Meltdown: Inside Out
transcript

Intro

Cronkite: From the massive ice sheet of Antarctica, to the pack ice of the Arctic Ocean, ten percent of the earth's surface is covered in ice. It contains most of the planet's fresh water; it reflects the sun's heat back into space, it is the habitat of some of the most unusual animals on Earth…and it's melting.

I'm Walter Cronkite, and this is *Meltdown: Inside Out*. Our planet's ice cover is melting faster than at any time in recorded history. Scientists see a bellwether of global warming:

Thompson: To me, it's some of the clearest evidence we can present that the world is changing, and that we should be concerned about it.

Cronkite: In the next hour we'll travel from pole to pole to learn what the loss of ice means for our world's climate and ecosystems. *Meltdown: Inside Out* is next; first, this news.

Part I

Cronkite: You're listening to a special report from WBUR Boston—*Meltdown: Inside Out*. Hello, I'm Walter Cronkite.

First, I want to talk to you about global warming. Let's agree on one thing: that as a whole, planet Earth is getting warmer. The world's scientists and industry leaders, and even its politicians are in accord on this much. The questions now are how will the planet be affected by this warming, and how fast will these changes occur? In this program we'll be focusing on what climate change means for the future of the world's ice.

From Greenland to Antarctica, from the Arctic Ocean to the Andes, we'll hear firsthand accounts of the latest research on three kinds: ice sheets, mountain glaciers and sea ice. Our guide to these "hotspots of cold" is veteran science journalist Daniel Grossman.

We begin in Greenland, the world's largest island, the size of the United States east of the Mississippi. Most of Greenland is covered by an ice sheet, containing enough ice to add as much as twenty-three feet to sea level world-wide – if it all melted.

Under the pressure of its stupendous mass, the Greenland ice sheet flows from its center, two miles thick, to its perimeter, where great rivers of ice called outlet glaciers squeeze through narrow passes in Greenland's rocky rim to the sea.

Lately, a dramatic increase in the flow of these outlet glaciers has attracted the interest of many of the world's experts on climate change and ice. With growing evidence that the ice sheets of Greenland and Antarctica may not be as stable as once thought, scientists are intensifying their efforts in the field. To get an idea of what they're finding, we join reporter Daniel Grossman on the Greenland coast, in the town of Ilulissat.

sound of barking dogs, water

Grossman: Ilulissat on this warm spring day looks like other Inuit towns I've visited. The prefab houses are painted in pastel hues, and sled dogs lounge in the yards. But this village of native hunters has a distinction. It has front row seats for watching the drama of global warming unfold. Ilullisat is located at the mouth of a thirty-mile-long fjord that begins at Jakobshavn Isbrae, the world's fastest moving glacier, probably the birthplace

of the iceberg that sunk the Titanic. I'm here to learn about the Greenland ice sheet, and I've chartered a boat to see bergs break off into the ocean.

boat sound

Grossman: For most of the 1990s, Jakobshavn, one of Greenland's major outlet glaciers, flowed at about two feet an hour. Though no faster that a garden snail, that's exceptionally fast for a glacier. Then, just before the year 2000, scientists were shocked when it suddenly doubled its speed. The outlet glacier now spews out icebergs the size of a city block at a phenomenal rate—about 50 billion tons of bergs a year. It's too dangerous to go to Jakobshavn itself, so we've steamed to the Eqi glacier, 6 hours north.

calving sound

Grossman: It looks like a frothy river rapids frozen in place, squeezed between low hills of grey stone. The seemingly motionless stream is made of thousands of bluish blocks of fractured ice. It fans out where it hits the sea, forming a sheer cliff many stories high. Every few minutes a hunk the size of a truck, or even a house, peels off the face in clouds of spray and pulverized ice. This is "calving."

calving sound

Grossman: Until the late 1990s, scientists did not expect global warming to have much impact on the Greenland ice sheet. Then Jakobshavn and two other big outlet glaciers started calving at unprecedented rates.

In 2007 the ice sheet lost about twice as much ice as all the ice in the Alps. Some researchers say it's possible the ice sheet could shed mass even faster. They point to new evidence that the entire perimeter of the massive ice sheet is beginning to accelerate seaward.

calving sound

There's plenty of sound and fury here on the coast where the glaciers calve. But to understand what it's signifying, many researcher travel miles inland, on top of the ice sheet. I'm hitching a helicopter ride to a research site where's I'll join some of them. I've borrowed a duffle bag of heavy polar clothing, because though it's spring-like here on the coast, where I'm going its far below freezing.

zipping sound, wind, snow falling on tent

Grossman: Two days later, it's morning and I'm camped out at Swiss Camp, a research base 50 miles inland. It's run by Professor Konrad Steffen of the University of Colorado. There's nearly a mile of ice below me. Three cloth tents on steel frames—each about the size of a one-car garage—serve as kitchen, office and workshop. There's also a tower with weather sensors and half a dozen pale pink and yellow canvas tents for sleeping. Steffen first came here in 1990 to study Greenland's weather. He later bought the base, for three dollars, from the Swiss researcher who built it, saving the seller the trouble and expense of packing up all the gear and carting it home.

Steffen: I have a network of twenty automatic weather stations sitting on the ice sheet. They're all measuring about 30 parameters and transmit the data via satellite every hour back to Boulder, to our university.

Grossman: Steffen analyzes the data where it's warm and comfortable. But here, where he comes for a few weeks each year, it's nearly zero degrees Fahrenheit and snowing. Even in the tent the water bottle in the bottom of my expedition down sleeping bag froze solid overnight. But Steffen says it's not as cold here as it used to be. In the first several years he recorded, temperatures went down. He now knows this was the local impact of Mount Pinatubo, the volcano in the Philippines that erupted cataclysmically in 1991. It ejected million of tons of gasses and particulate matter high into the atmosphere and cooled the entire planet for several years.

Steffen: And then it started to get warmer. 1995 suddenly we had a huge melt here. And these meltings occurred more frequently. And about 1998 I realized that circumstances are not the same. It's getting really warmer at this location.

Grossman: Earth has warmed an average of about one degree Fahrenheit since the mid-1970s; the Arctic is warming much faster. Swiss Camp's winter temperature has risen about seven degrees since 1991, and the winter of 2006 was the warmest yet.

Steffen: Our weather stations told me, for example, in December and in January we should have had temperatures about minus twenty, minus thirty, minus forty degrees here. It was melting. In the middle of the winter we had several events. The thermometer was above the freezing point and we can see that in the snow because we have ice layers. This has not happened in 16 years.

Grossman: Many researchers are trying to figure out what's happening to the ice sheet. One of them is Jose Rial, a seismologist—an earthquake sleuth—from the University of North Carolina. Rial has joined Steffen at Swiss Camp for the last several weeks.

snowmobile being started

Rial: We don't do these things because they are easy. We do them because they are hard.

Grossman: Despite the fact that Rial grew up in the tropics of Venezuela, he seems at home dashing through the snow so near the North Pole. His head of wild white hair and bulky red parka give him a look vaguely reminiscent of Saint Nick.

Rial (talking to fellow passenger): Heigh-ho silver! (laughs)

snowmobile sound

Grossman: The seismologist began his career listening for the signs of covert Soviet nuclear explosions. Now he's using essentially the same equipment—super sensitive vibration sensors—to detect movement below and around Swiss Camp. Today's he's off to collect computer memory chips with data from a network of ten detectors he's deployed in a ring seven miles across. His route will take many frigid hours driving through the Arctic twilight.

Rial: Are you ready?

Assistant: Yes, I am ready.

snowmobile takes off into the distance

Grossman: I meet Rial the next day, rested and warmed with coffee from the camp's overworked espresso pot. He's viewing his first week of data on a laptop.

Rial: …hooohh…Oh man! This is going to be a bonanza…

Steffen: Oh, you've found another?

Rial: Look at this…There are events everywhere.

Grossman: The computer screen displays rows of wiggly lines showing how the ice jiggled in several places. Nobody has ever put such seismic stations on the ice sheet before. So he's unsure what to expect. He does hope to detect ice blocks at Jakobshavn Isbrae, miles away, scraping the bedrock as they march seaward or actually snap off into the ocean. If he's captured such an event, he says it should show up as identical signals arriving twenty seconds apart at two of his stations.

Rial: This is awesome! Look at that. This is about…oh sheeeuhh…Twenty [bleep] seconds! Hoohhaahh… [laughter]

Grossman: Konrad Steffen and other researchers in the cramped tent crowd around to witness Rial's discovery.

Rial: Oh my God! This is [bleep] Jakobshavn. I don't know what I have with all those clicks there—that's a problem.

Grossman: Rial can't tell what these results mean; they're too fresh. But when I call him some months later to learn more he says he's since discovered something even more important than the wiggles that excited him at Swiss Camp. He's found powerful ten- to twenty-minute rumbles that he believes are caused by pieces of the entire Greenland ice sheet dragging across its bedrock foundation. He estimates that the subsonic vibrations could be the thunderous thumping of a block of up to fifty cubic miles lurching fifteen feet. These measurements show that dramatic changes to the ice sheet are going on not only at the surface, but also deep below. They add weight to earlier research by NASA scientist Jay Zwally, who's been visiting the ice sheet for thirty-five years.

Zwally: The thinning at the margins that we've measured in the 1990s is an indication that the ice sheet responding to climate change. Now we're also seeing that some of the glaciers are accelerating, as detected by ice quakes, and we're seeing the melt acceleration here.

sound of airplane idling and taking off from ice sheet

Grossman: I've joined Zwally and Steffen in a ski-equipped prop airplane. By air, it's just a short hop from Swiss Camp to the site of a new weather station. From the sky I see that the snow-covered ice sheet is not the featureless plain it seems to be from the ground. It undulates gently, subtly echoing the hills and valleys of its rocky base. In places it has jagged cracks, and frozen rivers and lakes. I'm told that last winter's snow cover will soon be slick glare ice, crisscrossed by fast-flowing meltwater streams and rivers.

sound inside plane, props slowing down and material being moved out

Grossman: The researchers haul out toolboxes, shovels, electronics and hardware.

Sampson: Now we're going to hop out in a second. Yeah the toolbox…

sounds of assembling station, voices, augur drilling.

Grossman: The team assembles the station from pipes and cables and nuts and bolts. It looks like an artificial Christmas tree laid out flat on the snow, with a round antenna at the top, and shiny boughs.

Sampson: Where do you want to go with it?

Grossman: They drill a hole in the surface with an ice fisherman's auger. Together they hoist the contraption upright like the flag-raising soldiers at Iwo Jima and drop the bottom end into the hole.

Steffen: Okay. One two three….

Grossman: Hanging down like silvery ornaments are an odd assortment of instruments that measure sunlight, temperature, wind speed and direction, as well as snowfall. There's also a global positioning system, or GPS, device. That's Jay Zwally's experiment.

Zwally: We plant a pole in the ice with an antenna on, and then we have a GPS receiver that records the position of the pole in the ice, and then as it moves along with the ice, it tells us how fast the ice is moving.

Grossman: Zwally installed his first GPS device at Swiss Camp, in 1995. He was curious to know if the ice moved uniformly or changed over course of the year.

Zwally: And after we got one year's data back, we discovered that the first year there was almost no change.

Grossman: There, 50 miles from the coast, the ice crept seaward a foot a day without variation, as researchers thought it should; nothing interesting there. So Zwally stopped paying attention. But his device kept collecting data and, in 1999, the scientist took another look.

Zwally: We found that there was a significant speed up. And now we have measurements that show that the speed doubles in the summertime.

Grossman: From one foot a day to two feet a day. It doesn't sound like much. But a doubling in speed is big news. It's sort of as if the sun suddenly sped up in the sky. Zwally says the acceleration must mean that the ice sheet is getting unstuck from its bedrock and sliding seaward.

Zwally: These are new things in the ice sheet that will most likely make the losses larger in the future.

sounds of Steffen getting ready to go out on his snowmobile

Grossman: Back at Swiss Camp, Konrad Steffen is trying to find out why. With help from graduate student Kevin Sampson, he's setting up a radar device towed on a sled. He'll use it to peer into the upper 50 feet of the ice sheet. He's wants to know how warmth on top could influence the bottom.

Steffen: You want to follow?
Sampson: Yeah. How far you going to go?
Steffen: Oh, just across the basin.

start snowmobile

Grossman: Steffen thinks water from melting snow is the key to explaining the changes on the perimeter of the ice sheet. In summertime snow on the surface of ice sheet's rim thaws, producing torrents of water. Could this melt water trickle through a mile of solid ice to the bottom? Steffen says yes, because the ice isn't actually solid. It's riddled with cracks, like the ones I saw from the air.

Steffen: And the water can percolate through these ice cracks and actually reach the base of the ice sheet. It's like you put a small cushion underneath. And then it starts to move faster.

Grossman: Many glaciologists agree that summer meltwater is lubricating the base of the ice sheet's perimeter, causing it to sprint seaward. They say the sliding is in part responsible for the massive changes at the Jakobshavn outlet glacier.

Steffen: What does it mean? It's only a glacier. But if you start to have these outlet glaciers to advance that fast, they can actually draw out mass from further back. And you have to remember that we have three thousand meters of ice in the center of Greenland.

Grossman: Between 2005 and 2007 the amount of surface-melt across the ice sheet increased by ten percent. I asked Steffen recently about his latest expedition to Swiss Camp in the summer of 2007. He said the ice sheet's surface had thinned substantially since the previous summer.

Steffen: We lost about 1.2 to 2 meters of ice. And this has not happened in 18 years. And that shows me that we are increasing the area in Greenland where you melt, where you have meltwater ponding.

Grossman: Early in 2007, a team of scientists, including Konrad Steffen, reported the first evidence of similar large-scale melting in the interior of Antarctica. If meltwater there reaches bedrock, that would be even more worrisome, as the southern continent has ten times the amount of ice in Greenland.

Much of Greenland's ice sheet, as well as part of Antarctic's ice sheet, disappeared 130,000 years ago when Earth was only a few degrees warmer than today. If warming continues unchecked, Earth could reach that same temperature later this century. The collapse of the ice sheets would lag behind by many decades, if not centuries, but the result would be a catastrophic rise in sea level, inundating some of the world's largest cities.

music

Cronkite: Most of the world's ice resides in the massive Greenland and Antarctic ice sheets. But there are literally thousands of glaciers on mountains around the world, many in imminent danger from global warming.

After a short break we'll join reporter Daniel Grossman in South America, where scientist Lonnie Thompson is studying mountain glaciers. This is Walter Cronkite. You're listening to a special report from WBUR Boston—*Meltdown: Inside Out*.

Part II

Cronkite: You're listening to a special report from WBUR Boston—*Meltdown: Inside Out*. This is Walter Cronkite. Later in this program we'll travel from pole to pole with reporter Daniel Grossman, but first:

Anyone who's ever been to Glacier National Park or even just looked at a picture of the Swiss Alps knows that mountain glaciers are beautiful to behold. They also play an important role in regulating the flow of rivers and maintaining water supplies. But mountain glaciers, almost everywhere on Earth, are receding—melting down.

We continue our program in Peru, where Daniel Grossman has joined renowned scientist Lonnie Thompson on an expedition in the Andes Mountains.

sound of walking stick, hiking

Grossman: Lonnie Thompson hikes up a steep mountain-lined valley 40 miles outside of Cuzco, Peru. He sometimes doubles over gasping for breath. His asthma is sometimes exacerbated by extreme altitude, but he's made more than fifty mountain expeditions on five continents.

Thompson: And I have this vision of nighttime, crossing one of the passes out here, about a day's journey away, just totally sick, and puking between the ears of this horse.

Grossman: Thompson is a glaciologist at Ohio State University and one of America's most celebrated and decorated scientists. Recently he received the coveted Presidential Medal of Science. Thirty years ago, when he began his career, he was an outsider. He wanted to use ice cores from tropical mountains to study climate, at a time when other climate researchers were focusing on polar ice.

Thompson: You know, people don't normally think about tropics and ice. They don't go together. But here on these high mountaintops, they're a very distinct recorder of the history in this part of the world.

Grossman: Over the years, Thompson begged and borrowed to pay for his work, and eventually proved the value of tropical ice research. Now, his studies, like those of other scientists profiled in this program, are funded by the National Science Foundation.

Today, shielded from the sun above by a floppy wide-brimmed hat and supported from below by a steel-tipped walking stick, Lonnie Thompson is following the footsteps of an 18th century cleric. He's on the trail of a so-called miracle that created the opportunity for bona-fide scientific research.

Andean music, reading of fragment of Qoyllur Rit'i legend in Spanish

Translation: In the ranchlands of Ocongate there lived an indigenous man named Mayata. His ranch was located in the lowlands valley of Sinakara, at the foot of the majestic snowcapped peak of Qolqepunku.

Grossman: The legendary incident occurred on June 12, 1783 right here in Peru's Sinakara valley. As told in this version of the story, a church inquisitor was investigating a report by a shepherd of possible sacrilege by a mysterious young visitor.

Translation: Anxious to capture him, Dr. Lander reached out and to his great surprise caught ahold of a little tayanka shrub that grew from the rock.

Grossman: When the clergyman apprehended the youth under a headwall of craggy glaciated mountains he was dazzled with light. Suddenly, where the boy had been, Christ appeared, in agony.

Translation: He seemed to cry out 'my God. My God, why have you forsaken me.' Confused and stupefied, the men all fell to their knees in an ecstasy of faith.

music ends

Grossman: Fast-forward about one hundred fifty years: The location of the vision has become a holy site, attended each June by crowds of pilgrims. In the mid-1930s celebrated Peruvian photographer Martin Chambi made the arduous trek himself, lugging his heavy wooden camera.

sound of Thompson hiking

Thompson: It's up there…I think he was up on this slope here…looking down on the glacier…because you can see it.

Grossman: On this day, about seventy-five years later, glaciologist Lonnie Thompson is huffing and puffing up this worn path. He bears no offerings. But he does carry reproductions of photos Chambi snapped here.

Thompson: We want to look and see how much ice has been lost since the 1930s, by repeating photographs in about the same place.

Grossman: The snow-wrapped mountains captured by Chambi appear in living color as the scientist rounds a bend, searching for the exact vantage point from which the original photos were taken.

Thompson: You can see the change up there, for sure.

Grossman: Of course he hasn't yet been able to superimpose the Chambi shot on a photo from the present. But even eyeballing it, Thompson can see already that these glaciers are suffering.

Thompson: Particularly the one square in front of us. And that has lowered 100, 150 meters from where it was in the mid-30s. And then there's a number of glaciers here that have completely disappeared.

Grossman: These wasted ice fields are a few data points—puzzle pieces in the jigsaw of what's happening to the world's small glaciers, about 100,000 of them. Around the world they're melting. The World Glacier Monitoring service, based in Switzerland, recently announced results of a global survey of twenty-seven glaciers in nine mountain ranges. The glaciers lost a stunning thirty feet in thickness, on average, between 1980 and 2005.

A paper published in August of 2007 in the journal Science, predicts a loss of up to one-third of the volume of the world's small glaciers by the century's end. Although small glaciers contain much less water than the ice sheets of Greenland and Antarctica, the Science paper say they will be the leading cause of rising sea levels, at least through 2050.

Thompson wants precise figures: how fast are such glaciers melting and what happens when they're gone. He'll move mountains, or at least climb them, to find out.

Snorting horse, horses going through a stream, people walking

Grossman: I've joined Thompson on another trip, a day's drive from the site of the pilgrimage. Our destination is the Quelccaya Ice cap, the first tropical glacier Thompson studied thirty-three years ago. He's returned twenty-seven times since. We're a team of nineteen, including several reporters, six researchers, a cook and native guides. Our packs and cases are lashed to a dozen horses and donkeys. We labor up a boulder-strewn ridge and there, beyond more ridges and valleys, is what looks like a huge brilliant white bank of snow, the Quelccaya Ice cap. It's the world's largest tropical glacier. Thompson first came here to drill a core of ice at the summit, 18,500 feet above sea level.

Thompson: It's like a book. If you imagine a tree ring, there's a dust layer here every year. That record goes back over fifteen hundred years. So it's a very long, well kept record of the history of climate and environment in this part of the world.

Grossman: Thompson's team makes a base camp at the edge of the ice cap, where sharp shards of chocolate brown stone give way to Quelccaya's glittering dome. The distant valleys and ridges are dry and barren, but here there's water everywhere. It dribbles off the ice cap's edges, creating sparkling icicles. One day the researchers hike around the perimeter of the ice cap to a vantage point for viewing the Quelccaya's largest outlet glacier. It's a tongue of fractured ice hundreds of feet long that spills down from near the summit like a frozen water fall.

Thompson: Well, since the first aerial photograph was taken here, this whole ice cap has shrunk about thirty percent.
Grossman (in actuality): Looks like a lot of ice to me.
Thompson: A lot of ice, and a lot less than when we first came here.

Grossman: Thompson has been snapping photos of this outlet glacier from the exact same spot with a precision camera nearly every year for almost three decades. With these images he monitors its health as carefully as a pediatrician tracks a newborn's weight.

Thompson: If you look in the valley you can see that it took a hundred and fifty years for it to retreat up to where the edge of the lake is. That's where the ice was in 1978. A photo from last year has the ice coming down into the lake all the way across. This year we can see a huge amount of bedrock exposed on the right side of the glacier.
Grossman (in actuality): Is this more than you expected?
Thompson: Yes. We see these incremental changes every year. But this is much more than what we saw last year or the previous year.

Grossman: Thompson's predicts the ice tongue will retreat right up the cliff and will surely be gone within a decade. He says Quelccaya is now smaller than it's been in about 5,000 years.

Thompson: It's sad to see something you've worked on most of your life disappear before your eyes, and I think there's a real possibility, depending on my health, that I may be able to see the place where the drill hit bedrock back in 1983.
Grossman (in actuality): So the canary in the mine turned out to be on top of a mountain?
Thompson: Well, I think these tropical glaciers are canaries because what they tell us is that for an area known for its continuity of temperature, that temperatures are rising.

What's happening here in Quelccaya is happening on Mt. Kilimanjaro in Africa, on Mount Kenya, and throughout the Himalayas. So it's something we should take heed of.

Grossman: Thompson believes there is at least one good thing that can come from his life's work here: to convince the world that global warming is real and deadly serious, not a hoax or a half-baked theory.

Thompson: Quelccaya has no political agenda. It is summing up what's happening to its environment, and it's retreating. To me it's some of the clearest evidence that we can present to politicians, or policy makers, that the world is changing, and that we should be concerned about it.

sound of meeting, applause, speaker in hall

Grossman: Alpaca herders of Peru's high Andes are taking heed. Many of them graze their flocks at least part of the year in glacier-fed wetlands. Some such marshes are drying up, stressing livestock, and causing disputes over water rights and land use. Thompson is speaking to a gathering of shepherds and village representatives about global warming and its impacts, in Sicuani, the largest town near Quelccaya. A woman in the audience says that poor people in less-developed countries like Peru are taking the brunt of the problem. "What can we do?" she asks.

Thompson (speaking to audience): When I look at this issue, you are absolutely right. The most impacted are, in my opinion, the ones who have least contributed to the problem and yet have the least resources to actually deal with the changes that come along…

Grossman: While the people here can do little to slow global warming, Thompson says they must find ways to cope with the loss of the glaciers.

Thompson (speaking to audience): …well, the glaciers store water; they release it in the dry season…

Grossman: And western Peru has virtually no rain for six months a year. Everybody there needs water when it's dry; herders, farmers, as well as city dwellers. Dams may be one way to compensate for the loss of glacial meltwater. The problem is Peru can't afford a public works project of that magnitude.

Thompson and his colleagues keep coming up with more evidence that the world's small glaciers are under siege.

Thompson: We are seeing I believe an acceleration in the rate that ice is being lost in the tropics. And in many of these places we've passed what we might call the threshold of viability for these ice fields. They are remnants of another climate, and they will continue to disintegrate and ultimately disappear in today's climate.

music

Cronkite: In the program so far, we've been concerned with glaciers and ice sheets. But another important kind of ice floats: sea ice. When we return, reporter Daniel Grossman travels to the ends of the Earth, literally, to learn what's happening to sea ice and why it matters. This is Walter Cronkite. You're listening to a special report from WBUR Boston—*Meltdown: Inside Out*.

Part III

Cronkite: You're listening to a special report from WBUR Boston—*Meltdown: Inside Out*. This is Walter Cronkite.

Viewed from outer space, Earth is like a precious marble, streaked in tan and green and awash in blue. The Arctic ice cap perches on top, like a spotless doily. But now scientists are finding that sea ice, at both poles, is dwindling as Earth's climate heats up. In the final part of our program, we'll traverse the globe from bottom to top, to uncover the implications of this sea ice meltdown. But first: to Boulder, Colorado—and Daniel Grossman:

sounds of water, bird songs, creek

Grossman: High on a bluff overlooking Boulder is the castle-like Mesa Laboratory of the National Center for Atmospheric Research. It seems about as far as you can get from the polar oceans. But as home to several important climate research organizations, Boulder is a leading center of ice study. Ironically, Arapaho glacier—the headwaters of Boulder Creek, one source of the city's water supply—is shrinking rapidly. Inside the laboratory, ice specialist Marika Holland is viewing a video animation showing a forecast she's made of the Arctic ice cap.

Holland: So this is basically showing the sea ice cover at the end of the twentieth century, and you can see it's fairly stable from one year to the next—it has decreased a little bit by the beginning of the twenty-first century.

Grossman: Holland is a second-generation climate scientist. She's sitting in the same office her dad occupied until he retired several years ago. Her animation, produced with help from a supercomputer four flights below, is like a jerky home movie of planet Earth from space. The continents are black, the ocean is blue. And a morphing white blob in the center is the Arctic Ice cap. The years click by briskly from 1990 to 2049.

Holland: And then, you see it when it essentially goes.

Grossman: Each year the Arctic ice cap grows in the winter to a bit more than the combined area of the U.S. and Mexico, and then shrinks to about half that size in the summer. This animation shows the cap at its annual minimum, each September.

Holland: Yeah, you're going along, and then [snaps] boom! The ice cover retreats very rapidly. It goes around the year 2025.

Grossman: This would be the first time in thousands of years that the Arctic Ocean was ice-free. Clearly, Holland is a little unnerved by the prediction.

Holland: When I saw that in the climate model simulations, it was – it was a bit of a shock to me – I – I wasn't quite – I mean I was – I think that often we think of these changes as happening fairly gradually, and our models suggest that that's not necessarily the case.

Serreze: It is what we call a tipping point.

Grossman: A mile away, Marika Holland's colleague, Mark Serreze is a research scientist at the National Snow and Ice Data Center. He says that his satellite data are in agreement with Holland's predictions.

Serreze: We have a pretty good record, I think; fifty years plus now, of sea ice. And we've seen this remarkable loss of ice through this period. And that change seems to be accelerating

Grossman: Arctic sea ice in the summer of 2007 reached an all-time low. There was about thirty-nine percent less ice compared with the average summer minimum between 1979 and 2000. That's a reduction in area about the same as that of Alaska, Texas and California combined.

Serreze: It's all part and parcel of a larger pattern of a warming Arctic. And it's not something we're going to worry about fifty years from now. It is here and now and we're seeing it unfold before our eyes.

Grossman: The astounding contraction of the ice cap has led a few scientists to conclude that the Arctic Ocean could be nearly clear of ice as early as the summer of 2012. Regardless of the exact date, Marika Holland says it's the suddenness of this transformation, predicted in her computer model, that really counts.

Holland: I mean, if the retreat happens really over a ten-year period versus over a forty-year period, that is going to affect how societies, ecosystems adapt to those changes.

Grossman: A surprising variety of life exists in and around sea ice, from microorganisms to megafauna. As the ice dwindles, this habitat is being adversely affected in ways that are complex and hard to predict. Nowhere is this clearer than along the coast of the Antarctic Peninsula, the mountainous finger of land that sticks up from the South Pole toward South America.

sound of ship getting underway

Grossman: In 2003, I visited ecologist Bill Fraser at Palmer Station, an American base on the peninsula. It took nearly a week to get there by ship from southernmost Chile. After I arrived, Fraser took me to Torgersen Island. We motored through narrow straights, close by glaciers that flow from craggy peaks right to the water's edge.

sound of Zodiac, chain being thrown ashore, walking on beach

Grossman: Torgersen is one of several windswept outcroppings on the edge of Antarctica's great ice sheet. Bill Fraser has been studying penguins there since 1974.

Fraser: Right now we're standing in what is colony seven of the Torgersen Island Rookery. Even a decade ago the area you see around you was one very large colony of Adélie penguins with about 1000 breeding pairs. It was just solid Adélie penguins.

sound of Adélie penguins honking

Grossman: Adélies are about knee-high and have the stereotypical black-and-white pattern of cartoon penguins like "Tennessee Tuxedo." They waddle hilariously when they walk. When Fraser started working here as a graduate student in 1974, the pebble-covered islands in this region were blanketed with nesting Adélies.

Fraser: There were just so many of these birds around. They were everywhere. All the major islands had them on breeding sites by the thousands. You could not go anywhere without seeing thousands of Adélies.

Grossman: He's gone back almost every year since. Fraser told me that on his 30-year watch, the population had plummeted.

Fraser: We were working initially with 15,200 pairs and today, in the same study site, we're working with a little over 4000 breeding pairs.

sound of Adélies

Fraser: There was a time when you could go on some of those islands and the volume of noise, just the voices of the birds constant droning, that doesn't exist anymore.

Grossman: How is this situation connected to global warming? It may seem counterintuitive at first, but one important factor may be too much snow. Fraser says that snowfall on these islands has increased substantially in recent decades. Ironically, the extra snow is related to reduced sea ice. Less ice means more evaporation and thus, more precipitation.

sound of gravel, penguins

Fraser: What seems to be going on is that there's just a limit to how much snow Adélies can handle over their breeding sites. And what I mean by that is that when Adélies arrive on at their breeding territories they have to have access to these gravel areas. But if the snow is too deep, their physiology doesn't allow them to wait out the melt.

Grossman: When I was in the Antarctic with Bill Fraser in 2003 he predicted that the Adélies around Palmer Station would be extinct within a decade. He said colonies elsewhere in Antarctica were still going strong, but the birds at his site were destined to disappear. I recently checked in with the scientist at his home in Montana to see what's happened.

Fraser: The population trajectories that you probably remember have continued. In fact Adélie penguins are down by eighty percent. Two years ago we had our first extinction on Litchfield Island. That is the first time in 700 years that no Adélie penguins have nested on that island.

Grossman: Bill Fraser says the Adélie penguins at Palmer Station now have about five years left.

By melting the polar lid on the northern and southern seas, global warming is not only disrupting regional climates and endangering wildlife. It's also creating new opportunities for exploiting the ocean's oil and mineral wealth. The Arctic, which faces the most pronounced change in sea ice, will probably see the biggest impacts. Travel through and activities in an increasingly hospitable Arctic are expected to explode in coming decades, with possibly severe adverse consequences.

sound of tackle being brought up in the Jan Mayen

Grossman: In the city of Tromsø, Norway, 200 miles inside the Arctic Circle, I board the Norwegian research ship Jan Mayen. We sail several days north to the Barents Sea, on the edge of the Arctic Ocean just 800 miles from the North Pole. The Jan Mayen is trawling for fish on the sea floor. Some years the sea here would be frozen by now—it's December and pitch-dark 'round the clock. But the Barents Sea has much less sea ice than even ten years ago.

more sound of tackle being brought up

A big metal spool reels in a greasy steel cable from the water onto the rusty deck. Suddenly, in a spray of salt water, the line hauls up a clattering cluster of metal floats and other tackle. Behind it there's a net wriggling with fish.

Nahrgang: Okay, this is a polar cod. So now I can open it.

sound of crunching fish

Nahrgang: Here you can see the liver...

Grossman: In a laboratory below decks, researcher Jasmine Nahrgang brushes locks of black hair from her face and takes a scalpel to a palm-size silvery fish.

Nahrgang: …you have one liver on each side of the fish. Here you can see the stomach…

Grossman: Nahrgang [NAH-rung], a graduate student at the University of Tromsø is one of a dozen young researchers on this bleak cruise. The Barents Sea is biologically the most productive part of the Arctic Ocean. It supports incredibly rich stocks of fish, birds and marine mammals, many of which migrate to distant points during some part of the year. In economic terms, this region accounts for two billion dollars a year worth of captured fish. But little is known about the long term affects on these northern species of contamination from oil.

Wassmann: Our knowledge of the Arctic is very spotty, in terms of space, geography, and even more in time.

Grossman: Paul Wassmann is a professor at the College of Fishery Science in Tromsø, and leader of this cruise. He says this rare winter expedition is needed because so little is known about Arctic ecosystems. Previously shielded from most human influences, this region is expected to face substantial industrial exploration and exploitation as the ice recedes.

Wassmann: Well, there are clear signs that the exploration of gas and oil will expand into the Arctic. The basic number which people talk about is that about 25 percent of the non-exploited oil and gas resources of the world are to be found in Arctic regions. The largest gas field is the Stockman field, which is in the northeast Barents Sea. It will be in production maybe in seven, eight, ten years.

Grossman: Wassmann's colleagues on this ship have trapped a variety marine life at different depths to get a detailed picture of the possible impacts of spills and accidents. They've bottled, bagged and frozen samples for laboratory study on the mainland. But it will take years to determine the extent of the threat to the region's wildlife, posed by pollution from oil exploration and greatly increased ship traffic.

news clip: Russians planting flag under ice cap

Grossman: The Russians are not the only ones claiming a share of the riches expected as the ice cap shrinks. All eight Arctic nations, including the United States and the five Nordic countries, expect a cut.

news clips: new territorial claims on the Arctic by Canada, Denmark, U.S.

Grossman: In October of 2007, the U.S. Coast Guard announced that it would build its first base on the Arctic Ocean near Barrow, Alaska. At roughly the same time, a boatload of Russian fertilizer landed in the Arctic port of Churchill, Manitoba. This shipment, Churchill's first import from its Arctic neighbor, marks the beginning of the long-awaited expansion of commerce across the Arctic Ocean, and the new reality of life in the polar regions:

Oil exploration, increased ship traffic, penguins losing their habitat in the far south, polar bears facing the same threat in the far north; these local and regional effects of reduced sea ice are troubling. But Mark Serreze, of the National Snow and Ice Data Center in Boulder, says such ecological and physical changes at the poles themselves are probably just the tip of the proverbial iceberg.

Serreze: The real wakeup call, I think, is that there's growing evidence that we change that Arctic sea ice cover, and it starts to impact conditions in lower latitudes.

Grossman: Serreze says Earth's climate, with its wind, rain, storms and clouds, is like a complex engine powered by differences in temperature between the hot equator and cold poles. Global warming is equalizing these temperatures differences. Mark Serreze is worried.

Serreze: So we lose that sea ice, could there be a surprise in there? Some surprise change in the atmospheric circulation that we have a hard time dealing with, say, extended drought in some regions. Let's say we change the nature of precipitation patterns in the American breadbasket. Well, that can very quickly have strong economic impacts on our nation. A lot of different studies are giving different results. But the common thread of all of them is that sea ice matters.

Alley: We have to get this sorted out and we have to get this sorted out quickly.

Grossman: Richard Alley, of Penn State University, is one of the world's leading glaciologists. He says all the world's ice, including the great polar ice sheets, is vulnerable.

Alley: We've seen changes going on in Greenland and changes going on in Antarctica that surprised a lot of us. And those surprises seem to have come from warming and they seem to be putting water into the oceans a hundred years ahead of schedule.

Grossman: Scientists are often uncomfortable going beyond the findings of their research and making policy prescriptions; that is exchanging lab coats for suits. But scientists are also citizens. Ice researchers seem especially vocal, perhaps because they're on the frontlines of climate-change study.

Scambos: We need turn this around. We need to grow up and take care of the planet with a view of humanity being here and having a place to live for centuries to come.

Grossman: Ted Scambos is a colleague of Mark Serreze at the National Snow and Ice Data Center. In 2002, Scambos recorded the spectacular disintegration of Antarctica's Larsen B ice shelf, a 700-foot thick wedge of ice the size of Rhode Island.

Scambos: We're used to thinking about the earth as being bottomless, so vast, so capable of handling us and supporting us that we could never exceed its capability. Now we've

reached the limit, and we need to start planning, and planning carefully, and acting as though everything that we do has consequences.

Grossman: When I started investigating the hotspots of Earth's cold spots, all the world's ice seemed impossibly distant, permanent and unchanging, and not that relevant to me. But then I saw with my own eyes that as remote as ice caps and ice sheets may be, they're crucially important to wildlife, to the climate, to ocean currents and to people. And I learned how quickly they're dwindling. Nobody is certain what all these changes in Earth's vast frozen regions will bring. But one thing is sure: we will each be profoundly affected by the consequences in our own lifetimes.

Cronkite: For the past hour, Daniel Grossman has taken us on a tour of the iciest reaches of planet Earth, where the signs of global warming range from almost imperceptible to almost ineffable. The bad news is that global temperatures are continuing their upward trend. The good news is that the pace of climate change study is accelerating as well. The scientists we've met in this program are at the vanguard of climate research today. It is vitally important that such work will continue to inform us, as we confront the economic, technological and political challenges posed by global warming, and struggle to maintain a place for ourselves, and our descendants, on this planet in an era of profound change.

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