

Dr. Jane Lubchenco

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Greg Dalton: This is Climate One is changing the conversation about America's energy economy and environment. I'm Greg Dalton and today we're talking about the weather; the hot, wet, dry and weird weather. 2014 was the hottest year on record. Winter didn't go away. It still got cold, but temperatures around the world, around the country, are on the rise. Severe weather is also increasing. Big droughts and big floods are lots of crazy storms. Oceans are rising and eating into coastlines and threatening waterfront property. Over the next hour we'll talk about climate disruption and how we can address it. Later in the hour we'll also hear from a startup company Planet Labs that is putting satellites in space and mapping the massive changes to the earth's surface in near real-time. First, the weather in the oceans. Jane Lubchenco was administrator of the National Oceanic and Atmospheric Administration in President Obama's first term. She's currently distinguished university professor at Oregon State University. She's at Climate One today to receive the Stephen Schneider award for outstanding climate science communication, a \$15,000 prize in memory of the late Stanford climate scientist Stephen Schneider. Dr. Schneider was the first member of the Climate One advisory council. Please welcome Jane Lubchenco to Climate One today.

[Applause]

Jane Lubchenco welcome. So 2009, President Obama asked you to go to Washington to run the weather, and then the weather goes crazy. There's lots of storms, there's Hurricane Sandy, there's all sorts of things. Why did you do that to the weather?

Jane Lubchenco: NOAA has multiple responsibilities; weather, climate, oceans and coasts, so it's a pretty broad portfolio. But the weather in the National Weather Service is certainly one window into NOAA's responsibilities.

And little did I know, little did any of us know how crazy the weather was gonna be. And looking back on those four years it was actually the most extreme four years, 2009 to 2013, in any four-year period in U.S. history. We had over 660 major tornadoes we had 60 Atlantic hurricanes including Sandy, Isaac and Irene. We had six major, just devastating floods. We had record-breaking snowfall, prolonged heat waves, wildfires, you name it pretty much every category of weather and we broke records. And I frankly think that much of that weird weather is what has contributed significantly to more Americans paying attention to the very important issue of climate change. Because it was no longer in their view something that was way far down the road in the future or someplace way off in the Arctic. They were actually experiencing something that they knew was weird. And it was a major challenge to stay on top of the very important weather forecasts and disaster warnings that NOAA issues, to be able to try to keep people out of harm's way, have the forecasts be as accurate as they could be far in advance as they could be, and that effort is actually a very complicated one. It was fun as a marine biologist to go to NOAA.

I knew a lot about the ocean parts of NOAA and a fair amount about the climate responsibilities that NOAA had, but learning about weather forecasting and learning about satellites that are so important to being able to forecast the weather was really fun just, you know, this is the little kid in me, the scientist in me that really likes to learn new things and that was a real treat.

Greg Dalton: With big, fancy expensive toys in the sky.

Jane Lubchenco: I had the opportunity to fly through hurricane Sandy. NOAA has hurricane hunter planes --

Greg Dalton: Right.

Jane Lubchenco: -- that they fly through the hurricane multiple times to gather precious data that you can't get from satellites or from other planes that are sampling the vicinity both to understand what's happening inside the storm to do a better forecast but also to do research and improve the quality of the weather -- the hurricane forecast, whether it's the track or the intensity. And I am a very hands-on person and there were NOAA scientists and university scientists who were routinely flying through hurricanes and I wanted to understand what they were doing up there and so I had the wonderful but somewhat dubious experience, I get seasick so I was really worried about going up there, but I didn't get sick at all. It was very, very turbulent but the rhythmic motions of the boats that make me seasick. This was not rhythmic. This was just totally turbulent. So, it was a fascinating experience and I came away with much, much greater appreciation for the ends to which many scientists go to push the boundaries of knowledge and deliver important information to people to keep them safe.

Greg Dalton: And what are the bounds of knowledge now with regard to the human cause, the human fingerprints on things like hurricane Sandy? What is our -- is climate change contributing, amplifying, causing or unrelated? (0:10:27)

Jane Lubchenco: With all this bizarre weather, people were really beginning to ask the questions what is the connection between these extreme events and climate change, and I think this really came to a head with Hurricane Sandy because it was such a huge and very powerful storm and it created so much incredible damage. New York, New Jersey was bore the brunt of it but the storm actually affected all the way to the Great Lakes, so the entire Eastern Seaboard and the Great Lakes had impacts from Sandy. And especially after Mayor Bloomberg and Governor Christie started talking about this is a harbinger of things to come, many people were saying can we attribute Sandy to climate change? And I think that there's a whole science of attribution that is very, very active. Many people are interested in being able to do that. The science that enables us to do that is getting better and better and better, but we're not there yet to be able to say with any certainty in real time whether an event is caused by climate change. Usually we can do so in a year or so after the fact, but heads up the science is getting better and better and I'm hopeful that we will get to the point where we'll be able to do that.

Many scientists often answer this attribution question by saying you know we can't attribute to any particular event but this is consistent with what we would expect and that's absolutely true. But I think it's actually more powerful to use an analogy to describe the relationship and to connect it to something that people understand. And the one that I find helpful is an analogy with baseball. And it simply alludes to the fact that if a baseball player starts taking steroids he has a much better chance of hitting lots more home runs and some really big ones. Now, that doesn't mean you can point to any particular home run and say aha, that home run is because he's taking steroids, but the pattern of a lot more and bigger is attributable to his taking steroids. And by analogy I think what we're seeing is weather on steroids, weather on climate steroids and so I think that is the best answer to your question. But stay tuned because the science is getting better and better, our models are getting better, and I think in the not too distant future we'll be able to answer the question more directly in real time.

Greg Dalton: I'm wondering what Barry Bonds thinks about climate change but that's for another

day. So are you saying that we'll get to the point where the Weather Channel will say - there'll be a little bug on the Weather Channel to say "This storm is juiced by climate change" in real time, as it's happening? Is that a --

Jane Lubchenco: That's what many people are working on and I think it might come to pass.

Greg Dalton: How about specific things, people here in California are wondering about the drought. There's been something of a debate recently. There's one group of scientist say, hey the drought is very much related. NOAA had another report saying no it's not. You can understand how the public gets confused when that happens and then it kind of it's a staller, they walk away or they go back to what they originally thought. So, your thoughts on -- and I know you're more of an oceans experts than a California drought expert but what can we say about the California drought and climate?

Jane Lubchenco: So I am not an expert on attribution, but I think what's most important to understanding is that there is natural variability in our weather systems. We have droughts; we've had droughts for many, many years. We've had periods of intense rainfall. What's happening with climate change is that it is contributing directly to -- it is contributing to the general pattern of variability that exists. And so there is no doubt in my mind that the increased amount of energy in the system which is what climate change is doing, the increased temperatures that we've seen are certainly exacerbating any naturally occurring droughts that might've happened and so there's definitely a climate signal in there. The relative importance of climate versus natural variability in that particular event is not something that I'm qualified to say.

Greg Dalton: You are familiar with the oceans, and tell us what's happening. How has climate change manifested in the oceans, both in terms of warming, acidification, et cetera? What are we seeing in oceans?

Jane Lubchenco: So the oceans are most definitely warming and that's true around the globe. They are getting warmer and warmer.

Warmer water also holds less oxygen so the oceans are lower in oxygen than they were before. They are becoming more acidic because the oceans have been absorbing much of the carbon dioxide that people have been putting up into the atmosphere. And when oceans absorb that carbon dioxide they become more acidic. That's very problematic for a lot of marine life that makes shells or skeletons of calcium carbonate. We've already seen oysters and other shellfish be seriously affected by this increased acidification. And obviously oceans are becoming -- that sea level is rising. So there are multiple different ways that climate change is affecting oceans and that in turn, of course, affects people.

Greg Dalton: Yeah the oysters for sure. People who love oysters, that's a really tough one. What are the solutions? Can the oysters go somewhere or do something, how can they be protected?

Jane Lubchenco: A lot of life in the oceans is on the move these days. Some species are moving toward the poles or deeper to stay in cooler water. That's not an option for all species and they're moving at different rates and so the fabric of the communities is being affected. The interactions, you know, predator prey, the timing of when they reproduce. There are lots of changes that are underway. The global pattern of increasing acidity in oceans is also exacerbated by local runoff of nutrients, either carbon or nitrogen, to the ocean and so local runoff can make the problem even worse.

And so one immediate short-term solution is to help stem the flow of these nutrients to coastal

waters. But in the end reducing our emissions of CO₂ is absolutely needed to be able to, in the long term, to address ocean acidification.

Greg Dalton: There's also some very positive stories were oceans have -- and fish populations and marine ecosystems have bounced back. So tell us some of the positive stories were humans have helped or correct some of their previous excesses.

Jane Lubchenco: The changes that I described are not the only changes that are happening in oceans. There has been very significant overfishing at a global scale and this has been going on for quite some time. That overfishing and habitat destruction have been really problematic and all of those factors are interacting. We've had some amazing turnaround in addressing some of those problems. The four years that I was at NOAA we saw very, very dramatic changes in U.S. fisheries thanks to really strong legislation that was passed in 2006 and thanks to a very talented team at NOAA and very dedicated fishermen who were really interested in also ending overfishing, and some very skilled nongovernmental organizations working together. We've really completely turned the corner in ending overfishing in U.S. waters and it's a major success and something that really gives many people hope that we can address other major problems as well.

The European Union has been a major fishing nation like the U.S. and around 75% of their fisheries are currently overfished, so it's really, really serious. They took a look at how we had turned things around using this tough legislation but also changing the type of fishery management to be more -- change the economic incentives for fishermen and they were very attracted to that and last year passed a complete overhaul of their fisheries law that will put them on a path to recovering depleted species and ending overfishing, so it's really, really good news. In the year 2000, let me just give you a couple of numbers, in the year 2000 of all the depleted fisheries that existed in federal waters in the U.S., none of them had been recovered, zero, in the year 2000. The year that I want to NOAA, 2009, we had four species that had been recovered, rebuilt, and currently there are 32 species that have been recovered and rebuilt. So, not only are we ending overfishing, but we're actually rebuilding stocks that had been depleted. So, it is possible to do something that many people thought was impossible and a number of developing countries are beginning to tackle this problem too. So globally, there still very significant serious overfishing but we know how to fix it and there has been the political will and the interest on the part of the industry as well as good scientists and NGOs to actually come together and fix it. It's remarkable.

Greg Dalton: And what should consumers as individuals think about when they go to the grocery store and maybe they eat fish, what should they look for to not be part of the problem?

Jane Lubchenco: Part of the problem.

Greg Dalton: Yeah.

Jane Lubchenco: Yup.

Greg Dalton: Not feel guilty.

Jane Lubchenco: So one of the reasons that there has been this turnaround has been more and more consumer interest in buying only sustainably caught or farmed seafood and we now have the Monterey Bay Aquarium seafood watch card which provides very useful information. There's an app and so you can go to a restaurant or the grocery store and look up on your app, see what's a good alternative or what's good buy and what to avoid. And the Marine Stewardship Council is the other major certifier of seafood. And that's been, I think really important in driving public awareness about what's happening in oceans and the importance of decisions that people make but even more

importantly that's driven the great big huge buyers like the Costco's, the Walmart's and other big chains to commit to buy only sustainably caught or farmed seafood. So, we're seeing both on the demand side and supply side some very strong positive changes that give me hope that we can solve this problem. It's going to be harder with climate change and ocean acidification, but again these things are interacting.

And then the other good thing that's happening is creation of many large no-take marine reserves and even some smaller ones. California has been a real leader in this and the Marine Life Protection Act, creating networks of marine protected areas and no-take areas along the coast. Those can help to recover depleted fisheries and protect biodiversity. And so all these things fit together because species that are in the ocean are affected by all these things.

Greg Dalton: One person said to me recently that those protected areas are like hospice for fish. It's just where they go to die because the ocean's in such a bad shape. Is that too cynical?

Jane Lubchenco: It's actually much more -- yes it is too cynical -- it's much more positive than that. They have also been called, more appropriately, regeneration zones or fish banks because in fact, because fish are not being removed they can grow and grow really big and then that bounty spills over the edges, so they're actually acting to replenish depleted areas around them. And there is good evidence that areas, especially very large areas, that are protected like this where no extractive activities are allowed, those areas are more resistant to invasions from invasive species, they are more resilient in the face of a bleaching event caused by climate change with warmer water. So creation of healthy habitats that are not subjected to fishing or mining or drilling are likely a key component of making oceans more resilient and buying us some hope that we might have healthy oceans down the road.

Greg Dalton: What populations or geographies are most vulnerable to the changes happening in the oceans because of climate change?

Jane Lubchenco: If we look at ocean acidification, the West Coast of the U.S., Washington, Oregon in particular but also parts of California, are becoming more acidic at a faster rate in part because of the ocean dynamics of what happens off our coast with the upwelling--

Greg Dalton: That's cold water comes up from the deep.

Jane Lubchenco: Cold water comes up from the deep. And so those areas are -- and that's where for example we saw the first indications of problems with shellfish, with oysters, was off Oregon and Washington. So, some areas are becoming more acidic at a faster rate. Others are warming at different rates and part of the real challenge right now is to understand if there are sort of safe harbor areas where things aren't as bad as they are elsewhere and how we can utilize that knowledge as well as reducing carbon emissions because that's really what's driving a lot of these problems but also creating no-take marine protected areas and ending overfishing. Those will all help and they're all needed.

Greg Dalton: So what can an average citizen do listening to this who cares about the oceans? What can people do that will have an impact?

Jane Lubchenco: You know being active in reducing your own footprint and making your own decisions is important. But really paying attention to the politics of it and having members of State legislatures, of Congress, and having businesses, communities really show leadership in addressing climate problems as well as taking care of oceans. You know, things happen because citizens want them to happen and make them happen and, you know, California has certainly been a leader in

much of that and it's making a difference.

Greg Dalton: We're joined now by Alex Bakir, director of business development appointment at Planet Labs here at Climate One with Jane Lubchenco, former administrator of National Oceanic and Atmospheric Administration. I'm Greg Dalton. So, Alex Bakir, tell us how you got into first interested in climate and how that brought you to Planet Labs and we'll talk about what Planet Labs does.

Alex Bakir: Thanks. Great to be here. I just want to say congratulations and it's an honor sharing

Jane Lubchenco: Thank you.

Alex Bakir: the same stage with you. So, how did I get interested in climate change? Well, I kind of think most things are a combination of the luck, timing and personal experience. The personal experience was kind of growing up as kid. A lot of my dad's relatives from Iraq came as refugees and that kind of taught me the like life for family units, for cities, for nations is often driven by stuff that's pretty much out of your control. You might have like a mild hand on the rudder but you're not really fully steering the ship. Kind of the luck here is in high school had a great teacher called Mr. Apu introduce geography to me in a way that made me understand for the first time that yeah one of the biggest impacts that's gonna effect kind of all levels, families to nations, is going to be climate change and it's impacts. And kind of studying climate models at university where I studied geography in England, it became very clear that the pressing issue that will affect my family, the U.K., the world over my lifetime and beyond will be climate change, which led me to want to pursue a career within that field. I'm not a scientist, don't claim to be and have huge respect for the work that goes into the science that really kind of shapes our policy and social responses to issues today. But I did want to build a career bringing innovative financial or technology solutions to the marketplace. And so I started at the World Bank doing renewable energy and energy efficiency financing, moved back to London where I was involved in the world's largest private sector carbon fund, creating carbon assets and trying to put a price signal onto the externality of a lot of industrial society, and then came to California where I've been involved in venture capital and grant making to innovative technologies, and more recently for the last year been at Planet Labs. The premise of which very much captured my attention.

Greg Dalton: And so Planet Labs is mapping the surface of the world in near real-time and helps us understand deforestation and other things and I want to talk with Jane Lubchenco about how, yeah of how that connects with the government and other things.

Alex Bakir: Yeah that's right. So, we are building the world's largest constellation of satellites. We're not building a typical constellation which involves very large very, very costly hundreds of millions of dollars per single satellite system. We are deploying what we call microsatellites. And this probably won't work on radio, but just the benefit of the people in the room today there's a very diligent photographer right in front of me called Ed that has a very nice, I think, digital SLR camera with a 29 megapixel CCD. Ed if you wouldn't mind just showing the audience the kind of piece of equipment you are using?

[Laughter]

So kind of that is pretty much the size of one of our satellites.

Greg Dalton: It's a camera that an eager dad might use at a kid's soccer game or something like this.

Alex Bakir: Yeah, that's right. Obviously the kind of technology we use is more advanced than that. We have tested it in space, but it's kind of a similar premise. What if you could launch many satellites that size? What could you do, right? What if you could put a camera inside every one of them and operate hundreds of these things, what does that mean? What does that mean for the planet? Can you go to commercial business around that can that have societal impact at the same time? So that's basically what we're doing. Our goal over the next 12 months is to take a composite image of the entire planet once every 24 hours.

Greg Dalton: Jane Lubchenco, NOAA's in the satellite business, is this a threat or a complement to what the government's doing or filling a hole?

Jane Lubchenco: No, it's very exciting. It's nicely complementary. NOAA and NASA both operate a number satellites in space that are critically important to providing information that allows us to forecast the weather but also understand climate change, rescue people, measure changes in oceans. There are -- the satellites that we have our typically very large; very, very expensive; billions of dollars expensive; and they typically have multiple instruments on them that are either imaging the earth either the land or the water or both or the atmosphere, critically important, but also space to measure solar flares for example or to see if there are -- to measure solar wind for example. But those measurements are not just the visible wavelengths that Planet Labs is really working -- taking pictures that you can see and get incredible information from but measuring things you can't see in the atmosphere, measuring ozone, measuring the chemistry in the atmosphere, measuring rain, measuring ocean color, measuring sea surface heights, how high is the ocean, you know, where is it higher than other places.

So we can have very fine, very very precise measurements of sea level rise. How deep is the ocean. You can do bathymetry. You can measure the bottom of the ocean from space. So there are tons of things that these satellites do that are critically important that are not just visible wavelength information but other wavelengths, radiation, calculating the earth's radiation budget, the solar radiation. Those are all things that you can do from space. And I think one thing that people may not be totally aware of is, you know, if you are hiking or sailing and you have a disaster and you activate an emergency transponder beacon that signal goes up to one of our satellites and that is radioed back to earth and there are people that sit in the NOAA office that are tracking these help signals and directing, you know, calling up, finding out who is the closest emergency responder to go out and rescue somebody. So, you know, that's yet another service that some of these great big huge satellites are performing. And you've all seen, I'm sure, some great tracks of critters that have radio, I mean that have the special satellite tags on them whether it's great white sharks or turtles or whatever, that information is also relayed to satellites.

So the whole constellation of satellites that NOAA has either those that orbit around the earth and the earth is spinning underneath them or ones that sit up at a constant place over the earth and move with the earth, all of those satellites give us an incredible amount of information but they're very, very expensive.

I have to tell you the one story that I think that really brings it home. So many people I think are unaware of how important satellites are to our ability to forecast weather. And I can tell you that 90% of the data that go into our weather models come from satellites, so they're really, really important. When I was at NOAA we had a problem with one of our satellite systems. We had to fix that problem and then I had to go up to Capitol Hill and describe to them what we had done and why it was so important for Congress to fund this program. And this one member of Congress looked at me and he said doctor I don't need your weather satellites, I have the Weather Channel.

[Laughter]

And I thought, oops I better explain to him where the weather channels get its information as well as all of the other weather providers.

Greg Dalton: And some of the funding has been challenged. The CIA had a climate analysis group that was defunded. Some of the funding for climate work at NOAA has been challenged. So, how has the needs of the country for understanding the climate that's coming our way been compromised by some of the powers and shift in budget challenges and could something like Planet Labs fill that niche? First Jane and then Alex.

Jane Lubchenco: As I said, I think what Planet Labs is doing is really important and it's sort of a new model.

It is lots of satellites working together in a network to provide good pieces of very valuable information. And I think that's a really nice complement to and pretty much the antithesis of the great big huge, huge, huge and very costly satellites that the government operates. And people are really questioning how sustainable the big very expensive model is. And I think it's a robust discussion and I think we need to be exploring other models like what Planet Labs is doing because we really -- that information is so valuable, we really needed it.

Greg Dalton: Sounds like mainframe computers and iPhones sort of thing. Alex Bakir, how do you make money?

Alex Bakir: It's a great question.

[Laughter]

So we are a venture backed company. We do have customers and those customers are essentially buying pictures from us, buying individual pictures and composite pictures. Those buyers are --

Greg Dalton: Spy agencies? Government agencies, who are they?

Alex Bakir: So there is a lot of interest from governments, U.S. and around the world. We made a really conscious choice not to pursue the U.S. government as our first customer. Many other commercial satellite companies often go down that route just 'cause it's been so expensive and it kind of make sense to secure like a very big upfront contract. We chose not to do that because, we didn't need to number one, and number two we didn't want to get the lock in that comes from building to kind of government specification. That can very much drive your product development and frankly your marketing and commercial activities, so we will work with the government, were excited to, both the U.S. and beyond, but that has not been our focus over the first few years of the company.

Greg Dalton: So how -- says there's -- were expecting more volatile weather in the future, how could your information help people, help responders, bring more information when there's another Hurricane Sandy, another Hurricane Katrina, more super storms?

Alex Bakir: Yeah, and that's a really interesting and meaningful problem. Obviously, we will be taking pictures pretty quickly over areas that have been affected. We have actually struck up a number of partnerships in an initiative we call kind of Planet.org, or Planet Impact, where we hope to work with kind of academic institutions and nonprofits to really make sure this data gets into the hands of people that can use it for the betterment of science society. So, in this particular case we have a partnership with a group called Zooniverse at the University of Oxford. Now, they are super interesting. They have a community of about 2 million, essentially kind of academic citizen scientists that they kind of shoot out pictures to and those pictures can be of anything. They started by taking

pictures of the night sky, slicing them up in much smaller chunks and putting in front of people and asking them to tell them what was in the picture. It turns out humans are still like really good at identifying what's in pictures and computers and machine vision, not quite there. So they basically crowdsource imagery and they ask people to tell them what's there. So we're gonna use that same set of infrastructure to do classification post disaster. So hurricane happens, streets get flooded, buildings fall down, ships topple over. You kind of want your first responders to know the lay of the land. All right, what are they walking into? How serious and how widespread is the issue they're facing? You can see a lot of that. So we're gonna use that system and then pipe the data through a group called the crisis mappers who work with United Nations to make sure the information's in the right hands. So that's an example of a project that we are excited to undertake with the data we will be producing.

Greg Dalton: And Jane Lubchenco, there's other examples of crowdsourcing, getting information, getting more robust data that only humans can do. So talk about how that's helped NOAA flush out some of the historic data using citizen scientists and crowdsourcing.

Jane Lubchenco: I think this is one of the most exciting things that's happened in the last few years is just the engagement of broad numbers of people in the doing of science and at NOAA we also partnered with Zooniverse, the same group that we're just talking about. In this case the question is what can we say about the weather patterns in the North Atlantic where there aren't land-based stations to give us weather information in the period of time between the resolution you can get with ice core information and when satellites started giving us information about. So there's sort of this blank period of time where we didn't have any information. Well all of the naval ships that were going in those areas would take very routine, very precise measurements of weather observations. Those are all buried in logbooks. So the National Archives has all these naval logbooks and somebody had the bright idea of scanning all those, making them available on the web to people that Zooniverse would contact and say, hey would you like to adopt a ship and start reading through the logbook of this ship, and oh by the way you know when you come across the weather record for that day or the multiple records for a day, put it into this spreadsheet. And they've got this all figured out. They know how to get people interested, they know how to have multiple people do the same pages and to figure out who's giving accurate information and who isn't. So they've got that all figured out. But this old weather record project that NOAA had jointly with the National Archives and with the Zooniverse was just spectacularly successful. And we had a party to sort of announce many of the results and pointing out that now scientists can take these data and do something meaningful with them to characterize what the weather was like then. But there were a number of characters who had participated in this who showed up and talked about what they learned and why they were doing it, and most of them didn't really care about the weather they were essentially living vicariously through these logbooks whatever was happening onboard the ship and so they would talk about what people ate and all the palace intrigues that were going on the vessels or who fell overboard or whatever was going on, and it was a really interesting phenomena but delivering really useful valuable information for science. So, I think this crowdsourcing is a very powerful tool and more and more scientists are using it to help analyze very, very large amounts of information where you really need people to do something specific like identify something.

Greg Dalton: You're listening to Climate One at the Commonwealth Club. I'm Greg Dalton. Our guests today are Jane Lubchenco, former administrator of NOAA and Alex Bakir, head of business development at Planet Labs. I'm Greg Dalton. Alex Bakir, one of the things you're seeing is urbanization and deforestation. So, tell us how you're bringing new transparency to show in very quick time what's happening to the surface of the planet that's related to climate change.

Alex Bakir: So if you look at kind of the visible surface of the planet, I think everyone knows that

land use and land use change has been a massive driver of kind of carbon emissions last time I checked which was about 10 years ago, so I apologize if this data is wrong, it's about 20 to 30% as I understood it.

Generally, kind of forest land being converted to agriculture. What amazes me is as we build our system we look up more and more of the planet and more frequent timescales, right? So you're looking at China and you compare one picture this week from one last week and like, bridges are built, towns expand, like lakes physically dry up like in front of your eyes. Yeah, the forest of Amazonia kind of decreases and you get to see this, right? And I think that's incredibly useful as data steps to create for kind of science. There's also commercial value in there. But there's one aspect we don't talk about that frequently at Planet which I think is really important. Pictures of what's happening kind of connect with people. And a lot of what I heard this evening and in previous talks about climate change and the response to it is, people don't connect to it enough. And what I personally feel when I see a lot of our images and I see changes in agriculture, forestry, farming, urbanization, roads, rivers, is a real connection to what's happening. So I'm kind of excited and interested to see how that might actually have an impact on kind of the human psyche, showing changes within timescales and at resolutions that kind of show human's impact on the planet.

Greg Dalton: Jane Lubchenco, do you have any photos of you in that storm chaser plane? That's a photo I'd like to see.

Jane Lubchenco: I do have some.

Greg Dalton: Oh okay.

Jane Lubchenco: They're kind of shaky.

Greg Dalton: Sure you can post them on Twitter or Facebook later. I want to ask you before you go to audience questions about the U.S. Navy and how that is being impacted by climate change. They're not directly related to NOAA but you've clearly worked with them in your time in the Obama administration and doing a lot on clean fuels but there are also Navy bases are at risk from sea level rise and how's the role the Navy maybe connect with NOAA and change.

Jane Lubchenco: So, the Department of Defense more broadly takes climate change very seriously. They really see it as a national security threat. And there have been -- especially in the last few years this has really been a serious topic of discussion. The Navy is really on the front lines of that and they have had some really superb leaders who really understand how much sea level rise is a threat to all those naval bases. They also have had experience dealing with refugees and increased conflicts, and they see connections across these, so --

Greg Dalton: The Marines are to first ones to go in, so the Marines are on the frontlines.

Jane Lubchenco: They are indeed. And especially with ice melting in the Arctic, the Navy has had special attention not only to climate change more broadly because of sea level rise but because of the changes in the Arctic and what that portends for their operations, their responsibilities.

Greg Dalton: I asked the secretary of the Navy about that, he said we need some more ships to patrol the Arctic. So let's go to our audience questions. Welcome to Climate One.

Female Participant: Thank you. Holly Kaufman, congratulations again. I wanted to follow up on Greg's question about the funding of the satellites. My understanding was several years ago the U.S. government was not going to continue to fund the satellites we needed for the climate measurements and observation, so Jane could you update us on that? And I'm curious to know if

there's an issue of space trash with satellites and if we're able to reuse or recycle them in any way?
Thank you.

Jane Lubchenco: The challenge of funding these great big huge satellites is very, very real because they are so expensive. They take many, many years to build, its billions of dollars of NOAA's five billion dollar budget more or less. About two billion of that is satellites so it really is a huge chunk. And NASA is much, much larger and then the Department of Defense have their satellites, so there's lots and lots of money that goes into satellites. We had a program of building the next generation of polar orbiting satellites that had some serious problems that I inherited when I came to NOAA. We had to fix those problems and fixing them took a while and because the program had had such a difficult time in its earlier history many, many members of Congress were very concerned about whether they should invest the money for these satellites are not and they wanted to be reassured that in fact that the problems have been fixed and the satellite program was going to be successful. Part of the fixing of that satellite program entailed essentially the different agencies involved getting divorced. And what was left unfunded were some of the climate instruments, which is really, really important because not only do we need the information but we need information that is a continuous record of information. It's when it's broken then all that earlier information is just not as valuable.

So there's a real challenge to continually funding these instruments. And this presented an opportunity for members of Congress who were on an anti-climate, you know a climate denier bandwagon to not want to fund those instruments. So it has been a target of climate deniers and it's a very, very serious problem.

But it was caught up in these larger issues of expensive satellites and who's going to fund what.

Greg Dalton: Alex Bakir your satellites are made in San Francisco, are they recyclable?

Alex Bakir: Well it depends. I mean, I haven't seen an engineer turn one into a beer can yet but I maybe one of the spares over the next six months will end up that way. Are they recyclable? No, they're not necessarily recyclable but we also don't contribute to any kind of issue about trash in space. I understand what that might appear to be a problem, right? If there are hundred things up there kind of what happens? Are you destroying a global commons? Can other people then access space but we hear bigger more expensive satellites. All very good, very important questions. We kind of view space as a commons to be used by humanity. We would never want to inhibit others from doing that. So the height we choose to fly at, the altitude above the earth, is between kind of 400 and 550 kilometers. Not many people want to put other satellites there just because it's a little bit too close for the very big expensive satellites. What that means is we kind of de-orbit and burn up in the atmosphere on a pretty routine basis. It's an operational plan we have.

Greg Dalton: So they compost. They don't recycle. I got it, okay.

[Laughter]

Alex Bakir: I think that's right. Compared to kind of let's say carbon emissions from cars or power plants, I'm not sure that our camera size is going to have a significant impact on the atmosphere. But they do burn up and are distributed.

Greg Dalton: We'll call it composting. Next question. Welcome to Climate One.

Male Participant: Carter Brooks, artist and philosopher of climate art. Congratulations on Stephen Schneider Award and my question is about the occasion. Stephen had some great ways of

putting things and I wondered if there any of his particular ways or metaphors that he used to use that you find yourself using or you find yourself thinking about as you confront the issues of communication these days.

Greg Dalton: Answer that and then I also want you -- I neglected earlier, I wanted to get in before we end here your reflection on Stephen Schneider, Jane Lubchenco.

Jane Lubchenco: So thanks for that question and the opportunity. Steve -- I miss Steve and just seeing those images of him on the film really brought back how much I miss him and sure that's true of many of you. Steve was such a stalwart champion of science and of rigorous thinking, clear thinking, rigor, and he didn't suffer fools lightly. He really was -- he loved a good fight and he saw this as a worthy fight and he poured his heart and his soul into it. That was such a powerful model for many, many people in a firm. You know, for a long time he was really a lone voice in the wilderness and I think he would be astounded at how many new voices there are and how much they have been influenced by him.

I think this award is a really wonderful way to draw attention to his legacy. But all the people that are working, all the scientist that participated in the national climate assessment in the latest intergovernmental panel on climate change, all of those things, all of those people have been influenced by Steve in a very, very direct and powerful way.

One thing that Steve was very passionate about was passing his knowledge on helping to train new young scientists in communication, in sharp thinking. My son was a student of Steve's, took classes from Steve at Stanford and so I know how much Steve was pushing interdisciplinary thinking and really getting scientists out of their comfort zone and thinking more broadly about societal impacts. But one thing that Steve really loved doing was helping other scientists become better communicators. I co-founded the Leopold Leadership Program which trains midcareer academic environmental scientists to be better communicators of science, to tell stories, and to use metaphors and analogies to be human. And Steve every year would do really important training for the Leopold Leadership fellows and one thing that I remember he would always tell every group of fellows, people came to college the three thys. He would say know thyself, you know, know what you are good at and what you're not good at. Know thy audience, because communication is two way and you can't just be telling stuff, you need to understand where they are, you need to have a dialogue, you need to engage.

And the third thy was: know thy stuff. Don't start spouting off about things you don't know about, stick to what you know. If you don't know about it learn about it. But he would always say know thyself, know thy audience and know thy stuff. So whenever I think of Steve I always think of the three thys.

Greg Dalton: Next question. Welcome to Climate One.

Female Participant: I have a question and I was wondering about the potential for transitioning say fishermen into recruitment for characterizing maybe the waters, the terrestrial impacts on water quality, habitat assessments, that sort of thing. And I have to make a comment that I'm very disappointed that we don't have more public discourse about ocean impacts. There's a lot about climate and a lot against it but I think these oceanic impacts, all the stresses and pressures on it are so complex and I wonder what you have to say about the absence of that from public discourse. Thank you.

Jane Lubchenco: So thank you for shining a spotlight on oceans. They are incredibly important to people, to our lives, and that's not just people here but people around the world. We do need more

attention to that. Fishermen are out on the water. They're very observant. There are many opportunities that they have to be sharing information that they're learning and that works better some places in the world than others. So there are a number of programs that I know of where either government agencies or NGOs, nongovernmental organizations, are partnering with fishermen to actually report information so that we can have a better understanding of what's happening on the water and take advantage of their deep knowledge.

Greg Dalton: Welcome. Next question in Climate One.

Male Participant: I think it's kind of interesting, I'd like your insight into -- in a few months or you have a Republican control of both houses of Congress. This hasn't happened since 1994. One of the first things they did then in what was called the Newt Gingrich Congress was to shut down one of the technology parts of government, the Office of Technology Assessment, which was bipartisan, gave Congressmen more insight into technical issues. So that was the first thing they did. I'm curious what your speculation might be on what is about to happen to us in a few months in that area, like EPA, NOAA, NASA?

Greg Dalton: The Stephen Schneider Award is a crystal ball, it is being referred to as a crystal ball. So, Jane Lubchenco what do you see politically, quickly, in your crystal ball for Washington?

Jane Lubchenco: I think we have some clear indications that there is a lot of appetite among the to be majority party to roll back some of what the president has championed on the climate front, both with primarily EPA regulations but also to address a number of other issues about which they are not happy, immigration, there are number of other things. So, I think those have been foreshadowed. If there are surprises down the road, I'm not sure what those might be.

Greg Dalton: Some people talk about a Republican prison break out of people en masse coming out in favor of action on climate. We'll see if that happens. Next audience question. Welcome.

Female Participant: Hi Jane, congratulations on your award. I'm Carina Nelson and I am director of the Romberg Tiburon Center, San Francisco State's research laboratory on the Bay. And I've been really interested in the role what you think the role of policy for mitigating against things like sea level rise versus the prospect of raising people's attention to actually do something about climate change and carbon emissions to the extent that we mitigate and prevent exposure to major events and their really great catalytic ability to galvanize attention. I'm just wondering to the extent that we continue to mitigate, are we losing the opportunity to advance quickly on solving carbon emission problems?

Jane Lubchenco: So I'm not sure I understood that Carina.

Female Participant: There a major push right now in policy to try and create the ability to mitigate against sea level rise and sort of the impacts of climate change.

Greg Dalton: To adapt.

Jane Lubchenco: So you mean to adapt?

Female Participant: Yeah.

Jane Lubchenco: Got it.

Female Participant: So you sort of prevent, you know, the worst impacts of it. So to the extent that we continue to do that we are reducing people's exposure to catastrophic anecdotal events that

seem to galvanize their attention.

Jane Lubchenco: Yup. Thank you. There is essentially no doubt my mind that we need to be flat on on both fronts simultaneously. We need to be pushing ahead to reduce emissions as fast as possible and to be as smart as possible in use of energy. At the same time we do need to prepare for changes that have already been set in motion that are going to play out and we need to be doing both and I'm not sure that -- it's not one versus the other, we need both.

Greg Dalton: Were gonna wrap it up by asking Alex Bakir and Jane Lubchenco what you are doing personally in your own lives, quickly, to reduce your own carbon footprint. Alex Bakir.

Alex Bakir: I am trying to eat less red meat -- mainly because I'm in my mid-30s now and starting to get a bit of a belly - but it also wonderful carbon reduction potential by shifting my dietary preferences.

Greg Dalton: We have a program on that podcast coming up about whether beef are part of the solution or part of the problem. Anything else? No hamburger? Oh well, you're British, you don't hamburgers but, you know, so anything else other than the red meat?

Alex Bakir: Let me think about that. I try and help out where I can, ride my bike where possible and help out at various academic institutions where I've been. I try and encourage more young people to frankly build careers that kind of combine those two goals. You can, these days, build careers in academia commercial sector and other where you don't have to make a direct choice about what am I doing today and how is impacting the problem I care about.

Greg Dalton: Yeah, sustainability as a growth industry. Jane Lubchenco, last word on your own carbon foot print.

Jane Lubchenco: So pretty much ditto to what Alex had said but also, you know, just conserving as much energy as possible and -

Greg Dalton: Flying's usually the big one people talk about.

Jane Lubchenco: Oh, I was gonna say buying offsets.

Greg Dalton: Buying offsets for flying, yeah.

Jane Lubchenco: When I do have to fly.

Greg Dalton: I flew on a Florida Virgin America flight one time to a Climate conference and in Virgin America you can order things from your seat. So I ordered a drink and a sandwich and carbon offset \$10, that felt good, right? And so the flight attendant comes and she says here's your drink, here's your sandwich but I'm sorry I just can't find this offset thing. I was like no --

[Laughter]

-- that's something that I pay to make myself feel better for being here with you and she's like oh, you're the first person that's ever ordered that.

[Laughter]

Jane Lubchenco: No kidding.

Greg Dalton: So, with that we have to end it. Our thanks to Jane Lubchenco, former administrator of NOAA and winner of the 2014 Stephen Schneider Award here at Climate One, and Alex Bakir, director of business development at Planet Labs. I'm Greg Dalton. You can follow us on Twitter at Climate One and listen to podcasts in the iTunes Store Climate One. Thank you to audience here at the Commonwealth Club and on the radio. Thanks for coming and listening.

[Applause]

[End]