5.2 STATISTICAL ANALYSIS OF SURVEY DATA RELATED TO GENDER ISSUES AMONG ACADEMIC AMS MEMBERS

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1. INTRODUCTION

The American Meteorological Society (AMS) periodically conducts surveys of its members (e.g. Kellogg 1977; Stephens and Kazarosian 1992; Zevin and Seitter 1994; Michaels et al. 2001). These surveys have frequently been analyzed for the information they provide about gender issues in the atmospheric and related sciences (Simpson and LeMone 1974; LeMone and Waukau 1982; Winkler et al. 1996). The most recent survey was conducted in 2005 (Murillo et al. 2008). Since more than ten years have past since our earlier examination of the responses to an AMS survey, (Winkler et al. 1996, hereinafter, WTS96) we would like to analyze the results of the 2005 survey to see if there have been changes in the demographic characteristics of AMS members in academia particularly as they pertain to gender. This analysis is particularly important for the 2005 survey since for the first time universities and colleges are the largest employment category for regular members (Murillo et al. 2008).

The basic structure of the 2005 survey is described in detail by Murillo et al. (2008). Thus, our description below focuses only on those aspects which are particularly important for the analysis of academic AMS members.

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The 1993 survey (WTS96) had several limitations which complicated the analysis of the survey responses. Because of how the survey questions were worded, it was difficult to separate the respondents whose primary field was atmospheric science from those in other geosciences and from those in fields outside of the geosciences. In addition, the period for which tenure stream faculty reported their salary (9, 11 or 12 months) was not clear and likely varied between respondents. Confusion also existed on whether the respondents reported only their fixed salary or if additional income from summer teaching or research grants was included. Furthermore, salary information was collected for only a small number of broad categories. Individual salaries were assigned the midpoint of the relevant category when calculating mean salaries and other statistics, introducing uncertainty into the statistical analyses.

When designing the 2005 survey, particular attention was paid to these earlier limitations. Respondents were explicitly asked for the field of their primary employment. Also, faculty were asked how many months were included in their base salary and then requested to provide their

salary for that period. Other income was reported as secondary income. Salaries were given to the nearest thousands of dollars rather than for broad categories. These improvements to the survey permit a better picture compared to earlier analyses of the differing characteristics of men and women in tenure stream geoscience positions in colleges and universities.

Research scientists employed by academic institutions were also included in the analysis. Although the survey allowed for three categories of research scientists (research scientist, postdoctoral assistant, or research staff), no distinction was made between the different subgroups in the analysis. Non-tenure stream instructors were not included because of the very small number of women reporting this job title.

To limit the size of this paper, we will concentrate on three interesting aspects of the survey results: relative numbers, salary, age, and marital status.

2. METHODOLOGY

To be considered an assistant, associate or full professor, a person had to be employed full time in a tenured or tenure-stream position. Assistant, associate or full professors from schools that do not award tenure were considered to be tenure-stream faculty and were included in the analysis. Faculty and research scientists were grouped into three categories based on their primary employment field: atmospheric science or meteorology, another geoscience (climatology, geography, geology or geophysics, hydrology or oceanography), or an employment field outside of the geosciences. We confined our analysis to atmospheric science and other geosciences. The number of respondants respondents from fields outside the geosciences was relatively small, especially among women, and the fields represented are very diverse (e.g. from history to physics). Also, faculty and research scientists working outside the U.S. are not included as the survey did not request salary information for members residing abroad.

Differences between groups were evaluated using a parametric *t* test. If an F test indicated that the assumption of equal variance for two groups being compared was violated, the approximate *t* statistic was used in the place of the usual *t* statistic. Differences in the mean that are significant at the $\alpha = 0.10$ (alternatively, 90% confidence interval), $\alpha = 0.05$ (alternatively, 95% confidence interval) and $\alpha = 0.01$ (alternatively, 99% confidence interval) levels are noted in the tables. The α level is the probability of rejecting the null hypothesis (i.e. no difference between the two groups) when it is true.

3. NUMBERS AND SALARIES

Average salaries for men and women in atmospheric science are presented in Tables 1 and 2 and in other geosciences are presented in Tables 3 and 4. Note that the numbers given are the number reporting salary and not the total number of respondents of the survey.

In both atmospheric sciences and the other geosciences, the number of women faculty members remains substantially smaller than that of the men. For assistant professors, there has been only a modest increase (16% in the current survey versus 14% in 1993, WTS96). Low numbers of women faculty are not a problem unique to the atmospheric or geosciences. Even in biology, where 46% of the Ph.D. degrees

are awarded to women, only 15% of the full professors are women (Handelsman et al. 2005). Handelsman et al. (2005) cite several reasons for this discrepancy. One is that women are not encouraged to become faculty members or lack female faculty role models. Analysis of survey respondents with PhD degrees working in academia reveals that women Ph.D.s are less likely to have tenure stream faculty positions than male Ph.D.s and this difference is statistically significant ($\alpha < 0.05$). The lack of female faculty members means that many women PhD students will not have female role models. More encouragement of female Ph.D. students to become faculty members appears necessary in order to increase the number of women faculty in the geosciences.

Table 1. Mean salaries for men in atmospheric science

	Number	Mean Salary
Asst. Professor	45	$64,400[c]
Asso. Professor	34	$77,000
Full Professor	63	$107,200
Administrator	12	$143,000

[c] Male-female differences significant at α=0.10

Table 2. Mean salaries for women in atmospheric science

	Number	Mean Salary
Asst. Professor	9	$58,200[c]
Asso. Professor	7	$83,500
Full Professor	14	$109,000

[c] Male-female differences significant at α=0.10

In atmospheric science, male assistant professors earn higher salaries than women assistant professors. This difference is weakly significant. Female associate and full professors generally earn larger salaries than their male counterparts, although differences are not statistically significant.

In the other geosciences, the reverse situation prevails. At the assistant professor level, women have salaries slightly larger than those of men, but at the associate and full professor levels women earn less than men. At the full professor level the difference is statistically significant and at the associate professor level it is weakly significant. This disparity in salary at the higher ranks is possibly the result of past discrimination that has not been remedied.

Table 3. Mean salaries for men in other geosciences

	Number	Mean Salary
Asst. Professor	32	$61,000
Asso. Professor	48	$81, 900[c]
Full Professor	85	$118,200[b]
Administrator	11	$146,300

[b] Male female differences significant at α=0.05

[c] Male-female differences significant at α=0.10

Table 4. Mean salaries for women in other geosciences

	Number	Mean Salary
Asst. Professor	5	$61,800
Asso. Professor	10	$67,600[c]
Full Professor	9	$95,100[b]

[b] Male female differences significant at α=0.05

[c] Male-female differences significant at α=0.10

The average salaries for research scientists at universities (not including employees of the University Corporation for Atmospheric Research) are shown in Table 5 and Table 6. In both atmospheric science and the other geosciences men earn larger salaries than the women. In atmospheric science, this difference is highly statisti-

cally significant. Furthermore, women research scientists in atmospheric science are slightly more likely to have their PhD than the men compared to the other geosciences, where male research scientists are more likely to earned a PhD. Although the salary difference may partly reflect differences in years of experience (see below), we believe that the discrepancy is cause for concern because of the magnitude of the difference.

Table 5. Mean salaries for research scientists in atmospheric science at universities

	Number	Salary	% w/PhD
Men	135	$59,400[a]	74.3
Women	23	$51,000[a]	77.8

[a] Male female differences significant at α=0.01

Table 6. Mean salaries for research scientists in other geosciences at universities

	Number	Salary	% w/PhD
Men	42	57,000	89.3
Women	15	$52,100	71.4%

4. AGE AND EXPERIENCE

Age and year of terminal degree are given in Tables 7 and 8 for atmospheric scientists at universities and in Tables 9 and 10 for other geoscientists at universities. For both groups women assistant professors are slightly younger than the mean and received their PhD degrees somewhat more recently than the men, which may partially account for the higher salaries seen above for male assistant professors in atmospheric science but cannot account for the opposite difference seen for the other geosciences. Male assistant professors in atmospheric science, who responded to the 2005 survey, were over two years older and the female assistant professors almost three years older than those responding to the 1993 survey (WTS96). This age difference is even larger for the other geosciences. We believe these numbers suggest a trend towards hiring assistant professors with more experience which can present challenges for women. When the age at time of hire is younger, women can obtain a position as an assistant professor, earn tenure and still be able to have one or two children post tenure. As the age at time of hire increases, for assistant professors, this strategy is much more difficult.

Table 7. Age and year of terminal degree of men in atmospheric science at universities

	Age	Year of Terminal degree
Full Professor	56.5	1978
Asso. Professor	46.3	1990
Asst. Professor	37.6	1998
Research Sci.	40.6[a]	1994[a]

[a] Male female differences significant at α=0.01

Table 8. Age and year of terminal degree of women in atmospheric science at universities.

	Age	Year of Terminal Degree
Full Professor	55.2	1979
Asso. Professor	46.0	1990
Asst Professor	36.3	2000
Research Sci	35.9[a]	1999[a]

[a] Male female differences significant at α=0.01

For associate and full professors in the atmospheric sciences, age and number of years of experience are very similar for both men and women. In the other geosciences women associate and full professors are about the same age as the men but received their PhD degrees more recently,

particularly at the full professor level where the difference is highly statistically significant. These differences in age and experience may account for part of the salary differences seen between men and women at this level.

Table 9. Age and year of terminal degree of men in other geosciences at universities

	Age	Year of Terminal Degree
Full Professor	58.6	1977[c]
Asso. Professor	45.3	1991
Asst. Professor	39.5	1998
Research Sci.	41.3	1994[b]

[b] Male female differences significant at α=0.05

[c] Male-female differences significant at α=0.10

Table 10. Age and year of terminal degree of women in other geosciences at universities

	Age	Year of Terminal Degree
Full Professor	55.2	1982[c]
Asso. Professor	46.0	1993
Asst. Professor	40.4	2000
Research Sci.	38.9	1999[b]

[b] Male female differences significant at α=0.05

[c] Male-female differences significant at α=0.10

A similar pattern is seen for research scientists. Women research scientists are much younger and have fewer years of experience than men. These differences appear to be considerably larger for atmospheric science than for the other geosciences.

5. MARRIAGE AND FAMILY

An additional difference from the 1993 survey is the percentage of faculty members who are married or partnered. In the 2005 survey, respondents had the option to indicate a marital status of partnered. Because of the small who selected this category, partnered people were included in the married. For assistant professors in atmospheric science, 95% of the men and 92% of the women are married, and only slightly smaller percentages of assistant professors in the other geosciences are married (Tables 10-13). In contrast, 72 % of male and 62% of the female assistant professors responding to the 1993 survey were married. Part of this increasing trend towards marriage may be explained by the increase in the ages of assistant professors although that is not likely to be the only reason.

Table 10. Percentage of male atmospheric scientists who are married or have children under 18 years old.

	Percent Married	Percent with Children
Full Professors	91.4	37.4
Asso. Professors	94.5	76.4
Asst Professors	95.3	58.0
Research Sci.	71.0	38.8

Table 11. Percentage of female atmospheric scientists who are married or have children under 18 years old

	Percent Married	Percent with Children
Full Professors	92.9	53.3
Asso. Professors	71.4	42.8
Asst. Professors	92.3	33.3
Research Sci.	51.8	31.0

At the rank of associate professor, 85% of the men and 79% of the women who responded to the 1993 survey were married. These percentages are similar to those from the current survey. Among full

professors in 1993, 92% of men and 84% of women were married. Percentages from the current survey are similar for men but higher for women. Overall the marriage rates for faculty members are similar for with associate professors in atmospheric science and full professors in the geosciences displaying minor differences. Most research scientists are married but marriage rates are less than those of the faculty. Marriage rates are noticeably smaller for women research scientists in atmospheric science than for men.

Table 12. Percentage of men in other geosciences who are married or have children under 18 years old.

	Percent Married	Percent with Children
Full Professors	80.8	33.8
Asso Professors	84.4	55.3
Asst. Professors	84.3	53.1
Research Sci.	63.8	44.7

Table 13. Percentage of women in other geosciences who are married or have children under 18 years old.

	Percent Married	Percent with Children
Full Professors	100.0	33.3
Asso. Professors	80.0	60.0
Asst. Professors	80.0	80.0
Research Sci.	57.1	21.4

In atmospheric science, women assistant and associate professors are less likely to have children compared to men, but in the other geosciences women at these ranks are more likely to have children than men. At the full professor rank, women in atmospheric science are more likely than men to have children under the age of 18 years old. For a 55 year old woman (average age of female full professor) to have a 17 year old child, the child would have been born when the woman was 38 which is towards the end of a woman's child bearing years. Although women full professors are about the same age as men, it appears that the women may have started their families later. In contrast, the children of the male full professors are more likely to be adults. In the other geosciences, however, female and male full professors equally likely to have children living at home, although the women faculty at this rank are slightly younger than the men. Generally it appears as though women in the other geosciences do not put off having children as late as women in atmospheric science.

6. CONCLUSIONS

The responses to the 2005 survey indicate that the number of women faculty in atmospheric science and in the geosciences more generally increased only slightly since the 1993 survey. This small increase points to the need for a focused investigation of why women who earn PhDs in the geosciences do not choose faculty positions for their careers. Salary differences by gender for tenured and tenure-stream faculty, although still present, are smaller than in 1993. Salary inequities for research scientists, who were not included in the analysis of the 1993 survey reported in WTS96, appear to be larger than those for faculty.

Faculty members are older in the 2005 survey than they were in the 1993 survey. This difference reflects not merely an aging of the faculty but that assistant professors are being hired at older ages. This trend has important implications for women, as the analysis of the percentage of children under 18 years old by gender

and rank of faculty suggests that most women faculty in atmospheric science did not have children until after they received tenure.

Finally, the percentage of faculty who are married increased from the 1993 survey. This difference does not seem to be explainable from any trend in society as a whole nor is there a good explanation from what is happening in the geosciences or academia more generally. It does, however, have important implications for the recruitment of faculty members. Prospective faculty members are more likely to be concerned about jobs for their spouses in the prospective new community as well as in day care possibilities for their children.

Overall this analysis has shown that many changes can occur over a 12 year period and the information gained from membership surveys can be useful to the academic community and the discipline for a variety of reasons. The AMS should continue to conduct regular membership surveys and strive to further improve them.

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