IPCs.

Job Type	Conference	Percent of Attendees
Students	2015 NAMS	29.17%
	2016 NAMS	28.45%
	2018 NAMS	31.07%
	2019 NAMS	31.46%
	2019 ICLR	33.33%
	2019 AAS	20.23%
Postdocs	2015 NAMS	4.39%
	2016 NAMS	3.04%
	2018 NAMS	4.91%
	2019 NAMS	7.96%
	2019 ICLR	3.09%
	2019 AAS	6.94%

Table S17 | Percent of attendees that were students and postdocs at analyzed 2020 VCs.

Job Type	Conference	Percent of Attendees
Students	2020 ICLR	51.91%
	2020 AAS	20.54%
	2020 NAMS	44.41%
	2020 POM 1	49.00%
	2020 POM 2	48.86%
	2020 IWA	36.80%
Postdocs	2020 ICLR	3.63%
	2020 AAS	7.17%
	2020 NAMS	7.87%
	2020 POM 1	18.12%
	2020 POM 2	17.93%
	2020 IWA	8.99%

Table S18 | Attendance by scientists from R2 Universities, PUIs, and Minority Servings Institutions at historical AAS and NAMS IPCs.

Conference	Institution Type	2015	2016	2017	2018	2019	IPC Avg	2020 VC
AAS	R2	-	41	19	39	41	35	72
	PUI	-	89	49	71	60	67.25	116
	Minority Serving	-	10	15	7	3	8.75	7
NAMS	R2	29	18	-	21	23	22.75	33
	PUI	4	5	-	2	3	3.5	9
	Minority Serving	3	0	-	2	4	2.25	2

Table S19 | Number of attendees from each region at analyzed historically IPCs-turned-VCs.

Conference	Region	2015	2016	2017	2018	2019	IPC Avg	2020 VC
ICLR	USA	-	-	-	958	1493	1225.5	1977
	Unknown	-	-	-	0	0	0	0
	Other Americas	-	-	-	326	211	268.5	421
	Asia	-	-	-	242	273	257.5	844
	Europe	-	-	-	405	555	480	1441
	Africa	-	-	-	6	10	8	144
	Middle East	-	-	-	40	30	35	87
	Oceania	-	-	-	8	12	10	66
AAS	USA	-	619	522	647	643	607.75	1150
	Unknown	-	63	50	54	63	57.5	54
	Other Americas	-	7	10	7	8	8	58
	Asia	-	11	14	5	14	11	32
	Europe	-	22	17	22	21	20.5	84
	Africa	-	1	1	3	0	1.25	2
	Middle East	-	1	0	0	1	0.5	1
	Oceania	-	3	1	2	3	2.25	18
NAMS	USA	345	257	-	310	394	326.5	500
	Unknown	9	5	-	13	6	8.25	0
	Other Americas	10	9	-	16	45	20	24
	Asia	38	49	-	39	44	42.5	16
	Europe	22	17	-	26	42	26.75	54
	Africa	2	1	-	0	2	1.25	0
	Middle East	28	20	-	21	15	21	37
	Oceania	2	4	-	3	5	3.5	4

Table S20 | Networking features incorporated in the virtual platforms for analyzed historically IPCs-turned-VCs and for the always virtual IWA and POMs.

Conference	Social Media	Messaging	Video Chat	Virtual Reality	Local In-person Meetups
American Astronomical Society	Twitter, Instagram, Facebook, Linkedin	Community Chat Room	In-person Meetups (Zoom Room)	None	None
North American Membrane Society	Twitter	None	Virtual Hallways (Zoom Rooms)	None	None
International Conference on Learning Representations	None	Central Chat Feature	Social meetups	ICLRTown	None
Photonics Online Meetups	Twitter, WeChat, Linkedin	None	Gather.town	Mozilla Hubs, Gather.town	POM-Hubs
International Water Association Biofilms	None	Central Chat Feature, Whova Community	Gather.town	Gather.town	None

Table S21 | Analyzed historically IPCs-turned-VCs with listed historical years for which data is available, 2020 event dates and information on data sources and data types.

Conference	Number of Historical In-Person Conferences	Historical Years	2020 Virtual Conference Dates	Data Source			Data Type	
				Attendee Job Type	Attendee Gender	Attendee Institution	Attendee Origin Data Type	Platform Usage Data
International Conference on Learning Representations	2	2018-2019	04/26/20 - 05/01/20	Volunteer Survey	Volunteer Survey	-	Number of attendees by country	Google Analytics web page views
American Astronomical Society	4	2016-2019	06/01/20 - 06/03/20	Volunteer Survey	Gender API (attendee name query)	Registration Data	Attendee-specific city	Zoom webinar output data, iPoster platform data
North American Membrane Society	4	2015-2016, 2018-2019	05/18/20 - 05/21/20	Registration Data	Manual Designation	Registration Data	Attendee-specific city	Zoom webinar output data, iPoster platform data

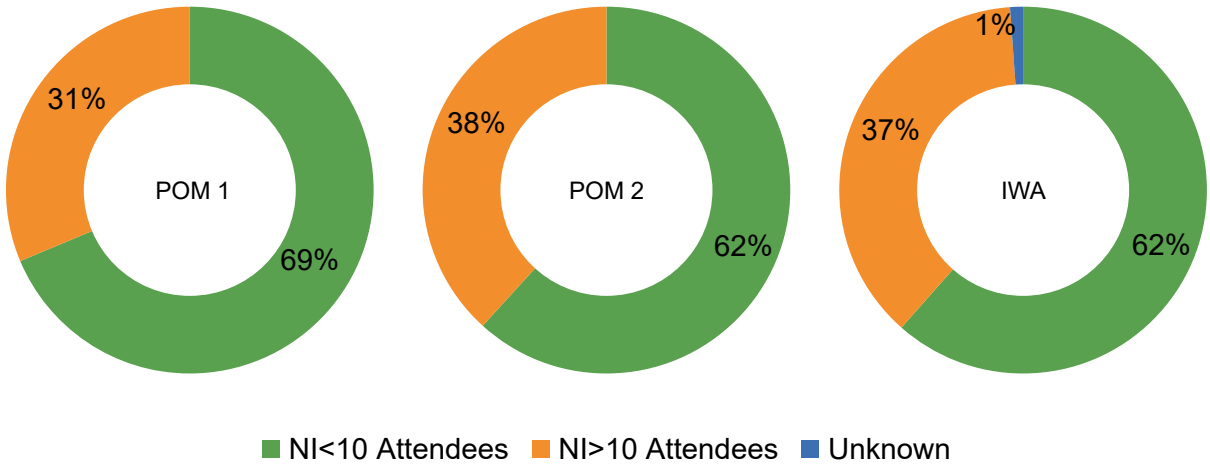

Fig. S1 | A large percentage of attendees to the always virtual POM 1, POM 2, and IWA were from NI>10. countries.

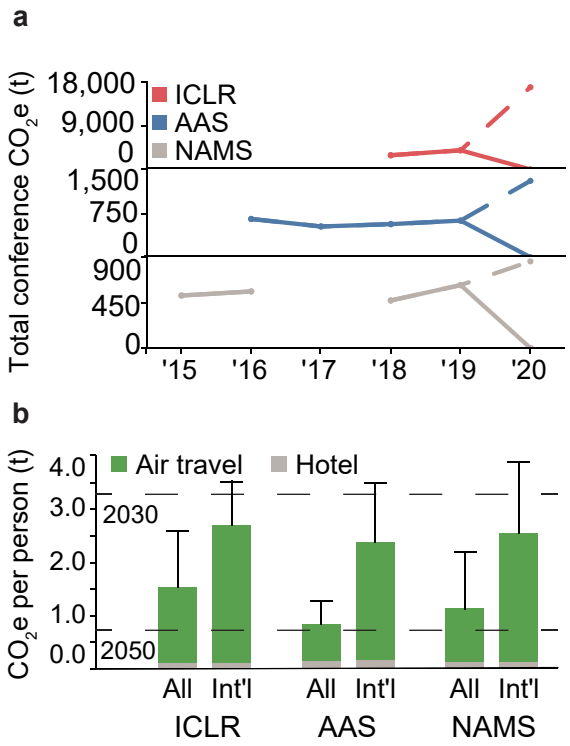

Fig. S2 | The cost and carbon footprint of IPCs are significant, increasing and inequitable. (**a**) The total summed carbon footprints of air travel and accommodation for all attendees to historical ICLR, AAS, and NAMS IPCs increased over time and the hypothetical 2020 IPC footprint (dotted line), calculated as the footprint if all VC participants had attended an IPC at the originally chosen location, was far greater than any previous conferences, while 2020 VCs had near zero footprint. (**b**) The average carbon footprint of attendance for domestic and international participants to the most recent IPCs (2019) (n=1 for ICLR, AAS, and NAMS) were significant compared to the proposed median global per capita annual carbon budgets for 2030 and 2050 in a collection of proposed decarbonization pathways designed to limit global warming to 1.5 C with a small overshoot[1]. Error bars are defined as the standard deviation of travel related carbon footprints for 2019 IPC attendees as calculating error for hotel carbon footprints was not possible.

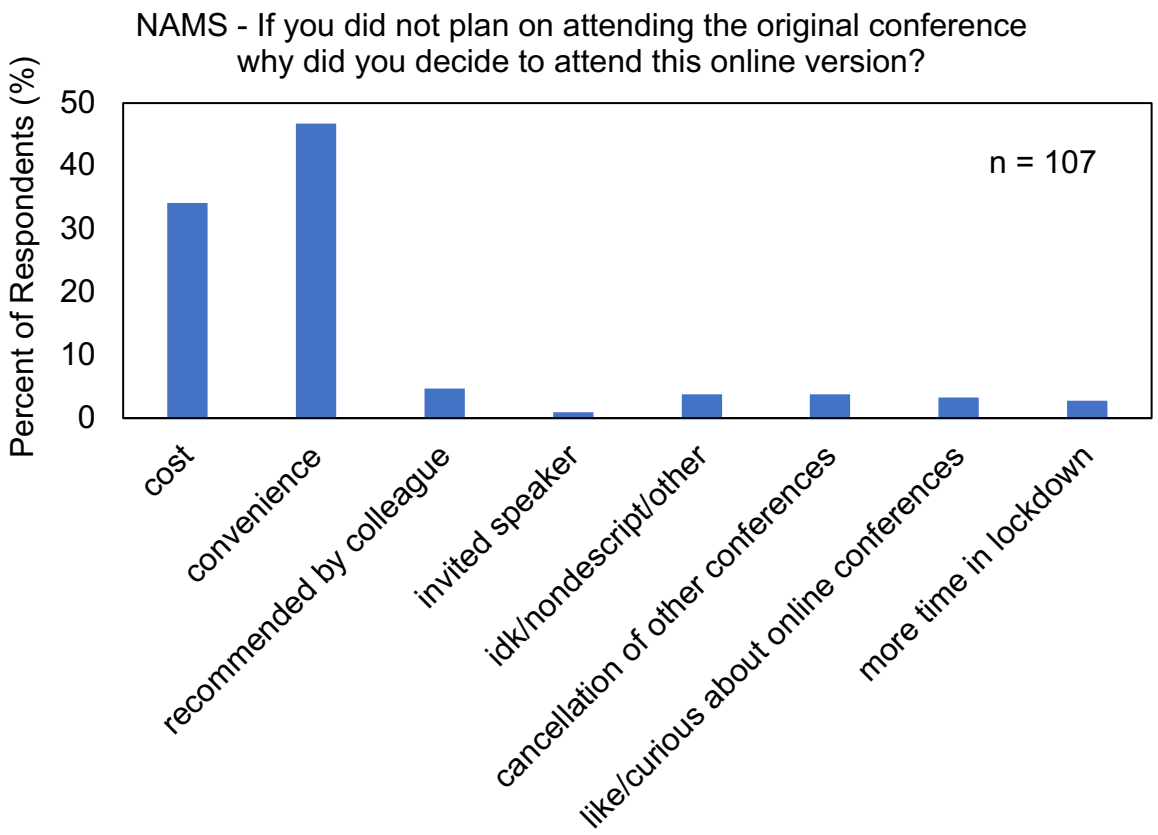

Fig. S3 | Cost and convenience were the most common reasons given by attendees for deciding to attend the 2020 NAMS VC after not planning on attending the originally scheduled 2020 NAMS IPC.

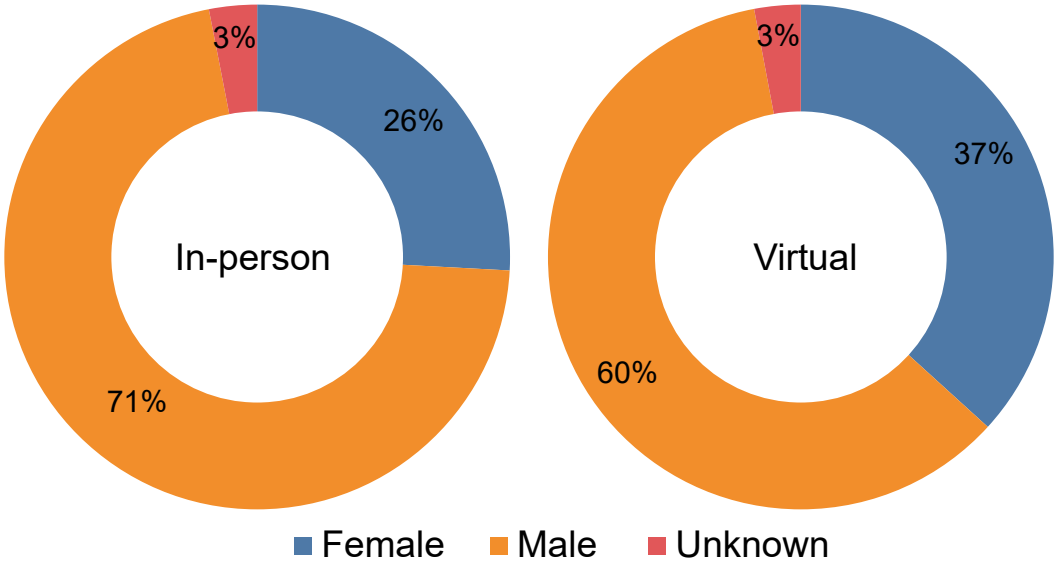

Fig. S4 | A larger percentage of abstracts submitted to NAMS after the decision to move online came from female scientists compared to before the decision to move online.

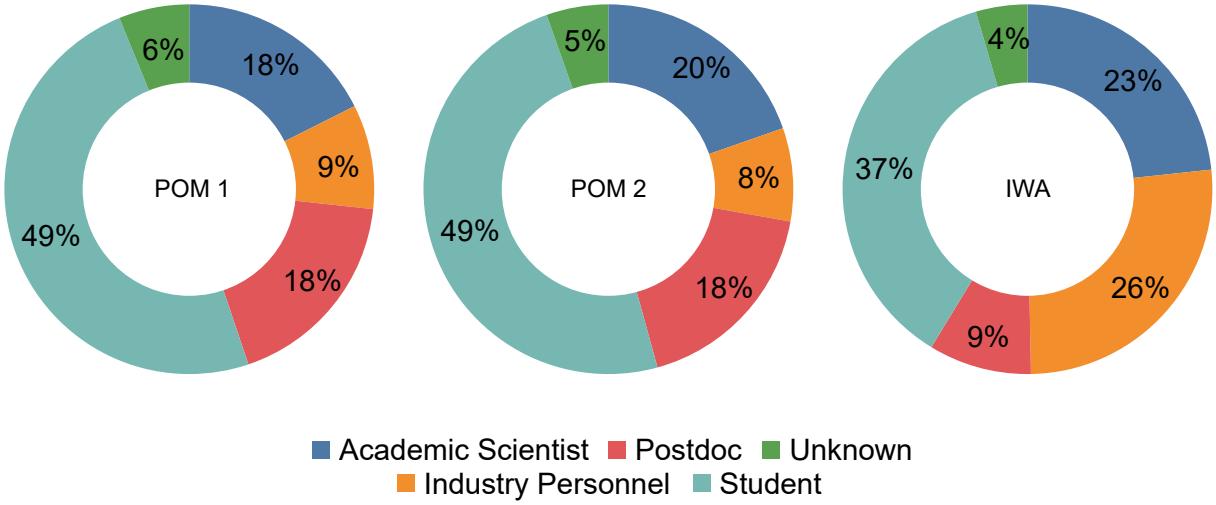

Fig. S5 | A large percentage of attendees to the always virtual POM 1, POM 2, and IWA were students.

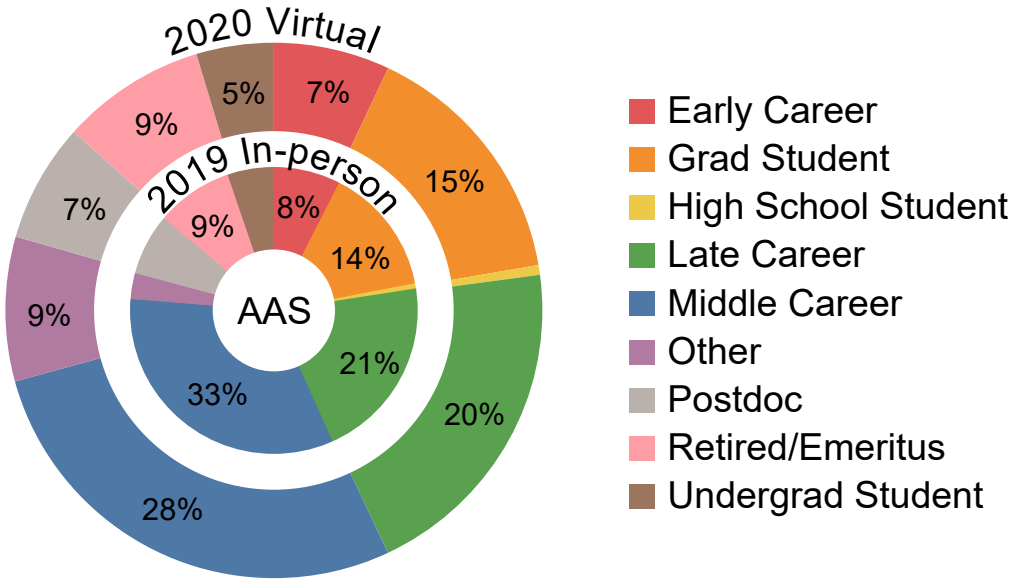

Fig. S6 | Percent makeup by job type was similar between the 2019 AAS IPC and the 2020 AAS VC.

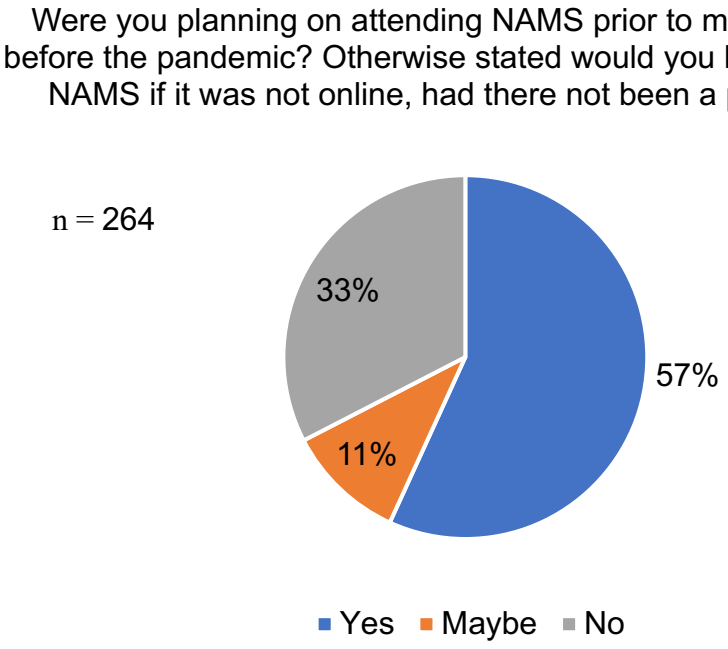

Fig. S7 | A significant percentage of 2020 NAMS VC attendees were not planning on attending the originally scheduled 2020 NAMS IPC before it was moved online.

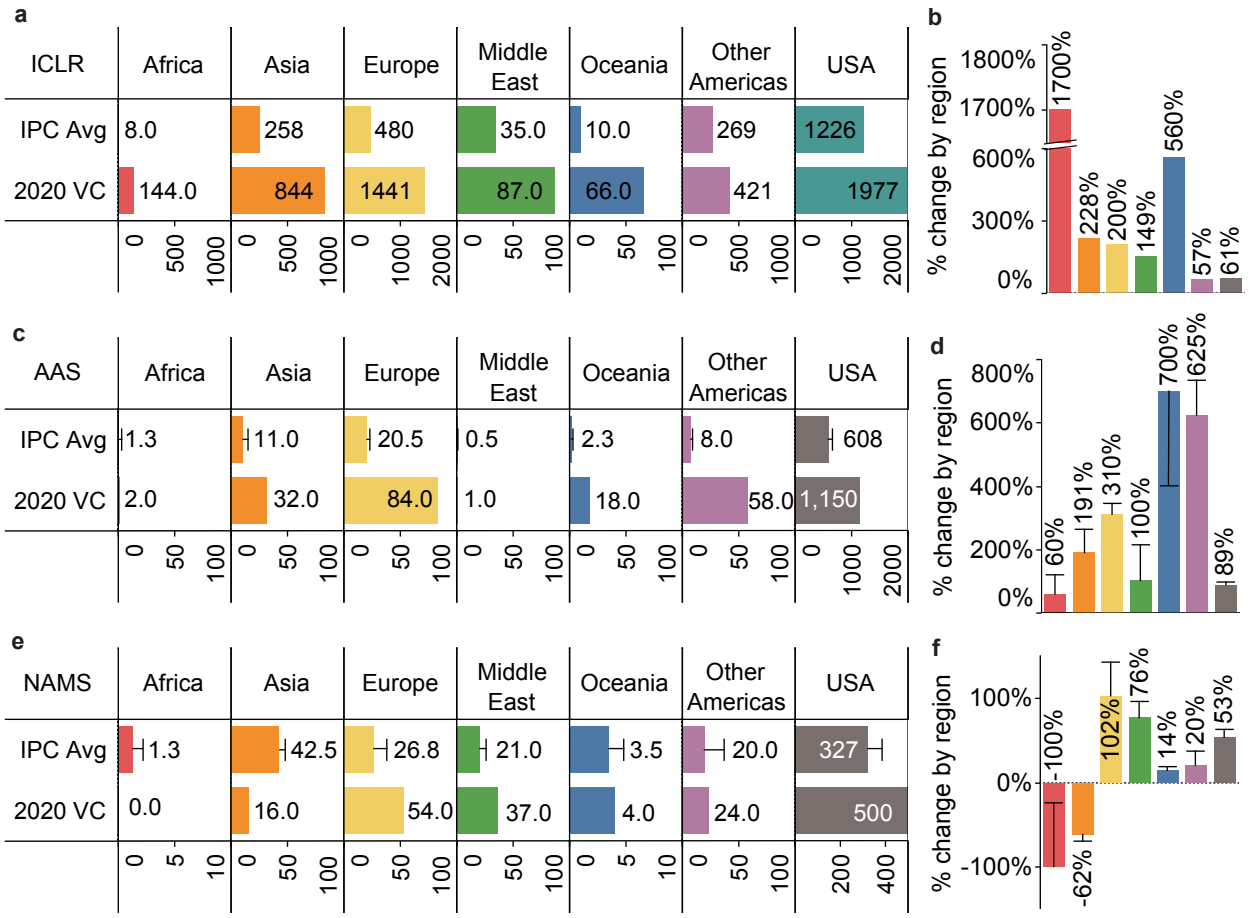

Fig. S8 | Attendance from most regions increased at VCs, but was dependent on conference format (synchronous, asynchronous, or blended format). (**a**) The mostly asynchronous 2020 ICLR VC (n=1) was attended by more scientists from all regions compared to the 2018-2019 ICLR IPCs (n=2). (**b**) A positive percent change in attendance for all regions was observed between the 2018-2019 ICLR IPCs (n=2) and the 2020 ICLR VC (n=1) as the asynchronous events could be consumed at the attendees leisure, with the highest percent increase in attendance observed for Africa and Oceania. (**c**) The synchronous 2020 AAS VC (n=1) was attended by more scientists from all regions than the 2016-2019 AAS IPCs (n=4), with the largest increases in attendance observed for Europe, Other Americas, and the United States. (**d**) A positive percent change in attendance for all regions was observed between the 2016-2019 AAS IPCs (n=4) and the 2020 AAS VC (n=1), with the highest percent increase in attendance observed for Oceania and Other Americas. (**e**) The synchronous 2020 NAMS VC (n=1) was attended by significantly more scientists from Europe, the Middle East and the United States than the 2015-2019 NAMS IPCs (n=4), while attendance by scientists from Asia decreased. *Error bars in all panels are defined as standard deviation and are not included for ICLR because n<3. (**f**) A positive percent change in attendance for most regions was observed between the 2015-2019 NAMS IPCs (n=4) and the 2020 NAMS VC (n=1), while percent change in attendance by Asia and Africa decreased, likely because the synchronous talks were held around midnight local time in Asia. *Error bars in all panels are defined as standard deviation and are not included for ICLR IPCs because n<3.

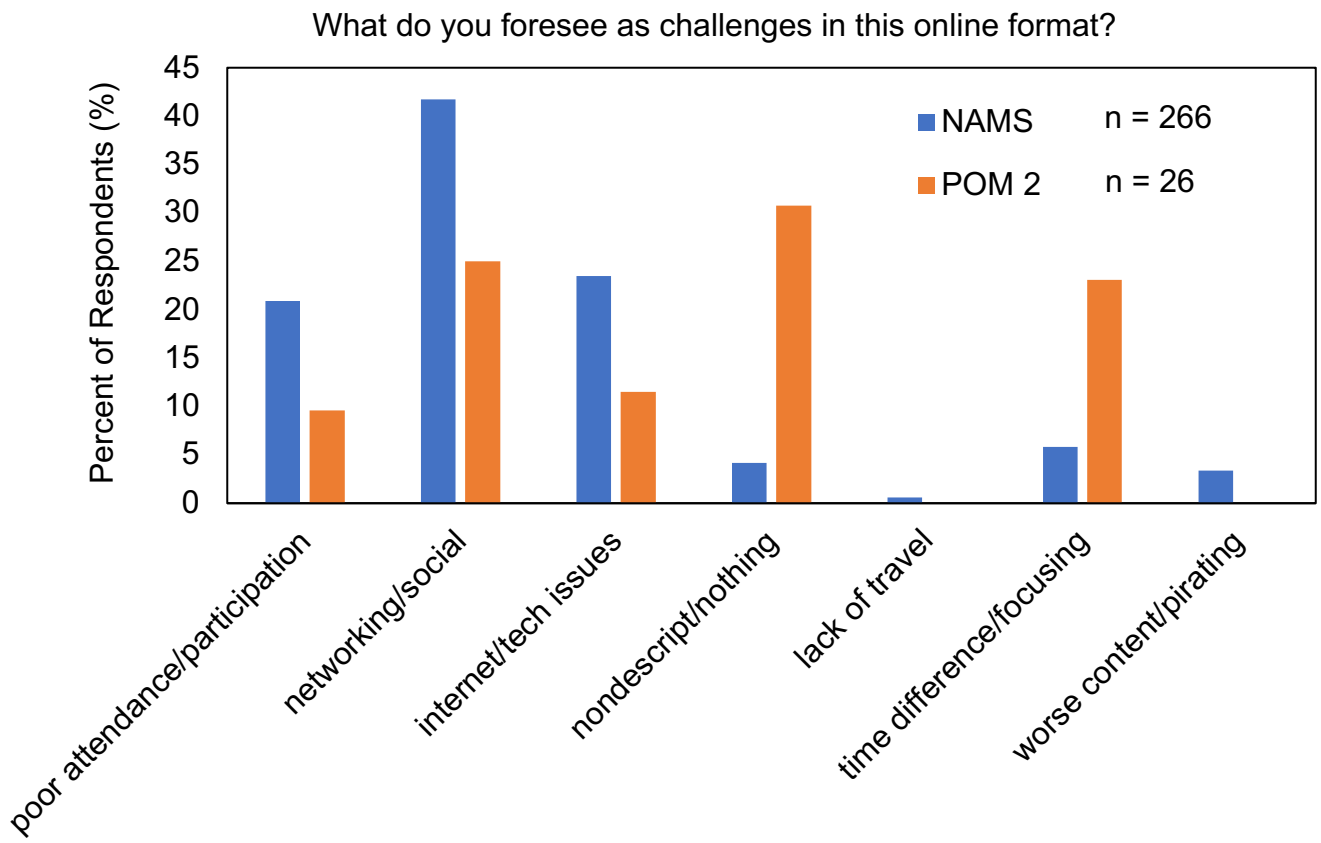

Fig. S9 | Large percentages of attendees to NAMS and POM 2 indicated that they foresaw networking/social and internet/tech issues as the greatest challenges in the online format.

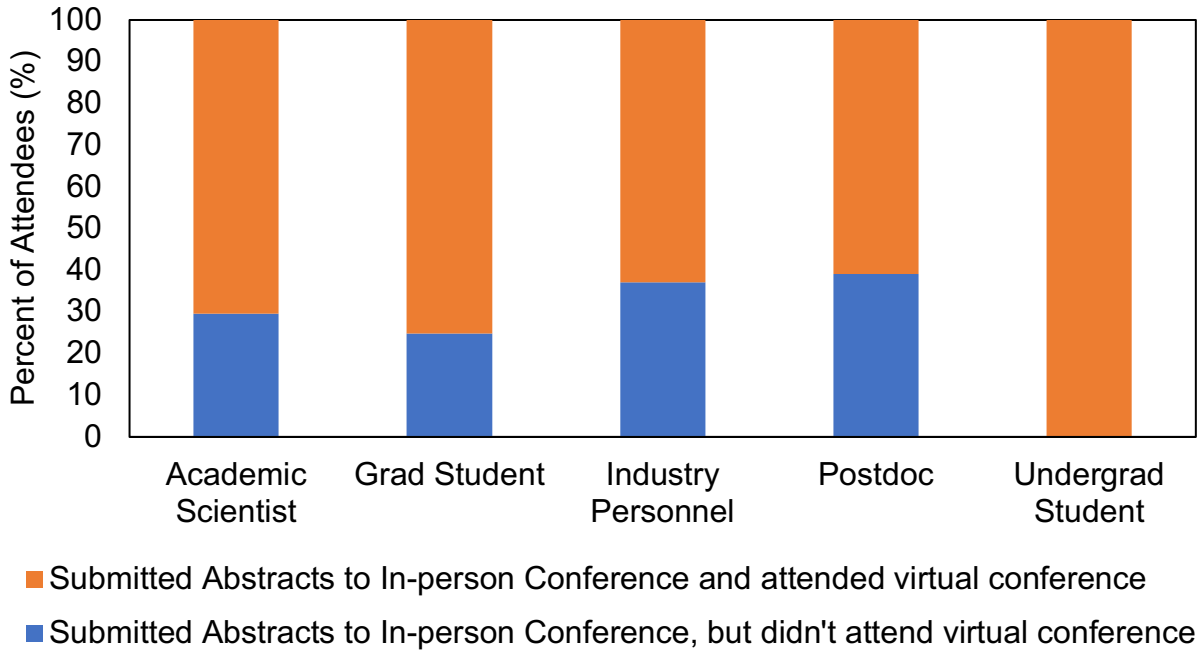

Fig. S10 | Relative to other job types, a larger percentage of graduate and undergraduate students that submitted abstracts to the originally planned 2020 NAMS IPC elected to attend the 2020 NAMS VC after the decision to move online.

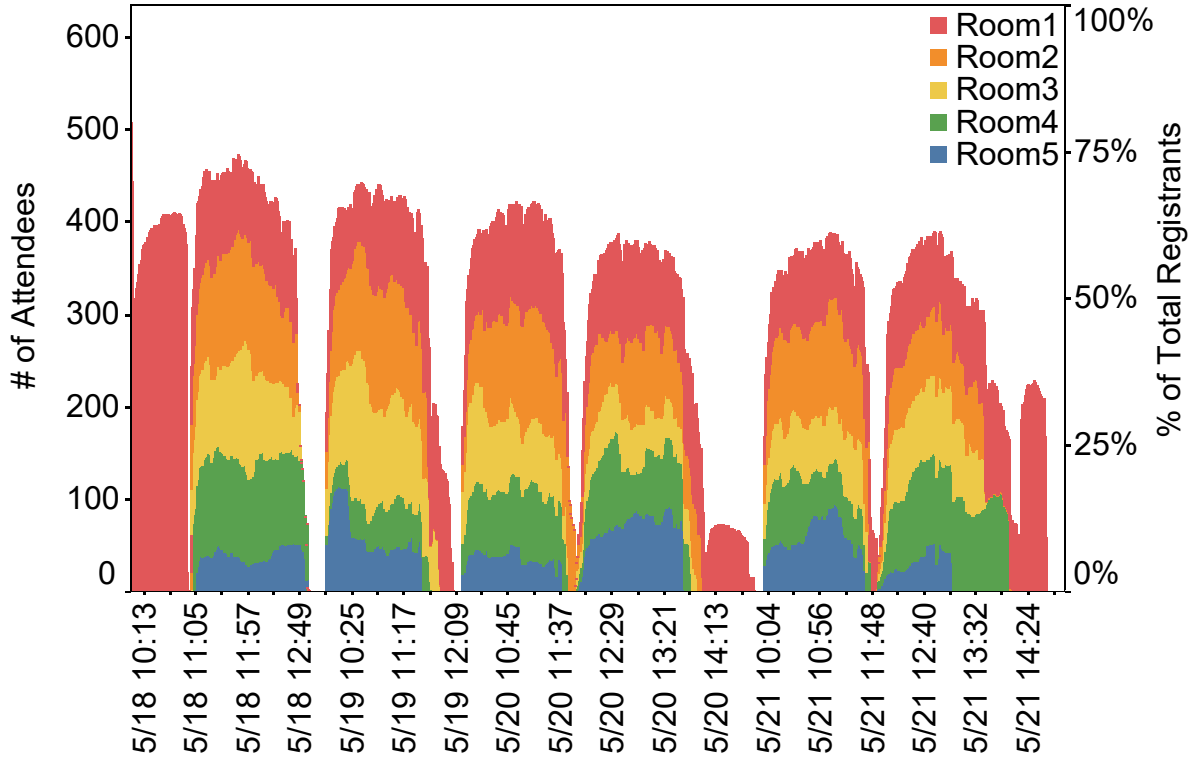

Fig. S11 | Attendees in each oral session and total percent of registrants participating in oral sessions throughout the 2020 NAMS VC.

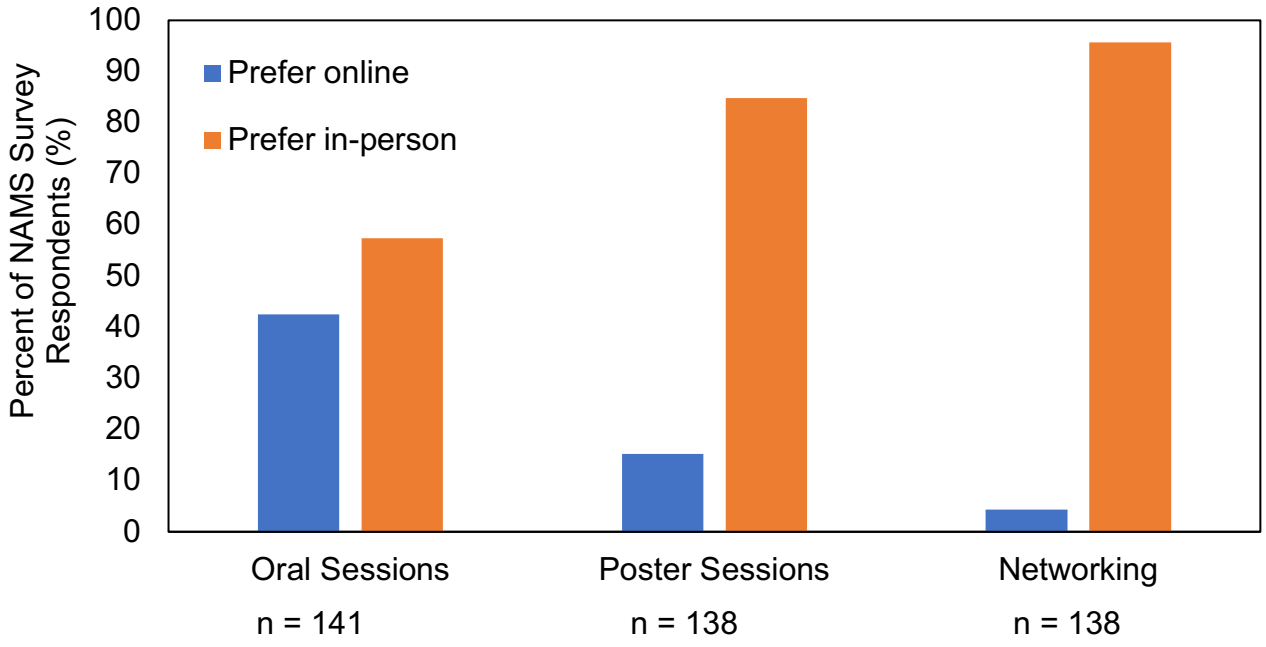

Fig. S12 | A significant portion of 2020 NAMS VC survey respondents indicated that they preferred the online format for oral sessions compared to the in-person format, while online poster sessions and online networking were less popular.

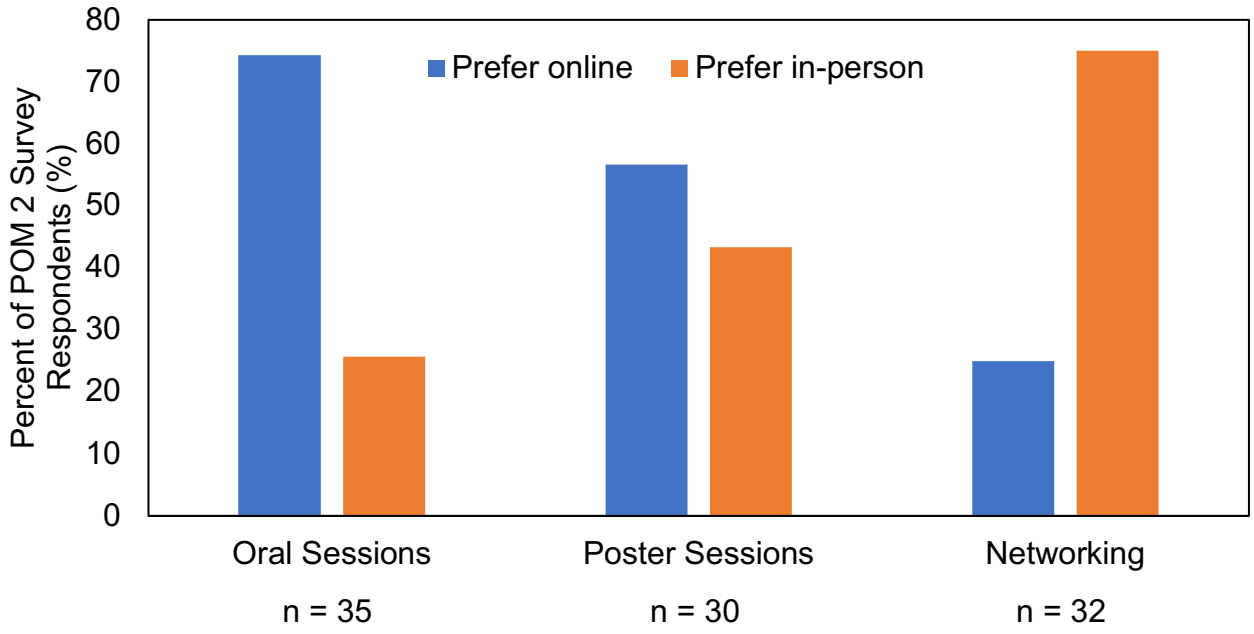

Fig. S13 | The majority of POM 2 survey respondents indicated that they preferred the online format for oral sessions and poster sessions compared to the in-person format, while networking was less popular.

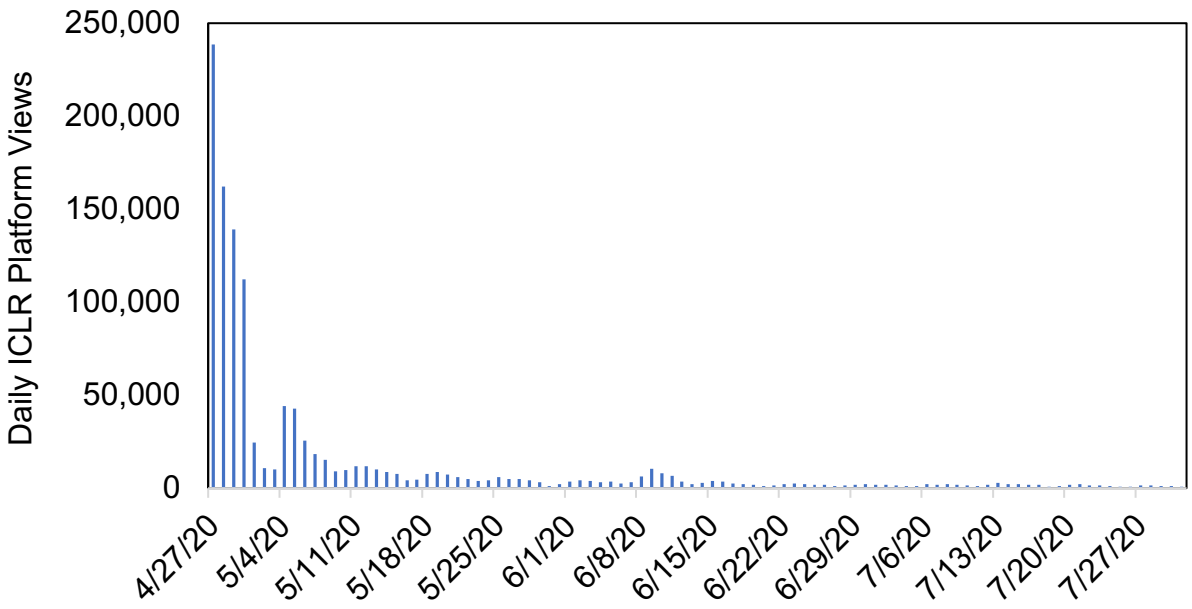

Fig. S14 | 2020 ICLR VC platform page views continued to accrue at a significant rate for months after the scheduled conference dates.

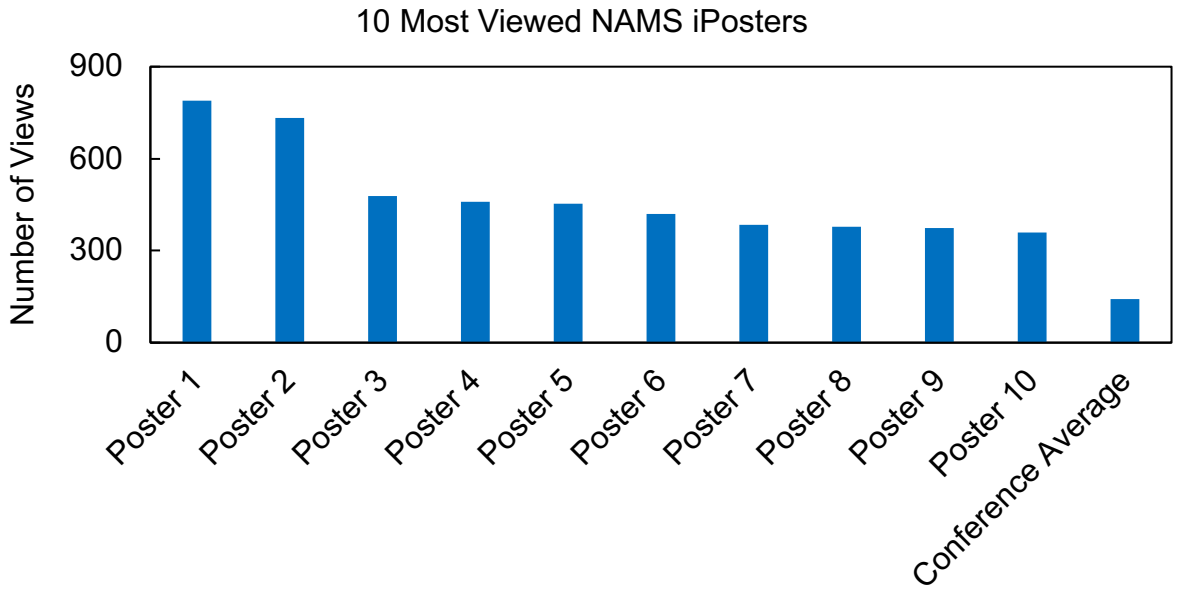

Fig. S15 | 2020 NAMS VC iPosters accrued high view counts, with the average poster receiving 142 views and the 10 most-viewed posters all accruing over 350 views.

References

1 Rogelj, J. *et al.* in *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* (eds V. Masson-Delmotte *et al.*) (2018).

2 Greenhouse Gases Equivalencies Calculator - Calculations and References. (United States Environmental Protection Agency, 2020).

3 Reshef, O. *et al.* How to organize an online conference. *Nat. Rev. Mater.* **5**, 253-256, doi:10.1038/s41578-020-0194-0 (2020).

4 Tower, L. E. & Latimer, M. Cumulative disadvantage: Effects of early career childcare issues on faculty research travel. *Affilia* **31**, 317-330 (2016).

5 Gone Virtual: Lessons from ICLR2020. (International Conference on Learning Representations, medium.com, 2020).

6 Rush, A. & Strobelt, H. MiniConf - A Virtual Conference Framework. (2020).

7 Achakulvisut, T. *et al.* Improving on legacy conferences by moving online. *eLife* **9**, 4, doi:10.7554/eLife.57892 (2020).

8 Yakar, D. & Kwee, T. C. Carbon footprint of the RSNA annual meeting. *European Journal of Radiology* **125**, 5, doi:10.1016/j.ejrad.2020.108869 (2020).