

1 **Gender Representation of Speaking Opportunities at the American Geophysical Union**
2 **Fall Meeting**

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5 **Implicit and explicit biases impede the participation of women in geoscience(1).**

6 **Documented biases include the quality of postdoctoral recommendation letters(2) and**

7 **opportunities to review research articles(3). Across career stages, attending conferences**

8 **and presenting research are ways to spread scientific results, find job opportunities and**

9 **funding, and gain awards and recognition. However, biases in geoscience conference**

10 **presentations are currently unknown. Here we present an analysis of the American**

11 **Geophysical Union (AGU) Fall Meeting abstract dataset from 2014 to 2016 of invited**

12 **authors and oral and poster presentations. Our results indicate that overall, women**

13 **were invited and assigned oral presentations less often than men for the AGU Fall**

14 **Meetings. However, when we control for career stage, we see similar rates between**

15 **women and men and women sometimes outperform men. Women also elect for poster**

16 **only presentations more than men. Male primary conveners (from students to more**

17 **senior career stages) allocate invited abstracts and oral presentations to women less**

18 **often and below the proportion of women authors. Our results show the need to provide**

19 **equal opportunity to women in speaking roles at scientific conferences as part of the**

20 **overall effort to advance and retain women in STEM fields.**

21

22 There are conscious efforts underway to increase gender equity in science, technology,

23 engineering and mathematics (STEM) fields such as the National Science Foundation's

24 ADVANCE: Increasing the Participation and Advancement of Women in Academic Science

25 and Engineering Careers program. However, despite numerous initiatives to increase the

26 enrollment and retention of women in STEM, the causes of the continued gender disparity is
27 difficult to ascertain. Implicit and explicit biases hinder the participation of women in STEM
28 fields(1). Many gender related biases are documented from disparities in the strength of
29 letters of recommendation(2), solicitation to review research articles(3), and academic pay(4).

30

31 Attending and presenting at conferences is one way researchers expand their network, seek
32 collaborators, connect with mentors, and improve research visibility. In particular, presenting
33 research as an invited speaker and giving an oral presentation are ways to efficiently
34 disseminate scientific results and build one's career. Speaking at a conference is important to
35 career advancement across career stages, particularly for finding job opportunities, funding,
36 and gaining awards and recognition.

37

38 The American Geophysical Union (AGU) Fall Meeting is the world's largest geoscience
39 conference with over 22,000 abstract submissions each year. The meeting covers a wide
40 breadth of Earth and space sciences such as atmospheric sciences, volcanology and space
41 physics. Thus, the AGU Fall Meeting provides a high-powered test for equality in the
42 allocation of speaking opportunities to men and women across a broad range of geosciences.

43

44 **The Abstract Database**

45

46 AGU is an international scientific association with 60,000 members from 137 countries.
47 Since 2013, AGU has asked its members to self-report sex (female, male), highest degree
48 obtained, including year, and other demographic data. For the AGU Fall Meeting 2014 to
49 2016 abstract database (here after referred to as the abstract database), 98% ($n = 65,247$) of
50 abstract authors self-identify as male or female, of which 98% provided career information (n

51 = 64,209). Note that although authors self-identify their sex, our binary analysis
52 (female/women/male/men) does not capture the spectrum of gender identity.

53

54 Career stage is self-identified as student or retired, or calculated based on number of years
55 since highest degree obtained: early career (0-10 years), mid-career (10-20 years),
56 experienced (>20 years). AGU defines these career stages for award eligibility.

57

58 Women submitted 32% of all abstracts ($n = 20,900$) and are concentrated in the student and
59 early career stages (77% of women vs. 60% of men, Figure 1). This distribution of women
60 reflects the “leaky pipeline” and the historical barriers for participation for women in STEM
61 fields(5).

62

63 For the AGU Fall Meeting, topical sessions are proposed by a self-organized group of up to
64 four members, led by a primary convener who must be an AGU member. Traditionally, there
65 are two types of sessions: oral and poster. The primary convener and the co-convener(s) can
66 also invite a limited number of authors.

67

68 During abstract submission, authors opt to be assigned an oral or poster presentation by the
69 conveners or may opt for a “poster only” presentation. The primary convener and co-
70 convener(s) then assign abstract submissions as either oral or poster presentation. When an
71 author opts for a “poster only” abstract submission, it typically remains a poster presentation
72 (99%).

73

74 The AGU membership is representative of those actively engaged in academic, government
75 and industry research within the United States(3). Women are 28% of the AGU membership,

76 which is similar to the percentage of women currently employed in physical sciences
77 (chemists and material scientists: 30%; environmental scientists and geoscientists: 24%; other
78 physical scientists 38%)(6) and science and engineering occupations (28%)(7).

79

80 **Speaking at Conferences**

81

82 Overall, fewer women than men are given the opportunity to highlight their research through
83 invited abstracts and oral presentations (Figure 2, Supplementary Materials for all statistical
84 tests and tables). However, this result is impacted by the gender demographics of AGU. The
85 most common career category for women is student (39% of women authors are students vs.
86 25% of men) and students have fewer speaking opportunities overall (i.e. students are 4.8%
87 of invited abstracts and 15% oral presentations).

88

89 Women were invited to submit abstracts at a lower rate than men [10% vs. 12%, Figure 2A,
90 $\chi^2(1, 65246) = 96.8, p < 0.001$]. AGU states the objective of invited authors are to 1) raise
91 the profile of the session and to 2) attract “authors who would not otherwise submit an
92 abstract to a session in an effort to, for example, enhance diversity or interdisciplinary
93 perspectives or feature early-career scientists.”

94

95 Of invited authors ($n = 7,539$), 31% were early career ($n = 2,363$) and 38% were mid-career
96 ($n = 2,859$). We find women are invited at a significantly higher rate than men within the
97 early career (10.9 vs. 9.9%) and mid-career (20.4 vs. 18.9%) stages. The early career stage
98 includes postdoctoral training, which for women is the “leakiest” part of the STEM career
99 pipeline(8). Women are also more likely than men to spend more time in postdoctoral
100 positions before securing tenure-track jobs(9).

101

102 In 2016, for logistical reasons, the AGU reduced the number of invited abstracts a primary
103 convener could invite from four to two. Notably, this change was associated with a reduction
104 in the gender bias for invited abstracts. That is, although women continued to be invited to
105 submit abstracts at a lower overall rate than men, the difference between women and men
106 was less in 2016 than 2014/2015 [2014/2015: $\chi^2(43,535) = 81.0, p < 0.001$; 2016: $\chi^2(21,710)$
107 $= 14.1, p < 0.001$; difference: $\chi^2(1) = 66.9, p < .001$].

108

109 Of all authors that opt to be assigned to an oral or poster presentation by the conveners ($n =$
110 31,348), women were assigned oral presentations at a lower rate than men [41.1% vs. 44.5%,
111 Figure 2B $\chi^2(1, 31347) = 31.1, p < 0.001$]. When we control for career stage, we see no
112 significant difference between women and men.

113

114 **The Role of the Primary Convener**

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116 The primary convener leads the decision to invite and assign oral or poster presentations for a
117 specific session. Although we have gender and career stage information for the primary
118 convener, the abstract database does not include gender and career stage information for co-
119 conveners. We therefore do not test for possible co-convener influence on gender parity.

120

121 Male and female primary conveners invited women authors 24% ($n = 1,302$) and 34% ($n =$
122 716) of the time, respectively (Figure 3A). Men primary conveners invited fewer women
123 authors at early career, mid-career and experienced career stages. Male and female primary
124 conveners assigned women authors oral presentations 29% ($n = 3,769$) and 37% ($n = 1,733$)

125 of the time, respectively (Figure 3C). Men primary conveners assigned fewer women authors
126 oral presentations at student, early career, mid-career and experienced career stages.

127

128 We also examined whether there were differences in inviting and assigning oral presentations
129 by career stage of the primary conveners themselves. From student to more senior career
130 stages, men primary conveners invited (Figure 3B) and assigned (Figure 3D) fewer women
131 than women primary conveners. Thus, regardless of primary convener career stage, primary
132 convener men provided fewer opportunities to women.

133

134 Male primary conveners allocated 72% of all abstracts ($n = 47,812$). Because men primary
135 conveners control a larger portion of abstracts, their higher preference for other men
136 (compared to female primary conveners) has a disproportionate impact on the visibility of
137 women as invited or oral presentation speakers.

138

139 **Women Opt Out**

140

141 Women elect for poster only presentations more than men [32% vs. 26%, Figure 2C, χ^2 (1,
142 43514) = 134.9, $p < 0.001$]. This relationship is significant across the student (44% vs. 41%),
143 mid-career (22% vs. 20%) and experienced (20% vs. 15%) career stages.

144

145 The “confidence gap”(10) may explain why women disproportionately opt for poster
146 presentations. Women tend to underestimate their ability and performance in science(11).
147 Electing to present a poster may be more desirable if women feel their science is “not ready”
148 for an oral presentation and/or an oral presentation feels like a high stakes performance.

149 Alternatively, women may opt for poster only presentations because presentation times are
150 more flexible and/or they feel posters might provide more networking opportunities.

151

152 **A Path Forward**

153

154 Overall, our results suggest that female scientists are offered fewer speaker opportunities than
155 men. However, these results are influenced by the gender demographics of AGU where
156 women disproportionately occupy the student career stage. Ninety-three percent of invited
157 abstracts and 83% oral presentations are allocated to more senior career stages where there
158 are fewer women due to the “leaky pipeline” and the historical barriers women face in STEM
159 fields. When we control for career stage, early and mid-career women are invited at a higher
160 rate than men and we do not see any other statistically significant differences between
161 women and men for invited abstracts and oral presentations. Women also elect for poster
162 only presentations more often than men.

163

164 Male conveners offered fewer invited abstracts and speaking opportunities to women; this is
165 discouraging because men control >70% of the abstract allocations. This implies the reason
166 AGU has gender parity when we control of career stage is because women disproportionately
167 invite other women. This means the underrepresented gender is doing the burden of gender
168 parity efforts.

169

170 Attending conferences and interacting with colleagues is vital to the exchange of ideas within
171 the science community. By giving oral presentations, scientists increase professional
172 visibility, widely disseminate results and improve their communication skills. The

173 opportunity to speak is fundamental to career advancement across career stages for job
174 opportunities, collaborations, awards and recognition.
175
176 Reducing gender bias in speaking roles is critical for the advancement of women in science.
177 Promoting student and early career stages for invited abstracts and oral presentations may
178 help as women are concentrated in these career stages. Encouraging more women to act as
179 primary conveners may also reduce the overall gender imbalance. All conveners may benefit
180 from interventions and/or implicit bias training prior to inviting and assigning oral
181 presentations to speakers. For instance, after an analysis of gender bias in peer review within
182 AGU publications(3), AGU now includes a statement asking authors to help improve the
183 diversity of the reviewer pool during the manuscript submission process(12). This small
184 intervention improved the gender diversity of the suggested reviewer pool, particularly for
185 male authors.

186

187 **Figure Captions**

188 **1. American Geophysical Union Fall Meeting Gender Demographics.** Proportion of total
189 abstracts by career stage (A) and proportion of abstracts by gender by career stage (B).

190 **2. Author submissions to American Geophysical Fall Meeting.** Proportion of invited
191 authors (A), authors assigned oral presentations (B) and authors opting for posters (C) by
192 gender by career stage. Total here is the proportion of total abstracts.

193 **3. Primary convener allocations for American Geophysical Fall Meeting.** Proportion of
194 women across career stages invited by primary convener gender (A). Proportion of women
195 invited by primary conveners' gender and career stage (B). Proportion of women across
196 career stages assigned oral presentations by primary convener gender (C). Proportion of
197 women assigned oral presentations by primary conveners' gender and career stage (D).

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