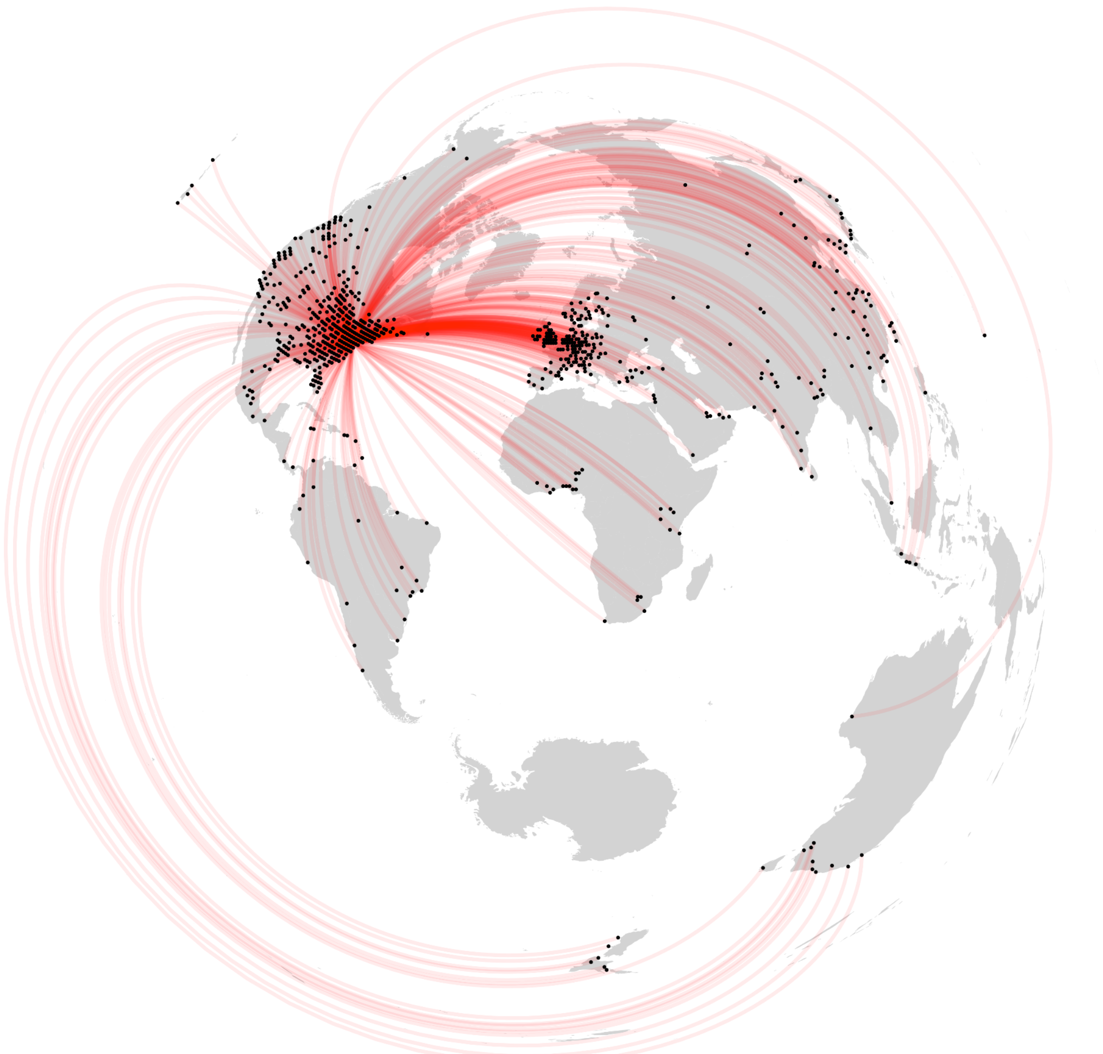
Carbon Emissions Associated with Travel to AAG Annual Meetings



Great circle arcs describing travel distances to the 2019 AAG Annual Meeting in DC.

Recommended citation: AAG (2021) Carbon Emissions Associated with Travel to AAG Annual Meetings. Unpublished analyses prepared for the American Association of Geographers by JGS Projects, October 2021, 28 pp.

Data sets

AAG data describing conference attendees were available for five conferences. AGU conference data were available through GitHub for one conference.

Table 1. Comparison of total attendee numbers across AAG and AGU conferences and the percentages that enter subsequent analyses. The 2016 AAG meeting and 2019 AGU meeting were both held in San Francisco.

	Meeting Venue						
	AGU 2019 San Francisco	**AAG 2015** Chicago	**AAG 2016** San Francisco	**AAG 2017** Boston	**AAG 2018** New Orleans	**AAG 2019** DC	**AAG 5-year Mean**
Attendees	~28000	8692	8648	9028	8153	8485	**8601**
% in sample	~85.7	96.9	97.8	97.5	97.8	98.1	**97.6**

Methods

Used methods and concepts outlined in AGU Nature paper to estimate CO_2 emissions associated with travel.

Translated AGU Python scripts to R scripts.

Data describing the city, state, and country associated with each attendee were used to geocode their location, which we assumed to be the origin of their conference travel.

COMPARING AAG MEETINGS (2015-2019) WITH EACH OTHER AND WITH AGU (2019)

Table 2. Comparison of travel distances and carbon emissions across AAG and AGU conferences. The 2016 AAG meeting and 2019 AGU meeting were both held in San Francisco.

	Meeting Venue						
	AGU 2019 San Francisco	**AAG 2015** Chicago	**AAG 2016** San Francisco	**AAG 2017** Boston	**AAG 2018** New Orleans	**AAG 2019** DC	**AAG 5-year Mean**
Attendees in sample	24008	8425	8458	8805	7977	8324	**8398**
Total travel (millions km)	244.5	52.8	78.3	61.4	58.3	51.9	**60.5**
Travel per attendee (km)	10182	6269	9262	6975	7310	6230	**7209**
Total emissions (tCO2)	69334	13665	21863	16318	15612	13761	**16244**
Emissions per attendee (tCO2)	2.89	1.62	2.58	1.85	1.96	1.65	**1.93**

This table offers summary statistics for five AAG meetings and one AGU meeting. On average, AAG meetings from 2015-2019 had carbon footprints that were approximately 23% the size of the AGU footprint for 2019. This difference was due to AAG having, on average, 34% the number of attendees as AGU. In addition, the average AAG attendee traveled only 71% as far as the average AGU attendee. The AAG meeting in San Francisco was closest to the AGU conference in terms of travel and emissions.

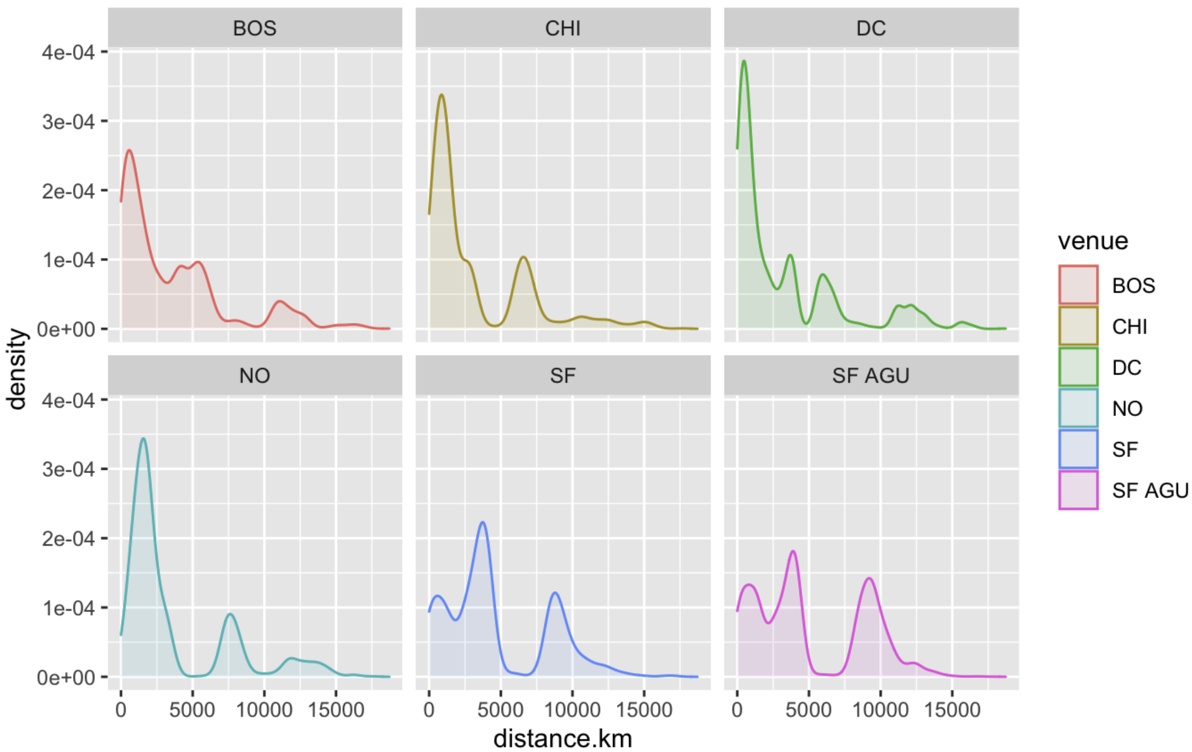


Figure 1. Distribution of great circle distances from venues to attendee origins (one-way).

The distinct peaks near 0 for most of the AAG meetings are driven by the spatial distribution of AAG members, which occur primarily on the east coast of the US. SF meetings for AAG and AGU show two moderate peaks within 5000 km, representing (primarily) attendees from the east and west coasts of the US. The distinct troughs typically result from the presence of Atlantic (and Pacific) Oceans.

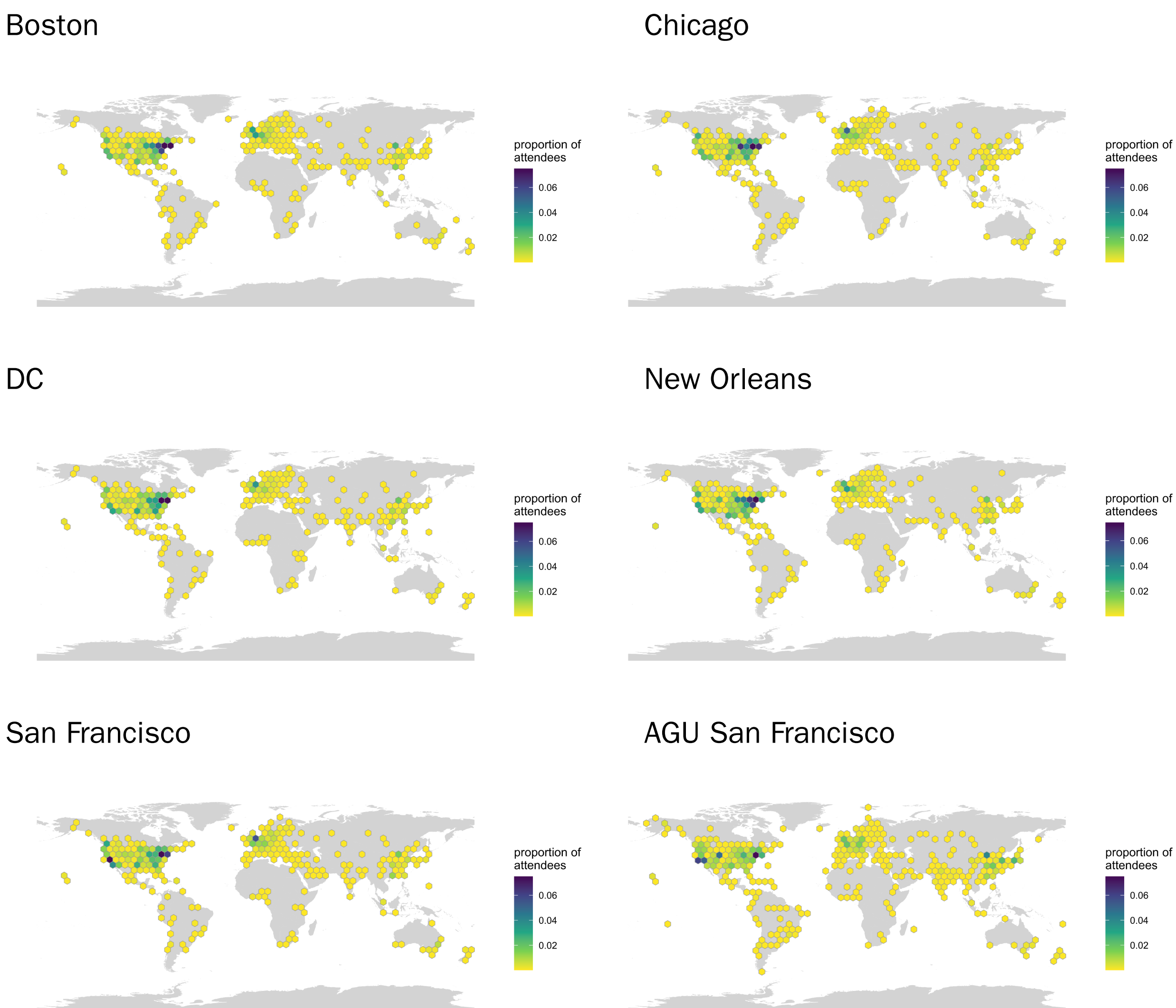


Figure 2. Spatial distribution of attendees.

Among AAG meetings, shifts in the spatial distribution of attendees, particularly within the US, reflects the regional pull of particular meetings and/or constraints on traveling greater distances. The AAG and AGU meetings in SF both pull from both coasts of the US; however, compared to AGU, the AAG tends to have less widely distributed international pull (there is a hotspot of AAG attendees in the UK).

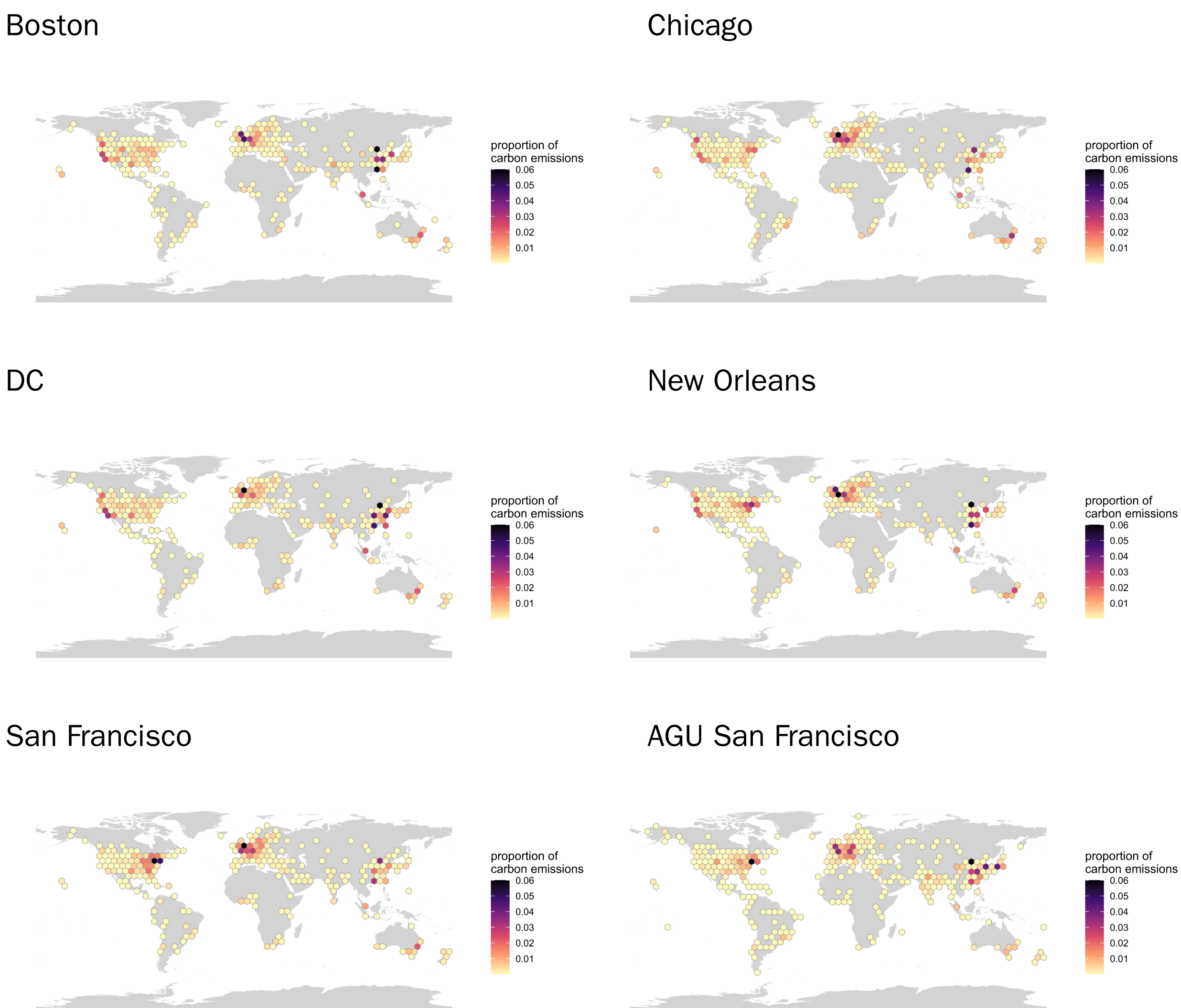


Figure 3. Spatial distribution of carbon emissions associated with travel.

Maps of carbon emissions reflect how changing meeting venues can influence which attendees' travel contributes most to the carbon footprint of the meeting.

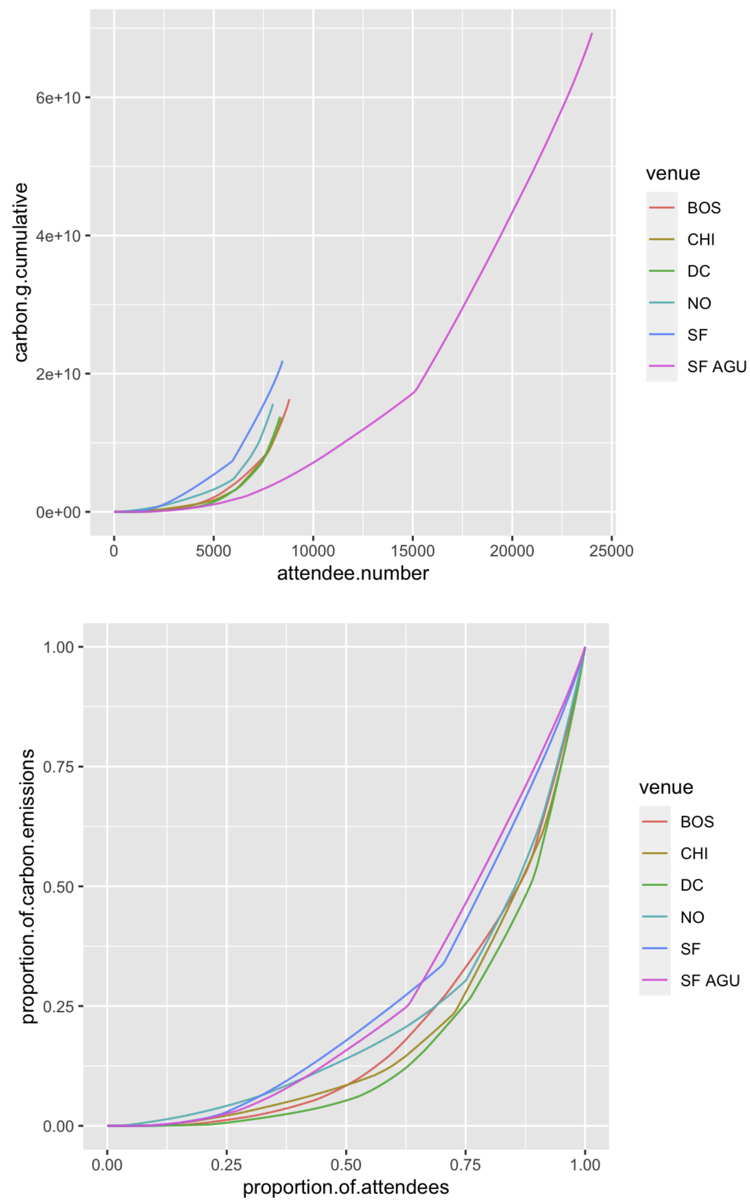


Figure 4. Cumulative carbon emissions associated with travel. Attendees are ordered by per capita emissions.

The top figure gives absolute numbers of attendees and carbon emissions and shows clearly that the AGU meeting has a larger carbon footprint than the AAG meetings as a result of having more attendees. The bottom figure gives relative values and shows clearly that both meetings in SF accumulate carbon emissions more quickly than the other venues (because most attendees have to travel relatively further to SF). Attendees of the AAG meeting in DC contributed carbon relatively slowly due to their greater proximity to the venue.

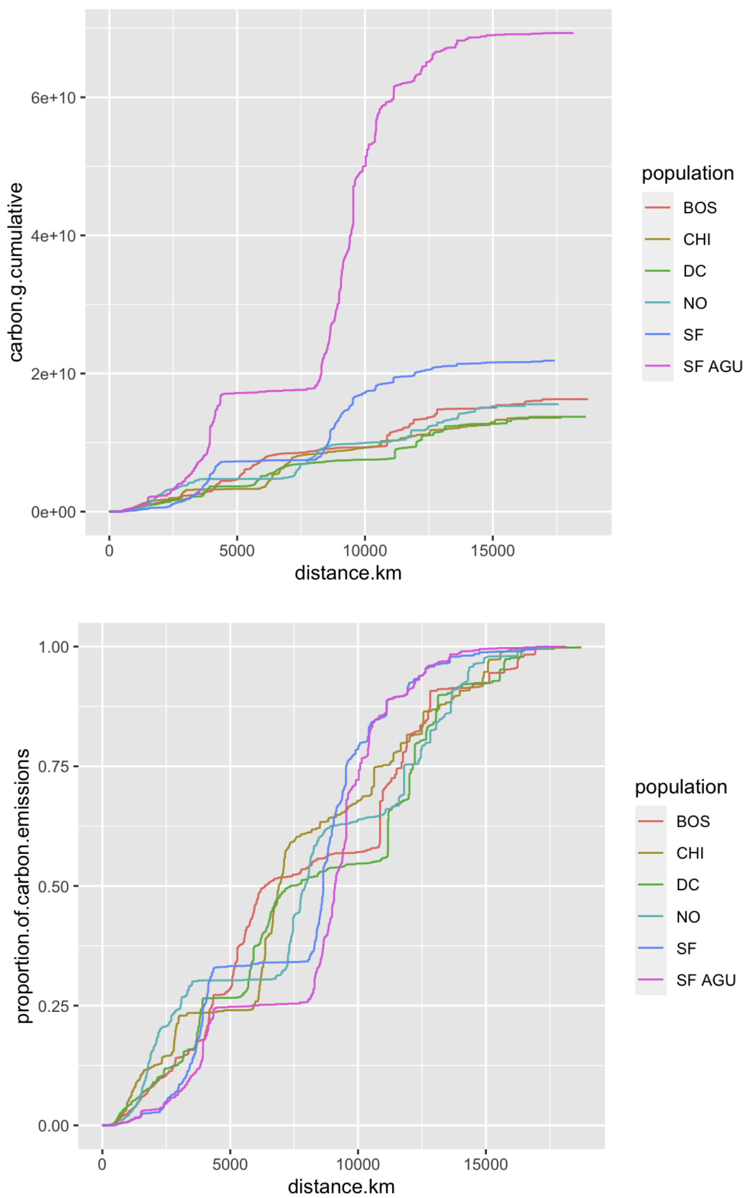


Figure 5. Cumulative carbon emissions associated with travel from different distances to the meeting venue.

The top figure shows distances from each venue and cumulative carbon emissions. It offers leverage for understanding the distance at which carbon costs really start to mount up due to the locations of attendees. The bottom figure shows accumulation relative to the meeting's total carbon emissions. Meetings in SF show steep slopes around 4000 km due to pull from the east coast of the US and around 8000 km due to pull from Europe and Asia.

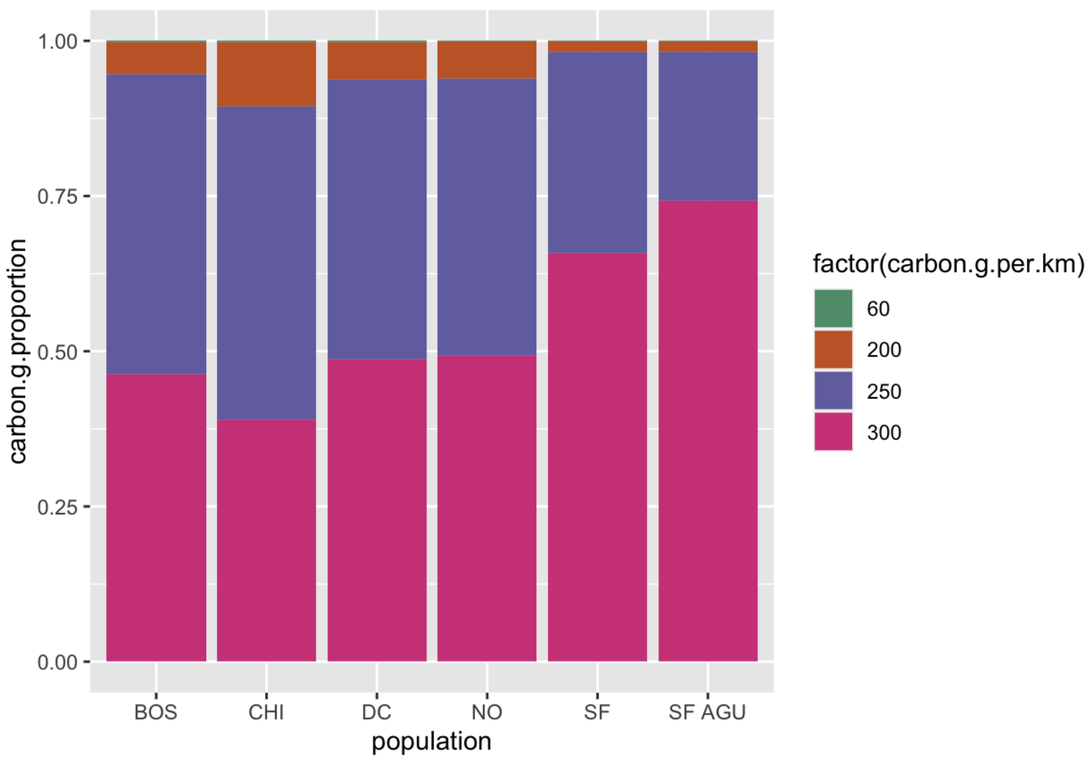


Figure 6. Emissions as a function of travel mode (60 = rail/bus/car; 200 = short-haul flight; 250 = long-haul flight; 300 = super long-haul flight).

The vast majority of carbon emissions for all meetings are generated by long-haul flights (250 g of CO2 per km) and super long-haul flights (300g of CO2 per km). This is especially true for the two meetings in SF.

UNDERSTANDING POTENTIAL CARBON COSTS OF HOSTING THE AAG 2024 MEETING IN HAWAII

Table 3. Comparison of travel distances and carbon emissions associated with travel to the AAG 2024 meeting in Honolulu using different sets of prospective attendees from AAG meetings between 2015 and 2019.

	Prospective Honolulu Attendee Population					
	AAG 2015 Chicago	AAG 2016 San Francisco	AAG 2017 Boston	AAG 2018 New Orleans	AAG 2019 DC	Mean
N attendees	8425	8458	8805	7977	8324	**8398**
Total travel (millions km)	132.6	128.6	140.6	122.0	128.5	**130.4**
Travel per attendee (km)	15735	15205	15964	15298	15432	**15527**
Relative difference in travel per attendee	2.51	1.64	2.29	2.09	2.48	**2.20**
Total emissions (tCO2)	35990	35088	38624	32943	34565	**35442**
Emissions per attendee (tCO2)	4.27	4.15	4.39	4.13	4.15	**4.22**
Relative difference in emissions per attendee	2.63	1.60	2.36	2.11	2.52	**2.25**

Estimates of carbon costs associated with hosting AAG 2024 in Honolulu range from 1.60 to 2.52 times as great (mean 2.25) as for a meeting in the continental US based on different assumptions about the distribution of attendees.

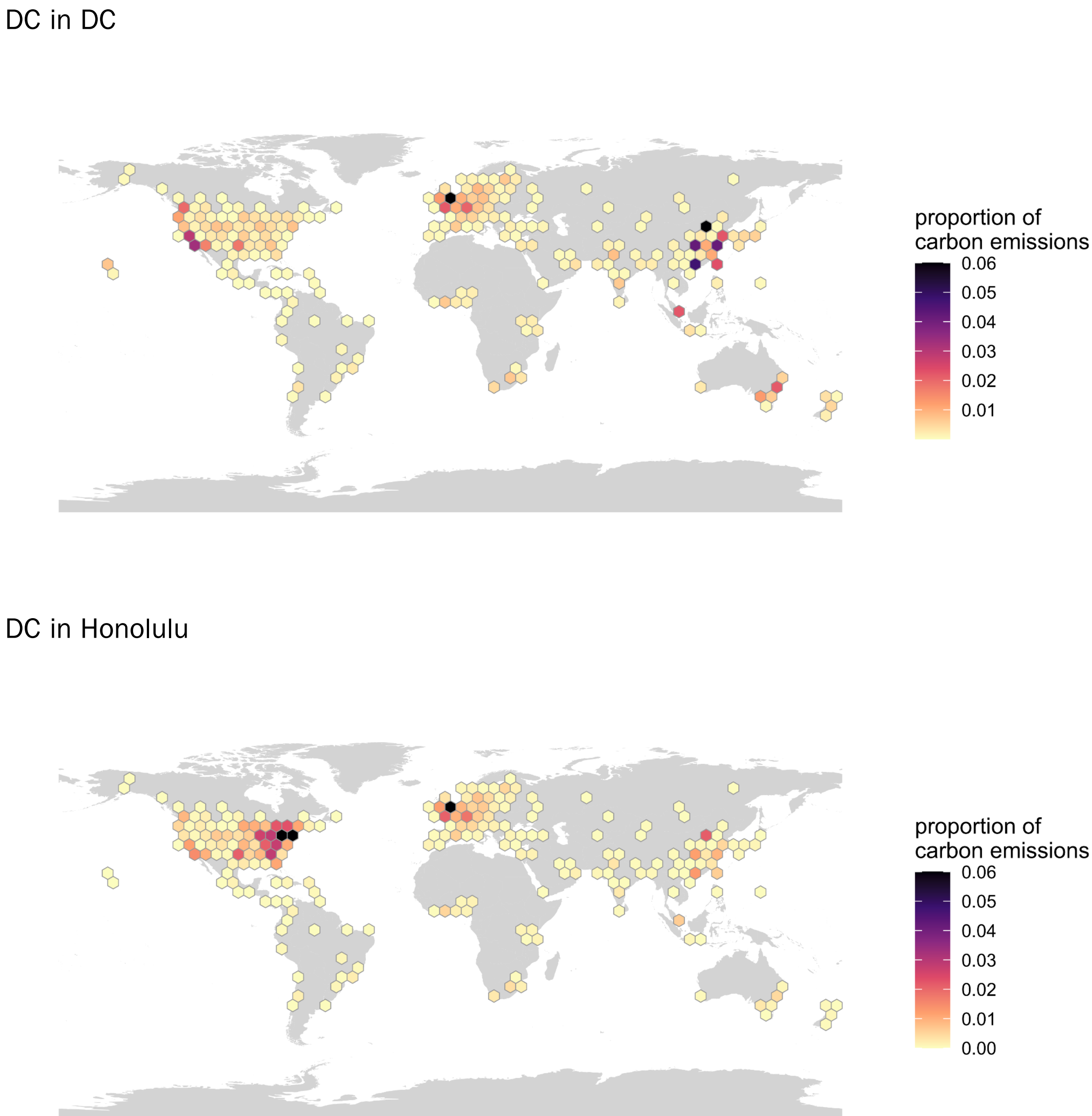


Figure 7. Spatial distribution of emissions associated with travel for the DC meeting attendees at meetings in DC and Honolulu.

These two maps enable visual comparison of which attendees' travel contributes most to the carbon footprints of meetings in DC and in Honolulu. In both cases, the assumed pool of attendees is the group that actually attended the 2019 meeting in DC.

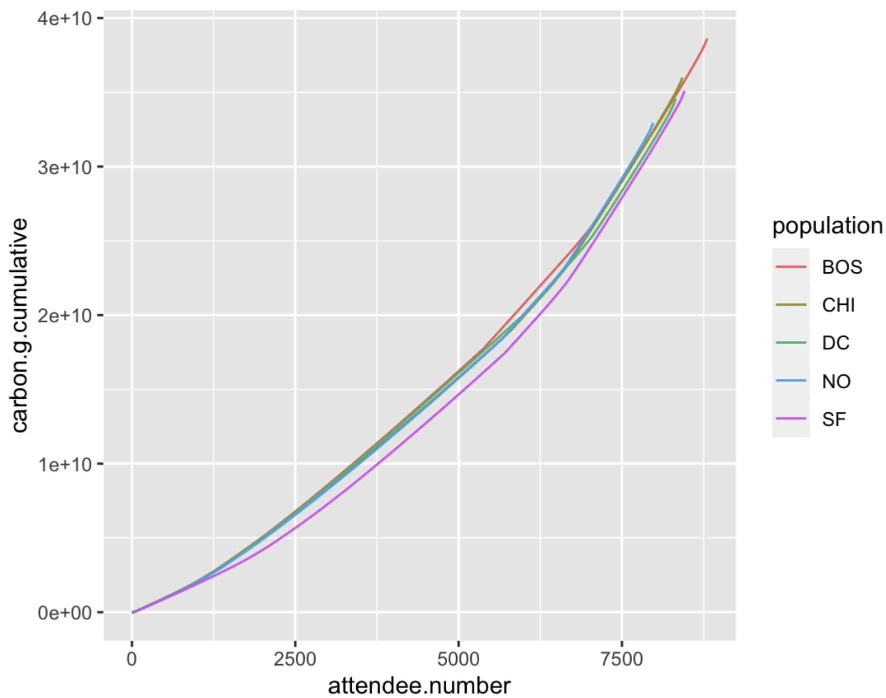


Figure 8. Cumulative carbon emissions associated with travel. Attendees are ordered by per capita emissions.

The figure offers leverage for understanding how different numbers of attendees contribute to the total carbon footprint of a Honolulu meeting. The assumption about where attendees will come from makes relatively little difference to total carbon emissions or the rate at which carbon costs accumulate.

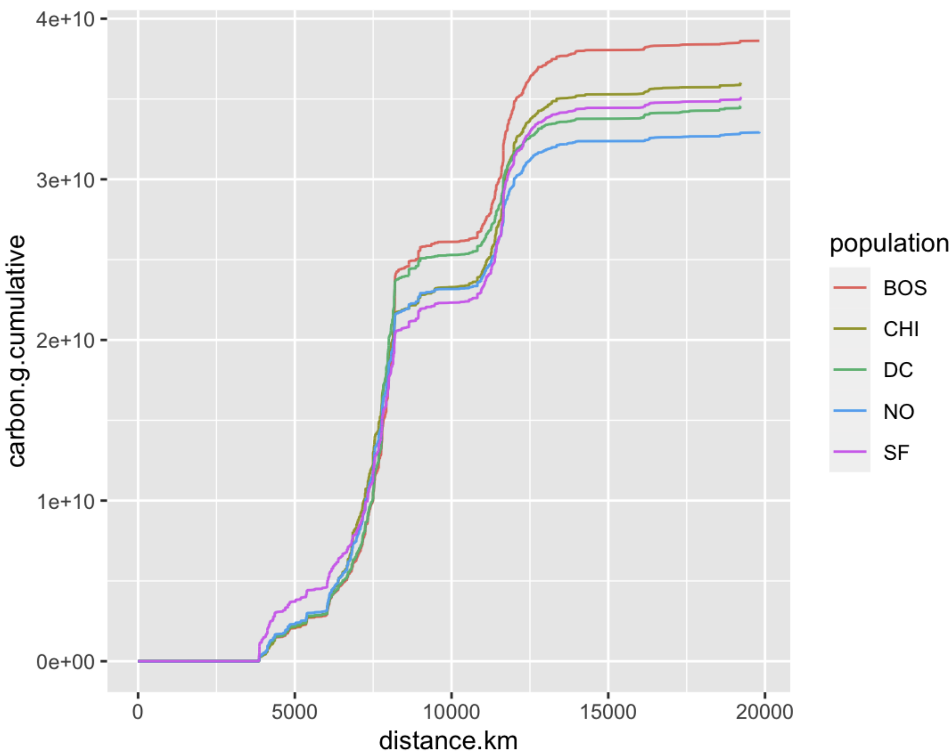


Figure 9. Cumulative carbon emissions associated with travel from different distances to Honolulu.

The figure offers leverage for understanding the distance at which carbon costs accumulate for a Honolulu meeting based on different assumptions about the spatial distribution of the attendee population. Hardly any costs accumulate within 4000 km of Honolulu because essentially all of the attendees will travel further than 4000 km.

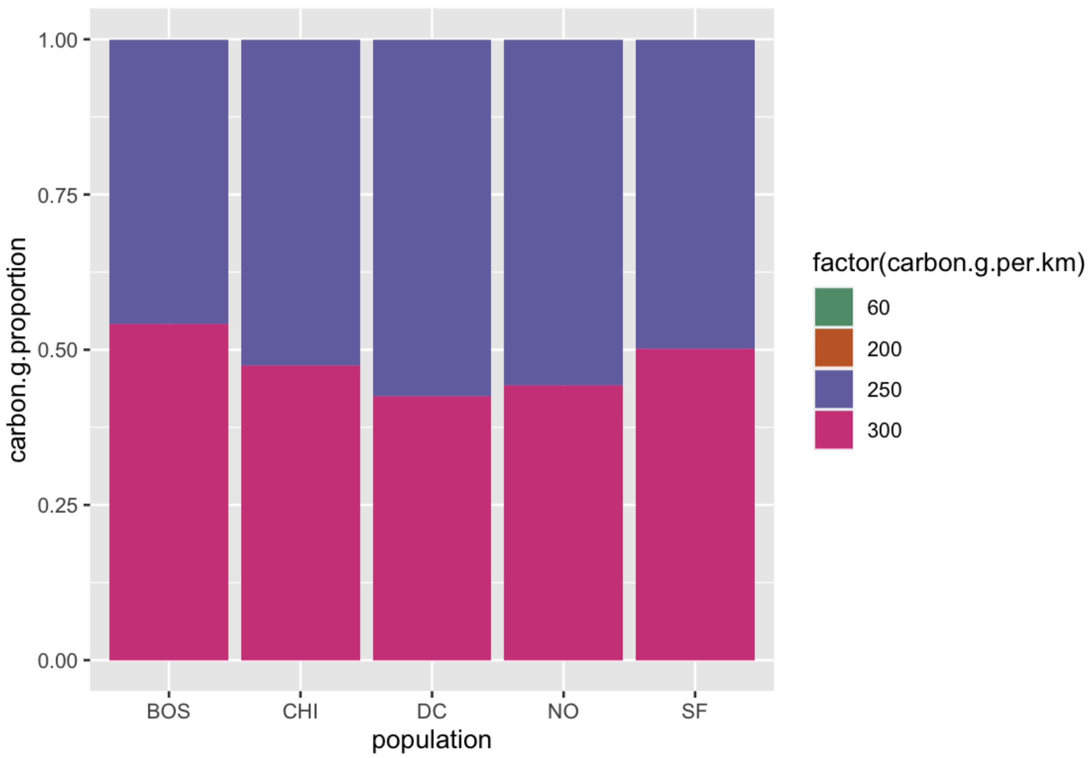


Figure 10. Hypothetical emissions for an AAG meeting in Honolulu as a function of travel mode (60 = rail/bus/car; 200 = short-haul flight; 250 = long-haul flight; 300 = super long-haul flight).

Regardless of what assumptions we make about the spatial distribution of prospective attendees, the vast majority of carbon emissions would be generated by long-haul flights (250 g of CO2 per km) and super long-haul flights (300g of CO2 per km).

HOW A MEETING IN HAWAII MIGHT BE MITIGATED BY ADDING COMPLEMENTARY MEETING VENUES

Table 4. Comparison of travel distances and carbon emissions associated with travel to the AAG 2024 meeting in Honolulu when additional meeting hubs are offered at Dublin, Ireland and Ottawa, Canada. Five different sets of prospective attendees are used from AAG meetings between 2015 and 2019.

	Prospective Attendee Population					
	AAG 2015 Chicago	**AAG 2016** San Francisco	**AAG 2017** Boston	**AAG 2018** New Orleans	**AAG 2019** DC	**Mean**
N attendees	8425	8458	8805	7977	8324	**8398**
Total travel (millions km)	33.7	41.4	38.1	34.9	35.8	**36.8**
Travel per attendee (km)	3999	4895	4329	4377	4302	**4380**
Relative difference in travel to nearest node versus Honolulu only	0.25	0.32	0.27	0.29	0.28	**0.28**
Total emissions (tCO2)	8348	10494	9692	8796	9023	**9271**
Emissions per attendee (tCO2)	0.99	1.24	1.10	1.10	1.08	**1.10**
Relative difference in emissions for travel to nearest node versus Honolulu only	0.23	0.30	0.25	0.27	0.26	**0.26**
Proportion attendees in Honolulu	0.08	0.16	0.11	0.11	0.11	**0.11**
Proportion attendees in Dublin	0.20	0.20	0.19	0.16	0.15	**0.18**
Proportion attendees in Ottawa	0.72	0.64	0.70	0.73	0.75	**0.71**

The table shows that the expected carbon costs of hosting a meeting in Honolulu can be mitigated by 70 to 77% (mean 74%) if additional meeting venues are provided in Ottawa and Dublin and we assume that attendees travel to the nearest venue. On average, 71% of prospective attendees would travel to Ottawa, 18% to Dublin, and 11% to Honolulu.

Honolulu

Honolulu, Ottawa, Dublin

Figure 11. Hypothetical great circle travel arcs for the AAG 2024 annual meeting.

The top map shows travel to Honolulu when considered as the only venue. The bottom map shows travel to the closest of three venues: Honolulu, Ottawa, or Dublin. In both maps, attendees of the AAG 2019 meeting in DC are used as points of origin.

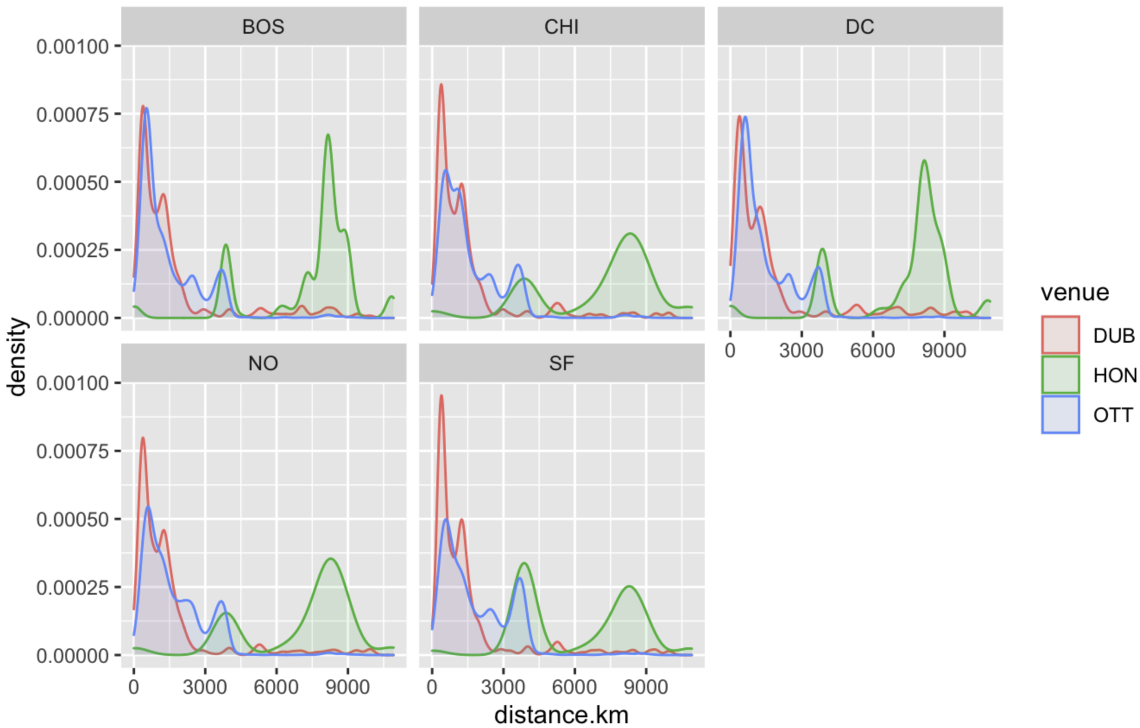
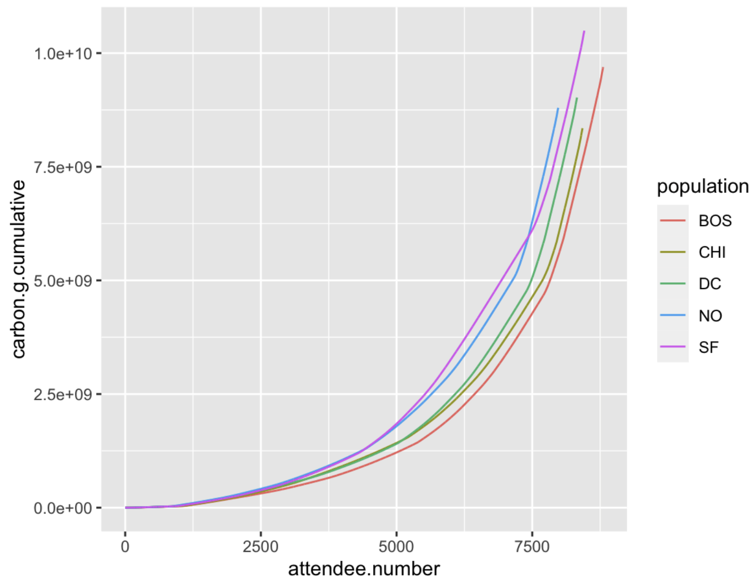


Figure 12. Distribution of great circle distances from the closest of three hubs (Honolulu, Dublin, and Ottawa) to attendee home locations (one-way). Five different pools of prospective attendees are considered from AAG meetings between 2015 to 2019.

In all of the facets (i.e., different populations of meeting attendees), the distributions of distances traveled to either Ottawa or Dublin are markedly different from the distribution of distances traveled to Honolulu.



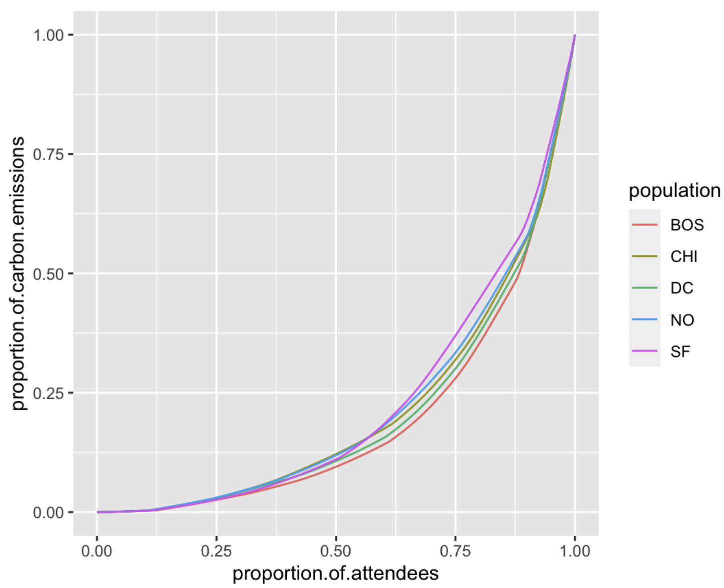


Figure 13. Cumulative carbon emissions associated with travel to a Honolulu-Ottawa-Dublin meeting. Attendees are ordered by per capita emissions.

The figure offers leverage for understanding how different numbers and proportion of attendees contribute to the total carbon footprint of a Honolulu-Ottawa-Dublin meeting. The assumption about where attendees will come from (i.e., which population of attendees) makes relatively little difference to the rate at which carbon costs accumulate.

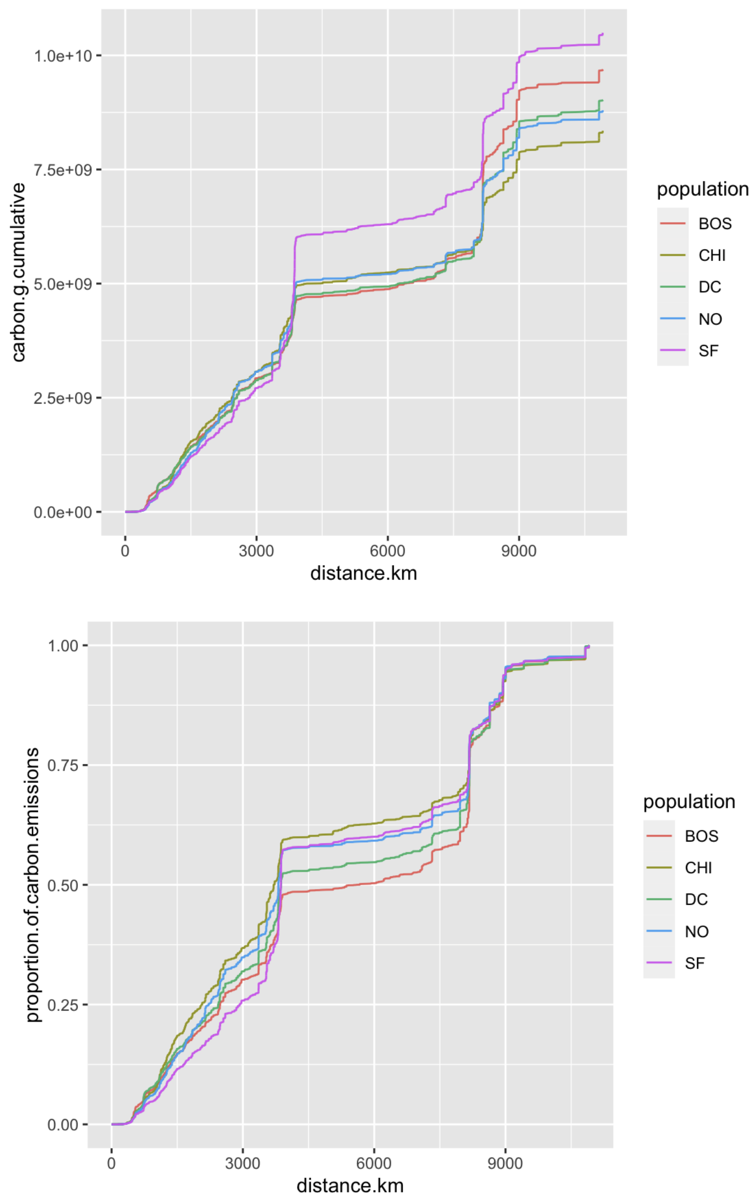


Figure 14. Cumulative carbon emissions associated with travel from different distances to the closest 3-hub meeting venue. The figures offer leverage for understanding the distance at which carbon costs really start to mount up.

The figure offers leverage for understanding the distance at which carbon costs accumulate for a Honolulu-Ottawa-Dublin meeting based on different assumptions about the spatial distribution of the attendee population.

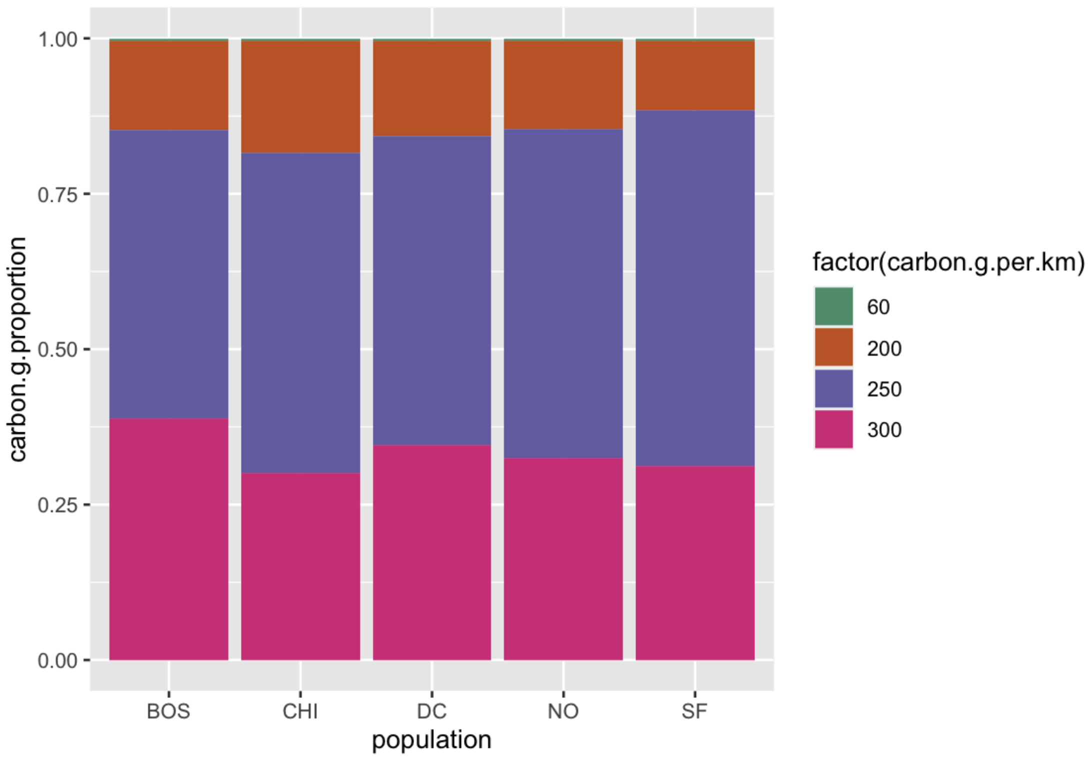


Figure 15. Hypothetical emissions for an AAG meeting in Honolulu-Ottawa-Dublin as a function of travel mode (60 = rail/bus/car; 200 = short-haul flight; 250 = long-haul flight; 300 = super long-haul flight).

As for other meetings, the majority of carbon emissions are generated by long-haul flights (250 g of CO2 per km) and super long-haul flights (300g of CO2 per km). However, long-haul and super long-haul flights (especially) contribute relatively less to the overall carbon footprint because more attendees are traveling on short-haul flights.

COMPARING CARBON FOOTPRINTS FOR HONOLULU AND WASHINGTON DC MEETING SCENARIOS RELATIVE TO THE 5-YEAR AVERAGE FOR AAG MEETINGS (2015-2019)

Honolulu Scenarios

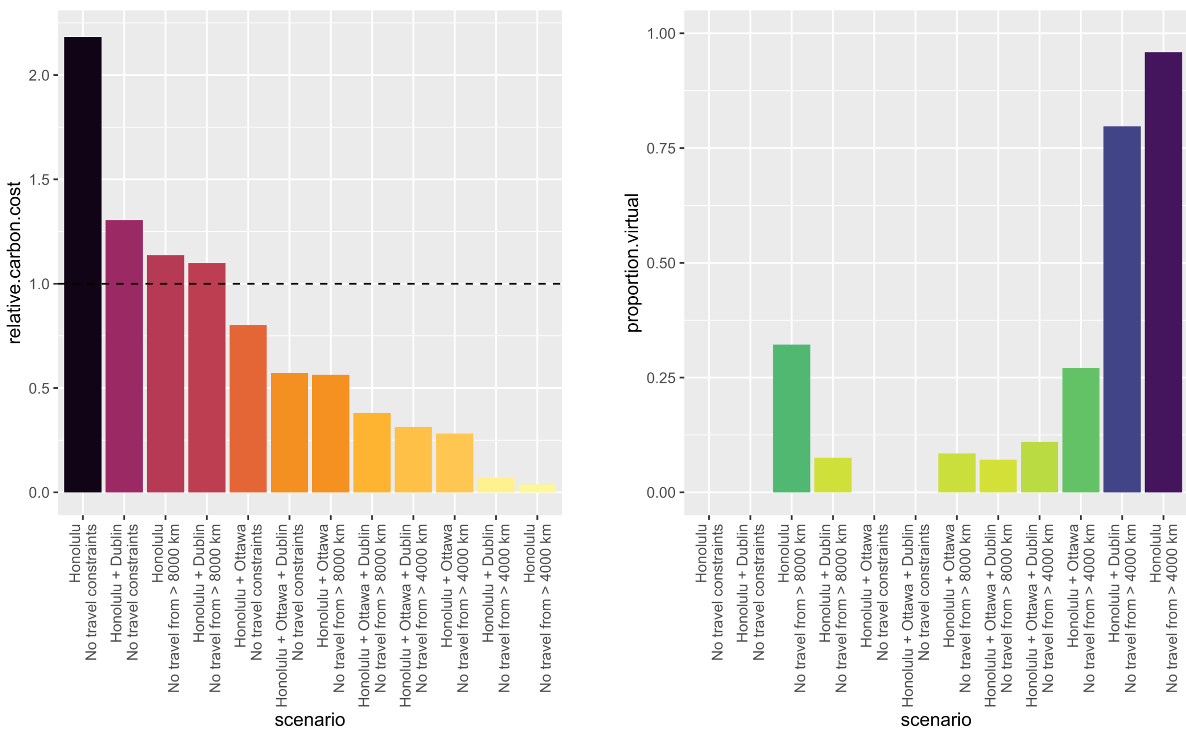


Figure 16. Comparison of total carbon emissions and virtual attendance for a hypothetical Honolulu meeting relative to the 5-year (2015-2019) average for AAG meetings. Scenarios reflect combinations of venue (+ nodes) and distance-based travel constraints. Attendees located beyond distance constraints are assumed to attend virtually. Scenarios are ordered by decreasing emissions.

DC Scenarios

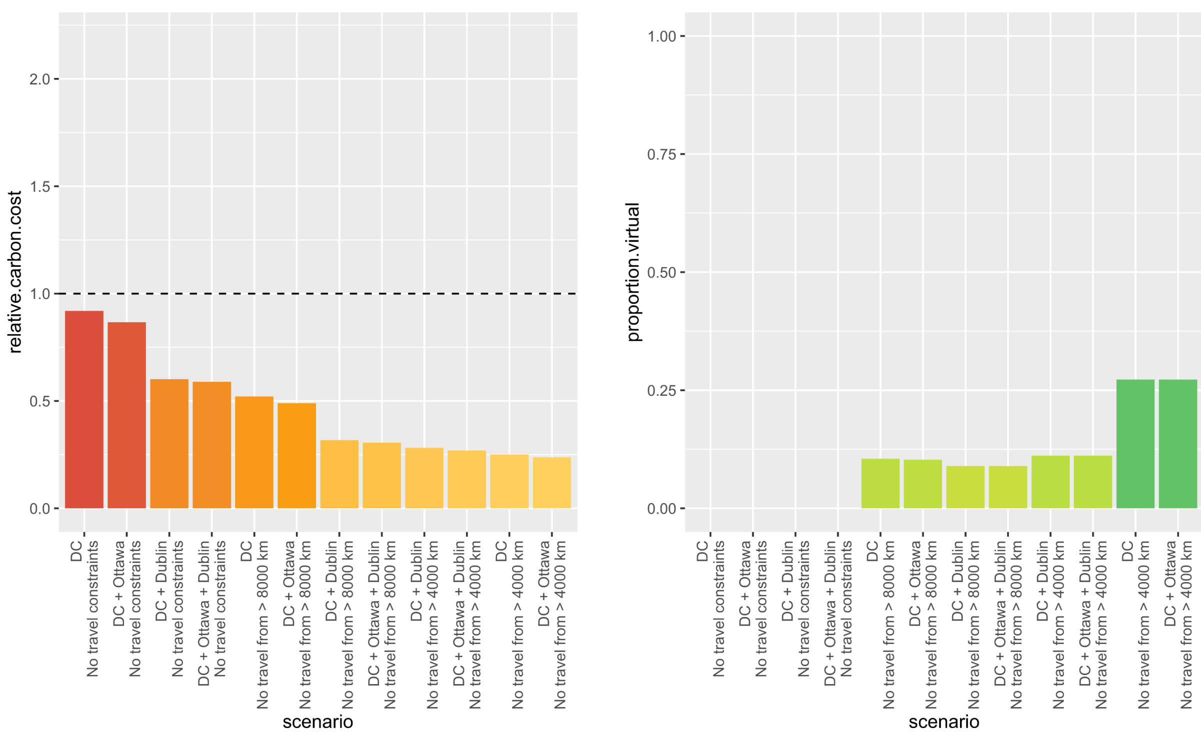
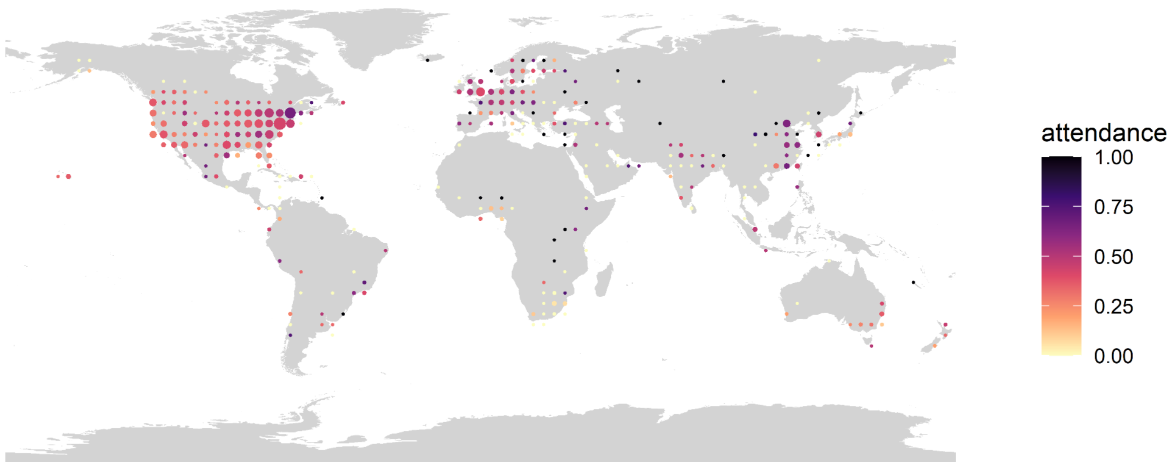


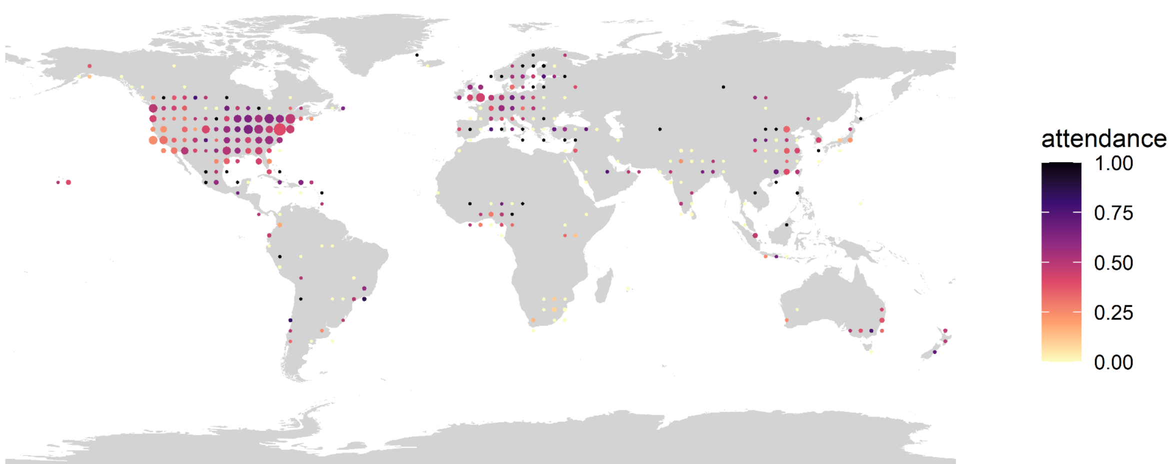
Figure 17. Comparison of total carbon emissions and virtual attendance for a hypothetical DC meeting relative to the 5-year (2015-2019) average for AAG meetings. Scenarios reflect combinations of venue (+ nodes) and distance-based travel constraints. Attendees located beyond distance constraints are assumed to attend virtually. Scenarios are ordered by decreasing emissions.

REGIONAL DRAW OF AAG MEETINGS

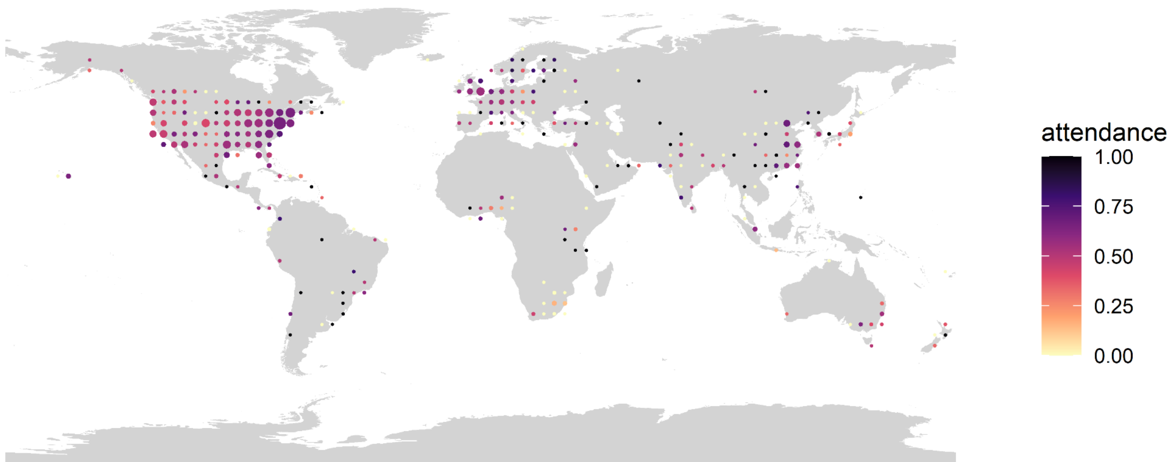
Boston



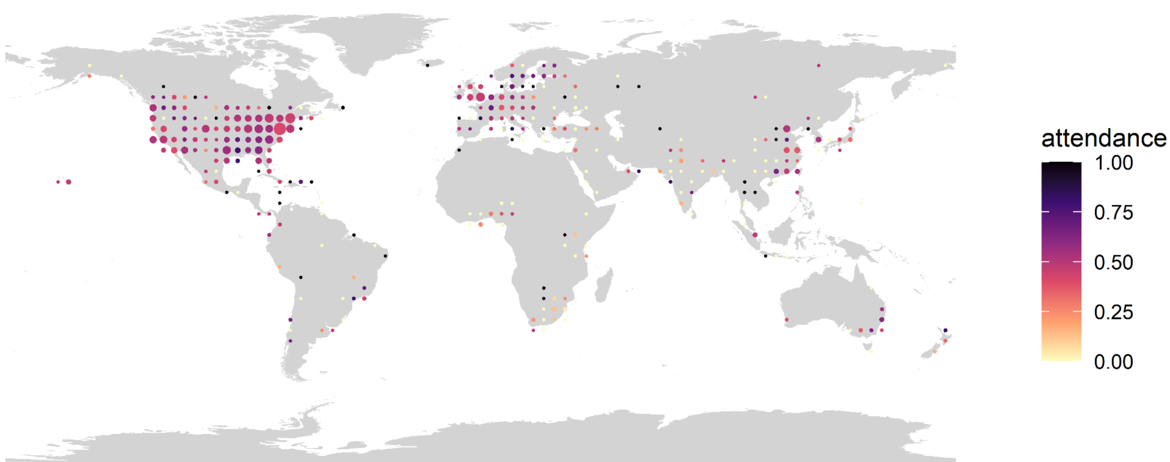
Chicago



DC



New Orleans



San Francisco

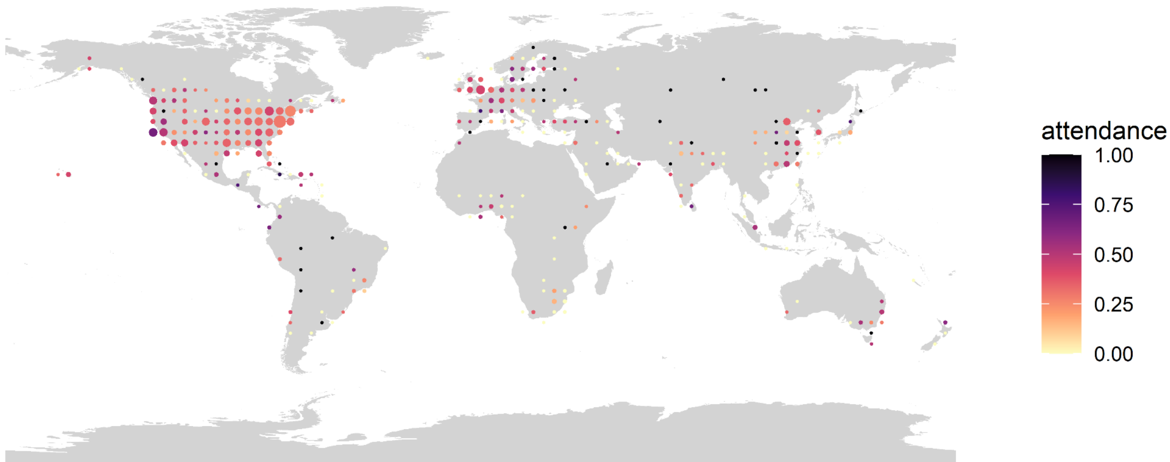


Figure 18. The proportion of AAG members attending annual meetings in different locations. Colors indicate the proportion of members attending. Circle sizes indicate the number of members in 5 x 5 degree cells.

While the relative sizes of points remain relatively constant across meetings (i.e., the spatial distribution of membership is relatively consistent), the colors of points change due to shifts in meeting venue.

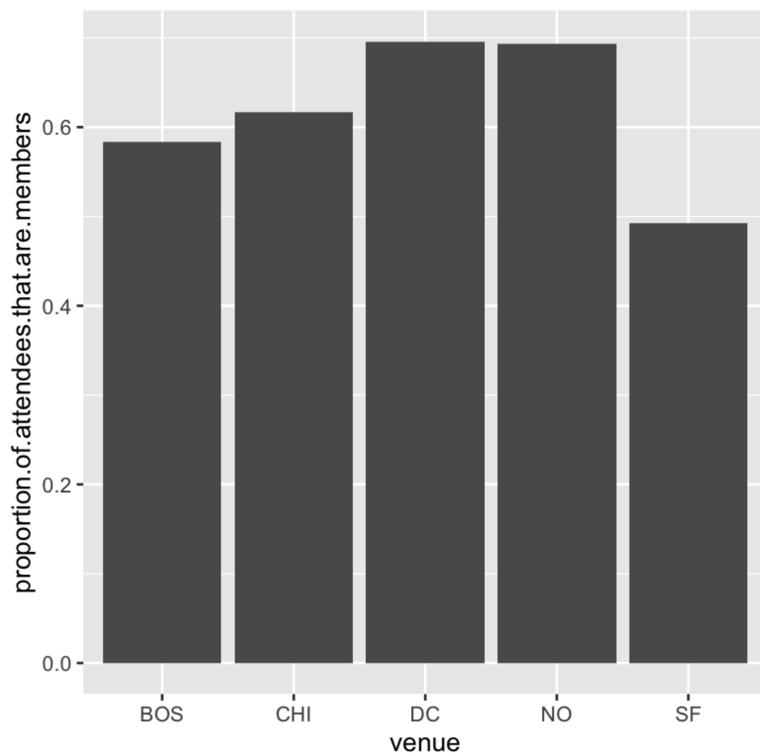


Figure 19. The proportion of meeting attendees that are members.

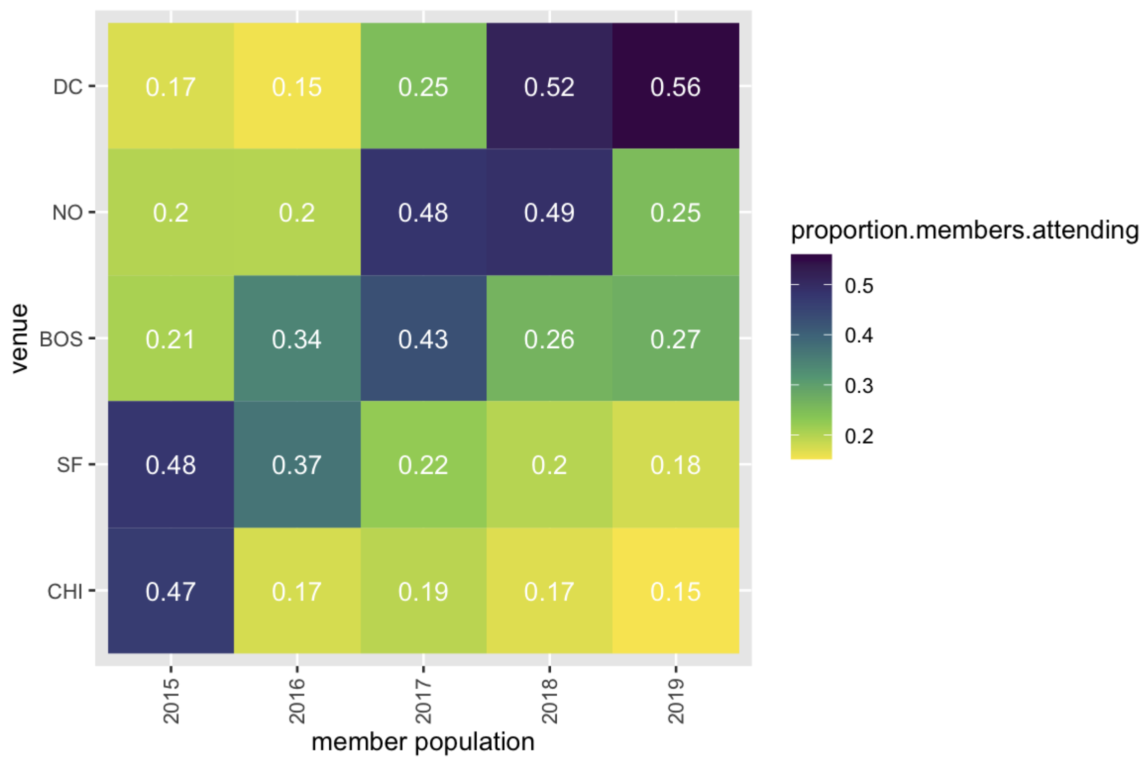


Figure 20. Proportion of the member populations from each of five years that attended meetings from 2015 to 2019.

There is marked turnover in the member population across meetings. For example, Only 17% of the people that were members in 2015 attended the 2019 meeting. Only 15% of people that were members in 2019 attended the 2015 meeting in Chicago.