Scientists Answer Students' Questions about the Earth's Cold Places

These questions were asked by 8th grade science students in a classroom setting in a Denver, Colorado, middle-school in 2009. Science students connected with National Snow and Ice Data Center (NSIDC) scientists through interactive question and answer sessions. Students asked their questions and scientists responded. With down-to-earth examples and terms that are simple to understand, students and scientists shared their thoughts and knowledge about climate change.

Note: Most of the students' questions are listed below. A few questions that students asked were omitted because they were not recorded in their entirety. The questions below are as close to the actual students' questions as possible. The scientists gave verbal responses to the students' questions.

NSIDC Scientists:
Ted Scambos
Julienne Stroeve

1 QUESTIONS ANSWERED BY TED SCAMBOS

1. Were you scared to go to Antarctica?

"We needed to be well prepared. Also, when you go to Antarctica, you get a lot of training. The government group that takes care of Antarctica -- The National Science Foundation -- they see to it that everybody knows how to rescue people that have fallen into a crevasse, they see to it that everybody knows how to survive if they're alone in the snow, they can dig a snow trench. Everybody always carries emergency rations of food and fuel. If you have fuel, you can make water almost anywhere in Antarctica because there's snow everywhere. No, we weren't scared to go to Antarctica, but we did prepare, so that we didn't have to worry about what would happen."

2. How does the ice break down?

"The ice that we saw in that big shelf that collapsed that was the size of the city of Denver, and it crumbled into pieces, that was actually breaking because the water I was showing on the surface of the ice shelf was seeping into the ice, and causing it to fracture. It breaks up into thousands of pieces because of just a little bit of water on the surface. This is one of the things that we learned about Antarctica. You don't have to wait until all of this huge thick pile of ice melts all the way to the ground. That little bit of water on top in a place like Antarctica has a big effect on the ice that's underneath it. So, you can fracture it, and break it apart very quickly."

3. When was Antarctica first spotted?

"There's a couple of debates about that. Way back in 1821 there was a guy named Palmer, Nathaniel B Palmer. And he spotted some of the land in Antarctica. In that map that I showed you before that's on your hand he found it right there in that area of the Antarctic Peninsula which is on the Northernmost part of Antarctica, the part closest to South America. He saw some land there for the first time. Now the reason they were down there is because they were hunting for seals, and there was a lot of seals in this area, and there are a lot of islands around Antarctica, and nobody has seen the mainland until 1820. And then another fellow, an American, in 1840 and a Frenchman, at the same time, saw the land mass and recognized that Antarctica was a huge continent, not just a small patch of land - the peninsula, but a huge continent. And that was in 1840 - over 150 years ago."

4. How do glaciers form?

"Glaciers form in areas either high up in the mountains or in the polar regions of the Earth where the winter snow that falls doesn't melt away completely. It's so cold in winter, and the summer is so short, that before all of the snow can melt, it starts to be winter again, and then a new layer of snow forms on top of it. And that goes on for years, and years, and years. And you get this huge pile of snow that starts to come up - like at your school - it would start to come up to the first floor, and a few years later, it starts burying the second floor, and then the third floor, and then over the top and then way up like the sky-scrapers down in Denver. And all that weight of snow starts to press down on the lower level, weighing down the snow, and starts to squeeze it. Ice - it feels like a rock, right? When you're holding it in your hand, it feels hard. Actually, it's kind of soft, in fact sometimes, if you bite into some ice, you can feel it 'bend' just before it breaks between your teeth. Ice is actually very soft - don't try it with a rock, you can try it with ice; don't try it with a rock. Ice is relatively soft compared to rock, and it will actually bend and squeeze like toothpaste if you have a whole bunch of pressure. Like I said, the height of a skyscraper down in Denver. So that's what it takes to make a glacier. Pile up lots and lots of snow, start squeezing that snow out like toothpaste, and then if you're in the mountains, it'll start to flow in between the valleys of the mountains, and out into the ocean."

5. Can an iceberg move onto land?

"Remember I said - can icebergs move onto land? They do do that. But because they have so much of the ice below the surface of the water -- remember I showed that thin layer on top and nine times as much below. Before it actually comes up on the land, it gets stuck on the ocean bottom, off the shore. So, in a lot of places, you'll see icebergs just off the coast because they're stuck on the sea bed as they were trying to come in towards shore. And then they'll slowly melt and maybe come in a little bit closer. There are some pictures I've seen on the internet where blocks of ice

have been washed up onto a beach, but they're really small. If it's a big iceberg, it's off-shore because it's so deep; the ice is floating so deep."

6. How long can an iceberg exist?

"That's a good question too. In Antarctica, the ocean water is really, really cold, and the ice doesn't melt very fast. So, if the iceberg stays close to Antarctica where the water is really cold. It'll stay there for years and years and years, and drift around Antarctica. There's an iceberg that is still trapped against the coast of Antarctica that broke off over 20 years ago, and it's still there. So it can last a long time. But if they drift, go in a circle around Antarctica over the years, it takes them years to do it, and then get swept out into the main part of the ocean around Antarctica, then they melt very fast, within a few months."

7. Was it hard to go to Antarctica?

"You've got to be prepared to work every day, digging a lot of snow, setting up your camp, doing the science, fixing computers. Every time I go to Antarctica I lose 5 to 10 pounds, even though I eat 2 or 3 times as much, I lose weight - and most of the people there - because you have to work so hard to keep your body warm, and to do everything that you have to do. If the government agrees, and you have a good project, and they're going to send you out to the middle of Antarctica, it's a huge amount of investment to put people out there in the middle of Antarctica. So, they have to make use of every moment of every day they can, except when they're sleeping, to try to get some work done."

8. How old is Antarctica?

"It first started to get covered with ice about 30 million years ago. Now that's after the age of the dinosaurs, but it's an age when there was a lot of mammals, but you wouldn't recognize them. They look very different from the animals we're used to seeing today. How long has Antarctica been a continent, been a landmass? That's a difficult question too. Parts of Antarctica are probably as old as any continent on Earth; as old as South Africa, as old as parts of Greenland, as old as Wyoming, these are the oldest pieces of continent on the Earth. So, hundreds of millions to billions of years old. But Antarctica as we think of it today, with ice on it, started about 30 million years ago. And it really looked pretty much like today - covered with ice from coast to coast, about 3 million years ago."

9. Is Antarctica really far away?

"It's about 9,000 miles away."

10. How do icebergs form?

"How do icebergs form? Icebergs form when that glacier we talked about before, gets squeezed down, squeezed like toothpaste, goes out to the coast, and then there'll be a crack on the surface..."

11. Are there houses in Antarctica?

"Two countries have decided to build two little villages in Antarctica, and have people live there, and there are even elementary schools there, and K-12 schools there, and families that have spent many years there. The two countries are Argentina and Chile. And they decided to do this because they're thinking maybe someday they want to claim part of Antarctica as part of their country. For now, there's no claim in Antarctica, Antarctica belongs to the whole world. But these two countries are saying 'well, maybe someday, we'd want to have a piece of Antarctica that we own'. And that will have to be discussed in places like the United Nations and stuff. But they actually put two towns there with houses in Antarctica, and they asked some families to go down there and live, and do research, and just basically stay there for several years, and have kids there. Having kids in a place is very important in international law for making a claim on that country."

12. How deep is the water in Antarctica?

"How deep is it? Well, it changes. I mean it goes from the coast to the deep ocean. So, it's as steep as it is anywhere in the ocean around the Earth. It gets up to 3 miles deep not too far from the coast of Antarctica. But most of the coastline is only a few hundred of a few thousand feet deep."

13. Why is it not important to Denver if sea level rises?

"But what's Denver's nickname? The Mile-High City. So we're a mile above sea level. So even if all the ice on Earth melted, it wouldn't come as far as Colorado. That doesn't mean we don't have to worry about the problem. Because people that live on the coast will want to find areas to live in that aren't affected by the ocean sea-level rise. Eventually, a hundred years from now. So, what we need to do is think about how we're going to plan for this changing climate that we'll have in the next century. And make sure that it's not a big problem for everybody on Earth."

14. In Antarctica, does weather affect the use of technology?

"It's so hard to keep your computer going, and measurement systems going because it's so cold. Batteries don't want to work. Your screen on your computer will get so cold that first it won't glow, you can't see it, and then you can barely see it. And then it'll get so cold that the screen will crack open if you're not careful. It's really difficult to make that technology work. They wanted to put a

wind power station at the South Pole, but so far they have not figured out how to get that big wind generator turbine to spin through the winter without breaking because it's so cold."

15. What is global warming?

"Over the last 50 years or so, measurements of temperature all over the Earth have shown that temperature on the Earth on average is going up. It's a little bit warmer than it used to be. And it's been changing fairly steadily through the last 50 years. Now, at the same time we know that all of these power plants that we have on Earth and all of our cars put out a chemical called carbon dioxide; it's part of what burning is, is to take something like wood or coal or oil or gasoline and burn it to get energy. And all of those materials wood, coal, oil, natural gas, they all have carbon in them. It wouldn't be such a big problem, except that this carbon dioxide molecule has a way of blocking the heat that's trying to leave the Earth. The sun shines on the Earth, and it warms up, and then that heat leaves the Earth by radiating out into the sky. When it's a clear, dark, night, it feels colder because all the heat is radiating into space. This molecule, carbon dioxide, it will block that heat a little bit. So now what scientists think is that the reason that it has gotten warmer in the last 50 years is that we put so much carbon dioxide out, we got so many power plants, so many cars, so many furnaces burning natural gas, and we're adding carbon dioxide to the atmosphere. And it's true, if you measure it, there's more carbon dioxide in the air now than there has been in a long, long, long time. Not since the whole Earth was a jungle has there been this much carbon dioxide in the atmosphere. So, we need to rethink, we need to adjust, how much carbon dioxide is in the atmosphere. The way we could do that is by using things to generate energy that don't produce carbon, that don't need a fire, basically, to make energy. A wind machine doesn't need fire to make energy, solar plants or solar cells don't need fire to make energy. And nuclear power plant also doesn't use fire to make energy, it uses a special kind of chemical reaction that's not a fire; it makes a lot of energy. And, we can save energy, we can conserve energy, like we're doing now. We have the lights turned off, we're trying not to use too much energy to save money for the school, and also save energy. All those things are going to help us. But you know what, the key to this is going to be you guys -- you guys are going to have to come up with some good ideas about how to get more energy to everybody, or how to get rid of the carbon dioxide that we're using in our coal plants right now. So, I hope you guys will take that up, because I think the Earth is going to get very uncomfortable by the time you're older unless we do something about this."

16. If you drive a heavy truck on ice, will it break?

"It could be a problem. I showed you the picture of McMurdo and there was that big flat area of ice next to it. And right in January or February - that's late in summer, then if you were to drive a truck out -- they stopped driving trucks out, because the ice is too thin. They know how thick it is, if it gets too thin, they don't drive trucks out. But if they did, it would fall through. In fact, one of the first explorers brought one of the very first cars, it was actually a big snowmobile, down to Antarctica,

and he unloaded it out on the ice, and it fell through. And it's on the bottom of the ocean there, it's over a hundred years old."

17. What's the biggest iceberg?

"The biggest iceberg that we know of, because Antarctica has been around for a long time, but we haven't mapped it except in the last 100 - 150 years or so. There was an iceberg in the year 2000 that cracked off, very close to that base in McMurdo that was 250 miles long, and 40 miles wide. If anybody knows what New York looks like, it was as big as Long Island."

2 QUESTIONS ANSWERED BY JULIENNE STROEVE

1. Why is Greenland called Greenland?

"A long time ago, the Vikings, they founded both Iceland and Greenland. And they really liked Iceland, it was beautiful, it's green, it has thermal pools, and some glaciers. And Greenland was a block of ice, basically. And so, they wanted to fool people about which was a nicer place to be, because they didn't want everybody to go to Iceland. So, they named Iceland, Iceland, to drive people away, and Greenland, Greenland, even though it was all ice."

2. How cold does it get in Alaska?

"I've been up to Alaska in March; it's been about -40 degrees. Which is pretty cold, and sometimes it'll get to -20, but it's still very, very cold in Alaska in the springtime. And in the summertime, it'll get above freezing, and in the last years, it's been really, really warm in the Arctic part of Alaska, and the local people that live there have been swimming in the ocean, it's been getting that warm."

3. Is global warming going to shrink the Earth?

"It's not going to shrink the Earth, but what it's going to do is shrink all the areas that are covered by snow and ice. So, the amount of snow and ice on the planet is going to keep shrinking and shrinking. And hopefully, it won't disappear, but certainly if we keep warming up and warming up, that could be one of the outcomes."

4. How is global warming caused?

"What we know is causing global warming is that these gases that we're putting in the atmosphere that really didn't exist in the concentrations and the amounts that they do today, that we're putting

in from people driving cars, burning coal, even methane that's being released from livestock, for example, or thawing of permafrost. That's what's causing the temperatures in the atmosphere to rise, and that's what we call global warming. But of course, global warming doesn't mean temperatures are going to rise everywhere on the Earth. Some regions are actually going to get cooler. But it's the overall global temperature that goes up that we refer to as global warming."

5. Is there global warming on other planets?

"That's another question I wouldn't completely know the answer to, but certainly, other planets are not having the same problems that we're having of increases of CO2 because of activity of the species. At least not that we know, because we only know a few planets that are around our sun, but on those planets, no, we're not seeing anything like global warming happen."

6. Sea ice – is it salty or fresh?

"Sea ice, when it forms, they are freezing the ocean, and when it does that, it's going to take all the salt out of the sea ice, we call it the brine. So, it's being ejected out of the ice. Now if it is just formed that winter, the sooner there's found salt in the ice, but the older the ice is, the less salt is has, because over time, it just keeps ejecting out the brine. So really old ice, is pretty much just fresh water, there's no more salt left in there."

7. What will increase sea level?

"Our sea level is going to go up because of melting on land. So, if you melt the ice on land, like the glaciers or the ice sheet, that's where the sea level rise is going to come from. A little bit also comes from the thermal expansion of the ocean. So as the temperature of the ocean heat up, it actually expands, and gets bigger, you can put it that way. But most of it is coming from the glaciers and the ice sheets that are melting."

8. Does littering have something to do with global warming?

"You know, in some sense it could. Because basically, the things that you're throwing away, that don't decompose back into the Earth are being produced using either chemicals, or heat, and water, and different things to produce those products, that actually do produce global warming, they do pollute, and do increase gas emissions. So not directly, but sort of indirectly."

9. If sea ice is the only ice in Greenland are there any different kinds?

"Well, the sea ice, again, is just the part of the ocean that freezes over, so it's not actually Greenland. Because Greenland is an island; there's land underneath the ice. And that ice in Greenland comes from snowfall. So basically, that's very different than with coming into the ocean,

because the ocean freezes to form sea ice. So, you find that in the Arctic on the North Pole, and we find it in Antarctica as well, around the whole Antarctic ice sheet."

10. Could something like the Day After Tomorrow actually happen?

"The movie The Day After Tomorrow is sort of based on this idea that the thermohaline circulation is going to shut down, and so you keep melting the ice up in the Arctic, for example, because it makes the water very fresh, there's no need to basically have the Gulf Stream come so far North anymore, which would throw Europe into a mini Ice Age. But climate models also show that there is another balancing effect that if you don't have this ice in the Arctic ocean anymore, you're also exporting less ice out of the Arctic through the barrier between like Greenland and Eurasia, there's the Fram Strait that's up there, and the ice actually gets exported out there, and melts there, which also affects the thermohaline circulation. So, if we have less ice coming out, then maybe that's a compensating effect with shutting down the thermohaline circulation. But it also needs to be taken into account though if Greenland starts to melt a lot more, where water will be discharged into the ocean, up in the Arctic, for example, but we're really not sure. I don't think it's going to be quite that catastrophic. I think there's going to be some big shifts in our climate in the next 20 years or so, and we're going to be feeling these impacts. But the problem with this part of the science is that we have to do these sorts of projections based on model analysis, and our models aren't perfect. And so we try to make our models represent as many things about the Earth and how things work as possible, but they're not perfect. And we don't really have any good idea of what this looked like in the past, so we can't say 'well, the last time the Arctic ocean was ice-free, this is what the Earth looked like'. We don't have a good sense of that right now."

11. How does picking up trash, turning off lights, and saving water help the Earth?

"So basically, when you turn off the lights, you're emitting less CO2. So that's one way that's turning off the lights helps. You're also using less energy as well, which is also going to help with the CO2 emissions. And conserving water, water is an interesting thing, because as the climate warms up, we think the preservation of water is really going to change on this planet. And so sometimes, Colorado gets drier, and you have less water here, you're going to have to be conserving more and more water. Because what a lot of models show is that this is what happens to Colorado. So, water is going to become very precious. And places like Chile, for example, Santiago, Chile, they have a very big glacier that supplies all the water, but that glacier is shrinking very, very quickly, so they're very concerned about where their next water is coming from, because the glacier that gives them their water is going away."

12. If carbon dioxide (CO_2) is on the sun, is sun going to explode?

"The CO_2 is just going to be up in the atmosphere so it gets released by things we do on the ground here, and then it goes up in our atmosphere, but it can't escape into the outer space, because we have a sort of invisible blanket that covers the planet that keeps all the of the gases, and everything in our atmosphere. So, it's not going to actually go up to the sun. And in terms of when the sun is going to explode, I don't think any of us really know the answer to that question. Certainly, the lifetime of the sun is not going to be infinite, but we don't really have a good sense of when that will happen. Millions of years, probably."

13. What if we help the polar bears by feeding them?

"This is a hard one, because we all get very saddened by images of polar bears not being able to feed, and polar bears dying. What they do is go out on the sea ice, and look for openings and cracks in the ice where the seals come up to get a breath of air. And they wait at these holes, and as soon as a seal pops up, they pounce on it. And that's how they eat, and it really is their only or primary food source. And so if they can't get to the seals they basically don't eat. Whether or not they could adapt to eating on land -- if all of a sudden, they're stuck on land and they can't get out to the seals -- can they eat caribou or muskox? I don't think the polar bears would be able to adapt that quickly, because this is a change that's going to happen probably very, very fast for them, and they're not going to be able to adapt quick enough. But there have been some interesting stories about hybrid bears being found; so a grizzly mating with a polar bear. They have found a couple of those now. So maybe there is some way the species is going to do some adaptations, I don't really know."

14. How come we don’t put polar bears in captivity?

"There are some polar bears in zoos, but if you've been to the Denver Zoo and you've seen those polar bears, they don't look very happy. They're not in the right climate for them. They need to be in the frozen North, and instead they're in Denver where it gets up to 100 degrees in the summertime, that's not the right environment for polar bears to be in. I mean, they should really be in the Arctic, where they belong."

15. Do you enjoy being a scientist?

"I do, it's interesting because you're always learning new things, and you try to get money to different studies, and come up with creative ideas, and help other people find it interesting as well, and fund your research board. For me, I really enjoy field work, so if I get a chance to go to the Arctic to see the different studies, with space data that I'm getting from satellites, I love that, it's my favorite part of the job, is getting to go to the Arctic. And it's adventurous, it's great. And there is pressure that you have to publish, and you have to do a lot of presentations about your work, but

you're also very free to choose what you want to study, and what you want to learn about, and that's really nice."

16. How do you make global warming not happen?

"Basically, we're going to have to start really reducing the activities and things that are causing carbon dioxide, CO2 damage going up. And there's a lot of governments getting together soon in December in Copenhagen in Denmark, to renegotiate what we should be doing with our emissions. But even these negotiations are showing that we're going to be really a lot more CO2 in the atmosphere than what a lot of scientists is past a dangerous level. And a lot of scientists are thinking, in order to really start to change that, you're going to have to stop your coal fire power plant, that's one thing we'll have to eradicate to reduce our CO2. And that's going to take some time to do, but that's the main thing that is going to have to happen."

17. What about penguins?

"They live in Antarctica, and for the most part, Antarctica is not warming as quickly as the Arctic. So, it's a little bit sheltered from some of the warmness that's happening, so the penguin colonies tend to be a bit more stable right now, but they're very, very sensitive to climate change. There was a warming event that happened in the 70's and the Emperor penguins in that region - 50% of the population declined. It's been about 5 years, and they haven't come back. They're a very long-lived species, they only give birth to one chick a year, and they can't handle such dramatic events in their population. If you look at projections of what's going to happen to sea ice overtime in Antarctica, that's going to go down over time as well, and the extinction rate for penguins is pretty high if that happens. So certainly, right now Antarctica is not warming as fast, but the projections are all going to be for a lot of warming in Antarctica too, eventually, which means the penguins are going to suffer as well, eventually."

18. Could we put the polar bears in Antarctica?

"One thing, I guess, they might eat up all the penguins, that's probably not a good idea. There was a story from this guy that was studying some birds in the Arctic, and some polar bears were stranded on this island, and he was studying these birds for 30 years, and these polar bears were stranded there, and the ice retreated, they couldn't get off, and they destroyed that bird population, completely wiped it out. So, I guess that could happen to the penguins, and that wouldn't be good."

19. You made a statement about Arctic warming faster than Antarctic – why would one be warming more than the other?

"They're very, very different in that for one, most all of the land masses are in the Northern Hemisphere. So, we have, the Arctic oceans covered by sea ice, the South pole's covered by land

and this big Antarctic continent, and there's not a whole lot of land in the Southern Hemisphere, and so what happens too is it's mostly influenced by changes going on in the ocean. The Antarctic's very protected and so it's actually determined mostly by the circulation that's going on with the ocean and the winds around Antarctica, and so they're very protective sort of what's going on in the Northern Hemisphere where all most of the warming's happening and all the human activity is happening that's affecting really those landmasses first, and Antarctica's a little protected but some things that are showing up is that there's the West Antarctic peninsula which is warming very, very quickly, and that's the part that's closest up towards South America. And so that part is warming very fast, I think it's actually maybe warming a little faster than the Arctic overall. Just in the Antarctic Peninsula, I think it's warmed 5 degrees in the last 20 years. Which is quite a bit. So any trends in melting, or collapses of ice shelves happening on that part of it. One thing that climate change shows in the Antarctic is you're actually going to get strengthening of the circumpolar vortex; the circulation around Antarctica. Which actually causes stronger winds and causes the ice to get pushed away from the coast of Antarctica, sea ice. Which then, in retrospect, causes more new ice formation, because those open water areas are exposed to the atmosphere. So right now, some climate models say 'well, as you keep warming up the planet, you strengthen that circulation around the Antarctic continent, which actually causes you to get more sea ice'. And so they're very different in how they respond to changes right now. Eventually, all the models will show that 'yes, Antarctica is going to melt, too'. It's just much, much further down the road than what's happening in the Northern Hemisphere."

20. Will seals die if sea ice melts?

"One thing that people have been seeing with the seal population, is that the seals are also dependent on the sea ice, so they basically build their nest to give birth to their pups under the snow that's on top of the sea ice. And so one thing that's been happening to the seals is that the ice is melting earlier in the spring, and so it's breaking up quicker, and then all those baby seal pups are being dumped into the ocean without being fully weaned yet. So, there's been some evidence of more seals dying and drowning because they're actually not fully weaned before the ice breaks up and melts. Also, the polar bears are probably finding them a little quicker and easier, because with the snow melting, all of a sudden, they're exposed. So, there is some sign of seals also being affected right now by changes in the sea ice."

21. What is the ozone layer?

"[One ozone molecule is made up of three oxygen atoms]. Basically, what it does is it helps block UV radiation from reaching the surface of the Earth. And I think it was the 70's, the scientists were able to discover that this ozone that tends to be in the stratosphere, so it's above the layer where we are -- we're in the lower troposphere -- higher and higher up in the stratosphere, that's where the ozone resides. And scientists noticed that there is a hole in that ozone layer, and it was over

Antarctica first, but now it's also in the Northern Hemisphere. And they discovered that there's a lot of gases that interact with those oxygen molecules that help break them down. And things like chlorofluorocarbons - CFCs, things like that, were really shown to be damaging to ozone, to breaking it down. But then a lot of work went into seeing that this was happening, and the governments came together and said 'look, we have to stop producing these chemicals that are breaking the ozone layer down' and so we did stop doing that, and the ozone layer is slowly coming back, which is a good thing."