

YALE PROJECT ON  
**CLIMATE CHANGE**  
COMMUNICATION

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# Americans' Knowledge of Climate Change





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## **Executive Summary**

**Americans' Knowledge of Climate Change** reports results from a national study of what Americans understand about how the climate system works, and the causes, impacts, and potential solutions to global warming.

The study found that 63 percent of Americans believe that global warming is happening, but many do not understand why. In this assessment, only 8 percent of Americans have knowledge equivalent to an A or B, 40 percent would receive a C or D, and 52 percent would get an F. The study also found important gaps in knowledge and common misconceptions about climate change and the earth system. These misconceptions lead some people to doubt that global warming is happening or that human activities are a major contributor, to misunderstand the causes and therefore the solutions, and to be unaware of the risks. Thus many Americans lack some of the knowledge needed for informed decision-making in a democratic society. For example, only:

- 57% know that the greenhouse effect refers to gases in the atmosphere that trap heat;
- 50% of Americans understand that global warming is caused mostly by human activities;
- 45% understand that carbon dioxide traps heat from the Earth's surface;
- 25% have ever heard of coral bleaching or ocean acidification.

Meanwhile, large majorities incorrectly think that the hole in the ozone layer and aerosol spray cans contribute to global warming, leading many to incorrectly conclude that banning aerosol spray cans or stopping rockets from punching holes in the ozone layer are viable solutions.

However, many Americans do understand that emissions from cars and trucks and the burning of fossil fuels contribute to global warming, and that a transition to renewable energy sources is an important solution.

In addition, despite the recent controversies over “climategate” and the 2007 IPCC report, this study finds that Americans trust scientists and scientific organizations far more than any other source of information about global warming.

Americans also recognize their own limited understanding of the issue. Only 1 in 10 say that they are “very well informed” about climate change, and 75 percent say they would like to know more. Likewise, 75 percent say that schools should teach our children about climate change and 68 percent would welcome a national program to teach Americans about the issue.

# Introduction

Knowledge about climate change can be divided into several general and overlapping categories: knowledge about how the climate system works; specific knowledge about the causes, consequences, and potential solutions to global warming; contextual knowledge placing human-caused global warming in historical and geographic perspective; and practical knowledge that enables individual and collective action. This study included measures related to each of these key dimensions, along with other measures such as public desire for more information, trust in different information sources, and climate change risk perceptions, policy preferences, and behaviors.

## Methodology

These results come from a nationally representative survey of American adults, aged 18 and older. The sample was weighted to correspond with US Census Bureau demographic and Gallup political party identification parameters for the United States. The surveys were conducted by Knowledge Networks, using an online research panel of American adults. The survey was conducted June 24 through July 22, 2010 with 2,030 American adults. The margin of sampling error is plus or minus 2 percent, with 95 percent confidence. Question order and wording can also introduce error into the results of surveys.

For analysis, some items were re-coded as a 1 (a correct answer) or 0 (an incorrect answer, including don't know & refused). For example, several questions asked respondents whether a statement was "definitely true", "probably true", "probably false", or "definitely false". These responses were converted into a simple true vs. false dichotomous measure. Likewise, questions that provided the response options "a lot", "some", "a little", "not at all" or "don't know" were also converted into simple dichotomous variables for analysis.

In some cases, there is a clear "correct" or "incorrect" answer, strongly supported or strongly rejected by well-established scientific evidence. In other cases, there is a "best" answer reflecting broadly held scientific agreement, but somewhat more subjective. We provide references to peer-reviewed, scientific sources for each answer (see the Appendix: Answer Key). Best or correct answers are indicated with a (V). Unknown or uncertain answers are indicated with a (\*). All results show percentages among all respondents, unless otherwise labeled. Totals may occasionally sum to more than 100 percent due to rounding. The term "order of items randomized" refers to a standard survey technique in which questions and/or response categories are presented to respondents in a random order. This technique helps to prevent "order bias" in respondent answers.

## Grading the Public

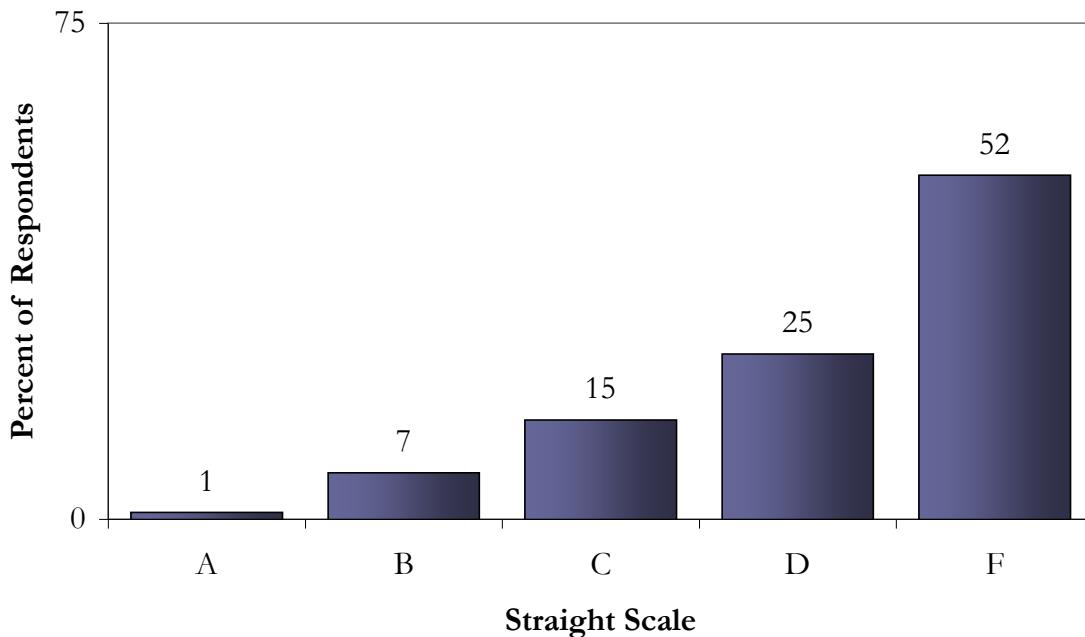
As a first-brush estimate of overall public knowledge about climate change, a straight grading scale was constructed, using only those items for which there was a correct or best answer. To adjust for the difficulty of some items, only questions that were answered correctly by at least 25 percent of the respondents were included in the grade calculation (although all results are reported below in the results section). Thus this "grade" is based on a total of 81 individual questions. Each respondent was given a percentage score based on their total number of correct answers. Graded on a straight

scale (scores 90% and above = A, 80-89% = B, 70-79% = C, 60-69 = D, and scores 59% and below = F), 1 percent of the public received an A, 7 percent a B, 15 percent a C, 25 percent a D, and 52 percent an F, indicating that relatively few Americans have an in-depth understanding of climate change.

This “grade”, however, should be interpreted with caution. Some questions clearly were harder to answer than others. Likewise, other researchers might have chosen to assess different types of climate-related knowledge, which perhaps the public better understands. It is also important to recognize that very few Americans have ever taken a formal course on climate change, so it is perhaps unsurprising that they lack detailed knowledge about the issue. Instead, these results likely reflect the unorganized and sometimes contradictory fragments of information Americans have absorbed from the mass media and other sources. Further, many of these questions are outside the everyday practical needs of most people. Most people don’t need to know about climate change in their daily life, thus it is not surprising that they have devoted little effort to learning these details.

Nonetheless, many of these questions reveal important gaps in knowledge and common misconceptions about climate change and the earth system. These misconceptions lead some people to doubt that climate change is happening or that human activities are a major contributor, to misunderstand the causes and therefore the solutions, and to be unaware of the risks. Thus many Americans lack some of the knowledge needed for informed decision-making about this issue in a democratic society.

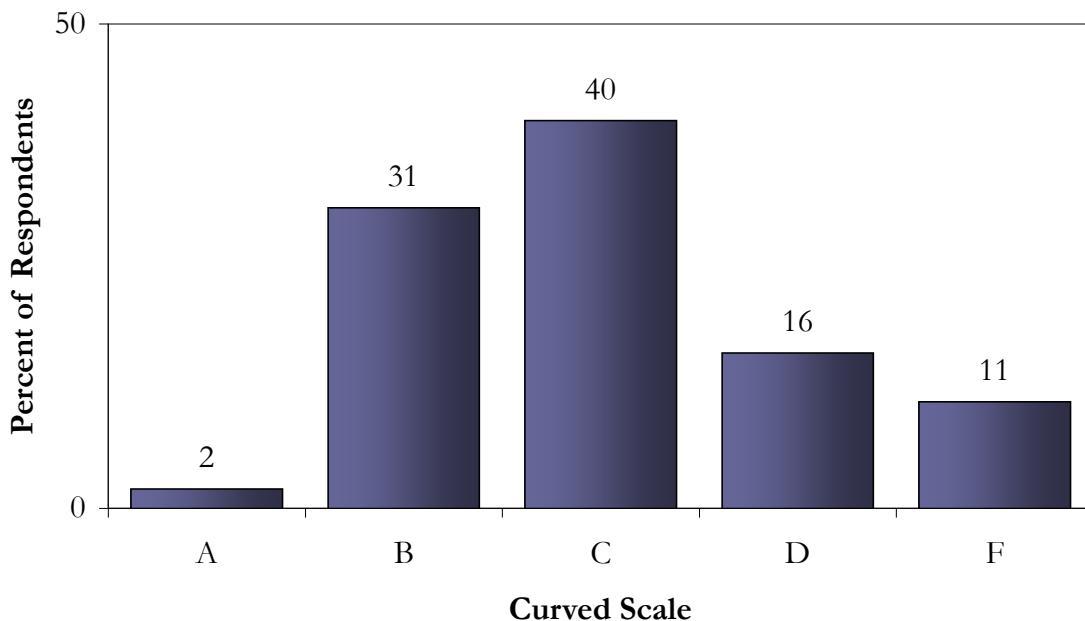
### Grading Public Knowledge of Climate Change



To further adjust for the difficulty of some questions, we constructed a curved grading scale as an alternative scoring system. First, the mean percentage score was calculated (54%). Scores +/- 0.5 standard deviations from the mean (44% to 65%) were assigned the letter grade C. Scores ranging from +/- 0.5 to 1.5 standard deviations from the mean were assigned the letter grades B (66% to 86%) and D (23% to 43%) respectively. Finally, scores ranging from +/- 1.5 to 2.5 standard deviations from the mean were assigned the letter grades A (87% or higher) and F (22% or less) respectively.

This grading system thus enables us to see that although overall public knowledge of climate change is low, there is significant variation within these scores, with a third of Americans scoring an A or B on this curved scale, over a third scoring a C, and over a quarter scoring a D or F. This grading system will be particularly useful for subsequent analyses comparing the relative levels of knowledge across different groups within American society.

### Grading Public Knowledge of Climate Change



# Summary Results

## Self-reported Knowledge

- Relatively few Americans (11 to 14%) say they are “very well informed” about how the climate system works or the different causes, consequences, or potential solutions to global warming, while 51 to 52 percent say they are “fairly well informed.”

## Climate Change Beliefs and Worry

- A majority (63%) of Americans understand that global warming is happening, while 19 percent say it is not happening, and 19 percent say they don’t know.
- Half of Americans (50%) say that if global warming is happening, it is caused mostly by human activities. Over a third (35%) say that if it is happening, it is caused by natural changes, while 7 percent reject the question and say global warming is not happening.
- Thirty-nine percent (39%) say that most scientists think global warming is happening, while 38 percent say there is a lot of disagreement among scientists whether or not global warming is happening.
- Just over half of Americans say they are very (16%) or somewhat worried (39%) about global warming, while 45 percent say they are not very (26%), or not at all worried (19%).

## Understanding of the “Greenhouse Effect”

- A large majority of Americans (87%) have heard of the “greenhouse effect”, but 13 percent have not.
- Of those that have heard of the greenhouse effect, however, 66 percent correctly understand that it refers to “gases in the atmosphere that trap heat.” Twenty-one percent incorrectly believe it refers to the Earth’s protective ozone layer, while another 10 percent say they don’t know. Thus nationally, 57 percent of American adults have both heard of and correctly understand what the greenhouse effect is.
- Majorities of Americans correctly understand that greenhouse gases, changes in the Earth’s orbit around the sun, volcanic eruptions, the amount of dust in the atmosphere, sunspots, clouds, and whether the Earth’s surface is light or dark colored (albedo) can affect the average temperature of the Earth. Many incorrectly believe, however, that earthquakes and the phases of the moon also affect the Earth’s temperature. Finally, 16 to 33 percent of Americans say they don’t know whether any of the above can affect the average global temperature of the Earth.
- A plurality (45%) of Americans understand that carbon dioxide is good at trapping heat from the Earth’s surface. Relatively few, however, understand that methane (25%) or water vapor (12%) are important heat-trapping gases as well.

## Weather vs. Climate

- Majorities of American adults correctly understand that weather often changes from year to year (83%) and that “climate” means the average weather conditions in a region (74%). Majorities, however, incorrectly believe that the climate often changes from year to year or

that “weather” means the average climate conditions in a region, suggesting that many people continue to confuse weather and climate.

### The Flow of Heat Across the Planet

- A slight majority (54%) understands that ocean currents carry heat from the equator toward the poles, but 34 percent say they don’t know whether this is true or false. Fewer Americans (33%) correctly understand that the atmosphere does not carry heat from the poles (which are cold) towards the equator (which is warm), while 40 percent say they don’t know.

### Climate Change: Past and Present

- A majority of Americans (73%) correctly understands that current conditions are not colder than ever before in Earth’s history, but a majority (55%) incorrectly believes the opposite – that the Earth’s climate is now warmer than it has ever been before (this is false – global temperatures have been warmer than current conditions many times in the past).
- A majority of Americans (67%) correctly understands that the Earth’s climate has not been the same for millions of years, but a large majority (67%) incorrectly believes that the Earth’s climate has always shifted gradually between warm and cold periods.
- Fewer than half of Americans (41%) understand that the last 10,000 years have been unusually warm and stable, compared to the climate of the past million years.
- While a majority (57%) understands that rising levels of carbon dioxide in the atmosphere have caused global temperatures to increase in the past, relatively few (24%) understand that the converse is also true – that rising temperatures have caused levels of carbon dioxide in the atmosphere to increase as well. (Global temperatures and carbon dioxide levels can influence each other through positive or negative feedbacks.)
- A majority (63%) believes that climate changes have played an important role in the advance or collapse of some past human civilizations.

### Temperature Estimates

- Respondents were given the current temperature of the Earth’s surface (approximately 58° Fahrenheit) as a reference point. They were then asked what they thought the average temperature was during the last ice age. The correct answer is between 46° and 51°. The median public response, however, was 32° – the freezing point of water – while many other people responded 0°.
- Americans, however, did much better estimating the Earth’s surface temperature 150 years ago (before the Industrial Revolution). The correct answer is approximately 56° to 57° Fahrenheit. The median public response was 54°.
- When asked what temperature they thought it would be by the year 2020 if no additional actions are taken to reduce global warming, the median response was 60°, slightly higher than the scientific estimate of 58.4° Fahrenheit.
- Likewise, when asked what temperature they thought it would be by the year 2050, the median response was 62°, slightly higher than the scientific estimate of 60 to 61° Fahrenheit.

## Conceptual Models of Climate Change

- Americans have very different mental models of the stability of the climate system. Respondents were shown a series of simple pictures and text describing 5 different models of climate stability and asked which one best represented their understanding of how the climate system works. A third (34%) selected a “threshold” or “tipping point” model describing a stable climate, but stable only within certain limits. In this model, a small amount of global warming will have little to no effect, but a large amount of warming will cross critical thresholds and have dangerous effects. By contrast, nearly a quarter (24%) selected a “gradual” model describing a climate slow to change, in which global warming will gradually lead to dangerous effects. Next, 21 percent of Americans selected a “random” model describing a completely unpredictable climate system, in which we do not know what will happen. Finally, relatively few chose a “fragile” model describing a delicately balanced climate, in which a small amount of global warming will have abrupt and catastrophic effects (11%) or a “stable” model, describing a very stable climate system that will be unaffected by global warming (10%). At different time or spatial scales the climate system can exhibit each of these behaviors, but the best overall answer is the threshold model.

## Fossil Fuels

- Most Americans correctly understand that coal (80%) and oil (76%) are fossil fuels. They are a little more confused, however, about natural gas – 60 percent correctly identify it as a fossil fuel, but 17 percent say it is not, while an additional 23 percent say they don’t know. Most Americans also correctly understand that solar energy and hydrogen are not fossil fuels, but 28 percent incorrectly believe that wood is a fossil fuel.
- Americans have a limited understanding of where the energy in fossil fuels originally came from. Just over half (52%) correctly understand that the energy in fossil fuels comes from photosynthesis by plants over millions of years, while 29 percent correctly understand that the sun was the ultimate source of energy in these fuels. Nearly half (47%) incorrectly say that fossil fuels are the fossilized remains of dinosaurs. Twenty percent of Americans say fossil fuels come from uranium in the Earth. Finally, substantial numbers (25-36%) say they do not know whether each of these answers are true or false.

## Carbon Dioxide

- A large majority of Americans (67%) correctly identifies carbon dioxide as a gas produced by the burning of fossil fuels.
- Over three-quarters of Americans (76-78%) say they simply don’t know how much carbon dioxide was in the atmosphere in 1850 or today. Very few (6-7%) correctly understand that there were roughly 290 parts per million of carbon dioxide in the atmosphere in 1850, compared to 390 parts per million today.
- When presented with five simple graphs describing different trajectories of the amount of carbon dioxide in the atmosphere over the past 500 years, 40 percent of the public correctly selects the graph depicting exponential growth. Another 41 percent select the graph depicting a linear rise, while fewer than 10 percent choose each of the other three graphs depicting no change in the amount of carbon dioxide, a linear decrease, or an exponential decrease.

- A majority of Americans (62%) correctly understands that even if human beings were to stop burning fossil fuels today, global warming would not immediately stop, however, 57 percent incorrectly believe that the amount of carbon dioxide in the atmosphere would decrease almost immediately or don't know.
- Likewise, few Americans (19%) correctly understand that on average carbon dioxide stays in the atmosphere hundreds to thousands of years once it has been emitted.
- Americans are equally likely to believe that either China (36%) or the United States (34%) is the world's largest emitter of carbon dioxide. China recently supplanted the United States as the world's largest emitter.
- A plurality (42%) of Americans correctly understands that the United States emits the most carbon dioxide per person. However, nearly a third (31%) say they don't know, while 18 percent incorrectly say China.

### Causes of Global Warming

- Majorities of Americans correctly understand that cars and trucks, burning fossil fuels for heat and electricity, deforestation, and cows contribute to global warming.
- Majorities of Americans, however, incorrectly believe that the hole in the ozone layer, toxic wastes, aerosol spray cans, volcanic eruptions, the sun, and acid rain contribute to global warming.
- A majority believes that nuclear power plants also contribute to global warming. Nuclear power plants do not emit greenhouse gases when they generate energy, although there are emissions associated with plant construction, operation, decommissioning, and the mining and milling of uranium.
- Almost half of Americans (49%) incorrectly believe that the space program contributes to global warming.

### Climate Skeptic Arguments

- Many Americans incorrectly believe that since scientists can't predict the weather more than a few days in advance, they can't possibly predict the climate of the future (42%) or that computer models are too unreliable to predict the climate of the future (37%).
- A third of Americans (35%) incorrectly believe that in the 1970s, most scientists were predicting an ice age.
- A third of Americans (33%) also incorrectly believe that since the Earth's climate has changed naturally in the past, humans are not the cause of global warming today.
- Relatively few (19%) incorrectly believe that any recent global warming is caused by the sun, that the record snowstorms last winter in the eastern U.S. prove that global warming is not happening (18%), or that the Earth is actually cooling, not warming (15%).
- Only 12 percent of Americans say that global warming is happening, but will be more beneficial than harmful.
- All of these items, however, include from 19 to 47 percent of Americans who say they don't know whether these statements are true or false.

### Impacts

- A large majority (68%) of Americans correctly understands that global warming will cause some places to get wetter, while others will get drier.

- Likewise 58 percent correctly understands that global warming will increase crop yields in some places, and decrease it in others.
- Half of the public (51%) correctly understands that the decade from 2000 to 2009 was warmer than any other decade since 1850.
- More than half (59%) of Americans incorrectly believe that global warming will cause temperatures to increase by roughly the same amount in all countries, or say they don't know (some regions of the Earth will warm much more than others).
- Twenty-one percent of Americans correctly understand that most of the glaciers on Earth are melting. By contrast, 11 percent say all of them are melting, 48 percent say only some of them are, and 4 percent say none of them are melting.
- Of those who said that all, most, or some of the Earth's glaciers are melting, the large majority (84%) correctly understands that the speed of melting has increased over the past 100 years.
- Large majorities correctly understand that the melting of land ice in Antarctica (76%), mountain glaciers (73%), and warmer ocean temperatures (60%) are causes of global sea level rise.
- A large majority (76%) also says that the melting of sea ice on the Arctic Ocean is a cause of sea level rise. For many years, it was assumed that sea ice melting would not contribute to sea level rise, as the ice already displaced an equal amount of water (which is why your glass of ice water does not overflow when the ice cubes melt). This assumption, however, has been challenged by recent research that finds a small, but significant contribution to global sea levels from Arctic sea ice as well, due to the difference in density and temperature between sea ice (fresh water) and the ocean below (salt water) (see Appendix).
- Most Americans, however, probably do not understand the above nuance, as evident in their response to the next question, which asked which of the listed causes has contributed the most to sea level rise so far. Arctic sea ice is the most commonly selected answer (34%), with Antarctic land ice second at 24 percent. The correct answer, however, is thermal expansion by the warming oceans (22%).
- Majorities of Americans say they simply do not know how much global sea levels rose from 1900 to 2000 (57%) or how much they may rise by 2100 (48%), if no additional actions are taken to reduce global warming.
- Large majorities of Americans have read or heard nothing about either coral bleaching (75%) or ocean acidification (77%).
- Of those Americans who have heard of these two climate-change related issues, 54 percent correctly understand that warmer ocean temperatures cause coral bleaching, while 32 percent correctly understand that absorption of carbon dioxide by the ocean causes ocean acidification.

## Solutions

- Large majorities of Americans correctly understand that the following actions would reduce global warming if they were done worldwide: switching from fossil fuels to renewable energy sources (75%), planting trees (81%), reducing tropical deforestation (73%); switching from gasoline to electric cars (75%), driving less (76%), increasing public transportation (67%), switching from regular incandescent to compact fluorescent bulbs (69%), insulating buildings, (65%), and switching from fossil fuels to nuclear power (59%).
- Large majorities of Americans, however, incorrectly believe that reducing toxic waste (67%) or banning aerosol spray cans (69%) would reduce global warming. An additional 43 percent

incorrectly believe that if we stopped punching holes in the ozone layer with rockets, it would reduce global warming.

- Majorities do not believe or don't know if placing a large tax on all fossil fuels (53%), having at most 2 children per family (60%), or stopping the eating of beef (69%) would reduce global warming.
- Finally, large majorities of Americans do not believe that proposed geo-engineering solutions – like fertilizing the ocean to make algae grow faster (64%) or using airplanes to scatter dust high in the atmosphere (81%) – will reduce global warming, including more than 4 out 10 who say they simply don't know.
- When asked which one action would do the most to reduce global warming, switching from fossil fuels to renewable energy sources was the action most selected (36%).

### Information Sources

- Americans' most trusted sources of information about global warming are the National Oceanic and Atmospheric Administration (NOAA) (78%), the National Science Foundation (74%), scientists (72%), science programs on television (72%), natural history museums (73%), and science museums (72%).
- Roughly a quarter of Americans have visited a science, technology, or natural history museum in the past 12 months, while more have visited a nature center (37%) or zoo or aquarium (43%).
- Relatively few Americans (8%) have ever attended a global warming lecture or event with hands-on activities, while 14 percent have seen an exhibit on global warming at a science center or museum.
- Americans say they have learned the most about global warming from television (88%), newspapers (71%), family and friends (69%), books or magazines (68%), and the internet (65%).
- Nearly 4 out of 10 Americans (39%) say they follow news about the environment very (7%) or somewhat closely (32%), while 71 percent say they follow the local weather forecast very (32%) or somewhat closely (39%).
- Americans say they have thought about global warming a lot (17%), some (35%), a little (33%), or not at all (15%).
- Just over a quarter (27%) say that the issue of global warming is either extremely (7%) or very important to them personally (20%).
- A large majority, however, says that they need a lot more (25%), some more (26%), or a little more information (25%) about global warming before making up their mind about the issue.
- Americans say that the internet (38%) is the first place they would go to get more information about global warming, followed by television (16%), and government websites (12%).
- Finally, large majorities of Americans say that schools should teach our children about the causes, consequences, and potential solutions to global warming (75%) and that the government should establish programs to teach Americans about the issue (68%).

## Detailed Results

Q1. Recently, you may have noticed that global warming has been getting some attention in the news. Global warming refers to the idea that the world's average temperature has been increasing over the past 150 years, may be increasing more in the future, and that the world's climate may change as a result. What do you think? Do you think that global warming is happening?

Yes (✓)	63
No	19
Don't Know	19

*People who answered yes to question 1 (i.e. those who believe global warming is happening) were asked the following question.*

Q2. How sure are you that global warming is happening?

Extremely sure	21
Very sure	35
Somewhat sure	39
Not at all sure	4
N	1261

*People who answered no to question 1 (i.e. those who do not believe global warming is happening) were asked the following question.*

Q3. How sure are you that global warming is not happening?

Extremely sure	18
Very sure	35
Somewhat sure	41
Not at all sure	6
N	366

Q4. Assuming global warming is happening, do you think it is...

Caused mostly by human activities (✓)	50
Caused by both human activities and natural changes (vol.)	6
Caused mostly by natural changes in the environment	35
None of the above because global warming isn't happening	7
Other	2
Don't know (vol.)	1

Q5. Which comes closer to your own view?

Most scientists think global warming is happening (✓)	39
Most scientists think global warming is not happening	6
There is a lot of disagreement among scientists about whether or not global warming is happening	38
Don't know enough to say	17

Q6. How worried are you about global warming?

Very worried	16
Somewhat worried	39
Not very worried	26
Not at all worried	19

Q7. Personally, how well informed do you feel you are about ...

How the Earth's "climate system" works

Very well informed	11
Fairly well informed	51
Not very well informed	33
Not at all informed	5

The different causes of global warming

Very well informed	13
Fairly well informed	52
Not very well informed	31
Not at all informed	5

The different consequences of global warming

Very well informed	14
Fairly well informed	52
Not very well informed	29
Not at all informed	5

Ways in which we can reduce global warming

Very well informed	14
Fairly well informed	50
Not very well informed	30
Not at all informed	6

Q8. Have you ever heard of the “greenhouse effect”?

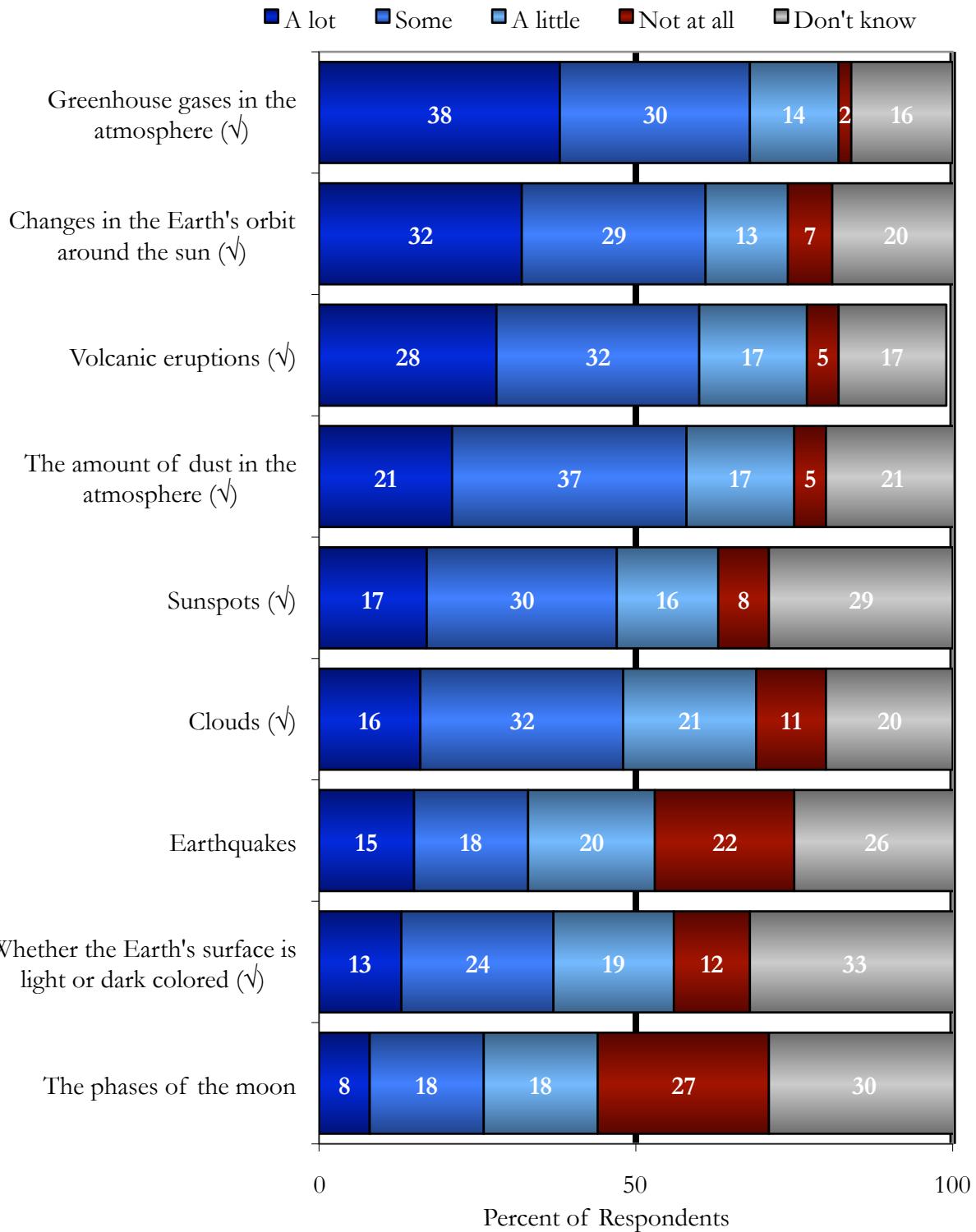
Yes	87
No	13

*People who answered yes to question 8 (i.e. those who had heard of the “greenhouse effect”) were asked the following question.*

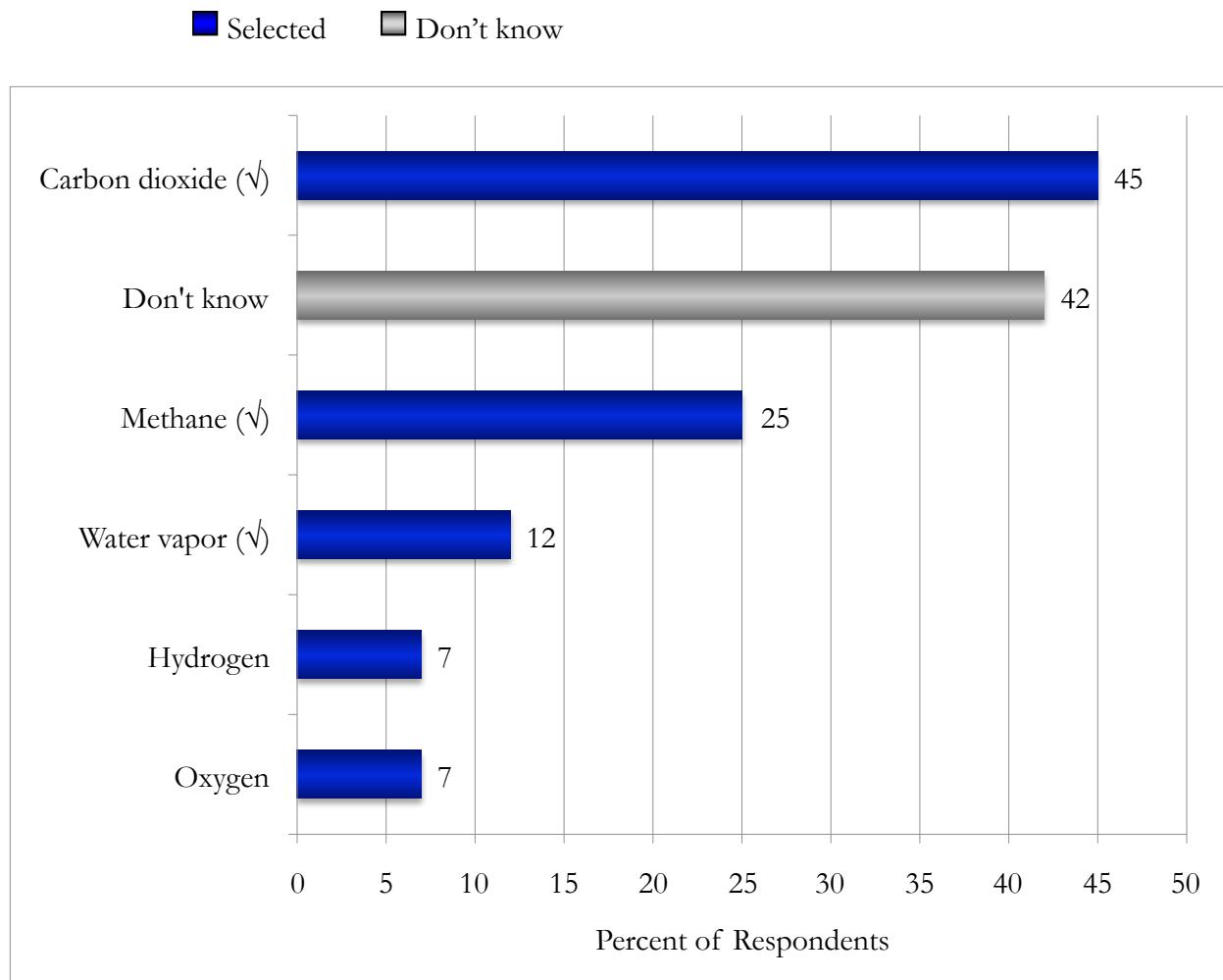
Q9. The “greenhouse effect” refers to: (*order of items randomized*)

Gases in the atmosphere that trap heat (✓)	66
The Earth’s protective ozone layer	21
Pollution that causes acid rain	1
How plants grow	3
Don’t know	10
N	1738

Q10. How much can each of the following affect the average global temperature of the Earth? (order of items randomized)

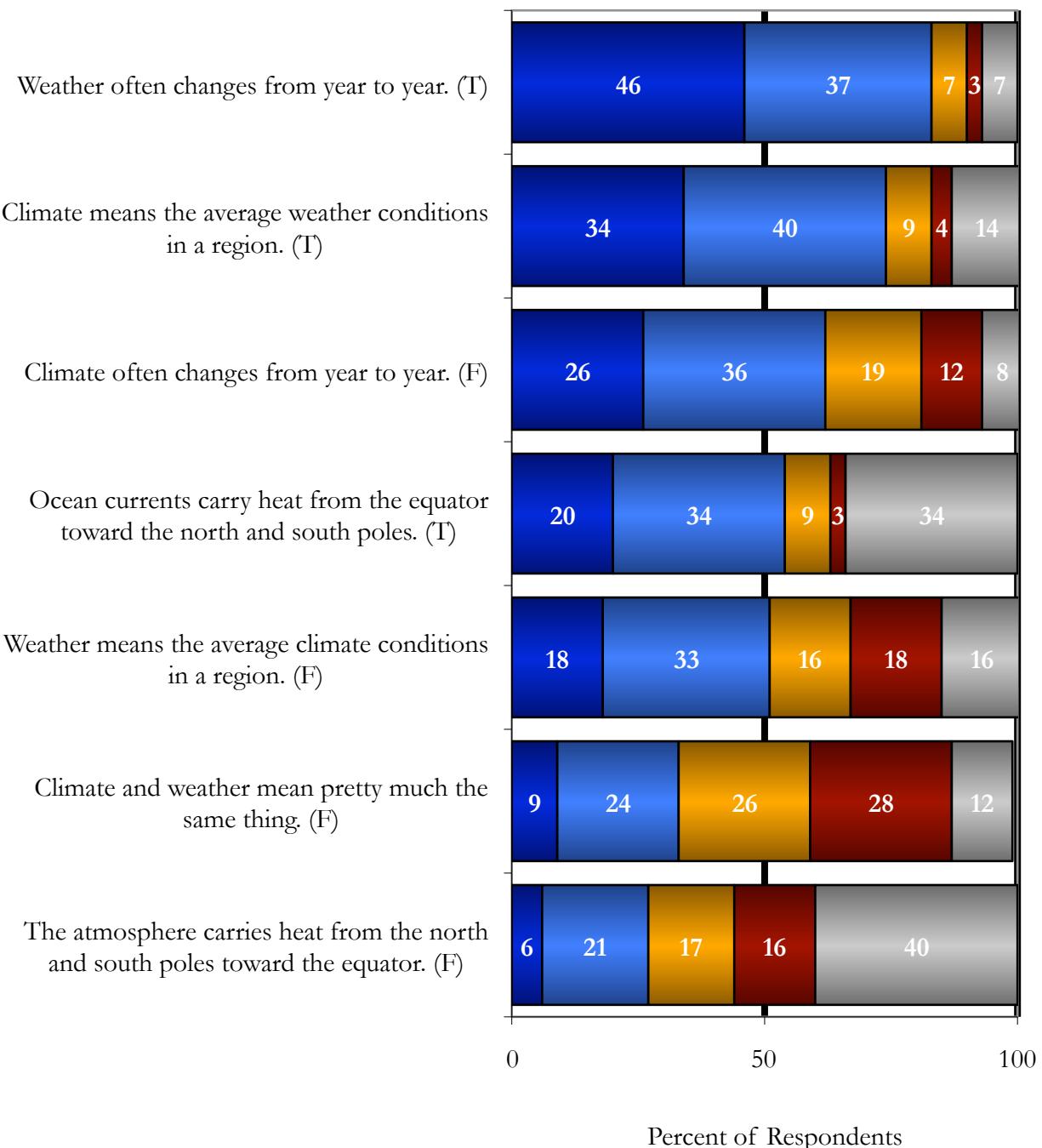


Q11. Which of the following gases in the atmosphere are good at trapping heat from the Earth's surface? (*order of items randomized*)



Q12. Are each of the following statements definitely true, probably true, probably false, definitely false, or you do not know? (*order of items randomized*)

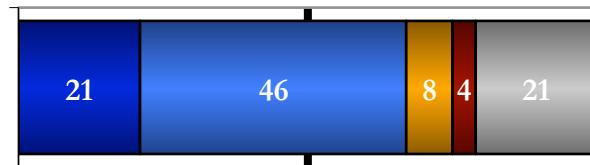
■ Definitely true ■ Probably true ■ Probably false ■ Definitely false ■ Don't know



Q13. Are each of the following statements definitely true, probably true, probably false, definitely false or you do not know? (*order of items randomized*)

■ Definitely true ■ Probably true ■ Probably false ■ Definitely false ■ Don't know

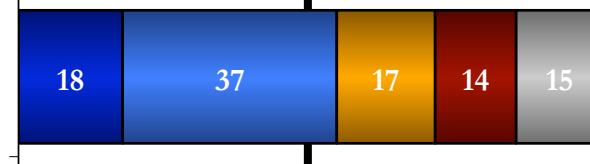
In the past, the Earth's climate always shifted gradually between warm and cold periods. (F)



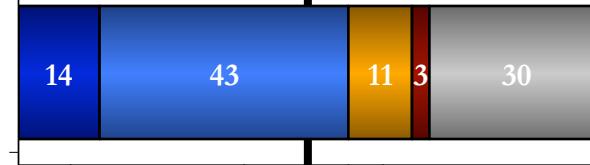
Climate changes have played an important role in the advance or collapse of some past human civilizations. (T)



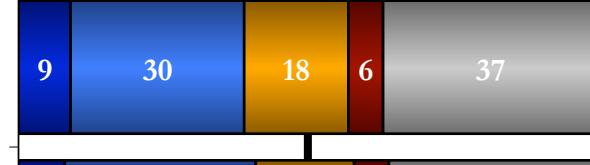
The Earth's climate is warmer now than it has ever been before. (F)



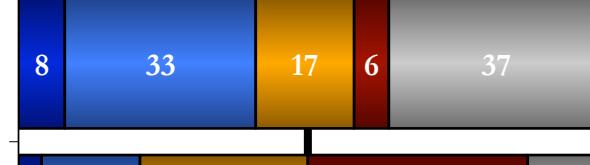
In the past, rising levels of carbon dioxide in the atmosphere have caused global temperatures to increase. (T)



In the past, rising global temperatures have caused carbon dioxide levels in the atmosphere to increase. (T)



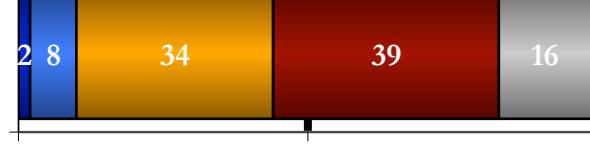
Compared to the climate of the past million years, the last 10,000 have been unusually warm and stable. (T)



The Earth's climate has been pretty much the same for millions of years. (F)

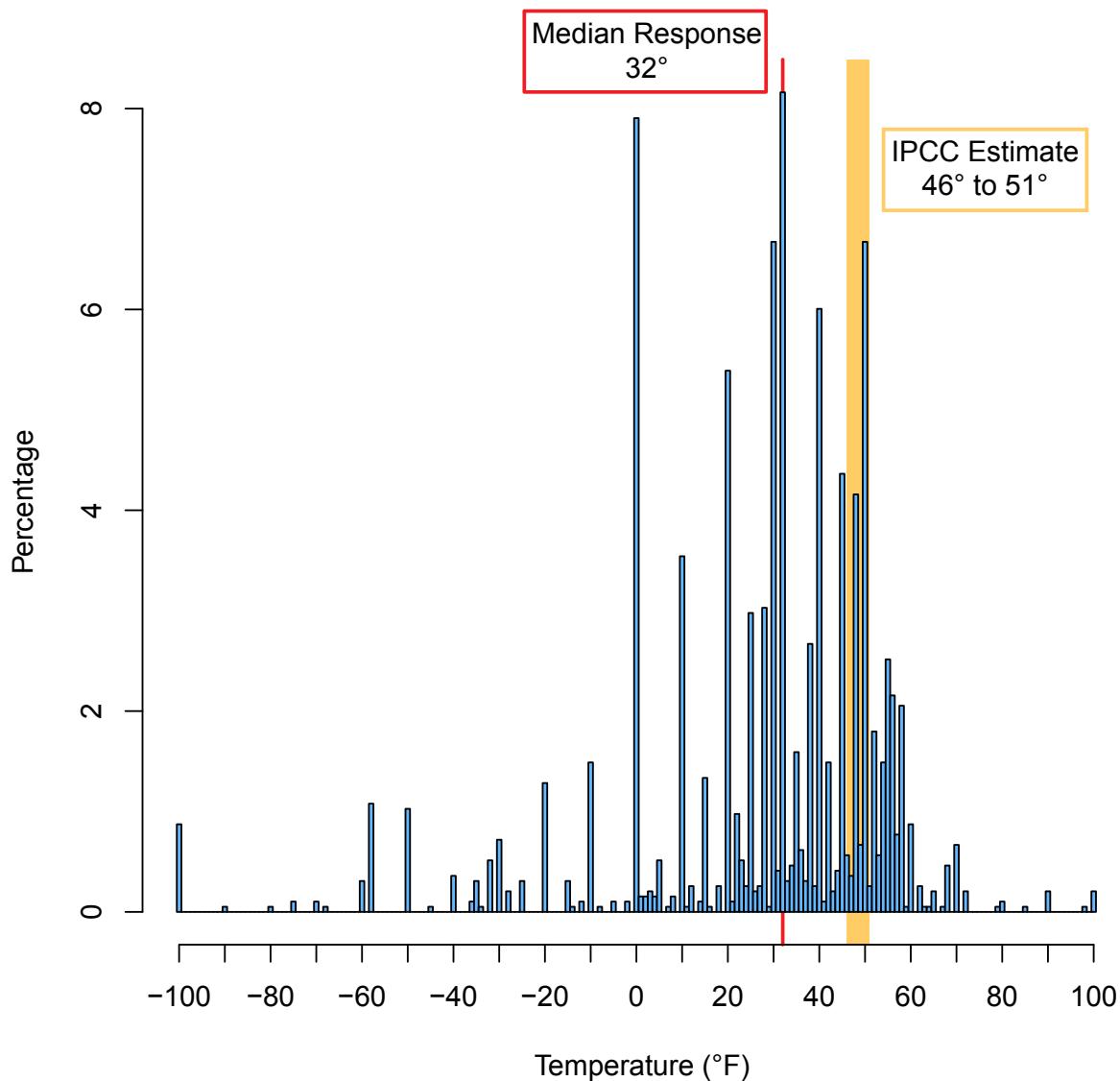


The Earth's climate is colder now than it has ever been before. (F)



Percent of Respondents

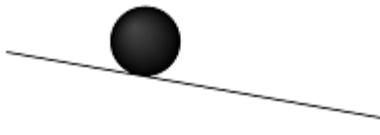
Q14. The average temperature of the Earth's surface is currently about 58 degrees Fahrenheit. What do you think the average temperature of the Earth's surface was during the last ice age?<sup>1</sup>



<sup>1</sup> A few extreme responses beyond -100° and +100° are not depicted in the graphic.

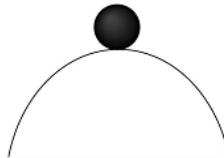
Q15. People disagree about how the climate system works. The five pictures below illustrate five different perspectives. Each picture depicts the Earth's climate system as a ball balanced on a line, yet each one has a different ability to withstand human-caused global warming. Which one of the five pictures best represents your understanding of how the climate system works? (*images randomized*)

**Gradual**



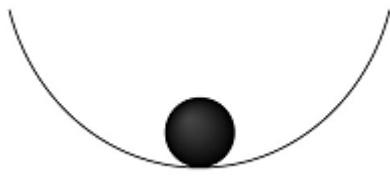
Earth's climate is slow to change. Global warming will gradually lead to dangerous effects.

**Fragile**



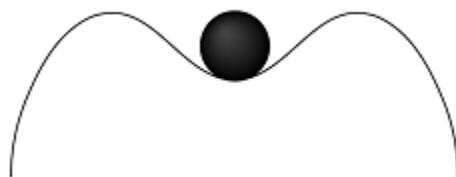
Earth's climate is delicately balanced. Small amounts of global warming will have abrupt and catastrophic effects.

**Stable**



Earth's climate is very stable. Global warming will have little to no effects.

**Threshold**



Earth's climate is stable within certain limits. If global warming is small, climate will return to a stable balance. If it is large, there will be dangerous effects.

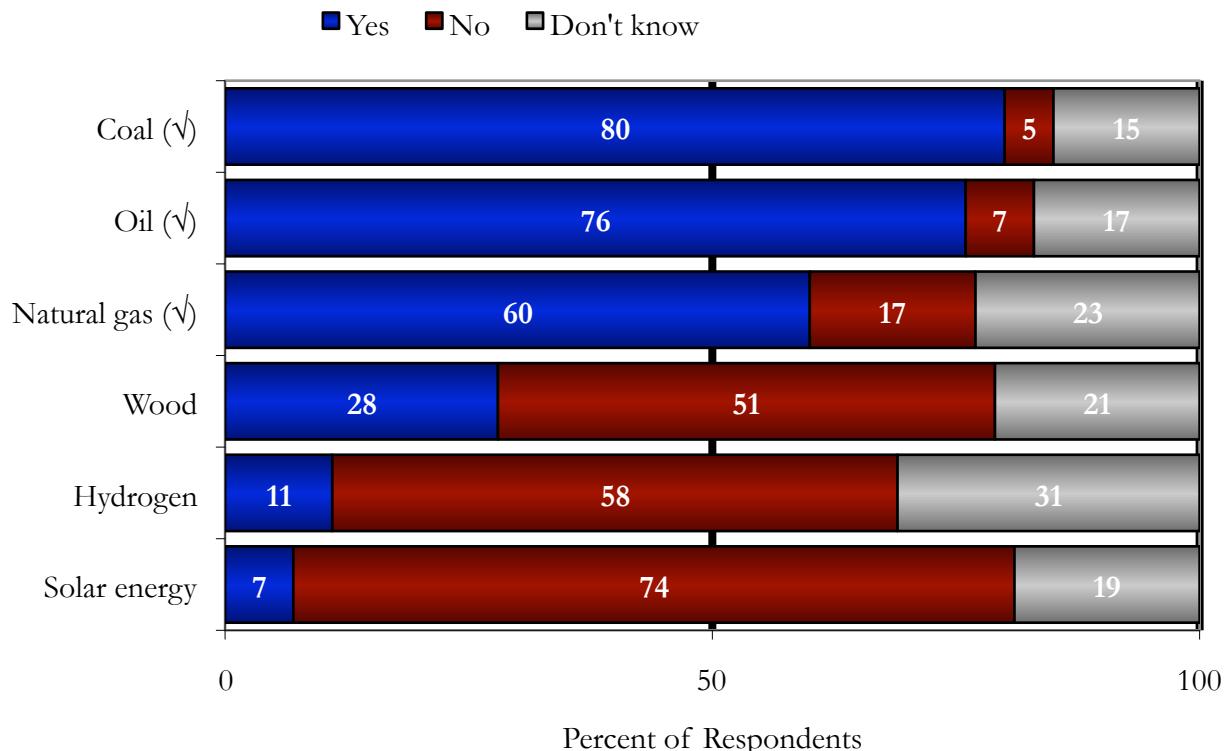
**Random**



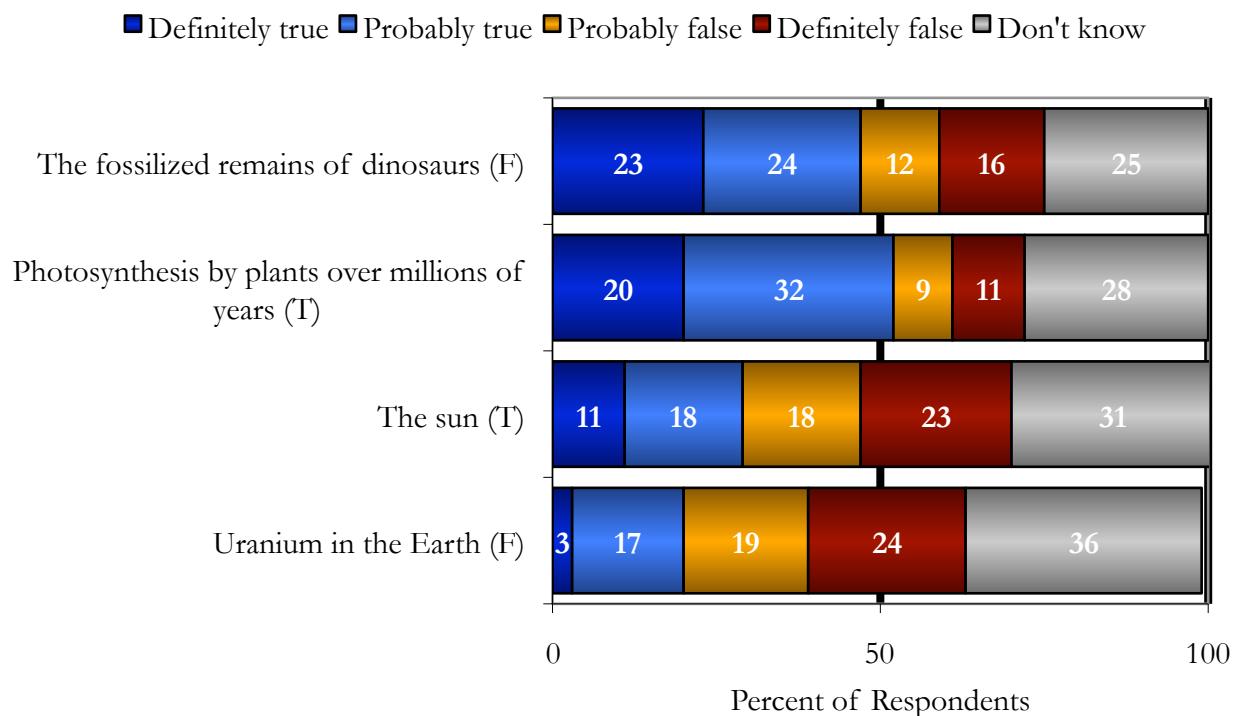
Earth's climate is random and unpredictable. We do not know what will happen.

Gradual	24
Fragile	11
Stable	10
Threshold (✓)	34
Random	21

Q16. Which of the following are “fossil fuels”? (*order of items randomized*)



Q17. The energy in fossil fuels originally came from: (*order of items randomized*)



Q18. What gas is produced by the burning of fossil fuels? (*order of items randomized*)

Oxygen	2
Hydrogen	4
Helium	1
Carbon dioxide (✓)	67
Don't know	26

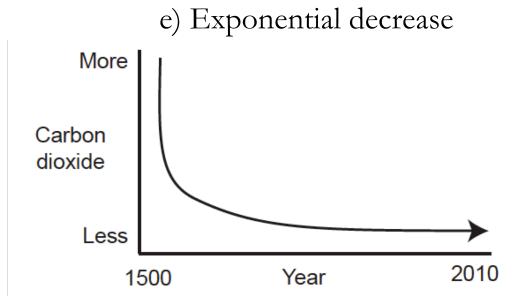
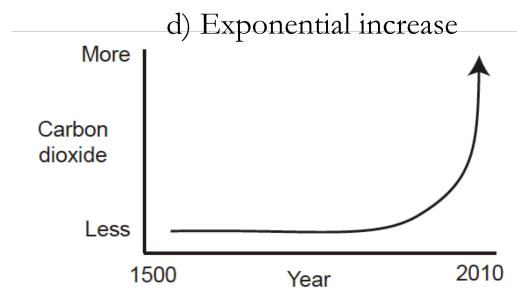
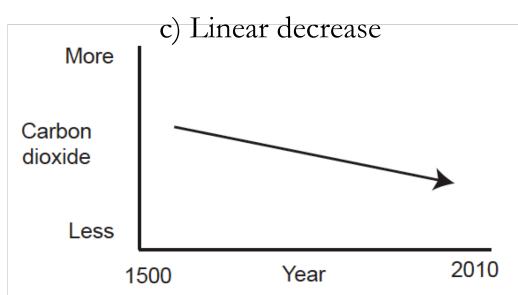
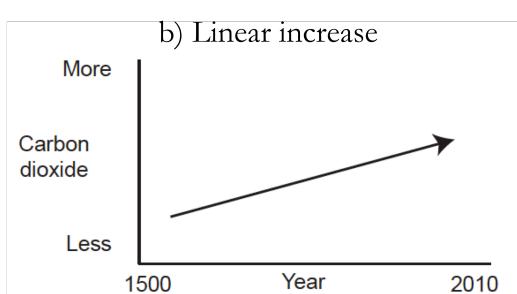
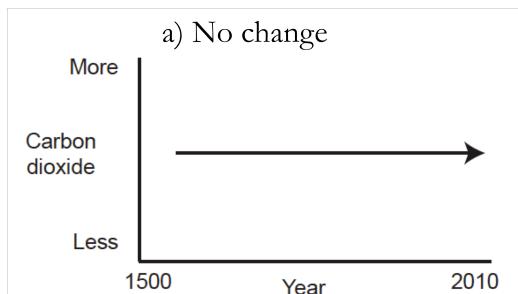
Q19. To the best of your knowledge, roughly how much carbon dioxide was in the atmosphere in the year 1850?

150 parts per million	10
290 parts per million (✓)	6
350 parts per million	4
390 parts per million	2
450 parts per million	1
Don't know	78

Q20. Roughly how much carbon dioxide is in the atmosphere today?

150 parts per million	2
290 parts per million	3
350 parts per million	6
390 parts per million (✓)	7
450 parts per million	6
Don't know	76

Q21. Which picture best represents your understanding of how the amount of carbon dioxide in the atmosphere has changed over the past 500 years?<sup>2</sup>



a) No change	8
b) Linear increase	41
c) Linear decrease	7
d) Exponential increase (✓)	40
e) Exponential decrease	5

Q22a. If we were to stop burning fossil fuels today, the amount of carbon dioxide in the atmosphere would decrease almost immediately. (F)

Definitely true	5
Probably true	32
Probably false	30
Definitely false	13
Don't know	20

<sup>2</sup> Labels not provided

Q22b. If we were to stop burning fossil fuels today, global warming would stop almost immediately. (F)

Definitely true	2
Probably true	14
Probably false	37
Definitely false	25
Don't know	23

Q23. On average, how long does carbon dioxide stay in the atmosphere once it has been emitted?

A few days	4
A few years	13
A hundred years (✓)	13
A thousand years (✓)	6
Don't know	64

Q24. Which of the following countries emits the largest total amount of carbon dioxide? (*order of items randomized*)

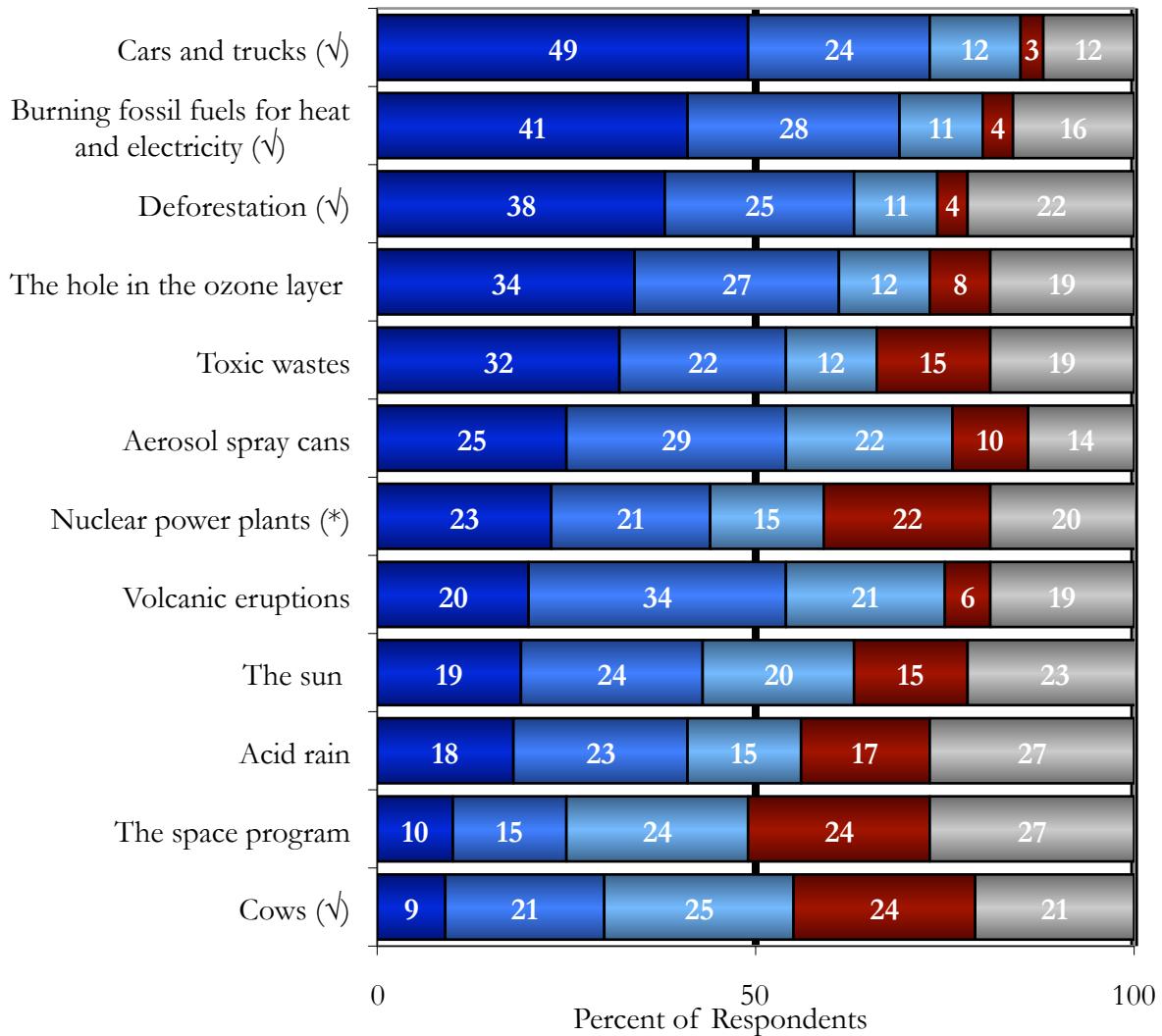
United States	34
China (✓)	36
India	2
Germany	1
Japan	4
Don't know	24

Q25. Which of the following countries emits the most carbon dioxide **per person**? (*order of items randomized*)

United States (✓)	42
China	18
India	4
Germany	1
Japan	5
Don't know	31

Q26. How much does each of the following contribute to global warming?<sup>3</sup> (order of items randomized)

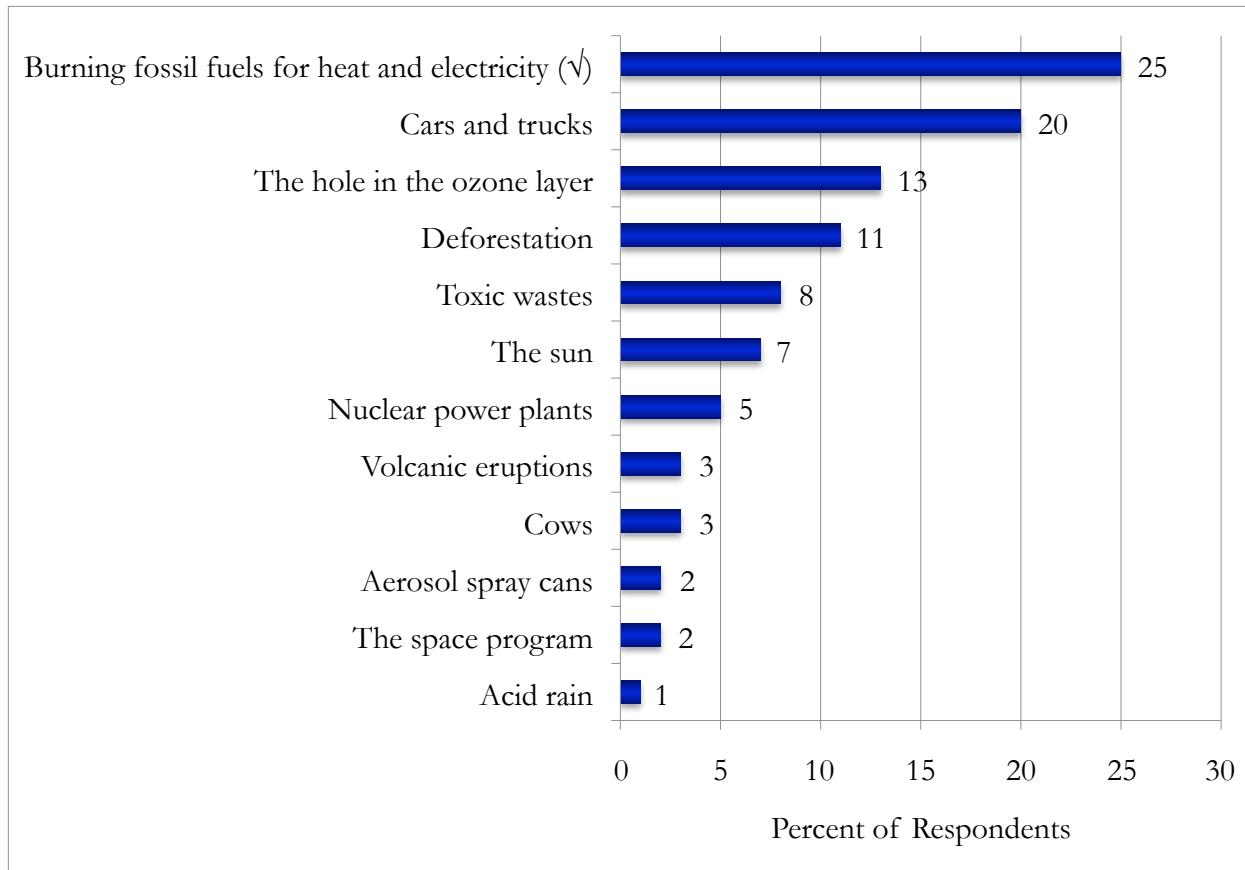
■ A lot ■ Some ■ A little ■ Not at all ■ Don't know



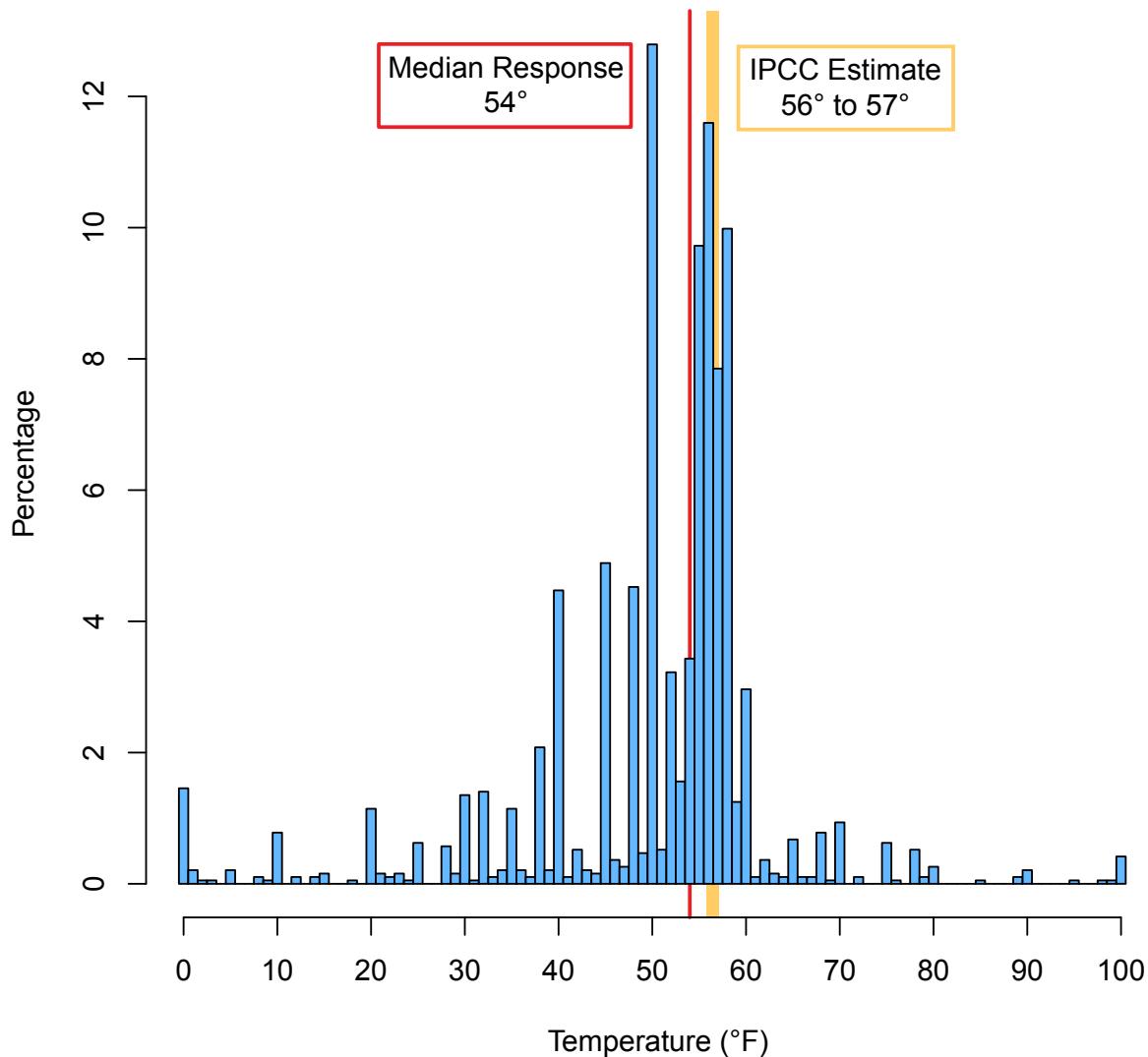
<sup>3</sup>Although nuclear power generation does not emit carbon dioxide, there are fossil fuel intensive activities associated with the full lifecycle of nuclear power plants, including nuclear power plant construction, operation, the mining and milling of uranium, and power plant decommissioning.

*People who answered “a lot” or “some” to more than one item in question 26 were asked the following question ( $n = 1451$ ).*

Q27. Of the following, which one do you think contributes most to global warming?

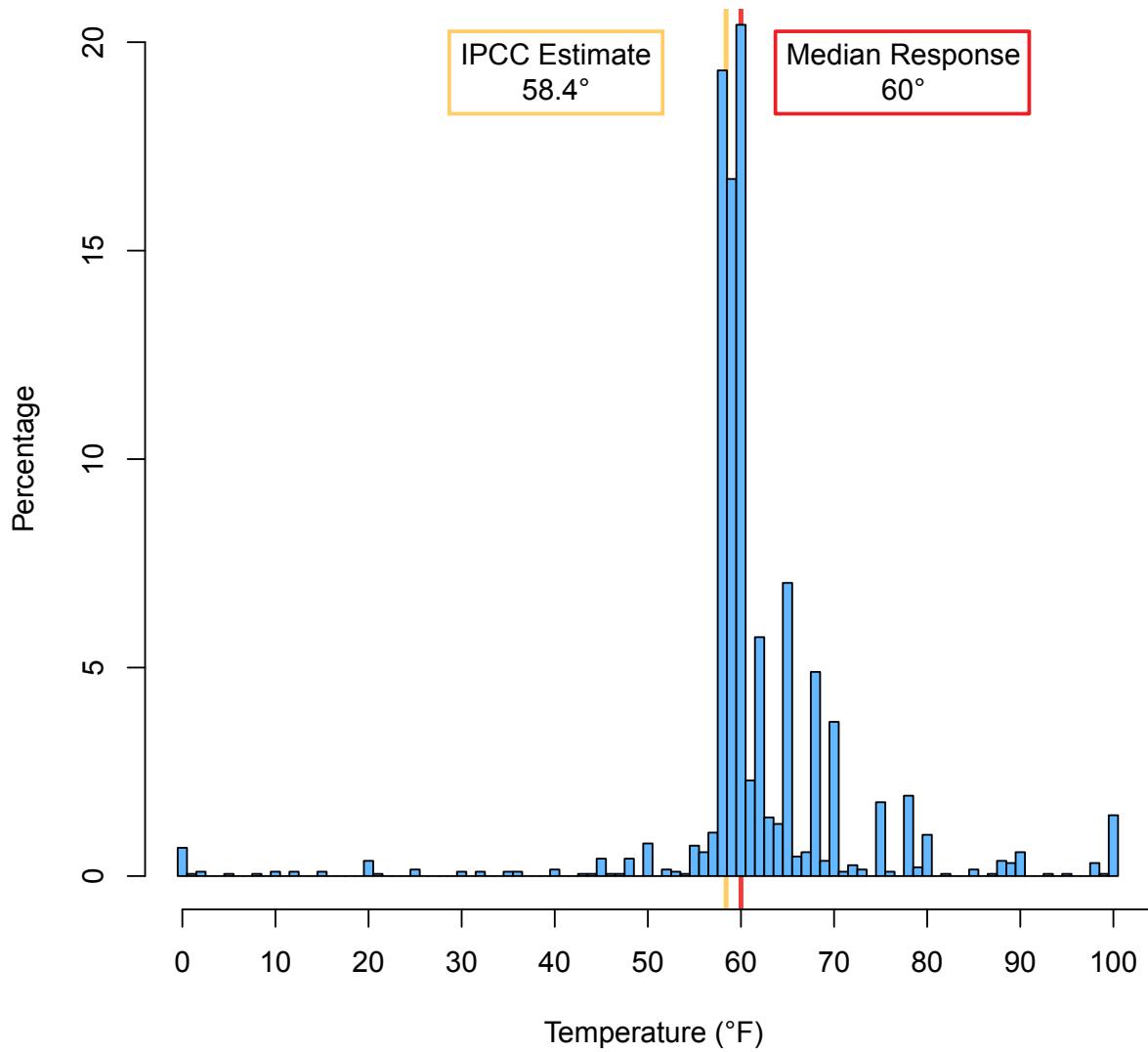


Q28. The average temperature of the Earth's surface is currently 58 degrees Fahrenheit. What temperature do you think it was **150 years ago?**<sup>4</sup>



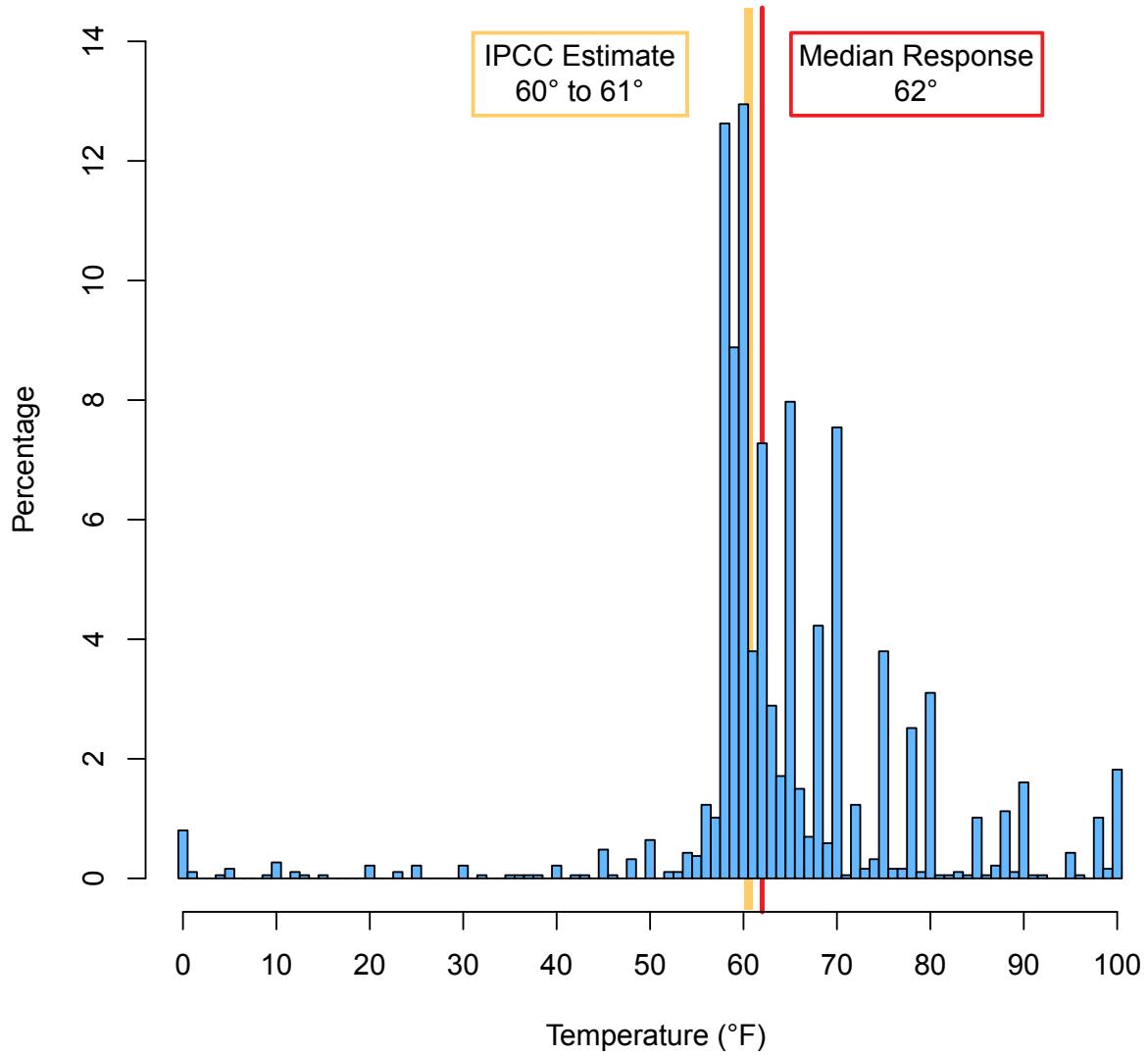
<sup>4</sup> A few extreme responses beyond -0° and +100° are not depicted in the graphic.

Q29. The average temperature of the Earth's surface is currently 58 degrees Fahrenheit. If no additional actions are taken to reduce global warming, what temperature do you think it will be by the year 2020?<sup>5</sup>



<sup>5</sup> A few extreme responses beyond -0° and +100° are not depicted in the graphic.

Q30. The average temperature of the Earth's surface is currently 58 degrees Fahrenheit. If no additional actions are taken to reduce global warming, what temperature do you think it will be by the year 2050?<sup>6</sup>



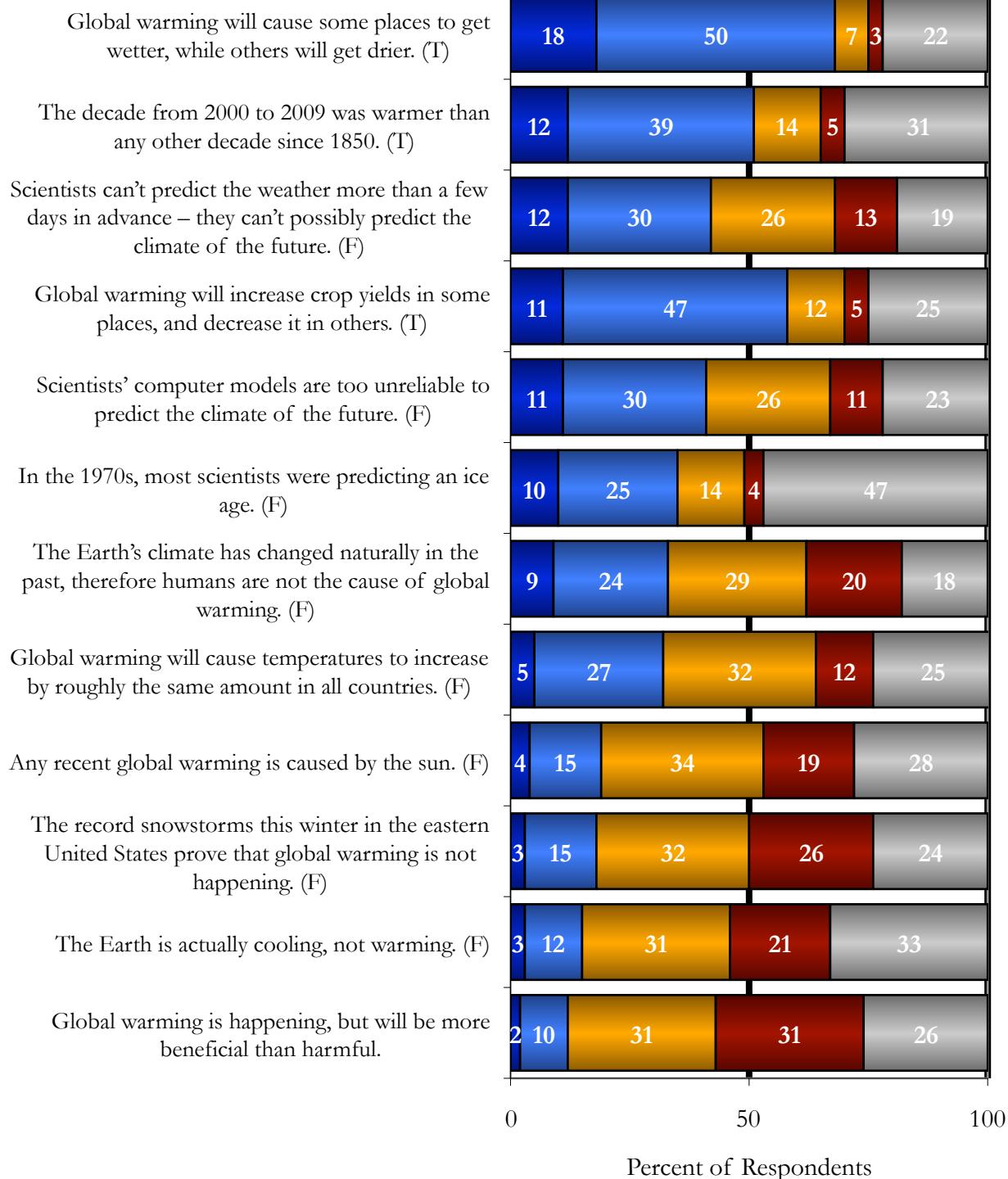
<sup>6</sup> A few extreme responses beyond -0° and +100° are not depicted in the graphic.

Q31. Are each of the following statements definitely true, probably true, probably false, definitely false, or do you not know? (*order of items randomized*)

Definitely true  
Definitely false

Probably true  
Don't know

Probably false



Q32. Which of the following statements is correct?

All of the glaciers on Earth are melting away	11
Most of the glaciers on Earth are melting away (✓)	21
Some of the glaciers on Earth are melting away	48
None of the glaciers on Earth are melting away	4
Don't know	16

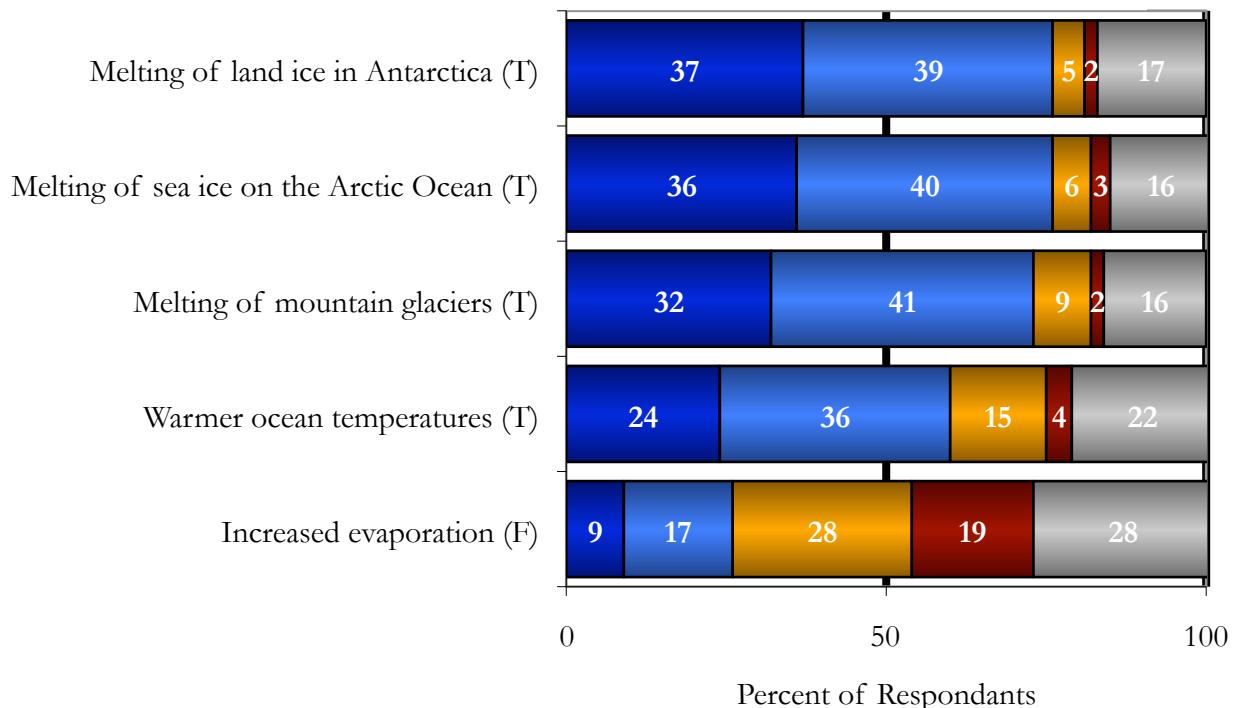
*People who answered “all”, “most”, or “some of the glaciers on Earth are melting away” to question 32 were asked the following question.*

Q33. Over the past 100 years, has the speed of glacier melting increased, decreased, or stayed the same?

Increased (✓)	84
Stayed the same	14
Decreased	2
N	1600

Q34. Which of the following can cause global sea levels to rise? (*order of items randomized*)

■ Definitely true ■ Probably true ■ Probably false ■ Definitely false ■ Don't know



*People who answered “definitely” or “probably true” to more than one cause in question 34 were asked the following question.*

Q35. Of the causes you selected, which **one** has contributed the most to sea level rise so far?

Melting of mountain glaciers	19
Melting of sea ice on the Arctic Ocean	34
Melting of land ice in Antarctica	24
Warmer ocean temperatures (✓)	22
Increased evaporation	2
<b>N</b>	<b>1482</b>

Q36. How much do scientists estimate that global sea levels rose from 1900 to 2000?

10-12 feet	3
3-4 feet	11
6-9 inches (✓)	26
Zero	4
Don't know	57

Q37. If no additional actions are taken to reduce global warming, how much do you think global sea levels will rise by the year 2100?

10-12 feet	13
3-4 feet (✓)	17
6-9 inches (✓)	16
Zero	6
Don't know	48

Q38. How much, if anything, have you read or heard about coral bleaching?

A lot	1
Some	9
A little	15
Nothing	75

*People who answered “a lot,” “some,” or “a little” to question 38 were asked the following question.*

Q39. Which of the following causes coral bleaching? (*order of items randomized*)

Warmer ocean temperatures (✓)	54
Chemical spills in the ocean	11
Acid rain	8
Overfishing	3
Don’t know	24
<b>N</b>	<b>491</b>

Q40. How much, if anything, have you read or heard about ocean acidification?

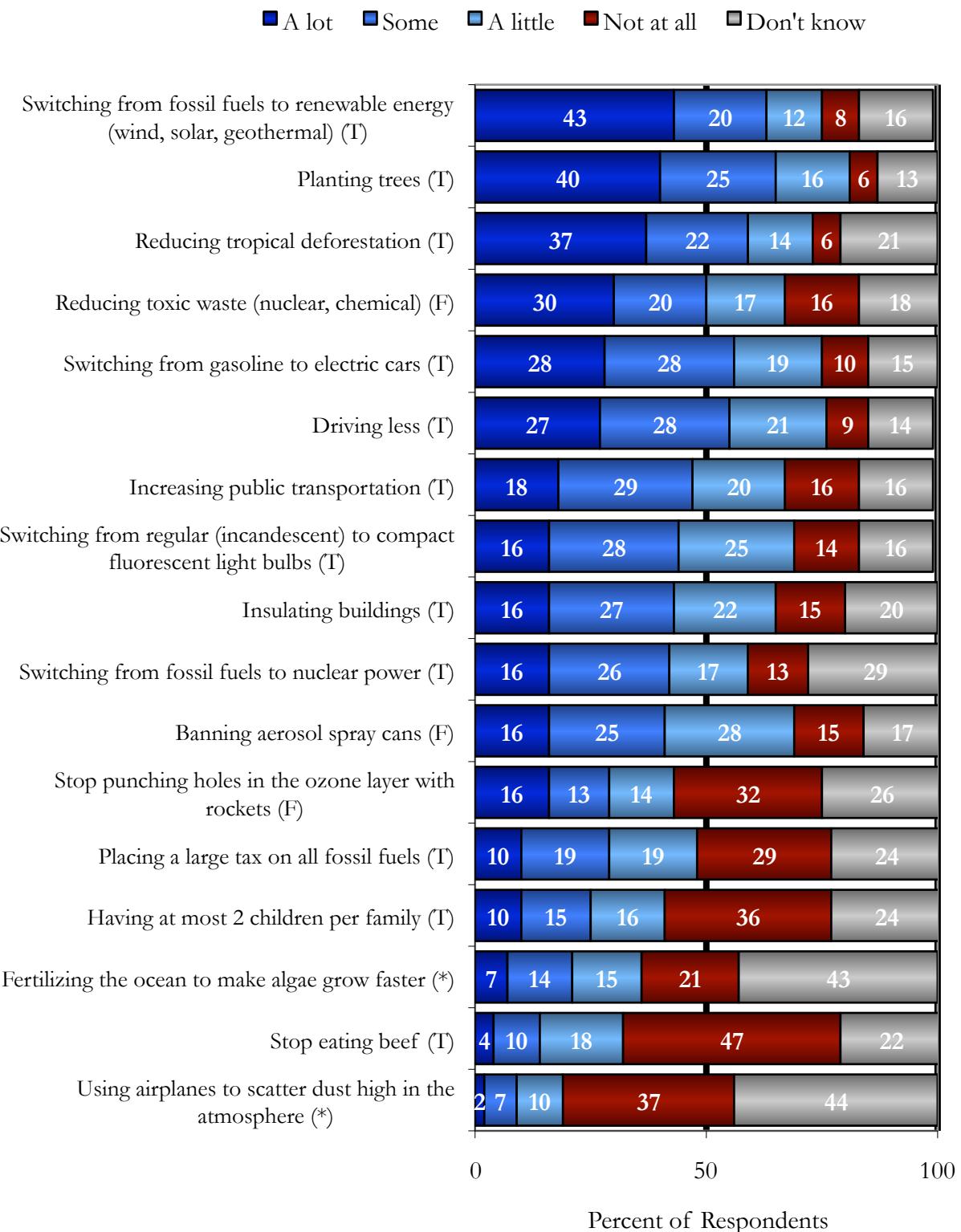
A lot	1
Some	6
A little	17
Nothing	77

*People who answered “a lot,” “some,” or “a little” to question 40 were asked the following question.*

Q41. Which of the following causes ocean acidification? (*order of items randomized*)

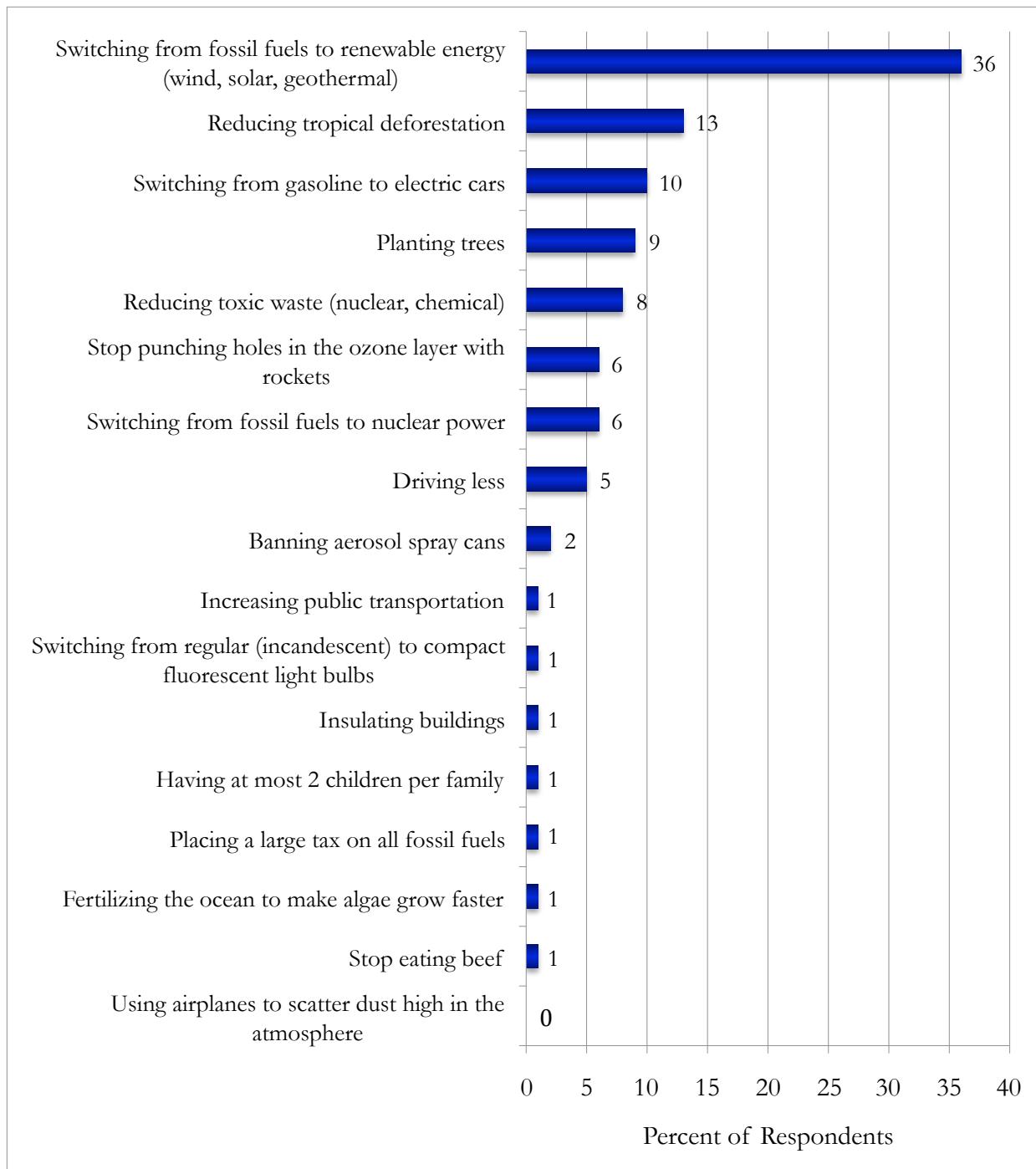
Absorption of carbon dioxide by the ocean (✓)	32
Chemical spills in the ocean	16
Acid rain	19
Warmer ocean temperatures	13
Don’t know	21
<b>N</b>	<b>467</b>

Q42. How much do you think each of the following actions would reduce global warming if they were done **worldwide?** (*order of items randomized*)



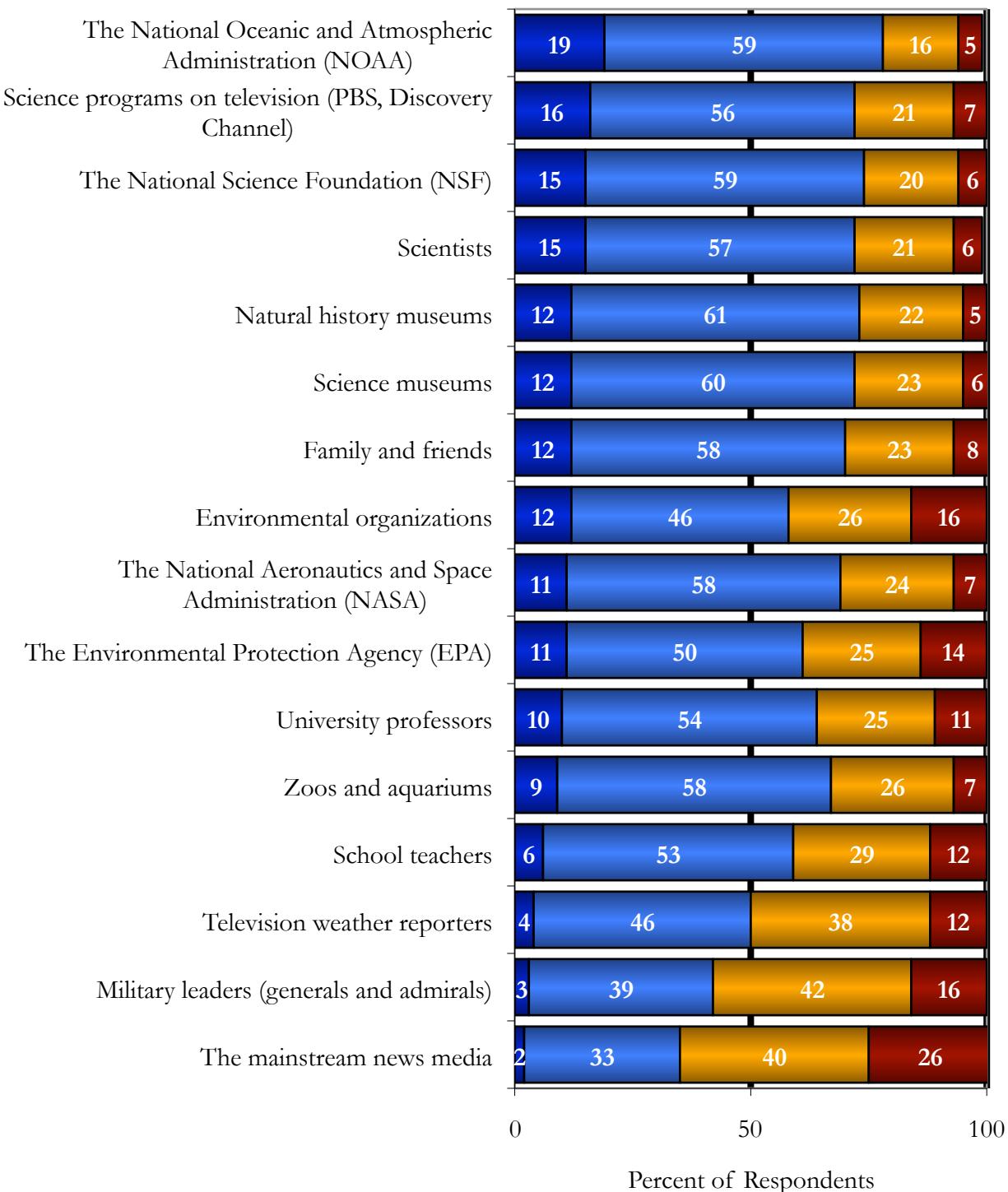
*People who answered “a lot,” “some” or “a little” for more than one action in question 42 were asked the following question. (n = 1470)*

Q43. Of the following actions, which **one** do you think would reduce global warming the most?

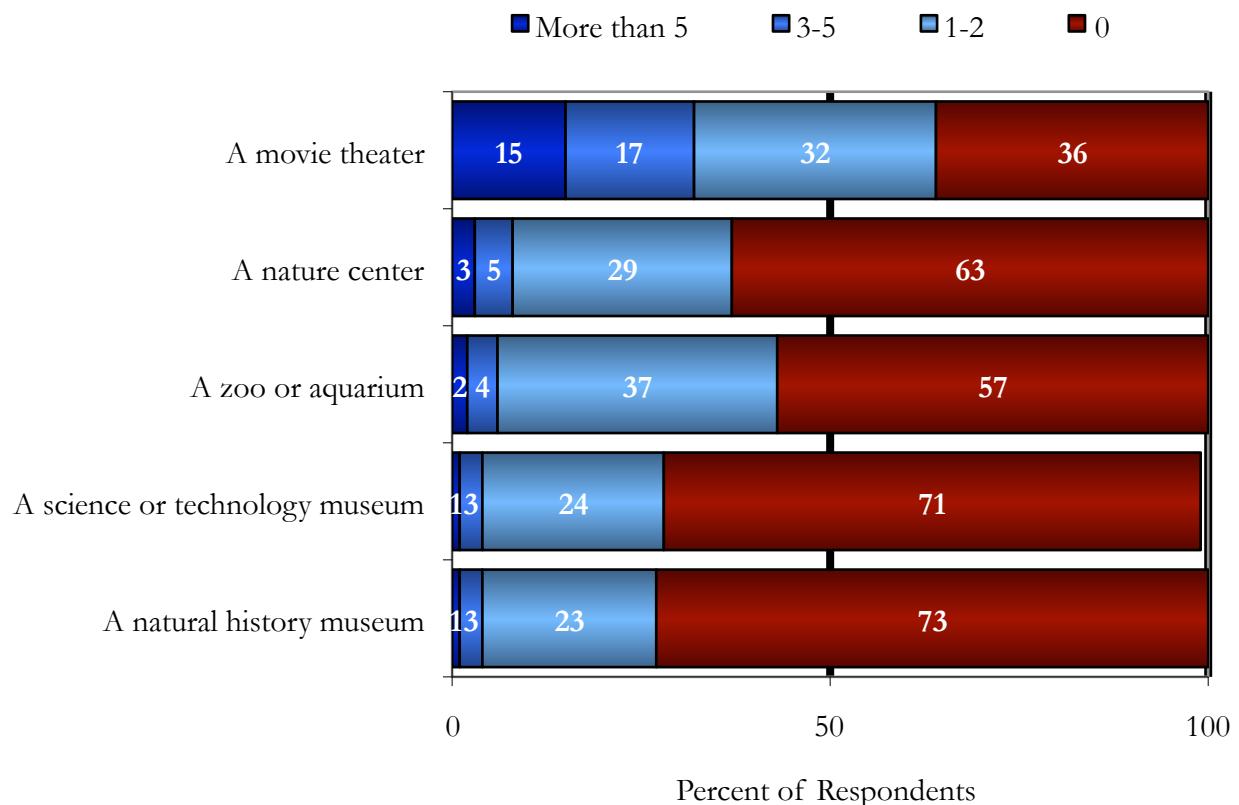


Q44. How much do you trust or distrust the following as a source of information about global warming? (order of items randomized)

■ Strongly trust ■ Somewhat trust ■ Somewhat distrust ■ Strongly distrust



Q45. Over the past 12 months, how many times have you visited each of the following?



Q46. Have you ever attended the following at a science center or museum?

A lecture about global warming

Yes	8
No	92

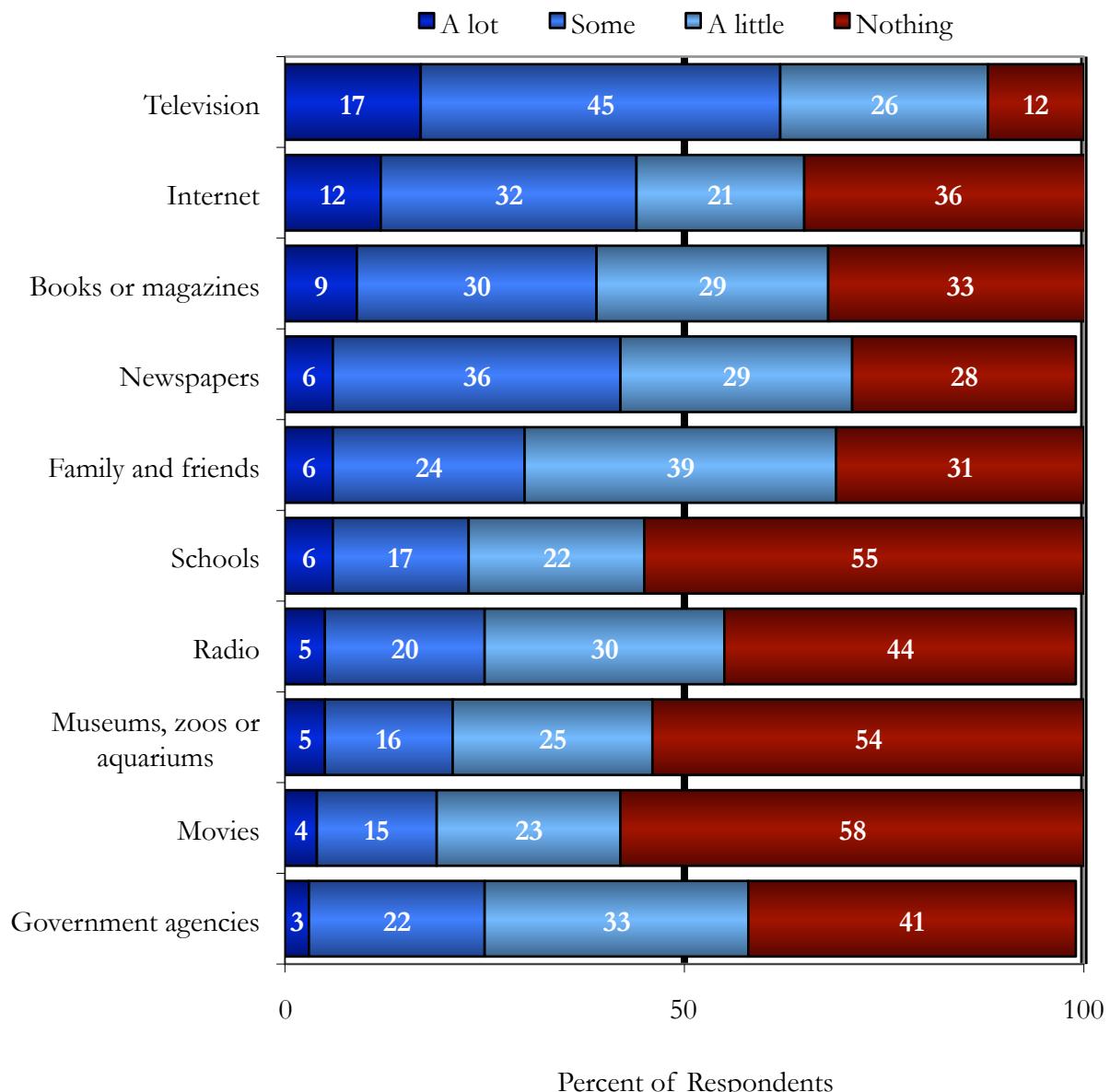
An exhibit about global warming

Yes	14
No	86

An event with hands-on activities for children and families about global warming

Yes	8
No	92

Q47. How much have you learned about global warming from each of the following sources?



Q48. How closely do you follow news about the environment?

Very closely	7
Somewhat closely	32
A little	45
Not at all	16

Q49. How closely do you follow news about the local weather forecast?

Very closely	32
Somewhat closely	39
A little	22
Not at all	7

Q50. How much had you thought about global warming before today?

A lot	17
Some	35
A little	33
Not at all	15

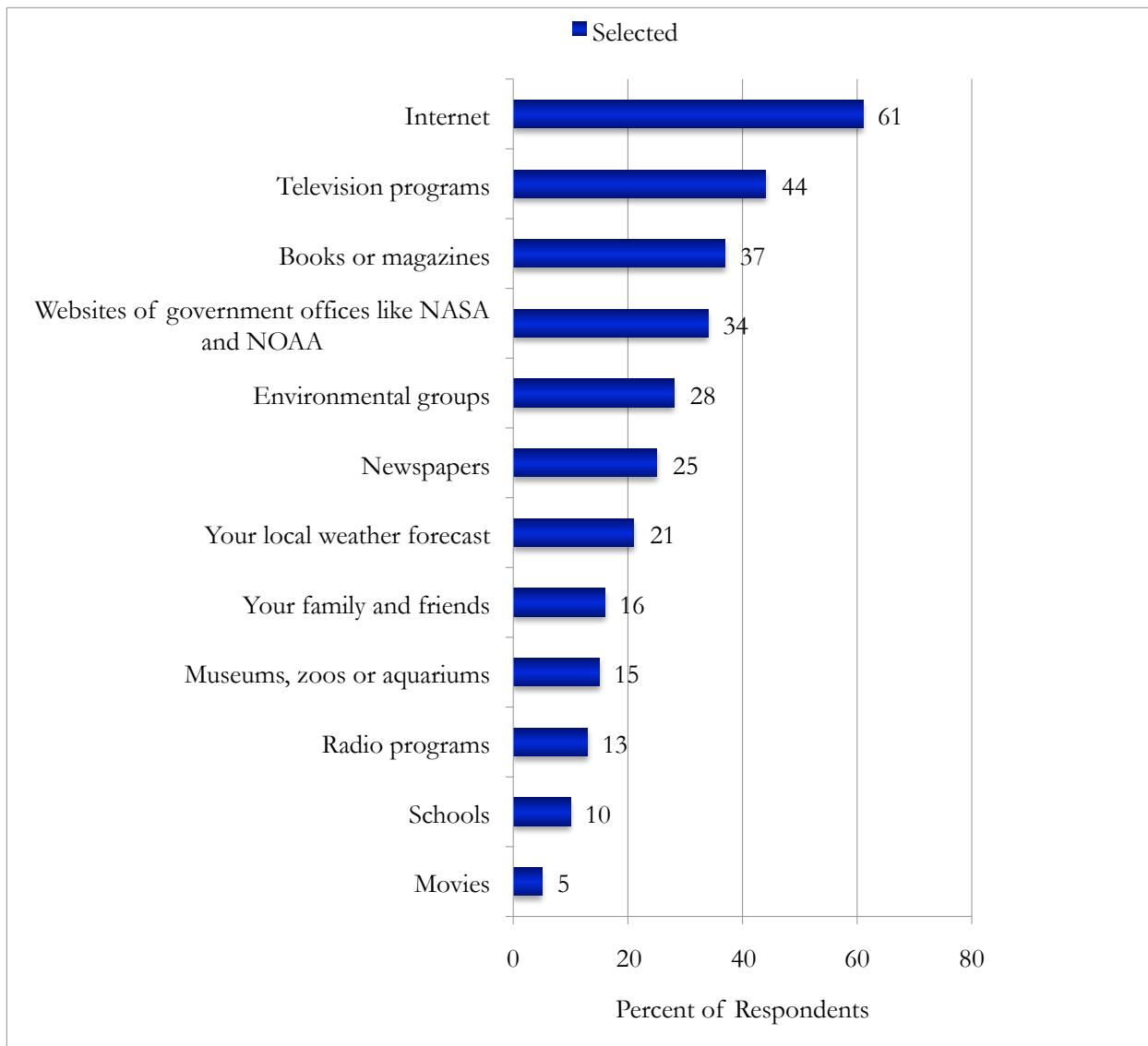
Q51. How important is the issue of global warming to you personally?

Extremely important	7
Very important	20
Somewhat important	38
Not too important	21
Not at all important	14

Q52. On some issues people feel that they have all the information they need in order to form a firm opinion, while on other issues they would like more information before making up their mind. For global warming, where would you place yourself?

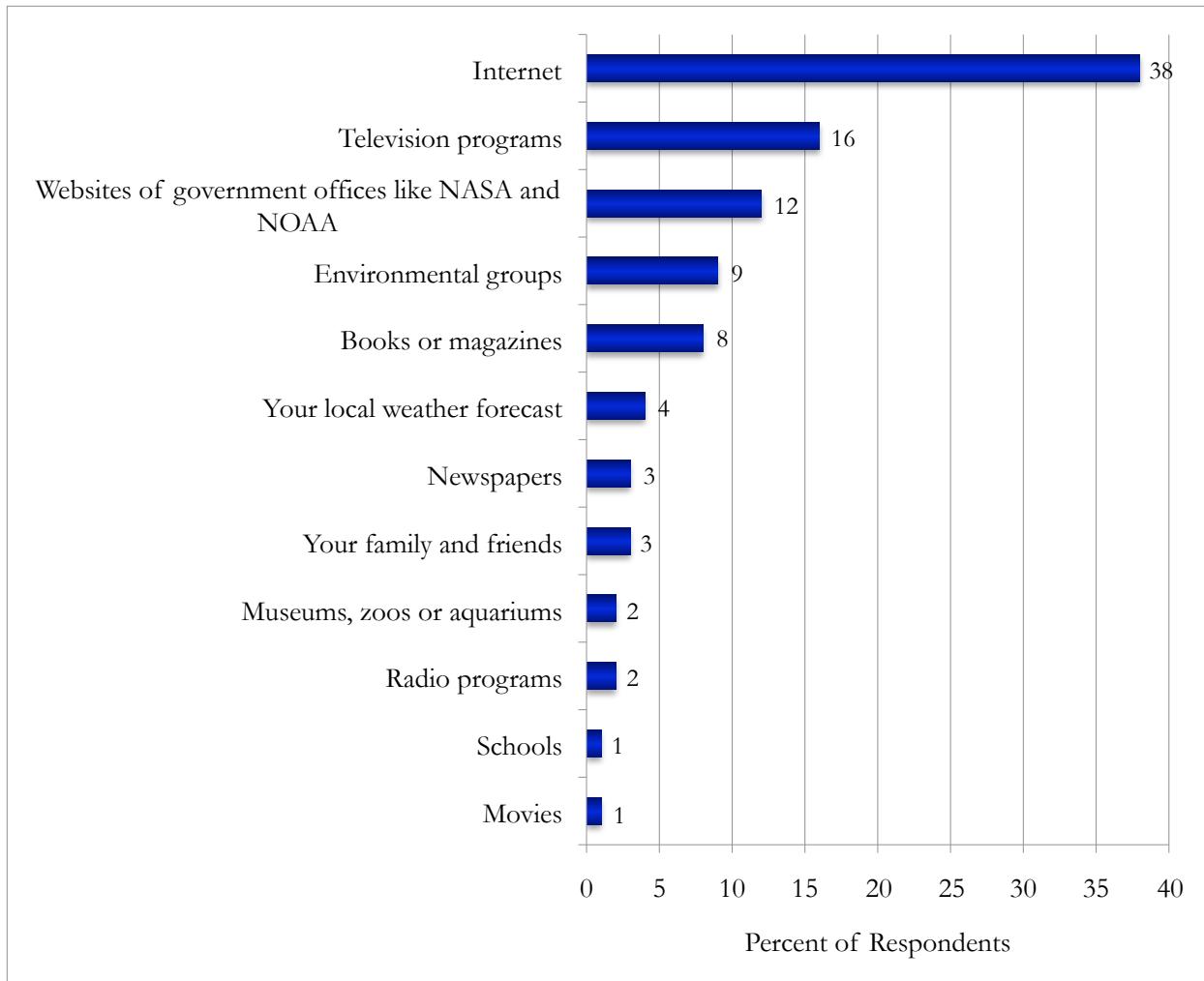
I need a lot more information	25
I need some more information	26
I need a little more information	25
I do not need any more information	24

Q53. If you wanted to learn more about global warming, where would you go to get more information?



*People who selected at least one information source in question 53 were shown just their selections and asked the following question. (n = 1,920)*

Q54. Of the following, which one would you go to first to learn more about global warming?

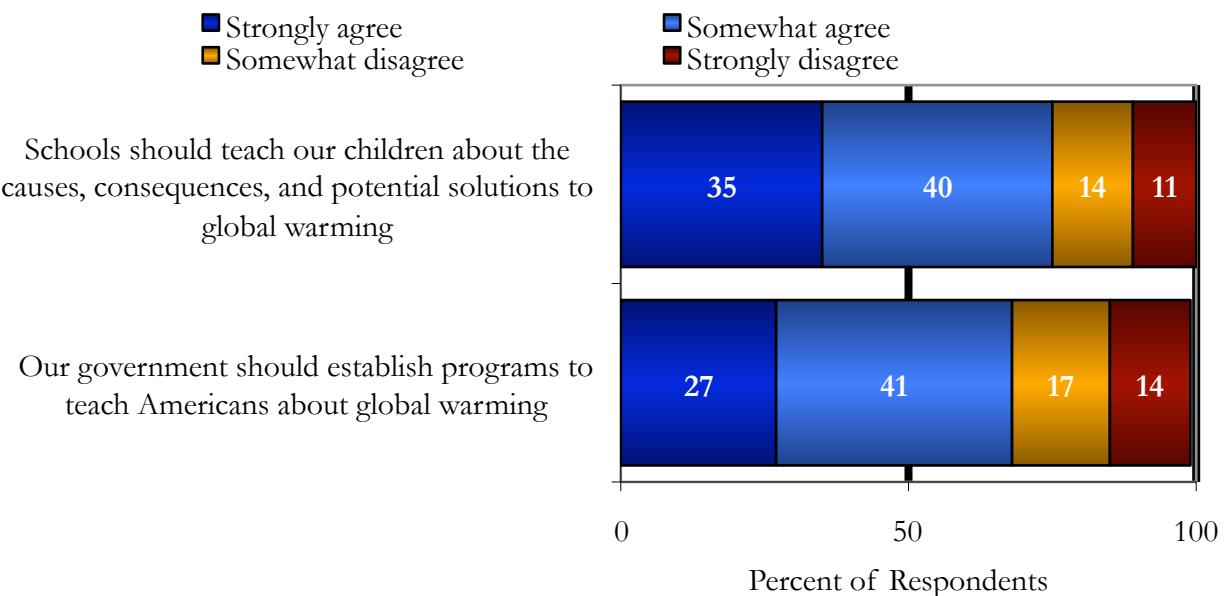


Q55A. How much do you agree or disagree with the following statement?

“I could easily change my mind about global warming.”

Strongly agree	5
Somewhat agree	32
Somewhat disagree	36
Strongly disagree	28

Q55B. How much do you agree or disagree with the following statements?



## Appendix: Answer Key

**Q1.** Recently, you may have noticed that global warming has been getting some attention in the news. Global warming refers to the idea that the world's average temperature has been increasing over the past 150 years, may be increasing more in the future, and that the world's climate may change as a result. What do you think? Do you think that global warming is happening? [Correct answer: Yes]

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p. 9; IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, p. 30; Matson, P.A., Dietz, T., Abdalati, W., Busalacchi, Jr., A.J., Caldeira, K., Corell, R.W., DeFries, R.S., Fung, I.Y., Gaines, S., Hornberger, G.M., Lemos, M.C., Moser, S.C., Moss, R.H., Parson, E.A., Ravishankara, A.R., Schmitt, R.W., Turner, II, B.L., Washington, W.M., Weyant, J.P., Whelan, D.A. (2010) Advancing the science of climate change. National Academies Press, Washington, D.C., p. 506.

**Q4.** Assuming global warming is happening, do you think it is... [Correct answer: caused mostly by human activities]

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p. 13; IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, p. 39; Modern Global Climate Change. Karl, Thomas R. and Trenberth, Kevin E. (5 December 2003) *Science* **302** (5651) 1719-1723.

**Q5.** Which comes closer to your own view? [Best answer: most scientists think global warming is happening]

For example, see: Anderegg, W., Prall, J., Harold, J. and Schneider, S. (2010) Expert credibility in climate change. *Proceedings of the National Academy of Sciences of the United States of America*, p. 1; Oreskes, N. (2004) The Scientific Consensus on Climate Change *Science* **306** (5702), 1686.

**Q9.** The “greenhouse effect” refers to: (*order of items randomized*) [Correct answer: gases in the atmosphere that trap heat]

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p. 14; Le Treut, H., R. Somerville, U. Cubasch, Y. Ding, C. Mauritzen, A. Mokssit, T. Peterson and M. Prather, 2007: Historical Overview of Climate Change. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 115-116.

**Q10. How much can each of the following affect the average global temperature of the Earth? (order of items randomized)** [Correct answers: greenhouse gases in the atmosphere, changes in the Earth's orbit around the sun, volcanic eruptions, the amount of dust in the atmosphere, clouds, sunspots, and whether the Earth's surface is light or dark colored. Incorrect answers: earthquakes and the phases of the moon.]

For example, U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p. 14-16; see: Le Treut, H., R. Somerville, U. Cubasch, Y. Ding, C. Mauritzen, A. Mokssit, T. Peterson and M. Prather, 2007: Historical Overview of Climate Change. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 96-97; 107-108; Lean, Judith L. 2010. Cycles and trends in solar irradiance and climate. *Wiley Interdisciplinary Reviews: Climate Change*. Vol 1, Issue 1. pp 111-122. Dec 22, 2009. doi:10.1002/wcc.018.

**Q11. Which of the following gases in the atmosphere are good at trapping heat from the Earth's surface? (order of items randomized)** [Correct answers: carbon dioxide, methane, and water vapor. Incorrect answers: oxygen and hydrogen.]

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p. 14-16; Le Treut, H., R. Somerville, U. Cubasch, Y. Ding, C. Mauritzen, A. Mokssit, T. Peterson and M. Prather, 2007: Historical Overview of Climate Change. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 115-116.

**Q12. Are each of the following statements definitely true, probably true, probably false, definitely false, or you do not know? (order of items randomized)**

For the following 5 items, for example, see: Le Treut, H., R. Somerville, U. Cubasch, Y. Ding, C. Mauritzen, A. Mokssit, T. Peterson and M. Prather, 2007: Historical Overview of Climate Change. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 104-105.

- Weather often changes from year to year [true]
- Climate is the average weather conditions of a region [true]
- Climate often changes from year to year [false]
- Weather means the average climate conditions for a region [false]

- Climate and weather mean pretty much the same thing [false]
- Ocean currents carry heat from the equator to the north and south poles [true]

For example, see: Trenberth, K. E. and J. M. Caron, 2001 Estimates of meridional atmosphere and ocean heat transports *Journal of Climate*, **14**, 3433-3443; Morgan, G. and Smuts, T. (1994) Global warming and climate change: More on 'What is climate change?' Carnegie Mellon University, Department of Engineering and Public Policy. <http://www.gcrio.org/gwcc/booklet1.html>

- The atmosphere carries heat from the north and south poles toward the equator [false]

For example, see: Barry, L., Craig, G. C., & Thuburn, J. (2002). Poleward heat transport by the atmospheric heat engine. *Nature*, **415**(6873), 774-777; Trenberth, K. E. and J. M. Caron, 2001 Estimates of meridional atmosphere and ocean heat transports *Journal of Climate*, **14**, 3433-3443.

**Q13. Are each of the following statements definitely true, probably true, probably false, definitely false or you do not know? (order of items randomized)**

- In the past, the Earth's climate always shifted gradually between warm and cold periods [false]

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p. 26; Committee on Abrupt Climate Change, National Research Council (2002) Abrupt climate change: Inevitable surprises, National Academies Press, 244 p.; Alley, R.B., Marotzke, J., Nordhaus, W.D., Overpeck, J.T., Peteet, D.M., Pielke Jr., R.A., Pierrehumbert, R.T., Rhines, P.B., Stocker, T.F., Talley, L.D., Wallace, J.M. (2003) Abrupt climate change. *Science* **299**, 2005-2010.

- Climate changes have played an important role in the advance or collapse of some past human civilizations [true]

For example, see: Weiss, H. and Bradley, R. S. (2001) Archaeology-what drives societal collapse? *Science* **291**, 609–610; deMenocal, P.B. (2001) Cultural responses to climate change during the late Holocene. *Science* **292**, p. 667-673.

- The Earth's climate is warmer now than it has ever been before [false]

For example, see: Zachos, J., Pagani, M., Sloan, L., Thomas, E., Billups, K. (2001) Trends, Rhythms, and Aberrations in Global Climate 65 Ma to Present. *Science* **292**(5517) p. 686-693; IPCC (2007) *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)], p. 449.

- In the past, rising levels of carbon dioxide in the atmosphere have caused global temperatures to increase [true]

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p.16; Caillon, N., Severinghaus, J.P., Jouzel, J., Barnola, J.-M., Kang, J., Lipenkov, V.Y. (2003) Timing of Atmospheric CO<sub>2</sub> and Antarctic Temperature Changes Across Termination III. *Science* **299**, p. 1728-1731; Monnin, E., Indermühle, A., Dännenbach, A., Flückiger, J., Stauffer, B., Stocker, T.F., Raynaud, D., Barnola, J.-M., (2001) Atmospheric CO<sub>2</sub> concentrations over the Last Glacial Termination. *Science* **291**(5501), p. 112-114; Lorius, C., Jouzel, J., Raynaude, D., Hansen, J., Le Treut, H. (1990) The ice-core record: Climate sensitivity and future greenhouse warming. *Nature* **347**, p. 139-145.

- In the past, rising global temperatures have caused carbon dioxide levels in the atmosphere to increase [true]

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p.16; Stott, L., Timmermann, A., Thunell, R. (2007) Southern Hemisphere and Deep-Sea Warming Led Deglacial Atmospheric CO<sub>2</sub> Rise and Tropical Warming. *Science* **319**(5849) p. 435-438; Siegenthaler, U., Stocker, T. F., Monnin, E., Luthi, D., Schwander, J., Stauffer, B., et al. (2005). Stable carbon cycle-climate relationship during the late Pleistocene. *Science*, **310**(5752), 1313-1317; Caillon, N., Severinghaus, J.P., Jouzel, J., Barnola, J.-M., Kang, J., Lipenkov, V.Y. (2003) Timing of Atmospheric CO<sub>2</sub> and Antarctic Temperature Changes Across Termination III. *Science* **299**, p. 1728-1731; Monnin, E., Indermühle, A., Dännenbach, A., Flückiger, J., Stauffer, B., Stocker, T.F., Raynaud, D., Barnola, J.-M., (2001) Atmospheric CO<sub>2</sub> concentrations over the Last Glacial Termination. *Science* **291**(5501), p. 112-114.

- Compared to the climate of the past million years, the last 10,000 have been unusually warm and stable [true]

For example, see: Petit, J. R., Jouzel, J., Raynaud, D., Barkov, N.I., Barnola, J.-M., Basile, I., Bender, M., Chappellaz, J., Davisk, M., Delaygue, G., Delmotte, M., Kotlyakov, V.M., Legrand, M., Lipenkov, V.Y., Lorius, C., Pepin, L., Ritz, C., Saltzman, E., Steinenard, M. (1999) Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica. *Nature* **399**, p. 429-436; Siegenthaler, U., Stocker, T. F., Monnin, E., Luthi, D., Schwander, J., Stauffer, B., et al. (2005). Stable carbon cycle-climate relationship during the late Pleistocene. *Science*, **310**(5752), 1313-1317.

- The Earth's climate has been pretty much the same for millions of years [false]

For example, see: Matson, P.A., Dietz, T., Abdalati, W., Busalacchi, Jr., A.J., Caldeira, K., Corell, R.W., DeFries, R.S., Fung, I.Y., Gaines, S., Hornberger, G.M., Lemos, M.C., Moser, S.C., Moss, R.H., Parson, E.A., Ravishankara, A.R., Schmitt, R.W., Turner, II, B.L., Washington, W.M., Weyant, J.P., Whelan, D.A. (2010) Advancing the science of climate change. National Academies Press, Washington, D.C., p. 157; Zachos, J., Pagani, M., Sloan, L., Thomas, E., Billups, K. (2001) Trends, Rhythms, and Aberrations in Global Climate 65 Ma to Present. *Science* **292**(5517) 686-693; IPCC (2007) *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)], p. 449.

- The Earth's climate is colder now than it has ever been before [false]

For example, see: Matson, P.A., Dietz, T., Abdalati, W., Busalacchi, Jr., A.J., Caldeira, K., Corell, R.W., DeFries, R.S., Fung, I.Y., Gaines, S., Hornberger, G.M., Lemos, M.C., Moser, S.C., Moss, R.H., Parson, E.A., Ravishankara, A.R., Schmitt, R.W., Turner, II, B.L., Washington, W.M., Weyant, J.P., Whelan, D.A. (2010) Advancing the science of climate change. National Academies Press, Washington, D.C., p. 157; IPCC (2007) *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)], p. 449.

**Q14. The average temperature of the Earth's surface is currently about 58 degrees Fahrenheit. What do you think the average temperature of the Earth's surface was during the last ice age? [Best answer: between 46 and 51 degrees Fahrenheit]**

For example, see: NOAA (2009) State of the climate: Global analysis, Annual 2009. <http://www.ncdc.noaa.gov/sotc/?report=global&year=2009&month=13>; Jansen, E., J. Overpeck, K.R. Briffa, J.-C. Duplessy, F. Joos, V. Masson-Delmotte, D. Olago, B. Otto-Bliesner, W.R. Peltier, S. Rahmstorf, R. Ramesh, D. Raynaud, D. Rind, O. Solomina, R. Villalba and D. Zhang, 2007: Palaeoclimate. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 451.

**Q15. People disagree about how the climate system works. The five pictures below illustrate five different perspectives. Each picture depicts the Earth's climate system as a ball balanced on a line, yet each one has a different ability to withstand human-caused global warming. Which one of the five pictures best represents your understanding of how the climate system works? (images randomized) [Best answer: Threshold]**

At different times or spatial scales the climate system can exhibit each of these behaviors, but the best of these five options is probably the Threshold model. For example, see: National Research Council (U.S.). Committee on Abrupt Climate Change. (2002). Abrupt climate change: Inevitable surprises, p. 12.

**Q16. Which of the following are “fossil fuels”? (order of items randomized) [Correct answers: coal, oil, and natural gas. Incorrect answers: wood, solar energy, and hydrogen.]**

For example, see: U.S. Department of Energy (2008) How fossil fuels were formed. [http://www.fossil.energy.gov/education/energylessons/coal/gen\\_howformed.html](http://www.fossil.energy.gov/education/energylessons/coal/gen_howformed.html)

**Q17. The energy in fossil fuels originally came from: (order of items randomized) [Correct answers: photosynthesis by plants over millions of years and the sun. Incorrect answers: the fossilized remains of dinosaurs and uranium in the earth.]**

For example, see: U.S. Department of Energy (2008) How fossil fuels were formed. [http://www.fossil.energy.gov/education/energylessons/coal/gen\\_howformed.html](http://www.fossil.energy.gov/education/energylessons/coal/gen_howformed.html)

**Q18. What gas is produced by the burning of fossil fuels? (order of items randomized)**  
[Correct answer: carbon dioxide]

For example, see: Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland, 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 135.

**Q19. To the best of your knowledge, roughly how much carbon dioxide was in the atmosphere in the year 1850? [Correct answer: 290 parts per million]**

For example, see: Carbon Dioxide Information Analysis Center. Frequently asked global change questions. <http://cdiac.ornl.gov/pns/faq.html>

**Q20. Roughly how much carbon dioxide is in the atmosphere today? [Correct answer: 390 parts per million]**

For example, see: Tans, P. (2010) Recent Global CO<sub>2</sub>. NOAA/ESRL, [www.esrl.noaa.gov/gmd/ccgg/trends](http://www.esrl.noaa.gov/gmd/ccgg/trends).

**Q21. Which picture best represents your understanding of how the amount of carbon dioxide in the atmosphere has changed over the past 500 years? [Correct answer: an exponential increase]**

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p. 14; Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland, 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 135.

**Q22a. If we were to stop burning fossil fuels today, the amount of carbon dioxide in the atmosphere would decrease almost immediately. [false]**

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p. 15; IPCC, 2007: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)], p. 824-825; Solomon S, Plattner G-K, Knutti R, Friedlingstein P. 2009. Irreversible climate change due to carbon dioxide emissions. *Proc Natl Acad Sci U S A* 106: 1704–1709.

**Q22b. If we were to stop burning fossil fuels today, global warming would stop almost immediately. [false]**

For example, see: IPCC Climate Change 2007: Synthesis Report, p. 46; U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p. 15.

**Q23. On average, how long does carbon dioxide stay in the atmosphere once it has been emitted? [Best answers: a hundred years or a thousand years]**

For example, see: Archer, D., Eby, M., Brovkin, V., Ridgwell, A., Cao, L., Mikolajewicz, U., et al. (2009). Atmospheric Lifetime of Fossil Fuel Carbon Dioxide. *Annual Review of Earth and Planetary Sciences*, 37, 117-134; IPCC, 2007: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)], p. 824-825; Solomon S, Plattner G-K, Knutti R, Friedlingstein P. 2009. *Irreversible climate change due to carbon dioxide emissions*. *Proc Natl Acad Sci U S A* 106: 1704–1709.

**Q24. Which of the following countries emits the largest total amount of carbon dioxide? (order of items randomized) [Correct answer: China]**

For example, see: Boden, T.A., G. Marland, and R.J. Andres. 2010. Global, Regional, and National Fossil-Fuel CO<sub>2</sub> Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001\_V2010.

**Q25. Which of the following countries emits the most carbon dioxide per person? (order of items randomized) [Correct answer: the United States]**

For example, see: Boden, T.A., G. Marland, and R.J. Andres. 2010. Global, Regional, and National Fossil-Fuel CO<sub>2</sub> Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001\_V2010.

**Q26. How much does each of the following contribute to global warming? (order of items randomized) [Significant contributors to global warming: cars and trucks, burning fossil fuels for heat and electricity, deforestation, cows. Minor or non-contributors to global warming: the hole in the ozone layer, toxic wastes, aerosol spray cans, nuclear power plants<sup>7</sup>, volcanic eruptions, the sun, acid rain, the space program]**

For example, see: Hegerl, G.C., F. W. Zwiers, P. Braconnot, N.P. Gillett, Y. Luo, J.A. Marengo Orsini, N. Nicholls, J.E. Penner and P.A. Stott, 2007: Understanding and

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<sup>7</sup> Although nuclear power generation does not emit carbon dioxide, there are fossil fuel intensive activities associated with the full lifecycle of nuclear power plants, including nuclear power plant construction, operation, the mining and milling of uranium, and power plant decommissioning. For example, see: Sovacool, B.K. (2008). Valuing the greenhouse gas emissions from nuclear power: A critical survey. *Energy Policy*, 36, 2940– 2953.

Attributing Climate Change. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 702-703; Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007). B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds) Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA; Steinfeld, H., Gerber, P. (2006). Livestock's long shadow: environmental issues and options. Rome: Food and Agriculture Organization of the United Nations; Morgan, G. and Smuts, T. (1994) Global warming and climate change: Common misconceptions about climate change. Carnegie Mellon University, Department of Engineering and Public Policy. <http://www.gcrio.org/gwcc/misconceptions.html>; Lean, Judith L. 2010. Cycles and trends in solar irradiance and climate. *Wiley Interdisciplinary Reviews: Climate Change*. Vol 1, Issue 1. pp 111-122. Dec 22, 2009. doi:10.1002/wcc.018; Kempston, W. (1991). Lay Perspectives on Global Climate Change. *Global Environmental Change-Human and Policy Dimensions*, 1, 183-208; Bostrom, A., Morgan, M. G., Fischhoff, B., & Read, D. (1994). What do People Know About Global Climate-Change. 1. Mental Models. *Risk Analysis*, 14, 959-970; Read, D., Bostrom, A., Morgan, M. G., Fischhoff, B., & Smuts, T. (1994). What do People Know About Global Climate-Change. 2. Survey Studies of Educated Laypeople. *Risk Analysis*, 14, 971-982.

**Q27. Of the following, which one do you think contributes most to global warming?**  
[Correct answer: burning fossil fuels for heat and electricity]

For example, see: IPCC, 2007: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)], p. 36.

**Q28. The average temperature of the Earth's surface is currently 58 degrees Fahrenheit. What temperature do you think it was 150 years ago? [Correct answer: between 56 to 57 degrees Fahrenheit]**

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p. 17; IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 5; Jones, P., New, M. Parker, D., Martin, S., and Rigor I., (1999) Surface air temperature and its changes over the past 150 years. *Reviews of Geophysics*, 37(2), 173-199.

**Q29. The average temperature of the Earth's surface is currently 58 degrees Fahrenheit. If no additional actions are taken to reduce global warming, what temperature do you think it will be by the year 2020? [Unknown as it depends on future choices and events, but IPCC estimates approximately 58.4° F]**

For example, see: IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 12.

**Q30. The average temperature of the Earth's surface is currently 58 degrees Fahrenheit. If no additional actions are taken to reduce global warming, what temperature do you think it will be by the year 2050? [Unknown as it depends on future choices and events, but IPCC estimates between 60 and 61° F]**

Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver and Z.-C. Zhao, 2007: Global Climate Projections. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 749.

**Q31. Are each of the following statements definitely true, probably true, probably false, definitely false, or do you not know? (order of items randomized)**

- **Global warming will cause some places to get wetter, while others get drier [true]**

For example, see: Trenberth et al (2007). Observations: Surface and Atmospheric Climate Change. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon et al (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 238.

- **The decade from 2000 to 2009 was warmer than any other decade since 1850 [true]**

For example, see: Willett et al (2009). State of the Climate in 2009: Global Climate. *Bulletin of the American Meteorological Society*, 91 (7), S19.

- **Scientists can't predict the weather more than a few days in advance – they can't possibly predict the climate of the future [false]**

For example, see: Hansen et al (2006). Global temperature change. *PNAS*, 103, (39), 14288–14293; Hansen et al (2007). Climate simulations for 1880–2003 with GISS modelE. *Climate Dynamics*, 29, 661–696.

- **Global warming will increase crop yields in some places, and decrease it in others [true]**

For example, see: Easterling et al (2007) Food, fibre and forest products. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, p. 275.

- **Scientists' computer models are too unreliable to predict the climate of the future [false]**

For example, see: Hansen et al (2006). Global temperature change. *PNAS*, 103, (39), 14288–14293; Hansen et al (2007). Climate simulations for 1880–2003 with GISS modelE. *Climate Dynamics*, 29, 661-696.

- **In the 1970s, most scientists were predicting an ice age [false]**

For example, see: Peterson et al (2008). The Myth Of The 1970s Global Cooling Scientific Consensus. *Bulletin of the American Meteorological Society*, 89, 1325-1337.

- **The Earth's climate has changed naturally in the past, therefore humans are not the cause of global warming [false]**

For example, see: Forster et al (2007). Changes in Atmospheric Constituents and in Radiative Forcing. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 135.

- **Global warming will cause temperatures to increase by roughly the same amount in all countries [false]**

For example, see: Christensen et al (2007). Regional Climate Projections. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 850-851.

- **Any recent global warming is caused by the sun [false]**

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p. 20; Lockwood (2008). Recent changes in solar outputs and the global mean surface temperature. III. Analysis of contributions to global mean air surface temperature rise. *Proceedings of the Royal Society A*, 464, p. 1387.

- **The record snowstorms this winter in the eastern United States prove global warming is not happening [false]**

For example, see: Masters, J. (2010). Heavy snowfall in a warming world. The Weather Underground,  
<http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=1427>; Ritter, M. (2010) Experts: Cold snap doesn't disprove global warming. Associated Press, January 6, <http://abcnews.go.com/Technology/wireStory?id=9495864>; Chang, K. (2010) Feeling that cold wind? Here's why. New York Times, January 9, <http://www.nytimes.com/2010/01/10/weekinreview/10chang.html>; Herring, D., Higgins, W., and Halpert, M. (2010) Can record snowstorms and global warming co-exist? NOAA ClimateWatch Magazine, <http://www.climatewatch.noaa.gov/2010/articles/can-record-snowstorms-global-warming-coexist>; Hoerling, M., Human, K., and Deluisi, B. (2010) Forensic meteorology solves the mystery of record snows, <http://www.climatewatch.noaa.gov/authors/martin-hoerling-katy-human-barb-deluisi-noaa-earth-system-research-laboratory>.

- **The Earth is actually cooling, not warming [false]**

For example, see: Trenberth et al (2007). Observations: Surface and Atmospheric Climate Change. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon et al (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 237.

- **Global warming is happening, but will be more beneficial than harmful**

Ultimately a value judgment. But see: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, UK, 982pp.; Stern, N. H., & Great Britain Treasury. (2007). *The economics of climate change: the Stern review*. Cambridge, UK; New York: Cambridge University Press.

### **Q32. Which of the following statements is correct? [Correct answer: Most of the glaciers on Earth are melting away]**

For example, see: IPCC, 2007: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)], p. 30; Pritchard, H. D., Arthern, R. J., Vaughan, D. G., & Edwards, L. A. (2009). Extensive dynamic thinning on the margins of the Greenland and Antarctic ice sheets. *Nature*, 461(7266), 971-975; Dyurgerov, M.B. and Meier, M.F. 2000. Twentieth century climate change: Evidence from small glaciers. *Proceedings of the National Academy of Sciences* 97(4):1406-1411; Williams, R.S., Jr., and Ferrigno, J.G., eds., 2010, Glaciers of Asia: U.S. Geological Survey Professional Paper 1386-F.

**Q33. Over the past 100 years, has the speed of glacier melting increased, decreased, or stayed the same? [Correct answer: Increased]**

For example, see: IPCC, 2007: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)], p. 109; Pritchard, H. D., Arthern, R. J., Vaughan, D. G., & Edwards, L. A. (2009). Extensive dynamic thinning on the margins of the Greenland and Antarctic ice sheets. *Nature*, 461(7266), 971-975; Rignot, E., & Kanagaratnam, P. (2006). Changes in the velocity structure of the Greenland ice sheet. *Science*, 311(5763), 986-990.

**Q34. Which of the following can cause global sea levels to rise?**

For the following five items, see: Bindoff, N.L., J. Willebrand, V. Artale, A, Cazenave, J. Gregory, S. Gulev, K. Hanawa, C. Le Quéré, S. Levitus, Y. Nojiri, C.K. Shum, L.D. Talley and A. Unnikrishnan, 2007: Observations: Oceanic Climate Change and Sea Level. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 409; National Snow and Ice Data Center (2009). The Contribution of the Cryosphere to Changes in Sea Level. [http://nsidc.org/sotc/sea\\_level.html](http://nsidc.org/sotc/sea_level.html); Shepherd, A., Wingham, D., Wallis, D., Giles, K., Laxon, S., & Sundal, A. V. (2010). Recent loss of floating ice and the consequent sea level contribution. *Geophysical research letters*, 37.

- **Melting of land ice in Antarctica [true]**
- **Melting of sea ice on the Arctic Ocean [true]**
- **Melting of mountain glaciers [true]**
- **Warmer ocean temperatures [true]**
- **Increased evaporation [false]**

**Q35. Of the causes you selected, which one has contributed the most to sea level rise so far? [Best answer among all causes: Warmer ocean temperatures]**

For example, see: National Snow and Ice Data Center (2009). The Contribution of the Cryosphere to Changes in Sea Level. [http://nsidc.org/sotc/sea\\_level.html](http://nsidc.org/sotc/sea_level.html)

**Q36. How much do scientists estimate that global sea levels rose from 1900 to 2000? [Correct answer: 6-9 inches]**

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p.18; Bindoff, N.L., J. Willebrand, V. Artale, A, Cazenave, J. Gregory, S. Gulev, K. Hanawa, C. Le Quéré, S. Levitus, Y. Nojiri, C.K. Shum, L.D. Talley and A. Unnikrishnan, 2007: Observations: Oceanic Climate Change and Sea Level. In:

*Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 409; Church, J.A. & White, N.J. (2006). A 20th century acceleration in global sea-level rise. *Geophysical Research Letters*, 33, L01602 .

**Q37. If no additional actions are taken to reduce global warming, how much do you think global sea levels will rise by the year 2100? [Unknown answer, but IPCC 2007 estimated between 8 inches and 2 feet; newer estimates 3 to 4 feet]**

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p. 25; Meehl, G. A. *et al.* in *IPCC Climate Change 2007: The Physical Science Basis* (eds Solomon, S. *et al.*) 747–845 (Cambridge Univ. Press, 2007); Rahmstorf, S. A semi-empirical approach to projecting future sea-level rise. *Science* 315, 368–370 (2007); Pfeffer, W. T., Harper, J. T. & O'Neal, S. Kinematic constraints on glacier contributions to 21st century sea-level rise. *Science* 321, 1340–1343 (2008).

**Q39. Which of the following causes coral bleaching? (order of items randomized)** [Correct answer: Warmer ocean temperatures]

For example, see: Hoegh-Guldberg O, Mumby PJ, Hooten AJ, Steneck RS and others (2007) Coral reefs under rapid climate change and ocean acidification. *Science* 318:1737–1742; Douglas AE (2003) Marine Pollution Bulletin 46:385–392.

**Q41. Which of the following causes ocean acidification? (order of items randomized)** [Correct answer: Absorption of carbon dioxide by the ocean]

For example, see: U.S. Global Change Research Program (2009) Global Climate Change Impacts in the United States. p.17; Caldeira, K.; Wickett, M.E. (2003). "Anthropogenic carbon and ocean pH". *Nature* 425 (6956): 365–365. doi:[10.1038/425365a](https://doi.org/10.1038/425365a); Orr, James C.; *et al.* (2005). "Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms". *Nature* 437 (7059): 681–686. doi:[10.1038/nature04095](https://doi.org/10.1038/nature04095); Hoegh-Guldberg O, Mumby PJ, Hooten AJ, Steneck RS and others (2007) Coral reefs under rapid climate change and ocean acidification.

**Q42. How much do you think each of the following actions would reduce global warming if they were done worldwide? (order of items randomized)**

For the following ten items, for example, see: IPCC, 2007: *Climate Change 2007: Mitigation of Climate Change: Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds.)]; America's Climate Choices: National Research Council (2010) Limiting the Magnitude of Future Climate Change, [http://books.nap.edu/openbook.php?record\\_id=12785&page=R1](http://books.nap.edu/openbook.php?record_id=12785&page=R1); Stern, N. H., & Great Britain. Treasury. (2007). *The economics of climate change: the Stern review*. Cambridge, UK; New York: Cambridge University Press.

- **Switching from fossil fuels to renewable energy [true]**
- **Planting trees [true]**
- **Reducing tropical deforestation [true]**
- **Switching from gasoline to electric cars [true]**
- **Driving less [true]**
- **Increasing public transportation [true]**
- **Switching from regular to compact fluorescent light bulbs [true]**
- **Insulating buildings [true]**
- **Switching from fossil fuels to nuclear power [true]**
- **Placing a large tax on all fossil fuels [true]**
- **Having at most 2 children per family [true]**

For example, see: Murtaugh, P.A. & Schlax, M.G. (2009). Reproduction and the carbon legacies of individuals. *Global Environmental Change*, 19, 14-20.

- **Stop eating beef [true]**

For example, see: Stehfest, E. et al (2009). Climate benefits of changing diet. *Climatic Change*, 95, 83-102; Friel, S. et al (2009). Public health benefits of strategies to reduce greenhouse-gas emissions: food and agriculture. *The Lancet*, 374, 2016-2025.

- **Reducing toxic waste [false]**

For example, see: Bostrom, A., M.G. Morgan, B. Fischhoff and D. Read (1994). What do people know about global climate change? *Risk Analysis*, 14(6), 959-970.

- **Banning aerosol spray cans [false]**
- **Stop punching holes in the ozone layer with rockets [false]**

For example, see: Kempton, W. (1991). Lay Perspectives on Global Climate Change. *Global Environmental Change-Human and Policy Dimensions*, 1, 183-208. Bostrom, A., Morgan, M. G., Fischhoff, B., & Read, D. (1994). What do People Know About Global Climate-Change. 1. Mental Models. *Risk Analysis*, 14, 959-970. Read, D., Bostrom, A., Morgan, M. G., Fischhoff, B., & Smuts, T. (1994). What do People Know About Global Climate-Change. 2. Survey Studies of Educated Laypeople. *Risk Analysis*, 14, 971-982.

- **Fertilizing the ocean to make algae grow faster [uncertain]**

For example, see: Buesseler, K.O (2008). Ocean Iron Fertilization--Moving Forward in a Sea of Uncertainty. *Science*, 319, 162; Boyd, P. W., Jickells, T., Law, C. S., Blain, S., Boyle, E. A., Buesseler, K. O., et al. (2007). Mesoscale iron enrichment experiments 1993-2005: Synthesis and future directions. *Science*, 315(5812), 612-617.

- **Using airplanes to scatter dust high in the atmosphere [uncertain]**

For example, see: The Royal Society (2009). Geoengineering the climate: Science, governance and uncertainty. Available at: <http://royalsociety.org/geoengineering-the-climate/>; Crutzen, P. J. (2006). Albedo enhancement by stratospheric sulfur injections: A contribution to resolve a policy dilemma? *Climatic Change*, 77(3-4), 211-219; Robock, A., A. Marquardt, B. Kravitz, and G. Stenchikov (2009), Benefits, risks, and costs of stratospheric geoengineering, *Geophys. Res. Lett.*, 36, L19703, doi:10.1029/2009GL039209.

