Bracing for Impact: America's Risks and Resilience

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Recorded on March 18, 2013

Greg Dalton: Welcome to Climate One, a conversation about America's energy, economy and environment. To understand any of them, you have to understand them all. I'm Greg Dalton.

2012 was an astounding year of weather records. It was the hottest year ever in the United States, a searing drought parched more than half of the country, and a freak collision of thunderstorms slammed the Atlantic Coast, leaving four million people without power. The grand finale was Hurricane Sandy. Climate scientists have been warning about this kind of disruption for decades, and they say severe weather will become more fierce and more frequent in the future. Over the next hour, we'll look at recent wild weather, discuss what's ahead. Joining our live audience at the Commonwealth Club in San Francisco, we're pleased to have two people who spend their days thinking about this cheery topic. John Englander is author of *High Tide on Main Street: Rising Sea Level and the Coming Coastal Crisis*. Angela Fritz is a meteorologist and a climate scientist with Weather Underground. Please welcome them to Climate One.

[Applause]

Angela Fritz, let's begin with you and ask, how did you get into this interesting world of climate science?

Angela Fritz: Well, I originally started off knowing that I wanted to be a meteorologist from a young age. When I was very young, my mother said that I used to stand up next to the plate glass window in my living room and stare at the thunderstorms while the rest of my family was in the basement. So I just kind of knew -- I knew that's what I was gonna do. And so I went to college at Valparaiso University, studied meteorology, weather, went storm chasing every summer; it was great.

And then when I finished that, you know, it was getting towards my fourth year and I said, you know, what do I actually want to do with this, and I knew I didn't want to be on television and so, you know, what else is there. And I decided that I needed to kind of broaden that atmospheric science study into climate and climate science and then the relationship between weather and climate. And so that's really how it all started.

Greg Dalton: Great. And we'll get into that a little more about the distinction between weather and climate. John Englander, you were in Greenland in 2007. Tell us about how -- what happened there and how that led to the book on sea level rise.

John Englander: Sure. I have been involved with ocean issues for three or four decades, and in 2004, I was running what's called International SeaKeepers. It was a group of yacht owners who had a system that allowed their yachts to collect data and transmit it by satellite. And they were kind of all over the place politically, if you will, of left, right, conservative, liberal, but while I was helping them perfect that system and the data, I was concerned about climate change. It had become an issue for me back in the late '90s, some talks with Jacques Cousteau just before he died. And actually, the whole issue of climate environment is something that I've been interested in for

years but was confused about some issues. And as I was running the SeaKeepers, I took some of the billionaires to Greenland to look at ground zero for sea level rise, and there were still skepticism. And I was just, how do you communicate this. And standing there the first night, I realized, looking at the ocean, it's sea level because the sea level rises as the ice melts and the shoreline moves inland that it destroys real estate values.

And the coastline moving inland for the first time in 6,000 years is a story that gets everybody's attention no matter what their economic or social or even location because the people I was in Greenland with came from Denver. It was three families from Denver, Colorado, which will never face sea level rise there but were interested because of where dedication, where their relatives saw it then realizing that our global economy brings goods in through the coastal ports, and even if you live in a mile high city, you're dependent upon the coastal infrastructure and our economy, and that was telling to me and that's why I started to write the book.

Greg Dalton: And these billionaires, were they also -- that have the yachts presumably, were they also persuaded by that visual experience?

John Englander: Yes, I think they were. They came with different attitudes. There were three families on this particular trip adjusting -- then some of their teenage grand kids. But even though they came skeptical, we're clearly much more sensitized than persuaded by the end of the trip.

Greg Dalton: And do you know what they've done since with that knowledge? Is that affected in any way for the?

John Englander: I can't say that. I don't know. I've lost touch with that.

Greg Dalton: Let's talk about the distinction. Sea level has been rising and falling over many -- you know, many millennia, many --

John Englander: Yeah.

Greg Dalton: -- throughout the history of the earth. So how do we distinguish between what's happening now and the natural cycles that happens every 100,000 years or so the seas go through a cycle? So how do we know it's not natural cycles now?

John Englander: Absolutely. Well, humans have had an impact on things for centuries or, at the best, thousands of years going back to our earliest agriculture. That's kind of the belief that maybe over a thousand years, we've had some effect, okay, regardless of how long you think you -- how old the earth is or whatever. But that's about how far back it goes. Sea level history, as you alluded to, deals with the ice ages, and what I had studied in college, which gave me the great foundation for this, I've been fascinated to see that as the ice ages, which are roughly a 100,000-year cycle, driven by something called the Milankovitch cycle but that it's 95,000 to 125,000 years over a regular period, and for 5 million years, we've had an ice age roughly every 100,000 years.

And as two miles of ice melts, the ocean rises 300 feet or 400 feet. I think that was amazing. And we were ignorant of it because, for 6,000 years, they've been kind of at the present level which is more or less our civilization, in our perspective, and we go to the beach, we think that's where it's always been and always will be. But I was intrigued 40 years ago when I studied this, but back then, there was no concept that the ice sheets would melt. And now you've all seen photographs of the melting Arctic ice cap, and we know that the Arctic will be ice-free in September maybe in three years but certainly within 20 years. The fact that it's been frozen for three million years makes the case more clear than anything else that we're in different times.

Greg Dalton: And it's also, isn't it, that the rate of increase now, this happens over thousands of years were -- now it's happening over decades and centuries. Isn't that a key factor as well as that there's already 50 feet or so, you write, baked in, to what's already happened that we haven't seen.

John Englander: In fact -- and I missed the last part which is really key to your first -- your prior question which is sea level rise is up and down 300 feet or 400 feet. We're at the normal top spot, the normal warm point, and after 20,000 years of warming, we should be entering the 80,000-year phase toward cooling and growing ice sheets and dropping sea level. The fact that it's now doing the opposite, and the Arctic is melting, the ocean is eight-tenths of -- a degree and a half Fahrenheit warmer, proves that we've broken the cycle and that warming correlates with the amount of CO2 level which is 40% higher than it's been in the last 10 million years. And so that's the key. When you look at it in the historic context of ice ages, and that we should be entering an 80,000-year cooling but we're warming, that's the difference between the natural cycle and what is different now for the first time in 10 million years.

Greg Dalton: Angela Fritz, does that mean we've hit a tipping point?

Angela Fritz: Yeah. I think that we've probably -- I mean, it depends on what you consider a tipping point, but I think that we have reached the new normal. I think that's a phrase that a lot of people like to use as an analogy with the tipping point and I do think that we're in kind of this new paradigm of climate. The Anthropocene maybe is something that we can call this.

Greg Dalton: And so what does that mean? What does the Anthropocene mean?

Angela Fritz: The era influenced by humans, by anthropogenic influences. And I do think that we're seeing this, like John points out, in sea level rise. You know, that's physical evidence that this is happening, and it's not just a modeling, studying. It's not just something that's kind of remote, and his story about communicating, how to communicate that to people that may be skeptical and may not quite understand what's going on is something that's very near and dear to my heart and, you know, that's kind of -- we have taken similar paths. I always try and relate climate change to here, to San Francisco. If you're in San Francisco, what's gonna happen in Cleveland, Ohio, or Chicago or Denver, and I think that that's where it really hits home.

Greg Dalton: And over the last century, this would have been close to an inch of sea level rise, it's perceived to be something that happens very slowly gradually over time. Is that always gonna be the case or could it happen very quickly? I remember Richard Alley was here, a scientist from Climate -- from Penn State, says that it probably won't happen really fast, but it could.

John Englander: Well, three points. One is it's actually been seven or right inches, 18 centimeters in the last century.

Greg Dalton: Okay.

John Englander: Here in California, it's a little bit less. There's a cooler -- sea level isn't equal around the world, strangely, for some complicated reasons. The east coast is more. Here it's a little bit less. But sea level globally has been seven or eight inches higher than it -- 100 years ago.

Greg Dalton: Which doesn't sound like much.

John Englander: No, but it's rising. The rate of rise acceleration has doubled in the last 30 years. That's the first indicator of a problem. On a straight line basis, it will get to be a couple of feet by the end of the century, but it's increasing. And if you -- depending on how you plot the curve, you get to a meter or two meter by the end of the century. But to your last part of the question, "could it

get sudden," there are two things which could suddenly accelerate the projections. One is the release of methane, which is percolating out of the Arctic both in the seabed and the permafrost, and methane is far more powerful as a greenhouse gas or insulator or heat trapper than CO2. In fact, it's hundreds of times, but it deteriorates into CO2, so they say it's 20 times average more powerful over a century. Methane is one. The second one is there's two glaciers in the Antarctica that are softening, and if they release, as was predicted 35 years ago, they could dramatically, catastrophically rise sea level around the world, and they are not in the projections because it's still just a possibility not a probability.

Greg Dalton: I was at the International Arctic Research Center in Fairbanks, Alaska, a year or two ago, and there was a Russian scientist there looking at methane leaking from the ocean floor which, at that point, very few people were talking about. The New York Times had a huge spread on methane release from the tundra above land, and no one was looking at the methane coming from it. So there's a big part of like, "Oh, wow, they could come out of nowhere," so to speak, and change everyone's expectations about how fast this could happen.

John Englander: And the amount of methane buried in the seabed apparently is multiples of all the energy and fossil fuels that we look at, oil, petroleum and/or natural gas even or coal. It's a huge amount, but it is buried in permafrost and in the seabed. Japan just did an experiment last week to actually mine that methane.

They put something that I think a few hundred meters and did a technique to release the methane and then extract it to maybe able to use that energy which is an interesting idea but potentially risky because, if you provoke just like liquification with an earthquake, if you provoke it, you know, maybe we're gonna get this catastrophic rise. In history, about 50 million years ago, there was something called the "methane megafart" that scientists kind of loosely term it, which was a huge release of methane that caused the catastrophic climate change, but in geologic time, that happened over thousands of years. That's quick in geologic time. One of our problems is working fronting geologic timescales with human timescales now, and the warming and release is potentially much faster.

John Englander: And it's hard for our minds even to grok those two timescales. Let's start briefly about the IPCC, the most recent scientific report, which had a famous asterisk which excluded the potential melting from Greenland and Antarctica because they couldn't say it with high degree of confidence. Angela, tell us the significance of that little footnote and how it means that the science was actually much more cautious than this.

Angela Fritz: Right. The science actually, especially in the IPCC, does tend to be more cautious, and for something like the 2007 report where we thought, "Wow, this is really impactful," it was only the tip of the iceberg, so to speak. And even relating to John's point about methane and permafrost and the methane and seabeds, in the report that's going to come out this year, the Fifth Report, that is also -- that's another huge asterisk in this report that's coming out that they have gone into this saying, "The models don't capture this," we haven't even really tried just because it's such a huge question mark and it's hard for science to grasp exactly how much methane is there, and how much could potentially be released. And so you'll see something that comes out this year that might be very conservative and it's going to be -- I mean, they're saying it's likely to be much worse than this.

So whatever comes out, it's going to the low end, I think is what they're saying.

John Englander: You know, when it came -- the fourth assessment of 2007, as Angela said, is said between 18 and 59 centimeters which, for Americans, is 7 to 17 inches, and what a lot of the press did was they did two silly things. One is they said, "Well, 7 to 17 inches, average it, that's a foot. So a foot of sea level rise, if that's what the intergovernmental panel on climate change says it could be

the worst case," which isn't what they said at all, you know, "that's not too bad. We can cope with that." And they didn't notice, in effect, the asterisk at the top of the column and right below where it said, "This does not count dynamic changes in the ice sheets of Greenland and Antarctica, for the reason that, 93 years in the future from 2007, we can't predict exactly what they'll be because they're accelerating so quick. Now, that's -- so the only count of thermal expansion, as the ocean gets warmer and it expands very slightly, a few inches, and the glacier is melting basically, and what had already happened in Greenland and kind of straight lining it. Or it's ridiculous because 98% of the waters in Greenland and Antarctic are ice sheets.

Greg Dalton: Let's talk about 2012. We saw quite some amazing weather events in 2012. Angela Fritz, you have a -- on your blog, you had sort of a greatest hits of 2012. So run us through all the things that happened from the fires to floods, et cetera, in 2012. There's some amazing --

Angela Fritz: Yeah.

Greg Dalton: -- video footage as well that you got.

Angela Fritz: Everyone loves a good top ten list, right? So specifically, in July of -- or was it August of 2012 --

John Englander: The Watson River?

Angela Fritz: Yes. Greenland experienced melting that was unprecedented in satellite history, at least. And 90% -- 97% of the surface area of Greenland was warming at one time, and the result was that the Watson River and another river in Greenland, which tends to be where the melt water comes off in December, because Greenland does go through a melting phase in December, was double its prior record.

And so it took out bridges. There's videos on YouTube of just this raging river. And when I saw that, I have to say there are very few moments in climate change because it happens slowly and over time that you kind of grip your chair and think, "Oh, gosh," you know, "this is really big," and that was a big moment for me, you know. I think that that might have been a bigger moment for me even than Hurricane Sandy, which was another item from last year, or the wildfires or even the drought. That was kind of one of those, you know, this-is-happening-right-now moments.

Greg Dalton: And the reason you got that lump in your stomach is because you understand that's a visual conveyance of data, and you understand that if that starts to melt really fast, what that means for all these other things.

Angela Fritz: Right. And there's this idea that we don't know when the Greenland ice sheet could lose its stability and, I mean, literally slide off the continent. I mean, there are some scientific nuances to that, but the more that that melting, I could just imagine like getting under the ice sheet, between the continent and the ice sheet, and just lubricating it and then at what point do you start to see this ice slipping off into the ocean? And we could have already hit that point of no return with Greenland and we might not know it for a few years down the road. So when something like that happens, I always -- it's definitely a wake up call, even for climate scientists, I think.

Greg Dalton: The late great Stephen Schneider, climate scientist, was here one time and said that the tipping points are out there. We don't know where they are, and we may not know we've crossed them until 50 years after we've crossed them.

Let's talk a little bit about storms and droughts, how this may come home directly to more Americans. We saw some fantastic droughts and storms in 2012. Let's talk about the impact of

those and is that something we're gonna expect more of?

Angela Fritz: Right. So the great drought of 2012 was as bad as the Dust Bowl, and at one point, 62% of the United States was in more than a moderate drought, so that's what I would call, you know, an impressive drought across the United States. And as of late February, you know, unless we see some top 10% event in March or April, we're going to continue that drought into 2013, and it's hard to tell at this point how bad it could get in 2013.

So, again, we're looking at multi-year droughts now. This isn't just a single year event, and again the heat wave of last year was another reason for that drought and it kind of -- they amplify each other. They kind of feed off of each other, the drought and the heat, and we could be seeing more of that this year. There were some very interesting research just published by Jennifer Francis at Rutgers, where she found that Arctic sea ice loss and the greening, so to speak, of the Arctic and the continental areas around the Arctic could be changing how the jet stream pattern works, in effect. It's slowing it down. It's making it more amplified. I mean, what that means is that we are seeing more extreme weather and we likely will continue to see more extreme weather, and not only that, but it'll probably last longer because, you know, the way the jet stream works, the jet stream exists because the tropics are warm and the Arctic is cold, you know, and it's strengthened by the difference between those two things. So the warmer the Arctic, the colder -- I'm sorry, the warmer the tropics, the colder the Arctic, the stronger the jet stream is.

So what happens when you make the Arctic warmer but the tropics don't warm up as much? You know, and that's essentially what's happening here. You're weakening the jet stream so making it slower, and then you're also making the ridges and the troughs longer as well, so you're getting those extremes and you're getting longer extremes. And so that's -- that might be what we saw last year with the heat wave. You know, U.S. saw a record high last year in temperature in 2012. So they could be linked.

Greg Dalton: And isn't it also what's affected Hurricane Sandy and once thought that Sandy was going to -- will take it right out into the Atlantic, and all of a sudden, it took this dramatic turn which was unusual, unexpected. Was that the blocking of the jet stream?

Angela Fritz: It might have been. So as we were forecasting Hurricane Sandy, you know, five to ten days in advance, we saw Sandy kind of, you know, skirting along the east coast and then heading out to sea which is typical and what we would expect hurricanes and tropical cyclones in the North Atlantic to do. Somewhere between three and five days before, we saw the model start to come into agreement about Sandy taking that left hook toward the -- you know, toward the west and into the east coast. And, you know, the first time you see that in the model, you think, "Hm, I don't really know if I believe that so much," but then, you know, you start to see it in multiple simulations and you realize that this is what you're going for. And so while this was happening, there was a blocking pattern literally in the atmosphere. We call it a blocking pattern where the jet stream kind of slows down and pauses in its configuration. And that means that the weather around the blocking pattern kind of has to go around it, you know. It's basically a big block in the atmosphere and that's kind of what we saw with Sandy and the reason that it took that left hook into the coast.

And so the connection between the research that I was just talking about in Sandy is that could that have been because of the Arctic sea ice melt and the greening of the Arctic, and could we see more of that in the future? You know, would Sandy have happened with or without climate change, that's hard to tell and that's something that I don't think any scientist is willing to put their thumbprint on. But, you know, what happens once that storm develops? There's more water vapor in the atmosphere, sea level is rising which means higher surge, and now we've got more extreme jet stream patterns that could be searing the storms in ways that we didn't understand before.

Greg Dalton: If you're just joining us on the radio, Angela Fritz, is atmospheric scientist at Weather Underground. Other guest today at Climate One is John Englander, author of *High Tide on Main Street: Rising Sea Level and the Coming Coastal Crisis*. I'm Greg Dalton.

All right. John Englander, I want to get you in on Sandy, in particular, you know, the contribution of sea level rise to Sandy, and also the notion that you point out in your book is that, storms come and go, floods come and go, but sea level rise is permanent, other storm surges, but it's always there. It doesn't just go away.

John Englander: That's right. Even though people are heightened to what could happen by Sandy because it was a dramatic event and a place that you don't typically think of, and it was just coincidental that it happened a week after my book came out and I described that event hitting Atlantic City in New York, which was fortuitous, I guess, in some ways unfortunate that it happened, but I asked people to dissect it into a couple of different things. Sea level in New York is about a foot higher than it was a century ago, and it's going to rise long term and it's not gonna go down for 1,000 years. So that's one line on the graph, if you will. Then it could get worse because of the methane and the melting in Antarctica and Greenland, et cetera, as Angela is just talking about. That's the second component. The third is it was a storm, and storm surge, we're familiar with, whether it be hurricanes or a cyclone. Storms are episodic. They're hard to predict in terms of magnitude, location and when.

But -- and they recede. We recover from a storm. You don't recover from sea level rise because it won't go down for 1,000 years. So those are differences to your point. And then if a storm happens at high tide or, even worse, if it happens at an extreme high tide, a lunar high tide, as happened with Sandy, you have another foot of water on top of that -- for the storm to be based upon. And then we have the two things of the geologic topographic amplifiers. You have one here in the Bay Area of San Francisco. New York Harbor is another one, for different reasons. There are different geographic -- Providence Island is another one that I pointed out. So there are different configurations that we don't think of that have the tendency to amplify those storm surge and wave heights. And then there's the built environment, you know, what are the structures we build, the marinas, the sea walls, the things which either reflect or deflect a wave, or perhaps trap it. And people talked about could they have built a barrier in New York Harbor to stop the water coming in. And I said they could have, but they'll probably have a heck of a liability because they would have deflected it to New Jersey and it'd be even worse there. And so it's not the simplest situation when you've got that kind of a global storm surge.

Greg Dalton: So what are the areas that are most vulnerable? You write a lot about Florida and sandstone or limestone. So what are the areas where people really ought to be where in right now?

John Englander: Well, I live in Florida and -- well, people in South Florida tend to think that it -- to put up seawalls, that won't do any good, as I explained, because it's poor as limestone, and even if you built an impenetrable barrier around Florida or an island, it's just gonna come up through the middle of the ground because it's like a solid sponge, if you will, but with pores. So those areas, low-lying areas that are limestone are particularly vulnerable. But then there are places where the configuration forces water into the bit of a funnel.

You have that here in the Bay Area and the South Bay with other vulnerabilities of levies and liquification, but -- Narragansett Bay, any place where there's a bigger body of water that's going into a narrower body, the water's gonna pile up. And so that -- those are particular places -- not all over the world, frankly. But it's the -- so low land, porous rock, and then where you have a structure that funnels water.

Greg Dalton: So what's Florida doing about this?

John Englander: They're starting to get concerned. And it's different than out here because here, you have many state, local agencies and groups that are looking at what do we do, but the Bay Area will be here 200 years from now. It'll look different. There'll be some things that have changed, some adaptations, could be so amazing engineering exercises, but you have enough relief here of elevation that you're gonna be here. Miami won't be there 200 years from now. There's no way. I mean, it's six feet high and you -- it's just --it's gonna be in underwater. There may be a little island left. It would be like the northernmost island in the Florida Keys, but -- as opposed to part of the mainland. But people are starting to think about that and it's just starting, but Miami is three million people today and maybe will peak at four million by mid-century. I think it'll be 300,000 or 400,000 people living on house boats and stilt homes and things like that, a century or two from now. So it's a different future --

Greg Dalton: So Miami becomes Sausalito, that's what's gonna happen.

John Englander: I guess so.

Greg Dalton: There's a part in your book where you talked to people that you're at a cocktail party and you're saying you're writing a book on sea level rises. When someone -- people lean over to you and say -- what did they say?

John Englander: "How long do I have?"

Angela Fritz: Yeah.

John Englander: And they do it quietly. They don't want others to know. It's -- it was -- it happened to me repeatedly. Every time somebody said, "Oh, John is writing a book about sea level rise." It's like, "Psst," you know, "how long do we have?"

Angela Fritz: How long do we have?

Greg Dalton: Well, if I sell within a decade -- you're right, if I sell within a decade, I'll be okay, right? I'll keep my beachfront condo for ten years. I'll get out before people realize -- I'll be all right.

John Englander: I think generally that's true, but the truth is I try and be totally honest about it. We can give you an estimate of sea level's linear growth or curve. We can talk about the catastrophic things which could happen over a decade but haven't happened yet, although methane is starting. But then there's storm surge, as we saw with Sandy, we got to add that on top, and when that hits at a high tide. So the truth is there is no year or answer because of those variables, just those four. But this is a promise, it gets worse and worse by decade. That's all I can tell you, okay, for sure, and it will get worse for the next centuries. I can also prove that to you because the heat is in the ocean already.

Greg Dalton: And there are some things happening in Florida. There's a couple of Republican congressmen who've introduced a law which is called the -- with the Homeowners' Defense Act or something, it's called -- dubbed the "beach house bailout" which basically they're trying to position the federal government so that if there's a short fall and the state funds, if something like Sandy hits Florida, that the federal government is on the hook, sort of a promissory note to come bail out Florida if something like that happens. They want Uncle Sam to commit the money now.

John Englander: Yeah. I talk about several points what I call intelligent adaptation, and besides

seeing the big picture and looking at geologic, you know, particular situations, I say that you need to realize that, sooner or later, coastal properties will be -- known to be impermanent that they have a life, not like land that's inland. We use to think that all land was permanent. Coastal land now, whether it lasts 50 years or 250 years, it's not permanent. That's a concept. The second one to your point is -- is the fifth point of my five is that you can't count on government bailouts for the long-term because there is not enough money in the world to bail people out of sea level rise recovery, but you don't recover the land, okay, as opposed to storm recovery, where you can recover the land, and we haven't made that distinction yet.

Greg Dalton: I want to ask Angela Fritz a secret question, just between us. Where should we buy land?

[Laughter]

Angela Fritz: Not on the ocean front.

Greg Dalton: Okay. All right. All right.

Angela Fritz: Write that down.

Greg Dalton: Costa Rica?

Angela Fritz: Yeah, Costa Rica, maybe. So -- yeah. So there are some places that might be better off in climate change than others.

John Englander: Tropics?

Angela Fritz: The tropics might be good. You know, like I said, the tropics aren't going to warm as much as, say, the Arctic or anywhere else, in the world and so they're not going to see as much impact maybe, although, you know, they'll probably see more rain with more water vapor in the air. So if you can deal with the rain, maybe you'll want to move to Costa Rica or Nicaragua and then cross your fingers for no hurricanes.

Greg Dalton: Okay. John Englander, let's talk about Boston Vision. Some people have seen this coming for a long time. Boston has been hit a couple of times recently. Tell us about Boston Vision. 1988, some people in Boston sort of looked into the future fairly accurately.

John Englander: Yeah. It's an amazing little story that -- I do recall that and have some diagrams. In 1988, the Boston Society of Architects staged a competition to look at 100 years for what their city might be like, and they invited the architectural community to put in different designs in different categories, and one of them by a visionary, MIT graduate, Antonio DiMambro, looked at sea level rise, and on the basis of a three-foot rise over the next 100 years which was then reasonably out there in terms of what it could be, it's gotten worse now, but came up with an amazing little scheme to connect the islands offshore, off Boston Harbor, not the Vineyard in Nantucket but the ones right up Deer Island and so on, the right, you know, ten miles from Boston proper, there's a stream of islands, and the way connect them with bridges, tunnels and lochs so the boats could come in and out and keep the level in Boston Harbor what it is today.

And, amazingly, not only did the plan win in its category, one of the three categories that won first place, it actually didn't cost anything in the long term because the value of improved coastal waterfront real estate that was saved or created by this plan would pay, in round figures, for the idea. Now, whether that's accurate or not isn't the issue. The point is with really good thinking, we can come up in certain places with some great plans that actually have promise and future. Sadly,

that plan from 1988 still sits on the shelf. Nobody has said, "Let's forget a way to do this over the next century."

Greg Dalton: So who's doing a good job now in terms of getting on this? The Bay Area? You mentioned a place in Florida, not so much. So who's practicing or pursuing intelligent adaptation?

John Englander: I'd have to say, without any pandering to where I sit here in San Francisco that, from my awareness, that I think the bay areas had a better multi-institutional, multisectoral awareness and looking at possibilities, they brought in Dutch architects, they've -- the BCDC, the different governmental groups here have for, I don't know, 10 years, been looking at what does this mean. And thinking through the complex issues, you know, from not only San Francisco proper to down in the South Bay where you have the salt ponds to the Sacramento River, which is a highly complex situation, but I'm not aware of anywhere in the world, except for Holland perhaps which had a different situation, that -- certainly nowhere in the United States that has looked at it quite so comprehensively and multisectorally which you're to be commended.

Greg Dalton: Angela Fritz, so your company is about to move from waterfront to further inland, is that coincidence or is that because you've got a lot of scientists who know too much that was --

Angela Fritz: [Laughter] Unfortunately I can't blame science on this entirely. We're not moving because of sea level rise. It's a little bit to do with earthquakes. We're down in the South of Market area which is known for its fabulous liquefaction, and so we're going to be moving up to the financial district which, I don't know if you know, isn't necessarily all that much better. It might be a little bit better, but it's still not the best.

Greg Dalton: And -- sorry.

John Englander: No, but the point is, that what I've learned from being out here is that the -- at the south end of the bay, you know, the border between here and Silicon Valley, if you will, there's a perception that they're not on the bay because they have all those salt ponds. But as I've also learned, the potential earthquake liquification that could instantly eliminate the salt ponds would expose Silicon Valley, some of which is 10 feet below sea level to very rapid exposure to sea level rise and there's no perception of that, generally in that important part of California.

Greg Dalton: And so climate risk and seismic risk are often thought about as separate things, but if there's an earthquake at a -- during a high tide or a king tide, could that actually make more profound the impacts of that earthquake?

Angela Fritz: Sure sounds like it.

Greg Dalton: John?

John Englander: Yes, I would totally agree. I mean, again, you have a particular vulnerability here with earthquakes, the liquification, the fact that certain clays will just collapse under the right seismic impulse most people don't know about, but the fact that that will destroy all of the salt ponds at the south end, which are the barrier between low-lying land and the bay, is something nobody's thought of or very few but some planters here have thought of.

Greg Dalton: Sounds like either a good movie or a really scary scenario. Angela Fritz, tell us about some of the new science we can look forward to. This is a big year for climate science.

There's gonna be another IPCC report. What's new in the science that's gonna shed some light for us on this kind of drought weather, et cetera?

Angela Fritz: Yeah, I think that there were -- the difference between climate science back in 2007 when the last IPCC report was released and the science now is that, you know, climate science is not -- it's not difficult. It's pretty basic, you know. It's actually something that we figured out in the early 1900s, and we've known for a long time, and now what we're trying to get over is the hurdle of getting everyone else to accept that very basic science, that greenhouse gas can cause warming and that we are actually, you know, impacting our climate --

Greg Dalton: This is high school science and physics, right?

Angela Fritz: This is very high school science. It's very high school science. And it's something that has been widely accepted in the scientific community, although, you know, 97% of climate scientists agree that climate change is happening and that it's man-made and that we should do something about it, only 50% of this country knows that. So there's that -- there's this gap, there's this 47% gap, and I think that -- so that's a struggle, but -- that climate science has to overcome in itself.

John Englander: Angela knows too much. I mean, I think to say that climate science is fundamental and basic is over simplified like going to your cardiologist and saying, well, we understand, you know, heart issues and, you know, all these technical terms. It's true that greenhouse gas were identified in 1826 and, in 1896, that [0:37:37] -- you know, described what would happen as CO2 levels increased and warming would happen, and he was remarkably accurate. That's true in the annals of climate science, but the public doesn't understand that and there's still doubt for different reasons. Some of it's emotional. They don't want to leave. They may dislike Al Gore or whatever, whatever their reasons are that they just don't want to believe it, okay?

And the fact that CO2, a colorless gas, can trap heat with an amazing power is hard to believe. It defies common belief. Even that was proven in 1826 by Joseph Fourier, didn't even require modern technology. It's a simple fact of physics. And methane is 256 times more powerful as a greenhouse gas. The reason the earth is a degree and a half Fahrenheit warmer than a century ago is because CO2 has gone from 280 to 395, a 40% increase. Those numbers add up. In physics, atmosphere and chemistry, however you want to look at it, the results were there and it correlates with the amount of CO2 we put in the air. The dots do connect, if you want to look at the information. But people who don't want to believe do it for emotional reasons or ignorance. One guy came up to me and said, "So, Mr. Englander, I know sea level's been higher and methane's been higher a long time ago, this is just a cycle." I said, "I'm really glad you know that," you know. "So sea level has been higher before so let's make sure we're on the same database. When was the last time that sea level was much higher than today? I'll give you five choices," because he was in front of some people trying to be a smart guy. I said, "Was it 1,000 years, 10,000, 100,000, a million or 10 million years ago?" And his face got a little white. He said, "I have no idea." So just knowing that it happened before doesn't mean anything. The question is where does it fit in with natural science?

Greg Dalton: When was it?

John Englander: It was 120,000 years ago. Sorry.

Greg Dalton: Got it.

John Englander: 120,000 years ago, at the last warm spot, ice age was roughly 100,000 years apart, at the last comparable warm spot, sea level got 25 feet higher than today. We're gonna go way past that because the ocean is lot warmer than it got back then. There's a lag time from CO2 to temperature to melting the ice to rising the ocean.

It's that lag time that is what we can't comprehend because we think in terms of where we're gonna have lunch tomorrow or years a long time. It takes hundreds of years to melt the ice sheets. Some say thousands of years. That defies our human experience which goes back 10,000 or a few hundred thousand years at most. That's why we are in ignorance. Just in your timescales, Greg, you mentioned the -- or Angela mentioned the Anthropocene, this period of time that's now gonna be probably renamed because it's a human effect of climate. The Holocene, not to get technical here, was 11,000 years long. That's the stable period that we all remember one way or another. But earth climate has been, you know, the Jurassic, the dinosaur era, there was no ice on earth, sea level was 200 feet higher, there were alligators in Alaska. Earth has had vastly changing climate, but we got into the stability of the last 10,000 years, the Holocene. That stability still had the ice ages moving up and down nine degrees Fahrenheit, global average, but now we've departed so we need to rename it because when you look at the continuum of four and a half billion years, we've entered a new era.

Greg Dalton: If you're just joining us, our guest today at Climate One is John Englander, author of *High Tide on Main Street: Rising Sea Level and the Coming Coastal Crisis*. Other guest is Angela Fritz, an atmospheric scientist with Weather Underground. I'm Greg Dalton.

We're gonna invite your participation and put a microphone up here, and invite you to ask some questions and cheer us up. And one part of question will -- I'll be delighted to have your participation, and the line will start with our producer, Jane Ann, over there, and then we'll -- let's go to audience questions. Yes, sir. Welcome.

Dan Miller: Hi, Dan Miller. James Hansen on his website published an article recently that says that if Greenland is melting exponentially instead of linearly, we'll see three feet of sea level rise by this mid-century, about 35 or 40 years from now, and then much more after that, and he said that scientists are sort -- have a bias towards linear, but there's no reason to assume that.

What -- he didn't say it was -- there's not enough satellite data yet, would be a few more years before we can tell which one it is. What's your thoughts on that?

John Englander: What Hansen really said in that paper, and that was really an ominous paper in some ways because he's been pretty right for 30 years, is, he said, "It's not linear." In other words, you can't do what they want to do in North Carolina which says the future century would be just like the last century so we can straight line it. They tried to pass a lot of that effect in North Carolina. But he says, "It's a geometric progression, and if it doubles every decade, which it could, but we don't know yet, we won't know for a decade or two, we could get five meters which is 16 feet of sea level rise this century. A lot of people thought he said, "That would happen." He didn't. He just said it's a non-linear trend and he thinks there's geometric progression. The second part, to answer that question, is the confirmation that he has that makes a lot of sense is that the melting Arctic ice cap, around the North Pole, it doesn't add the sea level because it's floating sea ice, most people don't think of that, but it's like ice on a glass, it doesn't affect the level, but what it is is the visual proof of warming. It's been three million years. It's gonna be gone. And that's a feedback loop because you go from bright white ice which reflects heat, to dark, almost black seawater. You change the reflectance of a big part of the earth from 80% or 90% to 6%, and that warming is one of those feedback loops that, as it happens, it warms, and as it warms, you get more melting. And Jim thinks that -- Dr. Hansen thinks that that's really indicative of why the models are actually not forecasting adequately was gonna happen and why he thinks it could be as bad as 15 feet or 16 feet, but he does point out that it's a non-linear curve and even if we had 15 feet of sea level rise this century, which would be catastrophic, that it will be the worst of the last decade and almost as bad at the decade before that.

The correlate that people don't think about is they all talk about the end of the century as if that's the stopping point. It gets worse the next decade, the next decade and the next decade and so on.

Greg Dalton: Angela Fritz, anything to add?

Angela Fritz: No, that was -- you summed it up.

John Englander: Thanks.

Greg Dalton: Yeah, 80% of the rise could happen in the last two decades. Let's have our next audience question.

Female Audience: Okay. I'm trying to connect the dots from what you've been saying. The lack of ozone at both poles, the decreasing ozone layer at both poles, the methane increase will produce hotter times which will probably evaporate water from the ocean and increase the hurricanes that perhaps come in, making droughts more in America and stuff, so the hurricanes coming in will be sucked into the mid west through the gulf and produce more storms to increase the water over land, taking it from the ocean, and with the sun taking the water from the ocean, won't anything evaporate?

Greg Dalton: So put some of the pieces together how all these things are interacting. Angela Fritz?

Angela Fritz: Right. So specifically, you know, tropical storms and climate change is still -- it's one of the big remaining question marks, I think, in climate science, and there's been a lot of studies. The first -- one of the first big ones was in 2005 right before Katrina hit. It was another fortuitous event where they published the paper and then Katrina, and it was all at the same time and what are you gonna do, that said that, you know, statistically, it looks like the number of category, three, four and five hurricanes could be increasing, et cetera, et cetera.

There's been a lot of talk about data quality and the fact that it seems like hurricanes have been tracked for a very long time, but in reality, it hasn't been that long and what can we really say about this data.

Greg Dalton: Yeah.

Angela Fritz: And physically, it's one of those things where we still don't quite understand how climate change is going to impact tropical cyclones because it's a balance of effect. So on the one hand, we suspect that wind shear over the North Atlantic, which is something that inhibits tropical cyclone formation, is going to increase, so we would say, "Oh, good. We're not going to get as many tropical cyclones." That's bad for the drought, but it's good for coastal communities and the damage that it does. Then on the other hand, sea surface temperature is obviously rising and we're obviously evaporating more water into the atmosphere, so you would -- then you would say, "Oh, geez, that's gonna make the storms stronger after they do develop." And so there's this yin and yang and there's a balance, and we haven't quite figured out which side of the fence we're gonna land on with that. You know, that being said, once something forms, it's very difficult to say, you know, overall, where are they going to go? Are they going to go into the gulf of Mexico and relieve that summer drought more often, or are they gonna go out to sea more often, and that's something that we're still out to lunch on, you know. We don't quite know. And I think the only thing that's going to provide us with more insight is more data, and that just means more time. But we know that things are changing, and that there's a climate impact -- thumbprint on most weather events and that's kind of what I think we need to focus on.

John Englander: Two quick points to add to that. A friend in England, Sir Christian, a very famous scientist, says it's not global warming or climate change as much as climate destabilization, that climate change is naturally -- we've had a stable climate for 10,000 years. We can't predict all of the results.

The one thing I'd clarify, a lot of people confuse the ozone hole and the efforts of the Montreal Protocol to deal with the CFCs and stuff like that, which is an issue for ultraviolets mostly, is not a heat issue as much and it's separate. The concern about the atmosphere is the CO2 increase, methane, nitrous oxide and other gases, part of your air quality control issues out here in California, but globally, that trap heat, the CO2 -- the ozone was an ultraviolet issue, so they're separate. But what we have now -- you tried to describe a really interesting model of weather, and it's fascinating to listen to it. Weather is so complex, we can't -- as Angela says, we can't figure it out, okay? All we know is that we get so much heat, the earth spins, you have land and ocean masses that heat and cool differently, and we have currents, the Gulf Stream, the El Niños, La Niñas and the jet stream, if you think about it. That highly complex system nobody pretends to model out for hundreds of years as climate. Weather goes out two or three weeks at best and we're getting pretty good at that, but weather is short term. Climate is what happens over years and years and decades, okay? We're playing with it. We're trying to. All we know is this, the earth's a degree and a half warmer, you're gonna get more evaporation. More moisture in the air is gonna come down as either rain or snow, depending upon the temperature, and the temperature is gonna shift as the jet stream moves which is what happened and that's why we're getting more snow in place we didn't used to.

Greg Dalton: And so stronger winter storms are also validation of a climate change --

John Englander: Yes.

Greg Dalton: -- not refuting climate change.

John Englander: Absolutely.

Angela Fritz: Right.

Greg Dalton: Let's have our next audience question.

Male Audience: I'm wondering if attempts to protect coastline are sort of like nimby or fallout shelters, not in my coastline? You talked about a lot of uncertainties, the ocean's gonna rise.

Greg Dalton: Yes.

Male Audience: How does this impact policy? Does it really make sense to try to protect coastlines or should we try to revert the whole thing? Maybe it'd make more sense to have some geo-engineering solutions or -- I don't know if you can call it solutions, I'd like your thoughts on that.

Thanks.

John Englander: The problem is that, even if we stop all greenhouse gases today, if not another molecule or carbon dioxide or methane went to the atmosphere, sea level is gonna rise because there's extra heat already in the ocean. And the next equilibrium point will be tens of feet higher. It's just maybe a 1,000 years from now. We can slow it.

So I think away from that is that we need to adapt to this new reality that for the first time in our perception of human history that the shoreline will slowly but surely move inland and then be worsened by storms. So we need to adapt regardless.

The geo-engineering is an interesting question. It's not appropriate, I think, to decide that here in the next few minutes, but we are probably going to do some geo-engineering to try and reverse the impacts. We've been geo-engineering the planet for the last two centuries, and --

Greg Dalton: Unintentionally, yeah.

John Englander: Yes. And so we should look at that, but let's not separate that from having to adapt to this new reality because this won't be reversed quickly.

Greg Dalton: We're talking about severe weather and sea level rise at Climate One. Let's have our next audience question.

Male Audience: Yes. In the San Francisco Bay Area, a lot of the poorest people live in the flatlands areas of the community, and I don't know whether this is true in other parts of the country. I wonder if you would describe the -- or try to define or give us some indication of what the impacts, the differential impacts will be on those who are maybe more privileged and have other resources and those report.

Greg Dalton: John Englander.

John Englander: It's a good point and the lower socio-economic strata, not just United States but in the world, probably has less resources to change. And in some cases, they live near the water. But from Bangladesh, where tens of millions of people are exposed to inches of sea level rise being a problem to communities here, that's really true.

But there's also billionaires that have low-lying islands in the Pacific or the Bahamas and places like that. So it's not as -- it's not an exposure in terms of your wealth, but I think what the difference is that poor people don't have options and resources to move, okay? And that's a real issue. The people who -- the billionaire says, "Well, okay, I just have to move back to my home in Colorado from, you know, from the Florida Keys, that's okay." The person in Bangladesh or in the coastal Florida -- I talked to a community of elderly people in Florida who didn't have the resources to move from a low-lying community to people out here -- that's a bigger problem that we have to think of as a society from a humanitarian standpoint. But it's not -- I mean, it's not that poor people live, you know, lower ground necessarily. I mean, there's a lot of desirable, gorgeous property on the ocean. The problem all came because we thought that sea level was sea level and always would be sea level, meaning the shoreline always was and always will be. We didn't know different than that until 50 years ago, and that's the problem. And most people still don't know it.

Greg Dalton: The coast is not a constant. Who would have thought, right? Even though we studied geology, we know that, at some point, areas far inland were under water. We just somehow thought that was -- it couldn't happen again. Let's have our next question. Yes, sir. Welcome.

Jeff Potter: Yes, Jeff Potter. I haven't heard anything for a while since there were some mention some years ago about the slowing of the Gulf Stream to the point where it stops, which it has happened in the past, resulting from the melting of the tundra and so on in North America especially, and that additional freshwater and also from the melting of Greenland flowing into the North Atlantic dilutes the saltwater such that it's lighter, does not sink, and flows south and can you elaborate on that?

John Englander: Sure.

Jeff Potter: And which would really impact New England and bring northern Europe to its knees.

John Englander: Right. The Gulf Stream in the Atlantic, which comes up from the Gulf of Mexico up the coast of Florida and up around in toward Europe, is a warming current that redistributes heat, as Angela said, which is what their patterns tend to do. They really are heat redistribution mechanisms. That's what a hurricane does. And it's a really prominent on and really part of our stable weather to have that Gulf Stream. The silly movie, The Day After Tomorrow, showed the Gulf Stream stopping, and three days later New York City being, you know, under 20 feet of ice, as what could happen. To your question, there are signs that the Gulf Stream is slowing, but it's so -- it's hard to say it objectively. But there are signs. But even if -- and the primary driver would be that the melting in Greenland and the Arctic would lower the salinity, and stop the cold weather going down at the north and the warm water at the south in the Gulf of Mexico in effect rising and that's the current, okay? It's really the Atlantic meridional overturning current, they call it. But it's shown as the Gulf Stream.

Even if it's gonna slow down, I don't believe that's gonna be the dramatic effect. It could be really serious, but again, it's a time scale issue. I think that's centuries, okay? I think the sea level issue is gonna be a problem before that. But it's our geologic timescale perspective. People talk about the poles reversing as if it's gonna happen. The poles are reversed, that takes 1,000 years, even when they reverse from North to South Pole. We have a very poor geologic timescale sets, and I think that stopping the Atlantic current -- I can't prove it because we've never warmed this quickly, we've never melted this much ice this quickly, but my geologic senses, we're talking centuries, even at a worst case.

Greg Dalton: Angela Fritz?

Angela Fritz: Yeah. You know, actually, I did a little bit of research on the meridional overturning circulation, as John said. And, yes, I do think that it is centuries and I don't necessarily -- you know, sea level rise is kind of a right now thing and an extreme is an even more right now thing. And so that's kind of what I choose to focus on. And also, you know, if the Gulf Stream does slow down, it's not entirely clear to us, I think, what the impacts will be, but we know what the impacts are going to be right now and in the next couple of decades. You know, there's sea level rise and there's extreme weather, and there's heat and flood and drought. And so that's what I think that we need to focus on because that's our higher risk.

Greg Dalton: Let's have our next question in Climate One. Yes, sir. Welcome.

Peter Hopkinson: I find this absolutely riveting. My name is Peter Hopkinson. I'm an architect. I'm a fellow in the American Institute of Architects. In fact, I started architecture right across the street at One Bush with Skidmore, Owings & Merrill. I've gone around the world, wound up in New York, and my question is about New York, but I've not moved here permanently and I live in Sausalito fairly high up, how much we don't understand.

And my question is, and I hope you have, have you connected with the New York -- I'm also a past president of the Boston Society of Architects, I might add. But I wonder whether you're connected with the various New Yorkers who are working on post-Sandy thinking and the proposals that have been made, some of them, three or four years ago, in programs put together called "Rising Currents." And I urge, if you haven't connected with them, I'm highly recommending that you do because there's a group, a terrific -- actually several groups that are working on this very same thing for New York which, as you have mentioned, is quite different from San Francisco, nonetheless I would think they would be a terrific cross-fertilization.

And I'd be happy to help you connect to --

John Englander: Thank you.

Peter Hopkinson: -- any way I possibly can. And --

Greg Dalton: So what has New York learned? There's these plans out there, this big gate, you know --

John Englander: Yes.

Greg Dalton: -- that would just bounce the problem to Jersey. What --

John Englander: Well, it's rainstorm. There's still people without power, you know. I mean, so it depends on who in New York. There's companies that were shut down for 10 or 12 days during Sandy that are now paying attention to what could -- when could this happen again. People in New Jersey under Governor Christie are being a little more proactive on the sense of how should we rebuild differently to allow for other, you know, coastal problems and architecturally being proactive, I think. In New York, Governor Cuomo, in a similar but different way, has proposed a $400 million buyout fund to relocate people off the coast and I was interviewed by one radio station to ask what I thought of it, and I said, "Well, in principle, it's a good idea to move back from the coast or build up and find technologies to adapt to this new reality. But thinking that the government has enough money to buy people out of coastal exposure is, I think, the opposite way to go. We need to reduce the economic incentives to be on the coast, whether it's slowly phasing out coastal -- subsidized coastal flood insurance and telling people that, "No matter what happens, the government will come in here and rescue you." You may be able to do that after a storm, you can't do that at seal level rises decade by decade for centuries. There's not enough money in the world. So we have to, again, tease apart storm surges and episodic transient event from sea level rise, which is up "permanent event" being 1,000 years or more. And I think, you know, while it's nice to buy out people at their pre-Sandy values, what we're really doing is prolonging this idea that the government will protect you from obvious risk, and I think that building on the coast is an obvious risk, and it's now clearer and we looking at it differently, and we need to encourage that kind of intelligent economic behavior.

Greg Dalton: Creates a moral hazard, doesn't it? Let's have our next audience question. Yes, welcome.

Paloma Pavel: Thank you. I'm Dr. Paloma Pavel and I'm founder of Breakthrough Communities.

And I'm so grateful for this event today and want to raise a slightly different angle which is the health impact, and how we begin speaking and thinking together as communities about this, not only our individual biological health but the health of our communities. And here, in particular, in the Bay Area, we've been engaging with the one Bay Area, climate action planning process and trying to bring community groups together. We have one event this Saturday where we're showing a film and then having community dialogue groups. But we'd like to know how can we be more effective in working together to address the health effects and the concerns of ordinary citizens, not as a real estate issue but really as a health issue. Scary stuff. How do we begin working together.

Greg Dalton: Thank you. We haven't touched on health. We got about three minutes left and perhaps one other question. So let's touch briefly on health. It's not just property.

Angela Fritz: Well, I think that there are connections between bringing people together over health as they are bringing people together over consensus on climate change and things like this. And, you know, John was talking earlier about people have a hard time understanding the basic

science of climate change, and I think that there's another element to this and that it's scary and that it's traumatic, and a lot of people describe -- there's a lot of psychology, I think, around climate change and people are describing it as a trauma. And you go through the phases of denial and all of this stuff, too, and that you need to present it in a way where people can leave feeling like they can do something about it, otherwise they just shut down. So I think that it's about empowerment, and being able to communicate what you can do personally to help alleviate the problem and to help yourself and to help the people in your community, and that's how the best, you know, dialogue is going to be opened, I think.

Greg Dalton: And adaptation is something that people feel they have more control over, whether they protect the road or protect a part of their community, it's something they can get their arms around versus this abstract gas as a global problem and China's really in charge. It's hard to get around that. Let's have our last audience question. Yes, sir. Welcome.

Eric Kristofferson: Hi, Eric Kristofferson, and I'll be brief. I'm a father of two young children and I'm watching them in their elementary school. They're really becoming aware of some of the environmental issues. In conclusion, what are some things -- it looks like the politicians aren't gonna get there fast enough, in this country at least, that are gonna be grassroots movements that are gonna help to slow down this warming? And one idea that's been proposed is painting all the roofs white. And if you could just touch upon one or two that you think that the grassroots could start to do. Thank you.

John Englander: In California, the group, Citizens Climate Lobby, which has got chapters all over the place, I believe, but they're -- to my knowledge, there are simple premises to tell legislators that people care, and they advocate -- one of the policies advocated by Dr. James Hansen, which we need to find a way to price carbon and it's that simple. And while painting roofs white is an interesting idea and the low carbon stoves for India, there's some neat things that could reduce soot which -- the carbon which is an important issue. But I think the single policy change that would put the problem into the economic sphere, where millions of decisions are made a day by people, is to price carbon and I don't think it's necessary cap and trade which has, you know, been a favorite vehicle but has not worked as well, and Hansen again has articulated that there may be a simpler mechanism. I'm not gonna get into that policy question, but to me, that's where the economic decisions need to be. So over the decades, we find different reasons to get off of the fossil fuels and onto the renewable fuels. And I can't think of another single policy change that will get us in the right direction decade by decade by decade.

Greg Dalton: I'll just mention a couple of things. We've had some discussions here, whole discussions here. One reason -- our podcast, you can look up in iTunes called "Individual Matter," which was about this whole idea "does painting your roof white or buying electric car lead to more civic engagement and better policy," linking individual action and policy. That's Individual Matter, that podcast. Also a couple of great groups, Cool The Earth, in schools, we had the founder here recently at Climate One, and we also had the founder of the Alliance for Climate Education which talks with high schoolers around the country. So a lot of great resources out there. We've come to the end of our time. We'd like to thank John Englander, author of *High Tide on Main Street: Rising Sea Level and the Coming Coastal Crisis*, and Angela Fritz, atmospheric scientist at Weather Underground. I'm Greg Dalton. Thank you for coming to Climate One today.

[Applause]