Climate Change Study

Summary Report

October 2022

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I. METHODOLOGY STATEMENT

The Fairleigh Dickinson University Poll (FDU) an independent, university-based research organization conducted this current study on behalf of the Heartland Institute. The survey was designed to provide insight into the views of meteorologists and people with expertise in meteorology or related fields. Interviews were carried out online in September and October of 2022. Members of the target population were identified via membership in professional organizations, online profiles and social media networks. Once members of the target population were identified, a random process was used to select which identified individuals would be approached and asked to participate in the survey. Respondents were offered a significant monetary incentive for their participation, as is standard in targeted surveys of professional groups.

Surveys were conducted in English, and self-administered via web interfaces, and restricted to US residents. Respondents did not know the topic of the survey, or why they had been contacted, when they were initially approached about the survey. At no point during the survey was the sponsor of the survey mentioned, though this information was made available to respondents upon request. We believe that leaving the sponsor of the poll unknown to the sample during the response process is a necessary step in avoiding social desirability bias. In general, when respondents know – or believe that they know – the desired outcome of the survey sponsor, they shift their responses in line with their perception of the desired outcome.

Respondents might also draw conclusions (erroneously or not) about any desired outcome of the survey measures from the survey items themselves. To ensure that the items themselves do not provide any desirability cues, all items were subject to rigorous cognitive testing both to ensure that they were understood in the same way by all respondents, and that they didn't provide any cues as to the survey sponsor or lead to the perception of any desired outcomes.

By stressing the anonymity of responses in the sample solicitation process, not referencing the sponsor of the survey, avoiding any biased wording in items, and avoiding any detailed demographic items that could lead to the identification of participants (or the perception among participants that they could be identified) we have taken all possible steps to limit such bias in the responses.

The total sample size of the survey was 400. This figure is smaller than most surveys of general population groups within the US, but is in line with surveys of smaller groups, like meteorologists. In surveys like this, the external validity of the sample – the extent to which it can be generalized to the larger population of interest – arises not from the

sample size, but rather from the sampling strategy. In this case, the online nature of the survey means that we have necessarily missed portions of the population of meteorologists (or others with expertise in meteorology or climatology) who do not have an online presence. To ameliorate this issue, we oversampled members of the population that were considered less likely to have significant online presences, mostly on the basis of age. The targeting of a narrow sample, as in this case, leads to a higher incidence of respondents eligible for the survey, increasing response rates, a key indicator of representativeness in non-probability samples.

The main drawback of the sample size is that it limits our ability to draw conclusions about differences between sub-groups. As such, while it makes sense for us to draw conclusions about the sample divided two or three ways, dividing up the sample more ways may lead to erroneous conclusions based on differences observed due to chance, rather than underlying differences between the groups.

Any problems arising from the sample size are mostly ameliorated by the distribution of responses in the main outcome measures of interest. While it is commonly ignored in the presentation of results, the margin of error associated with survey results is a function of both the sample size and the distribution of responses. Outcome measures with mean values closer to the middle of potential responses (i.e. 0.5 on a 0 to 1 scale) are associated with greater uncertainty than responses skewing closer to the edges of the distribution. As such, an outcome measure with a mean value of 95% or 5% of the sample has a level of uncertainty equivalent to a sample size of 4 to 5 times larger with a mean value of 50%. Put another way, for those outcome measures with very high levels of agreement within the sample, increased sample size would do very little to reduce the levels of uncertainty associated with the measure: more sample would be very unlikely to substantially change the results.

In any survey that relies on paid respondents, researchers have to cope with respondents wanting to participate in the survey, without being eligible. As such, screener questions were used to ensure that the respondents fit the parameters of the study. Before knowing the topic of the survey or the requirements for participation, respondents were asked to indicate their area of expertise, and their academic credentials. Respondents who chose topics irrelevant to the study (biology, social sciences, etc) were excluded from the sample, as was anyone who did not have at least a BA in the named fields.

All told, the conversion rate of the study – the percent of contacts that led to a completed survey – was 17.9 percent. This is on the very high end of the expected range for expert surveys, most likely because of the use of targeted solicitations. That is, nearly everyone contacted was eligible to participate based on the factors that led to the initial contact, and the incentive structure made respondents willing to participate after the contact. To

put this figure in contact, a similar rate for a national telephone poll is typically less than 1 percent. This high conversion rate builds our confidence in the external validity of the sample. When the conversion rate is low, it becomes difficult to argue that the portion of the underlying population that completed the survey are no different than those who did not. On the other hand, a relatively high conversion rate indicates that the respondents are unlikely to be significantly different than other potential respondents who did not take part in the survey.

When best practices are followed, samples such as this one are generally representative of the population in question, but because nonprobability panels do not start with a frame where there is a known probability of selection, standard measures of sampling error and response rates cannot be calculated. There is no way to calculate, for instance, a legitimate margin of error for the sample.

However, some indication of the external validity of the sample can be obtained from the degree of weighting that would be necessary to make the survey sample align with the known demographic characteristics of the population. In this case, there are relatively few demographic characteristics available, but we were able to obtain some indication of the educational and sex characteristics of the population. Based on these figures, weights were calculated on what would be required to make these characteristics of our sample equivalent to the characteristics of the overall population. It should be noted that the weights discussed are only used for this calculation. The data presented in the report have not been weighted.

Based on the amount of weighting necessary, Kish's formula for effective sample size was used to calculate design effects for the sample at 1.32. Generally, this indicates that achieving the final reported weighted sample size for the weighted demographic factors would lead to sampling error 32 percent larger than would be calculated for a hypothetical simple random sample with the same size and a perfect response and completion rate. This figure is in the lower range of expected design effects for online samples, indicating that the sample is similar on the weighted demographic characteristics to the population of meteorologists in the US as a whole. Note that this calculation is not dependent on using actual weighted data but is based on calculated hypothetical perfect weights.

We can also assess the external validity of the data by looking at differences between early and late respondents within the dataset. If the respondents who are most likely to respond to the survey invitation differ from the underlying population, we would expect that respondents who come later to the sample would differ from those who came earlier to the sample. The logic is as follows: suppose that the people who we were unable to sample differ from those who we were able to sample in ways that are related to the

outcome variables of interest. This would mean that we have a biased sample of the underlying population. However, it is unlikely that there would be a clear line between those willing to participate in the sample, and those who are not willing to do so. More likely, there is a range of willingness to participate. As such, we can safely assume that those respondents who enter the survey later, after having not initially participated, or only upon repeated attempts to contact, are closer to those potential members of the sample who declined to participate than those respondents who agree to participate earlier in the sampling process. So, if those respondents who respond later in the sampling process are substantially different in the outcome variables than those who responded earlier, it indicates that those who didn't respond at all might be even more different on those variables. This would be a signal that the sample is biased: by definition, a sample in which non-respondents are very different from respondents on outcome measures is a biased sample.

We can assess this measure of non-response bias by comparing the results of the outcome variables of interest between the first and second half of the sample (divided by time of survey completion). On none of the outcome variables do we observe a difference of more half a standard deviation between the first and second half of the sample (a measure which is impacted by the generally low variance in these measures) after controlling for demographic indicators. As such, it is reasonable to conclude that within the sampling frame, non-response is not substantially biasing the results of the outcome measures of interest. Of course, we cannot assess any potential differences between our sample and respondents outside of the sampling frame (for instance, respondents who have no online presence). This is not a problem with our sampling procedure so much as a general limitation of the survey research process.

In sum, while it is impossible to fully assess the external validity of this, or any non-probability sample, all available metrics point towards the representativeness of the sample. A full probability sample of the population of interest, in theory, could provide different results, and would have a stronger initial case for external validity. However, such a survey is entirely hypothetical, and while this is not the best possible survey of this population that is possible, it is, to our knowledge, the best that has been carried out.

II. Executive Summary

The FDU Poll carried out an online survey of 400 individuals with a background and expertise in meteorology, climatology, and closely related fields. Interviews were carried out online in September and October of 2022. Members of the target population were identified via membership in professional organizations, online profiles and social media networks. Once members of the target population were identified, a random process was used to select which identified individuals would be approached and asked to participate in the survey. Respondents were offered a monetary incentive for their participation, as is standard in targeted surveys of professional groups.

Surveys were conducted in English, and self-administered via web interfaces, and restricted to US residents. Respondents did not know the topic of the survey, or why they had been contacted when they were initially approached about the survey. At no point during the survey was the sponsor of the survey mentioned, though this information was made available to respondents upon request. This is, to our knowledge, the first independent study of this population. For the analysis, FDU analyzed the data across 5 key factors: Age (30 and under, 31-40, 41-50, 50+); Degree Earned (Bachelor's, Master's, Other); Field of Study (Meteorology, Climatology, Other); Gender (Male, Female), and Membership in 6 key Organizations (Yes, No).

The study finds:

- About 4 in 5 (79%) of respondents are a member in at least one of the key meteorological/climate related organizations tested (American Meteorological Association, National Weather Association, American Association of State Climatologists, American Geophysical Union, Geological Society of America, American Physical Society).
- Seventy-two percent indicate their field of study was meteorology, while 23 percent studied climatology. All other fields account for about 5 percent.
- Nearly 3 in 4 (72%) identify themselves as meteorologists. Eleven percent say they are researchers. Fewer are educators (7%) or work in technical areas (7%).
- Seventy-six percent of respondents hold a bachelor's degree. Eighteen percent have a master's and 6 percent have a Ph.D. This is broadly in line with the normal distribution of professionals in these fields.
- Nearly 3 in 5 (57%) are a member in the American Meteorological Society. Thirty-four percent are members in the National Weather Association.
- Overall, 96 percent believe that global climate change, or global warming is occurring.

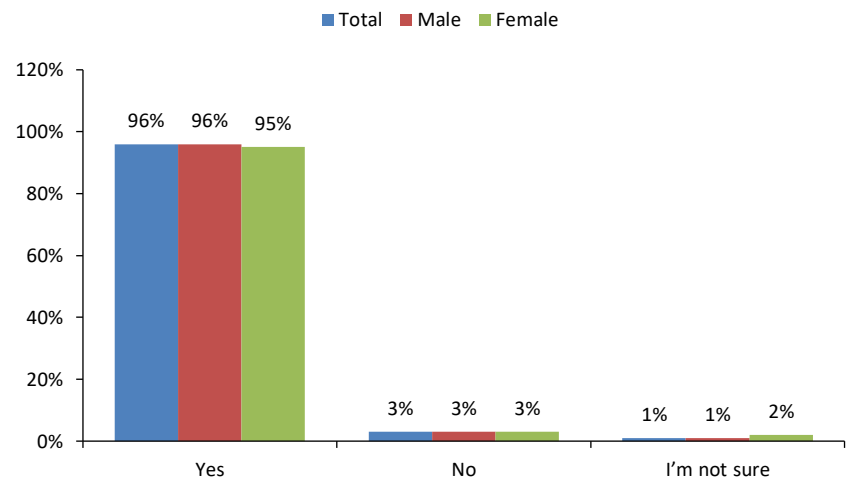
- Those who believe climate change is occurring attribute 75 percent of that change, on average, to human activity. Nine percent believe that humans account for less than half of the change, while the majority, 54 percent, say humans account for more than 75 percent of climate change.
- Just over half (59%) say that global climate change will have a significant harm on living conditions for those alive today. Thirty percent say it will have a slight harm, and about 8 percent believe living conditions will improve or remain unchanged due to climate change. Three percent are either unsure, or do not believe that any change in the climate will occur.
- Forty-one percent of respondents believe the frequency of severe weather events has increased significantly in recent years. About half (46%) say it has increased slightly. Additionally, 12 percent say the frequency of severe weather has not changed.
- Forty-two percent believe the severity of such severe weather events has increased significantly, while 46 percent say such events have increased slightly. An additional 10 percent believe there has been no change, or there has been a slight decrease in the severity of weather events.
- Age plays a key factor in perceptions. Across 4 of the 5 key measures, those 50 and older are less likely than those 30 and under to believe the effects of climate change is or will be severe.
- Those who do not belong to one of the 6 key organizations are more likely than those who are members to say living conditions will be significantly harmed. Non-members are also more likely to believe the severity of weather conditions have increased significantly in recent years.
- More women than men believe both the frequency of severe weather and the severity of such weather has increased significantly in recent years.

III. DETAILED RESEARCH RESULTS

Q1. Do you believe global climate change (sometimes referred to as "global warming") is occurring?

Overall, 96 percent believe that global climate change, or global warming is occurring. Those aged 30 and younger (99%) are significantly more likely to believe it to be true than do those 50 years and older (88%). There are no additional significant differences across any of the measured demographics.

Chart 1. Believe Global Climate Change is Occurring



Total Sample = 401; Male = 239; Female = 162

Believe Global Climate Change is Occurring

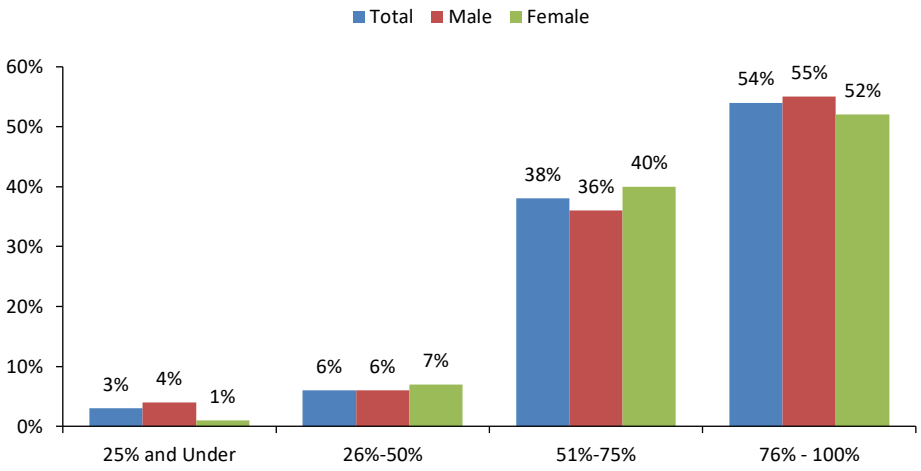
	Age				Degree		
Responses	**30U**	**31-40**	**41-50**	**50+**	**Bachelor's**	**Master's**	**Other**
N=	**113**	**118**	**118**	**52**	**305**	**73**	**23**
Yes	99%	96%	96%	88%	96%	92%	100%
No	1%	3%	2%	10%	2%	5%	0%
Not Sure	0%	2%	3%	2%	1%	3%	0%

	Field of Study			Member of Pro Org.	
Responses	**Meteorology**	**Climatology**	**Other**	**Yes**	**No**
N=	**290**	**91**	**20**	**314**	**87**
Yes	94%	99%	100%	95%	99%
No	4%	0%	0%	3%	1%
Not Sure	2%	1%	0%	2%	0%

Q2A. To the extent that you believe that climate change is currently occurring, what percentage of climate change do you believe is due to human activity?

Respondents who believe that climate change/global warming is occurring attribute, on average, 75 percent of that change to human activity. Just 9 percent believe that humans account for less than half of the change, and the majority, 54 percent, say humans account for more than 75 percent of climate change. No meaningful differences exist across the measured demographics.

Chart 2. Percent Climate Change Caused by Humans



Total Sample = 384; Male = 230; Female = 154
Means: Total = 75; Male = 74; Female = 76

Percent Climate Change Caused by Humans

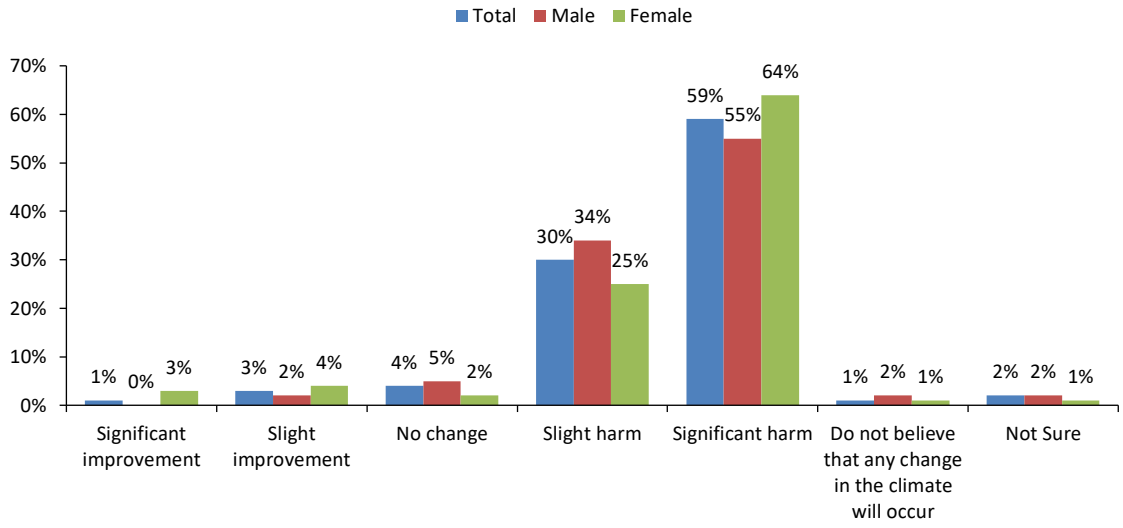
	Age				Degree		
Responses	**30U**	**31-40**	**41-50**	**50+**	**Bachelor's**	**Master's**	**Other**
N=	**112**	**113**	**113**	**46**	**294**	**67**	**23**
25% and Under	1%	3%	2%	9%	3%	1%	0%
26%-50%	8%	6%	5%	4%	6%	6%	4%
51%-75%	29%	41%	41%	41%	39%	37%	13%
76%-100%	62%	50%	52%	46%	51%	55%	83%
Mean	77%	74%	75%	72%	74%	77%	84%

	Field of Study			Member of Pro Org.	
Responses	**Meteorology**	**Climatology**	**Other**	**Yes**	**No**
N=	**274**	**90**	**20**	**298**	**86**
25% and Under	3%	1%	0%	3%	2%
26%-50%	8%	3%	0%	6%	8%
51%-75%	35%	48%	25%	38%	37%
76%-100%	54%	48%	75%	54%	52%
Mean	75%	74%	81%	75%	74%

Q3. In your judgment, what will be the overall impact of global climate change on living conditions for people alive today, across the globe?

Just over half (59%) say that global climate change will have a significant harm on living conditions for those alive today. Thirty percent say it will have a slight harm, and about 8 percent believe living conditions will improve or remain unchanged due to climate change. Younger respondents are more likely to say that it will cause at least slight harm to living conditions (96% in the 30 and under age group) than older respondents (87% among those 41 to 50; 75% among those over 50). Those in the Climatology field are more likely (73%) than those in the Meteorology field (54%) to believe climate change will have significant harm on living conditions. Similarly, those who are not a member of the professional organizations are more likely (69%) than members (56%) to say there will be a significant harm to living conditions.

Chart 3. Impact on Human Living Conditions



Total Sample = 401; Male = 239; Female = 162

Impact on Human Living Conditions

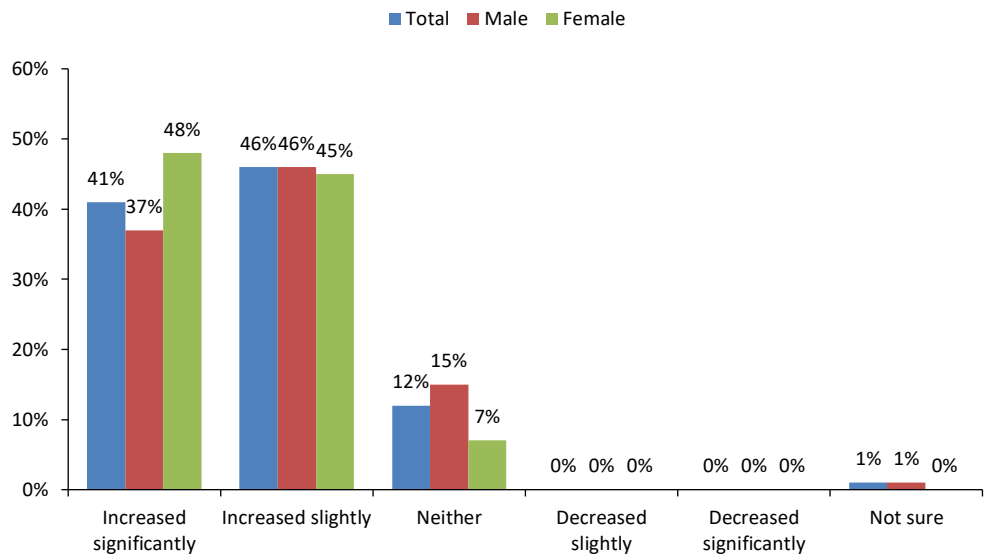
	Age				Degree		
Responses	**30U**	**31-40**	**41-50**	**50+**	**Bachelor's**	**Master's**	**Other**
N=	113	118	118	52	305	73	23
Significant improvement	1%	3%	1%	0%	1%	1%	0%
Slight improvement	1%	3%	5%	0%	3%	3%	4%
No change	2%	3%	3%	12%	3%	8%	4%
Slight harm	27%	36%	27%	31%	32%	29%	13%
Significant harm	69%	53%	60%	44%	58%	56%	70%
Do not believe that any change in the climate will occur	0%	1%	1%	8%	1%	3%	0%
Not Sure	0%	1%	3%	6%	2%	0%	9%

	Field of Study			Member of Pro Org.	
Responses	**Meteorology**	**Climatology**	**Other**	**Yes**	**No**
N=	**290**	**91**	**20**	**314**	**87**
Significant improvement	1%	0%	5%	1%	1%
Slight improvement	2%	4%	0%	4%	0%
No change	3%	5%	5%	4%	3%
Slight harm	34%	18%	30%	32%	26%
Significant	54%	73%	60%	56%	69%
Do not believe that any change in the climate will occur	2%	0%	0%	2%	0%
Not Sure	2%	0%	0%	2%	0%

Q4. To the best of your knowledge, how has the frequency of severe weather events changed in recent years (such as hurricanes, extreme drought and wildfires, etc.), if at all?

Forty-one percent of respondents believe the frequency of severe weather events has increased significantly in recent years. About half (46%) say it has increased slightly. Those in the 50+ age group (79%) are less likely than those aged 30 and under (90%) to believe the frequency of severe weather events have increased at least slightly. Women (93%) are more likely than men (83%) to believe the frequency of severe weather events has increased at least slightly in recent years.

Chart 4. Change in Frequency of Severe Weather Events



Total Sample = 401; Male = 239; Female = 162

Change in Frequency of Severe Weather Events

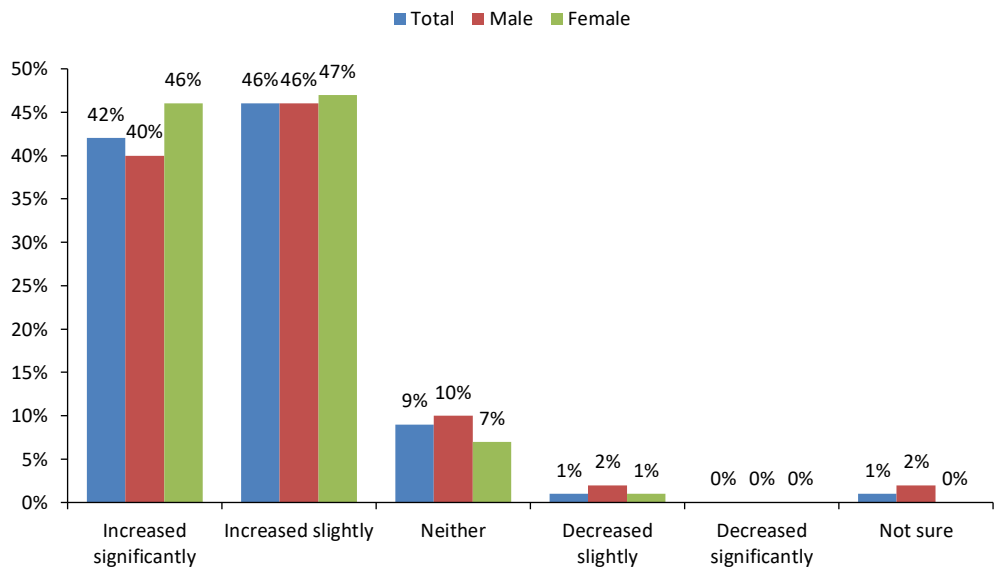
	Age				Degree		
Responses	**30U**	**31-40**	**41-50**	**50+**	**Bachelor's**	**Master's**	**Other**
N=	**113**	**118**	**118**	**52**	**305**	**73**	**23**
Increased significantly	46%	39%	41%	38%	39%	47%	61%
Increased slightly	44%	53%	42%	40%	49%	37%	26%
Neither	9%	8%	15%	21%	12%	12%	13%
Decreased slightly	0%	1%	0%	0%	0%	0%	0%
Decreased significantly	0%	0%	0%	0%	0%	0%	0%
Not sure	1%	0%	2%	0%	0%	4%	0%

	Field of Study			Member of Pro Org.	
Responses	**Meteorology**	**Climatology**	**Other**	**Yes**	**No**
N=	**290**	**91**	**20**	**314**	**87**
Increased significantly	38%	46%	70%	40%	45%
Increased slightly	48%	44%	20%	45%	48%
Neither	13%	10%	10%	13%	7%
Decreased slightly	0%	0%	0%	0%	0%
Decreased significantly	0%	0%	0%	0%	0%
Not sure	1%	0%	0%	1%	0%

Q5. To the best of your knowledge, how has the severity of severe weather events changed in recent years (such as hurricanes, extreme drought and wildfires, etc.), if at all?

Forty-two percent believe the severity of such weather events has increased significantly in recent years, while 46 percent say such events have increased slightly. An additional 10 percent believe there has been no change, or there has been a slight decrease in the severity of weather events. Those aged 50 and above (77%) are less likely than their cohorts to say the severity has increased at least slightly, and more likely to say it has not changed (23%). More women (93%) than men (86%) to believe the severity of weather events has increased in recent years. Those not a member in the professional organizations asked about are more likely than members to say the severity of weather has increased significantly (52% vs. 39%, respectively).

Chart 4. Change in Severity of Severe Weather Events



Total Sample = 401; Male = 239; Female = 162

Change in Severity of Severe Weather Events

	Age				Degree		
Responses	**30U**	**31-40**	**41-50**	**50+**	**Bachelor's**	**Master's**	**Other**
N=	**113**	**118**	**118**	**52**	**305**	**73**	**23**
Increased significantly	46%	41%	38%	46%	40%	51%	48%
Increased slightly	44%	51%	51%	31%	50%	37%	22%
Neither	7%	7%	6%	23%	8%	8%	22%
Decreased slightly	1%	1%	3%	0%	2%	0%	4%
Decreased significantly	1%	0%	0%	0%	0%	0%	0%
Not sure	1%	1%	2%	0%	0%	4%	4%

	Field of Study			Member of Pro Org.	
Responses	**Meteorology**	**Climatology**	**Other**	**Yes**	**No**
N=	**290**	**91**	**20**	**314**	**87**
Increased significantly	42%	37%	60%	39%	52%
Increased slightly	44%	55%	40%	49%	38%
Neither	11%	4%	0%	9%	8%
Decreased slightly	1%	3%	0%	2%	1%
Decreased significantly	0%	0%	0%	0%	1%
Not sure	1%	0%	0%	1%	0%

SAMPLE CHARACTERISTICS

VI. Sample Characteristics –

Major Field of Study

Meteorology	72%
Climatology	23%
Geology	3%
All Else	2%

Professional Activity

Meteorologist	72%
Researcher	11%
Educator	7%
Technical	7%
All Else	2%

Highest Degree Earned

Bachelors (BA/BS)	76%
Masters	18%
Ph.D.	6%

Age

30 and Under	28%
31-40	29%
41-50	29%
(50+)	13%

Current Employer

Private Sector	60%
University/Academic	16%
Government/IGO	13%
Non-Profit/NGO	8%
Retired	1%

Organizations a Member

American Meteorological Society	57%
National Weather Association	34%
American Association of State Climatologists	10%
American Geophysical Union	8%
All Others	9%
None of the Above	21%

Gender

Male	60%
Female	40%

APPENDIX

Questionnaire

[Screeners: These questions are used to ensure that respondents are eligible to participate in in the survey]
We appreciate your willingness to answer some questions about climate change and related issues. First, we need to determine if you are eligible to complete the survey.

S1. How would you describe your major field of study?

- Climatology
- Meteorology
- Physics
- Geology
- Hydrology
- Biology **(TERMINATE)**
- Other Natural Science **(TERMINATE)**
- Social Science (Psychology, Political Science, Anthropology, and so on) **(TERMINATE)**
- None of the above **(TERMINATE)**

S2. What is the highest degree that you have earned so far?

- No College Degree **(TERMINATE)**
- Associates Degree (AA) **(TERMINATE)**
- Bachelor's degree (BA/BS)
- Master's degree (MA/MS)
- PhD
- Other Professional Degree (JD, MD, EdD)

S3. Which of the following best describes your current employer?

- University/Academic
- Non-Profit/NGO
- Government/IGO
- Private Sector
- Not currently employed
- Retired

S4. Which of the following best describes the area of your professional activity:

- Researcher
- Meteorologist
- Educator
- Technical
- Other

We'd like to ask you a few questions about your understanding of global warming. Your responses will be kept strictly confidential; we are just interested in your opinion, based on your understanding of the science.

Q1. Do you believe global climate change (sometimes referred to as “global warming”) is occurring?

Yes
No **(Skip to Q3)**
I’m not sure **(Skip to Q3)**

Q2. To the extent that you believe that climate change is currently occurring, what percentage of climate change do you believe is due to human activity? Please answer using the following scale, where zero means that humans are not responsible for any of the climate change that is occurring, and 100 means that humans are responsible for all of the climate change that is occurring.

[Slider running from 0-100, with initial value set at 50]

Q3. In your judgment, what will be the overall impact of global climate change on living conditions for people alive today, across the globe:

Significant improvement in living conditions
Slight improvement in living conditions
No change in living conditions
Slight harm to living conditions
Significant harm to living conditions
Do not believe that any change in the climate will occur
Not Sure

(Rotate Q4 and Q5)

Q4. To the best of your knowledge, how has the **frequency** of severe weather events changed in recent years (such as hurricanes, extreme drought and wildfires, etc), if at all?

Increased significantly
Increased slightly
Neither increased nor decreased
Decreased slightly
Decreased significantly
Not sure

Q5. To the best of your knowledge, how has the **severity** of severe weather events changed in recent years (such as hurricanes, extreme drought and wildfires, etc), if at all?

Increased significantly
Increased slightly
Neither increased nor decreased
Decreased slightly
Decreased significantly
Not sure

D1. Which of the following organizations are you currently, or have recently been a member?

American Meteorological Society
American Association of State Climatologists
National Weather Association
American Geophysical Union
American Physical Society
Geological Society of America

D2. What is your Age?

_____

D3. What is your gender?

Male
Female