

Engaging with Climate Change: Possible Steps for SIGPLAN

Preliminary Report of the SIGPLAN Climate Committee

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Executive Summary

The developing threat of climate change demands an engaged response—not only from policymakers and regulatory agencies, but also from organizations that promote carbon-intensive activities, such as ACM’s Special Interest Group on Programming Languages (SIGPLAN).

SIGPLAN’s emphasis on international conferences promotes air travel, a significant and growing contributor to global warming. In view of this — and the concern that many SIGPLAN members have expressed about climate change — SIGPLAN has a clear responsibility to understand and explore ways of reducing the costs of its conference-focused approach to promoting exchange of ideas. This conversation is also timely in view of other emerging concerns about travel, including restrictions on visa rules, infectious disease outbreaks, and questions about fair access for computer scientists from less wealthy regions. [Section 1](#) lays out this argument in more detail.

This report aims to begin a conversation among SIGPLAN members about how SIGPLAN might respond to the issue of climate change, focusing on ways to mitigate the climate impact of conferences. We do not advocate specific actions here, but rather aim to lay out as many options as possible, examining their pros and cons in terms of both carbon impact and possible effects on conference culture. The ultimate goal is to build consensus within the community around how best to *balance* environmental and other harms on one hand with the significant benefits of conferences on the other.

Potential responses to climate change can be grouped according to the degree to which they disrupt SIGPLAN’s current ways of doing business. On the easy end of the scale are information-gathering activities aimed at quantifying and communicating the environmental impact of conferences. For conference organizers, for example, it would be helpful to develop tools for modeling the CO₂ cost of hosting past events and estimating the cost of future ones. Similarly, conference participants might find it useful to learn (e.g., as part of the registration process) how much atmospheric CO₂ their attendance will generate. [Section 2.1](#) develops these ideas.

Next, beyond simply gathering information and raising consciousness, a broad range of actions might help mitigate the carbon impact of conferences. The simplest of these, involving no changes beyond increased cost, is to purchase *carbon offsets* to neutralize the climate impact of either whole conferences or individual participants. [Section 2.2](#) summarizes the pros and cons of this approach; a deeper discussion can be found in a [companion document](#).

Conference program committees often meet in person to decide a final conference program. We could avoid physical PC meetings in favor of alternatives such as fully asynchronous PC discussions supported by tools such as HotCRP and EasyChair, synchronous-but-distributed meetings where some or all PC members are remote, or more unusual possibilities like “split” meetings where PC members travel shorter distances to gathering points for their region. Active experimentation along these lines is already underway. [Section 2.3](#) discusses these alternatives.

For conferences themselves, a number of relatively simple changes could significantly reduce carbon costs. First, we could plan conferences to reduce carbon impact, either in choosing locations or (less obviously) in planning meals for participants. Second, we could make physical attendance at the conference optional for authors of accepted papers. And third, we could support remote participation by speakers and others in a variety of ways, from well-established tools like live streaming and closed captioning to more adventurous technologies like robotic telepresence avatars. [Section 2.4](#) considers possibilities in these areas.

More ambitiously, we can consider deeper changes to SIGPLAN’s conference culture. We could, for instance, merge two or more existing conferences into larger mega-conferences — in the limit, perhaps even colocating *all* SIGPLAN conferences. Or, conversely, we could encourage smaller regional conferences. We could hold a single conference simultaneously at two or more sites, with arrangements for live-streaming talks from one location to the other(s). In the longer run, we could consider creating entirely virtual conferences. Or we could promote a “journal-first” view of publishing that de-emphasizes conferences altogether. Examples of successful alternative models can be found in a number of other fields, for example the single-yearly-meeting model of the American Geophysical Union. [Section 2.5](#) develops these ideas.

Finally, as a way of motivating a continued focus on developing and testing ideas for reducing carbon emissions, SIGPLAN could consider committing to a year-on-year reduction in overall net emissions; for example, a 5% reduction per year would get us to roughly an 80% reduction over current emissions in 2050. [Section 2.6](#) discusses this idea.

Beyond changes to conferences, there are a number of ways in which SIGPLAN and other ACM societies might contribute more directly to progress on climate change by fostering research to address it. [Section 3](#) surveys some examples of work already underway.

Your comments on this report are greatly appreciated! The text is available as a live Google Doc at <https://goo.gl/YrmTQT>. You can add comments or make direct edits (which will show up as suggestions that we can quickly curate), or you can email your thoughts to the climate committee chair, Benjamin Pierce (bcpierce@cis.upenn.edu).

1 Motivation

A [strong scientific consensus](#) holds that the global climate is warming, that a significant reason for this is human activity—particularly burning fossil fuels, which emit carbon dioxide (CO₂), a greenhouse gas—and that inaction is likely to result in significant harm to human populations via reduced food and water supplies, extreme weather, rising sea levels, and other effects.

This is clearly a significant concern for policymakers and for society at large. But why should it concern SIGPLAN in particular? For at least two reasons:

SIGPLAN culture involves significant air travel, a major contributor to global warming. At the moment, being a successful programming languages researcher necessitates publishing in (and thus attending) SIGPLAN conferences with some regularity. This is simply because the field's most respected publication vehicles are the proceedings of SIGPLAN's flagship conferences.¹ Thus, standard participation in the scientific process necessitates travel for SIGPLAN members, which very often involves flying. But air travel is [particularly problematic](#) when it comes to global warming. Airplane flights currently produce significant CO₂ emissions, and in-flight airplanes' proximity to the upper atmosphere [magnifies](#) the impact of those emissions. Moreover, while large-scale activities are underway on de-carbonizing many spheres of activity (e.g., electric and "plug-in hybrid" cars that can be powered by wind and solar power plants), and significant progress is being made (e.g., new solar [will soon be cheaper](#) in some places than gas), there are currently [few prospects](#) for alternatives to fossil fuels in aviation, at least in the short term. We put these concerns in context below.

SIGPLAN is particularly invested in air-travel-intensive international conferences. There is good reason for this, as in-person communication is highly effective for sharing and developing new ideas and carrying on collaborations. SIGPLAN is one of ACM's largest SIGs, with nearly 2000 registered members (as of mid-2017). According to <http://sigplan.org/Conferences/>, SIGPLAN sponsors or co-sponsors 17 conferences. Of these, PLDI, POPL, OOPSLA, ICFP, and PPOPP have SIGPLAN as the primary sponsor, and these serve as the anchor for other conferences, as well as affiliated workshops. Most of these events attract between 300 and 600 attendees. According to our own experience and conversations with peers, SIGPLAN members often attend more than one conference per year, resulting in multiple flights. SIGPLAN's approach of hosting many conference events contrasts with other scientific groups which favor fewer, larger events. Examples within ACM include SIGGRAPH, CHI, and SC, which are the (lone) flagship events of SIGGRAPH, SIGCHI, and SIGHPC, and attract many thousands of participants.

SIGPLAN has strong communities in both Europe and North America, which means that major conferences require a significant number of trans-Atlantic flights. As SIGPLAN has expanded in size in recent years, it has sought to expand geographically as well, necessitating flights to more far-flung places for those in the current core communities. Expansion is a laudable goal: science benefits from a diversity

¹ While University administrations have previously (and artificially) valued journal papers more than peer-reviewed conference papers, such behavior is likely to (further) diminish. This is because either (a) the administration has come to realize the top SIGPLAN conference papers are at the same level of quality as the best journal papers, or because (b) many of SIGPLAN's best conference papers are now journal papers, following the advent of the new ACM journal, the [Proceedings of the ACM on Programming Languages \(PACMPL\)](#).

of views. As computer science has grown in South America, Asia, the Middle East, and other parts of the world, SIGPLAN has sought to nurture PL researchers in these communities. A common tactic is to host major conferences in growth areas. PLDI '12 was hosted in China. POPL '15 was hosted in India. ASPLOS '15 was hosted in Turkey. ICFP '16 and '11 were hosted in Japan. Unfortunately, such locations increase the overall carbon footprint of the event as the core community from North America and Europe has further to travel (and flights involve more connections, which are expensive in terms of CO₂ emissions).

To put these concerns in context, consider the following question: **What fraction of her personal lifetime carbon budget does a computer scientist use by attending POPL one time?**

Answer: Roughly speaking, a single trip to POPL consumes **three percent** of a computer scientist's lifetime carbon budget, so traveling to three conferences per year will exhaust her lifetime budget in just eleven years. This three percent figure can be derived as follows. According to [Meinshausen et al in Nature](#), in order to have an 80% chance of limiting global warming to 2°C, cumulative carbon dioxide emissions from 2000 to 2049 must be constrained to 886 metric gigatons (Gt). According to the World Resources Institute's Climate Analysis Indicators [Tool 2.0](#), the world has already emitted more than 492 Gt since 2000, leaving only 394 Gt for the world to emit. There are currently about 7 billion people on the planet. Ignoring growth in world population, and leaving aside the argument that people in developing countries should be entitled to a larger share of the remaining allowable carbon emissions, each computer scientist's "fair share" of remaining allowable emissions is about 56 metric tons of atmospheric CO₂. Taking into account the intensifying effect of high-altitude emissions, a single economy-class round trip from, say, Philadelphia to Paris emits 1.64 tons of CO₂ per person—i.e., about 3% of a computer scientist's *total* lifetime carbon budget—not just for air travel, but for all greenhouse-gas-generating activities. This simple calculation is obviously open to criticism—e.g., one might argue that computer scientists are doing work of such high social value that they should have much larger carbon budgets than most people or, conversely, that most computer scientists are from developed countries that have already consumed far more than their fair share of the global budget. Moreover, different studies give a range of values to the remaining carbon budget and the speed at which it is being exhausted. Even so, the numbers are sobering.

In [Heat](#), George Monbiot argues that, since air travel is uniquely dependent upon fossil fuels, unlike heating our homes and businesses, ground transport, or indeed most of our other uses of energy, we need to move toward a world where an individual can fly, say, from the U.S. to Australia at most once in her lifetime.

SIGPLAN has a responsibility to understand, and respond to, the costs of its conference-focused approach. What all this adds up to is that SIGPLAN's conference-centric modus operandi, while it has significant benefits, also imposes significant costs to the environment. It is therefore imperative that, as responsible professionals, we carefully understand those costs and explore possible mitigations and their positive and negative impacts. At a minimum, doing so will raise awareness of the issues.

As scientists we are committed to the same scientific process that has produced the current understanding of climate change. Actions, not just words, are the best way to show that we believe in that process. A convincing demonstration of our belief would be to curb activities that involve air travel, at least to some degree. We can hope that others will follow our lead or build on the information we gather, resulting in collective action that makes a real difference.

One might argue that, in the grand scheme, SIGPLAN's contribution to global emissions is very small. While this is correct in a sense—SIGPLAN is indeed responsible for only a tiny fraction of global emissions—it is equally true of *every* individual source of emissions! The important number to look at is the size of SIGPLAN's emissions scaled by the number of people involved—i.e., the cost per person. This cost is significant.

Naturally, we must be proportionate in any action we take,² and it is important to consider potential negative consequences of actions aimed to reduce CO2 emissions. Getting people together in the same physical location at the same time is a proven way of fostering high-quality communication: it takes bandwidth-limiting (and potentially flakey) technology out of the communication path, and it enables smooth transitions between different modes of interaction, from one-on-one to large groups and from the more technical to the more social. In these respects it is significantly better than current remote-presence technologies. Also, looking beyond the professional benefits of conferences to their attendees, it is also crucial to remember that computer-science conferences have important long-term benefits to society. We are not talking here about carbon impacts of vacation travel, but rather recognizing the need to trade off our conferences' significant (if hard to quantify) social benefits against the social costs of carbon emissions.

A separate concern is that ACM's business model increasingly relies on revenue from conferences, as publications move to open-access models and thus generate less revenue. Reducing conference attendance could harm open access and other important initiatives. Of course, business models can be rethought, but this concern should be kept in mind when discussing possible ways forward.

SIGPLAN members are concerned about climate change. We, the authors of this report, are not operating in a vacuum. In early 2016 the topic was raised by Michael Hicks, SIGPLAN Chair, at the SIGPLAN Executive Committee meeting. There was strong support for studying the problem further. Later, Hicks published a [blog post on the carbon footprint of conference travel and possible mitigations](#). This blog post elicited several personal interactions expressing support for further action. More recently, in a survey of POPL '17 attendees, the POPL organizers asked the question “As announced at the business meeting, SIGPLAN has formed a committee to consider possible responses to the issue of climate change. Do you have any thoughts for this committee, or would you like to be involved in the discussion?” 45 of the survey's 227 respondents answered the question. Of these, 38 expressed support for the committee's goal, while 7 felt it was not SIGPLAN's responsibility. (More details on these survey responses as well as surveys from later conferences can be found in an [appendix](#).) Earlier drafts of this document have generated significant interest at SIG Governing Board (SGB) meetings, which include all of ACM's SIG chairs.

Carbon impact overlaps with other restrictions on travel. Some actions discussed in this report might also offer helpful approaches to non-climate-related travel concerns. Recent developments in

² Indeed, there has been energetic criticism in both public forums and the policy literature (e.g., from [Oren Cass](#), [David Henderson](#), and [John Cochrane](#)) of the tendency toward apocalyptic pronouncements by some of those urging strong action on climate change. But even these critics do not contend that climate change is *not* a significant concern—just that it should not be elevated above other significant concerns such as nuclear proliferation, political instability, ethnic and religious extremism, and global pandemics. We agree that all of these issues deserve urgent attention, but note that SIGPLAN is not in a position to do anything much, as an organization, about most of them, while its emphasis on air travel does give it the ability—and thus, we would argue, the responsibility—to influence climate change outcomes quite directly.

international affairs, such as the U.S. State Department's early-2017 visa and immigration rules and reciprocal actions by other countries, have increased the complexity of international travel for many and made such travel unattractive or completely infeasible for some. Conferences are responding to this (and other travel concerns such as the Zika outbreak in Brazil) by exploring a range of options for remote participation.

Moreover, the existing cost calculus of conference travel tends to benefit the "haves" over the "have-nots," reducing or preventing participation by scholars with less grant funding or from institutions or countries with greater financial challenges. This has the danger of promoting insider-ism within the smaller community that is able to afford travel. Efforts to address these issues should inform conversations about mitigating climate impact, and vice versa.

SIGPLAN researchers can also address climate change individually. Finally, while our primary consideration here is the impact of conference travel, a side effect of many of the actions we consider would be raising awareness of the gravity of the climate change problem among SIGPLAN members, potentially spurring other activity to help address it. In particular, SIGPLAN researchers are involved in many different research activities that might lead to helpful advances; e.g., work on low-power computing could reduce the need for fossil fuels.

2 Possible actions

We now take up the main task of this report: collecting, organizing, describing, and evaluating the large number of actions that SIGPLAN might consider in response to climate change. For each, we lay out both pros and cons as we see them; our aim is to foster discussion, rather than to advocate for any particular actions. The section is organized "from easiest to hardest"—beginning with steps that seem fairly easy and less likely to be controversial, then proceeding to ideas whose balance of pros and cons is less clear.

2.1 Understanding impacts

A key thing that could be done right away would be to more accurately understand the carbon impact of current SIGPLAN conferences.

For conference organizers. One task that can be done in the short term is for SIGPLAN to carefully gather data into a report tabulating the estimated carbon impact of the main SIGPLAN conference events. These would be the events colocated with POPL, PLDI, OOPSLA, and ICFP (and perhaps PPOPP).

The main focus of this information-gathering exercise would be on air travel. While hotel power generation, food production, ground transportation, and other activities contribute to the carbon cost of a conference, we propose to ignore these at the start. Doing so makes sense because their comparative CO₂ impact is smaller than air travel,³ and because looking at predictable technology development, they are less dependent on the use of fossil fuels.

To estimate air travel costs, we could develop software to estimate a likely itinerary from each attendee's professional home to the airport nearest the conference event. This itinerary would be fed into a carbon footprint calculator such as the one at <http://carbonfootprint.com> (which conveniently provides a web

³ According to [this analysis](#), for example, 70% of a typical conference's CO₂e is due to air travel.

services API). With this, we would compute an estimate of the total footprint due to air travel for the conference event. We could also provide attendees the option of providing their itinerary to us directly, and/or to indicate whether they are taking ground transportation to the event. Carbon impacts of various local transportation options could also be included, if they are determined to be significant. The software we develop could be shared with other ACM SIGs, and some of the information it generates could usefully be shared with conference participants as well as organizers. ACM might be able to help fund the development of such software.

To understand the impact of hosting multiple conferences, it might be useful to associate each registrant with a unique identifier,⁴ summing their total carbon footprint for all SIGPLAN events in a given year. Doing this could help us understand the CO2 reduction that could take place by reducing the number of conferences attended that year (e.g., from 2 or 3 down to 1).

With this software, we could also imagine carrying out “what if” scenarios, e.g., imagining what the optimal (with respect to CO2) conference location might have been for a particular set of attendees. These could be useful in CO2-conscious conference location planning. Indeed, if the software is easy enough to use, we could even make the carbon footprint calculation a required part of the budget estimate requirements for getting SIGPLAN approval for conferences.

To further support “what if” planning, we could also develop surveys to understand attendees’ motivations and behaviors and their responses to particular alternative conference plans.

For conference participants, there are a variety of ways that we might help people understand the carbon impact of their own conference travel. For example, the registration web site might automatically calculate and display the estimated carbon cost of travel to this conference, either “just FYI” or with an offer of some kind of carbon offsets (see below). Conference web sites might also provide information on which airlines are using newer / more efficient planes, or help people compare air, rail, and other ground transportation when planning their travel.

Recent progress

Mike Hicks is leading the development of a [conference carbon calculator](#) that can be used both by individuals, to quickly calculate the carbon emissions for a single conference trip, and by conference organizers to calculate, in bulk, the total carbon cost of a conference by uploading registrant data in CSV format.

2.2 Carbon offsets

One simple idea for mitigating the impact of air travel is to hold conferences as usual, but afterwards **buy carbon offsets** based on their estimated carbon footprint. Carbon offsets refer to actions meant to counterbalance CO2 emissions. One example of a carbon offset is planting trees, which consume CO2, to counteract CO2 emitted by the burning of fossil fuels. A more indirect carbon offset is contributing to “green” projects aimed at reducing future CO2 emissions. Example projects might include building solar arrays or wind farms, which produce “clean energy,” developing more efficient fossil-fuel burning engines or means of power generation, or building a methane capture station.

⁴ After careful consideration of the privacy costs of this association!

Carbon offsets are not without [problems](#). First, they are at most a stopgap solution: the jet fuel is still getting burned, and there is only a finite capacity to offset that. Indeed, some climate scientists argue that carbon offsets are actually [worse than doing nothing](#) because they perpetuate carbon-profligate consumption habits and encourage building more carbon-intensive infrastructure such as airports and runways. Moreover, there are a number of types of offset projects (methane capture, reforestation, supporting solar and wind development, etc.).

On the other hand, there are many who argue that carefully chosen offsets can play a significant role in slowing the pace of warming and give more time to develop green technologies.

If SIGPLAN were to pay, in some form, for carbon offsets, what provider should they use? Some investigation uncovered <http://atmosfair.de/>, [Cool Effect](#), and [carbonfootprint.com](#) (the offset provider used by the UK government). [According to the NRDC](#), “a quality assurance system has developed to verify the quality of your offsets. At the top level are standard-setting groups, such as the Climate Action Reserve, which establish rules and protocols for offset projects. Below them are retail certification programs, like [Green-e Climate](#), which help individuals identify reliable carbon offset sellers.” A related question is what offset to purchase; different offsets cost different amounts. For example, at [carbonfootprint.com](#), offsetting 700 metric tons of carbon ([the estimated footprint of PLDI '16](#)) by planting trees in the UK would cost \$11721.48, while buying shares in their Global Portfolio VCS (which funds a range of carbon reduction projects) would cost \$5451.85.

Recent progress

We have come to believe that carbon offsetting is an effective short-term mechanism for mitigating climate damage from SIGPLAN activities. A more thorough summary of carbon offsets from the point of view of SIGPLAN and other scientific societies can be found in a new [report](#) by Richard Kim and Benjamin Pierce.

2.3 Changes to PC meetings

The technical program for SIGPLAN conferences and workshops is typically determined by a program committee (PC). The PC supplies expert reviews and discusses papers to determine which should be included in the program. For major conferences, these meetings have traditionally been held in person, which requires the 20–30 PC members to fly to a particular location. Aside from allowing for high-bandwidth, real-time discussion about papers, physical PC meetings have also provided important opportunities for networking, especially for younger PC members. On the other hand, they impose a nontrivial carbon cost. We explore ways to reduce that cost while retaining some of the benefits.

Asynchronous PC meetings. Some larger computer-science conferences have already shifted to a model where most or all of the work of the PC is carried out asynchronously, via conference-support services such as [HotCRP](#) and [EasyChair](#), perhaps augmented with live discussions of specific papers or groups of papers by subsets of the PC.

Online PC meetings.⁵ For those conferences that still feel the need for synchronous PC meetings with all or at least some of the PC members participating at the same time, these meetings can be carried out online, to avoid the need to travel. The technology supporting online meetings is getting better and cheaper every year. The oldest, and most established, service providers are [WebEx](#) and [GotoMeeting](#), both of which offer multiple plans at different price points, supporting an increasing number of participants (up to 100). They are relatively expensive. But there are newcomers to this space, some of which offer free plans supporting small groups. Google Hangouts (free) now routinely supports meetings with 15 people without the many technical issues that plagued it in the earlier years. Other newcomers to the voice/video services include [BlueJeans](#), which can support up to 50 participants on a plan of less than \$10/month (a more expensive Enterprise plan supports 100 participants). Finally, [Zoom](#) is considered by many (including some of us) to be the new leader in the area. The National Science Foundation has already moved in this direction for many of its panels (they use WebEx).

Moving PC meetings to be asynchronous or online has advantages and disadvantages. The most obvious advantage is its minimal carbon footprint: no travel, which is ideal. Another major advantage is a lot less disruption, particularly for participants with small children and busy schedules—this affects many people at some point in their lives, but it affects women the most.

The potential disadvantages are twofold:

1. When people participate in online meetings from home/office, especially in larger groups, it is much harder to be engaged in the meetings. This lack of immersion may degrade the quality of the discussion and even the PC's decisions, though this hypothesis has never been assessed rigorously.
2. Participating in a physical PC meeting makes people feel recognized, and gives everyone in the group unrestricted access to an elite group of peers, both during the meeting and the down time. This access is especially important for fostering interactions between younger and more senior researchers. (It's difficult to quantify the benefits of this kind of access for career development of younger researchers, but in our informal discussions with colleagues about potential changes to PC meetings it is frequently mentioned as a concern.) Online meetings remove this access. One potential way to compensate for the loss of networking at the PC meeting might be to sponsor a PC dinner or other gathering or a PC-only workshop before/during/after the conference (though some PC members may not actually attend the conference).

Split physical meetings. Given that program committees often have multiple people from the same parts of the world, the meeting can be organized in several locations, connected via teleconferencing / online meeting technologies. This decreases carbon footprints by eliminating long-distance air travel, requiring people to travel only within their regions (for example, North America, South America, Europe, Asia, Australia). As compared to online meetings, splitting physical meetings increases opportunities for networking (but only within regions).

⁵ These suggestions for online PC meetings could also be useful more generally: SIGPLAN or ACM could help discover and publicize good technologies for remote interaction/teleconferencing. Many SIGPLAN members already do a great deal of their work via tools like Skype or Google Hangouts, but most of these tools are currently lacking in robustness, while at the same time there are now so many offerings that it is hard for individuals to track which ones are best. A collective action to evaluate and promote a few good tools could save a lot of people a lot of wasted productivity and reduce the perceived need to travel for high-bandwidth time with colleagues.

Colocating PC meetings with conferences. It is sometimes possible to organize the PC meeting of one conference to be coincident with another conference that many PC members are likely to attend anyway. Doing so helps avoid additional long-distance travel by those members of the PC. However, colocation may require some adjustments to the timelines, and not all conferences have a partner conference at the right time of the year.

Recent progress

POPL'18 employed an asynchronous PC meeting, augmented with online, synchronous conversations. This is the first time that POPL has not had a physical PC meeting. In his [PC chair's report](#), Andrew Myers presented the PC members' responses to a number of questions from a survey after the PC had finished its work. Some take-away points:⁶

- The fact that the PC meeting was virtual had a significant positive effect on recruiting people to join the committee in the first place.
- Holding the meeting virtually did not have a significant effect (either positive or negative) on the PC members' perceived engagement in the process.
- Having a PC member explicitly assigned to push discussion forward on each paper was helpful.
- Review quality was perceived by PC members as about the same. Actually, 15% more review text was generated per paper than in 2017.
- Overall reactions to the question "Should we have online PC meetings in the future?" were:
 - 59% Yes!
 - 23% No!
 - 9% Don't care
 - Two individual comments: "Only in some years" and "In person PC meetings work well but don't seem worth the time / travel cost. But more effort is required to preserve what works well about in-person PC discussion in an online setting."
- Some selected comments from the survey can be found [here](#).

POPL 2019, POPL 2020, and ICFP 2020 will also have virtual PC meetings.

2.4 Short-term changes to conferences

SIGPLAN's emphasis on conference-based publishing creates an unfortunate conflict. A conscientious PL researcher may wish to curb air travel to reduce her personal impact on climate change, but doing so is directly at odds with her professional success. Three possible mitigators for this situation are **planning conferences to reduce carbon impact**, making **conference participation optional**, and/or making **remote participation feasible**. We discuss these in turn.

Carbon-friendly conference planning. Conference organizers could also take into account carbon footprint when choosing the conference location. As of now, carbon footprint is not part of the process. The main factors for conference choice tend to be fixed arrangements with an eye toward serving the existing community ("twice in the USA, then once in Europe or elsewhere"), attempts to expand reach (e.g., by hosting the conference in new locations such as China, India, etc.), attempts to diversify the

⁶ ...with the caveat that an online poll evaluating online reviewing could have selection bias! -- these are responses from 22 members out of a total PC of 50.

location (“we were there only 5 years ago”), and attempts to minimize monetary cost (e.g., costs of hotel rooms, conference facilities, etc.).

Locations that are geographically central and well-connected by air would minimize carbon cost. A simple rule of thumb is to pick locations that are major airline hubs, so that people can fly direct. As the take-off and landing are the most carbon-intensive portions of a flight, cutting the number of separate flights in the itinerary can make a big difference.

But we would not want to simply have all conferences in the same central location year after year. One idea is to pick locations or regions with a probability scaled according to carbon cost. For example, one might choose some reasonably central location as a baseline B , and then rotate locations L commensurate with their cost $C(L)$ above the baseline, i.e., $C(L) - B$. For example, if location X has cost $C(X)$ and location Y has cost $C(Y)$, then X would be chosen twice as often as Y if $2 * (C(X) - B) = C(Y) - B$. The acceptable average “above baseline” cost would have to be weighed against other competing concerns, such as monetary cost, diversity of location, etc.

The carbon impact of conference food planning could also be taken more explicitly into consideration. For example, instead of making meat the default and vegetarian meals a “special diet” that must be requested explicitly, we could make vegetarian food the default and provide meat only upon request, or equivalently offer a “vegetarian discount” during registration. (This idea has some nice side benefits: reducing the cost of the default meal package, reminding people that eating meat is a carbon-intensive activity, and making conferences friendlier to attendees that are already vegetarian or who have diets that place limits on meat, such as kosher or halal.)

Optional participation. An optional participant would be permitted to publish her paper at a SIGPLAN conference, and have it appear in the proceedings, but would not be obligated to attend the conference and give a talk—the talk could be skipped, or could perhaps be given by a local colleague who is not a co-author. This option would allow the author to not only reduce her personal carbon footprint, but would also allow her to save money in the form of conference registration and travel costs. (That said, SIGPLAN already helps defray travel costs for those who need help.)

There are several problems with optional participation. The first is simply that if large numbers of authors opt out of attending the conference, then the experience of those who do attend may be diminished. One loss would be the presentation that the author would normally make; another would be the opportunity to interact with the author about her work. Both could be mitigated by permitting (or even requiring) remote participation for authors, as discussed below.

Another problem would be lost revenue. As mentioned in the Motivation section, ACM is increasingly relying on conference registrations for its operating budget as the push for more open-access publication options gains steam. Allowing authors to publish a paper in a conference proceedings without requiring at least one author to register for the conference could, at scale, be fiscally problematic. On the other hand, SIGPLAN is already quite generous in paying registration and travel costs for those who need it, so some lost registrations will not actually affect overall inflows/outflows.

Remote participation. There are several ways to allow remote participation at a conference for those who wish not to attend: recording talks, live-streaming talks, supporting remote interaction, and allowing remote presentations.

- *Recording talks.* First, as is already increasingly our habit, talks given at the conference can be recorded and made available shortly after the event concludes. At best, this is passive participation, as viewers will not be able to interact with conference authors or attendees in any way. But at the least they gain a benefit previously only available to those physically present. For this to be most useful, though, conference organizers need to treat the recording of talks with the same urgency and care that they do the handling of published papers. At the moment, talk recording is “best effort”—venue recording capabilities (such as the AV system, or wifi) are not assessed with talk recording as a requirement, and recording is handled by volunteers.
- *Live-streaming talks.* A step up from after-the-fact publication of recorded talks is live streaming. This places higher requirements on the venue. For example, it signals the need for a reliable, high-bandwidth connection used to (only) broadcast the talk. But it also opens the possibility for remote interaction (more below). Live streaming might also improve the experience for multi-tracked conferences; assuming that live-streamed talks are immediately made available in recorded form, an attendee could watch a talk in a parallel track prior to the end of the conference so as to better interact with an attending author. Dealing with multiple timezones is obviously an issue, so live streaming may need to be supplemented with quick-access recording.
 - One option for live streaming is to make the arrangements “in-SIG.” For example, SIGCHI has its own recording equipment (five “capture stations”) that it uses to stream its events. (See [here](#) for its policy on sharing this equipment with its conference chairs.) SIGPLAN has its own video recording equipment, but this equipment is not capable of streaming live. We could buy equipment and handle it ourselves.
 - Another option is to hire a professional service provider. Two providers we know of are [MeetEcho](#), based in Italy and suitable for European based conferences, and [Confreaks](#), based in the US. As examples of costs, Confreaks charged US\$6125 for a two-day, single-track event. MeetEcho quoted €600 per track per day for the filming / streaming (this includes post-prod if needed) and €700 per on-site staff / day (1 staff / track). A conference like ICFP would thus cost €3,900 for the 3 days technical track, while POPL would be €7,800 for the 3 days of (parallel) technical track.

A related service we might consider is live captioning of talks. Captioning not only benefits the hard of hearing and anyone who is not a native English speaker, it also results in a searchable text record of the talks. One option is [White Coat Captioning](#). It costs about \$120 per hour for captioning.

ACM has formed an ad hoc committee on live streaming (chaired by [Nenad Medvidovic](#)), which will be putting together a report of options employed by other SIGs.

- *Remote interaction.* Live streaming opens further possibilities for remote interaction. For example, post-talk Q&A could allow questions from remote participants, perhaps gathered by the session chair during the talk (some have [argued](#) that this is a better way to take questions anyway!). These remote questions/interactions might even be live-streamed—say via a large Google Hangout. As a more high-tech possibility, we could imagine supporting a limited number of telepresence avatars at SIGPLAN events. Indeed, we would not be the first to do so: SIGCHI’s signature meeting used robot avatars for telepresence at its 2016 event; see [here](#) (the telepresence Co-Chairs were [Carman Neustaedter](#) and [Irene Rae](#)). Ideas for on-line participation

in PC meetings, mentioned [above](#), may also be relevant for remote interactions at full conferences.

Remote interaction could also be extended to the more social parts of conferences. For example, one could imagine arranging “virtual coffee break” conversations between remote speakers and those who attended their talk, or one-on-one video conversations between live and remote (or remote and remote) attendees—in particular, between young researchers and more established ones.

- *Remote presentations.* Whether or not livestreaming and remote interaction is supported for attendees, some form of remote presentation could be supported for authors. Doing so would allow an author to give a talk without necessarily attending the conference. Remote presentations could be pre-recorded and played at the event (the inverse of talk recording now), or could be live-streamed to the event. The main complication of remote presentations is that speakers need the right equipment, software, and expertise to prepare and/or present their talk, whereas, with livestreaming, it is the conference itself that delivers the content. In the short term, it would be useful to gather information about the costs of buying or renting this kind of equipment. (Many research institutes have it already.) It would also be a good idea to look into costs of services like [Panopto](#), which offers straightforward “packaged solutions” for both recording and livestreaming presentations.

As one concrete data point, remote presentations were supported for SIGCOMM '16, held in Brazil, motivated by the danger posed by the zika virus. Speakers recorded talks in advance, using a variety of different tools, and were available via Skype during the recording's presentation, so they could answer audience questions. All presentations had a separate speaker video with synchronized slides. According to Jon Crowcroft, one of the organizers, a surprising side benefit was that many times the recorded presentation was better than the average in-person presentation, due to the extra care and time spent recording and editing. An obvious downside, observed Crowcroft, was the reduced quality of possible professional networking for the presenter, owing to not being physically present.

Recent progress

The organizers of both ICFP 2017 and POPL 2018 have invested significant energy in supporting remote participation, via high-quality livestreaming of talks and online discussion forums. Jeremy Gibbons, ICFP 2017 general chair, wrote a [blog post about using Slack at ICFP](#).

2.5 Deeper changes to conference culture

Another approach to addressing climate issues is to rethink the conference culture that has emerged, organically over many decades, in SIGPLAN (and computer science generally) and consider more radical changes to it.

Merge existing conferences into larger conferences. SIGPLAN currently sponsors seventeen conferences/symposia organized, roughly, around seven physical events. Not everyone in the community goes to all these events. But many people go to between one and three, and these are just the conferences sponsored by SIGPLAN; a typical researcher in our field attends several more

conferences/symposia/workshops every year sponsored by other SIGs and other organizations. While SIGPLAN has no control over those other events, we could reduce our seven events into a smaller number—one, two or three—without reducing the number of publication venues. For example, OOPSLA and ICFP could easily be organized in the same week, in the same place, since historically they occur at around the same time.

Taking it to the limit, we could move towards organizing only one mega-conference per year, where all papers of all existing subcommunities would be presented in parallel sessions. This would certainly address some of the overlap and reduce SIGPLAN-related travel. The disadvantages are in the networking experience: a mega-conference with perhaps thousands of participants is very different from the small- to medium-size conferences we have now, with less than 500 participants. In a mega-conference, it may be harder for people to find each other. But, on the other hand, a mega-conference might in principle provide more opportunities for networking, especially if they are designed with the help of social media. For example, organizers might use a platform like Slack before, during and after the conference to create communication channels that smaller groups of people could use to organize ad-hoc meetings.

One potential downside of merging conferences and/or reducing the number of conferences overall is that ACM's business model is shifting more toward conferences, so cutting those will cut revenue which could support efforts such as increasing open access to publications. But perhaps increased registration fees could offset the revenue lost in this way. Another downside, especially for participants with families or teaching jobs, is that traveling for longer than five or six days may be much more difficult; running two or more closely related conferences in direct succession may be difficult for this reason.

Encouraging regional conferences. In this alternative model, most conferences would be regional—e.g. North America, Europe, Asia, South America, Australia. This would reduce long-distance air travel, with the side benefit that this could reduce costs and hassle for attendance and thus may raise overall participation. But it would keep particular conferences smaller, which some would view as a benefit. A possible downside is that it would encourage regional over international collaboration. It is also not clear how existing conferences could be transformed into regional events.

Multi-site conferences. In yet another alternative vision, one could imagine the same conference taking place at the same time in two different cities—say, one in Europe and one in North America. Some or all of the talks would be shared via livestreaming, while most or all social activities would of course be localized. As with regional conferences, there are benefits to overall participation. There are some obvious logistical difficulties with this. Would talks start at 6AM at one site and go till 11PM at the other? Would there perhaps be both “shared tracks” and “local tracks”? Nevertheless, this idea seems to come up surprisingly often in discussions.

Virtual conferences. Although it seems clear that virtual-reality technology is not ready yet to support a high-quality conference experience (especially the social parts), it is certainly worth considering what such a thing might look like and exactly what would be needed to make it a viable alternative to live meetings.

Journal-first publishing. Another option to consider is adding a “journal-first” track to conferences, whereby authors of recent journal papers are invited to present their work at the conference. The advantage of this approach is that it starts to shift the publishing culture away from conference proceedings and towards journals. This, in turn, facilitates an eventual reduction in the number of conferences. Scientific fields where journal publishing dominates tend to hold many fewer conferences.

(Indeed, it is notable how resources like arXiv and PLOS ONE are increasingly used for rapid publication and dissemination in other fields. Isn't it ironic that we in CS relatively lag in our exploitation of electronic media for collaboration and idea-sharing and steadfastly rely on physical meetings in remote locations?)

Models from other fields. As we consider deeper changes to the current ACM/SIGPLAN conference culture, we can look to other fields for examples of successful strategies. For example, the American Geophysical Union (AGU) Fall Meeting is a highly effective meeting that brings a lot of researchers together in one place and also garners significant media attention (and probably revenue). Similarly, there might be useful ideas to steal from the remote-education community. For example, one promising way that is currently being explored for delivering courses to a geographically distributed audience is combining online lectures with local study groups; could this idea be adapted to the context of a technical conference?

Recent progress

To inform discussions of potential conference mergers, Mike Hicks collected some statistics on the degree of overlap between the registrants of different SIGPLAN conferences over the past five years. Some preliminary results can be found in the slides for a [presentation](#) by Peter Thiemann at ICFP 2017. Somewhat disappointingly, even the largest overlaps (ICFP+POPL, SPLASH+PLDI, and PLDI+POPL) turn out to be only in the 5% range.

Arrangement	Overlapping regs.	Total registrations	% overlap
ICFP+PLDI	20	940	2%
ICFP+POPL	57	968	5%
ICFP+SPLASH	16	1066	1%
PLDI+POPL	49	937	5%
PLDI+SPLASH	53	1026	5%
POPL+SPLASH	30	1054	2%
One big conference	173	1964	8%

2.6 Emissions Reduction Targets

All of the above ideas can be considered piecemeal, or they can be organized under the umbrella of a general commitment to a certain level of emissions reductions, year on year, with a specific long-term target. For example we could agree to find ways to offset the carbon footprint of SIGPLAN by 5% per year (from the current baseline). This would put SIGPLAN in line with the 80%-reduction-by-2050 roadmaps that the EU, California, New York City, and other entities have committed to.

To make this work, the main requirements are:

1. A reliable way of *calculating* SIGPLAN's total emissions in the course of a given year. ACM's new [conference carbon calculator](#) is a good start.
2. A strong, sustained commitment from both members and officers to ever-more-ambitious reduction targets.
3. Serious long-range thinking. For the first few years, 5% reductions in net emissions can probably be achieved relatively cheaply and without deep changes to the way conferences are organized, using a combination of carbon offsets and straightforward “fat trimming.” Sustaining this level of reductions over the long term is a different matter.

3 Supporting carbon-friendly research

Finally, though the main focus of this report has been on conferences, it is worth emphasizing that a great deal more could be done by professional societies and funding bodies to incentivize research with positive broader environmental impacts. As just one example, more work is needed on load balancing and smart-grid technologies for resource-intensive server farms.

Some computer science researchers, including a handful of SIGPLAN members, have begun to apply their efforts in this direction ([Steve Easterbrook](#) and [Dan Grossman](#) are good examples), but there seems currently to be insufficient general support for these kinds of applied, interdisciplinary efforts, especially with an explicit environmental focus.

A thoughtful article related to this set of issues is [What can a technologist do about climate change](#).

More immediately, an effort to develop a “virtual conference package” incorporating some of the ideas discussed above might raise interesting research topics (from systems issues all the way up through HCI). Developing such a package might be interesting both for ACM to support and for ACM members across a range of disciplines to participate in.

Other parts of ACM are working actively along related lines. For example, SIGCAS (the Special Interest Group on Computers and Society) sponsors a yearly Workshop on Computing within Limits ([LIMITS](#)). Also worth mentioning is the International Conference on Information and Communication Technology for Sustainability ([ICT4S](#)).

Finally, [CompSustNet](#) is a research network sponsored by the National Science Foundation through an Expeditions in Computing award. The network is exploring new research directions in computational sustainability, including cross-cutting computational topics such as optimization, dynamical models, big data, machine learning, and citizen science, and applying these methods to sustainability challenges including conservation, poverty mitigation and renewable energy. CompSustNet builds on the work of the [Institute for Computational Sustainability \(ICS\)](#).

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This document has benefitted from thoughtful comments by readers too numerous to list here. You know who you are: Thank you!

Appendix: Surveys and experience reports

POPL 2017

POPL '17 attendees were asked for their opinions about this committee's charge and possible actions SIGPLAN could take, as part of the post-conference survey; 45 of the 227 respondents answered this question, and of these, 38 expressed support for the committee's goal. Here is a sampling of free-response comments given by respondents:

- 1 was concerned about the negative impact of merging/co-locating conferences or having multiple locations for the same conference, while 6 suggested they would favor such steps.
- 3 people suggested being smart about using resources, in particular being conscious of where the conference is located, and also being "green" in other ways.
- 4 specifically suggested accommodating remote attendance. 3 specifically suggested a preference for using carbon offsets (either for all, or giving the option to the attendee).
- 1 person suggested doing PC meetings online.

ICFP 2017

ICFP 2018 attendees were asked to consider some possible responses to the issue of climate change. They were asked two Likert-scale questions, first ranking the attractiveness of colocating ICFP and POPL:

Not attractive: 1 36 26.3%
2 24 17.5%
3 28 20.4%
4 22 16.1%
Very attractive: 5 27 19.7%

and second the attractiveness of remote participation:

Not attractive: 1 25 18.2%
2 15 10.9%
3 24 17.5%
4 39 28.5%
Very attractive: 5 34 24.8%

All told, 137 of the 151 respondents to the survey answered these questions (out of the 594 ICFP 2017 registrants that were offered the chance to fill out the survey).

Respondents were also offered the opportunity to fill in free-response comments in response to a field labeled "other ideas". Several noted that paying for carbon offsets was about \$10 per person and suggested paying that. If ICFP and POPL were to colocate, several expressed concern about submission deadline (generally noting that having the two deadlines spread out in the year is important to them).

The other major innovation at ICFP 2017 was live streaming of talks and the use of Slack to coordinate questions. The attendees generally were very happy to have the opportunity to interact via Slack.

A substantial portion of the survey respondents (but not a majority) were in favor of remote participation, with 13% saying they would participate remotely and 43% saying they might (if there were good infrastructure for it). Respondents were also asked for ideas on how to make remote participation attractive. Common themes were that high-quality audio and video was important and that requiring payment was unacceptable. Several expressed the opinion that remote participation, while important and useful, is no substitute for being present in person.

Jeremy Gibbons, ICFP 2017 general chair, wrote a [blog post about using Slack at ICFP](#).

(Thanks to Robby Findler for contributing this summary of the survey responses!)

POPL 2018

We made a first experiment with offering carbon offsets to registrants at POPL 2018. The POPL registration website included a link that participants could choose to follow to reach an offset purchase page at [atmosfair](#), a major carbon offset vendor. Participation was voluntary, and ACM was not involved in the purchase in any way. Unfortunately, participation via this mechanism was minimal: only three people reported on the post-conference survey that they had taken advantage of the opportunity to purchase offsets (out of 127 total responses). It seems that offset purchases need to be automatic (with an opt-out mechanism) during registration to get good participation.

