

American Teens' Knowledge of Climate Change

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Executive Summary

American Teens' Knowledge of Climate Change reports results from a national study of what American teens in middle and high school understand about how the climate system works, and the causes, impacts and potential solutions to global warming.

This report describes how knowledge of climate change varies across both American teens and adults. Using a straight grading scale, 25 percent of teens received a passing grade (A, B, or C), compared to 30 percent of American adults. While knowledge levels vary, these results also indicate that relatively few teens have an in-depth understanding of climate change. Fifty-four percent of teens received a failing grade (F), compared to 46 percent of adults.

Understanding of Climate Change

In general, American teens know about the same or less than American adults about how the climate system works and the causes, consequences, and solutions of climate change. For example:

- 54% of teens say that global warming is happening, compared to 63% of adults;
- 35% of teens understand that most scientists think global warming is happening, compared to 39% of adults;
- 75% of teens understand that coal is a fossil fuel, compared to 80% of adults;
- 46% of teens understand that emissions from cars and trucks substantially contribute to global warming, compared to 49% of adults;
- 62% of teens say that switching from fossil fuels to renewable energy sources worldwide would reduce global warming a lot or some, compared to 63% of adults.

However, American teens have a better understanding than adults on a few important measures. For example:

- 57% of teens understand that global warming is caused mostly by human activities, compared to 50% of adults;
- 77% of teens understand that the greenhouse effect refers to gases in the atmosphere that trap heat, compared to 66% of adults;
- 52% of teens understand that carbon dioxide traps heat from the Earth's surface, compared to 45% of adults;
- 71% of teens understand that carbon dioxide is produced by the burning of fossil fuels, compared to 67% of adults.

Knowledge Gaps

This study also identified numerous gaps between expert and teen knowledge about climate change. For example, only:

- 7% of teens know how much carbon dioxide there is in the atmosphere today (approximately 390 parts per million);

- 17% of teens have heard of coral bleaching;
- 18% of teens have heard of ocean acidification.

Furthermore, for many knowledge questions American teens are also more likely than adults to provide a “Don’t know” response. For example:

- 34% of teens don’t know enough to say whether scientists think global warming is happening, compared to 17% of adults;
- 26% of teens don’t know that greenhouse gases in the atmosphere affect the average global temperature of the Earth, compared to 16% of adults;
- 34% of teens don’t know that past climate changes have played an important role in the advance or collapse of past human civilizations, compared to 23% of adults;

Common Misconceptions

This study also found important misconceptions leading many American teens to misunderstand the causes and therefore the solutions to climate change. For example, like adults, many teens confuse climate change and the hole in the ozone layer:

- 35% of teens believe that the hole in the ozone layer is a large contributor to global warming;
- 21% of teens believe that aerosol spray cans are a large contributor to global warming;
- 44% of teens believe that stopping rockets from punching holes in the ozone layer would reduce global warming.

However, American teens also recognize their limited understanding of the issue. Fewer than 1 in 5 say they are “very well informed” about how the climate system works or the different causes, consequences, or potential solutions to global warming, and only 27 percent say they have learned “a lot” about global warming from in school. Importantly, 70 percent of teens say they would like to know more about global warming.

Seventy-three percent of teens say they would turn to the Internet to learn more about global warming, compared to 61 percent of adults. Teens are less likely than adults to look to television programs or books or magazines for more information about global warming.

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 517 American teens (aged 13 to 17) and 1,513 adults, conducted June 24 through July 22, 2010. Households both with and without teens were randomly selected from the nationally representative online research panel of Knowledge Networks. The teen data comes only from those households with teens, while the adult data comes from all sampled households, including those with and without teens. Teen and adult samples were each separately weighted to correspond with US Census Bureau demographic parameters for the United States. The margin of sampling error for the teen data is plus or minus 4 percent, and plus or minus 2 percent for the adult data, 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 (✓). 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 American Teens

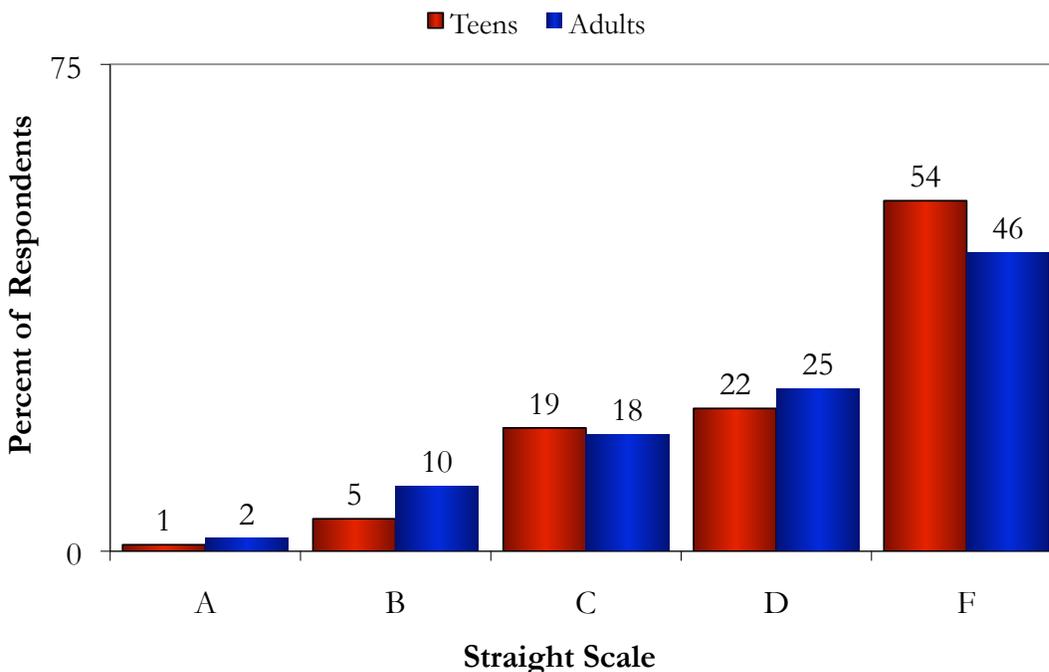
As a first-brush estimate of overall teen knowledge about climate change, a straight grading scale was constructed, using only those items for which there was a correct or best answer. To adjust for the difficulty of some items, only questions that were answered correctly by at least 25 percent of teens 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 75 individual questions. Each respondent was given a percentage score based on their total number of correct answers and 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). On this scale, 25 percent of teens received a passing grade (A, B, or C) indicating that relatively few American teens have an in-depth understanding of climate change. For comparison, the same 75 questions were used to grade American adults. On this scale, 30 percent of adults received a passing grade. 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 teens better understand.

It is also important to recognize that although some schools have started teaching about climate change, few teens have ever taken a formal course on the topic, 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 teens have absorbed from the mass media, their parents, and other sources. Further, many of these questions are outside the practical concerns of most teens, who don’t need to know about climate change in their daily life or in school, thus it is not surprising that they have devoted little effort to learning these details.

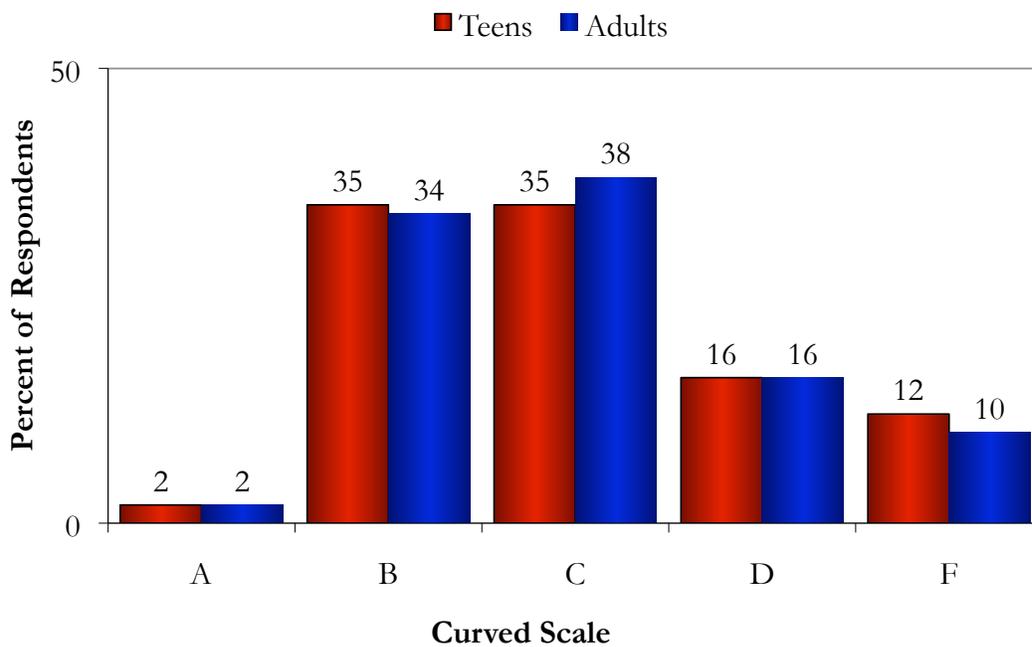
Nonetheless, many of these questions reveal important gaps in knowledge and common misconceptions about climate change and the earth system. These misconceptions lead some teens to doubt that climate change is happening or that human activities are a major contributor, to misunderstand the causes and therefore the solutions, and to be unaware of the risks. Thus many American teens lack some of the knowledge they will need to make informed decisions about climate change both now and in the future as students, workers, consumers, homeowners, and citizens.

Grading Teens' 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 (51%). Scores +/- 0.5 standard deviations from the mean (39% to 63%) 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 (64% to 87%) and D (15% to 38%) respectively. Finally, scores ranging from +/- 1.5 to 2.5 standard deviations from the mean were assigned the letter grades A (88% or higher) and F (14% or less) respectively. On this curved grading system, 72 percent of teens receive a passing grade. Note, however, that relatively few teens receive an A, even in this curved grading system. For comparison, a curved grading scale was also constructed for adults. Using this scale, 74 percent of adults receive a passing grade.

Grading Teens' Knowledge of Climate Change



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?

	Teens	Adults
Yes (✓)	54	63
No	16	19
Don't Know	30	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?

	Teens	Adults
Extremely sure	20	21
Very sure	31	35
Somewhat sure	46	39
Not at all sure	3	4
<i>N</i>	274	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?

	Teens	Adults
Extremely sure	18	18
Very sure	32	35
Somewhat sure	37	41
Not at all sure	12	6
<i>N</i>	80	366

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

	Teens	Adults
Caused mostly by human activities (√)	57	50
Caused by both human activities and natural changes (vol.)	4	6
Caused mostly by natural changes in the environment	26	35
None of the above because global warming isn't happening	11	7
Other	1	2
Don't know (vol.)	1	1

Q5. Which comes closer to your own view?

	Teens	Adults
Most scientists think global warming is happening (√)	35	39
Most scientists think global warming is not happening	4	6
There is a lot of disagreement among scientists about whether or not global warming is happening	27	38
Don't know enough to say	34	17

Q6. How worried are you about global warming?

	Teens	Adults
Very worried	11	16
Somewhat worried	32	39
Not very worried	31	26
Not at all worried	26	19

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

How the Earth's "climate system" works

	Teens	Adults
Very well informed	13	11
Fairly well informed	40	51
Not very well informed	32	33
Not at all informed	16	5

The different causes of global warming

	Teens	Adults
Very well informed	11	13
Fairly well informed	45	52
Not very well informed	30	31
Not at all informed	15	5

The different consequences of global warming

	Teens	Adults
Very well informed	13	14
Fairly well informed	43	52
Not very well informed	28	29
Not at all informed	16	5

Ways in which we can reduce global warming

	Teens	Adults
Very well informed	18	14
Fairly well informed	42	50
Not very well informed	24	30
Not at all informed	17	6

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

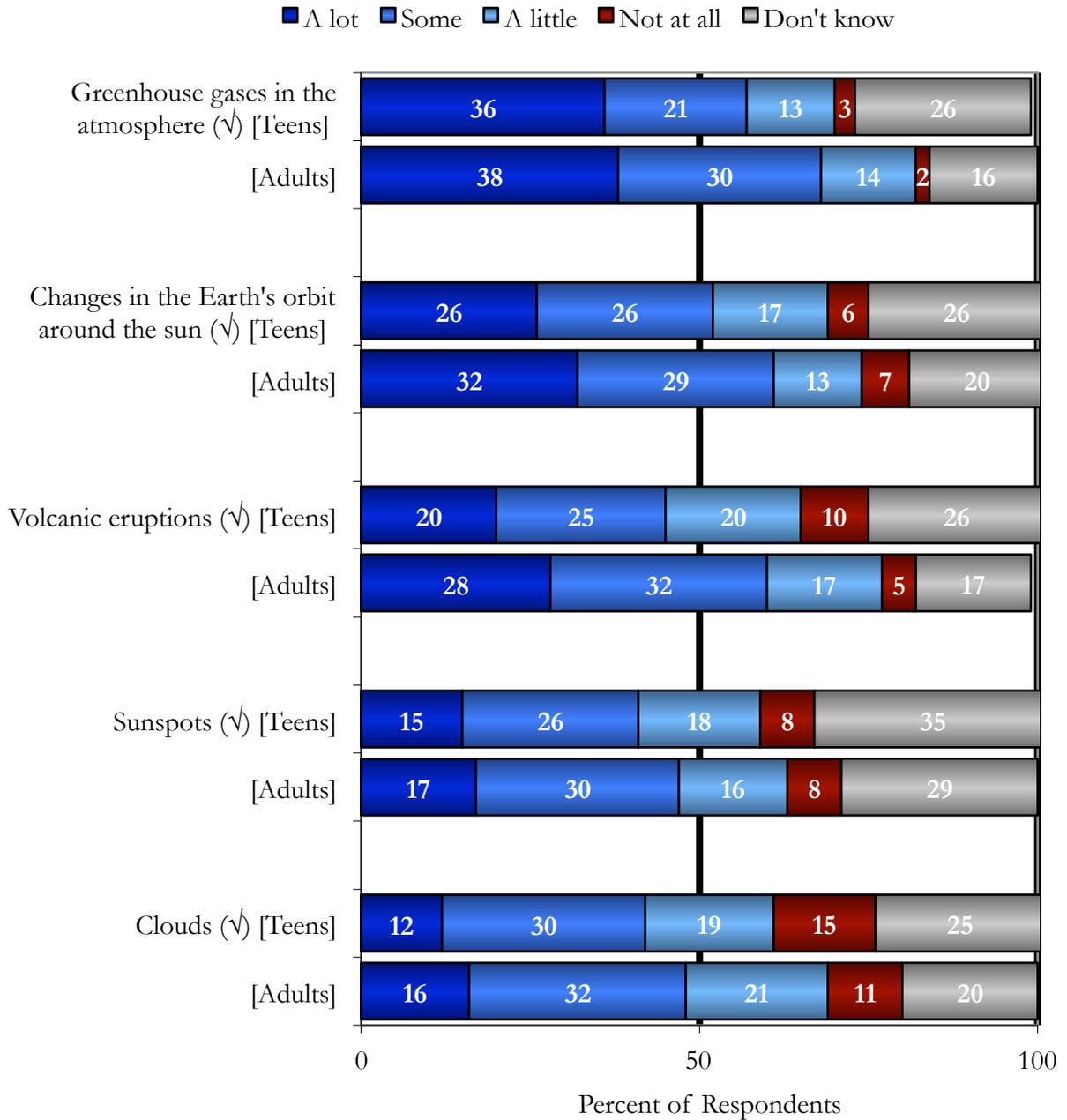
	Teens	Adults
Yes	69	87
No	32	13

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

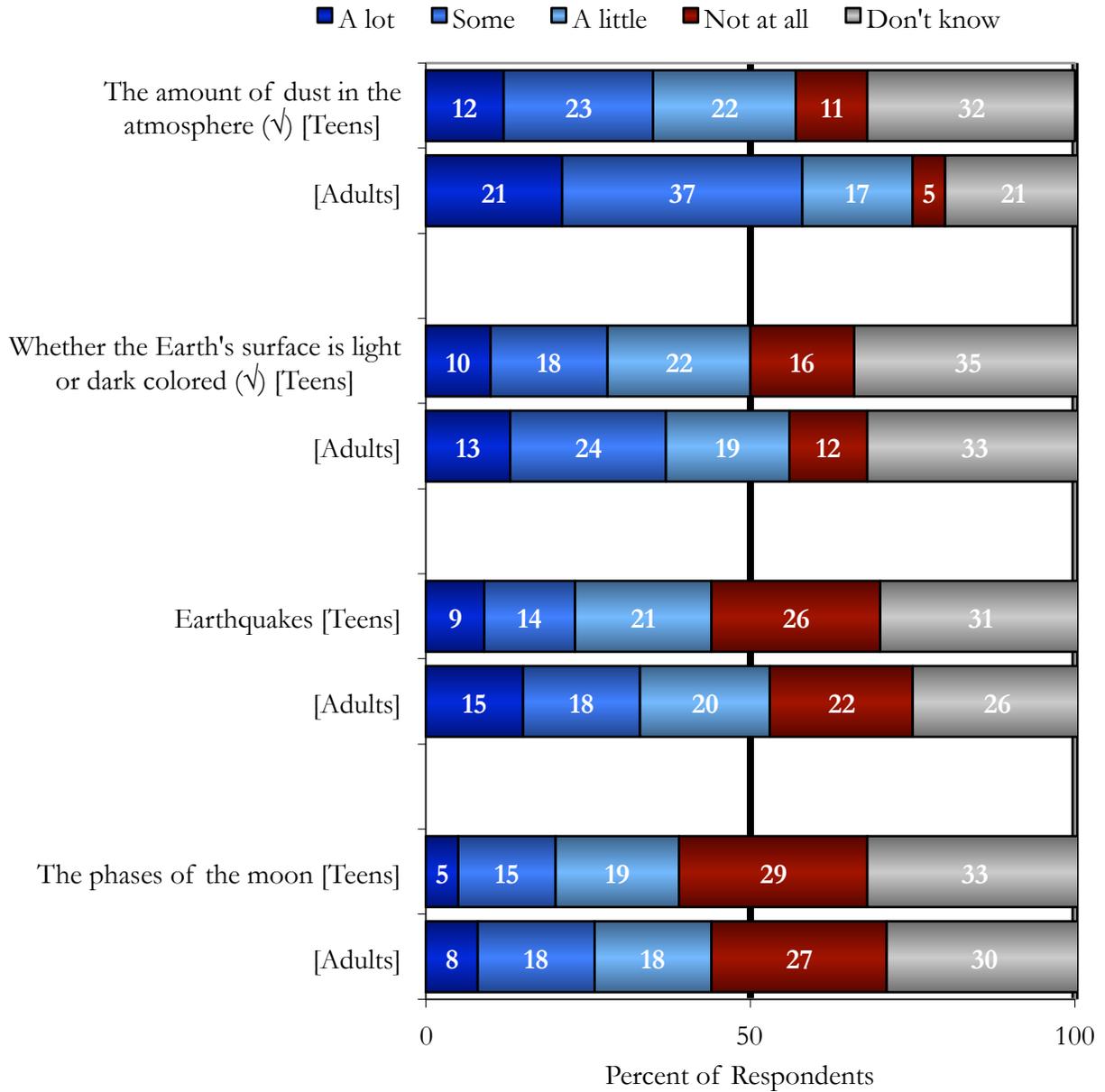
Q9. The “greenhouse effect” refers to: *(items randomized)*

	Teens	Adults
Gases in the atmosphere that trap heat (√)	77	66
The Earth’s protective ozone layer	11	21
Pollution that causes acid rain	1	1
How plants grow	2	3
Don’t know	8	10
<i>N</i>	<i>351</i>	<i>1738</i>

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

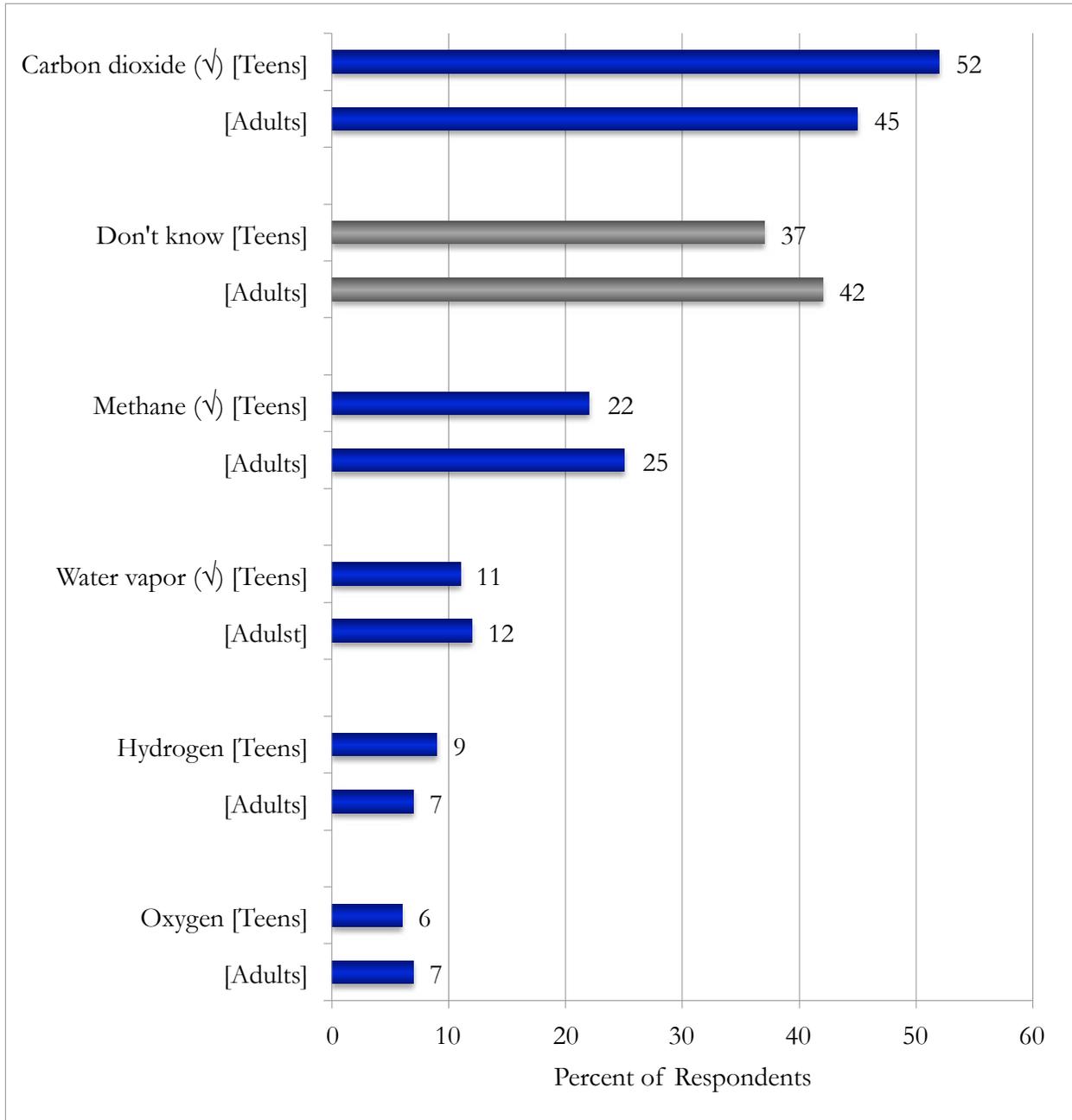


Q10 continued. How much can each of the following affect the average global temperature of the Earth? (*items randomized*)



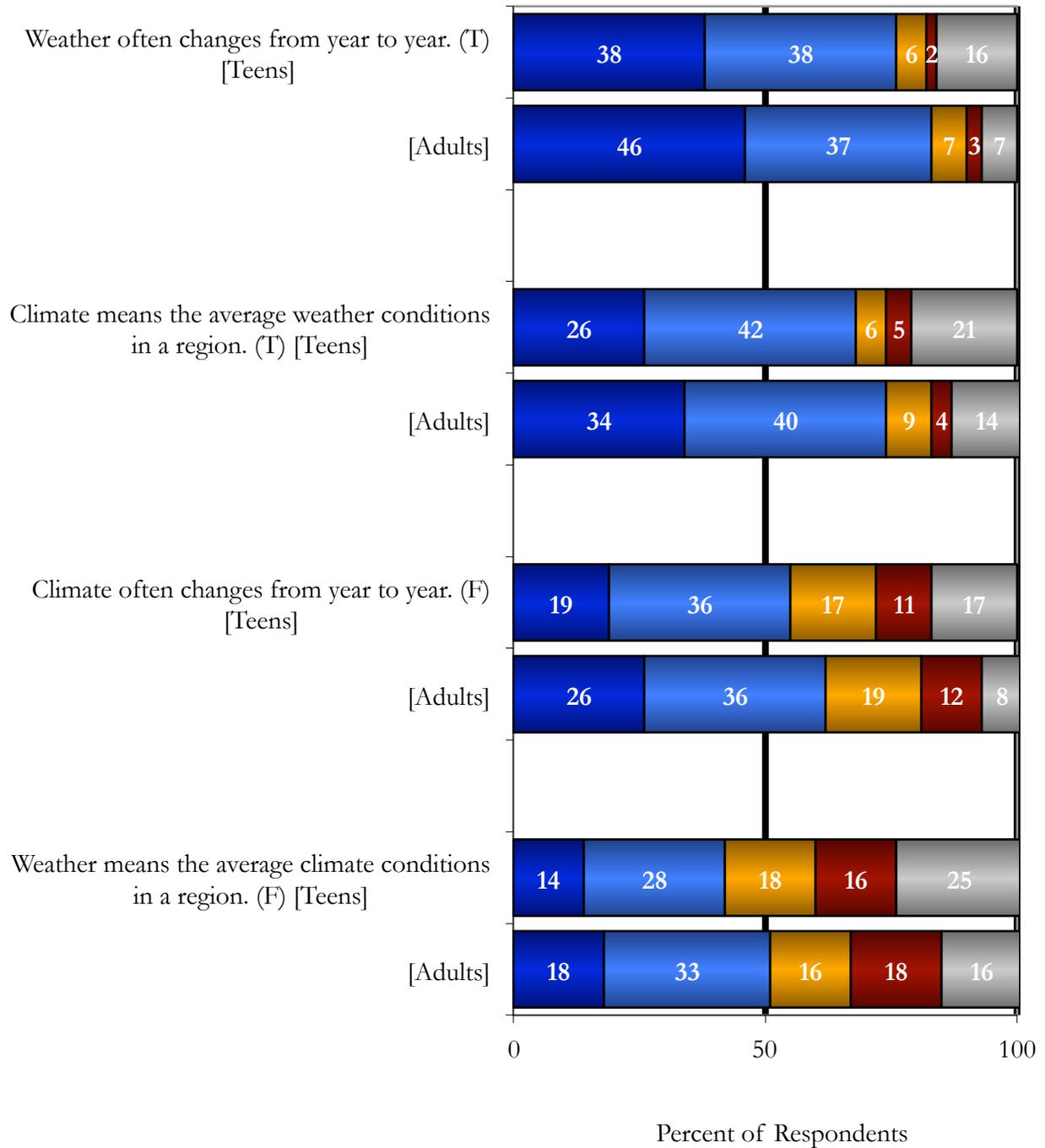
Q11. Which of the following gases in the atmosphere are good at trapping heat from the Earth's surface? (*items randomized*)

■ Selected ■ Don't know



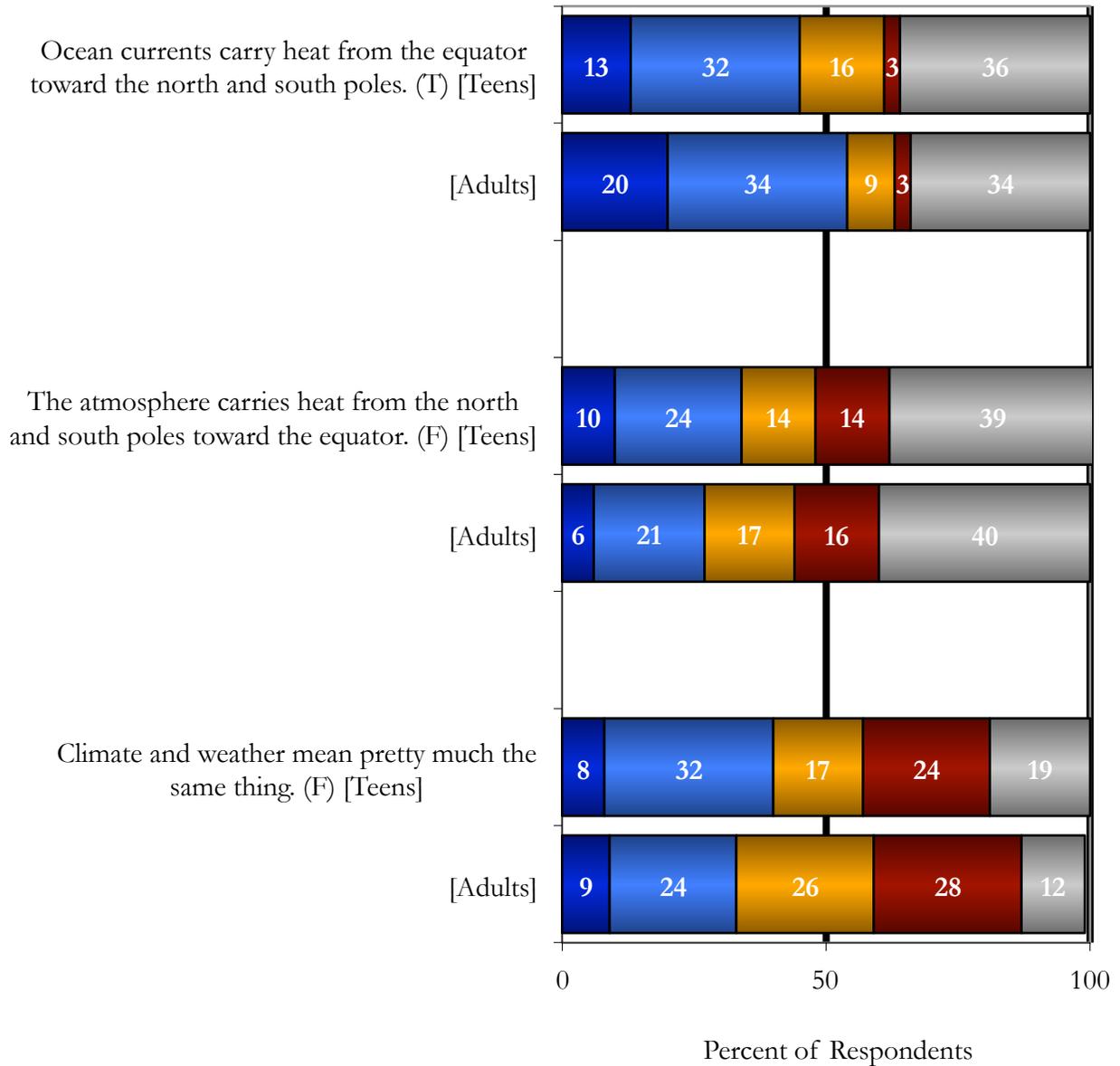
Q12. Are each of the following statements definitely true, probably true, probably false, definitely false, or you do not know? (*items randomized*)

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

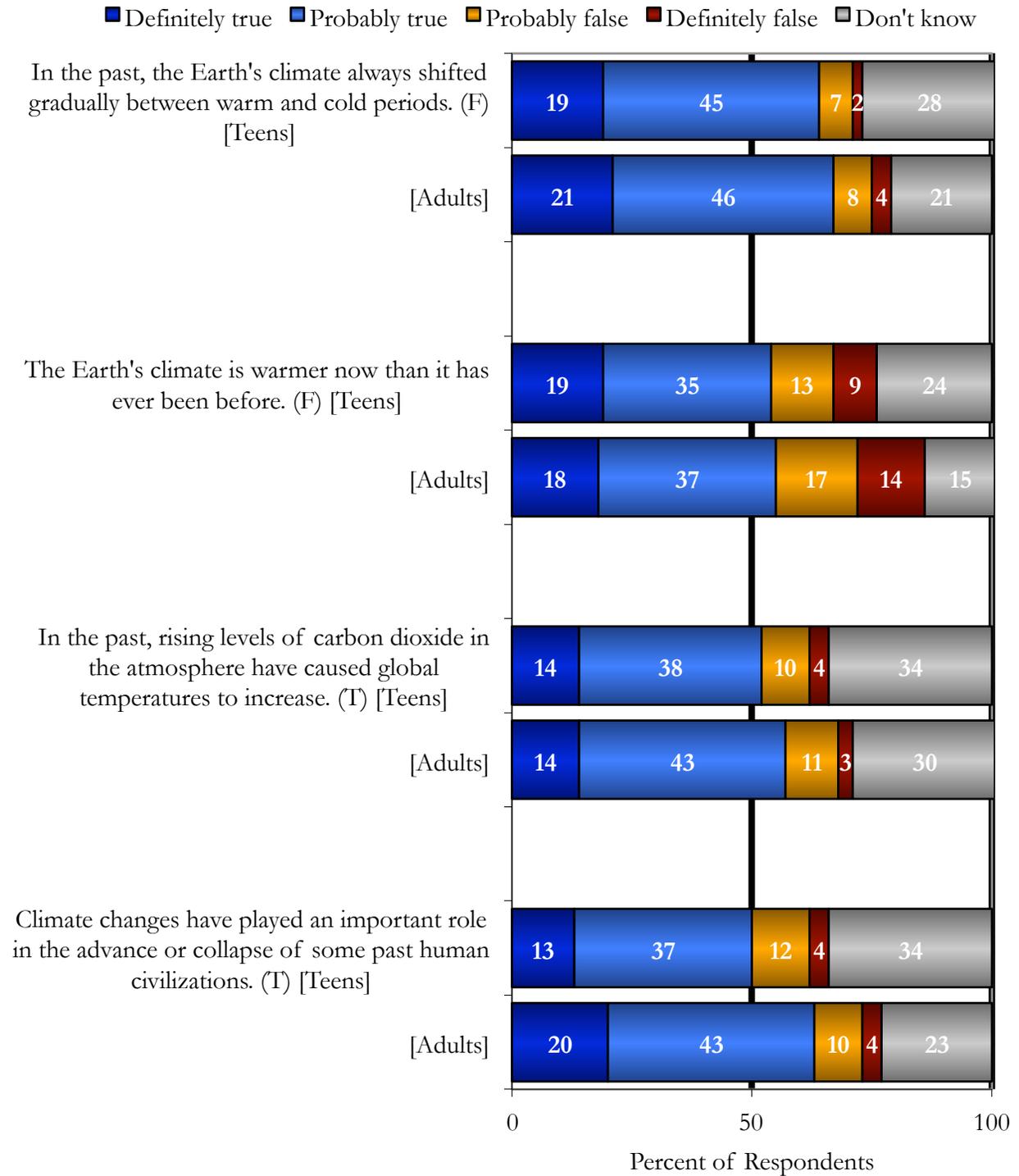


Q12 continued. Are each of the following statements definitely true, probably true, probably false, definitely false, or you do not know? (*items randomized*)

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

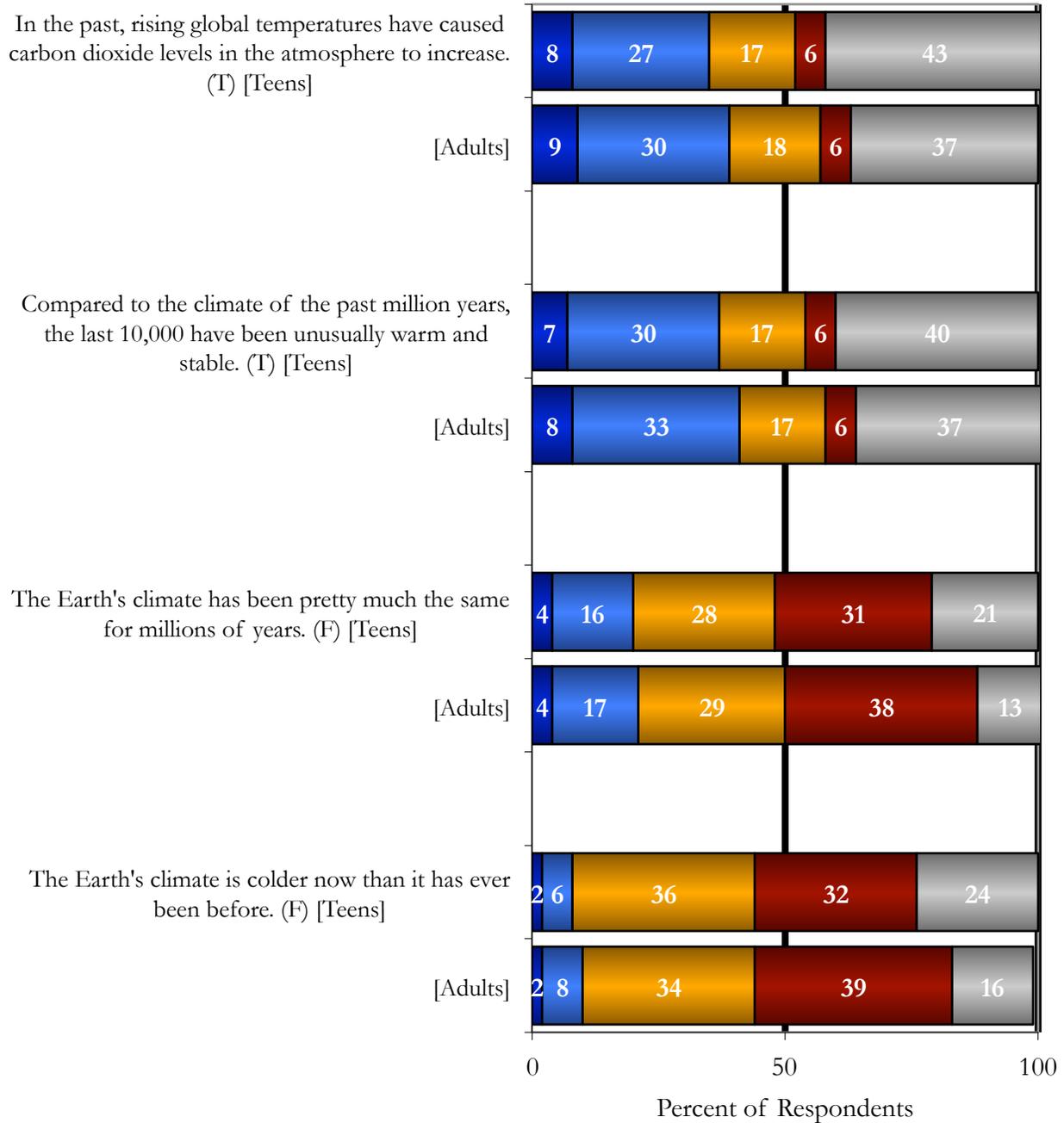


Q13. Are each of the following statements definitely true, probably true, probably false, definitely false or you do not know? (*items randomized*)



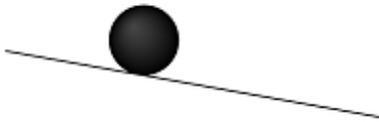
Q13 continued. Are each of the following statements definitely true, probably true, probably false, definitely false or you do not know? (*items randomized*)

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



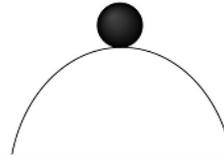
Q14. People disagree about how the climate system works. The five pictures below illustrate five different perspectives. Each picture depicts the Earth's climate system as a ball balanced on a line, yet each one has a different ability to withstand human-caused global warming. Which one of the five pictures best represents your understanding of how the climate system works? (*images randomized*)

Gradual



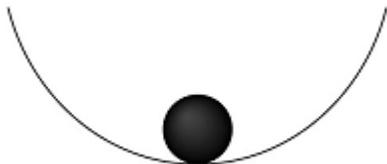
Earth's climate is slow to change. Global warming will gradually lead to dangerous effects.

Fragile



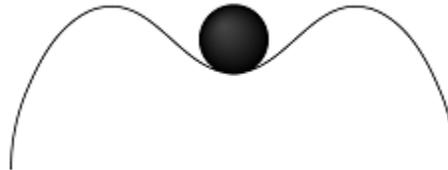
Earth's climate is delicately balanced. Small amounts of global warming will have abrupt and catastrophic effects.

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.

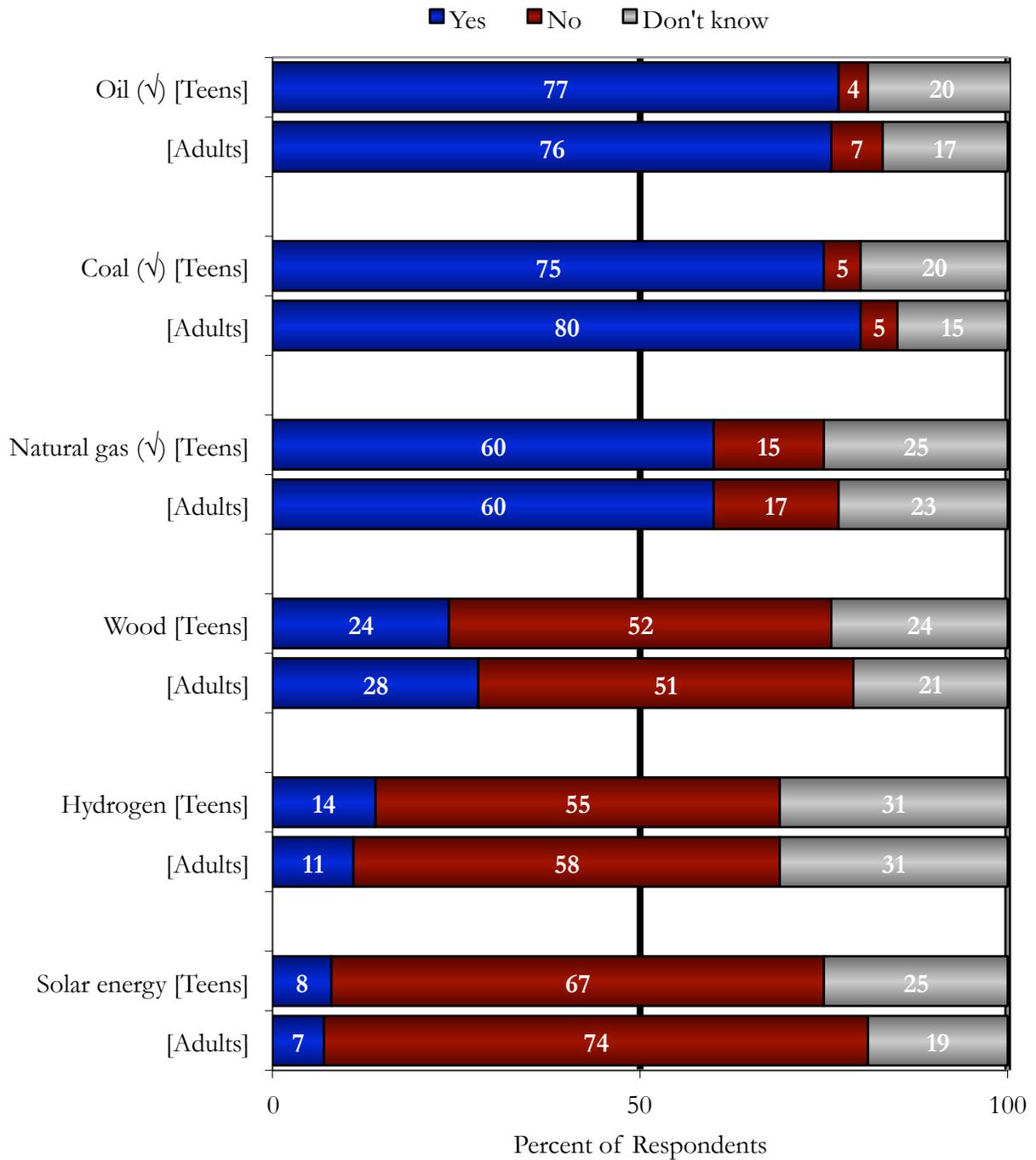
Random



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

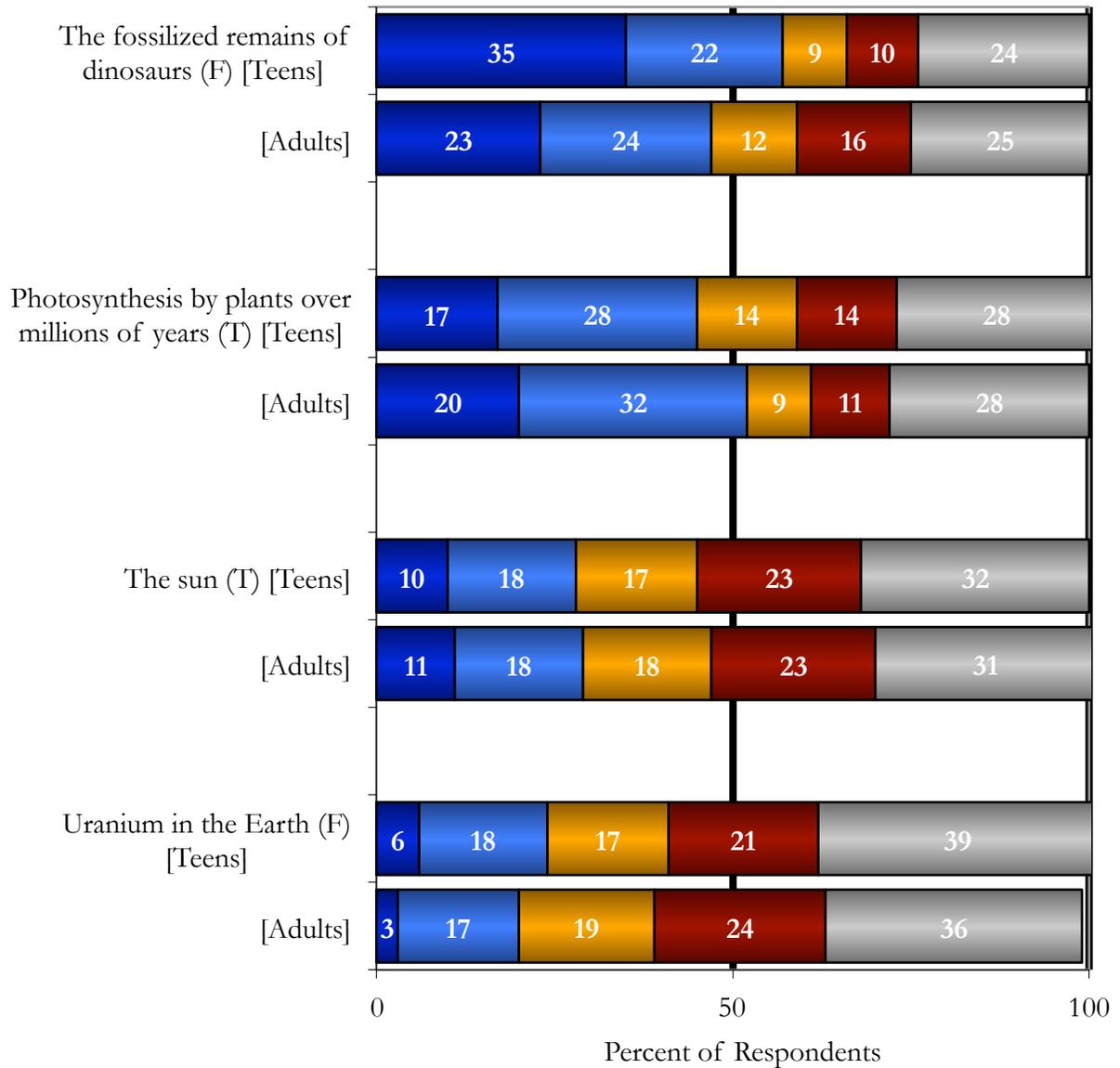
	Teens	Adults
Gradual	26	24
Fragile	8	11
Stable	11	10
Threshold (✓)	31	34
Random	23	21

Q15. Which of the following are “fossil fuels”? (*items randomized*)



Q16. The energy in fossil fuels originally came from: *(items randomized)*

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



Q17. What gas is produced by the burning of fossil fuels? (*items randomized*)

	Teens	Adults
Oxygen	1	2
Hydrogen	3	4
Helium	1	1
Carbon dioxide (✓)	71	67
Don't know	24	26

Q18. To the best of your knowledge, roughly how much carbon dioxide was in the atmosphere in the year 1850?

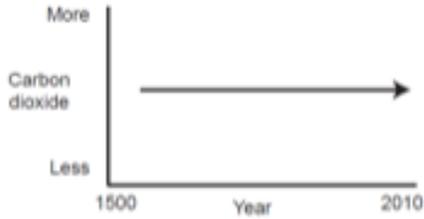
	Teens	Adults
150 parts per million	12	10
290 parts per million (✓)	8	6
350 parts per million	4	4
390 parts per million	1	2
450 parts per million	1	1
Don't know	74	78

Q19. Roughly how much carbon dioxide is in the atmosphere today?

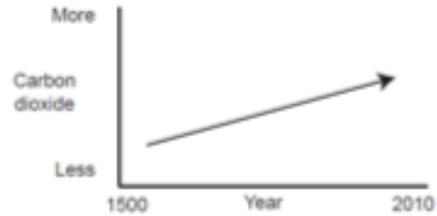
	Teens	Adults
150 parts per million	2	2
290 parts per million	5	3
350 parts per million	7	6
390 parts per million (✓)	7	7
450 parts per million	7	6
Don't know	73	76

Q20. Which picture best represents your understanding of how the amount of carbon dioxide in the atmosphere has changed over the past 500 years?¹

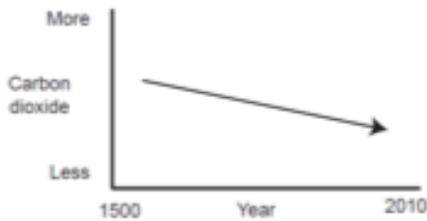
a) No change



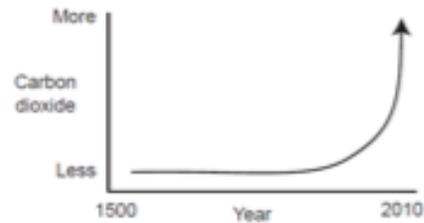
b) Linear increase



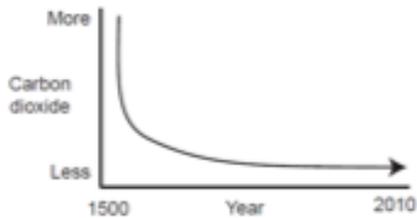
c) Linear decrease



d) Exponential increase



e) Exponential decrease



	Teens	Adults
a) No change	11	8
b) Linear increase	44	41
c) Linear decrease	6	7
d) Exponential increase (✓)	36	40
e) Exponential decrease	3	5

Q21a. If we were to stop burning fossil fuels today, the amount of carbon dioxide in the atmosphere would decrease almost immediately. (F)

	Teens	Adults
Definitely true	9	5
Probably true	36	32
Probably false	23	30
Definitely false	10	13
Don't know	22	20

¹ Labels not provided

Q21b. If we were to stop burning fossil fuels today, global warming would stop almost immediately. (F)

	Teens	Adults
Definitely true	4	2
Probably true	19	14
Probably false	34	37
Definitely false	20	25
Don't know	23	23

Q22. On average, how long does carbon dioxide stay in the atmosphere once it has been emitted?

	Teens	Adults
A few days	6	4
A few years	11	13
A hundred years (✓)	17	13
A thousand years (✓)	6	6
Don't know	60	64

Q23. Which of the following countries emits the largest total amount of carbon dioxide? (*items randomized*)

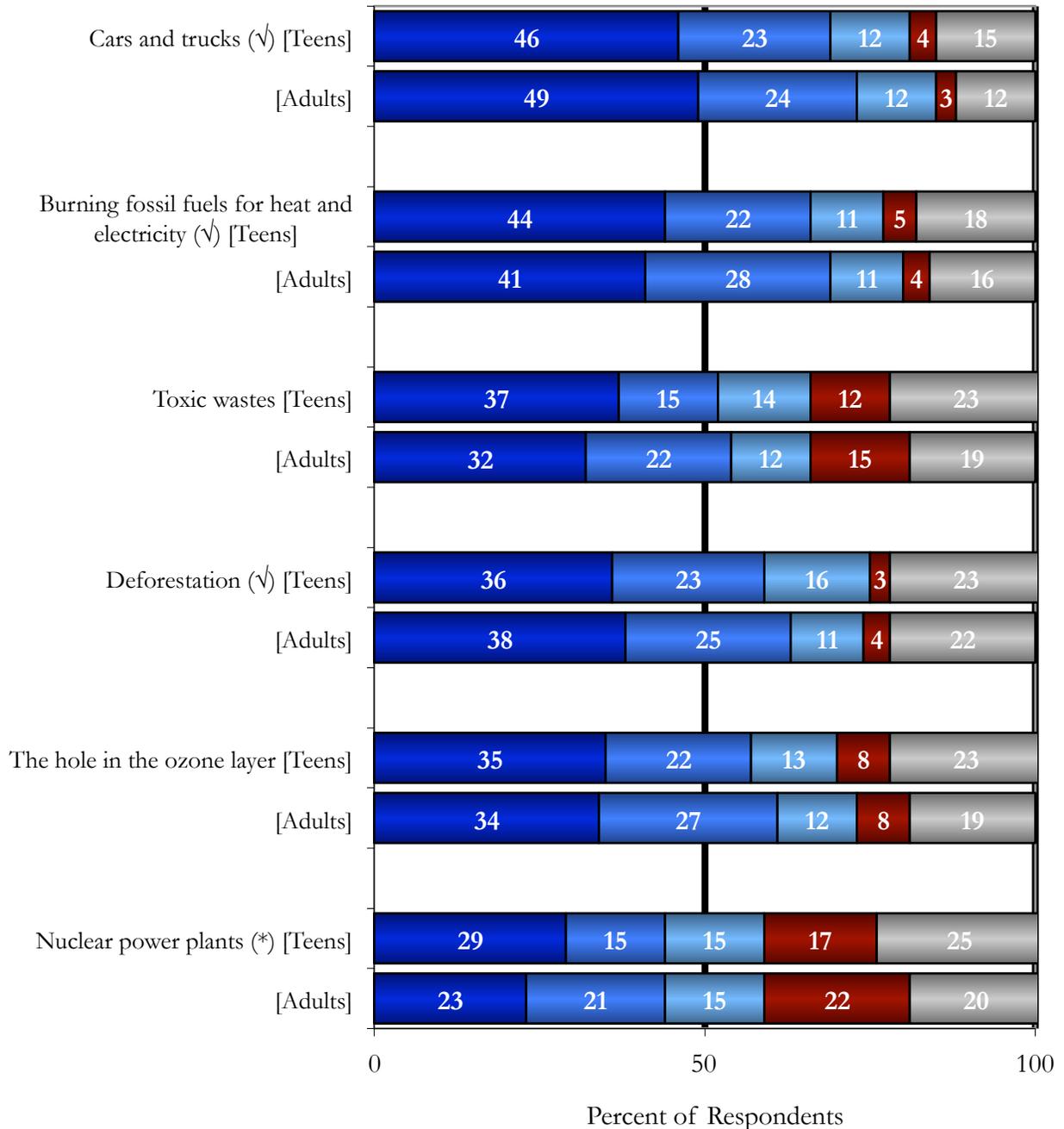
	Teens	Adults
United States	25	34
China (✓)	33	36
India	3	2
Germany	2	1
Japan	5	4
Don't know	31	24

Q24. Which of the following countries emits the most carbon dioxide **per person**? (*items randomized*)

	Teens	Adults
United States (✓)	39	42
China	19	18
India	3	4
Germany	1	1
Japan	4	5
Don't know	34	31

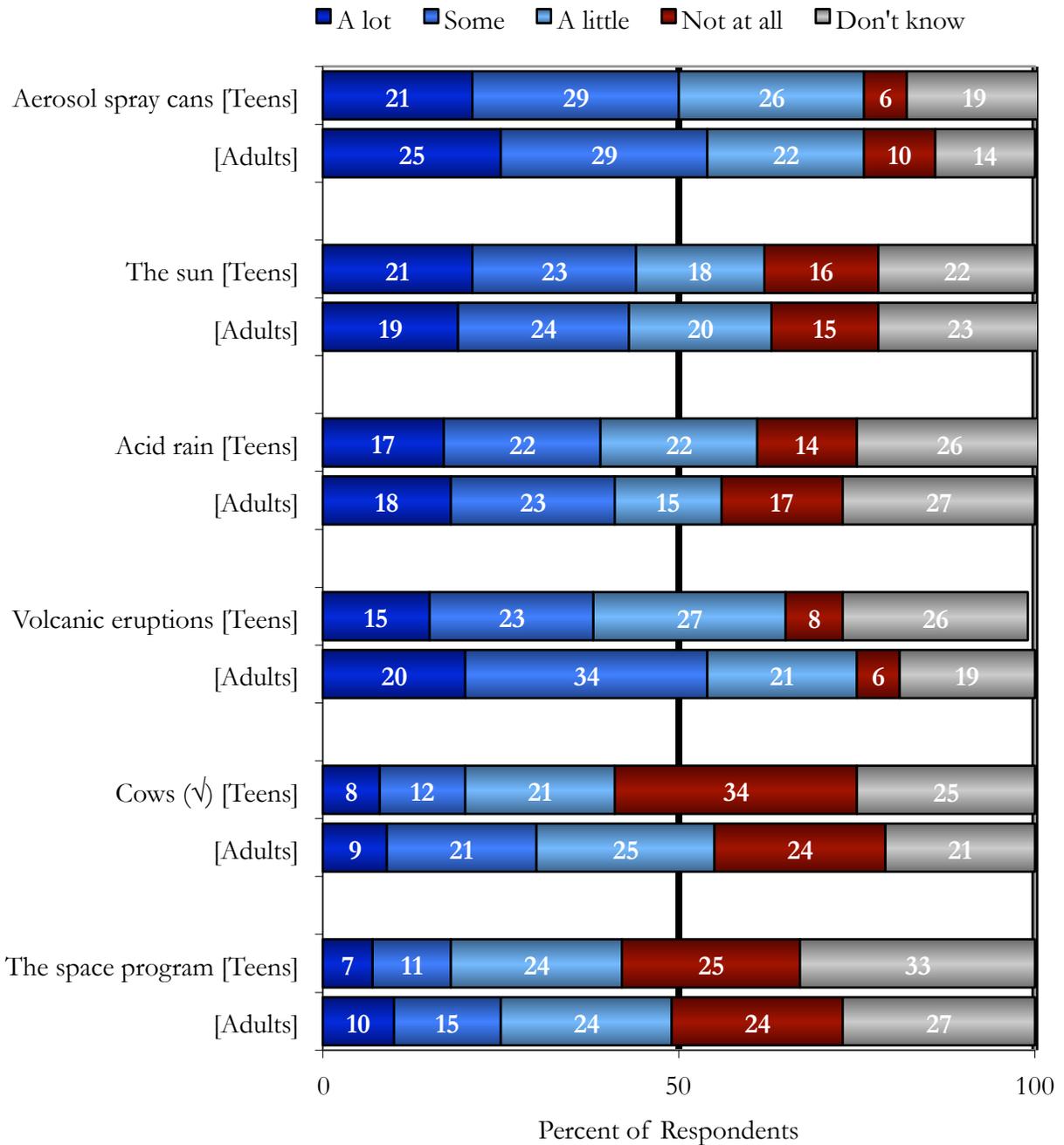
Q25. How much does each of the following contribute to global warming?² (*items randomized*)

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



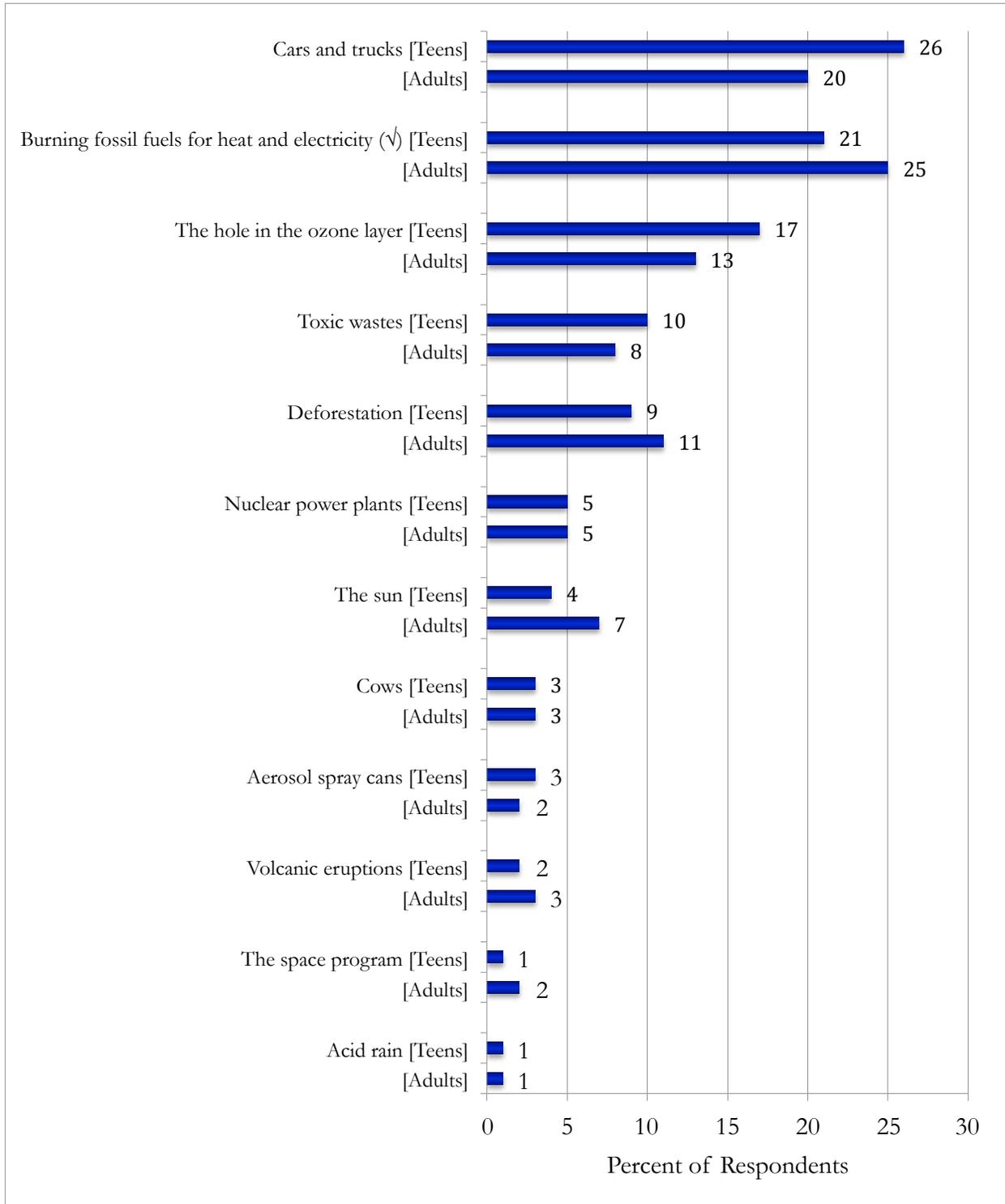
² Although nuclear power generation does not emit carbon dioxide, there are fossil fuel intensive activities associated with the full lifecycle of nuclear power plants, including nuclear power plant construction, operation, the mining and milling of uranium, and nuclear power plant decommissioning.

Q25 continued. How much does each of the following contribute to global warming? (*items randomized*)



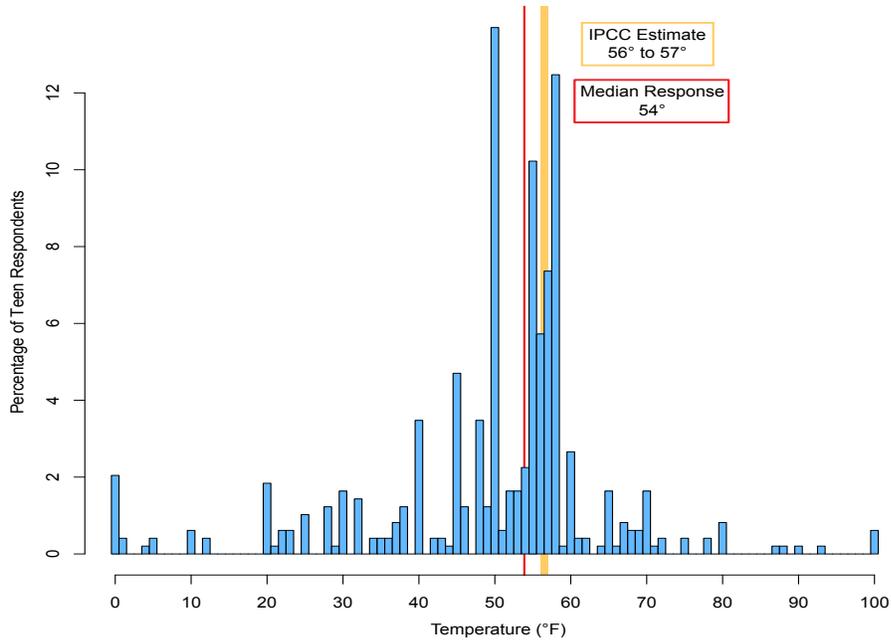
People who answered “a lot” or “some” to more than one answer in question 25 were asked the following question (n = 345).

Q26. Of the following, which one do you think contributes most to global warming?

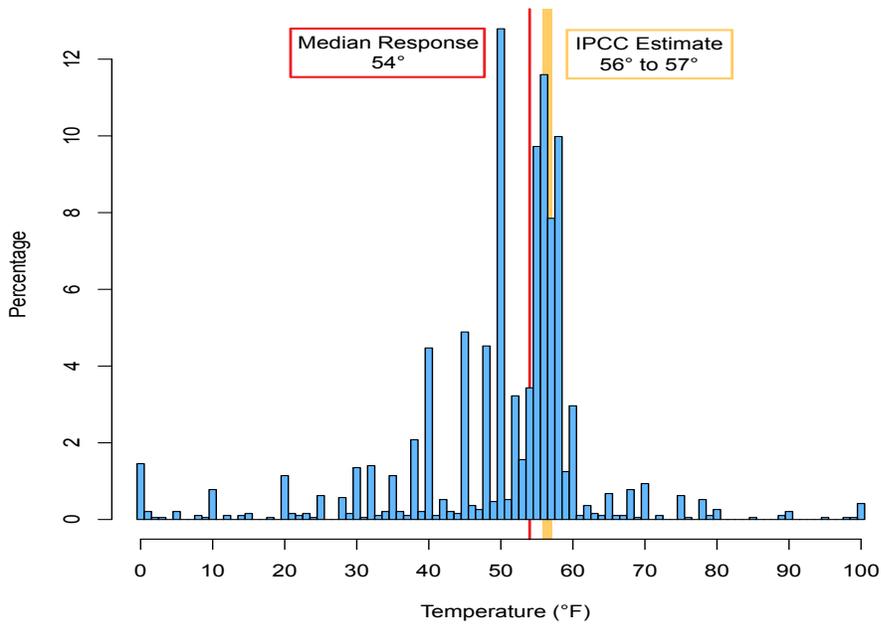


Q27. The average temperature of the Earth's surface is currently 58 degrees Fahrenheit. What temperature do you think it was **150 years ago**?

Teens

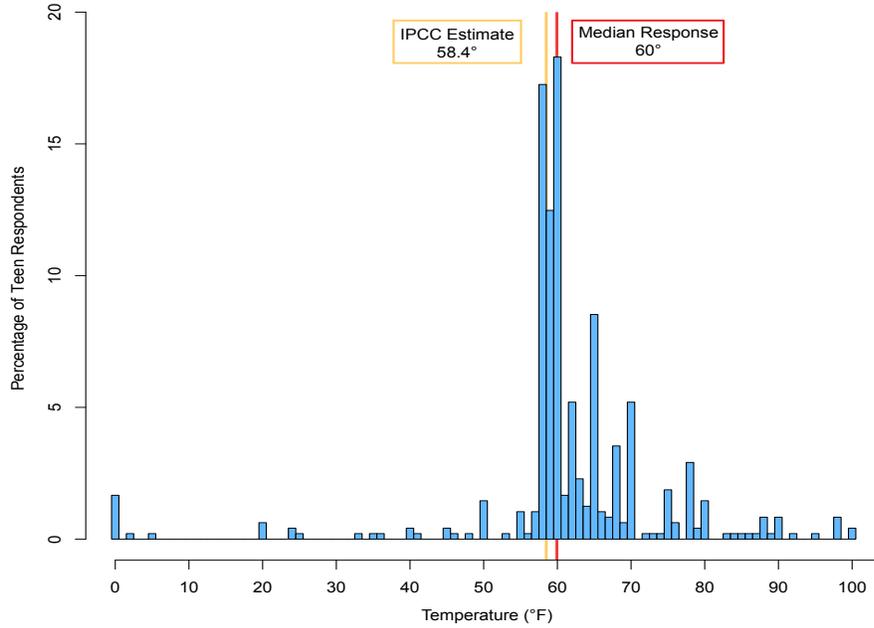


Adults

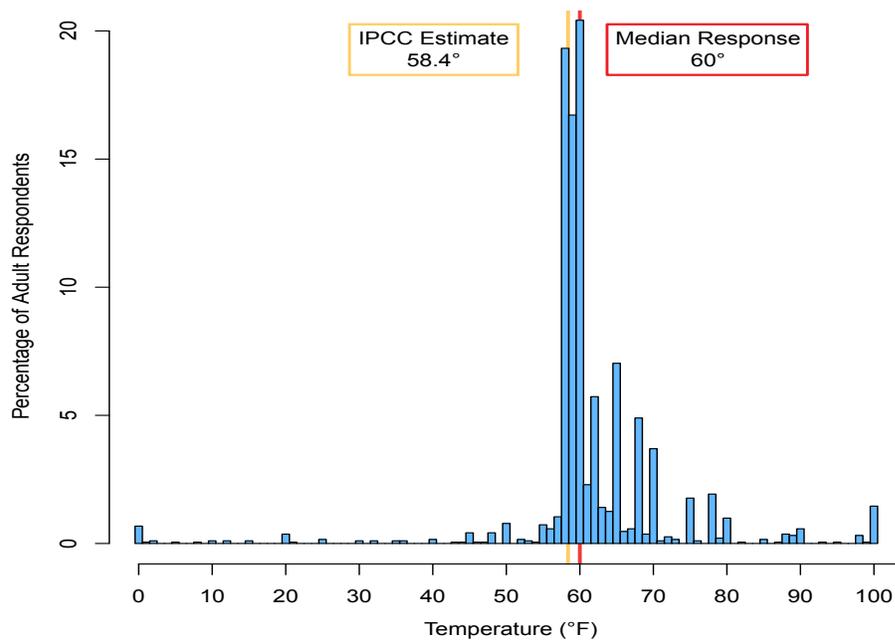


Q28. The average temperature of the Earth's surface is currently 58 degrees Fahrenheit. If no additional actions are taken to reduce global warming, what temperature do you think it will be by the year 2020?

Teens

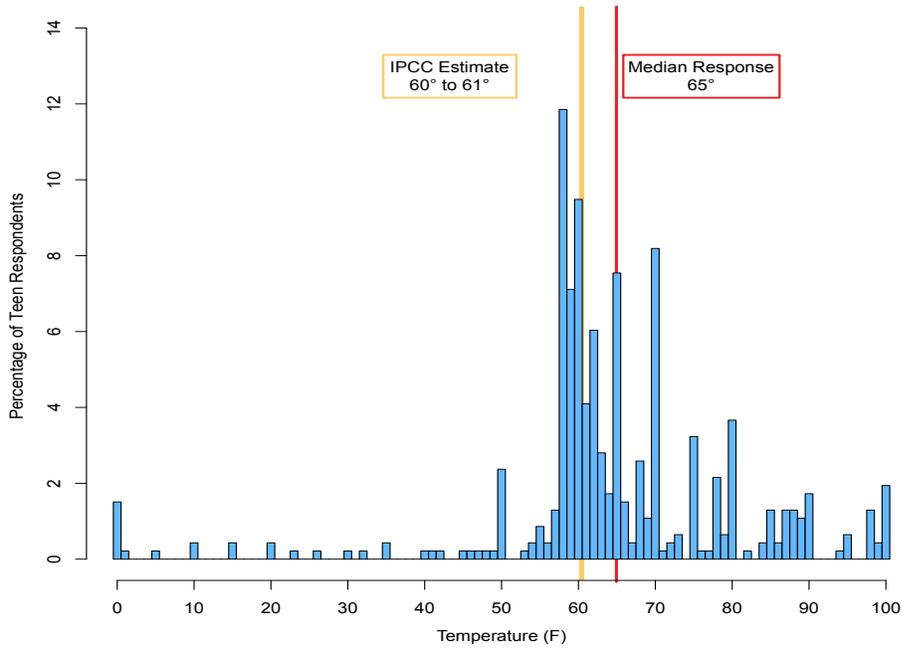


Adults

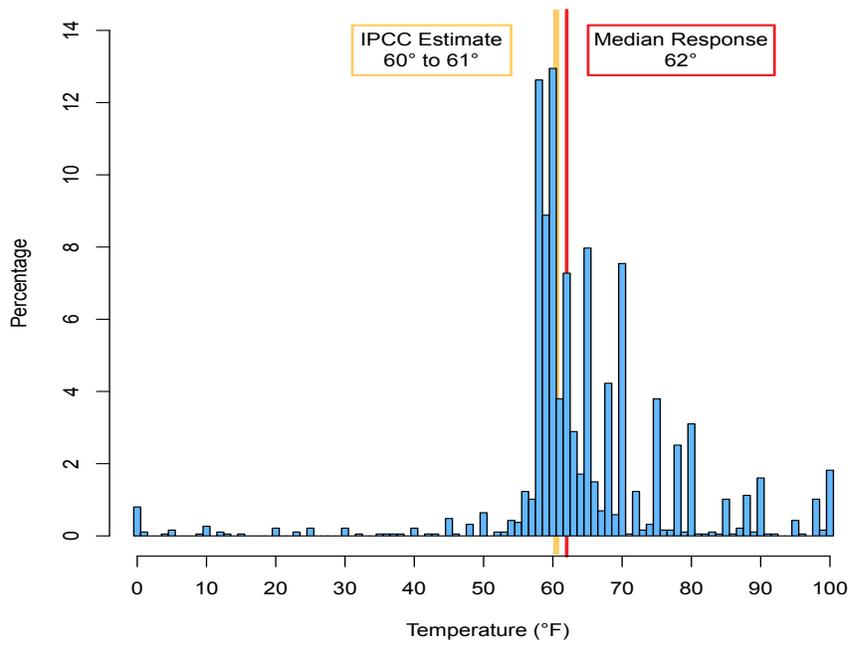


Q29. The average temperature of the Earth's surface is currently 58 degrees Fahrenheit. If no additional actions are taken to reduce global warming, what temperature do you think it will be by the year 2050?

Teens

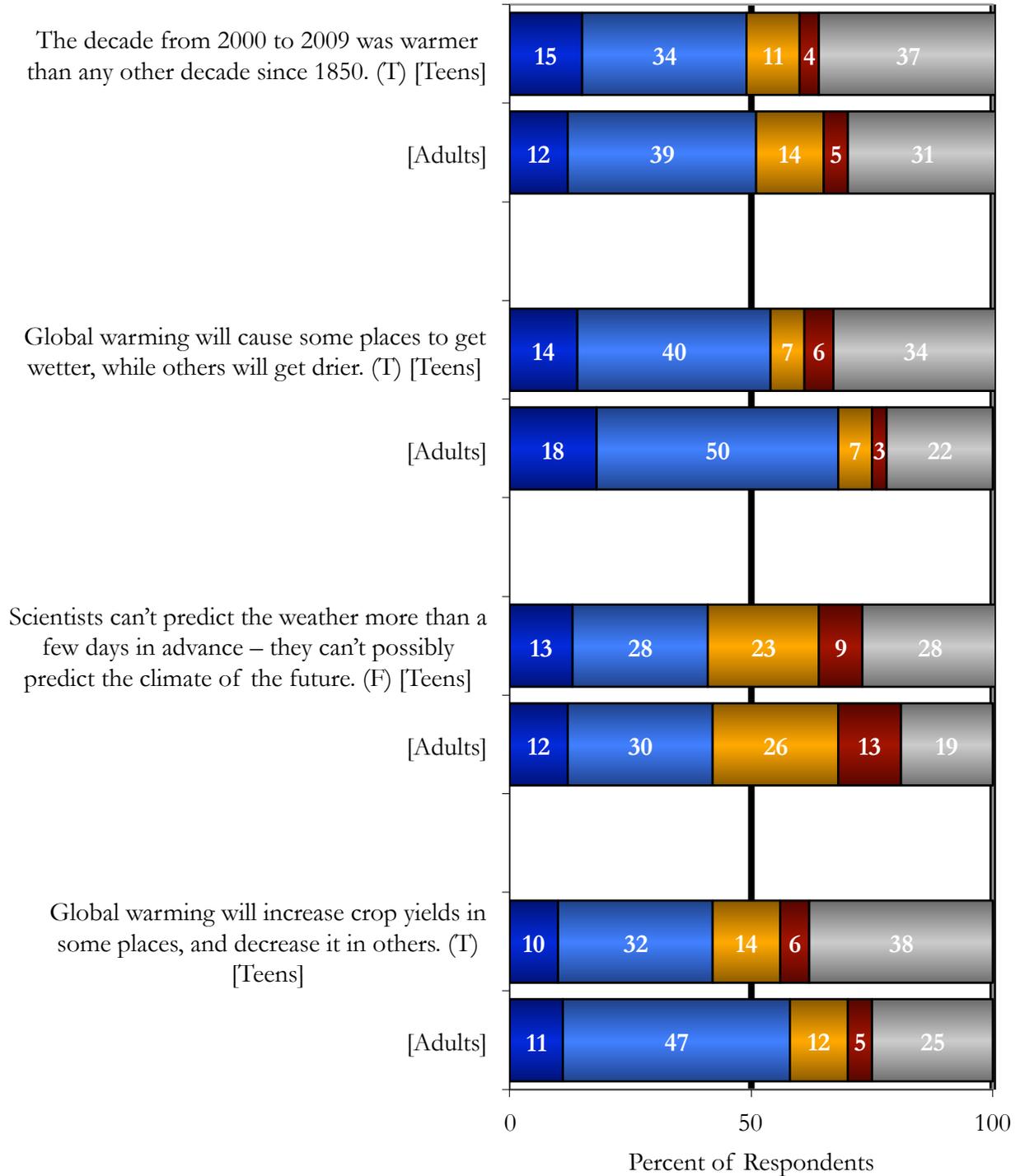


Adults



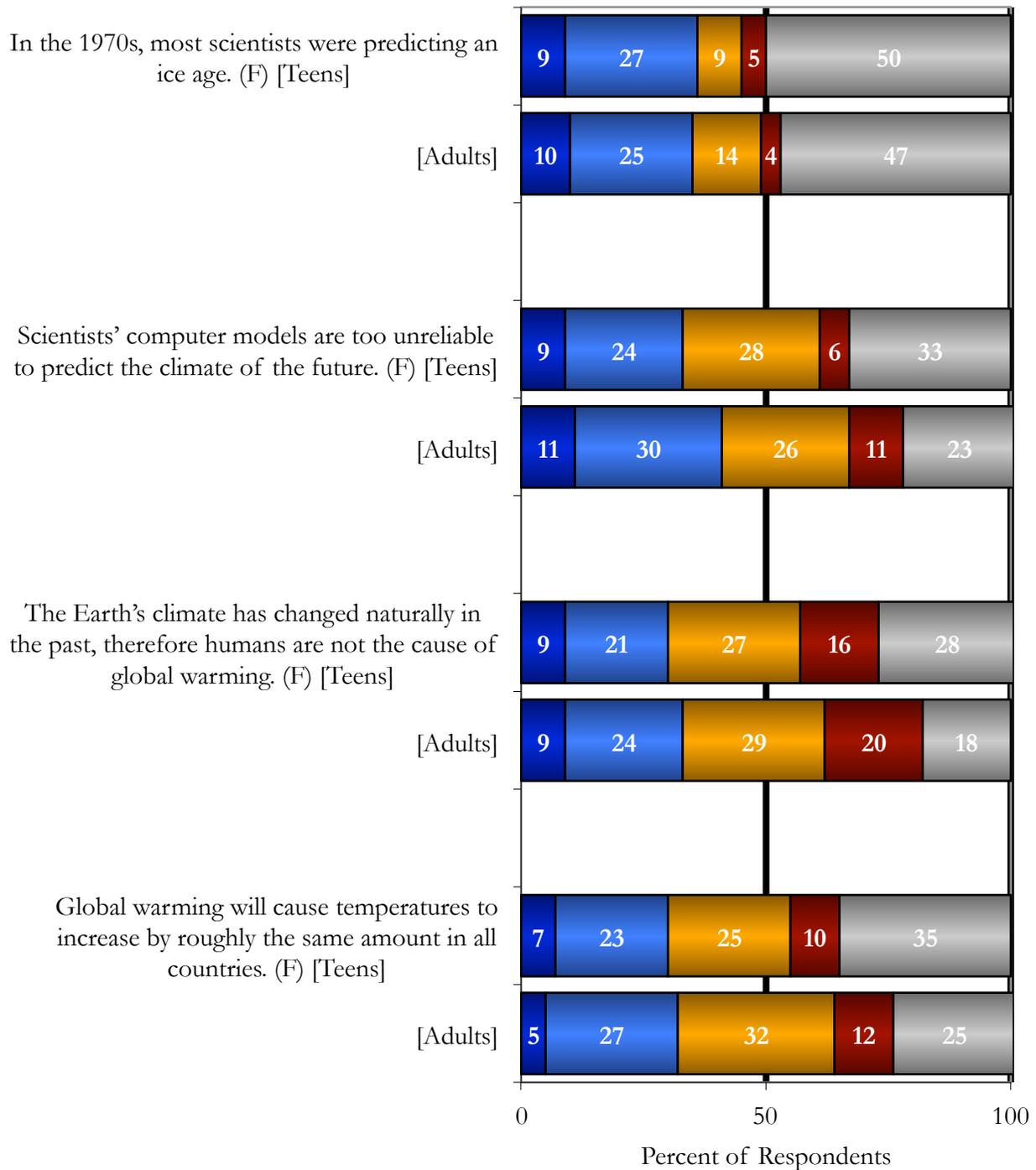
Q30. Are each of the following statements definitely true, probably true, probably false, definitely false, or do you not know? (*items randomized*)

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



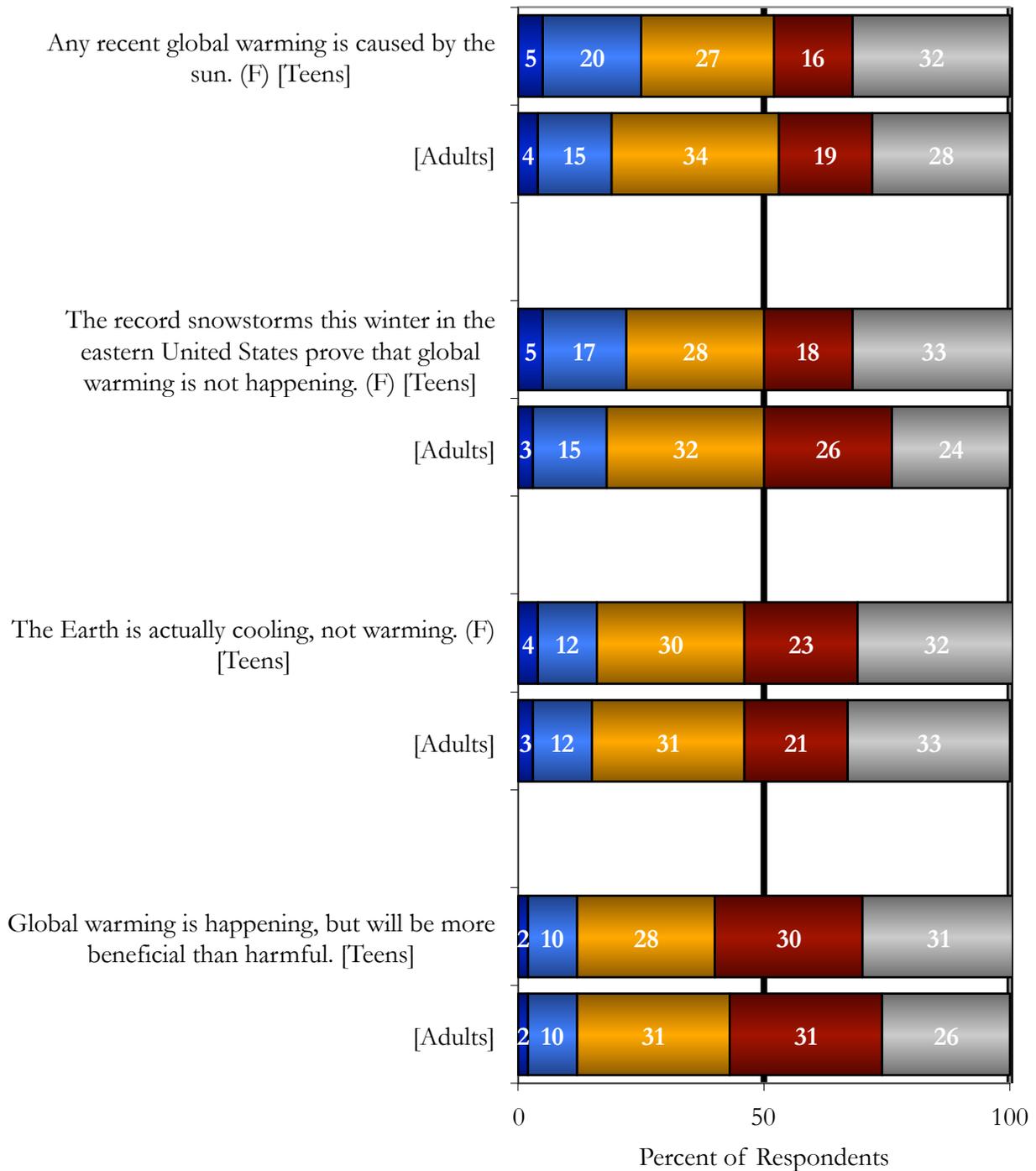
Q30 continued. Are each of the following statements definitely true, probably true, probably false, definitely false, or do you not know? (*items randomized*)

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



Q30 continued. Are each of the following statements definitely true, probably true, probably false, definitely false, or do you not know? (*items randomized*)

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



Q31. Which of the following statements is correct?

	Teens	Adults
All of the glaciers on Earth are melting away	20	11
Most of the glaciers on Earth are melting away (✓)	22	21
Some of the glaciers on Earth are melting away	31	48
None of the glaciers on Earth are melting away	2	4
Don't know	25	16

People who answered “all”, “most”, or “some of the glaciers on Earth are melting away” to question 31 were asked the following question.

Q32. Over the past 100 years, has the speed of glacier melting increased, decreased, or stayed the same?

	Teens	Adults
Increased (✓)	81	84
Stayed the same	18	14
Decreased	0	2
<i>N</i>	<i>369</i>	<i>1600</i>

People who answered “definitely” or “probably true” to more than one cause in question 33 were asked the following question.

Q34. Of the causes you selected, which **one** has contributed the most to sea level rise so far?

	Teens	Adults
Melting of mountain glaciers	24	19
Melting of sea ice on the Arctic Ocean	29	34
Melting of land ice in Antarctica	29	24
Warmer ocean temperatures (✓)	16	22
Increased evaporation	1	2
<i>N</i>	<i>342</i>	<i>1482</i>

Q35. How much do scientists estimate that global sea levels rose from 1900 to 2000?

	Teens	Adults
10-12 feet	4	3
3-4 feet	16	11
6-9 inches (✓)	23	26
Zero	4	4
Don't know	53	57

Q36. If no additional actions are taken to reduce global warming, how much do you think global sea levels will rise by the year 2100?

	Teens	Adults
10-12 feet	14	13
3-4 feet (✓)	17	17
6-9 inches (✓)	15	16
Zero	6	6
Don't know	48	48

Q37. How much, if anything, have you read or heard about coral bleaching?

	Teens	Adults
A lot	1	1
Some	5	9
A little	11	15
Nothing	83	75

People who answered “a lot”, “some”, or “a little” to question 37 were asked the following question.

Q38. Which of the following causes coral bleaching? (*items randomized*)

	Teens	Adults
Warmer ocean temperatures (✓)	30	54
Chemical spills in the ocean	29	11
Acid rain	14	8
Overfishing	1	3
Don't know	25	24
<i>N</i>	<i>86</i>	<i>491</i>

Q39. How much, if anything, have you read or heard about ocean acidification?

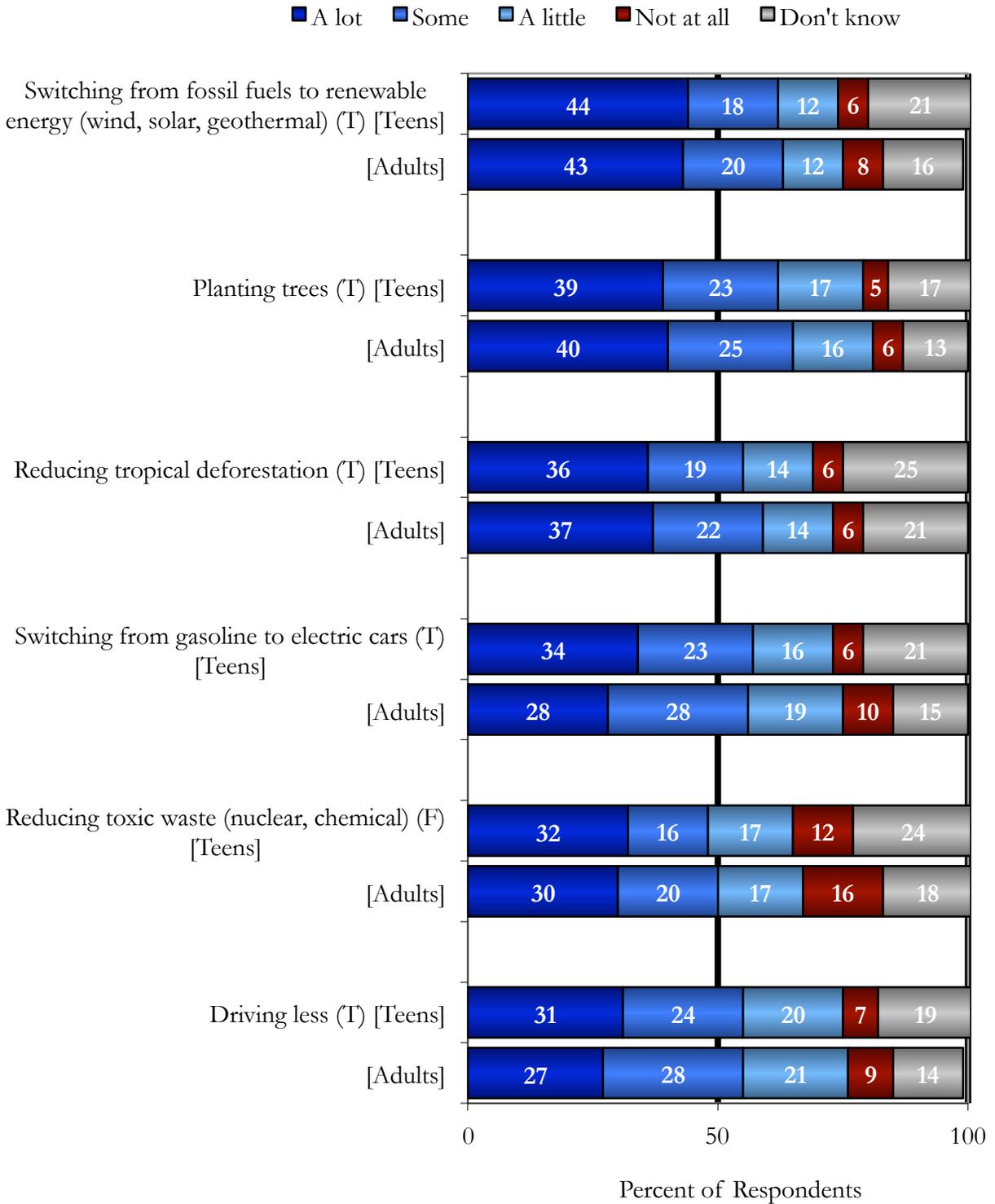
	Teens	Adults
A lot	1	1
Some	5	6
A little	12	17
Nothing	82	77

People who answered “a lot”, “some”, or “a little” to question 39 were asked the following question.

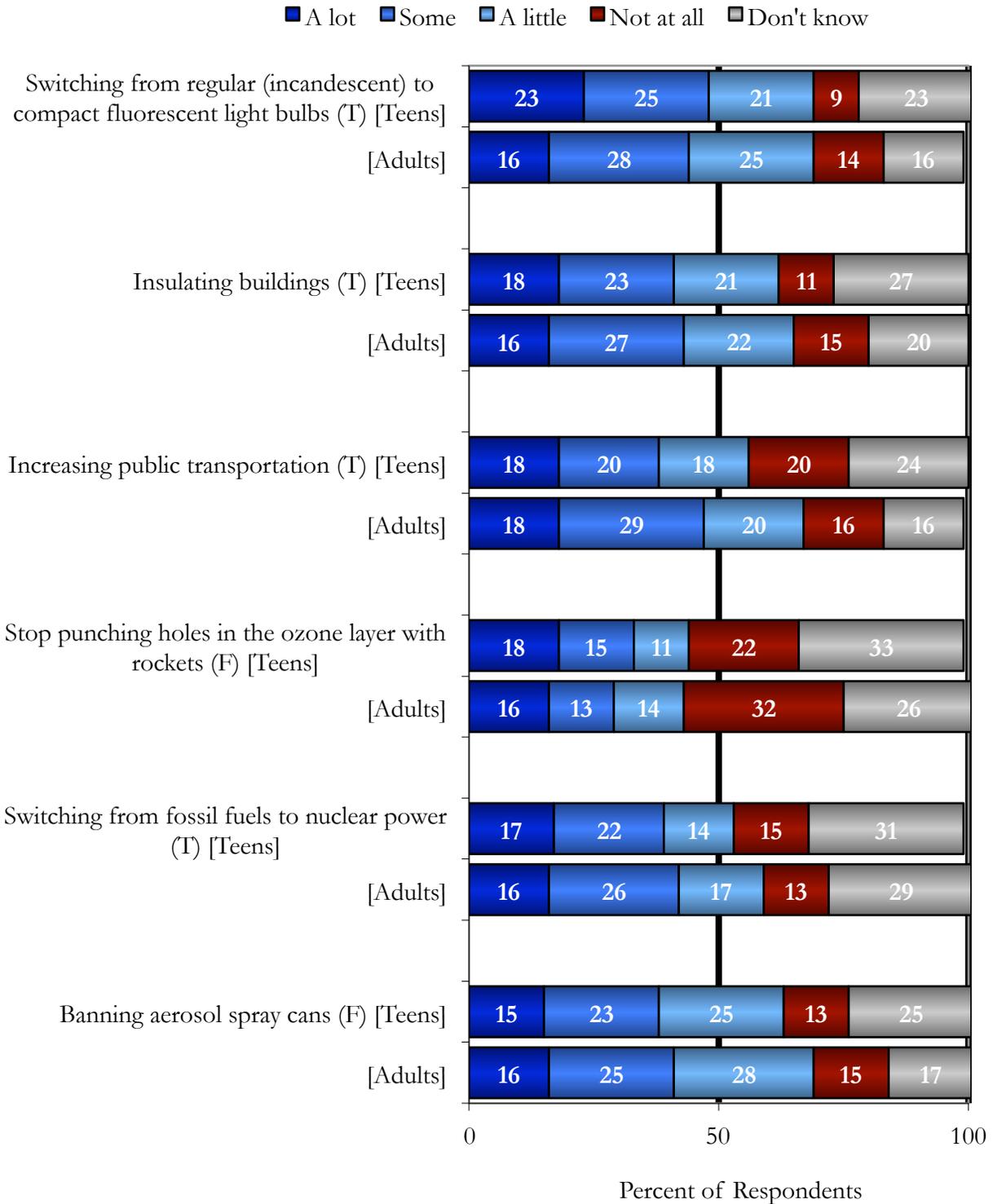
Q40. Which of the following causes ocean acidification? (*items randomized*)

	Teens	Adults
Absorption of carbon dioxide by the ocean (✓)	17	32
Chemical spills in the ocean	33	16
Acid rain	25	19
Warmer ocean temperatures	7	13
Don't know	17	21
<i>N</i>	<i>92</i>	<i>467</i>

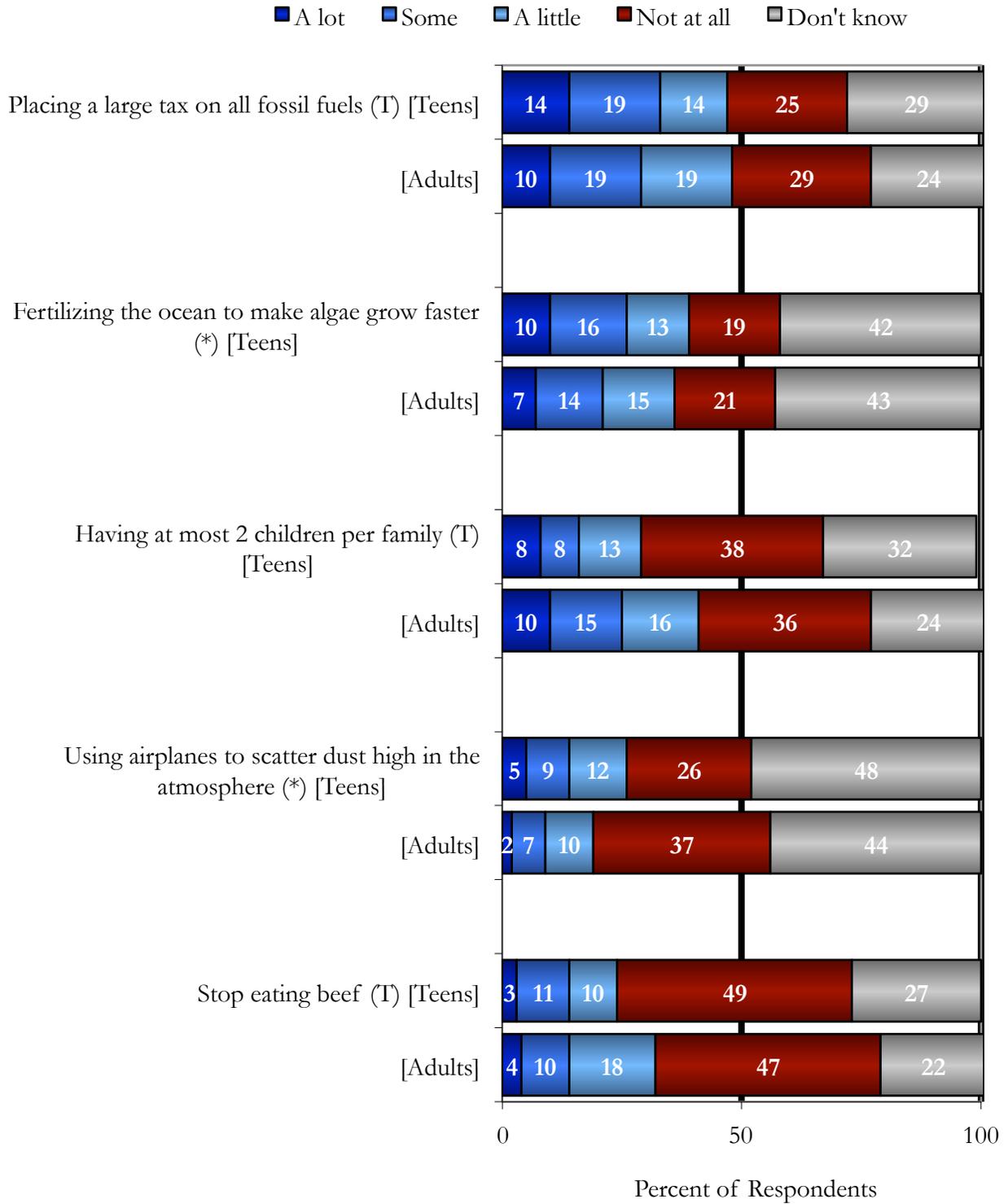
Q41. How much do you think each of the following actions would reduce global warming if they were done **worldwide**? (*items randomized*)



Q41 continued. How much do you think each of the following actions would reduce global warming if they were done **worldwide**? (*items randomized*)

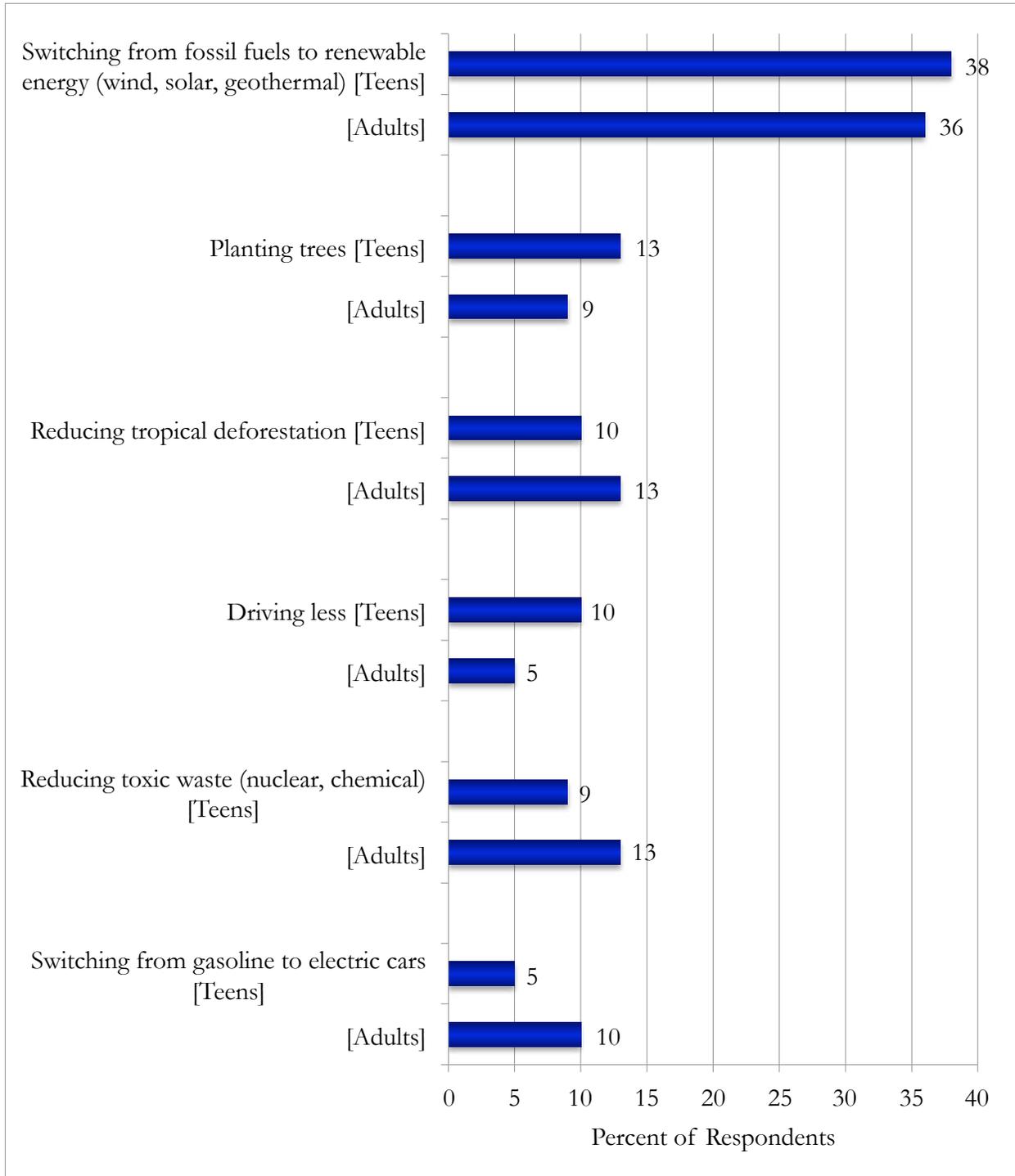


Q41 continued. How much do you think each of the following actions would reduce global warming if they were done **worldwide**? (*items randomized*)

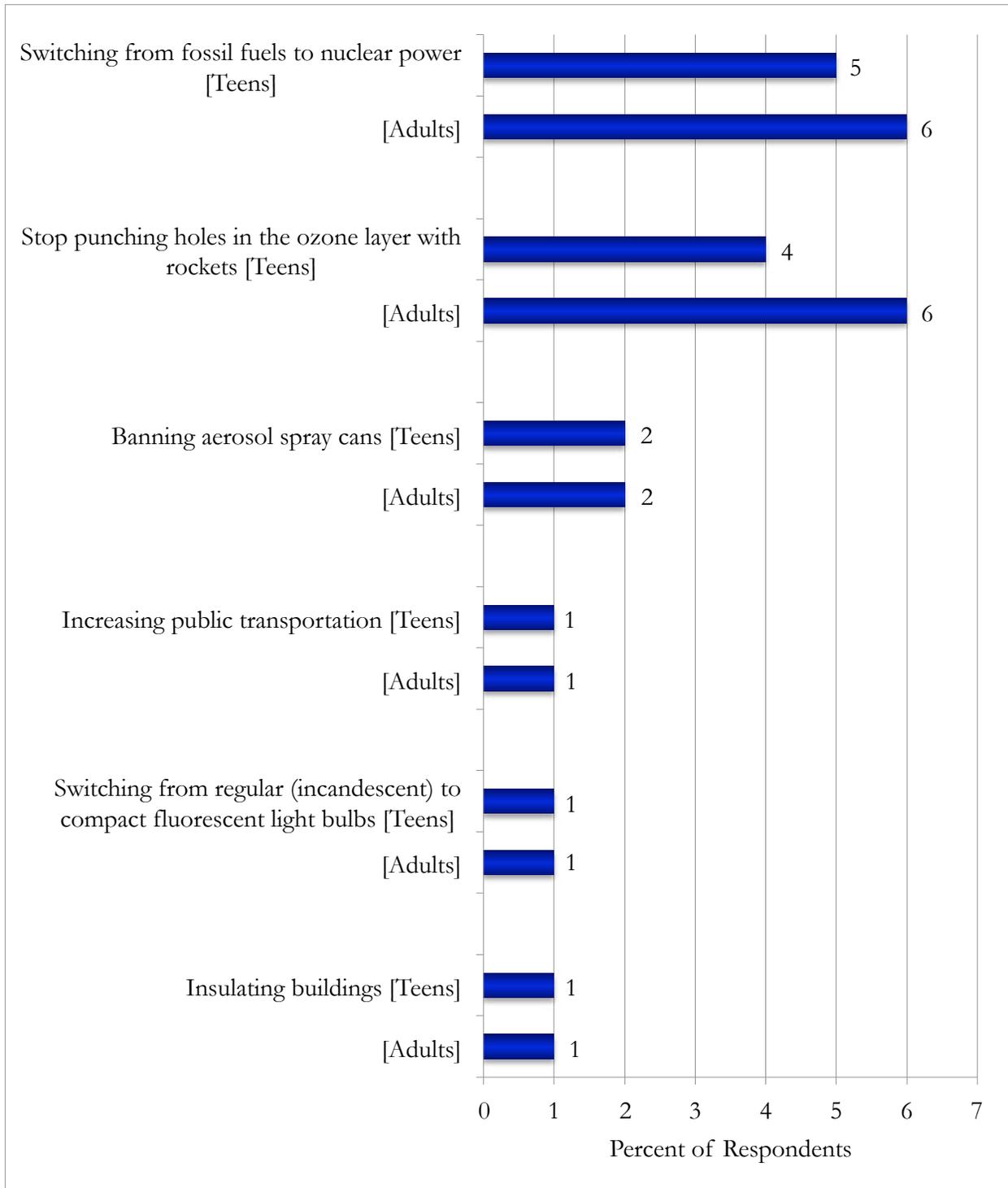


People who answered “a lot”, “some”, or “a little” for more than one action in question 41 were asked the following question (n = 356).

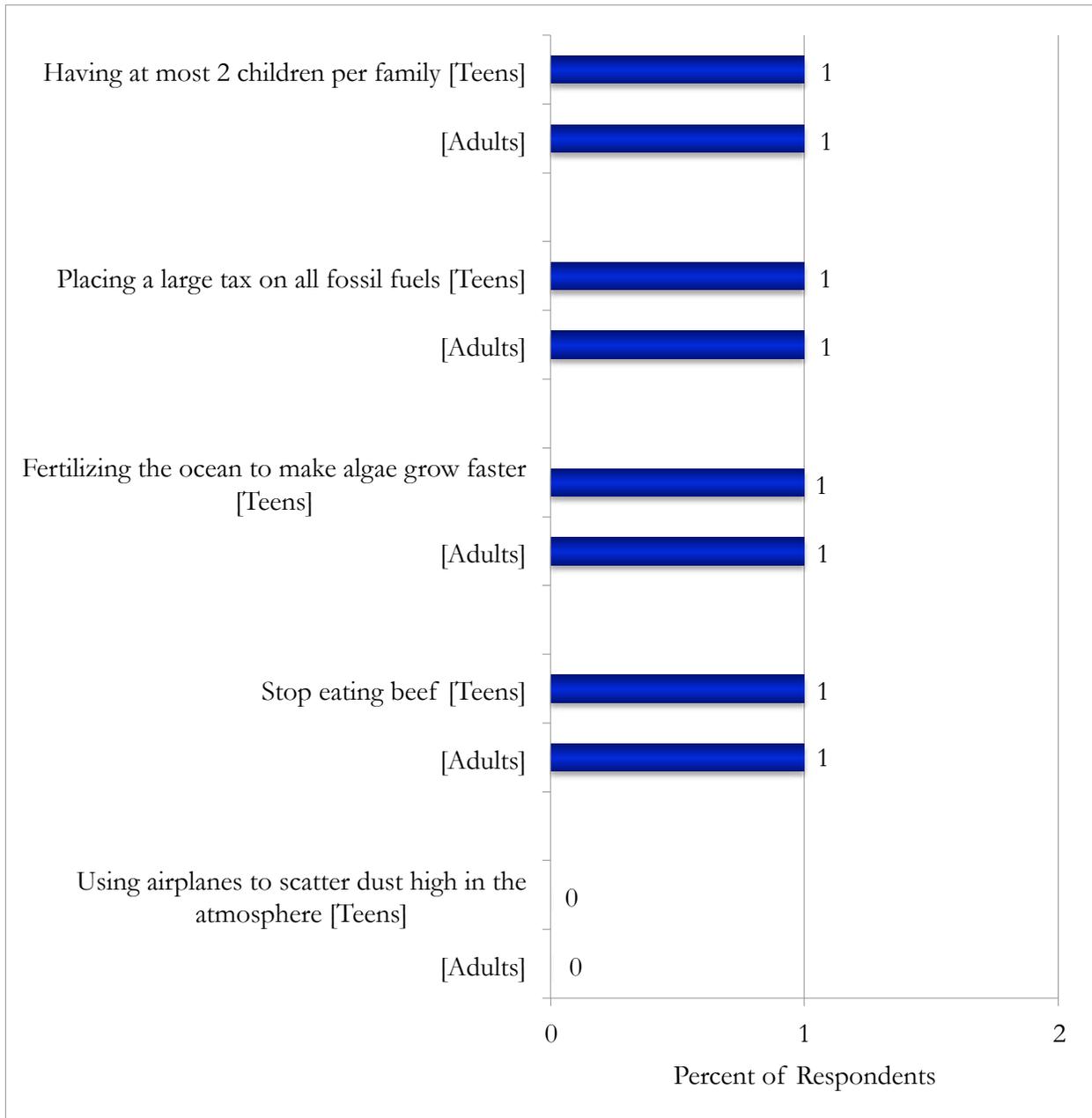
Q42. Of the following actions, which **one** do you think would reduce global warming the most?



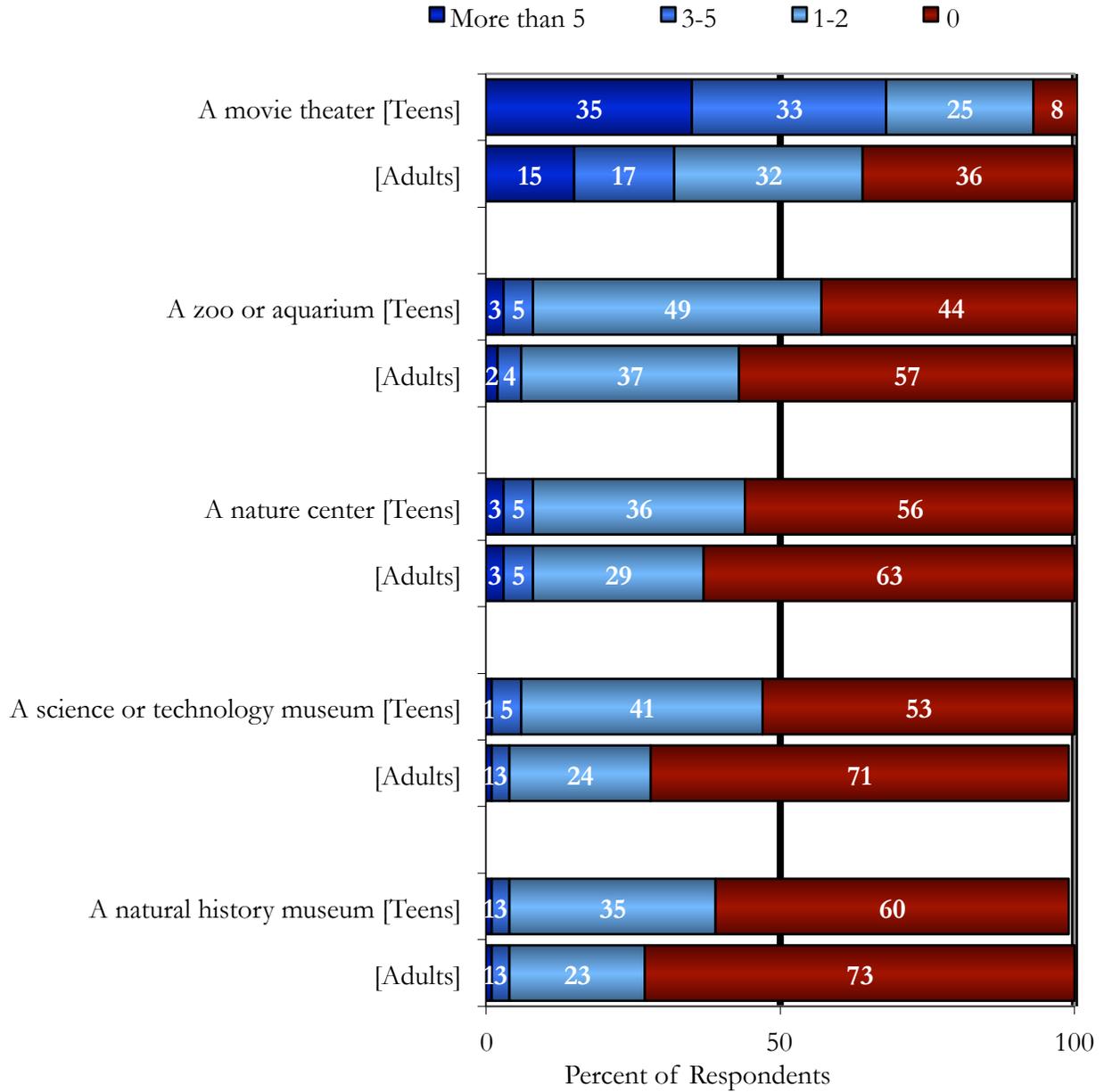
Q42 continued. Of the following actions, which **one** do you think would reduce global warming the most?



Q42 continued. Of the following actions, which **one** do you think would reduce global warming the most?



Q43. Over the past 12 months, how many times have you visited each of the following?



Q44. Have you ever attended the following at a science center or museum?

A lecture about global warming

	Teens	Adults
Yes	11	8
No	89	92

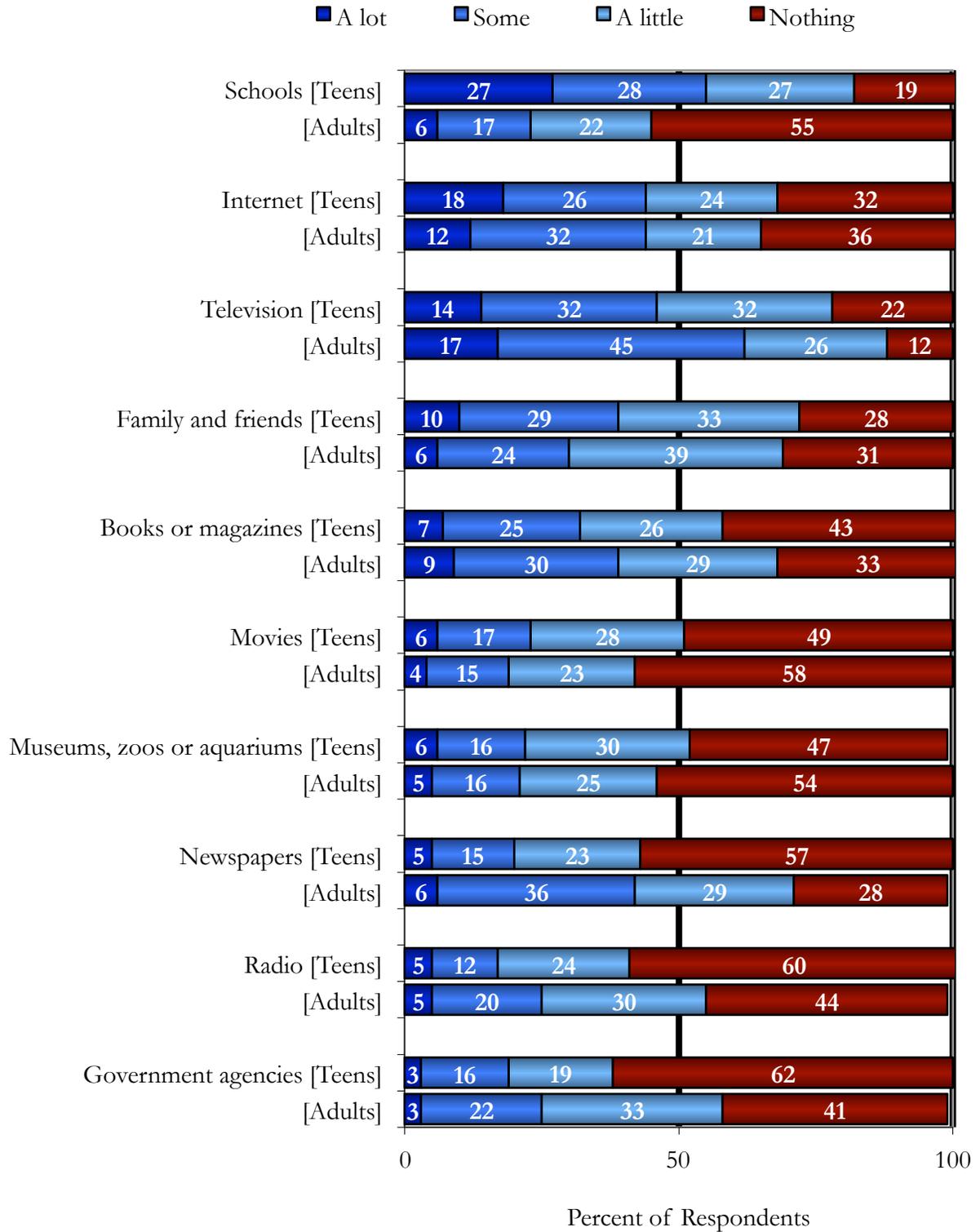
An exhibit about global warming

	Teens	Adults
Yes	18	14
No	83	86

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

	Teens	Adults
Yes	12	8
No	88	92

Q45. How much have you learned about global warming from each of the following sources?



Q46. How much have you learned about the following at school?

How the Earth's "climate system" works

A lot	25
Some	42
A little	22
Nothing	12

The causes of global warming

A lot	22
Some	35
A little	28
Nothing	15

The consequences of global warming

A lot	22
Some	34
A little	29
Nothing	15

Ways to reduce global warming

A lot	25
Some	30
A little	29
Nothing	16

Q47. How closely do you follow news about the environment?

	Teens	Adults
Very closely	2	7
Somewhat closely	15	32
A little	40	45
Not at all	43	16

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

	Teens	Adults
Very closely	12	32
Somewhat closely	21	39
A little	44	22
Not at all	24	7

Q48. How much had you thought about global warming before today?

	Teens	Adults
A lot	7	17
Some	22	35
A little	39	33
Not at all	32	15

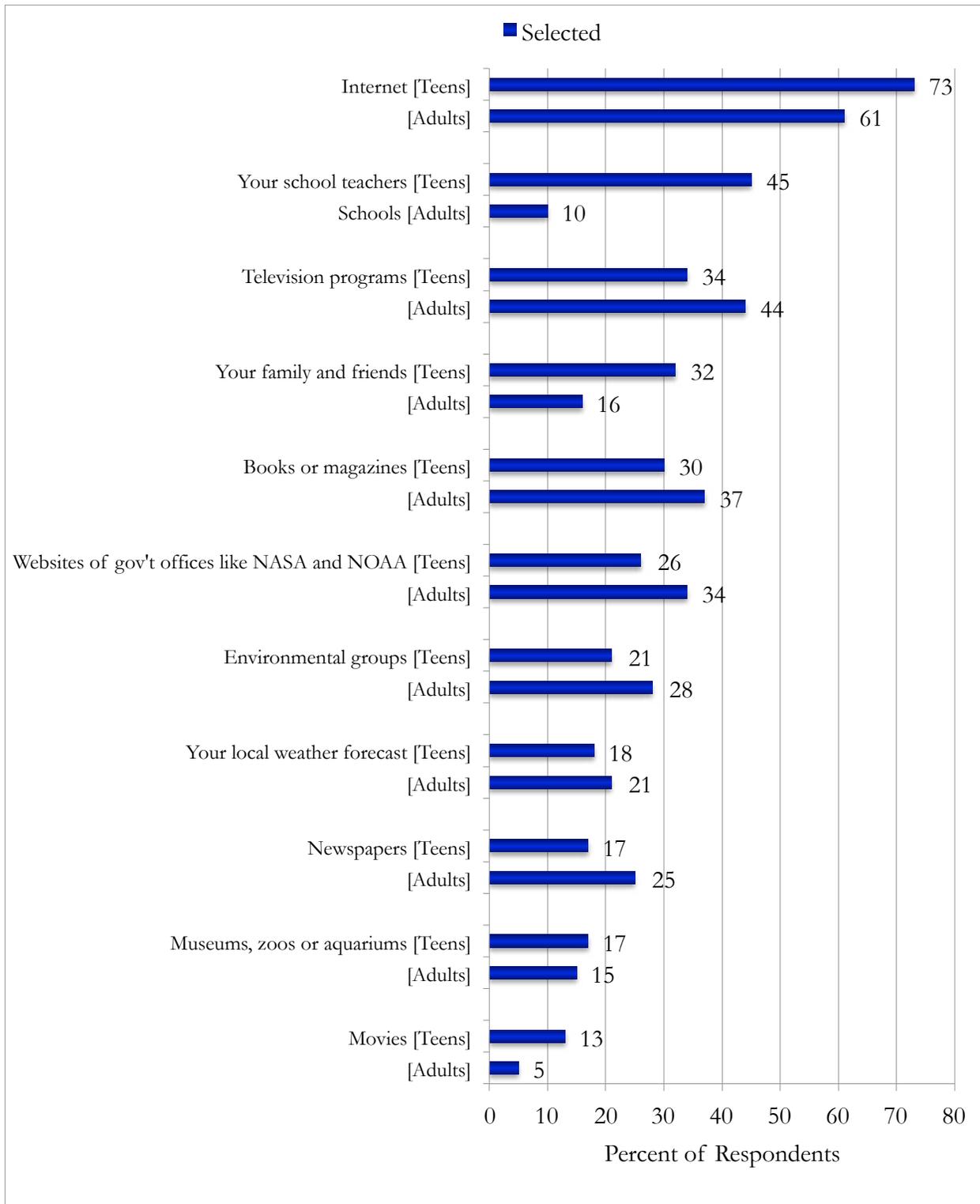
Q49. How important is the issue of global warming to you personally?

	Teens	Adults
Extremely important	6	7
Very important	13	20
Somewhat important	34	38
Not too important	26	21
Not at all important	22	14

Q50. 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?

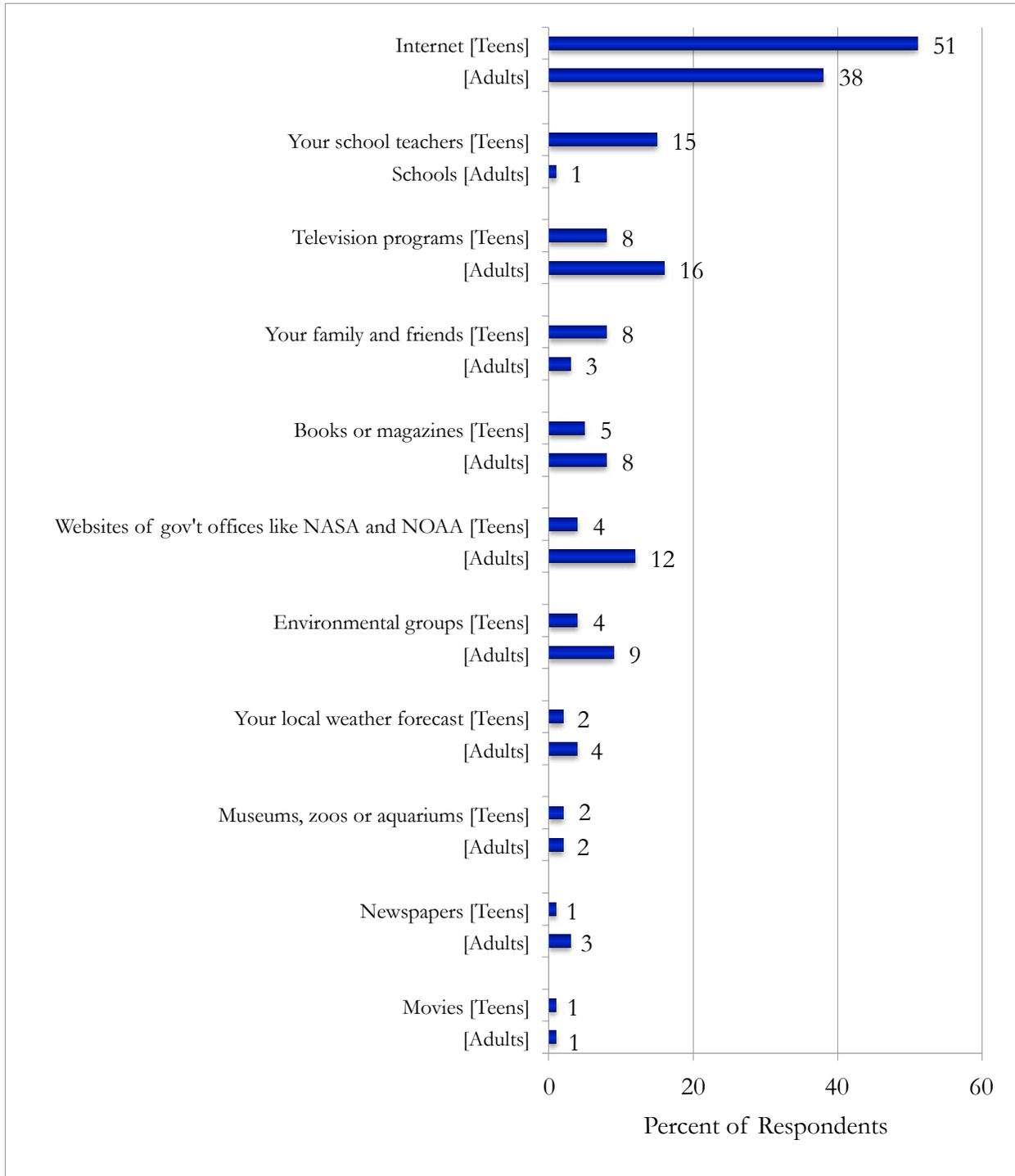
	Teens	Adults
I need a lot more information	22	25
I need some more information	25	26
I need a little more information	23	25
I do not need any more information	30	24

Q51. 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 51 were shown just their selections and asked the following question (n = 492).

Q52. Of the following, which one would you go to first to learn more about global warming?



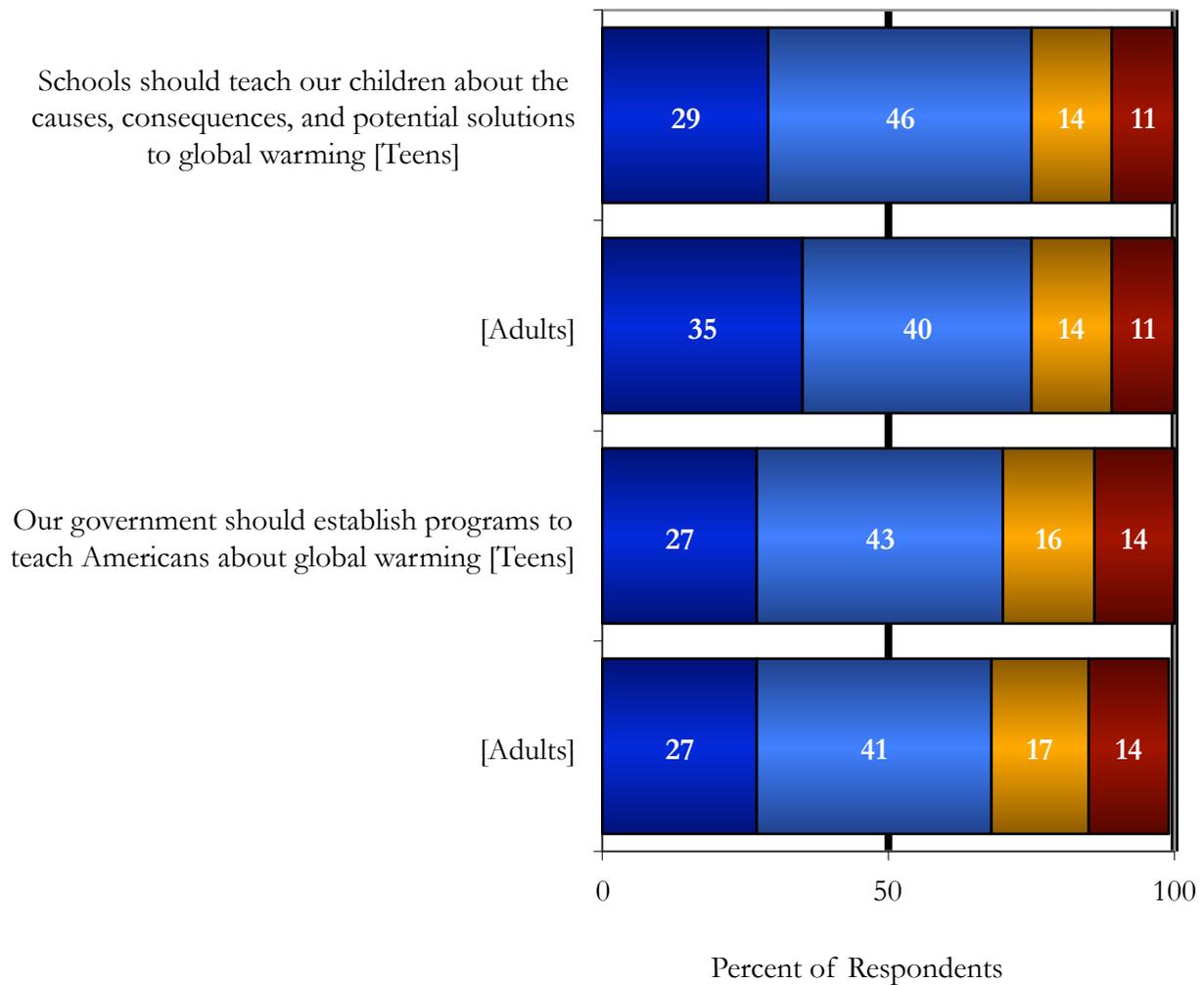
Q53A. How much do you agree or disagree with the following statements?

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

	Teens	Adults
Strongly agree	4	5
Somewhat agree	36	32
Somewhat disagree	33	36
Strongly disagree	26	28

Q53B. How much do you agree or disagree with the following statements?

■ Strongly agree
 ■ Somewhat agree
 ■ Somewhat disagree
 ■ Strongly disagree



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., & Thurnburn, 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 CO₂ and Antarctic Temperature Changes Across Termination III. *Science* **299**, p. 1728-1731; Monnin, E., Indermühle, A., Dällenbach, A., Flückiger, J., Stauffer, B., Stocker, T.F., Raynaud, D., Barnola, J.-M., (2001) Atmospheric CO₂ 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 CO₂ 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 CO₂ and Antarctic Temperature Changes Across Termination III. *Science* **299**, p. 1728-1731; Monnin, E., Indermühle, A., Dällenbach, A., Flückiger, J., Stauffer, B., Stocker, T.F., Raynaud, D., Barnola, J.-M., (2001) Atmospheric CO₂ 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., Stievenard, 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 that 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. 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.

Q15. 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

Q16. 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

Q17. 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.

Q18. 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>

Q19. Roughly how much carbon dioxide is in the atmosphere today? [Correct answer: 390 parts per million]

For example, see: Tans, P. (2010) Recent Global CO₂. NOAA/ESRL, www.esrl.noaa.gov/gmd/ccgg/trends.

Q20. 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.

Q21a. 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.

Q21b. 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.

Q22. 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.

Q23. 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 CO₂ 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.

Q24. 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 CO₂ 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. 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 plants³, 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 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

³ 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.

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; 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.

**Q26. 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.

Q27. 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.

Q28. 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.

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 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.

Q30. 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.

Q31. 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.

Q32. 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.

Q33. 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; 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]**

Q34. 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

Q35. 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 .

Q36. 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'Neel, S. Kinematic constraints on glacier contributions to 21st century sea-level rise. *Science* **321**, 1340–1343 (2008).

Q38. 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.

Q40. 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; 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; Hoegh-Guldberg O, Mumby PJ, Hooten AJ, Steneck RS and others (2007) Coral reefs under rapid climate change and ocean acidification.

Q41. 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; 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.